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870TH－十一號幹線(北大嶼山至元朗)的可行性研究

補充資料

就編號 870TH－十一號幹線的可行性研究的撥款申請，郭家麒議員在2018年1月16日致函本局及工務小組委員會主席，要求政府提供補充資料。本局現回覆如下:

(1) 要求政府提供《青衣至大嶼山連接路－可行性研究》報告

因應委員的要求，現附上《青衣至大嶼山連接路－可行性研究》(只有英文版本)，供委員參閱（為減少用紙，建議報告副本存放

於秘書處供委員查閱)。但請委員留意，基於此研究是在約十年前完成，報告的內容（包括人口及就業規劃、道路網絡、法例要求、接駁到市區的道路及其他前設等）已經過時，不再適用。

(2) 要求政府提供《小蠔灣發展及相關運輸基建的技術性研究-可行性研究》報告

郭議員於信中引述了《小蠔灣發展及相關運輸基建的技術性研究-可行性研究》行政摘要的內容。根據該行政摘要，該項研究其中一個主要目的是評估擬議小蠔灣發展的初步技術可行性及測試不同發展潛力的土地用途方案對北大嶼山各主要道路的影響，當中採用了直至 2041 年的規劃數據。行政摘要指出在發展潛力最大的土地用途方案下，預計在 2041 年，單靠擬議的十一號幹線及 P1 號公路，北大嶼山的交通可能出現擠塞的情況，但若一併考慮青衣至大嶼山連接路方案，將可緩解有關的交通擠塞情況。行政摘要亦指出在其他發展潛力的土地用途方案，有擬議的十一號幹線及與之連接的 P1 號公路，北大嶼山的交通 (包括青嶼幹線)於 2041 年的情況仍可控制。

正如我們回應立法會議員提問時不斷強調，在進行十一號幹線的可行性研究時，我們將尋求可行的方案，包括為青衣至大嶼山連接路的需要進行交通評估，以應付新界西北與北大嶼山的發展所引致的交通需求。我們並不會接受令北大嶼山公路和青嶼幹線交通不勝負荷的建議。

至於郭議員要求政府提供《小蠔灣發展及相關運輸基建的技術性研究-可行性研究》的報告文本，我們已向土木工程拓展署查詢，他們表示該研究已大致完成，該研究的行政摘要已上載於土木工程拓展署的網頁，供公眾閱覽。至於該研究的報告文本仍在整理中，他們會於稍後時間按一貫做法，隱去商業或敏感資料後，將該報告文本放於該署的可持續大嶼辦事處供公眾索閱，並按議員

要求提供報告副本予立法會供議員參閱。

運輸及房屋局局長

(梁世豪  代行)

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2018 年 2 月 12 日

HIGHWAYS DEPARTMENT

Hong Kong-Zhuhai-Macao Bridge

Hong Kong Project Management Office

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link – Feasibility Study

Final Report for the Assignment (Final)
Volume 1 - Text

January 2009



Meinhardt Infrastructure and Environment Ltd

邁進基建環保工程顧問有限公司

Highways Department
Hong Kong-Zhuhai-Macao Bridge Hong Kong Project Management Office
The Government of the Hong Kong Special Administrative Region

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CONTENTS

1 INTRODUCTION 1-1

1.1 General 1-1
1.2 Project Background and Description 1-1
1.3 Objectives of Assignment 1-2
1.4 Objectives and Scopes of this Report 1-3
1.5 Structure of this Report 1-4
1.6 Abbreviations 1-5

2 DEVELOPMENT OF ALIGNMENT OPTIONS 2-1

2.1 General 2-1
2.2 Major Constraints 2-1
2.3 Connections at Tsing Yi 2-2
2.4 Connections at Lantau 2-5
2.5 Alignment Options - Immersed Tube Tunnel Schemes 2-7
2.6 Alignment Options – Long-Span Bridge Schemes 2-8
2.7 Summary of Key Technical Aspects of Alignment Options 2-11

3 TRAFFIC IMPACT ASSESSMENT STUDY 3-1

3.1 Overview and Objectives 3-1
3.2 Approach and Assumptions 3-2
3.3 TYLL Scheme Options 3-10
3.4 TYLL Traffic Forecasts for Options Assessment 3-14
3.5 NWNT Traffic Forecasts – With/Without TYLL 3-18
3.6 Financial Assessment 3-27
3.7 Economic Assessment 3-30

4 MARINE TRAFFIC IMPACT ASSESSMENT STUDY 4-1

4.1 Introduction 4-1
4.2 Survey of Present Traffic and Forecast of Future Traffic Levels 4-1
4.3 Assessment of Present Risk Environment and Initial Alignment Assessment 4-3
4.4 Preliminary Marine Alignment Review 4-4
4.5 Evaluation of Possible Bridge Deck and Tunnel Requirements 4-4
4.6 Preliminary Ship Impact Protection System Review 4-5
4.7 Investigation of Traffic Risk within a Dynamic Marine Traffic Simulator 4-6
4.8 Baseline Collision Risk Assessment 4-7
4.9 Evaluation of Impact of Options on Anchorage and Marine Facilities 4-13
4.10 Radar Impact Assessment 4-18
4.11 Recommendation of Practical Operational and Constructional Measures 4-18

5 OPTION ASSESSMENT 5-1

5.1 General 5-1
5.2 Assessment Methodology 5-1
5.3 Assessment Criteria 5-2
5.4 Alignment Options for Assessment 5-4

5.5 Sensitivity Testing 5-13
5.6 Conclusions 5-14

6 SUSTAINABILITY ASSESSMENT STUDY 6-1

6.1 Approach and Methodology 6-1
6.2 The Need for a Link between Tsing Yi and Lantau 6-1
6.3 Economic Issues 6-2
6.4 Environmental Issues 6-5
6.5 Social and Other Issues 6-7
6.6 Part 1: Adopting CASET Criteria 6-8
6.7 Part 2: CASET and Other Sustainability Criteria 6-14
6.8 Summary 6-17

7 ENGINEERING FEASIBILITY STUDY 7-1

7.1 Description of Preferred TYLL Alignment 7-1
7.2 Highway Design 7-3
7.3 Toll Plaza and Administration Facilities 7-6
7.4 Rock Tunnel 7-9
7.5 Tunnel Ventilation 7-10
7.6 Long-span Bridge 7-12
7.7 Artificial Island 7-17
7.8 Viaducts 7-17
7.9 Construction and Demolition Materials 7-21
7.10 Works Area 7-21

8 GEOTECHNICAL APPRAISAL STUDY 8-1

8.1 Previous Site Investigations and Studies 8-1
8.2 Proposed Site Investigation for this Assignment 8-1
8.3 Preliminary Geology and Ground Models 8-2
8.4 Geological Constraints 8-3

9 UTILITY IMPACT ASSESSMENT STUDY 9-1

9.1 General 9-1
9.2 Land Utilities at Lantau 9-1
9.3 Land Utilities at Tsing Yi 9-2
9.4 Impacts on Utilities 9-4

10 DRAINAGE REVIEW 10-1

10.1 Existing Drainage Conditions 10-1
10.2 Preliminary Assessment of Existing Drainage 10-2
10.3 Potential Drainage Impact and Mitigation Measures 10-3
10.4 Proposed Drainage System 10-4

11 ENVIRONMENTAL REVIEW 11-1

11.1 Introduction 11-1
11.2 Air Quality 11-1
11.3 Noise 11-4
11.4 Water Quality 11-6
11.5 Ecology 11-9

11.6 Fisheries 11-15
11.7 Waste Management 11-16
11.8 Cultural Heritage 11-19
11.9 Landscape and Visual 11-21
11.10 Hazard to Life 11-24

[redacted]

13 IMPLEMENTATION STRATEGY AND PROGRAMME 13-1

13.1 Implementation Strategy 13-1
13.2 Implementation Programme 13-6

14 COST ESTIMATE 14-1

14.1 Base Estimate 14-1
14.2 Risk Analysis 14-1
14.3 Summary of Cost Estimate 14-2
14.4 Recurrent Cost 14-2

15 CONCLUSIONS AND RECOMMENDATIONS 15-1

15.1 Alignment Options and Constraints 15-1
15.2 Traffic Impact Assessment Study 15-1
15.3 Marine Traffic Impact Assessment Study 15-2
15.4 Option Assessment 15-4
15.5 Sustainability Assessment 15-4
15.6 Engineering Feasibility Study 15-5
15.7 Geotechnical Appraisal Study 15-7
15.8 Utility Impact Assessment Study 15-9
15.9 Drainage Review 15-9
15.10 Environmental Review 15-10

[redacted]

15.12 Implementation Strategy, Programme and Cost Estimates 15-14
15.13 Recommendations 15-14

APPENDICES

Appendix A Major Development Assumptions
Appendix B1 Year 2030 Traffic Forecasts – Reference Case
Appendix B2 Year 2030 Traffic Forecasts – NWNT Options, No TYLL
Appendix B3 Year 2030 Traffic Forecasts – NWNT Options, With TYLL
Appendix C Existing Drainage Catchment
Appendix D Geological Maps of the Study Area

[redacted]

Appendix F Capital Cost and Recurrent Cost Estimate

FIGURES

Figure 1.1 Indicative Alignment from the Study Brief

Figure 2.1 Key Issues and Constraints – Lantau
Figure 2.2 Key Issues and Constraints – Tsing Yi
Figure 2.3 Key Issues and Constraints – Marine
Figure 2.4 T1 Connection with East Tsing Yi Viaduct
Figure 2.5 T2 Connection via East Tsing Yi Viaduct Slip Road
Figure 2.6 T3 Connection via CT9 and East Tsing Yi Viaduct
Figure 2.7 T4 Connection via East Tsing Yi Viaduct Slip Road
Figure 2.8 T5 Connection with West Tsing Yi Viaduct
Figure 2.9 L1 or L2 Connection with Tsing Lung Bridge
Figure 2.10 L3 Connection with Tsing Lung Bridge and North Lantau Highway
Figure 2.11 L4 Connection with Penny's Bay Highway
Figure 2.12 Option 1 – Immersed Tube Tunnel
Figure 2.13 Option 2 – Immersed Tube Tunnel
Figure 2.14 Option 3 – Immersed Tube Tunnel
Figure 2.15 Option 4 – Long Span Bridge
Figure 2.16 Option 5 – Long Span Bridge
Figure 2.17 Option 6 – Long Span Bridge
Figure 2.18 Option 7 – Long Span Bridge

Figure 3.1 Area of Influence for Traffic Assessment
Figure 3.2 Reference Case Strategic Highway Network
Figure 3.2 NWNT Strategic Highway Network Options (2030)

Figure 7.1 Layout of Preferred TYLL Alignment
Figure 7.2 Layout of TYLL Western Interchange with Tsing Lung Bridge and North Lantau Highway
Figure 7.3 Layout of TYLL Eastern Connection with ETYV and Tsing Yi Road
Figure 7.4 Typical Sections for Elevated Highway Structures
Figure 7.5 Layout of Toll Plaza and Other Facilities
Figure 7.6 Typical Section for Rock Tunnel
Figure 7.7 Schematic Diagram of Tunnel Ventilation System
Figure 7.8 Arch Bridge across Kap Shui Mun Fairway
Figure 7.9 Suspension Bridge across Ma Wan Fairway
Figure 7.10 Typical Cross Section of Artificial Island Reclamation
Figure 7.11 Balanced Cantilever Erection by Gantry
Figure 7.12 Span-by-span Erection
Figure 7.13 Balanced Cantilever Erection by Form Traveller
Figure 7.14 Works Area at North Lantau

Figure 8.1 Previous Ground Investigation Layout Plan (Sheet 1 of 3)
Figure 8.2 Previous Ground Investigation Layout Plan (Sheet 2 of 3)

Figure 8.3 Previous Ground Investigation Layout Plan (Sheet 3 of 3)
Figure 8.4 Additional Ground Investigation Layout Plan (Sheet 1 of 3)
Figure 8.5 Additional Ground Investigation Layout Plan (Sheet 2 of 3)
Figure 8.6 Additional Ground Investigation Layout Plan (Sheet 3 of 3)
Figure 8.7 Geotechnical Constraints at Marine Area
Figure 8.8 Slope Features Affecting or Affected by Eastern Landing
Figure 8.9 Slope Features Affecting or Affected by Western Landing
Figure 8.10 Recommended Extent of Future Natural Terrain Hazard Study (Sheet 1 of 2)
Figure 8.11 Recommended Extent of Future Natural Terrain Hazard Study (Sheet 2 of 2)

Figure 9.1 Existing Storm Drainage Near Toll Plaza
Figure 9.2 Existing Storm Drainage at East of Toll Plaza
Figure 9.3 Existing CLP Installation Near Eastern Portion of Tsing Yi Road
Figure 9.4 Existing Storm Drainage Near Eastern Portion of Tsing Yi Road
Figure 9.5 Existing Gas Mains Near Eastern Portion of Tsing Yi Road

Figure 11.1 Representative Air and Noise Sensitive Receivers – Tsing Yi
Figure 11.2 Representative Air and Noise Sensitive Receivers – Lantau
Figure 11.3 Water Quality Sensitive Receivers (Excluding Ecological Sensitive Receivers)
Figure 11.4 Habitat Map of Terrestrial Study Area
Figure 11.5 Marine Ecological and Fisheries Sensitive Receivers
Figure 11.6 Distribution of Chinese White Dolphin (CWD) in North Lantau
Figure 11.7 Geological Background of Preferred Alignment of TYLL in Tsing Yi
Figure 11.8 Geological Map of Tang Lung Chau
Figure 11.9 Potential Built Heritage Resources
Figure 11.10 Landscape Resources
Figure 11.11 Landscape Character Areas
Figure 11.12 Potential Visually Sensitive Receivers
Figure 11.13 PHIs and Explosive Dumping Ground

Figure 13.1 Project Implementation Programme (Sheet 1 of 2)
Figure 13.2 Project Implementation Programme (Sheet 2 of 2)

DRAWINGS

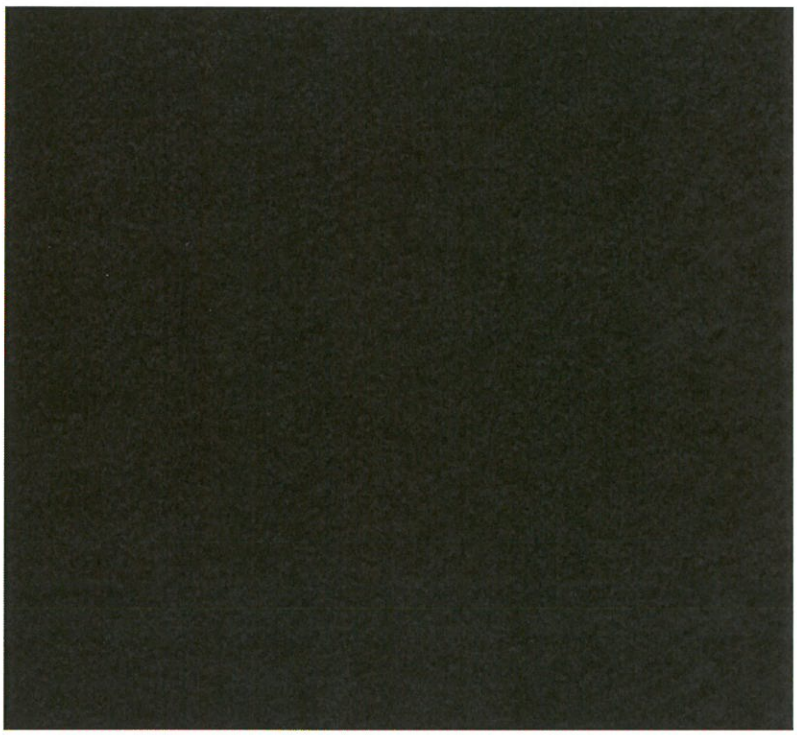
91065/GL/100 General Layout Plan Key Plan
91065/GL/101 General Layout Plan (Sheet 1 of 17)
91065/GL/102 General Layout Plan (Sheet 2 of 17)
91065/GL/103 General Layout Plan (Sheet 3 of 17)
91065/GL/104 General Layout Plan (Sheet 4 of 17)
91065/GL/105 General Layout Plan (Sheet 5 of 17)
91065/GL/106 General Layout Plan (Sheet 6 of 17)
91065/GL/107 General Layout Plan (Sheet 7 of 17)
91065/GL/108 General Layout Plan (Sheet 8 of 17)
91065/GL/109 General Layout Plan (Sheet 9 of 17)
91065/GL/110 General Layout Plan (Sheet 10 of 17)
91065/GL/111 General Layout Plan (Sheet 11 of 17)

91065/GL/112 General Layout Plan (Sheet 12 of 17)
91065/GL/113 General Layout Plan (Sheet 13 of 17)
91065/GL/114 General Layout Plan (Sheet 14 of 17)
91065/GL/115 General Layout Plan (Sheet 15 of 17)
91065/GL/116 General Layout Plan (Sheet 16 of 17)
91065/GL/117 General Layout Plan (Sheet 17 of 17)

91065/GL/201 Vertical Profile of TYLL Mainline (Sheet 1 of 2)
91065/GL/202 Vertical Profile of TYLL Mainline (Sheet 2 of 2)

91065/GL/203 Vertical Profile of Western Link Roads
91065/GL/204 Vertical Profile of Eastern Link Roads and Slip Roads

91065/GL/301 Typical Cross Sections (Sheet 1 of 2)
91065/GL/302 Typical Cross Sections (Sheet 2 of 2)



SECTION 1

Introduction

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

1 INTRODUCTION

1.1 General

1.1.1 On 2 February 2007, Highways Department (HyD) of the Government of the Hong Kong Special Administrative Region appointed Meinhardt Infrastructure and Environment Ltd, under Agreement No. CE 40/2006 (HY), to provide professional services in respect of Tsing Yi Lantau Link (TYLL) - Feasibility Study (hereinafter called "the Assignment"). The date for the commencement of the Assignment was 31 January 2007.

1.2 Project Background and Description

1.2.1 In 2003, Transport Department (TD) conducted a review of the traffic and infrastructure requirements in Northwest New Territories (NWNT) and North Lantau. The review looked into the traffic demand forecast, and ascertained whether the existing road network had the potential to handle the future traffic demands. In addition, the review determined the requirements for the transport network, in terms of long-term transport planning, to ensure that facilities would be provided in time to meet the needs. The review was further refined in 2004, with updated planning criteria and traffic figures. Four possible packages of road projects, namely Packages A, B, C and D, were initially identified in the review to make up the maximal network of new roads to meet the traffic demands of NWNT and North Lantau. After further refinement, a Package E was later included. The five packages are:

Package A

- A1 Road connecting Hong Kong – Zhuhai – Macao Bridge and North Lantau Highway
- A2 Lantau Road P1 between Tung Chung and Sunny Bay
- A3 Tsing Yi Lantau Link
- A4 Pa Tau Kwu section of Chok Ko Wan Link Road

Package B

- B1 So Kwun Wat Link Road
- B2 Sham Tseng Tunnel Link Road

Package C

- C1 Lam Tei Tunnel
- C2 So Kwun Wat Interchange
- C3 Tai Lam Chung Tunnel
- C4 Tsing Lung Bridge and interchanges at Tuen Mun Road and North Lantau Highway
- C5 "Coastal Road" from Tsing Lung Bridge and an interchange with Tsing Yi Lantau Link

Package D

D1 Tuen Mun Western Bypass
D2 Tuen Mun Chek Lap Kok Link

Package E

E1 Tuen Mun Eastern Bypass
E2 Widening of the Expressway section of Tuen Mun Road to dual 4-lane

1.2.2 For more information on the packages and their functions, reference may be made to LegCo Paper Nos.:

- CB(1)1096/04-05 (07) on "NWNT Traffic and Infrastructure Review 2004" released on 18 March 2005;
- CB(1)1096/04-05(08) on "Reconstruction and Improvement of Tuen Mun Road" released on 18 March 2005; and
- CB(1)2023/06-07(05) on "Traffic and Transport Arrangements for the commissioning of Shenzhen Bay Port and Northwest New Territories Traffic and Infrastructure Review" released on 9 July 2007.

1.2.3 TYLL, in Package A of the above review, was originally envisaged as a dual 2-lane highway between Tsing Yi and Lantau. It connected with the Pa Tau Kwu section of the Chok Ko Wan Link Road and the Coastal Road in Package C. In general, TYLL was originally defined as an east-west road link between Tsing Yi and Lantau, having strategic connections to Route 8 at Tsing Yi, Tsing Lung Bridge (TLB) at Kwai Shek of Lantau and Penny's Bay Highway at Chok Ko Wan of Lantau. The originally envisaged indicative route of TYLL is shown in **Figure 1.1**.

1.2.4 Notwithstanding the above, the main functions of TYLL, as determined by this Assignment, are to:

- provide additional traffic capacity between Lantau and the urban area;
- provide an east-west contingent link;
- support traffic capacity between NWNT and the urban area; and
- enhance port connectivity.

1.3 Objectives of Assignment

1.3.1 The main objectives of the Assignment are to:

a) evaluate all possible alignment options for TYLL, and recommend a feasible and cost effective alignment for TYLL, fulfilling all the requirements mentioned in the Assignment Brief;

b) recommend a realistic implementation programme for the recommended TYLL; and

c) provide sufficient details so as to allow preliminary design of TYLL to proceed in the next stage.

1.3.2 During the course of the Assignment, the following deliverables were issued for comment.

- Traffic Impact Assessment Study Report and associated working papers;
- Marine Traffic Impact Assessment Study Report and associated working papers;
- Option Assessment Report and associated working papers;
- Sustainability Assessment Study Report;
- Engineering Feasibility Study Report and associated working papers;
- General Layouts of the Project and Preliminary Traffic Aids Drawings;
- Construction and Demolition Material Management Plan;
- Land Requirement Study Report;
- Preliminary Review of Environmental Impacts and Project Profile;
- Geotechnical Desktop Study Report and Site Investigation Report;
- Preliminary Geotechnical Appraisal Report;
- Utility Impact Assessment Study Report;
- Preliminary Drainage Review Report and Project Profile;
- Implementation Programme; and
- Summary Report on Cost Estimates.

1.4 Objectives and Scopes of this Report

1.4.1 The Assignment starts with the development of the feasible alignment options for the TYLL, followed by traffic impact assessment, marine traffic impact assessment,

sustainability assessment and option assessment for all the feasible alignment options.

1.4.2 Proceeding from the selection of the preferred TYLL alignment, the Assignment then refines the engineering layout, examines the engineering feasibility, conducts geotechnical appraisal, and reviews utility, drainage and environmental impacts associated with the construction and implementation of the preferred TYLL alignment. Implementation strategy is also developed, and capital and recurrent costs estimated.

1.4.3 The objective of this Final Report is to present the key study elements, findings and recommendations of all the assessments and studies conducted at various stage of the Assignment. This is an extract of the major studies in the Assignment with a view to seeking the relevant policy bureaux's approval of the TYLL project. As only the essential information is included in this Report, readers are advised to refer to the reports of the respective studies for the study and assessment details.

1.5 Structure of this Report

1.5.1 The Report is structured as follows:

- **Section 2: Development of alignment options**
  This section discusses the existing situation on Tsing Yi and Lantau within the Study Area and the philosophy behind the development of the alignment options.

- **Section 3 to Section 6: Assessment studies for the developed alignment options**
  These sections present the key study elements and findings of the various assessments for the alignment options described in Section 2. The assessments include Traffic Impact Assessment, Marine Traffic Impact Assessment, Option Assessment and Sustainability Assessment respectively.

- **Section 7: Engineering feasibility study**
  This section contains the refined engineering alignments and layouts developed from the preferred TYLL alignment selected from the option assessment, and presents the findings of the engineering feasibility study.

- **Section 8 to Section 11: Studies for the preferred TYLL alignment**
  These sections summarise the findings of the various studies for the preferred TYLL alignment described in Section 7. Geotechnical Appraisal Study, Utility Impact Assessment Study, Drainage Impact and Environmental Review are covered in these sections.

- **Section 12: Land requirement study**
  This section discusses the land requirement for the implementation of the TYLL project. The possible works areas for the construction of the TYLL are also suggested.

- **Section 13: Implementation strategy and programme**
  This section discusses the possible strategy for the implementation of the TYLL, including contract packaging and procurement approach. This section also contains the implementation programme with key programme activities highlighted.

- **Section 14: Cost estimate**
  This section presents the base cost estimates and risk analysis of the Project.

- **Section 15: Conclusions and Recommendations**
  This section summarises the overall conclusions and recommendations of the Assignment.

1.6 Abbreviations

1.6.1 The following abbreviations are used in this report:

Government Departments

DSD	Drainage Services Department
EPD	Environmental Protection Department
FSD	Fire Services Department
GEO	Geotechnical Engineering Office
GIU	Geotechnical Information Unit
HyD	Highways Department
LandsD	Lands Department
MD	Marine Department
PlanD	Planning Department
TD	Transport Department
WSD	Water Services Department

Roads

CKWLR	Chok Ko Wan Link Road
ETYV	East Tsing Yi Viaduct
HKSWC	Hong Kong Shenzhen Western Corridor
HZMB	Hong Kong – Zhuhai – Macao Bridge
LL	Lantau Link
LTT	Lam Tei Tunnel
NLH	North Lantau Highway
PBH	Penny's Bay Highway
SCB	Stonecutters Bridge
SHW	Siu Ho Wan
TKB	Ting Kau Bridge
TLB	Tsing Lung Bridge
TLT	Tai Lam Tunnel
TMCLKL	Tuen Mun-Chek Lap Kok Link
TMEB	Tuen Mun Eastern Bypass
TMLL	Tuen Mun Lantau Link

TMR	Tuen Mun Road
TMWB	Tuen Mun Western Bypass
TYLL	Tsing Yi Lantau Link
WKH	Western Kowloon Highway
WTYV	West Tsing Yi Viaduct

Locations / Places

AWE	Asia World-Expo
CT9	Container Terminal 9
CT10	Container Terminal 10
LLP	Lantau Logistics Park
LMC	Lok Ma Chau
MKT	Man Kam To
NWNT	Northwest New Territories
NWWCZ	North Western Water Control Zone
STK	Sha Tau Kok
TMCA	Tsing Ma Control Area
WBWCZ	Western Buffer Water Control Zone

Others

AOI	Area of Influence
APCO	Air Pollution Control Ordinance
AQO	Air Quality Objectives
ASRs	Air Sensitive Receivers
CITES	Convention on the International Trade in Endangered Species of Flora and Fauna
CT	Container Truck
CWD	Chinese White Dolphin
CZ	Consultation Zone of PHI
DIA	Drainage Impact Assessment
EIAO	Environmental Impact Assessment Ordinance
EIRR	Economic Internal Rate of Return
EP	Environmental Permit
FCZ	Fish Culture Zone
FIRR	Financial Internal Rate of Return
GLA	Government Land Allocation
GV	Goods Vehicle
HKPSG	Hong Kong Planning Standards and Guidelines
ITT	Immersed tube tunnel
LCT	Landscape Character Type
LSB	Long-span bridge
MSFD	Motorised Smoke and Fire Damper
MVCTS	MVA's in-house Four Stage Strategic Transport Model of the HKSAR
NPV	Net Present Value
NSRs	Noise Sensitive Receivers
OHVD	Overhead Ventilation Duct

PCU	Passenger Car Unit
PHI	Potential Hazardous Installation
PV	Private Vehicle
RSP	Respirable Suspended Particulate
SDM	Stormwater Drainage Manual
SRTM	Sub-Regional Traffic Model
SSSI	Site of Special Scientific Interest
STT	Short Term Tenancy
TIA	Traffic Impact Assessment
TM-EIAO	Technical Memorandum on Environmental Impact Assessment Process
TPDM	Transport Planning and Design Manual
TPEDM	Territorial Population and Employment Data Matrices
TSP	Total Suspended Particulate
V/C ratio	Volume / Capacity Ratio
VSRs	Visual Sensitive Receivers
WBSE	White-bellied Sea Eagle
WCZs	Water Control Zones
WPCO	Water Pollution Control Ordinance
WQO	Water Quality Objectives

(Not Used)

SECTION 2

Development of Alignment Options

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

2 DEVELOPMENT OF ALIGNMENT OPTIONS

2.1 General

2.1.1 A total of seven alignment options with various possible landing arrangements were developed for evaluation under the traffic impact, marine traffic impact, option and sustainability assessments. These seven options involve immersed tube tunnels (Alignment Options 1 to 3) and long-span bridges (Alignment Options 4 to 7), with different connection locations and layouts to the strategic highway networks at Tsing Yi and Lantau respectively. These options are presented below.

2.2 Major Constraints

2.2.1 The alignment options have been developed with due regard to the existing and potential future major constraints in the study area. These are shown in **Figures 2.1** to **2.3**, and are summarised as follows:

- Marine channels, including Ma Wan Fairway and Kap Shui Mun Fairway;
- Marine anchorages, including Ma Wan Anchorage and Pun Shan Shek Anchorage;
- Site of existing Container Terminal 9 (CT9) at Tsing Yi;
- Potential site of the proposed Container Terminal 10 (CT10) at Southwest Tsing Yi;
- Disused Explosive Dumping Ground off the southwest corner of Tsing Yi;
- Uncontaminated Mud Disposal Ground off the southwest corner of Tsing Yi;
- Airport Height Restriction Zone;
- Structural Height Intrusion Limitation Zone on Lantau;
- Tso Wan Village and Fa Peng Village on Lantau;
- Pa Tau Kwu Archaeological Site and Tang Lung Chau Lighthouse;
- Hong Kong Disneyland Theme Park;
- Oil Depots on Tsing Yi;
- The Industrial Zone on Tsing Yi Island;
- Marine access to China Merchants Container Services Ltd Mid-stream Container Terminal and Floating Docks at west coast of Tsing Yi;

- Existing natural coastline and visual character of North-east Lantau; and
- Possible future reclamation and tourism development in North-east Lantau.

2.3 Connections at Tsing Yi

2.3.1 Three potential locations have been identified for the connection between TYLL and the strategic highway network at Tsing Yi. These are either directly onto the Route 8 East Tsing Yi Viaduct (ETYV) or Route 8 West Tsing Yi Viaduct (WTYV), or alternatively a connection to TYLL can be made via the CT9 slip roads at the ETYV.

Direct Connection with East Tsing Yi Viaduct (Connection Option T1)

2.3.2 **Figure 2.4** shows a direct connection between TYLL and the ETYV in the direction of Stonecutters Bridge and the urban area beyond.

Merits

2.3.3 The merits of this direct connection option are as follows:

- This connection option would provide the most direct route.
- It would also provide the most direct bridge-to-bridge connection between the Stonecutters Bridge and TYLL.

Demerits

2.3.4 The demerits of this direct connection option are as follows:

- The TYLL link roads would need to be relatively high.
- It would not be possible for this connection option to combine vertically with any of the immersed tube tunnel alignment options.
- This connection option makes no provision for local access to CT9.
- The westbound link road from the ETYV to TYLL would cross over the northwest corners of both the factory complex at TYTL 128 and encroach onto the boundaries of the Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre.

Indirect Connection with East Tsing Yi Viaduct via CT9 Slip Roads (Connection Options T2, T3 and T4)

2.3.5 **Figures 2.5** to **2.7** show three variations of an indirect connection between TYLL and the ETYV via the CT9 slip roads in the direction of Stonecutters Bridge and the urban area beyond.

Merits

2.3.6 The merits of these indirect connection options are as follows:

- These connection options would provide a route, albeit indirectly, between TYLL and Route 8 in both directions.
- These connection options would also provide local access to CT9.
- These connection options may be combined vertically with either any of the immersed tube tunnel alignment options or any of the long-span bridge alignment options.
- Connection Options T2 and T3 avoid both the site of the factory complex at TYTL 128 and the site of the Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre.
- Connection Options T2 and T3 would only affect open areas west of Tsing Yi Road and south of Ramblers Crest.

Demerits

2.3.7 The demerits of these indirect connection options are as follows:

- Connection Option T2 comprises a series of slip roads, and can therefore hardly be considered a proper link road connection between two strategic highways.
- Connection Option T4 would impact significantly on both the site of the factory complex at TYTL 128 and the site of the Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre. The impacts on the latter site alone make this connection option unfeasible.
- Connection Option T4 would also affect the HIT Tsing Hong Wan Depot and a small area of CT9.
- Connection Options T2, T3 and T4 would have potential traffic noise and visual impacts on the Hong Kong Institute of Vocational Education and Rambler's Crest.

Direct Connection with West Tsing Yi Viaduct (Connection Option T5)

2.3.8 **Figure 2.8** shows a direct connection between TYLL and the WTYV in the direction of Stonecutters Bridge and the urban area beyond.

Merits

2.3.9 The merits of this direct connection option are as follows:

- This connection option would provide a direct route between TYLL and Route 8.

- This connection option would also provide a direct bridge-to-bridge connection between the Stonecutters Bridge and TYLL.

- Furthermore, it would allow local access to CT9 via the CT9 slip roads south of the Nam Wan Tunnel.

Demerits

2.3.10 The demerits of this direct connection option are as follows:

- It would add about 1 to 1.5 km to the overall length of TYLL compared to Connection Option T1.

- The tight radii within the short sections of bored tunnel would necessitate widening for sight-lines, which would not be good practice.

- The layout of the link roads would make contra-flow operation impossible for tunnel maintenance or in case of breakdown or accident. This demerit alone makes this connection option unfeasible.

- This connection option introduces further roads and connections within a section of the strategic highway network at Tsing Yi that is already relatively congested with roads and connections.

- The link roads would have to cross the busy Cheung Tsing Highway twice, as well as the WTYV.

- This connection option would affect the two town lots namely TYTL 48 S.A. ss.1 & Ext (ICI D.G. Building) and TYTL 97 (DSL Office). Resumption/clearance of town lots are often very difficult and costly.

Summary

2.3.11 Connection Option T5 at WTYV is unfeasible, since it cannot accommodate contra-flow operation within the sections of bored tunnel, and will therefore not be considered further.

2.3.12 Connection Option T4 at CT9 is unfeasible, since it would have significant impacts on the Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre, and will therefore not be considered further.

2.3.13 Connection Option T3 at CT9 is superior to Option T2, since it would provide continuous link roads between the ETYV and TYLL, albeit via the existing slip roads that would need to be transformed into link roads, and will therefore be considered further, with the immersed tube tunnel alignment options.

2.3.14 Connection Option T1 at ETYV is superior to Option T2, since it would provide direct link roads between the ETYV and TYLL, and will therefore be considered further, with the long-span bridge alignment options.

2.4 Connections at Lantau

2.4.1 As discussed in **Section 1** of this report, TYLL was originally envisaged to connect with the Pa Tau Kwu section of the Chok Ko Wan Link Road (CKWLR) and the Coastal Road in Package C of the "NWNT Traffic and Infrastructure Review 2004".

2.4.2 One of the primary functions of TYLL (combined with TLB) is to support traffic capacity between NWNT and the urban area by relieving congestion on the Ting Kau Bridge along the Route 3 corridor and the section of Tuen Mun Road between Tsing Lung Tau and Sham Tseng.

Connection with Tsing Lung Bridge (Connection Options L1 and L2) (via the Coastal Road)

2.4.3 **Figure 2.9** shows two possible connections with TLB at Kwai Shek.

Merits

2.4.4 The merits of these connection options are as follows:

- Connection Option L1 could possibly provide access to any potential future developments along the east coast of Lantau.
- Connection Option L2 would avoid the potential impacts associated with the coastal route of Option L1.

Demerits

2.4.5 The demerits of these connection options are as follows:

- Connection Option L1 would have potential impacts on Tso Wan Village and Fa Peng Village, as well as the adjacent northeast coastline of Lantau in general.
- Connection Option L1 would require extensive cutting at Ng Kwu Leng in order to pass under Kap Shui Mun Bridge.
- Connection to NLH cannot be provided.

Connection with Tsing Lung Bridge and North Lantau Highway (Connection Option L3)

2.4.6 **Figure 2.10** shows a possible combined connection with TLB at Kwai Shek and North Lantau Highway (NLH) at the existing Lantau Toll Plaza.

Merits

2.4.7 The merits of this connection option are as follows:

- Connection Option L3 would provide the most direct route between TYLL and TLB and between TYLL and NLH.
- Connection Option L3 would avoid the potential impacts associated with the coastal route of Option L1.
- This option would also avoid the potential impacts associated with the connection to Penny's Bay.

Demerits

2.4.8 The demerits of this connection option are as follows:

- Connection Option L3 would require large-scale reprovisioning of the existing Lantau Toll Plaza the local widening of NLH.

Connection with Penny's Bay Highway (Connection Option L4) (via Chok Ko Wan Link Road)

2.4.9 **Figure 2.11** shows the practical / logical connection with Penny's Bay Highway (PBH) at Chok Ko Wan.

Merits

2.4.10 The merits of this connection option are as follows:

- Connection Option L4 would provide a direct route between TYLL and Penny's Bay.

Demerits

2.4.11 The demerits of this connection option are as follows:

- Connection Option L4 would have potential impacts on the Pa Tau Kwu peninsula, which is home to a White-bellied Sea Eagle (WBSE) nest, and adjacent area.
- Connection Option L4 would also have potential impacts on Hong Kong Disneyland Theme Park, with increased heavy goods vehicles (i.e. container lorries) using PBH.

Summary

2.4.12 None of the above connection options at Lantau are unfeasible. However, not all of the connection options can be combined with all of the main alignment options, due

to differences in their respective layouts and geometric designs. The pairing of the connection options with the main alignment options is discussed below.

2.5 Alignment Options - Immersed Tube Tunnel Schemes

2.5.1 The possible connection options for the immersed tube tunnel schemes are summarised in **Table 2.5.1** below.

Table 2.5.1 Possible Connection Options for Immersed Tube Tunnel Schemes

Alignment Option	Route 8 Connection	TLB Connection	PBH Connection
1	T3	L1	L4
2	T3	Not possible	L4
3	T3	L2	L4

Alignment Option 1

2.5.2 **Figure 2.12** shows Alignment Option 1, which is the southern most immersed tube tunnel scheme for TYLL.

2.5.3 This alignment option commences at Connection Option T3, where it passes into bored tunnel immediately south and below the east portal of the Nam Wan Tunnel, behind the Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre. From here, the bored tunnel continues south-westward under Tsing Yi Road, parallel to the Tsing Yi Gas Turbine Power Station, before heading into an immersed tube tunnel north of the Mobil Oil Depot under an open storage area.

2.5.4 The immersed tube tunnel passes through the southeast corner of the Disused Explosive Dumping Ground, and then continues south-westward under the Ma Wan Fairway and south of Pun Shan Shek, before turning northward onto reclamation just north of Pa Tau Kwu Pak Wan. From here, the main alignment heads north on elevated structure over Fa Peng Village and connects with Connection Option L1 (i.e. the Coastal Road) and TLB.

2.5.5 A pair of link roads separate from the main alignment and loop back on elevated structure across the sea, before passing into bored tunnel under Pa Tau Kwu, and connecting with Connection Option L4 (i.e. CKWLR) and PBH.

Alignment Option 2

2.5.6 **Figure 2.13** shows Alignment Option 2, which is the most direct immersed tube tunnel scheme for TYLL.

2.5.7 This alignment option commences at Connection Option T3, where it passes into bored tunnel immediately south and below the east portal of the Nam Wan Tunnel, behind the Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre. From

here, the bored tunnel continues westward under Nam Wan, before heading into an immersed tube tunnel under the China Merchants Container Services Ltd Mid-stream Container Terminal.

2.5.8 The immersed tube tunnel passes around the north edge of the Disused Explosive Dumping Ground, under the Ma Wan and Kap Shui Mun Fairways, and then continues south-westward towards Pa Tau Kwu Pak Wan. From here, the immersed tube tunnel passes back into bored tunnel under Pa Tau Kwu, and connects with Connection Option L4 (i.e. CKWLR) and PBH.

Alignment Option 3

2.5.9 **Figure 2.14** shows Alignment Option 3, which is the most northern immersed tube tunnel scheme for TYLL.

2.5.10 This alignment option commences at Connection Option T3, where it passes into bored tunnel immediately south and below the east portal of the Nam Wan Tunnel, behind the Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre. From here, the bored tunnel continues north-westward under Nam Wan, before heading into an immersed tube tunnel under the China Merchants Container Services Ltd Mid-stream Container Terminal.

2.5.11 The immersed tube tunnel passes clear of the north edge of the Disused Explosive Dumping Ground, and then continues north-westward under the Ma Wan Fairway, before turning south-westward under the Kap Shui Mun Fairway and onto reclamation just south of Ngam Hau Shek. From here, the main alignment continues south-westward at-grade, before passing into bored tunnel under Pa Tau Kwu, and connecting with Connection Option L4 (i.e. CKWLR) and PBH.

2.5.12 A pair of link roads separate from the main alignment and loop back on elevated structure across the sea, before passing into bored tunnel under Fa Peng Teng and connecting with Connection Option L2 (i.e. the Coastal Road) and TLB.

2.6 Alignment Options – Long-Span Bridge Schemes

2.6.1 The possible connection options for the long-span bridge schemes are summarised in **Table 2.6.1** below.

Table 2.6.1 Possible Connection Options for Long-Span Bridge Schemes

Alignment Option	Route 8 Connection	TLB Connection	PBH Connection
4	T1	L2	L4
5	T1	L2	L4
6	T1	L2	L4
7	T1	L3	Not provided

Alignment Option 4

2.6.2 **Figure 2.15** shows Alignment Option 4, which comprises a long-span suspension bridge with a span of 2440 m between the towers and a maximum possible span/dip ratio of approx. 18.2.

2.6.3 This alignment option commences at Connection Option T1, where it passes into bored tunnel immediately southwest of the east portal of the Nam Wan Tunnel. From here, the bored tunnel continues westward, before emerging from the hillside and crossing Tsing Yi Road, and heading out onto the long-span suspension bridge.

2.6.4 From Tsing Yi, the suspension bridge continues westward, and crosses the Ma Wan and Kap Shui Mun Fairways, before dropping down onto elevated structure towards Ngam Hau Shek. From this point, the main alignment heads north on elevated structure over Fa Peng Village, before passing into bored tunnel under Fa Peng Teng and connecting with Connection Option L2 (i.e. the Coastal Road) and TLB.

2.6.5 A pair of link roads separate from the main alignment and head south on elevated structure, before passing into bored tunnel under Pa Tau Kwu and connecting with Connection Option L4 (i.e. CKWLR) and PBH.

Alignment Option 5

2.6.6 **Figure 2.16** shows Alignment Option 5, which comprises a long-span suspension bridge with a span of 2140 m between the towers and a maximum possible span/dip ratio of approx 15.2.

2.6.7 This alignment option commences at Connection Option T1, where it passes into bored tunnel immediately southwest of the east portal of the Nam Wan Tunnel. From here, the bored tunnel continues north-westward, and then turns south-westward, before emerging from the hillside and crossing Tsing Yi Road, and heading out onto the long-span suspension bridge.

2.6.8 A pair of slip roads is provided between the suspension bridge and Tsing Yi Road to provide access to CT9 and the potential site of the proposed CT10 at Southwest Tsing Yi. Some local road improvement works would be necessary to accommodate the slip roads.

2.6.9 From Tsing Yi, the suspension bridge continues south-westward, and crosses the Ma Wan and Kap Shui Mun Fairways, before dropping down onto elevated structure just south of Ngam Hau Shek. From this point, the main alignment heads north on elevated structure behind Fa Peng Village, before passing into bored tunnel under Fa Peng Teng and connecting with Connection Option L2 (i.e. the Coastal Road) and TLB.

2.6.10 A pair of link roads separate from the main alignment and head south on elevated structure, before passing into bored tunnel under Pa Tau Kwu and connecting with Connection Option L4 (i.e. CKWLR) and PBH.

Alignment Option 6

2.6.11 **Figure 2.17** shows Alignment Option 6, which comprises a long-span suspension bridge with a span of 1750 m between the towers and a maximum possible span/dip ratio of approx. 11.4.

2.6.12 This alignment option commences at Connection Option T1, where it passes into bored tunnel immediately southwest of the east portal of the Nam Wan Tunnel. From here, the bored tunnel heads south-westward under Nam Wan Kok, before emerging from the hillside. From here, the highway crosses Tsing Yi Road and the north part of the power station site on elevated structure, before passing back over Tsing Yi Road. The highway then heads out onto the long-span suspension bridge above an open storage area just north of the Mobil Oil Depot.

2.6.13 A pair of slip roads is provided between the suspension bridge and Tsing Yi Road to provide access to CT9 and the potential site of the proposed CT10 at Southwest Tsing Yi. Some local road improvement works would be necessary to accommodate the slip roads.

2.6.14 From Tsing Yi, the suspension bridge continues south-westward, and crosses the Ma Wan Fairway, before dropping down onto elevated structure over the Pun Shan Shek Anchorage. From here, the highway heads north and then west towards the south of Ngam Hau Shek. From this point, the main alignment heads north on elevated structure behind Fa Peng Village, before passing into bored tunnel under Fa Peng Teng and connecting with Connection Option L2 (i.e. the Coastal Road) and TLB.

2.6.15 A pair of link roads separate from the main alignment and head south on elevated structure, before passing into bored tunnel under Pa Tau Kwu and connecting with Connection Option L4 (i.e. CKWLR) and PBH.

Alignment Option 7

2.6.16 **Figure 2.18** shows Alignment Option 7, which comprises:

- a long-span suspension bridge with a span of 1,800 m between the towers and a span/dip ratio of approx 12.3; and
- an arch bridge with a span of 500 m between the supports, and with structure below 110 mPD.

2.6.17 This alignment option commences at Connection Option T1, where it passes into bored tunnel immediately southwest of the east portal of the Nam Wan Tunnel. From here, the bored tunnel continues north-westward under Nam Wan, before emerging from the hillside and crossing Tsing Yi Road, and heading out onto the long-span suspension bridge above the China Merchants Container Services Ltd Mid-stream Container Terminal.

2.6.18 A pair of slip roads is provided between the suspension bridge and Tsing Yi Road to provide access to CT9 and the potential site of the proposed CT10 at Southwest

Tsing Yi. Some local road improvement works would be necessary to accommodate the slip roads.

2.6.19 From Tsing Yi, the suspension bridge continues north-westward, and crosses the Ma Wan Fairway and Anchorage, before dropping down onto elevated structure towards Tang Lung Chau. Just east of this island, the highway turns more westward and passes onto the arch bridge, which crosses the Kap Shui Mun Fairway, before connecting with Connection Option L3 and TLB and NLH.

2.6.20 No connection to PBH is provided with Option 7 due to the connectivity at NLH.

2.7 Summary of Key Technical Aspects of Alignment Options

2.7.1 The key technical aspects of the immersed tube tunnel (ITT) alignment options are summarised in **Table 2.7.1** below for reference.

Table 2.7.1 Key Technical Aspects of the ITT Alignment Options

ITT Alignment Option	Length of ITT (m)	Length of Approach Tunnel (m)	Overall Length of Tunnel Crossing (m)
1	3,850	1,550	5,400
2	3,930	850 + 1,630	6,410
3	3,980	1,610	5,590

2.7.2 The key technical aspects of the long-span bridge (LSB) alignment options are summarised in **Table 2.7.2** below for reference.

Table 2.7.2 Key Technical Aspects of the LSB Alignment Options

LSB Alignment Option	Span (m)	Tower / Structure Height (mPD)	Dip of Main Cable (m)	Span/Dip[(1)] Ratio	Angle between Cable and Deck
4	2,440	215	134	18.2	N/A
5	2,140	220	140	15.2	N/A
6	1,750	230	153	11.4	N/A
7 [(2)]	1,800	220	146	12.3	N/A
7 [(3)]	500	110	N/A	N/A	N/A

Notes: (1) Span/Dip Ratio for Tsing Ma Bridge is approx. 11 and for Tsing Lung Bridge is 14.4.
(2) Suspension bridge across Ma Wan Fairway.
(3) Arch bridge across Kap Shui Mun Fairway.

(Not Used)

SECTION 3

Traffic Impact Assessment Study

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

3 TRAFFIC IMPACT ASSESSMENT STUDY

3.1 Overview and Objectives

3.1.1 This chapter covers the forecasting approach, traffic forecasts, and findings of the Traffic Impact Assessment (TIA) for the TYLL alignment options and other NWNT strategic highway network options. The TIA played an important role in the development and evaluation of TYLL alignment options, and in the assessment of the strategic highway network for the NWNT.

3.1.2 The first stage in the analysis was a review of the various TYLL connection options at each end of the TYLL i.e. the location and configuration of the connections at Tsing Yi and Lantau. The second stage was to combine the connection options with the 7 TYLL alignment options which were then assessed in greater detail. This was then followed by further analysis of various strategic highway network options for the NWNT and toll assessments and other sensitivity tests such as the location of the proposed CT10. Throughout the study, the traffic assessment has provided inputs to the overall scheme design, impact assessment, and evaluation.

Objectives of the TIA

3.1.3 The specific tasks and objectives of the TIA are summarised as follows:

- Comprehensively review traffic data presently available and collect data to supplement the existing information.
- Validate a Sub-regional Traffic Model (SRTM) against observed traffic flows for the 2006 base year on major links and key interchanges and junctions within the Area of Influence (AOI).
- Provide daily and peak hour traffic forecasts for the road network within the AOI for the purpose of evaluating road infrastructure demand between Tsing Yi and Lantau with due consideration to the anticipated traffic demand between NWNT / Lantau/ Tsing Yi and the rest of the urban area.
- Carry out a range of toll sensitivity tests to enable the development of an optimum toll strategy for the TYLL taking into account the various NWNT road infrastructure options, and the considerations regarding toll-free movements for non-Lantau traffic (i.e. the traffic through TLB and TYLL to Tsing Yi or through the TYLL and TLB to Tsing Lung Tau).
- Conduct sensitivity tests relating to the potential CT10, which may be located at either north-west Lantau and south-west Tsing Yi.
- Determine the TYLL alignment and capacity requirements including the connections, lane configurations, and interchange arrangements with the local road network.

- Determine any adverse traffic impacts on the road network within the AOI during construction and operation of the recommended TYLL and recommend mitigation measures at the problem areas identified.

3.1.4 A comprehensive assessment of the NWNT traffic demand and infrastructure options was required to achieve the study objectives. There will be inter-related effects between the NWNT-Lantau connection options under consideration and other connecting, supplementary and/or alternative highway schemes including but not limited to the Tuen Mun Eastern Bypass (TMEB), Route 10, Lantau Road P1 and Tuen Mun Road (TMR) Improvements.

3.1.5 The proposed Area of Influence (AOI) for the traffic impact assessment is shown in **Figure 3.1**.

3.2 Approach and Assumptions

Traffic Model Development

3.2.1 A two-stage forecasting approach was applied using the SAR-wide multi-modal Transport Model (MVCTS) to provide the strategic traffic figures to investigate strategic choices and to generate traffic matrices for a more detailed Sub-regional Traffic Model (SRTM) of the AOI. The AOI covered the NWNT (including Tsing Yi) and North Lantau. The modelling approach has been used extensively in Hong Kong and is capable of producing useful and accurate forecasts, depending of course on the accuracy of the input assumptions. The MVCTS was recently calibrated to TCS-2002, and GVTCS-2003 and CBS and validated to 2004. It was further updated and re-validated to a base year of 2005 for the recent CE45/2005 (HY) - Link Options between Tuen Mun and Lantau – Feasibility Study.

3.2.2 A single SRTM was used to generate the traffic flows used in the assessment. The model is based on CUBE VOYAGER software. Additional zoning and network detail was added to better represent the route choices between NWNT, Lantau, Tsing Yi and Kowloon. The zoning systems were designed to reflect the most recent information about existing and future developments, particularly on Lantau.

3.2.3 The SRTM was validated to 2006 across extensive screenlines for the AM and PM peak hour periods. Traffic forecasts for the design year 2030 was prepared using the latest available planning data and model assumptions which are set out in detail in the TIA Report of this Assignment and discussed below.

Traffic Forecasts and V/C Ratios

3.2.4 The traffic forecasts are presented in terms of vehicle flows, and Volume/Capacity (V/C) ratios for an "average weekday". In general, a capacity of 3,100 vehicles per direction was assumed for a dual 2-lane road, 4,700 vehicles for a dual 3-lane road, and 6,300 vehicles for a dual 4-lane road. As stated in the NWNT Traffic and Infrastructure Review 2004 and the recent June 2007 update, a V/C ratio is normally used to reflect traffic situation during peak hours. A V/C ratio below 1 is considered

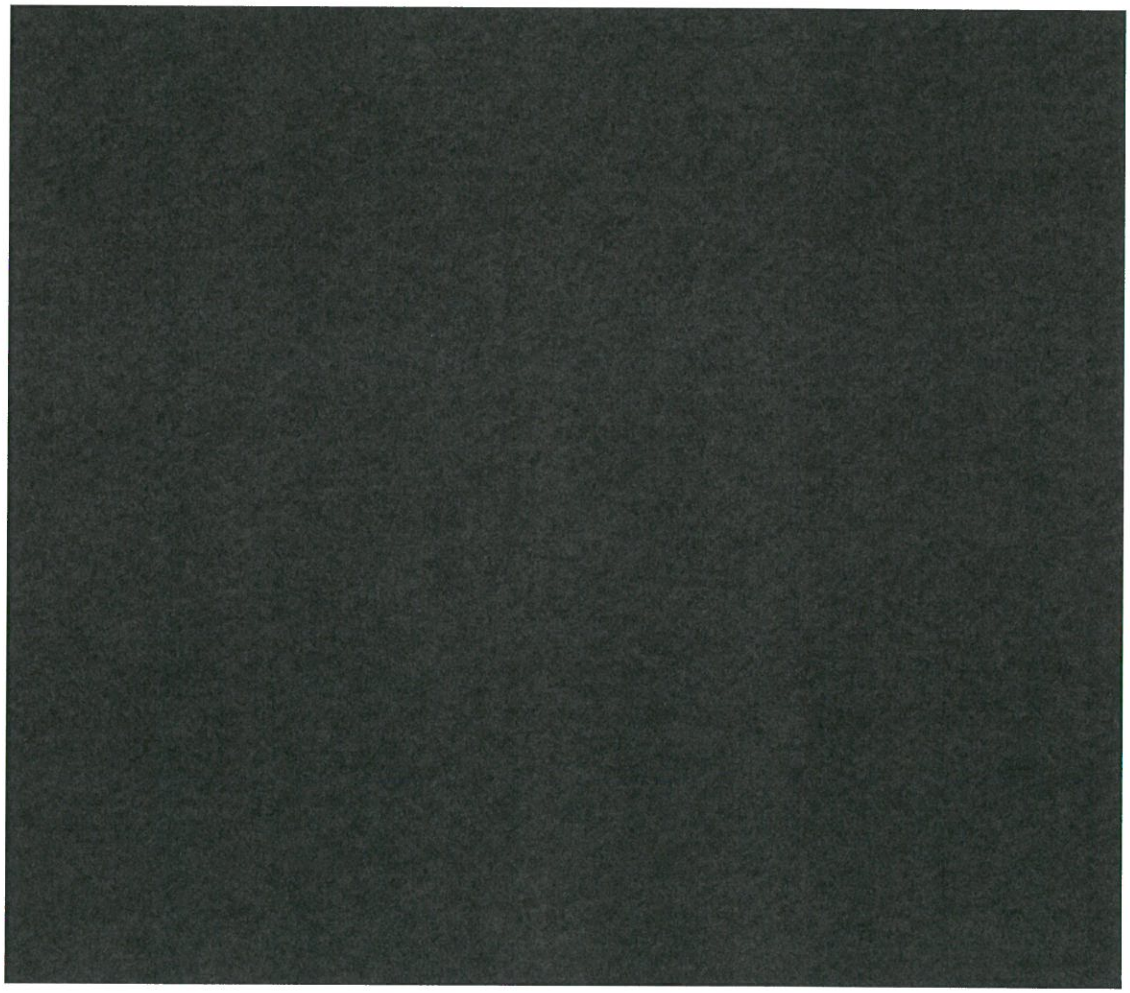
acceptable. A V/C ratio above 1.0 indicates the onset of mild congestion and a V/C ratio between 1.0 and 1.2 would indicate a manageable degree of congestion. A V/C ratio above 1.2 indicates the onset of more serious congestion.

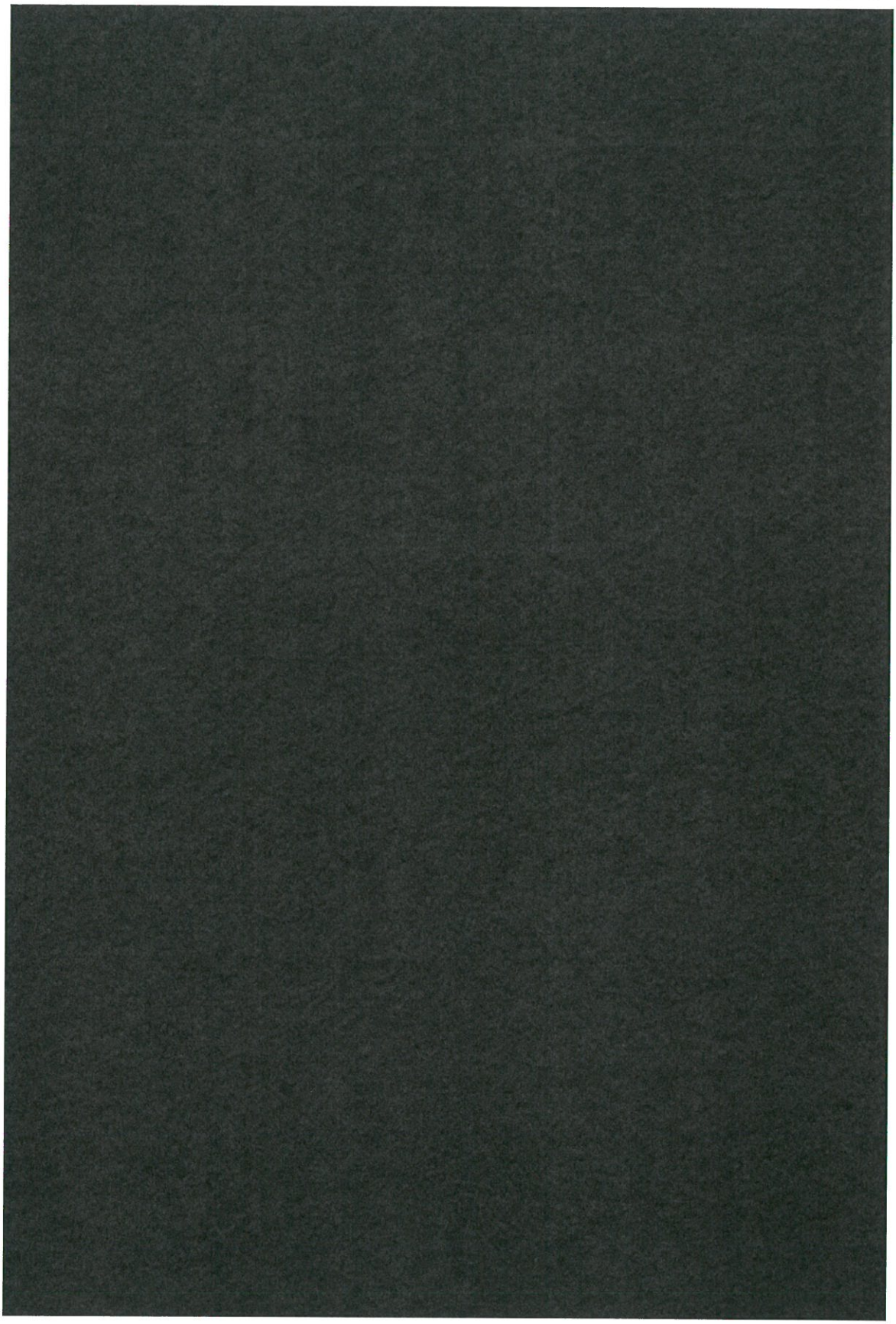
3.2.5 The assumptions regarding the timing of new developments, and particularly how to handle peak flows at special generators such as the Airport and the proposed CT10 – which sometimes have significantly higher flows than the average weekday – will be important in determining the timing of new infrastructure. Note that these forecasts include traffic to/from the Asia World-Expo (AWE) Phase II for a "normal" public exhibition event, and are based on an "average" weekday for Airport demands.

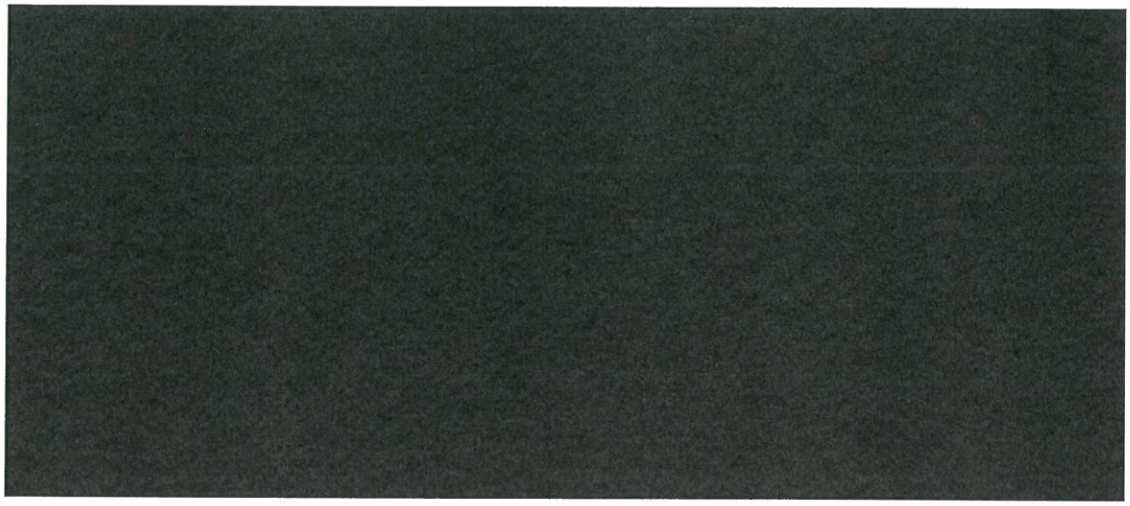
Planning Data Assumptions

3.2.6 The population and employment assumptions are summarised by Sector in **Tables 3.2.1** and **3.2.2** respectively. For consistency with the other ongoing feasibility studies within the NWNT, the TPEDM (2003-based) Scenario I dataset was adopted for years 2016 and 2021. For year 2030, the HK2030 planning data matrix developed under the "Hong Kong 2030: Planning Vision and Strategy" was adopted.

3.2.7 The strategic assumptions regarding population/employment were updated by the latest information regarding specific developments described below.







Economic Growth and Vehicle Fleet Size

3.2.8 Economic growth assumptions are presented in **Table 3.2.3** based on information in the 2007/2008 budget speech and consultants data.

Table 3.2.3 GDP Growth Assumptions

Year	Percentage Growth Per Annum
2005	7.3%
2006	6.8%
2007	5.0%
2008-2011	4.5%
2012-2030	3.5%

Notes:
(1) 2005 taken from the 2006/07 budget speech (22 Feb 2006)
(2) 2006, 2007 and 2008-2011 data taken from the 2007/08 budget speech (28 Feb 2007)
(3) 2012-2030 data from consultants

3.2.9 Vehicle fleet size assumptions are presented in **Table 3.2.4** and were adopted for the reference case forecasts for this Study for consistency with other ongoing studies.

Table 3.2.4 Vehicle Fleet Size

Year	PV Mid-Year Fleet Size	GV Mid-Year Fleet Size
2006	390,100	111,300
2011	441,400	114,100
2016	487,300	117,000
2021	525,000	120,000
2030	574,000	126,000

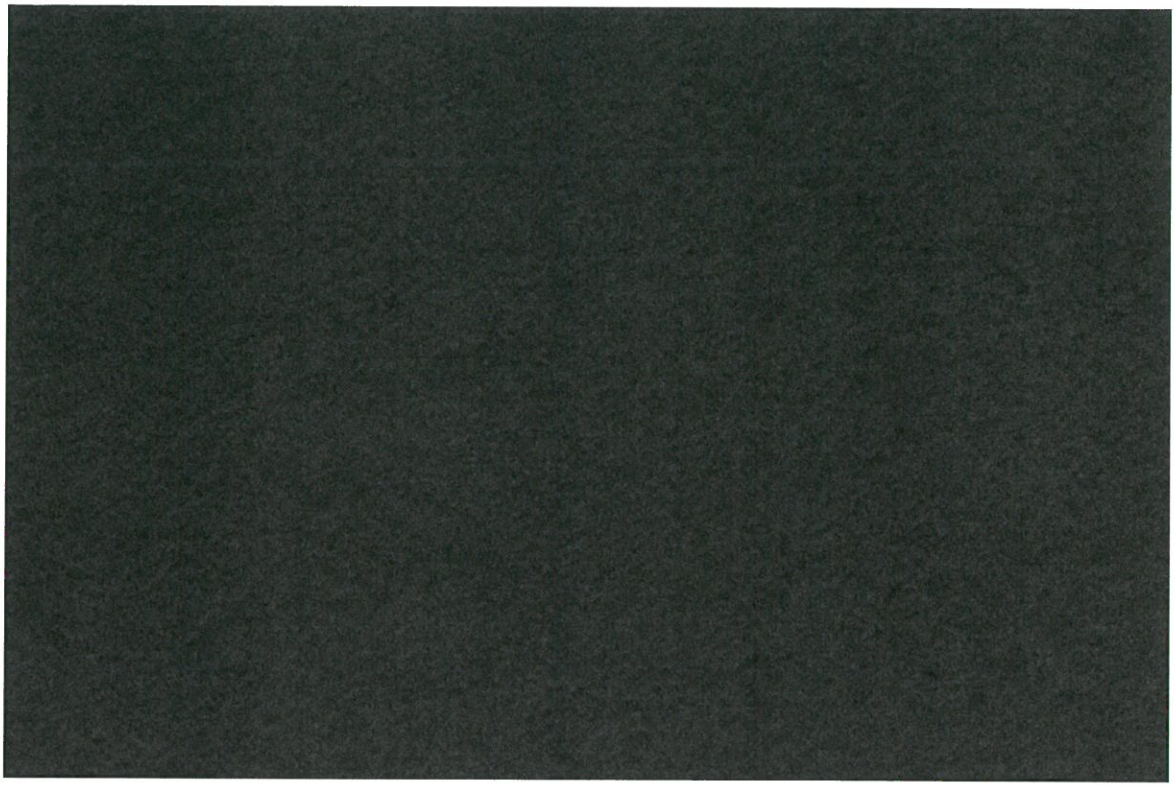


3.2.10 Traffic to/from certain locations cannot readily be forecast using the main models. In these cases, explicit assumptions regarding traffic generation/attraction were made, and the forecast traffic to/from these sites was added to the highway assignments. Sub-modules were included within MVCTS to deal with the specific trip distributions, peak factors and modal choice associated with the following major developments:

[redacted]

- Airport-related passenger and cargo traffic
- Disneyland Theme Park traffic
- Goods vehicle (including Container Terminal 10) traffic
- Other specific developments such as the Lantau Logistics Park (LLP) and Asia World-Expo (AWE)

[redacted]



3.2.12 Port usage forecasts are shown in **Table 3.2.6.** Data for 2016 and 2021 were consistent with the cross-boundary forecasts provided by Planning Department and other recent government studies in the NWNT. Forecast assumptions for 2030 are taken directly from the Hong Kong Port-Master Plan 2020 (HKP2020) Study. The proposed CT10 was assumed at Northwest Lantau for the main traffic forecasts. Sensitivity tests with the port at Southwest Tsing Yi, and without a CT10, were also conducted.

Table 3.2.6 Port Productivities of Container Terminals (TEU '000s per year)

Year	CTs 1-8	CT9	CT10	Total
2006	15,640		N/a	15,640
2016	16,040	5,020	3,800	24,860
2021	16,720	5,110	7,400	29,230
2030	17,800	5,200	11,400	34,400

Note: Data for 2016 and 2021 are extrapolated from the port cargo forecasts in the HKP2020 Study

3.2.13 Airport usage forecasts as adopted for the recent Link Options between Tuen Mun and Lantau – Feasibility Study were taken as a reference point as shown in **Table 3.2.7.** Year 2030 was derived by extrapolation. The Airport Authority advised that the numbers are confidential and should not be quoted outside of Government departments without their consent.

Table 3.2.7 Hong Kong International Airport Average Day Usage Forecasts

Year	2005	2006	2016	2021	2025	2030
Daily Air Passengers	72,230	78,865	116,686	131,981	143,077	158,268
Daily Cargo (Tonnes)	7,468	7,877	13,056	15,580	17,635	20,859

Notes:
(1) Source: Airport Authority Hong Kong, Master Plan 2025
(2) Excluding Transfer/Transit Passengers and Transhipment Cargo
(3) Cargo includes freight only i.e. air mail is excluded

3.2.14 Other specific developments such as the Lantau Logistics Park (LLP) and Asia World Expo (AWE) are set out in **Appendix A**.

Strategic Highway Network Assumptions

3.2.15 Reference Case strategic highway network assumptions are presented in **Tables 3.2.8** to **3.2.10** for years 2011, 2016 and 2021 and are illustrated in **Figure 3.2**. The assumptions as shown were adopted as a starting point for the reference case forecasts in this study. The following points should be noted:

- Only major highway projects have been listed in the tables below.
- District or local improvement projects have not been included.
- The list excludes potential schemes such as those under consideration in the ongoing NWNT Review.

Table 3.2.8 2011 Strategic Road Network Assumptions

2011 Road Network Assumption (In Addition To Year 2006 Network)	Configuration
New Territories	
Route 8 (formerly Route 9) (Tsing Yi to Sha Tin)	D3
Sha Tin Trunk Road T3	D2/D3[(1)]
Sha Tin Trunk Road T4	D2
Route 9 (formerly Route 5) Extension from Shek Wai Kok to Chai Wan Kok	D2
Widening of Tung Chung Road	S2
Improvements to Tuen Mun Road Town Centre Section (as described for the Base Case in LegCo Paper No. CB(1)2023/06-07(05))	D3
Reconstruction and Improvement to Tuen Mun Road Expressway Section	D3
Cross Boundary	
Deep Bay Link	D3
Hong Kong Shenzhen Western Corridor	D3

Notes:
(1) The configuration of these proposed highways varies at different sections of the road.
(2) The above network assumptions do not include the possible highway packages proposed in the NWNT Review.

Table 3.2.9 2016 Strategic Road Network Assumptions

2016 Road Network Assumption (In Addition To 2011 Network)	Configuration
Hong Kong	
Central – Wan Chai Bypass	D3/D4 (1)
Kowloon	
Route 6 (formerly Route 11) – Central Kowloon Route	D3
Widening of Gascoigne Road Flyover	D2
Route 6 (formerly Route 11) – Trunk Road T2 (Kai Tak – Cha Kwo Ling Link)	D2
New Territories	
Route 6 (formerly Route 11) – TKO – Lam Tin Tunnel	D2
Cross Bay Link at Tseung Kwan O	D2
Tolo Highway/Fanling Highway Widening (between Island House Interchange and Tai Hang and Tai Hang and Fanling)	D4
Tsuen Wan Road Upgrading	Add 2 lanes per direction
Dualling of Hiram's Highway between Clear Water Bay Road and Sai Kung Town	D2
Hong Kong – Zhuhai – Macao Bridge Hong Kong Link Road	D3
Tuen Mun Western Bypass	D2
Tuen Mun-Chek Lap Kok Link	D2
Cross Boundary	
Hong Kong-Zhuhai-Macao Bridge	D3

Notes:
(1) The configuration of these proposed highways varies at different sections of the road.
(2) The above network assumptions do not include the possible highway packages proposed in the NWNT Review 2004.

Table 3.2.10 2021 Strategic Road Network Assumptions

2021 Road Network Assumption (In Addition To 2016 Network)	Configuration
Hong Kong	
Island Eastern Corridor Improvement between Causeway Bay and North Point	D4/D5 (1)

Notes:
(1) The configuration of these proposed highways varies at different sections of the road.
(2) The above network assumptions do not include the possible highway packages proposed in the NWNT Review 2004

Railway Network Assumptions

3.2.16 Future railway network assumptions are present in **Table 3.2.11.**

Table 3.2.11 Railway Network Assumptions

By 2011 (In Addition to Year 2006 Network)
Kowloon Southern Link
Tseung Kwan O South Station
By 2016 (In Addition to 2011 Network)
Kwun Tong Line Extension
Shatin to Central Link
West Island Line

South Island Line (East)
Northern Link
Express Rail Link
By 2021 (In Addition to 2016 Network)
South Island Line (West)
North Hong Kong Island Line

Reference Case Highway Toll Assumptions

3.2.17 Toll assumptions are presented in **Table 3.2.12.** In accordance with other government studies, future tolls are assumed to remain constant in real terms. These tolls were adopted for reference case forecasts for this study in order to be consistent with other ongoing studies.

3.2.18 The rationale for tolls on the new links is that traffic will pay the equivalent amount as for an equivalent existing link. For example, traffic to Lantau will pay the same as the current Lantau Link, and traffic on the TMEB/TMWB would pay the same as Tai Lam Tunnel (Route 3). As traffic on the TMEB/TMWB has the option of a toll-free route via TMR, the tolls for these bypass schemes can be considered a high-end assumption. Indeed the Tuen Mun-Chek Lap Kok Link (TMCLKL) Study has recommended that the TMWB adopt a zero-toll level.

3.2.19 For TLB traffic, in view of the free parallel route offered by Ting Kau Bridge (TKB), the reference case will assume that no toll would be charged for bypassing traffic between Tuen Mun and Tsing Yi / Urban using both TLB & TYLL at the same time (i.e. for traffic passing both TLB & TYLL in a single journey but without stopping on Lantau Island). This is consistent with the NWNT Review 2004.

3.2.20 In the current set of forecasts, the toll-free route is only provided for traffic using both TLB & TYLL. For example, traffic using Tuen Mun Lantau Link (TMLL) and Lantau Link (LL) or TYLL would be subject to double-toll and is therefore discouraged.

Table 3.2.12 Toll Assumptions - 2006 Dollars

Toll Facility	Car/Taxi	Light Goods Vehicle	Medium Goods Vehicle	Heavy Goods Vehicle	Tractor Unit
Shing Mun Tunnel	5	5	5	5	5
Lion Rock Tunnel (LRT)	8	8	8	8	8
Tate's Cairn Tunnel (TCT)	12	18	23	23	38
Route 8 between Cheung Sha Wan and Sha Tin	*10*	*10*	*15*	*20*	*20*
Tseung Kwan O (TKO) Tunnel	3	3	3	3	3
TKO – Lam Tin Tunnel	*3*	*3*	*3*	*3*	*3*
Eastern Harbour Crossing (EHC)	25	38	50	75	100
Cross Harbour Tunnel (CHT)	20/10	15	20	30	40
Western Harbour Crossing	40/35	55	80	110	140

Toll Facility	Car/Taxi	Light Goods Vehicle	Medium Goods Vehicle	Heavy Goods Vehicle	Tractor Unit
Aberdeen Tunnel	5	5	5	5	5
Lantau Link	15	20	25	40	40
Tsing Lung Bridge[2] (TLB)	*15*	*20*	*25*	*40*	*40*
Tuen Mun – Lantau Link (TMLL)	*15*	*20*	*25*	*40*	*40*
Tuen Mun – Chek Lap Kok Link (TMCLKL)	*15*	*20*	*25*	*40*	*40*
Tsing Yi – Lantau Link (TYLL)	*15*	*20*	*25*	*40*	*40*
Tai Lam Tunnel (R3-CPS)	25	28	35	40	40
Lam Tei Tunnel and Tai Lam Chung Tunnel (LTT)	*25*	28	*35*	*40*	*40*
Tuen Mun Western Bypass (TMWB)	*25*	28	*35*	*40*	*40*
Tuen Mun Eastern Bypass (TMEB)	*25*	28	*35*	*40*	*40*

Notes:

(1) Tolls for motorcycles are assumed to be the same as private cars.

(2) Proposed highway projects (including the committed ones and those under planning) are shown in italics as their actual toll levels could only be determined nearer the time of opening.

3.3 TYLL Scheme Options

3.3.1 The Tsing Yi Lantau Link (TYLL) is intended to fulfil two primary functions:

- To provide a new corridor between Lantau and the Urban Area in order to relieve anticipated future congestion on the Lantau Link.
- To form part of a future supplementary corridor for NWNT-Urban traffic to relieve the TKB and TMR which are expected to be critical links in the future NWNT network. This role requires the Tsing Lung Bridge, or an equivalent connection between Lantau and Tuen Mun, to be in place.

3.3.2 The TYLL alignments options are shown in **Figures 2.12 – 2.18**. All TYLL scheme options connect both to NLH and TLB on Lantau Island and to Route 8 on Tsing Yi Island close to East Tsing Yi Viaduct.

3.3.3 **Table 3.3.1** summarises the connection options on Lantau and Tsing Yi for each of the seven alignment options. The toll plaza arrangements are discussed in the section below.

Table 3.3.1 Summary Traffic Features of TYLL Alignment Options

	TYLL	Lantau Connection		Tsing Yi Connections	
	Type	Via CKWLR	Via Coastal Rd	Route 8	Tsing Yi access
1	Tunnel	Yes	TLB only	Via ETYV Slips	ETYV slips
2	Tunnel	Yes	None	Via ETYV Slips	ETYV slips
3	Tunnel	Yes	TLB only	Via ETYV Slips	ETYV slips
4	Bridge	Yes	TLB only	Direct	None
5	Bridge	Yes	TLB only	Direct	Tsing Yi West

	TYLL Type	Lantau Connection		Tsing Yi Connections	
		Via CKWLR	Via Coastal Rd	Route 8	Tsing Yi access
6	Bridge	Yes	TLB only	Direct	Tsing Yi West
7	Bridge	None	TLB & NLH	Direct	Tsing Yi West

3.3.4 A major distinction can be made from a traffic perspective between the tunnel options (Alignment Options 1-3) and the bridge options (Alignment Options 4-7). Generally the tunnel options are not preferred as:

- They involve longer travel distance (some of which is due to the long, circuitous ramps required).
- They tend to have long, circuitous ramps that reduce travel speeds, particularly for heavy goods vehicles, buses and coaches.

Lantau Connections

3.3.5 All scheme options provide for the two key strategic connections:

- TYLL to the NLH Corridor (i.e. NLH and Road P1) for Lantau ↔ Urban traffic movements.
- TYLL to TLB for NWNT ↔ Urban traffic movements.

3.3.6 On Lantau, Alignment Options 1, 3, 4, 5 and 6 are conceptually similar in that they each provide a "dual connection" to two routes on Lantau namely a) NLH / Road P1 via PBH and b) TLB via the Coastal Road. Under these options, improvements are proposed to Sunny Bay interchange to provide a direct connection between PBH and Road P1.

3.3.7 The TYLL options which differ in terms of Lantau Connections are as follows:

3.3.8 Alignment Option 2 provides only a connection to Lantau via PBH. For NWNT network options with the TLB in place, this TYLL option is considerably longer than the alternatives for NWNT ↔ traffic and is therefore considered deficient for NWNT – urban movements. (With an alternate connection option to Lantau – such as the TMLL – the scheme is comparable to other TYLL options in terms of distance, but may be constrained by the capacity of Sunny Bay Interchange).

3.3.9 Alignment Option 7 lands further north on Lantau and provides connections to both the NLH and TLB, and does not connect via PBH.

3.3.10 For Lantau ↔ urban traffic, Alignment Option 7 connects to a widened NLH and a connection is then provided between NLH and Road P1 to the west of Sunny Bay. The advantage of this scheme is the shorter travel distances and avoidance of impact on PBH. Assessments indicate that there is sufficient capacity on the section of NLH between TLB and Sunny Bay to cater for the required movements. However there may also be potential implications in terms of reduced flexibility to implement differential tolls for different movements to/from Lantau.

Tsing Yi Connections

3.3.11 On Tsing Yi Island, the primary traffic goal is to provide a strategic connection to the Route 8 (urban-bound), and a secondary goal is to enable access to the local road network. All seven Alignment Options provide the required strategic connection, and all options, apart from Alignment Option 4, provide local access to Tsing Yi.

3.3.12 The Tunnel Alignments (Options 1 to 3) connect to Route 8 (Stonecutters Bridge) via the Route 8 Slip Roads at Tsing Yi East Interchange to/from Tsing Yi Road close to CT9. These options provide good local access, but relatively poor mainline connectivity to/from Route 8 in the following respects:

- A loop movement of around 1.5 kilometres is required which is far from ideal for a strategic highway connection.
- Although two-lane slip roads are provided to/from the ETYV at least part of the capacity of these lanes will be utilised by South Tsing Yi traffic. This means that the residual capacity for TYLL to/from Route 8 through traffic would be limited to less than two lanes of traffic.

3.3.13 The Bridge Alignments (Options 4 to 7) are preferred in terms of strategic connectivity as they provide full two-lane connections to/from Route 8 and which are direct i.e. without any loop movements.

3.3.14 However in terms of local access, Option 4 provides no local access to Tsing Yi which means that Tsing Yi traffic will need to use the alternative of Route 3 (and therefore will not use Route 10 Lam Tei Tunnel). This TYLL option can be considered to be somewhat deficient in traffic terms as it constraints the strategic route choice for local traffic.

3.3.15 Options 5 to 7 all provide local access via a connection to Tsing Yi Road on the western side of Tsing Yi. Note the connection allows for only partial traffic movements for the TYLL ↔ CT9 direction. Routings to/from developments to the North West of Tsing Yi (such as the potential CT10 location) would require traffic to U-turn, and if CT10 were to proceed, it is assumed that a roundabout would be required for this traffic.

Proposed Toll Plaza Arrangements

3.3.16 The toll plaza arrangements for the various options are as follows:

- For all options, TLB ↔ Lantau traffic is captured by the (existing) Lantau Toll Plaza for Tsing Ma Control Area (TMCA). This is likely to become a two-way toll plaza should other Lantau Connections, such as the TMCLKL, be in place.
- Alignment Options 1, 3, 4, 5 and 6 (the "dual connection" options) have a toll plaza east of PBH to capture Lantau ↔ Urban traffic using TYLL.
- All Alignment Options apart from Alignment Option 2 provide a toll-free segregated route between TLB and the TYLL (i.e. the Coastal Road or equivalent). Alignment Option 2 would require intelligent tolling strategies to provide a toll-free route for NWNT – urban traffic using both the TMCA toll station and the TYLL toll station. However, given the travel distances involved, only small amounts of traffic are forecast to make this movement.

- Under Alignment Option 7, an expanded and modified TMCA Lantau Toll Plaza captures all Lantau traffic to/from TLB, LL and TYLL.

3.3.17 Under these arrangements, a toll-free route between Tuen Mun Road and Tsing Yi is provided via TLB, Lantau Coastal Road, and TYLL. Traffics on TMEB or Tai Lam Tunnel are subject to toll plazas associated with those specific schemes. Traffic to/from Lantau is tolled.

3.3.18 For all options, the existing TMCA Lantau Toll Plaza will capture traffic between (a) TLB – Lantau and (b) LL – Lantau. Under Option 7, the TMCA will also capture TYLL – Lantau traffic. The traffic arrangements have been arranged to provide adequate provision for merging/weaving movements. At the detailed design stage, further review of toll booth requirements would be warranted given the likely advances in Intelligent Tolling Strategies by the earliest opening year of 2022. This may include technologies like Automatic Number Plate Recognition (ANPR), Dedicated Short Range Communication (DSRC) and Global Positioning System (GPS) which could reduce congestion at toll plaza and automating toll collection. Indeed, with a partial or complete removal of the requirements for toll booths, the land requirements would be much reduced and there may also be advantages in terms of traffic management arrangements.

3.4 TYLL Traffic Forecasts for Options Assessment

Year 2030 Forecast Key Links – TYLL Options

3.4.1 This section presents a comparison of the TYLL alignments at year 2030. The impact of other possible schemes on the selection of the preferred TYLL alignment is discussed in **Section 3.5**. To assist the TYLL options development process, traffic forecasts were presented as follows:

- NWNT Option 1N (No TYLL) - which includes the Reference Case network plus Route 10 Lam Tei Tunnel (LTT) (dual 3-lanes), TLB (dual 3-lanes) and Lantau Road P1 between Sham Shui Kok and Sunny Bay (dual 2-lanes).
- NWNT Option 1T (With TYLL) - the above NWNT Option 1N plus each of the seven TYLL alignment options.

3.4.2 NWNT Option 1 was used for the options assessment as it provides a higher end set of traffic forecasts for scheme design in that:

- The adoption of Route 10 LTT in place of the TMEB / TMR option reduces the likelihood of traffic diverting away from TLB due to congestion on TMR.
- The zero-toll for the non-Lantau traffic using the TYLL will give a higher-end estimate of demand.

3.4.3 The traffic forecasts for key links in year 2030, peak hour, peak direction flows are presented in **Table 3.4.1** in terms of V/C ratios. The table presents NWNT Option 1N (No TYLL) and the seven alignments of NWNT Option 1T (With TYLL).

Table 3.4.1 Forecast V/C Ratios – 2030 AM Peak Hour, Peak Direction

Highway Link	No. of Lanes	Volume to Capacity Ratio							
		NWNT Option 1	TYLL Alignment Option						
			1	2	3	4	5	6	7
Route 3 Tai Lam Tunnel	3	1.10	1.09	1.09	1.09	1.09	1.09	1.09	1.09

Highway Link	No. of Lanes	Volume to Capacity Ratio							
		NWNT	TYLL Alignment Option						
		Option 1	1	2	3	4	5	6	7
Tuen Mun Road (So Kwun Wat)	3	0.86	0.86	0.87	0.86	0.86	0.86	0.86	0.87
Tuen Mun Road (Sham Tseng)	3	1.36	1.10	1.10	1.09	1.08	1.06	1.08	1.04
Tuen Mun Road (Ting Kau)	3	1.18	1.10	1.11	1.09	1.11	1.09	1.09	1.11
Ting Kau Bridge	3	1.23	1.04	1.03	1.05	1.01	1.01	1.03	0.97
Lantau Link	3	1.17	0.92	0.93	0.90	0.85	0.83	0.86	0.82
LL – R3(South) Connections	3	1.40	1.04	1.09	0.98	0.90	0.88	0.93	0.88
NLH (east of SHW)	3	1.11	1.12	1.12	1.10	1.12	1.13	1.13	1.12
NLH (west of SHW)	3	1.23	1.26	1.26	1.26	1.26	1.26	1.26	1.26
Road P1 (east of SHW)	2	0.28	0.31	0.32	0.31	0.38	0.32	0.34	0.32
Route 10 LTT	3	0.69	0.73	0.71	0.73	0.73	0.73	0.73	0.72
Route 10 TLB	3	0.52	0.77	0.73	0.76	0.80	0.81	0.78	0.84
TMWB	2	0.01	0.02	0.01	0.01	0.02	0.02	0.01	0.02
TMCLKL	2	0.55	0.49	0.49	0.48	0.49	0.49	0.49	0.48
TYLL	(3)	n/a	0.68	0.62	0.69	0.78	0.80	0.75	0.85
PBH	(3)	0.14	0.16	0.69	0.52	0.53	0.55	0.54	0.14
Lantau Coastal Road (TLB traffic)	(2)	n/a	0.79	n/a	0.45	0.74	0.72	0.64	n/a
Route 3 Cheung Tsing Tunnel	3	0.83	0.88	0.87	0.91	0.87	0.89	0.86	0.89
Route 8 Nam Wan Tunnel	3	0.98	0.66	0.70	0.63	0.55	0.51	0.60	0.53
Route 8 Stonecutters Bridge	3	0.93	1.04	1.05	1.03	1.07	1.07	1.09	1.12
Route 8 Cheung Sha Wan – Shatin Section	3	0.53	0.53	0.53	0.54	0.53	0.52	0.53	0.54
Route 3 WKH (South of Route 8)	3	1.21	1.19	1.21	1.21	1.21	1.21	1.20	1.21
Overall Summary									
Average of Above	n/a	0.87	0.81	0.83	0.80	0.82	0.81	0.81	0.80
Maximum of Above	n/a	1.40	1.26	1.26	1.26	1.26	1.26	1.26	1.26

Notes:

(1) Figures in brackets are proposed lane configurations adopted in this study.

3.4.4 With NWNT Option 1 but without the TYLL, the forecast showed that a number of key links would be congested with V/C ratios close to or above 1.2 including TMR (Sham Tseng and Ting Kau), Ting Kau Bridge and Lantau Link. Route 10 LTT and TLB would be relatively under-used (assuming a D3 lane capacity) as these routes serve only traffic to/from Lantau without the TYLL.

3.4.5 With the TYLL in place, the network would be improved in several respects:

- The critical links of TMR, TKB and the Lantau Link would be relieved to V/C ratios of 1.2 or less.
- There would be a much more even balance of traffic between the LTT / TLB and Route 3 / TKB and between Route 3 Cheung Tsing Tunnel/Bridge and Route 8 Stonecutters Bridge (SCB).

3.4.6 It was also apparent that there could be some potential issues as follows:

- Route 8 Nam Wan Tunnel would become less utilised (from close to 1.0 to around 0.6-0.7 in the tunnel options or to 0.5–0.6 in the bridge options) as traffic

diverts to the TYLL. However, this reduction was expected as traffic reassigns, and the merging between TYLL and ETYV / Stonecutters Bridge would be a major constraint if Nam Wan Tunnel is more heavily used.

3.4.7 Although all of the TYLL options would relieve traffic on the LL, there would be some key differences in performance as follows:

- All Options would achieve the aims of providing relief to the LL and the TKB / TMR corridor. The extent of this relief would tend to be greater in the bridge options (4 to 7).
- There is a large difference between Options 1 and 7 and other options in terms of impact on PBH although this is not a critical link in terms of V/C ratios.

3.4.8 The model found that only a part of the Lantau traffic would divert to the TYLL, with the rest continuing to use the LL. The diversion of a proportion of the traffic would prevent the LL from becoming congested. However the balance of Lantau – Urban traffic selecting TYLL or LL is very sensitive, and hence the shorter TYLL options were favoured in the assessment. Indeed, in the off-peak period, with lower traffic levels on Lantau Link, the less direct TYLL tunnel options could be particularly under-utilised.

Year 2030 Network Performance – TYLL Options

3.4.9 The peak hour traffic model summary vehicle assignment and network performance statistics are provided in **Table 3.4.2** for all Alignment Options at 2030. It was found that:

- All options decrease overall vehicle travel time, but increase vehicle distance. The increase in vehicle distance is due to two effects. Firstly there is some traffic generation effect due to the additional capacity. Secondly, with TYLL, Route 10 becomes a viable high-speed option and so may attract some traffic from slower and more direct routes. The improvement in travel speeds is quite pronounced which reflects the greater usage of Route 10 LTT with the TYLL in place.
- Alignment 7 gives the lowest increase in vehicle distance reflecting the more direct routings in this option. The bridge alignments generally perform better than the tunnel options.

Table 3.4.2 AM Peak Hour Network Performance Statistics (PV plus GV) – 2030

Within the AOI	NWNT Option 1	TYLL Alignment Option						
		1	2	3	4	5	6	7
Veh. Distance (veh-kms)	1,346,131	1,353,935	1,349,947	1,353,060	1,347,767	1,347,101	1,349,262	1,340,218
Veh. Time (veh-hours)	43,153	39,644	39,533	39,417	39,277	39,247	39,302	39,150
Speed (km/hr)	31.19	34.15	34.15	34.33	34.31	34.32	34.33	34.23
Difference from Base Case								
Veh. Distance (veh-kms)	n/a	7,804	3,816	6,929	1,636	970	3,131	-5,913
Veh. Time (veh-hours)	n/a	-3,509	-3,620	-3,736	-3,876	-3,906	-3,851	-4,003
Speed (km/hr)	n/a	2.96	2.95	3.13	3.12	3.13	3.14	3.04

% Difference from Base Case								
Veh. Distance (veh-kms)	n/a	0.58%	0.28%	0.51%	0.12%	0.07%	0.23%	-0.44%
Veh. Time (veh-hours)	n/a	-8.13%	-8.39%	-8.66%	-8.98%	-9.05%	-8.92%	-9.28%
Speed (km/hr)	n/a	9.48%	9.47%	10.04%	10.00%	10.03%	10.05%	9.74%

Tsing Yi Lantau Link Capacity

3.4.10 The following findings were drawn from the 2030 traffic forecasts:

- TYLL options that provide a dual-two lane configuration are likely to be sufficient in terms of achieving acceptable V/C ratios at year 2030. However V/C ratios at major NWNT key links are close to or slightly over 1.0.

- A three-lane configuration of the TYLL is preferred for contingency purposes in case of Lantau Link closure.

3.4.11 Note however that the full three lanes are unlikely to be fully utilised during "normal operation" as the traffic constraints would preclude the TYLL operating much above 2 lanes of traffic without constraint. In particular, the TYLL connections to Route 8 at Tsing Yi, plus the strategic connections for Route 8 traffic to Route 3 south of Lai Wan Interchange are likely to be the critical locations. In the event of contingency operation, traffic management measures could be implemented to increase the capacity available to TYLL traffic.

Tsing Yi Connections

3.4.12 The traffic forecasts confirmed that:

- A 2-lane connection between TYLL and Route 8 (ETYV / Stonecutters Bridge) is required to meet the peak hour demand of 3,000 vehicles and the dual 3-lane Route 8 Stonecutters Bridge is likely to be operating at capacity as Route 8 Nam Wan Tunnel traffic is also using this link.

- Access to Tsing Yi is an important component of the scheme. Around 1,000 vehicles are forecast to use the TYLL slip-road connections to Tsing Yi and hence a 1-lane configuration would suffice.

Lantau Connections

3.4.13 In terms of corridor demands, the assessment found that:

- Non-Lantau traffic movements (NWNT-urban movements) via the TYLL are forecast be some 2,500 vehicles. A 2-lane connection between TLB and the TYLL was therefore recommended.

- Lantau - Urban traffic demand is forecast to be around 2,500 vehicles. However routing for this traffic is very sensitive (particularly the choice via TYLL/Route 8 or LL/Route 8) and demands could potentially be higher. Given the potential contingency role of the TYLL, a minimum dual 2-lane configuration was recommended.

Tsing Yi Lantau Preferred Scheme

3.4.14 During the refinement and development of the TYLL options, the above capacity recommendations were adopted for each of the TYLL options where possible. The Options Assessment Report presented the comparison and evaluation of TYLL options.

3.4.15 TYLL Alignment Option 7 is preferred on traffic grounds, although all bridge options scored relatively well. The tunnel options were not favoured.

3.4.16 TYLL Alignment Option 7 is preferred overall following the comprehensive assessment presented in the Options Assessment Report. TYLL Alignment Option 7 was therefore adopted for the TYLL assessment.

3.5 NWNT Traffic Forecasts – With/Without TYLL

Description of NWNT Scheme Options – No TYLL

3.5.1 The NWNT strategic network options as shown in **Figure 3.3** were assessed at year 2030 in the traffic model. The NWNT network options were first run without the TYLL. The NWNT Options were then assessed with the TYLL in place to quantify the impact of the TYLL

3.5.2 Toll assumptions equivalent to the Reference Case were assumed as follows:

- TMEB / TMWB / LTT tolls will be equivalent to existing Route 3 country park section.
- TMCLKL / TLB will be equivalent to existing Lantau Link.
- NWNT-Urban traffic travelling via Lantau would be subject to a double-toll i.e. both the toll on the LL and the new crossing to Lantau.

3.5.3 The schemes for assessment are summarised in **Table 3.5.1**.

Table 3.5.1 Summary of NWNT Network Options (Year 2030)

NWNT Option	Option 1 TLB+LTT	Option 3 TLB + TMEB + TMR
Reference Network	✓	✓
NWNT-Lantau Link	TMCLKL (D2) & TLB (D3)	TMCLKL (D2) & TLB (D3)
NWNT Infrastructure	TMWB (D2) & LTT (D3)	TMWB (D2) & TMEB (D2)
Tuen Mun Road	As Reference	D4 between TMEB & TLB
Lantau Road P1	Sham Shui Kok to Sunny Bay	Sham Shui Kok to Sunny Bay

Note: The Reference Case includes:

a) TMR Improvements to dual 3-lane (Expressway section).
b) TMR-Town Centre Section improvements to 3 lanes in each direction through widening and addition of a Kowloon-bound flyover at Wong Chu Road.
c) TMCLKL
d) TMWB

NWNT Network Options - No TYLL

3.5.4 The traffic forecasts for year 2030, peak hour, peak direction flows are presented in **Table 3.5.2** in terms of VC ratios. The table presents the Reference Case plus the two NWNT Options (No TYLL). Traffic flows are presented in **Appendix B**.

Table 3.5.2 Forecast V/C Ratios for NWNT Network Options – No TYLL, 2030

	No. of Lanes	Ref Case	NWNT Option 1N	NWNT Option 3N
Route 3 Tai Lam Tunnel	3	1.24	1.10	1.18
Tuen Mun Road (So Kwun Wat)	3/4	1.17	0.86	1.15
Tuen Mun Road (Sham Tseng)	3	1.37	1.36	1.32
Tuen Mun Road (Ting Kau)	3	1.25	1.18	1.18
Ting Kau Bridge	3	1.31	1.23	1.23
Lantau Link	3	1.26	1.17	1.16
LL – Route 3(South) Connections	3	1.43	1.40	1.41
NLH (east of SHW)	3	1.18	1.11	1.12
NLH (west of SHW)	3	1.23	1.23	1.23
Road P1 (east of SHW)	2	n/a	0.28	0.29
Route 10 LTT / TMEB	3/2	n/a	0.69	0.68
Route 10 TLB	3	n/a	0.52	0.45
TMWB	2	0.33	0.01	0.12
TMCLKL	2	0.76	0.55	0.55
TYLL	(3)	n/a	n/a	n/a
PBH	(3)	0.14	0.14	0.14
Lantau Coastal Road (TLB traffic)	(2)	n/a	n/a	n/a
Route 3 Cheung Tsing Tunnel	3	0.84	0.83	0.87
Route 8 Nam Wan Tunnel	3	0.90	0.98	0.96
Route 8 Stonecutters Bridge	3	0.83	0.93	0.89
Route 8 Cheung Sha Wan – Shatin Section	3	0.56	0.53	0.53
Route 3 WKH (South of Route 8)	3	1.18	1.21	1.19
Overall Summary				
Average of Above	n/a	0.99	0.87	0.88
Maximum of Above	n/a	1.43	1.40	1.41

Notes:
(1) Figures in brackets are proposed lane configurations adopted in this study.
(2) A dual-four lane configuration was assumed for TMR-So Kwun Wat Section under Option 3.

3.5.5 The Reference Case scenario shows severe congestion on many key links in the NWNT. Tuen Mun Road, Ting Kau Bridge and Lantau Link have V/C ratios close to or above 1.3. The Reference Case network would not be able to support the level of assumed development, and network improvements will be necessary.

3.5.6 However even with the addition of the NWNT Network Options 1N or 3N, the forecasts indicate that all options would remain congested in some locations with the main issues as follows:

- NWNT Option 1N (TLB, LTT, P1) – V/C ratios close to or above 1.3 on TMR (Sham Tseng and Ting Kau), Route 3 Ting Kau Bridge and Lantau Link. Route 10 LTT and TLB would be relatively under-used (assuming a dual 3-lane capacity) as these routes serve only traffic to/from Lantau without the TYLL. TMR issues could be addressed potentially by widening to D4 lanes, so the critical links are TKB and LL.

- NWNT Option 3N (TLB, TMEB, TMR widening, P1) – V/C ratios close to or above 1.3 on TMR (So Kwun Wat, Sham Tseng and Ting Kau), Route 3 Ting Kau Bridge and Lantau Link. Note that TMR is already assumed at dual 4-lane and so further improvements to TMR may be constrained.

Year 2030 Network Performance – NWNT Options, No TYLL

3.5.7 The peak hour traffic model summary vehicle assignment and network performance statistics are provided in **Table 3.5.3** for the NWNT Options at 2030 (No TYLL). It was found that:

- Under both of the NWNT Options, there is an improvement in travel speeds of around 3-4 km/hr.

- The changes in distance travelled are minor (less than 1%). The generated trips due to greater accessibility are offset by the more direct routings.

- The changes in travel times are notable with both options showing reductions in the range of 10% to 15% compared with the Reference Case.

Table 3.5.3 Peak Hour Network Statistics – Year 2030, No TYLL

Within the AOI (PV+GV)	Ref Case	NWNT Option 1N	NWNT Option 3N
Veh. Distance (veh-kms)	1,930,160	1,917,331	1,928,535
Veh. Time (veh-hours)	70,461	60,683	63,513
Speed (km/hr)	27.39	31.60	30.36
Difference from Reference Case			
Veh. Distance (veh-kms)	n/a	-12,829	-1,625
Veh. Time (veh-hours)	n/a	-9,778	-6,948
Speed (km/hr)	n/a	4.20	2.97
Percent Difference from Reference Case			
Veh. Distance (veh-kms)	n/a	-0.66%	-0.08%
Veh. Time (veh-hours)	n/a	-13.88%	-9.86%
Speed (km/hr)	n/a	15.34%	10.85%

NWNT Network Options – With TYLL

3.5.8 The impact of adding the TYLL to the network options is presented in **Table 3.5.4** for comparison with **Table 3.5.2**. For example, NWNT Option 1T is NWNT Network Option 1N plus the TYLL.

3.5.9 Toll assumptions equivalent to the Reference Case were assumed. This means that:

- TMEB / TMWB / LTT tolls will be equivalent to existing Route 3 country park section.
- TMCLKL / TLB will be equivalent to existing Lantau Link.
- NWNT-Urban traffic travelling via TLB/TYLL would have a toll-free route. Other routeings such as TMCLKL-LL and TMCLKL–TYLL would be subject to a toll on each crossing.

Table 3.5.4 Forecast V/C Ratios for NWNT Network Options – With TYLL, 2030

	No. of Lanes	Ref Case	NWNT Option 1T	NWNT Option 3T
Route 3 Tai Lam Tunnel	3	1.24	1.09	1.16
Tuen Mun Road (So Kwun Wat)	3/4	1.17	0.87	1.17
Tuen Mun Road (Sham Tseng)	3	1.37	1.04	1.01
Tuen Mun Road (Ting Kau)	3	1.25	1.11	1.09
Ting Kau Bridge	3	1.31	0.97	1.01
Lantau Link	3	1.26	0.82	0.78
LL – R3(South) Connections	3	1.43	0.88	0.82
NLH (east of SHW)	3	1.18	1.12	1.13
NLH (west of SHW)	3	1.23	1.26	1.26
Road P1 (east of SHW)	2	n/a	0.32	0.32
Route 10 LTT / TMEB	3/2	n/a	0.72	0.72
Route 10 TLB	3	n/a	0.84	0.75
TMWB	2	0.33	0.02	0.12
TMCLKL	2	0.76	0.48	0.53
TYLL	(3)	n/a	0.85	0.83
PBH	(3)	0.14	0.14	0.14
Lantau Coastal Road (TLB traffic)	(2)	n/a	n/a	n/a
Route 3 Cheung Tsing Tunnel	3	0.84	0.89	0.88
Route 8 Nam Wan Tunnel	3	0.90	0.53	0.48
Route 8 Stonecutters Bridge	3	0.83	1.12	1.06
Route 8 Cheung Sha Wan – Shatin Section	3	0.56	0.54	0.54
Route 3 WKH (South of Route 8)	3	1.18	1.21	1.20
Overall Summary				
Average of Above	n/a	0.99	0.80	0.81
Maximum of Above	n/a	1.43	1.26	1.26

Notes:
(1) Figures in brackets are proposed lane configurations adopted in this study.
(2) A dual-four lane configuration was assumed for TMR-So Kwun Wat Section under Option 3.
(3) The V/C ratio for Options 1T and 3T is based on TYLL Alignment Option 7.

3.5.10 The forecasts show that V/C ratios on the Lantau Link and the LL connections to Route 3 (South) are much reduced in all NWNT Options with the TYLL in place.

The primary differences between the options relate to the level of relief provided to the TKB and TMR (Expressway Section). The key links are discussed below:

- In NWNT Option 1T (TLB, LTT, P1 plus TYLL), the effect of the TYLL is to reduce V/C ratios on the strategic road network in the NWNT to 1.15 or less. The most critical links in this scenario are the dual 3-lane Route 3 WKH in Kowloon (South of Route 8, and north of the planned Central Kowloon Route) and NLH (west of SHW) that are forecast to operate at V/Cs slightly over 1.20. Traffic congestion on NLH could be addressed potentially by the introduction of Road P1 (Tung Chung and Sham Shui Kok) whilst the congestion on R3 WKH is unlikely to be an issue as corridor traffic would be diverted to use the less utilised Lin Cheung Road (V/C ratio of 0.82) and R5 West Kowloon Corridor (V/C ratio of 0.73).
- Under NWNT Option 3T (TLB, TMEB, TMR Widening, P1 plus TYLL) Tuen Mun Road (SKW) is forecast to perform more poorly than under Option 1T (v/c ratio of 1.17). Other links (except R3 WKH (South of Route 8) and NLH (west of SHW)) are forecast to operate with V/C ratios less than 1.15 as the TLB/TYLL provides an attractive route for "through" traffic. However the congestion on TMR is a serious constraint given widening to dual-4 lanes is already assumed so further capacity improvements may be more difficult to achieve.

3.5.11 The primary finding is that the two NWNT options perform similarly. The most notable difference is that under Option 3T the TMR (SKW) section performs less well, but still within acceptable limits (v/c ratio <1.2).

Year 2030 Network Performance – NWNT Options, With TYLL

3.5.12 The peak hour traffic model summary vehicle assignment and network performance statistics are provided in **Table 3.5.5** for the NWNT Options at 2030 (With TYLL). The impact of the TYLL for each of the NWNT Options is also presented (i.e. the difference compared with **Table 3.5.3**)

3.5.13 Both options decrease overall vehicle travel time, with vehicle distance remaining essentially unchanged, in comparison to the NWNT Option – No TYLL.

3.5.14 With NWNT Option 1 plus TYLL the network shows a large improvement in vehicle travel time (reduction of 22%) due to the relief to the LL and the introduction of the toll-free route between TLB and Route 8. NWNT Option 3 plus TYLL also includes this route, but the level of traffic is constrained by the capacity of Tuen Mun Road between TMEB and TLB, plus the connections between TMR and TLB. In this case the reduction in vehicle travel time is less – around 16%.

Table 3.5.5 Peak Hour Network Statistics – Year 2030, With TYLL

Within the AOI (PV+GV)	Ref Case	NWNT Option 1	NWNT Option 3
Veh. Distance (veh-kms)	1,930,160	1,909,562	1,924,937
Veh. Time (veh-hours)	70,461	55,129	58,977
Speed (km/hr)	27.39	34.64	32.64

Within the AOI (PV+GV)	Ref Case	NWNT Option 1	NWNT Option 3
Difference from Reference Case			
Veh. Distance (veh-kms)	n/a	-20,599	-5,223
Veh. Time (veh-hours)	n/a	-15,331	-11,484
Speed (km/hr)	n/a	7.24	5.25
Percent Difference from Reference Case			
Veh. Distance (veh-kms)	n/a	-1.07%	-0.27%
Veh. Time (veh-hours)	n/a	-21.76%	-16.30%
Speed (km/hr)	n/a	26.45%	19.15%
Difference from NWNT Option – No TYLL (Table 3.5.3)			
Veh. Distance (veh-kms)	n/a	-7,769	-3,598
Veh. Time (veh-hours)	n/a	-5,554	-4,536
Speed (km/hr)	n/a	3.04	2.27
Percent Difference from NWNT Option – No TYLL (Table 3.5.3)			
Veh. Distance (veh-kms)	n/a	-0.41%	-0.19%
Veh. Time (veh-hours)	n/a	-9.15%	-7.14%
Speed (km/hr)	n/a	9.63%	7.49%

Sensitivity Test - TYLL Capacity

3.5.15 A sensitivity test is presented in **Table 3.5.6** below assessing the implications of TYLL dual 2-lane or dual 3-lane configuration, using NWNT Option 1T as a basis. The results highlight the sensitivity of the routeings with a reduction in peak flow of 780 vehicles on the TYLL. Other links showing an increased traffic flow include Route 8 Nam Wan Tunnel (+340 vehicles), Lantau Link (+300 vehicles) and Ting Kau Bridge (+300 vehicles). With the lower capacity on TYLL, the route becomes less attractive so there is less diversion of both Lantau-Urban traffic and NWNT-Urban traffic.

Table 3.5.6 Sensitivity Test for TYLL Dual 2-Lane Configuration – Forecast V/C Ratios Year 2030

	No. of Lanes	N1T (TYLL D3)	N1T (TYLL D2)	Diff. in VC Ratio	Diff. in Vehicles
Route 3 Tai Lam Tunnel	3	1.09	1.09	0.00	24
Tuen Mun Road (So Kwun Wat)	3	0.87	0.87	0.00	-35
Tuen Mun Road (Sham Tseng)	3	1.04	1.11	0.07	328
Tuen Mun Road (Ting Kau)	3	1.11	1.11	0.00	27
Ting Kau Bridge	3	0.97	1.03	0.06	302
Lantau Link	3	0.82	0.89	0.07	306
LL – R3(South) Connections	3	0.88	0.97	0.09	277
NLH (east of SHW)	3	1.12	1.11	-0.01	-63
NLH (west of SHW)	3	1.26	1.26	0.00	1
Road P1 (east of SHW)	2	0.32	0.34	0.02	51
Route 10 LTT	3	0.72	0.72	0.00	15
Route 10 TLB	3	0.84	0.76	-0.08	-366

	No. of Lanes	N1T (TYLL D3)	N1T (TYLL D2)	Diff. in VC Ratio	Diff. in Vehicles
TMWB	2	0.02	0.02	0.00	3
TMCLKL	2	0.48	0.48	0.00	2
TYLL	3/2	0.85	1.03	0.18	-779
PBH	(3)	0.14	0.14	0.00	0
Lantau Coastal Road (TLB traffic)	(2)	n/a	n/a	n/a	n/a
Route 3 Cheung Tsing Tunnel	3	0.89	0.88	-0.01	-28
Route 8 Nam Wan Tunnel	3	0.53	0.60	0.07	340
Route 8 Stonecutters Bridge	3	1.12	1.05	-0.07	-333
Route 8 Cheung Sha Wan – Shatin Section	3	0.54	0.52	-0.02	-83
Route 3 WKH (South of Route 8)	3	1.21	1.20	-0.01	-43
Overall Summary					
Average of Above	n/a	0.80	0.82	n/a	n/a
Maximum of Above	n/a	1.26	1.26	0.09	340

Notes:
(1) Figures in brackets are proposed lane configurations adopted in this study.

Sensitivity Test - Tolls

3.5.16 In NWNT Option 1T, the rationale for tolls on the new links was that traffic will pay the equivalent amount as for an equivalent existing link. For example, traffic to Lantau will pay the same as the current Lantau Link, and traffic on the TMEB/TMWB would pay the same as Tai Lam Tunnel (Route 3).

3.5.17 For NWNT-Urban traffic, in view of the free parallel route offered by Ting Kau Bridge (TKB), it was assumed in NWNT Option 1T that no toll would be charged for bypassing traffic between Tuen Mun and Tsing Yi / Urban using both TLB & TYLL at the same time. To investigate the traffic sensitivity to alternative toll levels, toll sensitivity tests at 50% and 100% of the current Lantau Link toll were carried out for year 2030 as shown in **Table 3.5.7**. Other toll rates such as the TMWB were maintained at the NWNT Option 1T toll levels.

