ROUTE 3 CONTRACTORS CONSORTIUM

ROUTE 3 TAI LAM TUNNEL & YUEN LONG APPROACH
NORTHERN SECTION

Volume 1

Detailed Environmental Impact Assessment

Final Report

October 1995

CONSULTANTS IN
ENVIRONMENTAL
SCIENCES (ASIA) LTD

Room 1201, Tai Yau Building
181 Johnston Road, Wanchai, Hong Kong
Telephone : (852) 2893 1551 Facsimile : (852) 2891 0305

EIA-076.5/BC

QUALITY ASSURANCE POLICY STATEMENT

Consultants in Environmental Sciences (Asia) Ltd is committed to satisfying the requirements of its Clients at the highest standards of professional ethics.

It is the Company's objective to provide services which meet the required specification and are produced on time in a cost-effective manner.

In pursuit of these objectives, the Directors have implemented Quality Systems based on ISO 9001 standard. All employees of the Company have a responsibility for quality.

The quality procedures are under continual review by senior Management to ensure that the changing needs of the Company's Clients are met.

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

CES (ASIA) LTD DOCUMENT RELEASE FORM			
TITLE	Route 3 Tai Lam Tunnel & Yuen Long Approach - Northern Section Volume 1 DEIA		
CLIENT	Route 3 Contractors Consortium		
REPORT NO.	726	PROJECT NO.	96530
STATUS	Final	DATE OF ISSUE	19/10/95
QUALITY CONTROL	NAME	SIGNATURE	DATE
CHECKED BY	W Tung	W Tung	19-10-95
TECHNICAL REVIEWER	A Y Kwok	[illegible]	19-10-95
APPROVED BY	S Howard	S. Howard	19/10/95

REMARKS : The information supplied and contained within this report is, to the best of our knowledge, correct at the time of printing. Where information has been supplied by third parties, such information is reproduced here in good faith.

CES (Asia) Ltd accepts no responsibility for changes made to this report by third parties.

CONTENTS

		Page
1	INTRODUCTION	1-1
	1.1 Background	1-1
	1.2 Construction Requirements	1-2
	1.3 Scope of Work	1-3
	1.4 Project Area	1-3
	1.5 Report Structure	1-3
2	PROJECT DESCRIPTION	2-1
	2.1 Background	2-1
	2.2 Design	2-1
	2.3 Northern Section	2-3
3	EXISTING ENVIRONMENT	3-1
	3.1 Sensitive Receivers	3-1
	3.2 Cumulative Impacts	3-1
	3.3 Noise	3-2
	3.4 Air Quality	3-2
	3.5 Water Quality	3-3
	3.6 Ecology	3-3
	3.7 Heritage	3-3
4	NOISE	4-1
	4.1 Legislation and Guidelines	4-1
	4.2 Selected Sensitive Receivers	4-3
	4.3 Construction Noise Assessment	4-4
	4.4 Operational Noise Assessment	4-19
5	AIR QUALITY	5-1
	5.1 Legislation and Guidelines	5-1
	5.2 Selected Sensitive Receivers	5-1
	5.3 Methodology	5-4
	5.4 Assumptions and Input Information	5-5
	5.5 Predicted Impacts	5-10
	5.6 Conclusions	5-14
6	WATER QUALITY	6-1
	6.1 Legislation and Guidelines	6-1
	6.2 Selected Sensitive Receivers	6-1
	6.3 Assumptions and Input Information	6-1
	6.4 Predicted Impacts	6-2
	6.5 Conclusions	6-7
7	ECOLOGY	7-1
	7.1 The Study Area	7-1
	7.2 Relevant Hong Kong Regulations	7-1
	7.3 Relevant International Conventions	7-2
	7.4 Agriculture & Fisheries Department Fish Pond Categories	7-3
	7.5 Vegetation	7-3
	7.6 Stream Ecology	7-7

7.7 Birds 7-7
7.8 Reptiles and Amphibians 7-18
7.9 Mammals 7-18
7.10 Summary of Impact Avoidance and Mitigation Measures 7-20
7.11 References 7-20

8 VISUAL AND LANDSCAPE IMPACT 8-1

9 WASTE MANAGEMENT 9-1
9.1 Legislation 9-1
9.2 Waste Generation and Handling During Construction Phase 9-2
9.3 Mitigation Measures and Recommendations 9-7

