

# CONTENTS

<b>1</b>	<b>Introduction .....</b>	<b>1-1</b>
1.1	Project Title.....	1-3
1.2	Project Proponent.....	1-3
1.3	DEIA Consultant.....	1-3
1.3.1	DEIA Team Members .....	1-4
1.4	DEIA Report .....	1-5
1.4.1	Legal Requirements .....	1-5
1.4.2	Terms of Reference (TOR).....	1-6
1.4.3	EIA Guidelines.....	1-6
1.4.4	Scope of DEIA Study.....	1-6
1.4.4.1	DEIA Study Components.....	1-6
1.4.4.2	DEIA Study Boundaries .....	1-7
1.5	Report Structure .....	1-9
<b>2</b>	<b>Statement of Need.....</b>	<b>2-1</b>
2.1	Strategic Opportunity .....	2-1
2.1.1	Business Environment.....	2-1
2.1.1.1	Storage Terminalling Potential.....	2-1
2.2	Synergy Value with Various Clusters.....	2-3
2.3	Benefits .....	2-3
2.3.1	Environmental benefits .....	2-3
2.3.2	Benefits to the State and Malaysian Economy.....	2-4
2.4	Synergy with Existing Legislations and Policies.....	2-5
<b>3</b>	<b>Project Options .....</b>	<b>3-1</b>
3.1	Project Location.....	3-1
3.1.1	International Boundaries.....	3-4
3.2	Project Concept.....	3-5
3.3	Project Components .....	3-7
3.3.1	Reclamation.....	3-7
3.3.2	Marine Facilities.....	3-12
3.3.2.1	Marine Traffic.....	3-12
3.3.2.2	Jetties .....	3-13
3.3.3	Capital Dredging.....	3-20
3.3.4	Onshore Development.....	3-23
3.3.4.1	Sellable Land.....	3-25
3.3.4.2	Phase 1 .....	3-25
3.3.4.3	Phase 2 .....	3-27
3.3.4.4	Phase 3 .....	3-29
3.3.5	Access Bridge.....	3-31
3.4	Buffer Zone.....	3-31
3.4.1	Regulatory Requirement.....	3-31
3.4.2	Categories of Industry.....	3-31
3.4.3	Required Buffer Zones.....	3-33
3.5	Project Status .....	3-35
3.5.1	Project Approvals .....	3-35
3.5.2	Planning Compliance.....	3-35
3.5.2.1	National Physical Plan .....	3-35
3.5.2.2	Guidelines on Siting and Zoning of Industries, 2 <sup>nd</sup> Revised Edition, 2012.....	3-35
3.6	Project Activities .....	3-35
3.6.1	Pre-Construction.....	3-35
3.6.2	Construction .....	3-36
3.6.2.1	Temporary Works .....	3-36



3.6.2.2	Management of Construction Activities	3-37
3.6.2.3	Reclamation and Capital Dredging	3-37
3.6.2.4	Marine Facilities	3-38
3.6.2.5	Onshore Operational Facilities	3-39
3.6.2.6	Construction Emissions and Wastes	3-41
3.6.3	Operations	3-42
3.6.3.1	Strategic Oil Storage Terminal on Phase 1	3-42
3.6.3.2	Phases 2 and 3	3-43
3.6.3.3	Management of Operations	3-43
3.6.3.4	Operations Emissions and Wastes	3-43
3.6.4	Project Abandonment / Decommissioning	3-47
3.7	Project Implementation Schedule	3-47
<b>4</b>	<b>Project Description</b>	<b>4-1</b>
4.1	Site Selection	4-1
4.2	Reclamation Layout	4-1
4.2.1	Option 1	4-2
4.2.2	Option 2	4-4
4.2.3	Option 3	4-5
4.2.4	Option 4	4-6
4.2.5	Project Layout (Final proposed layout)	4-7
4.3	No Project Option	4-8
<b>5</b>	<b>Existing Environment</b>	<b>5-1</b>
5.1	Physical-Chemical Environment	5-1
5.1.1	Data Collection and Sources	5-1
5.1.2	Topography and Bathymetry	5-2
5.1.2.1	Topography	5-2
5.1.2.2	Bathymetry	5-2
5.1.3	Geology	5-5
5.1.4	Marine Sediments	5-5
5.1.4.1	Sediment Grain Size	5-6
5.1.4.2	Sediment Chemistry	5-7
5.1.5	Meteorology	5-10
5.1.5.1	Wind	5-10
5.1.5.2	Rainfall	5-14
5.1.6	Hydrographic Conditions	5-14
5.1.6.1	Current Flows	5-14
5.1.6.2	Water Levels	5-19
5.1.6.3	Wave Condition	5-19
5.1.7	Hydrology and Drainage	5-24
5.1.7.1	Assessment of River Flows	5-25
5.1.8	Coastal Geomorphology	5-28
5.1.8.1	Coastal Setting	5-28
5.1.8.2	Possible Causes of Erosion	5-31
5.1.9	Water Quality	5-32
5.1.9.1	Water Quality Status	5-34
5.1.9.2	River Water Quality Status	5-37
5.1.10	Air Quality	5-39
5.1.11	Ambient Noise	5-40
5.1.12	Vibration	5-40
5.2	Biological Environment	5-41
5.2.1	Data Collection and Sources	5-41
5.2.2	Terrestrial Ecology	5-42
5.2.2.1	Vegetation	5-42
5.2.2.2	Fauna	5-45
5.2.3	Avifauna	5-47
5.2.3.1	Species Diversity	5-48
5.2.3.2	Conservation Status	5-50

5.2.3.3	Summary .....	5-52
5.2.4	Marine Ecology .....	5-53
5.2.4.1	Mangrove .....	5-53
5.2.4.2	Seagrass Habitat .....	5-62
5.2.4.3	Coral .....	5-76
5.2.4.4	Marine Megafauna .....	5-86
5.2.4.5	Fish Fauna .....	5-97
5.2.4.6	Plankton Communities .....	5-100
5.2.4.7	Benthic Communities .....	5-111
5.3	Human Environment .....	5-120
5.3.1	Data Collection and Sources .....	5-120
5.3.1.1	Socio-economic Survey Methodology .....	5-121
5.3.2	Settlements .....	5-122
5.3.3	Land Use .....	5-123
5.3.3.1	Existing Land Use Zoning .....	5-123
5.3.4	Socio Economic Profile .....	5-127
5.3.4.1	Demography of Population in the Study Area .....	5-127
5.3.4.2	Background of Respondents .....	5-129
5.3.5	Fisheries and Aquaculture .....	5-132
5.3.5.1	Aquaculture .....	5-140
5.3.5.2	Past and Present State of Fishery .....	5-141
5.3.5.3	Perception on Proposed Project .....	5-141
5.3.5.4	Willingness to Change Occupation .....	5-143
5.3.6	Tourism .....	5-145
5.3.7	Public Health .....	5-146
5.3.7.1	Health Indicator Data .....	5-146
5.3.7.2	Health Issues .....	5-147
5.3.7.3	Social Well-being .....	5-148
5.3.8	Public Perception .....	5-149
5.3.8.1	Awareness and Acceptability .....	5-149
5.3.8.2	Findings .....	5-150
5.3.9	Land Traffic .....	5-151
5.3.9.1	Results .....	5-152
5.3.10	Marine Traffic and Navigation .....	5-157
5.3.10.1	Existing Navigation Aids .....	5-160
5.3.10.2	Shipping Traffic Statistics .....	5-161
5.3.10.3	Marine Safety .....	5-163
5.4	Committed Developments in the Vicinity of the Project .....	5-163
5.5	Environmentally Sensitive Receptors .....	5-166
<b>6</b>	<b>Predicted Environmental Impacts and Mitigation Measures .....</b>	<b>6-1</b>
6.1	Impact Assessment Framework .....	6-2
6.1.1	General Analysis Scope .....	6-2
6.1.1.1	Spatial Scope .....	6-2
6.1.1.2	Impact Assessment Scenarios .....	6-2
6.1.1.3	Definitions .....	6-4
6.1.2	Rapid Impact Assessment Matrix (RIAM) .....	6-4
6.1.2.1	Evaluation Criteria .....	6-4
6.1.2.2	Score and Range System .....	6-7
6.2	Coastal Hydraulics .....	6-7
6.2.1	Evaluation Framework .....	6-8
6.2.1.1	Impact Indicators .....	6-8
6.2.1.2	Scope .....	6-9
6.2.2	Sensitive Receptors .....	6-10
6.2.3	Construction .....	6-10
6.2.3.1	Potential Impacts .....	6-10
6.2.4	Operation .....	6-10
6.2.4.1	Potential Impacts .....	6-10

