

TABLE OF CONTENT

TABLE OF CONTENT	i
LIST OF TABLES	viii
LIST OF FIGURES	xii
LIST OF PLATES	xix
LIST OF APPENDIXES	xx

EXECUTIVE SUMMARY

1.0 INTRODUCTION	ES-1
1.1 Project Title	ES-1
1.2 Project Proponent and Consultants	ES-1
1.3 Legal Requirements	ES-2
1.4 Conformance with the Government's Development Plans	ES-3
2.0 STATEMENT OF NEED	ES-3
3.0 PROJECT OPTION	ES-4
4.0 PROJECT DESCRIPTION	ES-5
4.1 Project Components	ES-7
5.0 EXISTING ENVIRONMENT	ES-7
6.0 POTENTIAL SIGNIFICANT IMPACTS AND MITIGATING MEASURES	ES-14
7.0 RESIDUAL IMPACTS	ES-19
8.0 CONCLUSION	ES-43
9.0 PERFORMANCE MONITORING (PM) & COMPLIANCE MONITORING (CM)	ES-43
10.0 IMPACT MONITORING	ES-45
11.0 DOE TOR APPROVAL CONDITIONS	ES-46

RINGKASAN EKSEKUTIF

1.0 PENGENALAN	RE-1
1.1 Tajuk Projek	RE-1
1.2 Penggerak Projek dan Perunding	RE-1
1.3 Keperluan Undang-undang	RE-2
1.4 Pematuhan kepada Pelan Pembangunan Kerajaan	RE-3
2.0 KEPERLUAN PROJEK	RE-3
3.0 OPSYEN/ PILIHAN PROJEK	RE-4
4.0 HURAIAH PROJEK	RE-6
4.1 Komponen Projek	RE-6
5.0 KEADAAN ALAM SEKITAR SEDIA ADA	RE-8
6.0 POTENSI IMPAK SIGNIFIKAN & LANGKAH PENCEGAHAN	RE-15
7.0 KESAN RESIDU	RE-21
8.0 KESIMPULAN	RE-49
9.0 PEMANTAUAN PRESTASI (PM) & PEMANTAUAN PEMATUHAN (CM)	RE-50
10.0 PEMANTAUAN IMPAK	RE-52
11.0 SYARAT KELULUSAN TOR JAS	RE-52

CHAPTER 1: INTRODUCTION

1.0	FOREWORD	1-1
1.1	PROJECT TITLE	1-1
1.2	PROJECT PROPONENT AND CONSULTANTS.....	1-2
1.3	LEGAL REQUIREMENT	1-12
1.4	CONFORMANCE WITH THE GOVERNMENT'S DEVELOPMENT PLANS	1-12

CHAPTER 2: TERMS OF REFERENCE (TOR) OF THE EIA STUDY

2.0	INTRODUCTION	2-1
2.1	PROJECT TITLE	2-1
2.2	EIA CONSULTANT AND EIA STUDY TEAM MEMBERS	2-2
2.3	SCOPE OF PROJECT	2-2
2.4	PROJECT ALTERNATIVES AND ENVIRONMENTAL IMPACTS.....	2-3
2.5	STUDY BOUNDARIES	2-15
2.5.1	SIGNIFICANT IMPACTS TO BE STUDIED	2-21
2.6	SIGNIFICANT ENVIRONMENTAL IMPACTS TO BE STUDIED.....	2-22
2.6.1	ZONE OF IMPACT AND SENSITIVE RECEPTORS	2-22
2.6.2	ASSESSMENT OF IMPACT	2-23
2.7	ASSESSMENT STANDARDS	2-23
2.8	TIMELINE OF STUDIES	2-24
2.9	CONSIDERATION OF CONCURRENT PROJECTS	2-25
2.10	DESCRIPTION OF MODELLING TOOLS/ ASSESSMENT METHODOLOGIES	2-25
2.11	POSSIBLE MITIGATION MEASURES	2-26
2.12	DOE TOR APPROVAL CONDITIONS.....	2-27

CHAPTER 3: STATEMENT OF NEEDS

3.0	INTRODUCTION.....	3-1
3.1	GROWTH OF PENANG	3-1
3.2	PENANG'S GDP AND ECONOMIC GROWTH	3-2
3.3	TRANSPORT SITUATION IN PENANG – VEHICLE RE-REGISTRATION	3-6
3.4	PENANG ROAD NETWORK	3-8
3.5	STATEMENT OF NEED	3-12

CHAPTER 4: PROJECT OPTIONS

4.0	INTRODUCTION.....	4-1
4.1	PROJECT OPTIONS.....	4-1
4.1.1	Alignment Options	4-1
4.1.2	Elevated Highway and Tunnels vs. At Grade Highway.....	4-11
4.1.3	Tunnelling Options	4-16
4.1.4	No Project Option	4-27

CHAPTER 5: PROJECT DESCRIPTION

5.0	INTRODUCTION	5-1
5.1	PROJECT CONCEPT	5-1
5.2	PROJECT LOCATIONS.....	5-2
5.2.1	PIL 1 Highway Corridor.....	5-2
5.2.2	PIL 1 Highway Interchange.....	5-14
5.3	PROJECT DESIGN	5-20
5.3.1	Viaduct Design	5-20
5.3.1.1	Viaduct Foundation	5-22
5.3.1.2	Typical Viaduct Superstructure	5-22
5.3.1.3	Special Span-Balanced Cantilever Box Girder	5-23
5.3.1.4	Special Span – Cable Stayed Bridge.....	5-26
5.3.1.5	Special Consideration – Pier Positions along Sg Ara and Sg Kluang	5-28
5.3.1.5.1	Sg Ara.....	5-28
5.3.1.5.2	Sg Kluang	5-38
5.3.1.5.3	Sg Kluang River Mouth	5-44
5.3.1.5.4	PIL1 – LCE Interchange	5-44
5.3.2	Tunnel Design.....	5-48
5.3.3	Embankment Design	5-52
5.4	CONSTRUCTION METHOD.....	5-54
5.4.1	Viaduct Construction Method.....	5-54
5.4.1.1	Utilities Relocation	5-54
5.4.1.2	Bored Pile	5-54
5.4.1.3	Pile Cap.....	5-57
5.4.1.4	Piers	5-58
5.4.1.5	Cross Beam	5-58
5.4.1.6	Beam and Deckslab	5-59
5.4.1.7	Balance Cantilever Box Girder Construction	5-59
5.4.2	Tunnel Construction.....	5-62
5.4.3	Embankment Construction Method	5-74
5.4.4	Traffic Management (TMP).....	5-74
5.4.5	Night Work.....	5-77
5.5	CONSTRUCTION FACILITIES.....	5-77
5.5.1	Tunnel Construction Facilities.....	5-77
5.5.2	Centralized Staff Quarter (CLQ)	5-82
5.5.3	Machinery and Equipment Depot.....	5-83
5.5.4	Explosive Magazine	5-84
5.5.5	Store Yard.....	5-85
5.5.6	Beam Casting Yard	5-87
5.6	ENVIRONMENTAL CONTROL MEASURES	5-88
5.7	PROJECT IMPLEMENTATION SCHEDULE	5-89