10 CONCLUSIONS 10-1

Appendices

Appendix A Environmental Section of Construction Requirements
Appendix B Location of Noise Sensitive Receivers
Appendix C Construction Noise Notional Source Distances and Coordinates
Appendix D Operational Noise Modelling Data
Appendix E Operational Noise Mitigation Option 4
Appendix F Calculation of Dust Emissions
Appendix G Predicted TSP Levels at Selected Receivers
Appendix H Predicted NO_2 Levels from Open Road Design at Selected Receivers
Appendix I Predicted NO_2 Levels (1.5 m above Ground) from Noise Mitigation Option 4 at Selected Receivers
Appendix J Predicted NO_2 Levels (3 m and 4 m above Ground) from Noise Mitigation Option 4 at Selected Receivers
Appendix K Predicted NO_2 Levels (5 m above Ground) from Noise Mitigation Option 4 at Selected Receivers
Appendix L Water Quality Testing Results
Appendix M Estimated Fish Pond Loss
Appendix N Selected Dutch Values for Assessing the Significance of Soil Contamination

List of Tables

Table 1.1	Recommendations of ACE EIA Sub-Committee on the PDS2EA	1-1
Table 3.1	Background noise measurements	3-2
Table 3.2	Air quality results for Yuen Long Kau Hui	3-2
Table 4.1	Hong Kong construction noise level limits	4-2
Table 4.2	Construction noise: permitted hours of operation for piling	4-2
Table 4.3	Hong Kong Planning Standards and Guidelines: road traffic noise	4-3
Table 4.4	Representative noise sensitive receivers	4-5
Table 4.5	Selected noise sensitive receivers, construction phase impacts	4-7
Table 4.6	GCL2 worst case earthworks PME deployment	4-9
Table 4.7	GCL4 worst case structural works PME deployment	4-11
Table 4.8	Worst case construction works affecting St. Joseph's Primary School (R1514) prior to relocation	4-12
Table 4.9	Summary of normal operational on-times for different items of PME	4-12
Table 4.10	Summary of committed mitigation measures for earthworks	4-12
Table 4.11	Summary of committed mitigation measures for structural works	4-13
Table 4.12	Worst case facade construction noise levels at St Joseph's Primary School prior to relocation	4-13
Table 4.13	Worst case facade construction noise levels (earthworks) at sensitive receivers	4-14
Table 4.14	Worst case facade construction noise levels (structural) at sensitive receivers	4-16
Table 4.15	Assumed prevailing morning peak hour traffic flows	4-20
Table 4.16	Predicted 2011 morning peak hour traffic flows	4-21
Table 4.17	Estimate of numbers of NSRs exposed to noise levels over the HKPSG criteria	4-28
Table 4.18	Estimated effectiveness of Mitigation scheme 4	4-29
Table 4.19	Summary of traffic noise modelling results	4-31
Table 5.1	Hong Kong Air Quality Objectives	5-1
Table 5.2	Selected representative air quality sensitive receivers	5-2
Table 5.3	Predicted dust emissions during construction	5-7
Table 5.4	Vehicle fleet composition and emission factors for year 2011 (AM peak hour)	5-8
Table 5.5	Tunnel emission rates for year 2011 (AM peak hour)	5-9
Table 5.6	Air quality sensitive receivers with the ten highest maximum 1-hour average TSP concentrations	5-11
Table 5.7	Selected air quality sensitive receivers with the ten highest maximum 1-hour average NO_2 concentrations	5-12
Table 5.8	Comparison of the top ten highest maximum 1-hour average NO_2 concentrations between the open road design and noise mitigation 4	5-14
Table 7.1	AFD categorization of fish ponds in Hong Kong	7-3
Table 7.2	Estimated loss of habitats (ha) in north study area	7-5
Table 7.3	Native plants recorded on the study area during 1993-1995 surveys which provide forage sources for birds and which are recommended for use in revegetation	7-6
Table 7.4	Birds recorded on the north study area during 26-27 May 1993 and October 1994 to May 1995	7-9
Table 7.5	Fish pond loss and reinstatement due to Route 3 north area works (areas in hectares)	7-12
Table 7.6	Disturbance indices for Deep Bay area egretries (ranked from least disturbance to greatest disturbance)	7-13
Table 9.1	Monthly rock and soft spoil generation rates	9-4

