

# TABLE OF CONTENTS

## VOLUME 1

<b>EXECUTIVE SUMMARY</b> .....	<b>1</b>
Background and Purpose .....	1
Overview of Previous Work .....	1
Other Relevant Fixed Links & Tunnels Worldwide .....	1
The Environment and Geology of the Study Area .....	1
Assessment of Alternative Fixed Link Concepts .....	2
<i>Bridge</i> .....	2
<i>Causeway</i> .....	2
<i>Tunnels</i> .....	2
<i>Comparison Summary of Alternatives</i> .....	3
Implementation Schedule .....	4
Regulatory and Environmental Issues .....	4
Economic and Business Case Analysis .....	4
Financing Considerations .....	7
Conclusions .....	7
<b>1 INTRODUCTION</b> .....	<b>8</b>
1.1 Background and Purpose.....	8
1.2 Overview of Previous Work.....	9
1.3 Study Approach.....	10
<b>2 REVIEW OF RELEVANT FIXED LINKS WORLDWIDE</b> .....	<b>12</b>
2.1 Øresund Link.....	12
2.2 Storebælt Crossing.....	13
2.3 Channel Tunnel.....	13
2.4 Lantau Link.....	14
2.5 Chesapeake Bay Bridge-Tunnel.....	15
2.6 Confederation Bridge.....	16
2.7 Summary of Fixed Links.....	16
2.8 Other Relevant Tunnels.....	17
<b>3 THE PHYSICAL ENVIRONMENT OF THE STUDY AREA AND DESIGN CRITERIA/CONSIDERATIONS</b> .....	<b>18</b>
3.1 Climate.....	18
<i>Air Temperature</i> .....	18
<i>Precipitation</i> .....	18
<i>Winds</i> .....	18
<i>Degree Days</i> .....	18
<i>Icing</i> .....	18
3.2 Oceanography.....	19
<i>Bathymetry</i> .....	19
<i>Currents</i> .....	20
<i>Waves</i> .....	20
3.3 Sea Ice.....	20

3.4	Icebergs .....	21
3.5	Geology .....	23
	<i>Bedrock Geology</i> .....	23
	<i>Surficial Geology</i> .....	27
	<i>Geological Faulting and Water Ingress Considerations</i> .....	28
3.6	Design Criteria and Considerations .....	29
	<i>Environmental Design Criteria</i> .....	29
3.7	Capacity and Dimensional Requirements for the Fixed Link ...	30
	<i>Traffic volumes and mode of transit</i> .....	30
	<i>Road Tunnel</i> .....	32
	<i>Rail Tunnel</i> .....	35
	<i>HVDC Cabling Requirements</i> .....	36
<b>4</b>	<b>ASSESSMENT OF ALTERNATIVE FIXED LINK CONCEPTS .....</b>	<b>39</b>
4.1	Bridge .....	39
4.2	Causeway .....	41
4.3	Tunnels .....	44
	4.3.1 <i>Bored Tunnel</i> .....	44
	4.3.2 <i>Drill and Blast</i> .....	56
	4.3.3 <i>Immersed Tube Tunnel (ITT)</i> .....	62
4.4	Comparison of Alternatives .....	71
	<i>Risk Assessment</i> .....	71
	<i>Comparison Summary</i> .....	73
<b>5</b>	<b>DEVELOPMENT OF THE PREFERRED ALTERNATIVE .....</b>	<b>75</b>
5.1	Schedule .....	75
5.2	Cost Comparison .....	76
<b>6</b>	<b>REGULATORY AND ENVIRONMENTAL ISSUES .....</b>	<b>77</b>
6.1	List of Applicable Legislation, Standards, and Permits .....	78
<b>7</b>	<b>ECONOMIC AND BUSINESS CASE ANALYSIS .....</b>	<b>81</b>
7.1	Transportation Demand .....	81
	7.1.1 <i>Markets Served</i> .....	81
	7.1.2 <i>Primary Target Markets</i> .....	83
	7.1.3 <i>Traffic Projections - Fixed Link</i> .....	91
	7.1.4 <i>Traffic Projections - Upgraded Ferry</i> .....	100
7.2	Tolls and Revenue Forecasts .....	104
7.3	Economic Evaluation .....	106
	7.3.1 <i>Internal Revenues and Costs</i> .....	106
	7.3.2 <i>Present Value Analysis for Base Case</i> .....	108
	7.3.3 <i>Present Value Analysis for the Upgraded Ferry</i> .....	110
	7.3.4 <i>Results of Economic Analyses</i> .....	112
<b>8</b>	<b>FINANCING CONSIDERATIONS &amp; FINANCIAL ANALYSIS .....</b>	<b>119</b>
8.1	Financing Considerations .....	119
	<i>Public Infrastructure Financing Alternatives</i> .....	119
	<i>Private Finance and Risk Transference</i> .....	122
	<i>Capital Markets - Expectations</i> .....	123
8.2	Financial Analysis .....	124
	<i>Selection of Key Target Parameters</i> .....	124

*Financial Analysis Results*.....124

**9 CONCLUSIONS**..... **127**

9.1 Study Findings..... 127

9.2 Future Required Activities..... 128

**VOLUME 2**

**APPENDICES**

APPENDIX A	Study Phase 1 – List of References
APPENDIX B	C-CORE Iceberg Scour Risk Report
APPENDIX C	Detailed Report on ITT Option
APPENDIX D	Detailed Breakdown of Cost Estimates
APPENDIX E	Breakdown of Highway Tunnel Operating / Maintenance Costs
APPENDIX F	Breakdown of Railway Tunnel Operating / Maintenance Costs
APPENDIX G	Economic Analysis Workbooks

This report has been prepared by Hatch Mott MacDonald (HMM), who have worked independently under contract to the Leslie Harris Centre of Regional Policy and Development, “the Harris Centre”, formerly the “Public Policy Research Centre”. The material within this report is intended for use by the Harris Centre, the Government of Newfoundland and Labrador and the Government of Canada. The distribution of the report will be as determined by the Government of Newfoundland and Labrador and the Government of Canada. It reflects the information available and the judgement of HMM and its subconsultants. Acceptance of this report by the Harris Centre or by the Province or the Federal Government is for contractual purposes only, and should not be construed as acceptance of the opinions and conclusions contained therein. Any use, which a third part makes of this report, or any reliance on decisions to be based on it, is the responsibility of such party.