6.2.4.2	Mitigation Measures.....	6-35
6.2.4.3	Residual Impacts .....	6-41
6.2.4.4	Cumulative Effects.....	6-41
6.3	Coastal Morphology.....	6-45
6.3.1	Evaluation Framework .....	6-45
6.3.1.1	Impact Indicators .....	6-45
6.3.1.2	Numerical Modelling Methodology .....	6-46
6.3.1.3	Scope .....	6-47
6.3.2	Sensitive Receptors.....	6-47
6.3.3	Construction .....	6-47
6.3.3.1	Potential Impacts .....	6-47
6.3.3.2	Mitigation Measures.....	6-57
6.3.3.3	Residual Impacts .....	6-57
6.3.4	Operation .....	6-57
6.3.4.1	Potential Impacts .....	6-57
6.3.4.2	Mitigation Measures.....	6-60
6.3.4.3	Residual Impacts .....	6-60
6.4	Water Quality.....	6-60
6.4.1	Evaluation Framework and Methodology .....	6-61
6.4.1.1	Impact Indicators .....	6-61
6.4.1.2	Methodology .....	6-62
6.4.2	Sensitive Receptors.....	6-64
6.4.3	Construction .....	6-65
6.4.3.1	Potential Impacts .....	6-65
6.4.3.2	Mitigation Measures.....	6-82
6.4.3.3	Residual Impacts .....	6-85
6.4.4	Operational Phase .....	6-85
6.4.4.1	Potential Impacts .....	6-86
6.4.4.2	Mitigation Measures.....	6-101
6.4.4.3	Residual Impacts .....	6-101
6.5	Hydrology and Drainage .....	6-102
6.5.1	Evaluation Framework and Methodology .....	6-102
6.5.1.1	Scope .....	6-102
6.5.2	Construction .....	6-103
6.5.2.1	Possible Blockage of Rivers .....	6-103
6.5.2.2	Mitigation Measures.....	6-104
6.5.2.3	Residual Impacts .....	6-104
6.5.3	Operational Phase.....	6-104
6.5.3.1	Impacts to Sg. Pulai.....	6-104
6.5.3.2	Streams Discharging on the eastern shoreline of Tg. Piai .....	6-105
6.5.3.3	Mitigation Measures.....	6-106
6.5.3.4	Residual Impacts .....	6-106
6.6	Air Quality .....	6-106
6.6.1	Evaluation Framework .....	6-106
6.6.1.1	Ambient Air Quality Guidelines .....	6-106
6.6.1.2	Environmental Quality (Clean Air) Regulations 2014 .....	6-107
6.6.1.3	American Conference of Governmental Industrial Hygienists (ACGIH).....	6-107
6.6.1.4	Methodology / Assumptions.....	6-107
6.6.2	Sensitive Receptors and Baseline Air Quality Features .....	6-108
6.6.3	Construction .....	6-109
6.6.3.1	Potential Impact.....	6-109
6.6.3.2	Mitigation Measures.....	6-110
6.6.3.3	Residual Impacts .....	6-110
6.6.4	Operational Phase Impacts.....	6-111
6.6.4.1	Estimated Emission Concentrations .....	6-111
6.6.4.2	Air Quality Modelling Results .....	6-111
6.6.4.3	Mitigation Measures.....	6-121
6.6.4.4	Residual Impacts .....	6-121

6.7	Noise .....	6-121
6.7.1	Evaluation Framework .....	6-121
6.7.1.1	Standards and Tolerance Limits .....	6-122
6.7.2	Sensitive Receptors .....	6-123
6.7.3	Construction .....	6-123
6.7.3.1	Potential Impacts .....	6-123
6.7.3.2	Mitigation Measures .....	6-129
6.7.3.3	Residual Impacts .....	6-129
6.7.4	Operation .....	6-129
6.7.4.1	Predicted Impacts .....	6-129
6.7.4.2	Mitigation Measures .....	6-133
6.7.4.3	Residual Impacts .....	6-133
6.8	Terrestrial Ecology .....	6-133
6.8.1	Evaluation Framework .....	6-133
6.8.2	Sensitive Receptors .....	6-133
6.8.3	Construction .....	6-134
6.8.3.1	Predicted Impacts .....	6-134
6.8.3.2	Proposed Mitigation Measures .....	6-136
6.8.3.3	Residual Impacts .....	6-136
6.8.4	Operation .....	6-137
6.8.4.1	Predicted Impacts .....	6-137
6.8.4.2	Proposed Mitigation Measures .....	6-138
6.8.4.3	Residual Impacts .....	6-138
6.9	Mangrove .....	6-138
6.9.1	Evaluation Framework .....	6-138
6.9.1.1	Scope .....	6-139
6.9.2	Sensitive Receptors .....	6-139
6.9.3	Construction .....	6-139
6.9.3.1	Predicted Impacts .....	6-139
6.9.3.2	Proposed Mitigation Measures .....	6-140
6.9.3.3	Residual Impacts .....	6-140
6.9.4	Operation .....	6-140
6.9.4.1	Potential Impacts .....	6-140
6.9.4.2	Proposed Mitigation Measures .....	6-143
6.9.4.3	Residual Impacts .....	6-146
6.10	Avifauna .....	6-147
6.10.1	Evaluation Framework .....	6-147
6.10.1.1	Avifauna Responses to Construction Disturbance .....	6-147
6.10.1.2	Scope .....	6-148
6.10.2	Sensitive Receptors .....	6-148
6.10.3	Construction .....	6-149
6.10.3.1	Potential Impacts .....	6-149
6.10.3.2	Proposed Mitigation Measures .....	6-150
6.10.3.3	Residual Impacts .....	6-151
6.10.4	Operation .....	6-151
6.10.4.1	Potential Impacts .....	6-151
6.10.4.2	Proposed Mitigation Measures .....	6-153
6.10.4.3	Residual Impacts .....	6-153
6.11	Macrobenthos .....	6-154
6.11.1	Evaluation Framework .....	6-154
6.11.1.1	Scope .....	6-154
6.11.2	Sensitive Receptors .....	6-154
6.11.3	Construction .....	6-155
6.11.3.1	Potential Impacts .....	6-155
6.11.3.2	Proposed Mitigation Measures .....	6-156
6.11.3.3	Residual Impacts .....	6-157
6.11.4	Operation .....	6-157
6.11.4.1	Potential Impacts .....	6-157



6.11.4.2	Proposed Mitigation Measures .....	6-166
6.11.4.3	Residual Impacts .....	6-166
6.12	Plankton.....	6-167
6.12.1	Evaluation Framework .....	6-167
6.12.2	Sensitive Receptors.....	6-167
6.12.3	Construction .....	6-167
6.12.3.1	Potential Impacts .....	6-167
6.12.3.2	Proposed Mitigation Measures .....	6-168
6.12.3.3	Residual Impacts .....	6-168
6.12.4	Operations .....	6-168
6.12.4.1	Potential Impacts .....	6-168
6.12.4.2	Proposed Mitigation Measures .....	6-170
6.12.4.3	Residual Impacts .....	6-170
6.13	Fish Fauna.....	6-171
6.13.1	Evaluation Framework .....	6-171
6.13.2	Sensitive Receptors.....	6-171
6.13.3	Construction .....	6-171
6.13.3.1	Potential Impacts .....	6-171
6.13.3.2	Proposed Mitigation Measures .....	6-173
6.13.3.3	Residual Impacts .....	6-173
6.13.4	Operation.....	6-173
6.13.4.1	Proposed Mitigation Measures .....	6-175
6.13.4.2	Residual Impacts .....	6-175
6.14	Marine Megafauna.....	6-176
6.14.1	Evaluation Framework .....	6-176
6.14.1.1	Scope .....	6-176
6.14.2	Sensitive Receptors.....	6-176
6.14.3	Construction .....	6-177
6.14.3.1	Potential Impact.....	6-177
6.14.3.2	Proposed Mitigation Measures .....	6-179
6.14.3.3	Residual Impacts .....	6-180
6.14.4	Operation.....	6-180
6.14.4.1	Potential Impacts .....	6-180
6.14.4.2	Proposed Mitigation Measures .....	6-181
6.14.4.3	Residual Impacts .....	6-182
6.15	Seagrass .....	6-182
6.15.1	Evaluation Framework .....	6-182
6.15.2	Sensitive Receptors.....	6-183
6.15.3	Construction .....	6-183
6.15.3.1	Potential Impacts .....	6-183
6.15.3.2	Proposed Mitigation Measures .....	6-184
6.15.3.3	Residual Impacts .....	6-184
6.15.4	Operation.....	6-184
6.15.4.1	Potential Impacts .....	6-184
6.15.4.2	Proposed Mitigation Measures .....	6-186
6.15.4.3	Residual Impacts .....	6-186
6.16	Coral.....	6-187
6.16.1	Evaluation Framework and Scope .....	6-187
6.16.2	Sensitive Receptors.....	6-187
6.16.3	Construction .....	6-187
6.16.3.1	Potential Impacts .....	6-187
6.16.3.2	Mitigation Measures.....	6-188
6.16.3.3	Residual Impacts .....	6-188
6.16.4	Operation.....	6-188
6.16.4.1	Potential Impacts .....	6-188
6.16.4.2	Proposed Mitigation Measures .....	6-190
6.16.4.3	Residual Impacts .....	6-190
6.17	Socio-Economic.....	6-191