Table 9.2	Rock spoil utilisation	9-5
Table 9.3	Number of employees and refuse arisings at different work sites	9-6
Table 9.4	Generation of waste from structure and earthwork teams	9-6

List of Figures

Figure 2.1	Design Refinements	2-4
Figure 3.1	Heritage Sites Identified in the Northern Study Area	3-5
Figure 4.1	Selected Noise Sensitive Receivers (Au Tau Interchange)	4-35
Figure 4.2	Selected Noise Receivers (Main Cut to Au Tau)	4-36
Figure 4.3	Mitigation 4	4-37
Figure 4.4	Mitigation 5	4-38
Figure 4.5	Mitigation 6	4-39
Figure 5.1	Schematic Location Plan of Selected Air Quality Sensitive Receivers	5-15
Figure 5.2	1-Hour Average NO_2 Contour at 1.5 m Above Local Ground Level (Open Road Design) in Year 2002	5-16
Figure 5.3	1-Hour Average NO_2 Contour at 1.5 m Above Local Ground Level (Noise Mitigation 4) in Year 2002	5-17
Figure 5.4	1-Hour Average NO_2 Contour at 3 m Above Local Ground Level (Noise Mitigation 4) in Year 2002	5-18
Figure 5.5	1-Hour Average NO_2 Contour at 4 m Above Local Ground Level (Noise Mitigation 4) in Year 200	5-19
Figure 5.6	1-Hour Average NO_2 Contour at 5 m Above Local Ground Level (Noise Mitigation 4) in Year 2002	5-20
Figure 6.1	Water Sensitive Receivers	6-8
Figure 6.2	Existing Streams and Proposed Box Culverts at the Northern Section	6-9
Figure 6.3	Sampling Location for Pond Water Testing	6-10
Figure 6.4	Water Quality in Ponds to be Drained	6-11
Figure 7.1	Locations of Eroded Hillsides Available for Compensatory Planting	7-22
Figure 7.2	Locations of Ko Po Tseun and Tung Shing Lei Heronries	7-23
Figure 7.3	Ko Po Tseun Heronry Location in Relation to Route 3 Works	7-24
Figure 7.4	Tung Shing Lei Heronry Location in Relation to Route 3 Works	7-25
Figure 7.5	Pond Restoration at Au Tau Interchange Showing Proposed Stream Configuration	7-26
Figure 7.6	Pond Restoration at Au Tau Interchange Showing Proposed Stormwater Flow	7-27

1 INTRODUCTION

1 INTRODUCTION

1.1 Background

The new Hong Kong International Airport at Chek Lap Kok on the north coast of Lantau Island is scheduled to commence operations in 1997. To serve the new airport as well as the proposed container terminals 10 and 11 (also located on Lantau Island), extensive infrastructure and transport links are required.

Route 3 Tai Lam Tunnel and Yuen Long Approach (R3 TLT & YLA) is an integral part of this supporting transport network, extending from Ting Kau to Au Tau, including the Northern Link (Au Tau Interchange to Yuen Long) and the connection to the New Territories Circular Road (NTCR).

An Environmental Assessment (EA) study for the R3 TLT & YLA (including the conveyor system under a separate cover) Preliminary Design Stage 2 (PDS2) was undertaken by Freeman Fox Maunsell for Highways Department according to a brief provided by the Environmental Protection Department (EPD). This study, hereafter referred to as the PDS2EA, was completed in March 1994, conditionally recommended for endorsement by the Advisory Council on the Environment (ACE) EIA Subcommittee on 5 July 1994 and was subsequently endorsed by the full ACE committee, subject to the conditions given in Table 1.1.

This project is now being undertaken by a franchisee, Route 3 (CPS) Company Limited, that has delegated responsibilities for design and construction to the Route 3 Contractors Consortium (R3CC). A set of Construction Requirements are given in Appendix 5 part I of the Project Agreement, including requirements for a Detailed Environmental Impact Assessment (DEIA) for aspects which were not covered adequately by the PDS2EA or had considerable design changes. The environmental sections of these Construction Requirements are included in Appendix A.