CHAPTER 6: EXISTING ENVIRONMENT

6.0	INTRODUCTION	6-1
6.1	PHYSICAL ENVIRONMENT	6-1
6.1.1	Topography	6-1
6.1.2	Land Use	6-7
6.1.3	Geology	6-12
6.1.3.1	Alluvium	6-12
6.1.3.2	Weathered Rock	6-13
6.1.3.3	Fault	6-15
6.1.3.4	Joints	6-15
6.1.3.5	Groundwater	6-15
6.1.3.6	Seismicity	6-16
6.1.4	Soil	6-17
6.1.5	Meteorological Condition	6-20
6.1.6	Traffic	6-26
6.1.6.1	Road/Highway Inventory	6-26
6.1.6.2	Traffic Volume 2015	6-33
6.1.6.3	Traffic Composition	6-44
6.1.7	Hydrology	6-44
6.1.8	Air Quality	6-46
6.1.8.1	Malaysian Ambient Air Quality Standards 2013	6-46
6.1.8.2	Ambient Air Quality	6-47
6.1.9	Noise and Vibration	6-52
6.1.10	Water Quality	6-67
6.2	BIOLOGICAL ENVIRONMENT	6-77
6.2.1	Flora-Forest Vegetation	6-79
6.2.1.1	Plant Diversity and Composition	6-79
6.2.1.2	Plant Community and Distribution	6-79
6.2.1.3	Plant Biomass and Carbon Stock	6-82
6.2.2	Fauna	6-85
6.2.2.1	Medium and Large Sized Mammals	6-86
6.2.2.2	Birds	6-88
6.2.2.3	Reptiles	6-94
6.2.2.4	Amphibians	6-96
6.3	SOCIO ECONOMY	6-99
6.3.1	Population and Demographic Characteristics of Penang and the Study Area	6-99
6.3.2	Economic Base	6-105
6.3.3	Potentially Affected Communities	6-106
6.3.3.1	Affected Communities	6-106
6.3.3.2	Affected Land and Property	6-111
6.3.4	Sensitive Receptors	6-113
6.3.4.1	Jalan Bagan Jermal, Jalan Gottlieb and Youth Park Corridor	6-113
6.3.4.2	Air Itam Corridor	6-114
6.3.4.3	Paya Terubong Corridor	6-114
6.3.4.4	Relau Corridor	6-114

6.3.4.5	Sungai Ara and Sg Kluang Corridor.....	6-114
6.3.5	Public Perception and Stakeholder Feedback	6-117
6.3.5.1	Methodology	6-117
6.3.5.2	Public Perception.....	6-119
6.3.6	Public Health	6-133
6.3.6.1	Existing Public Health in the State of Penang.....	6-133
6.3.6.2	Existing Public Health in the District of Barat Daya and Timur Laut	6-135
6.3.6.3	Existing Air Quality Status of the Districts	6-138
6.3.6.4	Community Survey	6-141

CHAPTER 7: EVALUATION OF IMPACTS

7.0	INTRODUCTION	7-1
7.1	IDENTIFICATION AND PREDICTION OF IMPACTS	7-1
7.1.1	Zone of Impact and Sensitive Receptors.....	7-1
7.1.2	Approach for Assessment of Potential Impacts.....	7-2
7.1.3	Impact Matrix.....	7-2
7.2	POTENTIALLY SIGNIFICANT IMPACTS DURING PROJECT PLANNING AND PRE-CONSTRUCTION STAGE.....	7-15
7.2.1	Socio-economic Impacts	7-15
7.2.2	Land Acquisition : Social Impacts	7-24
7.2.3	Utilities Relocation	7-28
7.3	POTENTIALLY SIGNIFICANT IMPACTS DURING CONSTRUCTION STAGE	7-29
7.3.1	Geology and Geotechnical	7-34
7.3.1.1	Construction of Viaduct/Interchange/CLQ/Support Facilities	7-35
7.3.1.2	Construction of Tunnels	7-36
7.3.2	Waste Generation	7-37
7.3.2.1	Construction of Viaduct/Interchange/CLQ/Support Facilities	7-37
7.3.2.2	Construction of Tunnels	7-38
7.3.3	Traffic	7-40
7.3.3.1	Construction of Viaduct/Interchange/CLQ/Support Facilities	7-40
7.3.3.2	Tunnel Construction.....	7-42
7.3.4	Air Quality	7-42
7.3.4.1	Construction of Viaduct/Interchange/CLQ/Support Facilities	7-43
7.3.4.2	Tunnel Construction.....	7-44
7.3.5	Soil Erosion and Sedimentation	7-44
7.3.5.1	Construction of Viaduct/Interchange/CLQ/Support Facilities	7-45
7.3.5.2	Tunnel Construction.....	7-49
7.3.6	Floods.....	7-49
7.3.6.1	Construction of Viaduct/Interchange/CLQ/Support Facilities	7-50
7.3.6.2	Tunnel Construction.....	7-51
7.3.7	Water Quality	7-51
7.3.7.1	Construction of Viaduct/Interchange/CLQ/Support Facilities	7-52
7.3.7.2	Tunnel Construction.....	7-53
7.3.8	Noise and Vibration	7-53
7.3.8.1	Construction of Viaduct/Interchange/CLQ/Support Facilities	7-55
7.3.8.2	Tunnel Construction.....	7-55
7.3.9	Safety and Health.....	7-56

7.3.9.1 Construction of Viaduct/Interchange/CLQ/Support Facilities	7-56
7.3.9.2 Tunnel Construction.....	7-57
7.3.9.3 Hazard Identification.....	7-58
7.3.10 Heritage.....	7-59
7.3.11 Flora and Fauna.....	7-59
7.4 DETAILED EXAMINATION OF IMPACTS	7-60
7.4.1 Noise	7-60
7.4.2 Vibration.....	7-68
7.4.3 Air Quality – Potential Impacts: Operations Phase.....	7-69
7.4.4 Traffic Impact during Operation Stage.....	7-112
7.4.5 Hydrology	7-118
7.4.5.1 Hydraulic Modelling Study	7-120
7.4.5.2 Impacts of Pier Construction on Coastal Processes at the LCE Interchange ...	7-181
7.5 EMERGENCY RESPONSE PLAN.....	7-199
7.6 POTENTIALLY SIGNIFICANT IMPACTS DURING OPERATIONAL STAGE	7-199