6.17.1	Evaluation Framework .....	6-191
6.17.1.1	Scope .....	6-191
6.17.2	Sensitive Receptors.....	6-192
6.17.3	Construction .....	6-192
6.17.3.1	Predicted Impacts.....	6-192
6.17.3.2	Proposed Mitigation Measures .....	6-199
6.17.3.3	Residual Impacts .....	6-201
6.17.4	Operations.....	6-204
6.17.4.1	Predicted Impacts.....	6-204
6.17.4.2	Proposed Mitigation Measures .....	6-212
6.17.4.3	Residual Impacts .....	6-213
6.18	Quantitative Risk Assessment .....	6-216
6.18.1	Evaluation Framework and Methodology.....	6-216
6.18.1.1	Risk Criteria .....	6-216
6.18.1.2	Methodology.....	6-217
6.18.2	Sensitive Receptors.....	6-217
6.18.3	Predicted Risk .....	6-219
6.18.4	Proposed Mitigation Measures .....	6-223
6.18.4.1	Further Actions to Manage Risk.....	6-223
6.18.4.2	Procedural: Operation.....	6-224
6.18.4.3	Maintenance .....	6-224
6.18.4.4	Fire Fighting System.....	6-224
6.18.5	Residual Impacts .....	6-224
6.19	Health Impact Assessment .....	6-224
6.19.1	Evaluation Framework .....	6-224
6.19.2	Scope .....	6-225
6.19.3	Sensitive Receptors.....	6-226
6.19.4	Construction .....	6-227
6.19.4.1	Potential Impacts .....	6-227
6.19.4.2	Proposed Mitigation Measures .....	6-228
6.19.4.3	Residual Impacts .....	6-228
6.19.5	Operation.....	6-228
6.19.5.1	Potential Impacts .....	6-228
6.19.5.2	Proposed Mitigation Measures .....	6-230
6.19.5.3	Residual Impacts .....	6-231
6.20	Land Use Compatibility Assessment .....	6-231
6.20.1	Evaluation Framework .....	6-231
6.20.2	Potential Impacts .....	6-231
6.20.3	Proposed Mitigation Measures .....	6-233
6.20.4	Residual Impact.....	6-233
6.21	Land Traffic.....	6-233
6.21.1	Evaluation Framework .....	6-233
6.21.1.1	Traffic Condition .....	6-234
6.21.2	Scope .....	6-236
6.21.3	Sensitive Receptors.....	6-236
6.21.4	Construction .....	6-237
6.21.4.1	Traffic Generation .....	6-237
6.21.4.2	Roadway Performance .....	6-241
6.21.4.3	Proposed Mitigation Measures .....	6-242
6.21.4.4	Residual Impacts .....	6-244
6.21.5	Operation.....	6-244
6.21.5.1	Predicted Impacts.....	6-244
6.21.5.2	Proposed Mitigation Measures .....	6-246
6.21.5.3	Residual Impacts .....	6-247
6.22	Marine Traffic and Navigation .....	6-248
6.22.1	Evaluation Framework .....	6-248
6.22.2	Scope .....	6-248
6.22.3	Sensitive Receptors.....	6-248

6.22.4	Construction .....	6-249
6.22.4.1	Potential Impacts .....	6-249
6.22.4.2	Mitigation Measures .....	6-251
6.22.4.3	Residual Impacts .....	6-251
6.22.5	Operation .....	6-252
6.22.5.1	Potential Impacts .....	6-252
6.22.5.2	Mitigation Measures .....	6-258
6.22.5.3	Residual Impacts .....	6-259
6.23	Summary of Impacts .....	6-260
<b>7</b>	<b>Economic Valuation Analysis .....</b>	<b>7-1</b>
7.1	Evaluation Objectives .....	7-1
7.2	Methods .....	7-1
7.3	Identification of Incremental Gains and Losses .....	7-2
7.4	Valuation of Gains and Losses .....	7-2
7.4.1	Marine Biology (Loss of Mudflat and Muddy Seabed due to Reclamation) .....	7-4
7.4.2	Marine Biology (Loss of Mudflat or Muddy Seabed in the Dredged Area) .....	7-4
7.4.3	Marine Biology (Loss and Regeneration of Mangrove) .....	7-5
7.4.4	Loss of Fishing Ground and Direct Access to the Sea .....	7-5
7.4.5	Recreational/Aesthetic Value .....	7-6
7.5	Overall Assessment .....	7-6
<b>8</b>	<b>Environmental Management Plan .....</b>	<b>8-1</b>
8.1	Scope .....	8-1
8.2	Objectives .....	8-1
8.3	Responsibilities .....	8-1
8.3.1	Proponent .....	8-2
8.3.2	Contractor .....	8-2
8.3.2.1	Pre-construction .....	8-3
8.3.2.2	During Construction .....	8-3
8.3.2.3	Reporting .....	8-3
8.3.3	Project Manager .....	8-3
8.3.4	Environmental Officer .....	8-4
8.3.5	Safety, Health and Environment Officer .....	8-4
8.3.6	Field Supervisors .....	8-4
8.3.7	Environmental Monitoring / EMP Consultant .....	8-5
8.3.8	Accredited Laboratory .....	8-5
8.3.9	Training and Awareness .....	8-5
8.4	Review and Update of EMP .....	8-5
8.5	Compliance with Environmental Requirements .....	8-5
8.6	Monitoring Programme .....	8-7
8.6.1	Management of Suspended Sediments during Reclamation and Dredging .....	8-7
8.6.1.1	Reclamation Works .....	8-7
8.6.1.2	Dredging and Reclamation Works (Phase 2) .....	8-9
8.6.2	Ambient Water Quality .....	8-13
8.6.2.1	Construction Stage Monitoring .....	8-13
8.6.2.2	Operations Stage Monitoring .....	8-16
8.6.3	Coastal Bathymetric Profile Monitoring .....	8-19
8.6.4	Ecological Impacts .....	8-20
8.6.4.1	Biological Monitoring .....	8-20
8.6.4.2	Habitat Monitoring .....	8-25
8.6.5	Air Quality .....	8-30
8.6.5.1	Compliance Monitoring .....	8-30
8.6.5.2	Impact Monitoring .....	8-31
8.6.6	Ambient Noise Level .....	8-32
8.6.6.1	Compliance Monitoring .....	8-32
8.6.6.2	Impact Monitoring .....	8-32
8.6.7	Social Impact .....	8-33
8.6.7.1	Compliance Monitoring .....	8-33



8.6.7.2	Impact Monitoring .....	8-34
8.6.8	Fisheries and Aquaculture .....	8-35
8.6.8.1	Compliance Monitoring .....	8-35
8.6.8.2	Impact Monitoring .....	8-35
8.7	Reporting Requirements.....	8-36
8.8	Emergency Response Plan (ERP).....	8-36
8.8.1	Compliance Monitoring .....	8-36
8.8.2	Oil Spill .....	8-36
8.8.3	Collision at Sea.....	8-37
8.9	Project Closure .....	8-37
8.9.1	Design for Decommissioning .....	8-37
8.9.2	Compliance Monitoring .....	8-38
8.9.3	Decommissioning Plan .....	8-38
8.10	Final EMP Requirements.....	8-39
<b>9</b>	<b>Summary and Conclusions .....</b>	<b>9-1</b>
<b>10</b>	<b>References.....</b>	<b>10-1</b>

## FIGURES

Figure 1.1	Project location .....	1-2
Figure 1.2	Geographic area of the DEIA study, overall and for individual components.....	1-8
Figure 3.1	Key features of the project site .....	3-2
Figure 3.2	Project and boundary points (coordinates of the boundary points shown in Table 3.1).....	3-3
Figure 3.3	International boundaries within the project area.....	3-5
Figure 3.4	Layout for the Integrated Petroleum Hub and Maritime Industrial Park .....	3-6
Figure 3.5	Location of proposed sand source site.....	3-8
Figure 3.6	Reclamation phasing.....	3-9
Figure 3.7	Alignment of drainage channel .....	3-11
Figure 3.8	Cross section sketch of drainage channel .....	3-12
Figure 3.9	Jetty layout .....	3-14
Figure 3.10	Jetty 1 layout .....	3-15
Figure 3.11	Jetty 2 layout .....	3-17
Figure 3.12	Shore connected berth layout .....	3-19
Figure 3.13	Area to be dredged to -14 m CD.....	3-21
Figure 3.14	Proposed disposal area for dredged material.....	3-22
Figure 3.15	Planned land use.....	3-24
Figure 3.16	Phase 1 (Strategic Oil Storage Terminal).....	3-26
Figure 3.17	Details of Phase 2 plots and nominal tank layout.....	3-28
Figure 3.18	Phase 3 plots and nominal tankage layout.....	3-30
Figure 3.19	Overall buffer zone for the project as per the Guidelines for Siting and Zoning of Industry and Residential Areas (2012).....	3-34
Figure 3.20	Details of planned shore protection works.....	3-38
Figure 3.21	Location of noise sources in the plant .....	3-44
Figure 3.22	Location of air emissions point source.....	3-46
Figure 3.23	Overall project schedule.....	3-47
Figure 3.24	Phase 1 Project Schedule.....	3-48
Figure 4.1	Reclamation layout (Option 1) .....	4-3
Figure 4.2	Project layout (Option 2) .....	4-4
Figure 4.3	Project layout (Option 3) .....	4-5
Figure 4.4	Project Layout (Option 4) .....	4-6
Figure 4.5	Project Layout (Final proposed layout).....	4-7
Figure 4.6	All reclamation layouts .....	4-8
Figure 5.1	Bathymetry and project area with reclamation outlined in orange .....	5-3