Table 3.5.7 Sensitivity Test for TYLL Through Traffic Tolls – Forecast V/C Ratios Year 2030

	No. of Lanes	N1T (0% of LL)	TT1 (50% of LL)	TT2 (100% of LL)	TT1–N1T	TT2-N1T
Route 3 Tai Lam Tunnel	3	1.09	1.09	1.09	0.00	0.00
Tuen Mun Road (So Kwun Wat)	3	0.87	0.87	0.87	0.00	0.00
Tuen Mun Road (Sham Tseng)	3	1.04	1.09	1.12	0.05	0.08
Tuen Mun Road (Ting Kau)	3	1.11	1.11	1.10	0.00	0.01
Ting Kau Bridge	3	0.97	1.02	1.05	0.05	0.08
Lantau Link	3	0.82	0.85	0.87	0.03	0.05
LL – R3(South) Connections	3	0.88	0.93	0.95	0.05	0.07
NLH (east of SHW)	3	1.12	1.12	1.11	0.00	-0.01
NLH (west of SHW)	3	1.26	1.26	1.26	0.00	0.00

	No. of Lanes	N1T (0% of LL)	TT1 (50% of LL)	TT2 (100% of LL)	TT1–N1T	TT2-N1T
Road P1 (east of SHW)	2	0.32	0.34	0.36	0.02	0.04
R10 LTT	3	0.72	0.72	0.72	0.00	0.00
R10 TLB	3	0.84	0.77	0.74	-0.07	-0.10
TMWB	2	0.02	0.01	0.01	-0.01	-0.01
TMCLKL	2	0.48	0.49	0.49	0.01	0.01
TYLL	(3)	0.85	0.75	0.68	-0.10	-0.17
PBH	(3)	0.14	0.14	0.14	0.00	0.00
Lantau Coastal Road (TLB traffic)	(2)	n/a	n/a	n/a	n/a	n/a
R3 Cheung Tsing Tunnel	3	0.89	0.92	0.91	0.03	0.02
R8 Nam Wan Tunnel	3	0.53	0.53	0.61	0.00	0.08
R8 Stonecutters Bridge	3	1.12	1.03	1.05	-0.09	-0.07
R8 CSW – Shatin Section	3	0.54	0.54	0.54	0.00	0.00
R3 WKH (South of Route 8)	3	1.21	1.21	1.21	0.00	0.00
Overall Summary						
Average of Above	n/a	0.80	0.80	0.80	n/a	n/a
Maximum of Above	n/a	1.26	1.26	1.26	0.05	0.08

Notes:
(1) Figures in brackets are proposed lane configurations adopted in this study.

3.5.18 The toll tests change NWNT-Urban traffic levels slightly, and the main impact is on the balance between the TLB and TKB. With a toll-free TLB/TYLL, the TLB V/C ratio is forecast to increase from 0.74 to 0.84, with a corresponding reduction in the TKB from 1.05 to 0.97. The 50% toll tests show a similar pattern to the zero-toll tests but with roughly half the impact.

3.5.19 The reduced toll tests (0% and 50%) tend to show a small reduction in V/C ratios on the key links of TMR and Ting Kau Bridge. The flows on the TLB tend to reflect the changes on the TYLL i.e. the 0% and 50% toll tests on the TYLL increase TLB flows.

3.5.20 For Lantau-Urban traffic, it was assumed in NWNT Option 1T that traffic to Lantau will pay the same as the current Lantau Link. To investigate the traffic sensitivity to alternative toll levels, toll sensitivity tests at 0% and 50% of the current Lantau Link toll were carried out for year 2030 as shown in **Table 3.5.8**. Other toll rates such as the TMWB were maintained at the NWNT Option 1T toll levels.

Table 3.5.8 Sensitivity Test for TYLL Lantau Traffic Tolls – Forecast V/C Ratios Year 2030

	No. of Lanes	N1T (100% of LL)	TT1 (0% of LL)	TT2 (50% of LL)	TT1–N1T	TT2-N1T
Route 3 Tai Lam Tunnel	3	1.09	1.09	1.08	0.00	-0.01
Tuen Mun Road (So Kwun Wat)	3	0.87	0.86	0.86	-0.01	-0.01
Tuen Mun Road (Sham Tseng)	3	1.04	1.15	1.10	0.11	0.06
Tuen Mun Road (Ting Kau)	3	1.11	1.13	1.13	0.02	0.02

	No. of Lanes	N1T (100% of LL)	TT1 (0% of LL)	TT2 (50% of LL)	TT1–N1T	TT2-N1T
Ting Kau Bridge	3	0.97	1.06	1.01	0.09	0.04
Lantau Link	3	0.82	0.63	0.73	-0.19	-0.09
LL – R3(South) Connections	3	0.88	0.60	0.74	-0.27	-0.14
NLH (east of SHW)	3	1.12	1.13	1.13	0.01	0.01
NLH (west of SHW)	3	1.26	1.27	1.26	0.01	0.00
Road P1 (east of SHW)	2	0.32	0.38	0.36	0.06	0.04
R10 LTT	3	0.72	0.73	0.72	0.01	0.00
R10 TLB	3	0.84	0.67	0.76	-0.17	-0.08
TMWB	2	0.02	0.02	0.02	0.00	0.00
TMCLKL	2	0.48	0.47	0.48	-0.01	0.00
TYLL	(3)	0.85	0.89	0.87	0.04	0.02
PBH	(3)	0.14	0.14	0.14	0.00	0.00
Lantau Coastal Road (TLB traffic)	(2)	n/a	n/a	n/a	n/a	n/a
R3 Cheung Tsing Tunnel	3	0.89	0.90	0.91	0.01	0.02
R8 Nam Wan Tunnel	3	0.53	0.44	0.47	-0.09	-0.06
R8 Stonecutters Bridge	3	1.12	1.05	1.08	-0.07	-0.04
R8 CSW – Shatin Section	3	0.54	0.56	0.55	0.02	0.01
R3 WKH (South of Route 8)	3	1.21	1.21	1.20	0.00	-0.01
Overall Summary						
Average of Above	n/a	0.80	0.78	0.79	n/a	n/a
Maximum of Above	n/a	1.26	1.27	1.26	-0.27	-0.14

Notes:
(1) Figures in brackets are proposed lane configurations adopted in this study.

3.5.21 The toll tests change Lantau-Urban traffic levels slightly, and the main impact is on the balance between the TYLL and LL. With a toll-free TYLL, the TYLL V/C ratio is forecast to increase from 0.85 to 0.89, with a significant reduction in the LL from 0.82 to 0.63. The 50% toll tests show a similar pattern to the zero-toll tests but with roughly half the impact.

3.5.22 The reduced toll tests (0% and 50%) tend to show a reduction in NWNT-Urban traffic via the TYLL, hence diverting traffic from TLB to TKB. The flows on the TLB tend to reflect the changes on the TYLL i.e. the 0% and 50% toll tests on the TYLL decrease TLB flows.

Sensitivity Test - Location of the Proposed CT10

3.5.23 A sensitivity test with the proposed CT10 located at Southwest Tsing Yi in place of Northwest Lantau was undertaken as shown in **Table 3.5.9**. The proposed CT10 is forecast to generate/attract around 700 vehicles in each direction (1,400 two-way vehicles). As most of this traffic is container trucks (with a PCU factor of 3), the proposed CT10 flow is equivalent to around 2000 pcus each-way.

3.5.24 However, adopting a port location at Tsing Yi in place of Northwest Lantau has a relatively small impact on traffic flows in the NWNT. In NWNT Option 1T, the

greatest reductions are on TYLL (reduction of 670 vehicles) and TLB (reduction of 280 vehicles). This reduction on TYLL of 670 vehicles (peak direction) is less than the traffic to/from the proposed CT10 mainly due to the traffic diversion effects of non-CT10 traffic to TKB/SCB corridor. These effects are expected given the high V/C ratios shown for Route 8 Stonecutters Bridge in NWNT Option 1T.

Table 3.5.9 Sensitivity Test for Location of Proposed CT10 – Forecast V/C Ratios Year 2030

Scenario:	**NWNT Option 1T Network**	
Port Location:	**Port at Northwest Lantau**	**Port at Tsing Yi**
Route 3	1.09	1.09
Tuen Mun Road (So Kwun Wat)	0.87	0.88
Tuen Mun Road (Sham Tseng)	1.04	1.11
Tuen Mun Road (Ting Kau)	1.11	1.11
Ting Kau Bridge	0.97	1.05
Lantau Link	0.82	0.89
LL – R3(South) Connections	0.88	1.00
NLH (east of SHW)	1.12	1.13
NLH (west of SHW)	1.26	1.26
Road P1 (east of SHW)	0.32	0.31
R10 LTT	0.72	0.76
R10 TLB	0.84	0.78
TMWB	0.02	0.00
TMCLKL	0.48	0.41
TYLL	0.85	0.70
PBH	0.14	0.14
Lantau Coastal Road (TLB traffic)	n/a	n/a
R3 Cheung Tsing Tunnel	0.89	0.88
R8 Nam Wan Tunnel	0.53	0.64
R8 Stonecutters Bridge	1.12	1.04
R8 CSW – Shatin Section	0.54	0.54
R8 WKH (South of Route 8)	1.21	1.21
Overall Summary		
Average of Above	0.80	0.81
Maximum of Above	1.26	1.26

3.6 Financial Assessment

NWNT Options, No TYLL

3.6.1 Revenues are calculated using toll assumptions and volumes of different types of vehicles from the traffic model, factored from an average weekday to an annual total. The traffic flows and revenue are summarised in **Table 3.6.1**. The annual revenue is calculated using the Reference Case toll assumptions. A scheme design life of 40 years was used for the financial assessment. The assessment is based on the benefits calculated for year 2030.

3.6.2 Revenue for the existing Lantau Link, the proposed second crossing to Lantau (TMCLKL / TLB), the bypass of Tuen Mun (TMWB, TMEB, LTT), plus the TYLL was quantified. This approach separately quantifies the reduction in revenue forecast due to the reduction in traffic on the existing Lantau Link.

Table 3.6.1 Marginal Revenue due to NWNT Options, No TYLL - Year 2030

Marginal Annual Revenue (HK$ Millions)	Option 1	Option 3
	TLB D3 + LTT D3 + P1	TLB D3 + TMEB + TMR D4, P1
Existing LL	-82.0	-103.5
Lantau Crossing	250.1	220.5
Bypass Route	398.6	145.3
TYLL	0.0	0.0
Total of Above	566.7	262.2
Total - Exclude Impact on LL	648.7	365.7

Note: Lantau Crossing refers to TMCLKL and TLB
Bypass Route refers to TMWB and TMEB or LTT

3.6.3 The net present value (NPV) at different discount rates and the financial internal rate of return (FIRR) are summarized in **Table 3.6.2** for the evaluation including / excluding the existing Lantau Link. The range of discount chosen reflects different weighted average costs of capital. Government low risk rate would be in the order of 5%. The ruling of the arbitrator for the New Hong Kong Tunnel Company Ltd, set the regulatory permissible return at 15-17%.

3.6.4 In the assessment excluding the change in Lantau Link revenue, the FIRR indicates that both Option 1 and Option 3 do not perform well financially with a FIRR of –2.7 and –3.8 respectively.

3.6.5 If the impact on Lantau Link is taken into account, the financial performance is considerably worse for all options, with FIRR of -3.6% and -6.5% for Option 1 and Option 3 respectively.

Table 3.6.2 Financial Evaluation Results of NWNT Options (No TYLL)

NPV (HK$ Millions at 2007 Prices)	**Option 1**	**Option 3**
	TLB, LTT, P1	TLB, TMEB, TMR D4, P1
Including Impact on Lantau Link		
NPV at 5%	-17170	-13154
NPV at 10%	-12686	-9245
NPV at 15%	-9129	-6526
FIRR	-3.6%	-6.5%
Excluding Impact on Lantau Link		
NPV at 5%	-16352	-12121
NPV at 10%	-12416	-8904
NPV at 15%	-9018	-6387
FIRR	-2.7%	-3.8%

Impact of TYLL

3.6.6 The marginal revenue due to the TYLL is summarised in **Table 3.6.3** for NWNT Option 1. Note that the revenue excludes non-Lantau (NWNT-urban) traffic using the links to/from Lantau. Hence, although the TYLL increases flow on the TLB, there is no revenue gain under the reference case toll schedule. The revenue gain is generated by increased trips to/from Lantau (excluding through traffic), plus increased use of LTT.

Table 3.6.3 NWNT Option 1 Revenue With/Without TYLL - Year 2030

HK$ Millions at 2007 Prices	Option 1 - TLB, LTT, P1, No TYLL	Option 1 - TLB, LTT, P1 With TYLL	Marginal Revenue due to TYLL
Existing LL	1132.9	811.1	-321.8
Lantau Crossing	694.3	664.7	-29.5
Bypass Route	557.0	580.4	23.4
TYLL	0.0	517.9	517.9
Total of Above	2384.2	2574.1	189.9

Note: Lantau Crossing refers to TMCLKL and TLB
Bypass Route refers to TMWB and TMEB or LTT
Revenue for TLB and TYLL excludes NWNT-urban traffic as zero toll is assumed.

3.6.7 The impact of the TYLL on NWNT Option 1 is summarised in **Table 3.6.4** based on the costs of TYLL, and the marginal revenue presented in **Table 3.6.3**.

3.6.8 The NPV at different discount rates and the FIRR are summarized in **Table 3.6.4** for the TYLL evaluation based on the total marginal revenue presented in **Table 3.6.3.**

3.6.9 The result for NWNT Option 1 indicates that the TYLL scheme does not perform well financially with a FIRR of –7.3%. This is because there is a reduction in LL revenue, and the non-Lantau (NWNT-urban) traffic using both TLB and TYLL are not subject to a toll and therefore generate no marginal revenue.

Table 3.6.4 Financial Evaluation of TYLL with NWNT Option 1

	NPV (HK$ Millions at 2007 Prices)
NPV at 5%	-10540
NPV at 10%	-5904
NPV at 15%	-3372
FIRR	-7.3%

3.6.10 The impact of the TYLL on NWNT Option 3 is summarised in **Table 3.6.6** based on the costs of TYLL, and the marginal revenue presented in **Table 3.6.5.**

Table 3.6.5: NWNT Option 3 Revenue With/Without TYLL - Year 2030

HK$ Millions at 2007 Prices	Option 3 - TLB, LTT, P1, No TYLL	Option 3 - TLB, LTT, P1 With TYLL	Marginal Revenue due to TYLL
Existing LL	1111.3	799.4	-312.0
Lantau Crossing	664.6	661.4	-3.3
Bypass Route	303.7	307.5	3.8
TYLL	0	536.3	536.3
Total of Above	2079.7	2304.6	224.9

Note: Lantau Crossing refers to TMCLKL and TLB
Bypass Route refers to TMWB and TMEB or LTT
Revenue for TLB and TYLL excludes NWNT-urban traffic as zero toll is assumed.

3.6.11 The result for NWNT Option 3 indicates that the TYLL scheme does not perform well financially with a FIRR of -5.9% but is considerably higher than for Option 1. This difference reflects the TLB/TYLL to be better utilised by NWNT to Urban traffic under Option 1, which are not subject to a toll and therefore generate no marginal revenue.

Table 3.6.6: Financial Evaluation of TYLL with NWNT Option 3

	NPV (HK$ Millions at 2007 Prices)
NPV at 5%	-10238
NPV at 10%	-5823
NPV at 15%	-3345
FIRR	-5.9%

3.7 Economic Assessment

Highway Travel Time Savings (NWNT Options, No TYLL)

3.7.1 Travel time savings are the primary source of economic benefits. Direct benefits accrue to travellers to/from Lantau whom enjoy both more direct and quicker journeys. Indirect benefits accrue to non-Lantau traffic (for example across Ting Kau Bridge) that enjoys higher travel speeds, and therefore reduced travel time, as traffic diverts from congested routes such as TMR, TKB and LL onto the new TYLL corridor. Although bus vehicle travel time savings are relatively smaller, the higher vehicle occupancy means that public transport travel time savings are a significant component of the overall time savings.

3.7.2 The estimated highway travel time benefits are shown in **Table 3.7.1**. The savings were calculated using a matrix-based approach to calculate the benefits to the "reference case" users and the "induced" traffic separately. Reference case users enjoy the full benefit of the travel time savings in the with/without scheme case. The "induced" traffic due to the scheme are calculated using the "consumer surplus" principle whereby each trip receives half of the benefits in the with/without scheme case.

Table 3.7.1 Annual Travel Time Savings (Veh-hours) – Year 2030

Scheme	Option 1	Option 3
	TLB, LTT, P1	TLB, TMEB, TMR D4, P1
Marginal Changes in Comparison to the Reference Case, Veh-hours (Million)		
Bus Vehicles	-1.0	-0.7
Goods Vehicle	-10.8	-9.7
Passenger Veh.	-17.3	-14.7
Total	-29.1	-25.1
Value of Travel Time Benefits, HK$, (Million)		
Bus Vehicles	2987	2044
Goods Vehicle	2569	2318
Passenger Vehs.	3439	2915
Total	8995	7277

Note: The above travel time savings are calculated on the "consumer surplus" approach for the HKSAR

Operating Cost Savings (NWNT Options, No TYLL)

3.7.3 Operating cost savings accrue from reductions in distance travelled. Savings due to improved travel speeds have not been included. The estimated highway operating cost savings are shown in **Table 3.7.2**.

Table 3.7.2 Highway Distance and Operating Cost Savings – Year 2030

Scheme	Option 1	Option 3
	TLB, LTT, P1	TLB, TMEB, TMR D4, P1
Marginal Change in Distance , Veh-kms (Million), In Comparison to Reference Case		
Goods Vehicle	-73.6	-39.8
Passenger Veh.	-56.2	1.2
All	-129.7	-38.6
Value of Operating Cost Benefits, HK$, (Million)		
Total	2044	622

Accident Cost Savings (NWNT Options, No TYLL)

3.7.4 Benefits related to the cost of avoided accidents are included but relative to the overall qualitative benefits, the cost savings are very small. The number of accidents avoided is estimated by applying the reductions in vehicle distance travelled to the accident rates published in annual statistics on road traffic accidents and is shown in **Table 3.7.3**. The average cost saving of an accident avoided is assumed to be about $120,000.

Table 3.7.3 Number of Accidents Avoided Compared to Reference Case - 2030

Scheme	Option 1	Option 3
	TLB, LTT, P1	TLB, TMEB, TMR D4, P1
Marginal Change in Accidents In Comparison to Reference Case		
Goods Vehicle	-11	0
Passenger Veh.	-19	-4
All	-30	-4
Value of Accident Benefits, HK$, (Million)		
Total	3.5	0.5

Economic Assessment - NWNT Options, No TYLL

3.7.5 The results of the economic evaluation are shown in **Table 3.7.4** and indicate that Option 3 has the best economic internal rate of return (EIRR). Option 1 has the lowest EIRR primarily due to the higher costs for the dual 3-lane LTT tunnel.

Table 3.7.4 Economic Evaluation Results – NWNT Options, No TYLL

Scheme	Option 1	Option 3
	TLB, LTT, P1	TLB, TMEB, TMR D4, P1
NPV (HK$ Millions at 2007 Prices)		
NPV at 5%	82106	59308
NPV at 10%	12297	9100
NPV at 15%	-910	-453
EIRR	14.2%	14.5%

Economic Assessment – Impact of TYLL

3.7.6 **Table 3.7.5** presents an initial assessment of the economic impact of the TYLL based on the costs and benefits for TYLL Alignment 7. For this purpose, the TYLL costs are assumed to be equal for all NWNT options, and so the differences in NPV and EIRR relate to the different level of benefits resulting from each option.

3.7.7 The findings indicate that with NWNT Option 1, the TYLL performs well in economic terms (EIRR of 17.3%) as this option enables the LTT/TLB to be better utilised by NWNT to Urban traffic, which therefore relieves TMR and Ting Kau Bridge. In Option 3, "through" traffic from NWNT – Urban is discouraged from using the TYLL due to heavy traffic at TMR.

3.7.8 The economic benefits of the TYLL under other options is 15.2% and is lower than Option 1. The benefit for Option 3 is at a reasonable level. These differences reflect the level of attractiveness and capacity available for NWNT to urban traffic via the new TYLL corridor.

Table 3.7.5 Economic Evaluation Results – Impact of TYLL on NWNT Options

Scheme	Option 1	Option 3
	TLB, LTT, P1	TLB, TMEB, TMR D4, P1
NPV (HK$ Millions at 2007 Prices)		
NPV at 5%	53211	39964
NPV at 10%	8966	5864
NPV at 15%	995	80
EIRR	17.3%	15.2%

Economic Assessment – NWNT Options, Overall Impact with TYLL

3.7.9 **Table 3.7.6** presents the combined assessment of the economic impact of the NWNT Options including the TYLL based on the costs and benefits for TYLL Alignment 7. The NPVs from **Table 3.7.4** and **Table 3.7.5** are summed to give the net benefits relative to the Reference Case.

3.7.10 The overall economic assessment indicates that Option 1 shows the greatest net benefit (i.e. total benefits minus total costs after discounting) at the lower discount rates.

Table 3.7.6 Economic Evaluation Results – NWNT Options, With TYLL

Scheme	Option 1	Option 3
	TLB, LTT, P1	TLB, TMEB, TMR D4, P1
NPV (HK$ Millions at 2007 Prices)		
NPV at 5%	135318	99272
NPV at 10%	21263	14964
NPV at 15%	85	-373
EIRR	15.1%	14.7%

(Not Used)

SECTION 4

Marine Traffic Impact Assessment Study

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

4 MARINE TRAFFIC IMPACT ASSESSMENT STUDY

4.1 Introduction

4.1.1 An assessment of the marine traffic impacts associated with various alignment options proposed for TYLL has been conducted. This has covered the following principal issues:

a) Review of marine facilities, future development plans and current traffic pattern;

b) Survey of present traffic and forecast of future traffic levels;

c) Assessment of present risk environment and initial alignment assessment;

d) Evaluate bridge ship impact design requirements;

e) Investigation of traffic risk within a dynamic marine traffic simulator;

f) Examine the radar impact of the various link options; and

g) Recommendation of practical operational and constructional measures.

4.2 Survey of Present Traffic and Forecast of Future Traffic Levels

4.2.1 A comprehensive visual survey of marine traffic at Route 8 viaduct augmented by the recent TMLL Marine Traffic Impact Assessment has allowed the development of a representative traffic structure. MD MARA radar and video visual survey databases have also been used to develop representative traffic levels within the Study Area to assist the construction of a marine traffic simulation model.

4.2.2 **Table 4.2.1** presents the average traffic distribution with respect to vessel type:

Table 4.2.1 Ma Wan & Kap Shui Mun Fairway Daylight Traffic Summary from Visual Survey (average daily daylight activity)

Channel	O-G Cargo	Rivertrade	Tug & Tow	O-G Passenger	Fast Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Other Small Craft	*TOTAL*
Ma Wan	18	263	43	5	187	2	31	9	15	1	5	579
	3%	45%	7%	1%	32%	0%	5%	1%	3%	0%	1%	100%
Kap Shui Mun	0	125	10	0	61	1	7	14	2	1	0	221
	0%	56%	4%	0%	28%	1%	3%	6%	1%	1%	0%	100%

4.2.3 The distribution of traffic routes and volumes is illustrated as follows:

Figure 4.1 Traffic Routes (across Ma Wan Fairway)

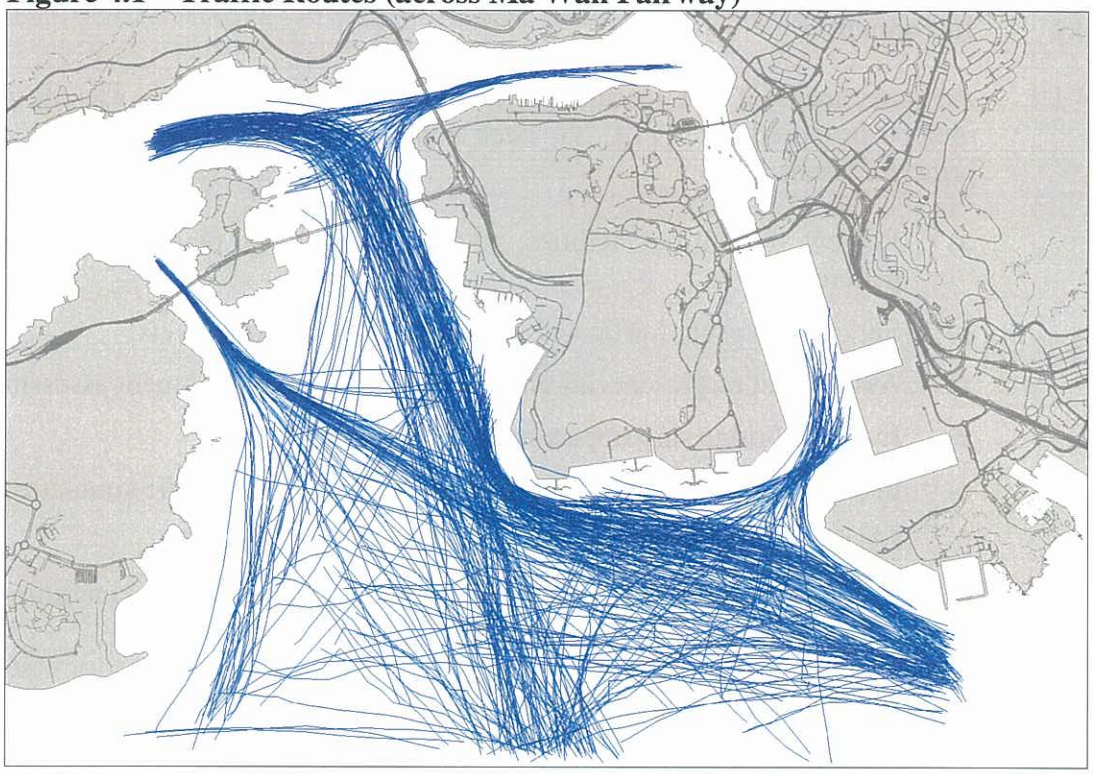
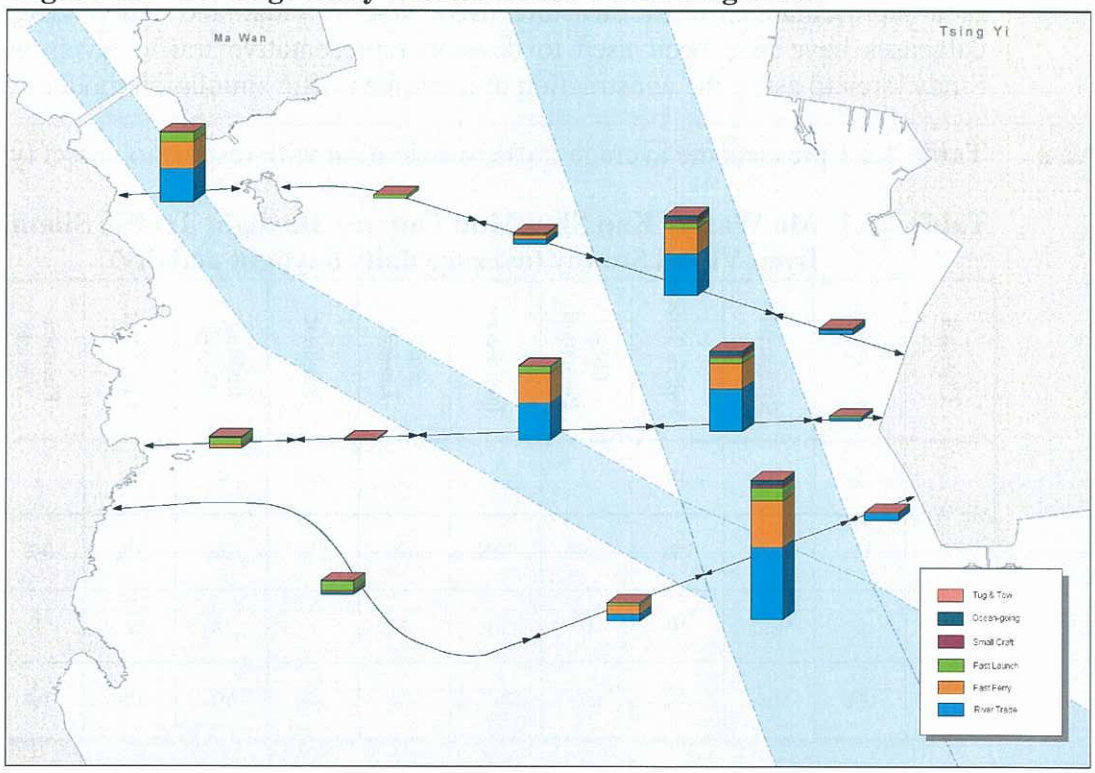


Figure 4.2 Average Daily Traffic across TYLL Alignment



4.2.4 It is identified that Rivertrade and Ferry are the major component of the traffic mix in the Study Area forming approximately 80% of the almost 2,400 daily traffic movements, and movements are focussed along Ma Wan Fairway and Kap Shui Mun Fairway.

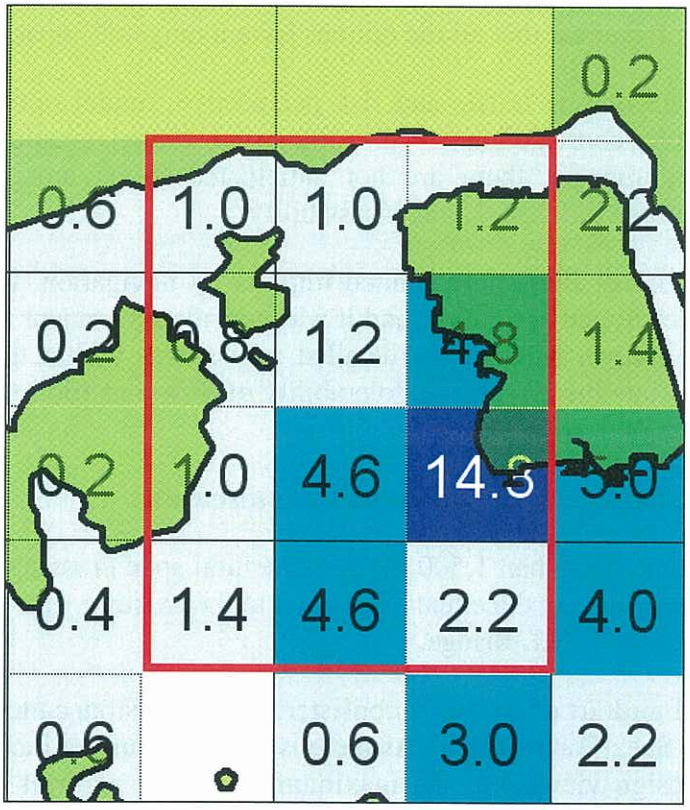
4.2.5 A thorough assessment of anticipated "worst case" marine traffic levels in Hong Kong up to 2030 has been developed on the basis of the best available data sources, taking account of most optimistic cargo projections, vessel size increases and forecast variance.

4.2.6 Broadly speaking a 50% rise in traffic is forecast to 2030 with an average annual increase of 1.6% from 2007 to 2030 is projected.

4.3 Assessment of Present Risk Environment and Initial Alignment Assessment

4.3.1 **Figure 4.3** illustrates the average annual incident distribution within the Study Area for 2001-2005. An annual average of 38.6 collisions are identified within Ma Wan Waters; this percentage is approximately 15% of the HKSAR occurrence of collision incidents.

Figure 4.3 Average Annual Reported Collisions in the Western Model and Focus Study Area, in red (2001 - 2005)



4.3.2 Data on the distribution of vessel incidents has been collected directly from Marine Department Accident & Investigation Section; it is found that the fatality rate per

collision in the whole of Western and Ma Wan waters (0.1) is higher than that of HKSAR waters (0.02) although the data is very sensitive to individual events.

4.3.3 The collision incidents within the Study Area may be summarised as follows:

- Impact within Kap Shui Mun Fairway: 5%
- Impact within Ma Wan Anchorage: 16%
- Impact within Ma Wan Fairway: 55%
- Impact within Western Anchorage: 13%
- Impact within Western Fairway: 7%
- Impact north Siu Kau Yi Chau 4%

4.3.4 As identified above the collision incidents are distributed in Ma Wan Fairway, Ma Wan Anchorage and at the fairway junction.

4.4 Preliminary Marine Alignment Review

4.4.1 Various alignment options have been reviewed and the potential hazards and constraints highlighted. It is clear that all the options have a range of impacts.

4.4.2 From a purely long term marine traffic and risk perspective, tunnel options score more favourably. While construction of the immersed tunnel would develop temporary construction impacts, there are not anticipated to be any long-term drawbacks regarding marine traffic risk and accessibility.

4.4.3 While the presence of bridge piers pose limited impacts on navigation, to varying degrees, all 4 options developed are viable, and it was considered prudent to take all four long-span bridge options forward for detailed assessment within the marine traffic model to demonstrate the impact and tolerability of flow constriction on local risk levels to the horizon year of 2030.

4.5 Evaluation of Possible Bridge Deck and Tunnel Requirements

4.5.1 A long-span bridge with no less than 1,500 metres structural span crossing Ma Wan Fairway and a bridge span at least the equal dimension to the existing Kap Shui Mun Bridge shall be proposed for TYLL Bridge.

4.5.2 The currently proposed airdraft of 68.5m is consistent with the Stonecutters Bridge and exceeds that of the Suez Canal (68m). As there is room for further increases the airdraft from bridge design viewpoint, the maximum allowable airdraft of higher than 68.5m will be adopted at this time.

4.5.3 The analysis conducted within this section has highlighted that a waterdepth at least equal to the existing seabed conditions is adopted for deep draught channel depth for

the immerse tube tunnel options. The immersed tube tunnel would be buried deep enough at the approach channel of the potential CT10 reclamation site.

4.6 Preliminary Ship Impact Protection System Review

4.6.1 International Guidelines ("Guide Specification and Commentary for Vessel Collision Design of Highway Bridges", American Association of State Highway and Transportation Officials (AASHTO), 1991.) note that as the risk of collision within the channels depends decisively on the horizontal clearance of the navigation span, this should be as large as can be technically and economically justified. They further advise:

> *Bridges with main spans less than 2 or 3 times the design vessel LOA are particularly vulnerable to vessel collision...Bridges with main spans less than 2 times the channel width are particularly vulnerable to vessel collision*

4.6.2 For the proposed TYLL a Post-Panamax container vessel based on the locks dimension of Panama Canal expansion[1] proposal has been adopted as the design ship. After expansion, the Panama Canal is expected to be able to handle vessels up to 12,000 TEU (GRT > 125,000) in size. A maximum length of up to approximately 427m for such a vessel suggests that the minimum span for Bridge Options 4-7 at 1,800m is 4.2 times the design vessel length (1800/427) and comfortably exceeds the minimum threshold for bridge spans.

4.6.3 Various options for bridge ship impact protection have been reviewed and the potential benefits and limitations highlighted. Key issues are highlighted below:

Table 4.6.1 Protection System Advantages/Disadvantages

Protection System	Advantages	Disadvantages
Strengthen Existing Piers	Limited additional works and structure	Ship impact loadcase may dominate design of piers.
Timber Fender	Simple design, easy to install and relatively low cost for minor vessel impact forces	Inefficient for large collision because of the extremely large impact loading onto the fender
Rubber Fender	Simple design, easy to install, cheap and commercially available and occupies less space in channel	Not suitable design for large collision impacts
Concrete Fender	Simple design	Low elasticity impact, sacrificial element for even low impact collisions.
Steel Fender	Relatively complex design	High maintenance requirement.
Pile Supported System	Design for high impact loads associated with collision	Expensive as significant cantilever vertical piles required

(1) After expansion, the Panama Canal is expected to be able to handle vessels up to 12,000 TEU in size. It is estimated that this expansion will be completed by 2014. A (new) third set of locks, 427 meters (1,400 feet) long, 55 meters (180 feet) wide, with a draft of 18.3 meters (60 feet) will supplement the two existing sets of locks.

Protection System	Advantages	Disadvantages
Dolphin Protection	Particularly suitable for precasting and deeper water	Significant expense and visual impact if adopted for all piers
Artificial Island or Reef Protection	High effective vessel collision protection	Significant impact on tidal flows
Floating Systems	Quick to install	Large stand-off from piers required. High maintenance. Vulnerable to overrun by vessels with sharply raked bows

4.6.4 It is recommended that artificial island protection should be adopted for the proposed long-span bridge. While there is remote risk of impact to the tower if Options 4 to 7 was selected - an assessment of the risk of incident, consequences will need to be developed when the project progresses to the next stage.

4.7 Investigation of Traffic Risk within a Dynamic Marine Traffic Simulator

4.7.1 The marine risk to navigating within the main channel has been developed following analysis within the *DYMITRI* Dynamic Marine Traffic Simulation model – a tool widely adopted on prior local studies of this nature.

4.7.2 The following time horizons with and without CT10 have been examined within the risk assessment:

- 2030 Baseline (without TYLL Options i.e. TYLL Tunnel Options 1-3);
- 2030 Option 4;
- 2030 Option 5;
- 2030 Option 6; and
- 2030 Option 7.

4.7.3 The marine simulation model was used to test all four long span bridge options. The modelling steps employed for the marine risk simulation assess future case included:

1) Review forecast data.
2) Identify and apply distinct vessel class, or route, traffic increase allocations.
3) Represent future vessel size increases by volume type.
4) Run model, develop collision distribution and assess collision distribution (for all vessels, and specific areas / vessels / routes identified as suffering significant increases in collision / grounding risk).
5) Benchmark years were reviewed against the baseline to identify the impact of traffic increases alone on the local risk environment.

6) Review routes impacted by the proposed TYLL alignment options.

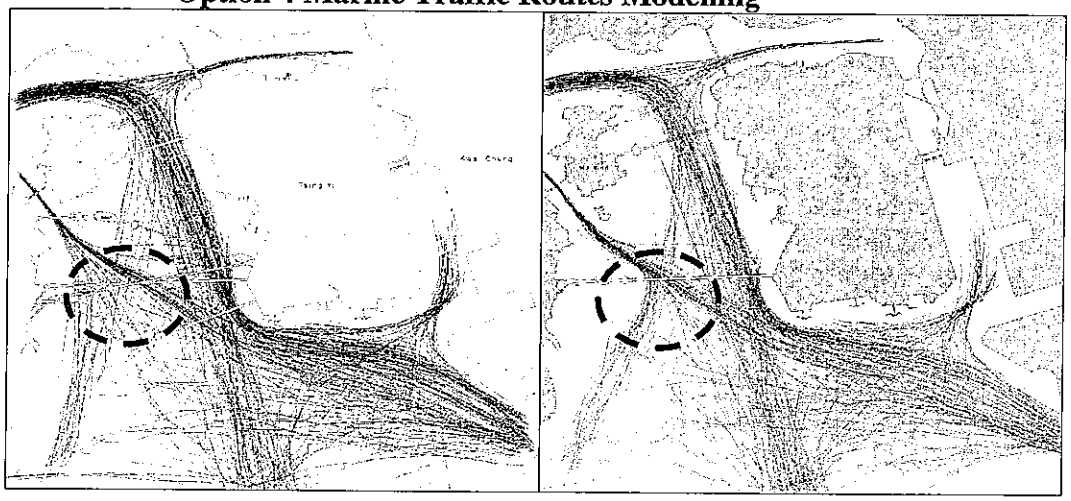
7) Make judgments regarding the relocation and distribution of routes. For those cases where a route passes over or under TYLL it is necessary to re-direct vessel to reflect the future paths in the presence of an artificial islands and bridge tower. This important process is shown in **Figure 4.4** below.

8) The width of the original route at the closest point of approach to the proposed TYLL link is developed.

9) Assess collision distribution, for all vessels, and specific areas / vessels / routes identified as suffering significant increases in collision / grounding risk.

10) Results were reviewed against the Baseline to identify the impact of the TYLL cumulative impact on the local risk environment.

Figure 4.4 GIS Screen Dump for with and without Re-routing for TYLL Option 4 Marine Traffic Routes Modelling



4.7.4 The impact of background and local additional activity has been included in the traffic structure for timeframes up to 2030. Forecasts of other traffic have been made with respect to the methodologies as previously adopted for local projects on this nature and most optimistic updated Hong Kong Port MasterPlan 2020 study assumptions. Traffic associated the present and future marine facilities and with adjacent users has also been included within the model.

4.8 Baseline Collision Risk Assessment

4.8.1 Prior to examining the impact of the proposed TYLL Options it was necessary to develop the baseline risk for three cases namely:

- Baseline without CT10 and without TYLL 2007;
- 2030 with CT10; and

- 2030 without CT10;

Table 4.8.1 Baseline and 2030 Annual Collisions in Study Area

	CT10	Anticipated Annual Collisions Focus Study Area
Baseline 2007	No	38.6
2030 (without CT10)	No	80.3
2030 (with CT10)	Yes	81.1 (+1%)

4.8.2 A key result is that the 50% increase in total vessel traffic from 2007 to 2030 has led to a 110% increase in incidents. This result highlights the sensitivity of the Study Area to changes in marine traffic, and the significance of this parameter in reviewing TYLL alignments. It is also consistent with experience of this type of modelling that the increase in risk is approximately twice the increase in traffic levels.

4.8.3 It should be noted that this result, conservatively, assumes that the risk of collision per encounter remains static. However, research has illustrated a falling collision rate in Hong Kong in recent years, even given an increase in marine traffic activity.

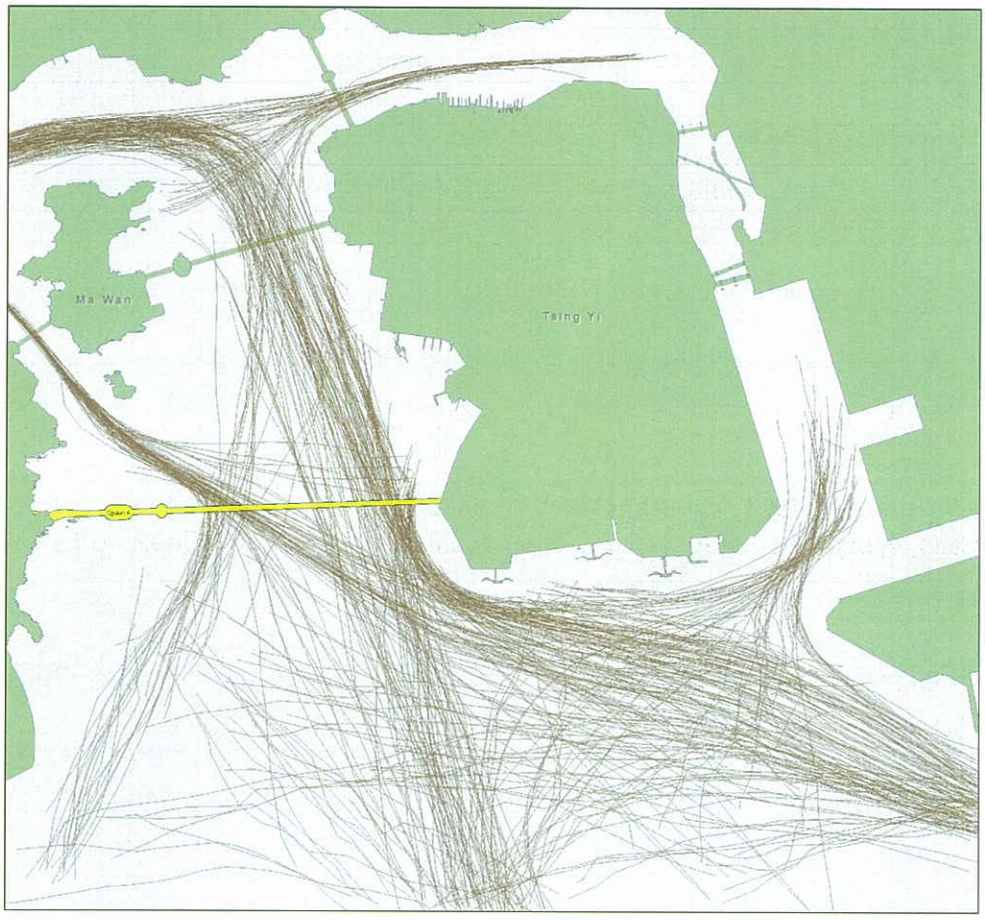
4.8.4 The impact on total traffic risk of CT10 appears limited, due to the relatively small number of vessels, however it is recognised that it would develop other congestion impacts. The scenario without CT10 at southwest Tsing Yi (80.3 collisions) shows a smaller collision levels within the Study Area than the scenario with CT10, as such the "with CT10 scenario" represents a more conservative case and will be represented as the "Base Year 2030" case.

2030 Alignment Option 4 (With and Without CT10)

4.8.5 The Option 4 alignment and future traffic paths in the presence of an artificial island and bridge tower are illustrated in **Figure 4.5**.

4.8.6 For this worst-case scenario the available navigable water space between the artificial island sited northeast of Pun Shan Shek Anchorage and Ma Wan navigation channel was reduced. In this connection, marine safety in the concerned water area will be impacted by the introduction of artificial island/bridge pier. A key observation is that for Option 4, risk will transfer to the main navigation channel and its surrounding waters.

Figure 4.5 Option 4: Bridge Pier/ Artificial Island in Pun Shan Shek Anchorage

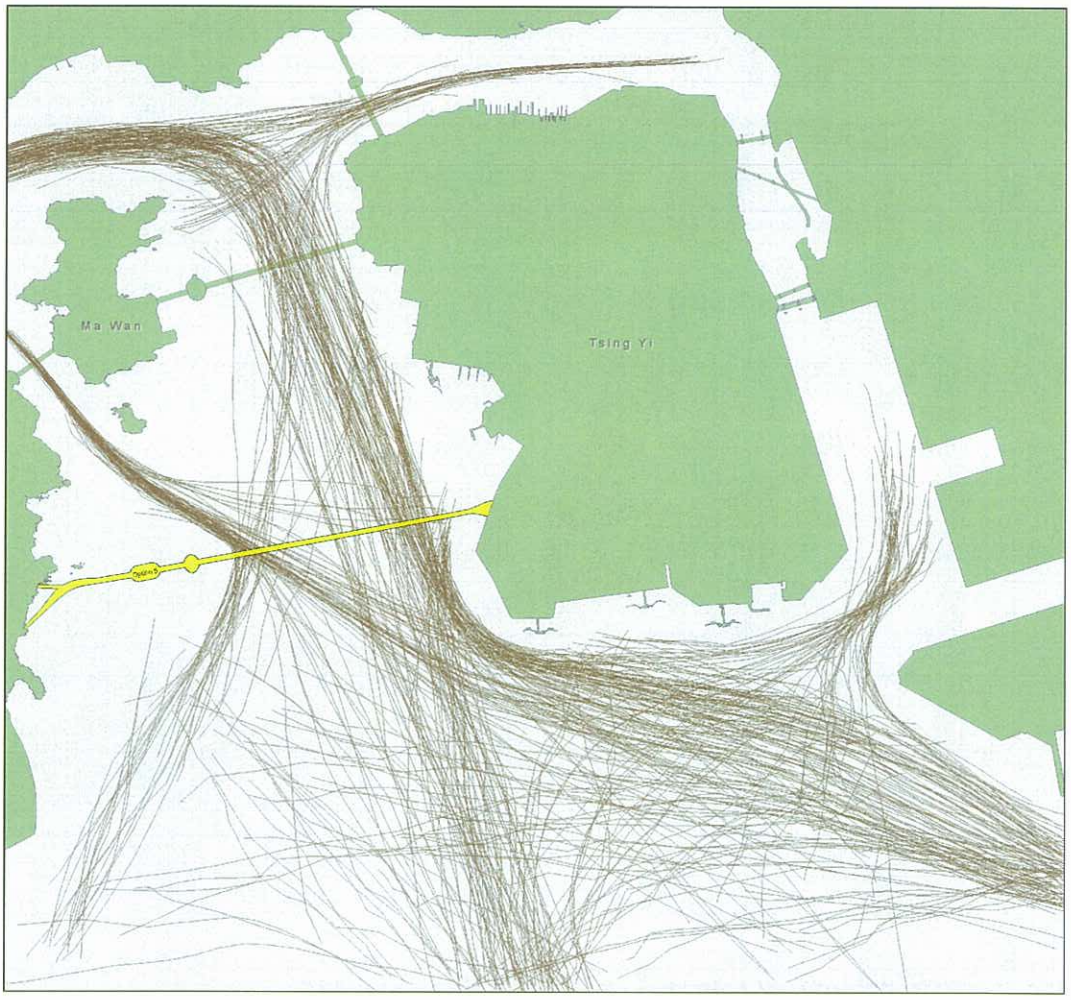


2030 Alignment Option 5 (With and Without CT10)

4.8.7 The Option 5 comprises a narrower span compared to Option 4 with bridge pier/ artificial island locations sited in a similar manner to Option 4.

4.8.8 Option 5 with slightly narrower navigation span is anticipated to impose similar impact than Option 4.

Figure 4.6 Option 5: Bridge Pier/ Artificial Island in Pun Shan Shek Anchorage (Narrow Span)

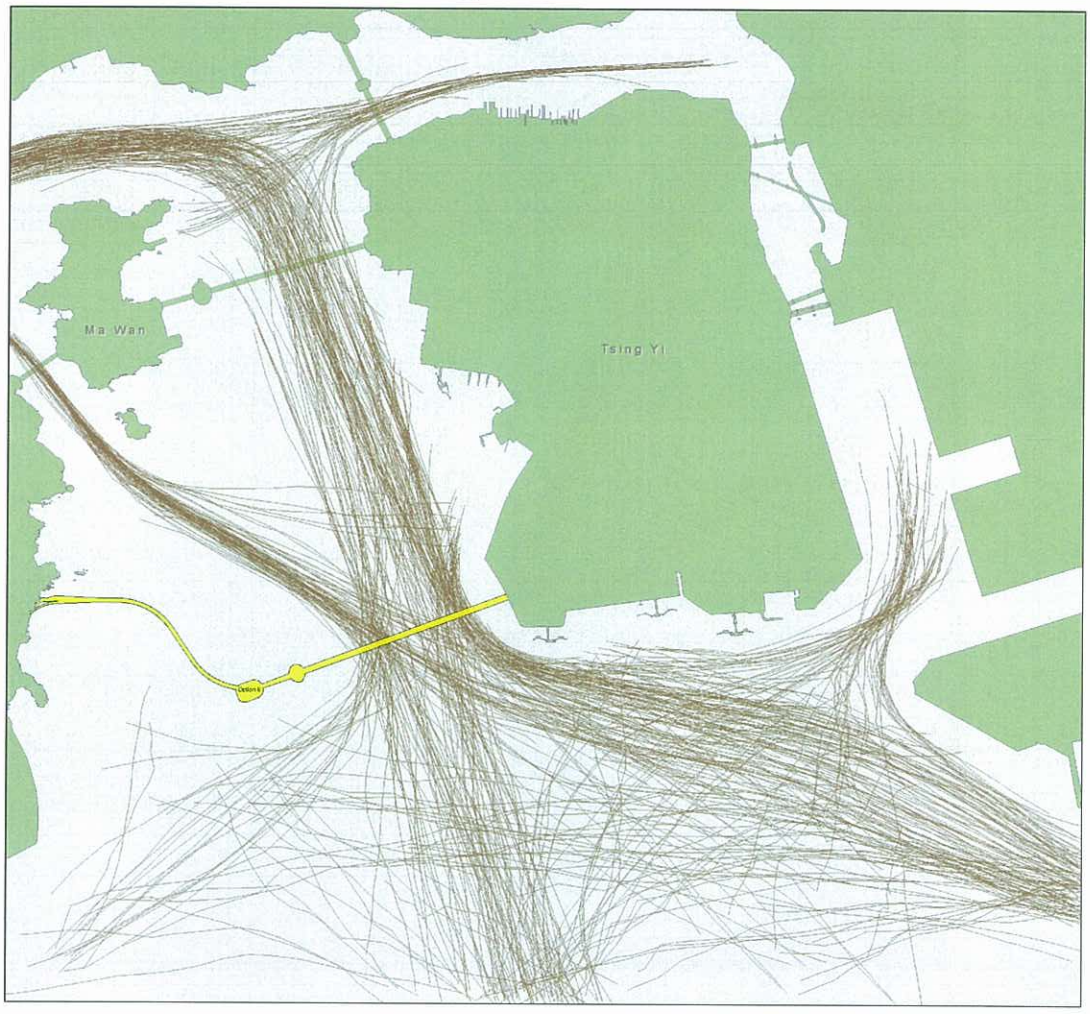


2030 Alignment Option 6 (With and Without CT10)

4.8.9 For Option 6 alignment option, future traffic paths and risk modelling results in the presence of artificial island and bridge pier sited at centre of Pun Shan Shek Anchorage and the extensive sea viaducts required are illustrated in **Figure 4.7**.

4.8.10 It is apparent that the Option 6 with artificial island and bridge pier sited adjacent to Ma Wan Fairway would impose significant adverse impact onto the existing navigation channel and protrude into the "desire line" of vessels navigation or turning into the anchorages. At the south, as the number of re-routed traffic movements within the concerned area are considerable and major risk increases to navigation routes occur.

Figure 4.7 Option 6: Bridge Pier/ Artificial Island at Centre of Pun Shan Shek Anchorage (1750 m Span)

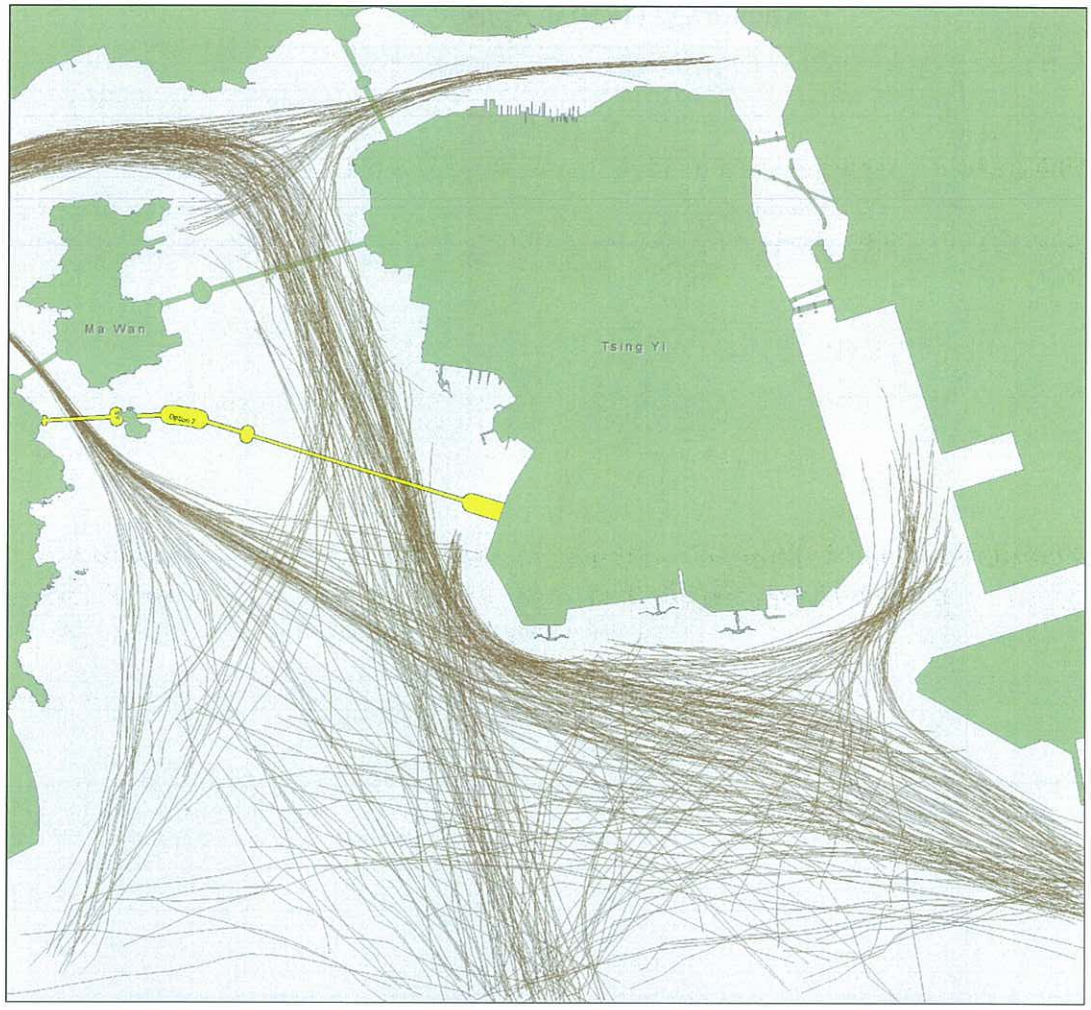


2030 Alignment Option 7 (With and Without CT10)

4.8.11 For Option 7, with the configuration of existing navigation waterspace remaining substantially unchanged, it is expected to see the marine risk profile remains static for all test cases.

4.8.12 The impact for the artificial island/bridge tower proposed adjacent to Tang Lung Chau (Option 7) is less significant due to the present existence of Ma Wan Island which acts to separate traffic, while the coastal reclamation is out of the principal traffic streams.

Figure 4.8 Option 7: Bridge Pier/ Artificial Island in Ma Wan Anchorage



Comparison of Collision Risk for TYLL Alignment Options

4.8.13 To illustrate the collision risk comparison between four TYLL alignment options, the results of the Baseline and Benchmark 2030 assessment are presented in **Figure 4.9**.

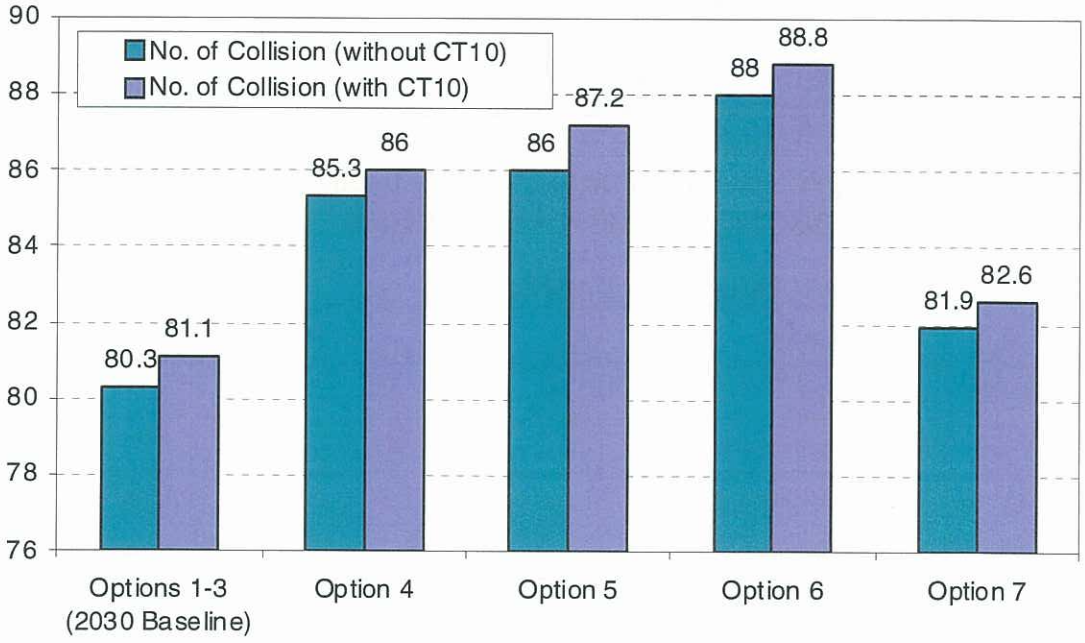
4.8.14 In summary, Options 1 to 3 as tunnels (2030 Baseline) score best on a marine risk basis, with Option 7 the preferred bridge alignment.

4.8.15 The final scoring with respect to Marine Feasibility/Safety Criterion (the ability to be able safely navigate past the TYLL without adverse impact, reflecting the risk simulation results) is shown below.

Table 4.8.2 Marine Feasibility/Safety Ranking

Alignment Option 1	Alignment Option 2	Alignment Option 3	Alignment Option 4	Alignment Option 5	Alignment Option 6	Alignment Option 7
100	100	100	60	60	60	80

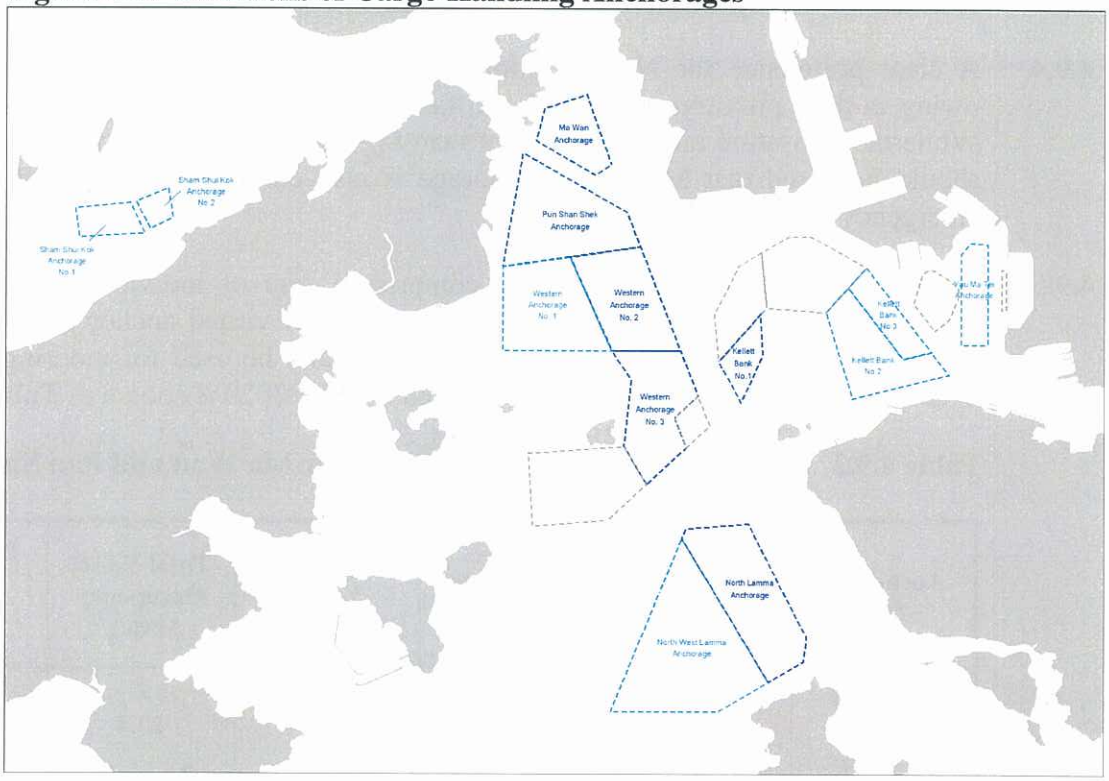
Figure 4.9 Collision Risk for TYLL Alignment Options (With and Without CT10)



4.9 Evaluation of Impact of Options on Anchorage and Marine Facilities

4.9.1 **Figure 4.10** illustrates the location of local anchorages:

Figure 4.10 Locations of Cargo Handling Anchorages



4.9.2 In all, Hong Kong currently has 1,492 ha of deepwater cargo handling anchorages, and 1,410 ha of shallow water cargo handling anchorages. Combined, they provide some 2,902 ha of usable anchorages space.

4.9.3 Productivity at anchorages is primarily affected by utilisation rates. The utilisation of anchorage was sourced from HKP2020 based roughly on a study carried out by Marine Department (MD) in 2001 - *"Review of Supply and Demand of Buoys and Anchorages"* with reference to anchorage throughput data from MD. The utilisation rate are broken down in **Table 4.9.1** as follows:

Table 4.9.1 Utilisation of Anchorage

Anchorage Site	Utilisation Rate (as % of Time)
Deep Water	
North Lamma Anchorage	81.7
Western Anchorage No.2	86.8
Western Anchorage No.3	66.4
Pun Shan Shek Anchorage	62.2
Ma Wan Anchorage	60.0
Shallow Water	
Yau Ma Tei Anchorage	98.9
Western Anchorage No.1	54.7
North West Lamma Anchorage	32.3

4.9.4 A clear preference for North Lamma and Western anchorage No.2 is apparent, owing to their proximity to land-based facilities and better operating environment. While the utilisation rate for both Pun Shan Shek and Ma Wan are less than 65%, it should be noted that Ma Wan Anchorage is also employed as a buffer zone for emergency use.

4.9.5 Giving that the anchorages actually comprise a grid of individual areas (swing circles) occupied by individual vessel, the number of virtual anchor points (i.e. the central portion of anchorage area which can actually be used for mooring) for Ma Wan and Pun Shan Shek anchorage provided by HKP2020 is shown in **Table 4.9.2**.

Table 4.9.2 Number of Virtual Anchor Points for Ma Wan and Pun Shan Shek Anchorage

Anchorage Site	Average Water Depth (m)	Anchorage Area (ha) (1)	Average Vessel Length (m)	Total Vessel Occupancy Area (2)	Number of Virtual Anchor Points
Pun Shan Shek Anchorage	18.1	352.1	200	23.3	11

Anchorage Site	Average Water Depth (m)	Anchorage Area (ha) (1)	Average Vessel Length (m)	Total Vessel Occupancy Area (2)	Number of Virtual Anchor Points
Ma Wan Anchorage	25.0	138.4	200	28.3	3
Sub-Total		***490.5***			***14***
				Total Deep Water Anchor Points of HK	***33***

(1) Anchorage area has been factored to exclude un-usable corners of the areas
(2) HKP2020 referred vessel occupancy as swing circle

4.9.6 It is identified that 14 anchor points at each given time could be potentially impacted by the TYLL; these two anchorages contributed to 42% of deep water anchor point in Hong Kong.

4.9.7 In considering the limitation imposed on the existing Ma Wan and Pun Shan Shek Anchorages with a combined area of 490 ha, **Figure 4.11** to **Figure 4.13** aims to illustrate the anchorage space loss due to each tunnel option. (In reality, the existing Tsing Ma Bridge Tower protection arrangement together with a height restriction area will be employed to protect the bridge and its spans.)

4.9.8 Since there is no precedence case for allowing anchoring activities on top of a tunnel structure in Hong Kong, a 250 metres no anchor zone either side was assumed for tunnel options. Un-usable corners of the anchorage areas were also excluded. In consistent with the existing Lantau Link, no-anchor zone is not required for long span bridge options.

Figure 4.11 Loss of Anchorage Space for Tunnel Option 1 (250m exclusion)

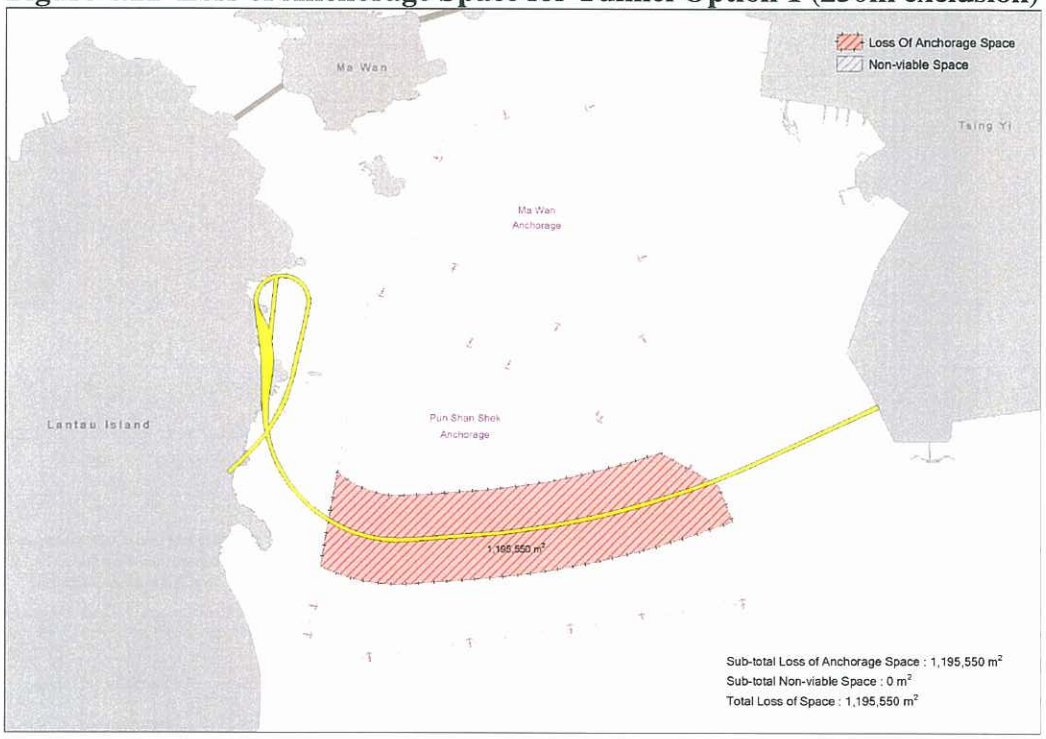


Figure 4.12 Loss of Anchorage Space for Tunnel Option 2 (250m exclusion)

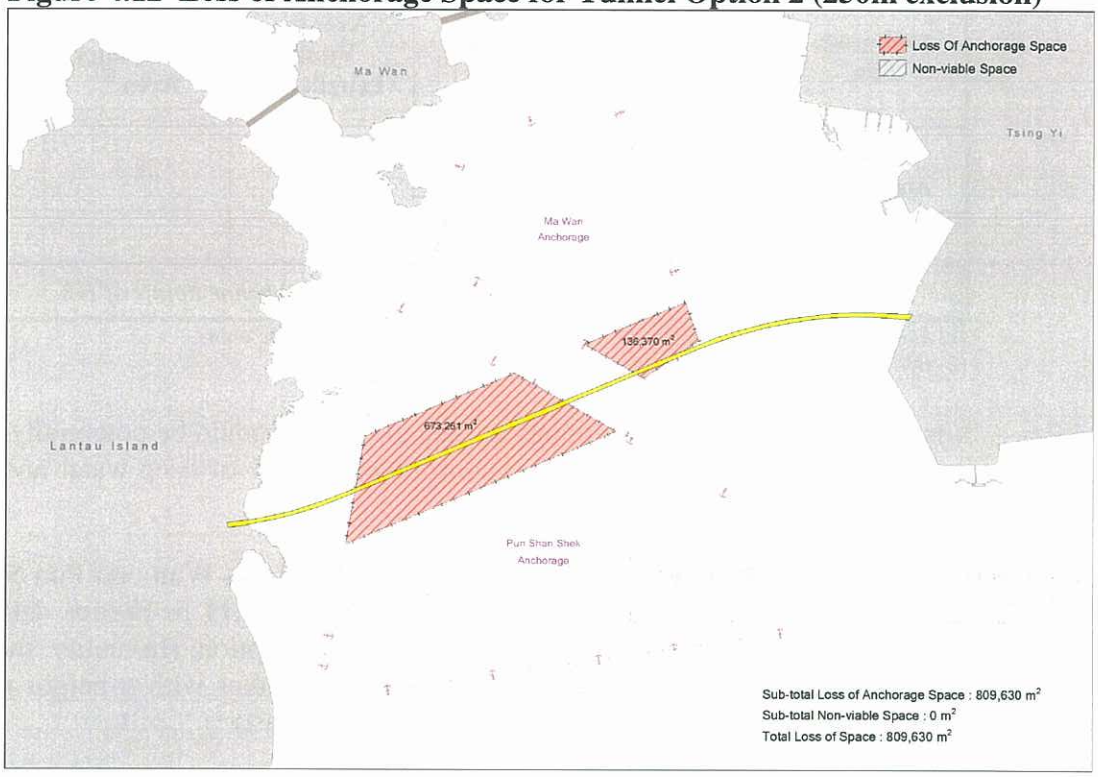
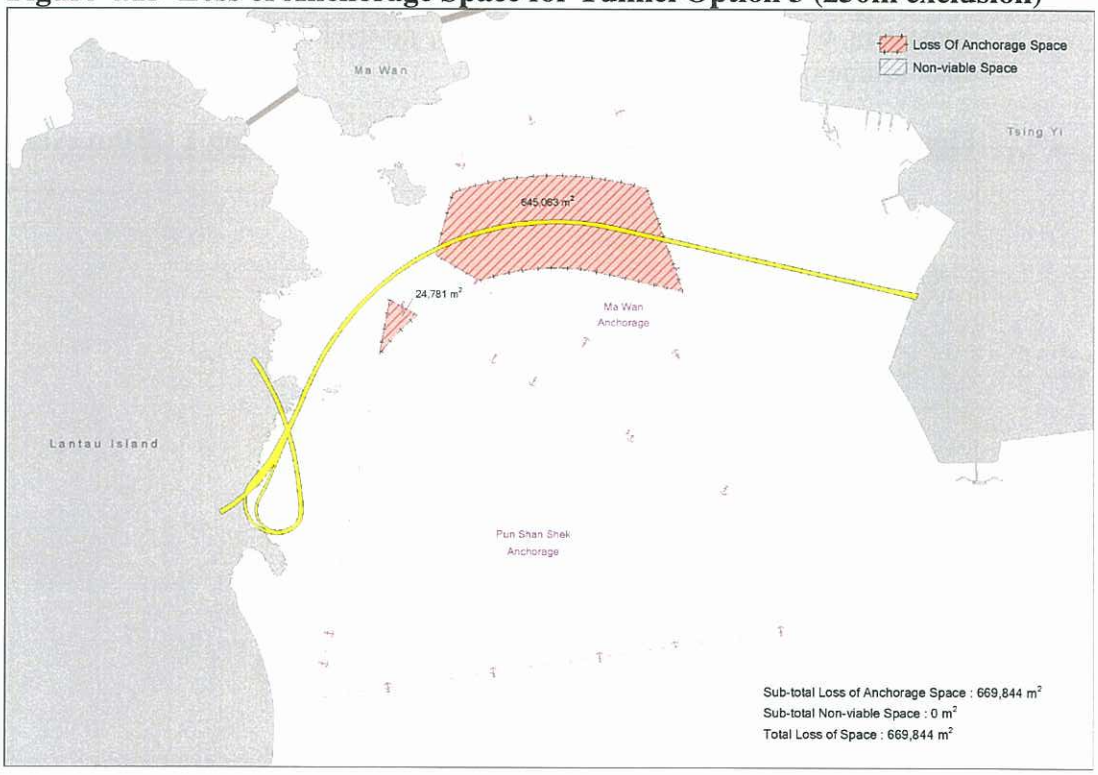


Figure 4.13 Loss of Anchorage Space for Tunnel Option 3 (250m exclusion)



4.9.9 The results of loss of anchorage space assessment are summarised in **Table 4.9.3**.

Table 4.9.3 Loss of Anchorage Space (ha)

TYLL Options	Man Wan Anchorage	Pun Shan Shek Anchorage	Total Loss (Percentage)*
	250m excl	250m excl	250m excl
Tunnel			
Option 1	-	**120**	**24%**
Option 2	**14**	**67**	**17%**
Option 3	**64**	**2**	**13%**
Bridge			
Option 4	0	21	4%
Option 5	0	30	6%
Option 6	-	6	1%
Option 7	7	-	1%

*Recommended exclusion (250m for tunnel) in **bold***
** Loss of Anchorage space divided by total anchorage area of 490.5 ha of Pun Shan Shek and Ma Wan*

4.9.10 The historic trend of berthing rates at anchorages is anticipated to remain static, and has the potential to fall as vessel sizes rise above what can be effectively handled in the anchorage and liner companies consolidate and focus operations at container terminals at CT10, Kwai Chung and the Shenzhen ports.

4.9.11 A loss of deep water anchorage space is anticipated due to the TYLL. This will increase average deep water anchorage utilisation. The absence of significant drivers for additional marine anchorages suggests that this level will not rise significantly. If it was conservatively assessed that the growth rates of the last 10 years were applied the level would not broach 90% utilisation for almost 50 years.

4.9.12 The latest "*Study on Hong Kong Port Cargo Forecasts 2005/2006*" published by Transport and Housing Bureau, Transport Branch (April 2008) further confirmed that the demand for anchorages is not predicted to exceed demand upto year 2030 and recommended that no extensions or new anchorage areas are required. However, mitigation measure and synergy with CT10 for anchorage reprovisioning would be further studied at the detailed design phase of TYLL and CT10 investigation.

4.9.13 While construction of the immersed tunnel would develop temporary construction impacts, there are not anticipated to be any long-term drawbacks regarding marine traffic risk and accessibility. From a purely long term marine traffic and risk perspective, tunnel options score more favourably.

4.9.14 The marine operational impact ranking has been refined from the initial Options Assessment by review of anchorage areas, and the impact on shoreside facilities. The revised ranking is as follows:

Table 4.9.4 Marine Operational Impact

Alignment Option 1	Alignment Option 2	Alignment Option 3	Alignment Option 4	Alignment Option 5	Alignment Option 6	Alignment Option 7
20	80	80	20	20	0	20

4.10 Radar Impact Assessment

4.10.1 After consideration of the four initial bridge alignment options, it is proposed to build an additional radar facility, at one of four bridge tower / artificial island sites, to recapture the shadowed radar signal on the TYLL bridge structure.

4.10.2 Detailed radar design will be conducted at the investigation phase of the project. The methodology will involve:

- Review of previous Marine Department Radar studies.
- Needs Assessment: This will involve defining the areas to be covered by radar(s), international standards to be met, systems to link radar(s) to MD VTS and Marine Police RSS and necessary support infrastructure.
- Site and Radar Options Assessment: This work element will include a site options assessment which will identify potential sites and examine coverage losses for each site before, during and post construction. Radar options will be explored and rated against international standards, coverage requirements, integration with MD and Marpol and cost effectiveness.
- Design and Costing and Reporting: The preferred radar(s) will be designed and cost in preparation for tendering. Draft and Final tender documents will be prepared for tendering of TYLL radar contract.

4.11 Recommendation of Practical Operational and Constructional Measures

4.11.1 The marine construction ranking has been refined from the initial Options Assessment as follows:

Table 4.11.1 Marine Construction Safety Ranking

Alignment Option 1	Alignment Option 2	Alignment Option 3	Alignment Option 4	Alignment Option 5	Alignment Option 6	Alignment Option 7
20	20	20	60	60	40	60

4.11.2 Bridge viaducts and the seaward extremities of the artificial island(s) should be fitted with Indicators of Structure Limits at their seaward extremities. Bridge

lighting for the sea viaduct navigation spans should be established in conformance with International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) recommendation.

4.11.3 A series of recommendations have been developed with respect to the minimum requirements for marine plant, navigation and traffic management, and the control of marine works prior to and during construction of the TYLL. It is further recommended that a marine liaison group including support from all key parties be established to co-ordinate the safe conduct of the works.

4.11.4 The final navigation arrangement should be assessed in a Navigation Simulator, e.g. the Full Mission Ship Simulator in the Marine Department Training Centre (http://www.mardep.gov.hk/en/others/mdtc.html) or other suitable facility.

(Not Used)

SECTION 5

Option Assessment

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

5 OPTION ASSESSMENT

5.1 General

5.1.1 Seven alignment options have been developed for the TYLL crossing between Tsing Yi and Lantau. Three immersed tube tunnel options and four long span bridge options described in **Section 2** were evaluated under the option assessment. The assessment focused on the selection of the preferred TYLL alignment.

5.1.2 This Section is to summarise the findings in the Option Assessment Report. The option assessment methodology and criteria, evaluation of the alignment options and finally the recommendation of a preferred alignment are presented in the following sections.

5.2 Assessment Methodology

5.2.1 In order to examine and evaluate the alignment options in all aspects, the following methodology was adopted in the assessment. It covers both the evaluation of the landing options and the assessment of the alignment options.

Step 1 – Establish relevant criteria for comparative analysis

Step 2 – Weight relevant criteria for comparative analysis

Step 3 – Compare alignment options for each criterion

Step 4 – Calculate total score of each alignment option

Step 5 – Carry out sensitivity testing for the option assessment

5.2.2 Steps 1 and 2 regarding the assessment criteria are presented in more details in **Section 5.3**, where the assessment of alignment options including sensitivity testing are carried out in **Sections 5.4** to **5.6**.

5.2.3 The alignment options were compared and marked comparatively for each criterion, and assigned a score as follows:

Mark	Score
Very Good	100
Good	80
Fair	60
Poor	40
Very Poor	20

5.2.4 The total weighted score of each alignment option was then calculated using the following formula. The best alignment option was then selected by comparing the total scores.

Total Score = $\sum (W_{sy} \times \sum (S_{ix} \times W_x))$, where:

S_{ix} = score for Alignment Option (i) against criterion (x);
W_x = weight of criterion (x); and
W_{sy} = weight of set of criteria (y).

5.3 Assessment Criteria

5.3.1 The alignment options and landing options were assessed under seven broad criteria sets with various sub-criteria within each broad set as shown below in **Table 5.3.1**.

Table 5.3.1 Weighting of Each Criteria Set

Criteria Set	Criterion	Weighting
Road Traffic Criteria Weighting = 20%	Strategic Highway Network Performance	30%
	Adequacy of TYLL Connections	30%
	Development Access	20%
	Routing Efficiency	20%
Marine Traffic Criteria Weighting = 15%	Marine Construction Safety	20%
	Marine Feasibility	30%
	Marine Operational Impact	50%
Engineering Criteria Weighting = 15%	Design and Standards for Alignment Geometry	25%
	Geotechnical Constraints	20%
	Reclamation Works	15%
	Impacts on Operations of Mud Pits	10%
	Impacts on Disused Explosive Dumping Ground	20%
	Operation and Maintenance	10%
Environmental Criteria Weighting = 20%	Air Quality	10%
	Noise	10%
	Water Quality / Flows	10%
	Construction Waste	10%
	Ecology	20%
	Landscape & Visual	15%
	Cultural Heritage	10%
	Hazard to Life	15%

Criteria Set	Criterion	Weighting
Land Use and Planning Criteria Weighting = 15%	Land Resumption (Private Land)	30%
	Land Clearance (STT / GLA)	30%
	Burial Grounds and Fung Shui Areas	20%
	Impact on the Potential CT10 Location or Other Planned Land Uses	20%
Costs and Programme Criteria Weighting = 7.5%	Capital Cost	40%
	Recurrent Cost	40%
	Construction Period	20%
Public Acceptability Criteria Weighting = 7.5%	Impact on Local Community	60%
	Visual Intrusion / Loss of View	40%

Sensitivity Testing

5.3.2 To test the robustness of the selection process, sensitivity tests are proposed. In each test, one of the broad criteria sets will have its overall weighting boosted by 50% (multiplier 1.5) and 100% (multiplier 2.0), whilst the other criteria sets have their overall weightings reduced proportionately. Tests on each criterion set will therefore be carried out for each multiplier, as shown in **Table 5.3.2** for multiplier 1.5, with the overall weighting adopted for each criteria set in each of the seven sensitivity tests for each multiplier.

Table 5.3.2 Sensitivity Testing (Multiplier 1.5)

Criteria Set	Proposed Overall Weighting (W_{sy}) (%)							
	Base	Sensitivity Test						
	Set A	Set B	Set C	Set D	Set E	Set F	Set G	Set H
Road Traffic	20	1.5 x A						
Marine Traffic	15		1.5 x A					
Engineering	15			1.5 x A				
Environmental	20				1.5 x A			
Land Use and Planning	15					1.5 x A		
Costs and Programme	7.5						1.5 x A	
Public Acceptability	7.5							1.5 x A
Totals:	100	100	100	100	100	100	100	100

Weightings reduced proportionately to suit

Weightings reduced proportionately to suit

5.4 Alignment Options for Assessment

5.4.1 The following alignments will be assessed in this section, as described in **Section 5.3**.

- Alignment Option 1 to Option 3, which are immersed tube tunnels with connection T3; and
- Alignment Option 4 to Option 7, which are long-span bridges with connection T1.

Assessment under Road Traffic Criteria

5.4.2 The traffic-related features of the seven alignments have been discussed in **Section 3**. The scorings for the seven alignment options with respect to Road Traffic Criteria are shown in **Table 5.4.1**.

Table 5.4.1 Road Traffic Scoring for Alignment Options

Criterion	Alignment Option							Discussion
	A1	A2	A3	A4	A5	A6	A7	
Strategic Highway Network Performance	60	20	60	80	80	80	80	All Options achieve the aims of providing relief to the LL and the TKB / TMR corridor. The extent of this relief tends to be greater in the bridge options (4 to 7), and Option 2 provides the least relief to TKB.
Adequacy of TYLL Connections	40	20	40	80	80	80	80	Options 4 to 7 all provide direct 2-lane connections to/from ETYV and thus are marked highest. Options 1 to 3 provide a somewhat indirect 2-lane connection to/from ETYV and are scored lower.
Development Access	80	80	80	20	60	60	60	Option 4 provides no local access to Tsing Yi and is marked lowest. All of the other options provide a reasonable standard of access to Tsing Yi. No difference between the options is assumed on Lantau.
Routing Efficiency	40	20	40	80	60	60	100	All options decrease overall vehicle travel time, but increase vehicle distance. Option 7 gives the lowest increase in vehicle distance reflecting the more direct routings in this option. The bridge alignment options generally perform better than the tunnel options.

Assessment under Marine Traffic Criteria

5.4.3 **Table 5.4.2** shows the scoring of the seven alignment options with respect to Marine Traffic Criteria.

Table 5.4.2 Marine Traffic Scoring for Alignment Options

Criterion	Alignment Option							Discussion
	A1	A2	A3	A4	A5	A6	A7	
Marine Construction Safety	20	20	20	60	60	40	60	Tunnel Options (Options 1 to 3) will require routing and traffic control that may adversely impact local operations. For Options 4, 5 and 7, the construction of bridge imposes minor restriction on access from / to Ma Wan and Kap Shui Mun fairway.
Marine Feasibility	100	100	100	60	60	60	80	Options 1 to 3 comprise immersed tunnel, there are not anticipated to be any long-term drawbacks regarding marine feasibility. Bridge options (Options 4 to 7) propose artificial island or bridge pier to be constructed at the existing anchorage(s), thus, these options have a lower rating.
Marine Operational Impact	20	80	80	20	20	0	20	Options 4 to 7 that required reclamation on both island and/or has potential impact to anchorage area. Option 1 would impose more impact on the Anchorage than Option 3, and thus has a lower rating. A value of "Good – 80" has been applied to Options 2 and 3.

Assessment under Engineering Criteria

5.4.4 **Table 5.4.3** shows the scoring of the seven alignment options with respect to Engineering Criteria.

Table 5.4.3 Engineering Scoring for Alignment Options

Criterion	Alignment Option							Discussion
	A1	A2	A3	A4	A5	A6	A7	
Alignment Geometry	40	60	40	80	80	60	100	Option 1, 2 and 3 are unable to maintain the desired speed of 80km/h between Route 8 and TYLL. Options 1 and 3 will be unable to maintain the desired constant speed of 80km/h at the desirable radii at Lantau. Options 4, 5 and 6 have radii of 500m within tunnel at the CKWLR section. Option 6 has a "dog leg" 500m radii on sea viaduct at Pun Shan Shek Anchorage. Option 7 has the best alignment which meets all the desirable minimum standards for the TPDM.

Criterion	Alignment Option							Discussion
	A1	A2	A3	A4	A5	A6	A7	
Geotechnical Constraints	40	60	40	40	40	40	60	Options 1, 2 and 3 will pass through the borrow area 1 which will have disturbed sub-marine soil conditions. Options 1, 4, 5, 6 and 7 will require large scale site formation and natural terrain hazard study. Tunnels of Option 3, 4 and 5 will pass through inferred faults with potentially unfavourable geological conditions at both Tsing Yi and Lantau. Option 7 will only connect to TLB and NLH directly on Lantau. No rock tunnel at Lantau will be required.
Reclamation Works	20	100	40	80	60	80	40	Option 1 has the most reclamation out of the options. Option 2 has no permanent reclamation, with only a small temporary reclamation during construction. Options 4 and 6 have the least permanent reclamation. Option 5 has the fourth most reclamation and Option 3 and 7 have the second and third most reclamation.
Impacts on Operations of Mud Pits	60	60	60	100	100	100	100	All the options do not affect any mud pits within the vicinity. Options 1, 2 and 3 on the other hand, pass through the sand borrow pit between Tsing Yi and Lantau. Options 1, 2 and 3 have therefore been rated "Fair" whereas Options 4, 5, 6 and 7 have all been rated "Very Good".
Impacts on Disused Explosive Dumping Ground	20	60	80	80	100	80	100	Option 1 passes through the disused explosives dumping ground in ITT. Option 2 is not directly in the dumping ground but there is still the potential of disturbing disused explosives. Option 3 passes area where there should not be any potential for any disused explosives. Options 4 and 6 pass over the top of the disused explosives dumping ground where there are no potential impacts associated with the dumping ground at this height.
Operation and Maintenance	20	40	20	80	80	80	60	Options 1, 2 and 3 are ITT options and will potentially have greater operation and maintenance requirements than Options 4, 5, 6 and 7 which are long span bridge options. Option 2 has longer overall tunnel length. The operation and maintenance of Option 7 will be more than that of Options 4, 5 and 6 due to the additional arch bridge crossing the Kap Shui Mun Fairway.

Assessment under Environmental Criteria

5.4.5 **Table 5.4.4** summarises the scoring of the seven alignment options with respect to Environmental Criteria.

Table 5.4.4 Environmental Scoring for Alignment Options

Criterion	Alignment Option							Discussion
	A1	A2	A3	A4	A5	A6	A7	
Air Quality	40	40	40	80	60	80	80	Options 1, 2 and 3 are ITT options which have lower score. Since all accumulated air pollutants inside the tunnel will be expelled from the portals based on the tunnel design. All bridge options have comparative higher score. However, additional proposed slip road connecting to Tsing Yi Road of Option 5 could cause some impacts to some ASRs which are in close proximity to the proposed alignment.
Noise	40	60	60	100	100	100	80	The NSRs and spatial extent of the noise impact are similar to air quality and are thus rated similarly. For Option 1, the proposed viaduct along the coastline of North Lantau is in close proximity to some nearby NSRs and its rating is considered lower. For Option 7, NSRs on North Lantau which is in close proximity to the proposed alignment and its rating is comparatively lower than other bridge options.
Water Quality / Flows	60	80	40	80	60	60	40	Option 3 requires the largest volume of dredging among the ITT options for its construction. Option 2 has no potential for generating long term operational impacts. Option 4 does not require coastal reclamation at the Tsing Yi landfall. Option 7 requires the largest volume of dredging for any of the long span bridge options and has lower rating.
Construction Waste	40	60	40	80	80	80	100	For the bridge options (Options 4, 5, 6 and 7), the total amounts of excavation and dredging required are much lower than the ITT options (Options 1, 2 and 3). Option 7 will generate the lowest amount of land base excavated material compared to other bridge options)

Criterion	Alignment Option							Discussion
	A1	A2	A3	A4	A5	A6	A7	
Ecology	20	40	20	40	40	40	80	All the options, except Option 7, have the CKWLR rock tunnel connecting the Pa Tau Kwu Pak Wan to PBH. The construction of the rock tunnel and associated interface structures may cause a reasonable level of disturbance to the WBSE. In addition, Options 1, 3, 4, 5 and 6 would further affect woodland habitat at Fa Peng and a few species of ecological interest. Option 7 avoids the WBSE and also most high value habitat or species of ecological interest and is rated highest.
Landscape & Visual	20	100	40	40	60	40	80	For Option 1, the natural Lantau coastline would be despoiled with the large scale coastal reclamation. Option 2 would only have minimal visible structures at the tunnel portal ends and the tall viaducts at the Tsing Yi side are similar and comparable to the existing highway networks. Among the bridge options, Option 7 is the most preferable alignment in landscape and visual terms. The impacts at the Lantau coastline would be limited to the small section.
Cultural Heritage	40	40	20	40	40	40	60	Options 1 and 3 will have direct impacts on one archaeological site. Options 2 and 3 also come in close proximity to the commemorative stone at Pa Tau Kwu. Option 4 passes in close proximity to Vase Rock and may have direct impacts on it. Option 5 and 6 will directly impact the archaeological site at Pa Tau Kwu Pak Wan. Option 7 has the lowest potential amount of impact on terrestrial archaeological sites of all the options and no adverse impacts are anticipated.
Hazard to Life	40	60	60	40	40	20	40	For Alignment Options 2 and 3, the alignment will be in tunnel after entering the portal at Tsing Yi and the risk to users during the operational stage would be expected to be relatively low. For Option 1, the cut-and-cover tunnel would be close proximity to the PHI. For the bridge options (Options 4, 5, 6 and 7), the landfall at the west of Tsing Yi is within at least the CZ of three PHIs and associated slip roads, if any, are also within the CZ of several PHIs. In addition, Option 6, in particular, has a main alignment very close to the Mobil oil depot west terminal.

Assessment under Land Use and Planning Criteria

5.4.6 **Table 5.4.5** shows the scoring of the seven alignment options with respect to Land Use and Planning Criteria.

Table 5.4.5 Land Use and Planning Scoring for Alignment Options

Criterion	Alignment Option							Discussion
	A1	A2	A3	A4	A5	A6	A7	
Land Resumption (Private Land)	60	80	40	20	40	20	40	Options 4 and 6 affect the most private lands. Options 4, 5, 6 and 7 require easement over a multi-storey building in lot TYTL 128. Options 4, 5 and 7 require resumption of lot TYTL 60 where complications and large amount of compensation are expected. Options 2 and 3 will temporarily suspend the business operation of lot TYTL 60. Option 2 affects the least private land and is rated highest.
Land Clearance (STT/GLA)	20	40	40	100	80	60	80	Option 1 affects the most GLA/STT, a total of 22 GLA/STT are affected. Option 4 affects only 10 GLA/STT and requires the least Government land clearance with 3,310 m^2, and is therefore rated the highest.
Burial Grounds and Fung Shui Areas	40	100	40	60	80	60	80	No burial grounds have been affected by any of the options on Tsing Yi or Lantau. Options 1 and 3 could affect potential fung shui areas along the east coast of Lantau. Options 4, 5 and 6 will affect similar areas of woodland on Lantau which could potentially be a fung shui area to the local villages. Options 2 and 7 do not affect any burial grounds or potential fung shui areas, but Option 7 does pass close by to a number of identified graves. Therefore, Option 2 is rated highest.
Impact on the Potential Future CT10 Location or Other Land Uses	40	100	40	20	20	20	40	Options 4, 5, 6 and 7 will all pass through the potential future CT10 location and will therefore have the most impact. Options 1, 2 and 3 will be in tunnel underneath the potential future CT10 location, and therefore will not have any impact. However, Options 1 and 3 will affect the possible reclamation and tourism development in North-east Lantau. Therefore, Option 2 is rated highest.

Assessment under Costs and Programme Criteria

5.4.7 **Table 5.4.6** shows the scoring of the seven alignment options with respect to Cost and Programme Criteria.

Table 5.4.6 Costs and Programme Scoring for Alignment Options

Criterion	Alignment Option							Discussion
	A1	A2	A3	A4	A5	A6	A7	
Capital Cost	20	100	60	40	20	80	80	Options 1 and 5 are the most expensive due to the additional reclamation for both options, as well as additional looping sea viaduct for Option 1 and additional slip roads for Option 5. Option 2 has the lowest capital cost. This is due to having no permanent reclamation or connection to TLB, and is therefore rated highest.
Recurrent Cost	20	40	20	60	80	100	80	Options 1 and 3 have the highest recurrent cost. This is due to the ITT and overall rock tunnels associated with these options. Option 6 has the lowest recurrent cost. This is due to having the shortest long span bridge, as well as the least amount of rock tunnels overall. Option 6 is therefore rated highest.
Construction Period	40	40	20	60	80	100	100	Options 1, 2 and 3 will ITT construction. This is a linear construction activity and therefore will take up the longest period of time for construction. Option 3 has the longest ITT and is rated lowest. Options 4, 5, 6 and 7 comprise of different structures along the length of their alignments, which can all potentially be carried out in parallel. Options 6 and 7 have shorter span suspension bridge and the construction period is comparatively shorter.

Assessment under Public Acceptability Criteria

5.4.8 **Table 5.4.7** shows the scoring of the seven alignment options with respect to Public Acceptability Criteria.

Table 5.4.7 Public Acceptability Criteria Scoring for Alignment Options

Criterion	Alignment Option							Discussion
	A1	A2	A3	A4	A5	A6	A7	
Impact on Local Community	20	60	40	80	100	100	80	Option 1 will impact on all the local communities on Tsing Yi and Lantau, as well as those on Ma Wan, due to its connection T3 at Tsing Yi, looping sea viaducts on Lantau and the close proximity of the Coastal Road to Ma Wan. Options 2 and 3 will impact on the local communities on Tsing Yi and Options 3 and 4 will impact on Fa Peng Village on Lantau. Option 7 will only impact on the local communities on Ma Wan. Option 5 and 6 do not affect any of the local communities, and therefore are rated highest.
Visual Intrusion/ Loss of View	20	100	40	60	60	40	80	Option 1 is the most visually intrusive due to the additional reclamation which scars the natural coastline of Lantau, as well as looping sea viaducts across the shoreline and up towards the Coastal Road. Option 2 has no visual intrusion or loss of view, since the majority of the alignment is in tunnel, hidden away from view. This option is therefore given the highest rating. Option 7 is the closest to the Lantau Link and Tsing Ma Bridge among those bridge options (Options 4, 5, 6 and 7), and therefore will not be visually intrusive.

Overall Scoring for Alignment Options

5.4.9 A summary of the scores with respect to each set of assessment criteria and the total score with criteria weightings applied are presented in **Table 5.4.8**. It is concluded that Alignment Option 7 has the highest score amongst the seven alignment options.

Table 5.4.8 Summary and Total Score for Alignment Options 1 to 7

Criteria Set	Criterion	Weight	Score for Alignment Option						
			1	2	3	4	5	6	7
Road Traffic Criteria Weight = 20%	Strategic Highway Network Performance	30%	60	20	60	80	80	80	80
	Adequacy of TYLL Connections	30%	40	20	40	80	80	80	80
	Development Access	20%	80	80	80	20	60	60	60
	Routing Efficiency	20%	40	20	40	80	60	60	100
	Weighted Sub-total for Road Traffic Criteria Set		**10.80**	**6.40**	**10.80**	**13.60**	**14.40**	**14.40**	**16.00**

Criteria Set	Criterion	Weight	Score for Alignment Option						
			1	2	3	4	5	6	7
Marine Traffic Criteria Weight = 15%	Marine Construction Safety	20%	20	20	20	60	60	40	60
	Marine Feasibility	30%	100	100	100	60	60	60	80
	Marine Operational Impact	50%	20	80	80	20	20	0	20
	Weighted Sub-total for Marine Traffic Criteria Set		**6.60**	**11.10**	**11.10**	**6.00**	**6.00**	**3.90**	**6.90**
Engineering Criteria Weight = 15%	Design and Standards for Alignment Geometry	25%	40	60	40	80	80	60	100
	Geotechnical Constraints	20%	40	60	40	40	40	40	60
	Reclamation Works	15%	20	100	40	80	60	80	40
	Impacts on Operations of Mud Pits	10%	60	60	60	100	100	100	100
	Impacts on Disused Explosive Dumping Ground	20%	20	60	80	80	100	80	100
	Operation and Maintenance	10%	20	40	20	80	80	80	60
	Weighted Sub-total for Engineering Criteria Set		**4.95**	**9.60**	**7.20**	**11.10**	**11.25**	**10.35**	**11.85**
Environmental Criteria Weight = 20%	Air Quality	10%	40	40	40	80	60	80	80
	Noise	10%	40	60	60	100	100	100	80
	Water Quality / Flows	10%	60	80	40	80	60	60	40
	Construction Waste	10%	40	60	40	80	80	80	100
	Ecology	20%	20	40	20	40	40	40	80
	Landscape and Visual	15%	20	100	40	40	60	40	80
	Cultural Heritage	10%	40	40	20	40	40	40	60
	Hazard to Life	15%	40	60	60	40	40	20	40
	Weighted Sub-total for Environmental Criteria Set		**7.00**	**12.00**	**7.80**	**11.60**	**11.40**	**10.60**	**14.00**

Criteria Set	Criterion	Weight	Score for Alignment Option						
			1	2	3	4	5	6	7
Land Use and Planning Criteria Weight = 15%	Land Resumption (Private Land)	30%	60	80	40	20	40	20	40
	Land Clearance (STT / GLA)	30%	20	40	40	100	80	60	80
	Burial Grounds and Fung Shui Areas	20%	40	100	40	60	80	60	80
	Impact on the Potential CT10 Location or Other Planned Land Uses	20%	40	100	40	20	20	20	40
	Weighted Sub-total for Land Use and Planning Criteria Set		**6.00**	**11.40**	**6.00**	**7.80**	**8.40**	**6.00**	**9.00**
Cost and Programme Criteria Weight = 7.5%	Capital Cost	40%	20	100	60	40	20	80	80
	Recurrent Cost	40%	20	40	20	60	80	100	80
	Construction Period	20%	40	40	20	60	80	100	100
	Weighted Sub-total for Cost and Programme Criteria Set		**1.80**	**4.80**	**2.70**	**3.90**	**4.20**	**6.90**	**6.30**
Public Acceptability Criteria Weight = 7.5%	Impact on Local Community	60%	20	60	40	80	100	100	80
	Visual Intrusion / Loss of View	40%	20	100	40	60	60	40	80
	Weighted Sub-total for Public Acceptability Criteria Set		**1.50**	**5.70**	**3.00**	**5.40**	**6.30**	**5.70**	**6.00**
	Total Scores		**38.7**	**61.0**	**48.6**	**59.4**	**62.0**	**57.9**	**70.1**
	Rank		**7**	**3**	**6**	**4**	**2**	**5**	**1**

Note: decimals are shown rounded off to one decimal place, but full figure is used in calculation.

5.5 Sensitivity Testing

5.5.1 As described in **Section 5.3**, the sensitivity of the selection process to changes in weightings was carried out. The changes of weightings involve multipliers of 1.5 and 2.0 on the various criteria set weightings.

5.5.2 The findings of the analysis were:

Sensitivity multiplier 1.5

- Option 7 had the best weighted score in each sensitivity priority;

- Option 5 had the second best weighted score in five of the seven sensitivity priorities, with the exception of the Marine Traffic and Land Use and Planning priorities, where it came in third; and

- Option 2 had the third best overall weighted score, coming third in four of the sensitivity priorities, except for Road Traffic. However, it came in second for the Marine Traffic and Land Use and Planning priorities.

Sensitivity multiplier 2.0

- Option 7 had the best weighted score in each sensitivity priority;

- Option 5 had the second best weighted score in four of the seven sensitivity priorities, with the exception of Marine Traffic, Environmental and Land Use and Planning priorities, where it came in third; and

- Option 2 had the third best overall weighted score, coming in second for Marine Traffic, Environmental and Land Use and Planning priorities and third in Cost and Programme and Public Acceptability with other sensitivity priorities coming in forth and fifth.

5.5.3 Based on the sensitivity testing result, Alignment Option 7, same as the result from the base assessment, is more outstanding since this alignment scores better overall.

5.6 Conclusions

5.6.1 Based on the results of the assessment of the alignment options presented in this Report, Option 7 is the preferred alignment option for the TYLL. This preferred TYLL option is suggested to be taken forward for subsequent engineering feasibility study and other impact assessment studies.

5.6.2 From the assessment of the seven alignment options, Alignment Option 7 has the highest overall score. It scores the highest under the Road Traffic, Engineering and Environmental criteria, and scores the second highest under Marine Traffic, Land Use and Planning, Costs and Programme, and Public Acceptability criteria.

5.6.3 From marine traffic collision risks perspective, tunnel (Alignment Options 1 to 3) is more desirable due to the absence of bridge structure, but the drawback is the likely loss of anchorage area. As agreed at the Project Steering Group Meeting on 20 December 2007, the feasibility of tunnel option will not be totally ruled out and will need to be critically re-assessed in the next stage of the Project.

SECTION 6

Sustainability Assessment Study

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

6 SUSTAINABILITY ASSESSMENT STUDY

6.1 Approach and Methodology

Objectives

6.1.1 As part of this Assignment, a sustainability assessment of the TYLL has been conducted to evaluate the chosen options for the TYLL from a sustainability perspective. This section reports on the findings.

6.1.2 The sustainability assessment differs from the option assessment because it considers the overall need for TYLL and compares TYLL options to a without TYLL scenario.

6.1.3 The objectives of the sustainability assessment are to:

- Identify and assess the economic, social, environmental and cross-sectoral issues and implications of different alignment options for the TYLL; and
- Set out the positive and negative impacts, present key issues and trade-offs to facilitate planning and decision-making.

Method and Scope

6.1.4 The sustainability assessment draws on findings of past studies as well as the results of the technical assessments undertaken as part of this Assignment. The scope of the sustainability assessment is to:

- Set out the background and broad need for the TYLL based on past studies and establish an appropriate without TYLL scenario.
- Present the estimated impacts of TYLL using indicators of the Computer Aided Sustainability Evaluation Tool (CASET) and further selected relevant sustainability indicators. The indicators have been grouped for presentational purposes into three categories: economic, environmental and social.
- Consider TYLL options in two parts:
  - Using CASET as an evaluation framework; and
  - Using all the selected sustainability indicators.

6.2 The Need for a Link between Tsing Yi and Lantau

Review of Infrastructure Requirements

6.2.1 The NWNT Traffic and Infrastructure Review 2004, undertaken by TD, demonstrated that existing infrastructure was sufficient to cope with increasing traffic in the short (to 2011) to medium (2016) term. In the very long term the

review demonstrated serious congestion resulting from population growth, new development and increased cross boundary traffic and additional infrastructure was required.

Consideration of Alternatives and the Without TYLL Scenario

6.2.2 Under the NWNT Review 2004, four possible packages of road projects were developed to help meet traffic demands in the long term. After further refinement a fifth package was added. The five packages can be found in **Section 1.2**.

6.2.3 This section presents the findings of the sustainability assessment undertaken for, the TYLL (Package A) and associated infrastructures. As similar reports are being concurrently produced for the other options, no explicit alternative to the TYLL has been considered. The counterfactual adopted for the purpose of considering the overall need and justification for the Project is therefore "Without TYLL." Where appropriate, the latest available baseline data has been included to present the situation as it currently stands.

6.3 Economic Issues

Selected Economic Indicators

6.3.1 Economic issues for the TYLL[2] are concerned with cost, both capital and recurrent, and financial and economic viability. The selected indicators for economic issues are:

- Financial viability – measured by the Net Present Value (NPV) and Financial Internal Rate of Return[3] (FIRR) over the design life of the Project.
- Economic viability – as measured by the NPV and Economic Internal Rate of Return[4] (EIRR) over the design life of the Project, but in this case, calculated using cost benefit analysis (CBA) – a CASET indicator. The CBA is limited to those costs and benefits that can be quantified and monetised.
- Investment ratio – as measured by Gross domestic fixed capital formation as a ratio to GDP – a CASET indicator[5].

[2] This SA draws on the findings of a number of technical papers conducted for the purposes of the TYLL Options study. In particular, the traffic impacts and subsequent economic, financial and fixed capital implications draw on the results of the Traffic Impact Assessment Study.

[3] The FIRR is the discount rate at which the NPV of the cash flow of annual costs and revenues is equal to zero.

[4] The EIRR is the discount rate at which the NPV of the cash flow of annual economic costs and benefits is equal to zero.

[5] The consultants have included the investment ratio since it is one of the CASET indicators. However, the indicator will give a more positive result for more expensive projects as it is entirely related to costs and as such is rather misleading. Indicators of return (which incorporate costs and benefits/revenues) are more appropriate indicators.

Cost Estimates

6.3.2 The cost estimates are based on the engineering and environmental studies and are expressed in Q3 2007 prices. The costs for the TYLL, set out in **Table 6.3.1** include contingencies and an allowance for risk. The full breakdown in HK$ is as follows:

Table 6.3.1 Summary Cost Estimates for TYLL (HK$ Million Q3 2007 prices)

Cost Breakdown	Alignment No.						
	1	2	3	4	5	6	7
Viaducts & Roads	4,060	1,184	2,786	2,505	4,199	3,784	3,160
Tunnel	9,815	9,769	10,427	1,937	1,881	1,687	789
Long-span Bridge	-	-	-	9,439	7,916	7,307	8,845
Reclamation	430	-	310	121	377	137	423
Buildings & TCSS (+ Other Misc.)	544	517	532	506	510	522	530
Environmental Mitigation Measures	113	105	112	29	29	26	25
Risk & Contingencies	4,538	3,510	4,297	4,409	4,522	4,083	4,177
Design & Supervision	2,418	1,871	2,290	2,349	2,410	2,176	2,226
Total Capital Cost	21,918	16,956	20,754	21,295	21,844	19,722	20,175
Recurrent Cost	216	204	211	184	175	163	170

6.3.3 The cheapest alignment option is Alignment 2 in terms of the combined capital and recurrent costs at about HK$17 billion. Alignment options 1 and 5 are the most expensive at almost HK$22 billion. These costs, both capital and recurrent, are incorporated into the lifecycle analysis of the financial and economic viability and are thus not considered separately.

Financial and Economic Viability

6.3.4 The FIRR and EIRR and associated NPVs have been calculated for the design life of the Project. The construction period for each alignment option is estimated as between 6 and 7 years. The recurrent costs are included for all years following completion of the construction contracts. The design life is based on an assumed 40 years operational period after commissioning of the project in accordance with guidance in TBTC No. 2/2001. The NPVs presented adopt hurdle/discount rates of 5% for financial return and 5% for economic return. The 5% hurdle rate for the financial analysis reflects a lower bound estimate of financial viability as would be adopted by the Government; procurement through the private sector would require a

higher discount rate in line with the weighted average cost of capital[6]. The 5% discount rate for the economic analysis reflects the social discount rate as adopted by Government:

- FIRR includes financial costs and TYLL toll revenues;
- EIRR includes economic costs[7] and three benefit streams:
  - Time Savings;
  - Travel Cost Savings; and
  - Reduced Incidence of Accidents.

6.3.5 The selected criteria are summarised in **Table 6.3.2.**

Table 6.3.2 Economic Indicators

	Alignment No.						
	1	2	3	4	5	6	7
Financial Viability							
NPVat 5%	-12665	-9661	-11838	-11579	-11777	-10582	-10540
FIRR	-11.9%	-8.6%	-9.2%	-12.5%	-10.7%	-9.8%	-7.3%
Economic Viability							
NPVat 5%	40862	38091	36461	39279	39792	36468	53211
EIRR	13.6%	14.7%	13.2%	14.7%	14.6%	14.7%	17.3%
Investment Ratio							
Fixed Capital as a % of GDP (%)*	21.1	21.0	21.0	21.1	21.1	21.1	21.1

Note *: compares to a "No TYLL" value of 20.8

6.3.6 None of the alignments produce an FIRR that exceeds the discount rate of 5%. The best performing option is Alignment 7. All option alignment revenues cover the operation and maintenance costs on an annual basis but the revenues do not cover the initial cost of capital at the 5% discount rate for any of the alignments. This is to be expected as it is assumed that some of the non Lantau (NWNT-urban) traffic using both Tsing Lung Bridge and the TYLL will be toll free to provide a consistent charging system with alternative routes such as the Ting Kau Bridge, which will reduce revenue.

[6] For example, the Arbitrator's Decision on New Hong Kong Tunnel Company Ltd, January 2005, stated that a "reasonable but not excessive return should continue to be an IRR of between 15-17% over the life of the tunnel franchise"

[7] For the purpose of calculating the EIRR, economic costs are assumed to be the same as the financial costs given that environmental mitigation measures are included in the cost estimates and the opportunity cost of the land is approximated by the land resumption and reprovisioning cost.

6.4 Environmental Issues

Selected Environmental Criteria

6.4.1 Environmental concerns with respect to the TYLL include air quality, noise, tidal flow and water quality, waste, ecology and landscape and visual. Where possible, CASET indicators have been incorporated but the localised nature of impacts limits their use in differentiating between alignments. Details of the CASET indicators for the environmental impacts are provided in **Table 6.4.1** below.

6.4.2 The sustainability assessment assumes that environmental impacts will be mitigated wherever possible, with relevant costs included in the estimates. However, as is appropriate at this stage in the overall analysis for TYLL, precise environmental mitigation measures have not been developed for each of the alignment options. Further mitigation measures will be developed for the preferred option at a later stage.

Table 6.4.1 CASET Indicators of Environmental Impact

Parameter	Base-line	No TYLL	Marginal Impact over Baseline / No TYLL						
			Alignment No.						
			1	2	3	4	5	6	7
Air Quality Impact									
Air Pollutants Index[1]	112.7%	small improve-ment	0	0	0	0	0	0	0
Toxic Air Pollutants[2]	26.9%	small improve-ment	0	0	0	0	0	0	0
Carbon Dioxide Emissions[3]	38,100	Un-known but larger	As for No TYLL	As for No TYLL	As for No TYLL	As for No TYLL	As for No TYLL	As for No TYLL	As for No TYLL
Noise Impact									
Excessive Noise Exposure[4]	14%	Un-known	0	0	0	0	0	0	0
Water Quality Impact									
Marine Water Quality Index[5]	82.3%	Un-known	0	0	0	0	0	0	0
Impacts on Waste Management									
Remaining Landfill Capacity[6]	83 Mm^3	0	0	0	0	0	0	0	0

[1] Composite Index for Criteria Air Pollutants based on Percentage of the Air Quality Objectives.

[2] Composite Index for Criteria Air Pollutants Based on Percentage of Acceptable Risk.

[3] Quantity (Tonnes) of carbon dioxide emitted per year.

[4] Percentage of population exposed to excessive noise.

[5] Composite Index for Marine Water Quality Pollutants based on Percentage of the Water Quality Objectives.

[6] Total Remaining Landfill Capacity (by Volume). Note that Landfill Capacity to be exhausted by 2015.