CHAPTER 8: MITIGATION MEASURES

8.0 INTRODUCTION.....	8-1
8.1 MITIGATION MEASURES DURING PROJECT PLANNING AND PRE-CONSTRUCTION STAGE.....	8-2
8.1.1 Land / Property Acquisition	8-2
8.1.2 Utilities Relocation	8-6
8.2 MITIGATION MEASURES DURING CONSTRUCTION STAGE.....	8-7
8.2.1 Geology and Geotechnical	8-7
8.2.1.1 Construction of Viaduct/ Interchange/ CLQ/ Support Facilities.....	8-7
8.2.1.2 Construction of Tunnels	8-8
8.2.2 Waste Management.....	8-9
8.2.2.1 Construction of Viaduct/ Interchange/ CLQ/ Support Facilities.....	8-9
8.2.2.2 Construction of Tunnels	8-11
8.2.3 Traffic Management.....	8-11
8.2.4 Air Quality	8-21
8.2.5 Noise and Vibration	8-32
8.2.6 Floods and Coastal Processes	8-45
8.2.7 Soil Erosion.....	8-48
8.2.8 Water Quality.....	8-59
8.2.9 Socio-Economy.....	8-61
8.2.10 Other Issues/ Considerations	8-62
8.2.11 Night Work.....	8-66
8.2.12 Public Safety & Health.....	8-67
8.2.13 Flora & Fauna	8-69
8.3 OPERATION PHASE.....	8-71
8.3.1 Commisioning	8-71
8.3.2 Operations Phase	8-71
8.3.3 Operational Facilities and Abnormal Conditions	8-72
8.3.4 Highway Aesthetics	8-73
8.3.5 Traffic Study	8-73
8.4 RESIDUAL IMPACTS.....	8-83
8.5 PROJECT ABADONMENT	8-87

CHAPTER 9: ENVIRONMENTAL MANAGEMENT PLAN (EMP)

9.0	INTRODUCTION	9-1
9.1	OBJECTIVE OF THE EMP	9-2
9.2	COMPLIANCE WITH RELEVANT ENVIRONMENTAL REQUIREMENT	9-2
9.3	GUIDANCE SELF REGULATION THROUGH ENVIRONMENTAL MAINSTREAMING TOOLS	9-2
9.3.1	Environmental Policy (EP)	9-4
9.3.2	Environmental Budgeting (EB)	9-4
9.3.3	Environmental Monitoring Committee (EMC)	9-4
9.3.3.1	Penang State Government	9-6
9.3.3.2	Project Delivery Partner	9-6
9.3.3.3	Environmental Officer	9-7
9.3.4	Environmental Facility (EF)	9-8
9.3.5	Environmental Competency (EC)	9-8
9.3.6	Environmental Reporting and Communication (ERC)	9-9
9.3.6.1	External Reporting	9-9
9.3.6.2	Internal Reporting	9-10
9.3.6.3	Communication Channels	9-11
9.3.7	Environmental Transparency (ET)	9-12
9.3.8	Environmental Mainstreaming Tools Compliance Report	9-12
9.4	ENVIRONMENTAL MONITORING PROGRAMME 9-16	
9.4.1	Performance Monitoring (PM)	9-16
9.4.1.1	Water Quality	9-16
9.4.1.2	Noise and Vibration	9-17
9.4.1.3	Air Quality	9-17
9.4.2	Compliance Monitoring (CM)	9-18
9.4.2.1	Water Quality	9-18
9.4.2.2	Noise and Vibration	9-18
9.4.2.3	Air Quality	9-18
9.4.3	Impact Monitoring	9-19
9.4.3.1	Water Quality	9-19
9.4.3.2	Noise and Vibration During Construction	9-19
9.4.3.3	Air Quality	9-20
9.5	ENVIRONMENTAL AUDITING	9-20
9.6	EMERGENCY RESPONSE PLAN	9-24

CHAPTER 10: STUDY FINDINGS

10.0	FOREWORD	10-1
10.1	PROJECT PROPONENT AND CONSULTANTS	10-1
10.2	LEGAL REQUIREMENTS	10-1
10.3	CONFORMANCE WITH THE GOVERNMENT'S DEVELOPMENT PLANS	10-2
10.4	PROJECT NEED / STATEMENT OF NEED	10-4
10.5	PROJET OPTIONS	10-4

10.6	PROJECT DESCRIPTION.....	10-5
10.6.1	Project Concept.....	10-6
10.6.2	Project Components / Activities and Potential Impacts	10-6
10.7	RESIDUAL IMPACTS.....	10-10
10.8	INCIDENT MANAGEMENT / EMERGENCY RESPONSE PLAN (ERP)	10-11
10.9	EMP AND ENVIRONMENTAL MONITORING.....	10-12
10.10	KEY RECOMMENDATIONS.....	10-12
10.11	CONCLUSIONS.....	10-15

LIST OF TABLES

		Page
Table 5.1	Elevations of the Proposed PIL 1 Highway	ES-7
Table 5.2	AM & PM Peak Hour Average Highway Speed in Differing Parts of the State	ES-10
Table 6.1	“Capture Rate” Analysis Results (PIL1 – LCE)	ES-19
Table 7.1	Potential Impacts and Mitigation Measures for the PIL1 Highway.	ES-21
Table 9.1	Performance Monitoring Descriptors	ES-44
Table 9.2	Compliance Monitoring Descriptors	ES-44
Table 10.1	Impact Monitoring Descriptors	ES-45
Table 11.1	TOR Approval Conditions	ES-47
Jadual 5.1	Aras Ketinggian bagi Kawasan Cadangan Projek Lebuhraya PIL 1	RE-8
Jadual 5.2	Purata Waktu Puncak AM & PM Kelajuan Lebuhraya untuk Bahagian Berbeza di Negeri Pulau Pinang	RE-11
Jadual 6.1	Keputusan Analisis “Capture Rate” (PIL1 – LCE)	RE-21
Jadual 7.1	Potensi Impak dan Langkah Kawalan untuk lebuhraya PIL 1	RE-23
Jadual 9.1	Penerangan Pemantauan Prestasi (PM)	RE-50
Jadual 9.2	Penerangan Pemantauan Pematuhan (CM)	RE-51
Jadual 10.1	Penerangan Impak Pemantauan (IM)	RE-52
Jadual 11.1	Syarat-syarat Kelulusan TOR	RE-53
Table 1.2.1	EIA Study Team Members	1-4
Table 2.4.1	PIL1 Corridor Sections	2-6
Table 2.5.1	General Assessment of Potential Impacts Imposed by the Project Activities	2-17
Table 2.5.2	Project Activity and Significant Impacts	2-22
Table 2.7.1	Criteria for Assessing Environmental Quality	2-24
Table 2.8.1	EIA Study Timeline	2-24
Table 2.10.1	Modelling Tools and Assessment Methodologies Adopted for this EIA Study	2-25
Table 2.11.1	Possible Mitigation Measures that are Applicable for the PIL1 Project	2-26
Table 3.2.1	Penang’s International Air Cargo Handled and Sea Gross Registered Tonnage	3-6
Table 3.3.1	Number of Vehicle Re-Registration in Penang, 2008-March 2014	3-7
Table 3.4.1	Major Expressways and Roads in Penang Island	3-9