Figure 5.2	Detail of the bathymetry and proposed project area outlined with reclamation delineated in orange and dredging basin in burgundy.....	5-4
Figure 5.3	Geology of the study area .....	5-5
Figure 5.4	Sediment grain size properties for surface marine sediments samples collected within and around the proximity of the proposed development.....	5-6
Figure 5.5	Sediment (% Sand). .....	5-7
Figure 5.6	Sampling sites for the collection of surface marine sediments for chemical analysis.....	5-8
Figure 5.7	Chlorophyll-a presence in surface marine sediments samples .....	5-10
Figure 5.8	Location of meteorological stations (Senai Airport, Jurong Flatted Factory and Semakau) considered for use in this assessment. ....	5-11
Figure 5.9	Annual wind rose based on Semakau wind measurements for the period January 2010 – June 2012. ....	5-12
Figure 5.10	Wind roses of Semakau wind for different climatic conditions from January 2010 to June 2012.....	5-12
Figure 5.11	Example - Wind measurements during a Sumatra Squall on 28 Aug 2010 from Semakau station. ....	5-13
Figure 5.12	Average monthly rainfall for Pontian and Senai, 2008 -2012 (Source: <i>Meteorological Department Johor</i> ). Bards indicate maximum and minimum monthly rainfall over the record period. ....	5-14
Figure 5.13	Representative spring tide current speed and direction during flood (above) and ebb (below) tide. ....	5-16
Figure 5.14	Typical predicted mean and maximum current speed in the study area.....	5-17
Figure 5.15	Net or residual currents computed over 15 day period. NE monsoon (left), SW monsoon (right) and inter monsoon (bottom). ....	5-18
Figure 5.16	Measured water levels in the study area. ....	5-19
Figure 5.17	Predicted wave conditions (significant wave height) in the study area during NE Monsoon (top) and SW monsoon (bottom). ....	5-21
Figure 5.18	Significant wave heights at three locations over the period from Jan 2010 to May 2012. ....	5-21
Figure 5.19	Aerial view of docking ships offshore of Tuas. (Source: Google Earth Pro, image dated June 14, 2012).....	5-22
Figure 5.20	Modelled ship wakes for an inbound (above) outbound vessel (bottom). ....	5-23
Figure 5.21	Rivers discharging into the project area.....	5-24
Figure 5.22	Estimated discharge from catchment M10 for long term period (top) and averaged to represent mean runoff over a year .....	5-25
Figure 5.23	Location of outlet points used in the model.....	5-27
Figure 5.24	Overview of shoreline condition and coastal protection.....	5-31
Figure 5.25	Location of water quality sampling stations .....	5-33
Figure 5.26	Water quality status for the marine stations.....	5-35
Figure 5.27	Depth averaged temperature (left) and dissolved oxygen (right) measurements at each of the marine stations for the three different seasons. The dissolved oxygen Class 2 and Class E standards below which DO should not fall are shown as the 2 different dashed lines. ....	5-35
Figure 5.28	Depth averaged orthophosphate phosphorus (left) and nitrate nitrogen (right) measurements at each of the marine stations for the three different seasons. The dissolved oxygen Class 2 and Class E standards which the nutrients should not exceed are shown as the 2 different dashed lines.....	5-36
Figure 5.29	Depth averaged Total Suspended Solids (TSS - left) and Chlorophyll-a (right) measurements at each of the marine stations for the three different seasons. The Class 2 and Class E standards which TSS should not exceed are shown as the two different dashed lines.....	5-36
Figure 5.30	Location of riverine stations for water quality, all of which are classified as Class E waters.....	5-37
Figure 5.31	Mid depth temperature (left) and dissolved oxygen (right) measurements at each of the riverine stations for the three different seasons. The dissolved oxygen Class 2 and Class E standards below which DO should not fall are shown as the 2 different dashed lines. ....	5-38
Figure 5.32	Mid depth orthophosphate phosphorus (left) and nitrate nitrogen (right) measurements at each of the riverine stations for the three different seasons. The dissolved oxygen Class 2 and Class E standards which the nutrients should not exceed are shown as the 2 different dashed lines.....	5-38
Figure 5.33	Mid depth Total Suspended Solids (TSS - left) and Chlorophyll-a (right) measurements at each of the riverine stations for the three different seasons. The Class E standards which TSS should not exceed are shown as the dashed line.....	5-38
Figure 5.34	Location of air sampling, and noise and vibration monitoring stations.....	5-39

Figure 5.35	Vegetation type within the vicinity of the project area .....	5-43
Figure 5.36	Avifauna survey stations. ....	5-48
Figure 5.37	Overall bird species richness .....	5-49
Figure 5.38	Types of inland and mangrove bird species found in the study area .....	5-49
Figure 5.39	Types of waders species found in the study area .....	5-50
Figure 5.40	Conservation status of bird species found within study area as categorised by the Protection of Wildlife Act 1972.....	5-51
Figure 5.41	Number of inland and mangrove bird species protected under the Protection of Wildlife Act 1972....	5-51
Figure 5.42	Number of waders bird species protected under the Protection of Wildlife Act 1972 .....	5-52
Figure 5.43	Mangroves within the vicinity of the project area. "Photo location" indicates the locations of Photo 5.14 to Photo 5.17 below. ....	5-54
Figure 5.44	Location of seagrass beds within the study area.....	5-63
Figure 5.45	Location of coral reefs at the study area. Red line denotes the outer boundary of the reef. ....	5-76
Figure 5.46	Coral percentage cover for each transect at P. Merambong. ....	5-77
Figure 5.47	Map showing locations of life sightings and stranding of various cetacean species in Peninsular Malaysia. The letters indicate species observed as per Table 5.15 and locations are listed in Table 5.14 (Source: Ponampalam, L., 2012 /32/). ....	5-87
Figure 5.48	List of megafauna recorded around Johor waters and the proposed project area. (The yellow dots indicates dugong sightings while 2-letters in blue indicates other megafauna sightings, as per Table 5.15) .....	5-90
Figure 5.49	Spatial distribution of seahorse species around Peninsular Malaysia. (Source: Choo & Liew, 2003 /35/) .....	5-95
Figure 5.50	Graph showing number of turtle landings versus number of eggs laid in Melaka. (Source: Pontian Sand Source EIA, 2012). ....	5-97
Figure 5.51	Locations of fisheries sampling stations within and around the proposed project area. The pie chart indicates the catch-per-unit-effort (in g/m <sup>2</sup> /hr), in blue: western Tg. Piai stations (F9 & F10), red: eastern Tg. Piai stations (F1, F2, F3, F4), and green: Sg. Pulai stations (F5, F6, F7 & F8). ....	5-98
Figure 5.52	Seasonal trend for overall species count and Catch-per-unit-effort for fish fauna and crustaceans from all stations.....	5-99
Figure 5.53	Phytoplankton study areas and stations. ....	5-101
Figure 5.54	Mean density (cells/mL) of Phylum Bacillariophyta at the study area. ....	5-102
Figure 5.55	Mean density (cells/mL) of Phylum Dinoflagellata at the study area. ....	5-103
Figure 5.56	Relative density of HAB species found during the Northeast monsoon.....	5-104
Figure 5.57	Relative density of HAB species found during the Southwest monsoon. ....	5-105
Figure 5.58	Relative density of HAB species found during intermonsoon. ....	5-106
Figure 5.59	Mean density (cells/mL) of Phylum Cyanophyta at study area. ....	5-107
Figure 5.60	Total mean density (cells/ml) of phytoplankton at the study area. ....	5-108
Figure 5.61	Mean diversity Index (H') of Phytoplankton at study area.....	5-108
Figure 5.62	Mean composition of the zooplankton at the study area. ....	5-109
Figure 5.63	Total mean density (cells/ml) of zooplankton at the study area. ....	5-110
Figure 5.64	Mean diversity (H') of zooplankton at the study area. ....	5-110
Figure 5.65	Mean density (ind./m <sup>2</sup> ) of macrobenthos at study area. ....	5-111
Figure 5.66	Benthos composition and density within the project area during Northeast monsoon. ....	5-112
Figure 5.67	Benthos composition and density within the project area during Southwest monsoon. ....	5-113
Figure 5.68	Benthos composition and density within the project area during intermonsoon. ....	5-114
Figure 5.69	Mean zoobenthos biomass during northeast monsoon.....	5-115
Figure 5.70	Mean zoobenthos biomass during southwest monsoon. ....	5-116
Figure 5.71	Mean zoobenthos biomass during intermonsoon.....	5-117
Figure 5.72	Overview of habitat and pressure variables used as predictors for modelling the abundance of macrobenthos.....	5-118
Figure 5.73	Predicted zoobenthos biomass. ....	5-119
Figure 5.74	Baseline Southwest monsoon bivalve density.....	5-120
Figure 5.75	Location of villages within 5km of the project site.....	5-122
Figure 5.76	Existing land use as per Pontian Local Plan within 5 km from the project modified to include major projects (see Drawings for A3 size figure).....	5-126
Figure 5.77	Population composition in Pontian District based on Mukim (Source: Population Distribution and Basic Demographic Characteristics, Statistics Department 2011). ....	5-127