Table 1.1 Recommendations of ACE EIA Sub-Committee on the PDS2EA

Recommendation	Status and Commentary
Additional ecological survey to cover four seasons before commencement of work.	Supplementary surveys were carried out from late August, 1994 through January 1995 by Highways Department. R3CC continued and completed the fourth season of this survey in May 1995. The report has been submitted to ACE's EIA Subcommittee in September 1995.
Off-site compensatory planting at a ratio of no less than 3:1	R3CC will undertake the compensatory planting in areas as indicated in Figure 7.1 of this DEIA
The final EIA to be submitted to ACE for consultation.	The final DEIA for the Southern Section was endorsed by ACE in September 1995. This final DEIA for the Northern Section will be submitted to ACE for consultation.
Off-site restoration of wetland.	Highways Department believes that off-site restoration of wetland is not viable for this project. R3CC, however, will reinstate areas of ponds within the work site which are not required as part of construction, operation and maintenance of the permanent works.

This DEIA fulfills the requirements of the assessment for the Northern Section of R3 TLT & YLA extending from the Kam Sheung Access Road to the Au Tau Interchange and Yuen Long Approach.

The environmental impacts associated with the southern section of the project have been evaluated in the Southern Section DEIA and submitted under separate cover. It was presented to ACE's EIA Subcommittee in September 1995.

Two documents have also been presented to ACE by R3CC. The first was an Information Paper on the environmental impacts of the preliminary works taking place in the first 6 months of the project. This was endorsed by the ACE. The second covered the environmental impacts of the conveyor system. This was also endorsed. Neither of these papers relates to activities in the Northern Section.

1.2 Construction Requirements

These requirements are reproduced in Appendix A.

1.2.1 Key Issues

Key issues which must be taken into account in monitoring and/or mitigating environmental impacts identified in clause 10.2 of the requirements are as follows:

- associated fixed noise sources of constructed facilities;
- traffic noise;
- effect on air quality, particularly along Yuen Long Approach, at the portals and ventilation exhaust points of Tai Lam Tunnel and inside the tunnel;
- visual impact, and landscaping and environmental reprovisioning;
- ecological and heritage impact;
- water quality impact;
- disposal of soil, construction waste and unsuitable material;
- traffic impact to existing roads during construction;
- construction noise, dust and vibration.

These issues are covered by this DEIA, with the exception of (1) the impact of traffic flows on the local highway network, which is not an environmental issue and is covered by the traffic consultant, (2) air quality at the tunnel portals which has been addressed in the Southern Section DEIA and (3) air quality in the tunnel, which is being covered by the ventilation designers.

1.2.2 Ecology

Four ecological issues are highlighted by the requirements, as follows:

- Clause 10.3.2 - determine the area, species and precise location of woodlands affected by the execution of the works;
- Clause 10.1.6 - complete the four-season ecological survey already partially completed by Government and prepare a report identifying the need and measures to be taken to mitigate the impact of the constructed facilities on the ecology;
- Clause 9.3.2 - for fish ponds within the works area but not required for construction of works, maintain the ponds during construction and return the ponds to their

original condition including the quality of water;
- Clause 9.3.3 - for fish ponds affected by the temporary works, but not required in the long term, determine suitable enhancements to improve their ecological value.

1.2.3 Environmental Monitoring and Audit

Detailed requirements for environmental monitoring and audit (EM&A) are outlined in clauses 10.4-10.10.

1.3 Scope of Work

It has been agreed that EPD's standard scope of work will be employed for this project as far as is appropriate in relation to the evaluation of environmental impacts related to changes between the preliminary design and the final design. It should also be noted that Clause 10.1.2 indicates that "existing buildings and buildings to be built in the future for which proposals have been submitted and agreed by the Government" are to be considered in the DEIA. This report is prepared in accordance with these requirements.

1.4 Project Area

For the purpose of addressing environmental matters associated with the R3 TLT & YLA, the project is divided into a Southern Section and a Northern Section. This report is the DEIA for the Northern Section of the Route 3 TLT & YLA north of the Kam Sheung Access Road to the Yeun Long Southern Bypass.

1.5 Report Structure

This report is presented in 2 volumes, as follows:

Volume 1 DEIA for the Northern Section
Volume 2 EM&A Manual for the Northern Section

Volume 1 consists of 10 sections, as follows:

1) Introduction;
2) Project Description;
3) Existing Environment (including Heritage);
4) Noise;
5) Air Quality;
6) Water Quality;
7) Ecology;
8) Visual and Landscape Impact;
9) Waste Management; and
10) Conclusions.

Volume 2 is a stand-alone document.