6.4.3 The CASET indictors show that some of the alignments will have significant environmental impacts compared with the existing baseline. Although relatively little is known about the "No TYLL" for the year 2030, none of the alignments are anticipated to significantly impact on Hong Kong wide criteria relative to "No TYLL". The only exception is the significant quantity of marine sediment from the tunnel options which will require marine disposal and this is covered below.

6.4.4 To better differentiate between the alignments, a relative assessment of environmental impacts against the baseline and the "No TYLL" counterfactual is presented in **Table 6.4.2** below, although most of the analyses are qualitative in nature given that more detailed studies, such as water modelling, have yet to be undertaken.

Table 6.4.2 Relative Environmental Impacts

	Base-line	No TYLL	Marginal Impact over Baseline / No TYLL						
			Alignment No.						
			1	2	3	4	5	6	7
Air Quality Impact									
Relative to other alignment options	N/A	N/A	Poor	Poor	Poor	Good	Fair	Good	Good
Noise Impact									
Relative to other alignment options	N/A	N/A	Poor	Fair	Fair	Very Good	Very Good	Very Good	Good
Water Quality Impact									
Relative to other alignment options	N/A	N/A	Fair	Good	Poor	Good	Fair	Fair	Poor
Impacts on Waste Management									
Volume of dredged spoil (Mm^3)	N/A	0	6.2	4.9	7.2	0.24	0.67	0.24	0.71
Net impact on construction waste management	N/A	0	Large	Large	Large	Very Small	Small	Very Small	Small
Visual Impacts									
Relative to other alignment options	N/A	0	Very Poor	Very Good	Poor	Poor	Fair	Poor	Good

6.4.5 The relative assessment shows that Alignments 4-7 (the bridge alignments) have less impact on the environment than the Alignments 1-3 (the tunnel alignments). Of the bridges, Alignment 4 is ranked the best but has a poor ranking for visual aspects.

6.5 Social and Other Issues

Selection of Indicators

6.5.1 Social impacts are taken to be those impacts which most directly affect people including traffic, cultural heritage impacts and planning and lands impacts.

- Traffic impacts – measured by cost of freight transport, average travel distance and travel time in the territory (CASET criteria). Additional criteria include travel speed, congestion as well these measures in the identified Study Area.
- Marine traffic impacts – measured by number of collisions within the Study Area.
- Cultural heritage impacts – measured by the discovery of new archaeological sites and the destruction of existing sites (CASET criteria).
- Planning and lands impacts – measured by the area of private lots and Government land holdings affected and the impacts on new development.

Social Impacts

6.5.2 A relative assessment of environmental impacts against the baseline and the "No TYLL" is presented in **Table 6.5.1** below.

Table 6.5.1 Social Impacts

	Baseline	No TYLL	Alignment No.						
			1	2	3	4	5	6	7
Impacts on Freight Costs									
Goods vehicle costs as a % of GDP	3.09%	4.38%	4.35%	4.34%	4.34%	4.33%	4.33%	4.34%	4.32%
Total annual freight costs	49,470	70,886	70,411	70,364	70,373	70,186	70,185	70,233	70,014
Impacts on Travel Distance and Travel Speed									
Distance travelled by passengers during morning peak by all major groups of transport modes (km)	10.63	12.16	12.18	12.16	12.17	12.15	12.15	12.16	12.13

	Baseline	No TYLL	Alignment No.						
			1	2	3	4	5	6	7
Travel speed (km/hour)	34.9	26.7	28.0	27.9	28.0	27.9	27.9	27.9	27.9
Impacts on Traffic Congestion									
NWNT Strategic Road Network AM Peak average	0.81	0.81	0.77	0.76	0.77	0.78	0.78	0.77	0.76
Impacts on Marine Traffic									
Number of collisions per annum within Study Area	33	81.1	81.1	81.1	81.1	86.0	87.2	88.8	82.6
Cultural Heritage Impacts									
Number of recorded archaeological sites	253	320	320	320	320	320	320	320	320
Cultural heritage impacts	N/A	Un known	Poor	Poor	Very Poor	Poor	Poor	Poor	Fair
Impacts on Planning and Development									
Total area of land (private lots & Government land holdings) affected by project (m^2)	0	0	64,280	39,980	46,860	18,230	22,180	28,420	23,800

6.5.3 The assessment highlights no territory-wide adverse social impacts that could jeopardise the construction of TYLL. Impacts are instead mostly positive, helping to alleviate growing freight costs and road congestion as well as boost average travel speeds. The alignments which are ranked as poor for cultural heritage could reduce impacts by mitigation.

6.6 Part 1: Adopting CASET Criteria

6.6.1 For the part 1 sustainability assessment, the consultants have adopted CASET indicators where appropriate. Sixteen indicators are included, as follows:

- Construction Waste;
- Cost Benefit;
- Fixed Capital;
- Unemployment Rate;

- Unemployment Rate;
- Air Pollutants Index;
- Toxic Air Pollutants;
- Carbon Dioxide Emitted Per Year;
- Excessive Noise Exposure;
- Marine Water Quality Index;
- Remaining Landfill Capacity;
- Significant Landscape Areas;
- Significant Landscape Points;
- Freight Costs;
- Travel Distance;
- Travel Speed; and
- Number of Recorded Archaeological Sites.

6.6.2 The results, based on the selected CASET indicators and adopting the ball diagram CASET presentation methodology, are set out in **Table 6.6.1**. The symbols represent changes from the baseline.

- Construction Waste indicates that the without project scenario will not generate any construction waste but that all of the alignment options will generate waste requiring disposal to different extents, from sediment dredging of large quantities for the ITT (Options 1-3) to small quantities for bridge piers (Options 4-7). It was intended that the dredging for the reclamation areas would be limited to the sea wall perimeter areas in order to reduce the amount of sediment to be removed. It has now been agreed to follow a 'no dredging' approach to the reclamations whereby even this relatively small amount of dredging will not be undertaken. This will make a significant difference to the bridge options over the ITT options. In addition the material from rock tunnels on Tsing Yi should all be reusable on site for all options;

- Cost Benefit demonstrates that all of the alignments show a positive economic return and there are traffic benefits such as increased travel speed and reduced congestion (for the major links in the area). Under the without project, there is no investment and no benefits and some of the traffic issues (increased congestion, decreased travel speed) would be negative and the without project therefore shows a moderate to large deterioration;

- Criteria Air Pollutants demonstrates that the TYLL is not expected to affect Hong Kong wide air quality;

- Toxic Air Pollutants demonstrates that the TYLL is not expected to affect Hong Kong wide air quality;

- Carbon Dioxide Emitted indicates that the TYLL is not expected to significantly contribute to Hong Kong's overall greenhouse gas emissions;

- Excessive Noise Exposure demonstrates that the TYLL is not expected to affect Hong Kong wide noise levels and not affect the percentage of the population exposed;

- Fixed Capital demonstrates that all of the alignment options are positive but the impact is small. Again with no TYLL there is no investment and no impact;

- Unemployment Rate shows that the alignment options are all expected to provide some job opportunities. These will include directly for the planning, design, construction and operation of the TYLL and also indirectly from facilitating transportation, tourism and other business;

- Freight Costs show a moderate deterioration under the without TYLL scenario by 2030 compared to the baseline. The deterioration is moderate under all the alignment options as it is significantly influenced by the causes of the predicted background increases, but it is less than for the without TYLL in all options;

- Remaining Landfill Capacity demonstrates that by 2015 existing landfill capacity will have been exhausted and what will happen to the indicator by 2030 is unknown. However, the small quantities of waste from the project which will go to landfill would not effect the baseline situation;

- Marine Water Quality Index demonstrates that the TYLL is not expected to affect Hong Kong wide water quality;

- Significant Landscape Areas demonstrates no change under the without TYLL scenario and very small negative impacts under each of the alignment options;

- Significant Landscape Points demonstrates no change under the without TYLL scenario and small negative to medium positive impacts under each of the alignments;

- Travel distance shows a large deterioration under the without TYLL scenario compared to the baseline. Under all options this deterioration is of the same order probably due to traffic switching from shorter routes to take advantage of the increases travel speed;

Table 6.6.1 CASET Indicators

Variation 1: Option 1 - Tunnel
Variation 2: Option 2 - Tunnel
Variation 3: Option 3 - Tunnel
Variation 4: Option 4 - Bridge
Variation 5: Option 5 - Bridge
Variation 6: Option 6 - Bridge
Variation 7: Option 7 - Bridges

Indicator	Without Scenario	Variation 1	Variation 2	Variation 3	Variation 4	Variation 5	Variation 6	Variation 7
Carbon dioxide emitted per year	⊘⊘	⊘⊘	⊘⊘	⊘⊘	⊘⊘	⊘⊘	⊘⊘	⊘⊘
Construction Waste	❍	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘	⊘	⊘	⊘
Cost-Benefit	⊘⊘⊘	☑☑☑	☑☑☑	☑☑☑	☑☑☑	☑☑☑	☑☑☑	☑☑☑
Criteria air pollutants	☑	☑	☑	☑	☑	☑	☑	☑
Excessive noise	❍	❍	❍	❍	❍	❍	❍	❍
Fixed capital	❍	☑☑	☑☑	☑☑	☑☑	☑☑	☑☑	☑☑
Freight costs	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘
Landfill capacity	❍	❍	❍	❍	❍	❍	❍	❍
Marine water quality	❍	⊘⊘	⊘⊘	⊘⊘	⊘⊘	⊘⊘	⊘⊘	⊘⊘
Significant Landscape Features (Area)	❍	⊘⊘⊘	❍	⊘⊘	⊘⊘	☑☑	☑☑	☑☑☑
Significant Landscape Features (Point)	❍	❍	❍	❍	❍	❍	❍	❍
Toxic air pollutants	☑	☑	☑	☑	☑	☑	☑	☑
Travel distance	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘
Travel speed	⊘⊘⊘⊘⊘	⊘⊘⊘⊘⊘	⊘⊘⊘⊘⊘	⊘⊘⊘⊘⊘	⊘⊘⊘⊘⊘	⊘⊘⊘⊘⊘	⊘⊘⊘⊘⊘	⊘⊘⊘⊘⊘
Unemployment Rate	❍	☑	☑	☑	☑	☑	☑	☑
Social Checklist								
Archaeological/historical sites	❍	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘⊘	⊘⊘

Legends

❍ Annotates no change to the current baseline situation

	Very Small	Small	Moderate	Moderate to Large	Large	Very Large
Improvement	☑	☑☑	☑☑☑	☑☑☑☑	☑☑☑☑☑	☑☑☑☑☑☑
Deterioration	⊘	⊘⊘	⊘⊘⊘	⊘⊘⊘⊘	⊘⊘⊘⊘⊘	⊘⊘⊘⊘⊘⊘

(Not Used)

- Travel speed shows a large deterioration under the without TYLL scenario compared to the baseline. Under all options the deterioration is reduced to moderate; and

- Number of Recorded Archaeological Sites shows that the number of sites will increase by 2021 (and even more by 2030) and that there will be no change to the baseline situation with or without TYLL.

6.6.3 The results show that for this project, CASET indicators are more helpful at presenting the "with" and "without" project scenario than distinguishing between the with project options. This is largely because the CASET indicators tend to gauge territorial impacts while many of the impacts of the TYLL would be expected to be relatively small and localised. None-the-less, CASET results do make a number of important points, as follows:

- Of the sixteen reported criteria 4 show improvements with TYLL compared to without, 10 show no change and only 2 show negative impacts.

- Positive impacts are shown for economic and travel speed impacts and negative impacts shown for environmental / archaeological impacts; these are the trade offs of the project.

- Based on the CASET scoring system, the largest positive impact is for economic cost benefit.

- The greatest negative impact is large for the ITT alignments Options 1-3 and for the Archaeological / Historical sites for all of the options, although the latter could be mitigated.

6.6.4 Further analysis of the ranking of the options provides more information about the differences between the options, as shown in **Table 6.6.2** below.

Table 6.6.2: CASET Indicators, Ranking

Indicator	Base-line	No TYLL	Alignment No.						
			1	2	3	4	5	6	7
Construction Waste	1	1	8	7	9	3	5	3	6
Cost Benefit	9	9	5	7	6	4	3	1	2
Fixed Capital	5	5	5	9	8	2	1	4	3
Unemployment Rate	9	9	1	1	1	1	1	1	1
Air Pollutants Index	1	1	1	1	1	1	1	1	1
Toxic Air Pollutants	1	1	1	1	1	1	1	1	1
Carbon Dioxide Emitted	1	2	2	2	2	2	2	2	2
Excessive Noise Exposure	1	1	1	1	1	1	1	1	1
Marine Water Quality Index	1	1	1	1	1	1	1	1	1

Indicator	Base-line	No TYLL	Alignment No.						
			1	2	3	4	5	6	7
Remaining Landfill Capacity	1	2	2	2	2	2	2	2	2
Significant Landscape Areas	1	1	9	3	6	6	5	6	4
Significant Landscape Points	1	1	1	1	1	1	1	1	1
Freight Costs	1	9	8	6	7	4	3	5	2
Travel Distance	1	5	9	5	8	3	3	5	2
Travel Speed	1	9	7	2	7	2	2	2	2
Archaeological Sites	2	1	1	1	1	1	1	1	1

6.6.5 Ranking the alignment options helps to distinguish between them. **Table 6.6.2** shows the trade-off between environmental impacts where No TYLL scores well but scores poorly on other economy and business related indicators. Of the alignment options, Option 7 is the winner by a small margin.

- The three ITT alignments rank significantly worse than the bridge alignments in terms of the total sum of the rankings and each of them is the worst of the alignments for some of the indicators.
- The bridge alignments rank best for construction waste, cost benefit, fixed capital and freight costs and are not the worst alignment for any of the indicators.
- Alignment 6 ranks well on construction waste, travel speed and fixed capital and best for cost benefit.
- Alignment 7 ranks well on cost benefit and best of the alignments for freight costs and travel distance.

6.6.6 An assessment using CASET offers limited information to the decision maker.

- There is a trade off between traffic and economic benefits versus environmental impacts.
- However the environmental impacts are relatively small (apart from construction waste – sediment disposal for the tunnel options) compared to some moderate positive economic and traffic impacts.
- Of the alignment options, there is no clear winner.

6.7 Part 2: CASET and Other Sustainability Criteria

6.7.1 The consultants have adopted a wider selection of sustainability indicators for part 2 of the sustainability assessment. Twenty-six indicators are included, including the 16 CASET indicators.

6.7.2 The results are set out in **Table 6.7.1** which presents the rankings of the alignment options against the selection of sustainability indicators described previously.

Key Issues

6.7.3 The discussion in previous chapters highlighted five sustainability issues:

- Financial viability – The alignments do not return positive NPVs at the 5% discount rate. The TYLL's financial return to the Government will not be high enough to cover capital costs. However, this is at least partially due to the expectation that much of the traffic will not be going to/from Lantau and the toll free assumption for this traffic. The Government would need to subsidise the TYLL in some form.

- Waste management – there will be difficulties in finding appropriate marine mud disposal sites to handle the marine sediment generated during TYLL construction if the ITT options (Options 1-3) are selected.

- Travel speed and traffic congestion – TYLL will improve the predicted congestion problems in NWNT and possibly in the HKSAR as a whole.

- Archaeological sites – It will be important to ensure that the TYLL will not impact any archaeological sites in the Study Area.

- Marine traffic – The long-span bridge options increase the marine risk by between 3 and 11%.

6.7.4 Originally considered to be a likely issue, cultural heritage (specifically marine archaeological impact) does not feature significantly but its impact is highly uncertain. This is the nature of archaeological impact, since without conducting site investigation, it is not clear if anything may / will be found but, if something is found, then it could be significant.

6.7.5 Key issues are highlighted in orange in **Table 6.7.1**. Blue marks the lowest ranking and yellow the highest.

Table 6.7.1 Sustainability Indicators and Rankings

Indicator	Alignment No.						
	1	2	3	4	5	6	7
Construction Waste*	6	5	7	1	3	1	4
Cost Benefit*	5	7	6	4	3	1	2
Fixed Capital*	5	7	6	2	1	4	3
Unemployment Rate*	1	1	1	1	1	1	1
Financial Viability	7	6	4	4	3	2	1
Air Pollutants Index*	2	2	2	2	2	2	2
Toxic Air Pollutants*	2	2	2	2	2	2	2

Carbon Dioxide Emitted*	2	2	2	2	2	2	2
Relative Air Quality Impact	7	7	7	1	4	1	1
Excessive Noise Exposure*	2	2	2	2	2	2	2
Relative Noise Impact	7	5	5	1	1	1	4
Marine Water Quality Index*	2	2	2	2	2	2	2
Relative Tidal Flow and Water Quality	3	1	7	1	3	3	7
Remaining Landfill Capacity*	2	2	2	2	2	2	2
Relative Waste Management	7	7	7	1	3	1	3
Footprint	7	1	4	2	6	2	5
Landscape Areas*	7	1	4	4	3	4	2
Landscape Points*	2	2	2	2	2	2	2
Landscape and Visual Impacts	7	1	4	4	3	4	2
Freight Costs*	7	5	6	3	2	4	1
Travel Distance*	7	4	6	2	2	4	1
Travel Speed*	7	1	7	1	1	1	1
Traffic Congestion	2	7	2	2	7	7	1
Marine Traffic	1	1	1	5	6	7	4
Number of Archaeological Sites*	2	2	2	2	2	2	2
Relative Cultural Impact	2	2	7	2	2	2	1
Land Lots Affected	7	5	6	1	2	2	4

* denotes CASET indicators

Key sustainability indicators
1 = highest ranking
7 = lowest ranking

Relative Performance of Alignment Options

6.7.6 From a simple numeric viewpoint, option 4 performs well and is the best ranked in terms of the most (jointly) highest ranked indicators, the least worst ranked indicators (none) and the lowest summation of rankings; however option 7 also performs well. Some options rank better than others on some criteria and poorer on others. The reader should note that the differences between the alignment options tend to be small compared to the differences with and without TYLL.

- Alignments 4 and 7 have the highest number of first (1) rankings, 8 of the 27 indicators; Alignments 1 and 3 have the lowest with two each;
- Alignment 4 has the lowest number of bottom (7) rankings with none; Alignment 1 has eleven bottom rankings;
- Of the economic associated indicators, Alignment 7 performs the best and Alignment 2 performs the worst;

- Of the environmental indicators, Alignment 4 performs best, scoring 1 for the most indicators where there are differential scores. Alignment 3 performs poorly ranking bottom for most of the indicators that give differential scores. For many of the environmental criteria, it is not possible to distinguish between the alignments;

- Of the traffic related indicators Alignment 7 performs best with Alignment 1 clearly the worst having most of the worst indicators; and

- Of the remaining social indicators Alignments 4 and 7 perform best with each having a first and second best ranking and no worst rankings.

6.7.7 For the highlighted key issues

- Alignment 7 performs best in terms of financial viability;

- Alignments 4 and 6 perform best in terms of relative waste management;

- Alignments 1 and 3 perform best in terms of travel speed and Alignment 7 is best for traffic congestion; and

- Alignments 1-3 (tunnels) perform best in terms of marine traffic.

6.8 Summary

6.8.1 The TYLL appears to be justified in traffic terms, comparing the overall impact relative to the baseline of with and without TYLL alignment options for travel speed and for reduced congestion on the surrounding major road links. A significant environmental impact is the large quantity of sediment which will require marine disposal from the three immersed tube tunnel options. There are other environmental impacts which need to be taken into consideration but initial assessment suggests that these can be largely mitigated and the identified key issues will be assessed in greater detail if the project goes forward. There is thus a trade off between environmental impacts considered to be small (apart from sediment disposal requirements for the tunnel options) and improved traffic performance.

6.8.2 None of the alignments deliver positive financial returns at the 5% discount rate meaning that Government subsidy would be required to support the TYLL.

6.8.3 For the CASET indicators only, a simple summation of rankings indicates that the bridge options (Options 4 to 7) perform well with Option 7 the best. For the combined CASET and other sustainability indicators, Option 4 is the best performer in terms of simple rankings but all of the bridge options perform well and there are only relatively small differences between them. Some of the likely environmental impacts will be associated with the construction stage and as such will be relatively short term/temporary and will be localised.

(Not Used)

SECTION 7

Engineering Feasibility Study

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

7 ENGINEERING FEASIBILITY STUDY

7.1 Description of Preferred TYLL Alignment

General

7.1.1 As discussed in **Section 5**, Alignment Option 7 was recommended as the preferred alignment for the TYLL. It is the northern most alignment amongst options developed, and is shown in **Figure 7.1**. It was endorsed by the Project Steering Group at its meeting on 20 December 2007. Proceeding from the option assessment and Project Steering Group endorsement, the preferred alignment was further refined.

7.1.2 The alignment option commences at connection with TLB and NLH. It then passes eastward onto the arch bridge, which crosses the Kap Shui Mun Fairway towards Tang Lung Chau, before passing onto the elevated structure linking the suspension bridge. Just east of Tang Lung Chau, the highway turns more southward and passes onto the suspension bridge, which continues south-eastward, and crosses the Ma Wan Anchorage and Fairway towards Tsing Yi.

7.1.3 At Tsing Yi, the suspension bridge crosses above the China Merchants Container Services Ltd Mid-stream Container Terminal (MSCT), where it passes towards the hillside and crosses Tsing Yi Road, after which it passes into the rock tunnel. From here, the rock tunnel continues south-eastward under Nam Wan, before emerging from the hillside immediately southwest of the east portal of the Nam Wan Tunnel, behind the Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre. The alignment option then ends by a connection with ETYV.

7.1.4 A pair of slip roads is provided between the suspension bridge and Tsing Yi Road to provide access to CT9 and the potential site of the proposed CT10 at Southwest Tsing Yi. Some local road improvement works would be necessary to accommodate the slip roads.

7.1.5 No connection to PBH is provided with this alignment option due to the connectivity at NLH.

7.1.6 The key project elements of the preferred and refined TYLL alignment comprises,

- Rock Tunnel;
- Suspension Bridge;
- Arch Bridge;
- Artificial Island and Reclamation;
- Reprovisioning of Lantau Toll Plaza; and
- Viaducts and Roads.

The TYLL Western Connection

7.1.7 **Figure 7.2** shows the TYLL Western Interchange with TLB and NLH. The interchange comprises a dual two-lane highway, which emerges from TLB at Kwai Shek before crossing over NLH on elevated structure and connecting with TYLL at-grade, and a pair of two-lane link roads, which connects from NLH at the existing Lantau Toll Plaza.

7.1.8 To accommodate these link road branches, the existing Lantau Toll Plaza will need to be relocated to about 250m south-westward to the existing location as well as the service road will be re-aligned. Also, the section of NLH between the reprovisioned Lantau Toll Plaza and Sunny Bay Interchange would require widening to dual five-lane carriageway. Excavation to natural terrain in Ng Kwu Leng and existing man-made slopes along NLH and Lantau Link will be associated with the construction of these link roads and local widening of NLH.

The Marine Crossing Section

7.1.9 The TYLL will cross the channel between North Lantau Island and Tsing Yi via an arch bridge, viaduct and a long-span suspension bridge in a straight alignment.

7.1.10 The arch bridge, with a span of 500 m between the supports and with structure below 110 mPD, will extend from the elevated section in Yi Chuen across the Kap Shui Mun Fairway and then the section will transverse onto a viaduct towards northern portion of Tang Lung Chau. The suspension bridge, with a span of 1,800m between the towers and a span/dip ratio of approx 12.3, will continue the TYLL from the viaduct crossing the Ma Wan Anchorage and Ma Wan Fairway to the Tsing Yi section.

7.1.11 Land formation will be required to accommodate the bridge towers, cable anchorage and viaduct piers. Reclamation area will be located immediate east of Yi Chuen; immediate west, approximately 500m and 1000m to the east of Tang Lung Chau; as well as area fronting MSCT in the west of Tsing Yi.

The TYLL Eastern Connection

7.1.12 **Figure 7.3** shows the TYLL Eastern Connection with ETYV. The connection comprises a pair of two-lane link roads that connects with the ETYV in between the CT9 slip roads at the ETYV. The link roads will cross over the CT9 slip roads and the ETYV on elevated structure.

7.1.13 While the suspension bridge approaches to Tsing Yi from the west, the marine section will be divided into main road connecting to a proposed twin bored rock tunnel across the south Tsing Yi, and slip roads connecting to Tsing Yi Road after approaching the reclaimed area fronting MSCT. This section will be in form of elevated structure crossing over the MSCT and Tsing Yi Road.

7.1.14 Crossing over the MSCT and Tsing Yi Road, the alignment will continue eastward to the west portal of the proposed rock tunnel where will be a possible location for

the tunnel ventilation building. The alignment will extend straight eastward and emerge from the east portal to connect with Tsing Sha Control Area at ETYV through a section of elevated structure. The alignment between the east portal and connection with ETYV will be just behind the Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre.

7.1.15 Slip roads to Tsing Yi Road will extend from area over the reclaimed land fronting MSCT. Totally two flyover slip roads (one for each direction) will connect to Tsing Yi Road from TYLL at area near MSCT and Mobil Oil Depot. To accommodate the slip roads, the section of Tsing Yi Road between junction with Tsing Keung Road and Tsing Yi Gas Turbine Power Station will be re-aligned which involves excavation of existing roadside slope features.

7.2 Highway Design

Alignment Design Criteria

7.2.1 The proposed TYLL is a dual 3-lane road link with a design speed of 80 km/hr which provides an additional strategic route crossing between Lantau and Tsing Yi. General engineering layout drawings (**Drawing Nos. 91065/GL/100** to **117**) and typical cross sections (**Drawing Nos. 91065/GL/301** to **302**) for the TYLL were produced and A3 copies are included in this Report.

7.2.2 The alignment geometry design criteria used are summarised in **Tables 7.2.1** to **7.2.3** below. They comply with the requirements stated in the TPDM.

Table 7.2.1 Horizontal & Vertical Alignment Design

Design Criterion	Design Speed	
	50 km/h	**80 km/h**
Radius (Desirable Min.)	125 m (R4)	320 m (R4)
Radius (Normal Min.)	88 m (R3)	230 m (R3)
Radius (Absolute Min.)	44 m (R1)	115 m (R1)
Tunnel Gradient (Desirable Max.)	3%	3%
Gradient, Other (Desirable Max.)	5%	4%
Vertical Crest Curves (Desirable Min. K)	10	55
Vertical Crest Curves (Absolute Min. K)	6.5	30

Design Criterion	Design Speed	
	50 km/h	80 km/h
Vertical Sag Curves (Desirable Min. K)	13	26
Vertical Sag Curves (Absolute Min. K)	9	20

Table 7.2.2 Carriageway Width

Road Type	Hard Shoulder	Carriageway	Marginal Strip
Single One-lane	3.3 m	4 m	1 m
Single Two-lane (at-grade or on viaduct)	3.3 m	7.3 m	1 m
Single Two-lane (in each tunnel tube)	-	7.3 m	0.5 m on both sides
Dual Three-lane	3.3 m	11.0 m	1 m
Dual Two-lane (for elevated local roads only)	-	5.5 m	1 m (plus 1.6m central divider)

Note: carriageway to be widened on curve in accordance with the TPDM V2 3.4.4.

Table 7.2.3 Lane Configurations

Carriageway	Lane configurations	Design speed	Direction
Mainline (1,000 m between TLB and NLH)	Dual two-lane	80 km/h	N/A
Mainline (4,000 m between NLH and Tsing Yi Road, comprising 500 m arch bridge and 1,800 m suspension bridge)	Dual three-lane	80 km/h	N/A
Mainline (1,620 m between Tsing Yi Road and ETYV, comprising 1,320 m tunnel)	Dual two-lane	80 km/h	N/A
LE01 (1,120 m)	Single two-lane	80 km/h	EB NLH to EB TYLL
LE02 (1,050 m)	Single two-lane	80 km/h	EB NLH to NB TLB
LW01 (880 m)	Single two-lane	80 km/h	WB TYLL to WB NLH
LW02 (980 m)	Single two-lane	80 km/h	SB TLB to WB NLH

Carriageway	Lane configurations	Design speed	Direction
TE01 (650 m)	Single two-lane	80 km/h	EB TYLL to EB ETYV
TE02 (910 m)	Single one-lane	50 km/h	EB TYLL to Tsing Yi Road
TW01 (690 m)	Single two-lane	80 km/h	WB ETYV to WB TYLL
TW02 (910 m)	Single one-lane	50 km/h	Tsing Yi Road to WB TYLL

Note: all dimensions are rounded-up to nearest 10m.

Mainline Alignment

7.2.3 A dual two-lane mainline carriageway will be provided continuing from the TLB. After merging with the two-lane link road from NLH, TYLL becomes a dual three-lane carriageway from Lantau crossing the waters to Tsing Yi at the MSCT. A pair of slip roads drops from the mainline and connects with Tsing Yi Road. TYLL then becomes a twin two-lane bored tunnel with the west tunnel portal near MSCT and the east tunnel portal behind the Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre and connects with the ETYV of the Tsing Sha Control Area.

7.2.4 The design speed for the mainline of TYLL is 80 km/h as it connects Lantau Link in the west and Stonecutters Bridge in the east both having a speed limit of 80km/h. TYLL has a carriageway width of dual three-lane as given in **Table 7.2.2**. **Figure 7.4** shows the typical section of the suspension bridge structure.

7.2.5 The longitudinal alignment of the TYLL mainline uses a range of gradients between 0.67% and 2.50%. The minimum horizontal radius for the mainline will be 500 m, which meets the desirable minimum radius of R4 (320 m) for an 80 km/h design speed. The vertical profile of TYLL mainline is shown in **Drawing Nos. 91065/GL/201** to **202**.

Interchange with TLB and NLH

7.2.6 The design speed for the link roads between TYLL, NLH and TLB is 80 km/h, with carriageway widths of single two-lane as given in **Table 7.2.2**. **Figure 7.4** shows the typical section of the viaduct structure. The corresponding vertical profiles for the western link roads are shown in **Drawing No. 91065/GL/203**.

7.2.7 Due to the constraints imposed by the MTRC Airport Express Railway and its tunnel portal at Tai Tsing Chau, NLH eastbound link road to TLB uses a horizontal radii of 250m which can fulfil the normal minimum radii of R3 (230 m) for 80 km/h. About 285 m long of the NLH westbound link road from TLB will have a down gradient of 6% in order to provide adequate headroom for NLH.

7.2.8 A pair of bus bypass slip roads is provided for the through bus traffic along NLH in order to avoid excessive weaving from the near sided autotoll lane to the centre lanes of the Lantau Link.

Connections with ETYV and CT9

7.2.9 The design speed for the link roads between TYLL and ETYV is 80 km/h with carriageway widths of single two-lane as given in **Table 7.2.2**, whereas the slip roads between TYLL and Tsing Yi Road has a design speed of 50 km/h with carriageway widths of single one-lane. **Figure 7.4** shows the typical sections of elevated structures with carriageway widths for both single one-lane and single two-lane carriageways. The corresponding vertical profiles for the eastern link roads and slip roads are shown in **Drawing No. 91065/GL/204**.

7.2.10 The desirable minimum radius of R4 (320 m) for 80 km/h has been maintained for all link roads connecting to and from TYLL and ETYV. The eastbound link road will have a down gradient of 6% for a short section (65 m) after crossing over the ETYV as well as the CT9 slip roads.

7.2.11 The slip roads to and from Tsing Yi Road fulfil both the desirable minimum radius of R4 (125 m) and desirable maximum gradient of 5% for 50 km/h.

7.3 Toll Plaza and Administration Facilities

Toll Plaza

7.3.1 The re-provisioned toll plaza and associated facilities will be located about 250 m south-westward from the existing Lantau Toll Plaza as shown in **Figure 7.5**. The toll plaza is approximately 600 m in length with a maximum width of 124 m. The speed limit of the mainline alignment approaching from east and west of the toll plaza will adopt similar arrangement as the existing NLH, i.e. 110 km/h west of the toll plaza, with transition area having a speed limit of 80 km/h on eastbound when approaching the toll plaza, 80 km/h east of the toll plaza, and 50 km/h through the toll plaza area.

7.3.2 The toll plaza has provision of 24 tolling lanes, 12 lanes entering Lantau and 12 lanes leaving Lantau. The 7 central toll lanes of the toll plaza will be reversible and collect tolls in any direction. This will provide a total of 15 toll lanes in any one direction and increase the capacity of the toll plaza in that direction. Four auto-toll lanes will be provided in each direction, and will be evenly distributed along the toll plaza in order to ensure smooth and safe traffic flow and to avoid unnecessary weaving movement.

7.3.3 The outermost toll lanes will accommodate exceptionally wide vehicles and have an extra-wide lane no less than 6.2m wide. This lane can also be used as an auto-toll for vehicles as well as buses without the need to weave across the other toll lanes when entering or exiting the bus lay-bys.

7.3.4 The toll booths/kiosks and equipment will be protected upstream with traffic barriers, bollards and possible crash attenuators, with a toll plaza canopy to shelter the toll booths/kiosks. The bollards will be mounted on the traffic island just next to the upstream corners of the toll booths. This can provide clear warning to drivers on the toll booth structure and also provide extra protection to it. The toll booths shall be designed in accordance with the requirements in TPDM Volume 11 and relevant guidelines/code of practice in relation to the occupational safety and health.

7.3.5 Approach traffic signing prior to the toll plaza area is instrumental for warning users of the plaza ahead and preparing them for the upcoming transaction, with lane control signal above and a movable bar at each booth indicating whether a booth is open or closed.

7.3.6 A toll collector subway with CCTV surveillance system, connecting the toll booths and the administration building, is provided for safe access for both the toll collectors and for secure delivery of the collected tolls to and from the secure zone of cash office and vault.

7.3.7 A 7.3 m wide vehicular subway and a 7.3 m wide two-way service road are provided to enable easy access to all buildings and facilities within the toll plaza. The vehicular subway enables westbound maintenance vehicle to cross underneath NLH near the bus lay-bys to the administration building via the re-aligned service road. The two-way service road also provides access to/from NLH and the MTRC Airport Express Railway tunnel portal and the shipyard in Tai Tsing Chau.

7.3.8 At present, as Lantau Link is the only road link to/from Lantau Island, one-way tolls (i.e. aggregate toll for round-trip) are collected from motorists using the Lantau Link. By the time TYLL is in place, TLB and TMCLKL will also provide connections to/from Lantau Island. A two-way toll is therefore suggested for traffic to/from Lantau. A toll-free segregated route between TLB and TYLL is provided through a pair of direct link for NWNT – urban traffic. Under this arrangement, TYLL together with TLB will be able to offer a toll-free route between TMR and Tsing Yi.

Administration and Tunnel Buildings

7.3.9 An administration building will be required to house the staff and personnel needed to administer the daily running, operation and maintenance of the toll plaza and TYLL. A five-storey administration building with a Central Control Room and a 180 degree view overlooking the toll plaza area is proposed. The building is adjacent to the eastbound tolling lanes, and shall contain offices for toll facility personnel and traffic control and surveillance systems (TCSS) personnel in non-secure zones, as well as secure zones for the money-handling functions and operations of the toll plaza.

7.3.10 The administration building will be equipped with the same system as the existing building on the lower three floors plus the surveillance systems, operation and maintenance equipments required for TYLL on the upper two floors. An outline

administration building room schedule is included in the Engineering Feasibility Study Report.

7.3.11 The detailed arrangement will be subject to review based on the consideration that Tsing Ma Control Area (TMCA), TLB and TYLL may be operated by single operator or different operators. The operation mechanism of the infrastructures should be reviewed in the next phase of the Project. The current outline scheme is developed assuming a merged operation with the TMCA.

7.3.12 Ventilation building will be required for the tunnel ventilation system. The ventilation building will be located at the west tunnel portal as shown in **Figure 7.3**. The building will house all the equipment necessary to fully operate and maintain the ventilation system within the rock tunnel.

Other Ancillary Facilities

7.3.13 Other ancillary TYLL facilities include,

- Bus lay-bys with canopy and passenger queue railings on both sides of the toll plaza – double width of 7.3 m wide and able to accommodate approximately ten buses each at any one time, inter-connected by a pedestrian subway which runs under the toll plaza.

- Tunnel portal cross-over – to enable tunnel maintenance closure and allow vehicles to cross from eastbound carriageway to the westbound carriageway and vice-versa, for one-tube two-way operation.

- Recovery areas with adequate covered parking spaces for recovery and other service vehicles at both tunnel portals – to ensure fast and instant recovery and rescue operation for both tunnel tubes.

- Weigh stations at both tunnel portals and before both approaches to TYLL bridges – for the control and prosecution of overweight vehicle, with station locations shown in **Figures 7.3** and **7.5** (locations should be carefully chosen to prohibit overweight vehicles from entering the long-span bridges and tunnel).

- Over-height vehicle detection facilities and control kiosks – to detect for over-height vehicles which could seriously damage the operation of the tunnel crossing, indicative locations are shown in **Figures 7.3**.

- Dangerous goods vehicle detection facilities – detection can be done by CCTV or by tunnel operations staff in patrol cars or at control kiosks.

- Sub-control room on Tsing Yi side (indicative location shown in **Figure 7.3**) – for better control and regulation of traffic in the tunnel due to the distance and geographical constraints between the tunnel and the proposed administration building on Lantau.

Impact to Existing TMCA MOM Agreement

7.3.14 The existing management, operation and maintenance of TMCA (including the toll collection) is now outsourced to private sector under an agreement, which will expire in May 2013. As the TYLL does not need to be in place before year 2021, it is likely that any impact due to re-provisioning of Lantau Toll Plaza on the TMCA MOM agreement can be resolved through revised scope and special conditions appended into the agreement when it is renewed / retendered.

7.3.15 As routing between Tsing Yi and Tuen Mun through TYLL and TLB will be toll free, tolling for TYLL to/from Lantau will be in a similar manner to the existing NLH, most likely at the re-provisioned Lantau Toll Plaza. It is therefore most direct to include management, operation and maintenance of TYLL (including the toll collection) into the scope of TMCA. However, the exact arrangement is subject to further investigation in the subsequent stages of the Project.

Impact to TMCA Ordinance

7.3.16 The management, operation and maintenance of the TMCA (including the collection of tolls) is governed by the Tsing Ma Control Area Ordinance (Cap. 498) and the boundaries of TMCA and the toll area of TMCA are fixed as delineated on the TMCA boundary plan prepared under the TMCA Ordinance. In the event that TYLL is to be included into the TMCA, the relevant clauses and the plan of boundaries of the area will need to be varied.

7.4 Rock Tunnel

Design

7.4.1 The rock tunnel is approximately 1.32 km long in total. Due to the relatively short tunnel section, the main method of excavation used will most likely be the drill and blast method. The typical cross section for rock tunnel is shown in **Figure 7.6**. The dual 2-lane carriageway of TYLL will be accommodated into two separate tunnel tubes, with each traffic bound in one tunnel tube. The geometry has been optimised in terms of the traffic structural gauge and the service requirements.

7.4.2 Walkways are provided on both sides of each tunnel tube with utilities such as electrical cables for maintenance and operation and water supplies for fire mains laid below the walkways in a service trench. An Overhead Ventilation Duct (OHVD) slab is provided above the carriageway for ventilation.

7.4.3 The principal concerns associated with the drill and blast method is the potential adverse effects of ground vibration on adjacent slopes, buildings, structures, services and utilities. In this Project, consideration should be given to the unstable / loosened rock blocks lying on the hillsides or from the rock cliffs, rock slope instability, intermittent suspension of traffic flow at Tsing Yi Road, and potential impact to the nearby oil depots. The delivery of explosives for blasting also has potential hazard to the public.

7.4.4 According to Geotechnical Engineering Office (GEO) Circular No. 27, a blasting assessment should be undertaken to assess the adverse effects and hazards, and to propose measures to demonstrate the practicality of carrying out the required blasting works. Such assessment should be conducted at the next stage of the TYLL Project.

Construction

7.4.5 The majority of the tunnel length has an overburden thickness that appears to range from a minimum of 22m to a maximum of 112m, with a significant overlying cover that appears to be generally greater than 10m. Given the current understanding on the tunnel location, configuration and ground conditions, it is considered that a drill and blast excavation method is both practical and economical, although the issue of site access for delivery of explosives warrants further investigation. Further consideration should also be given to the geotechnical issues associated with locations where the tunnel alignment crosses areas where locally weak or fractured zones would be expected. A more specific and detailed ground investigation would therefore be required.

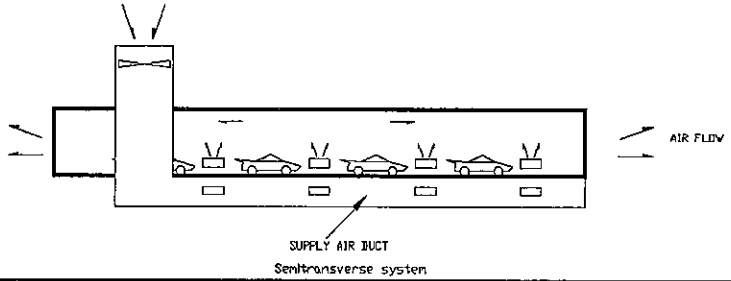
7.4.6 The tunnelling works consists of drilling a controlled number of holes into the tunnel face to a designated depth and then loading the drilled holes with an appropriate blasting agent. The loaded holes are detonated and the broken rock is removed from the tunnel. The construction technique involves sequential excavation and support with a variable excavation sequence and face area depending on the ground response. The newly blasted section will need to be stabilised temporarily during excavation.

7.5 Tunnel Ventilation

Recommended System for the TYLL

7.5.1 There are three common types of tunnel ventilation system, namely longitudinal, fully transverse and semi-transverse systems. Semi-transverse system is the recommended system for the TYLL tunnel. It is mainly due to its cost effective system configuration, simple system design and subsequently simple control and operation, and the omission of jet fans reducing the operation and maintenance costs.

7.5.2 Semi-transverse system has fresh air supply duct running along the entire tunnel length or sections of the tunnel they serve. Uniformly distributed inlet grilles connecting the supply air duct with the tunnel are usually at road level. The figure below shows the typical arrangement of a semi-transverse system.



Semitransverse system

System Description

7.5.3 Schematic diagram of the tunnel ventilation system is shown in **Figure 7.7**. The proposed semi-transverse tunnel ventilation system shall consist of fans, dampers, silencers and concrete ventilation duct running along the tunnel top slab. All the fans will be accommodated in the portal ventilation buildings.

7.5.4 It was estimated that the minimum cross-sectional area of the concrete air duct at each tunnel tube is $16m^2$, and the total fan capacity of each tunnel tube is $240m^3/s$, which is able to fulfil normal, congestion and fire emergency airflow requirements (with one standby fan provided during fire emergency). Details of the estimation are provided in the Engineering Feasibility Study Report.

7.5.5 Along the overhead concrete ventilation duct, tee-off will be allowed at regular interval and connected to fire rated duct extended to high level of the tunnel to achieve better ventilation and smoke control performance. Each ventilation opening at the fire rated duct will be fitted with pneumatic type motorised smoke and fire damper (MSFD). The electro-pneumatic panel controlling the operation of MSFD will be located behind the tunnel cladding.

7.5.6 As the tunnel ventilation system will also be used for smoke control in case of fire emergency, all fans, dampers and silencers, etc shall be suitable for continuous operation at 250°C for one hour as per Fire Services Department (FSD) requirements.

7.5.7 In order to monitor the pollution level within the tunnel, an air quality monitoring system will be provided at strategic locations along each tunnel tube. To minimize future maintenance of the sensors, the open path type system widely adopted in other vehicular tunnels in Hong Kong shall be adopted.

Modes of Operation

Normal Operation

7.5.8 The concentration of CO, NO_2 and diesel smoke shall be continuously monitored by the air quality control system installed inside the tunnel. The operation of the tunnel ventilation system will be controlled by tunnel air quality monitoring system during normal traffic / congestion traffic conditions. Operation of tunnel ventilation fans under free flow traffic condition (normally at 30 km/h or above) is normally not required.

Congestion Operation

7.5.9 The number of vehicles inside the tunnel will increase when the traffic speed is reduced, and the piston airflow will be less effective. When the tunnel air quality system detects either the CO, NO_2 or diesel smoke are approaching the allowable limit, tunnel ventilation fans will be activated to dilute the pollutant inside the tunnel.

7.5.10 The operation of tunnel ventilation fans will normally be in steps. The first tunnel ventilation fan is to be operated when any of the CO, NO_2 and diesel smoke concentration had reached 80% of the allowable level. If the pollutant concentration continues to rise upon the activation of tunnel ventilation fans, an additional group of fans will be activated.

Emergency Operation

7.5.11 Each tunnel tube is to be divided into 3 smoke zones each around 450 metres in length as a basis for a zonal smoke control system. Tunnel fire detection system that can determine the fire location will be installed inside the tunnel. Basically the system will be linear type and make use of modern glass fibre cable technology. It is using an operating principle with semi-conductor laser diodes and an evaluation process designed for the purpose. The responses time of the system shall be around 90 seconds.

7.5.12 Once fire occurred and detected inside the tunnel, the tunnel ventilation system will be converted from supply to exhaust mode in around 60 seconds. All MSFD within the fire zone will be switched on to extract smoke. Smoke, due to its buoyancy, will rise and spread horizontally along the tunnel ceiling before the fans are in full operation.

7.5.13 As the buoyancy force of the smoke or the residual piston airflow of the traffic may cause smoke spill to adjacent smoke zone, the smoke extraction system capacity shall be designed to allow simultaneous operation of 2 smoke zones. The smoke extraction system of the second smoke zone shall only be operated when smoke is detected by the tunnel fire detection system. For boundary fire between 2 smoke zone, the system operation strategy is to be the same.

7.5.14 For evacuation under fire emergency, tunnel users will escape from the tunnel tube on fire to the non-incident tube via tunnel cross passages. Based on FSD requirement, tunnel cross passages shall be provided at 100 metres interval. All tunnel cross passages shall be fitted with self-closing doors with necessary fire resisting period to prevent both smoke ingress and fire spread to the non-incident tunnel. In all fire scenarios, the ventilation system of the non-incident tunnel tube will be shut down to minimize disturbance of the smoke extraction system operation.

7.6 Long-span Bridge

Crossing over Kap Shui Mun Fairway – Arch Bridge

7.6.1 The arch bridge, with a span of 500 m between the supports, starts at the elevated section of the TYLL in Yi Chuen, passes across Kap Shui Mun Fairway and ends at the viaduct towards northern portion of Tang Lung Chau. While the bridge is in close proximity to the designated helicopter entry/exit routes, the maximum height of the structure is at 110mPD, which can fulfil Government Flying Service's operational requirements. A cable-stayed bridge at this location would adversely

affect the flight safety due to the need for high towers, and is therefore not recommended.

7.6.2 The proposed arch bridge is a central single steel tied arch supported by two concrete cantilevered approach spans on the concrete pylons. The outline of the arch bridge structure is shown in **Figure 7.8**. The steel tied arch span is in the order of 250m to 300m and the horizontal forces of the arch are restrained by the bridge deck, which ties the ends of the arch together, just like the string of a bow.

7.6.3 The weight of the arch will be transferred to the seaward end of each of the concrete pylon structures, which causes the two inclined pylons in compression while the horizontal members in tension. The unbalanced tension force and overturning moment will be counterbalanced by the vertical pylons positioned at the shoreward end of the system.

7.6.4 The concrete support system is in a simple form, evoking strength and weight, while the arch portion is light and elegant. Combining powerful concrete supports, monolithic columns, and steel arch structure which becomes progressively lighter as it rises; this arrangement demonstrates the idea of adherence to a hierarchy of materials and forms, chosen in relation to their positions from the ground.

7.6.5 In the next design stage, parametric studies will be carried out, together with the geotechnical information, to determine the relative spans for steel arch and for concrete approach. If required, additional piers will be provided to give vertical support for the approach decks at the position of the combined foundation of the inclined pylons.

Crossing over Ma Wan Fairway – Suspension Bridge

7.6.6 The suspension bridge, with a span of 1,800m between the towers, starts at the viaduct from northern portion of Tang Lung Chau, passes across Ma Wan Anchorage and Ma Wan Fairway and ends at the elevated section of the TYLL in southwest Tsing Yi near the west tunnel portal. The outline of the suspension bridge elevation is shown in **Figure 7.9**.

7.6.7 A cable-stayed bridge with span of 1800 m would require towers with height much in excess to the Airport Height Restriction. To reduce the span and hence the tower height, an extra tower at the mid-way of the Ma Wan Fairway would be required. Considering the consequent adverse effects, the cable-stayed form is therefore not suggested and suspension bridge is proposed for this section of TYLL.

Span-to-sag Ratio

7.6.8 The Airport Height Restriction imposes a limitation on the tower heights in this Project. For a suspension bridge, the tension forces in the cables are related to the cable sag at mid-span, and a shallower cable will require a larger area of cables. The span-to-sag ratio for this section of TYLL is proposed to be approximately 12.3. Considerations on the effects of span-to-sag ratios include:

- **Economic evaluation** – The most economical span-to-sag ratio is 8 when the costs of towers and decks are considered altogether. However, some designers would prefer a ratio around 10 to obtain greater stiffness from cables for suspension bridges, although higher costs of cables will be resulted.

- **Structural behaviours** – The results of parametric studies indicate that with increase of the span-to-sag ratio, greater stiffness of the bridge system will be expected.

Bridge Towers

7.6.9 Towers are considered as one of the most influential parts of suspension bridges in aesthetic appreciation. They are the major structural members to catch passengers' eye when travelling on the bridge, and the tower being seen is the portion of which above the deck. One of the prime considerations in aesthetics is the proportion of the structure, expressed in term of "aspect ratios", tower height above deck to its transverse width (dictated by the width of the deck). Higher value of aspect ratio would impart an impression of comfort and elegance. With an aspect ratio below 2.0, it can be considered as a dwarf.

7.6.10 Depending on the type of bridge deck to be used (to be discussed below), the current outline scheme for the TYLL suspension bridge will have an aspect ratio in the range between 2.81 (for a 3rd generation deck) and 4.17 (for a 2nd generation deck). The latter is within the range of typical values of aspect ratios and is therefore more preferable.

Deck Generations

7.6.11 The width of deck is governed by the number of lanes provided, and furthermore the aerodynamic stability of the bridge structure, as it is believed that wider deck would enhance the aerodynamic stabilities.

7.6.12 Conventional stiffened-truss deck is the so-called 1st generation of deck in suspension bridge, which is designed for increased flexural and torsional stiffness to resist the effect of wind forces, as used in the Akashi-Kaikyo Bridge, Japan.

7.6.13 The 2nd generation deck is the aerodynamically streamlined section, as used in the Severn Bridge, UK. It is designed to minimize the excitation forces and motion which cause aerodynamic instability, and at the same time provide sufficient stiffness of the bridge system in resisting those instabilities. Another bonus in this type of deck is the aesthetics of the structure in comparison with the stiffened-truss deck. Great Belt East Bridge, Denmark, and Tsing Ma Bridge, Hong Kong, both adopt 2nd generation deck.

7.6.14 The 3rd generation deck is, in fact, developed further from the 2nd generation deck, splitting the aerodynamically streamlined deck (normally a closed box) into a twin-box or multi-box. These boxes are connected by lightweight transverse beams at intervals along the span, and air gaps are maintained between the boxes for the aerodynamic stability purposes. It is claimed that critical wind speed could be

increased by spacing the decks further apart, without the use of a torsion box. Thus the total width of the deck is normally much wider than the 1st and 2nd generation decks. Messina Bridge, Italy, and Tsing Lung Bridge, Hong Kong, are designed for this type of deck. However it should be noted that none of these bridges with 3rd generation deck has actually been constructed so far.

7.6.15 It can be seen that for a main span of 1800m as in this study, any one of the above deck types is technically feasible. However, the 1st generation deck would require a rather deep deck, say a 12m to 14m deep truss. The deck itself does not look graceful, maintenance need to be seriously considered, and the cost of this type of deck may well be more costly than a 3rd generation deck.

7.6.16 3rd generation deck type would be an alternative. However, more work is needed to understand more its aerodynamic behaviour. As the bridge decks become wider, the wake effect will attract more concern, and should be treated as the principal wind problem. As such, we must continue to be vigilant in ensuring that its benefit clearly outweighs its risk.

7.6.17 Another main consideration is the cost of the 3rd generation deck type bridge. A study shows that the unit cost index, per lane per meter, is somewhat 39% higher in the case of Tsing Lung (3rd generation) than that in Tsing Ma (2nd generation), although the main spans are similar in both bridges. As there is not much information available for 3rd generation, the result would give a warning signal on this aspect, though more researches on the cost comparisons are needed.

7.6.18 In the light of the above, a 3rd generation deck is not the ideal choice in considering the cost, aesthetics, and the effect of wake action for wide decks. It is therefore proposed to adopt a 2nd generation deck box, possibly with slots as used in Tsing Ma. With experience in Tsing Ma (1377m span) and good example of Great Belt East (1624m span), it is believed that to stretch the main span to 1800m is feasible. The 2nd generation decks have widely been used for more than a half century, plus the advantages that the wind and structural health monitoring system in the existing Tsing Ma bridge would give good data basis to refer to, and the costs are believed to be cheaper in comparing with the 3rd generation deck.

Construction

7.6.19 The suspension bridge of TYLL will be constructed after the artificial islands are formed by reclamation, and towers and anchorages are constructed. As moderately or better rock will not be encountered at shallow depth, the possible foundation type will be caisson bearing on rock. The towers will be constructed in-situ with reinforced concrete using a slip-form system and the main suspension cables will be formed by the aerial spinning process. The suspension bridge segment will be installed by lifting from barge with conventional gantries. These are established techniques/technologies and do not pose insurmountable challenges.

7.6.20 For the arch bridge of TYLL, the whole tied arch can be prefabricated offsite, floated into place and lifted into position. An example for such construction method is the Fremont Bridge in USA, which is a double-deck highway bridge with a main

span of 382m. During its construction in 1973, the central part of 275m arch was assembled, floated into place and lifted 52m, the lifting weight of which was 6000 ton.

7.6.21 Lifting of the suspension bridge segment and arch structure will inevitably affect the busy shipping channel. The construction sequence, size of marine works areas and conditions under which construction may take place will be subject to agreement of Marine Department after a detailed Marine Impact Assessment Study with navigation simulation to be undertaken during the next stage of the TYLL Project. The assessment shall identify the operational constraints and with practical measures to minimise the potential marine impacts during the lifting operations over the busy shipping channel.

High Wind Management

7.6.22 There is a need for special traffic management arrangements for the two high-level bridges of the TYLL under strong wind condition. These arrangements are proposed to be executed in connection with the strong wind management currently implemented in the Lantau Link. The concept of the arrangements is suggested in the following paragraphs and will need to be reviewed/developed at the subsequent stage of the Project.

7.6.23 When wind speed reaches an hourly mean of 40 km/h (about Typhoon Signal No. 3), the centre lanes of the TYLL on both directions are suggested to be closed to road traffic and change lane would not be allowed. Wind susceptible vehicles including motor cycles and vehicles with an overall height exceeding 1.6 m are also suggested to be banned from using the TYLL, and would be diverted to use the lower deck of the Lantau Link via NLH, Tsing Yi Road or Nam Wan Tunnel. No wind susceptible vehicles are expected from the TLB under this wind condition.

7.6.24 For the condition with an hourly mean wind speed in excess of 65 kph (about Typhoon Signal No. 8), the TYLL is suggested to be completely closed to road traffic. All vehicles would then be diverted to the lower deck of the Lantau Link, of which the upper deck would also be closed under this wind condition.

7.6.25 Since vehicles carrying Category 1, 2 or 5 dangerous goods are prohibited from using the lower deck of the Lantau Link, they may not be able to gain land access to or from Lantau under the strong wind conditions.

7.6.26 While the above proposed TYLL traffic arrangements are not expected to cause management complication to the Lantau Link, it is believed that there are measures to increase the threshold of traffic diversion, so as to reduce the burden of the Lantau Link under strong wind conditions. This could be achieved by introducing wind shields on either side of the bridge deck to enhance wind protection for all vehicles. The high wind management and the effectiveness of wind shield will need to be further reviewed and developed at the next stage of the Project.

7.7 Artificial Island

7.7.1 Artificial islands around bridge piers provide highly effective vessel collision protection. It is particularly critical to design the island for empty or ballasted ships and barges which can slide up on the slopes of an island and travel relatively large distances before coming to a stop. This artificial island protection is similar to the Tsing Ma Bridge tower protection arrangement, for principal navigation spans.

7.7.2 The land for the artificial islands will be formed by reclamation. In view of the Government Policy to keep sediment in place as far as possible, non-dredged method involving drained reclamation with marine deposits left in place will be adopted. Vertical drains will be installed in the marine deposits prior to proceeding with the reclamation works. The land will be formed at a nominal reclamation level of +6mPD with sloping armour seawall at the peripheral of the islands. **Figure 7.10** shows the typical cross section of the reclamation.

7.7.3 The reclamation is estimated to require approximately 2.85Mm^3 fill material. The excavated material generated in the Project, especially from the rock tunnel can be used as fill material for the islands. Surcharging is required to accelerate settlements due to consolidation of the strata underlying the reclamation fill.

7.8 Viaducts

General Requirements

7.8.1 The TYLL western interchange provides interconnection amongst TYLL, TLB and NLH. Obstacles crossed include NLH and the MTR Airport Express Railway. Each viaduct will carry an 11.6m carriageway consisting of two lanes of traffic, a hard shoulder and a marginal strip. **Figure 7.4** shows the typical section of viaduct structures with carriageway width for single two-lane carriageways.

7.8.2 There are three sections of viaduct on the TYLL mainline. They include the section between Lantau Island and the arch bridge, between the arch bridge and the suspension bridge and between the suspension bridge and the west tunnel portal. In addition to spanning over Tsing Yi Road, the viaducts also span over MSCT. The first two of the above sections will carry a 15.3 m carriageway consisting of three lanes of traffic, a hard shoulder and a marginal strip, whereas the last of the above sections will carry a 11.6m carriageway consisting of two lanes of traffic, a hard shoulder and a marginal strip.

7.8.3 The TYLL eastern connection comprises four viaducts connecting the proposed TYLL with Tsing Yi Road and ETYV. In addition to spanning over Tsing Yi Road, Tsing Keung Street, ETYV and Tsing Ko Road, the viaducts also span over MSCT, Open Storage at Tsing Yi Road j/o Tsing Keung Street, Wah Tak Godown Company Limited warehouse and Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre. The link roads between TYLL and ETYV will carry an 11.6m carriageway consisting of two lanes of traffic, a hard shoulder and a marginal strip, whereas the slip roads between TYLL and Tsing Yi Road will carry an 8.3 m carriageway

consisting of one lane of traffic, a hard shoulder and a marginal strip. **Figure 7.4** shows the typical sections of viaduct structures with carriageway width for both single one-lane carriageway and single two-lane carriageway.

7.8.4 **Table 7.8.1** below summarises the general requirements for each elevated structure. The location of the structures can be found in **Figures 7.2** and **7.3**.

Table 7.8.1 Geometric Requirements and Obstacles Crossed

Elevated Structure	Minimum Radius (m)	Approximate Length (m)	Maximum Width (m)	Tallest Pier (m)	Obstacles and Constraints
TYLL western connection					
LE01	500	125+150	11.6	9	NLH, AER
LE02	250	220	11.6	21	NLH
LW01	600	210	11.6	7	NLH
LW02	320	390	11.6	22	NLH, TYLL
TYLL westbound	500	160	11.6	11	NLH
TYLL eastbound	500	250	11.6	11	NLH, AER
TYLL mainline					
TYLL eastbound (to arch bridge)	straight	220	15.3	63	None
TYLL westbound (from arch bridge)	straight	220	15.3	63	None
TYLL eastbound (to suspension bridge)	1000	1030	15.3	64	Sea
TYLL westbound (from suspension bridge)	1000	1030	15.3	64	Sea
TYLL eastbound (to west tunnel portal)	1500	530	11.6	68	Tsing Yi Road, TYLL, MSCT
TYLL westbound (from west tunnel portal)	1500	530	11.6	68	Tsing Yi Road, TYLL, MSCT
TYLL eastern connection					
TE01	320	600	11.6	70	Tsing Yi Road, Tsing Ko Road, ETYV, WTGCL
TE02	250	430	8.3	64	Tsing Yi Road, , TYLL, MSCT
TW01	224	620	11.6	69	Tsing Yi Road, Tsing Ko Road, ETYV, DC(HK)L, WTGCL
TW02	250	400	8.3	61	Tsing Keung Street, MSCT, OS,

Abbreviation:		
	AER	Airport Express Railway
	ETYV	East Tsing Yi Viaduct
	NLH	North Lantau Highway
	TYLL	Tsing Yi Lantau Link
	DC(HK)L	Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre
	MSCT	China Merchants Container Services Ltd Mid-stream Container Terminal
	OS	Open Storage at Tsing Yi Road j/o Tsing Keung Street
	WTGCL	Wah Tak Godown Company Limited warehouse

Structural Form

7.8.5 Precast prestressed single-cell concrete box girder is proposed for all the elevated structures. Span lengths for the proposed viaducts fall between 40m and 80m that is well within the economic range of 40m to 150m. Up to spans of 60m a constant depth section would be used with a depth-span ratio of 1:20, and segments could be positioned by crane if access is suitable or by erection gantry. Above 60m span the deck is more likely to be haunched with depth-span ratios of 1:16 at the pier, reducing to 1:35 at mid-span.

7.8.6 Where the viaducts span over NLH, ETYV or the TYLL mainline, the bridge support at the central reserve or at the space in-between viaducts should be built monolithic to the deck so as to eliminate the difficulties in gaining access for bearing replacement.

7.8.7 The precast segments are not to be wider than 2.5m in order to fulfil TD's requirement in transporting the units on public road. Typical weight of the segments is less than 35 tonnes that can be handled by 300t or 500t mobile cranes readily available in Hong Kong.

Selection of Construction Methods

7.8.8 **Figures 7.11, 7.12** and **7.13** shows the possible viaduct construction methods for the TYLL project. They are balanced cantilever erection by gantry, span-by-span erection and balanced cantilever erection by form traveller respectively.

7.8.9 Viaducts in the TYLL western connection share the common obstacles including the strategic NLH and MTR Airport Express Railway. Some of them also span over the existing sloping terrain. Balanced cantilever method by erection gantry is proposed for these viaducts to minimize substructure and foundation construction. The construction pattern is particularly suitable for very short window allowed for rail possession and lane closure on NLH should this become necessary. Link Roads LE01, LW01 and LW02, and the TYLL westbound and eastbound viaducts over NLH have spans in the order of 60m that exceeds the span limit of span-by-span construction method. The span-by-span method is however suitable for Link Road LE02 as an alternative method but longer construction period and higher construction costs need to be allowed for the construction of substructure and foundations.

7.8.10 Link Roads LE01 and LW01, and the TYLL westbound and eastbound viaducts over NLH are located less than 30m above and within 30m reach from a public road

or formed land. Mobile crane can be used during lane closure for the construction of these viaducts. However, Link Road LE01 and the TYLL viaducts will require careful planning of construction sequence and multi-positioning of the mobile crane for erection. This makes the employment of mobile crane unattractive for these viaducts.

7.8.11 Balanced cantilever method is also the preferred construction method for the viaducts in the TYLL mainline. This method can minimize substructure and foundation construction, especially for the section between arch bridge and suspension bridge.

7.8.12 Similarly, balanced cantilever method is also the preferred construction method for the viaducts in the TYLL eastern connection. This method can minimize substructure and foundation construction, and more importantly the required land resumption of the private lots such as MSCT and Wah Tak Godown Company Limited warehouse. The span-by-span method is suitable for Slip Road TW02 as an alternative method but longer construction period and higher construction and resumption costs need to be allowed for the construction of substructure and foundations.

7.8.13 Use of the methods by cast-in-place with conventional falsework and precast by crane are restricted in the TYLL mainline and eastern connection by the height of the viaducts above ground, which either makes the use of falsework not cost-effective, or practically beyond the reach of mobile cranes.

7.8.14 Construction in-situ by means of form traveller is also feasible as an alternative for the construction of all the viaducts in the study area, albeit a longer construction period. Constructing in parallel with the main viaducts, the employment of form travellers in the slip roads will complement the use of gantries in the main viaducts.

Substructures and Foundation

7.8.15 The viaduct superstructures are supported by reinforced concrete piers which are in turn supported by piled foundations. In case of obstruction, reinforced concrete portal frame structures can be used as a substitute to the piers. As a sacrificial structure, dolphins will be constructed adjacent to those pile caps located in the sea to protect the viaduct foundation and substructures from marine traffic impact if necessary.

7.8.16 Columns will be strategically positioned taking into account the appropriate viaduct spans for construction, minimization of private land resumption and avoidance of the key structures and roads below the viaducts. The avoided structures include the Airport Express Railway tunnel, Dow Chemical (HK) Ltd Tsing Yi Plant and Technical Centre and Wah Tak Godown Company Limited warehouse. The avoided roads include the strategic NLH, Tsing Yi Road, Tsing Keung Street and Tsing Ko Road.

7.9 Construction and Demolition Materials

7.9.1 Construction of tunnel, earthworks for link road and reprovisioning of Lantau Toll Plaza will generate large amount of construction and demolition (C&D) materials. A total amount of approximately 2.23 Mm^3 of C&D materials will be generated, and all of them are expected to be inert C&D materials.

7.9.2 The inert C&D materials are suggested to be used in the backfilling for the retaining walls, abutments and fill slopes, and in the reclamation of the artificial island and the seawall construction, as well as in road sub-base. The estimated required fill volume is approximately 3.41 Mm^3. Therefore, no surplus inert C&D material is envisaged from this Project, although an additional 1.18 Mm^3 of imported fill material will be required.

7.9.3 Although non-dredged method has been proposed for the reclamation and seawall construction, it is still expected that small quantity of marine sediment will be generated from the limited piling works for the bridges across the fairways. The estimated quantity is approximately 5,000 m^3.

7.10 Works Area

Bridge and Viaduct Construction

7.10.1 Similar to other highways projects in Hong Kong, it is increasingly difficult in finding a suitable location for the casting and fabrication facilities in the vicinity of the project area. It is a common practice to utilise established casting yards and fabrication yards across the border in Mainland China for the construction of bridge deck segments. Segments will be produced and stored in the yards before delivery.

7.10.2 It is recommended three-week stocking of the bridge deck segments be shipped and stored at a temporary storage in the vicinity of the construction area. The area should also allow additional space for loading and unloading activities.

7.10.3 Shortly before erection, segments will be transported by sea to a temporary barging point and the segments will then be transferred on road to the temporary storage area. A possible site is found on Cheung Tung Road near Yam O Wan as shown in **Figure 7.14**. The space is currently used for Penny's Bay Reclamation Stage 2 which should well be available before the commencement of the TYLL construction, although the availability of the site for this Project is not guaranteed at this early stage. Access to this storage area will be from Cheung Tung Road.

7.10.4 For the TYLL eastern connection at Tsing Yi, a temporary storage area is also required for the construction of the elevated link roads. A possible area is identified at MSCT. During construction, the artificial island nearby together with a portion of MSCT would be temporarily required for the construction of bridge towers and piers. The area could be a potential temporary storage area provided right of way is given to the lot owner. The effect on the operation of MSCT needs to be further investigated and reviewed, and alternative location may be required.

Site Offices

7.10.5 Area for site office would also be provided in the same area as the temporary storage area as shown in **Figure 7.14**. The plan area is considered sufficient for site offices for both the resident site staff and contractors, together with the necessary temporary storage area. Access to the site offices will be from Cheung Tung Road.

SECTION 8

Geotechnical Appraisal Study

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

8 GEOTECHNICAL APPRAISAL STUDY

8.1 Previous Site Investigations and Studies

8.1.1 A large volume of previous ground investigation data were retrieved from Geotechnical Information Unit (GIU) of the Geotechnical Engineering Office (GEO). The locations of the drillholes for these previous investigations are shown in **Figures 8.1** to **8.3**.

8.1.2 The site areas were studied based on the available aerial photographs from 1963 to 2006. The purpose is to identify any instability that may have been missed during Natural Terrain Landslide Inventory study and to identify the general temporal pattern of development in the Study Area. The archival aerial photographs are listed in Site Investigation Report.

8.2 Proposed Site Investigation for this Assignment

8.2.1 Land ground investigation works, marine ground investigation works and marine geophysical surveys were carried out for this Assignment to investigate the existing ground conditions within the Study Area. The proposed site investigation works were undertaken under various GEO term contracts, followed by subsequent laboratory testings on the recovered samples.

8.2.2 The land ground investigation works consisted of nine vertical drillholes – five vertical drillholes (BH4 to BH7 and BH9) at eastern landing on Tsing Yi and four vertical drillholes (BH12, BH13, BH15 and BH17) at western landing on Lantau, and associated in-situ testing along the preferred alignment. The purposes of the drillholes were to obtain initial ground information and information of the rock quality at and in the vicinity of the proposed elevated structure, tunnel and portal locations. The locations of the proposed investigation works are shown in **Figures 8.4** to **8.6**.

8.2.3 The marine ground investigation works consist of thirteen drillholes and seven continuous piezocone penetration tests (CPTs) along the preferred alignment of the TYLL in the marine area. The purposes of the drillholes were to obtain the information of ground conditions and correlation purposes of the geophysical surveys. The locations of the proposed investigation works are also shown in **Figures 8.4** to **8.6**.

8.2.4 The marine geophysical surveys comprising echo sounding, seismic reflection survey and side scan sonar were conducted covering the Study Area for investigating the sub-seabed stratification and buried features. Magnetic survey was also conducted for the identification of the extent of a nearby explosive dumping ground.

8.3 Preliminary Geology and Ground Models

8.3.1 According to the 1:100,000 Geological Map of Hong Kong and the Hong Kong Geological Survey 1:20,000 Map, Sheet No. 10, the geology of the site is mainly formed by igneous rocks of Jurassic, Mesozoic. The types of intrusive rocks consist of Shatin Granite and Lantau Dyke Swarm of Kwai Chung Suite, and Tai Lam Granite of Lamma Suite. The volcanic rock consists of Yim Tin Tsai Formation tuff of Tsuen Wan Volcanic Group. The superficial deposits belong to Quaternary. Details of geological setting of the study area are described in following sections. The geological maps of the study area are shown in **Appendix D**.

Eastern Landing – Tsing Yi Island

8.3.2 The eastern end of the preferred TYLL alignment option is located at the southern portion of Tsing Yi Island. The concerned portion of Tsing Yi Island is mainly formed by equigranular coarse and fine to medium grained biotite granite (Shatin granite) of Jurassic of Mesozoic Age. Intrusions of feldsparphyric rhyolite to porphyritic granite dykes (East Lantau rhyolite) of Jurassic of Mesozoic age are found locally in the area. Debris flow deposits is found as superficial deposits of quaternary at the hillside. Beach deposits and fills are found near the shoreline and reclaimed area as the superficial deposits.

8.3.3 Based on 1:20,000 geological map of the area, several faults crossing from northwest to southeast direction are inferred in the southern portion of Tsing Yi Island.

8.3.4 With reference to the available ground investigation data, a layer of colluvium with a maximum of 8m is present locally at the hillside. Below this colluvium layer is decomposed granite, feldsparphyric rhyolite or tuff.

8.3.5 A layer of fill with a maximum thickness of 40m is present in the reclaimed area. It generally lies above -25mPD. Underlying the fill is a layer of marine deposits with a maximum thickness of 18.5m. The marine deposits generally lies above -23mPD. Underlying the marine deposits is a layer of alluvium with a maximum thickness of 26m. Completely decomposed rock is found underneath the alluvium. The interface between the alluvium and the decomposed rock varies from -48mPD to -18mPD.

Western Landing – Lantau Island

8.3.6 The proposed alignment of TYLL is located at Northeast Lantau Island along eastern coast from Yi Chuen to Kwai Shek. This portion of Lantau Island is mainly formed by lapil lithic–bearing coarse ash crystal tuff (Yim Tin Tsai formation of Tsuen Wan volcanic group) of Jurassic of Mesozoic age. Intrusions of feldsparphyric rhyolite to porphyritic granite dykes (East Lantau rhyolite) and porphyritic medium grained to equigranular fine grained leucogranite (Tai Lam granite) of Jurassic of Mesozoic age are found locally in the area. Some mafic and intermediate dykes are found in this portion of Lantau Island. Superficial deposits of quaternary in the area are mainly debris flow deposits. Local beach deposits and

alluvium are found as superficial deposits along shoreline and old valley respectively.

8.3.7 Based on 1:20,000 geological map of the area, several faults crossing from northeast to southwest direction are inferred at the area.

8.3.8 With reference to the available ground investigation data, a layer of colluvium of thickness ranging from 0.5m to 31m is present locally at the hillside. Below this layer of colluvium is decomposed rock.

Marine Area

8.3.9 The superficial geology below the seabed at the area consists of marine mud and sand of Hang Hau formation. Two major faults crossing from northwest to southeast direction are inferred along Kap Shui Mun and Ma Wan Fairway.

8.3.10 The locations of the known borrow area and dumping ground are shown on **Figure 8.7** for reference.

8.3.11 With reference to the available ground investigation data, a layer of marine deposits with a maximum thickness of 21.5m is present below the seabed. The marine deposits generally lies above -24mPD. Underlying the marine deposit is a layer of alluvium with a maximum thickness of 14.5m. Completely decomposed rock is present below the alluvium. The interface between the alluvium and the completely decomposed rock varies from -55.2mPD to -12.85mPD. Rockhead of moderately decomposed or better rock varies from 5mPD to –53mPD.

8.4 Geological Constraints

8.4.1 The geological considerations for the preferred alignment of TYLL are largely based on the existing information available and the data from the recent ground investigation and geophysical surveys. The existing information includes the previous ground investigation data, aerial photo interpretation and geological maps.

8.4.2 The following findings of the assessment shall be verified by further ground investigation to be carried out at other stages of the Project.

8.4.3 The problematic geological features, the key geotechnical risks and constraints affecting the Project are identified and described in the following sections.

Potential Instability of Existing Registered Slope Features

8.4.4 There are numerous existing registered slope features that could affect or be affected by the proposed TYLL alignment. Their locations are shown in **Figures 8.8** and **8.9**. Stability assessment for these slope features shall be carried out at future design stages to determine any slope works and stabilization measures required. The category of these slopes shall be classified in accordance with Geotechnical Manual for Slopes (GEO 1984) and WBTC No. 13/99.

Variation in Lithologies, Rockhead Levels and Presence of Geological Structures

8.4.5 It should be noted that there might be possibility of significant variations in rockhead levels, particularly in the offshore area, due to the highly variable lithologies (including, composite dykes, granite and volcanic rocks) and the presence of geological structures in the study area. The past experience during the construction of pile foundations and ground anchors for Kap Shui Mun Bridge and Tsing Ma Bridge, where significant variations in rockhead levels were encountered, shall be referred. In this connection, further ground investigation shall be carried out to verify the ground conditions at these particular locations.

Foundation of Link Roads TE01, TE02, TW01 and TW02

8.4.6 The Link Roads TE01 and TW01 will connect the eastern tunnel portal and East Tsing Yi Viaduct and pass above existing works areas, buildings, at-grade and elevated roads and nullah. Underground conditions consist of fill, marine deposit, completely decomposed granite, highly decomposed granite and moderately decomposed or better granite. Pile foundation bearing on rock is considered feasible.

8.4.7 The Link Roads TE02 and TW02 will connect the eastern end of TYLL suspension bridge and Tsing Yi Road and pass above existing open storage areas and roads. Underground conditions consist of residual soil, fill, colluvium, completely decomposed granite, highly decomposed granite and moderately decomposed or better granite. Pile foundation bearing on rock is considered feasible.

8.4.8 For the pile foundation at the reclaimed area, compressible materials, such as marine deposit, are revealed from existing information. Negative skin friction should be considered in the design of the pile foundation.

8.4.9 Location of pile foundation of these link roads should be carefully selected to minimize the effect to the existing utilities.

Site Formation for Link Road TE01 and TW01

8.4.10 A major portion of TE01 and TW01 will be on an elevated structure while a minor portion connecting to the eastern portal of the proposed bored tunnel will be at-grade.

8.4.11 The at-grade section of TE01 and TW01 requires cutting back of the natural terrain beside it. Retaining structures will also be constructed to reduce the extent of slopes being cut. The design of retaining structures and newly formed cut slopes shall be carried out in accordance with Geoguide 1 and Geotechnical Manual for Slopes respectively. The design of newly formed cut slopes shall have a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes. Depending on the materials and conditions of the slopes, soil nails, rock dowels, passive rock anchors, buttress walls and wire meshing may be required to ensure the stability of the slopes.

Site Formation for Link Road TE02

8.4.12 The western portion of TE02 will be on an elevated structure while the eastern portion connecting to Tsing Yi Road will be at-grade.

8.4.13 For the at-grade section, the proposed road will encroach into a few existing registered features, namely 10NE-B/C254, 10NE-B/C255, 10NE-B/C262 and 10NE-B/C263 (**Figure 8.8**). Features no. 10NE-B/C254 and 10NE-B/C262 are soil slopes while 10NE-B/C255 and 10NE-B/C263 comprise soil and rock. To suit the alignment of TE02, these slopes will be partly cut back to a maximum angle of 45°. The design of newly formed slopes shall have a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes. In this regard, soil nails, rock dowels, passive rock anchors, buttress walls and wire meshing may be required to ensure the stability of the slopes.

Site Formation for Link Road TW02

8.4.14 The western major portion of TW02 will be on an elevated structure while a minor portion connecting to Tsing Yi Road at the east will be at-grade.

8.4.15 For the at-grade section, the proposed road will encroach into a few existing registered features, namely 10NE-B/CR253, 10NE-B/C254, 10NE-B/C255 and 10NE-B/CR257 (**Figure 8.8**). Features no. 10NE-B/C254 and 10NE-B/CR257 are soil slopes while 10NE-B/CR253 and 10NE-B/C255 comprise soil and rock. To suit the alignment of TW02, these slopes will be partly cut back to a maximum angle of 45°. The design of newly formed slopes shall have a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes. In this regard, soil nails, rock dowels, passive rock anchors, buttress walls and wire meshing may be required to ensure the stability of the slopes.

8.4.16 A new fill slope will also be formed along the alignment of TW02. The fill slope shall consist of well compacted fill and compacted in accordance with the General Specification for Civil Engineering Works. The maximum gradient of the fill slope is expected to be 30°. The stability of the fill slope shall have a minimum factor of safety of 1.4 in accordance with the Geotechnical Manual for Slopes. The fill slope shall be protected by hydroseeding for greening purpose.

Twin Bored Tunnel under Nam Wan

8.4.17 Given the current understanding on the tunnel location, configuration and ground conditions, it is considered that a drill and blast excavation method is both practical and economical, although the issue of site access for daily delivery of explosives warrants further investigation. Further consideration should also be given to the geotechnical issues associated with locations where the tunnel alignment crosses areas where locally weak or fractured zones would be expected. For these conditions a more specific and detailed ground investigation would be required with the likelihood of amendments to the tunnel support rendering it more appropriate to weak ground.

8.4.18 Apart from the drill and blast method, tunnel boring machines or other road header or mechanical rock breaking machines may also be applicable. However, these are not at this stage considered to be cost effective in terms of mobilization costs, high rates of maintenance and servicing works.

8.4.19 Rock blasting was considered to be the most appropriate method for the proposed tunnel construction. Consideration should be given to the following key hazards and sensitive receivers.

- Vibration-induced movement of potentially unstable rock blocks and boulders lying on the hillsides;
- Vibration-induced rockfall associated with loosened rock blocks from steep rock cliffs or outcrops;
- Vibration-induced rock slope instability; and
- Intermittent periods of suspension of traffic flow at Tsing Yi Road due to rock blasting near portal areas.

8.4.20 The sensitive receivers located close to the proposed tunnel alignment are Tsing Yi Road and the existing buildings and facilities along Tsing Yi Road, i.e. the DOW Chemical (Hong Kong) Ltd. Tsing Yi Plant and Technical Centre, EPD Hong Kong Chemical Waste Treatment Centre, Tien Chu Industrial Centre, Tsing Yi Gas Turbine Power Station, CRC Oil Depot, ESSO Oil Depot, Mobil Oil Depot and the Tsing Yi South Fresh Water Service Reservoir. The open storage area and dockyard on the west coast of Tsing Yi Island are considered less sensitive to vibration effects.

8.4.21 Daily delivery of explosive is proposed for routine tunnel rock blasting. It can avoid the problems on explosive storage on site provided that site access shall be available for the Mines Division explosive delivery trucks.

8.4.22 There will be one round of blasting per day. Since each round of blasting will include rock faces trimming, survey setting out, drilling of blasting hole, insertion of cartridge, ignition, mucking out, geological mapping and application of temporary protective measures, etc, the whole round of blasting will take about one day to complete.

8.4.23 It has been estimated that the overall construction of the TYLL would be completed in approximately 6 years. The construction of rock tunnel with one blast per day would unlikely affect the anticipated overall construction programme adversely. During the design stage of the Project, the consultant should undertake a blasting assessment according to GEO Circular No. 27, to demonstrate the practicality of carrying out the blasting works. However, to suit the contractor's site planning and construction sequencing, the contractor will develop his tunnel blasting requirements during the construction stage. The possible impact / hazard associated with the contractor's blasting requirements will be assessed and reported in the

contractor's blasting assessment report for the approval by GEO and other authorities.

8.4.24 A detailed boulder studies would be required to identify and resolve the majority of the engineering issues of concern in relation to the tunnel construction. This would be in addition to normal stability assessment of all existing slopes in the vicinity of the site. While it may be impractical to undertake extensive boulder treatment and rock stabilization works, a number of solutions are required to be designed for the appropriate and adequate temporary/permanent rockfall preventive systems and temporary site formation work across the affected natural terrain.

8.4.25 Further site investigation shall be carried out in future design stages. Technical recommendations on site investigation for tunnel works shall be in accordance with GEO Technical Guidance Note No. 24.

8.4.26 The preferred tunnel portals are generally remote from existing densely populated residential areas. The risks associated with rock blasting during tunnel construction is considered to be low, though a detailed blasting assessment should be carried out to quantify its effect in terms of blasting vibration limits, charging weight and operational blasting issues.

8.4.27 To control risks during construction, risk management approach shall be adopted and recommendation on geotechnical risk management for tunnel works shall be in accordance with GEO Technical Guidance Note No. 25 in future design stages.

8.4.28 To conclude, drill and blast tunnel excavation is considered to be feasible and practical with the supply of explosives made by daily delivery, providing that both the safety and environmental requirements can be met.

Site Formation Works for Tunnel Portals

8.4.29 Site formation including cut slopes and retaining structures are required for the tunnel portals on both ends. The available geological information shows that the portal area at the western end of the tunnel consists of a layer of colluvium overlying completely to highly decomposed granite. The rockhead is at about +70mPD, i.e. 6m above the proposed road level.

8.4.30 Based on the revealed geology, the site formation works shall consist of cut slopes of both rock and soil slopes. Subject to the condition of exposed rock surface, rock dowel, buttress walls or passive rock anchors may be required on the newly formed rock slopes to ensure adequate factor of safety against planar failure, wedge failure and toppling of any potential rock joint instabilities. Wire meshing may also be required to prevent falling of rock fragments to the portal area. For soil slopes, soil nails may be required to ensure the slopes are of adequate factor of safety against failure. All newly formed slopes shall achieve a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes.

8.4.31 For rock excavation, if blasting is employed, the operation should be carefully controlled. Trial operations for rock blasting should be carried out before the

commencement of works to determine the arrangement and amount of explosives to be used for each round of blast which will favour the progress of construction and yet will not cause unacceptable level of nuisance to the public and the surrounding environment. Like blasting the tunnel, the contractor will develop his blasting requirements during the construction stage to suit his site planning and construction sequencing. It should be noted that a blasting permit shall be applied for blast trials.

8.4.32 For the greening measures on the rock slopes, live planting, hydro-mulching or proprietary products such as "Geofibre" can be considered. However, it would incur extra maintenance cost.

8.4.33 In order to reduce the extent of the cut slopes, reinforced concrete retaining walls may be constructed to reduce the slope height. Depending on the retaining height, the wall could be typical L-shape retaining wall, or bored pile wall in case of limited working space. The design of the new retaining structures shall follow the latest version of Geoguide 1.

Site Formation for Re-alignment of Tsing Yi Road

8.4.34 The part of Tsing Yi Road between the existing Mobil Oil Depot and ESSO Oil Depot will be re-aligned to suit the connection with the Link Roads TE02 and TW02.

8.4.35 The proposed re-aligned Tsing Yi Road will encroach into a few existing registered features, namely 10NE-B/C55, 10NE-B/C56, 10NE-B/C254, 10NE-B/C255, 10NE-B/C270, 10NE-B/C273, 10NE-B/CR257, 10NE-B/F104 and 10NE-B/FR11 (**Figure 8.8**). Features no. 10NE-B/C55, 10NE-B/C254, 10NE-B/C273, 10NE-B/CR257, 10NE-B/F104 and 10NE-B/FR11 are soil slopes while 10NE-B/C56, 10NE-B/C255 and 10NE-B/C270 comprise soil and rock. To suit the re-alignment of Tsing Yi Road, these slopes will be modified and new cut slopes will be formed accordingly. The design of modified and newly formed slopes shall have a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes. In this regard, soil nails, rock dowels, passive rock anchors, buttress walls and wire meshing may be required to ensure the stability of the slopes.

Natural Terrain Hazard on Tsing Yi Island

8.4.36 Past natural terrain landslides within the project boundary were found on Tsing Yi Island. 3 were above the existing Tsing Yi Road at Nam Wan and 3 were near the proposed western tunnel portal. Detailed study on these incidents is recommended to be carried out during the next design stage.

8.4.37 Based on the currently available information, there would appear to be a relatively low risk of any major natural terrain hazards being impacted by the proposed rock tunnel construction. It is recommended that a detailed natural terrain hazard study including a thorough boulder survey and stream course survey shall be carried out to supplement the detailed tunnel design. The suggested extent of the future natural terrain hazard study is given in **Figure 8.10**.

8.4.38 Extensive slope cuttings may be required for the construction of the tunnel portals. However, both the portals are likely to be located within a natural hillside that is generally hidden from sight by surrounding ridges. Suitable engineering design of the portal structures, cut slopes and associated site formation could be undertaken without significant external constraints.

Artificial Islands and Reclamation Areas

8.4.39 Based on the available ground investigation information, the geology underlying the two proposed artificial islands at Ma Wan Anchorage would be marine deposit, alluvium and decomposed granite/feldsparphyric rhyolite.

8.4.40 As these artificial islands will be located off the existing shoreline, there is essentially no natural terrain hazard likely to impact on the construction of the islands and the operation of the associated structures.

8.4.41 There will be 3 reclamation areas. They will be located at the west of Tsing Yi Island, west of Tang Lung Chau and east of Yi Chuen on Lantau Island. The geology underlying the reclamation area at the west of Tsing Yi Island would consist of marine deposit, alluvium and decomposed granite, while decomposed granite/feldsparphyric rhyolite would be present at the other 2 reclamation areas.

8.4.42 Natural terrains are present behind the reclamation area at Yi Chuen. Natural terrain hazard may have impacts on the construction of the reclamation area and the operation of the associated structures. It is recommended that a detailed natural terrain hazard study including a thorough boulder survey and stream course survey shall be carried out to study the risks to the reclamation areas.

8.4.43 In order to minimize the dredging of marine deposit, the artificial islands and reclamation will be designed as drained reclamation with marine deposit left in place. For the area of seawall surrounding the island/reclamation, Deep Cement Mixing shall be applied to maintain adequate factor of safety of the seawall.

8.4.44 For drained reclamation, ground treatment with band drains and surcharge will be provided in order to accelerate the consolidation process and minimize the residual settlement. The ground treatment will be designed to achieve completion of primary consolidation of soft and compressible soil under the future working load. The residual settlement and differential settlement can be further reduced by surcharging the compressible soil to achieve over-consolidation ratio of 2.

Foundation for Piers of Long-span Bridge

8.4.45 Supporting structures will be constructed at the reclamation areas and artificial islands for the suspension bridge and arch bridge.

8.4.46 As moderately or better rock will not be encountered at a shallow depth, the possible foundation type for the piers of the bridges will be caisson bearing on rock. The effects of the negative skin friction on the foundation in view of the settlement of the

reclamation areas and artificial islands should be carefully considered during the design stage.

Foundation of Link Roads LE01, LE02, LW01, LW02 and Bus Bypass Routes

8.4.47 The Link Roads LE01 and LE02 will connect the NLH eastbound with the future TLB and the proposed TYLL, and pass above a natural terrain. Underground conditions consist of residual soil, colluvium, completely to highly decomposed granite/feldsparphyric rhyolite/tuff and moderately decomposed or better rock.

8.4.48 The Link Road LW01 will connect the NLH westbound and the proposed TYLL mainline westbound near Yi Chuen and pass above a natural terrain. Underground conditions consist of residual soil, colluvium, completely decomposed granite/feldsparphyric rhyolite/tuff, highly decomposed feldsparphyric rhyolite/tuff and moderately decomposed or better rock.

8.4.49 The Link Road LW02 will connect the NLH westbound and TLB and pass above NLH and a natural terrain. Underground conditions consist of colluvium, completely to highly decomposed granite/feldsparphyric rhyolite/tuff/basalt and moderately decomposed or better rock.

8.4.50 The possible foundation type of the viaducts will be pile foundation bearing on rock. The pile locations should be carefully selected in order to avoid any effect to the existing underground utilities.

Site Formation for Link Road LE01

8.4.51 The major portion of LE01 will be at-grade while the portion across NLH and at the junction with LE02 will be on an elevated structure.

8.4.52 For the at-grade section, the proposed road will encroach into a number of existing registered features, namely 10NE-A/C109, 10NE-A/C110, 10NE-A/C111, 10NE-A/F14, 10NE-A/F17, 10NE-A/F18 and 10NE-A/F47 (**Figure 8.9**). All these slopes are soil slopes. To suit the alignment of LE01, these slopes will be trimmed back to a maximum angle of 30° and 45 ° for fill slopes and cut slopes respectively. The design of newly formed slopes shall have a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes. In this regard, soil nails, may be required to ensure the stability of the slopes.

8.4.53 New fill slopes will also be formed along the alignment of LE01. The fill slopes shall consist of well compacted fill and compacted in accordance with the General Specification for Civil Engineering Works. The maximum gradient of the fill slope is expected to be 30°. The stability of the fill slopes shall have a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes. The fill slopes shall be protected by hydroseeding for greening purpose.

Site Formation for Link Road LE02

8.4.54 About half of the portion of LE02 will be at-grade while the northern portion connecting to TLB and the portion at the junction with LE01 will be on an elevated structure.

8.4.55 For the at-grade section, the proposed road will encroach into 2 existing registered features, namely 10NE-A/F14 and 10NE-A/F47 (**Figure 8.9**). Both of these slopes are soil slopes. To suit the alignment of LE02, these slopes will be trimmed back to a maximum angle of 30°. The design of newly formed slopes shall have a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes.

8.4.56 New fill slopes will also be formed along the alignment of LE02. The fill slopes shall consist of well compacted fill and compacted in accordance with the General Specification for Civil Engineering Works. The maximum gradient of the fill slopes is expected to be 30°. The stability of the fill slopes shall have a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes. The fill slopes shall be protected by hydroseeding for greening purpose.

Site Formation for Link Road LW01

8.4.57 The majority of the portion of LW01 will be at-grade while a minor portion at the junction with LW02 will be on an elevated structure.

8.4.58 For the at-grade section, the proposed road will encroach into a few existing registered features, namely 10NE-A/C102, 10NE-A/C107, 10NE-A/C108 and 10NE-A/C109 (**Figure 8.9**). All these slopes are soil slopes. To suit the alignment of LW01, these slopes will be trimmed back to a maximum angle of 45°. The design of newly formed cut slopes shall have a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes. In this regard, soil nails, may be required to ensure the stability of the slopes.

Site Formation for Link Road LW02

8.4.59 About half of the portion of LW02 will be at-grade while the northern portion connecting to TLB and the portion across NLH and TYLL mainline will be on an elevated structure.

8.4.60 For the at-grade section, the proposed road will encroach into 2 existing registered features, namely 10NE-A/C102 and 10NE-A/C107 (**Figure 8.9**). Both of these slopes are soil slopes. To suit the alignment of LW02, these 2 slopes will be trimmed back to a maximum angle of 45°. The design of newly formed cut slopes shall have a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes. In this regard, soil nails, may be required to ensure the stability of the slopes.

Site Formation for Bus Bypass Routes

8.4.61 There will be two bus bypass routes. One will be located to the north of NLH while the other will be located to the south of NLH.

8.4.62 For the northern bus bypass route, a major portion of it will be at-grade. Only a small portion of the route near the junction of Link Road LE01 and LE02 will be on an elevated structure.

8.4.63 For the at-grade section, the proposed route will encroach into 2 existing registered features, namely 10NE-A/C110 and 10NE-A/F15 (**Figure 8.9**). Both of these slopes are soil slopes. To suit the alignment of this bus bypass route, 10NE-A/C110 will be trimmed back to a maximum angle of 45° while 10NE-A/F15 will be trimmed back to a maximum angle of 30°.

8.4.64 Fill slopes will also be formed along the alignment of the route. The fill slopes shall consist of well compacted fill and compacted in accordance with the General Specification for Civil Engineering Works. The maximum gradient of the fill slopes is expected to be 30°. The fill slopes shall be protected by hydroseeding for greening purpose.

8.4.65 For the southern bus bypass route, the whole alignment will be formed at-grade. The proposed route will encroach into 3 existing registered features, namely 10NE-A/C102, 10NE-A/C107 and 10NE-A/C108 (**Figure 8.9**). All these slopes are soil slopes. To suit the alignment of this bus bypass route, these slopes will be trimmed back to a maximum angle of 45°.

8.4.66 The design of all newly formed slopes shall have a minimum factor of safety of 1.4 in accordance with the Geotechnical Manual for Slopes. In this regard, soil nails may be required to ensure the stability of the slopes.

Site Formation for Re-alignment of NLH

8.4.67 In order to facilitate the proposed alignment, the existing NLH shall be re-aligned. The re-aligned NLH will encroach into a number of existing registered features, including 10NW-B/C14, 10NW-B/C18, 10NW-B/C19, 10NW-B/C20, 10NW-B/C23, 10NW-B/C24, 10NW-B/C25, 10NW-B/C49, 10NW-B/C54, 10NW-B/C55, 10NW-B/F7, 10NW-B/F9, 10NW-B/F13, 10NW-B/F14, 10NW-B/F15, 10NW-B/F16, 10NW-B/F17, 10NW-B/F18, 10NW-B/F19, 10NW-B/F21, 10NW-B/FR26, 10NW-B/R7, 10NW-B/R8, 10NW-B/R9, 10NW-B/R10, 10NW-B/R11, 10NW-B/R12 and 10NW-B/R13 (**Figure 8.9**).

8.4.68 The existing features will be either trimmed back or removed. Soil nails will be applied on the soil slopes and rock dowels, buttress walls or passive rock anchors may be required for rock slope subject to the exposed rock joints. The newly formed slopes shall have a minimum factor of safety of 1.4 in accordance with Geotechnical Manual for Slopes.

Natural Terrain Hazard on Lantau Island

8.4.69 Past natural terrain landslides within the project boundary were found on Lantau Island. 3 were at Kwai Shek and 1 was at Tsing Chau Tsai. Detailed study on these incidents is recommended to be carried out during the future design stage.

8.4.70 Extensive cutting toward the existing hillside and retaining walls will be required to facilitate the re-alignment of NLH. At this stage it is considered that slope excavation using non-explosive methods would be more appropriate. This takes into account the presence of the existing traffic and the need to resolve the potentially complex and challenging task of providing effective and reliable protective measures during rock blasting operations on site.

8.4.71 Prior to the development of the design of the slope formation work, it is recommended that a detailed site investigation programme should be scheduled together with a natural terrain hazard study. They should be carried out to assess the impact that the proposed new slope formation would have on both the existing and proposed roads. The suggested extent of the future natural terrain hazard study is given in **Figure 8.11**.

(Not Used)

SECTION 9

Utility Impact Assessment Study

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

9 UTILITY IMPACT ASSESSMENT STUDY

9.1 General

9.1.1 Various utility undertakers and Government departments were contacted for the existing and planned utilities within the Study Area. The affected utilities were identified and they belong to,

- CLP Power Hong Kong Ltd.;
- Lighting Division, Highways Department;
- Drainage Services Department (DSD);
- Water Supplies Department (WSD);
- The Hong Kong & China Gas Co. Ltd. (HKCG);
- PCCW-HKT Telephone Ltd. (PCCW); Hong Kong Cable Television Ltd. (CATV); Hutchison Global Communications Ltd. (HCL); New World Telecommunications Ltd. (NWT).

9.1.2 The obtained utility plans and information were reproduced in 1:2000 drawings. They are included in the Utility Impact Assessment Study Report as report figures and will not be repeated in this Report.

9.2 Land Utilities at Lantau

CLP and Public Lighting Installations

9.2.1 To the west of the existing Lantau Link administration building, there is an existing 132kV cable running along the access road to the north of NLH. There is also an existing 11kV cable running at the roadside slope toe, along the eastbound of Lantau Link.

9.2.2 Public lighting cable runs within the central reserve and on both edges of NLH and Lantau Link.

Stormwater Drainage and Sewerage

9.2.3 Drainage Services Department (DSD) stormwater drainage systems are present in the vicinity of and across NLH. Other exclusive road drains are also expected along the road. No sewer pipe is identified along this section.

9.2.4 The following major drainage systems are found within the area of concern.

- a 1000 open channel crossing underneath NLH to the west of the major cut slope of the Lantau Toll Plaza, and connecting to a single cell 2500 x 2000 box culvert, with an outfall at the seafront;

- a 2 cells 2000 x 2000 box culvert to the east of the aforementioned open channel and underneath NLH, connecting to twin 2550 diameter pipes with an outfall at the seafront;

- a 1800 diameter cross-road pipe underneath the Lantau Link to the east of the existing toll booths, connecting to a 2500 open channel; and

- a 1950 diameter cross-road pipe underneath the Lantau Link, connecting with a 2000 open channel and 3000 open channel at downstream and upstream respectively.

Waterworks Installation

9.2.5 Water Supplies Department (WSD) has one DN300 fresh water main running along the access road to the north of NLH near the existing Lantau Toll Plaza. A strip of water works reserve is also assigned for this water main for the section next to the MTRC Airport Express Railway. There is no salt water main within the area of concern.

Gas Mains

9.2.6 Hong Kong and China Gas Company Ltd. (HKCG) gas pipelines run along the access road close to the MTRC Airport Express Railway. There are two existing 180 Intermediate Pressure A (IPA) gas mains and one proposed gas main running along this access road.

Telecommunication

9.2.7 Various telecommunication service providers have been contacted. The telecommunication cables are found to include PCCW, Hong Kong Cable TV (CATV), Hutchison (HCL), and New World Telecom (NWT). They are underground cables mainly laid on the access road to the north of NLH, and at the roadside slope toe along the westbound of Lantau Link. No Wharf T&T and Hong Kong Broadband Network (HKBN) cables are recorded in the area of concern.

9.3 Land Utilities at Tsing Yi

CLP and Public Lighting Installations

9.3.1 A 132kV power cable runs along with Tsing Yi Road near the DOW Chemical (Hong Kong) Ltd. Tsing Yi Plant and Technical Centre. No other high voltage cable is identified within this section.

9.3.2 Public lighting cables run along the central reserve and both sides of Tsing Yi Road, both sides of Tsing Ko Road and Tsing Sheung Road and central reserve of Tsing Yi Hong Wan Road.

Stormwater Drainage and Sewerage

9.3.3 DSD's stormwater drainage systems are present along Tsing Yi Road, Tsing Keung Street, Tsing Ko Road, Tsing Sheung Road and Tsing Yi Hong Wan Road. Other exclusive road drains are also expected along these roads. Sewer drainage pipes are found running along Tsing Yi Hong Wan Road from the junction with Tsing Sheung Road to the north.

9.3.4 There are three box culverts which may have interfaces with the proposed works for the TYLL. These culverts collect hinterland and road surface runoffs, and cross underneath Tsing Ko Road, Tsing Sheung Road and Tsing Yi Hong Wan Road.

- a 3500 x 3200 box culvert, with 15m drainage reserve, adjacent to Tai Tung Industrial Equipment Ltd; it is then connected to a 1 cell 3500 x 4100 box culvert near Tsing Ko Road, also with a 15m drainage reserve;
- a 3500 x 3700 box culvert with 15m drainage reserve, starting from south of the DOW Chemical (Hong Kong) Ltd. Tsing Yi Plant and Technical Centre; it then combines with the aforementioned 3500 x 4100 box culvert at Tsing Sheung Road / Tsing Sheung Lane junction to form a 2 cells 3500 x 4100 box culvert running towards the outfall; and
- a 2500 x 2800 box culvert, with 15m drainage reserve, from the junction of Tsing Yi Hong Wan Road and Tsing Sheung Road running to the south-east direction towards the outfall.

Waterworks Installation

9.3.5 A DN450 fresh water main runs along the western section of Tsing Yi Road. A DN300 fresh water main can be found on Tsing Keung Street. The Tsing Yi South Fresh Water Service Reservoir is located at the end of Tsing Nam Street. Along this road section, DN600 and DN400 fresh water mains are found.

9.3.6 There are three existing fresh water mains (two DN300 and one DN600) and one existing DN200 salt water main running along the eastern section of Tsing Yi Road. There are some water mains proposed to be laid near the Tai Tung Industrial Equipment Ltd and the DOW Chemical (Hong Kong) Ltd.

9.3.7 There are one DN200 existing fresh water mains and one DN150 existing salt water main running along Tsing Ko Road, Tsing Sheung Road and Tsing Yi Hong Wan Road.

Gas Mains

9.3.8 HKCG gas pipelines run along various sections of Tsing Yi Road, Tsing Ko Road and Tsing Yi Hong Wan Road. There is one existing 300 Low Pressure A (LPA) gas main and one existing 250 Low Pressure B (LPB) gas main identified at the western and eastern portions of Tsing Yi Road respectively. There is also one proposed gas main near Tsing Sheung Road.

Telecommunications

9.3.9 Only PCCW and HCL cables are found in the concerned areas. They are running along Tsing Yi Road, Tsing Keung Street, Tsing Ko Road, Tsing Sheung Road and Tsing Yi Hong Wan Road. No CATV, NTW and HKBN cables are recorded in the area of concern.

9.4 Impacts on Utilities

9.4.1 Only underground cables and pipelines would be affected by the TYLL and require utility diversions. No underground or at-grade utility structures will be affected. No overhead cables are close to the TYLL.

9.4.2 No submarine utility is identified in the vicinity of the proposed TYLL alignment. Therefore, it is anticipated that no submarine utility will be affected by the TYLL project.

Utility Diversion

9.4.3 Utility diversions are required mainly to cope with the realignment of the NLH at Lantau and Tsing Yi Road at Tsing Yi. The affected utilities are expected to be diverted in conjunction with the realignment of the concerned roads. The following table summarises the main diversion works and their approximate extent.

Service Providers	Type of Utility / Service	Location	Approx. Quantity (m)
CLP	Underground 11kV cable	NLH	220
	Underground 132kV cable	NLH and associated road	780
HyD Lighting	Public lighting cables	NLH	2650
	Public lighting cables	Tsing Yi Road	900
DSD / HyD	Storm drainage / road drain	Tsing Yi Road	840
WSD	Underground DN150 fresh water main	NLH	70
	Underground DN300 fresh water main	NLH	460
	Underground DN400 fresh water main	Tsing Yi Road	400
	Underground DN600 fresh water main	Tsing Yi Road	1000
	Planned fresh water main	Tsing Yi Road	600
PCCW	Underground telecommunication cable	NLH	1040
	Underground telecommunication cable	Tsing Yi Road	940
CATV	Underground telecommunication cable	NLH	1780
Hutchison	Underground telecommunication cable	NLH	1780
NWT	Underground telecommunication cable	NLH	1780

9.4.4 On Lantau, the reprovisioned toll plaza involves mainly at-grade road construction (**Figure 9.1**). Conflicts with the cross-road pipes and box culverts are not expected. The TYLL elevated road may have interface with the existing 1950 diameter cross-road pipe and the connecting box culverts (**Figure 9.2**). The piers and foundations of the elevated road should be properly placed to avoid the conflicts.

9.4.5 On Tsing Yi, this section of TYLL mainly comprises tunnel and elevated roads. There is no existing utility identified along the tunnel section. Impacts to the existing utilities arising from the tunnel are not envisaged. The elevated link roads cross over one 132kV power cable (**Figure 9.3**), a 3.5m x 3.2m box culvert (**Figure 9.4**), one 250 LPB gas main (**Figure 9.5**) and some water mains. No direct impact to these utilities is anticipated at this moment as the link road piers and foundations could strategically be placed to avoid conflict with those utilities.

Future Design Considerations

9.4.6 The TYLL elevated link roads will cross over drainage, watermains, gas mains and telecommunication cables at various locations. The existence of these utilities, together with their reserves (e.g. drainage reserve and waterworks reserve) should be one of the considerations to determine the pier locations in design stage. Hence, the utility diversion could be minimised.

Interface with Planned Utility

9.4.7 No major planned utility is identified in the area of concern. Therefore, no major impact to the planned utility is envisaged.

(Not Used)

SECTION 10

Drainage Review

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

10 DRAINAGE REVIEW

10.1 Existing Drainage Conditions

Lantau Section

10.1.1 The existing drainage systems in the vicinity of Lantau Section of the TYLL are located along and underneath the existing North Lantau Highway. The main catchment is sub-divided into 12 sub-catchments based on the tributaries and the identified crossroad drains/ outfalls as shown in **Figure C1** in **Appendix C**. No WSD catchwater or overflow facility was identified within the concerned catchments.

10.1.2 The total flow contributing catchment area is estimated of 182 ha. The drainage catchment of the existing hinterland areas is predominantly rural areas extending south to the Fa Peng Teng. There are numerous tributaries and natural channels within the concerned catchments contributing the surface runoff into the drainage outfalls for discharging into the sea.

10.1.3 The drainage outfalls of the catchment are in the form of open channels, drainage pipes and box culverts, crossing underneath North Lantau Highway and Airport Railway.

Tsing Yi Section

10.1.4 The existing drainage systems in the vicinity of Tsing Yi Section of the TYLL are located along and underneath the existing Tsing Yi Road. The main catchment is sub-divided into 6 sub-catchments based on the tributaries and the identified crossroad drains/ outfalls as shown in **Figure C2** in **Appendix C**. No WSD catchwater or overflow facility was identified within the concerned catchments.

10.1.5 The total flow contributing catchment area is estimated of 273 ha. The drainage catchment of the existing hinterland areas is predominantly rural areas extending north to Sam Chi Heung. There are numerous tributaries and natural channels within the concerned catchments contributing the surface runoff into the drainage outfalls for discharging into the sea.

10.1.6 The drainage outfalls of the catchment are in the form of open channels, drainage pipes and box culverts, locating along the seafront of the existing open storage areas and oil depots.

Flood Storage and Historical Flooding

10.1.7 There is no flood storage area identified within the study area.

10.1.8 A severe flooding at existing North Lantau Highway was occurred during the rainstorm on 7 June 2008. It was noted that the flooding was due to the blockage of the stormwater intake along North Lantau Highway. The TYLL should provide drainage mitigation measures in the design of proposed storm water intake at the next stage of the project.

10.2 Preliminary Assessment of Existing Drainage

Surface Runoff Estimation

10.2.1 The assessment was undertaken in accordance with the Stormwater Drainage Manual (SDM). The runoff coefficient for the impermeable areas including developed and planned development areas is 1.0 while for the steep hinterland areas, a runoff coefficient of 0.50 has been taken for the permeable areas. Peak instantaneous runoff was calculated using the Rational Method in accordance with Section 7.5.2 of the SDM, and assuming uniform intensity rainfall.

Rainfall Intensity

10.2.2 The average rainfall intensity was estimated on the basis of the design rainfall duration and return period from the Intensity-Duration-Frequency Relationship given in Section 4.3.2 and Table 2 of the SDM.

Design Return Periods of Flood Protection

10.2.3 The hydraulic performance of the existing drainage systems was assessed with respect to the flood protection levels of 2, 10, 50 and 200 years return periods.

10.2.4 For the design of proposed drainage systems, only the flood protection level of 1 in 50 years return period was adopted.

Flood Protection Levels

10.2.5 The flood protection level of a drainage system is determined from the effects of rainstorm event in conjunction with the tidal influence. The flood protection scenarios (extreme rainstorm event in conjunction with tide effect) are applied in the determination of flood levels in accordance with Section 6.4 and Table 11 of the SDM. The extreme tide levels under various return periods at Chi Ma Wan were used for the assessment.

Hydraulic Assessment

10.2.6 Assessment of the existing drainage system and the design of the proposed drainage network followed the fundamental hydraulic laws and the hydraulic charts published by Hydraulic Wallingford Research.

Summary of Preliminary Hydraulic Assessment of the Existing Drainage System

10.2.7 It is found that most of the outfalls within the concerned catchments are adequate to cater for the design peak runoff of 1 in 200 years return period except the exclusive road drains/ outfalls. However, it unlikely conceives the surcharge from these drainage systems as flooding. As the catchment areas for the individual road drain systems are relatively small, the surcharge flow will rapidly disperse to drainage systems at downstream.

10.2.8 The existing drainage systems which are identified with capacity inadequacies can be improved by upgrading the size or increasing the gradient of the drainage facilities as appropriate. The TYLL project will implement necessary mitigation measures in order not to cause an unacceptable increase in the risk of flooding in areas upstream of, adjacent to or downstream of the project site both during construction and upon completion.

10.3 Potential Drainage Impact and Mitigation Measures

Increase in Runoff

10.3.1 Apart from the existing roads, the project site is predominantly a rural landscape area. The replacement of existing pervious areas by impermeable surfaces will increase the volume of runoff for any given rainfall event. The additional impermeable surfaces and hence the runoff are expected from the formation of new road surfaces and the cut/ fill slopes.

10.3.2 However the new impermeable areas will only be small portion compare with the overall hinterland catchments, and as such the increase in runoff volume will be strictly local and insignificant. The concerned crossroad drains and outfalls will need to be upgraded with bigger pipe sizes or steeper gradients.

10.3.3 Other way of minimising the impact of increased runoff lies in the design of cut and fill slopes. A steeper slope performs 100% impermeable surface as it is hardly planted. Nevertheless, a gentle cut/ fill slope may be rehabilitated to a rural condition of grass, shrubs and trees, and thus restoring the pervious surface.

Obstruction of Overland Flows

10.3.4 The flow patterns, in term of velocity, direction and energy, will change when overland flow encounters the road embankment. The obstructed runoff volume depends on the drainage areas affected and the degree of impact will be proportional to the areas. Although cut slopes may change the existing overland flow patterns, the impacts are considered minimal.

10.3.5 Surface channel at embankment toe and cut slope crest will be designed to intercept the affected overland flow. Channel lining may be required at the outfall if the connecting system is a natural streamcourse in order to minimise the potential for scour erosion.

Catchmens Transfer

10.3.6 Transfer of runoff from one catchment to the other may happen upon completion of the roadworks. It is limited to road surface areas and the areas drained to surface channel at the sides of the road. The runoff will flow by gravity to the nearest systems. The percentage change of area of catchment, as a result of this transfer, is relatively small compared to the whole catchment area. It happens only at some local drainage systems and could be coped with by typical upgrading of the affected systems.

Extension of Box Culverts/ Crossroad Drains

10.3.7 The existing box culverts and crossroad drains in both Lantau and Tsing Yi Sections are proposed to be extended due to the road works of TYLL. The extensions in lengths of culverts and pipes will increase the hydraulic head loss and affect the hydraulic capacities of the systems. Increase in water level at the upstream drainage systems is therefore expected. Detailed hydraulic assessment is required to identify the impacts to the existing box culverts and crossroad drains arising from the proposed extensions.

Mitigation Measures During Construction

10.3.8 The drainage impacts during the construction stage are similar to the operation phase of the Project. The temporary works should be properly designed to ensure that no unacceptable increase in level of flooding risk would occur during the construction stage. Temporary drainage measures and flow diversions should be provided such that the drain or river are not over capacity.

10.4 Proposed Drainage System

Upgrading of Existing Drainage

10.4.1 The existing systems that were identified with capacity inadequacies can be improved by upgrading the size or increasing the gradient of the drainage facilities. However, only the systems affected by the TYLL will be improved in conjunction with the TYLL construction. The improvement should also take into account the drainage mitigation measures required for the implementation of TYLL.

10.4.2 The affected crossroad drains and outfalls will be upgraded to meet the flood protection standards. They will receive flows from the existing upstream hinterland areas and the proposed road and slope drainage systems of the TYLL. Their existing courses should be retained in order not to affect the upstream systems and the drain capacities.

Elevated Structures

10.4.3 There should be no adverse drainage impacts associated with the TYLL elevated roads as their pier locations could be designed to avoid critical drainage paths or natural streamcourses. No stream realignment is envisaged in the Project.