Figure 5.78	Working Age Population in Mukim Serkat in 2010 by age groups .....	5-128
Figure 5.79	Ethnic Composition of Mukim Serkat in 2010 .....	5-129
Figure 5.80	Educational level in the study area. ....	5-130
Figure 5.81	Employment categories of the respondents in Mukim Serkat within 5km radius of impact area .....	5-131
Figure 5.82	Household income per month of respondents in Mukim Serkat.....	5-132
Figure 5.83	Types of activities carried out by the respondents in the fishery industry .....	5-134
Figure 5.84	Fishing grounds frequented by fishermen of the study area which includes Sg Pulau, Pulau Kukup and Pulau Pisang. Indicative fishing ground is based on nearshore areas excluding the marine traffic separation scheme and anchorage areas. ....	5-135
Figure 5.85	Location of fish landing areas at various sites around Mukim Serkat. ....	5-136
Figure 5.86	Number of Fishermen Operated at Study Area according to the Social Survey .....	5-137
Figure 5.87	Number of Fishermen and Fishing Boat Operated around and within Study Area Capture Fishery .....	5-137
Figure 5.88	Types of fishing gear used by respondents .....	5-138
Figure 5.89	Type of fish catch as reported by respondents.....	5-139
Figure 5.90	The fish catch per trip (weight in kilogrammes) based on the number of fishermen respondents ...	5-140
Figure 5.91	Changes in fishery status before and after the existence of Tg Bin Power Plant and Tg Pelepas Port as reported by respondents.....	5-141
Figure 5.92	Respondents' perception on project potential impacts on their catch and income .....	5-142
Figure 5.93	Acceptance of the project based on the fishermen respondents .....	5-143
Figure 5.94	Willingness to change occupation.....	5-144
Figure 5.95	Perception of the respondents on the proposed project.....	5-149
Figure 5.96	Public perception of the potential impacts from the proposed project.....	5-150
Figure 5.97	Location of the traffic survey stations.....	5-152
Figure 5.98	Existing traffic flow along federal route FR95 towards Pulau Kukup (SCN1).....	5-154
Figure 5.99	Existing traffic flow along federal FR95 towards Pontian (SCN2) .....	5-154
Figure 5.100	Existing traffic flow along state route J111 towards Tg. Piai (SCN3) .....	5-155
Figure 5.101	Existing junction performance during AM peak period .....	5-156
Figure 5.102	Existing junction performance during PM peak period .....	5-157
Figure 5.103	Adjacent Port Facilities .....	5-158
Figure 5.104	Limits of Traffic Separation Scheme .....	5-159
Figure 5.105	Shipping traffic tracks – 1 to 7 July 2013 .....	5-160
Figure 5.106	Existing Key Navigation Aids in the vicinity of the Project .....	5-161
Figure 5.107	DID breakwaters and oil boom.....	5-166
Figure 5.108	Summary of identified sensitive receptors – within 10 km of project. (see Drawings for A3 size figure).....	5-168
Figure 5.109	Summary of identified sensitive receptors within 5 km of project (see Drawings for A3 size figure).....	5-169
Figure 6.1	Reclamation phases considered in the impacts assessment .....	6-3
Figure 6.2	Reclamation phases considered in the construction stage hydraulic and morphological impacts assessment.....	6-9
Figure 6.3	Typical spring flood tide current patterns, existing (top) and Phase 1 (bottom).....	6-11
Figure 6.4	Typical spring ebb tide current patterns, existing (top) and Phase 1 (bottom).....	6-12
Figure 6.5	Mean current speed for baseline and phase 1 (top) and difference (bottom). ....	6-13
Figure 6.6	Maximum current speed for baseline and phase 1 (top) and difference (bottom). ....	6-14
Figure 6.7	Typical spring flood tide current patterns, existing (top) and Phase 2 (bottom). ....	6-15
Figure 6.8	Typical spring ebb tide current patterns, existing (top) and Phase 2 (bottom).....	6-16
Figure 6.9	Mean current speed for baseline and phase 2 (top) and difference (bottom). ....	6-17
Figure 6.10	Maximum current speed for baseline and phase 2 (top) and difference (bottom). ....	6-18
Figure 6.11	Typical spring flood tide current patterns, existing (top) and Phase 3 (bottom). ....	6-20
Figure 6.12	Typical spring ebb tide current patterns, existing (top) and Phase 3 (bottom).....	6-21
Figure 6.13	Mean current speed for baseline and phase 3 (top) and difference (bottom). ....	6-22
Figure 6.14	Maximum current speed for baseline and phase 3 (top) and difference (bottom). ....	6-23
Figure 6.15	Location of water level extraction points .....	6-25
Figure 6.16	Water levels. Baseline and post construction. ....	6-26
Figure 6.17	Location of discharge extraction lines L1, L2 and L3. ....	6-27
Figure 6.18	Waves condition during typical NE monsoon for existing (top left), Phase 1 (top right) and difference (below). ....	6-29

Figure 6.19	Waves condition during typical SW monsoon for existing (top left), Phase 1 (top right) and difference (below).....	6-30
Figure 6.20	Waves condition during typical NE monsoon for existing (top left), Phase 2 (top right) and difference (below).....	6-31
Figure 6.21	Waves condition during typical SW monsoon for existing (top left), Phase 2 (top right) and difference (below).....	6-32
Figure 6.22	Waves condition during typical NE monsoon for existing (top left), Phase 3 (top right) and difference (below).....	6-33
Figure 6.23	Waves condition during typical SW monsoon for existing (top left), phase 3 (top right) and difference (below).....	6-34
Figure 6.24	Bathymetry, proposed control structure and drainage channel).See also cross sections of the drainage channel in Figure 6.25. ....	6-37
Figure 6.25	Cross section of proposed channel along the western perimeter of the reclamation. ....	6-38
Figure 6.26	Zoom of the differences in mean current speed from the existing condition without mitigation (top) and with mitigation (bottom). ....	6-39
Figure 6.27	Zoom of the differences in maximum current speed from the existing condition without mitigation (top) and with mitigation (bottom). ....	6-40
Figure 6.28	Reclamation of Phase 3 with cumulative conditions and mitigation structures.....	6-42
Figure 6.29	Differences in mean current speed from the existing condition for Phase 3 (top) and cumulative (bottom). ....	6-43
Figure 6.30	Differences in maximum current speed from the existing condition for Phase 3 (top) and cumulative (bottom).....	6-44
Figure 6.31	Phase 1 (reclamation): Bed level change over 28 day simulation period during NE-monsoon.....	6-48
Figure 6.32	Phase 1 (reclamation): Bed level change over 28 day simulation period during SW-monsoon.....	6-49
Figure 6.33	Phase 1 (reclamation): Bed level change over 28 day simulation period during inter-monsoon.....	6-50
Figure 6.34	Phase 2 (dredging and reclamation): Bed level change over 28 day simulation period for NE-monsoon.....	6-51
Figure 6.35	Phase 2 (dredging and reclamation): Bed level change over 28 day simulation period for SW-monsoon.....	6-52
Figure 6.36	Phase 2 (dredging and reclamation): Bed level change over 28 day simulation period for inter-monsoon.....	6-53
Figure 6.37	Phase 3 (reclamation): Bed level change over 28 day simulation period for NE-monsoon.....	6-54
Figure 6.38	Phase 3 (reclamation): Bed level change over 28 day simulation period for SW-monsoon.....	6-55
Figure 6.39	Phase 3 (reclamation): Bed level change over 28 day simulation period for inter-monsoon. ....	6-56
Figure 6.40	Overview of the Tg. Piai coastline.....	6-58
Figure 6.41	Sensitive receptors for water quality assessment and the existing water quality status .....	6-65
Figure 6.42	Phase 1 maximum suspended sediment concentration.....	6-66
Figure 6.43	Phase 1 seasonally averaged percentage exceedance of 5 mg/l.....	6-67
Figure 6.44	Phase 1 seasonally averaged percentage exceedance of 10 mg/l.....	6-68
Figure 6.45	Phase 1 seasonally averaged percentage exceedance of 25 mg/l.....	6-69
Figure 6.46	Phase 1 seasonally averaged percentage exceedance of 50 mg/l.....	6-70
Figure 6.47	Phase 2 maximum suspended sediment concentration.....	6-72
Figure 6.48	Phase 2 seasonally averaged percentage exceedance of 5 mg/l.....	6-73
Figure 6.49	Phase 2 seasonally averaged percentage exceedance of 10 mg/l.....	6-74
Figure 6.50	Phase 2 seasonally averaged percentage exceedance of 25 mg/l.....	6-75
Figure 6.51	Phase 2 seasonally averaged percentage exceedance of 50 mg/l.....	6-76
Figure 6.52	Phase 3 maximum suspended sediment concentration.....	6-77
Figure 6.53	Phase 3 seasonally averaged percentage exceedance of 5 mg/l.....	6-78
Figure 6.54	Phase 3 seasonally averaged percentage exceedance of 10 mg/l.....	6-79
Figure 6.55	Phase 3 seasonally averaged percentage exceedance of 25 mg/l.....	6-80
Figure 6.56	Phase 3 seasonally averaged percentage exceedance of 50 mg/l.....	6-81
Figure 6.57	5 mg/l exceedance along the Malaysian-Singaporean border with and without tidal timing. ....	6-83
Figure 6.58	5 mg/l exceedance along the Malaysian-Singaporean border with and without pre-bundling. ....	6-84
Figure 6.59	NE monsoon: Snapshot of predicted tracer concentration at 1 day after release for existing and proposed development phases.....	6-86
Figure 6.60	NE monsoon: Snapshot of predicted tracer concentration at 14 days after release for existing and proposed development phases.....	6-87