Table 4.1.1	Potential Impacts along Option 1 and Option 2 Alignments	4-8
Table 4.1.2	Merits and Demerits of Drill and Blast Method	4-19
Table 4.1.3	Merits and Demerits of TBM Method	4-24
Table 4.1.4	Summary of Environmental Merits and Demerits of 3 Tunneling Methods	4-25
Table 5.2.1	PIL1 Components / Sections	5-4
Table 5.4.1	Estimation of Explosives for Tunnel Blasting Works	5-73
Table 5.6.1	Environmental Issues and Mitigation Measures.	5-88
Table 6.1.1	Elevations of the Proposed PIL 1 Highway	6-2
Table 6.1.2	Slopes in the Proposed PIL 1 Highway Alignment	6-2
Table 6.1.3	Percent Land Use along the Alignment	6-7
Table 6.1.4	Land Use along the Project Corridor	6-8
Table 6.1.5	Earthquake Records of Magnitude > 7.0 and Distances within 600 km Radius from Penang Island (Azmi, 2014)	6-16
Table 6.1.6	Soil Loss and Sediment Zones	6-17
Table 6.1.7	Soil Loss Under Existing Conditions	6-19
Table 6.1.8	Sediment Yield Under Existing Conditions	6-19
Table 6.1.9	Summary of Climatological Data for Bayan Lepas	6-21
Table 6.1.10	Traffic Condition at Important Connections, Year 2015	6-33
Table 6.1.11	Traffic Conditions near the Proposed PIL 1 Alignment	6-34
Table 6.1.12	Junction Performance in Existing Year (Morning & Evening Peak), 2015	6-39
Table 6.1.13	Percent Traffic Composition	6-44
Table 6.1.14	Malaysia Ambient Air Quality Standard	6-46
Table 6.1.15	Description of the Ambient Air Quality Monitoring Stations	6-49
Table 6.1.16	Results of the Ambient Air Quality Monitoring	6-51
Table 6.1.17	Description of Noise and Vibration Monitoring Stations	6-52
Table 6.1.18	Permissible Sound Levels from Highway Traffic for the Proposed Highway	6-61
Table 6.1.19	Results of Ambient Noise Measurements	6-62
Table 6.1.20	Results of Vibration Measurements	6-65
Table 6.1.21	Description of Water Sampling Points	6-67
Table 6.1.22	Results of the Water Quality Analyses	6-69
Table 6.2.1	List of Sampling Points Along the Proposed PIL1 Corridor	6-77
Table 6.2.2	List of Mammals in the Survey Areas	6-86
Table 6.2.3	List of Bird Species Recorded in the Study Areas	6-90
Table 6.2.4	Reptiles Recorded in the Study Sites	6-94
Table 6.2.5	Amphibians Recorded in the Study Sites	6-96
Table 6.3.1	Population Growth Trend between the Inter-census Period	6-99
Table 6.3.2	Population, Households and Living Quarters in the State of Pulau Pinang by District in 2010	6-100
Table 6.3.3	Ethnic Composition in Penang by District 2010	6-101
Table 6.3.4	Population Distribution by Mukims in Timor Laut District 2010	6-102
Table 6.3.5	Population Distribution of Barat Daya District by Mukims in 2010	6-104
Table 6.3.6	Penang Gross Domestic Product by Industrial Sectors between 2005 and 2011	6-106

Table 6.3.7	Estimate of the Types and Numbers of Property/Land Acquisition for the PIL 1 Highway Project	6-111
Table 6.3.8	Comparison of health indicators between Penang and Malaysia (2014)	6-133
Table 6.3.9	Number of Cases of Diseases, 2015	6-134
Table 6.3.10	Number of Cases of Food and Waterborne Diseases in the Study Area, 2015	6-136
Table 6.3.11	Number of Cases of Vector Borne Diseases in the Study Area, 2015	6-136
Table 6.3.12	Number of Cases of Air and Sanitation Related Diseases in the Study Area, 2015	6-137
Table 6.3.13	Number of STI Cases in the Study Area, 2015	6-137
Table 6.3.14	Distribution of the Respondents According to Age Groups (n=932)	6-142
Table 6.3.15	Frequency and Type of Health Problems Claimed by the Respondents and Their Dependents in the Past Six Months in Both Areas	6-143
Table 6.3.16	Frequency of Diagnosis Among the Respondents and Their Dependents in the Past Six Months in Both Areas	6-143
Table 6.3.17	Type of Health Problems for Hospitalisation Among the Respondents and Their Dependents in the Past Six Months in Both Areas (n=13)	6-143
Table 7.1.1	Assessment of Potential Impacts Imposed by the Project Activities	7-9
Table 7.2.1	Socio-economic Impacts - Stakeholder Concerns	7-16
Table 7.2.2	Summary of Land/Property Acquisitions For PIL1 Project	7-17
Table 7.2.3	Land/Property Potentially Affected by the Project Development along Jalan Bagan Jermal, Jalan Gottlieb and Youth Park Corridor	7-19
Table 7.2.4	Land/Property Potentially Affected by the Project Development at Sg. Ara and along Sg. Ara and Sg. Kluang.	7-23
Table 7.3.1	Viaduct sections of the PIL1 Highway	7-29
Table 7.3.2	Interchange in the PIL1 highway and its' connectivity	7-30
Table 7.3.3	Location of PIL1 Support Facilities.	7-31
Table 7.3.4	Tunnel sections in the PIL1 Highway	7-33
Table 7.3.5	Tunnels – Area and Access Route	7-38
Table 7.3.6	Soil Loss - Worst Case Scenario	7-47
Table 7.3.7	Sediment Yield - Worst Case Scenario	7-47
Table 7.3.8	Soil Loss with Conservation Measures	7-47
Table 7.3.9	The Sediment Yield with Conservation Measures	7-48
Table 7.3.10	Soil Loss Tolerance Rates from Erosion Risk Map of Peninsular Malaysia	7-48
Table 7.3.11	Summary of Soil Loss and Sediment Contribution for the Overall Alignment	7-48
Table 7.3.12	Noise Levels for Typical Equipment Used During Earthwork and Construction of Access Road	7-54
Table 7.4.1	Prediction of Noise Levels During the Operations Stage During Peak Hour for Morning and Evening Traffic	7-61
Table 7.4.2	Vibration Dose Value above which Various Degrees of Adverse Comment may be expected in Residential Building (BS 6472: 1992)	7-68
Table 7.4.3	Description of the Section Considered in the Simulation	7-70
Table 7.4.4	Summary of CALINE4 Input Data	7-71