10.4.4 Drainage on bridge decks will be similar to the typical at-grade road drainage. The runoff will be directed to down pipes at piers at regular intervals. The collected runoff is then discharged to ground drainage or the sea.

10.4.5 The drainage flow in down pipe is usually turbulent with high velocity. The system should therefore be designed to prevent discharge against structures or avoid moving traffic and pedestrians, and to prevent erosion at the outlet. Overhanging sections of the bridge decks should be provided with a drip bead or notch.

Tunnel Sections

10.4.6 Construction and operation of the TYLL tunnel will not affect the surface flow paths or increase the runoff quantity of the catchments. Therefore, no adverse impact on the existing drainage system is expected.

10.4.7 Internal drainage should be pumped out and discharged into the nearest watercourse. Seepage from the tunnel should be discharged into the road drainage within the tunnel.

Artificial Island

10.4.8 The island will be located away from the existing coastline with clearance of approximately 300m. No adverse impact on the existing drainage systems and catchment characteristics arising from the reclamation of artificial island is expected.

10.4.9 New stormwater outfalls and drainage networks should be provided on the artificial island. Surface runoffs collected from the island should be diverted to the stormwater outfalls for discharging into the sea.

Reclamation

10.4.10 The new reclaimed area adjacent to the existing seawall will not intercept the drainage outfalls in the vicinity. No adverse impact on the existing drainage systems and catchment characteristics arising from the reclamation is expected.

10.4.11 New stormwater outfalls and drainage networks should be provided in the new reclaimed area. Surface runoffs collected from the reclaimed area should be diverted to the stormwater outfalls for discharging into the sea.

(Not Used)

SECTION 11

Environmental Review

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

11 ENVIRONMENTAL REVIEW

11.1 Introduction

11.1.1 The principle legislation that governs the overall environmental acceptability of this Project is the Environmental Impact Assessment Ordinance (EIAO). It aims to avoid, minimise and control any adverse impacts of Designated Projects defined under the Schedule 2 of the EIAO that may have an adverse impact on the environment and are subjected to the control of an Environmental Permit (EP), in addition to other relevant regulations such as the Air Pollution Control Ordinance (APCO). It is important to determine the nature of a project in order to determine the applicable legislative control.

11.1.2 Based upon the preliminary design outlined above and the key parameters summarised in the previous sections of this Report, the proposed TYLL alignment would constitute a Designated Project under Items A.1, A.7, A.8, C.1 and C.12 of Part I, Schedule 2 of the EIAO. Thus, the EIAO will be applicable to this project and detailed environmental studies would be required at a later stage. A preliminary environmental review has been undertaken to identify the key environmental issues and provide sufficient information for the preparation of Project Profile for the TYLL alignment in accordance with the format and requirements of the Technical Memorandum on Environmental Impact Assessment Process (TM-EIAO). The key findings are summarised in the subsequent sections.

11.2 Air Quality

Legislation

11.2.1 Air quality is regulated through the TM-EIAO, which specifies the compliance with the Air Quality Objectives (AQO) and the other standards established under the APCO, as shown in **Table 11.2.1**.

Table 11.2.1 Hong Kong Air Quality Objectives

Pollutant	Concentration[(i)] µg/m^3 Averaging Time				
	1 Hour[(ii)]	8 Hours[(iii)]	24 Hours[(iii)]	3 Months[(iv)]	1 Year[(iv)]
Sulphur Dioxide	800		350		80
Total Suspended Particulates			260		80
Respirable Suspended Particulates[(v)]			180		55
Nitrogen Dioxide	300		150		80
Carbon Monoxide	30,000	10,000			
Photochemical Oxidants (as ozone[(vi)])	240				
Lead				1.5	

Notes:
(i) Measured at 298K (25°C) and 101.325 kPa (one atmosphere).
(ii) Not to be exceeded more than three times per year.
(iii) Not to be exceeded more than once per year.

(iv) Arithmetic means.
(v) Respirable Suspended Particulates means suspended particulates in air with a nominal aerodynamic diameter of 10 micrometers and smaller.
(vi) Photochemical oxidants are determined by measurements of ozone only.

Air Sensitive Receivers

11.2.2 Air sensitive receivers (ASRs), as shown in **Table 11.2.2** and **Figures 11.1** and **11.2**, were identified within a 500m envelope of the TYLL alignment. As the majority of the alignment will be in tunnel at Tsing Yi and on the sea crossing Ma Wan Fairway, Ma Wan Anchorage and Kap Shui Mun Fairway, construction and operation impacts are only relevant to sensitive receivers in the vicinity of the connecting roads at either ends of the alignment at Lantau and Tsing Yi, southern part of Ma Wan, at the tunnel portals area at Tsing Yi, and the Lantau Toll Plaza. The study area at the eastern landing point is relatively sparsely populated and mainly consist of industrial facilities. The sensitive receivers at the western landing area consists of 3-4 village houses at San Po Tsui which are on the east side of the Ng Kwu Leng.

Table 11.2.2 Representative Air and Noise Sensitive Receivers

ASR ID	Receivers	Land Use	Approximate Distance from the Alignment (m)
Eastern Connection in Tsing Yi			
SR1[1]	Tai Tung Industrial Equipment Ltd.	Factory/Office	69
SR2[1]	Dow Chemical (Hong Kong) Ltd.	Factory/Office	42
SR3[1]	Chemical Waste Treatment Centre	Factory/Office	240
SR4[1]	CRC Oil Depot	Factory/Office	426
SR5[1]	Tien Chu Industrial Centre	Factory/Office	372
SR6[1]	Tsing Yi Power Station	Factory/Office	105
SR7[1]	ExxonMobil Oil Depot	Factory/Office	234
SR8[1]	Tsing Yi South Fire Station	Office	372
Ma Wan Channel and Kap Shui Mun Channel			
SR9[2]	Proposed Ma Wan Resort Hotel	Recreational Uses/Hotel	444
Western Connection in Lantau			
SR10[3]	Village house near Yi Chuen	Residential	84
SR11[3]	Temporary houses near Kap Shui Mun Bridge	Residential	168
SR12[2]	Village house at San Po Tsui	Residential	402
SR13[3]	Proposed tourism and recreation developments	Recreational uses/Hotel	150

[1] Sensitive receivers are relevant to air quality impact only
[2] Sensitive receivers more than 300m from the alignment are relevant to air quality impacts only.
[3] Sensitive receivers are both relevant to air quality and noise impacts.

Existing Environment

11.2.3 The eastern landing area has mainly been developed with industrial uses and contains major roads in the form of Route 8 at ETYV which will be the major sources of air pollution in the overall area. The western landing is largely unpopulated but contains some major infrastructure in form of the North Lantau Highway and may contain recreation uses / hotel development at the "Undetermined" zone adjacent to the existing Sunny Bay MTR Station. The closet EPD fixed monitoring stations to the study areas are located in Kwai Ching and

Tung Chung. Total Suspended Particulate (TSP), Respirable Suspended Particulates (RSP) and Nitrogen Dioxide (NO_2) concentrations have been extracted (average values for 2002 to 2006) as shown in **Table 11.2.3**, which are lower than the AQOs, except for RSP at Kwai Chung which is slightly above the AQO.

Table 11.2.3 TSP, RSP and NO_2 Concentrations from EPD's Kwai Chung and Tung Chung Monitoring Stations (average from 2002 to 2006)

Monitoring Station	TSP (Annual Average)(1)	RSP (Annual Average)(2)	Nitrogen Dioxide (Annual Average)(3)
Kwai Chung	79.2 $\mu g/m^3$	56.4 $\mu g/m^3$	65.6 $\mu g/m^3$
Tung Chung	68.8 $\mu g/m^3$	55.0 $\mu g/m^3$	46.6 $\mu g/m^3$

Note:
(1) Annual Air Quality Objective for TSP is 80 $\mu g/m^3$
(2) Annual Air Quality Objective for RSP is 55 $\mu g/m^3$
(3) Annual Air Quality Objective for NO_2 is 80 $\mu g/m^3$

Construction Phase Impacts

11.2.4 The key construction phase air quality impacts will be the potential for the generation of dust from exposed site areas, stockpiling, vehicle movement and excavation and handling of construction materials.

11.2.5 For the eastern connection of the alignment in Tsing Yi, the majority of the alignment is in tunnel. The bridge structures will be either precast segmental construction or balanced cantilever in-situ construction, and the works for the bridge piers will comprise only small works areas. For the section of TYLL alignment in Ma Wan Channel and Kap Shui Mun Channel, the proposed hotels at Ma Wan "Other Specified Uses" zone are not expected to experience dust impacts due the prevailing wind direction from northerly to easterly. For the western connection, the village houses near Yi Chuen and San Po Tsui, temporary houses near Kap Shui Mun Bridge, and proposed tourism and recreation developments at Sunny Bay are not expected to have significant dust impacts due to the prevailing wind direction from northerly to easterly.

11.2.6 A full quantitative construction dust assessment will be required at the next stage to determine the specific mitigation for specific ASRs. An environmental monitoring and audit programme will also need to be specified as required.

Operational Phase Impacts

11.2.7 The major impacts during operational phase will be due to the vehicular traffic emissions from TYLL alignment. The key areas of concern will be the areas with traffic emissions including the tunnel portals, ventilation shaft, bridge and slip roads.

11.2.8 The orientation of the eastern tunnel portal and ventilation buildings may cause accumulation of air pollutants in Tsing Yi and impact on adjacent ASRs. However, based on their height and orientation, it is expected that the emissions will be rapidly dispersed and no significant impacts are anticipated. At the western connection, the villages at San Po Tsui and Yi Chuen, temporary houses near Kap Shui Mun Bridge, and proposed hotels at Ma Wan "Other Specified Uses" and "Undetermined" zone

at Sunny Bay are within 500m of the proposed alignment and toll plaza. Significant impacts from the alignment and toll plaza would not be expected, but cumulative air quality impacts will need to be assessed.

11.2.9 A full assessment of the operation air pollution impacts from vehicles including both scenarios with and without any recommended operational noise barriers for the worst case traffic levels should be undertaken at the next stage to quantify any impacts.

11.3 Noise

Legislation

11.3.1 Non-restricted hours include daytime hours on working days which are not a Sunday or a public holiday between 07:00-19:00. The construction noise generated by the Project during the non-restricted daytime hours will be assessed with reference to the TM-EIAO as shown in **Table 11.3.1**. Any works within the restricted periods will be subject to applying Construction Noise Permits under the Noise Control Ordinance (NCO). An application for a Construction Noise Permit for percussive piling is assessed according to the Technical Memorandum on Noise from Percussive Piling under the NCO.

11.3.2 The impact of operational noise has been assessed according to the TM-EIAO, which stipulates a maximum L10 (1 hour) road traffic noise levels as shown in **Table 11.3.2** at sensitive facades of the various identified noise sensitive receivers (NSRs).

Table 11.3.1 Recommended Construction Noise Levels (Non-restricted Hours)

NSR	Noise Level L_{eq}(30 min) dB(A)
Dwelling	75
School / Educational Institutions	70 (Normal school hours) 65 (During examination)

Table 11.3.2 Acceptable Road Traffic Noise Levels

NSR	Road Traffic Noise L_{10}(1 hour) dB(A)
Domestic Premises, Hotels and Hostels	70
Places of Public Worship, Educational Institutions	65
Hospitals, Clinics, Homes for the Aged	55

Noise Sensitive Receivers

11.3.3 Potential NSRs include residences, hotels and hostels, etc including places where unaided voice communication is required (e.g. temple) within 300m of the alignment, and they are effectively the same as those ASRs in **Table 11.2.2** and **Figures 11.1** and **11.2**.

Existing Environment

11.3.4 There are 3 major types of development present in the study area of the selected TYLL, namely 1-2 storey village houses, temporary houses and hotel. The village houses are located near Yi Chuen, which is the closest to the TYLL alignment. Temporary houses are located near the Kap Shui Mun Bridge, which would be subject to less noise impacts from construction and traffic due to longer distance. The location of the NSR13 at the proposed recreation uses / hotel development at Sunny Bay was assumed with a 10m setback from the southern boundary of the "Undetermined" zone.

Construction Phase Impacts

11.3.5 Construction noise issues of Tsing Yi would be limited to the portal area and the construction of the slip roads. Construction works for the bridges and bridge piers will require a range of powered mechanical equipment, but as the works of deck construction would not be conducted concurrently with the works of foundation/pier construction, cumulative noise impacts of the works are not anticipated.

11.3.6 Based upon assessment of the construction noise at the NSRs in accordance with the methodology of the Technical Memorandum on Noise from Construction Work Other than Percussive Piling, some preliminary maximum noise levels at the identified sensitive receivers near the west landing point have been calculated and the results summarised in **Table 11.3.3**. As the SR9 at Ma Wan is outside the 300m study area of the noise assessment, significant construction noise impacts are not anticipated.

Table 11.3.3 Maximum Noise Levels (dB(A)) at NSRs during Bridge Construction without Noise Mitigation

Sensitive Receiver	Approx Distance# (m)	Noise Level without Mitigation, dB(A)						
		Deck Construction			*Foundation Construction*			
	Scenario	Formwork	Concreting	Elevation	Excavation	Piling	Formwork	Concreting
	SWL	119.8	115.5	112.0	125.9	120.5	118.0	115.5
SR10	84	76.3	72.0	68.5	82.4	77.0	74.5	72.0
SR11	168	70.3	66.0	62.5	76.4	71.0	68.5	66.0
SR13*	174	71.3	67.0	63.5	77.4	72.0	69.5	67.0

Notes:

76 Noise Level at the sensitive receiver exceeds relevant criteria of 75dB(A) for domestic premises or 70 dB(A) for schools.

\# The distance given represents the closest distance on plan from the alignment to the closest Sensitive Receiver within the area marked and not the actual distance of the proposed work individual construction activities to the receivers. As such the noise levels given will be the maximum and represent an absolute worst case.

* SR13 is a proposed tourism and recreational development located at the "Undetermined" zone, which may consist of a hotel and due to a lack of planning details, a 10m setback from the southern boundary of its site is assumed to define the location of the future sensitive receiver.

11.3.7 The 3 NSRs are expected to be subject to exceedances of the respective noise criteria during parts of the assumed construction works and a full set of mitigation measures will need to be explored and assessed at the next stage.

Operational Phase Impacts

11.3.8 A preliminary assessment of possible operational noise impacts was conducted for the determination of set back distance from the alignment. The noise levels were calculated using the agreed AM peak traffic levels for the year 2040 in terms of L10(dB(A)) and the noise levels in excess of the 70 dB(A) criteria occur along the TYLL alignment.

11.3.9 The assessment indicated that SR10 and SR11 would be subject to noise impact at a level greater than the criteria due to the existing Lantau Link and the proposed alignment. Therefore, mitigation measures may be required. As SR11 is a temporary dwelling, the need for installation permanent mitigation measures will be needed to be further investigated. SR 10 is mainly subject to noise impacts as a result of the proposed arch bridge and the slip road, LE01, so installation of the barriers in this location will likely be needed to screen the traffic noise.

11.3.10 A full quantitative assessment will be required at the next stage in order to predict in more detail the impacts on the NSRs and to define the scope and extent of any necessary direct noise mitigation and indirect technical remedies.

11.4 Water Quality

Legislation

11.4.1 Reference to the EIAO and TM-EIAO has been made for the water quality impact assessment, which set out the criteria and guidelines for evaluating water pollution. The Water Pollution Control Ordinance (WPCO) provides the statutory framework for the protection and control of water quality and establishes specific Water Quality Objectives (WQOs) to protect the beneficial uses of water resources in Water Control Zones (WCZs). The Technical Memorandum on Effluents Discharges under WPCO sets out the limits for effluent discharges, which control the physical, chemical and microbial quality of the effluent discharged into the drainage and sewerage systems, inland and coastal waters.

11.4.2 The Hong Kong Planning Standards and Guidelines (HKPSG) details the environmental requirements to be considered for protection of water quality during development planning. The Practice Note for Professional Persons (ProPECC) PN1/94 on Construction Site Drainage provides guidelines for handling and disposal of construction site discharges. The WQOs of seawater at intake point of salt water pumping stations for flushing issued by WSD specifies the criteria for assessing the water quality impacts on the seawater intakes of WSD.

11.4.3 The Environment, Transport and Works Bureau Technical Circular (Works) (ETWB TC(W)) No.34/2002 sets out the procedure for seeking approval to dredge/excavate sediment and the management framework for marine disposal of such sediment.

Water Sensitive Receivers

11.4.4 Apart from the Western Buffer WCZ (WBWCZ), there are a number of specific sensitive receivers within the study area which could be adversely affected by the TYLL to a greater or lesser extent both during construction and operation of the crossing and these are listed in **Table 11.4.1** and shown in **Figure 11.3**. There are also several sea outfalls in the study area which rely upon the tidal flows to disperse the effluent discharged from the diffusers. Any change to the local flow regime in the vicinity of these outfalls caused by the crossing could change the existing rate of dilution and dispersion of the effluent and result in changes to the existing water quality and possibly the extent to which the WQOs are satisfied.

Table 11.4.1 Water Sensitive Receivers (Excluding Ecological Sensitive Receivers)

Water Sensitive Receiver / Beneficial User ID	Location	Beneficial Use
WI 1	Kennedy Town	Saltwater Intake
WI 2	Tsing Yi	Saltwater Intake
WI 3	Tsuen Wan	Saltwater Intake
WI 4	Lok On Pai (planned)	Saltwater Intake
WI 5	Ta Pang Po (committed)	Saltwater Intake
WI 6	LLP (planned)	Saltwater Intake
WI 7	LLP (planned)	Saltwater Intake
WI 8	Butterfly Beach	Saltwater Intake
B 1	Butterfly Beach	Recreation
B 2	Castle Peak Beach	Recreation
B 3	Kadoorie Beach	Recreation
B 4	Cafeteria Old Beach	Recreation
B 5	Cafeteria Old Beach	Recreation
B 6	Golden Beach	Recreation
B 7	Angler's Beach	Recreation
B 8	Gemini Beach	Recreation
B 9	Hoi Mei Wan	Recreation
B 10	Casam Beach	Recreation
B 11	Ma Wan Tung Wan	Recreation
B 12	Lido Beach	Recreation
B 13	Ting Kau Beach	Recreation
B 14	Approach Beach	Recreation
B 15	Silvermine Bay	Recreation
B 16	Discovery Beach	Recreation
OF 1	Sandy Bay Outfall[1]	Dispersion of Effluent
OF 2	HATS Stage 1 Outfall[1]	Dispersion of Effluent
OF 3	Siu Ho Wan Outfall[1]	Dispersion of Effluent

Notes: [1] Submarine outfalls have been listed as beneficial users of the water body in the study area because they rely upon the existing tidal regime for the dispersion of effluent.

Existing Environment

11.4.5 The EPD Marine Water Quality data for 2006 noted that the WBWCZ had achieved 92% compliance with the WQOs, but that E. coli and Ammoniacal Nitrogen

concentrations were high because the effluent from the HATS Stage I Outfall from Stonecutters Island had yet to be equipped with disinfection facilities.

11.4.6 The WBWCZ currently receives significant effluent discharges from the HATS Stage I Outfall. Seawater is abstracted at a number of intakes and there are Secondary Contact Zones along the eastern shore of Lantau Island where there is one gazetted beach (Silvermine Bay) and one non-gazetted beach (Discovery Bay). There are a number of additional sensitive receivers in the neighbouring North Western Water Control Zone (NWWCZ) and both the NWWCZ and the WBWCZ are heavily influenced by the freshwater discharge from the Pearl River Delta.

11.4.7 Based on the average of sediment samples over the period 2002 to 2006, the sediment quality would be classified as Category L (uncontaminated) under ETWB TC(W) No. 34/2002. Sediment quality data from previous EIA studies were reviewed, e.g. Relocation of Yiu Lian Floating Dock No. 3, Tang Lung Chau Dangerous Goods Anchorage, and Northshore Lantau Development Feasibility Study. The sediment quality would have been categorised as Class L and Class M and some pockets of highly contaminated material could be present in the vicinity of the TYLL alignment.

Construction Phase Impacts

11.4.8 The potential for elevations in suspended solids concentrations would only persist for the period required to construct the reclamations and artificial islands. Elevations in possibly moderately contaminated suspended solids concentrations, although expected to be of limited duration, could also impact on marine water quality and the marine ecosystem.

11.4.9 Reclamations and the artificial island required for the construction of the TYLL are not expected to have any significant impact on large scale tidal flows and, therefore, the existing patterns of water quality and siltation. The reclamation on Tsing Yi Island has the potential to generate the largest changes in local tidal flow patterns and could result in some minor impact on water quality in the embayed areas immediately to the north of the reclamation. It is expected that the reclamations and the artificial island will be constructed without dredging the underlying soft marine deposits. As a result, sediment plumes from dredging works, the most significant construction impact often associated with marine works, will not arise.

11.4.10 Environmental monitoring and audit programme for water quality impacts will be required. Full detailed assessment of the water quality impacts should be undertaken at the next stage.

Operational Phase Impacts

11.4.11 Changes in tidal and seasonal flow patterns could result in indirect changes in the existing pattern of effluent dispersion from sea outfalls, marine water quality and siltation which could then impact on the marine ecosystem, but they are expected to remain small and possibly insignificant. While tidal flows in the embayed areas are considerably lower than in the main flow channel offshore, the flows in the embayed

areas are sufficiently large to maintain water quality at present and are expected to remain sufficiently large to ensure water quality is maintained following construction of the reclamation.

11.4.12 The reclamation required for the TYLL alignment on the west coast of Tsing Yi Island does extend into the main flow channel where, on the ebb tide, tidal water speeds could be in the range of 1m/s-2m/s (2knts-4knts). With respect to the possible impacts of the reclamations and artificial island on tidal flows, it is thought that most impacts will be small if not insignificant and will remain local to the reclamations.

11.4.13 A full operational hydrodynamic modelling assessment will be required to be undertaken in the next stage to determine any impacts and define suitable mitigation measures to ensure impacts are within acceptable levels.

11.5 Ecology

Legislation

11.5.1 Various legislation and guidelines are relevant to the assessment of terrestrial and marine ecological impacts. The Country Parks Ordinance (Cap. 208) provides for the designation and management of country parks and special areas. The marine Parks Ordinance (Cap. 476) 1995 applies to the marine park at Sha Chau and Lung Kwu Chau and limits certain activities in this area. The Forests and Countryside Ordinance (Cap. 96) prohibits felling, cutting, burning or destroying of trees and growing plants in forests and plantations on Government land, and the related subsidiary regulations prohibit the selling or possession of listed rare and protected plant species. Wild Animals Protection Ordinance (Cap. 170) protects all birds and most mammals. Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586) controls the trade in threatened and endangered species and local possession of them, and is the local legislation that implements Convention on the International Trade in Endangered Species of Flora and Fauna (CITES). Town Planning Ordinance (Cap. 131) provides for the zoning of coastal protection areas, SSSIs, Conservation Area, Country Park, Green Belt or other specified uses on statutory town plans that promote conservation or protection of the environment.

11.5.2 The HKPSG covers planning considerations relevant to conservation and details the principles of conservation, the conservation of natural landscape and habitats, historic buildings, archaeological sites and other antiquities, as well as enforcement. The TM-EIAO sets out the general criteria for evaluating the ecological importance of and hence the significance of potential ecological impacts and guidance for ecological assessment, respectively. The United Nations Convention on Biodiversity requires the signatories to make active efforts to protect and manage their biodiversity resources. The UN Biodiversity Treaty includes the Indo-Pacific Humpback Dolphin (Chinese white dolphin *Sousa chinensis* Osbeck, 1765) as a protected species and the CITES also lists *S. chinensis* in Appendix I.

Ecological Sensitive Receivers

Terrestrial Ecology

11.5.3 A preliminary terrestrial habit map is shown in **Figure 11.4**. Within a 500m envelope from the preferred TYLL alignment, recognised terrestrial sites of conservation importance includes only the Tsing Yi SSSI. The Tsing Yi SSSI was designated in 2005 to protect the only natural habitat for the endemic Hong Kong Croton (*Croton hancei*). This endemic species was first discovered on Hong Kong Island in 1850s and re-discovered at south Tsing Yi in 1997. The site is on a steep slope primarily vegetated with native woodland and *C. hancei* are confined to the woodland's shaded understorey. The Tsing Yi site is the only known site with natural living individuals of *C. hancei*, and recent survey by AFCD estimated that the population size at the site to be 1,728 individuals although AFCD has now propagated some individuals at Tai Tong nursery, Shing Mun Arboretum and other localities in the Country Parks as an ex-situ conservation measure. The species is considered as critically endangered in the mainland. This upland SSSI is, however, located at about 300m away (plane distant) from the tunnel alignment and would unlikely be affected by the project as the tunnel construction works would be underground.

11.5.4 Another important terrestrial ecological sensitive receiver is an egretry at San Po Tsui/To Kau Wan. A small population of Little Egret (*Egretta garzetta*) has been noted to roost in the coastal secondary woodland east of To Kau Wan. The Hong Kong Bird Watching Society subsequently confirmed that it was being used as a nesting site and 31 ardeid nests by Little Egret (25 nests), Greater Egret (1 nest) and Black-crowned Night Heron (5 nests) were recorded in 2002. The breeding population at this site, however, was not stable and has apparently moved to San Po Tsui in 2005. The latest egretry counts, however, again noted that San Po Tsui appeared to be abandoned in 2007. Egrets and herons are considered to be of regional and global conservation significance as the birds, although still common in Hong Kong, may be declining in numbers locally, largely as a result of the loss of suitable foraging habitats (e.g. through the in-filling of fishponds). While the breeding ardeids population at this egretry is not stable, the occasional occupancy suggested this area could be a suitable habitat for the ardeids and should, thus, be considered as an important ecological receiver.

11.5.5 The species of ecological interest are summarised in **Tables 11.5.1** and **11.5.2** and the overall evaluation of ecological value of habitat types within the present study area are summarised in **Table 11.5.3**.

Table 11.5.1 Reported Birds Species of Conservation Concerns

Species	Name English	Sighting[1]	Principal HK Status[2]	Conservation Concern[3]
Ardeola bacchus	Chinese Pond Heron	NL	R	PRC(RC)
Butorides striatus	Striated Heron	NL	Su	(LC)
Charadrius dubius	Little Ringed Plover	NL	W,R	(LC)
Cisticola juncidis	Zitting Cisticola	NL	W	LC
Corvus torquatus	Collared Crow	NL	R	LC

Species	Name English	Sighting[1]	Principal HK Status[2]	Conservation Concern[3]
Egretta garzetta	Little Egret	NL	R	PRC(RC)
Halcyon pileata	Black-capped Kingfisher	NL	AM,W	(LC)
Halcyon smyrnensis	White-throated Kingfisher	NL	AM,W,R	(LC)
Haliaeetus leucogaster	White-bellied Sea Eagle	NL	R	(RC)
Milvus migrans	Black Kite	NL & TY	W,R	(RC)
Nycticorax nycticorax	Black-crowned Night Heron	NL & TY	R	(LC)
Pandion haliaetus	Osprey	TY	W	RC
Phalacrocorax carbo	Great Cormorant	NL	W	PRC

[1]Sighting: NL = North Lantau; TY = Tsing Yi; [2]Principal HK status: R = Resident, W = Winter Visitor, S = Summer Visitor, M = Migrant, A = Autumn, Sp = Spring; [3]Conservation Concern: RC = Regional Concern, LC = Local Concern, PRC = Potential Regional Concern. Letters in parentheses indicate the assessment is on the basis of restrictedness in breeding/roosting sites rather in general occurrence.

Table 11.5.2 Evaluation of Floral Species of Ecological Interest Around Study Area

Species	From	Habitat	Location	Status
Amorphophallus variabilis	herb	Woodland	Tso Wan	Restricted
Ardisia faberi	shrub	Woodland	Tsing Yi	Rare
Croton hancei	shrub	Woodland	Tsing Yi	rare; endemic;
Cymbidium ensifolium	herb	Woodland	Tsing Yi	restricted, protected
Diplarcum caricinum	herb	Tall Shrub (pond side)	San Po Tsui	Restricted
Fimbristylis complanata	herb	Tall Shrub (pond side)	San Po Tsui	restricted
Lilium brownii	herb	Tall Shrub	Lantau Toll Plaza near Tsing Chau Tsai	restricted; protected
Phymatodes scolopendria	herb	Grassland / shrubland mosaic	San Po Tsui	rare
Tainia hongkongensis	herb	Woodland	Tsing Yi	very common; protected
Vitis balanceana	Climber	Tall Shrub	Kwai Shek, San Po Tsui	restricted

Table 11.5.3 Summary of Ecological Value of Terrestrial Habitat Types

Habitat Type	Ecological Value
Grassland/shrubland mosaic	Low
Developed Area	Low
Tall shrubland	Low
Woodland	South Tsing Yi SSSI: High Others: Moderate
Plantation	Low
Wasteland/ Orchard/Village	Low
Freshwater Habitats	Low

11.5.6 Based on the baseline ecological conditions presented above, it is considered that the terrestrial habitats present in the study area are generally of low ecological value as the species abundance and diversity were generally low and usually subjected to human disturbance. Secondary woodlands are ranked higher as they are relatively mature and also have the highest species diversity. Furthermore, a woodland in southern Tsing Yi has been designated as the South Tsing Yi SSSI which is the only locality where natural population of the endemic *Croton hancei* present.

Marine Ecology

11.5.7 The north-east Lantau waters is at about the eastern limit of the Indo-Pacific Humpback Dolphin *Sousa chinensis* which is locally know as the Chinese White Dolphin (CWD). *S. chinensis* is a highly endangered marine mammal that is recognised locally, regionally and internationally and it is the single most important sensitive receiver in the study area. The WBWCZ, however, is not their core habitat and individuals were only occasionally observed in this area.

11.5.8 Isolated colonies corals have been recorded in the waters off Sham Tsang. A few coral colonies were also noted at Sze Pak Wan, Peng Chau, Kau Yi Chau and Green Island further afield. The coral communities are, however, sparse compared to rocky reefs of similar depth in the oceanic eastern and southern waters of Hong Kong. At the coastal intertidal area, small patches of mangroves and seagrass were also recorded in the Sunny Bay and the coastal shore at Yi Chuen and Tang Lung Chau are relatively undisturbed and these are key marine ecology sensitive receivers in the wider study area.

11.5.9 The distribution of key marine ecology sensitive receivers and CWD in the wider study area is presented in **Figures 11.5 and 11.6**.

Construction Phase Impacts

Terrestrial Ecology

11.5.10 The preferred TYLL comprises a long suspension bridge. Most sections of the preferred TYLL alignment at Tsing Yi will be in rock tunnel or alongside existing roadways. Any potential impacts caused by the two portals would be expected to be small and above-ground facilities along the tunnel alignment such as intermediate ventilation shaft would not be anticipated necessary. At Lantau, the landing is on elevated viaduct and gradually descends to the Lantau Toll Plaza. Thus, land take of terrestrial habitats is minimal. Direct habitat loss due to land take for the project is mostly limited to the developed area which is subjected to constant human disturbance and the ecological value is low. The other habitat types affected are generally small and of limited ecological value. Based on the preliminary design, the size of the potentially affected habitats is estimated in **Table 11.5.4**.

Table 11.5.4 Preliminary Estimation of Potential Habitat Loss

Habitat	Size in Study Area (ha)	Size in Project Boundary (ha) *	Percentage within Project Boundary
Shrubby Grassland	252.7	45.0	17.8%
Developed Area	228.8	29.7	13.0%
Tall Shrubland	35.9	5.8	16.3%

Habitat	Size in Study Area (ha)	Size in Project Boundary (ha) *	Percentage within Project Boundary
Plantation	20.0	6.5	32.6%
Wasteland	19.2	3.8	19.6%
Woodland	2.6	0.3	11.0%
Orchard / Village	0.4	0.0	0.0%
Grand Total	**559.7**	**91.1**	**16.3%**

Notes: * The size in project boundary refers the size of habitats within the site boundary that could be directly affected by the Project. The project boundary includes temporary works area. It also included the above ground area for the rock tunnel at Tsing Yi. Hence, the values are conservative estimates and the actual area to be affected would be smaller. Percentage within project boundary refers to the area within the site boundary compare to the study area.

11.5.11 Indirect impacts to terrestrial ecology may arise from temporary land resumption for the construction works, temporary site storage, increased human activities associated with construction work, and construction site runoff, if uncontrolled. These potential impacts to the surrounding habitats and associated wildlife are not expected to be high because of the temporary nature of the construction works and given that regular checks on good construction practice is undertaken. The bird community associated with the terrestrial ecological resource in the study area may be temporary disturbed or displaced due to the increase human activities and background noise. While most of the birds species reported are commonly found in Hong Kong and, therefore, significant adverse impact is not anticipated, it is noted that there is an egretry at To Kau Wan/San Po Tsui and avoiding impacts to it will be essential.

Marine Ecology

11.5.12 Potential direct impacts on marine ecology arising from the construction activities may include:

- Permanent loss of approximately 26ha of mostly soft-bottom seabed for the construction of bridge towers/anchorages; and
- Permanent loss of small stretch of natural rocky shore habitat at Yi Chuen (~130m) and Tang Lung Chau (~180m) and artificial seawall at Tsing Yi (~180m).

11.5.13 Potential indirect construction phase impacts are mostly associated with the reclamation works and bridge installation which could include:

- Increased disturbance to marine life due to piling works and increased marine traffic;
- Elevation in suspended solids concentrations during the reclamation which may cause smothering of corals and other sessile benthos;
- Reduction of dissolved oxygen due to suspended solids which, combined with other factors, could reduced the dissolved oxygen concentration in the water columns; and

- Release of contaminants (from sediment or treatment agent) during in-situ treatment / solidification process.

11.5.14 A full assessment would be required at the next EIA stage to evaluate the extent of ecological impacts (both direct and indirect impacts) arising from construction activities.

Operational Phase Impacts

Terrestrial Ecology

11.5.15 The preferred TYLL alignment is mostly along existing transportation corridors (e.g. Route 9, East Tsing Yi Road, West Tsing Yi Road and North Lantau Highway), and the nearby habitats have been constantly subjected to indirect impacts of a similar nature. The fauna present around the area should have already been adapted to or tolerant to indirect disturbance. Given that the near by habitats generally have low abundance and richness of the animal wildlife, the impact due to increased human activity and background noise is expected to be minor. While the less tolerant species may be displaced to similar habitats available in the surrounding area due to increased background noise, the majority of the birds recorded in the study area are commonly found in Hong Kong and that the terrestrial habitats are located in close vicinity to major highway, it is anticipated that displacement may be temporary and the bird community will recover from the perturbation with no long-term adverse impact.

11.5.16 The notable exception to the above is the To Kau Wan/San Po Tsui egretry which is at present relatively free from disturbance impact (apart from the construction of biopiles at To Kau Wan which however avoided works during the ardeids breeding period between October-February). However, as discussed above, the establishment of egretry at north Lantau is at present uncertain although the historic colonisation suggested that the area could be a potential site. Detailed field survey would be required to characterise any egretries in the project area before a reliable assessment can be performed.

Marine Ecology

11.5.17 No direct impacts to marine ecological sensitive receivers are anticipated from the operation of the project.

11.5.18 It is considered to be unlikely that the operation of the TYLL will have a significant indirect impact on the marine environment (flows), hence secondary impacts to the water quality and marine ecology sensitive receivers are not anticipated.

11.5.19 Operational impact to marine ecological resources would be assessed based on findings of water quality and hydrodynamic assessment.

11.6 Fisheries

Legislation

11.6.1 Marine Fish Culture Ordinance (Cap. 353) regulates and protects marine fish culture zones (FCZ) that are designated under the ordinance. Fisheries Protection Ordinance (Cap. 171) regulates fishing activities for the conservation of fisheries resources and other marine life. The criteria of TM-EIAO are followed to determine the potential impacts to fisheries resources in the Study Area.

Existing Environment

11.6.2 The latest Port Survey 2006 revealed the production rate of the North Lantau remained about the same over time with most waters producing at 100-200kg/ha of adult fish including Ma Wan area where TYLL located. While some fish fry production at Ma Wan was reported in Port Survey 2001/02, no fry production was reported in Port Survey 2006.

11.6.3 There are no fish culture zones (FCZ) within a 500m envelope of the preferred alignment. The Ma Wan FCZ (~1,000m-1,200m from Yi Chuen and Tang Lung Chau) as shown in **Figure 11.5** consists of 108 licensed floating rafts as at July 2008 and traditionally the main species cultured are spotted grouper (*Epinephelus chlorostigma*), goldlined seabream (*Rhabdosargus sarba*), mangrove snapper (*Lutjanus argentimaculatus*) and pompano (*Trachinotus blochii*).

11.6.4 An artificial reef at the Chek Lap Kok Marine Exclusion Zone was deployed in 2000 to enhance the habitat quality and marine resources of the area and as a feeding station for Chinese White Dolphin. The artificial reef systems in Hong Kong have been reported to support higher numbers of medium and high value fish than both rocky shore and mud bottom habitat and a total 222 fish species have been recorded between 1998 and 2003.

Fisheries Sensitive Receivers

11.6.5 The major sensitive receiver is the Ma Wan FCZ which is relatively close to the project alignment. Spawning ground at north Lantau and artificial reef deployed at Chek Lap Kok Airport Exclusion Zone can be considered as Far Field receivers as they are some distance from the project site. The operators of capture fisheries would also be affected by the project related marine works and reclamation.

Construction Phase Impacts

11.6.6 Occupying the intertidal and sub-tidal areas for carrying out the marine works will cause temporary loss of fishing grounds. The extent of these impacts could be low to fairly moderate due to the relatively small areas affected and reversible impacts. Indirect impacts on changes in water quality, e.g. the temporary elevated suspended solids, remobilisation of contaminants from sediment, and reduction in dissolved oxygen content, etc may affect the fisheries sensitive receivers including the Ma Wan FCZ. These impacts will be localised and controlled with proper mitigation

measures. Temporary changes in the hydrodynamic regimes such as tidal flow patterns and flushing rate due to reclamation works, which may affect the aquatic biota due to restriction of water discharge capacity. The marine works will lead to a temporary influence on aquatic fauna due to underwater blasting, increased marine vessel traffic and construction works activities, etc. A full assessment will be required at the next stage to evaluate the extent of these impacts.

Operational Phase Impacts

11.6.7 Reclamation for artificial islands (for bridge towers and anchorages) and construction of columns and piers for viaducts will lead to permanent loss of fishing grounds due to the reclaimed land and piers of bridge structures (approximately 26ha). The extent of these impacts would be anticipated low to due to its small footprint and the fact that the affected areas are located in either anchorage sites or busy navigation channels with relatively restricted fishing opportunities. Permanent changes in the tidal flow pattern particularly the reduction of flushing rate due to the new reclamation would not be anticipated, but will need to be further assessed based on the hydrodynamic modelling results in the next stage. The impacts from the discharge and accidental spillage of contaminated runoff from road surface are anticipated to be insignificant with the implementation of proper mitigation measures and would be assessed based on the findings in water quality assessment.

11.7 Waste Management

Legislation

11.7.1 Compliance with all relevant requirements of the Waste Disposal Ordinance (Cap. 354) (WDO), Public Health and Municipal Services Ordinances (Cap. 132), and Public Cleansing and Prevention of Nuisances (Regional Council) By-laws should be achieved to control any nuisance from the collections and disposal of waste. Reference should be made to all relevant technical circulars issued by the former Works Branch and Environment, Transport and Works Bureau, e.g. ETWB TC(W) No. 33/2002 Management of Construction and Demolition Material Including Rock, ETWB TC(W) No. 19/2005 Environmental Management of Construction Site, and ETWB TC(W) No. 34/2002 Management of Dredged/Excavated Sediment, etc. Other related legislation will include the Land (Miscellaneous Provisions) Ordinance (Cap. 28), Waste Disposal (Charges for Disposal of Construction Waste) Regulation, Waste Disposal (Chemical Waste) (General) Regulation and the Code of Practice on the Package, Labelling and Storage of Chemical Wastes, and Dumping at Sea Ordinance (Cap. 466).

Existing Environment

11.7.2 The existing waste management issues within the Study Area relate largely to general refuse from residential properties and on-going construction projects, which are collected and disposed at the WENT landfill. Any material suitable to public fill will be transported to the fill bank. The available sediment quality data have indicated that the dredged materials will be likely classified as both Category L and Category M under the criteria as set out in the ETWB TC(W) No. 34/2002.

Construction Waste Impacts

11.7.3 The waste management implications will arise from the handling, storage, collection, transportation and disposal of waste material generated by the Project. The following waste management hierarchy should be adopted:

- Avoiding or minimising waste generation through changes in the design;
- Adopting better management practices to promote segregation of waste materials;
- Reuse and recycling; and
- Diverting waste to public dumps or other construction sites.

11.7.4 Activities during the construction phase will result in the generation of a variety of wastes including excavated materials suitable for reclamation and fill, marine sediment, C&D waste, chemical waste, general refuse, and sewage. The largest quantity of materials will comprise those excavated from the rock tunnel and formation of the immersed tube tunnel.

Excavated Material

11.7.5 A summary of the predicted quantities of material to be generated, the possible amount that could be reused and the surplus amount is shown in **Table 11.7.1**. The data are only estimates, as it is not possible at this stage to predict the preferred methods of unitisation of excavated material by the future contractor.

11.7.6 Approximately 74% of the inert C&D material generated is predicted to be in the form of rock, with only a small amount of "soft" or soil material will be generated. The main opportunity for reuse of the rock material generated is in the artificial islands for bridge piers with the majority of the rock generated potentially being reused in the marine environment.

Table 11.7.1 Summary of Generation and Reuse of C&D material

Location	Generated Quantities (m^3)	Reuseable Quantities (m^3)*	Surplus Quantities (m^3)
Works areas in Lantau:			
Soft:	337,168	-417,945	-80776
Grade II or above rock:	399,490	-52,243	347,247
Grade III or above rock:	399,490	-52,243	347,247
Sub-total:	**1,136,148**	**-522,431**	**613,718**
Works areas in marine channels:			
Soft:	0	-131,733	-131,733
Grade II or above rock:	0	-1,977,789	-1,977,789
Grade III or above rock:	0	-739,536	-739,536
Sub-total:	**0**	**-2,849,059**	**-2,849,059**

Location	Generated Quantities (m^3)	Reuseable Quantities (m^3)*	Surplus Quantities (m^3)
Works areas in Tsing Yi:			
Soft:	243,948	-31,439	212,510
Grade II or above rock:	506,366	-3,930	502,437
Grade III or above rock:	340,046	-3,930	336,117
Sub-total:	**1,090,361**	**-39,298**	**1,051,063**
Total	**2,226,510**	**-3,410,788**	**-1,184,279**

Notes: * capacity of receiving inert C&D material

Marine Sediment

11.7.7 Piling for bridge piers will generate marine sediment for disposal, which should be tested and classified in accordance with ETWB TC(W) No. 34/2002 before the appropriate disposal location can be determined. The disposal options will be determined according to the sediment classification including:

- Type 1 Open Sea Disposal (for Category L uncontaminated sediment);
- Type 1 Open Sea Disposal (Dedicated Sites) (for Category M contaminated materials that passed biological screening);
- Type 2 Confined Marine Disposal (for Category M contaminated material failed biological screening, Category H material with concentration less than ten times of lower chemical exceedance level, and Category H material passed biological screening); and
- Type 3 Special Treatment Disposal (Category H sediment failing the biological dilution test).

11.7.8 Although a non-dredging method is proposed to be adopted for reclamation and seawall construction, there will still be approximately 5,000 m^3 of marine sediment generated from the bored-piling works for the construction of bridge piers and towers on artificial islands.

Other Waste Materials

11.7.9 Other waste materials generated on-site will be of much smaller quantities and are not expected to be significant, which will include C&D wastes from site clearance, wood and steel from formwork, demolished road pavement, equipment and vehicle maintenance, unusable cement/grouting mixes, etc, which require proper disposal.

11.7.10 Chemical wastes will arise from the maintenance of plant and equipment and can pose environmental and health and safety hazards. As it is unlikely for large quantities to arise, there would be no significant impacts if they are properly handled, stored, transported and disposed.

11.7.11 General refuse will arise from office waste, newspapers, food wastes from canteen and packaging waste and will be disposed of at landfill. No impacts should occur from this waste material if it is handled, stored and disposed of properly.

11.7.12 The sewage waste generated form the construction workforce should be properly handled to avoid unacceptable odour problems and to safeguard the health of workers.

Mitigation Measures

11.7.13 Mitigation measures are required to ensure the proper handling, storage, transportation and disposal of waste is carried out. Also measures to ensure that the generation of waste is avoided and minimised and that waste materials are recycled and treated as far as practicable.

11.7.14 A Waste Management Plan should be developed and implemented in accordance with the guidelines as set out in the ETWB TC(W) No. 19/2005 Environmental Management of Construction Site, and other relevant technical circulars.

11.7.15 Assuming all reasonable mitigation measures are implemented, no residual adverse impacts from the handling, storage, transportation or disposal of the waste generated by the Project are predicted. However, a full waste management assessment should be undertaken in accordance with the TM-EIAO at the next stage.

11.8 Cultural Heritage

Legislation

11.8.1 The Antiquities and Monuments Ordinance (Cap. 53) provides the statutory framework for the preservation of objects of historical, archaeological and palaeontological interest, and it contains the statutory procedures for the declaration of monuments. The general criteria and guidelines for evaluating and assessing impacts to cultural heritage are given in the TM-EIAO. The HKPSG also details the principles of conservation of natural landscape and habitats, historical buildings and archaeological sites. The Criteria for Cultural Heritage Impact Assessment issued by the Antiquities and Monuments Office outlines the specific technical requirement for conducting terrestrial archaeological and built heritage impact assessments.

Existing Environment

Terrestrial Archaeological Potential

11.8.2 **Figure 11.7** shows the geological background of the location of the preferred alignment on Tsing Yi. It can be seen that the geology of the area is medium grained granite on steep hillsides with slope works. There is no potential for terrestrial archaeological deposits in the vicinity of the tunnel portals.

11.8.3 The works on the island of Tang Lung Chau are minimal and are located on solid geology of fine grained granite with intrusive feldsparphyric rhyolite. The island is

steep sided with rocky outcrops. There is no potential for archaeological deposits on the island. **Figure 11.8** shows the geological map of the island.

11.8.4 **Figure 11.7** also shows the geological background of the location of the preferred alignment in Northeast Lantau. The alignment runs through rocky and hilly terrain characterised by medium grained granite with intrusive coarse ash crystal tuff and small sections of debris flow deposits. The alignment also crosses over and along the existing North Lantau Highway. The study area in this location has no archaeological potential.

Built Heritage Potential

11.8.5 There is one Declared Monument in the project study area for the preferred TYLL alignment, namely the Tang Lung Chau (Kap Sing) Lighthouse constructed in 1911 and first went into service on April 29, 1912. There is also a small brick lighthouse keeper's house on the island (**Figure 11.9**).

11.8.6 There are no historical villages in the study area. However, the headland area at Ng Kwu Leng and the area to the south of the existing North Lantau Highway does have the potential for containing isolated ruins, historical graves and cultural landscape features, e.g. boulder trackways (**Figure 11.9**).

11.8.7 There are no Graded Historic Buildings and Government Historic Sites Identified by AMO in the study area.

Marine Archaeological Potential

11.8.8 The study area has very high marine archaeological potential as a result of documented historical activity, e.g. the remains the main shipping channel for traffic to the Pearl River Delta, evidence of shipwrecks, records of a severe typhoon in the mid 1830's resulting in shipping casualties, etc. The key issue for marine archaeological investigation is that there has been no marine archaeological investigation of the seabed in the study area.

Construction Phase Impacts

Terrestrial Archaeology

11.8.9 No areas of archaeological potential have been identified in the project study area for the proposed alignment and no adverse impacts are predicted to arise from the project. No further investigation of the project study area will be required.

Built Heritage

11.8.10 Direct impacts to currently unidentified built heritage resources may arise from the construction of the proposed alignment on Lantau. The study area on Tsing Yi has no potential for containing built heritage resources. Indirect impacts such as damage from vibration may occur to the Tang Lung Chau Lighthouse as a result of works during the construction phase. A built heritage impact assessment will be required for the proposed alignment at the EIA stage of the project. A built heritage survey

should be undertaken to identify any currently unrecorded built heritage resources on Lantau. The survey should also include the Tang Lung Chau Lighthouse to assess the current status of the Declared Monument.

Marine Archaeology

11.8.11 Due to the current absence of accurate data about the seabed it must be assumed at this stage that all disturbances to the seabed are a potential threat to marine archaeological resources. It is possible that previous activity affecting the seabed such as dredging or fishing will have reduced the archaeological potential of the study area. The geophysical survey will confirm the extent of previous disturbance and presence of dumped material. The location of temporary anchoring facilities for working vessels may result in additional disturbance on the seabed. Once the geophysical survey has been completed it will be possible to assess if any mitigation is required.

Operational Phase Impacts

11.8.12 No impacts are expected on built heritage, terrestrial and marine archaeology during the operational phase.

11.9 Landscape and Visual

Legislation

11.9.1 The TM-EIAO sets out the framework and guidelines for the assessment of potential landscape and visual impacts. Other relevant legislation includes the Town Planning Ordinance (Cap. 131), Forests and Countryside Ordinance (Cap. 96), Country Parks Ordinance (Cap. 208), etc. Reference to the HKPSG and other technical circulars of the Environment, Transport and Works Bureau and former Works Branch has been made.

Existing Environment

Potential Key Landscape Receivers

Landscape Resources

11.9.2 They are the physical components of landscape including geology, topography, soils, vegetation and hydrological features, with specific groups as shown in **Figure 11.10**.

Landscape Character Areas

11.9.3 The landscape within the study areas shows a variety of character types typical to Hong Kong ranging from industrial and significantly altered man made environments to the natural untouched peaks of Tsing Yi. In general, landscape is composed of and given its character by a number of natural and man made features. These differing Landscape Character Types (LCT's) can all be described as exhibiting a particular and consistent character or combination of physical features

such as land use, terrain, resources or development pattern and as a result exhibit a varied degree of sensitivity to change as brought about by the alignment options. The LCT's for the study area are illustrated in **Figure 11.11**.

Potential Visual Sensitive Receivers

11.9.4 The Zone of Visual Influence (Visual Envelope) is that area from which any part of the proposed Project can be seen. The extent of this zone is identified on **Figure 11.12**. Visual sensitive receivers (VSRs) are those visual receivers which fall within the ZVI as shown in **Table 11.9.1,** including residential, recreational, occupational and travelling VSRs.

Table 11.9.1 Potential Key Visually Sensitive Receivers (VSRs)

Ref	Location	Type of View	Sensitivity
Residential VSRs			
R1	Remaining residents at Tso Wan	Fixed / Restricted	Moderate
R2	Village residents at Ma Wan	Fixed / Restricted	High
R3	Upper floor residents with south views at Park Island	Fixed / Panorama	High
R4	Residents with south views at Sham Tseng including Sea Crest Villa, Lido Garden, Bellagio, Ocean Pointe	Fixed / Panorama	Moderate
R5	Residents with south views at Tsing Lung Tau including Hong Kong Garden, Royal Sea Crest, Lung Tang Court	Fixed / Panorama	Moderate
R6	Upper Floor Residents with oblique south views at Mayfair Garden	Fixed / Panorama	Moderate
R7	Residents with oblique south views at Ramblers Crest	Fixed / Panorama	Moderate
Cultural VSRs			
C1	Potential Users of Tourist Facilities as zoned on North Lantau ODP	Fixed / Panorama	Moderate
C2	Visitors to Pa Tau Kwu Pak Wan	Transitory / Panorama	High
C3	Visitors to Fa Peng	Transitory / Panorama	High
C4	Visitors to Tso Wan	Transitory / Panorama	High
C5	Hikers on Lantau hillside and footpaths	Transitory / Panorama	High
C6	Pleasure boat users travelling to N. Lantau	Transitory / Panorama	High
C7	Hikers on Tsing Yi Hill	Transitory / Panorama	Moderate
C8	Lantau Link Visitor Centre Viewing Platform	Fixed / Panorama	Moderate
C9	ACP Exhibition Centre Viewing Platform	Fixed / Panorama	Moderate
C10	Beach Users at Sham Tseng and Tsing Lung Tau	Fixed / Panorama	Low
C11	Potential Users of Tourist Facilities at HK Disneyland expansion area.	Fixed / Restricted	Low
Occupational VSRs			
O1	Workers at CT9	Fixed / Restricted	Low
O2	Staff and temporary residents at Tsing Yi IVE	Fixed / Restricted	Moderate
O3	Occasional staff at Yi Chuen	Fixed / Panorama	Low
O4	Occasional staff at Tang Lung Chau Lighthouse	Fixed / Panorama	Low
O5	Workers as Sai Tso Wan Oil Depot	Fixed / Restricted	Low
O6	Workers at Exxon Mobile industrial area South Tsing Yi	Fixed / Restricted	Low
O7	Shipping crew using Kap Shui Mun and Ma Wan channels	Transitory / Panorama	Low

Ref	Location	Type of View	Sensitivity
O8	Potential Workers at Tourist Facilities as zoned on North Lantau ODP	Fixed / Panorama	Low
O9	Potential Workers at Tourist Facilities at HK Disneyland expansion area.	Fixed / Restricted	Low
Transportation VSRs			
T1	Fast moving vehicles on Kap Shui Mun and Tsing Ma Bridges	Transitory / Panorama	Moderate
T2	Fast moving vehicles on Cheung Tsing Highway	Transitory / Panorama	Moderate
T3	Road users on Tsing Yi Road West – Nam Wan	Transitory / Panorama	Moderate
T4	Road users on Tsing Yi Road and CT9 distributors	Transitory / Glimpse	Low
T5	Fast moving vehicles on Stonecutters bridge	Transitory / Glimpse	Low

Landscape Planning Policy

11.9.5 The baseline for assessment includes both existing landscape and visual resources as well as planned projects which may be affected by the Project. Reference has been made in accordance with the Urban Design Guidelines (November 2002), North-East Lantau OZP No. S/I-NEL/12, Ma Wan OZP No. S/I-MWI/13, Tsing Yi OZP No. S/TY/22, and North-East Lantau Outline Development Plan, D/I-NEL/1. The Landscape Strategy of the 'Territory Development Strategy Review' endorsed in 1998 identifies most of the north coast of Lantau 'Existing Committed Urban Development Area'. The South West New Territories strategy development review indicates additional development in North East Lantau, including the current areas of Green Belt in the study area. The Revised Concept Plan for Lantau states that "new developments should not compromise the existing landscape setting or local environment, and landscaping should be carried out to mitigate the effect of any new development".

Potential Impacts

11.9.6 The eastern coastline of north Lantau Island is one of the few remaining natural undeveloped areas, not only within the study area but together with that of the South Lantau coast, the whole of urban Hong Kong. Its landscape resources consist of archaeological sites, ecological assets, traditional villages, natural untouched coastline, open hillsides, beaches and seasonal streams. It is a rare and valuable landscape resource little changed by development. However, it has become isolated by surrounding large scale development in the form of Disneyland Theme Park to the south, the Tsing Ma Bridge and Ma Wan Park Island to the north and faces the heavily modified coastline of Tsing Yi to the east making it further endangered by sprawling development. Roadways and viaducts are relatively incompatible with existing landscape resources but the impacts at the Lantau coastline would be limited to the small section linking to the Yi Chuen headland close to the Tsing Ma Bridge and the tower footings at Tang Lung Chau. The landscape and visual impacts could further be minimised with careful routing of the bridge deck landing to avoid/reduce hilltop and slope cutting on the Lantau side.

11.9.7 The Tsing Yi coast of the study area has, already been despoiled by existing development, such as the coastal oil industry facilities and container ports. The

significance threshold of project related landscape impacts in this area would thus be relatively low. Visually, almost any large scale engineering scenario could be absorbed into the already congested mix of industrial sites, highways, tunnel portals and reclaimed shoreline. As such, long term project related landscape and visual impacts at Tsing Yi should not be a major concern.

11.9.8 Visually, the new bridge will be associated contextually with the Tsing Ma Bridge, Stonecutters Bridge and potentially the Tsing Lung Bridge and the juxtaposition of these may create a strong and significant visual impact on a local and even international scale. Visual impact assessment at a later stage will determine whether these impacts are beneficial or adverse. However, overall the potential adverse impacts are likely to be considerably less than might be expected for such a large scale project.

11.10 Hazard to Life

Legislation

11.10.1 The EIAO requires that the risks associated with development in the vicinity of potential sources of hazard (e.g. dangerous goods storage) to population comply with the risk guidelines in the TM-EIAO. The HKPSG also states that, for every Potentially Hazardous Installation (PHI), a Consultation Zone (CZ) should be delineated within which proposed development will be referred to the Coordinating Committee on Land-use Planning and Control relating to Potentially Hazardous Installations (CCPHI) for consultation and with the CZ, planning restrictions may need to be imposed on future developments.

Existing Environment

11.10.2 There are five oil depots at south and south-west of Tsing Yi and they are all classified as PHIs (**Figure 11.13**) for the quantity of petroleum products (e.g., fuel oil, jet fuel, gasoline, LPG, etc.) stored. All these PHIs have a 1,000m CZ and the TYLL will cross through the CZ of four PHIs (Sinopec oil depot, ExxonMobil oil depot east and west terminals and Chevron oil depot). For the PHIs to the south of Tsing Yi, the largest risks to off-site personnel would be considered to be mainly associated with LPG storage and tanker unloading facilities in the event of major release. The TYLL alignment could well be within the range of major LPG release effects, particularly flash fires, boiling liquid expanding vapour explosion (BLEVE), fireballs and subsequent explosion.

Potential Impacts

11.10.3 The construction and operation of TYLL could represent a potential ignition source for released LPG. Traffic related ignition sources, however, may not be the major concern as TYLL, similar to Route 8, would be mostly in tunnel and away from the portals and build up of flammable LPG concentrations at elevation is not likely. Storage tanks of the PHIs, however, could be damaged by flying objects or severe blast effects from use of explosive nearby and any use of explosives in tunnelling

and foundation works would require rigorous control to prevent missile risk to storage tanks or terminal pipes.

11.10.4 Traffic using the TYLL in the vicinity of the PHIs could also be a target for risk effects. A potential hazard would be the LPG/smoke in harmful concentrations entering the tunnel portals. It should be noted that the prevailing wind at Tsing Yi south are easterly and south-easterly and away from the alignment.

11.10.5 Apart from the PHIs, according to the Hong Kong Geological Survey Map Sheet 10, there is also an explosive dumping ground at the southwest coast of Tsing Yi. While the explosive dumping ground is not a statutory PHI, it would need to be treated with great care as the potential risk associated with materials dumped into the area will be an issue. The population of construction staff, therefore, could be subject to potentially higher risks compared with other projects of similar type. However, as the preferred alignment will not encroach into this explosive dumping ground (at ~250m apart), it is anticipated that there would be no significant impact arising.

11.10.6 A Quantitative Risk Assessment will be required at the next stage to confirm that no unacceptable risks will arise or to define suitable mitigation measures. Depending on the Study Brief to be issued by EPD, hazard to life assessment related to the transport of explosive may also have to be assessed.

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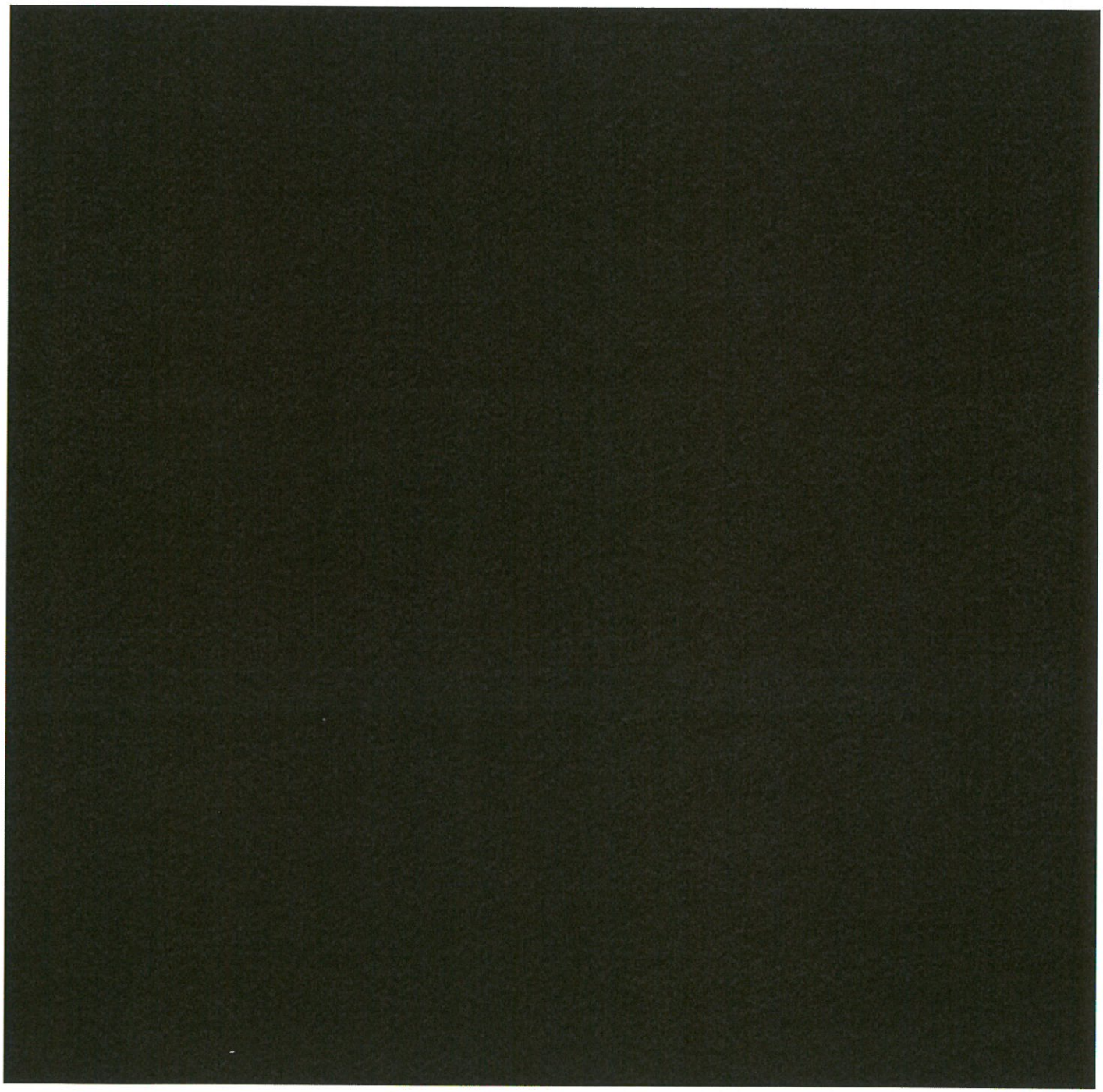

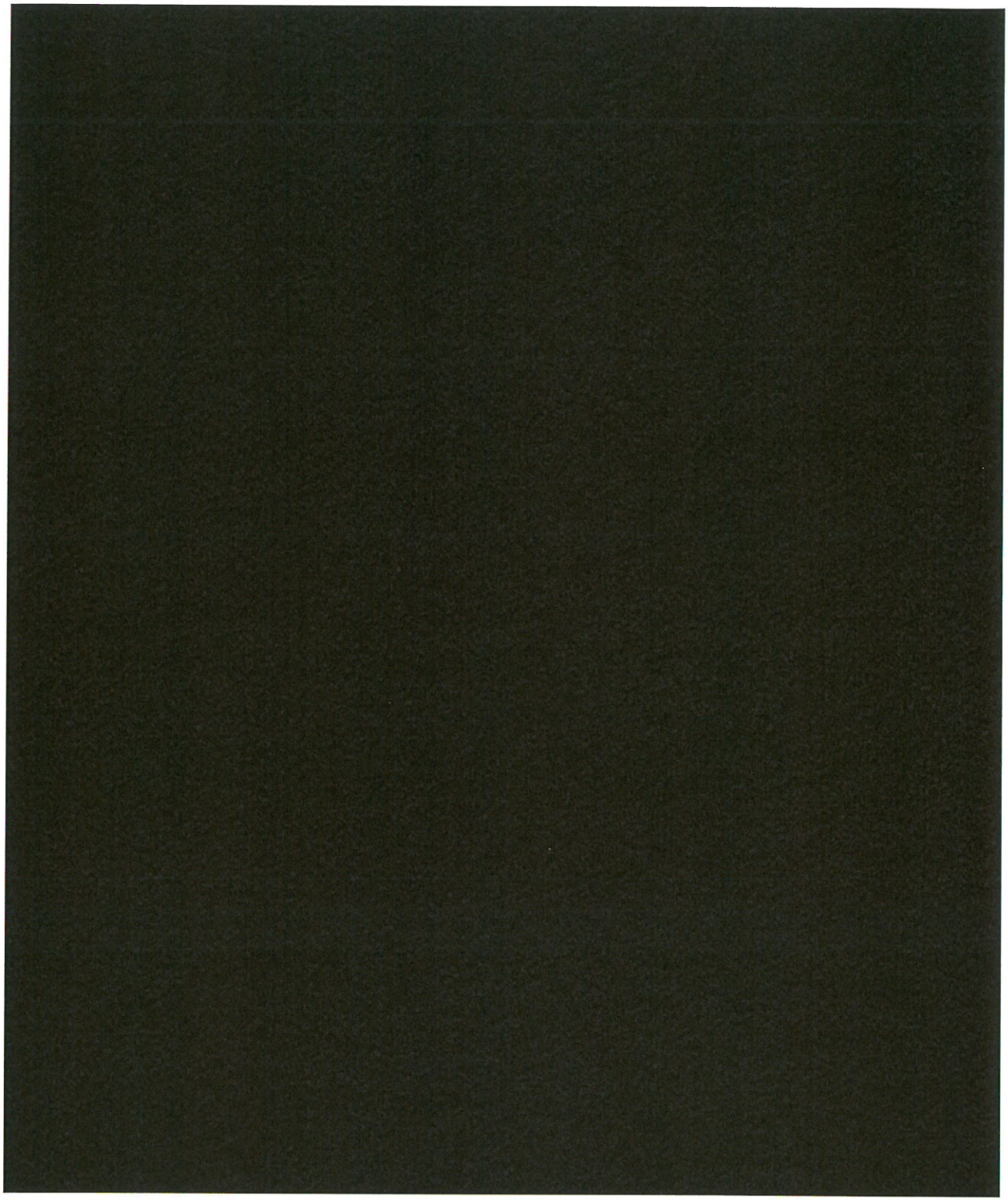

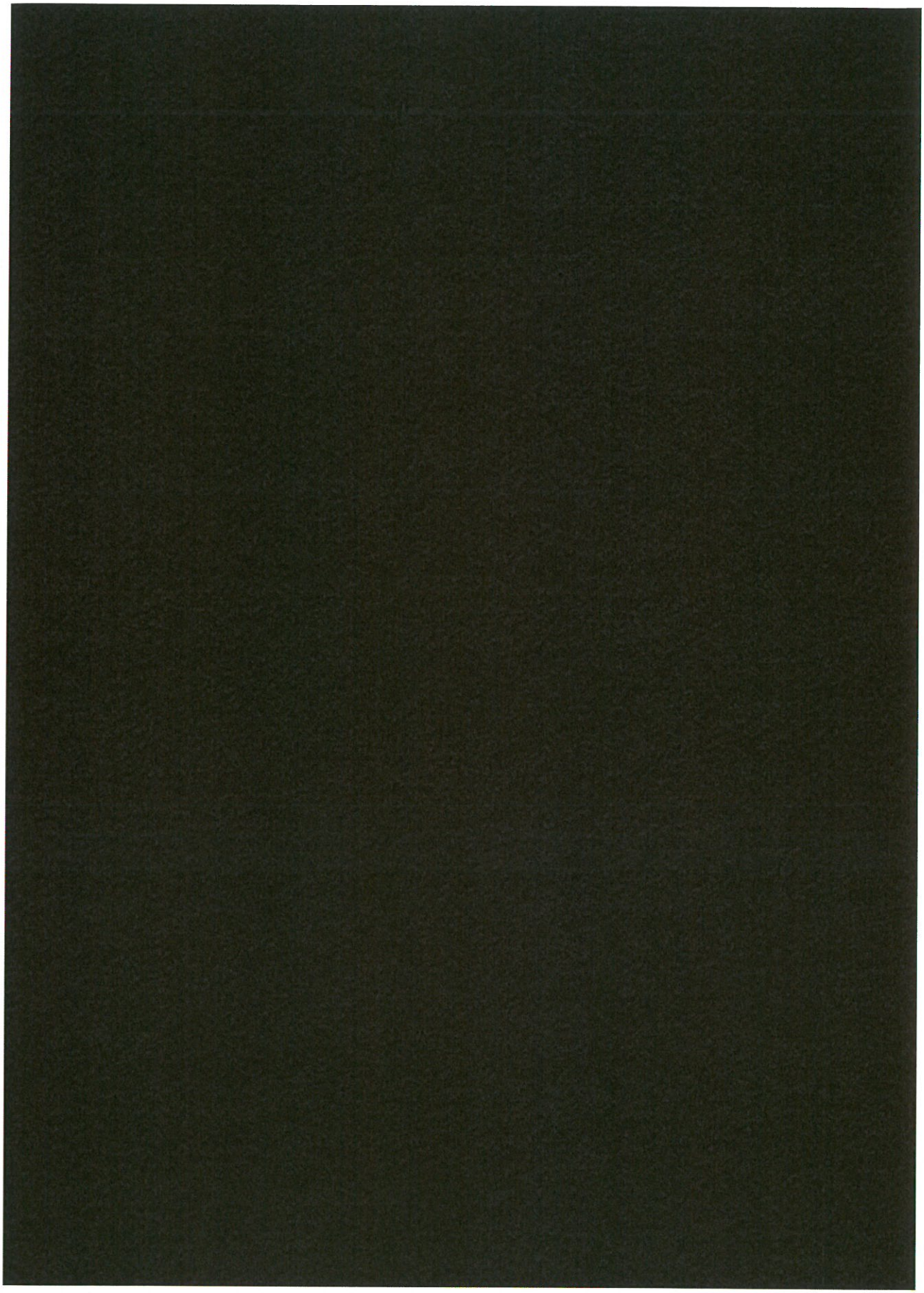

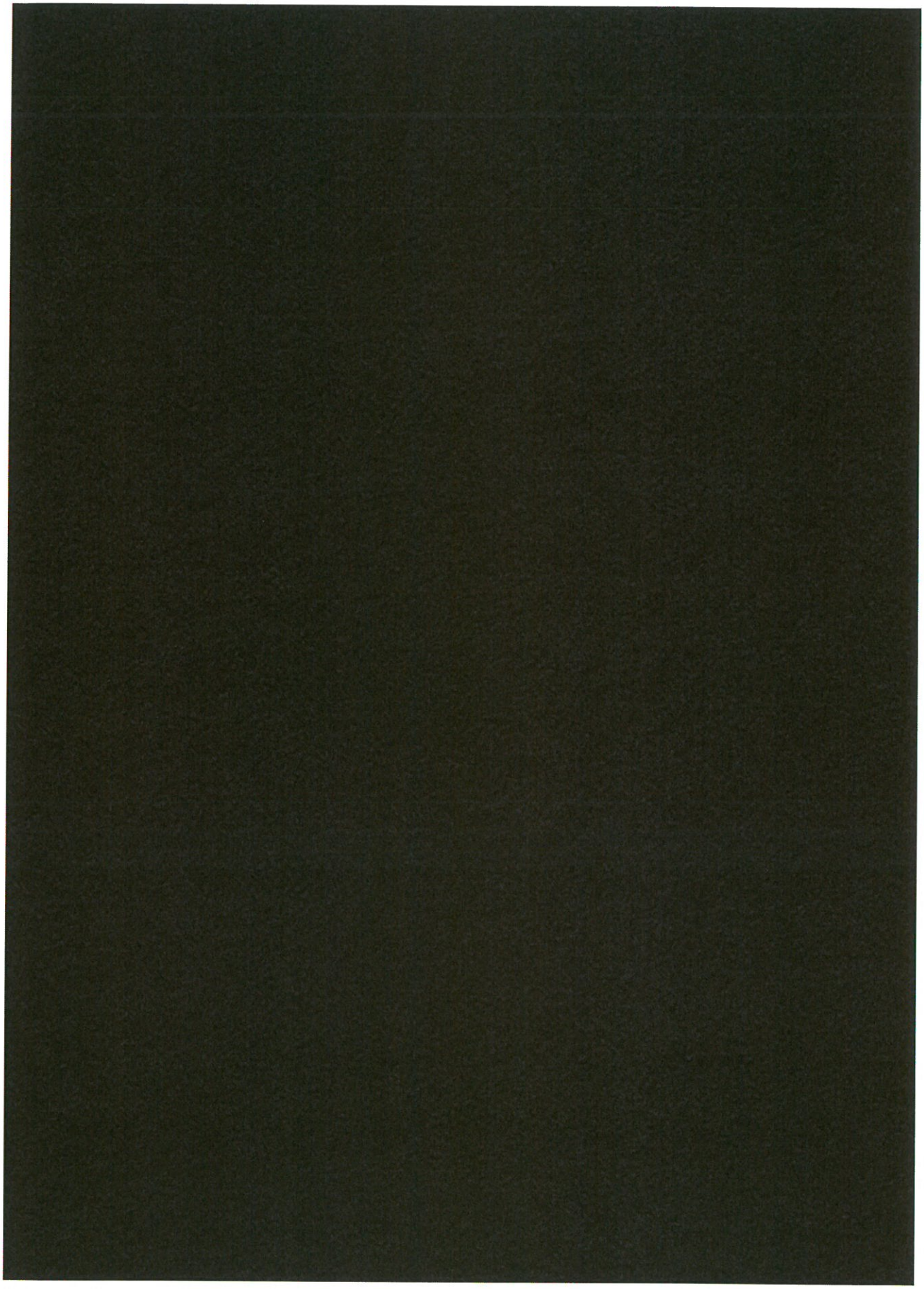

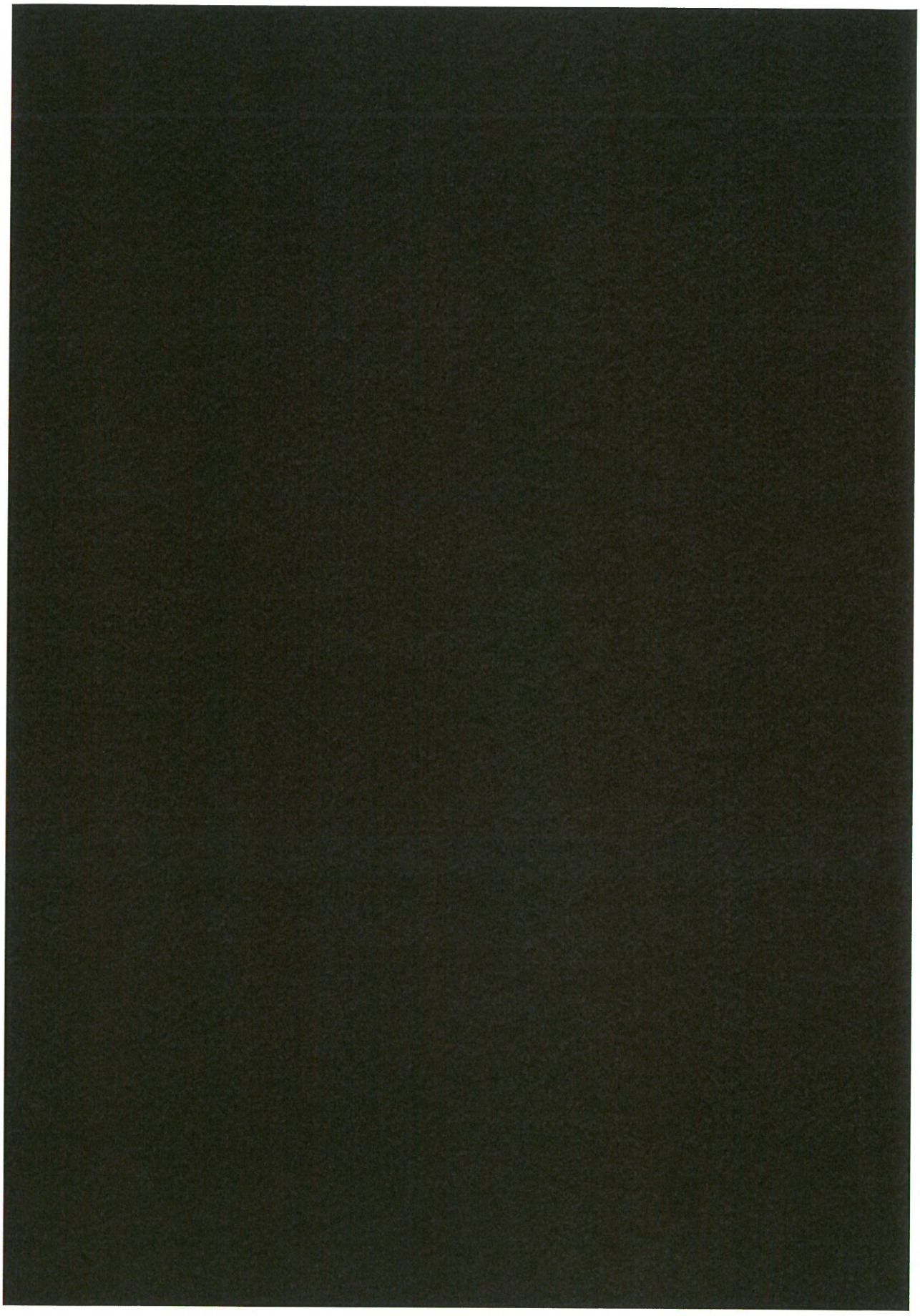

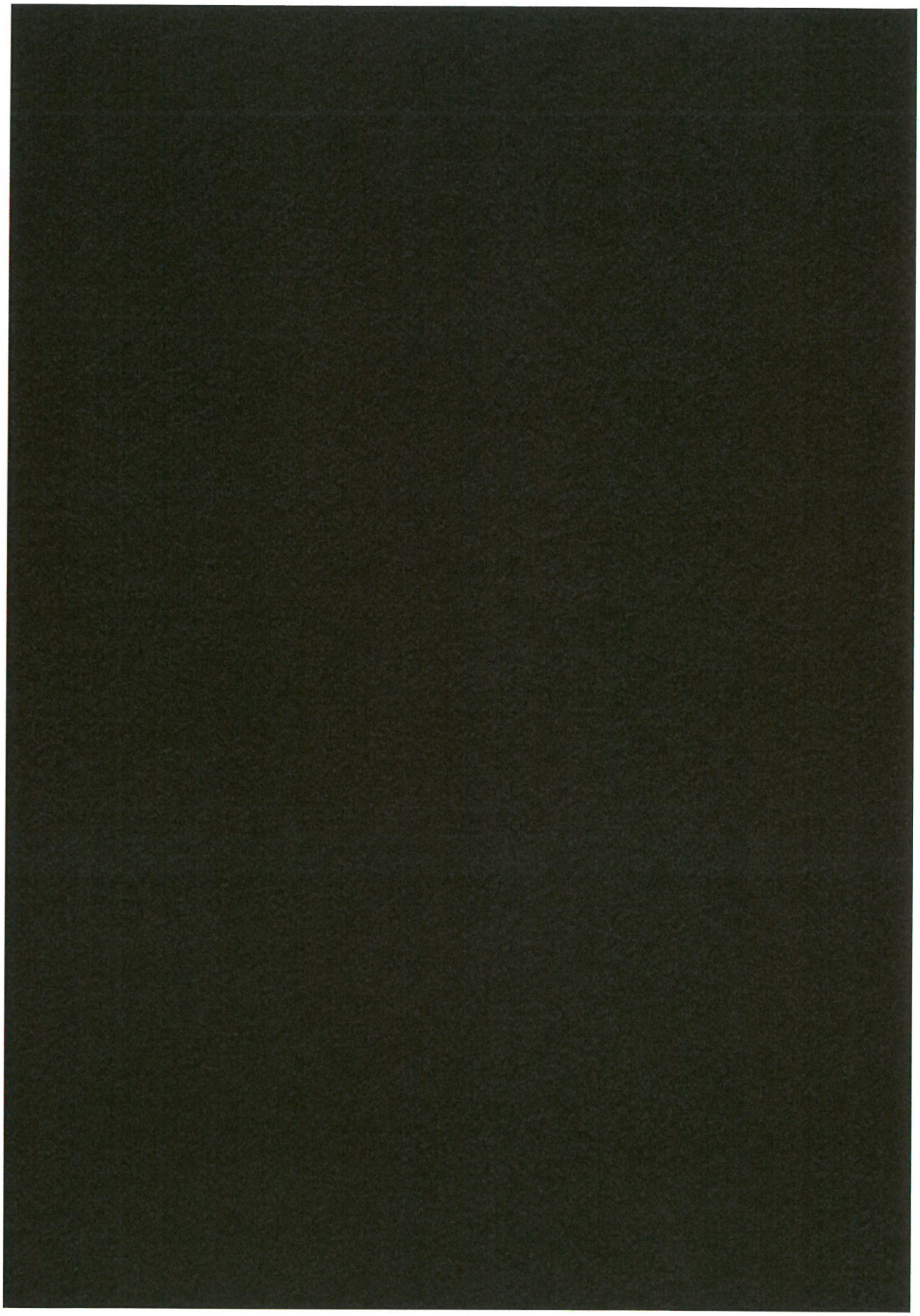

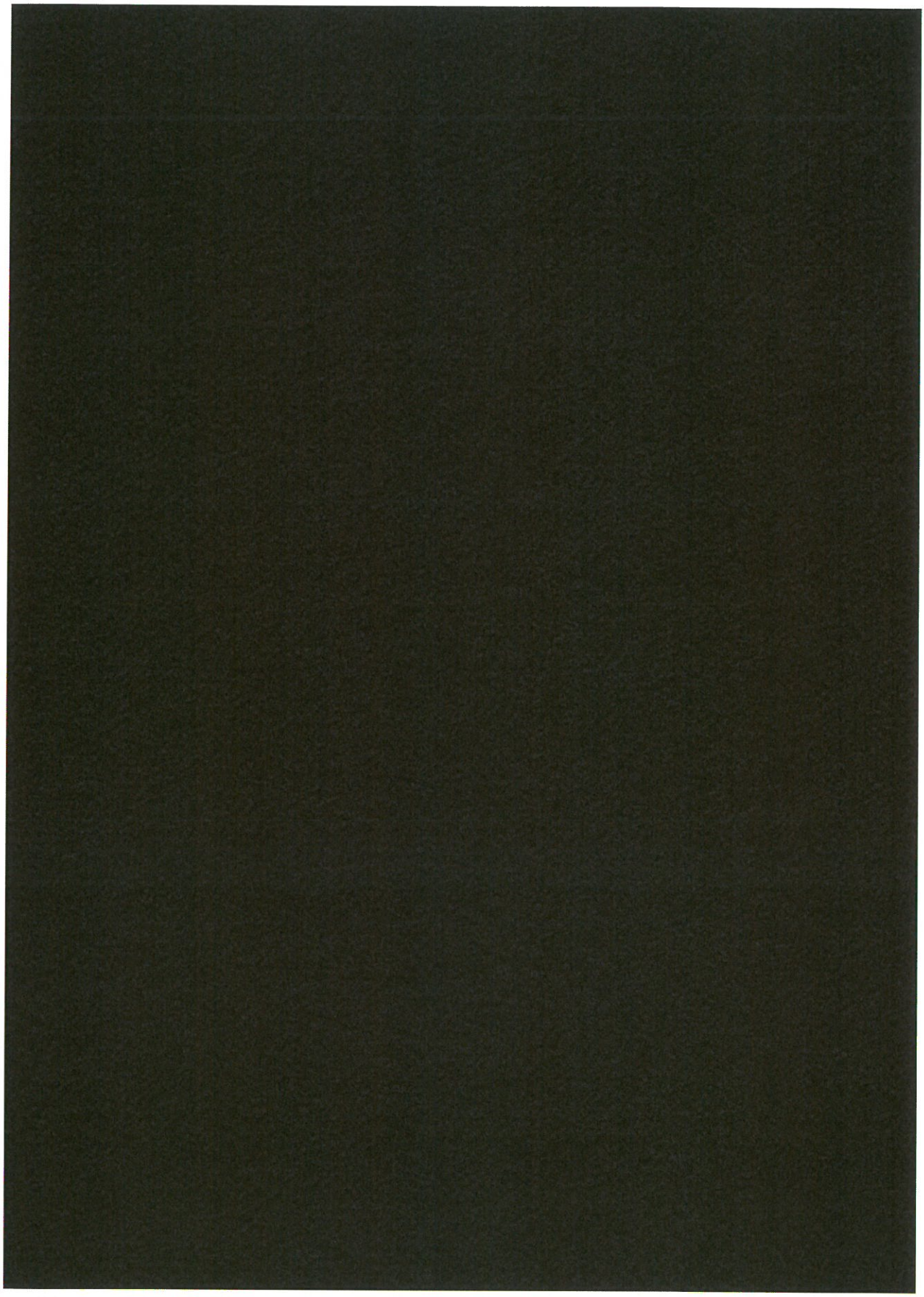

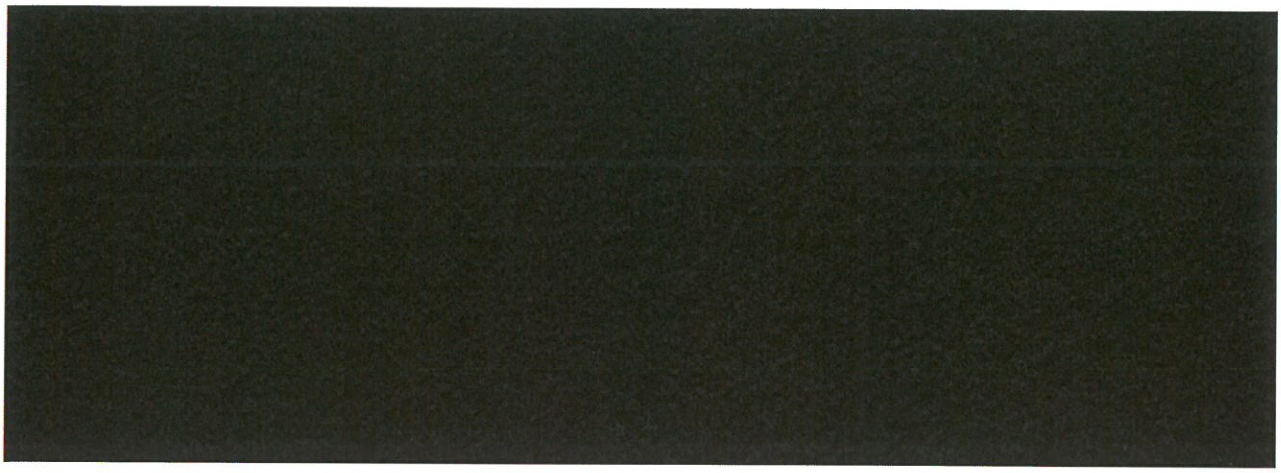

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SECTION 13

Implementation Strategy and Programme

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

13 IMPLEMENTATION STRATEGY AND PROGRAMME

13.1 Implementation Strategy

Contract Packaging

13.1.1 Before consideration is given to the implementation strategy for the TYLL, the contract packaging of the Project should be considered. Given its very size and nature, construction of the TYLL would be a considerable undertaking, and thus consideration must be given to the number of works contracts the Project should comprise. At one end of the scale, the Project could be carried out under a single works contract. On the other hand, the Project could be split in multiple works contracts. There are advantages and disadvantages to each approach, and also practicalities to consider, as discussed below.

13.1.2 A single works contract would have the advantage of having zero interfaces with adjacent contracts, which would avoid any associated co-ordination problems and potential disputes between neighbouring contractors. A single works contract would also be simpler to administer, in so far as there would be only one main contractor to deal with. On the other hand, a single works contract would entail greater risk to the Employer if the appointed contractor underperformed. Careful consideration must therefore be given to the value of a single works contracts in relation to the ability of potential contractors to handle such an amount. Entrusting a large project to a single contractor might simply overwhelm the contractor, and result in delay and commercial disputes.

13.1.3 Multiple works contracts would have the advantage of reducing the above risks to the Employer by sharing the workload between various contractors. This approach would also likely be favoured by the construction industry. There could also be programming advantages if it proved advantageous to commence certain parts of the project before the remainder by, for example, awarding an advance works contract for any reprovisioning works or for any reclamation works that might require a period of surcharging. On the other hand, multiple works contracts might simply serve to overcomplicate construction of the project.

13.1.4 The practicalities of both of the above approaches must be considered together with the requirements of the Project. The preferred option for the TYLL involves reclamations for bridge towers and anchorages. As non-dredged method with marine deposits left in place is intended to be adopted, a longer period of surcharging is anticipated for the reclamation works. Advance reclamation works contract may be necessary to expedite the overall construction of the Project.

13.1.5 At the same time, it is also intended that the C&D materials generated from the Project will be reused within the Project, in particular as the reclamation fill materials. In order to fully utilise the materials, it is necessary to package all the works of the Project, except the arch bridge and suspension bridge construction, as an advance works contract. This can facilitate the early commencement of the reclamation works using the generated C&D materials. However, this approach will

create contract interface and the expedition is not of significant level since the supply of reclamation fill would largely rely on tunnelling works at Tsing Yi and earthworks at Lantau.

13.1.6 Nevertheless, to reduce the risk brought about by a single contractor as discussed in **Section 13.1.2**, a probable arrangement is to package the works at Tsing Yi, including the tunnelling works, reclamation at southwest Tsing Yi and the construction of link roads connecting with ETYV, as one works contract. The C&D materials generated from this contract could fully be used in the Tsing Yi reclamation and other filling works within the contract, with only approximately 0.02 Mm^3 surplus materials.

13.1.7 Based on the above, different contract packaging approaches are available, which have their own pros and cons. However, the construction programme will be much the same as constrained by the time for reclamation followed by long-span bridge construction. The final arrangement of the contract packaging will be determined in the normal manner under the preliminary design and detailed design stages when this Project proceeds. At this stage, we have identified a possible scenario for each approach, as follows:

Single Contract Approach

13.1.8 The whole of the TYLL and associated works, including the local realignment of NLH and Tsing Yi Road, reprovisioning and expansion of Lantau Toll Plaza, and provisioning of slip roads to Tsing Yi Road, would be carried out under a single works contract.

Multiple Contracts Approach

13.1.9 The works would be split in multiple contracts as follows:

Contract A: This contract would comprise the rock tunnel and its portals, the reclamation at southwest Tsing Yi, the link roads connecting ETYV, and the realigned Tsing Yi Road.

Contract B: This contract would comprise the TYLL section at Lantau Island, link roads at Lantau, the Lantau Toll Plaza, and the reclamations at Ma Wan Anchorage and at Yi Chuen.

Contract C: This contract would comprise the arch bridge, the suspension bridge, the viaduct in between of the long-span bridges, TYLL section at Tsing Yi, and Tsing Yi Road slip roads.

Contract D: This contract would comprise the E&M works and systems (such as tunnel E&M works and services), building works (such as the administration building, ventilation building and portal buildings), toll collection system and the TCSS.

13.1.10 For the purposes of the procurement approach and implementation programme discussed below, we have assumed a single contract approach.

Procurement Approach

13.1.11 ETWB TCW No. 32/2004 includes a reference guide on procurement approaches commonly adopted for public works internationally to facilitate the adoption of a more rational and systematic approach for selecting the procurement approach for public works projects in Hong Kong.

13.1.12 A host of innovative procurement approaches have emerged in recent years, and the procurement approaches adopted for construction projects internationally are very diverse. Some of the procurement approaches may be practised around the world under slightly different names, but carry essentially the same features. In order to analyse the basic components of the different procurement approaches in a systematic and logical manner, these different approaches are generalised into four generic categories. Under each category, the most common derivatives and variations are also identified as sub-categories, as follows:

Category I - Designer Led

- Lump Sum Contract (with Bills of Quantities or with Drawings and Specification)
- Remeasurement Contract
- Term Contract
- Prime Cost Contract

Category II - Design & Construct

- Employer's Designer Novated
- Independent Designers
- Contractor's Designer

Category III - Design Construct & Operate

- Design Build Operate
- Prime Contracting

Category IV - Finance Design Construct & Operate

- Private Finance Initiative (PFI)
- Public Private Partnership (PPP)
- Build Operate Transfer (BOT)

13.1.13 The contractor's involvement in the key stages of the development process generally increases as the procurement approach moves from Category I to Category IV. The allocation of key responsibilities for each category is illustrated in **Table 13.1.1** below.

Table 13.1.1 Key Responsibilities for Procurement Categories (ETWB TCW No. 32/2004)

Party responsible for:	Category			
	I	II	III	IV
Concept Design	D	D	D	D/C
Design Development	D	C	C	C
Contract Administration	D	D	C	C
Construction	C	C	C	C
Operation	E	E	C	C
Finance	E	E	E	C/E

Legend: E = Employer
C = Contractor
D = Designer (appointed by the Employer)

13.1.14 Previous long-span bridge projects in Hong Kong have been implemented under Category I. The same approach could be used for the TYLL, since this Project also includes the necessary toll collection facilities common to these types of projects. We have assessed the procurement approach for the TYLL under all four categories using the selection criteria included in ETWB TCW No. 32/2004. The assessment is summarised in **Table 13.1.2** below.

Table 13.1.2 Assessment of Procurement Approach for the TYLL (ETWB TCW No. 32/2004)

Selection Criteria		Category				Remarks
		I	II	III	IV	
Cost	Lowest construction cost	+	+	+	0	Cat IV are marked "0". An integrated approach under a DBO or BOT contract will normally provide a cost-effective solution, in particular when analysing the project's life cycle cost. However, based on the condition that the TYLL is toll free through TLB, and an alternative route exists through Tsing Ma Bridge to and from Lantau, the contractor may submit a high tender sum for the works to compensate for the future operation and maintenance cost. For similar reason, Cat I and II marked "+" as a comparison.
	Price certainty at award of contract	+	+	+	+	No change to assessment given in Technical Circular

Selection Criteria		Category I	II	III	IV	Remarks
Time	Shortest overall construction programme	N/A				The TYLL will only be required after year 2021. This criterion is not considered critical at the current stage, and therefore is removed.
	Programme certainty at award of contract	+	+	+	+	No change to assessment given in Technical Circular
	Control of programming and planning on site	0	-	-	-	No change to assessment given in Technical Circular
Quality	Control over materials and workmanship	+	0	0	0	No change to assessment given in Technical Circular
	Control over choice of suppliers / sub-contractors	-	-	-	-	No change to assessment given in Technical Circular
	Control over bridge appearance	+	-	-	-	This criterion is added to reflect the significance of the long-span bridges being a potential landmark of the area as well as Hong Kong
	Design input from contractor	-	+	+	+	No change to assessment given in Technical Circular
	Suitability for complex design	+	+	+	0	The complex design element of the Project is mainly the long-span bridge which has to take account of both the structural performance and appearance consideration. The appearance aspect may be compromised in contractors' design in view of the construction cost. However, Cat II and III still have the benefit of allowing designer's free hand in developing alternative solutions.
Risk	Close relationship with designers	+	-	-	-	No change to assessment given in Technical Circular
	Single point responsibility	-	+	+	+	No change to assessment given in Technical Circular
	Damages of delay recoverable from contractor	0	+	+	+	No change to assessment given in Technical Circular
Management efficiency	Good management and coordination structure	-	+	+	+	No change to assessment given in Technical Circular
	Past experience in adoption of procurement approach	+	-	-	-	This criterion is added to reflect the fact that the neighbouring Tsing Ma Bridge has adopted Cat I procurement

Selection Criteria		Category I	II	III	IV	Remarks
Contractual security	Availability of standard contract forms	+	+	+	0	No change to assessment given in Technical Circular
Totals:	No. of "+":	9	9	9	6	
	No. of "0":	2	1	1	4	
	No. of "-":	4	5	5	5	

Key: "+" = Good
"0" = Neutral
"-" = Poor

13.1.15 The assessment indicates that Category I is a more preferable procurement approach as it has the most "good" and the least "poor". However, Category II and Category III should not be ruled out at this stage as they both have the same number of "good" as Category I. The final selection will require further consideration at the preliminary design and detailed design stages when this Project proceeds.

13.2 Implementation Programme

13.2.1 The implementation programme for the Project is shown in **Figures 13.1** and **13.2**. According to the findings of traffic impact assessment, the TYLL does not need to be in place before year 2021, but needs to be open to traffic by year 2030. In this connection, the programme has not indicated a definite time for road opening, but has only shown the anticipated duration of key activities for the project implementation.

13.2.2 The programme has been prepared with the following assumptions:

- The programme has been formulated on the principle that activities such as Environmental Impact Assessment (EIA) and Roads Ordinance gazetting can proceed in parallel.
- A minimum of one year has been provided in order to carry out all fieldwork and ecological surveys necessary for preparing the EIA report.
- The duration allowed for in the EIA to obtain the environmental permit is in accordance with the EIA Ordinance.
- Lands Department's requirement for Clearance Application Form to be lodged to them at least 12 months (from date of receipt) before gazetting of the plan and scheme under Cap. 370 so as to allow sufficient time for defining the private lots to be resumed under the scheme.
- Gazettal procedure will be carried out under expeditious arrangements, taking administrative steps to resolve objections. Four months is provided for resolving objections after the statutory objection period, with an extension of 3 months if necessary in accordance with the Project Administration Handbook.

- Acceptance of the EIA is required before scheme is authorised under the Roads Ordinance.
- One works contract is proposed and assumed in the programme, although other contract packaging arrangement could be considered as discussed above.
- Authority will be obtained to pre-qualify the works contract after funds are made available and after all public objections are resolved under the Roads Ordinance.
- Finance Committee will only approve funding for construction after the scheme has been authorised under Roads Ordinance gazetting.
- Tenders will be invited after funding has been approved by Finance Committee.

Key Programme Activities

13.2.3 Programme activities identified as being critical for the Project are:

Environmental Impact Assessment

13.2.4 The periods allowed for in the Environmental Review are:

(i)	Informal consultation with ACE EIA Subcommittee and Green Groups	-	4 months
(ii)	Fieldwork and Ecological Surveys (minimum)	-	12 months
(iii)	Finalise Draft EIA Report	-	3 months
(iv)	Finalise EIA Report	-	2 months
(v)	EPD Review	-	60 days
(vi)	ACE Review and Comment	-	2 months
(vii)	Public Inspection (concurrent with ACE review)	-	30 days
(viii)	EPD approval of EIA Report	-	30 days

Roads Ordinance Gazette

13.2.5 The programme has allowed the following periods for the critical gazette activities:

(i)	Statutory Gazette Objection Period	-	60 days
(ii)	Resolution of Objections	-	4 months
(iii)	Extension for Resolving Objections	-	3 months
(iv)	Scheme Authorisation	-	30 days

Pre-Qualification for Works Contract

13.2.6 The durations assumed for pre-qualification activities are:

(i)	Prepare and Finalise Documents	-	2 months
(ii)	Publish Pre-Qualification Invitation (international invitation)	-	1 month
(iii)	Prepare Proposals	-	1 month
(iv)	Pre-qualification Assessment	-	2 months

Tender for Works Contract

13.2.7 The durations assumed for the tendering activities are:

(i)	Tender Period	-	3 months
(ii)	Tender Assessment	-	3 months
(iii)	Tender Approval	-	2 weeks

13.2.8 The implementation programme indicates that the TYLL will be open to traffic in approximately eleven years after the commencement of the Investigation and Preliminary Design Consultancy.

SECTION 14

Cost Estimate

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

14 COST ESTIMATE

14.1 Base Estimate

14.1.1 The base estimate at September 2007 price level is prepared by measuring the quantities of the following major items of the Project:

- Viaducts & Roads;
- Tunnel;
- Bridge;
- Retaining Wall;
- Slope Works;
- Reclamation (Artificial Island);
- Building Works;
- Traffic Control and Surveillance System (TCSS);
- Miscellaneous Roadworks; and
- Environmental Mitigation Measures.

14.1.2 The unit rates are obtained from the Unit Costs for Highway Works issued by the Maintenance Account and Quantity Surveying Unit. In case the unit costs for the concerned works elements are not appropriate for the TYLL, reference is made to other sources. These sources have been restricted to other recent public works projects containing works of similar natures.

14.2 Risk Analysis

14.2.1 Estimating using risk analysis (ERA) is a procedure to identify risk in a formal manner in which a realistic estimated cost is attached to each risk. All Government works departments are required to follow the ERA approach. Following completion of the Base Estimate, activities involving significant risk were identified and values were apportioned to those risks. The sum of the average Risk Allowances was added to the Base Estimate which forms the Average Risk Estimate. The risk estimate is summarised below.

	HK$ M
Base estimate	13,772.3
Average risk allowances:	
Contract contingencies	2,203.6
Project contingencies	1,973.2
Average Risk Estimate (ARE)	**17,949.1**

14.3 Summary of Cost Estimate

14.3.1 The following table shows a summary of cost estimate for the TYLL at September 2007 price level. The details of the base estimate, identified risks and risk analysis are included in **Appendix F**.

Item	Description of Works	Total Amount (HK$ M)
1	Viaducts & Roads	2,607.9
2	Tunnel	789.1
3	Bridge	8,844.9
4	Retaining Wall	150.1
5	Slope Works	401.6
6	Reclamation (Artificial Island)	422.9
7	Building Works	390.4
8	TCSS	124.7
9	Miscellaneous Roadworks	15.6
10	Environmental Mitigation Measures	25.0
	Sub-total	**13,772.3**
11	Contract Contingencies	2,203.6
12	Project Contingencies	1,973.2
	Sub-total	**17,949.1**
13	Design & Related Services (2%)	359.0
14	Site Investigation & Site Supervision Fee	68.9
15	Construction Supervision Fee (10%)	1,794.9
16	EMSTF	3.0
	Total	**20,174.8**

14.4 Recurrent Cost

14.4.1 The recurrent costs for annual maintenance, energy and staff are based on Unit Rates of Annual Recurrent Maintenance for Highway Features published by Planning Unit of the Highways Department. The annual recurrent maintenance estimate for the Project is **HK$170.2 million**. Details of the estimate are presented in **Appendix F**.

SECTION 15

Conclusions and Recommendations

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

15 CONCLUSIONS AND RECOMMENDATIONS

15.1 Alignment Options and Constraints

15.1.1 A total of seven alignment options with various possible landing arrangements were developed for evaluation under the traffic impact, marine traffic impact, option and sustainability assessments. These seven options involve immersed tube tunnels (Alignment Options 1 to 3) and long-span bridges (Alignment Options 4 to 7). A summary of these options is presented below.

Alignment Option	Key Features	ETYV Connection	TLB Connection	PBH Connection
1	3,850m long ITT	indirect via CT9 slip road	via a coastal route	via CKWLR
2	3,930m long ITT	indirect via CT9 slip road	not possible	via CKWLR
3	3,980m long ITT	indirect via CT9 slip road	via an inland route	via CKWLR
4	2,440m span LSB	direct connection	via an inland route	via CKWLR
5	2,140m span LSB	direct connection	via an inland route	via CKWLR
6	1,750m span LSB	direct connection	via an inland route	via CKWLR
7	1,800m span LSB & 500m span arch bridge	direct connection	a combined connection with TLB and NLH	not provided

15.1.2 The options have been developed with due regard to the existing and potential future major constraints in the study area, as shown in **Figures 2.1** to **2.3**. These constraints include the marine channels and anchorages, existing and future container terminals, disused explosive dumping ground, mud pit, airport height restriction zone, structural height intrusion limitation zone on Lantau, archaeological site, Hong Kong Disneyland Theme Park, oil depots, etc.

15.2 Traffic Impact Assessment Study

15.2.1 The TIA aims to assess the traffic performance for the seven alignment options and determine traffic impacts on the NWNT road network.

15.2.2 All options would achieve the aims of providing relief to LL and TKB / TMR corridor. The extent of this relief would tend to be greater in the bridge options (4 to 7). All options decrease overall vehicle travel time but increase vehicle distance. Option 7 gives the lowest increase in vehicle distance reflecting the more direct routings in this option. The bridge options generally perform better than the tunnel options making Alignment Option 7 being the preferred option on traffic grounds. The 2030 traffic forecasts also indicates that although a dual two-lane configuration is sufficient of achieving acceptable V/C ratios (V/C ratios of major NWNT key links less than 1.2), a three-lane configuration of the TYLL is preferred for contingency purposes in case of Lantau Link closure.

15.2.3 As for the connections on Tsing Yi, a 2-lane connection between TYLL and Route 8 is required to meet the peak hour demand of 3,000 vehicles. Around 1,000 vehicles are forecast to use the TYLL slip road connection to Tsing Yi Road and hence a

single lane configuration would suffice. In Lantau, non-Lantau and Lantau – Urban traffic movements are forecast to be around 2,500 vehicles. A 2-lane connection between TLB and TYLL; LL and TYLL was therefore recommended.

15.2.4 The toll plaza arrangement for TYLL is designed to capture traffic between TYLL – Lantau, TLB – Lantau and LL-Lantau. Under this arrangement, only the Urban – Lantau traffic will be tolled and a toll-free route between Tuen Mun Road and Tsing Yi is provided via TLB and TYLL. To achieve a more efficient balance of traffic on links to / from Lantau, it is also proposed to apply the same toll level as used on the LL for Urban - Lantau traffic. However, the actual tolling arrangement for TYLL is yet to be determined and will be subjected to further review at later stage of the study.

15.2.5 Two NWNT network options, namely Option 1 (TLB + LTT) and Option 3 (TLB + TMEB + TMR) are being assessed under with / without TYLL scenario. The traffic forecasts for year 2030 shows that the without TYLL scenario even with the NWNT network options 1 or 3, the road network remain congested on many key links. Without TYLL, the NWNT network would not be able to support the level of assumed development and network improvements will be necessary.

15.2.6 On the other hand, the forecasts show that V/C ratios on the Lantau Link, LL connections to Route 3 (South), TKB and TMR (Expressway section) are much reduced in all NWNT network options with TYLL in place. The two NWNT network options perform similarly where TMR (SKW) section performs less well under Option 3, but still within acceptable limits (V/C ratio < 1.2).

15.2.7 In addition to the traffic assessment of TYLL, financial and economic assessments were also performed to determine the impact of TYLL. The financial assessment indicates that NWNT Option 3 has the best FIRR. However, both Option 1 and Optoin 3 do not perform well financially with a FIRR of -7.3% and -5.9% respectively. This is because there is a reduction in LL revenue, and the non-Lantau (NWNT-urban) traffic using both TLB and TYLL are not subject to toll generating no marginal revenue. The economic assessment indicates that with NWNT Option 1, TYLL performs well in economic terms (EIRR of 17.3%) as TYLL enables LTT/ TLB to be better utilised by NWNT to urban traffic, which therefore relieves Tuen Mun Road and Ting Kau Bridge.

15.3 Marine Traffic Impact Assessment Study

15.3.1 An assessment of the marine traffic impacts associated with options for the alignment of the TYLL has been conducted. This has covered the following principal issues:

a) Review of marine facilities, future development plans and current traffic pattern;
b) Survey of present traffic and forecast of future traffic levels;
c) Assessment of present risk environment and initial alignment assessment;
d) Evaluation of bridge ship impact design requirements;
e) Investigation of traffic risk within a dynamic marine traffic simulator;
f) Examination of the radar impact of the various link options; and
g) Recommendation of practical operational and constructional measures.

15.3.2 Comprehensive visual surveys of marine traffic have been coupled with existing radar databases to identify traffic levels within the Study Area to assist the construction of a marine traffic simulation model. A thorough assessment of anticipated "worst case" traffic levels up to 2030 has been developed on the basis of the best available data sources, taking account of most optimistic cargo projections, vessel size increases and forecast variance.

15.3.3 The various alignment options have been reviewed and the potential hazards and constraints highlighted. It is clear that all the options have a range of impacts.

- From a purely long term marine traffic and risk perspective, tunnel options score more favourably. While construction of the immersed tunnel would develop temporary construction impacts, there are not anticipated to be any long-term drawbacks regarding marine traffic risk and accessibility.
- While the presence of bridge piers pose limited impacts on navigation all options developed are viable and the bridge spans are not anticipated to impact or impede navigation of large ocean-going vessels - a maximum allowable airdraft of 68.5m (consistent with Stonecutters Bridge) has been recommended at this stage, however there is scope to raise this if warranted by future unanticipated developments in ship size/design.
- The analysis conducted within this section has highlighted that a waterdepth at least equal to the existing seabed conditions should be adopted for deep draught channel depth for the Immerse Tube Tunnel Options. The immersed tube tunnel would be buried deep enough at the approach channel of the potential CT10 reclamation site.

15.3.4 Various options for bridge ship impact protection have been reviewed and the potential benefits and limitations highlighted. It is recommended that artificial island protection should be adopted for the proposed long-span bridge.

15.3.5 The marine risk for vessels navigating adjacent to the TYLL has been developed following analysis within a marine traffic simulation model. Comparative analysis has identified that

- Tunnel Options would not impact operational marine risk; and
- The bridge options create relocation of marine traffic and increase risk by 7 to 11%. Option 7 is favoured amongst Bridge Options due to an increase of only 3% being forecast. The introduction of a bridge tower and artificial island adjacent to Tang Lung Chau is not anticipated to adversely impact the risk regime level in Ma Wan and Kap Shui Mun Fairway

15.3.6 It is identified that varying areas of the Ma Wan and Pun Shan Shek Anchorage could be potentially impacted by the TYLL. However the loss of some anchorage space is considered acceptable, particularly given the latest "*Study on Hong Kong Port Cargo Forecasts 2005/2006*" (April 2008) confirmation that demand for anchorages is not predicted to exceed demand up to year 2030. Nevertheless, it had been agreed at the Project Steering Group Meeting on 20 December 2007, that detailed assessment for reprovisioning of anchorage space to meet the future

demand arising from the loss of anchorage space caused by the proposed alignment, will be conducted at the next phase.

15.3.7 After consideration of the four initial bridge alignment options, it is proposed to build an additional radar facility, at one of four bridge tower / artificial island sites, to recapture the shadowed radar signal on the TYLL bridge structure. Detailed radar design will be conducted at the investigation phase of the Project.

15.3.8 A series of recommendations have been developed with respect to the minimum requirements for marine plant, navigation and traffic management, and the control of marine works prior to and during construction of the TYLL. It is further recommended that a marine liaison group including support from all key parties be established to co-ordinate the safe conduct of the works.

15.4 Option Assessment

15.4.1 The seven feasible alignment options for TYLL were evaluated under the option assessment. From the assessment, Alignment Option 7 has the highest overall score. It scores the highest under the Road Traffic, Engineering and Environmental criteria, and scores the second highest under Marine Traffic, Land Use and Planning, Costs and Programme, and Public Acceptability criteria. Alignment Option 7 was therefore recommended as the preferred alignment for the TYLL. This preferred TYLL option was endorsed by the Project Steering Group on 20 December 2007, and was suggested to be taken forward for subsequent engineering feasibility study and other impact assessment studies.

15.4.2 From marine traffic collision risks perspective, tunnel (Alignment Options 1 to 3) is more desirable due to the absence of bridge structure, but the drawback is the likely loss of anchorage area. As agreed at the Project Steering Group Meeting on 20 December 2007, the feasibility of tunnel option will not be totally ruled out and will need to be critically re-assessed in the next stage of the Project.

15.5 Sustainability Assessment

15.5.1 A sustainability assessment of the TYLL has been conducted to evaluate the chosen options for the TYLL from a sustainability perspective. The sustainability assessment considers the overall need for TYLL and compares TYLL options to a Without TYLL scenario.

15.5.2 The TYLL appears to be justified in traffic terms, comparing the overall impact relative to the baseline, with and without TYLL alignment options for travel speed and for reduced congestion on the surrounding major road links. A significant environmental impact is the large quantity of sediment which will require marine disposal from the three immersed tube tunnel options. There are other environmental impacts which need to be taken into consideration but initial assessment suggests that these can be largely mitigated. There is thus a trade off between environmental impacts considered to be small (apart from sediment disposal requirements for the tunnel options) and improved traffic performance.

15.5.3 None of the alignments deliver positive financial returns at the 5% discount rate meaning that Government subsidy would be required to support the TYLL.

15.5.4 For the CASET indicators only, a simple summation of rankings indicates that the bridge options (Options 4 to 7) perform well with Option 7 the best. For the combined CASET and other sustainability indicators, Option 4 is the best performer in terms of simple rankings but all of the bridge options perform well and there are only relatively small differences between them. Some of the likely environmental impacts will be associated with the construction stage and as such will be relatively short term/temporary and will be localised.