Figure 6.61	NE Monsoon: Differences in mean surface salinity for 3 development phases compared to baseline conditions .....	6-89
Figure 6.62	NE Monsoon: Mean total suspended sediment concentration for existing (top left), with project (top right) and difference (bottom) .....	6-91
Figure 6.63	SW Monsoon: Mean total suspended sediment concentration for existing (top left), with project (top right) and difference (bottom) .....	6-92
Figure 6.64	Inter Monsoon: Mean total suspended sediment concentration for existing (top left), with project (top right) and difference (bottom) .....	6-93
Figure 6.65	NE Monsoon: Differences in mean surface temperature for 3 development phases compared to baseline condition .....	6-95
Figure 6.66	Maximum oil thickness for worst case Scenario D .....	6-97
Figure 6.67	Time till exposure for worst case Scenario D .....	6-98
Figure 6.68	Streams discharging on the eastern shoreline of Tg Piai .....	6-103
Figure 6.69	Local receptors identified around the proposed project .....	6-109
Figure 6.70	Predicted GLC of TSP Contours (0.1 $\mu\text{g}/\text{m}^3$ interval) for 1-yr averaging time during operation phase .....	6-112
Figure 6.71	Predicted GLC of PM <sub>10</sub> contours (0.04 $\mu\text{g}/\text{m}^3$ interval) for 24-hr averaging time during operation phase .....	6-113
Figure 6.72	Predicted GLC of PM <sub>10</sub> contours (0.01 $\mu\text{g}/\text{m}^3$ interval) for 1-yr averaging time during operation phase .....	6-114
Figure 6.73	Predicted GLC of NO <sub>2</sub> contours (4.0 $\mu\text{g}/\text{m}^3$ interval) for 1-hr averaging time during operation phase .....	6-115
Figure 6.74	Predicted GLC of NO <sub>2</sub> contours (1.0 $\mu\text{g}/\text{m}^3$ interval) for 24-hr averaging time during operational phase .....	6-116
Figure 6.75	Predicted GLC of SO <sub>2</sub> contours (4.0 $\mu\text{g}/\text{m}^3$ interval) for 1-hr averaging time during operational phase .....	6-117
Figure 6.76	Predicted GLC of SO <sub>2</sub> contours (0.8 $\mu\text{g}/\text{m}^3$ interval) for 24-hr averaging time during operational phase .....	6-118
Figure 6.77	Predicted GLC of VOC contours (20.0 $\mu\text{g}/\text{m}^3$ interval) for 8-hr averaging time during operational phase .....	6-119
Figure 6.78	Predicted noise contours from reclamation activities .....	6-126
Figure 6.79	Predicted noise contours from construction of marine and onshore facilities .....	6-127
Figure 6.80	Location of noise sources in the plant .....	6-130
Figure 6.81	Predicted noise contours due to project development .....	6-132
Figure 6.82	Mangrove area loss within bridge footprint .....	6-141
Figure 6.83	Areas to be rehabilitated and replanted – eroding mangroves and seawall areas .....	6-144
Figure 6.84	Habitats for avifauna found within the project area .....	6-149
Figure 6.85	Location of intertidal mudflat loss .....	6-158
Figure 6.86	Predicted macrobenthos biomass – Phase 1, Southwest Monsoon .....	6-159
Figure 6.87	Predicted macrobenthos biomass – Phase 2, Southwest Monsoon .....	6-159
Figure 6.88	Predicted macrobenthos biomass – Phase 3, Southwest Monsoon .....	6-160
Figure 6.89	Predicted bivalve density – Phase 1, Southwest Monsoon .....	6-161
Figure 6.90	Predicted bivalve density – Phase 1, Southwest Monsoon .....	6-162
Figure 6.91	Predicted bivalve density – Phase 1, Southwest Monsoon .....	6-162
Figure 6.92	Fish landing areas around the project site .....	6-194
Figure 6.93	Distance of Project to the features along the coastal zone .....	6-208
Figure 6.94	Hazard-sensitive receptors at the site .....	6-218
Figure 6.95	Individual risk contours .....	6-220
Figure 6.96	Worst case scenario fire event .....	6-221
Figure 6.97	Worst case credible scenario fire event .....	6-222
Figure 6.98	Sensitive receptors related to human activities around project area .....	6-226
Figure 6.99	Air Quality Hazard Index within Study Area .....	6-229
Figure 6.100	Baseline Noise Level and the Permissible Noise Level during Operation Stage .....	6-229
Figure 6.101	Sensitive receptors along the affected road .....	6-237
Figure 6.102	Estimated peak traffic flow (background + construction) in 2015 .....	6-238
Figure 6.103	Estimated peak traffic flow (background + construction) in 2020 .....	6-239
Figure 6.104	Estimated peak traffic flow (background + construction) in 2025 .....	6-240
Figure 6.105	Estimated peak traffic flow (background + construction) in 2030 .....	6-241

Figure 6.106	Proposed road widening during construction of phase 1, 2 and 3 .....	6-243
Figure 6.107	Proposed upgrading of junction 1 to signalise junction .....	6-244
Figure 6.108	Estimated peak traffic flow (background + operation) in 2030 .....	6-245
Figure 6.109	LOS of the junction during morning peak hour with the proposed traffic light .....	6-246
Figure 6.110	LOS of the junction during evening peak hour with the proposed traffic light .....	6-247
Figure 6.111	Proposed upgrading of Junction 1 with dedicated ramp from Tg. Piai to Pontian .....	6-247
Figure 6.112	Sensitive Receptors for Navigation .....	6-249
Figure 6.113	Change in Maximum Current Speeds during NE Monsoon .....	6-254
Figure 6.114	Typical flood tide currents during NE monsoon .....	6-255
Figure 6.115	Typical ebb tide currents during NE monsoon .....	6-256
Figure 6.116	RIAM results for the overall project development – without mitigation. ....	6-261
Figure 6.117	RIAM results for the overall project development – residual impacts (with mitigation).....	6-261
Figure 8.1	EMP Workflow .....	8-2
Figure 8.2	Location of the fixed sediment plume monitoring stations during reclamation. ....	8-8
Figure 8.3	Flow diagram illustrating the feedback monitoring process.....	8-10
Figure 8.4	Locations of the fixed sediment plume monitoring stations during dredging and reclamation. ....	8-12
Figure 8.5	Water quality monitoring stations – construction stage. ....	8-14
Figure 8.6	Water quality monitoring stations – operations stage.....	8-17
Figure 8.7	Proposed location of the coastal profile monitoring.....	8-20
Figure 8.8	Locations of the plankton sampling stations.....	8-21
Figure 8.9	Location of the sampling stations for macrobenthos monitoring.....	8-23
Figure 8.10	Location of fish fauna monitoring stations. ....	8-25
Figure 8.11	Location of mangrove monitoring stations.....	8-27
Figure 8.12	Seagrass monitoring stations.....	8-28
Figure 8.13	Location of coral reef monitoring stations. ....	8-29
Figure 8.14	Air quality and noise monitoring stations .....	8-31