2 PROJECT DESCRIPTION

2 PROJECT DESCRIPTION

2.1 Background

The R3 TLT & YLA comprises the section of Route 3 from Tuen Mun Road in the south to Au Tau (near Yuen Long) in the north, where it will connect with the New Territories Circular Road and the Yuen Long Southern Bypass. It will provide a direct link connecting the North West New Territories and border crossing at Lok Ma Chau through to Tsuen Wan, Kwai Chung, Lantau, the West Kowloon Corridor and Hong Kong Island.

The R3 TLT & YLA provides a fully graded separated dual 3-lane highway 12 km long. This includes the 6.3 km elevated stretches of Yuen Long Approach Road and the 3.8 km Tai Lam Tunnel.

The Tai Lam Tunnel consists of two separate 3-lane road tunnels and central ventilation tunnels from the portals to the quarter points of the road tunnels. Ventilation plant buildings will be located at both portal areas.

There will be a 22-lane Toll Plaza and an Administration Building, accommodating the Central Monitoring and (Traffic) Control System, situated 1.5 km north of the North Portal of the Tai Lam Tunnel. An additional satellite control station will be located in the South Portal area.

At the Toll Plaza, sliproads will be provided to connect the main roadway to Kam Sheung Road situated to the east. The approach roadworks at the south connect to the northern end of the Ting Kau Bridge and Tuen Mun Road.

The Yuen Long Approach road will take the alignment from the Toll Plaza, north to northeast, to Kam Tin. Link roads connect the alignment to the existing Kam Tin Road near the villages of Ko Po San Tsuen and Ko Po Tsuen. The Yuen Long Approach road then bridges Kam Tin Road and Castle Peak Road prior to the Au Tau Interchange. From the Au Tau Interchange the alignment connects to the Yuen Long Southern Bypass and to the New Territories Circular Road to the north.

Route 3 (CPS) Company Limited has been selected as Franchisee for the Build, Operate and Transfer (BOT) Contract for the R3 TLT & YLA. Acting on behalf of the Franchisee a Joint Venture of Dragages and Nishimatsu, the Route 3 Contractors Consortium (R3CC), will undertake design and construction of the R3 TLT & YLA.

A Joint Venture of Maunsell Consultants Asia Ltd. and Scott Wilson Kirkpatrick (MSWJV) have been appointed by R3CC to undertake all aspects of design including the requirement for a Detailed Environmental Impact Assessment (Detailed EIA).

2.2 Design

An implicit component of the DEIA is to establish the changes between the Franchisee's detailed designs compared with the Preliminary Design. This is broken down into different subsections, which are addressed below:

Environmental assumptions:
No changes to the environmental assumptions have been made.

Engineering assumptions:
Figure 2.1 shows the refinements made to the design of the road. Briefly, these can be summarised as follows:

- The Toll Plaza layout has been modified to move the toll booths slightly south. This will result in less fill.
- South of the Au Tau Interchange, Link Road J has been reduced in length. This will result in more cut and less fill.
- At the Au Tau Interchange the alignment has been revised. This will result in less land take and wetland loss. In addition, roads on the edges of the interchange have been put onto low embankments.

Traffic assumptions:
The traffic load has been modified in the detailed design. As an indication of the magnitude of differences, PDS2EA assumed a two-way tunnel traffic of 8,090 vehicles, of which 80% were heavy vehicles; the present design assumes a two-way tunnel flow of 7,820 vehicles and 64% heavy vehicles. There are 3.3% reduction in total flow and 23% reduction in heavy vehicles. Such differences could be attributed to different assumptions about 'local' and 'cross border' traffic and differences in classifying the medium and heavy vehicle categories between the PDS2EA and the traffic study for this project.

The traffic consultant has undertaken a detailed review of the likely traffic volumes and vehicle mix on the Route 3 Country Park Section. The review of the vehicle mix was described in the Traffic Study Report. In summary, the predicted vehicle mix was based on the analyses of (1) the existing vehicle mixes on Tolo Highway and Tuen Mun Road and (2) the current vehicle mix of the cross border traffic. Cross border and local traffic were predicted for the Route 3 Country Park Section, and different vehicle categories including container vehicles were estimated.

The revised vehicle mix and forecasts used in this DEIA are therefore based on a thorough review of the existing vehicle mixes on the main corridor of demand, and reflect the likely proportion of 'local' and 'cross border' traffic utilising the Route 3 Country Park Section. These are in line with the latest figures from the Transport Department.