15.6 Engineering Feasibility Study

15.6.1 Proceeding from the option assessment study, the preferred and endorsed TYLL alignment was further refined and taken forward for engineering feasibility study.

Highway Design and Toll Plaza

15.6.2 The proposed TYLL is a dual 3-lane road link with a design speed of 80 km/hr which provides an additional strategic route crossing between Lantau and Tsing Yi. General engineering layout drawings, vertical profiles and typical cross sections for the TYLL are included in this Report.

15.6.3 The highway alignment was designed in accordance with the requirements stated in the TPDM. While the TYLL mainline can meet the desirable minimum radius of R4 for 80km/hr design speed and the desirable maximum gradient, the NLH eastbound link road to TLB can only meet the normal minimum radius of R3 due to the constraints imposed by the MTRC Airport Express Railway. Also, about 285 m long of NLH westbound link road from TLB and 65 m long of TYLL eastbound link road to ETYV will have a down gradient of 6% in order to meet the headroom requirements.

15.6.4 The existing Lantau Toll Plaza will be relocated and expanded for the TYLL at about 250m south-westward from its existing location. The toll plaza is approximately 600 m in length with a maximum width of 124 m, and will accommodate a combined total of 24 tolling lanes. Other toll plaza and TYLL ancillary facilities include administration and tunnel buildings, bus lay-bys, weigh station, overheight vehicle detection facilities, dangerous goods vehicle detection facilities, control kiosks, sub-control room, recovery areas, etc.

Rock Tunnel

15.6.5 The rock tunnel at Tsing Yi will most likely be constructed by drill and blast method. The principal concerns associated with the construction are the potential adverse effects of ground vibration on adjacent slopes, intermittent suspension of traffic flow at Tsing Yi Road, and potential impact to the nearby oil depots. The delivery of explosives for blasting also has potential hazard to the public. According to GEO Circular No. 27, a blasting assessment should be undertaken to assess the adverse effects and hazards, and to propose measures to demonstrate the

practicality of carrying out the required blasting works. Such assessment should be conducted at the next stage of the TYLL Project.

15.6.6 There are three common types of tunnel ventilation system, namely longitudinal, fully transverse and semi-transverse systems. Semi-transverse system is the recommended system for the TYLL tunnel. It is mainly due to its cost effective system configuration, simple system design and subsequently simple control and operation, and the omission of jet fans reducing the operation and maintenance costs.

Long-span Bridge

15.6.7 The arch bridge across Kap Shui Mun Fairway has a span of 500 m between the supports, and a maximum structural height at 110mPD, which can fulfil Government Flying Service's operational requirements. The proposed arch bridge is a central single steel tied arch supported by two concrete cantilevered approach spans on the concrete pylons. In the next design stage, parametric studies will be carried out, together with the geotechnical information, to determine the relative spans for steel arch and for concrete approach. If required, additional piers will be provided to give vertical support for the approach decks at the position of the combined foundation of the inclined pylons.

15.6.8 The suspension bridge, with a span of 1,800m between the towers, passes across Ma Wan Anchorage and Ma Wan Fairway. The span-to-sag ratio for this section of TYLL is proposed to be approximately 12.3, which will result in greater stiffness of the bridge system. While the tower heights are constrained by the Airport Height Restriction, a wide bridge deck will not give a good proportion of the structure in aesthetics term. In addition, after considering the aerodynamic behaviour and the cost of construction, the 2nd generation deck, as used in the Tsing Ma Bridge, is considered more ideal in comparison with a wider deck of the 3rd generation. The 2nd generation decks have widely been used for more than a half century. It also has the advantages that the wind and structural health monitoring system in the existing Tsing Ma Bridge would give good data basis to refer to.

15.6.9 Artificial islands around bridge piers provide highly effective vessel collision protection. The land for the artificial islands will be formed by reclamation. In view of the Government Policy to keep sediment in place as far as possible, non-dredged method involving drained reclamation with marine deposits left in place will be adopted. The land will be formed at a nominal reclamation level of +6mPD with sloping armour seawall at the peripheral of the islands. Fill material can be the excavated material generated from the rock tunnel construction.

15.6.10 As moderately or better rock will not be encountered at shallow depth, the possible foundation type for the bridge towers and supports will be caisson bearing on rock. After the artificial islands are formed and towers are constructed, the suspension bridge segment will be installed by lifting from barge with conventional gantries. These are established techniques/technologies and do not pose insurmountable challenges. For the arch bridge, the whole tied arch can be prefabricated offsite, floated into place and lifted into position.

Viaducts

15.6.11 Precast prestressed single-cell concrete box girder is proposed for all the elevated structures. Span lengths for the proposed viaducts fall between 40m and 80m that is well within the economic range of 40m to 150m.

15.6.12 Bridge deck segments will be produced across the border in Mainland China and shipped to site before construction. Possible site for temporary storage of bridge segments, and contractors' other equipments / materials are identified on Cheung Tung Road near Yam O Wan. The space is currently used for Penny's Bay Reclamation Stage 2, and the availability of the site should be further checked nearer the time of TYLL construction. On Tsing Yi side, the temporarily occupied area at MSCT can be a possible temporary storage area. However, the effect on the operation of MSCT needs to be further investigated and reviewed.

15.6.13 Various construction methods were reviewed with respect to the constraints and obstacles encountered by each elevated structure. All viaducts in this project, including those at the western connection at Lantau, eastern connection at Tsing Yi, as well as along the mainline, were recommended to be constructed using the balanced cantilever method with gantries. Construction in-situ by means of form traveller is also feasible as an alternative, albeit a longer construction period.

Site Offices

15.6.14 Area for site office would also be provided in the same area as the temporary storage area on Cheung Tung Road near Yam O Wan. The plan area is considered sufficient for site offices for both the resident site staff and contractors, together with the necessary temporary storage area.

15.7 Geotechnical Appraisal Study

Data Collection and Ground Investigation

15.7.1 Total of 76 volumes of previous ground investigation reports were retrieved from GIU and reviewed to assess the ground condition for the preferred TYLL alignment. Interpretation of aerial photograph dated from 1963 to 2006 was carried out in order to develop the site history including any past landslide and land uses.

15.7.2 Ground investigation works, including 9 numbers of land drillholes, 13 numbers of marine drillholes, 7 numbers of CPTs and a series laboratory testings were assigned for this Assignment to provide the basic ground conditions and review the consistency to the existing information from GIU. Marine geophysical surveys were also carried out to investigate the sub-seabed stratification and buried features.

Eastern Landing at Tsing Yi

15.7.3 A drill and blast excavation method is recommended for the construction of rock tunnel due to the significant hard rock excavation. The stability of the soil and rock slopes and the unstable / loosened rock blocks are the key hazards associated with

the vibration induced by the blasting works. Intermittent suspension of Tsing Yi Road traffic flow may be required.

15.7.4 As the tunnel is generally remote from the existing densely populated residential areas, the risk associated with rock tunnel blasting is considered to be low. However, a detailed blasting assessment should be conducted to assess the potential adverse effects and hazards.

15.7.5 Consideration should also be given to the geotechnical issues associated with locations where the tunnel crosses areas where locally weak or fractured zones would be expected. More specific and detailed ground investigation would be required.

15.7.6 Extensive site formation, including slope cuttings and retaining structures, may be required for the construction of tunnel portals, link roads and the re-aligned portion of Tsing Yi Road. The design of site formation shall follow Geotechnical Manual for Slopes and Geoguide 1. It is recommended that a detailed natural terrain hazard study should be carried out and also provision should be made for rock stabilization works at the slopes near the tunnel portals.

Western Landing at Lantau

15.7.7 The locations of link road foundations should be carefully selected to avoid affecting the existing utilities, in particular those for the existing Lantau Toll Plaza. Extensive cutting toward the existing hillside and retaining walls will be required in the re-alignment of NLH and relocation of Lantau Toll Plaza. At this stage it is considered that slope excavation using non-explosive methods would be more appropriate.

Marine Area

15.7.8 The artificial islands will be located off the existing shorelines and there is essentially no natural terrain hazard likely to impact on the construction of the islands. For the proposed reclamation at Yi Chuen, the natural terrain behind may pose hazard on the construction of reclamation and the operation of the associated structures. A detailed natural terrain hazard study including a thorough boulder survey and stream course survey is recommended to be carried out to study the risks to the reclamation area.

15.7.9 The artificial islands and reclamation areas can be constructed using the drained method having compressible material left in place with ground treatment works to accelerate the consolidation process.

Further Geotechnical Assessments

15.7.10 Further ground investigation shall be carried out in later stages to verify the ground conditions of the project area, in particular the offshore area where foundations of the preferred option of TYLL will be constructed and the area where the proposed tunnel is located.

15.7.11 All existing man-made slope features and natural terrain catchments will need to be studied, and necessary slope works and hazard mitigation measures will be carried out as part of the Project.

15.7.12 Further geotechnical assessment will need to be carried out for the preferred option at the Study/Investigation/Preliminary Design Stage to define the scope and programme of necessary slope works, and hazard mitigation measures to be carried out under the Project.

15.8 Utility Impact Assessment Study

15.8.1 Various utility undertakers and Government departments were contacted for the existing and planned utilities within the study area of this Assignment. The affected utilities include CLP power cables, HyD lighting cables, drainage and sewerage systems, water works and telecommunication cables.

15.8.2 Utility diversions are required for underground cables and pipelines only. The diversions are needed mainly to cope with the realignment of the NLH at Lantau and Tsing Yi Road at Tsing Yi. The affected utilities are expected to be diverted in conjunction with the realignment of the concerned roads. No submarine utility is identified in the vicinity of the proposed TYLL alignment. Therefore, it is anticipated that no submarine utility will be affected by the TYLL project.

15.8.3 The elevated link roads at Lantau may have interface with the existing 1950 diameter cross-road drainage pipe and the connecting box culverts. The piers and foundations of the link road should be properly placed to avoid the conflicts.

15.8.4 The elevated link roads at Tsing Yi cross over one 132kV power cable, a 3.5m x 3.2m box culvert, one 250 LPB gas main and some water mains. No direct impact to these utilities is anticipated at this moment as the link road piers and foundations could strategically be placed to avoid conflict with these utilities.

15.9 Drainage Review

15.9.1 The existing drainage systems which are likely affected by the road alignment of the TYLL were reviewed. Preliminary hydraulic assessment of the existing drainage systems reveals that most of the outfalls are adequate to cater for the design peak runoff of 1 in 200 years return period except the exclusive road drains/ outfalls. However, it is unlikely that surcharging from these drainage systems will be conceived as flooding.

15.9.2 The potential drainage impacts arising from the implementation of TYLL were studied. In general, adverse drainage impacts are not envisaged from the elevated structures and tunnel of TYLL. These features could either have their collected runoff discharged to the existing drainage or have their own drainage systems providing discharges to the sea.

15.9.3 The identified drainage impacts include increase in runoff due to the increase in impermeable surfaces of roadworks, obstruction of overland flow by road embankment and cut/ fill slopes, transfer of catchment arising from change of ground profile to suit the road alignment. However, these impacts are considered insignificant and can be catered for by typical upgrading of the existing local drainage systems.

15.9.4 The key potential drainage impacts are expected from the proposed extensions of existing box culvert and cross-road drain. Detailed hydraulic assessment is recommended to assess the potential impacts to the systems arising from the proposed extensions. As the preferred TYLL alignment is situated near coastal area and is subject to tidal effect, detailed backwater analysis is recommended to assess the potential impacts to the existing and proposed drainage systems under the combined effects of rainstorm event in conjunction with the tidal influence.

15.9.5 The TYLL should provide drainage mitigation measures in the design of proposed storm water intake at the next stage of the project.

15.9.6 A Drainage Impact Assessment (DIA) Study is required for this project. The DIA Study shall follow the scope and requirements set out in ETWB TC (Works) No. 2/2006 – "Drainage Impact Assessment Process for Public Sector Projects". The DIA Study for TYLL would be conducted at the next stage of the Project.

15.10 Environmental Review

Air Quality

15.10.1 Generation of dust from e.g. exposed works areas, stockpile, vehicle movement on unpaved roads, excavation and handling of construction materials, etc was identified as the key impact. This will require effective mitigation measures to minimise the impacts. Key air quality concerns during operational phase will be vehicular emissions from new road traffic from slip roads, and tunnel portal and tunnel ventilation shaft emissions (in Tsing Yi). Significant impacts will be unlikely due to rapid dispersion of emissions.

Noise

15.10.2 Construction noise impacts will arise from construction activities, e.g. drill, blast and material removal operations for the tunnel excavation and viaduct construction. Some of the closest sensitive receivers at the western connection in Lantau are expected to be subject to exceedances of noise criteria. Mitigation measures are likely to be required. Preliminary assessment for operational phase indicated that some of the closer receivers at the western connection in Lantau could be subject to noise levels exceeding the relevant criteria. It is expected that a range of noise barriers would be required.

Water Quality

15.10.3 Increased suspended solids due to marine reclamation and bored piling works are anticipated to be highly localised. Deployment of silt curtains and implementation of good site practices will reduce such impacts. Impacts on changes in

hydrodynamic regime due to marine construction works sites are only temporary. It is not anticipated that any adverse impacts will be encountered during the construction phase. For the operational phase, with proper design of the project layout, it is expected that the project would cause negligible changes in hydrodynamic regime and road surface runoff.

Ecology

15.10.4 At the western connection in Lantau, there would be permanent loss of some shrubby grassland, disturbance to potential egretry and rare/protected species anticipated. Temporary deterioration of water quality of natural streams may occur. Loss of mostly soft bottom benthic habitat and short sections of natural rocky shores habitat at Yi Chuen and Tang Lung Chau, indirect impacts on coral colonies near Sham Tseng and Sze Pak Wan and potentially at far field areas like Peng Chau, Kau Yi Chau and Green Island, and noise disturbance to Chinese White Dolphin would be anticipated. There would be no significant impacts on terrestrial ecology anticipated in the eastern connection in Tsing Yi. Whilst indirect impacts to the marine ecology are not anticipated, detailed water quality studies and assessment would be required to confirm the water quality impacts are within the acceptable levels. The need for ecological surveys such as vegetation survey/ habitat mapping, coral dive surveys, intertidal and benthic surveys should be considered in the next EIA stage to collect updated ecology information in the study area and confirm the existence of any sensitive ecological habitats/species, in particular to the areas subject to direct habitat loss.

Fisheries

15.10.5 Potential impacts on fisheries resources will include the temporary and permanent loss of fishing grounds (permanent loss: ~26ha of artificial island), temporary water quality deterioration, and permanent change in hydrodynamic regime. Mitigation measures during construction and operation will need to be determined based on the full assessment.

Waste Management

15.10.6 Construction activities will result in the generation of large quantity of various waste types. The waste management hierarchy which shows the desirability of various waste management methods and comprises the order of preference: avoidance, minimisation, recycling/reuse, treatment, and disposal should be applied.

Cultural Heritage

15.10.7 There were no direct or indirect impacts anticipated on any known archaeological sites or areas of archaeological potential. No built heritage resources identified within the area of land resumption, hence likely to be no direct impacts, but indirect impacts to the Declared Monument Tang Lung Chau Lighthouse the areas of built heritage potential identified at Ng Kwu Leng and along the existing North Lantau Highway may occur. Disturbance to the seabed will be the potential threat and damage to the submerged archaeological remains and resources due to dredging

works. Geophysical surveys should be conducted to establish the presence of marine archaeological resources.

Landscape and Visual

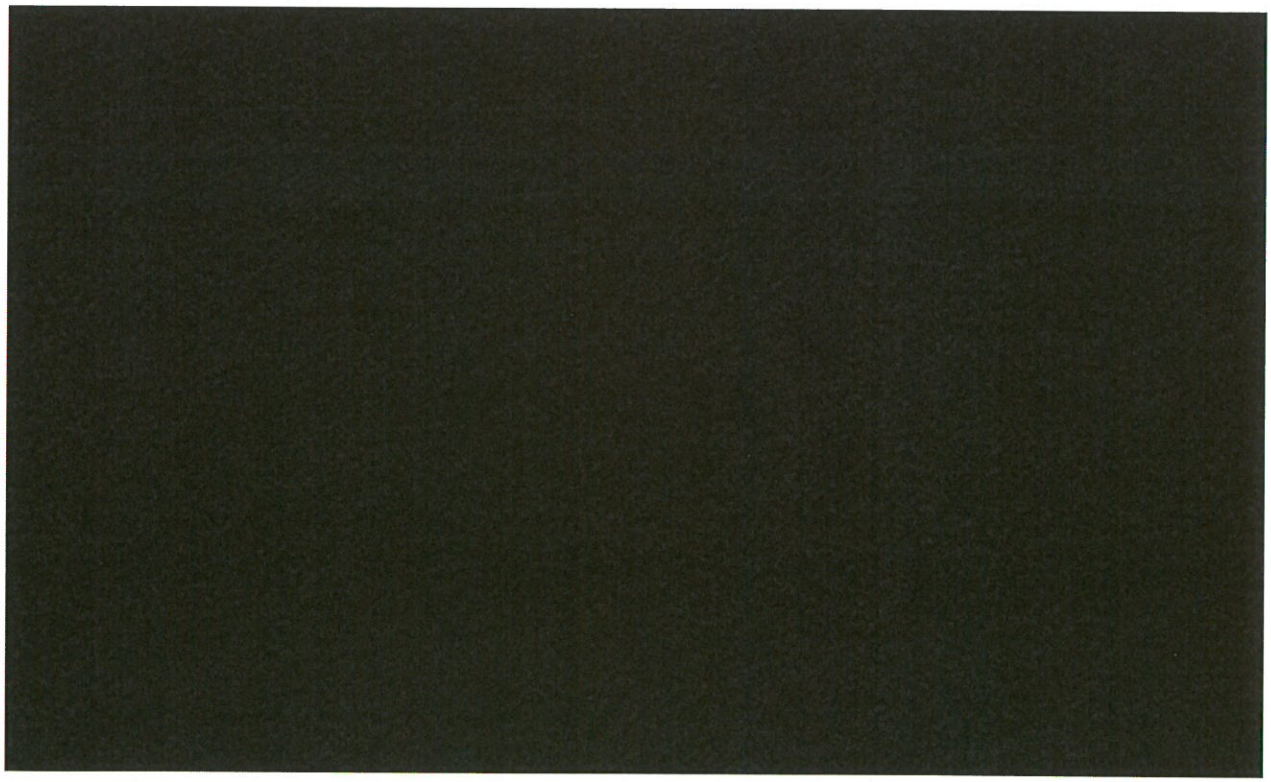
15.10.8 On landscape resources, there would be potential loss of sensitive natural coastline, open grass and shrub hillside, undisturbed ridgeline and coastal woodland tree groups from embankment works at proposed climbing roads, landing point and the Tsing Lung Bridge connection. Potential impacts on landscape characters to Coastal Upland and Hillside Landscape (more sensitive), and Transportation Corridor Landscape (less sensitive) at bridge landing area at San Po Tsui would be anticipated. The project may also cause impacts on Visually Sensitive Receivers. Impacts on Green Belt at Tang Lung Chau and San Po Tsui would be anticipated.

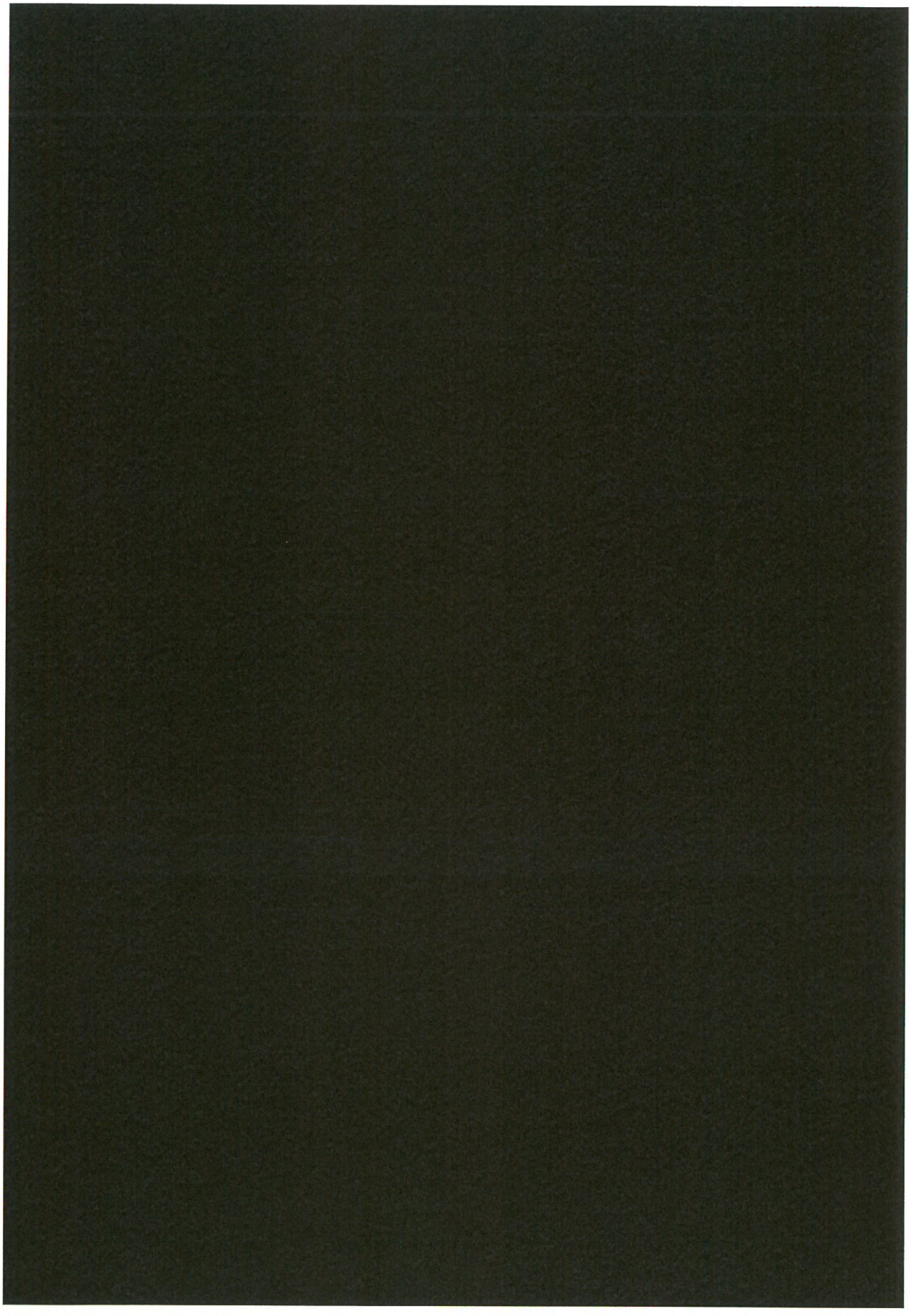
Hazard to Life

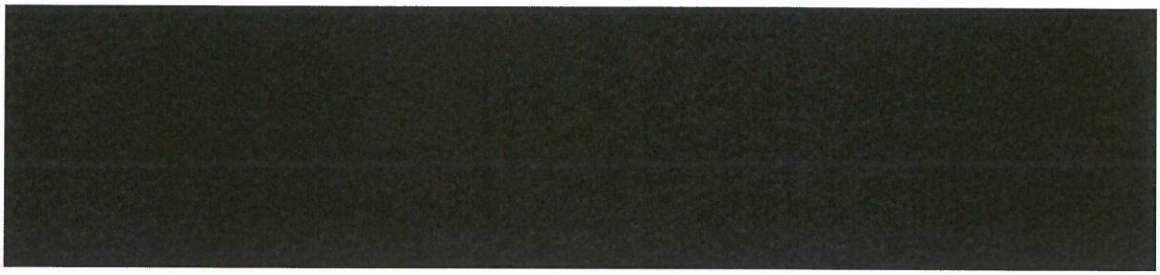
15.10.9 There would be potential risk of fire and explosion of LPG storage tanks and jetty, causing hazard to life of construction workers, future road users and operators at the eastern connection in Tsing Yi. Quantitative risk assessment to evaluate the individual and societal risks and recommend mitigation measures.

Overall Conclusion

15.10.10 Full assessments should be conducted to verify and confirm the scope and extent of mitigation measures necessary to reduce the environmental impacts to acceptable levels. It is anticipated that, with the proper implementation of mitigation measures, there will be no insurmountable impacts arising from the Project.







15.12 Implementation Strategy, Programme and Cost Estimates

15.12.1 The preferred option for the TYLL involves reclamation of the artificial islands, and it is intended that non-dredged method with marine deposits left in place will be adopted. Advance works contract may be necessary to expedite the construction of the Project. At the same time, however, to fully utilise the generated C&D materials for the reclamation, a single contract is required. Another strategy is to package all the works except the arch bridge and the suspension bridge, as an advance works contract. This can facilitate the early commencement of reclamation works while fully utilising the excavated C&D materials. However, this approach will create contract interface and the expedition is not of significant level. The final arrangement of the contract packaging should be further reviewed at the next stage of the Project.

15.12.2 Following the reference guide in ETWB TCW No. 32/2004, an assessment on the procurement approach for a single TYLL construction contract was conducted. It indicates that a more preferable procurement is under the Designer Led approach. However, the Design & Construct approach and the Design Construct & Operate approach should not be ruled out at this stage as they both are expected to perform well in most of the selection criteria. The final selection will require further consideration at the preliminary design and detailed design stages when this Project proceeds.

15.12.3 The implementation programme is shown in **Figures 13.1** and **13.2**. The activities identified as being critical to the completion of the Project include environmental impact assessment, roads ordinance gazette, pre-qualification and tender for works contract. The programme indicates that the TYLL will be open to traffic in approximately eleven years after the commencement of the Investigation and Preliminary Design Consultancy.

15.12.4 The average risk estimate of the TYLL at September 2007 price level is HK$20,174.8 million. The annual recurrent maintenance estimate for the Project is HK$170.2 million.

15.13 Recommendations

15.13.1 The following key works / studies are recommended to be undertaken at the next stage of the Project.

- Review of the feasibility of immersed tube tunnel across the fairways and anchorages in place of long-span bridge;
- Review of airdraft requirement with respect to the future developments in ship size/design;
- Detailed assessment for reprovisioning of anchorage space due to loss of anchorage space caused by the TYLL;
- Detailed radar design;
- Review of operation, maintenance and management interfacing issues (including TCSS provision and contingency arrangement for handling emergencies, incidents and inclement weather conditions with Tsing Ma Control Area and other tunnels in the vicinity);
- Detailed traffic impact assessment;
- Tolling strategy;
- Review of the proposed alignment of the Link at southwest Tsing Yi in light of the proposed Container Terminal 10 development;
- Detailed marine traffic impact assessment;
- Further marine and land ground investigations;
- Blasting assessment;
- Natural terrain hazard assessment;
- Geotechnical assessment on existing man-made slope features;
- Drainage impact assessment;
- Environmental impact assessment; and
- Identification of works areas, in particular the temporary storage areas and site offices at Tsing Yi and Lantau.

(Not Used)

APPENDIX A

Major Development Assumptions

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

MAJOR DEVELOPMENT ASSUMPTIONS

A.1 Introduction

A.1.1 There are a number of major developments on Lantau which are subject to ongoing studies and review.

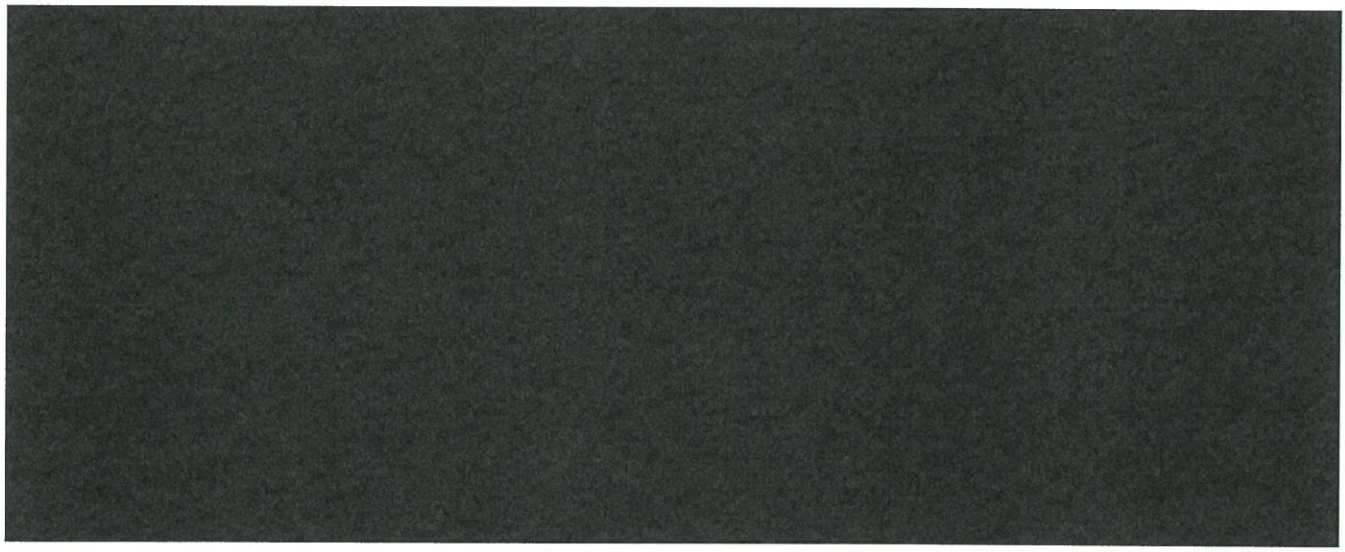
A.1.2 Planning Department has confirmed (email dated 27 March 2007 and comments on TP2.1) that the development information on Lantau as adopted for the recent Link Options between Tuen Mun and Lantau – Feasibility Study (TMLL) should be adopted for this study. The development assumptions in the rest of Hong Kong are the same as in **Tables 3.2.1** and **3.2.2** as updated development data is not available (email exchange with Planning Department on 3rd March 2007 refers).

A.1.3 Airport and port-related demands are presented in **Chapter 3**.

A.2 New Town and Residential Developments

A.2.1 Major residential developments were assessed as part of the standard MVCTS four-stage approach. Major developments include:

- Tung Chung Town Developments;
- Tuen Mun Area 55; and
- Hung Shui Kiu Developments.



A.3 Developments on Airport Island

A.3.1 Developments on Airport Island are given special attention in terms of trip-rates and distribution. These include:

- Sky City developments located in the North Commercial District (NCD) of Airport Island (which includes Sky Plaza), plus some additional development in the East Commercial District (ECD); and
- Asia World-Expo (AWE) future expansion.

A.3.2 The assumptions adopted for the recent CE45/2005 (HY) - Link Options between Tuen Mun and Lantau – Feasibility Study will be adopted as a reference point for this study and are summarised below. AAHK have confirmed (email dated 2 May 2007 refers) that this information remains the most appropriate basis for forecasting.

North and East Commercial District (NCD and ECD)

A.3.3 The information, as provided by the AAHK in April 2006, shown in **Tables A.2** to **A.4**. AAHK have recently confirmed that this information remains current and suitable for use, although the specific development mix is still under review.

Table A.2: Sky Plaza Development Plan (GFA sq m)

Type	2006	2010	2015	2020	Total
Office	32,850	59,640	59,640	59,640	211,770
Retail	38,360	7,210	7,210	7,210	59,990
Sub-total	71,210	66,850	66,850	66,850	271,760
Other Uses(2)	-		-	-	39,090
TOTAL					310,850

Notes:
(1) Development schedule data from MP2025 – Transport Study.
(2) "Other Uses" include SkyPier, Terminal, GTC and Ancillary Uses.

Table A.3: Sky City and Asia World Expo Development Plan (GFA sq m)

Type	2008	2010	2015	2020	2025	Total
Hotel	56,000	24,000	50,000	-	-	130,000
Office	-	-	-	165,655	165,655	331,310
Trademart(2)	-	-	35,000	-	-	35,000
AWE (Hall Space)	66,000	34,000	-	-	-	100,000
Sub-total	122,000	58,000	85,000	165,655	165,655	596,310
Other Uses(3)	-	-	-	-	-	110,000
TOTAL						706,310

Notes:
(1) Development schedule data from MP2025 – Transport Study.
(2) Trademart assumed to be 50% retail and 50% office.
(3) "Other Uses" include SkyPier, Terminal, GTC and Ancillary Uses.

Table A.4: Airport Support and Related Developments (GFA sq m)

Description	Estimated Completion Date	GFA (m^2)
Airport Support Development	2006 – 2015	1,611,800
Airport related Development	2006 – 2030	1,109,000

A.3.4 Development assumptions for the East Commercial District are for 40,000 m^2 GFA by 2015 for business/office purposes.

Asia World Expo

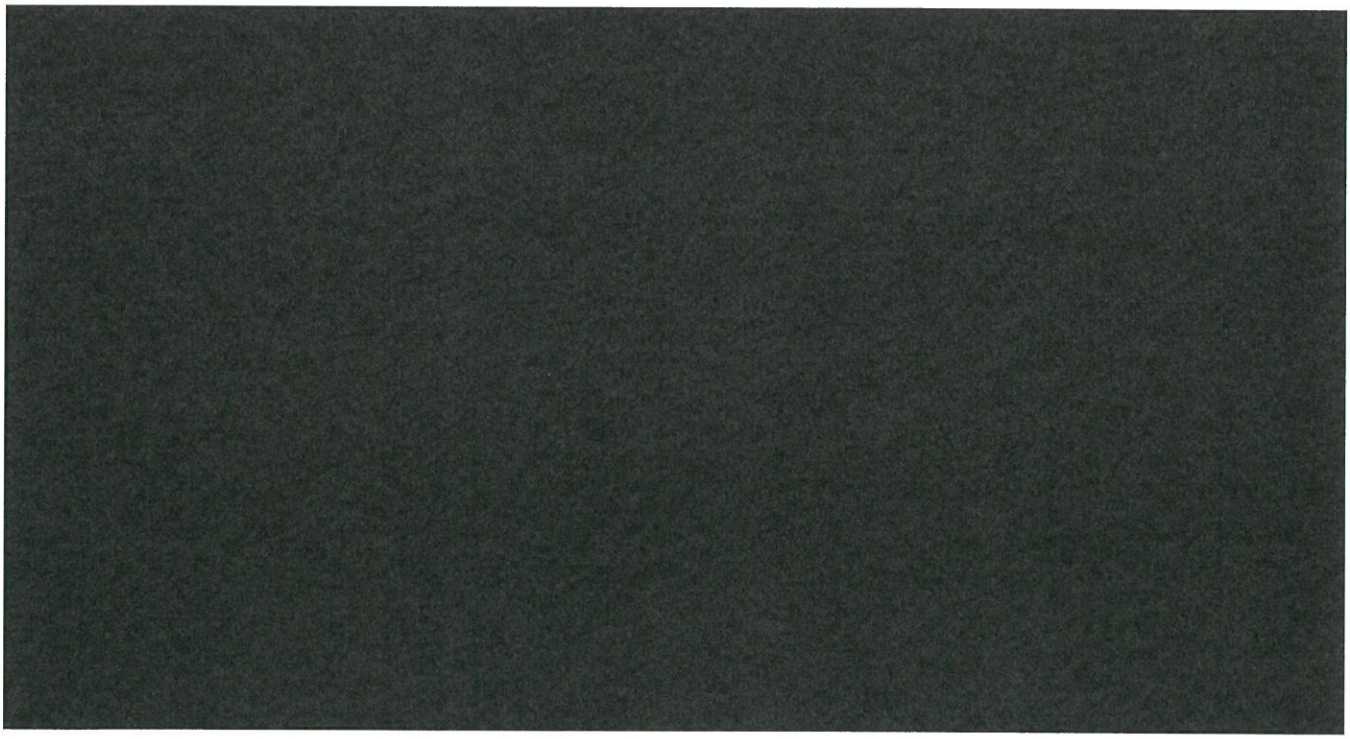
A.3.5 As advised by the AAHK from the Airport MasterPlan 2025, the AWE will increase in GFA from 66,000 m^2 for exhibition purposes in 2006 (Phase I) to 100,000 m^2 by 2010 (Phase II).

A.3.6 Phase I traffic to/from the AWE during an event was assessed as part of the Supplementary Traffic and Transport Provision Report (September 2004) for both a "Normal Event" (46,600 daily visitors/exhibitors) and a "Mega Event" (up to 80,000 daily visitors/exhibitors). According to these assumptions the AWE TIA found that a normal "public exhibition" event would generate/attract 1,165 PCUs in the peak direction AM/PM peak hour, and that a "mega public exhibition" would generate 1,949 PCUs.

A.3.7 For this assessment, the traffic generated by a "normal" public exhibition event at Phase II of the AWE will be included within the reference case traffic assessment. Traffic generated by a mega event has not been included within the Reference Case assessment for several reasons as follows:

- Events at the AWE which generate high volumes of traffic will be associated with temporary traffic management measures;
- The use of a normal event is considered reasonable in terms of infrastructure planning as a "mega-event" occurs only twice per year;
- The TIA recognised that it adopted conservative (high-end assumptions) in terms of assumed arrival/departure rate within the peak hour, and rail mode share for major events; and
- The peak hour for events at the AWE does not coincide with the peak hour for non-AWE traffic.

A.4 Tourism and Recreation Developments



A.4.2 The tourism and recreation developments are not significant generators of peak hour traffic on an average weekday but can cause high demands at peak times of year. For this assessment, traffic to/from the planned tourism and recreation developments will be based on the employment data at the site. However peak demand periods - which occur outside of an average weekday forecasts - will need wider consideration in the future traffic assessment for each of the new developments.

A.4.3 Surveys undertaken on Penny's Bay Highway (**Table A.5**) quantify the amount of normal weekday traffic and give a basis for future year traffic forecasts.

Table A.5: Observed Traffic on Penny's Bay Highway (March 2006)

	AM Peak Hour (PCUs)				PM Peak Hour (PCUs)			
Direction	**PV**	**GV**	**Other**	**Total**	**PV**	**GV**	**Other**	**Total**
Northbound	38	85	43	165	146	94	53	293
Southbound	170	127	41	338	43	40	45	127

Note: Other includes franchised bus and coach.

A.5 Freight and Logistics, and Transport Hubs

A.5.1 In addition to freight traffic related to the airport (cargo and flight-support related traffic), logistics-related developments include:

- Container Terminal 10;
- Lantau Logistics Park; and
- Transport Hub and Commercial Development at Siu Ho Wan MTR Depot.

Lantau Logistics Park at Siu Ho Wan

A.5.2 The implementation programme of the LLP is under review and the operation is likely to start beyond 2011. It is assumed that the full employment figure of over 10,000 is achieved by the 2016 modelled year, and that the number of daytime employees will be around 4,000. In the 72-hectare LLP, 600,000 square metres is planned for logistics uses and the remainder planned for road & utilities reserves, open space, support building facilities and marine cargo handling facilities.

A.5.3 The proposed landuse of the 40-hectare area to the west of the LLP is referred to "possible LLP extension or other compatible uses". At present, recreational use as a motor racing circuit is a possibility (see above). There is no development program for this extension. The LLP extension has been adopted in the base case assessment for year 2021 and 2030.

A.5.4 Traffic to/from the Lantau Logistic Park was previously assessed as part of the LLP Feasibility Study dated June 2007 and is summarised in **Table A.6** based on surveys at major logistics sites. It is assumed that these forecasts were for an "average" day, rather than a "peak" day.

A.5.5 The distribution of trips using the LLP was also estimated as part of the FS. For year 2021 with around 30% to/from the airport, 20% to/from CT10 (assumed at Northwest Lantau) and the remaining 50% mainly to/from areas apart from Lantau.

Table A.6: Lantau Logistics Park – Total Traffic Generation

PCUs / Hour	AM Gen.	AM Att.	PM Gen.	PM Att.
Based on a LLP of 600,000 sq. metres GFA				
2005	n/a	N/a	N/a	n/a
2011	1,000	900	1,200	1,000
2016	1,400	1,200	1,600	1,400
2021	1,700	1,500	1,800	1,700
Additional Traffic due to the Potential Logistics Park Extension (40 ha)				
2021	1,000	900	1,100	1,000

Note: Based on LLP TIA, June 2007.

Transport Hub and Commercial Development at Siu Ho Wan MTR Depot

A.5.6 The MTRCL proposal for a Transport Hub at Siu Ho Wan MTR Depot includes the following developments in Phase 1:

- An MTR station at Siu Ho Wan (on the Tung Chung Line);
- A parking facility for some 1,200 coaches and private cars;
- A large PTI which is subject to further study and agreement by Transport Department;
- A commercial complex of about 190,000 sq.m GFA of food, entertainment and retail; and
- Hotel development for about 1,800 rooms occupying around 70,000 sq. m. GFA.

A.5.7 According to the methodology adopted in the LLP FS, the traffic generation at the proposed transport hub is summarised in **Table A.7**. The majority of the demand is generated by the retail and hotel developments.

A.5.8 These development parameters were previously confirmed by Planning Department as an update to the 2003-based TPEDM, and are consistent with the assumptions adopted by the LLP Feasibility Study dated September 2005.

A.5.9 In the LLP TIA, the Transport hub development was assumed to be open by 2011 / 2012. Given the revised date for the HZMB and uncertainty over the opening date of the transport hub, the development will be assumed to be in place for the 2016 forecasts, and will not be included within the 2011 forecasts.

A.5.10 As stated above, these assumptions will require review following receipt of any updated information in the recent LLP TIA.

Table A.7: Transport Hub at Siu Ho Wan - Traffic Generation at Opening Year

PCUs / Hour	AM Gen.	AM Att.	PM Gen.	PM Att.
Year 2016	108	108	563	544

Note: Based on LLP TIA, June 2007.

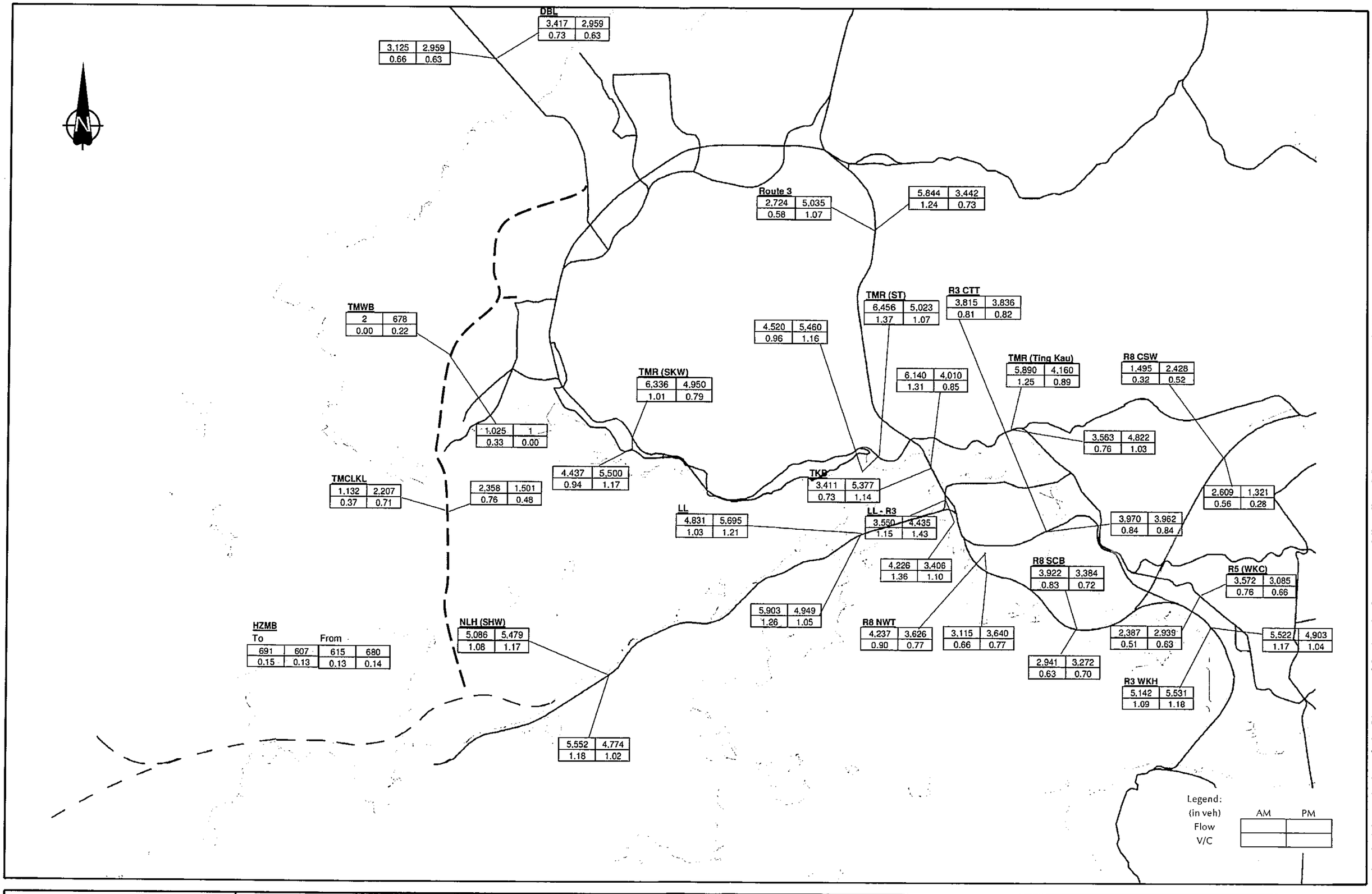
APPENDIX B1

Year 2030 Traffic Forecasts – Reference Case

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)



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邁進基建環保工程顧問有限公司

AGREEMENT NO. CE 40/2006 (HY)
TSING YI LANTAU LINK - FEASIBILITY STUDY

TRAFFIC FORECASTS FOR NWNT REF OPTION (NO TYLL), YEAR 2030

FIGURE B1.1

Scale N.T.S.

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APPENDIX B2

Year 2030 Traffic Forecasts – NWNT Options, No TYLL

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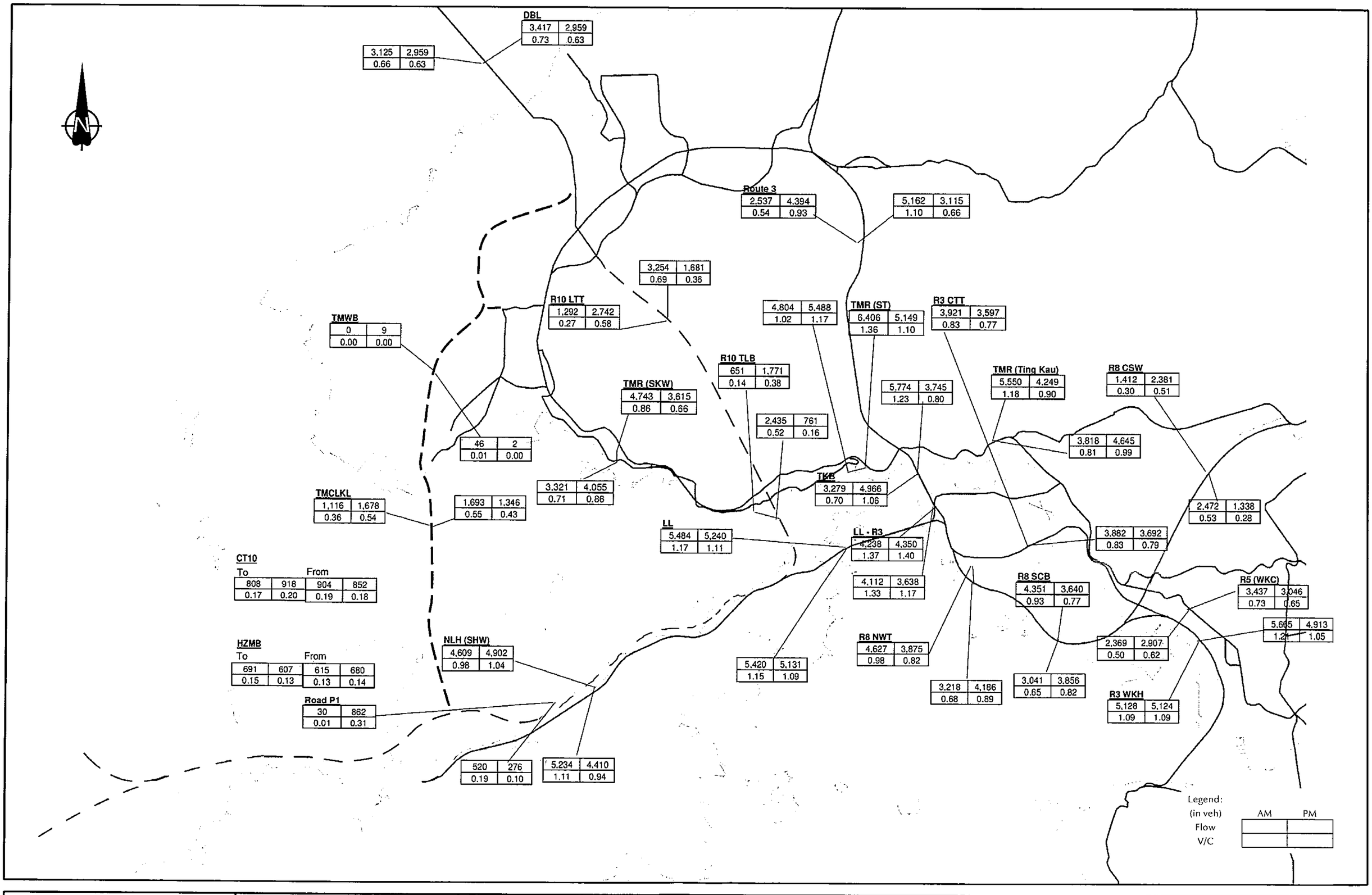

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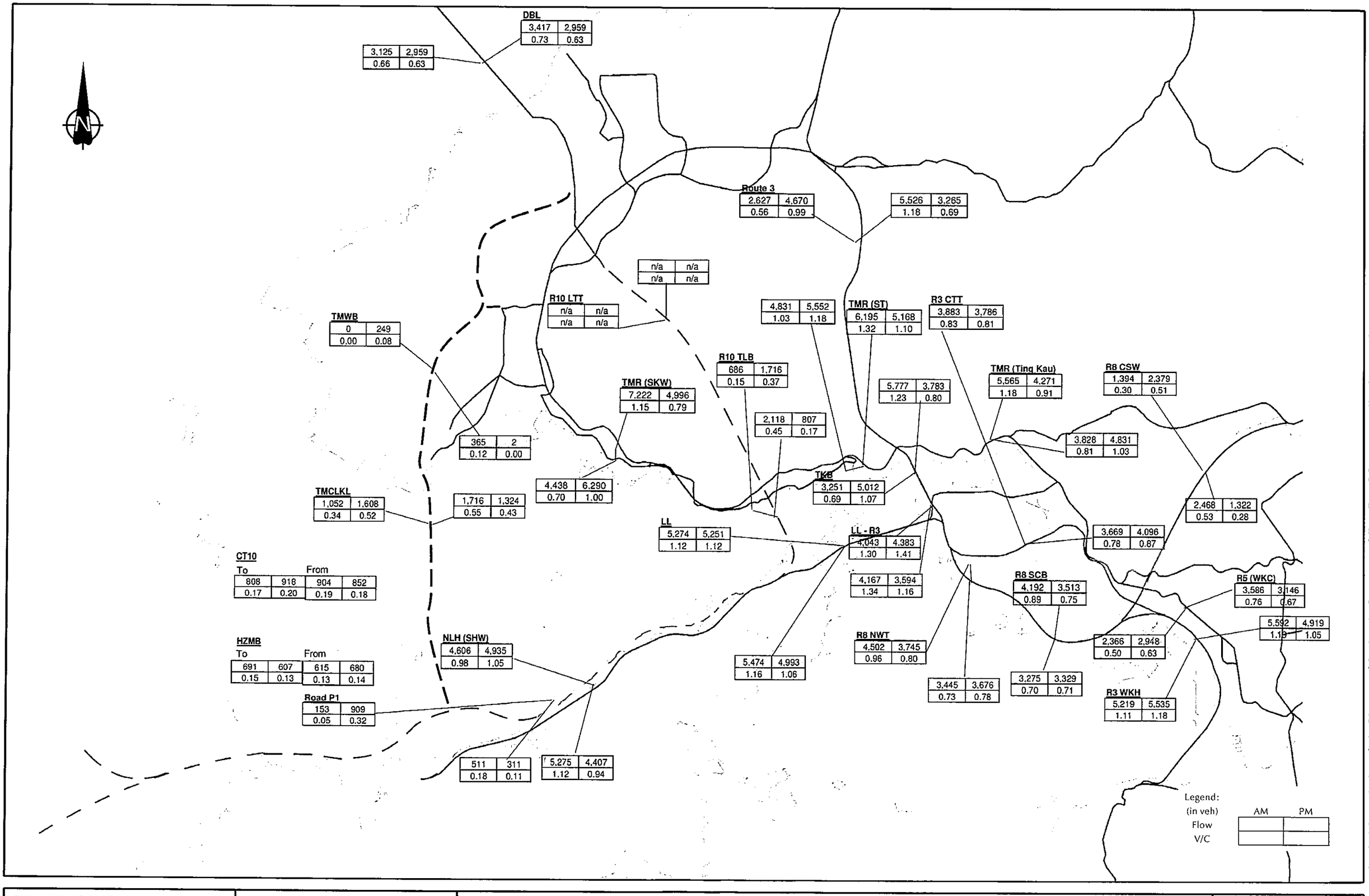
AGREEMENT NO. CE 40/2006 (HY)
TSING YI LANTAU LINK - FEASIBILITY STUDY

TRAFFIC FORECASTS FOR NWNT OPTION 1N (NO TYLL), YEAR 2030

FIGURE B2.1

Scale N.T.S.

CAD FILE : 26999/RDTIA2/B21.CDR/LLH/18NOV08



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Hong Kong - Zhuhai - Macao Bridge
Hong Kong Project Management Office

Meinhardt Infrastructure and Environment Limited
邁進基建環保工程顧問有限公司

AGREEMENT NO. CE 40/2006 (HY)
TSING YI LANTAU LINK - FEASIBILITY STUDY

TRAFFIC FORECASTS FOR NWNT OPTION 3N (NO TYLL), YEAR 2030

FIGURE B2.2

Scale N.T.S.

CAD FILE : 26999/RDTIA2/B22.CDR/LLH/13NOV08

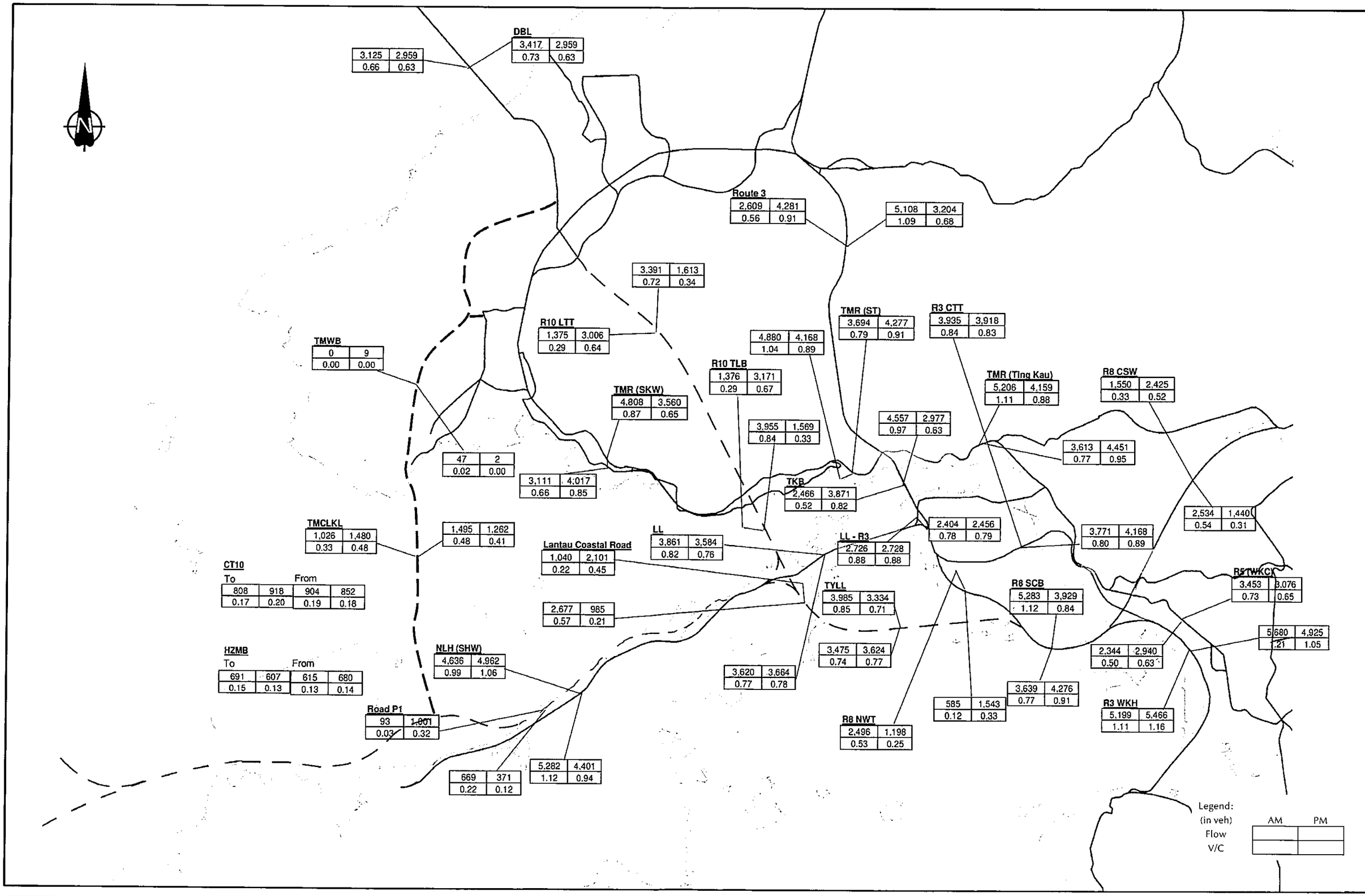
APPENDIX B3

Year 2030 Traffic Forecasts – NWNT Options, With TYLL

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)



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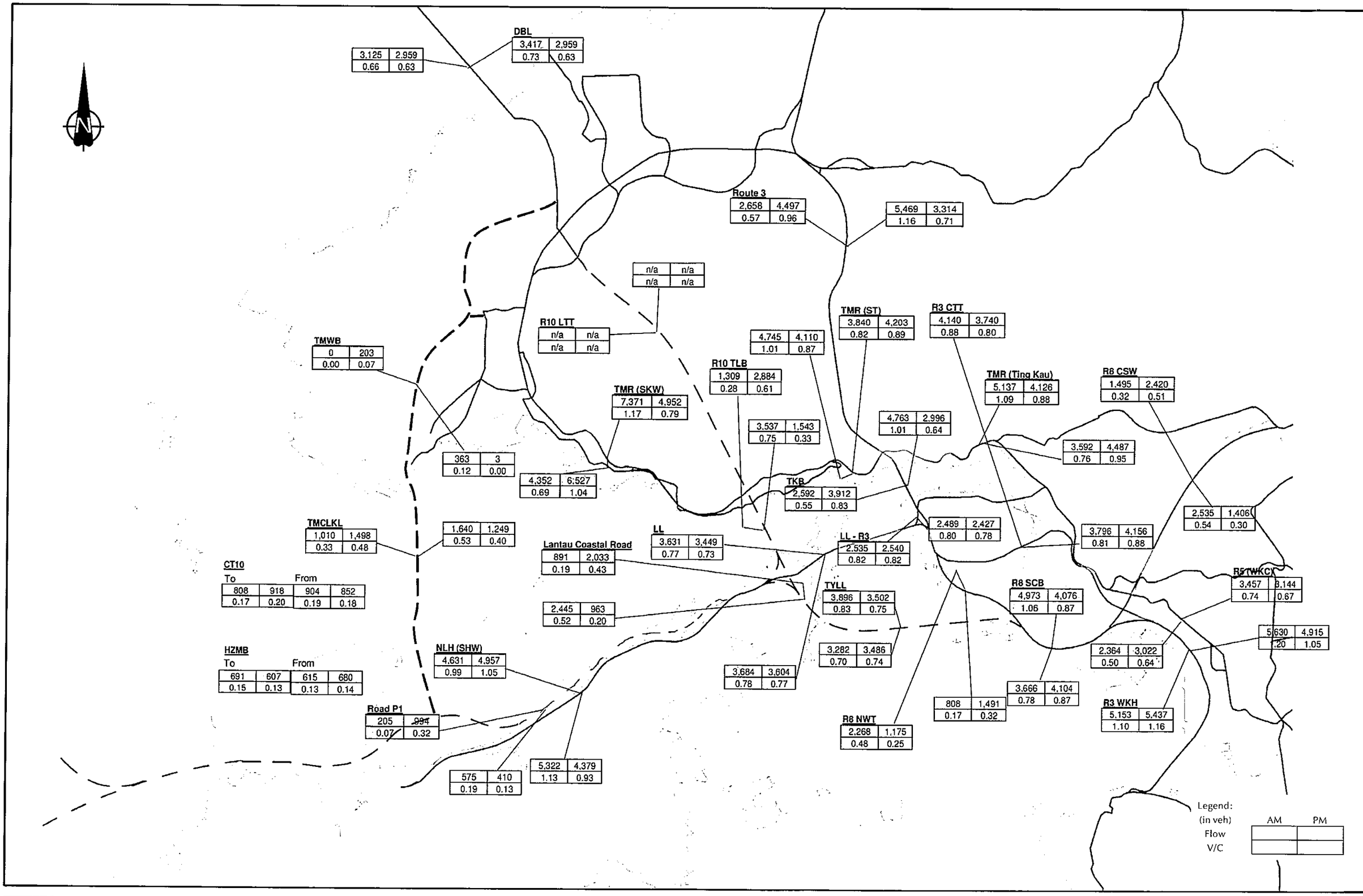
TSING YI LANTAU LINK - FEASIBILITY STUDY

TRAFFIC FORECASTS FOR NWNT OPTION 1T (WITH TYLL), YEAR 2030

FIGURE B3.1

Scale N.T.S.

CAD FILE : 26999/RDTIA2/B31.CDR/LLH/18NOV08



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AGREEMENT NO. CE 40/2006 (HY)
TSING YI LANTAU LINK - FEASIBILITY STUDY

TRAFFIC FORECASTS FOR NWNT OPTION 3T (WITH TYLL), YEAR 2030

FIGURE B3.2

Scale N.T.S.

CAD FILE : 26999/RDTIA2/B32.CDR/LLH/18NOV08

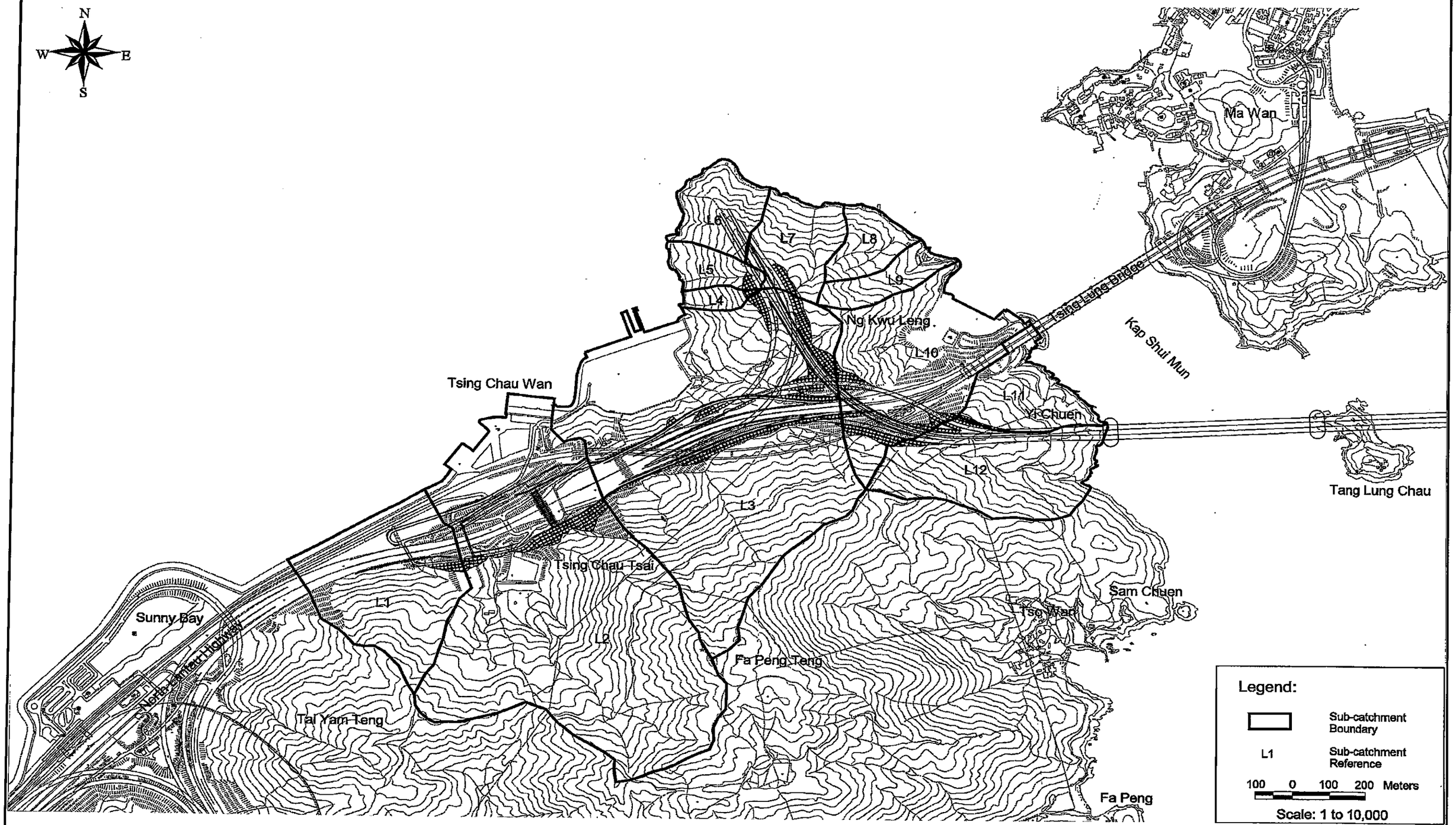
APPENDIX C

Existing Drainage Catchment

Agreement No. CE 40/2006 (HY)

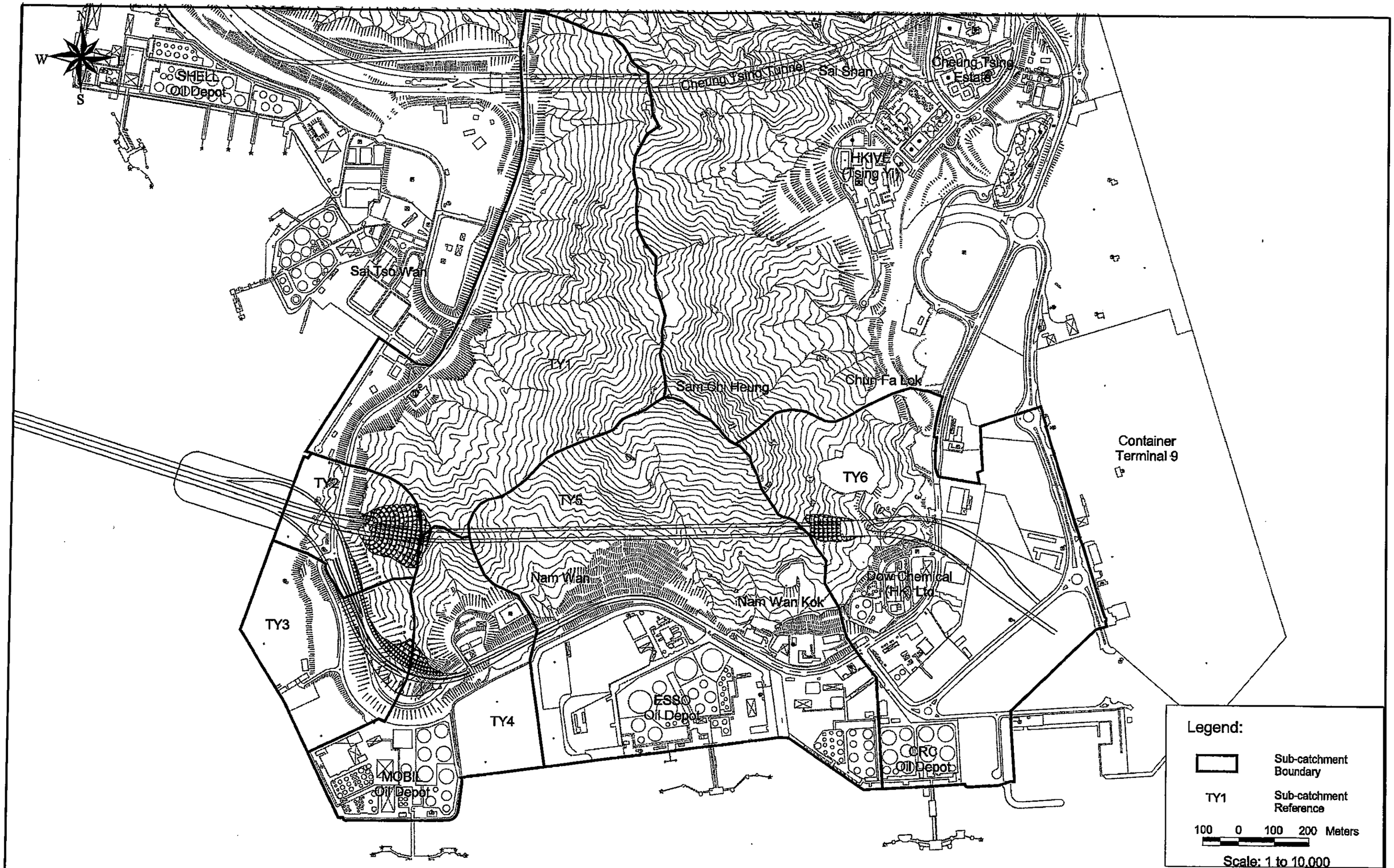
Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)



路政署 HIGHWAYS DEPARTMENT 港珠澳大橋香港工程管理處 Hong Kong - Zhuhai - Macao Bridge Hong Kong Project Management Office	Meinhardt Infrastructure and Environment Limited 邁進基建環保工程顧問有限公司	AGREEMENT NO. CE 40/2006 (HY) TSING YI LANTAU LINK - FEASIBILITY STUDY **EXISTING DRAINAGE CATCHMENS (SHEET 1 OF 2)**	**APPENDIX C1** Scale: AS SHOWN

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Appendix C1.dgn



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AGREEMENT NO. CE 40/2006 (HY)
TSING YI LANTAU LINK - FEASIBILITY STUDY

EXISTING DRAINAGE CATCHMENS (SHEET 2 OF 2)

APPENDIX C2

Scale: AS SHOWN

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Appendix C2.dgn

APPENDIX D

Geological Maps of the Study Area

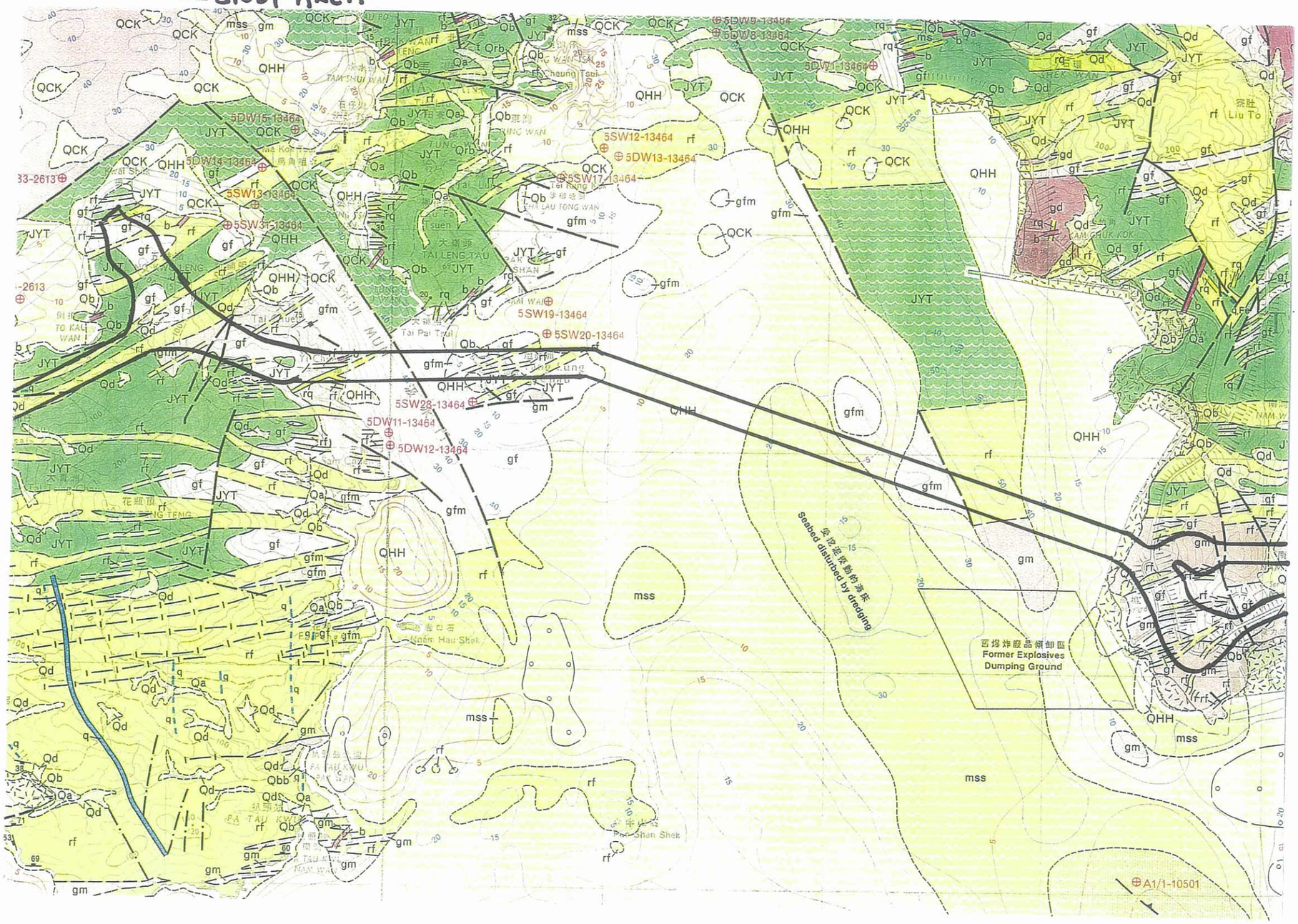
Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

LEGEND:

BOUNDARY OF STUDY AREA



GEOLOGICAL MAP OF PROPOSED TYLL ALIGNMENT

HONG KONG GEOLOGICAL SURVEY
香港地質調查

SILVER MINE BAY 銀鑛灣

Sheet 10 編號

SOLID AND SUPERFICIAL GEOLOGY 基岩和表土地質圖

Series HGM20 組別

Scale 1:20000 比例

SUPERFICIAL DEPOSITS 表土沉積

GENETIC CLASSIFICATION 成因類型		主要物質名稱 PRINCIPAL MATERIALS
Fill 填土		Natural soils and waste
Alluvium 沖積層	Qa	Silt, sand and gravel
Estuarine deposits 河口三角洲	Qi	Mud and sand
Beach deposits 海灘沉積	Qb	Sand
	Qbb	Cobbles and boulders
Back beach deposits 後海灘沉積	Qnb	Sand
Hang Hau Formation 坑口組 — Mud blanket 泥質覆蓋層	QHH	Mud showing acoustic turbidity (gas blanketing) 顯示聲學渾濁的泥土（氣體覆蓋） / Soft to very soft marine mud; some sand 軟至非常軟的海泥；含一些砂
Sand sheets/channel infill 砂床／水道填充	mss	Sand; some gravel and mud 砂；含一些礫石及泥
Sand banks 大型砂丘	mgb	Sand; some gravel and mud 砂；含一些礫石及泥
Debris flow deposits 泥石流沉積	Qd	Sand, gravel, cobbles and boulders in silt matrix 砂、礫石、卵石及巨石，夾在淤泥中
Terraced alluvium 階地沖積層	Qpa	Silt, sand and gravel 淤泥、砂及礫石
Debris flow deposits 泥石流沉積	Qpd	Sand, gravel, cobbles and boulders in silt matrix 砂、礫石、卵石及巨石，夾在淤泥中
Chek Lap Kok Formation 赤鱲角組	QCK	Clay, silt, sand and gravel, some oxidized features and organic material 黏土、淤泥、砂及礫石，含一些氧化特徵及有機物質

SOLID GEOLOGY 基岩地質

SEDIMENTARY AND VOLCANIC ROCKS 沉積岩和火山岩

NAMED ROCK DIVISIONS 地質單位名稱		主要岩石類型/特徵 PRINCIPAL ROCK TYPES/CHARACTERS
Lantau Formation 大嶼山組	Undivided 未分	JLT — Fine ash vitric tuff and lava
	Sunset Peak Member 沙洲尾段	Jlp — Lapilli-ash crystal tuff
Mount Davis Formation 摩星嶺組		JMD — Coarse ash crystal tuff
Shing Mun Formation 城門組 — Lung Kwu Sheung Member 龍鼓洲上段		Jsl — Tuff-breccia
Yim Tin Tsai Formation 鹽田仔組		JYT — Coarse ash crystal tuff
		s — Sandstone
		st — Siltstone
		t — Undifferentiated tuff and tuffite
		rh — Rhyolite lava
Lok Ma Chau Formation 落馬洲組 — Mai Po Member 米埔段		Cmp — Metasiltstone, metasandstone; graphite-bearing

MAJOR INTRUSIVE IGNEOUS ROCKS 主要侵入火成岩

gf	Fine-grained granite, <2mm
gfm	Fine- to medium-grained granite
gm	Medium-grained granite, 2-6mm
qgf	Fine-grained quartz tyenite, <2mm
qgm	Medium-grained quartz tyenite, 2-6mm
gd	Granodiorite
gdf	Fine-grained granodiorite, <2mm

MINOR INTRUSIVE IGNEOUS ROCKS 次要侵入火成岩（岩脈）

TERTIARY 第三紀

	Basalt
	Andesite
	Lamprophyre
rf	Feldsparphyre rhyolite
rq	Quartzphyric rhyolite
ap	Aplite
p	Pegmatite
q	Quartz vein

METAMORPHIC ROCKS 變質岩

Thermally metamorphosed rock around granitic intrusions — Metamorphosed / Hornfels

White wave ornament indicates water cover

GEOLOGICAL LINES 地質界線

- Geological boundary, superficial deposit
- Fill boundary, with limit of reclamation at date shown
- Geological boundary, solid rock
- Fault (crossmark indicates downthrow side)
- Mineral vein
- Photogeological lineament
- Dyke to dyke contact
- Isopach of Hang Hau Formation
- Limit of acoustic turbidity
- Sand bank crest (tick down fan slope)
- Limit of dumped material outside gazetted dumping ground

Broken lines on map face denote uncertainty

STRUCTURAL SYMBOLS 構造符號

	Undulating 起伏	Inclined 傾斜	Vertical 垂直	Linear Inclined 傾斜線狀	Linear Horizontal 水平線狀
Bedding	25	25		25	
Flow fabric	25	25		25	
Jointing	25	25			

All dips and plunges measured in degrees from horizontal

MINERAL AND MISCELLANEOUS SYMBOLS 礦產和其他符號

Mineral occurrence

Graphite	gr 石墨	Quartz	q 石英	Galena	Pb 方鉛礦
Copper	Cu 銅	Iron	Fe 鐵	Kaolin	K 高嶺土

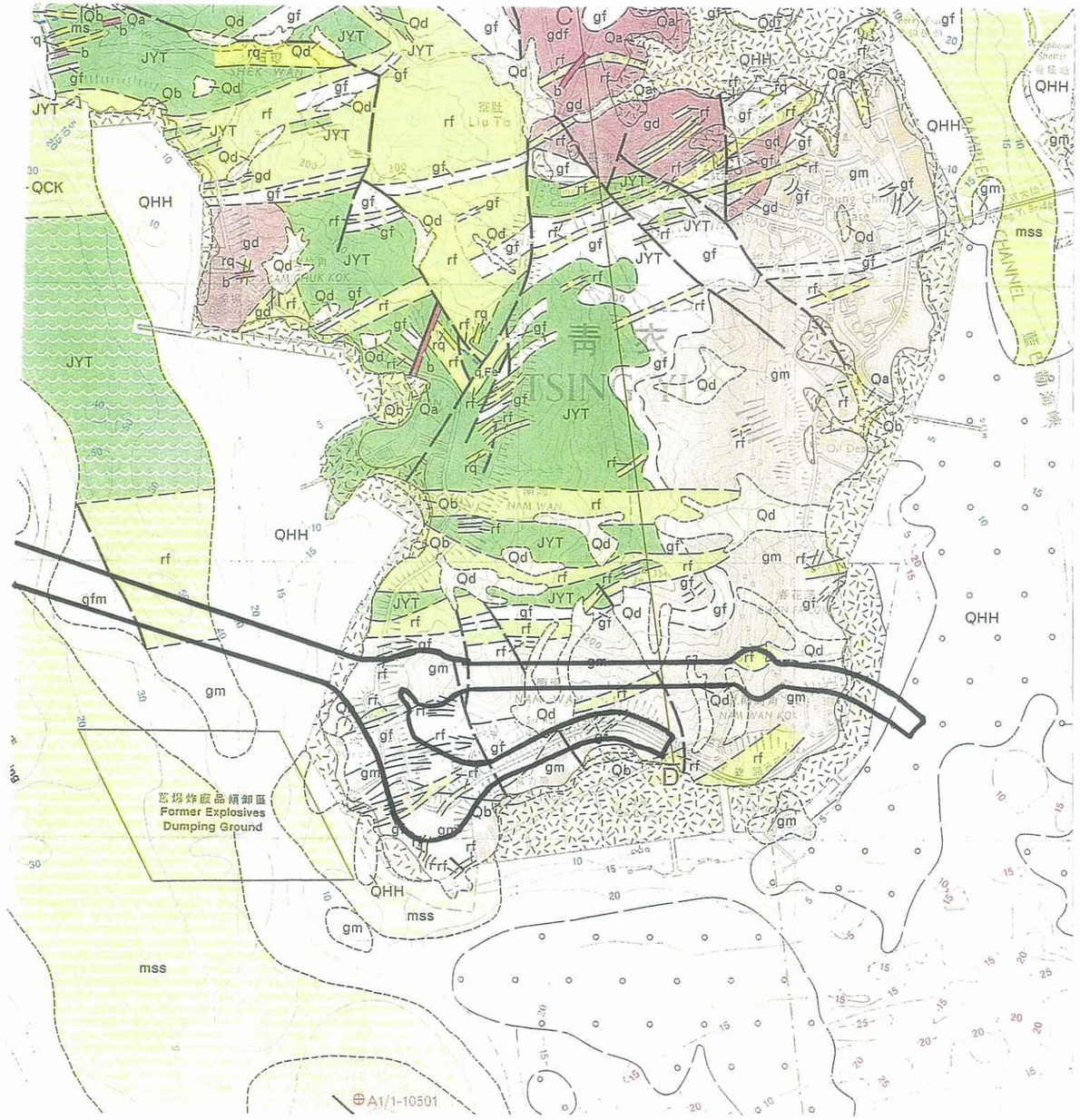
Mine adit, abandoned — Zn

Landslide backscar

Selected boreholes with number (numbered in two parts divided by -; the first part refers to its original site number, the second to its Geotechnical Information Unit (GIU) number) — e.g. A1/1-10501

LEGEND:

BOUNDARY OF STUDY AREA



GEOLOGICAL MAP OF LINK ROADS ON TSING YI ISLAND

HONG KONG GEOLOGICAL SURVEY
香港地質調查

SILVER MINE BAY 銀鑛灣

Sheet 10 編號

SOLID AND SUPERFICIAL GEOLOGY 基岩和表土地質圖

Series HGM20 組別

Scale 1:20000 比例

SUPERFICIAL DEPOSITS 表土沉積

GENETIC CLASSIFICATION		PRINCIPAL MATERIALS
Fill 填土		Natural earth and waste
Alluvium 沖積層	Qa	Silt, sand and gravel
Estuarine deposits 河口三角洲	Qi	Mud and sand
Beach deposits 海灘沉積	Qb	Sand
	Qbb	Cobbles and boulders
Back beach deposits 後灘沉積	Qrb	Sand
		Mud showing acoustic turbidity (gas blanking)
Mud blanket 泥質覆蓋層	QHM	Soft to very soft marine sandy some sand
Sand sheets/channel infill 砂層／水道填積	mss	Sand; some gravel and mud
Sand banks 水下砂洲	msb	Sand; some gravel and mud
Debris flow deposits 碎屑流沉積	QM	Sand, gravel, cobbles and boulders in silt matrix
Terraced alluvium 階地沖積層	Qpa	Silt, sand and gravel
Debris flow deposits 碎屑流沉積	Qpd	Sand, gravel, cobbles and boulders in silt matrix
	QCK	Clay, silt, sand and gravel, some oxidized horizons and organic material

SOLID GEOLOGY 基岩地質

SEDIMENTARY AND VOLCANIC ROCKS 沉積岩和火山岩

NAMED ROCK DIVISIONS		PRINCIPAL ROCK TYPES/CHARACTERS
Lantau Formation	Undivided	JLT — Fine ash vitric tuff and lava
	Sunset Peak Member	J1tc — Lapilli-ash crystal tuff
Mount Davis Formation		JMD — Coarse ash crystal tuff
Shing Mun Formation	Lung Kwong Shek Member	Jrs — Tuff-breccia
Yan Tin Tsai Formation		JYT — Coarse ash crystal tuff
		s — Sandstone
		st — Siltstone
		t — Undifferentiated tuff and tuffite
		rh — Rhyolite lava
Lok Ma Chau Formation	Mai Po Member	Cmp — Metasiltstone, metasandstone; graphite-bearing

MAJOR INTRUSIVE IGNEOUS ROCKS 主要侵入火成岩

gf	Fine-grained granite, <2mm
gfm	Fine- to medium-grained granite
gm	Medium-grained granite, 2–6mm
qsf	Fine-grained quartz syenite, <2mm
qsfm	Medium-grained quartz syenite, 2–6mm
gd	Granodiorite
qgd	Fine-grained granodiorite, <2mm

MINOR INTRUSIVE IGNEOUS ROCKS 次要侵入火成岩（脈岩）

TERTIARY 第三紀

	Dacite
	Andesite
	Lamprophyre
rf	Feldsparphyric rhyolite
rq	Quartzphyric rhyolite
ap	Aplite
p	Pegmatite
q	Quartz vein

METAMORPHIC ROCKS 變質岩

	Metamorphosed
	Hornfels

Thermally metamorphosed rock around granitic intrusions

White wave ornament indicates water cover

GEOLOGICAL LINES 地質界線

- Geological boundary, superficial deposit
- Fill boundary, with limit of reclamation at date shown
- Geological boundary, solid rock
- Fault (crossmark indicates downthrow side)
- Mineral vein
- Photogeological lineament
- Dyke to dyke contact
- Isopach of Hang Hau Formation
- Limit of acoustic turbidity
- Sand bank crest (tick down ice slope)
- Limit of dumped material outside gazetted dumping ground

Broken lines on map face denote uncertainty

STRUCTURAL SYMBOLS 構造符號

Undulating | Inclined | Vertical | Linear Inclined | Linear Horizontal

- Bedding
- Flow fabric
- Jointing

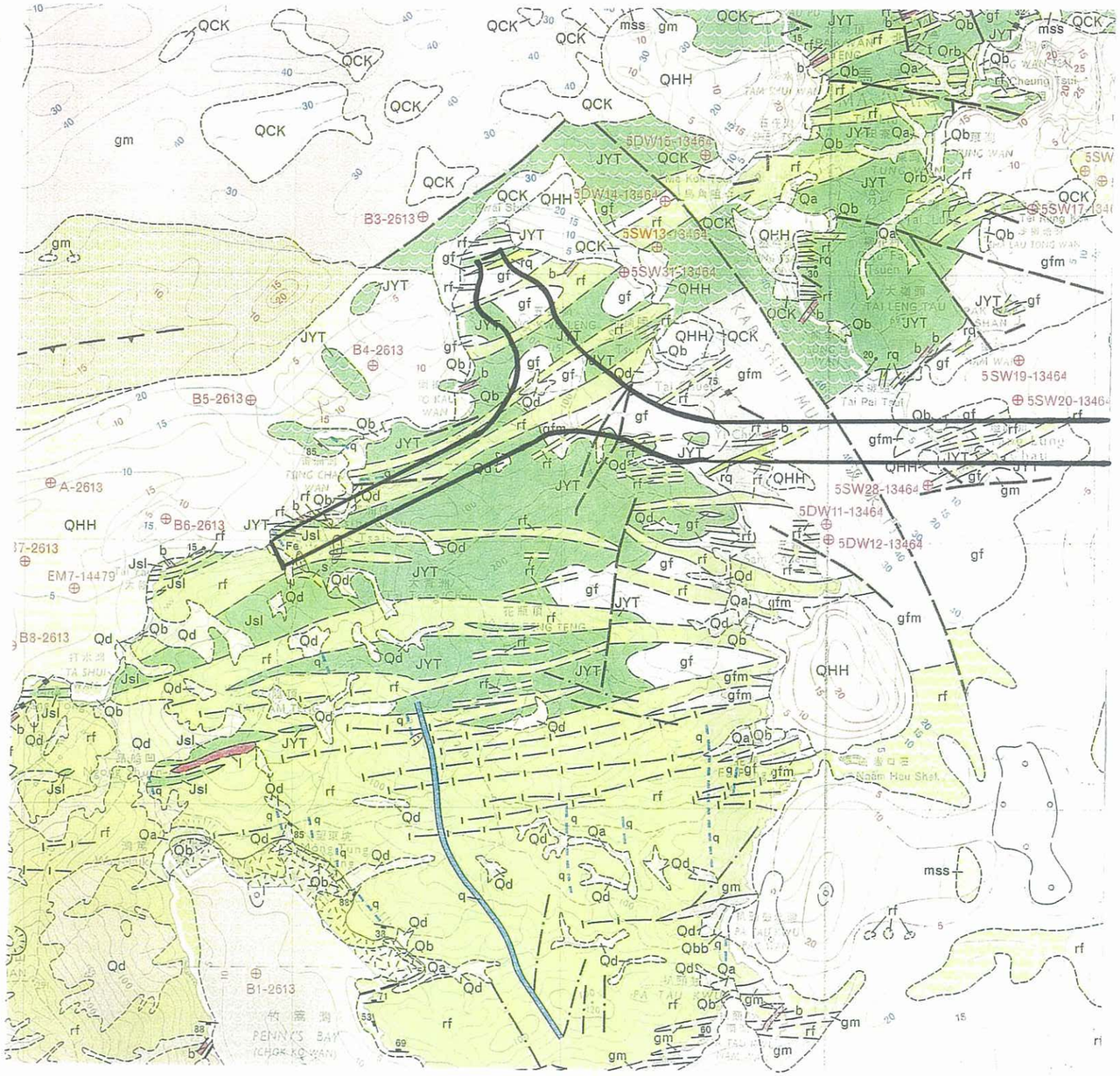
All dips and plunges measured in degrees from horizontal

MINERAL AND MISCELLANEOUS SYMBOLS 礦產和其他符號

- Mineral occurrence — Graphite gr 石墨; Quartz q 石英; Galena Pb 方鉛礦; Copper Cu 銅; Iron Fe 鐵; Kaolin K 高嶺土
- Mine adit, abandoned
- Landslide backscar
- Selected borehole with number (Numbered in two parts divided by -; the first part refers to its original site number, the second to its Geotechnical Information Unit (GIU) number) — e.g. A1/1-10501

LEGEND:

▭ BOUNDARY OF STUDY AREA



GEOLOGICAL MAP OF LINK ROADS ON LANTAU ISLAND

HONG KONG GEOLOGICAL SURVEY
香港地質調查

SILVER MINE BAY 銀鑛灣

Sheet 10 編號

SOLID AND SUPERFICIAL GEOLOGY 基岩和表土地質圖

Series HGM20 組別

Scale 1:20000 比例

SUPERFICIAL DEPOSITS 表土沉積

GENETIC CLASSIFICATION 成因類型		主要物質名稱	PRINCIPAL MATERIALS
Fill 填土		填土物質	Natural earth and waste
Alluvium 沖積層	Qa	淤積 - 沖積層	Silt, sand and gravel
Estuarine deposits 河口沉積	Qe	河口沉積	Mud and sand
Beach deposits 海灘沉積	Qb	海灘	Sand
	Qbb	海灘礫石層	Cobbles and boulders
Back beach deposits 海灘後沉積	Qvb	海灘後沉積	Sand
Mud blanket 淤泥覆蓋層	Qhm	覆蓋在表面的淤泥層	Mud (thawing geotechnic turbidity layer blanketing)
	Qhm	覆蓋在表面的淤泥層	Soft to very soft muddy marine loose sand
Sand sheets; channel infill 砂層 - 水道填積	mss	砂質沉積物覆蓋層	Sand; loose gravel and mud
Sand banks 水下砂洲	mxb	砂質沉積物覆蓋層	Sand; loose gravel and mud
Debris flow deposits 碎屑 - 泥石流	Qd	覆蓋在表面的碎屑 - 碎屑流沉積	Sand, gravel, cobbles and boulders in silt matrix
Terraced alluvium 梯田沖積層	Qpa	梯田 - 沖積層	Silt, sand and gravel
Debris flow deposits 碎屑 - 泥石流	Qpd	覆蓋在表面的碎屑 - 碎屑流沉積	Sand, gravel, cobbles and boulders in silt matrix
	QCK	覆蓋在表面的碎屑沉積	Clay, silt, sand and gravel, loose oxidized horizons and organic material

SOLID GEOLOGY 基岩地質

SEDIMENTARY AND VOLCANIC ROCKS 沉積岩和火山岩

NAMED ROCK DIVISIONS 地質單位名稱			PRINCIPAL ROCK TYPES/CHARACTERS 主要岩石類型/特徵
大嶼組 Lantau Formation	未劃分 Undivided	JLT	粗灰綠色凝灰質晶屑熔岩和凝灰岩 Fine ash vitric tuff and lava
	日落金 Sunset Peak Member	JLp	大嶼組 岩灰綠色晶屑凝灰岩 Lapilli-ash crystal tuff
Mount Davis Formation 摩星嶺組		JMD	粗灰綠色晶屑凝灰岩 Coarse ash crystal tuff
深涌組 Shek Lung Member / Shing Mun Formation		JSl	凝灰質角礫岩 Tuff-breccia
Yim Tin Tsai Formation 鹽田仔組		JYT	粗灰綠色晶屑凝灰岩 Coarse ash crystal tuff
		s	砂岩 Sandstone
		st	粉砂岩 Siltstone
		t	未分層凝灰岩和凝灰熔岩 Undifferentiated tuff and tuff-lava
		rh	流紋岩 Rhyolite lava
龍鼓灘群 SAI LAU KWAN GROUP	馬鞍山段 Lok Ma Chau Formation / Mai Po Member	Cmp	變質砂岩、變質泥岩和變質粉砂岩 Metasiltstone, metasandstone; graphite-bearing

MAJOR INTRUSIVE IGNEOUS ROCKS 主要侵入火成岩

gf	細粒花崗岩 - <2毫米	Fine-grained granite, <2mm
gfm	中細粒花崗岩	Fine- to medium-grained granite
gm	中粒花崗岩 - 2-6毫米	Medium-grained granite, 2-6mm
qgf	細粒石英花崗岩 - <2毫米	Fine-grained quartz syenite, <2mm
qgm	中粒石英花崗岩 - 2-6毫米	Medium-grained quartz syenite, 2-6mm
gd	花崗閃長岩	Granodiorite
qfd	細粒石英閃長岩 - <2毫米	Fine-grained granodiorite, <2mm

MINOR INTRUSIVE IGNEOUS ROCKS 次要侵入火成岩(脈岩)

TERTIARY 第三紀

	玄武岩	Basalt
	安山岩	Andesite
	煌斑岩	Lamprophyre
rf	斑狀流紋岩	Feldsporphyric rhyolite
rq	石英斑岩	Quartzphyric rhyolite
ap	細晶岩	Aplite
p	偉晶岩	Pegmatite
q	石英脈	Quartz vein

METAMORPHIC ROCKS 變質岩

Thermally metamorphosed rock around granitic intrusions 因花崗岩侵入而受熱變質的岩石	變質岩	Metamorphosed
	角岩	Hornfels

White wave ornament indicates water cover 白色波紋表示水域覆蓋

GEOLOGICAL LINES 地質界線

Geological boundary, superficial deposit	表土層地質界線
Fill boundary, with limit of reclamation at date shown	填土界線，附填土界線
Geological boundary, solid rock	基岩地質界線
Fault (crossmark indicates downthrow side)	斷層 (叉號指向下降一側)
Mineral vein	礦脈
Photogeological lineament	航空照片線性構造
Dyke to dyke contact	岩脈與岩脈接觸
Isopach of Hang Hau Formation	坑口組等厚線
Limit of acoustic turbidity	聲波混濁界線
Sand bank crest (tick down lee slope)	砂洲脊 (刻線指向背風坡)
Limit of dumped material outside gazetted dumping ground	指定傾倒區以外傾倒物料界線

Broken lines on map face denote uncertainty 圖面虛線表示界線不確定

STRUCTURAL SYMBOLS 構造符號

	Undulating 波狀	Inclined 傾斜	Vertical 垂直	Linear Inclined 線狀傾斜	Linear Horizontal 水平線狀
Bedding 層理	23	23			
Flow fabric 流動構造	23	23		23	
Jointing 節理	23	23			

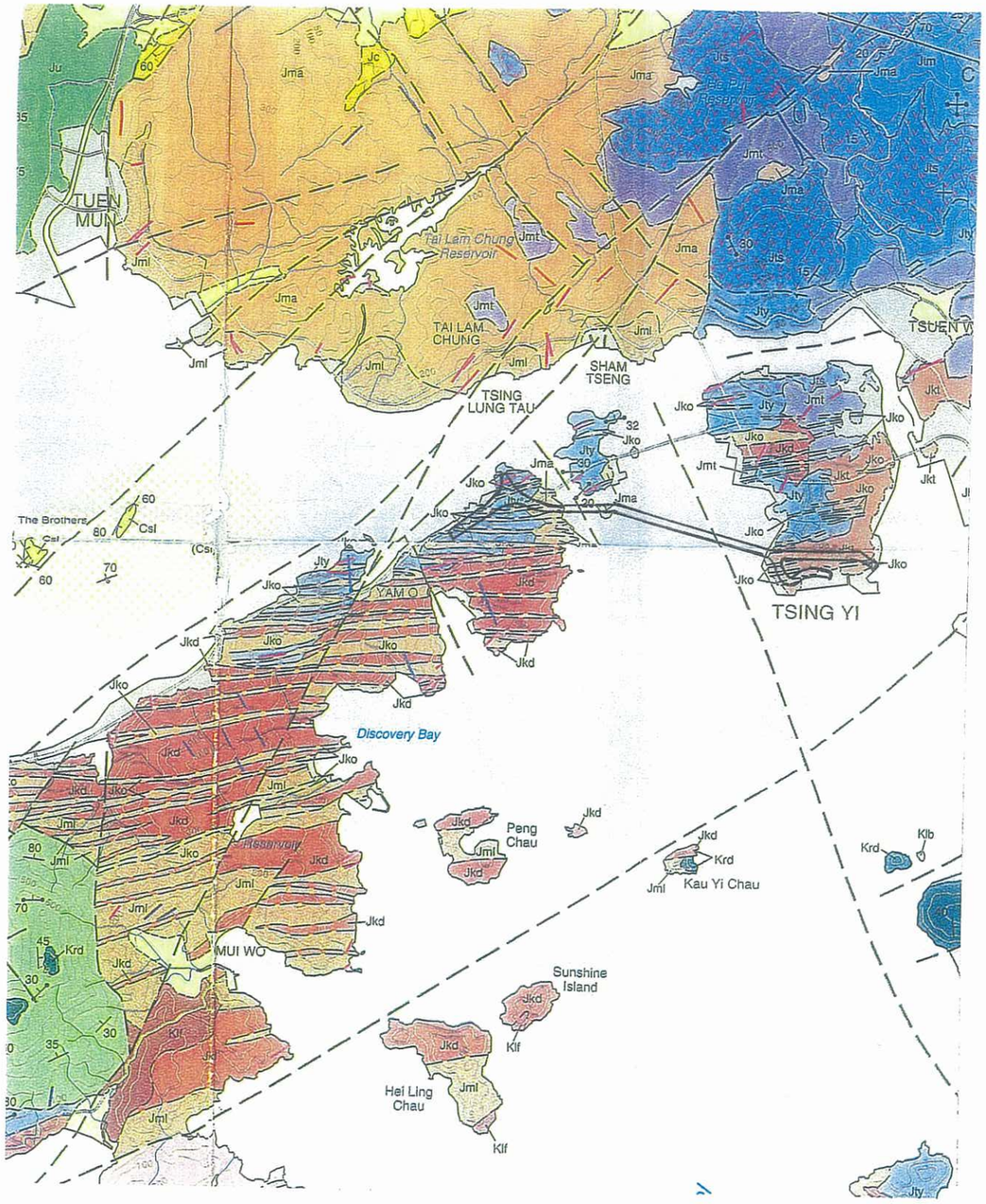
All dips and plunges measured in degrees from horizontal 所有傾角和傾伏角均以水平線為基準以度計

MINERAL AND MISCELLANEOUS SYMBOLS 礦產和其他符號

Mineral occurrence 礦產						Pb	
	Graphite 石墨	gr	Quartz 石英	q	Galena 方鉛礦	Pb	
	Copper 銅	Cu	Iron 鐵	Fe	Kaolin 高嶺土	K	
Mine adit, abandoned 廢棄礦坑							
Landslide backscar 滑坡							
Selected borehole with number (numbered in two parts divided by -; the first part refers to its original site number, the second to its Geotechnical Information Unit (GIU) number)							→ G AM6-10591

LEGEND:

BOUNDARY OF STUDY AREA



GEOLOGICAL MAP (PRE-QUATERNARY GEOLOGY) OF PROPOSED TYLL ALIGNMENT

1425

-- FEB 2001

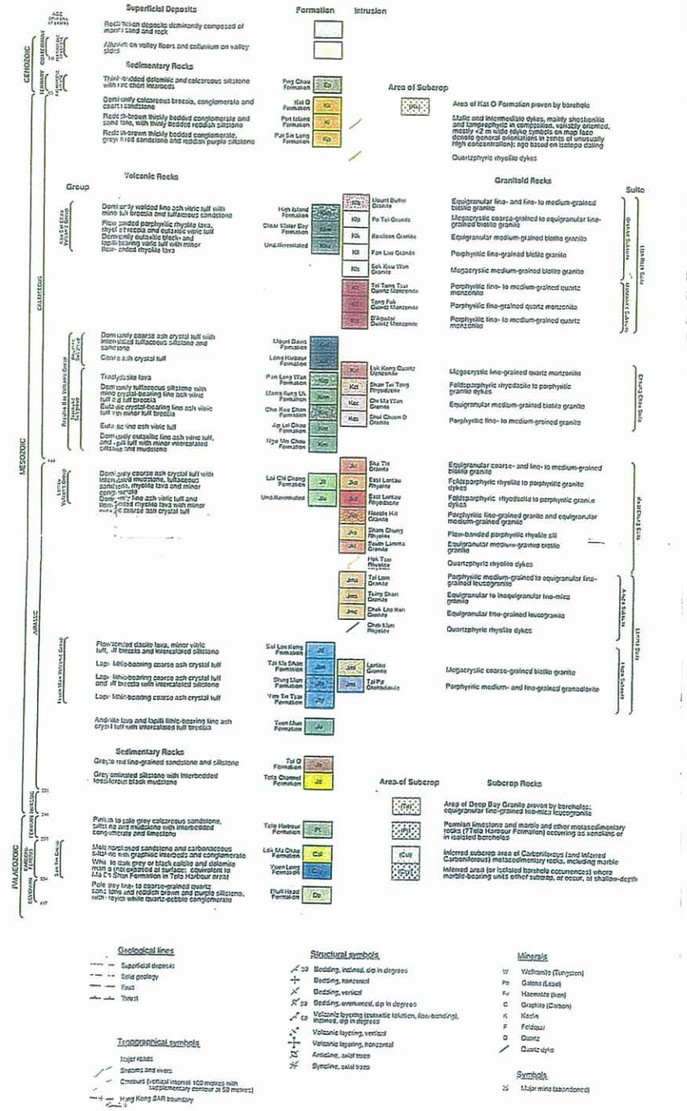
HONG KONG GEOLOGICAL SURVEY

GEOLOGICAL MAP OF HONG KONG

Series HGM100

Scale 1 : 100 000

First Edition - 2000



APPENDIX F

Capital Cost and Recurrent Cost Estimate

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study

Final Report for the Assignment (Final)

Base Cost Estimate

Item	Description of Works	Unit	Unit Rate (HK$)	Quantity	Total Amount (HK$)
1	**Viaducts & Roads**				
1.1	Viaduct	m^2	16,000	**115,924**	1,854,788,800
1.2	Viaduct (at grade section)	m^2	12,800	**58,838**	753,120,000
	Sub-total for Viaducts and Roads				**2,607,908,800**
2	**Tunnel**				
2.1	Rock Tunnel	m^2	28,400	**27,786**	789,122,400
	Sub-total for Tunnel				**789,122,400**
3	**Bridge**				
3.1	Suspension Bridge	m^2	99,500	**64,260**	6,393,870,000
3.2	Arch Bridge	m^2	86,000	**28,500**	2,451,000,000
	Sub-total for Bridge				**8,844,870,000**
4	**Retaining Wall**				
4.1	Insitu Reinforced Concrete (3m - 6m)	m^2	7,000	**3,125**	21,875,000
4.2	Reinforced Earth Wall	m^2	17,500	**7,326**	128,205,000
	Sub-total for Retaining Wall				**150,080,000**
5	**Slope Works**				
5.1	Western Tunnel Portal	m^3	210	**158,611**	33,308,310
5.2	Eastern Tunnel Portal	m^3	210	**22,809**	4,789,890
5.3	Tsing Yi Road	m^3	210	**631,741**	132,665,610
5.4	North Lantau Highway	m^3	210	**1,099,389**	230,871,690
	Sub-total for Slope Works				**401,635,500**
6	**Reclamation (Artificial Island)**				
6.1	Marine Works (Backfill)	m^3	120	**2,849,059**	341,887,080
6.2	Sea Walls	m^2	2,700	**30,000**	81,000,000
	Sub-total for Reclamation				**422,887,080**
7	**Building Works** (see App. A1 for breakdown)				
7.1	Building Works (incl. Toll Plaza & Admin Bldg)	Sum	-		390,403,000
	Sub-total for Building Works				**390,403,000**
8	**TCSS**				
8.1	TCSS	m	18,900	**6,600**	124,740,000
	Sub-total for TCSS				**124,740,000**
9	**Miscellaneous Roadworks**				
9.1	Traffic Signs, Lights, Gantries, etc.	Sum	-		15,648,050
	Sub-total for Miscellaneous Roadworks				**15,648,050**
10	**Environmental Mitigation Measures**				
10.1	Environmental Mitigation Measures	Sum	-		25,000,000
	Sub-total for Environmental Mitigation Measures				**25,000,000**

Base Cost Estimate:	**13,772,294,830**
The Project Estimate:	
Contract Contingencies	2,203,567,173
General Contingencies	1,973,188,161
	17,949,050,163
Design & Related Services [2%]	358,981,000
Site Investigation & Site Supervision Fee	68,861,000
Construction Supervision Fee [10%]	1,794,905,000
EMSTF	3,000,000
Total :	**20,174,797,163**

Tsing Yi Lantau Link Feasibility Study
Agreement No. CE 40/2006 (HY)

Risk Estimate

			TYLL			
(1) Risk Items	(2) Type V/F	(3) Probability of Occurrence (Fixed Risks Only)	(4) Average Risk Allowance ($)	(5) Maximum Risk Allowance ($)	(6) Spread (5-4) ($ x 10^ -5)	(7) Spread Square ($)
Client						
Additional client requirement	F	0.6	413,168,845	688,614,742	2,754.46	7,587,044
Project Co-ordination	F	0.6	413,168,845	688,614,742	2,754.46	7,587,044
Requirement for EIA	F	0.5	3,750,000	12,500,000	87.50	7,656
Design						
Geotechnical works	V	-	41,316,884	206,584,422	1,652.68	2,731,336
Design Development	V	-	275,445,897	1,377,229,483	11,017.84	121,392,707
Pricing						
Accuracy of pricing	V	-	550,891,793	1,377,229,483	8,263.38	68,283,398
Market conditions	V	-	275,445,897	1,377,229,483	11,017.84	121,392,707
Construction						
Contract variations	V	-	964,060,638	1,377,229,483	4,131.69	17,070,849
Contractor's claim attitude	V	-	964,060,638	1,928,121,276	9,640.61	92,941,291
Change of Policy Decision	V	-	137,722,948	688,614,742	5,508.92	30,348,177
Programme variation	V	-	137,722,948	688,614,742	5,508.92	30,348,177
		Subtotal $	**4,176,755,333**		**Subtotal $**	**499,690,387**
					Sq Root $	**22,354**
					Maximum Likely Addition $	**2,235,375,554**

Base Estimate: 13,772,294,830
Average Risk Estimate = Base Estimate + Total Average Risk Allowances :
17,949,050,163 30.33% on Base Estimate
Maximum Likely Estimate = Base Estimate + Total Average Risk Allowances + Maximum Likely Addition
20,184,425,718 46.56% on Base Estimate

The Project Estimate:		
	Base Estimate = $	13,772,294,830
Average Risk Allowance	(Contract Contingencies =$	2,203,567,173
	(General Contingencies = $	1,973,188,161
	Average Risk Estimate = $	**17,949,050,163**

TYLL

V = Variable Risk
F = Fixed Risk

Tsing Yi Lantau Link Feasibility Study
Agreement No. CE 40/2006 (HY)

Identified Risk

	TYLL
Total Base Estimate	13,772,294,830
Base Estimate for Foundation Works [1]	2,065,844,225
Base Estimate for Environmental Mitigation	25,000,000

Nature of Risk	Cost of Risk	HK$
Client		
Engineering Conditions/ Specification		
- Additional client requirement (F)	Max change to scope @ 5% estimate	688,614,742
	Ave Risk @ 3%	413,168,845
Project Co-ordination		
- Coordination with interfacing projects (F)	Max change likely @ 5%	688,614,742
	Ave Risk @ 3%	413,168,845
Site/ Environmental/ Legal/ Planning		
- Future EIA and mitigation measures (F)	Max cost if required @50%	12,500,000
	Ave Risk @ 15%	3,750,000
Design		
- Geotechnical works (V)	Max change to foundation works @10%	206,584,422
	Ave Risk @ 2%	41,316,884
- Design Development (V)	Max change to base estimate @10%	1,377,229,483
	Ave Risk @ 2%	275,445,897
Estimate/ Pricing		
- Accuracy of Pricing (V)	Max change to base estimate @10%	1,377,229,483
	Ave Risk @ 4%	550,891,793
- Market conditions (V)	Max change to base estimate @10%	1,377,229,483
	Ave Risk @ 2%	275,445,897
Construction		
- Contract variations (V)	Max change to base estimate @10%	1,377,229,483
	Ave Risk @ 7%	964,060,638
- Contractor's claim attitude (V)	Max change to base estimate @14%	1,928,121,276
	Ave Risk @ 7%	964,060,638
- Change of Policy Decision (V)	Max change to base estimate @5%	688,614,742
	Ave Risk @ 1%	137,722,948
- Programme variation (V)	Max change to base estimate @5%	688,614,742
	Ave Risk @ 1%	137,722,948

[1] 15% of Base Estimate of Elevated, Covered and Depressed Highway Structures (incl. pay for safety, environmental measures and preliminaries)

Agreement No. CE 40/2006 (HY) Tsing Yi Lantau Link Feasibility Study

Recurrent Cost

Item Description	Estimated Capital Construction Cost	Quantities (m/m2)		Annual Energy Cost per m/m^2	Annual Energy Cost	Annual Maintenance Cost per m/m^2	Annual Maintenance Cost	Annual Staff Cost per m/m^2	Annual Staff Cost	Total
1) Highways Department										
a) Viaducts & Roads										
High Speed Road		-	m^2	-	-	68.12	-	20.43	-	-
Running Surface of Vehicular Structure Supporting High Speed Road		267,522	m^2	-	-	8.35	2,235,125.45	2.48	663,419.40	2,898,544.85
High Speed Road (running surface of tunnel)		20,966	m^2	-	-	65.62	1,375,726.94	19.70	412,938.90	1,788,665.84
Vehicular Structure		294,274	m^2	-	-	50.06	14,729,903.81	15.07	4,434,944.46	19,164,848.28
Tunnel Structure		27,786	m^2	-	-	48.24	1,340,368.66	2.32	64,384.52	1,404,753.18
b) Lighting										
Dual 2-lane Carriageway (m)		-	m	31.39	-	14.96	-	3.16	-	-
2-lane Carriageway (m)		13,887	m	17.48	242,791.59	8.32	115,545.40	1.79	24,864.20	383,201.19
Gantry and Directional Sign		18,000	m	0.27	4,929.09	0.82	14,787.26	0.65	11,753.98	31,470.33
High Mast Lighting		725	m	3.69	2,672.63	14.22	10,308.71	0.71	511.62	13,492.96
c) Long Span Bridge & Arch Bridge										
High Speed Road	8,844,870,000.00				12,382,818.00		12,382,818.00		20,343,201.00	45,108,837.00
d) Landscape Works		8,700	m^2			26.61	231,490.05	7.66	66,669.13	298,159.19
Sub-total for HyD:					**12,633,211.31**		**32,436,074.29**		**26,022,687.22**	**71,091,972.81**
2) Transport Department										
a) Administration Buildings[#1]										
Admin. Buildings (Building Services)	164,480,889.28				8,224,044.46		1,644,808.89			9,868,853.36
b) Operation and Maintenance of Tunnel Services, TCSS, Toll Collection System and Other Facilities										
Operation and Maintenance of Tunnel Services, TCSS, Toll Collection System and Other Facilities [#2]	307,454,480.00				15,314,924.00		6,015,789.60		10,002,134.40	31,332,848.00
c) Annual Staff Cost for the operations, management and general administration										
Contractor's staff for the operations, management and general administration [#3]									38,000,000.00	38,000,000.00
TD Staff									5,200,000.00	5,200,000.00
EMSD Staff [#4]									10,000,000.00	10,000,000.00
Sub-total for TD:					**23,538,968.46**		**7,660,598.49**		**63,202,134.40**	**94,401,701.36**
3) Architectural Services Department										
Administration Buildings										
Administration Buildings (Building Works)[#5]	70,570,754.36						705,707.54		3,528,537.72	4,234,245.26
Sub-total for ArchSD:							**705,707.54**		**3,528,537.72**	**4,234,245.26**
4) Civil Engineering and Development Department										
Repairs and Maintenance Cost for Seawall										
Seawall[#6]	81,000,000.00						324,000.00		97,200.00	421,200.00
Sub-total for CEDD:							**324,000.00**		**97,200.00**	**421,200.00**
5) Leisure and Cultural Services Department										
Landscape Works		1,500	m^2			26.61	39,912.08	7.66	11,494.68	51,406.76
Sub-total for LCSD:							**39,912.08**		**11,494.68**	**51,406.76**
Price Level : September 2007				**Subtotal**	**36,172,180**	**Subtotal**	**41,166,292**	**Subtotal**	**92,862,054**	**170,200,526.19**

Note

1. Unit rate adopted are based on "Unit Rates of Annual recurrent Maintenance for Highway Features" published by Planning Unit of HyD dated January 2007
2. Price Adjustment Factor of 1.0643 is applied to convert the rates to September 2007 prices in accordance with Highway Construction Index (HyDCCI @9/2007 = 920; @9/2005 = 864.4)

[#1] Annual Energy Cost = 5% of capital cost ; Annual Maintenance cost = 1% of capital cost

[#2] Items include tunnel services and systems (such as tunnel lighting, ventilation, power supply, CMCS, F.S. system and communication systems), TCSS, toll collection system and service vehicles (see App. D1 for breakdown)

[#3] It is assumed that the operation and management of the tunnel and other operational facilities will be outsourced to an operator. A team of approx. 190 operations and supporting staff is allowed for the operations, management and general administration.