## TABLES

Table 1.1	Contact information of the project proponent .....	1-3
Table 1.2	DEIA study team consultants.....	1-4
Table 1.3	DEIA study team assistant consultants .....	1-5
Table 1.4	EIA study boundaries for the various environmental components.....	1-7
Table 1.5	DEIA report structure.....	1-9
Table 2.1	Planned storage capacity ('000 m <sup>3</sup> ) in Malaysia, 2011 – 2015. Source: Market Feasibility Study, 2012 by Jurong Consultants. ....	2-2
Table 2.2	Relevant International legislations and policies.....	2-5
Table 2.3	Relevant Federal legislations and policies.....	2-6
Table 2.4	Relevant State legislations and policies .....	2-7
Table 3.1	Boundary coordinates of the proposed project area .....	3-4
Table 3.2	Reclamation area based on phases .....	3-10
Table 3.3	Design Ship Sizes .....	3-13
Table 3.4	Estimated vessel calls at Jetties 1 and 2 and the shore connected berths.....	3-13
Table 3.5	Jetty 1 – Ship Sizes .....	3-15
Table 3.6	Jetty 2 – Ship Sizes.....	3-18
Table 3.7	Shore Connected Berths – Ship Sizes .....	3-20
Table 3.8	Planned project land use components.....	3-23
Table 3.9	Breakdown of storage capacity for Phase 1 .....	3-25
Table 3.10	Breakdown of storage capacity for Phase 2 .....	3-27
Table 3.11	Breakdown of storage capacity for Phase 3 .....	3-29
Table 3.12	Classification of industries as per the Guidelines for Siting and Zoning of Industry and Residential Areas (2012).....	3-32
Table 3.13	Required buffer zones.....	3-33
Table 3.14	Details of point source air emissions. ....	3-45

Table 4.1	Key details of each project option for reclamation layout .....	4-2
Table 5.1	Details of data collection for physical-chemical environment .....	5-1
Table 5.2	Laboratory results for marine sediment chemistry sampling. ....	5-9
Table 5.3	Tidal Levels at standard ports Tanjung Pelepas and Kukup. ....	5-19
Table 5.4	Runoff characteristics of the catchments (based on 11 years of simulated runoff). ....	5-26
Table 5.5	Design Stream Flows on east coast of Tg. Piai .....	5-28
Table 5.6	Water quality parameters .....	5-34
Table 5.7	Sound levels (LAeq) recorded at the sensitive receptors during the surveys in February and March 2014. ....	5-40
Table 5.8	Details of data collection for biological environment.....	5-41
Table 5.9	Mangrove sites in South Johor /, /.....	5-53
Table 5.10	Summary of mangrove species and density within study area.....	5-62
Table 5.11	Total average percent cover of seagrass found around Tanjung Piai – Sungai Pulau – Merambong Shoals. ....	5-64
Table 5.12	List of seagrass species found in the study area (Note: '+' = present, '-' = absent).....	5-65
Table 5.13	Percentage substrate cover of the reefs at Pulau Merambong. ....	5-77
Table 5.14	List of marine mammal species recorded in Peninsular Malaysia according to location of sightings and their conservation status. (Source: Ponampalan, L. 2012 /32/; Jaaman, S. A. 2004 /38/; Utusan Online 1999 /39/; Bernama Online 2006 /40/; The Star Online 2012 /41/; Choo et al. 2007 /36/ and Jaaman, S. A. 2002 /37/; unless indicated otherwise) .....	5-88
Table 5.15	List of marine mammal species recorded in Johor waters and the proposed project area. (Source: Ponampalam, L., 2012 /32/) .....	5-89
Table 5.16	Appearance of Dugong in Johor waters (with approximate distance to project site) (Source: DHI, 2014, Ponnampalam <i>et al.</i> , 2014) .....	5-92
Table 5.17	Status of marine mammal species .....	5-93
Table 5.18	Related planning blocks associated with the proposed project .....	5-123
Table 5.19	Land use within 5 km radius from the project .....	5-123
Table 5.20	Details on land use features found within 5 km radius from the project .....	5-124
Table 5.21	Population Distribution in Pontian District and Mukim Serkat in 2010.....	5-128
Table 5.22	Age distribution of Pontian District and Serkat Mukimin 2010.....	5-128
Table 5.23	Ethnic Composition of the Pontian District and Mukim Serkat in 2010 .....	5-129
Table 5.24	Age structure of respondents in the study area .....	5-130
Table 5.25	Family size in the study area .....	5-131
Table 5.26	Fishing Villages and the Jetties that would be affected within 5 km radius.....	5-133
Table 5.27	Reasons for objecting.....	5-143
Table 5.28	Fishermen age profile and their opinions regarding changing occupations and impact of proposed project.....	5-144
Table 5.29	Information on the public consultation.....	5-150
Table 5.30	Shipping Traffic in the Malacca Straits (ships per year) .....	5-162
Table 5.31	Shipping Traffic Statistics for Malaysian Ports in the vicinity of the Project (Ships per year) .....	5-162
Table 5.32	Shipping Traffic Statistics for Port of Singapore (Ships per year) .....	5-163
Table 5.33	Accident Statistics for PTP .....	5-163
Table 5.34	Key sensitive receptors within the study area .....	5-167
Table 6.1	Environmental impacts evaluated and chapter outline. ....	6-1
Table 6.2	Importance of the condition – scoring, generic and project-specific definitions. ....	6-4
Table 6.3	Magnitude of the impact .....	6-5
Table 6.4	Evaluation of magnitude of impact. ....	6-5
Table 6.5	Significance criteria for social impact assessment. ....	6-6
Table 6.6	Scale for Group B criteria. ....	6-7
Table 6.7	Range bands used for RIAM .....	6-7
Table 6.8	Impact severity matrix for sedimentation impacts on coral.....	6-45
Table 6.9	Impact severity matrix for sedimentation impact on seagrass.....	6-46
Table 6.10	Observed /estimated tolerances for sedimentation based on literature review for the dominant mangrove species observed around the Project site .....	6-46
Table 6.11	Impact assessment framework.....	6-61
Table 6.12	Threshold concentrations of suspended sediment .....	6-62
Table 6.13	Summary of spill estimations for reclamation works.....	6-63
Table 6.14	Summary of capital dredging parameters. ....	6-63



Table 6.15	Expected employment during construction of the proposed project .....	6-82
Table 6.16	Malaysia: Ambient air quality guidelines .....	6-106
Table 6.17	ACGIH Threshold Limit Value .....	6-107
Table 6.18	Details of points source emissions .....	6-108
Table 6.19	Predicted maximum incremental Ground Level Concentrations (GLC) .....	6-111
Table 6.20	Predicted cumulative Ground Level Concentrations (GLC) at receptors .....	6-119
Table 6.21	Schedule 1: Maximum permissible sound level (L <sub>Aeq</sub> ) by receiving land use for planning and new development. ....	6-122
Table 6.22	Maximum permissible sound level (L <sub>Aeq</sub> ) to be maintained at the existing noise climate. ....	6-122
Table 6.23	Ambient noise level monitoring results and permissible levels, based on a combination of Schedule 1 and Schedule 3 limits. ....	6-122
Table 6.24	Construction scenarios and list of assumed equipment for each scenarios .....	6-123
Table 6.25	Construction scenarios and the predicted noise level at the noise receivers. ....	6-124
Table 6.26	Construction vehicle noise propagation levels in dBA .....	6-128
Table 6.27	Principal noise sources of the plant operation .....	6-129
Table 6.28	Traffic forecast due to the project development .....	6-131
Table 6.29	Predicted incremental noise level at the noise sensitive receptors .....	6-131
Table 6.30	Predicted cumulative noise level at noise sensitive receptors during operational phase .....	6-131
Table 6.31	Mitigation measures to minimise impact to terrestrial ecology during construction .....	6-136
Table 6.32	Mitigation measures to minimise impact to terrestrial ecology during operations .....	6-138
Table 6.33	Mangrove condition .....	6-139
Table 6.34	Waterbird response to construction disturbance (Source: Institute of Estuarine and Coastal Studies, 2009) .....	6-148
Table 6.35	Changes in predicted total biomass of zoobenthos (wet weight) during the different project phases and monsoon seasons. ....	6-160
Table 6.36	Changes in predicted total density of bivalves during the different project phases and monsoon seasons. ....	6-163
Table 6.37	Impact severity matrix for sedimentation impact on seagrass. ....	6-182
Table 6.38	Impact severity matrix for sedimentation impacts on coral .....	6-187
Table 6.39	Significance rating categories used in the social impacts assessment .....	6-191
Table 6.40	Fishing Village and Jetty that would be affected within 5 km radius .....	6-192
Table 6.41	Visual Impact Rating for Tg Piai National Park .....	6-210
Table 6.42	Visual Impact Rating for Tg Piai Resort .....	6-211
Table 6.43	Hazard zones criteria and predicted distance from Project boundary. ....	6-219
Table 6.44	Types of pollutants and their corresponding recommended limit as per RMAQG .....	6-225
Table 6.45	Land use Compatibility Analysis .....	6-231
Table 6.46	Estimated employment for the proposed development by phase .....	6-234
Table 6.47	Description of level of services (LOA) to reflect the road performance .....	6-235
Table 6.48	Degree of saturation threshold and its corresponding level of service (LOS) .....	6-235
Table 6.49	Vehicular volume requirements to warrant signal control .....	6-236
Table 7.1	Summary of Environmental Services Effected by the Project .....	7-2
Table 7.2	Estimated Resource Value of Mudflat (2014 price) .....	7-4
Table 7.3	Estimated Environmental Value of Mangrove Area by Service Type (2014 price) .....	7-5
Table 7.4	Estimates of the total discounted loss in environmental services at the three rates used in the assessment .....	7-7
Table 8.1	Legislation applicable in the management of the study area .....	8-6
Table 8.2	Compliance monitoring activities for suspended sediment control .....	8-7
Table 8.3	Coordinates of the fixed sediment plume monitoring stations shown in Figure 8.2 above in WGS 1984 (decimal degrees). ....	8-8
Table 8.4	Suspended sediment monitoring programme for Phase 2 Dredging and Reclamation Works. ....	8-11
Table 8.5	Geographic coordinate for online turbidity monitoring station in WGS 1984 (decimal degrees). ....	8-12
Table 8.6	Water pollution control measures and methods for monitoring compliance .....	8-13
Table 8.7	Geographic coordinates and description of the water quality stations in WGS84 (decimal degrees). ....	8-15
Table 8.8	Water quality parameters to be analysed – construction stage .....	8-16
Table 8.9	Geographic coordinates and description of the water quality stations during operation stage in WGS84 (decimal degrees) .....	8-18
Table 8.10	Water quality monitoring parameters – operations stage .....	8-19