Table 7.4.5	Summary of Predicted Maximum Concentration for Modelled Air Pollutants	7-74
Table 7.4.6	Estimated tc values (Pre-Development)	7-135
Table 7.4.7	IDF Curves for Various Stations Within Penang.	7-137
Table 7.4.8	Region 2: Perak, Kedah, Penang and Perlis	7-137
Table 7.4.9	Rainfall Intensity (mm/hr) for various duration (minutes)	7-138
Table 7.4.10	Rainfall depth (mm) for various duration (minutes)	7-138
Table 7.4.11	Temporal Pattern for 3 hour Storm	7-138
Table 7.4.12	Tc and R for the Study Area	7-139
Table 7.4.13	Comparison of estimated flow using Clark Time-Area Method with Rational Method (100 Year ARI)	7-140
Table 7.4.14	Hydraulic Modelling Results along Sg Ara (Existing)	7-164
Table 7.4.15	Description of Hydraulic Modelling Results along Sg Ara (Straightened).	7-166
Table 7.4.16	Description of Hydraulic Modelling Results – Flow Characteristics at Constriction Stretch.	7-171
Table 7.4.17	Description of Hydraulic Modelling Results along Sg Kluang (Estuary)	7-179
Table 7.4.18	Annual Wave Statistics for Penang Offshore	7-183
Table 7.4.19	Significant Wave Height Values from Various Directions and Corresponding Wave Periods	7-184
Table 7.6.1	Potential Impacts During Operational Stage.	7-199
Table 8.1	Projected Peak Hour Traffic Volume and LOS at PIL 1, 2030	8-21
Table 8.2	Projected Peak Hour Traffic Volume and LOS at PIL 1, 2040	8-22
Table 8.3	Summary of AM & PM Peak Hours Average Highway Speed (kph)(Within Sector) in Differing Parts of the State	8-26
Table 8.4	Future Year 2030 Junction & Interchange Performance for DS04	8-26
Table 8.5	PIL 1 Link Performance for Future Year 2030	8-28
Table 8.6	“Capture Rate” Analysis Results	8-29
Table 8.7	Permissible Exposure Limits for Specified Possible Airborne Air Pollutants in the Tunnelling Workspace	8-40
Table 8.8	Air Blast Overpressure Damage Criteria	8-51
Table 8.9	Causes of Noise Levels during Blasting	8-51
Table 8.10	An Overview of the Effect of Different Blast Parameters on Ground Vibrations	8-53
Table 8.11	BMP Category and Objectives	8-68
Table 9.1	Roles and Responsibilities 107041100703	9-3
Table 9.2	Communication Channels	9-4
Table 9.3	Proposed Monitoring Programme	9-10
Table 9.4	Types of Environmental Reports and Submission Responsibility	9-13

LIST OF FIGURES

	Page
Figure 4.1	ES-6
Figure 4.2	ES-11
Rajah 4.1	RE-7
Rajah 4.2	RE-12
Figure 1.1	1-13
Figure 2.4.1	2-5
Figure 2.5.1	2-16
Figure 3.2.1	3-2
Figure 3.2.2	3-3
Figure 3.2.3	3-3
Figure 3.2.4	3-4
Figure 3.2.5	3-5
Figure 3.2.6	3-5
Figure 3.3.2	3-7
Figure 3.3.3	3-8
Figure 3.4.1	3-11
Figure 3.4.2	3-12
Figure 3.5.1	3-14
Figure 3.5.2	3-15
Figure 3.5.3 & Figure 3.5.4	3-16
Figure 3.5.5	3-17
Figure 3.5.6	3-18
Figure 3.5.7	3-19
Figure 3.5.8 (a)	3-19
Figure 3.5.8 (b)	3-20
Figure 3.5.9	3-20
Figure 3.5.10	3-21
Figure 3.5.11	3-21
Figure 3.5.13 & Figure 3.5.14	3-23
Figure 4.1.1	4-3
Figure 4.1.2	4-4
Figure 4.1.3	4-5
Figure 4.1.4	4-6
Figure 4.1.5	4-7
Figure 4.1.6	4-7
Figure 4.1.7	4-10
Figure 4.1.8	4-10
Figure 4.1.9	4-14
Figure 4.1.10	4-15
Figure 4.1.11	4-20
Figure 4.1.12	4-22

Figure 4.1.13	Tunnel Boring Machines	4-23
Figure 4.1.14	TBM showing shield ad conveyor for removal of excavated soil	4-24
Figure 5.1.1	PIL 1 Highway - Overall Layout	5-3
Figure 5.2.1	Components and Sections of the PIL1 Highway	5-5
Figure 5.2.2	PIL 1 Highway Corridor	5-6
Figure 5.2.3	Interchanges in the PIL 1 Highway	5-14
Figure 5.3.1	Typical Cross Section for Viaduct/Bridge with 0.5 m Marginal Strip	5-20
Figure 5.3.2	Lateral Distance (approx.) of the PIL1 alignment to the Air Itam Dam and Columbarium / Kek Lok Si Temple	5-21
Figure 5.3.3 (1)	Piles enclosed in pile cap and (2) Preparation of Formwork for a pile cap	5-22
Figure 5.3.4	Typical Cross Section for Viaduct/Bridge with 0.5 m Marginal Strip	5-23
Figure 5.3.5	Construction of Balanced Cantilever Box Girder.	5-24
Figure 5.3.6	Typical design of Balanced Cantilever Box Girder.	5-25
Figure 5.3.7	Cable Stayed Bridge (at Youth Park Area).	5-26
Figure 5.3.8	Plan & Profile of Cable Stayed Bridge at Youth Park	5-27
Figure 5.3.9	Artist Impression of Cable Stayed bridge at Youth Park	5-27
Figure 5.3.10 (a)	PIL 1 alignment at Taman Jajar	5-28
Figure 5.3.10 (b)	Taman Jajar Park	5-28
Figure 5.3.11	River realignment between Pier P16 – P20	5-30
Figure 5.3.12 (a)	Pier location near Masjid Al-Huda area	5-31
Figure 5.3.12 (b)	Pier location near Masjid Al-Huda area	5-32
Figure 5.3.12 (c)	The existing river protection wall beside Masjid Al-Huda	5-32
Figure 5.3.12 (d)	Mosque Compound	5-33
Figure 5.3.13	River realignment along Kampung Sg Ara (P22 – P34)	5-34
Figure 5.3.14	Layout showing the proposed river straightening in between Pier P34 to P36.	5-35
Figure 5.3.15	River below existing bridge at Jalan Tun Dr Awang to be straightened.	5-35
Figure 5.3.16	Location of pier P47, P49 and P50.	5-36
Figure 5.3.17	L Shape drain at Sg Relau Confluence and river realignment at downstream	5-37
Figure 5.3.18 (a)	L Shape drain to be extended.	5-37
Figure 5.3.18 (b)	Affected areas at Sg Kluang.	5-38
Figure 5.3.18 (c)	Space constraint at P97 – P101/Constraints at the airport flight path area.	5-40
Figure 5.3.19 (a)	L-Shape Wall (X-section D-D - Ref. Figure 5.3.18)	5-41
Figure 5.3.19 (b)	Re-aligned river section (Sg. Kluang P87-P107)(PIL1 alignment maintained))	5-41
Figure 5.3.20 (a)	Section A-A – River to be realigned to allow 6 m maintenance access as agreed with JPS	5-42
Figure 5.3.20 (b)	Section B-B – River to be realigned to allow 6 m maintenance access as agreed with JPS	5-43
Figure 5.3.21 (a)	Pier positions at Sg Kluang Estuary.	5-45
Figure 5.3.21 (b)	Section A-A	5-46
Figure 5.3.21 (c)	Section B-B	5-47
Figure 5.3.22	Location of Piers connecting PIL1 Highway with LCE.	5-48
Figure 5.3.23	Typical Cross section for Twin Drill & Blast Tunnel	5-49
Figure 5.3.24	Typical Cross Section for Embankment	5-53
Figure 5.4.1	Illustration of bored pile construction process (1) Pile Boring, (2 & 3) Reinforcement cage lowering & Flushing, (4) Pile Concreting.	5-55
Figure 5.4.2	Temporary steel deck as working platform for pile cap construction.	5-57
Figure 5.4.3	Photo (1) Typical Pier and (2) Portal	5-58
Figure 5.4.4	Cross beam formed by pre-cast segments.	5-59
Figure 5.4.5	Form Traveller.	5-60