[#4] It is assumed that EMSD staff will be engaged by TD through EMSTF under a Service Level Agreement for monitoring of the contractor's works.

[#5] Annual Maintenance cost = 1% of capital cost ; Annual Staff cost = 5% of capital cost

[#6] Annual Maintenance cost = 0.4% of capital cost ; Annual Staff cost = 30% of Annual Maintenance cost

HIGHWAYS DEPARTMENT
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

Agreement No. CE 40/2006 (HY)
Tsing Yi Lantau Link
Feasibility Study

Final Report for the Assignment (Final)
Volume 2
Figures & Drawings

January 2009

Meinhardt Infrastructure and Environment Ltd
邁進基建環保工程顧問有限公司

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link
Feasibility Study

Final Report for the Assignment (Final)
Volume 2 – Figures & Drawings

Contents

Figure 1.1 Indicative Alignment from the Study Brief

Figure 2.1 Key Issues and Constraints – Lantau
Figure 2.2 Key Issues and Constraints – Tsing Yi
Figure 2.3 Key Issues and Constraints – Marine
Figure 2.4 T1 Connection with East Tsing Yi Viaduct
Figure 2.5 T2 Connection via East Tsing Yi Viaduct Slip Road
Figure 2.6 T3 Connection via CT9 and East Tsing Yi Viaduct
Figure 2.7 T4 Connection via East Tsing Yi Viaduct Slip Road
Figure 2.8 T5 Connection with West Tsing Yi Viaduct
Figure 2.9 L1 or L2 Connection with Tsing Lung Bridge
Figure 2.10 L3 Connection with Tsing Lung Bridge and North Lantau Highway
Figure 2.11 L4 Connection with Penny's Bay Highway
Figure 2.12 Option 1 – Immersed Tube Tunnel
Figure 2.13 Option 2 – Immersed Tube Tunnel
Figure 2.14 Option 3 – Immersed Tube Tunnel
Figure 2.15 Option 4 – Long Span Bridge
Figure 2.16 Option 5 – Long Span Bridge
Figure 2.17 Option 6 – Long Span Bridge
Figure 2.18 Option 7 – Long Span Bridge

Figure 3.1 Area of Influence for Traffic Assessment
Figure 3.2 Reference Case Strategic Highway Network
Figure 3.3 NWNT Strategic Highway Network Options (2030)

Figure 7.1 Layout of Preferred TYLL Alignment
Figure 7.2 Layout of TYLL Western Interchange with Tsing Lung Bridge and North Lantau Highway
Figure 7.3 Layout of TYLL Eastern Connection with ETYV and Tsing Yi Road
Figure 7.4 Typical Sections for Elevated Highway Structures
Figure 7.5 Layout of Toll Plaza and Other Facilities
Figure 7.6 Typical Section for Rock Tunnel
Figure 7.7 Schematic Diagram of Tunnel Ventilation System
Figure 7.8 Arch Bridge across Kap Shui Mun Fairway
Figure 7.9 Suspension Bridge across Ma Wan Fairway
Figure 7.10 Typical Cross Section of Artificial Island Reclamation
Figure 7.11 Balanced Cantilever Erection by Gantry
Figure 7.12 Span-by-span Erection
Figure 7.13 Balanced Cantilever Erection by Form Traveller
Figure 7.14 Works Area at North Lantau

Figure 8.1 Previous Ground Investigation Layout Plan (Sheet 1 of 3)
Figure 8.2 Previous Ground Investigation Layout Plan (Sheet 2 of 3)
Figure 8.3 Previous Ground Investigation Layout Plan (Sheet 3 of 3)
Figure 8.4 Additional Ground Investigation Layout Plan (Sheet 1 of 3)
Figure 8.5 Additional Ground Investigation Layout Plan (Sheet 2 of 3)
Figure 8.6 Additional Ground Investigation Layout Plan (Sheet 3 of 3)
Figure 8.7 Geotechnical Constraints at Marine Area
Figure 8.8 Slope Features Affecting or Affected by Eastern Landing
Figure 8.9 Slope Features Affecting or Affected by Western Landing
Figure 8.10 Recommended Extent of Future Natural Terrain Hazard Study (Sheet 1 of 2)
Figure 8.11 Recommended Extent of Future Natural Terrain Hazard Study (Sheet 2 of 2)

Figure 9.1 Existing Storm Drainage Near Toll Plaza
Figure 9.2 Existing Storm Drainage at East of Toll Plaza
Figure 9.3 Existing CLP Installation Near Eastern Portion of Tsing Yi Road
Figure 9.4 Existing Storm Drainage Near Eastern Portion of Tsing Yi Road
Figure 9.5 Existing Gas Mains Near Eastern Portion of Tsing Yi Road

Figure 11.1 Representative Air and Noise Sensitive Receivers – Tsing Yi
Figure 11.2 Representative Air and Noise Sensitive Receivers – Lantau
Figure 11.3 Water Quality Sensitive Receivers (Excluding Ecological Sensitive Receivers)
Figure 11.4 Habitat Map of Terrestrial Study Area
Figure 11.5 Marine Ecological and Fisheries Sensitive Receivers
Figure 11.6 Distribution of Chinese White Dolphin (CWB) in North Lantau
Figure 11.7 Geological Background of Preferred Alignment of TYLL in Tsing Yi
Figure 11.8 Geological Map of Tang Lung Chau
Figure 11.9 Potential Built Heritage Resources
Figure 11.10 Landscape Resources
Figure 11.11 Landscape Character Areas
Figure 11.12 Potential Visually Sensitive Receivers
Figure 11.13 PHIs and Explosive Dumping Ground

Figure 13.1 Project Implementation Programme (Sheet 1 of 2)
Figure 13.2 Project Implementation Programme (Sheet 2 of 2)

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link
Feasibility Study

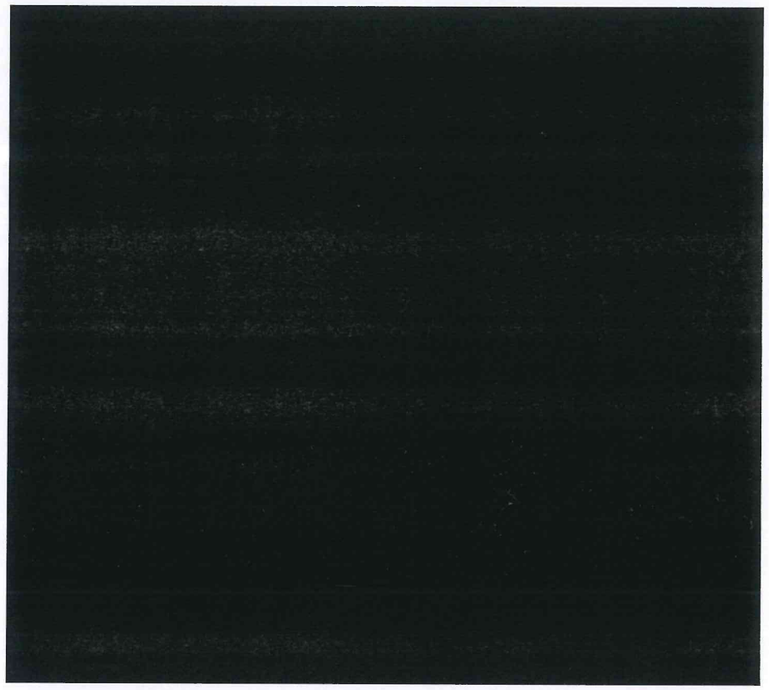
Final Report for the Assignment (Final)
Volume 2 – Figures & Drawings

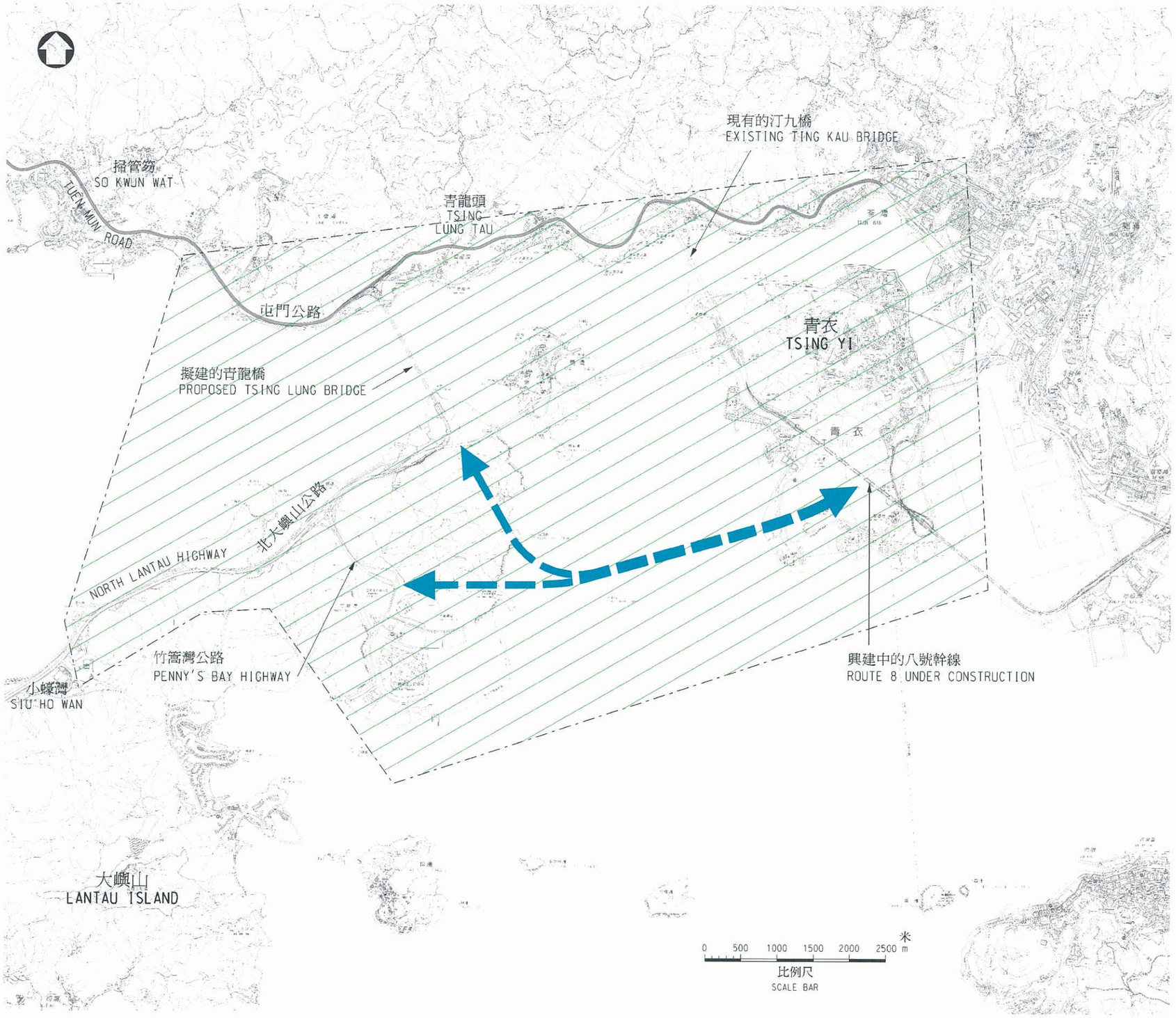
Contents

91065/GL/100 General Layout Plan Key Plan
91065/GL/101 General Layout Plan (Sheet 1 of 17)
91065/GL/102 General Layout Plan (Sheet 2 of 17)
91065/GL/103 General Layout Plan (Sheet 3 of 17)
91065/GL/104 General Layout Plan (Sheet 4 of 17)
91065/GL/105 General Layout Plan (Sheet 5 of 17)
91065/GL/106 General Layout Plan (Sheet 6 of 17)
91065/GL/107 General Layout Plan (Sheet 7 of 17)
91065/GL/108 General Layout Plan (Sheet 8 of 17)
91065/GL/109 General Layout Plan (Sheet 9 of 17)
91065/GL/110 General Layout Plan (Sheet 10 of 17)
91065/GL/111 General Layout Plan (Sheet 11 of 17)
91065/GL/112 General Layout Plan (Sheet 12 of 17)
91065/GL/113 General Layout Plan (Sheet 13 of 17)
91065/GL/114 General Layout Plan (Sheet 14 of 17)
91065/GL/115 General Layout Plan (Sheet 15 of 17)
91065/GL/116 General Layout Plan (Sheet 16 of 17)
91065/GL/117 General Layout Plan (Sheet 17 of 17)

91065/GL/201 Vertical Profile of TYLL Mainline (Sheet 1 of 2)
91065/GL/202 Vertical Profile of TYLL Mainline (Sheet 2 of 2)
91065/GL/203 Vertical Profile of Western Link Roads
91065/GL/204 Vertical Profile of Eastern Link Roads and Slip Roads

91065/GL/301 Typical Cross Sections (Sheet 1 of 2)
91065/GL/302 Typical Cross Sections (Sheet 2 of 2)





LEGEND:

INDICATIVE ALIGNMENT ONLY

STUDY AREA

路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong - Zhuhai - Macao Bridge
Hong Kong Project Management Office

Meinhardt Infrastructure and Environment Limited
邁進基建環保工程顧問有限公司

AGREEMENT NO. CE 40/2006 (HY)
TSING YI LANTAU LINK - FEASIBILITY STUDY

INDICATIVE ALIGNMENT FROM THE STUDY BRIEF

FIGURE 1.1

Scale N.T.S.

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Legend:

- Hong Kong Disneyland
- Government / Utility Facilities
- Committed Future Development
- Cultural Heritage / Archaeological Potential Site
- Archaeological Site
- CLP Cable
- Future Development
- Country Park (including proposed extension)
- Graves
- Lot / Holding Boundary
- Inferred Fault

北

N

Future Development at Sunny Bay (Tourism Hub)

MTRC Airport Express Railway

Penny's Bay Highway

North Lantau Highway

MTRC Disneyland Resort Line

Luk Keng Tsuen Archaeological Site

Yam O Archaeological Site

Wan Tuk Archaeological Site

Mong Tung Hang Archaeological Site

Inspiration Lake Recreation Centre CX 1645 GLL

Lantau North Country Park (including proposed extension)

Hong Kong Disneyland CKWL 1 NNG

Radar

Qing Dynasty Grave Site

Tso Wan Village Lot boundaries

Planned Service Reservoir

Fa Peng Teng Archaeological Site

Fa Peng Village Lot boundaries

Fa Peng Low Archaeological Potential Site

Tso Wan Cultural Heritage Site / Boundary Stone Sites

Pa Tau Kwu Pak Wan Archaeological Site

BROAD ROUTE OF TYLL

Pa Tau Kwu House Ruin

Memorial Stone Tablet

Pa Tau Kwu Nam Wan Archaeological Site

Penny's Bay Power Station DD 356 L 23 NNG

Fire Station GLA IS 436, 470, 471, GLA TIS 500

Public Transport Interchange CX 1644 GLL

Pa Tau Kwu: habitat of White Bellied Sea Eagle

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路政署 HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處 Hong Kong - Zhuhai - Macao Bridge Hong Kong Project Management Office

Meinhardt Infrastructure and Environment Limited 邁進基建環保工程顧問有限公司

AGREEMENT NO. CE 40/2006 (HY)
TSING YI LANTAU LINK - FEASIBILITY STUDY

KEY ISSUES AND CONSTRAINTS - LANTAU

FIGURE 2.1

Scale 1 : 15 000

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北

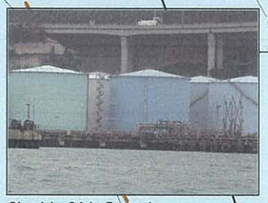
Tsing Ma Bridge

Cheung Tsing Highway

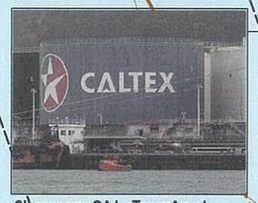
Dockyard



Shell Oil Depot



Chevron Oil Terminal



China Merchants Container Services Ltd
Mid-stream Container Terminal / Open Storage
TYTL 60 NNG



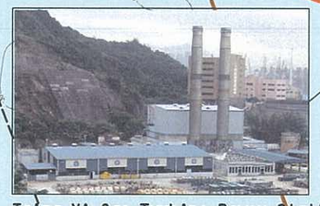
Yiu Lian
Floating
Dock No.3

BROAD ROUTE OF TYLL

Tsing Yi South Fresh
Water Service Reservoir
GLA-KT 1024



Mobil Oil Depot
(West Terminal)
TYTL 115 NNG



Tsing Yi Gas Turbine Power Station
SD/STT/PL/5



Hong Kong Institute
of Vocational Eduction
TYTL 123 NNG

Route 8 (under construction)

Tsing Yi Road

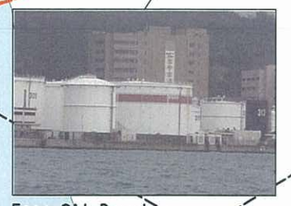
Tsing Yi Road

Tsing Yi Road
Substation
TYTL 171 NNG

Dow Chemical Plant
TYTL 75 RP NNG

Tien Chu (TY)
Industrial Centre
TYTL 75 RP NNG,
TYTL 75 EXT NNG

ICI
Chemical
Works



Esso Oil Depot
(East Terminal) TYTL 46 RP NNG



CRC Oil Depot
TYTL 127 NNG



EPD Hong Kong Chemical Waste
Treatment Centre GLA-KT 1020



Mayfair Garden
TYTL 83 RP NNG



Rambler Crest TYTL 140 NNG



Container Terminal 9
TYTL 9 RP NNG,
TYTL 9B NNG,
TYTL 9A NNG,
TYTL 139 RP NNG

Legend:

- Industrial
- School / Institutes
- Residential
- Government / Utility Facilities
- Container Terminal
- SSSI
- Lot / Holding Boundary
- Inferred Fault
- Potential Location for CT10 (as recommended in Hong Kong Port Master Plan 2020)

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TSING YI LANTAU LINK - FEASIBILITY STUDY

KEY ISSUES AND CONSTRAINTS - TSING YI

FIGURE 2.2

Scale 1 : 15 000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.2A.dgn

Ma Wan Fisherman's Village
Ma Wan Main Street Village
Ma Wan Town
Lau Fa Tsuen

Ma Wan Tung Wan Beach

Tsing Ma Bridge

Ma Wan

Tang Lung Chau

Special Area
Kap Shui Mun



Ma Wan Anchorage

Ma Wan Fairway

Kap Shui Mun Fairway

BROAD ROUTE OF TYLL

Explosive Dumping Ground (Disused)

Sand Borrow Area
(not used)



East Lantau:
habitat of the
Chinese White Dolphin



Pun Shan Shek
Anchorage

Uncontaminated Mud
Disposal Ground

Legend:
- Deep Water Channel
- Marine Disposal Facilities
- 260 Airport Height Restriction
- Inferred Fault
- CLP Cable
- 50 Structural Height Intrusion Limitation Zone

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KEY ISSUES AND CONSTRAINTS - MARINE

FIGURE 2.3

Scale 1 : 15 000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.3A.dgn

北

NAM WAN TUNNEL

+62.0

TO/FROM LANTAU

+71.3

TUNNEL PORTAL

Tai Tung Industrial Equipment Ltd

DOW Chemical (Hong Kong) Ltd. Tsing Yi Plant and Technical Centre

Factory Complex TYTL 128

EPD Hong Kong Chemical Waste Treatment Centre

TSING YI ROAD

TSING KO ROAD

TSING SHEUNG ROAD

TSING YI HONG WAN ROAD

CT 9

-6%

+67.5

+2.95%

60m

220m

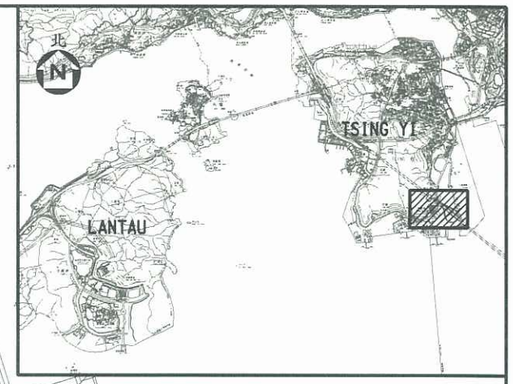
90m

45m

140m

EAST TSING YI VIADUCT

STONECUTTERS BRIDGE



KEY PLAN

① DIRECT ENTRY MERGING LANE SATISFIES DESIGN SPEED OF 80Km/h (TPDM V2 4.6.8.2) BUT NOT EXPRESSWAY STANDARDS WITH DESIGN SPEED OF 100Km/h

② DIRECT DIVERGE LANE SATISFIES DESIGN SPEED OF 80Km/h (TPDM V2 4.6.9.4) BUT NOT EXPRESSWAY STANDARDS WITH DESIGN SPEED OF 100Km/h

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TSING YI LANTAU LINK - FEASIBILITY STUDY

T1 CONNECTION WITH EAST TSING YI VIADUCT

FIGURE 2.4

Scale 1 : 3000

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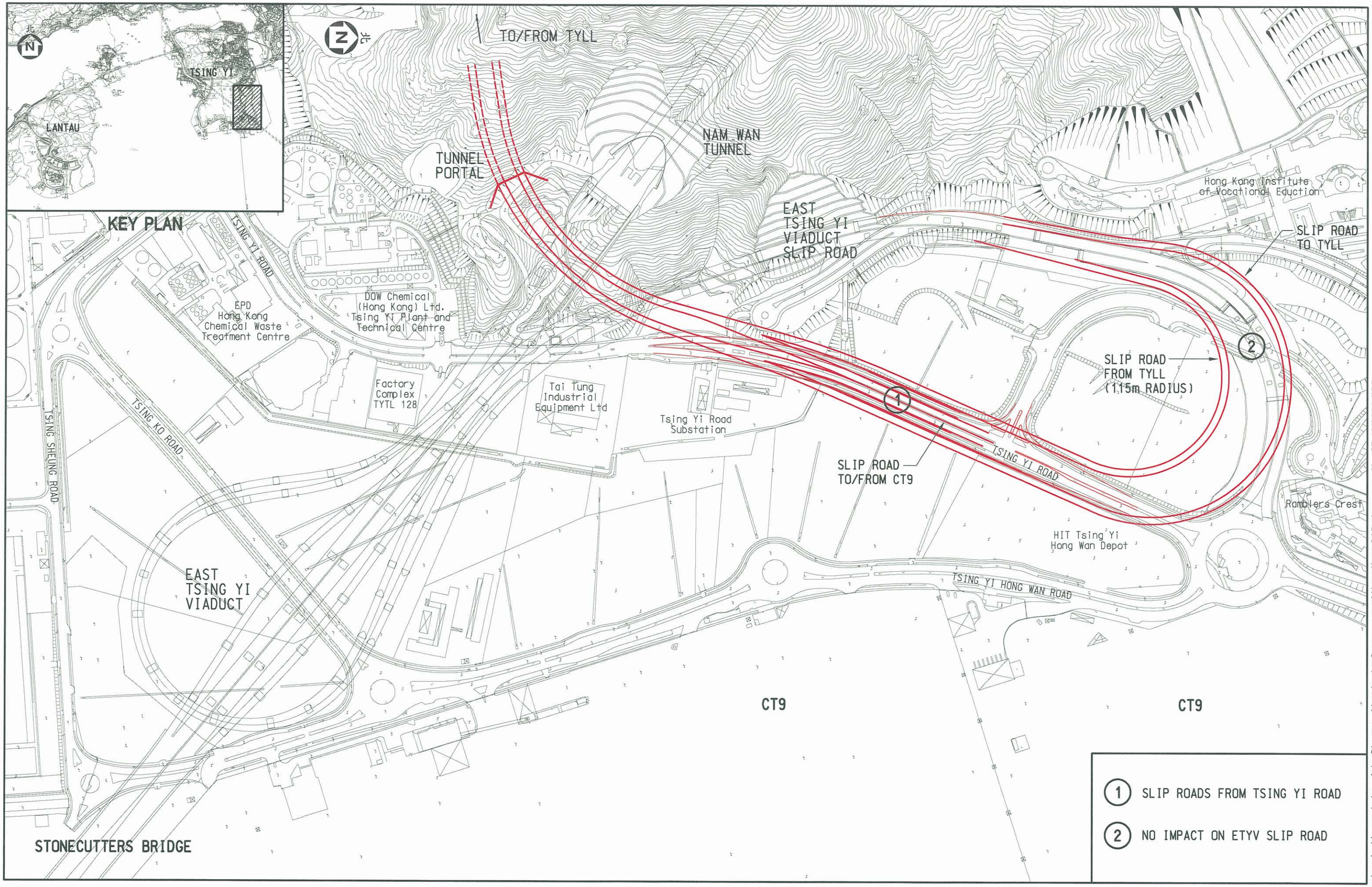

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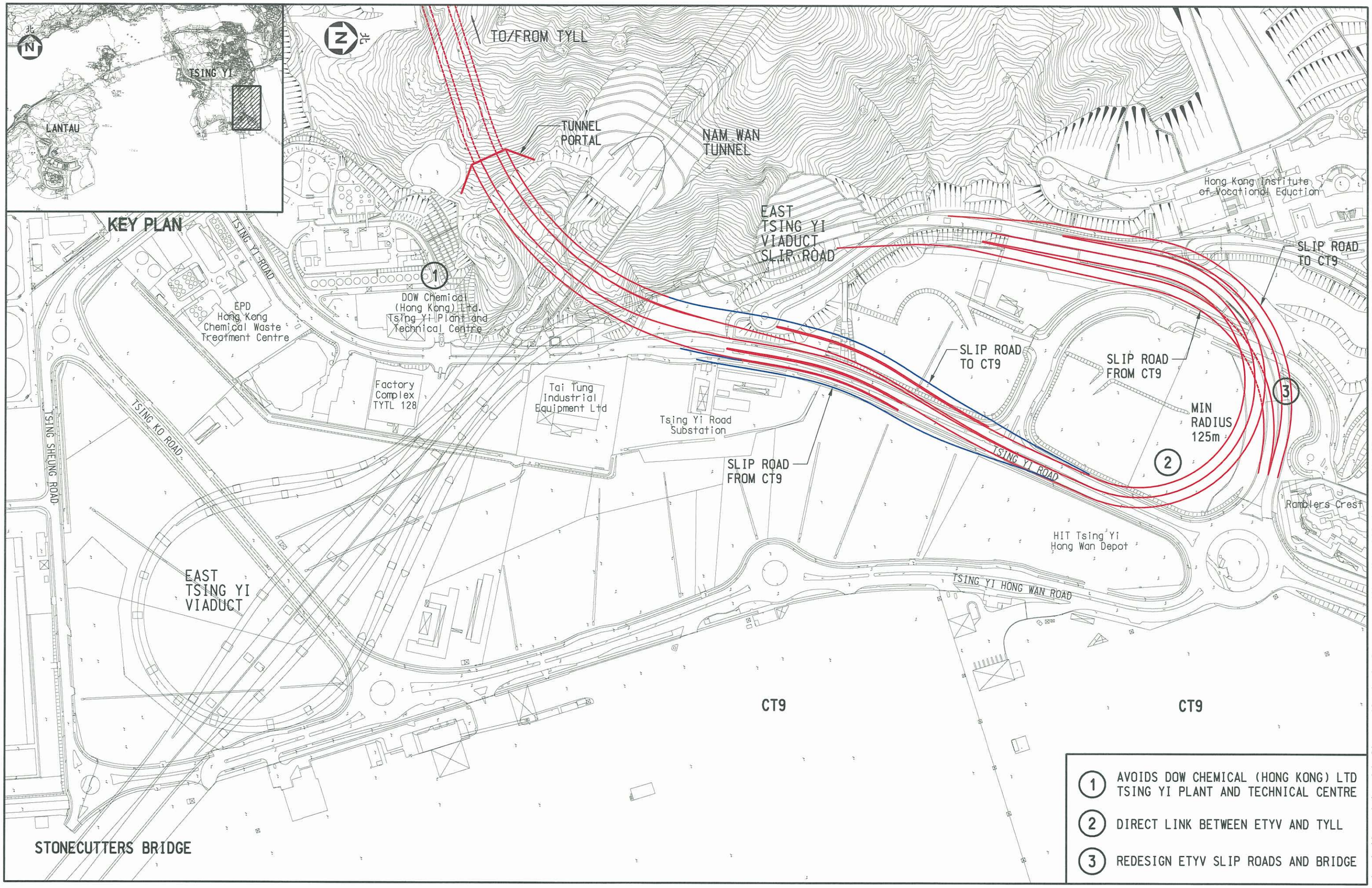
TSING YI LANTAU LINK - FEASIBILITY STUDY

T2 CONNECTION VIA EAST TSING YI VIADUCT SLIP ROAD

FIGURE 2.5

Scale 1 : 4000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.5A.dgn



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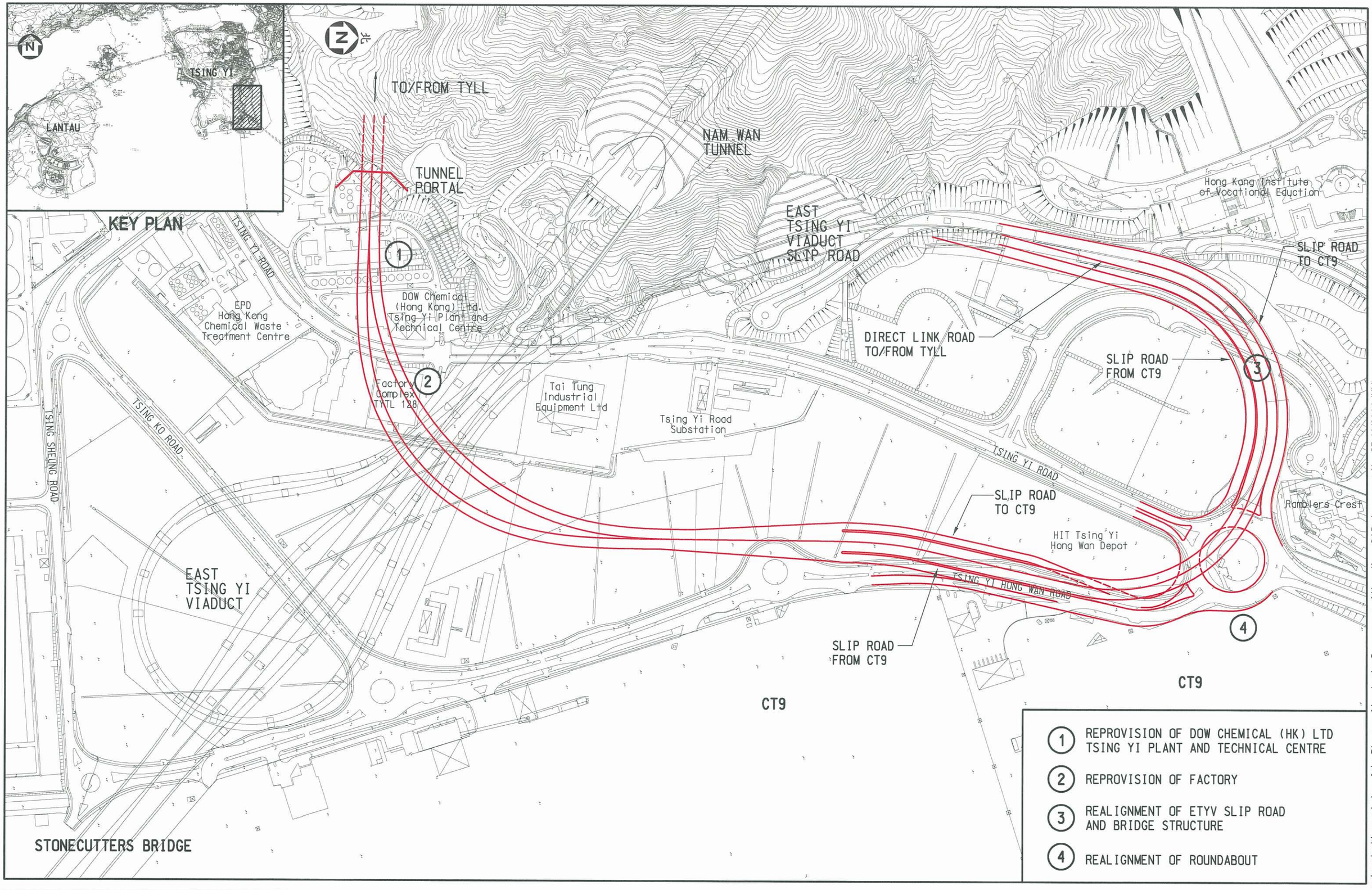
TSING YI LANTAU LINK - FEASIBILITY STUDY

T3 CONNECTION VIA CT9 AND EAST TSING YI VIADUCT

FIGURE 2.6

Scale 1 : 4000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.6A.dgn



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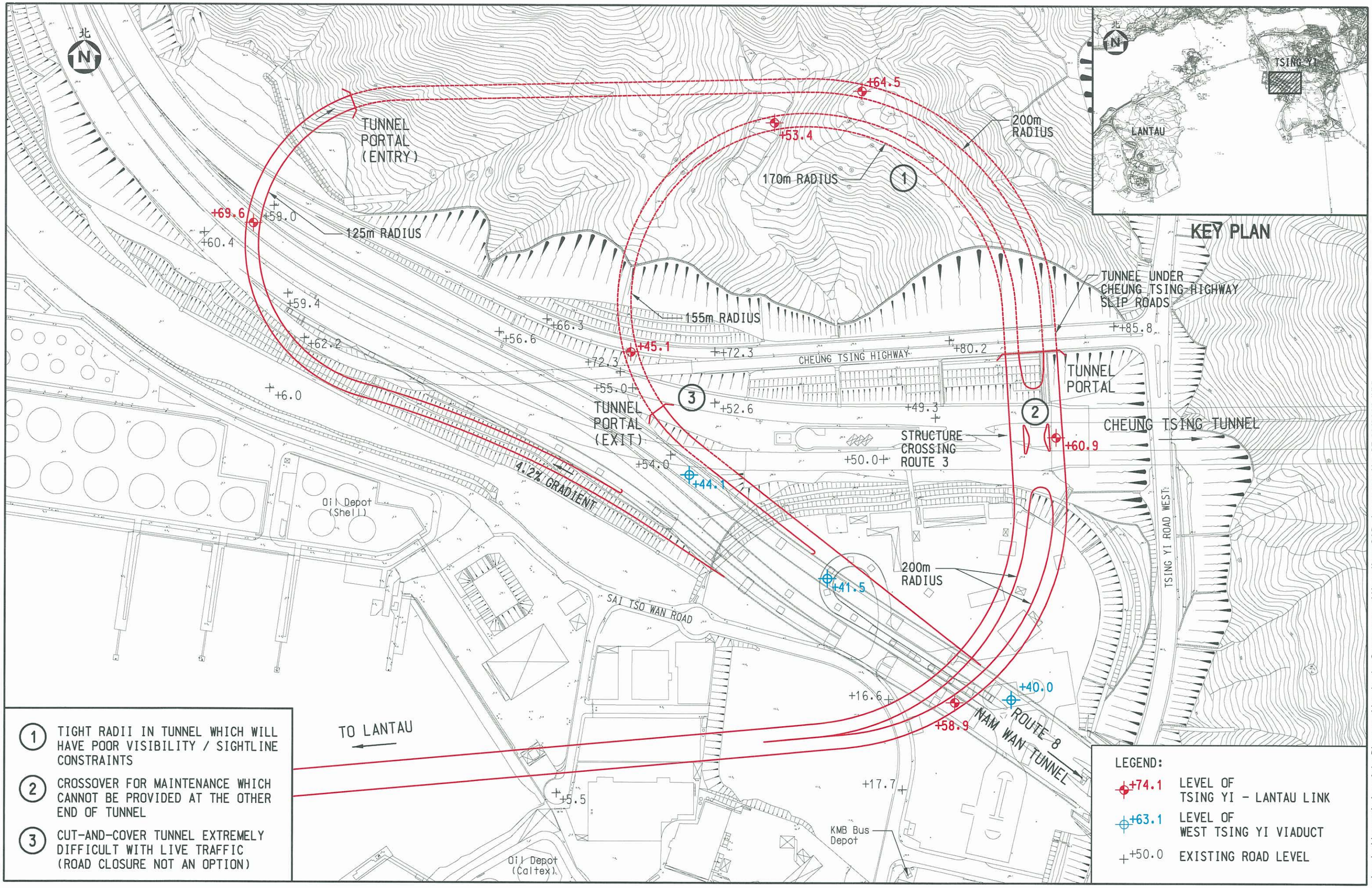
TSING YI LANTAU LINK - FEASIBILITY STUDY

T4 CONNECTION VIA EAST TSING YI VIADUCT SLIP ROAD

FIGURE 2.7

Scale 1 : 4000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.7A.dgn



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TSING YI LANTAU LINK - FEASIBILITY STUDY

T5 CONNECTION WITH WEST TSING YI VIADUCT

FIGURE 2.8

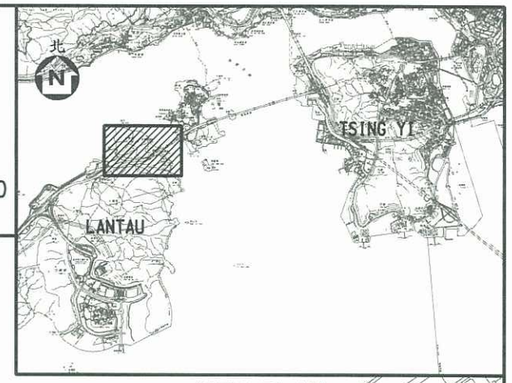
Scale 1 : 3000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.8A.dgn

北

TSING LUNG BRIDGE (BY OTHERS)

1. CONNECTION OPTION L1 UNDER KAP SHUI MUN BRIDGE
2. CONNECTION OPTION L2 OVER NLH
3. EXTENSIVE SLOPE CUTTING REQUIRED



KEY PLAN

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TSING YI LANTAU LINK - FEASIBILITY STUDY

L1 OR L2 CONNECTION WITH TSING LUNG BRIDGE

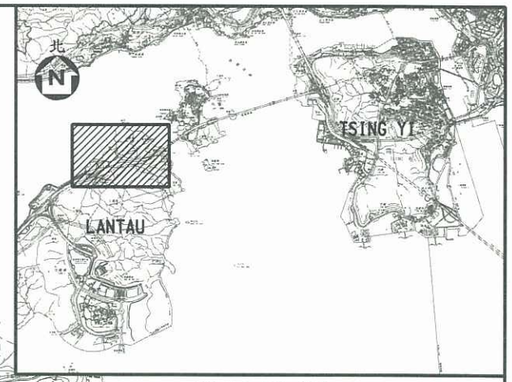
FIGURE 2.9

Scale 1 : 4000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.9A.dgn

北
N

TSING LUNG
BRIDGE
(BY OTHERS)



KEY PLAN

TO KAU WAN

NG KWU LENG

KAP SHUI MUN BRIDGE

LANTAU LINK

TSING YI
LANTAU LINK

TSING CHAU WAN

Lantau Toll Plaza
Administration Building

MTRC AIRPORT EXPRESS RAILWAY

NORTH LANTAU HIGHWAY

LANTAU

1 REPROVISION OF EXISTING TOLL PLAZA

2 DEDICATED BUS LANES TO AVOID WEAVING

3 EXTENSIVE SLOPE CUTTINGS

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TSING YI LANTAU LINK - FEASIBILITY STUDY

L3 CONNECTION WITH TSING LUNG BRIDGE AND NORTH LANTAU HIGHWAY

FIGURE 2.10

Scale 1 : 5000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.10A.dgn

北

PENNY'S BAY HIGHWAY

SUNNY BAY ROAD

INSPIRATION LAKE
RECREATION CENTRE

SLIP ROAD
TO TYLL

TUNNEL
PORTAL

TO
TSING YI

TOLL PLAZA

SLIP ROAD
FROM TYLL

MAGIC ROAD

Penny's Bay Power Station

INSPIRATION LAKE
RECREATION CENTRE

KEY PLAN

北

TSING YI

LANTAU

1 CONNECTION WITH
PENNY'S BAY HIGHWAY

2 BRIDGE UNDER ROUNDABOUT

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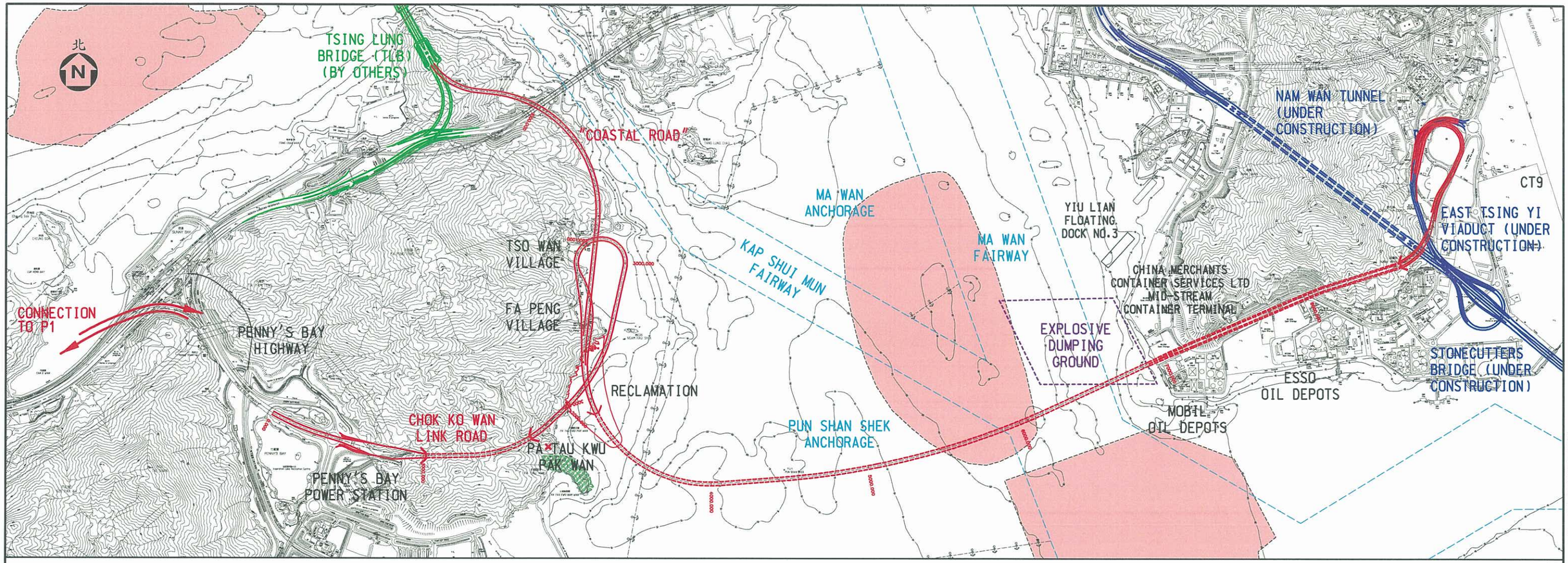
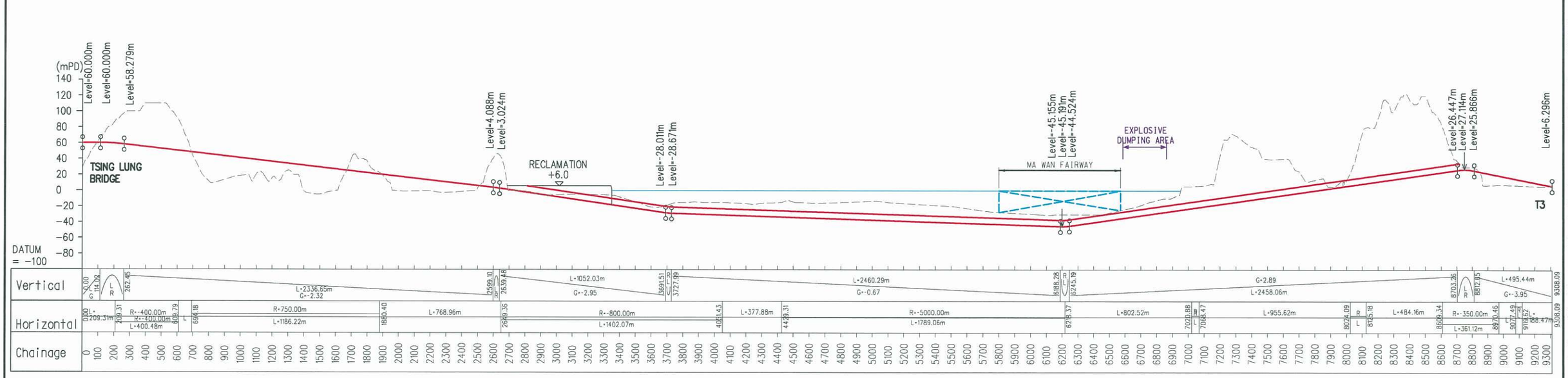
L4 CONNECTION WITH PENNY'S BAY HIGHWAY

FIGURE 2.11

Scale 1 : 4000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.11A.dgn





LONGITUDINAL SECTION OF OPTION 1

HORI. SCALE 1 : 25000
VER. SCALE 1 : 5000

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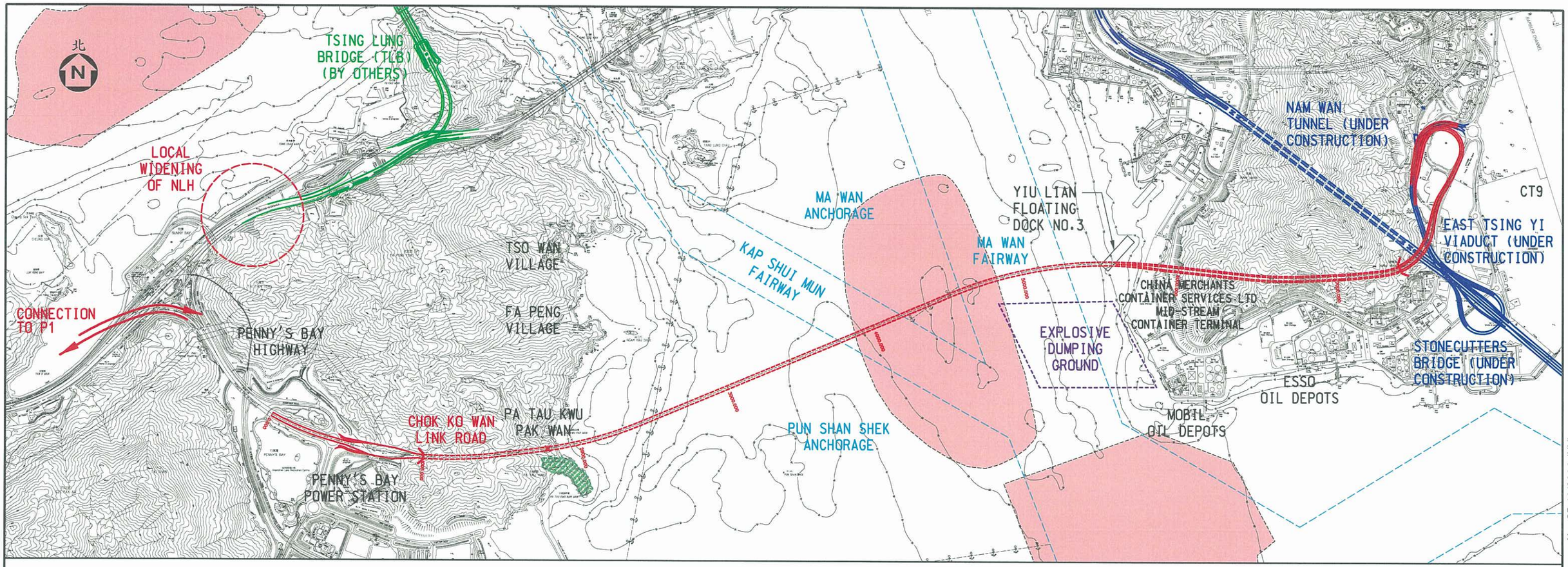
TSING YI LANTAU LINK - FEASIBILITY STUDY

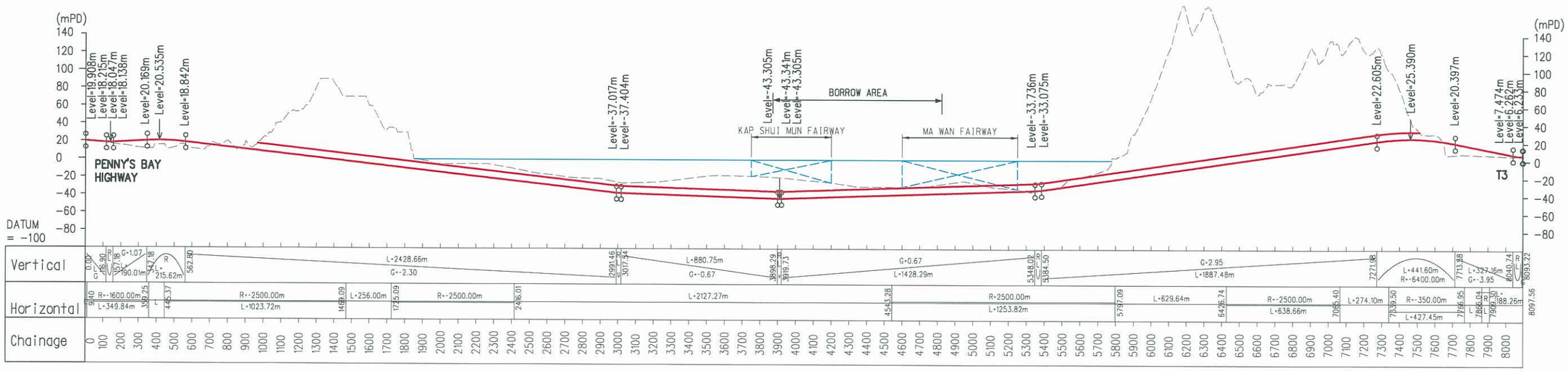
OPTION 1 - IMMERSED TUBE TUNNEL

FIGURE 2.12

Scale 1 : 25 000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.12A.dgn





LONGITUDINAL SECTION OF OPTION 2

HORI. SCALE 1 : 25000
VER. SCALE 1 : 5000

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TSING YI LANTAU LINK - FEASIBILITY STUDY

OPTION 2 - IMMERSED TUBE TUNNEL

FIGURE 2.13

Scale 1 : 25 000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.13A.dgn

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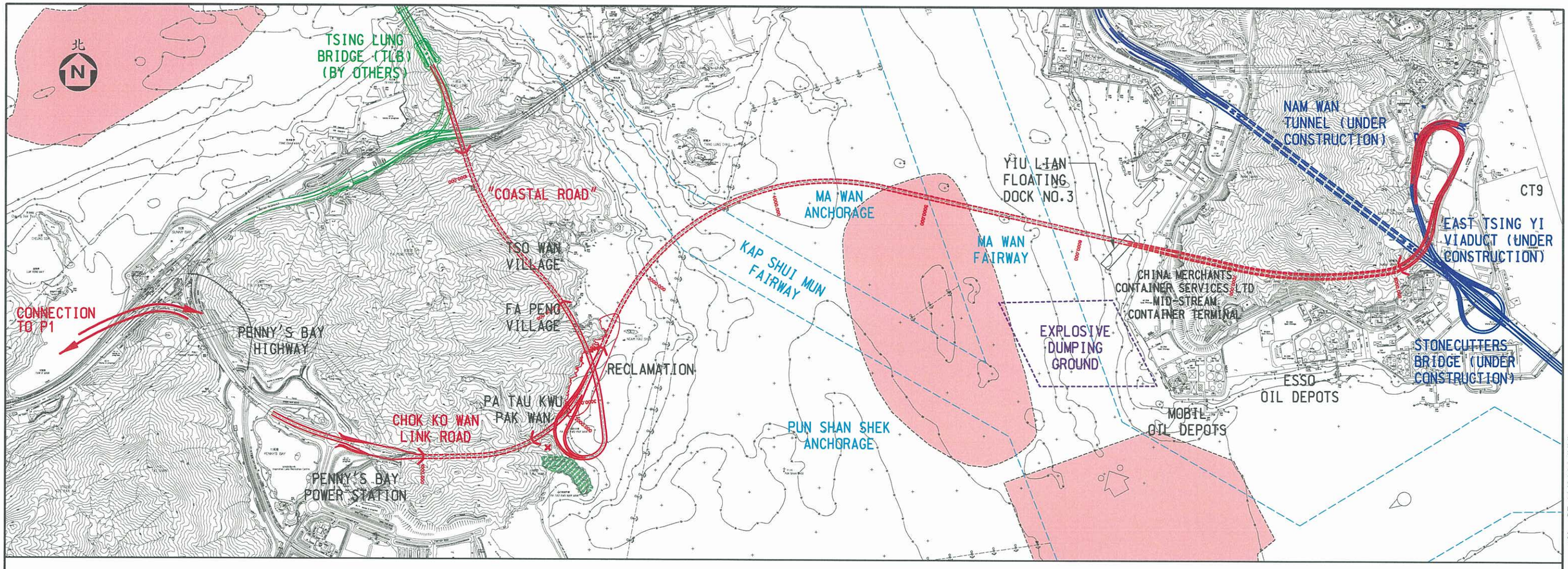

LONGITUDINAL SECTION OF OPTION 3

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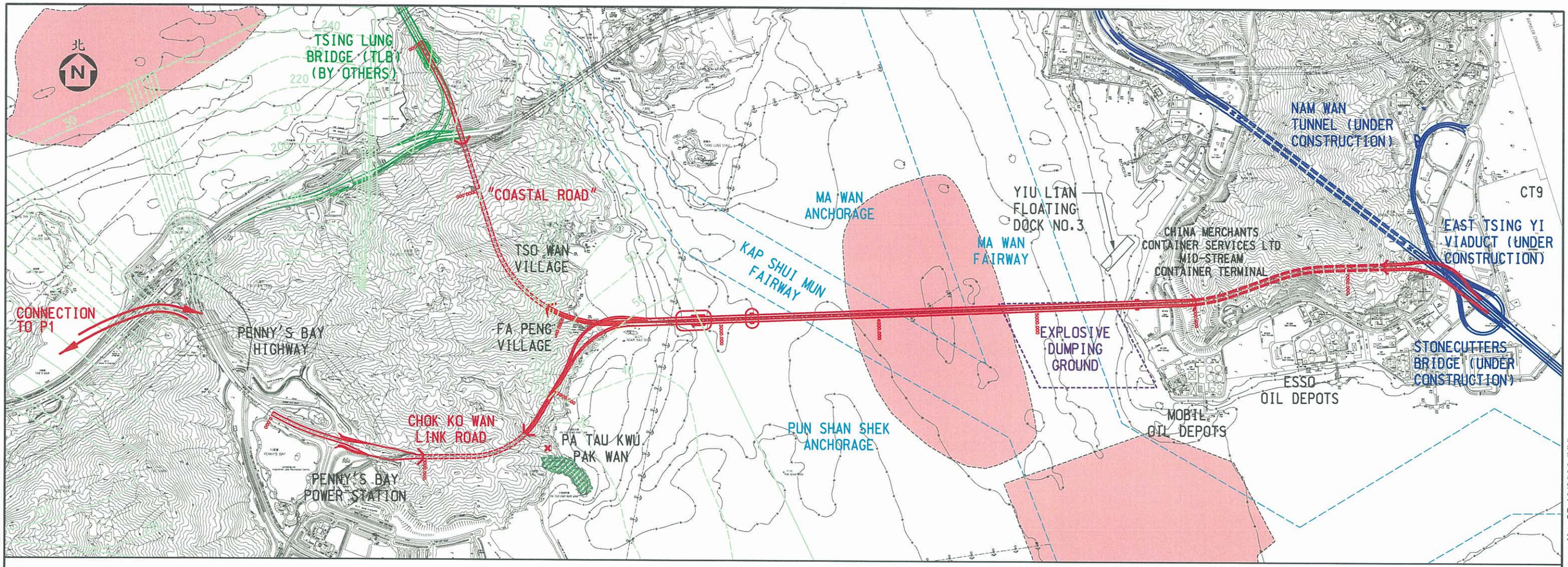
TSING YI LANTAU LINK - FEASIBILITY STUDY

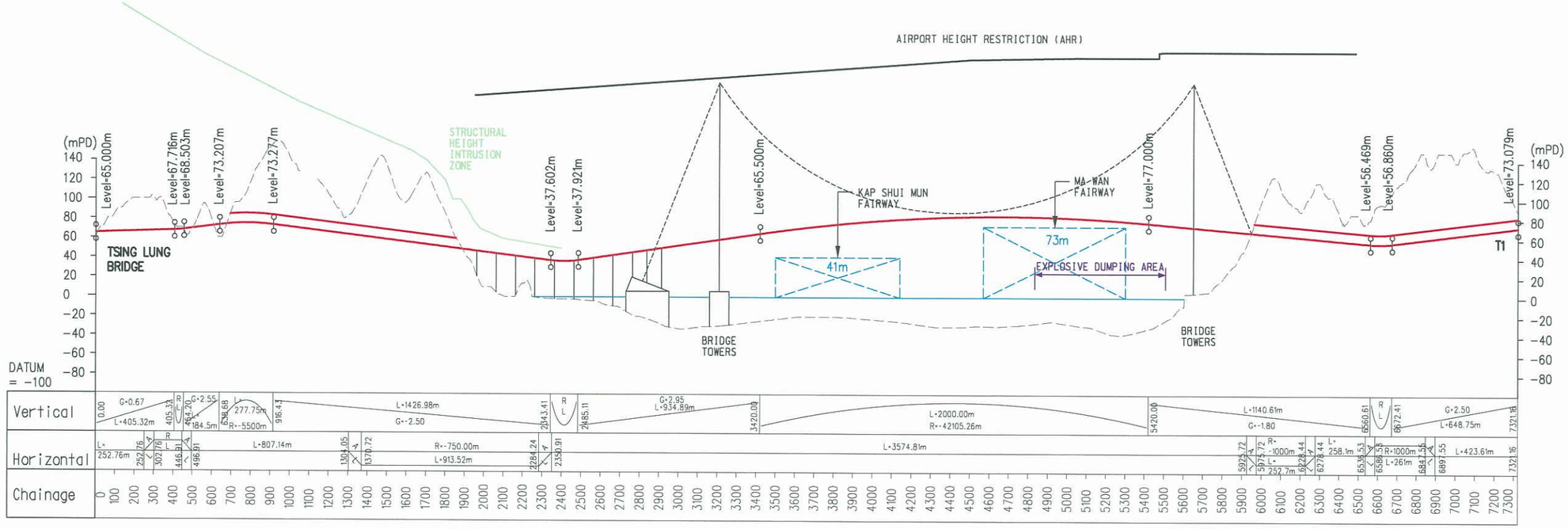
OPTION 3 - IMMERSED TUBE TUNNEL

FIGURE 2.14

Scale 1 : 25 000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.14A.dgn





LONGITUDINAL SECTION OF OPTION 4

HORI. SCALE 1 : 25000
VER. SCALE 1 : 5000

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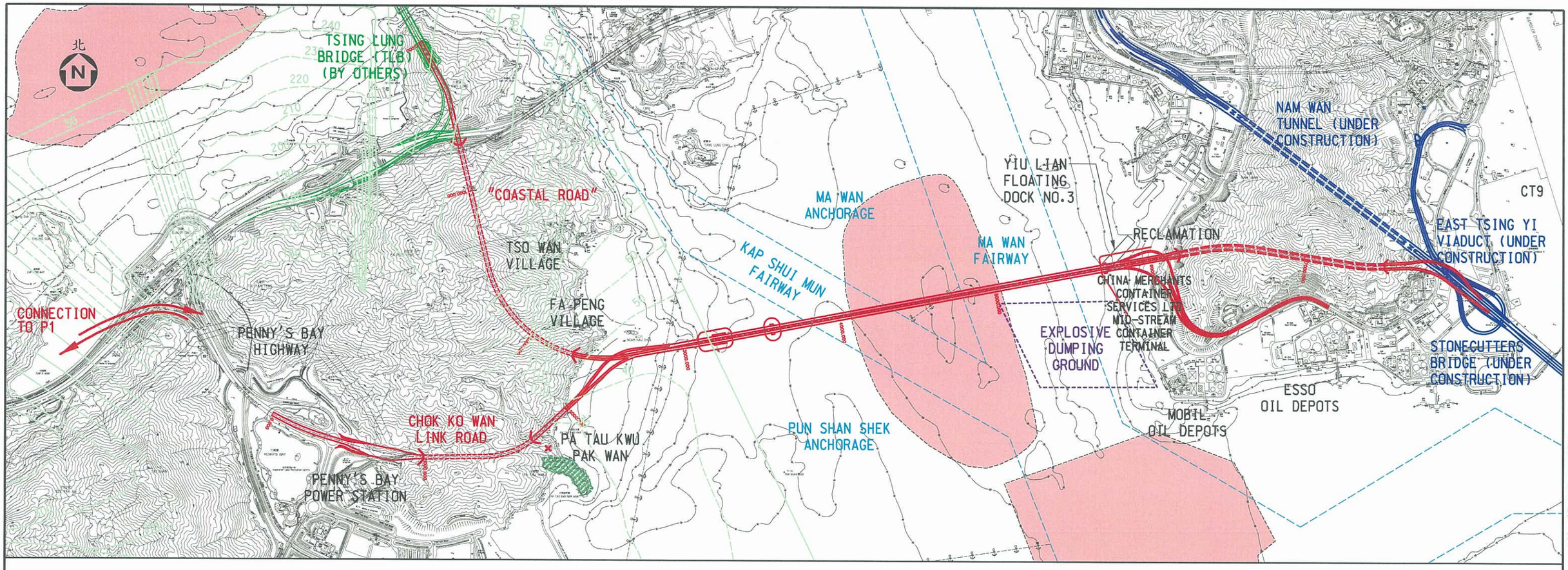
TSING YI LANTAU LINK - FEASIBILITY STUDY

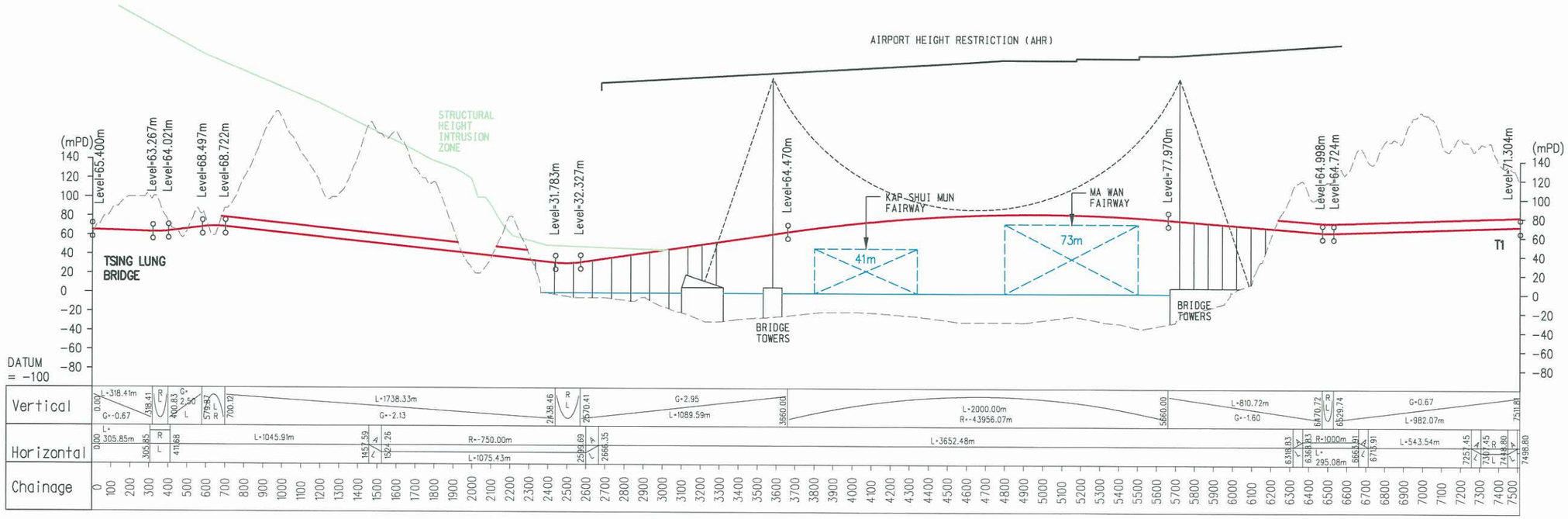
OPTION 4 - LONG SPAN BRIDGE

FIGURE 2.15

Scale 1 : 25 000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.15A.dgn





LONGITUDINAL SECTION OF OPTION 5

HORI. SCALE 1 : 25000
VER. SCALE 1 : 5000

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TSING YI LANTAU LINK - FEASIBILITY STUDY

OPTION 5 - LONG SPAN BRIDGE

FIGURE 2.16

Scale 1 : 25 000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.16A.dgn

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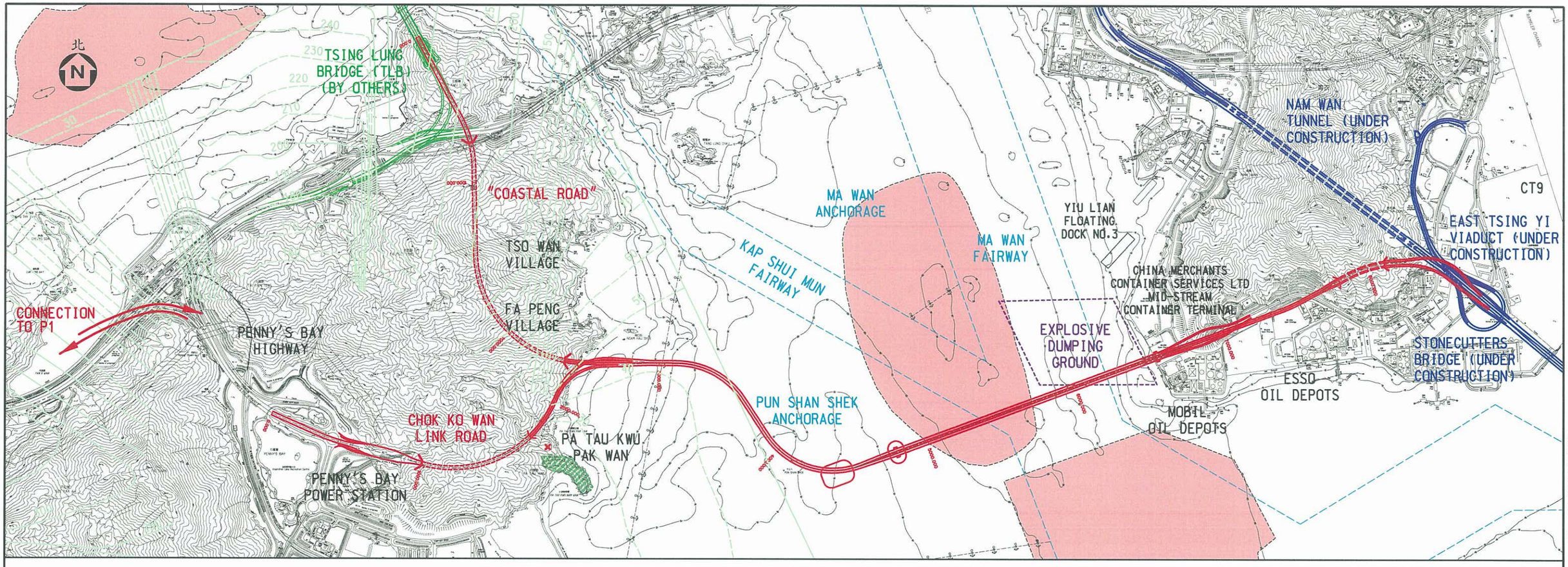

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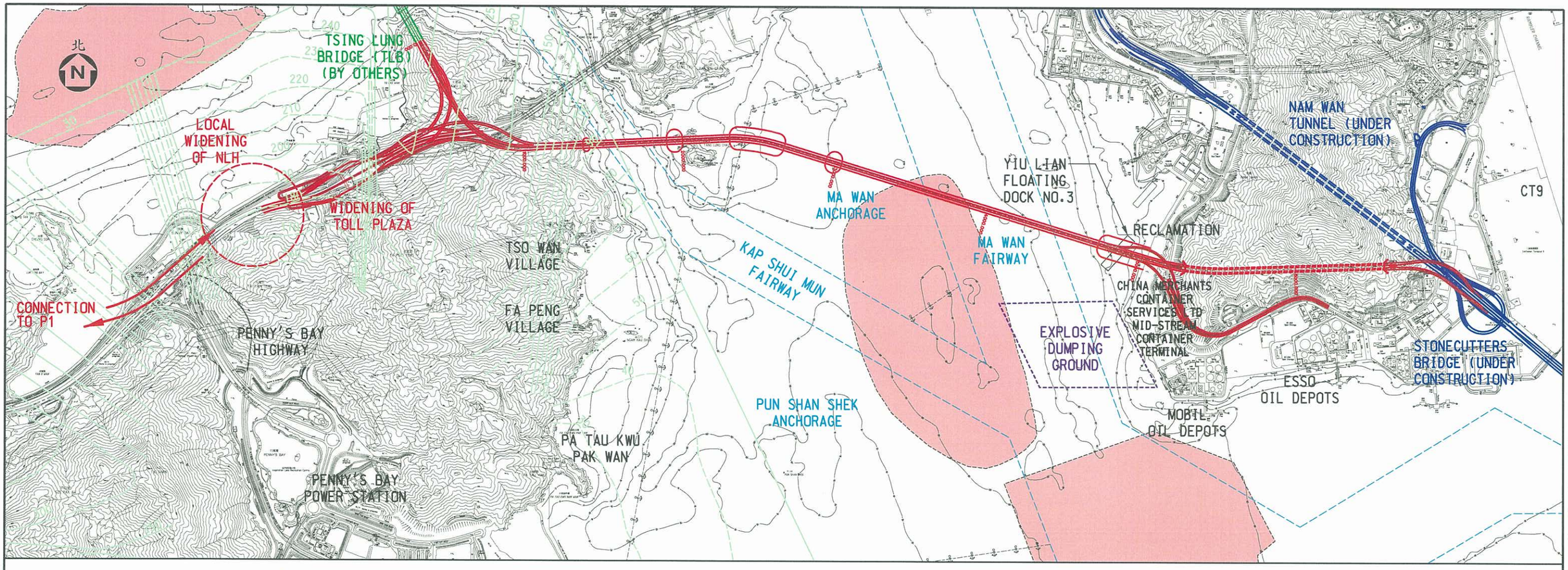
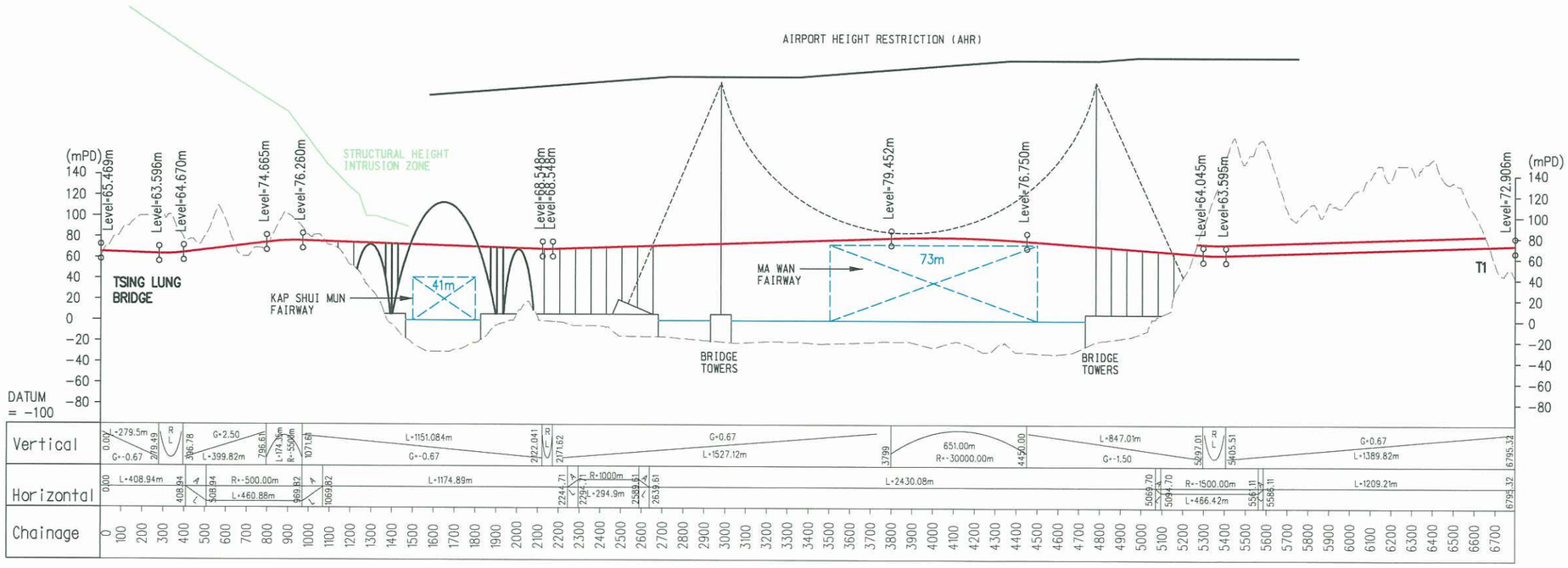
OPTION 6 - LONG SPAN BRIDGE

FIGURE 2.17

Scale 1 : 25 000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Fig 2.17A.dgn





LONGITUDINAL SECTION OF OPTION 7

HORI. SCALE 1 : 25000
VER. SCALE 1 : 5000

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TSING YI LANTAU LINK - FEASIBILITY STUDY

OPTION 7 - LONG SPAN BRIDGE

FIGURE 2.18

Scale 1 : 25 000

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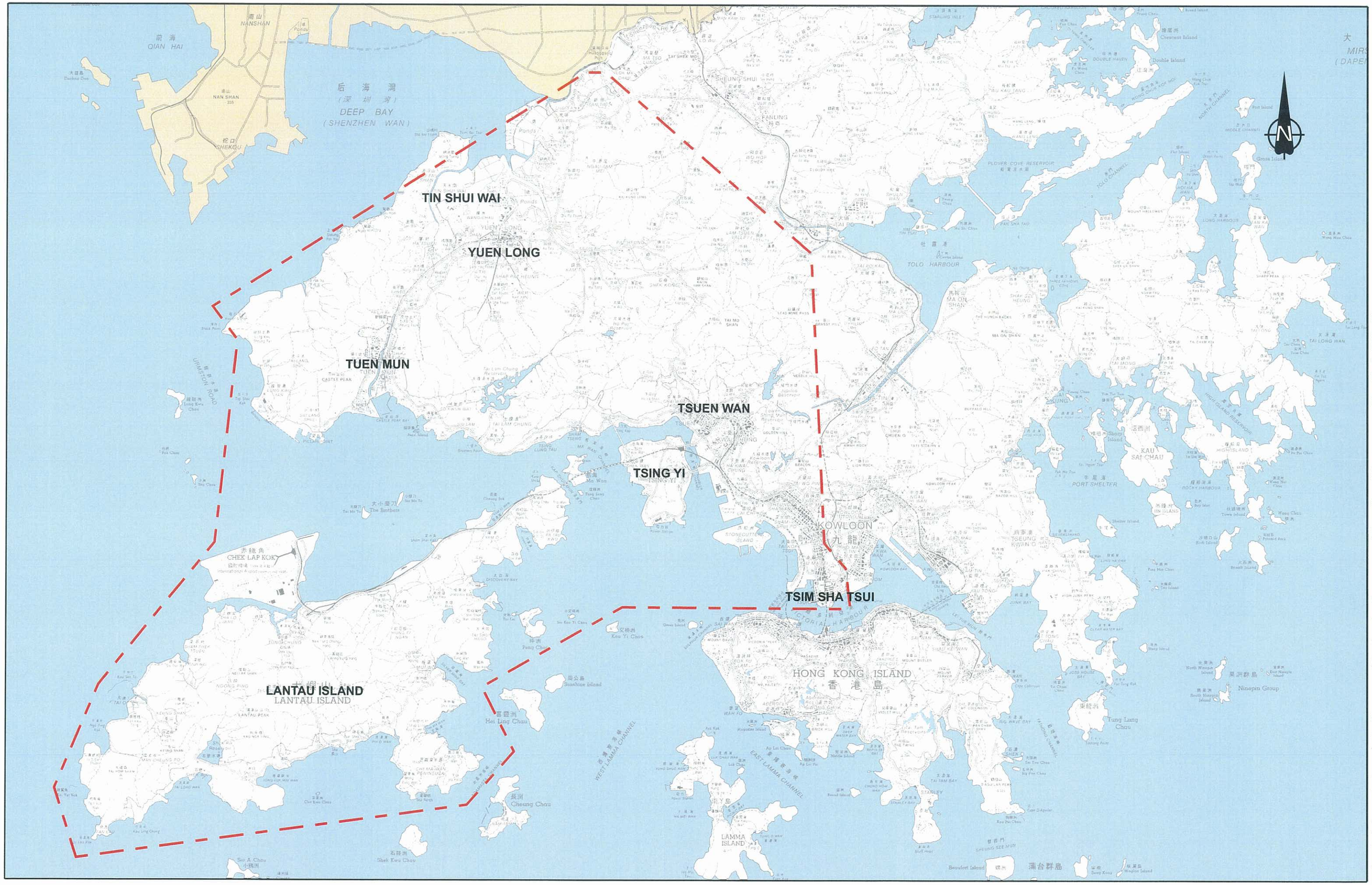

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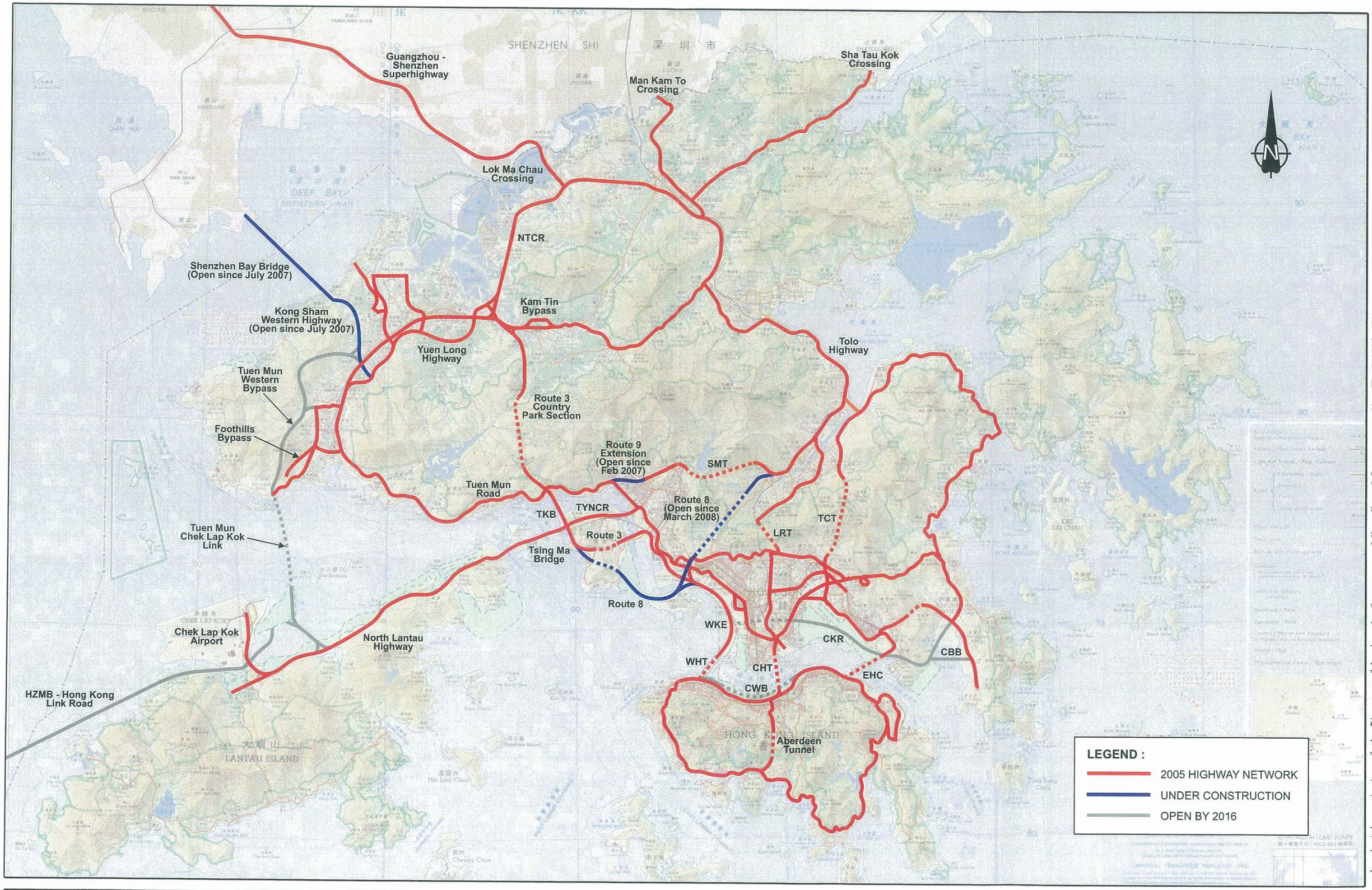
TSING YI LANTAU LINK - FEASIBILITY STUDY

AREA OF INFLUENCE FOR TRAFFIC ASSESSMENT

FIGURE 3.1

Scale N.T.S.

CAD FILE : 26999/FR/F31.CDR/LLH/19JAN09



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TSING YI LANTAU LINK - FEASIBILITY STUDY

REFERENCE CASE STRATEGIC HIGHWAY NETWORK

FIGURE 3.2

Scale N.T.S.

CAD FILE : 26999/FR/F32.CDR/LLH/2MAR09

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LEGEND :

- 2005 HIGHWAY NETWORK
- UNDER CONSTRUCTION
- PLANNED BY 2016
- POTENTIAL

Lok Ma Chau Crossing

Shenzhen Bay Bridge (Open since July 2007)

NTCR

Kong Sham Western Highway (Open since July 2007)

Kam Tin Bypass

Yuen Long Highway

Tuen Mun Western Bypass

Route 10 (Lam Tei Tunnel)

Route 3 Country Park Section

Foothills Bypass

Tuen Mun Eastern Bypass

Route 10 (Southern Section)

Route 9 Extension (Open since Feb 2007)

SMT

Tuen Mun Road - Widened to Dual 4-lane

TYNCR

Route 8 (Open since March 2008)

Tuen Mun Road

TKB

Tuen Mun Chek Lap Kok Link

Route 10 (Tsing Lung Bridge)

Route 3

LRT

Tsing Ma Bridge

Lantau Road P1

Tsing Yi Lantau Link

Route 8

CKWLR

WKE

Chek Lap Kok Airport

North Lantau Highway

WHT

CHT

CWB

路政署 HIGHWAYS DEPARTMENT 港珠澳大橋香港工程管理處 Hong Kong - Zhuhai - Macao Bridge Hong Kong Project Management Office	Meinhardt Infrastructure and Environment Limited 邁進基建環保工程顧問有限公司	AGREEMENT NO. CE 40/2006 (HY) TSING YI LANTAU LINK - FEASIBILITY STUDY NWNT STRATEGIC HIGHWAY NETWORK OPTIONS (2030)	FIGURE 3.3 Scale N.T.S.

CAD FILE : 26999/FR/F33.CDR/LLH/2MAR09

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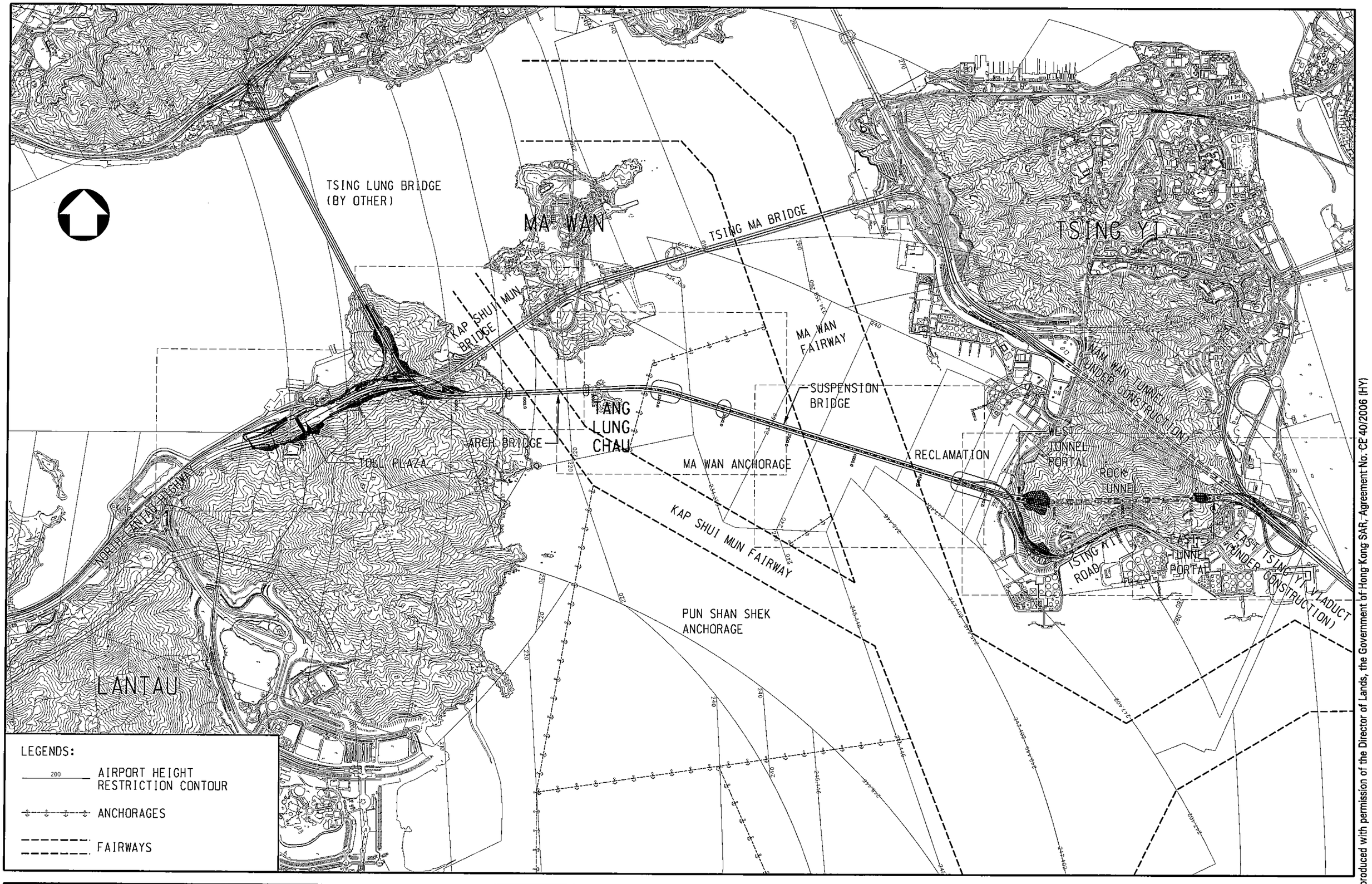

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LAYOUT OF PREFERRED TYLL ALIGNMENT

FIGURE 7.1

Scale 1 : 25 000 (A3)

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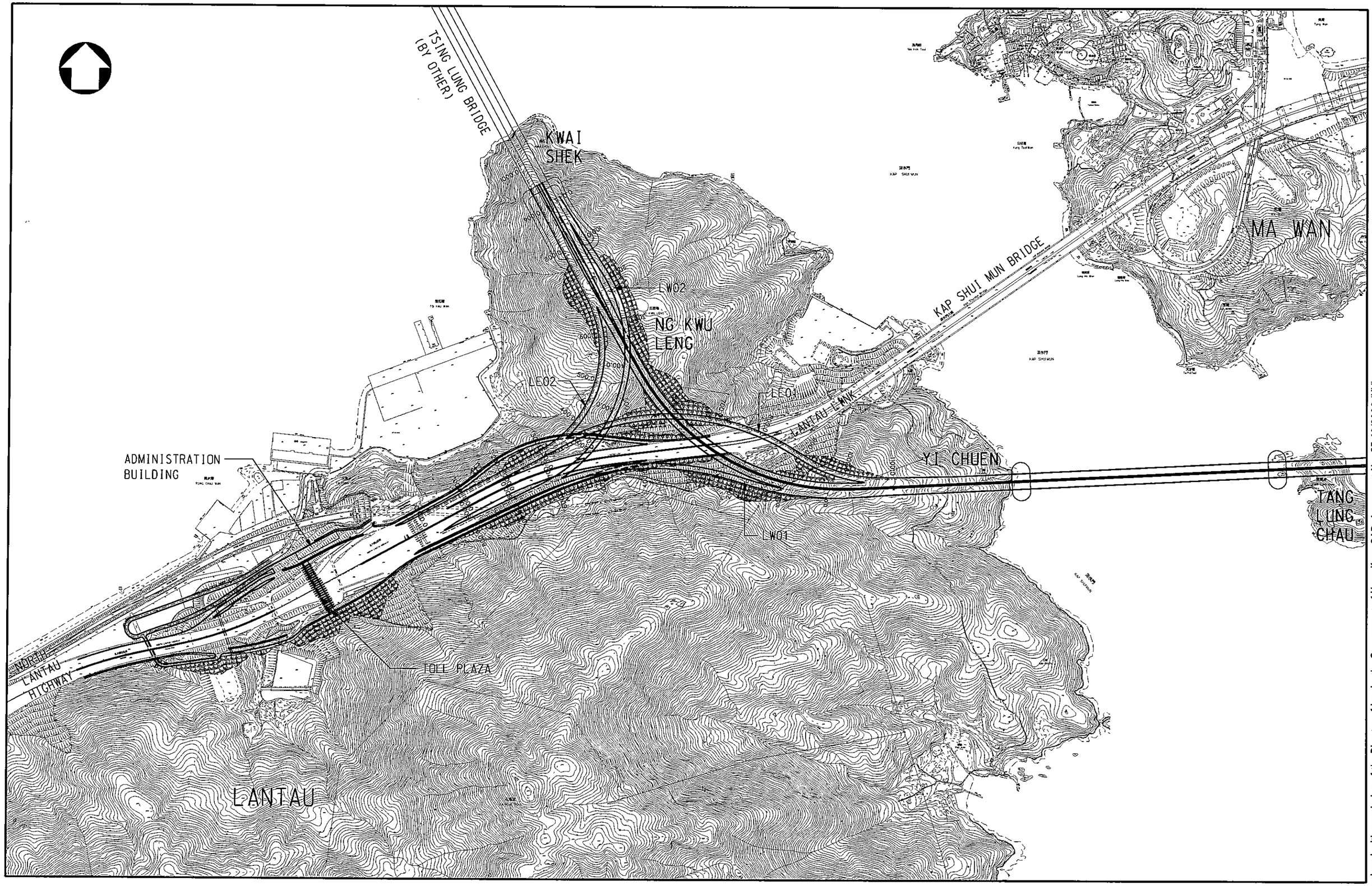

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LAYOUT OF TYLL WESTERN INTERCHANGE WITH TSING LUNG BRIDGE AND NORTH LANTAU HIGHWAY

FIGURE 7.2

Scale 1 : 7500 (A3)

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 7.2.dgn

TSING YI

NAM WAN TUNNEL (UNDER CONSTRUCTION)

CONTROL KIOSK

DETECTOR

RECLAMATION

TE02

TSING YI ROAD

ROAD CROSS-OVER (APPROX. 100m)

WEST TUNNEL PORTAL

VENTILATION BUILDING AND SUB-CONTROL ROOM

ROAD CROSS-OVER (APPROX. 100m)

EAST TUNNEL PORTAL

EAST TSING YI VIADUCT (UNDER CONSTRUCTION)

TE01

TWO2

MID STREAM CONTAINER TERMINAL

RECOVERY AREA

RECOVERY AREA

NAM WAN KOK

DOW CHEMICAL (HONG KONG) LTD

DETECTOR

TWO1

WEIGH STATION WITH CONTROL KOISK

TSING YI ROAD

WEIGH STATION WITH CONTROL KOISK

LEGENDS:

■ INDICATIVE LOCATION OF CONTROL KIOSK

INDICATIVE LOCATION OF OVER-HEIGHT VEHICLE DETECTOR

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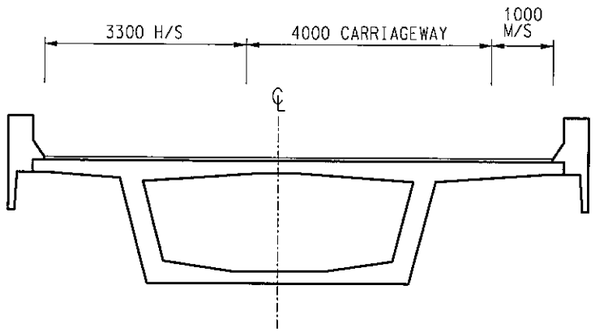
TSING YI LANTAU LINK - FEASIBILITY STUDY

LAYOUT OF TYLL EASTERN CONNECTION WITH ETYV AND TSING YI ROAD

FIGURE 7.3

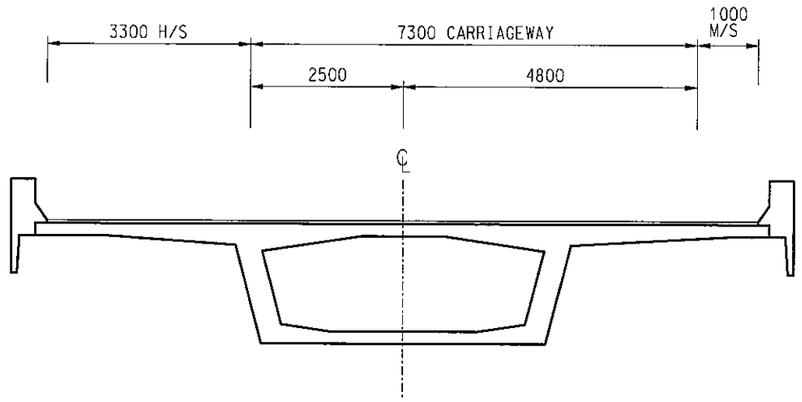
Scale 1 : 7500 (A3)

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 7.3.dgn



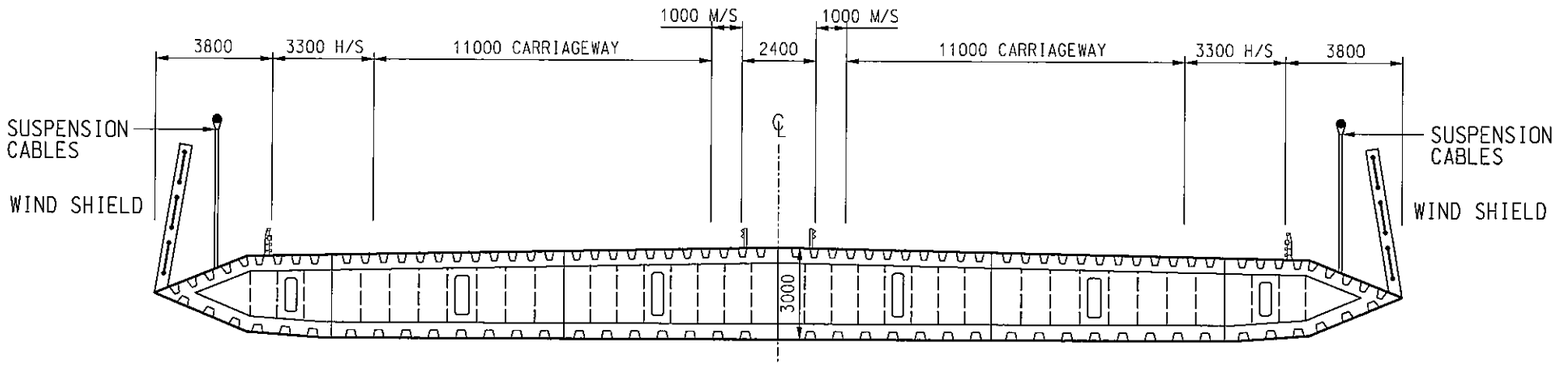
TYPICAL SECTION OF SINGLE ONE-LANE CARRIAGEWAY

SCALE 1 : 100(A3)



TYPICAL SECTION OF SINGLE TWO-LANE CARRIAGEWAY

SCALE 1 : 100(A3)



TYPICAL CROSS SECTION OF SUSPENSION BRIDGE

SCALE 1 : 200(A3)

ALL DIMENSIONS ARE SHOWN IN MILLIMETER UNLESS OTHERWISE NOTED.

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TSING YI LANTAU LINK - FEASIBILITY STUDY

TYPICAL SECTIONS FOR ELEVATED HIGHWAY STRUCTURES

FIGURE 7.4

Scale AS SHOWN

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 7.4.dgn

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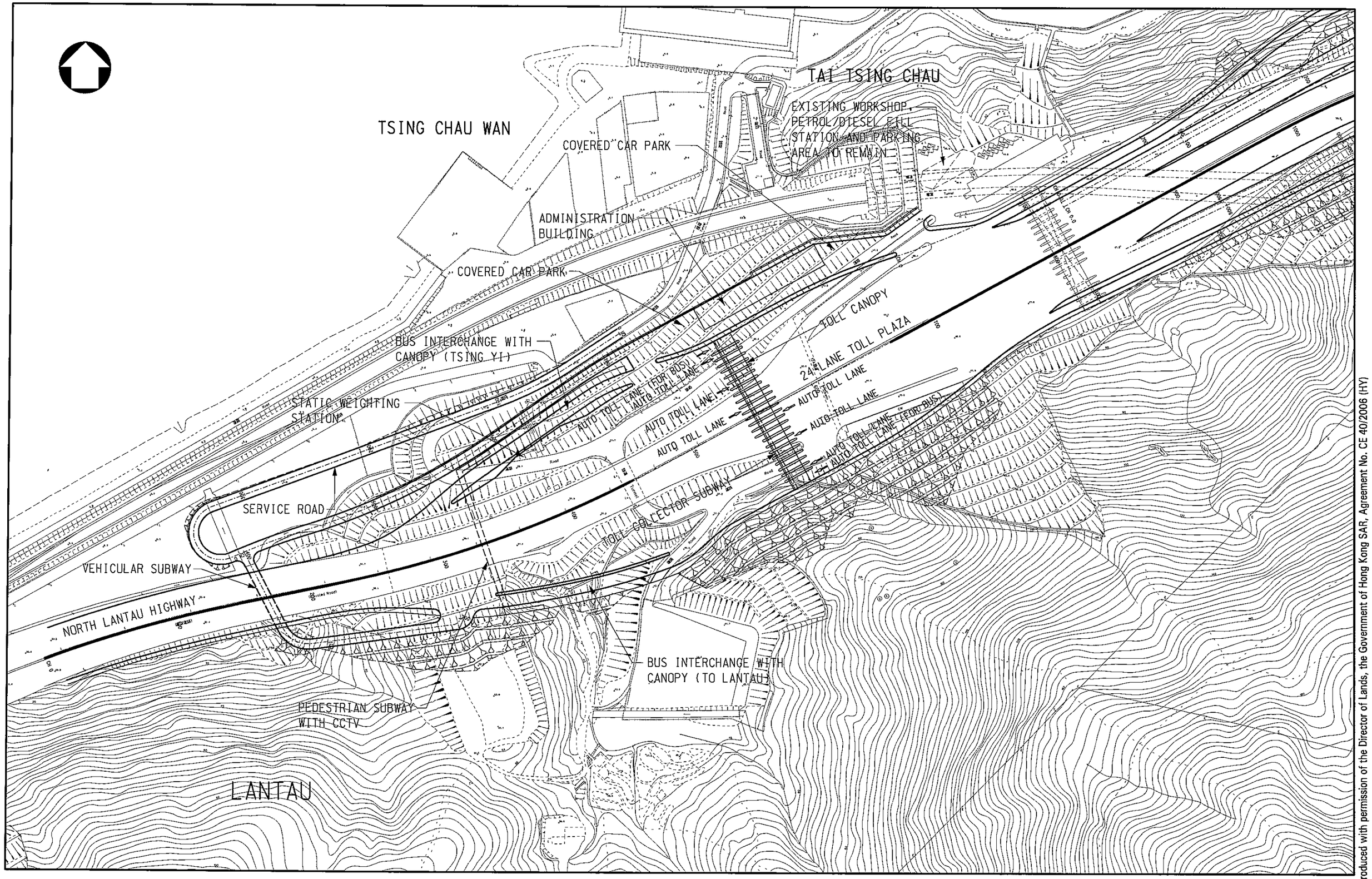

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LAYOUT OF TOLL PLAZA AND OTHER FACILITIES

FIGURE 7.5

Scale 1 : 2500 (A3)

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 7.5.dgn

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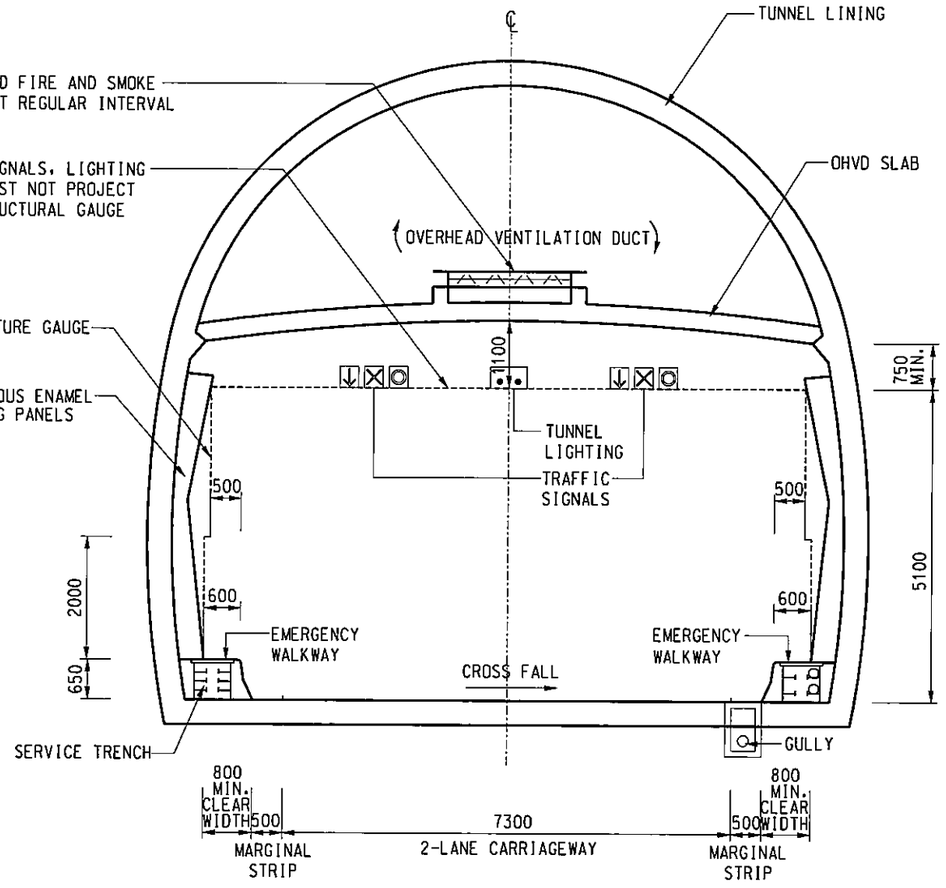

TYPICAL SECTION FOR DRILL AND BLAST TUNNEL
FOR ONE CARRIAGEWAY BOUND

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TYPICAL SECTION FOR ROCK TUNNEL

FIGURE 7.6

Scale 1 : 100 (A3)

CAD FILE : K:\F91065\REPORT\08_08_06 FinalReport\Figure 7.6.dgn

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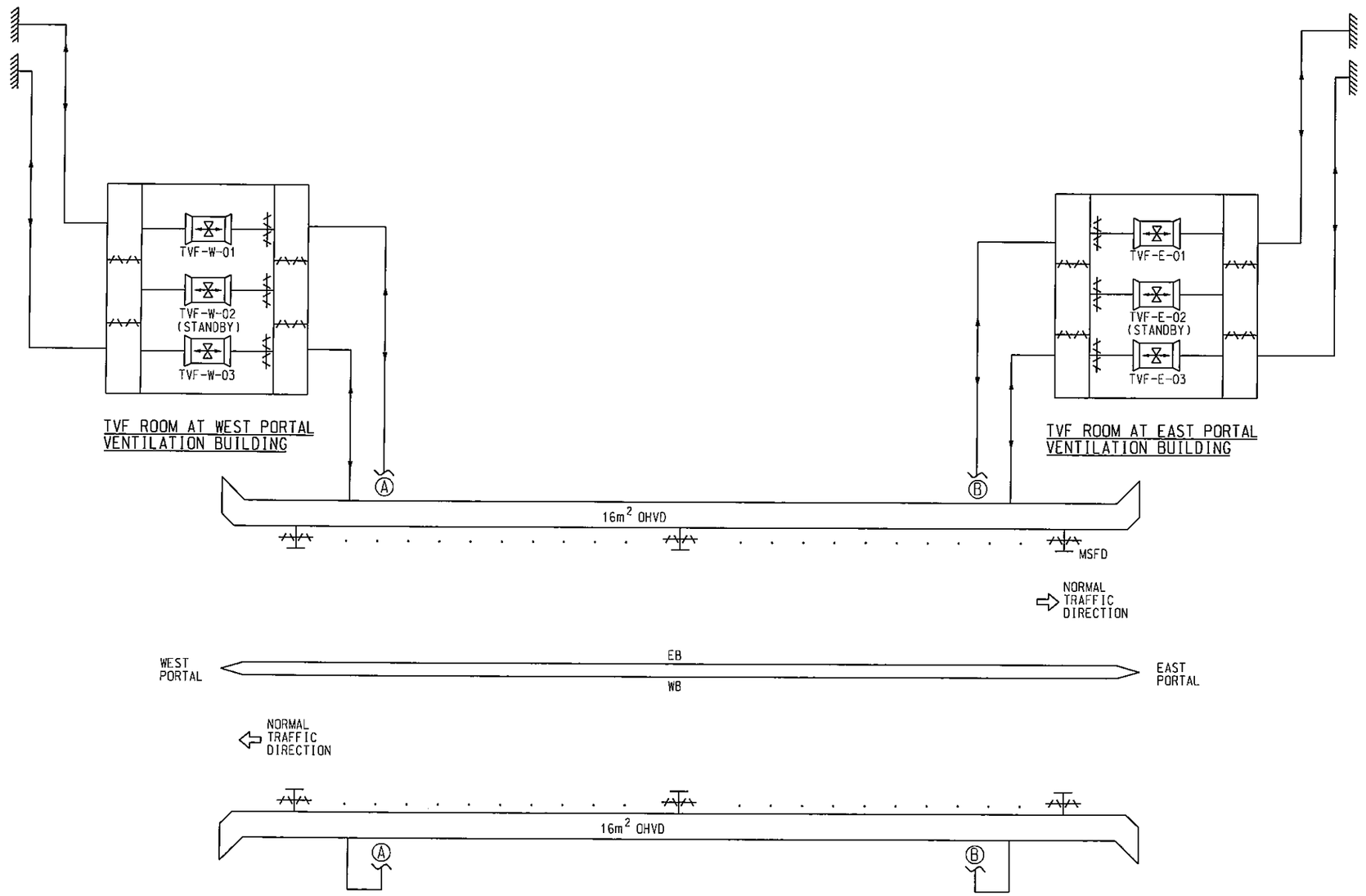

LEGEND:

- TUNNEL VENTILATION FAN (TRULY REVERSIBLE)
- MOTORIZED SMOKE AND FIRE DAMPER (MSFD)
- WEATHERPROOF LOUVRE

OHVD – OVERHEAD VENTILATION DUCT

NOTES:

1. ALL TVF ARE 2 SPEED. THE CAPACITY ARE $40m^3/s$ AND $80m^3/s$ AT LOW AND HIGH SPEED RESPECTIVELY.
2. ALL EQUIPMENT FOR SMOKE EXTRACTION SHALL BE ABLE TO WITHSTAND 250°C FOR ONE HOUR.