Table 8.11	Geographic coordinate and description of the sampling stations for plankton (phytoplankton and zooplankton) monitoring in WGS 1984 (decimal degrees).....	8-22
Table 8.12	Description of the sampling stations for macrobenthos monitoring.....	8-23
Table 8.13	Geographic coordinates (degrees, minutes) of the fish fauna monitoring stations.....	8-24
Table 8.14	Coordinates (decimal degrees) of transect start points for mangrove monitoring.....	8-26
Table 8.15	Location of the seagrass monitoring stations in decimal degrees.....	8-28
Table 8.16	Coordinates of coral reef monitoring stations (starting points).....	8-30
Table 8.17	Air emissions abatement measures and related compliance monitoring during the construction phase.....	8-30
Table 8.18	Compliance monitoring for air quality during operational phase.....	8-31
Table 8.19	Parameters to be measured in the air quality monitoring.....	8-32
Table 8.20	Noise management measures and compliance monitoring.....	8-32
Table 8.21	Socio economic compliance monitoring programme.....	8-33
Table 8.22	Socio economic feedback monitoring programme (interviews, stakeholder groups).....	8-34
Table 8.23	Compliance monitoring programme for mitigation of impacts to fisheries.....	8-35
Table 8.24	Compliance audit for project closure or abandonment (monthly during decommissioning).....	8-38

## PHOTOS

Photo 3.1	Example of a jetty structure to handle petroleum products.....	3-39
Photo 5.1	Stable mangrove coastline along the western coast of Tg. Piai National Park.....	5-28
Photo 5.2	Eroding mangrove coastline along the northeast coast of Tg. Piai National Park. South view towards the monument area.....	5-29
Photo 5.3	The semi-rigid protection scheme comprising loose sandbags placed on the foreshore in a side-by-side arrangement for the purpose of combating coastal erosion east of the monument area. Note the open section, which is caused by waves dislocating the sandbags.....	5-29
Photo 5.4	View of the site to the north of the Tg. Piai National Park, nearby Tanjung Piai Resort. A seawall has been constructed for protection, no mangrove forest remains there.....	5-30
Photo 5.5	Aerial view of the sand bag protection in the area north of the Tg Piai National Park.....	5-30
Photo 5.6	Vegetation along the shoreline from Tg. Piai to Tg. Bin (Photo 1).....	5-44
Photo 5.7	Vegetation along the shoreline from Tg. Piai to P. Kukup (Photo 2).....	5-44
Photo 5.8	Mixed vegetation of Tanjung Piai.....	5-45
Photo 5.9	Coconut and oil palm plantation in the study area (Photo 3).....	5-45
Photo 5.10	Monkeys in Tanjung Piai National Park (left) // and in P. Kukup taken during survey (right).....	5-47
Photo 5.11	Example of protected wildlife: wild boar (left) and pangolin (right) /, /.....	5-47
Photo 5.12	Lesser adjutant	5-52
Photo 5.13	Common sandpiper	5-52
Photo 5.14	Mangrove of Tanjung Piai (Photo 1).....	5-55
Photo 5.15	Mudflats of Tanjung Piai (Photo 2). Note the effect of the ongoing shore line erosion leading to the loss of mature trees.....	5-55
Photo 5.16	Mudflats of Tanjung Piai-Tanjung Bin (Photo 3).....	5-56
Photo 5.17	Mangrove of Tanjung Piai-Tanjung Bin (Photo 4).....	5-56
Photo 5.18	Eroded Coastline in Tg. Piai National Park; Bottom photo: Erosion Control Bag Placed in the Eroded Area.....	5-57
Photo 5.19	Aerial view of P. Kukup mangroves looking north-west.....	5-58
Photo 5.20	Mangrove of Pulau Kukup.....	5-58
Photo 5.21	Eroding mangrove on the northwestern side of P. Kukup.....	5-59
Photo 5.22	Mangrove of Pulau Kukup. Note undercutting of mature trees, commonly a result of boat wake.....	5-59
Photo 5.23	Aerial view of Sungai Pulai mangroves.....	5-60
Photo 5.24	Tributaries of Sungai Pulai: Sungai Tiram.....	5-61
Photo 5.25	Felling observed near Sg. Chengkeh.....	5-61
Photo 5.26	Surveys being conducted on the extensive seagrass area off PTP.....	5-64
Photo 5.27	Type of seagrasses found in the study area.....	5-66
Photo 5.28	Low tide at Pulau Merambong.....	5-67
Photo 5.29	Seaweed species found around the study area.....	5-69

Photo 5.30	Gastropods found at the study area.....	5-70
Photo 5.31	Bivalves and cephalopods found at the study area.....	5-71
Photo 5.32	Echinoderms found at the study area.....	5-72
Photo 5.33	Holothuroideans found at the study area.....	5-73
Photo 5.34	Anemones and shrimps found at the study area.....	5-74
Photo 5.35	Other invertebrates found at the study area.....	5-75
Photo 5.36	Reef conditions along the survey transects.....	5-78
Photo 5.37	Hard corals found around P. Merambong.....	5-79
Photo 5.38	Soft corals and Gorgonians found around P. Merambong.....	5-80
Photo 5.39	Associated reef fishes found around the reefs of P. Merambong.....	5-82
Photo 5.40	Associated macroinvertebrates found around the reefs of P. Merambong.....	5-83
Photo 5.41	Photos of some seaweeds found around the reefs of Pulau Merambong.....	5-85
Photo 5.42	Tanjung Piai National Park.....	5-145
Photo 5.43	<i>Tanjung Piai Resort</i> .....	5-146
Photo 5.44	State road J111.....	5-153
Photo 5.45	Meeting point of federal road FR95 and state road J111.....	5-153
Photo 5.46	Priority Junction connecting road from Tg. Piai to Kukup or Pontian Kechil.....	5-156
Photo 5.47	Aerial view of PTP within Pulai River taken in May 2013.....	5-164
Photo 5.48	Aerial view of southern part of PTP taken in May 2013.....	5-164
Photo 5.49	Tg. Bin Power Station (May 2013).....	5-165
Photo 5.50	Aerial view of Tg. Bin Power Station taken from river mouth of Pulai River in May, 2013.....	5-165
Photo 6.1	Existing coastal protection along the Piai Ramsar site – erosion of mangroves fronting the revetment are evident. Rehabilitation of these areas to restore the original hydrodynamic regime is recommended.....	6-145
Photo 6.2	Aerial view of Tg Piai showing the agricultural area and the flat terrain.....	6-209
Photo 6.3	Tg Piai National Park.....	6-209
Photo 6.4	Tg Piai Resort.....	6-210
Photo 6.5	Glennavis LNG tanks with blue colour treatment. Photo courtesy of The Neilston WebCam Photo Gallery. url: <a href="http://www.drookitagain.co.uk">http://www.drookitagain.co.uk</a> , downloaded October 24, 2014.....	6-213

## APPENDICES

A	Project Supporting Information
B	Field Data Collection
C	Bathymetric Survey Report
D	Socioeconomic Report
E	Numerical Modelling Studies
F	Fauna Survey Report
G	Marine Ecology Survey Report
H	Habitat Modelling Report
I	Navigation Study
J	Navigation Simulation Report
K	Quantitative Risk Assessment
L	Land Use Compatibility Report
M	Economic Valuation of Environmental Impacts
N	Traffic Impact Assessment
O	Health Impact Assessment



## DRAWINGS

- 1 Project Buffer Zone as per DOE's Guidelines for Siting and Zoning for Industries, 2nd Edition
- 2 Planned Land Use of the Proposed Project
- 3 Bathymetry Surrounding the Proposed Project Area
- 4 Existing Land Use as per Pontian Local Plan within 5 km of the Proposed Project
- 5 Summary of Identified Sensitive Receptors within 5 km of the Project
- 6 Summary of Identified Sensitive Receptors within 10 km of the Project
- 7 Port Facilities Adjacent the Proposed Project