Figure 5.4.6	Construction of Balanced Cantilever Box Girder using cast-insitu method	5-61
Figure 5.4.7	Process for construction of Cast In-situ Balance Cantilever Box Girder.	5-61
Figure 5.4.8	The tunnel portal can serve several purposes.	5-63
Figure 5.4.9	Preparation of tunnel entrances at the portal areas.	5-63
Figure 5.4.10	PIL1 Blasting Pattern	5-64
Figure 5.4.11	Tunnel end preparing for the drilling the rock and insertion of explosive	5-65
Figure 5.4.12	Placing explosives into face	5-65
Figure 5.4.13	Erection of gantry-type formwork for forming tunnel lining at entrance of the tunnel portal.	5-65
Figure 5.4.14	Forming the tunnel lining – laying of waterproofing membrane and fixing of reinforcement bar before concreting.	5-66
Figure 5.4.15	After the tunnel formed by drill and blast process, the newly formed tunnel surface is lined with an in-situ concrete lining to stabilize the exposed rock faces. Photo shows the travelling gantry-type formwork used to form the in-situ concrete lining.	5-66
Figure 5.4.16	An axial fan installed to provide ventilation during tunnel construction	5-66
Figure 5.4.17	Installation of the tunnel wall panel.	5-67
Figure 5.4.18 (a)	Indicative Layout of typical TMP (with road signs) for Road/Highway Construction.	5-76
Figure 5.4.18 (b)	Indicative Layout of typical TMP (with road signs) for Road/Highway Construction.	5-76
Figure 5.5.1	Indicative layout plan for Crusher / Concrete Batching plant at Jln Tanjong Tokong	5-78
Figure 5.5.2	Indicative layout of Relau Crusher / Concrete Batching Plant	5-82
Figure 5.5.3	Location of the proposed CLQ for workers in the PIL1 Project.	5-83
Figure 5.5.4	Location of the Machinery & Equipment Workshop	5-84
Figure 5.7.1	Project Implementation Schedule	5-90
Figure 6.1.1	Overall Elevation of the Study Area	6-3
Figure 6.1.2 (a)	Topography of the Proposed Project Site	6-4
Figure 6.1.2 (b)	Topography of the Proposed Project Site	6-5
Figure 6.1.3	Slope Classification of the Study Area	6-6
Figure 6.1.4 (a)	Land use along the Proposed Pan Island Link 1 Alignment	6-10
Figure 6.1.4 (b)	Land use along the Proposed Pan Island Link 1 Alignment	6-11
Figure 6.1.5	Geology of the Study Area	6-14
Figure 6.1.6	Mean 24-hour Temperature and Relative Humidity for Bayan Lepas	6-22
Figure 6.1.7	Mean Rainfall and No. of Raindays for Bayan Lepas	6-23
Figure 6.1.8 (a)	Annual Wind Rose for Bayan Lepas	6-24
Figure 6.1.8 (b)	Seasonal Wind Roses for Bayan Lepas	6-25
Figure 6.1.9	Highway Network	6-27
Figure 6.1.10	Traffic Conditions (Peak Hour)	6-35
Figure 6.1.11 (a)	Detailed AM/PM Traffic Peak	6-36
Figure 6.1.11 (b)	Detailed AM/PM Traffic Peak	6-37
Figure 6.1.11 (c)	Detailed AM/PM Traffic Peak	6-38
Figure 6.1.12	Junctions Examined (in Blue)	6-40
Figure 6.1.13 (a)	Junction (Detail A)	6-41
Figure 6.1.13 (b)	Junction (Detail B)	6-42
Figure 6.1.13 (c)	Junction (Detail C)	6-43
Figure 6.1.14	Hydrologic Characteristics of the Study Area	6-45
Figure 6.1.15 (a)	Monitoring Stations for Air Quality, Noise, and Vibration	6-56

Figure 6.1.15 (b)	Monitoring Stations for Air Quality, Noise, and Vibration	6-57
Figure 6.1.15 (c)	Monitoring Stations for Air Quality, Noise, and Vibration	6-58
Figure 6.1.15 (d)	Monitoring Stations for Air Quality, Noise, and Vibration	6-59
Figure 6.1.15 (e)	Monitoring Stations for Air Quality, Noise, and Vibration	6-60
Figure 6.1.16 (a)	Monitoring Stations for Water Quality	6-75
Figure 6.1.16 (b)	Monitoring Stations for Water Quality, Air Quality, Noise and Vibration	6-76
Figure 6.2.1	Sampling Points for Flora	6-78
Figure 6.2.2	The number of species recorded within each sampling point is strongly related to geographical location and well as the land use type in each locality.	6-80
Figure 6.2.3	The standing trees provide closed canopy conditions as seen in SP2 (thus less light reach the forest floor) which creates unfavourable growth conditions for other pioneer species.	6-81
Figure 6.2.4	Pioneer species such <i>Macaranga</i> spp. (lower left) are common in disturbed and open areas.	6-81
Figure 6.2.5	The coastal vegetation and mangrove associated species are able to thrive here although the growth is scarce (Sampling Point 10).	6-82
Figure 6.3.1	Districts in the State of Pulau Pinang & Mukims in Timur Laut	6-100
Figure 6.3.1 (a)	Mukims in Timur Laut District (Mukim 15 is in the foothills)	6-103
Figure 6.3.2	Effect to Potential Highway Users and Residents from the PIL1 Project Development	6-109
Figure 6.3.3	Sensitive Receptors Along the PIL1 Project Alignment	6-110
Figure 6.3.4	Sensitive Receptors along Gurney Drive to Youth Park	6-115
Figure 6.3.5	Sensitive Areas along Sg. Ara to LCE Expressway corridor	6-116
Figure 6.3.6	Public Acceptance of the PIL1 Highway Project in Penang Island	6-119
Figure 6.3.7	Reasons for Acceptance of the PIL1 Highway Project	6-120
Figure 6.3.8	Reasons for Accepting the PIL1 Highway Project according to Community Zones	6-121
Figure 6.3.9	Reasons for Non-Acceptance of the PIL1 Project	6-122
Figure 6.3.10	Public Perception on Existing Traffic Conditions in the Study Area	6-126
Figure 6.3.11	Public Responses on Environmental Impacts of PIL1 development	6-128
Figure 6.3.12	Public Perception during the Operations Phase of the Proposed PIL1 Project	6-130
Figure 6.3.13	Project Perception from the Tourist's Perspective	6-132
Figure 6.3.14	Frequency of Selected Non-communicable Diseases in the District, 2015	6-138
Figure 6.3.15 (a)	Maximum Monthly Ambient Air Pollutant Index (API) Status for USM Compared with Jerantut, 2014	6-139
Figure 6.3.15 (b)	Monthly PM10 Ambient Air Concentration USM Compared with Jerantut, 2014	6-139
Figure 6.3.15 (c)	Monthly NO2 Ambient Air Concentration for USM Compared with Jerantut, 2014	6-140
Figure 6.3.15 (d)	Monthly SO2 Ambient Air Concentration for USM Compared with Jerantut, 2014	6-140
Figure 6.3.15 (e)	Monthly CO Air Concentration for USM Compared with Jerantut, 2014	6-141
Figure 6.3.15 (f)	Monthly O3 Ambient Air Concentration for USM Compared with Jerantut, 2014	6-141
Figure 7.4.49 (a)	PIL1 Alignment along Sg. Ara (near Awang IC)	7-119
Figure 7.4.49 (b)	PIL1 Alignment along Sg. Kluang (at the estuary)	7-119
Figure 7.4.50	Location of the Study Area.	7-124
Figure 7.4.51	Location of the Affected Areas	7-125
Figure 7.4.52	PIL along Sg. Kluang (Flight Path)	7-125
Figure 7.4.53	Piers on River Reserve (Sg. Ara)	7-126