Identification of sensitive receivers:
A detailed survey was conducted to identify the potential sensitive receivers for detailed assessment of the air and noise impacts. Isolated receivers, other than the village clusters identified during the PDS2EA, were located. These isolated receivers are nearer to the site and are adopted in this DEIA. This survey fulfills the requirements of the ACE's EIA Subcommittee and the suggestions in the PDS2EA which states :

> "In order to obtain the precise number of NSRs affected, it would be necessary to conduct a very detailed site survey (including achieving access to all the properties to determine their nature and status) at the detailed design stage taking into account the final alignment and its land take requirements."

2.3 Northern Section

The Northern Section study area is shown in Figure 2.1. Works in the Northern Section will be carried out by Gammon Construction Ltd (GCL). Major activities include:

- Site formation, drainage and landscaping works.
- Earthworks for batter and embankment formation.
- Structural works for the culverts and all the bridges along the alignment.
- All roadworks.

Figure 2.1 Design Refinements

3 EXISTING ENVIRONMENT

3 EXISTING ENVIRONMENT

3.1 Sensitive Receivers

A detailed sensitive receiver survey has been carried out to determine the locations of sensitive receivers within 300 m of the road alignment. The results of this survey for the Northern Section are included in the EM&A Manual in Volume 2 of this report. The survey did not reveal any additional clusters of sensitive receivers that had not been identified in the PDS2EA. The isolated receivers in small houses, whose existence were noted in the PDS2EA, have now been clearly located and identified.

The site area of the Northern Section (north of the Kam Sheung Access Road) of R3 TLT & YLA lies within the catchment area of Kam Tin River which drains much of the area of East Yuen Long into Inner Deep Bay. The tributaries and streams within the Kam Tin catchment will be affected by the Route 3 project at both construction and operation stages. There are fish and duck ponds in the low lying region of the Yuen Long flood plain along and near the proposed road alignment. Some of these ponds will be backfilled permanently to form the site for the construction project, while some will be reinstated after project completion (refer to Chapter 7).

Specific sensitive receivers for the Northern Section of the PDS2EA report are summarized as follows:

- fish and duck farming, and agriculture in Kam Tin River Valley;
- users of the Country Park to the south of the section;
- scattered grave and ruin sites along the proposed alignment;
- Small Traders New Village west-north-west of Au Tau;
- Kam Tin River;
- Pok Oi Hospital between Sz Tsz Uk and Small Traders New Village.

3.2 Cumulative Impacts

All the impact evaluations take account of other projects in the area, where information has been made available on the environmental impact of those projects in time for incorporation into this report. The known project in the vicinity is the Kam Tin Drainage Protection Works, but the EIA for this project has not been made available to the consultants.

For the operational phase cumulative impact assessments for air quality and noise have been achieved by modelling the larger road network taking into account the predicted traffic growth. For the construction phase, a realistic background dust concentration was used for cumulative dust impact assessment. Cumulative construction noise impact was not done because the control of construction noise is based on specific noise sources, such as construction traffic noise or operational noise from fixed construction equipment, and not on the combination of noise from all sources.

3.3 Noise

A survey of background noise in the area was carried out for the PDS2EA in June 1993. Results are summarised in Table 3.1.

Table 3.1 Background noise measurements

Location	Monitored Facade Noise Level dB(A)	
	Morning Peak Hour Level	Minimum Daytime Level
	L_{10} (1 hr)	L_{eq} (1 hr)
Sha Po Tsuen	66	61
Ko Po Tsuen	77	72
Kong Tau	55	51

NOTE: From Table 5.1 in *Route 3 Preliminary Design Stage 2: Environmental Assessment Technical Report.* Noise measurements taken at upper storey facades. Morning peak hour around 09.00 hrs; daytime noise levels monitored from 07.00 to 19.00 hrs.

Sha Po Tsuen has some exposure to traffic on Castle Peak Road -- Tam Mei, which lies about 400 m west of the village. Future noise levels may increase if the railway reserve that runs about 250 m west of the village is utilised.

Ko Po Tsuen lies adjacent to Kam Tin Road, and is well exposed to noise from traffic.

Kong Tau is well removed from existing major roads, but will be close to the completed Yuen Long Southern Bypass. The future noise environment at this specific location is likely to be different.