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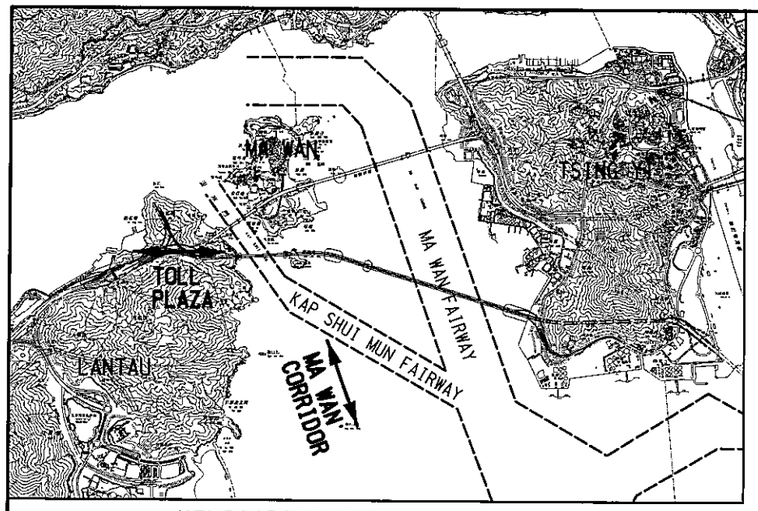
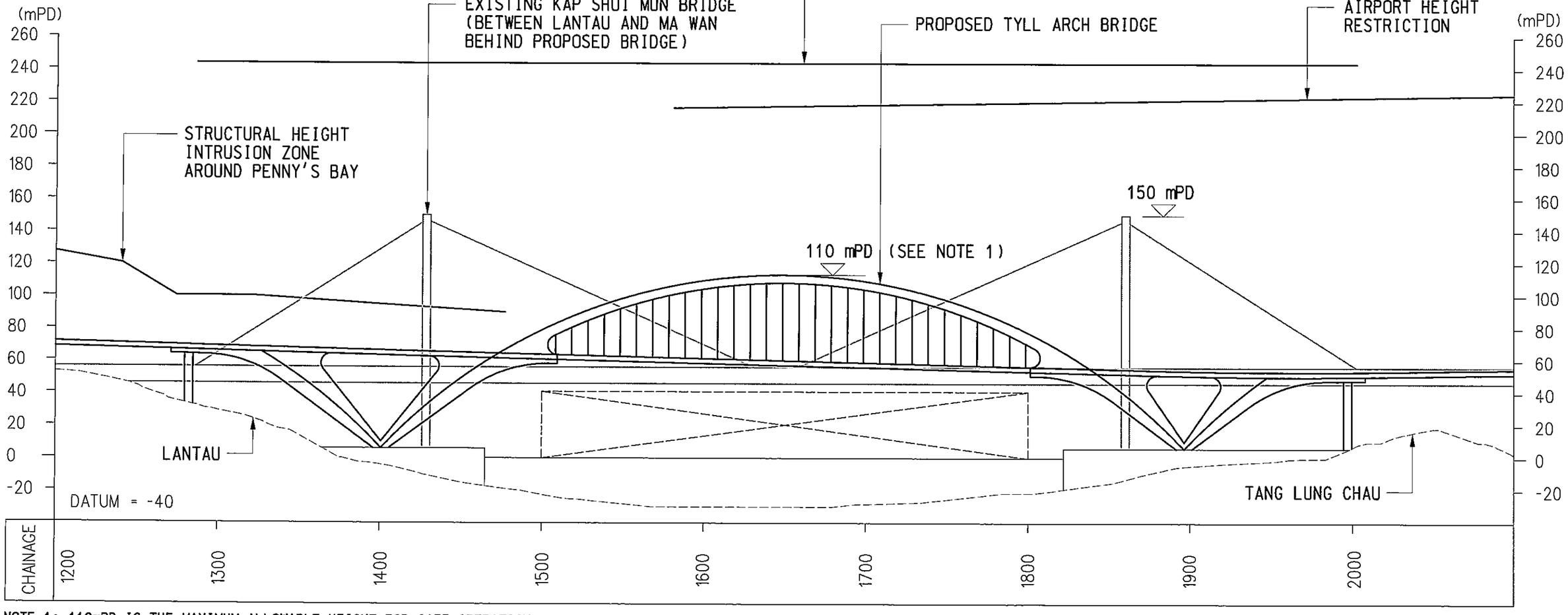


MAXIMUM HEIGHT FOR HELICOPTER OPERATION
MA WAN CORRIDOR 1000ft. AMSL
TOLL PLAZA 800/1000ft. AMSL

HELICOPTER ENTRY/EXIT ROUTE



NOTE 1: 110mPD IS THE MAXIMUM ALLOWABLE HEIGHT FOR SAFE OPERATION OF HELICOPTERS AS ADVISED BY GOVERNMENT FLYING SERVICE.

HORI. SCALE 1 : 2500
VER. SCALE 1 : 2500

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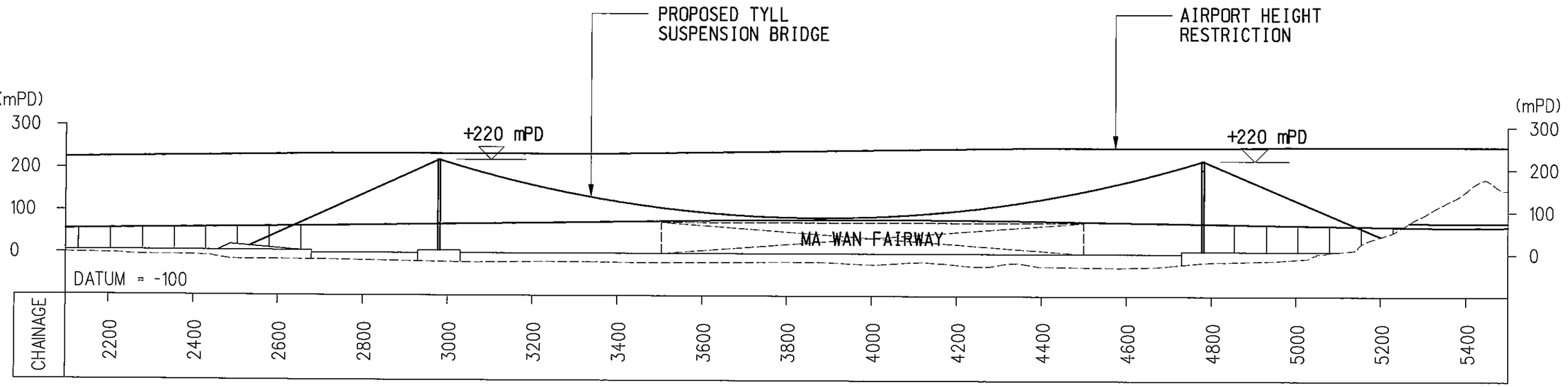
TSING YI LANTAU LINK - FEASIBILITY STUDY

ARCH BRIDGE ACROSS KAP SHUI MUN FAIRWAY

FIGURE 7.8

Scale 1 : 2500

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 7.8.dgn



HORI. SCALE 1 : 10 000
VER. SCALE 1 : 10 000

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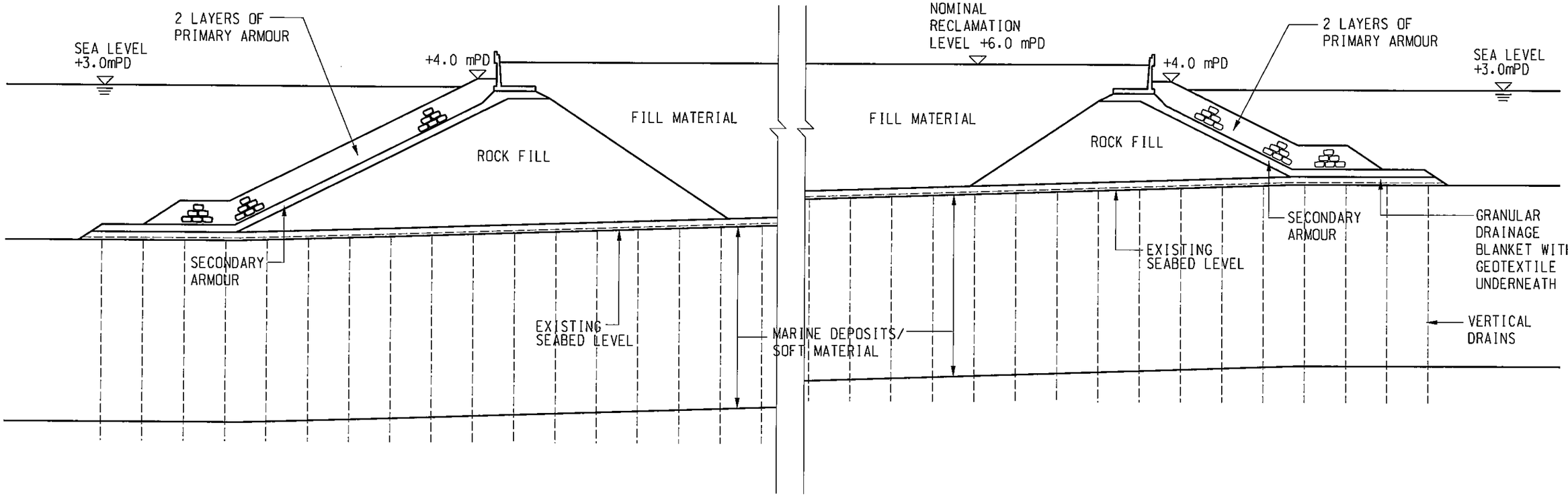
TSING YI LANTAU LINK - FEASIBILITY STUDY

SUSPENSION BRIDGE ACROSS MA WAN FAIRWAY

FIGURE 7.9

Scale 1 : 10 000

CAD FILE: K:\F91065\REPORT\08_08_06 FinalReport\Figure 7.9.dgn



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TYPICAL CROSS SECTION OF ARTIFICAL ISLAND RECLAMATION

FIGURE 7.10

Scale N.T.S

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 7.10.dgn

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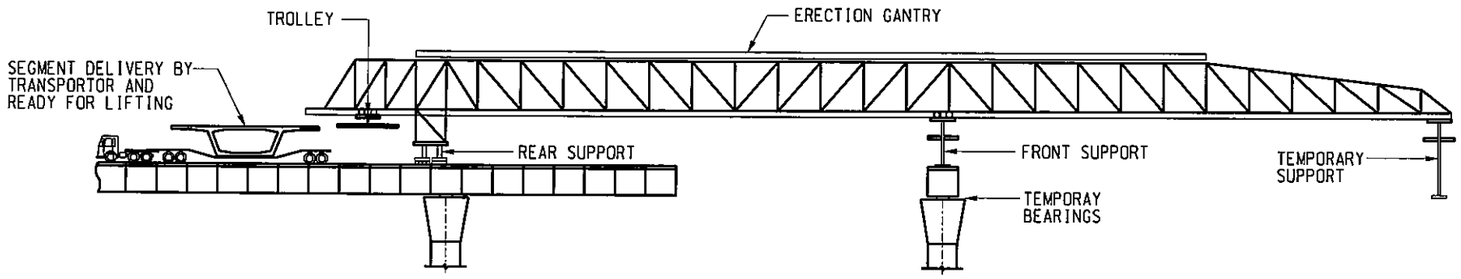
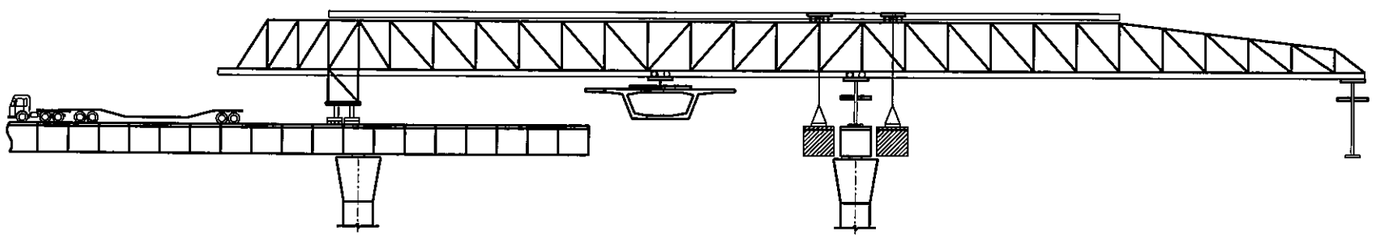


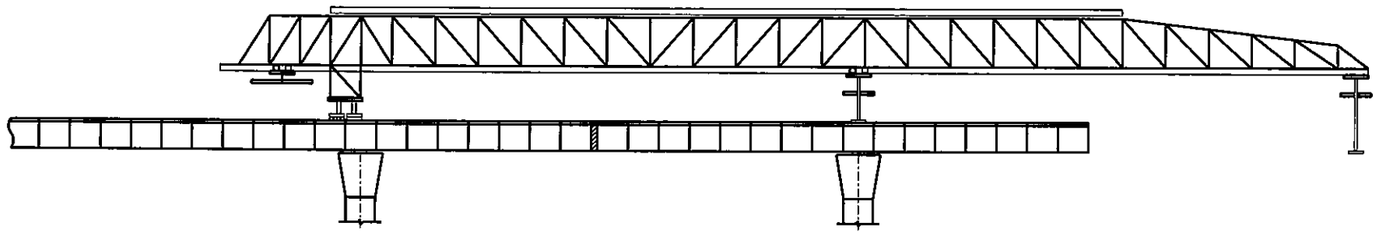
STAGE 1

* ERECT PIER HEAD SEGMENT AFTER SUBSTRUCTURE CONSTRUCTION.
* MOVE ERECTING GANTRY INTO POSITION.



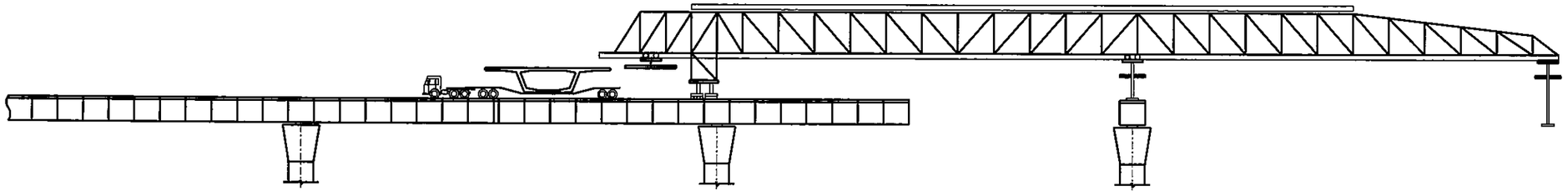
STAGE 2

* LIFT THE FIRST SEGMENTS EITHER SIDE OF THE PIER HEAD SEGMENT INTO POSITION.
* STRESS CANTILEVER TENDON.



STAGE 3

* REPEAT THE PROCESS UNTIL THE CANTILEVERS MEET AT MID SPAN.
* CAST IN-SITU STITCH.
* STRESS SPAN TENDON.



STAGE 4

* MOVE THE ERECTION GANTRY TO THE NEXT SPAN AND REPEAT STAGE 1 TO STAGE 3.

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BALANCED CANTILEVER ERECTION BY GANTRY

FIGURE 7.11

Scale N.T.S.

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 7.11.dgn

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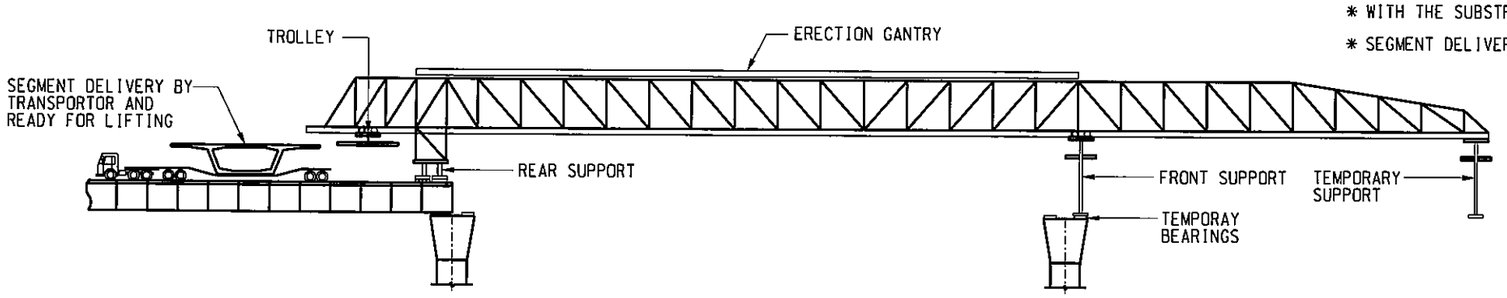
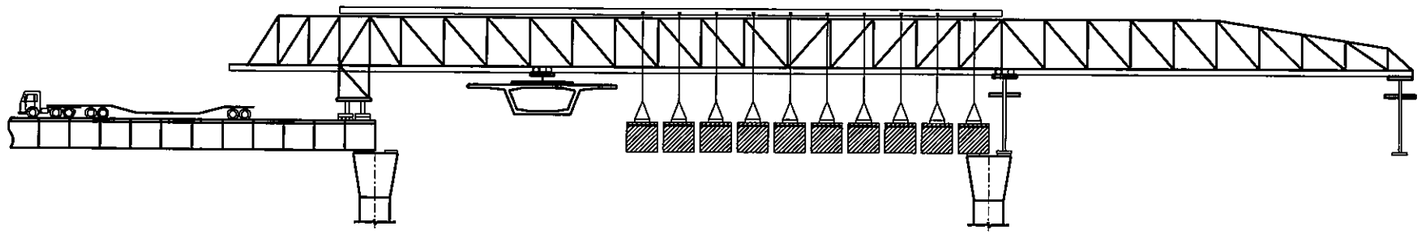
STAGE 1

* WITH THE SUBSTRUCTURES IN PLACE, MOVE THE ERECTION GANTRY IN POSITION FOR THE NEXT SPAN.
* SEGMENT DELIVERY ON THE COMPLETED DECK AND READY FOR LIFTING.



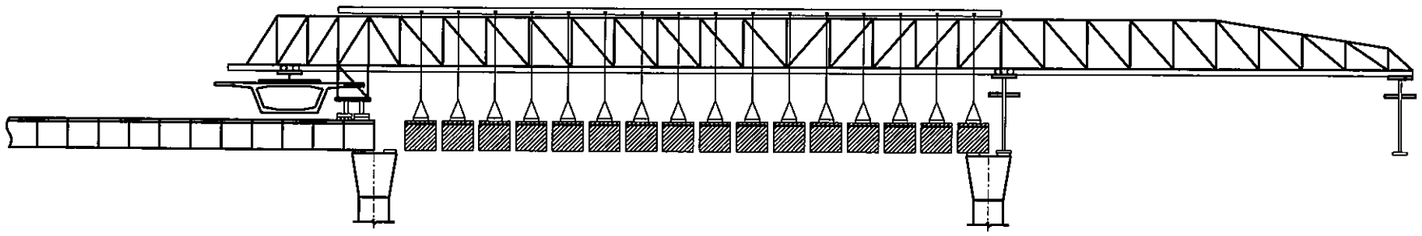
STAGE 2

* SEGMENTS LIFTED INTO POSITION BY TROLLEY.



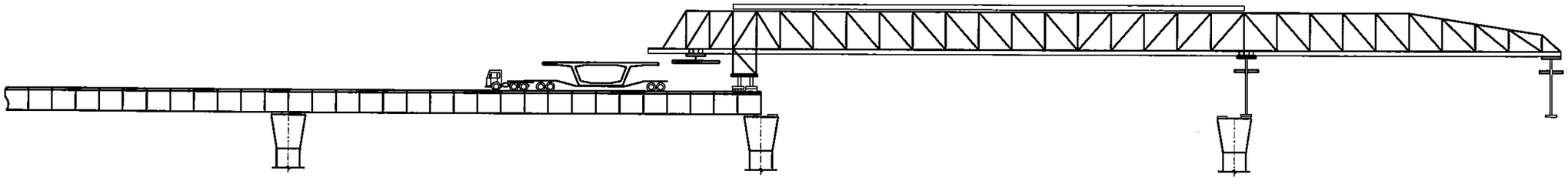
STAGE 3

* WITH ALL THE SEGMENTS IN PLACE, PROVIDE PRESTRESS.



STAGE 4

* MOVE THE ERECTION GANTRY TO THE NEXT SPAN AND REPEAT STAGE 1 TO STAGE 3.



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TSING YI LANTAU LINK - FEASIBILITY STUDY

SPAN-BY-SPAN ERECTION

FIGURE 7.12

Scale N.T.S.

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 7.12.dgn

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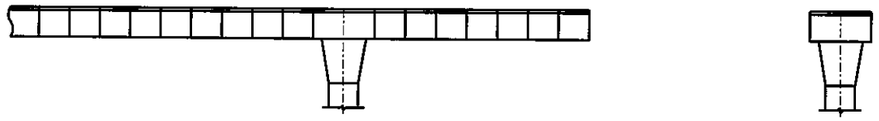
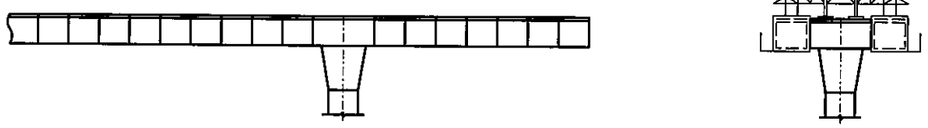


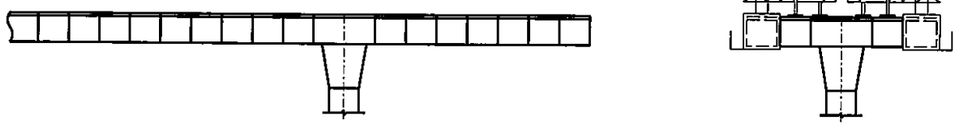
STAGE 1

* ERECT PIER HEAD SEGMENT AFTER SUBSTRUCTURE CONSTRUCTION.
* ASSEMBLE AND ERECT FORM TRAVELER.
* ERECT FORMWORK.



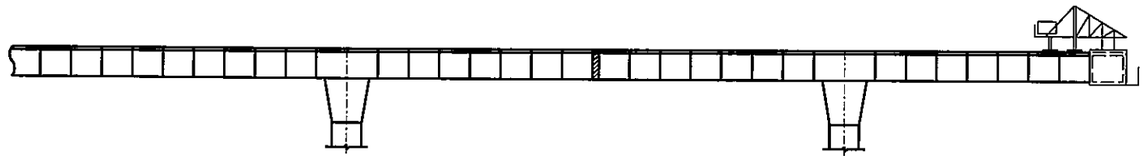
STAGE 2

* CAST SEGMENT.
* STRESS CANTILEVER TENDON.



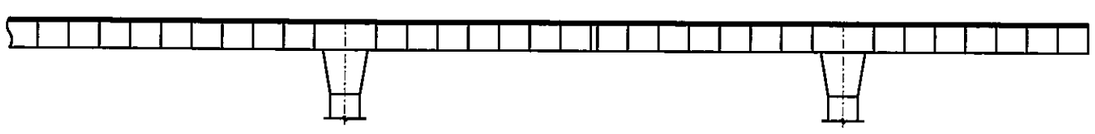
STAGE 3

* MOVE FORM TRAVELER TOGETHER WITH FORMWORK INTO NEXT POSITION.
* REPEAT STAGE 2.



STAGE 4

* REPEAT THE PROCESS UNTIL THE CANTILEVERS MEET AT MID SPAN.
* CAST IN-SITU STITCH.
* STRESS SPAN TENDON.



STAGE 5

* MOVE THE FORM TRAVELER TO THE NEXT SPAN AND REPEAT STAGE 1 TO STAGE 4.

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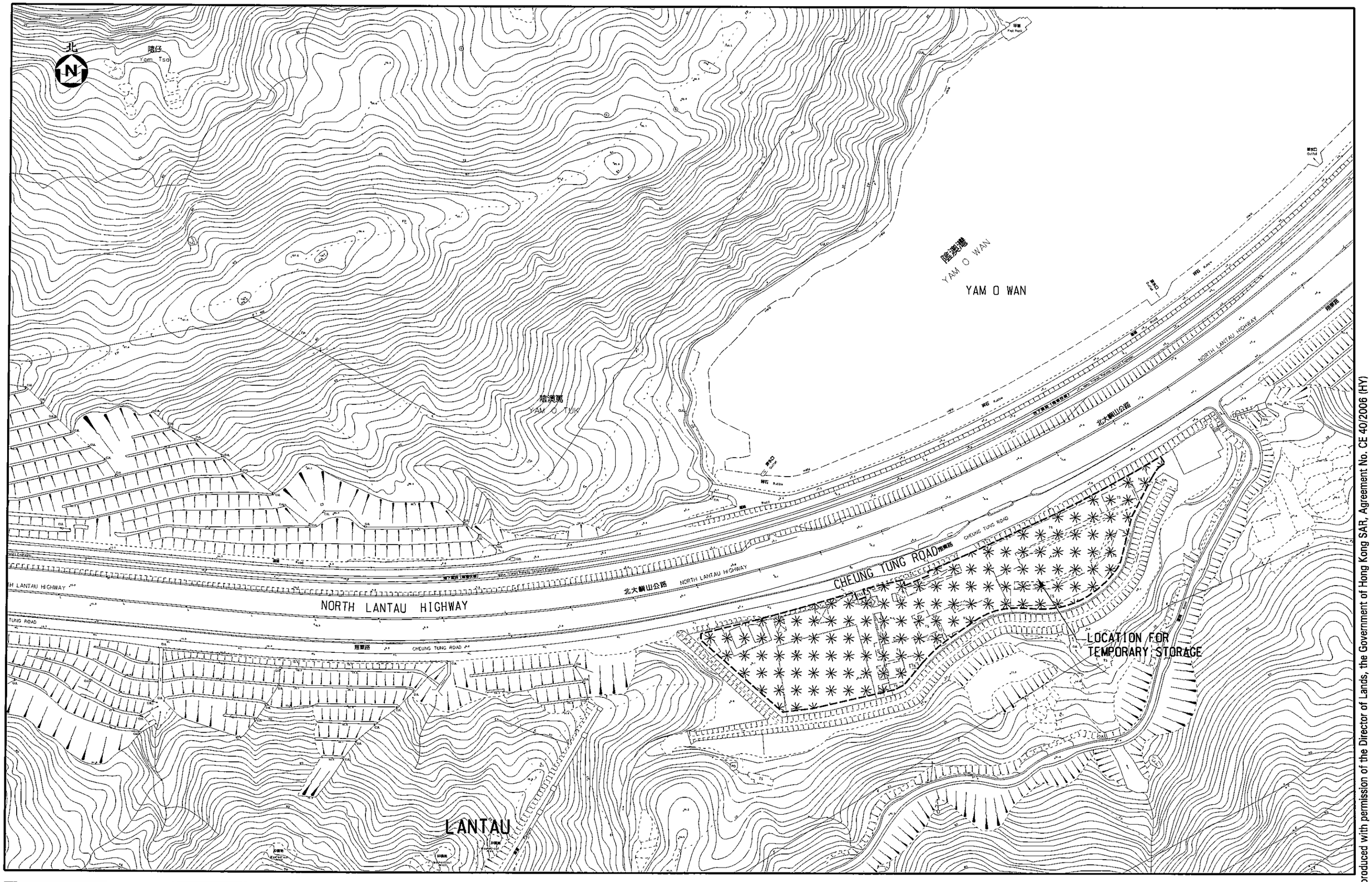
BALANCED CANTILEVER ERECTION BY FORM TRAVELER

FIGURE 7.13

Scale N.T.S.

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 7.13.dgn



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WORKS AREA AT NORTH LANTAU

FIGURE 7.14

Scale 1 : 2 500 (A3)

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 7.14.dgn



NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- +23.2 PROPOSED ROAD LEVEL
- 17484/EL412 EXISTING BOREHOLES

Rev	Issue Sheet	Amendment	By	Chk.	App.	Date
0	IFIC	Issued for Information & comment	CML	TC	SCI	JUN 08

Client

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港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

MEINHARDT
Meinhardt Infrastructure and Environment Limited
迈迪基建环保工程顾问有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

PREVIOUS GROUND INVESTIGATION
LAYOUT PLAN
(SHEET 1 of 3)

Drawn	Checked	Approved
CML	TC	SCI
First Issued: JUNE 2008	CAD File No.: FIGURE 8.1	Date: JUNE 2008
Scale: 1 : 5000 (A1), 1 : 10000 (A3)	Drawing No.: FIGURE 8.1	Rev.: 0

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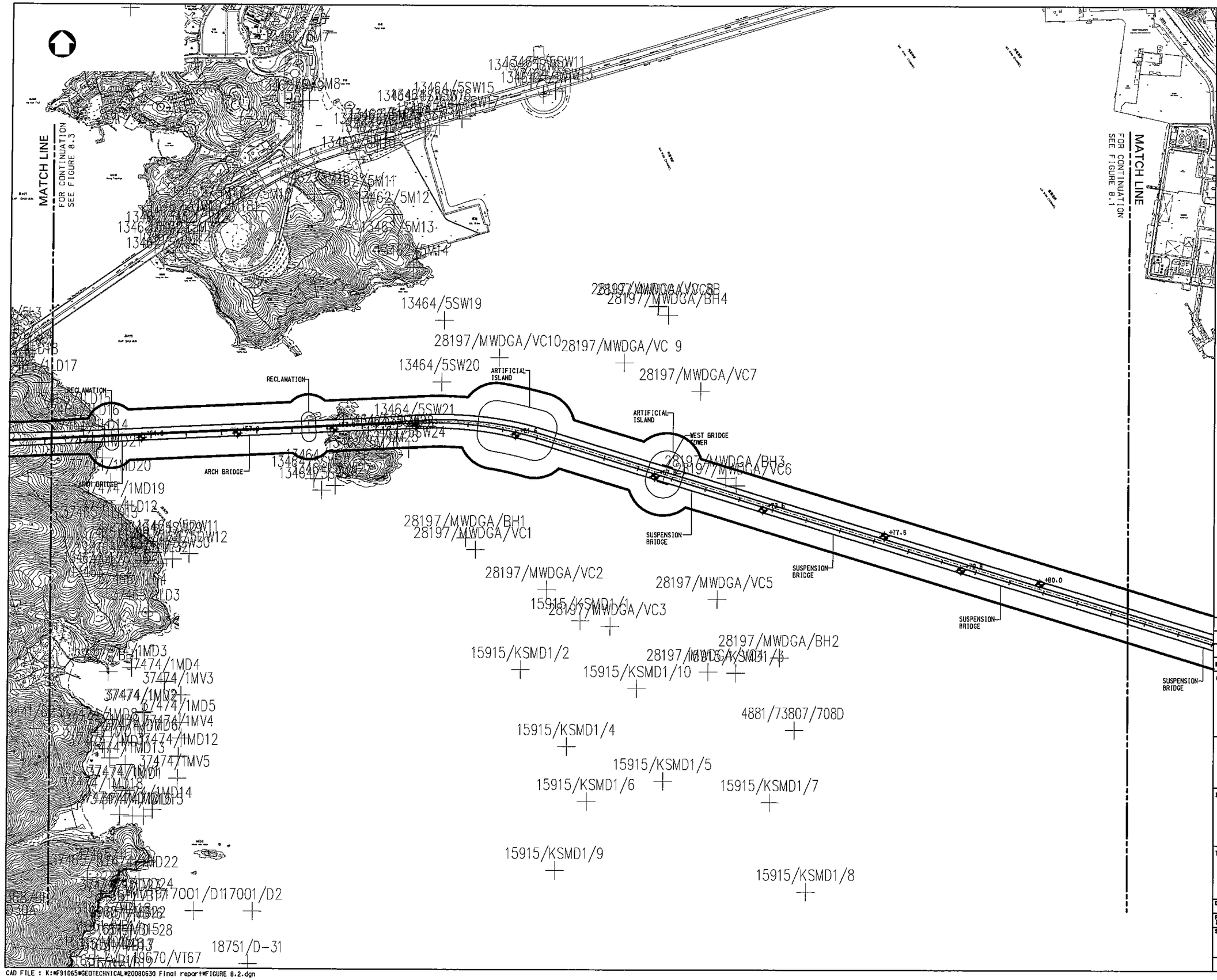
CAD FILE : K:\#F91065\#GEOTECHNICAL\#20080630 Final report\#FIGURE 8.1.dgn



NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- +23.2 PROPOSED ROAD LEVEL
- 17484/EL412 EXISTING BOREHOLES

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
0	IFIC	Issued for information & comment	CML	TC	SCI	JUN 08

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Title

PREVIOUS GROUND INVESTIGATION
LAYOUT PLAN
(SHEET 2 of 3)

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First Issued: JUNE 2008	CAD File No.: FIGURE 8.2	Date: JUNE 2008
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- CUT EARTHWORKS SLOPE
- +23.2 PROPOSED ROAD LEVEL
- 17484/EL412 EXISTING BOREHOLES

MATCH LINE
FOR CONTINUATION SEE FIGURE 8.2

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Title
PREVIOUS GROUND INVESTIGATION
LAYOUT PLAN
(SHEET 3 of 3)

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- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- +23.2 PROPOSED ROAD LEVEL
- BH6 ADDITIONAL BOREHOLES

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Title

ADDITIONAL GROUND INVESTIGATION
LAYOUT PLAN
(SHEET 1 of 3)

Drawn	Checked	Approved
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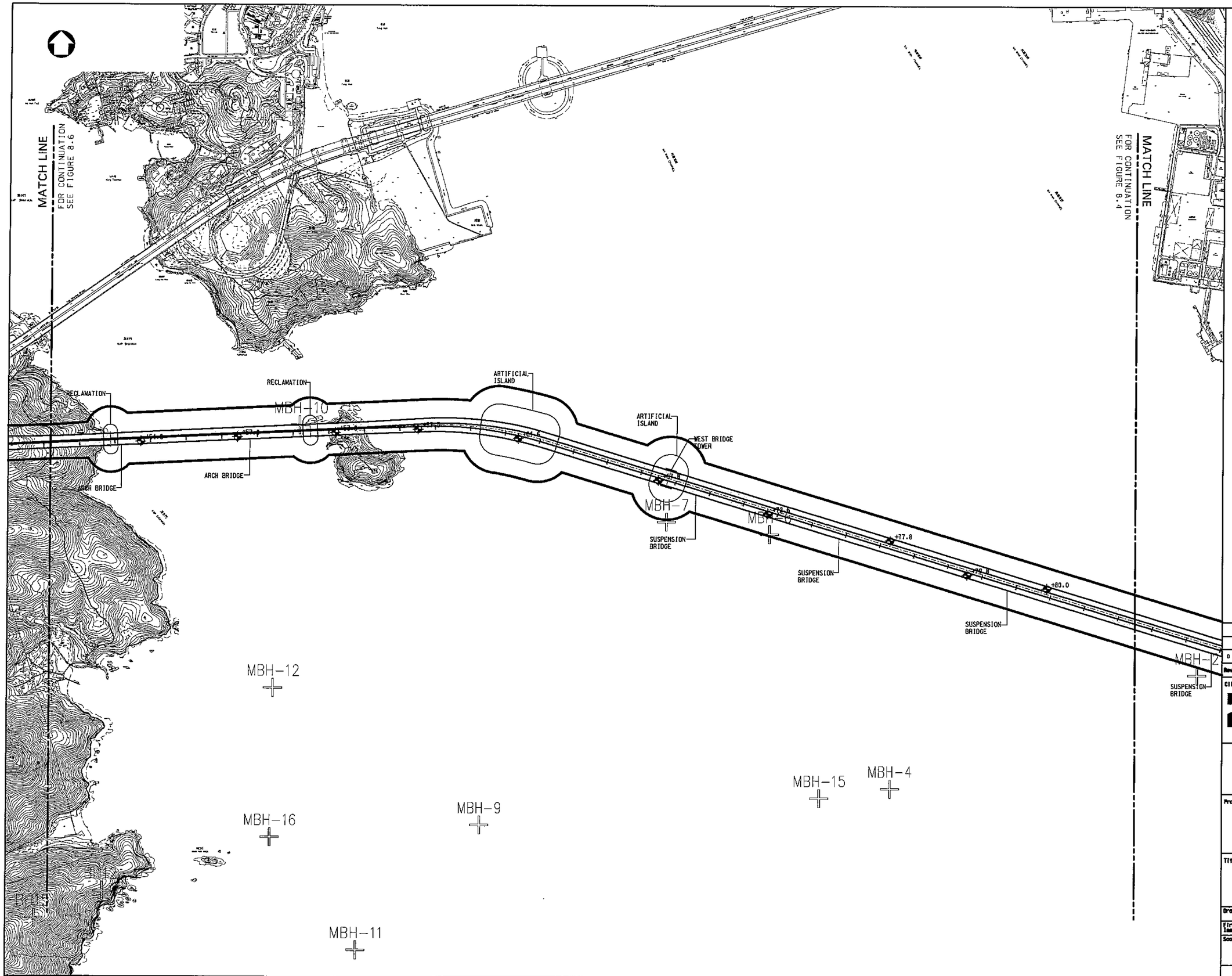
CAD FILE : K:¥F91065¥GEOTECHNICAL¥20080630 Final report¥FIGURE 8.4.dgn



NOTES:

1. ALL DIMENSIONS IN METERS. UNLESS OTHERWISE STATED.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- +23.2 PROPOSED ROAD LEVEL
- BH6 ADDITIONAL BOREHOLES

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Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

ADDITIONAL GROUND INVESTIGATION
LAYOUT PLAN
(SHEET 2 of 3)

Drawn	Checked	Approved
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First Issued: JUNE 2008	CAD File No.: FIGURE 8.5	Date: JUNE 2008
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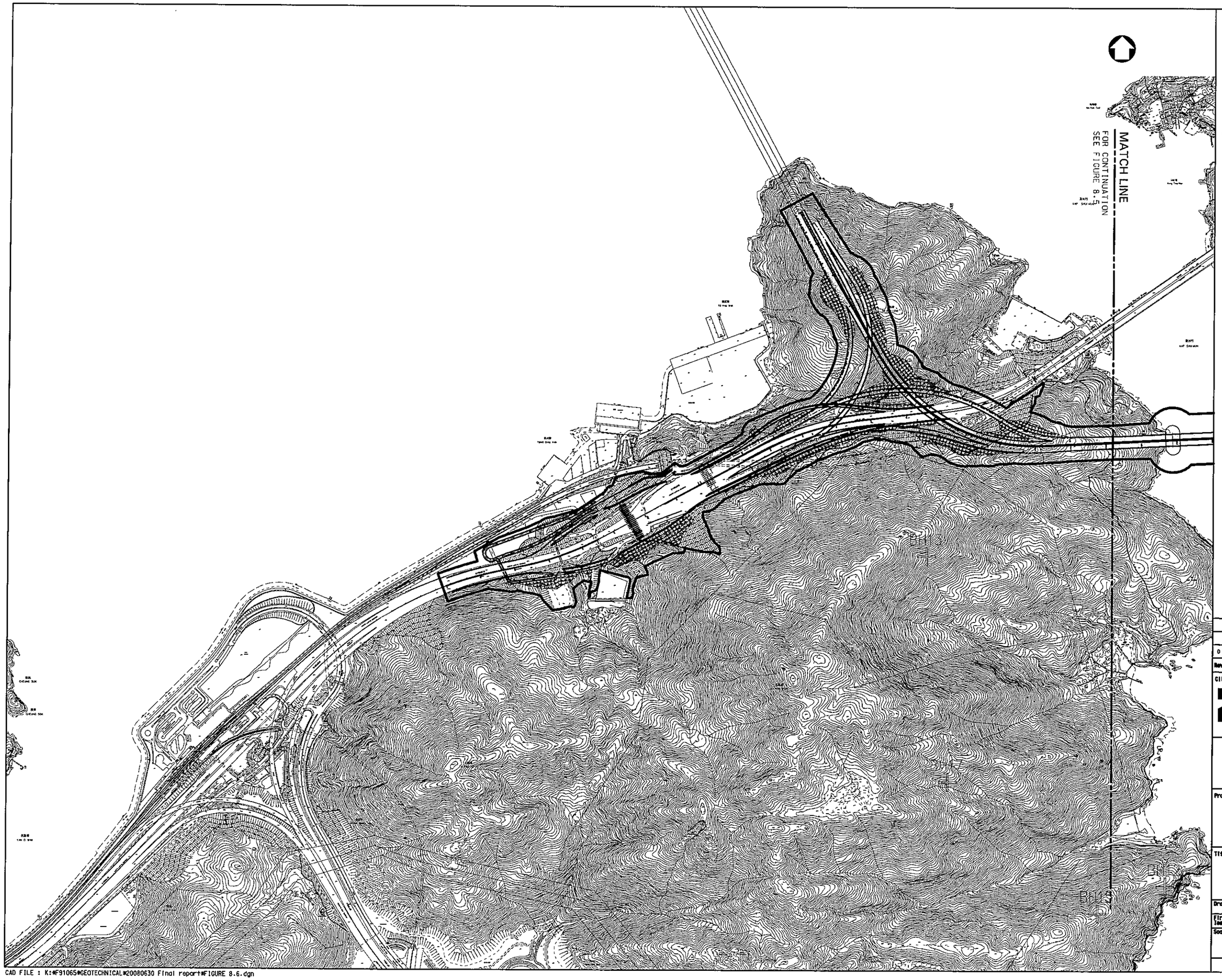
CAD FILE : K:¥F91065¥GEOTECHNICAL¥20080630 Final report¥FIGURE 8.5.dgn



NOTES:

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LEGENDS:

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- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- +23.2 PROPOSED ROAD LEVEL
- BH6 ADDITIONAL BOREHOLES

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LAYOUT PLAN
(SHEET 3 of 3)

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GEOTECHNICAL CONSTRAINTS AT MARINE AREA

FIGURE 8.7

Scale 1 : 15 000 (A3)

CAD FILE : K:\F91065\GEOTECHNICAL\20080630 Finalreport\FIGURE 8.7.dgn



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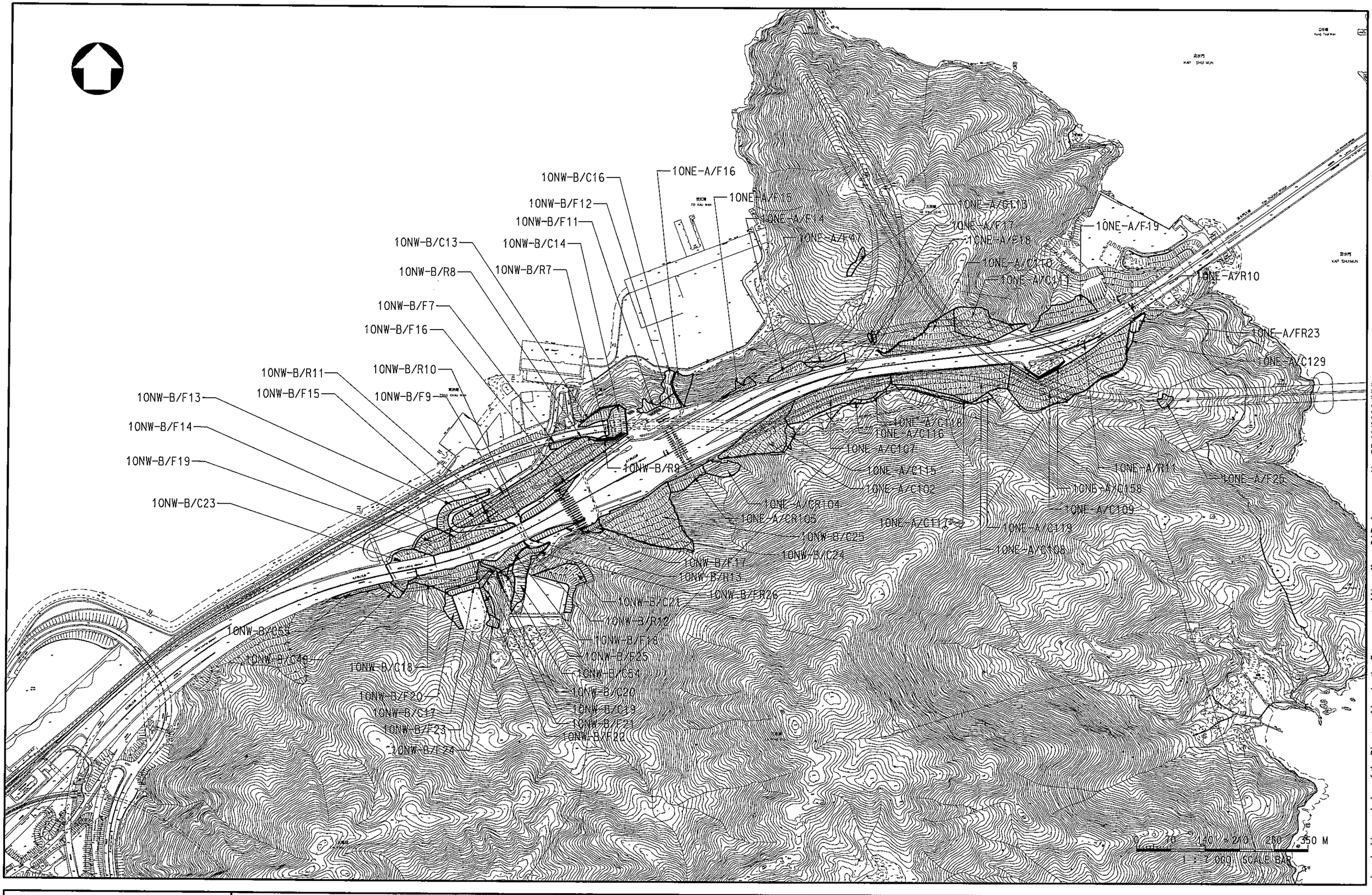
TSING YI LANTAU LINK - FEASIBILITY STUDY

SLOPE FEATURES AFFECTING OR AFFECTED BY EASTERN LANDING

FIGURE 8.8

Scale 1 : 7000 (A3)

CAD FILE : K:\F91065\GEOTECHNICAL\20080630 Final report\FIGURE 8.8.dgn



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SLOPE FEATURES AFFECTING OR AFFECTED BY NORTHERN LANDING

FIGURE 8.9

Scale 1 : 7000 (A3)

CAD FILE : K:\F91065\GEOTECHNICAL\20080630 Final report\FIGURE 8.9.dgn

LEGEND:

RECOMMENDED EXTENT OF FUTURE NATURAL TERRAIN HAZARD STUDY

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TSING YI LANTAU LINK - FEASIBILITY STUDY

RECOMMENDED EXTENT OF FUTURE NATURAL TERRAIN HAZARD STUDY (SHEET 1 OF 2)

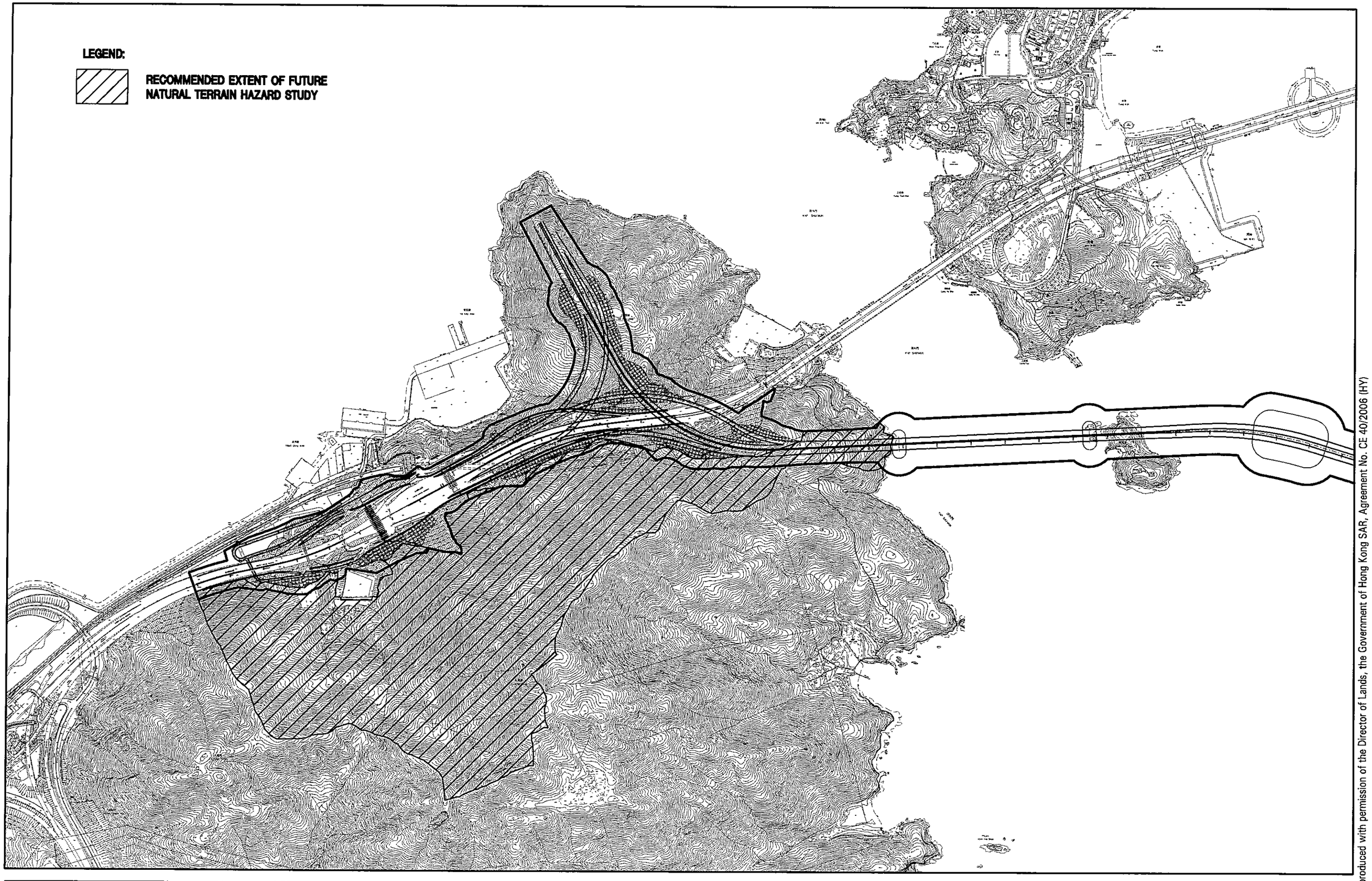
FIGURE 8.10

Scale 1 : 10000 (A3)

CAD FILE : K:\F91065\GEOTECHNICAL\20080630 Final report\Figure 8.10.dgn

LEGEND:

RECOMMENDED EXTENT OF FUTURE
NATURAL TERRAIN HAZARD STUDY



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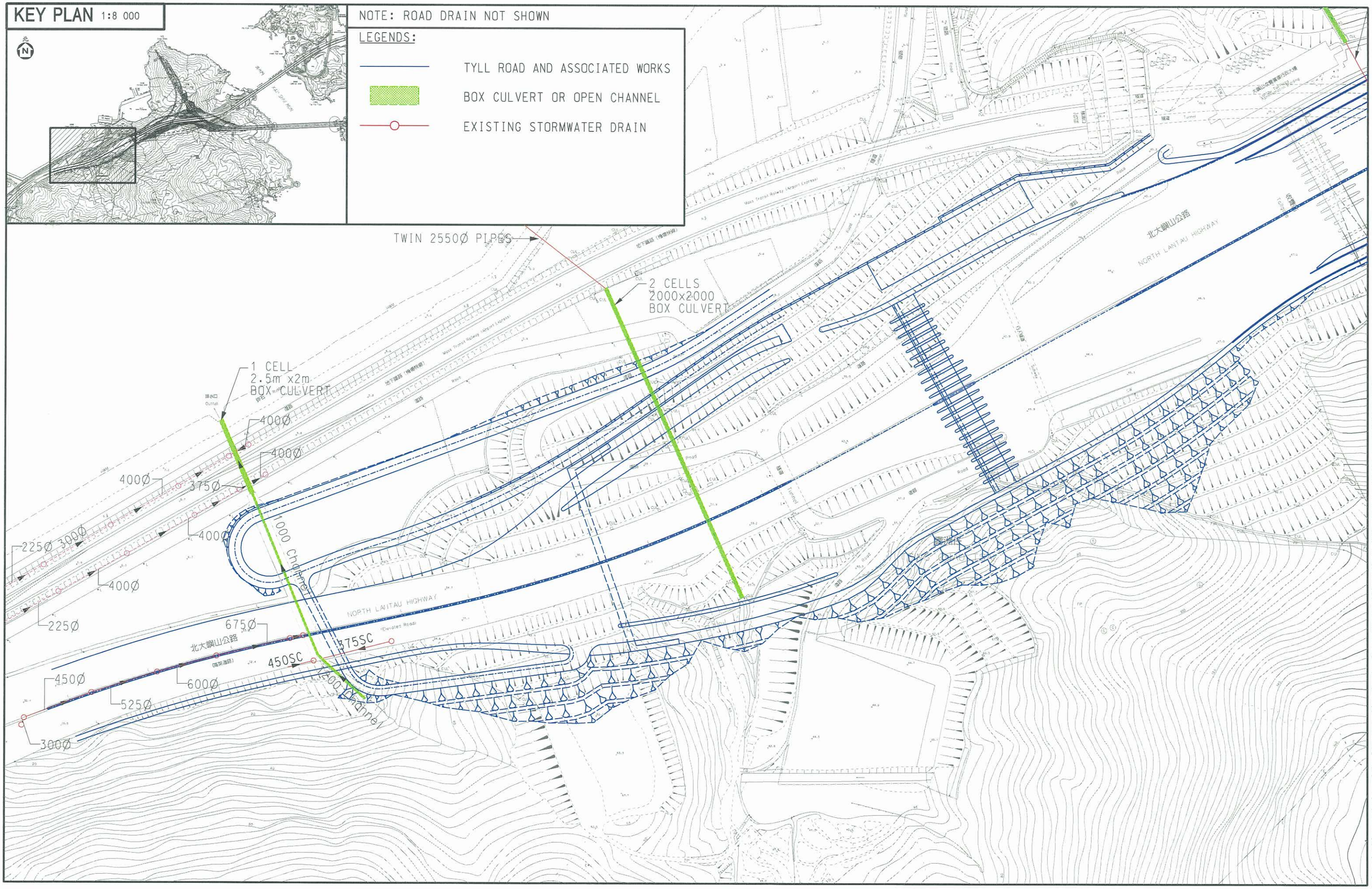
TSING YI LANTAU LINK - FEASIBILITY STUDY

RECOMMENDED EXTENT OF FUTURE NATURAL TERRAIN HAZARD STUDY (SHEET 2 OF 2)

FIGURE 8.11

Scale 1 : 10000 (A3)

CAD FILE : K:\F91065\GEOTECHNICAL\20080630 Final report\Figure 8.11.dgn



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AGREEMENT NO. CE 40/2006 (HY)
TSING YI LANTAU LINK - FEASIBILITY STUDY

EXISTING STORM DRAINAGE NEAR TOLL PLAZA

FIGURE 9.1

Scale 1 : 2000

CAD FILE : K:\F91065\REPORT\08_06_30 Final Report\Figure9.1.dgn

750Ø

5000 Channel

2000 OPEN CHANNEL

1950Ø "PIPE

800UC

1500 Channel

2500 Channel

大青洲
TAI TSING CHAU

1800Ø PIPE

3000 OPEN CHANNEL

北大嶼山公路
NORTH LANTAU HIGHWAY

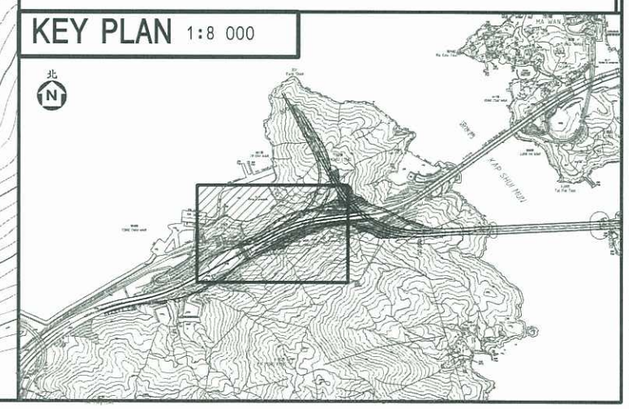
2500 Channel

NOTE: ROAD DRAIN NOT SHOWN

LEGENDS:

- TYLL ELEVATED ROAD
- TYLL ROAD AND ASSOCIATED WORKS
- BOX CULVERT OR OPEN CHANNEL
- EXISTING STORMWATER DRAIN

KEY PLAN 1:8 000



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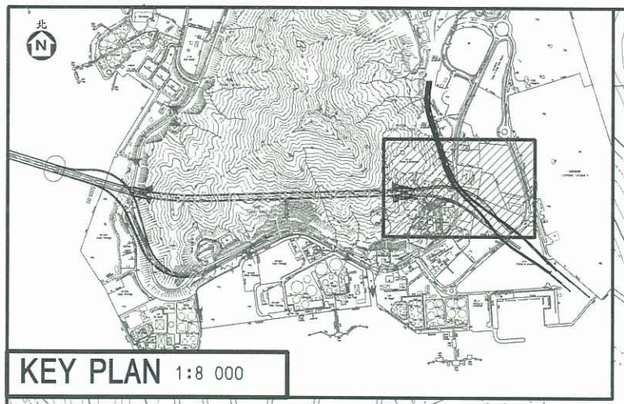
TSING YI LANTAU LINK - FEASIBILITY STUDY

EXISTING STORM DRAINAGE AT EAST OF TOLL PLAZA

FIGURE 9.2

Scale 1 : 2000

CAD FILE : K:\F91065\REPORT\08_06_30 Final Report\Figure9.2.dgn



KEY PLAN 1:8 000

NOTE : CLP LV CABLE NOT SHOWN

LEGEND:

- TYLL ELEVATED ROAD
- TYLL ROAD AND ASSOCIATED WORKS
- 132kV — EXISTING 132kV POWER CABLE

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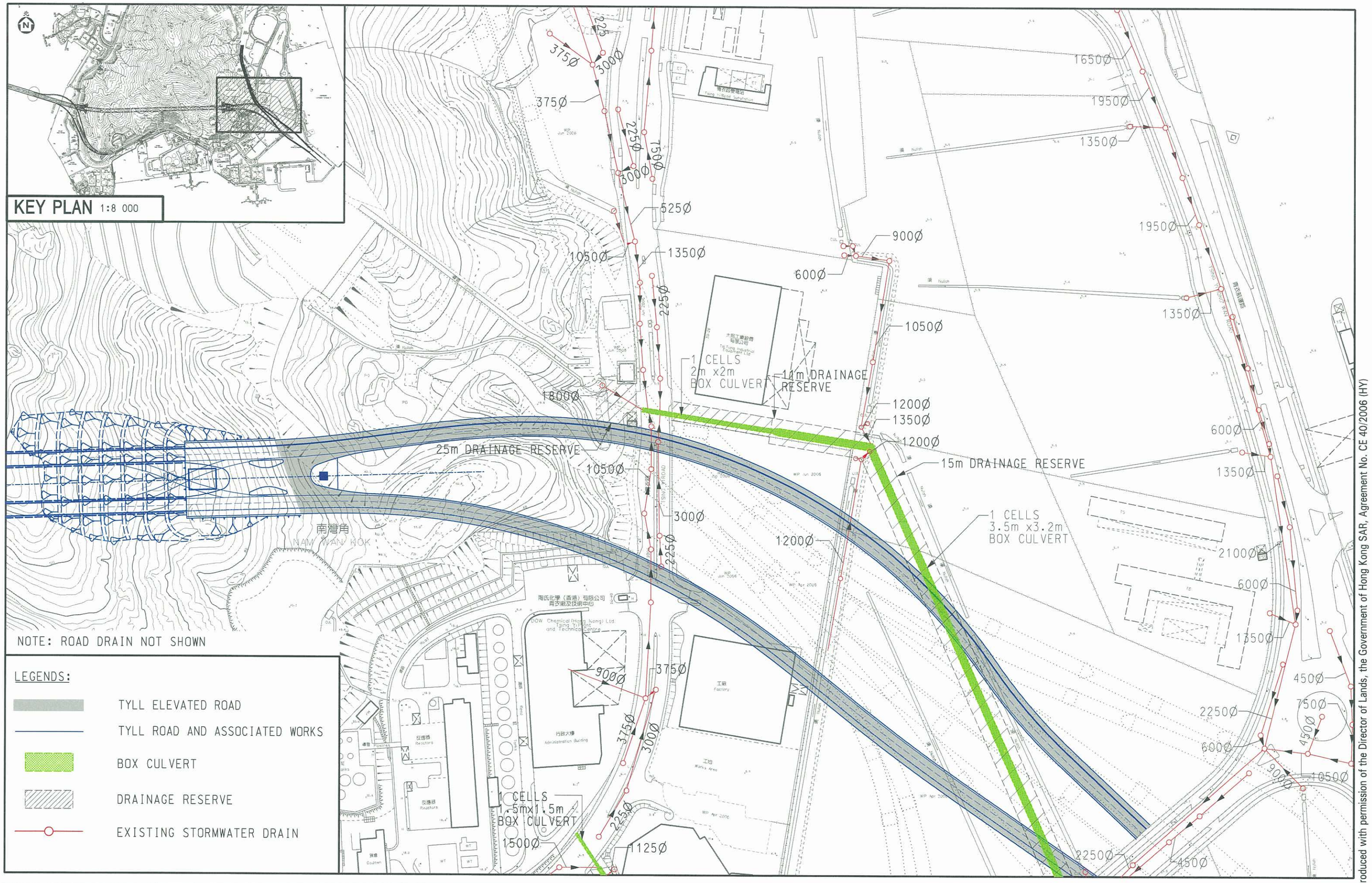
AGREEMENT NO. CE 40/2006 (HY)
TSING YI LANTAU LINK - FEASIBILITY STUDY

EXISTING CLP INSTALLATION NEAR EASTERN PORTION OF TSING YI ROAD

FIGURE 9.3

Scale 1 : 2000

CAD FILE : K:\F91065\REPORT\08_06_30 Final Report\Figure9.3.dgn



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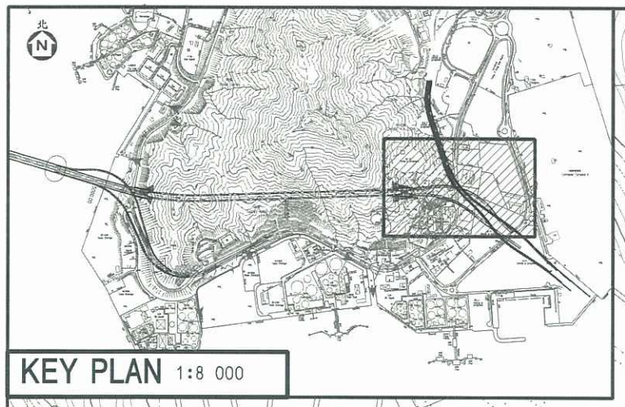
TSING YI LANTAU LINK - FEASIBILITY STUDY

EXISTING STORM DRAINAGE NEAR EASTERN PORTION OF TSING YI ROAD

FIGURE 9.4

Scale 1 : 2000

CAD FILE : K:\F91065\REPORT\08_06_30 Final Report\Figure9.4.dgn



KEY PLAN 1:8 000

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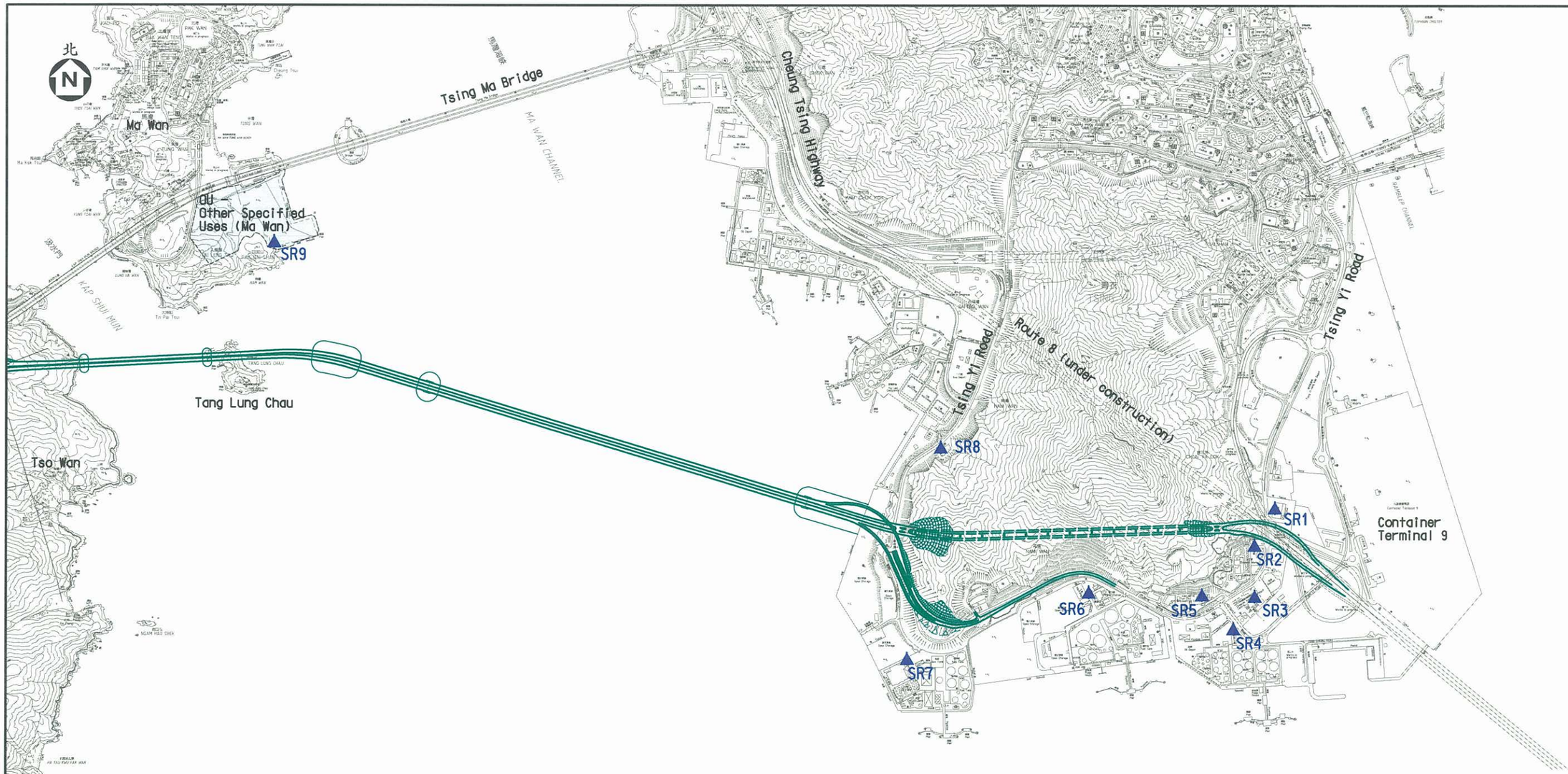
TSING YI LANTAU LINK - FEASIBILITY STUDY

EXISTING GAS MAINS NEAR EASTERN PORTION OF TSING YI ROAD

FIGURE 9.5

Scale 1 : 2000

CAD FILE : K:\F91065\REPORT\08_06_30 Final Report\Figure9.5.dgn



LEGEND:

▲ SR1 REPRESENTATIVE AIR SENSITIVE RECEIVERS

PREFERRED ALIGNMENT

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AGREEMENT NO. CE 40/2006 (HY)
TSING YI LANTAU LINK - FEASIBILITY STUDY

REPRESENTATIVE AIR AND NOISE SENSITIVE RECEIVERS - TSING YI

FIGURE 11.1

Scale 1 : 20 000

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LEGEND:

- SR10 REPRESENTATIVE AIR & NOISE SENSITIVE RECEIVERS
- SR9 REPRESENTATIVE AIR SENSITIVE RECEIVERS
- PREFERRED ALIGNMENT

北 N

TSING LUNG BRIDGE
Ma Wan
OU Other Specified Uses (Ma Wan)
SR9
Ng Kwu Leng
SR12
SR11
SR10
KAP SHUI MUN
Future Development at Sunny Bay (Tourism Hub)
SR13
Tang Lung Chau
Tso Wan
Fa Peng Tang
MTRC Airport Express Railway
North Lantau Highway
Penny's Bay Highway
MTRC Disneyland Resort Line
Penny's Bay
Pa Tau Kwu

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TSING YI LANTAU LINK - FEASIBILITY STUDY

REPRESENTATIVE AIR AND NOISE SENSITIVE RECEIVERS - LANTAU

FIGURE 11.2

Scale 1 : 20 000

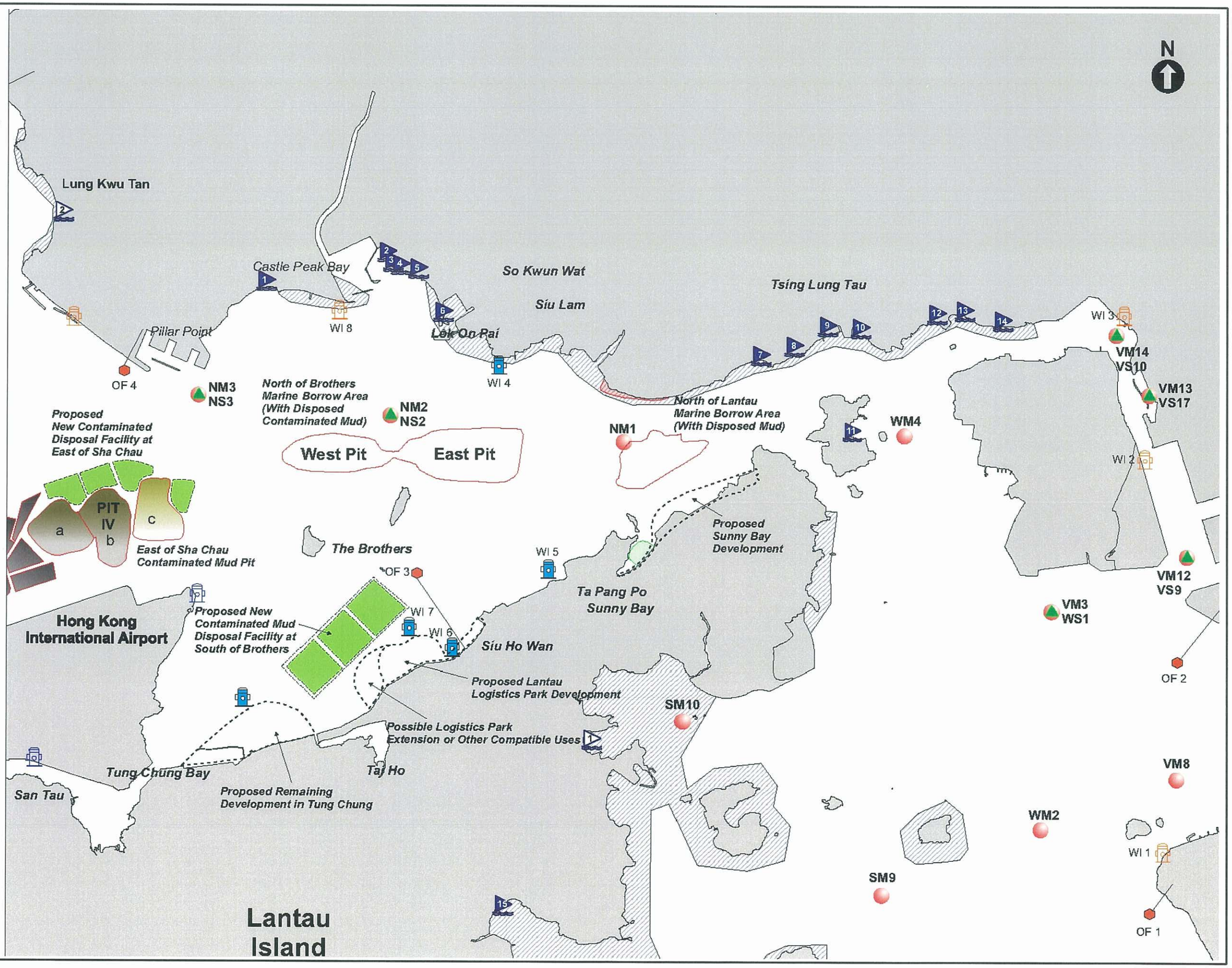
CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 11.2.dgn

Key:

- SI location for Improvement to Castle Peak Road between Ka Loon Tsuen and Siu Lam
- SI location for Road P1 advance works at Sunny Bay on Lantau Island
- Cooling water intakes
- Water intakes
- Proposed water intakes
- Effluent outfalls
- EPD water quality monitoring stations
- EPD sediment quality monitoring stations
- Secondary contact zone
- Proposed contaminated mud pit
- Planned development

Ungazetted beach
1 Discovery Bay
2 Lung Kwu Tan

Gazetted beach
1 Butterfly Beach
2 Castle Peak Beach
3 Kadorrie Beach
4 Cafeteria Old Beach
5 Cafeteria New Beach
6 Golden Beach
7 Angler's Beach
8 Gemini Beach
9 Hoi Mei Wan
10 Casam Beach
11 Ma Wan Tung Wan
12 Lido Beach
13 Ting Kau Beach
14 Approach Beach
15 Silvermine Bay



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TSING YI LANTAU LINK - FEASIBILITY STUDY

WATER QUALITY SENSITIVE RECEIVERS (EXCLUDING ECOLOGICAL SENSITIVE RECEIVERS)

FIGURE 11.3

Scale NO SCALE

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 11.3.dgn

N

Legend:

- Alignment
- Study Area
- Project Boundary
- Developed Area
- Plantation
- Shrubby Grassland
- Tall Shrubland
- Wasteland
- Woodland
- Orchard / Village
- Site of Special Scientific Interest

Ting Kau Beach
Ting Kau
Lido Beach
Casam Beach
Approach Beach
Sham Tseng
Hoi Mei Beach
Gemini Beach
Anglers' Beach
Tsing Lung Tau
Dragon Beach
Ma Wan Fish Culture Zone
Tsing Ma Bridge
Tung Wan
Ma Wan
Ma Wan Channel
Tsing Yi
Oil Depots
Container Terminal 9
Mid-stream Container Terminal
Stonecutters Bridge

Vitis balanceana
Fimbristylis complanata
Diplarcum caricinum
Phymatodes scolopendria
Lilium brownii
Amorphophallus variabilis
Croton hancei
Tainia hongkongensis
Cymbidium ensifolium
Ardisia faberii

Kwai Shek
Ng Kwu Leng
Sek Po Tsui
Kap Shui Mun Bridge
Kap Shui Mun
To Kau Wan
Tai Tsing Chau
Tsing Chau Wan
Yi Chuen
Sam Chuen
Tsing Chau Tsai
Sunny Bay
Fa Peng Teng
Tso Wan
Tsing Yi Peak
Nam Wan
Ngong Shuen Au
Fa Peng Ngam Hau Shek
Mong Tung Hang
Inspiration Lake
Pa Tau Kwu
CLP Power Station

500 0 500 Meters

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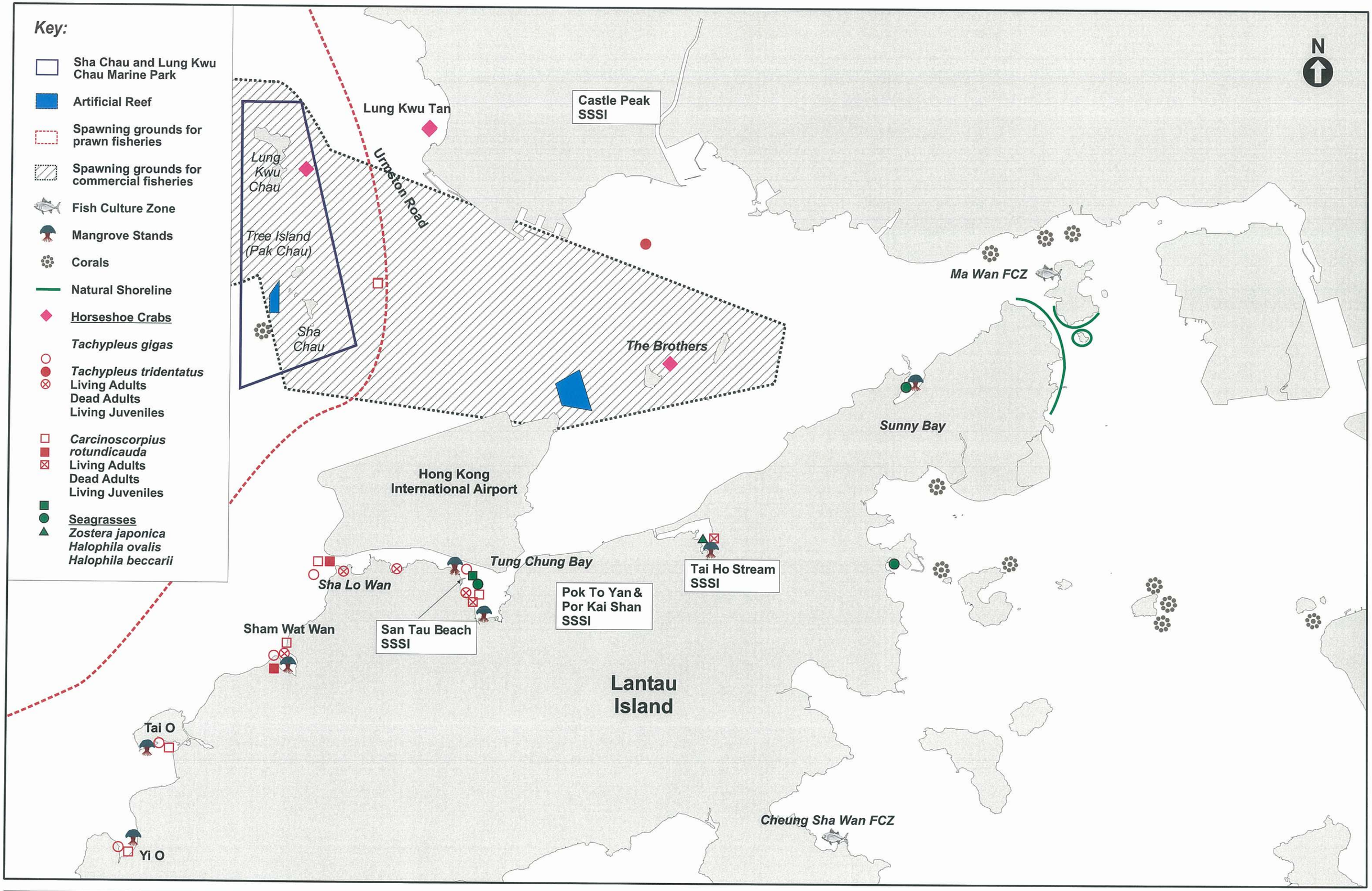
TSING YI LANTAU LINK - FEASIBILITY STUDY

HABITAT MAP OF TERRESTRIAL STUDY AREA

FIGURE 11.4

Scale 1 : 25000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 11.4.dgn



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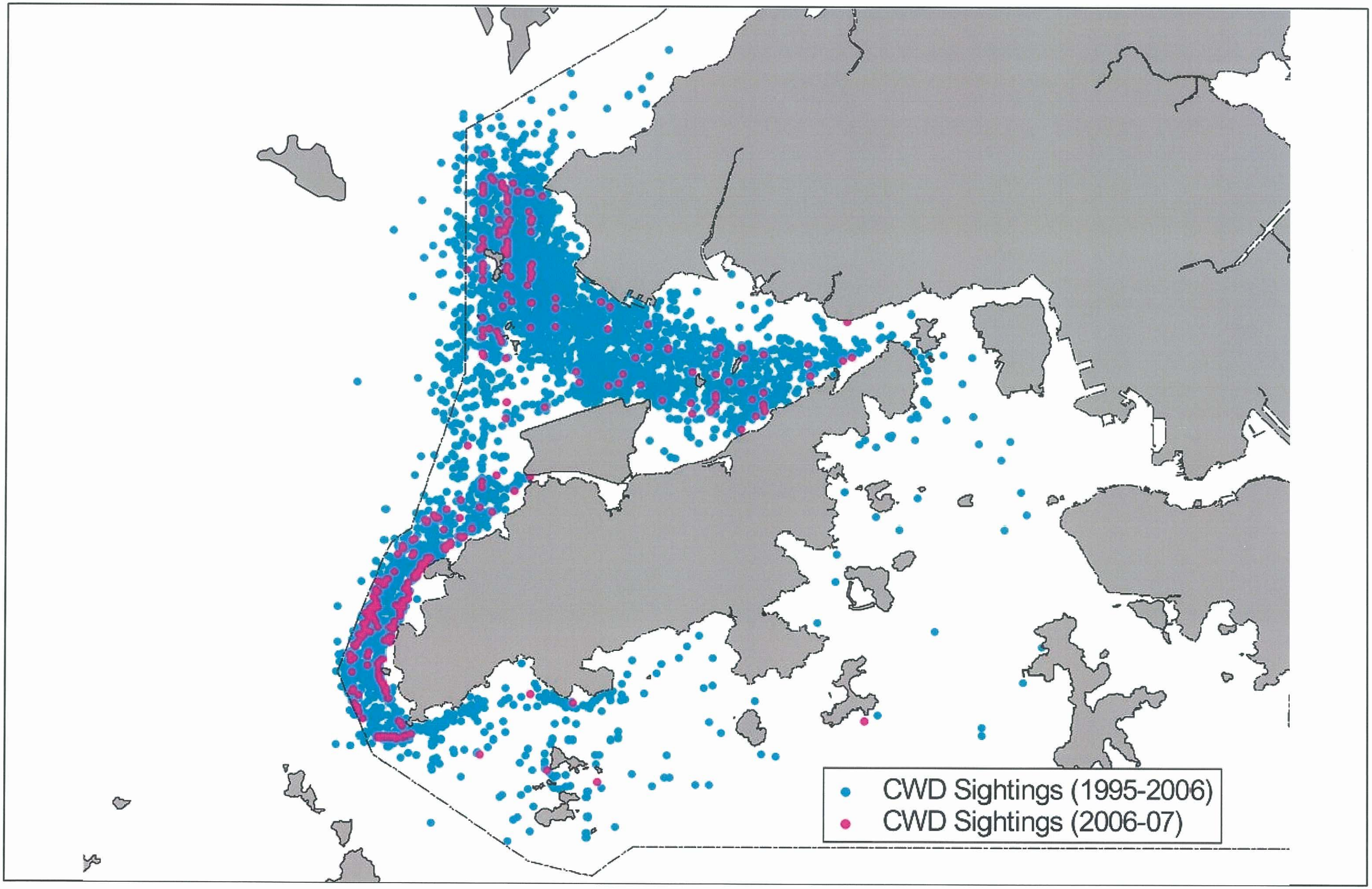
MARINE ECOLOGICAL AND FISHERIES SENSITIVE RECEIVERS

FIGURE 11.5

Scale NO SCALE

CAD FILE: K:\F91065\Environmental\TP7.1\.07_09_12\Fig 3.7.dgn



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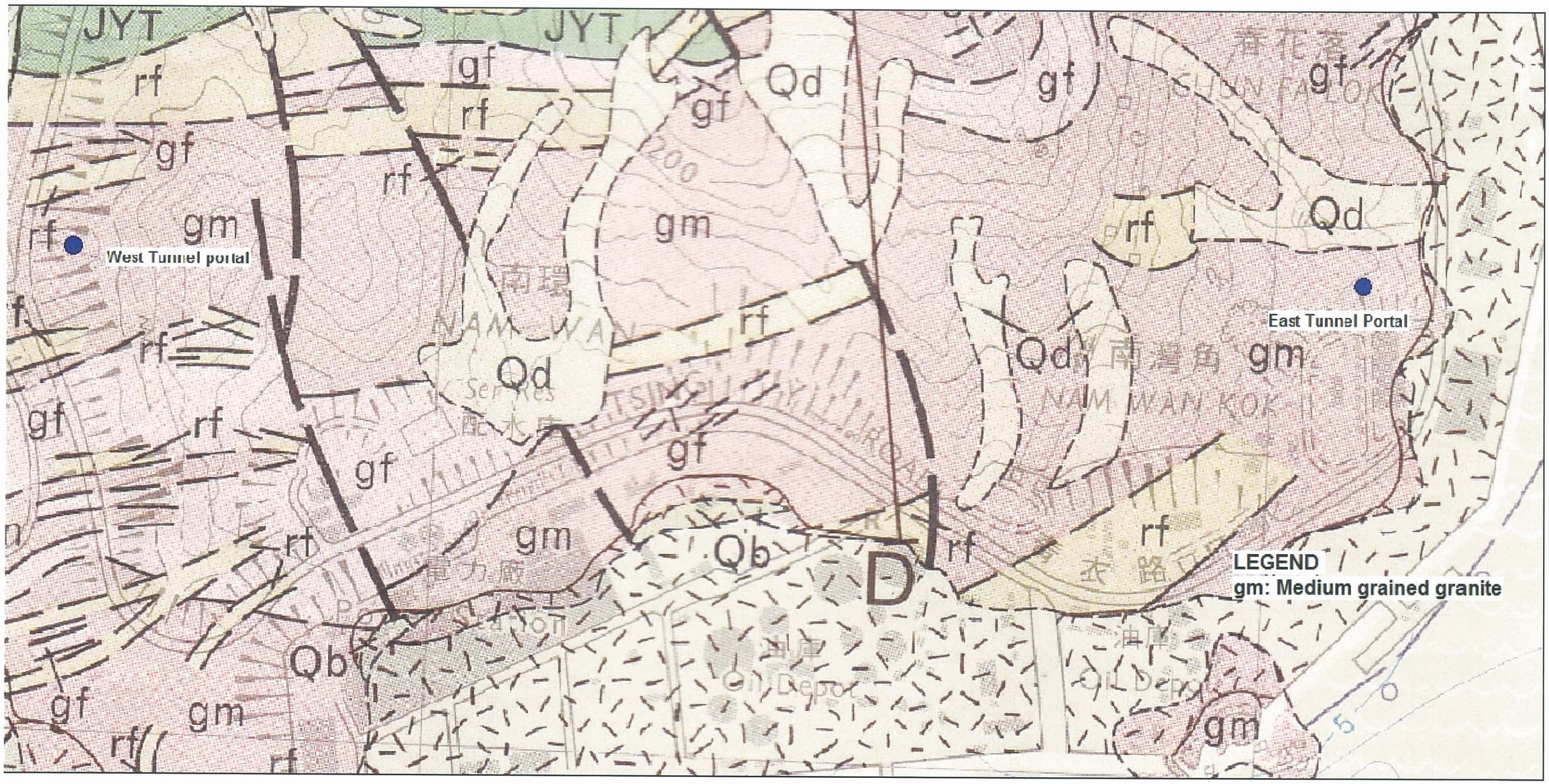
DISTRIBUTION OF CHINESE WHITE DOLPHIN (CWD) IN NORTH LANTAU

FIGURE 11.6

Scale NO SCALE

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 11.6.dgn



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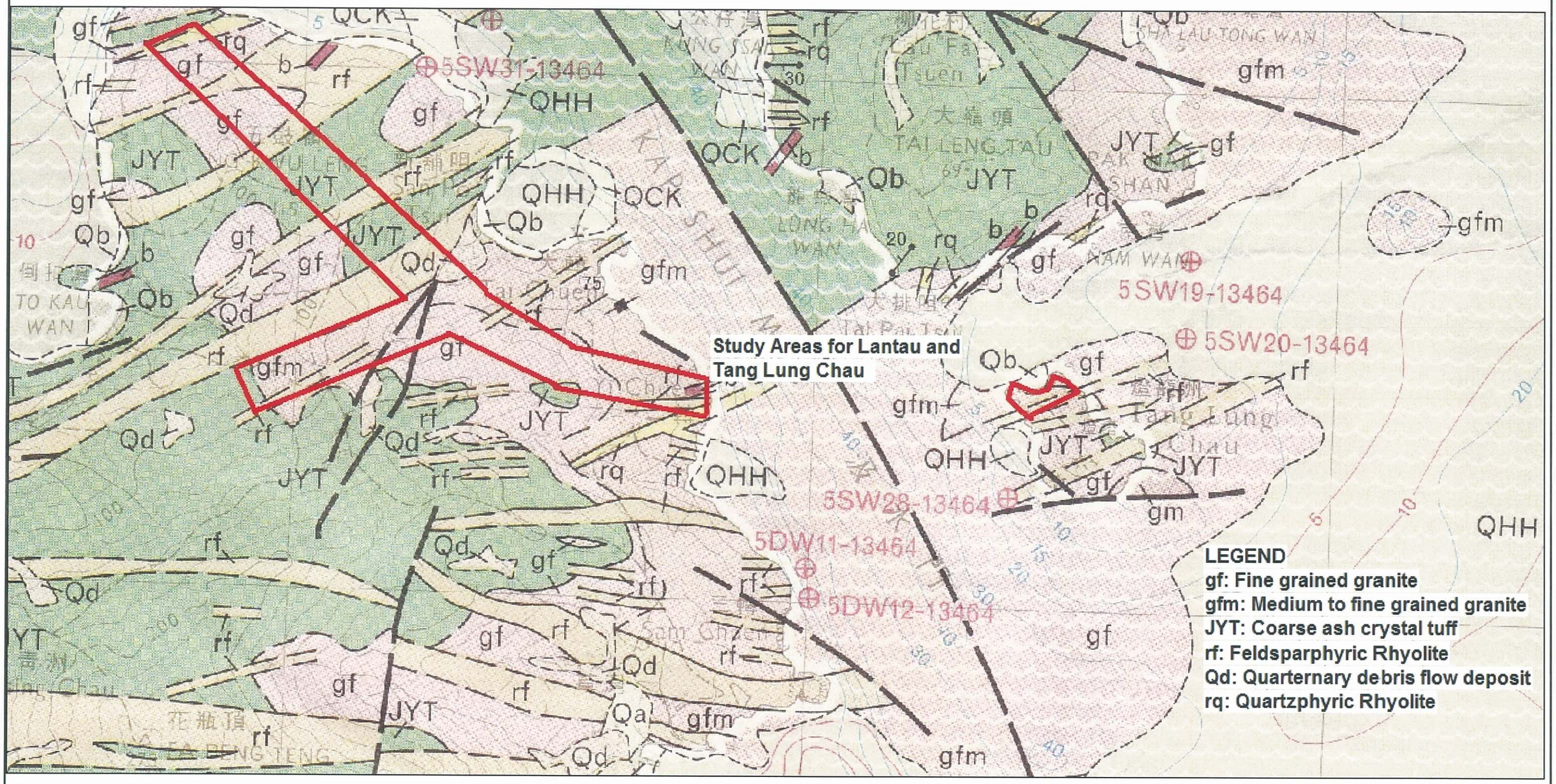
TSING YI LANTAU LINK - FEASIBILITY STUDY

GEOLOGICAL BACKGROUND OF PREFERRED ALIGNMENT OF TYLL IN TSING YI

FIGURE 11.7

Scale: NO SCALE

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 11.7.dgn



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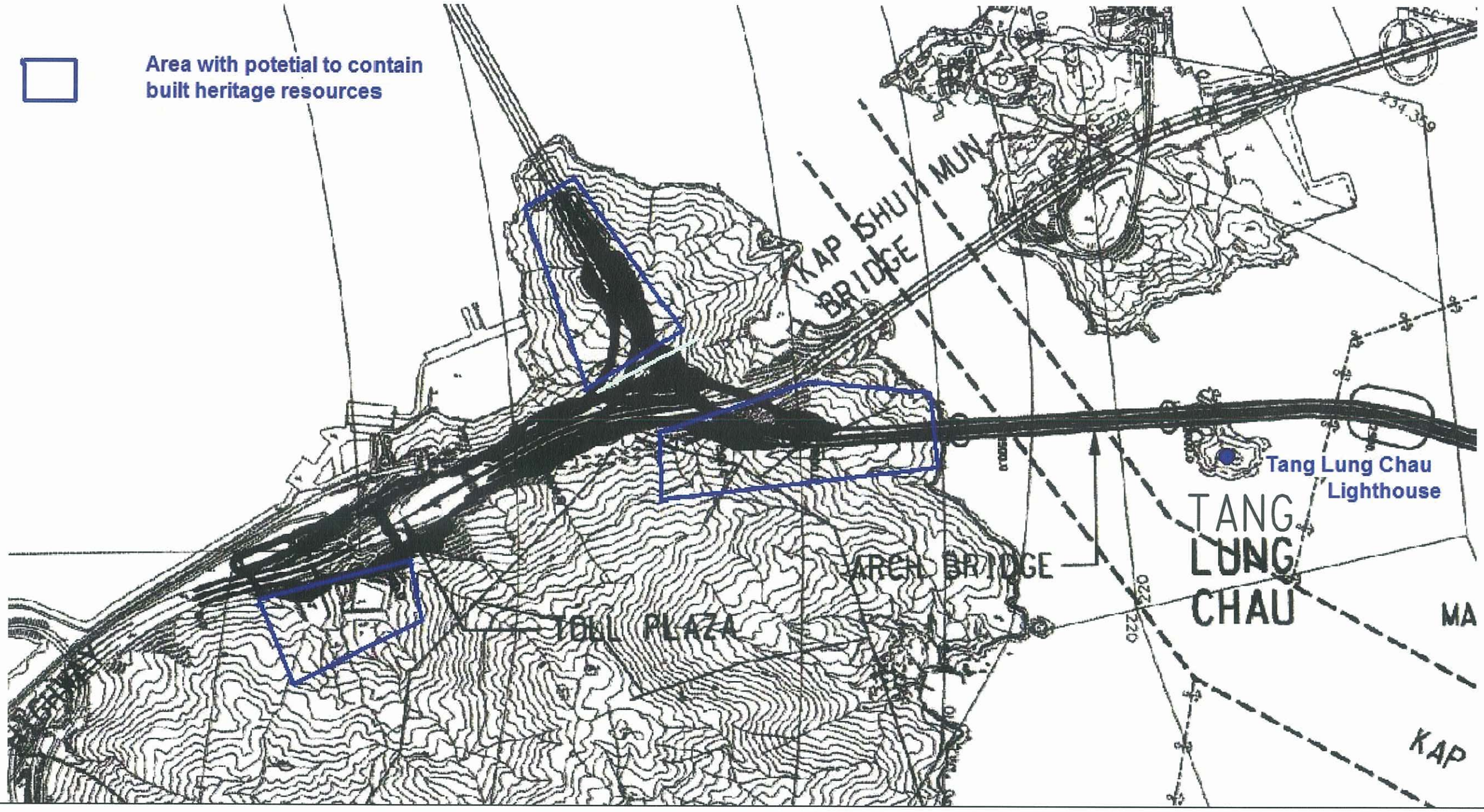
GEOLOGICAL MAP OF TANG LUNG CHAU

FIGURE 11.8

Scale NO SCALE

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 11.8.dgn

Area with potetial to contain built heritage resources



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TSING YI LANTAU LINK - FEASIBILITY STUDY

POTENTIAL BUILT HERITAGE RESOURCES

FIGURE 11.9

Scale NO SCALE

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 11.9.dgn

北

LANTAU

TSING YI

LEGEND:

PREFERRED ALIGNMENT

LEGEND – LANDSCAPE RESOURCES

- LR1 – NATURAL COASTLINE
- LR2 – OPEN GRASS/SHRUB HILLSIDE
- LR3 – UNDISTURBED RIDGE
- LR4 – WOODLAND/TREE GROUPS
- LR5 – NATURAL SANDY BEACH
- LR6 – STREAMS/WATER COURSES
- LR7 – FRESHWATER LAGOON
- LR8 – SHALLOW WATER/REEF
- LR9 – OPEN SEA

0 250 500 750 1000

METERS

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TSING YI LANTAU LINK - FEASIBILITY STUDY

LANDSCAPE RESOURCES

FIGURE 11.10

Scale 1 : 25 000

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北

KWL-371

LNT-124f

LNT-110

LNT-124e

LANTAU

TSING YI

KWL-350a

KWL-343

KWL-343a

KWL-342

0 250 500 750 1000

METERS

LEGEND:

PREFERRED ALIGNMENT

LEGEND – LANDSCAPE CHARACTER TYPES

- COASTAL UPLAND AND HILLSIDE
- UPLAND AND HILLSIDE
- RECLAMATION / ONGOING MAJOR DEVELOPMENT
- TRANSPORTATION CORRIDOR
- MISCELLANEOUS URBAN FRINGE
- INDUSTRIAL URBAN
- INSHORE WATER

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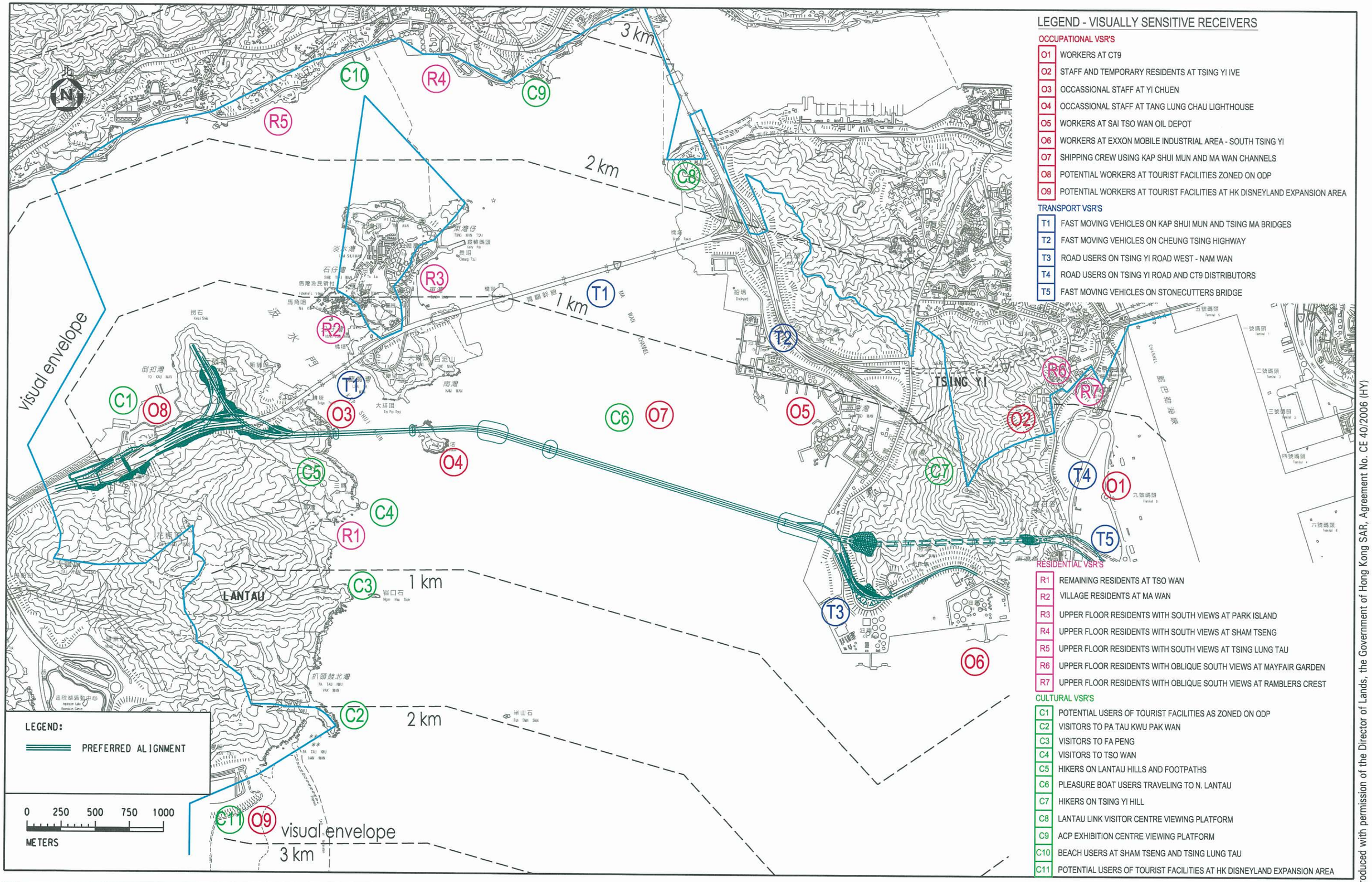
TSING YI LANTAU LINK - FEASIBILITY STUDY

LANDSCAPE CHARACTER AREAS

FIGURE 11.11

Scale 1 : 25 000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 11.11.dgn



LEGEND - VISUALLY SENSITIVE RECEIVERS

OCCUPATIONAL VSR'S

O1	WORKERS AT CT9
O2	STAFF AND TEMPORARY RESIDENTS AT TSING YI IVE
O3	OCCASSIONAL STAFF AT YI CHUEN
O4	OCCASSIONAL STAFF AT TANG LUNG CHAU LIGHTHOUSE
O5	WORKERS AT SAI TSO WAN OIL DEPOT
O6	WORKERS AT EXXON MOBILE INDUSTRIAL AREA - SOUTH TSING YI
O7	SHIPPING CREW USING KAP SHUI MUN AND MA WAN CHANNELS
O8	POTENTIAL WORKERS AT TOURIST FACILITIES ZONED ON ODP
O9	POTENTIAL WORKERS AT TOURIST FACILITIES AT HK DISNEYLAND EXPANSION AREA

TRANSPORT VSR'S

T1	FAST MOVING VEHICLES ON KAP SHUI MUN AND TSING MA BRIDGES
T2	FAST MOVING VEHICLES ON CHEUNG TSING HIGHWAY
T3	ROAD USERS ON TSING YI ROAD WEST - NAM WAN
T4	ROAD USERS ON TSING YI ROAD AND CT9 DISTRIBUTORS
T5	FAST MOVING VEHICLES ON STONECUTTERS BRIDGE

RESIDENTIAL VSR'S

R1	REMAINING RESIDENTS AT TSO WAN
R2	VILLAGE RESIDENTS AT MA WAN
R3	UPPER FLOOR RESIDENTS WITH SOUTH VIEWS AT PARK ISLAND
R4	UPPER FLOOR RESIDENTS WITH SOUTH VIEWS AT SHAM TSENG
R5	UPPER FLOOR RESIDENTS WITH SOUTH VIEWS AT TSING LUNG TAU
R6	UPPER FLOOR RESIDENTS WITH OBLIQUE SOUTH VIEWS AT MAYFAIR GARDEN
R7	UPPER FLOOR RESIDENTS WITH OBLIQUE SOUTH VIEWS AT RAMBLERS CREST

CULTURAL VSR'S

C1	POTENTIAL USERS OF TOURIST FACILITIES AS ZONED ON ODP
C2	VISITORS TO PA TAU KWU PAK WAN
C3	VISITORS TO FA PENG
C4	VISITORS TO TSO WAN
C5	HIKERS ON LANTAU HILLS AND FOOTPATHS
C6	PLEASURE BOAT USERS TRAVELING TO N. LANTAU
C7	HIKERS ON TSING YI HILL
C8	LANTAU LINK VISITOR CENTRE VIEWING PLATFORM
C9	ACP EXHIBITION CENTRE VIEWING PLATFORM
C10	BEACH USERS AT SHAM TSENG AND TSING LUNG TAU
C11	POTENTIAL USERS OF TOURIST FACILITIES AT HK DISNEYLAND EXPANSION AREA

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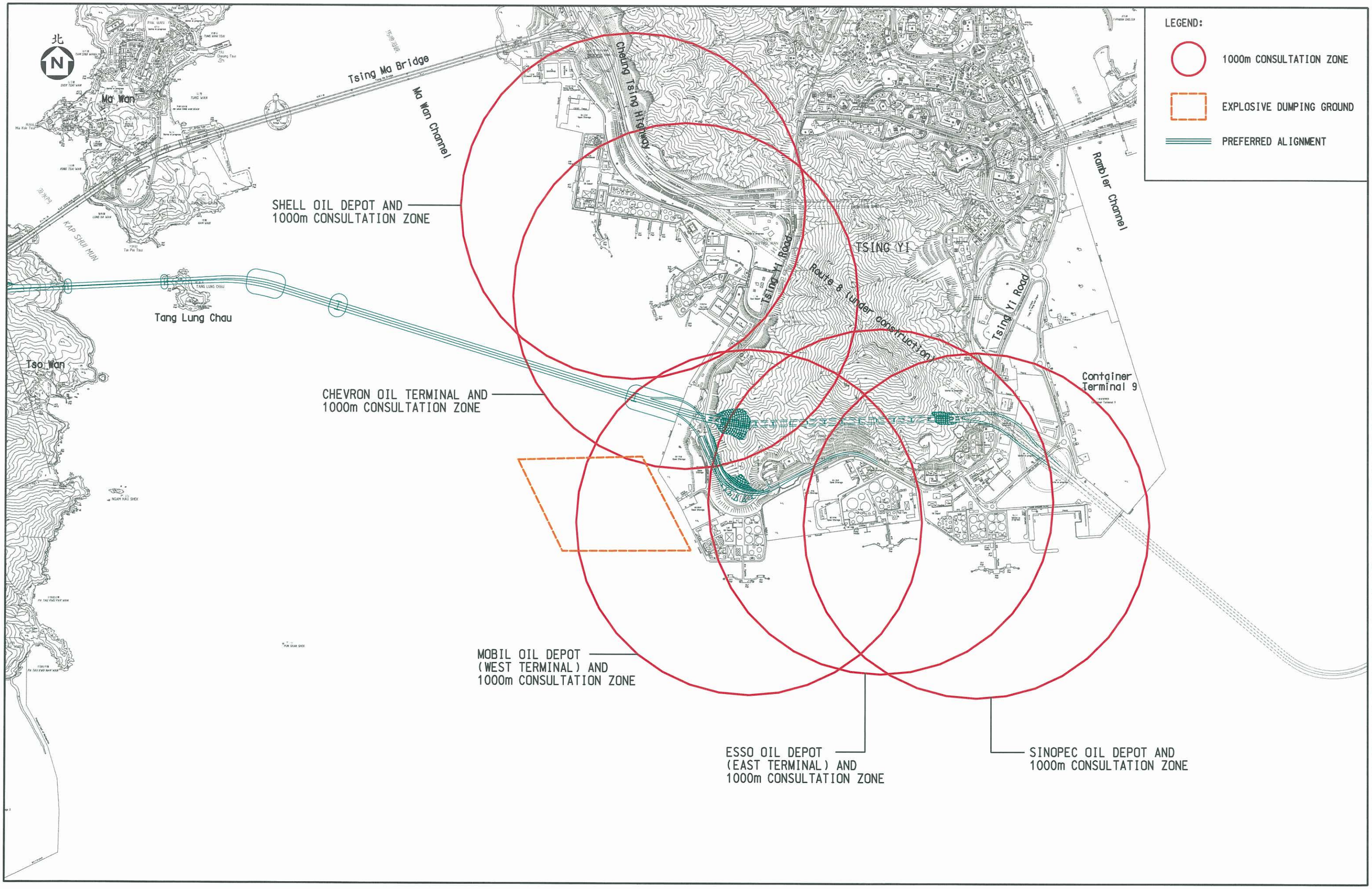
TSING YI LANTAU LINK - FEASIBILITY STUDY

POTENTIAL VISUALLY SENSITIVE RECEIVERS

FIGURE 11.12

Scale 1 : 25 000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 11.12.dgn



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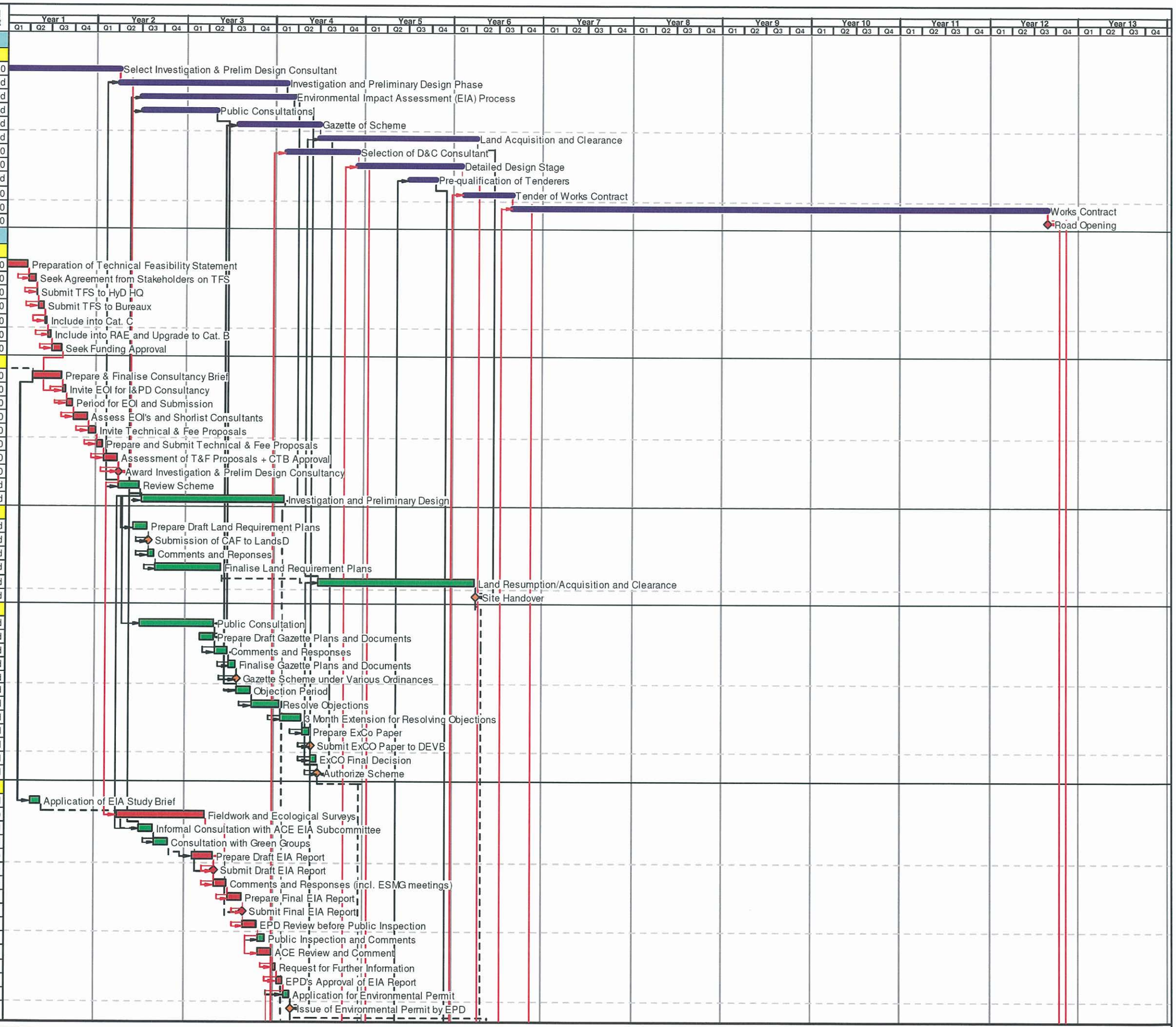
PHIs AND EXPLOSIVE DUMPING GROUND

FIGURE 11.13

Scale 1 : 20 000

CAD FILE : K:\F91065\REPORT\08_08_06 Final Report\Figure 11.13.dgn

Activity ID	Description	Calendar Days	Total Float
Summary			
1000	Select Investigation & Prelim Design	458 *	0
1010	Investigation and Preliminary Design Phase	684 *	61d
1020	Environmental Impact Assessment (EIA)	621 *	896d
1030	Public Consultations	302 *	149d
1040	Gazette of Scheme	333 *	149d
1050	Land Acquisition and Clearance	641 *	149d
1060	Selection of D&C Consultant	289 *	0
1070	Detailed Design Stage	426 *	0
1080	Pre-qualification of Tenderers	106 *	107d
1090	Tender of Works Contract	197 *	0
1100	Works Contract	2190 *	0
1110	Road Opening	0	0
Investigation and Preliminary Design Phase			
Funding Application			
2140	Preparation of Technical Feasibility Statement	92	0
2210	Seek Agreement from Stakeholders on TFS	31	0
2220	Submit TFS to HyD HQ	4	0
2230	Submit TFS to Bureaux	28	0
2240	Include into Cat. C	14	0
2250	Include into RAE and Upgrade to Cat. B	14	0
2260	Seek Funding Approval	44	0
Selection of I&PD Consultant			
2100	Prepare & Finalise Consultancy Brief	123	0
2110	Invite EOI for I&PD Consultancy	18	0
2120	Period for EOI and Submission	30	0
2130	Assess EOI's and Shorlist Consultants	61	0
2150	Invite Technical & Fee Proposals	31	0
2160	Prepare and Submit Technical & Fee	31	0
2170	Assessment of T&F Proposals + CTB	60	0
2180	Award Investigation & Prelim Design	0	0
2190	Review Scheme	93	63d
2200	Investigation and Preliminary Design	589	61d
Land Issues			
2310	Prepare Draft Land Requirement Plans	62	544d
2320	Submission of CAF to LandsD	0	544d
2330	Comments and Reponses	30	544d
2340	Finalise Land Requirement Plans	270	544d
2350	Land Resumption/Acquisition and Clearance	641	149d
2360	Site Handover	0	149d
Statutory Issues			
2400	Public Consultation	304	149d
2410	Prepare Draft Gazette Plans and Documents	60	149d
2420	Comments and Responses	60	149d
2430	Finalise Gazette Plans and Documents	30	149d
2440	Gazette Scheme under Various Ordinances	0	149d
2450	Objection Period	60	149d
2460	Resolve Objections	122	149d
2470	3 Month Extension for Resolving Objections	90	149d
2480	Prepare ExCo Paper	31	149d
2490	Submit ExCO Paper to DEVB	0	149d
2500	ExCO Final Decision	30	149d
2510	Authorize Scheme	0	149d
Environmental Issues			
2600	Application of EIA Study Brief	45	493d
2605	Fieldwork and Ecological Surveys	365	0
2610	Informal Consultation with ACE EIA	62	91d
2620	Consultation with Green Groups	61	91d
2630	Prepare Draft EIA Report	89	0
2640	Submit Draft EIA Report	0	0
2650	Comments and Responses (incl. ESMG	61	0
2660	Prepare Final EIA Report	62	0
2670	Submit Final EIA Report	0	0
2680	EPD Review before Public Inspection	60	0
2690	Public Inspection and Comments	30	3191d
2700	ACE Review and Comment	61	0
2710	Request for Further Information	14	0
2720	EPD's Approval of EIA Report	30	0
2730	Application for Environmental Permit	30	896d
2740	Issue of Environmental Permit by EPD	0	896d