Figure 7.4.54	Piers on river bank and river reserve along Taman Jajar	7-127
Figure 7.4.55	Piers within River Conveyance Near the Estuary	7-127
Figure 7.4.56	Layout of Sg Kluang Catchment and Nearby Catchments	7-129
Figure 7.4.57	Landuse Map of Sg. Kluang Catchment	7-130
Figure 7.4.58	Location of the Study Area	7-132
Figure 7.4.59	Study Area within Sg. Kluang Catchment.	7-133
Figure 7.4.60	Representations of the Project Area Sub-Catchments	7-135
Figure 7.4.61	Study Area and the Selected Design Storm Station	7-136
Figure 7.4.62	River Cross-Section at Outlet	7-141
Figure 7.4.63	River Cross-Section at CH 100	7-141
Figure 7.4.64	River Cross-Section at CH 500	7-142
Figure 7.4.65	River Cross-Section at CH 1000	7-142
Figure 7.4.66	River Cross-Section at CH 1500	7-143
Figure 7.4.67	River Cross-Section at CH 2000	7-143
Figure 7.4.68	River Cross-Section at CH 2500	7-144
Figure 7.4.69	Representation of Nodes and Links for the Proposed Drainage System.	7-146
Figure 7.4.70	Longitudinal Water Surface Profile (Upstream) Based on Existing Conditions (100 Year ARI)	7-147
Figure 7.4.71	Longitudinal Water Surface Profile (Downstream) Based on Existing Conditions (100 Year ARI)	7-148
Figure 7.4.72	Water level at various cross sections in Sg. Kluang (Upstream). Based on Existing Conditions (100 Year ARI)	7-149
Figure 7.4.73	Water level at various cross sections in Sg. Kluang (Downstream). Based on Existing Conditions (100 Year ARI)	7-149
Figure 7.4.74	Longitudinal Water Surface Profile (Upstream) Based on Existing Conditions (50 Year ARI)	7-150
Figure 7.4.75	Longitudinal Water Surface Profile (Downstream) Based on Existing Conditions (50 Year ARI)	7-151
Figure 7.4.76	Water level at various cross sections in Sg. Kluang (Upstream). Based on Existing Conditions (50 Year ARI)	7-152
Figure 7.4.77	Water level at various cross sections in Sg. Kluang (Downstream). Based on Existing Conditions (50 Year ARI)	7-152
Figure 7.4.78	Longitudinal Water Surface Profile (Upstream) Based on Existing Conditions (5 Year ARI)	7-153
Figure 7.4.79	Longitudinal Water Surface Profile (Downstream) Based on Existing Conditions (5 Year ARI)	7-154
Figure 7.4.80	Water level at various cross sections in Sg. Kluang (Upstream). Based on Existing Conditions (5 Year ARI)	7-155
Figure 7.4.81	Water level at various cross sections in Sg. Kluang (Downstream). Based on Existing Conditions (5 Year ARI)	7-155
Figure 7.4.82	River realignment between Pier P16 – P20	7-157
Figure 7.4.83	River realignment between Pier P16 – P20	7-157
Figure 7.4.84	River realignment along Kampung Sg Ara (P22 – P34)	7-158
Figure 7.4.85 (a)	Straightening of river between Pier 34 – Pier 36.	7-159
Figure 7.4.85 (b)	River below existing bridge at Jalan Tun Dr Awang to be straightened.	7-159
Figure 7.4.85 (c)	Cross Section near P97 – P101.	7-160
Figure 7.4.86	Layout of Existing Sg. Ara (Meandering)	7-161
Figure 7.4.87	Isometric View Longitudinal Water Surface Profile along Sg. Ara (Existing)	7-161
Figure 7.4.88	Longitudinal Water Surface Profile along Sg. Ara (50 Year ARI)	7-162