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Finish date	28AUG18
Data date	01JAN07
Run date	03NOV08
Page number	1A
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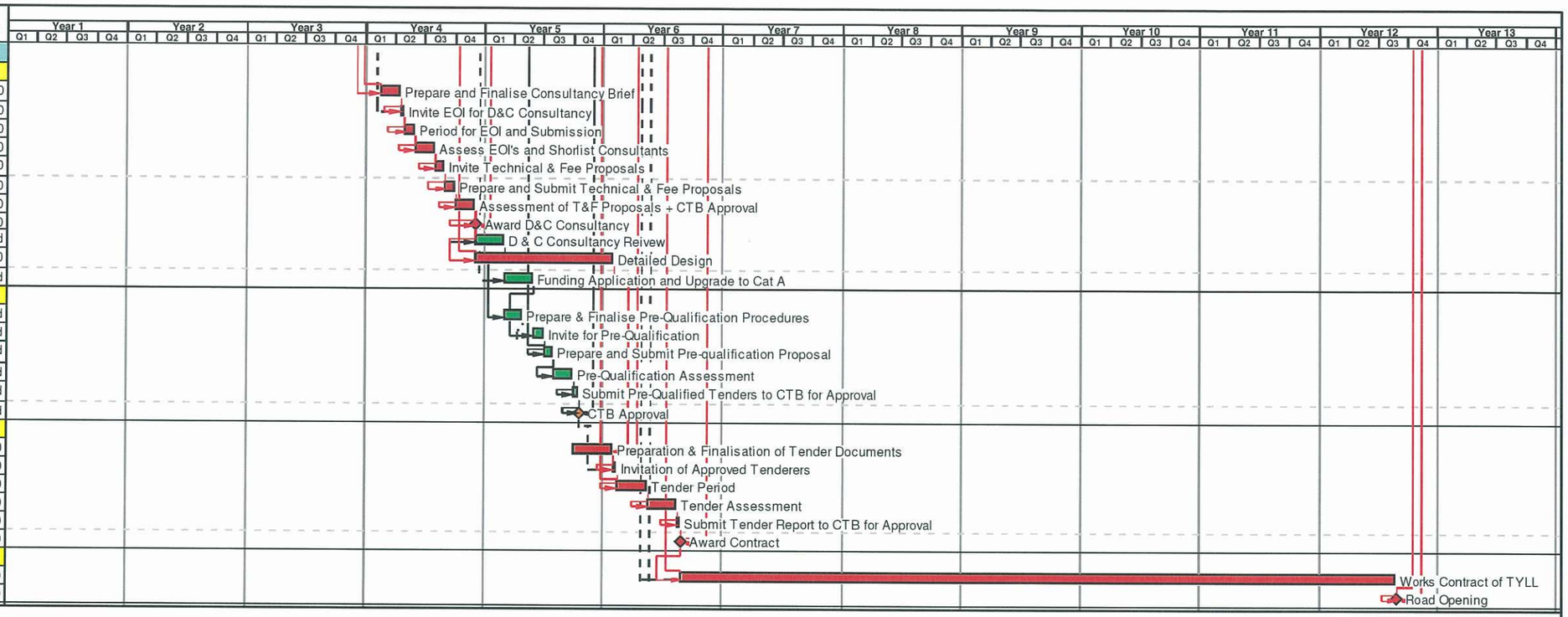
Early bar
Progress bar
Critical bar
Summary bar
Progress point
Critical point
Summary point
Start milestone point
Finish milestone point

Agreement No. CE 40/2006 (HY)

Tsing Yi Lantau Link - Feasibility Study
Project Implementation Programme

Figure 13.1
(Sheet 1 of 2)

Activity ID	Description	Calendar Days	Total Float
Design and Construction Phase			
Selection of D&C Consultant			
3100	Prepare and Finalise Consultancy Brief	61	0
3110	Invite EOI for D&C Consultancy	14	0
3120	Period for EOI and Submission	31	0
3130	Assess EOI's and Shorlist Consultants	61	0
3140	Invite Technical & Fee Proposals	31	0
3150	Prepare and Submit Technical & Fee	30	0
3160	Assessment of T&F Proposals + CTB	61	0
3170	Award D&C Consultancy	0	0
3180	D & C Consultancy Reivew	90	107d
3190	Detailed Design	426	0
3195	Funding Application and Upgrade to Cat A	92	107d
Pre-Qualification for Works Contract			
3200	Prepare & Finalise Pre-Qualification	61	138d
3220	Invite for Pre-Qualification	31	107d
3230	Prepare and Submit Pre-qualification Proposal	30	107d
3240	Pre-Qualification Assessment	62	107d
3250	Submit Pre-Qualified Tenders to CTB for	14	107d
3260	CTB Approval	0	107d
Tender Stage for Works Contract			
3300	Preparation & Finalisation of Tender	123	0
3310	Invitation of Approved Tenderers	14	0
3320	Tender Period	92	0
3330	Tender Assessment	91	0
3340	Submit Tender Report to CTB for Approval	14	0
3360	Award Contract	0	0
Construction of Works Contract			
3400	Works Contract of TYLL	2190	0
3410	Road Opening	0	0



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Progress bar
Critical bar
Summary bar
Progress point
Critical point
Summary point
Start milestone point
Finish milestone point

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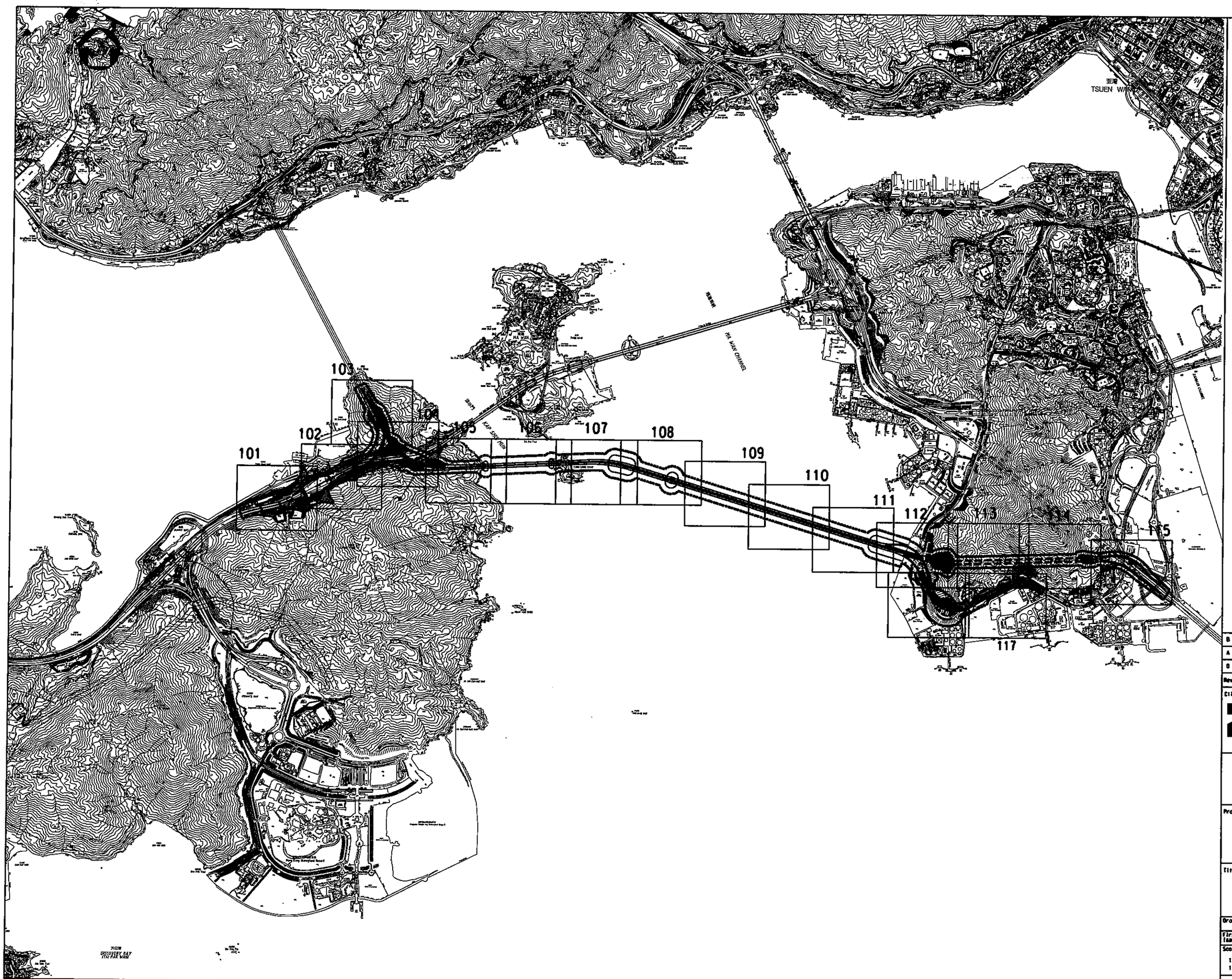
Tsing Yi Lantau Link - Feasibility Study
Project Implementation Programme

Figure 13.2
(Sheet 2 of 2)



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Rev	Issue Stat	Amendment	By	Chk.	App.	Date
B	IFI	Issued for Information				31/7/08
A	IFIC	Issued for Information & comment	CNL	TC	SCI	15/5/08
0	IFIC	Issued for Information & comment	CNL	TC	SCI	8/4/08

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Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
KEY PLAN

Drawn	Checked	Approved
CNL	TC	SCI
First Issued 8/4/08	CAD File No. 91065-P-GL100-B.dgn	Date 31/7/08
Scale 1 : 15 000 (A1) 1 : 30 000 (A3)	Drawing No. 91065/GL/100	Rev. B

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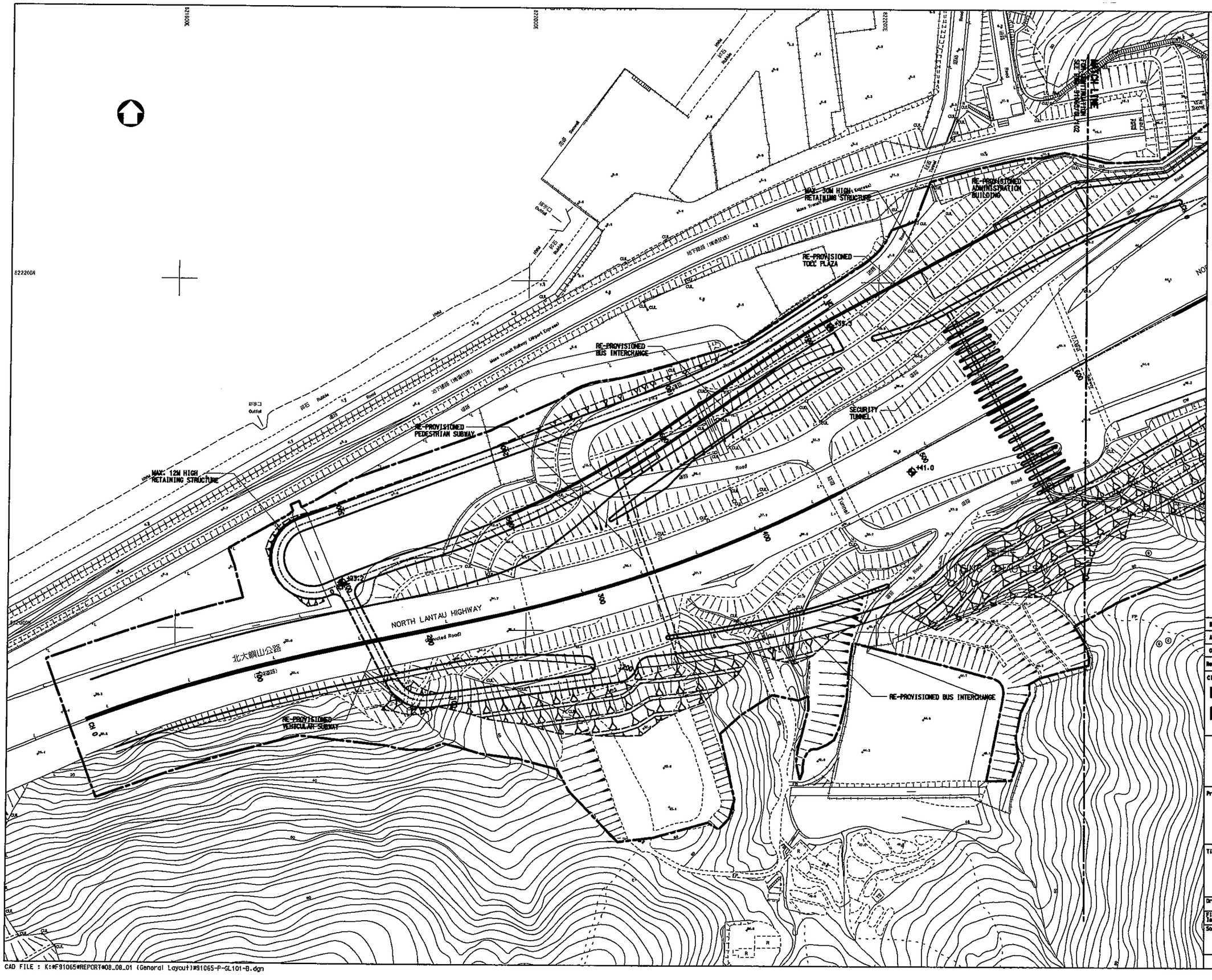

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2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
B	IFI	Issued for information				31/7/08
A	IFIC	Issued for information & comment	CML	TC	SCI	10/6/08
0	IFIC	Issued for information & comment	CML	TC	SCI	8/4/08

Client

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Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

MEINHARDT
Meinhardt Infrastructure and Environment Limited
運輸基建環保工程顧問有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 1 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued 8/4/08	CAD File No. 91065-P-GL101-B.dgn	Date 31/7/08
Scale 1 : 1000 (A1) 1 : 2000 (A3)	Drawing No. 91065/GL/101	Rev. B

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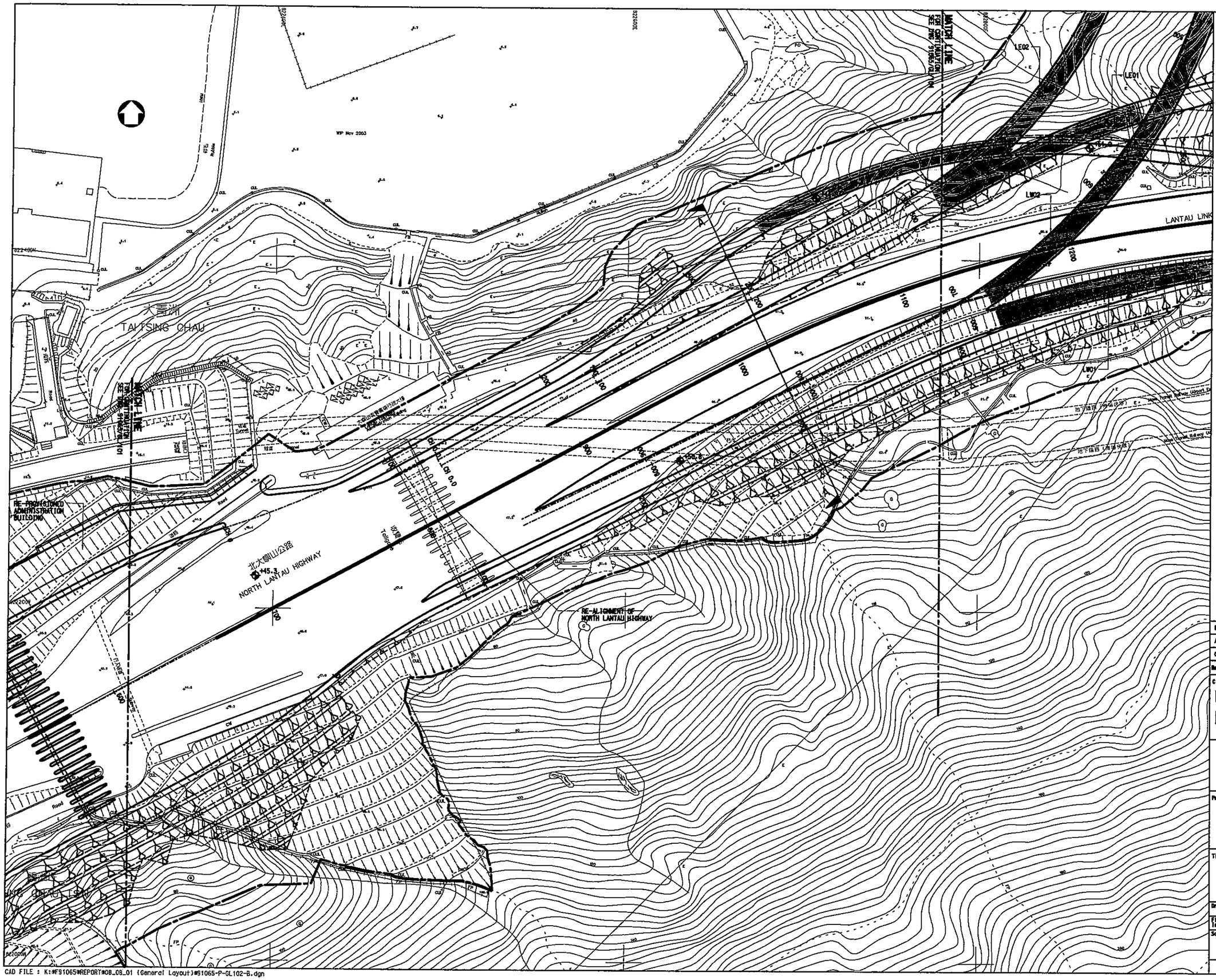

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3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stage	Amendment	By	Chk.	App.	Date
B	IFI	Issued for Information				31/1/08
A	IFIC	Issued for Information & comment	CML	TC	SCI	10/8/06
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/06

Client

路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

Meinhardt Infrastructure and Environment Limited
美瑞基建環保工程顧問有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 2 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued: 8/4/06	CAD File No.: 91065-P-GL102-B.dgn	Date: 31/1/08
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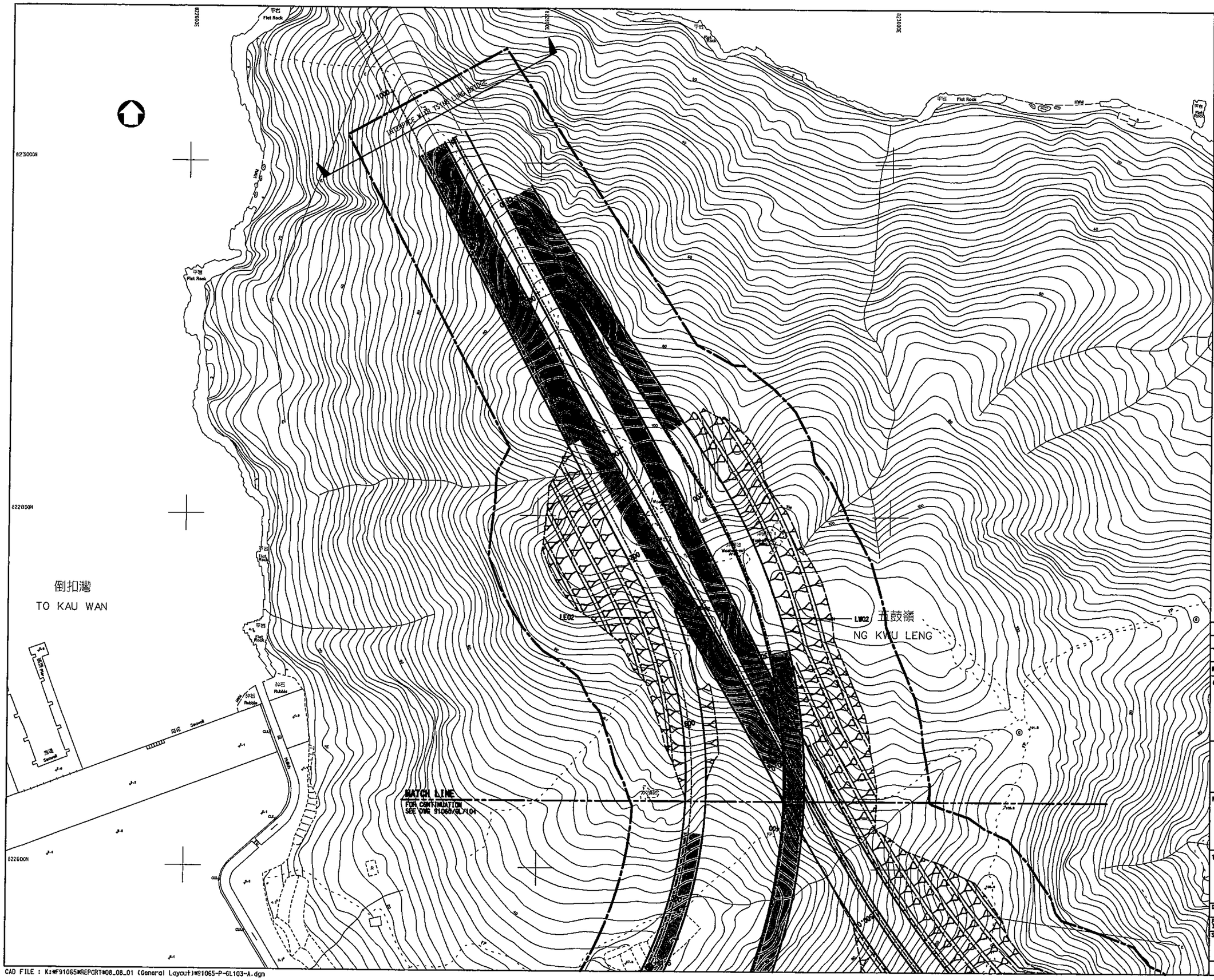

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for information				31/7/08
0	IFIC	Issued for information & comment	CML	TC	SCI	8/4/08

Client

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Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

MEINHARDT
Meinhardt Infrastructure and Environment Limited
運達基建環保工程顧問有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 3 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued 8/4/08	CAD File No. 91065-P-GL103-A.dgn	Date 31/7/08
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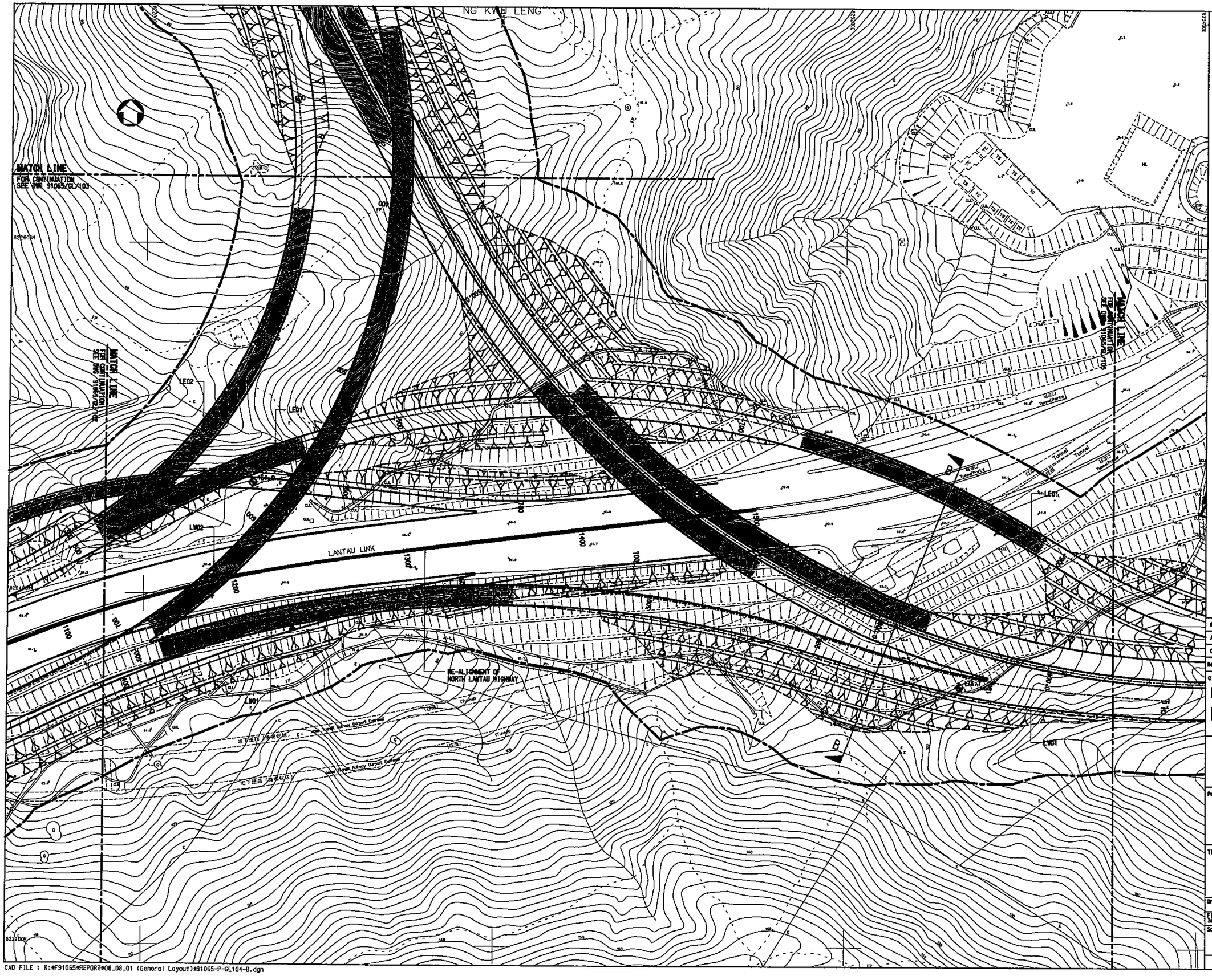

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
B	IFI	Issued for Information	CML	TC	SCI	31/1/08
A	IFIC	Issued for Information & comment	CML	TC	SCI	10/8/06
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/06

Client

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Hong Kong Project Management Office

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AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 4 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued 8/4/06	CAD File No. 91065-P-GL104-B.dgn	Date 31/1/08
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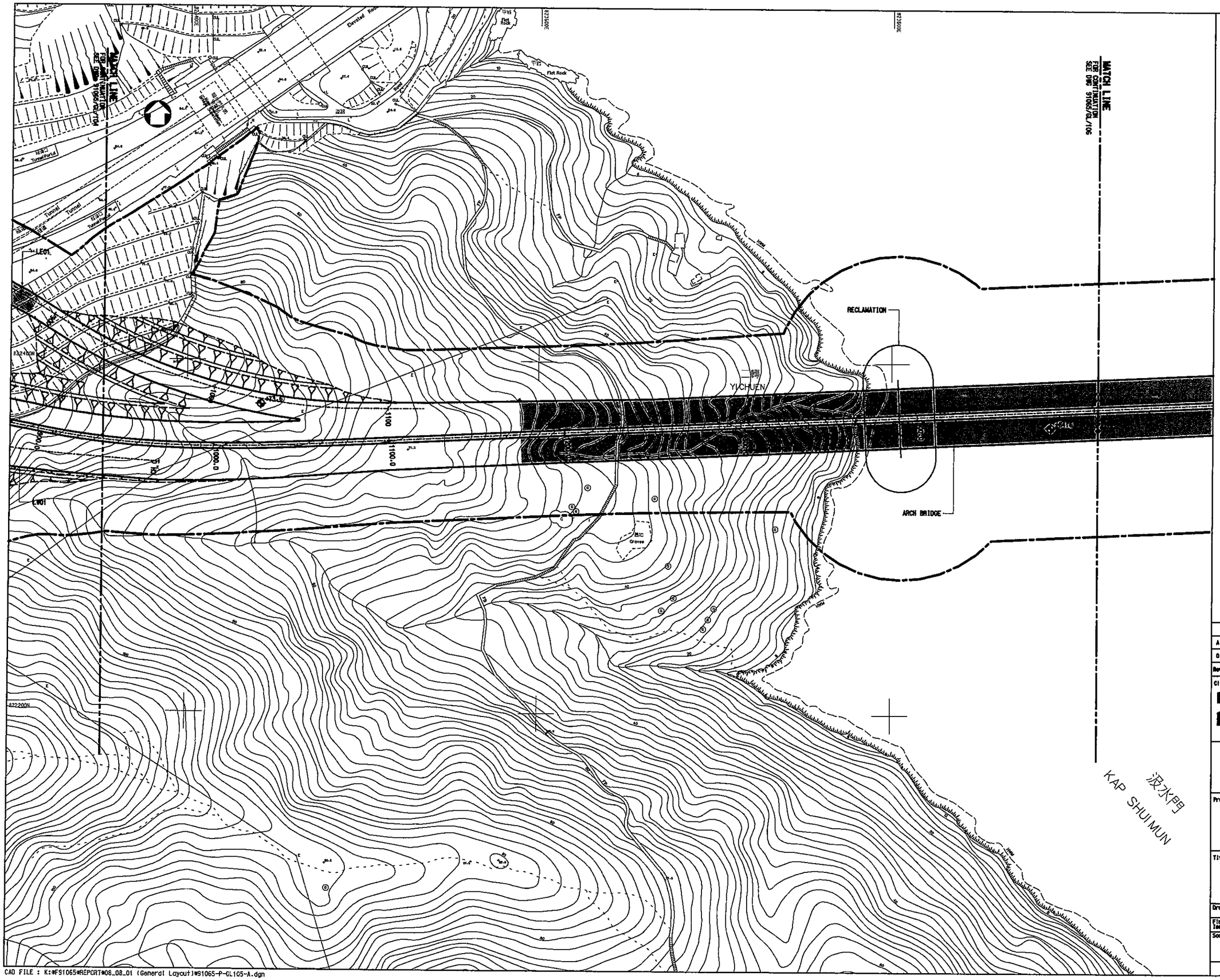

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information	CML	TC	SCI	31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	6/4/08

Client

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Hong Kong Project Management Office

MEINHARDT
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Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 5 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued 6/4/08	CAD File No. 91065-P-GL105-A.dgn	Date 31/7/08
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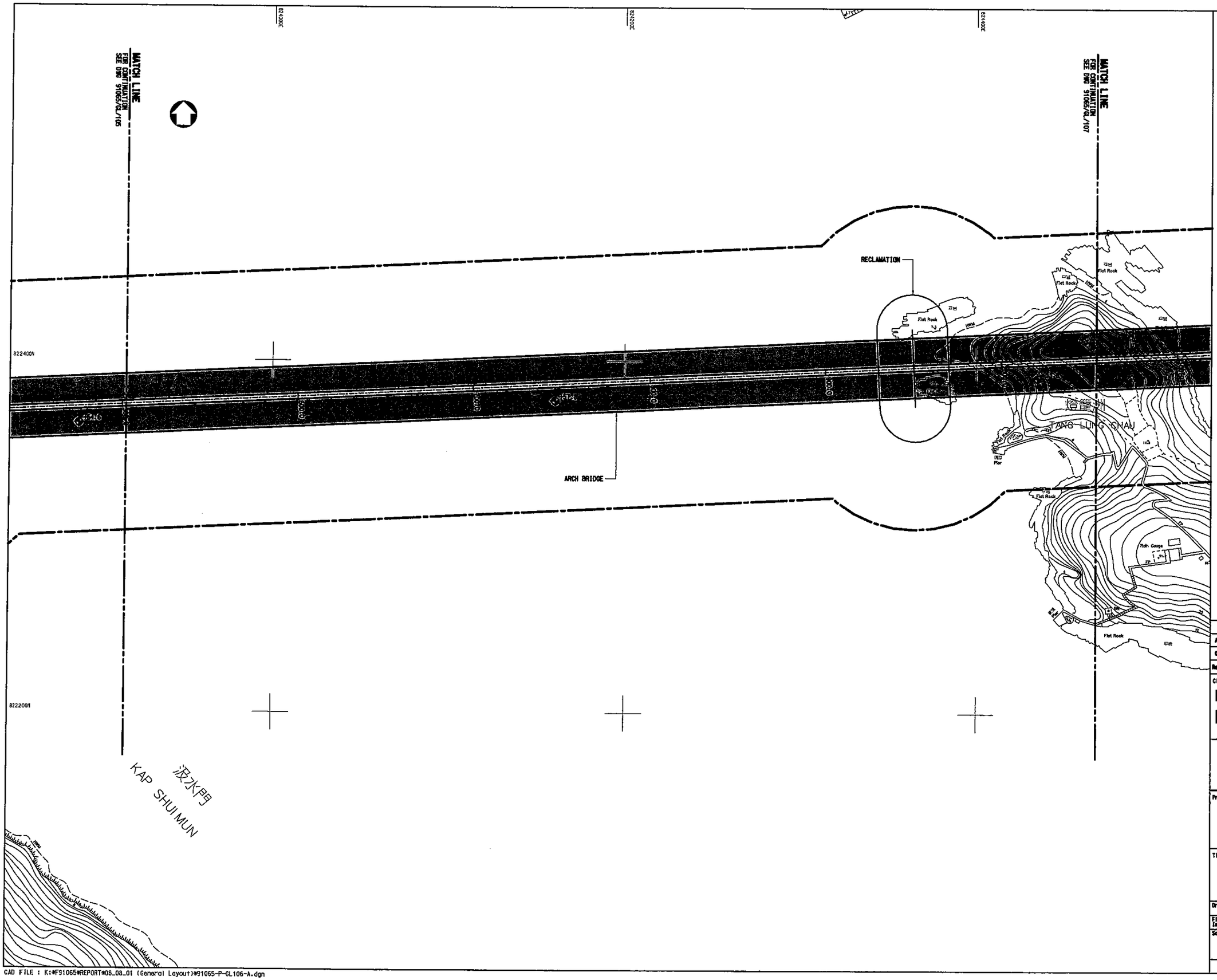

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information	CML	TC	SCI	31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/08

Client

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Hong Kong Project Management Office

Meinhardt Infrastructure and Environment Limited
滿地基建環保工程顧問有限公司

Project

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TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 6 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued: 8/4/08	CAD File No.: 91065-P-GL106-A.dgn	Date: 31/7/08
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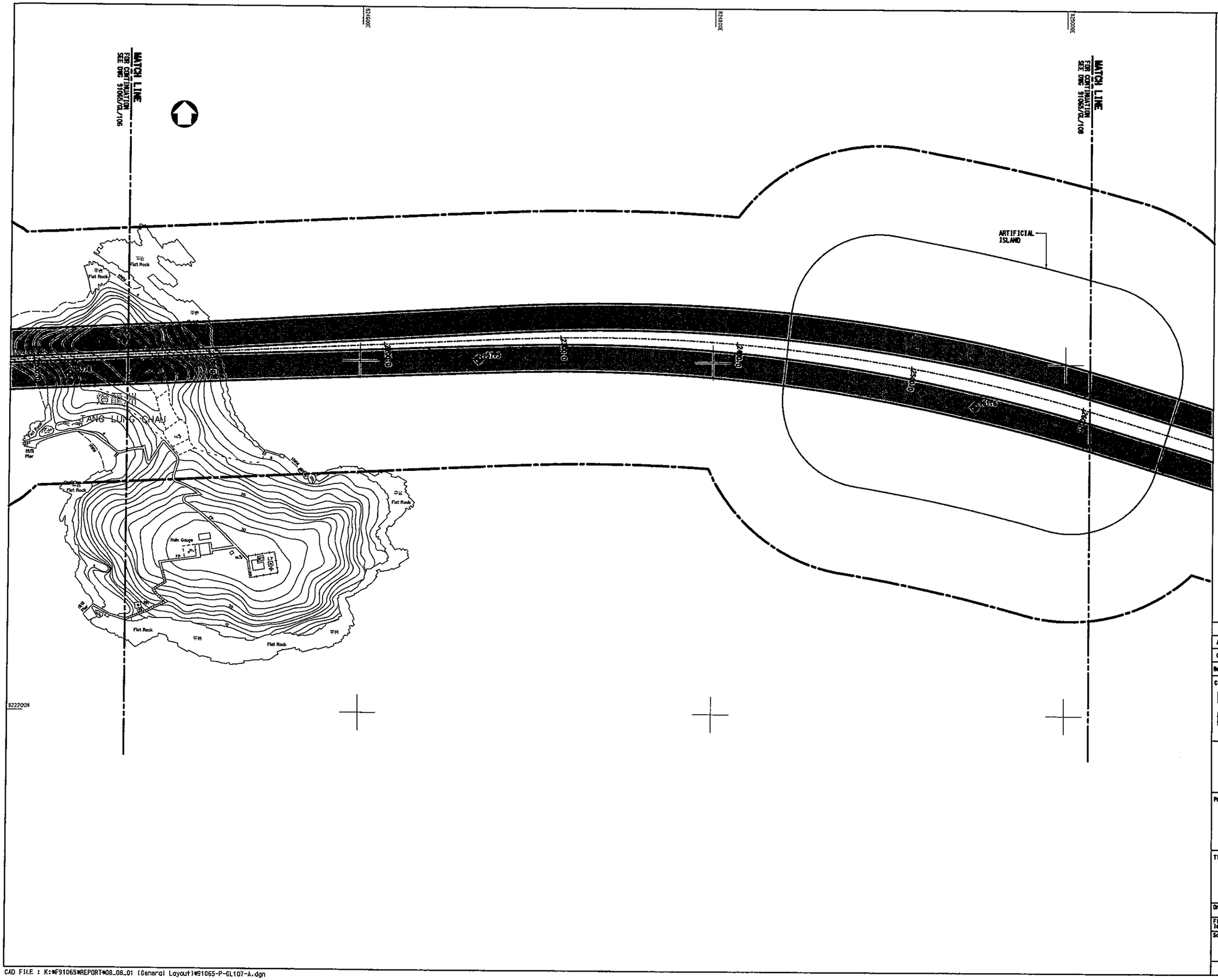

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information				31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/08

Client

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Hong Kong Project Management Office

MEINHARDT
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Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 7 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued 8/4/08	CAD File No. 91065-P-GL107-A.dgn	Date 31/7/08
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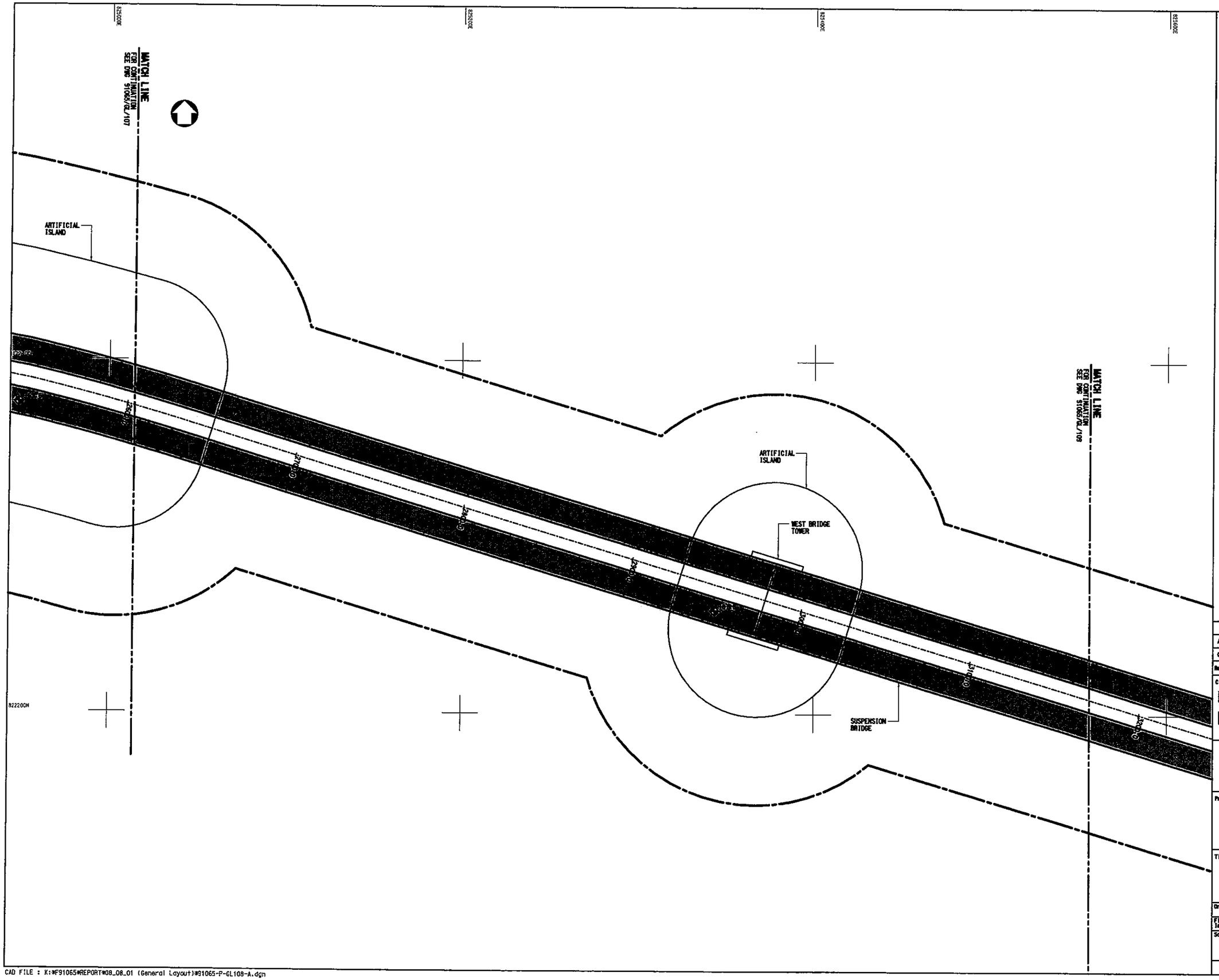

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information				31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/08

Client

路政署
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Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

MEINHARDT
Meinhardt Infrastructure and Environment Limited
運輸基建環保工程顧問有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 8 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued 8/4/08	CAD File No. 91065-P-GL108-A.dgn	Date 31/7/08
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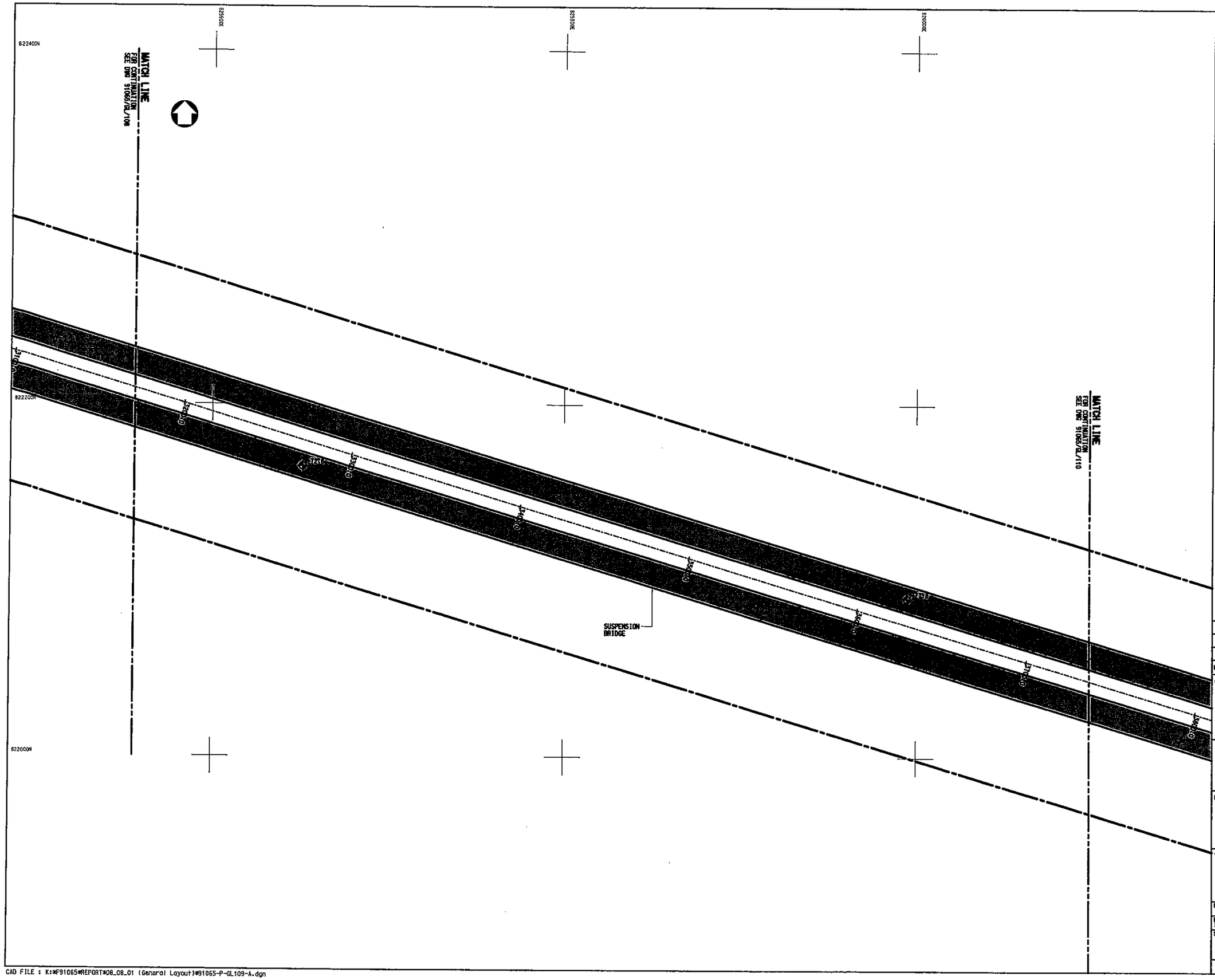

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

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A	IFI	Issued for Information	[illegible]	[illegible]	[illegible]	31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/08

Client

路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

MEINHARDT
Meinhardt Infrastructure and Environment Limited
[illegible]

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 9 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued 8/4/08	CAD File No. 91065-P-GL109-A.dgn	Date 31/7/08
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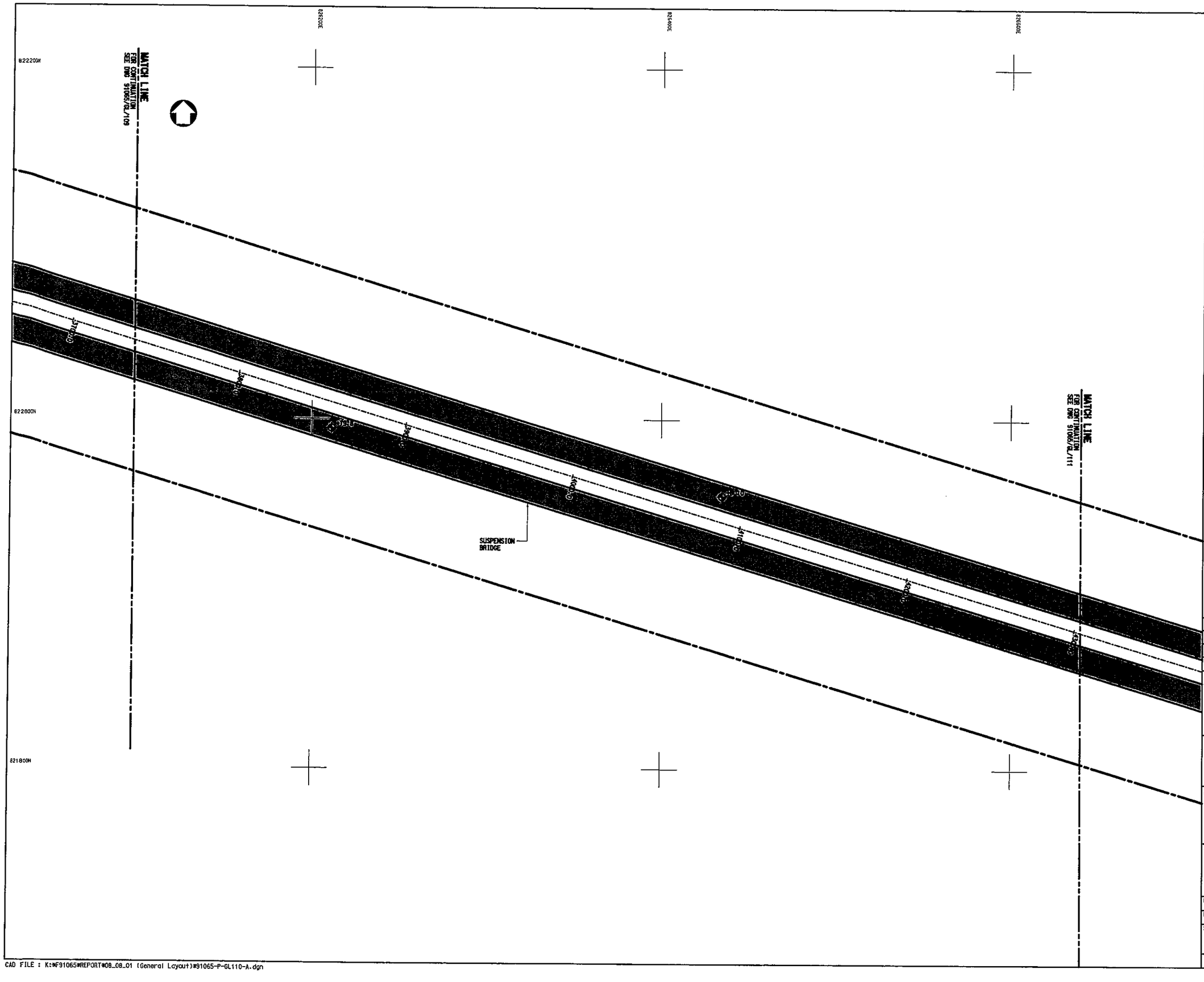

NOTES:

1. ALL DIMENSIONS IN METERS. UNLESS OTHERWISE STATED.
2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information	CML	TC	SCI	31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/08

Client

路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

Meinhardt Infrastructure and Environment Limited
迈进基建环保工程顾问有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 10 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued: 8/4/08	CAD File No.: 91065-P-GL110-A.dgn	Date: 31/7/08
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821800N

821600N

MATCH LINE
FOR CONTINUATION
SEE DWG 91065/GL/110

MATCH LINE
FOR CONTINUATION
SEE DWG 91065/GL/112

RECLAMATION

SUSPENSION BRIDGE

EAST BRIDGE TOWER

NOTES:

1. ALL DIMENSIONS IN METERS. UNLESS OTHERWISE STATED.
2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information	CWL	TC	SCI	31/7/08
0	IFIC	Issued for Information & comment	CWL	TC	SCI	8/4/08

Client

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HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

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Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 11 of 17)

Drawn	Checked	Approved
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First Issued: 8/4/08	CAD File No.: 91065-P-GL111-A.dgn	Date: 31/7/08
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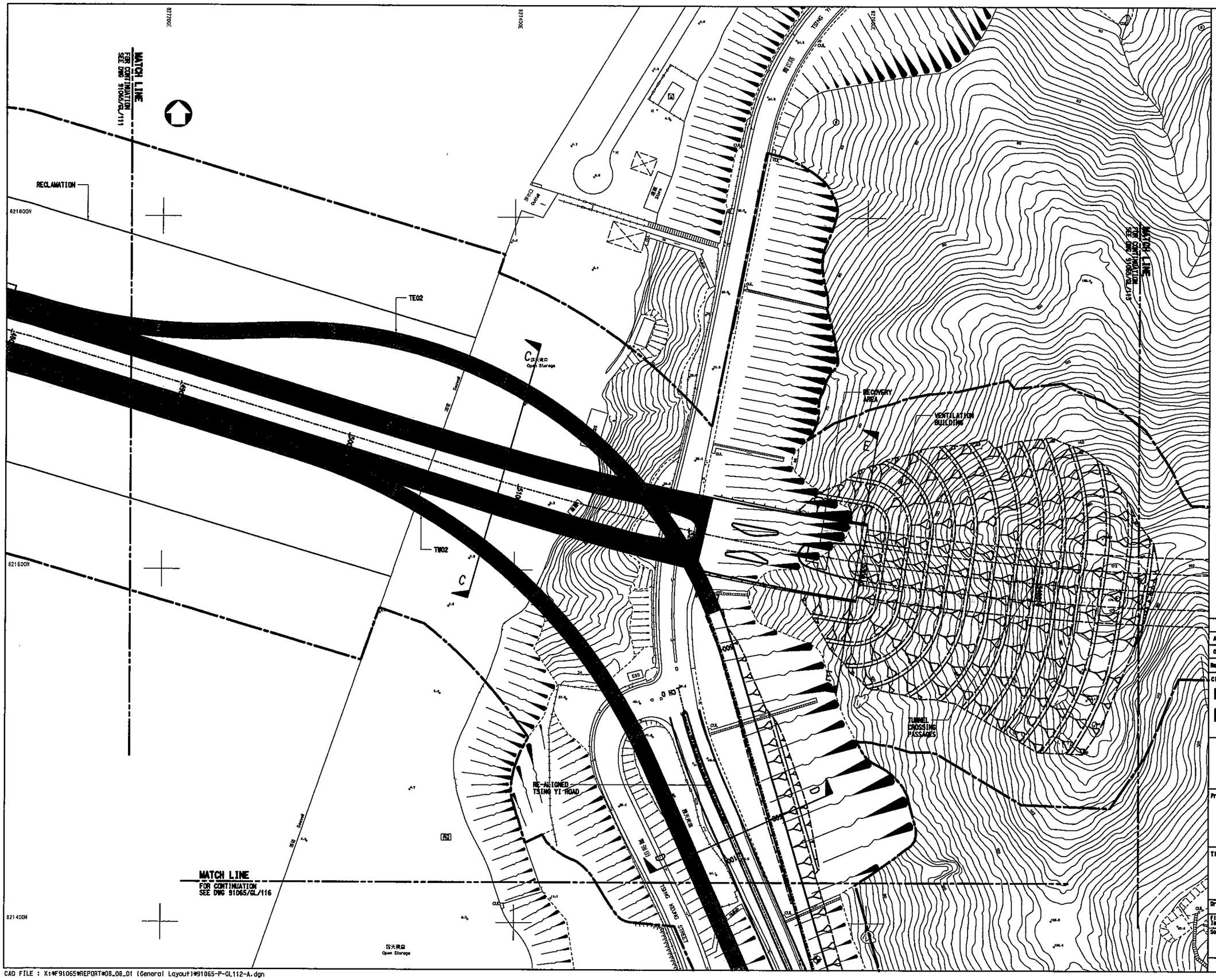

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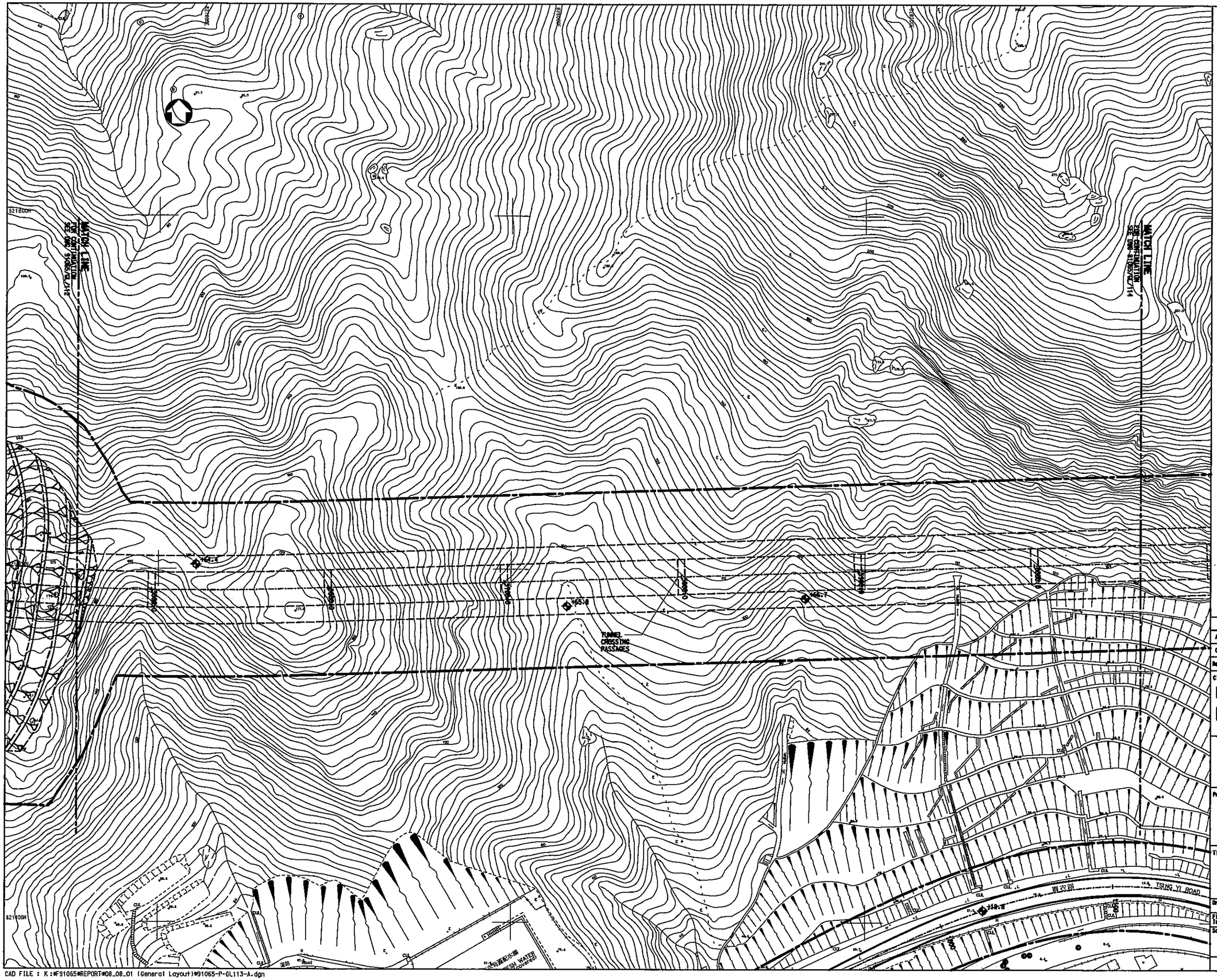

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
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3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information				31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/08

Client

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HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

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Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 13 of 17)

Drawn	CML	Checked	TC	Approved	SCI
First Issued	8/4/08	CAD File No.	91065-P-GL113-A.dgn	Date	31/7/08
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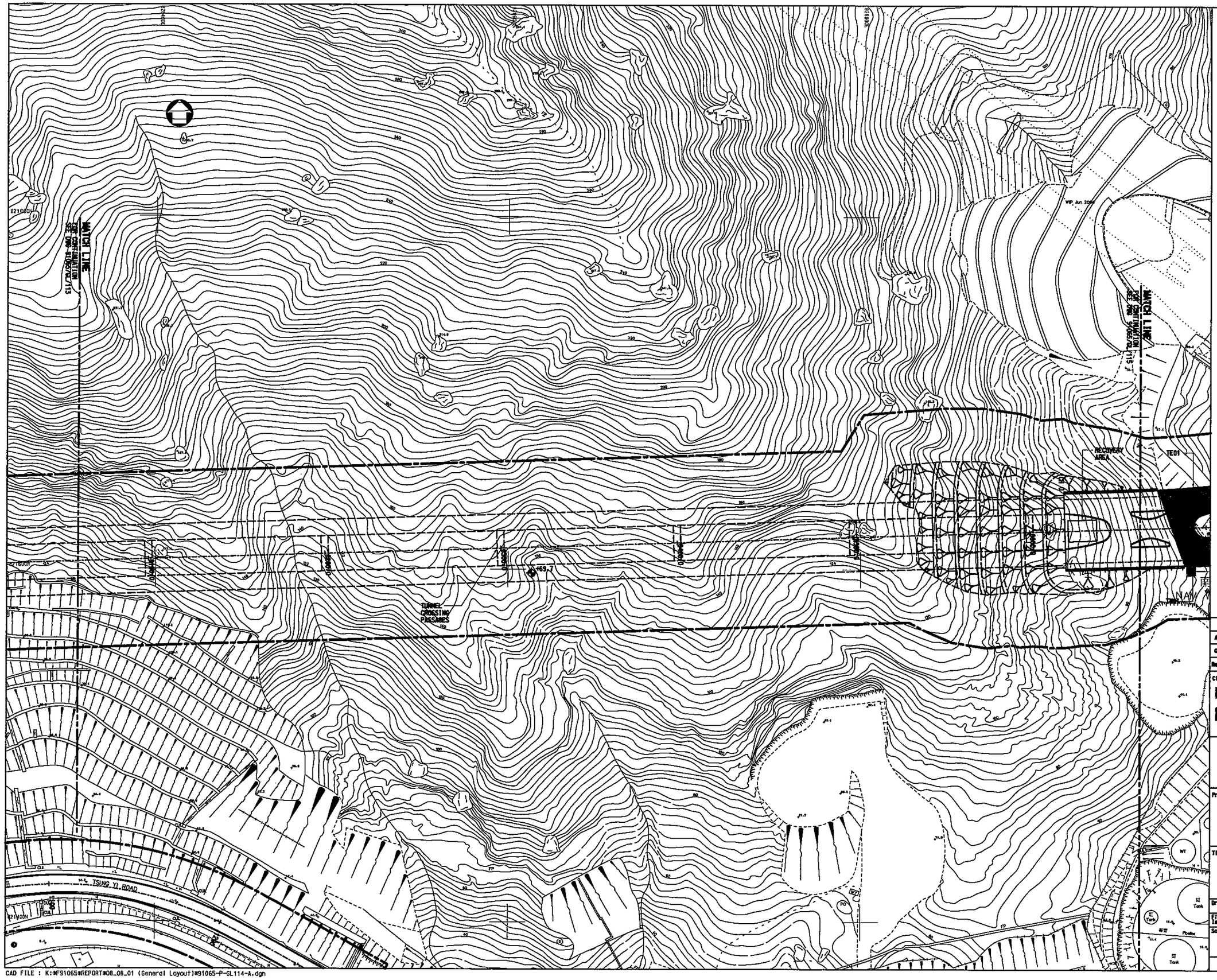

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LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
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- CUT EARTHWORKS SLOPE
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Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for information	[illegible]	[illegible]	[illegible]	31/7/08
0	IFIC	Issued for information & comment	CML	TC	SCI	8/4/08

Client

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HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

MEINHARDT
Meinhardt Infrastructure and Environment Limited
[illegible]

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 14 of 17)

Drawn	CML	Checked	TC	Approved	SCI
First Issued	8/4/08	CAD File No.	91065-P-GL114-A.dgn	Date	31/7/08
Scale	1 : 1000 (A1) 1 : 2000 (A3)	Drawing No.	91065/GL/114	Rev.	A

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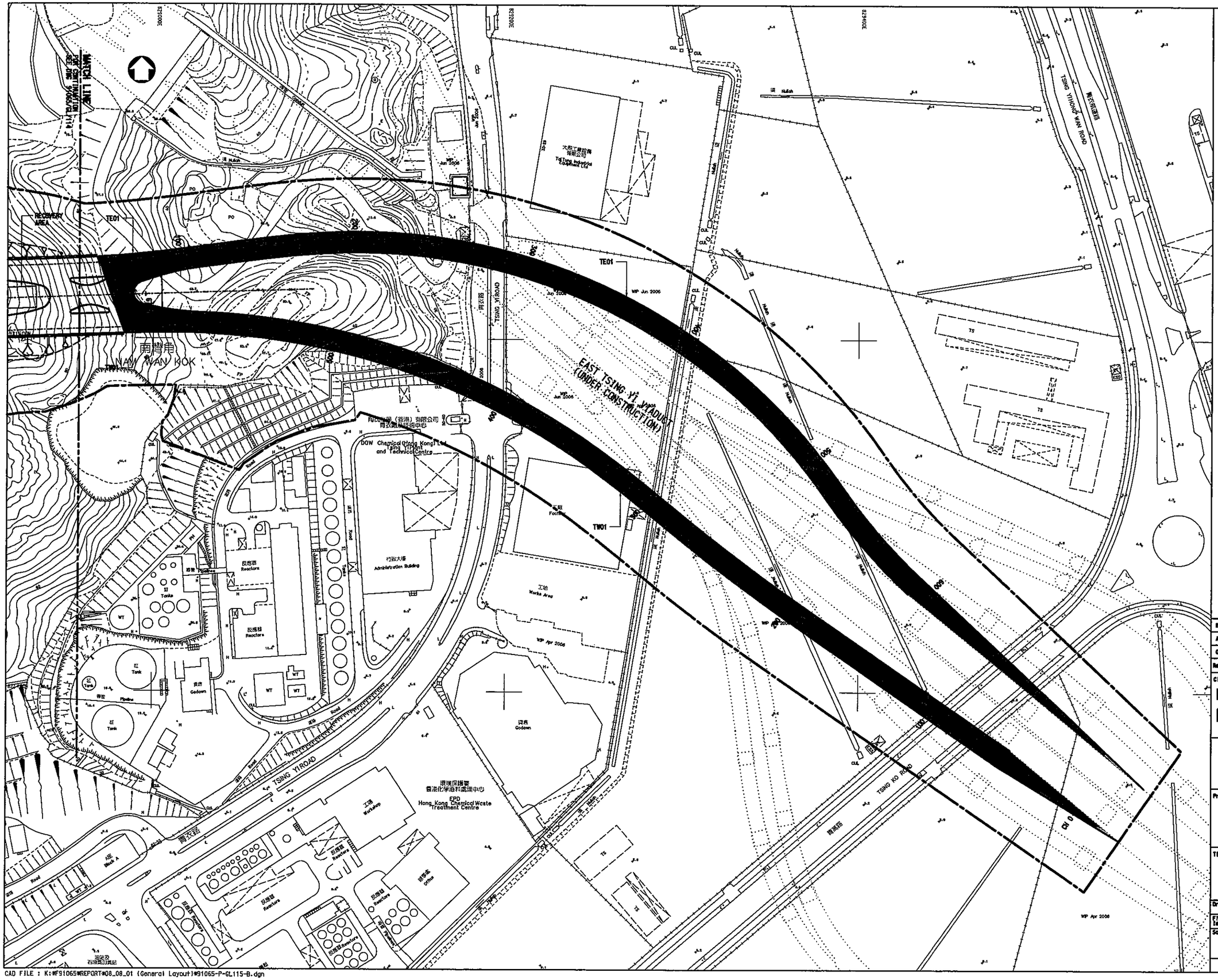

NOTES:

1. ALL DIMENSIONS IN METERS. UNLESS OTHERWISE STATED.
2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

- PROJECT BOUNDARY/LAND RESUMPTION LIMIT
- CARRIAGEWAY ON ELEVATED STRUCTURE
- CARRIAGEWAY IN TUNNEL
- FILL EARTHWORKS SLOPE
- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stage	Amendment	By	Chk.	App.	Date
B	IFI	Issued for Information			SCI	31/7/08
A	IFIC	Issued for Information & comment	CML	TC	SCI	10/6/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	6/4/08

Client

路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

Meinhardt Infrastructure and Environment Limited
迈雅基建环保工程顾问有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 15 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued: 6/4/08	CAD File No.: 91065-P-GL115-B.dgn	Date: 31/7/08
Scale: 1 : 1000 (A1) 1 : 2000 (A3)	Drawing No.: 91065/GL/115	Rev.: B

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CAD FILE : K:¥P91065¥REPORT¥08_08_01 (General Layout)¥91065-P-GL115-B.dgn

MATCH LINE
FOR CONTINUATION
SEE DWG 91065/GL/112

821400N

821200N

821000N

RE-ALIGNED
TSING YI ROAD

TSING KEUNG STREET

TSING YI ROAD

TSING HAU STREET

青衣路

青衣北路

青衣南路

青衣西路

青衣公園
Tsing Yi Park

青衣消防局
Tsing Yi Fire Station

青衣警署
Tsing Yi Police Station

青衣政府合署
Tsing Yi Government Offices

青衣市政大廈
Tsing Yi Municipal Services Building

青衣體育館
Tsing Yi Sports Centre

青衣游泳池
Tsing Yi Swimming Pool

青衣北公共運輸交匯處
Tsing Yi North Public Transport Interchange

青衣北公共運輸交匯處
Tsing Yi North Public Transport Interchange

青衣南公共運輸交匯處
Tsing Yi South Public Transport Interchange

青衣南公共運輸交匯處
Tsing Yi South Public Transport Interchange

青衣北邨
Tsing Yi North Estate

青衣南邨
Tsing Yi South Estate

青衣邨
Tsing Yi Estate

青衣花園
Tsing Yi Garden

青衣城
Tsing Yi Town Centre

青衣城市花園
Tsing Yi City Garden

青衣中心
Tsing Yi Centre

青衣商業中心
Tsing Yi Commercial Centre

青衣工業中心
Tsing Yi Industrial Centre

青衣工業大廈
Tsing Yi Industrial Building

青衣工業區
Tsing Yi Industrial Area

青衣貨櫃碼頭
Tsing Yi Container Terminal

青衣油庫
Tsing Yi Oil Depot

青衣發電廠
Tsing Yi Power Station

青衣污水處理廠
Tsing Yi Sewage Treatment Works

青衣垃圾轉運站
Tsing Yi Refuse Transfer Station

青衣墳場
Tsing Yi Cemetery

青衣公園
Tsing Yi Park

青衣消防局
Tsing Yi Fire Station

青衣警署
Tsing Yi Police Station

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Tsing Yi Government Offices

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Tsing Yi North Public Transport Interchange

青衣南公共運輸交匯處
Tsing Yi South Public Transport Interchange

青衣北邨
Tsing Yi North Estate

青衣南邨
Tsing Yi South Estate

青衣花園
Tsing Yi Garden

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Tsing Yi Town Centre

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Tsing Yi Power Station

青衣污水處理廠
Tsing Yi Sewage Treatment Works

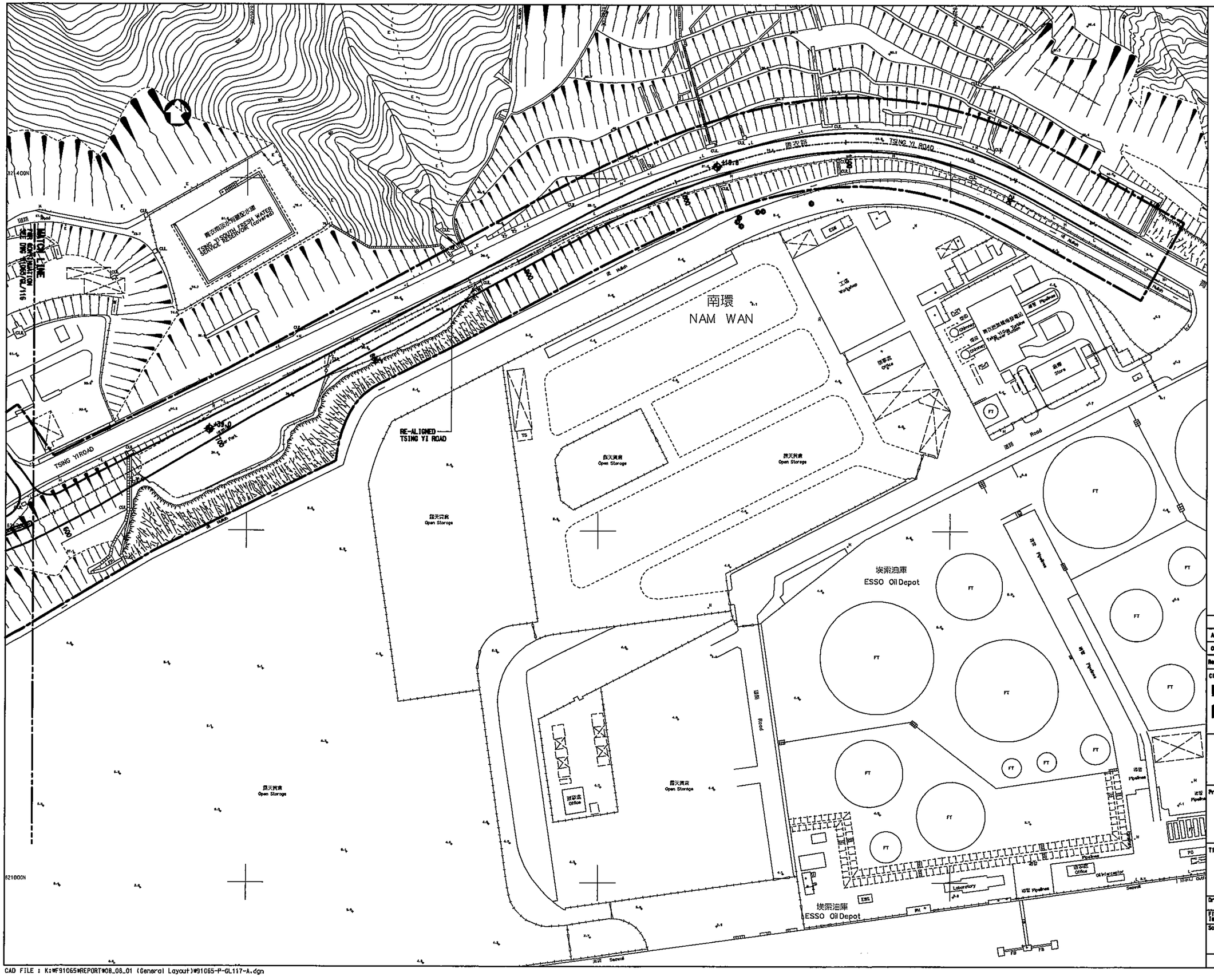
青衣垃圾轉運站
Tsing Yi Refuse Transfer Station

青衣墳場
Tsing Yi Cemetery

露天貨倉
Open Storage

露天貨倉
Open Storage

露天貨倉
Open Storage



NOTES:

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2. FOR HORIZONTAL AND VERTICAL PROFILES, REFER TO DWG. NO. 91065/GL/201 TO 204.
3. FOR CROSS SECTIONS, REFER TO DWG. NO. 91065/GL/301 TO 302.

LEGENDS:

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- CUT EARTHWORKS SLOPE
- RETAINING STRUCTURE
- +23.2 PROPOSED ROAD LEVEL

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information				31/7/06
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/06

Client

路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

MEINHARDT
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邁進基建環保工程顧問有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

GENERAL LAYOUT PLAN
(Sheet 17 of 17)

Drawn	Checked	Approved
CML	TC	SCI
First Issued 8/4/06	CAD File No. 91065-P-GL117-A.dgn	Date 31/7/06
Scale 1 : 1000 (A1) 1 : 2000 (A3)	Drawing No. 91065/GL/117	Rev. A

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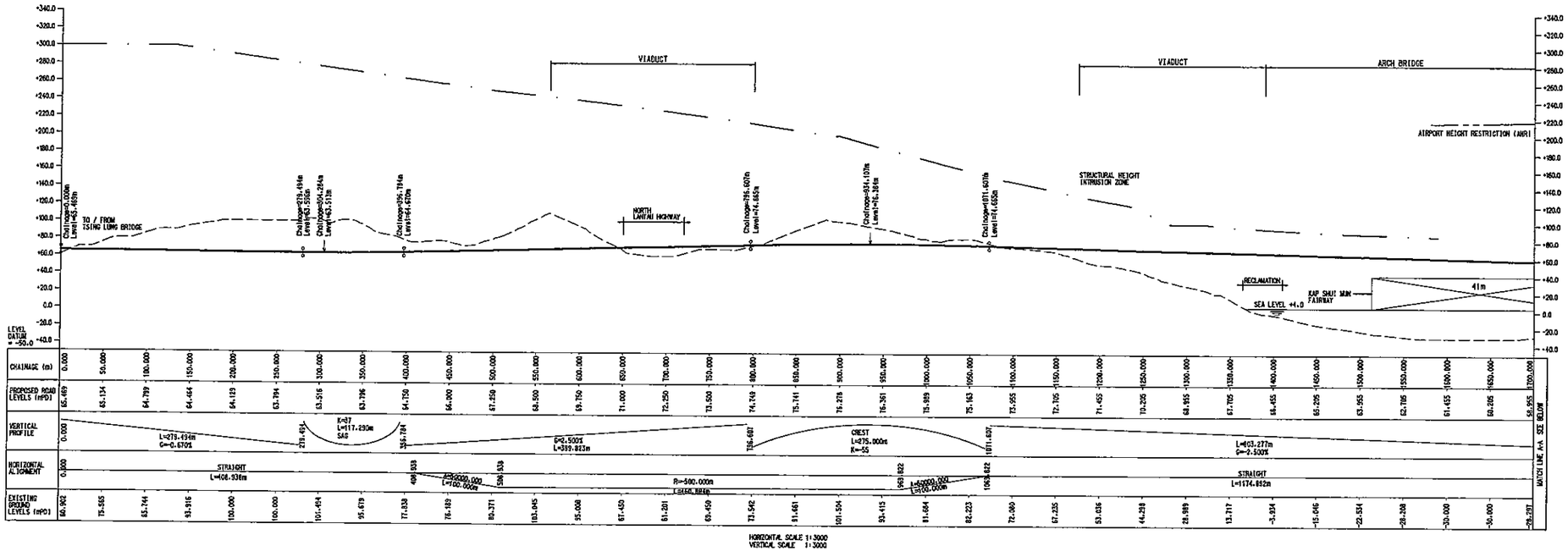

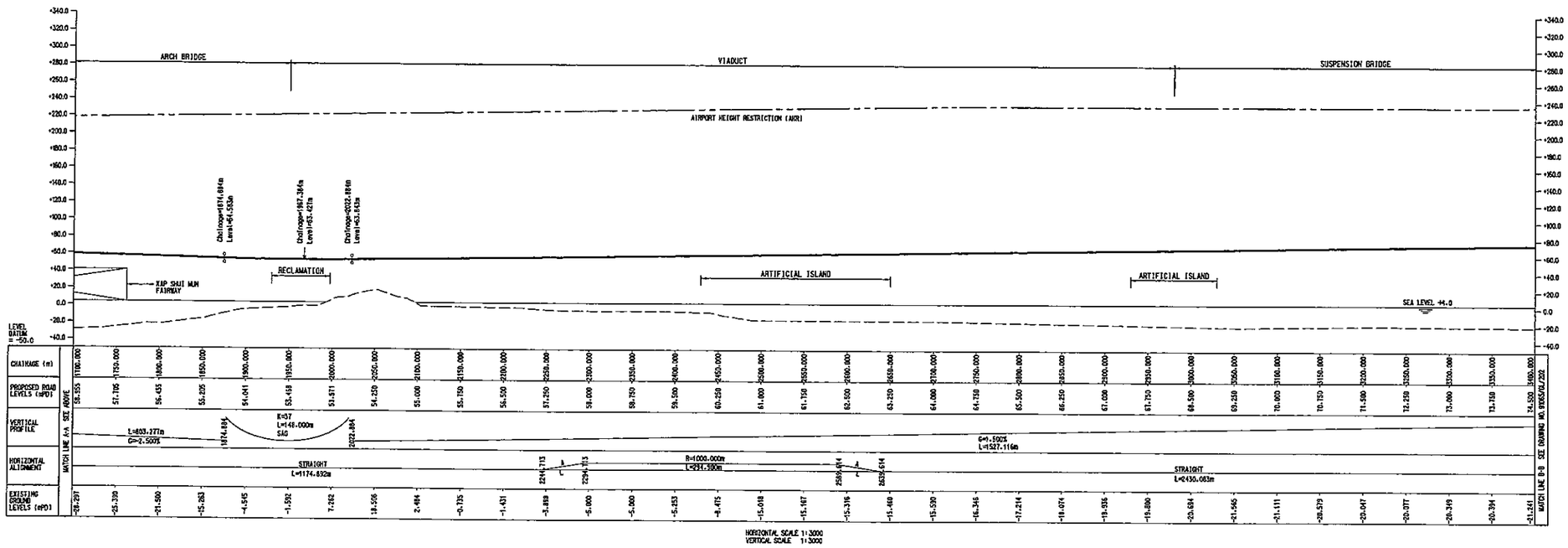

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
2. DRAWING TO BE READ IN CONJUCTION WITH GENERAL LAYOUT PLAN DWGS. NO. 91065/GL/101 TO 117.

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information	[signature]	[signature]	[signature]	31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/08

Client

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HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

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建造基建環保工程顧問有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

VERTICAL PROFILE OF TYLL MAINLINE
(Sheet 1 of 2)

Drawn	Checked	Approved
CML	TC	SCI
First Issued 8/4/08	CAD File No. 91065-P-GL201-A.dgn	Date 31/7/08
Scale AS SHOWN	Drawing No. 91065/GL/201	Rev. A

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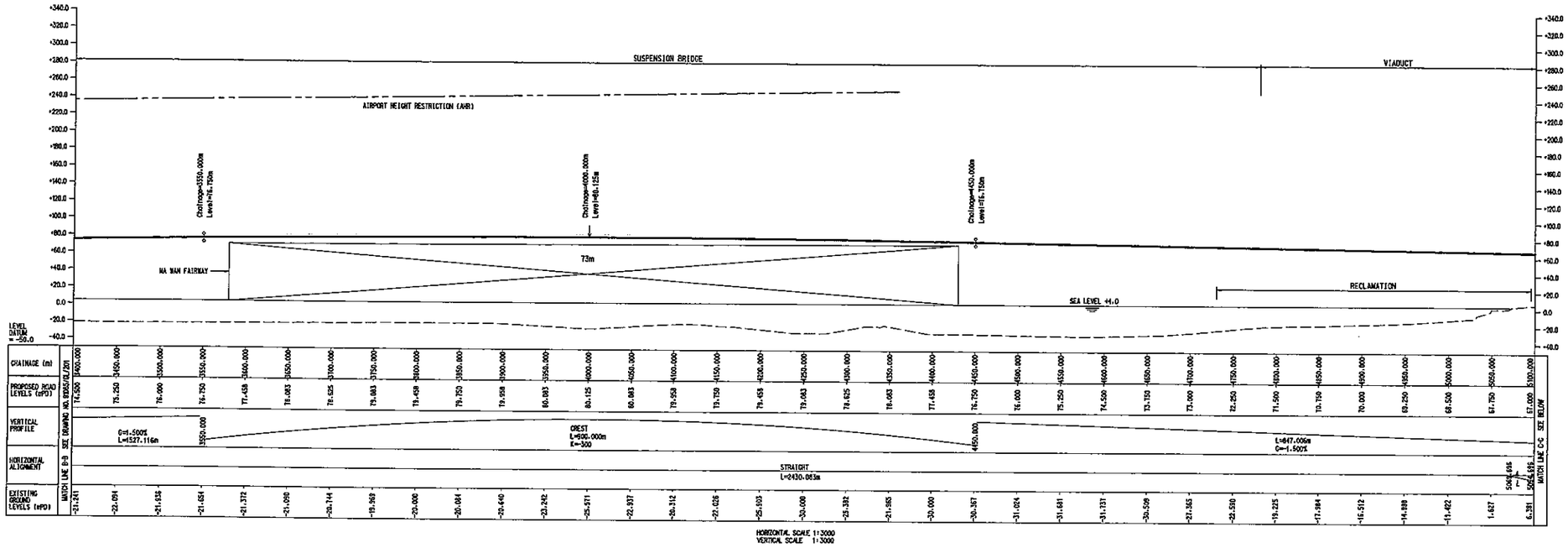

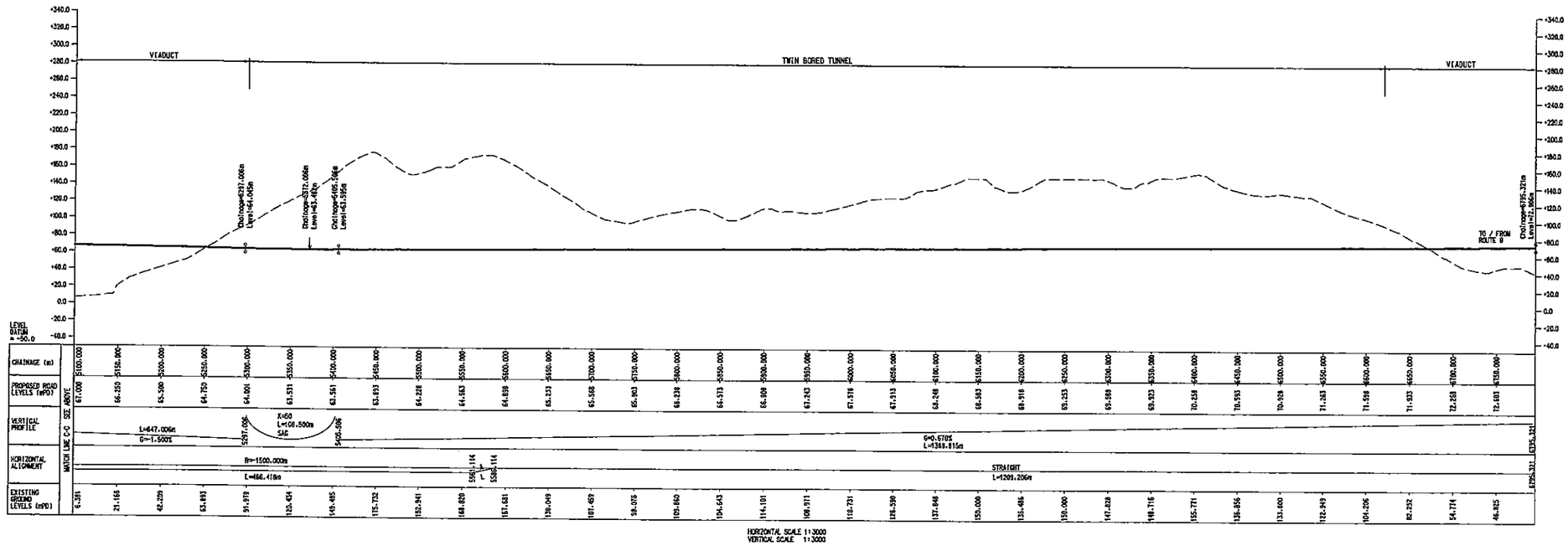

NOTES:

1. ALL DIMENSIONS IN METERS. UNLESS OTHERWISE STATED.
2. DRAWING TO BE READ IN CONJUCTION WITH GENERAL LAYOUT PLAN DWGS. NO. 91065/GL/101 TO 117.

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information	CML	TC	SCI	31/7/08
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Client

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HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

Meinhardt Infrastructure and Environment Limited
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Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

VERTICAL PROFILE OF TYLL MAINLINE
(Sheet 2 of 2)

Drawn	Checked	Approved
CML	TC	SCI
First Issued: 8/4/08	CAD File No.: 91065-P-GL202-A.dgn	Date: 31/7/08
Scale: AS SHOWN	Drawing No.: 91065/GL/202	Rev.: A

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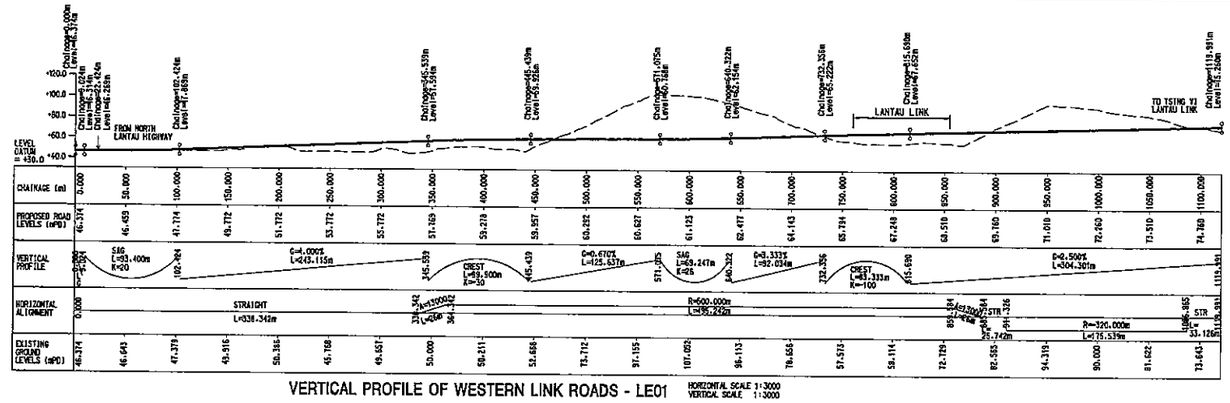
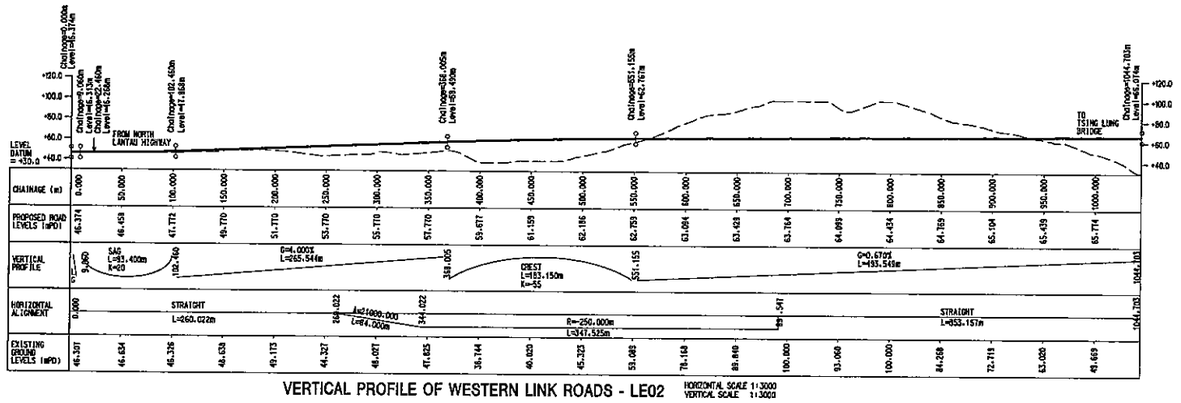
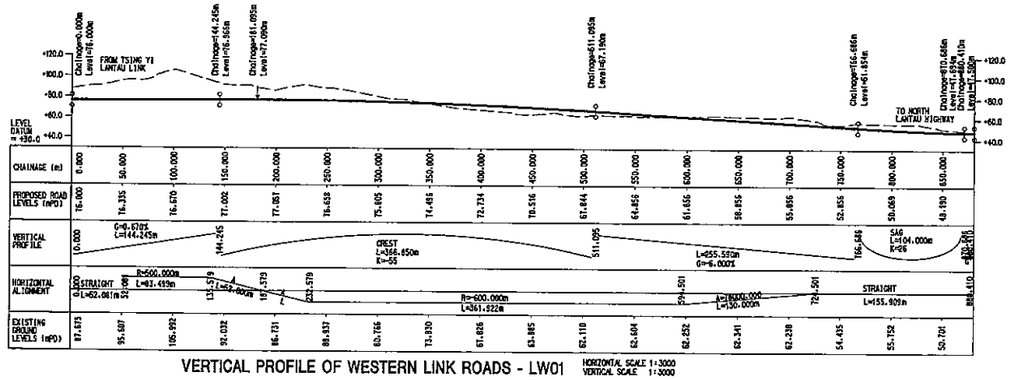


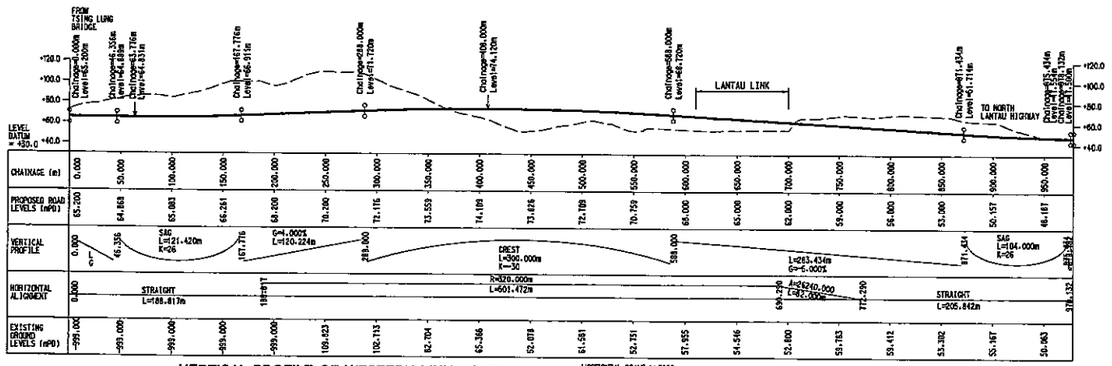
VERTICAL PROFILE OF WESTERN LINK ROADS - LE01 HORIZONTAL SCALE 1:3000 VERTICAL SCALE 1:3000



VERTICAL PROFILE OF WESTERN LINK ROADS - LE02 HORIZONTAL SCALE 1:3000 VERTICAL SCALE 1:3000



VERTICAL PROFILE OF WESTERN LINK ROADS - LW01 HORIZONTAL SCALE 1:3000 VERTICAL SCALE 1:3000



VERTICAL PROFILE OF WESTERN LINK ROADS - LW02 HORIZONTAL SCALE 1:3000 VERTICAL SCALE 1:3000

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
2. DRAWING TO BE READ IN CONJUCTION WITH GENERAL LAYOUT PLAN DWGS. NO. 91065/GL/101 TO 117.

Rev	Issue Stage	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information	CML	TC	SCI	31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/08

Client

路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

Meinhardt Infrastructure and Environment Limited
迈进基建环保工程顾问有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

VERTICAL PROFILE OF WESTERN LINK ROADS

Drawn	Checked	Approved
CML	TC	SCI
First Issued: 8/4/08	CAD File No.: 91065-P-GL203-A.dgn	Date: 31/7/08
Scale: AS SHOWN	Drawing No.: 91065/GL/203	Rev.: A

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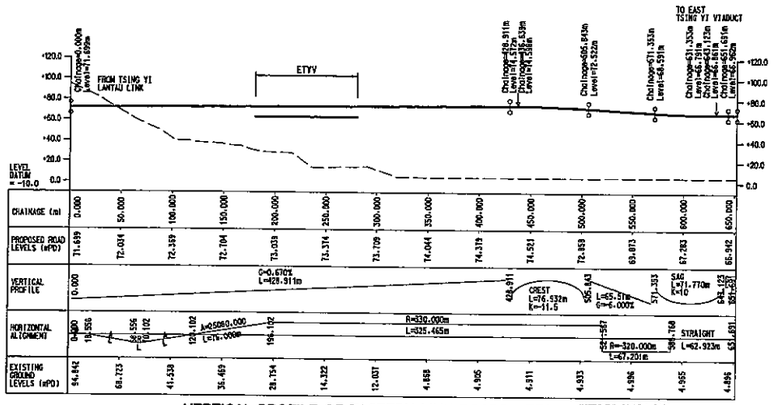
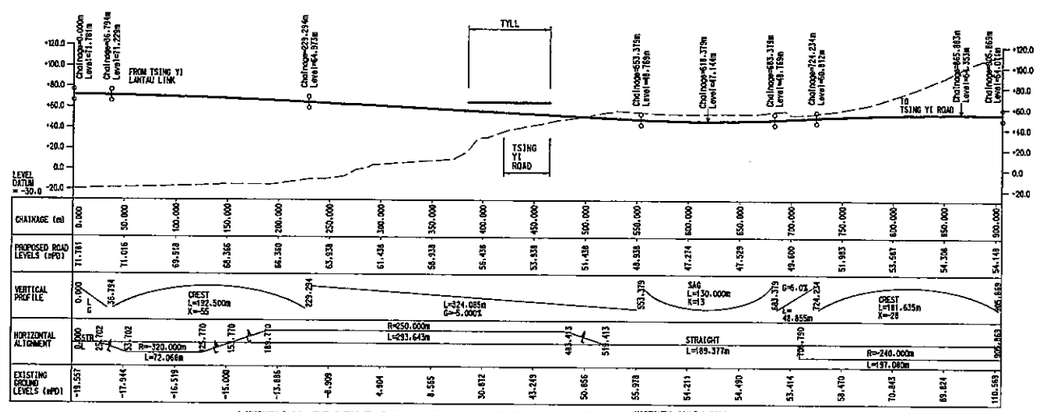
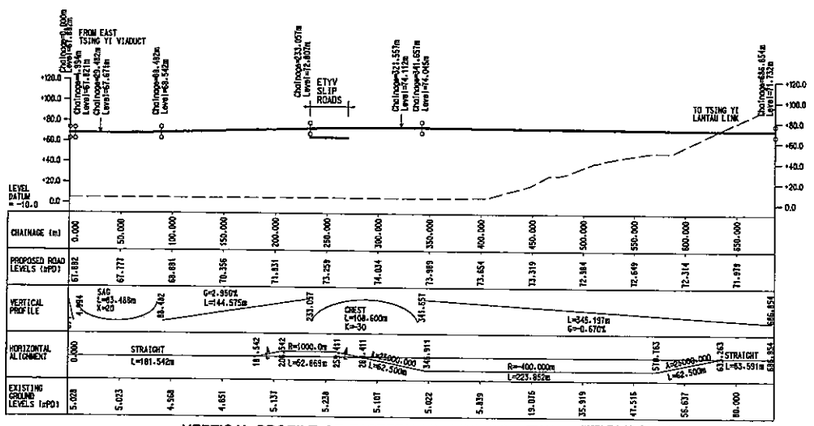
CAD FILE : K:¥F91065¥REPORT¥08_08_01 (General Layout)¥91065-P-GL203-A.dgn



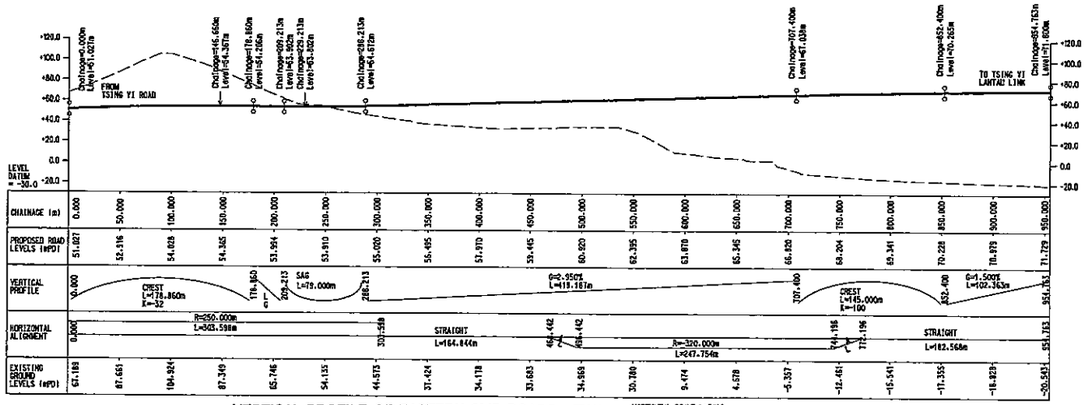
VERTICAL PROFILE OF EASTERN LINK ROADS - TE01 HORIZONTAL SCALE 1:3000 VERTICAL SCALE 1:3000



VERTICAL PROFILE OF EASTERN SLIP ROADS - TE02 HORIZONTAL SCALE 1:3000 VERTICAL SCALE 1:3000



VERTICAL PROFILE OF EASTERN LINK ROADS - TW01 HORIZONTAL SCALE 1:3000 VERTICAL SCALE 1:3000



VERTICAL PROFILE OF EASTERN SLIP ROADS - TW02 HORIZONTAL SCALE 1:3000 VERTICAL SCALE 1:3000

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
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Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information	CML	TC	SCI	31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/08

Client

路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

Meinhardt Infrastructure and Environment Limited
美雅基建環保工程顧問有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

VERTICAL PROFILE OF
EASTERN LINK ROADS AND SLIP ROADS

Drawn	Checked	Approved
CML	TC	SCI
First Issued: 8/4/08	CAD File No.: 91065-P-GL204-A.dgn	Date: 31/7/08
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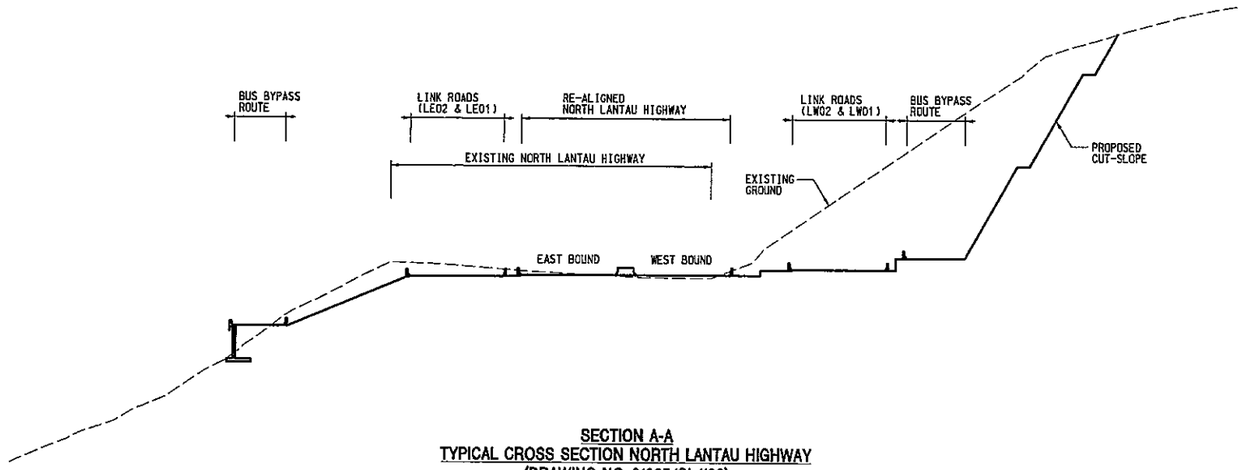
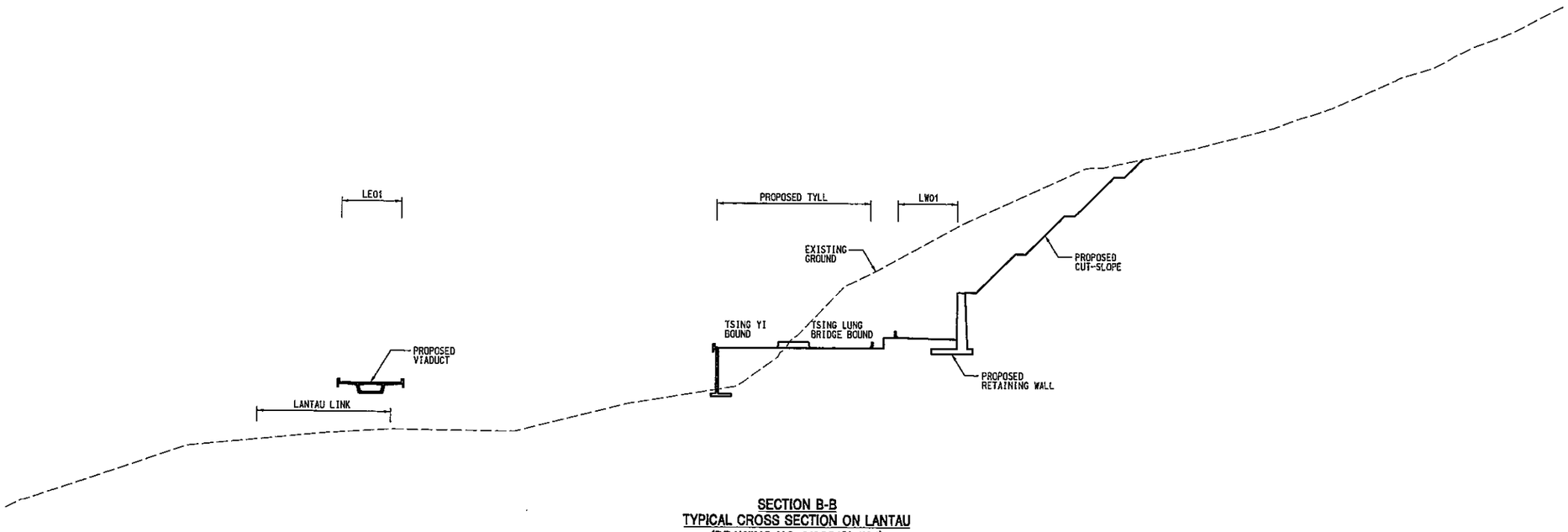


SECTION A-A
TYPICAL CROSS SECTION NORTH LANTAU HIGHWAY
(DRAWING NO. 91065/GL/102)



SECTION B-B
TYPICAL CROSS SECTION ON LANTAU
(DRAWING NO. 91065/GL/104)

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
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A	IFI	Issued for Information	[illegible]	[illegible]	[illegible]	31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/08

Client

路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong-Zhuhai-Macao Bridge
Hong Kong Project Management Office

MEINHARDT
Meinhardt Infrastructure and Environment Limited
運達基建環保工程顧問有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

TYPICAL CROSS SECTIONS
(Sheet 1 of 2)

Drawn	Checked	Approved
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First Issued 8/4/08	CAD File No. 91065-P-GL301-A.dgn	Date 31/7/08
Scale 1 : 500 (A1) 1 : 1000 (A3)	Drawing No. 91065/GL/301	Rev. A

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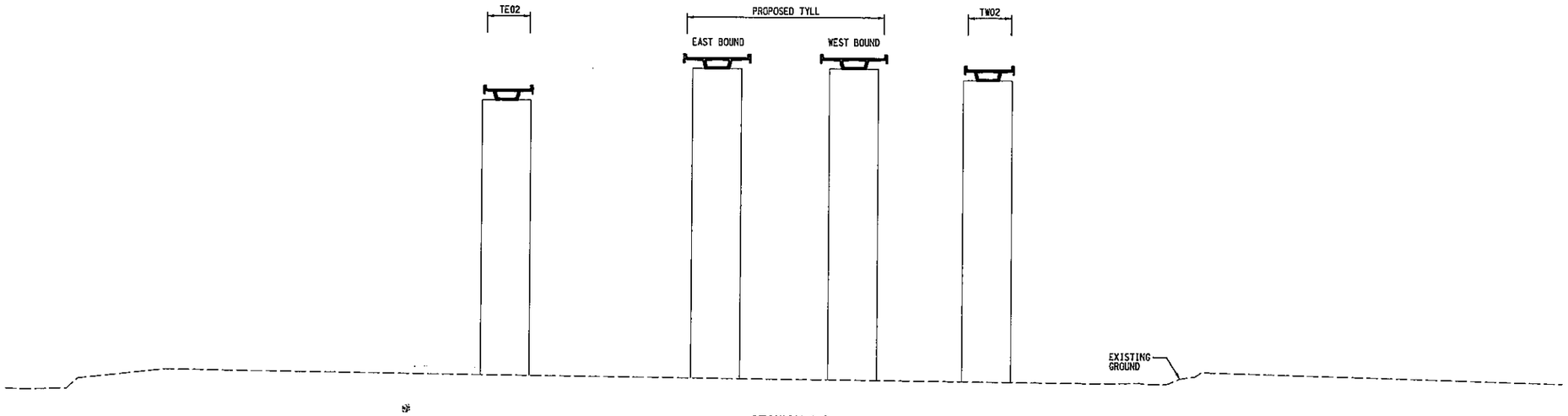
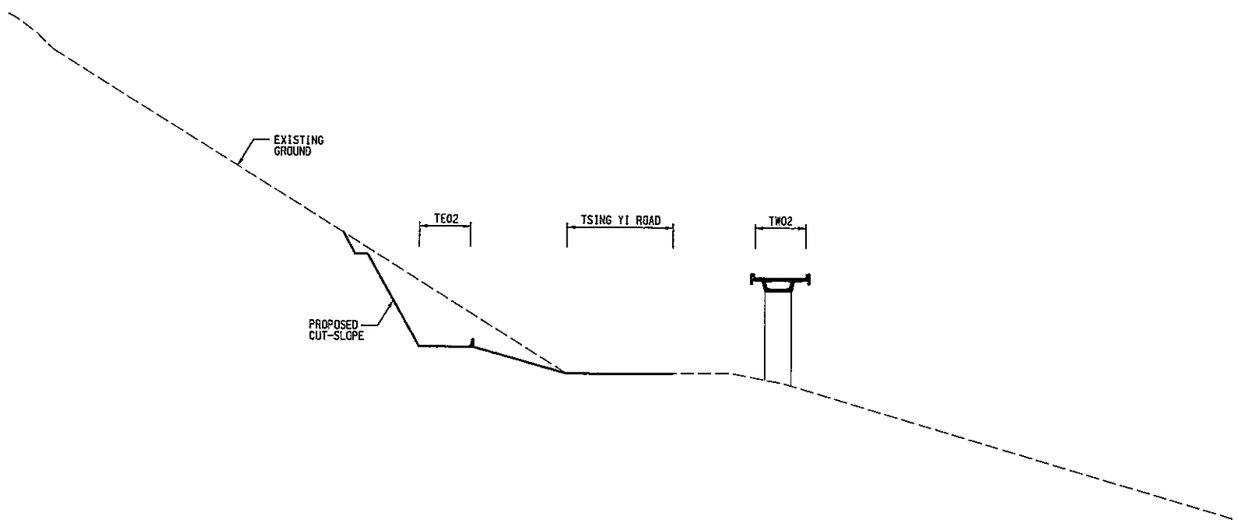
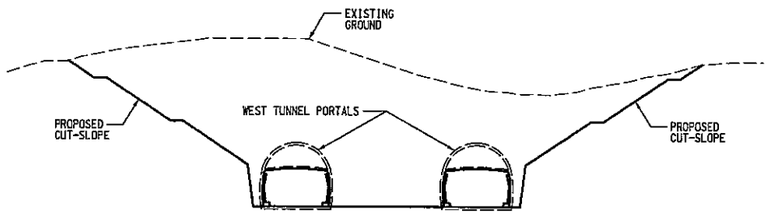


SECTION C-C
TYPICAL CROSS SECTION ON TSING YI
(DRAWING NO. 91065/GL/112)



SECTION D-D
TYPICAL CROSS SECTION TSING YI ROAD
(DRAWING NO. 91065/GL/112)



SECTION E-E
TYPICAL CROSS SECTION OF WEST TUNNEL PORTAL
(DRAWING NO. 91065/GL/112)

NOTES:

1. ALL DIMENSIONS IN METERS, UNLESS OTHERWISE STATED.
2. DRAWING TO BE READ IN CONJUCTION WITH GENERAL LAYOUT PLAN DWGS. NO. 91065/GL/101 TO 117.

Rev	Issue Stat	Amendment	By	Chk.	App.	Date
A	IFI	Issued for Information	[illegible]	[illegible]	[illegible]	31/7/08
0	IFIC	Issued for Information & comment	CML	TC	SCI	8/4/08

Client

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港珠澳大橋香港工程管理處
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Hong Kong Project Management Office

MEINHARDT
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運輸基建環保工程顧問有限公司

Project

AGREEMENT NO. CE 40/2006(HY)
TSING YI LANTAU LINK
- FEASIBILITY STUDY

Title

TYPICAL CROSS SECTIONS
(Sheet 2 of 2)

Drawn	Checked	Approved
CML	TC	SCI
First Issued 8/4/08	CAD File No. 91065-P-GL302-A.dgn	Date 31/7/08
Scale 1 : 500 (A1) 1 : 1000 (A3)	Drawing No. 91065/GL/302	Rev. A

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