Figure 7.4.89	Water Level at Selected Cross-Section (50 Year ARI)	7-163
Figure 7.4.90	River Model for Sg. Ara [Diversion (Straightened)]	7-165
Figure 7.4.91	Longitudinal Section of Sg. Ara.	7-165
Figure 7.4.92	Example of River Bank Protection at the diversion (Hard Structure)	7-167
Figure 7.4.93	Example of River Bank Protection at the diversion (Green Structure)	7-167
Figure 7.4.94	Layout at Sg. Kluang river Constriction near Flight Path	7-168
Figure 7.4.95	Model Setup at Flight Path (River Constriction)	7-169
Figure 7.4.96	Constriction at Flight Path	7-169
Figure 7.4.97	Water Surface Profile at the Sg. Kluang – with Constriction (Flight Path)	7-170
Figure 7.4.98	Water Level at the Upstream of Constriction Section	7-171
Figure 7.4.99	Water Level at the Constriction Section. (no overflowing).	7-172
Figure 7.4.100a	Locations of 3 Piers Within Sg. Kluang River Conveyance (Estuary)	7-173
Figure 7.4.100b	Locations of 3 Piers Within Sg. Kluang River Conveyance (Estuary)	7-173
Figure 7.4.100c	Locations of 3 Piers Within Sg. Kluang River Conveyance (Estuary)	7-174
Figure 7.4.100d	Locations of 3 Piers Within Sg. Kluang River Conveyance (Estuary)	7-174
Figure 7.4.101	Water Surface Profile at Sg. Kluang Outlet (Without Piers)	7-175
Figure 7.4.102	Longitudinal Water Surface Profile (With Piers)	7-176
Figure 7.4.103	Cross Section Water Level (Pier 1)	7-177
Figure 7.4.104	Cross Section Water Level (Pier 2)	7-177
Figure 7.4.105	Cross Section Water Level (Pier 3)	7-178
Figure 7.4.106	Longitudinal Water Surface Profile (With Pier)	7-178
Figure 7.4.107	Schematic drawing showing the location of the piers.	7-182
Figure 7.4.108	Proposed pier locations (in circle). Photo taken at the existing Tun Dr. Lim Chong Eu Expressway.	7-182
Figure 7.4.109	Penang offshore Wave Rose based on the annual statistics provided in Table C1.	7-184
Figure 7.4.110	Location of the tidal data collected from the Tide Table Malaysia 2017	7-186
Figure 7.4.111	Tidal levels for Kedah Pier.	7-186
Figure 7.4.112	Tidal level for Butterworth.	7-187
Figure 7.4.113	Expected Tidal Currents Patterns: Left - during floods and; Right - during ebbs	7-187
Figure 7.4.114	Bathymetric chart of the area (Chart: Bathymetry Chart No. 1366)	7-118
Figure 7.4.115	Existing view of the site after the bridge facing north	7-189
Figure 7.4.116	Existing view of the site from south of the bridge (facing north)	7-189
Figure 7.4.117	Existing view of the site facing south	7-190
Figure 7.4.118	Schematic plan showing temporary steel platform that will be used during the pier construction.	7-191
Figure 7.4.119	Schematic of piling rig operation	7-191
Figure 7.4.120	Expected effects of pier construction for the PIL1 elevated road.	7-193
Figure 7.4.121	Summary of expected effects of the PIL1 project	7-194
Figure 7.4.122	Example of rock revetment installed on a coastline.	7-195
Figure 7.4.123	Example of a training wall for river.	7-196
Figure 7.4.124	Alongshore drift direction (black arrow) and predominant wave direction (white headed arrow).	7-197
Figure 7.4.125	Example of Groynes structures.	7-197
Figure 7.4.126	Sine slab units with interlocking mechanism.	7-198
Figure 7.4.127	Sine slab system after about 3 years at Shah Beach Resort, Melaka.	7-198
Figure 8.1	Proposed PIL1 Information Centre (PIC) for the PIL1 Highway Project (Proposed Coordinating Committee Set-Up For Land/Property Acquisition matters, Resettlement Issue, Managing Public Complaints and Information Dissemination).	8-3

Figure 8.2 (a)	Example of Road Diversion TMP Drawing	8-13
Figure 8.2 (b)	Example of Road Diversion TMP Drawing	8-14
Figure 8.3	Example of Material and Waste Transport Routes - from Tunnel 1 Northern Portal to the Alternative Sites	8-18
Figure 8.4 (a)	Tunnel 1 North Portal at Youth Park.	8-16
Figure 8.4 (b)	Tunnel 1 South Portal at Ayer Itam	8-17
Figure 8.4 (c)	Tunnel 2 North Portal at Kek Lok Si	8-17
Figure 8.4 (d)	Tunnel 2 South Portal and Tunnel 3 North Portal	8-19
Figure 8.4 (e)	Tunnel 3 South Portal and Tunnel 4 North Portal	8-20
Figure 8.4 (f)	Tunnel 4 South Portal	8-20
Figure 8.5	PIL1 Capture Rate	8-29
Figure 8.6	An Example of Tunnel Ventilation Ducting and Emission Point at the Tunnel Portal	8-33
Figure 8.7	Typical Tunnel Ventilation System	8-38
Figure 8.8 (a)	Noise Barrier Highlighted in Red Lines along Jalan Bagan Jermal	8-43
Figure 8.8 (b)	Noise Barrier Highlighted in Red Lines along Jalan Gottlieb and Jalan Kuari	8-44
Figure 8.8 (c)	Noise Barrier Highlighted in Red Lines at Taman Cantik	8-44
Figure 8.8 (d)	Noise Barrier Highlighted in Red Lines at Taman Lintang	8-45
Figure 8.8 (e)	Noise Barrier Highlighted in Red Lines at Emerald Heights	8-45
Figure 8.8 (f)	Noise Barrier Highlighted in Red Lines at Oriental Garden and Paya Terubong	8-46
Figure 8.8 (g)	Noise Barrier Highlighted in Red Lines at Setia Vista	8-46
Figure 8.8 (h)	Noise Barrier Highlighted in Red Lines at Setia Green	8-47
Figure 8.8 (i)	Noise Barrier Highlighted in Red Lines at Kg Manggis, Kg Sungai Ara and Kg Tersusun Sg Ara	8-47
Figure 8.8 (j)	Noise Barrier Highlighted in Red Lines at Taman Gedung Height, Bandar Bayan Baru and the Industrial Zone	8-48
Figure 8.8 (k)	Noise Barrier Highlighted in Red Lines in the Industrial Zone near the LCE	8-48
Figure 8.9	Effect of Flyrock to Structures	8-53
Figure 8.10	Examples of coastal erosion prevention structures	8-56
Figure 8.11 (a)	Silt Curtain Attached to Plastic Barricade to Control Slurry from Flowing onto the Road Outside of the Work Site	8-61
Figure 8.11 (b)	Example of silt fence and sand bag along the working barrier	8-61
Figure 8.12	Bore Pile Soil/Sediment Placed into a Watertight Bin	8-62
Figure 8.13	Adapted/Modified Silt Trap for Soil/Slurry	8-62
Figure 8.14	Slurry Pumped from Silt Trap into a Tanker	8-62
Figure 8.15	Example of Storm Drain with its Pipe Visible Beneath it Due to Construction Work	8-82
Figure 9.1	Project Organization Structure	9-2
Figure 9.2	Environmental Management Roles & Responsibilities	9-3
Figure 10.3.1	Slow Moving Traffic Along Roads in Penang	10-1
Figure 10.3.2	Strategic Road Network	10-3

LIST OF PLATES

		Page
Plate 6.1.1	View from Penang Bridge	6-28
Plate 6.1.2	View from Jambatan Sultan Abdul Halim Muadzam Shah	6-28
Plate 6.1.3	View from Lebuhraya Tun Dr Lim Chong Eu	6-29
Plate 6.1.4	View from Jalan Sultan Azlan Shah	6-29
Plate 6.1.5	View from Jalan Paya Terubung	6-30
Plate 6.1.6	View from Jalan Bukit Gambir	6-30
Plate 6.1.7	View from Jalan Masjid Negeri	6-31
Plate 6.1.8	View from Jalan Bagan Jermal and Jalan Gottlieb	6-31
Plate 6.1.9	View from Jalan Burma and Jalan Kelawai	6-32
Plate 6.1.10	View from Jalan Ayer Hitam	6-32
Plate 6.3.1	Social Survey Carried out in the Study Area	6-118
Plate 6.3.2	FGDs and Public Meetings carried out in the Study Area	6-118
Plate 8.3.3	Example of a stabilized access road.	8-30
Plate 8.6.1	Fogging Exercise for Dengue Control	8-79



LIST OF APPENDICES

APPENDIX 1	Preliminary Site Assessment (PAT) Report
APPENDIX 2	TOR Endorsement and PIL Extension Letter
APPENDIX 3	Laboratory Analysis Certificates
APPENDIX 4	Hydraulic Modelling
APPENDIX 5	Air Quality Modelling