3.4 Air Quality

Air quality results for Yuen Long Kau Hui were quoted in the PDS2EA. These are given in Table 3.2. It should be noted that these results are from 1992 and that the location is close to the Yuen Long Industrial Estate, and therefore these levels can only be indicative of potential levels in the area.

Table 3.2 Air quality results for Yuen Long Kau Hui

Parameter	Concentration ($\mu g\ m^{-3}$)	
	Mean	Max. 24 hour average
Nitrogen Dioxide (NO_2)	38	52
Total Suspended Particulates (TSP)	71	103
Respirable Suspended Particulates (RSP)	57	82

3.5 Water Quality

The Kam Tin River has one of the larger catchment areas in the Yuen Long locality and the river water quality is monitored regularly by EPD. The relevant monitoring station for the Northern Section is station KT1 near Kat Hing Wai. The river water quality of the Kam Tin River is in general ranked as "very bad", with measured average dissolved oxygen (DO) level of 1.1 mg l^{-1} and biochemical oxygen demand (BOD) of 42 mg l^{-1} in 1993. The suspended solids (SS) concentration and ammonia nitrogen content were also high. The major source of pollutant rendering the water quality "very bad" was livestock waste.

Recent field measurement carried out in April 1995 showed that there was no improvement in the river water quality. Instead, deterioration was observed. Measured DO levels were as low as 0.8 mg l^{-1} while the BOD was very high, 820 mg l^{-1}. Suspended solids was 380 mg l^{-1}. Recent measurements (see Section 6) during the wet season (July 1995) showed low DO (0.4 mg l^{-1}) and high *E. coli* counts (3.7×10^6 cfu per 100 ml), but comparatively low BOD (9 mg l^{-1}) and SS (5 mg l^{-1}) concentrations.

3.6 Ecology

Preliminary ecological surveys for the environmental impact assessment (EIA) of the Route 3 highway project were conducted from March to June 1993 (Freeman Fox Maunsell 1993a, 1993b). A supplementary ecological survey to cover autumn and winter seasons was carried out from August 1994 through January 1995 (Freeman Fox Maunsell 1995) at the request of ACE. Impact assessments made subsequent to these surveys were based on preliminary alignments and designs provided by Highways Department in 1993. A final survey was undertaken during Spring 1995 and the results have been reported separately. The ecology of the existing environment is described in Section 7 of this report and is based on information collected up till May 1995.

The purpose of this DEIA is to address contractor revisions of the preliminary Highway Department designs and describe potential impacts due to those revisions. Key ecological issues were identified in previous reports, and included:

- loss of woodlands and woodland restoration measures
- loss of wetlands and wetland restoration measures, particularly for fish ponds affected by temporary works
- indirect impacts on colonial nesting and roosting sites for egrets and herons
- recommendations for ecological impact avoidance and mitigation

Ecological assessment in this report was based on the highway alignment, designs and information provided by R3CC in February-May 1995.

3.7 Heritage

The Antiquities and Monuments Office (AMO) of the Recreation and Culture Branch was consulted on heritage issues. Only three items of historical interest were identified in the Northern Section, as follows:

i) grave of Tang Wai-kap (T68);
ii) grave of Tang Kun (T72); and
iii) Poon Uk Hakka Mansion (T174).

The locations of these sites are shown on Figure 3.1. These sites were previously identified in the PDS2EA and were not considered to be adversely affected by the works. Design changes at Au Tau mean that the alignment is now either a similar distance or further from these locations. The findings of the PDS2EA are therefore reinforced.

Figure 3.1 Heritage Sites Identified in the Northern Study Area

Figure 3.1 Heritage Sites Identified in the Northern Study Area

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

4 NOISE

4 NOISE

4.1 Legislation and Guidelines

4.1.1 Introduction

The Noise Control Ordinance (NCO) defines construction and fixed noise limits. Non-statutory criteria, such as the Hong Kong Planning Standards and Guidelines (HKPSG) and the eligibility criteria relating to the ExCo directive, *Equitable Redress for Persons Exposed to Increased Noise Resulting from the Use of New Roads,* are relevant to the assessment of traffic noise impacts.

4.1.2 Noise Assessment (Construction Noise)

The NCO provides for the control of construction noise. Assessment procedures and standards are set out in two Technical Memoranda (TM) associated with the Ordinance: the *Technical Memorandum on Noise from Construction Work other than Percussive Piling* and the *Technical Memorandum on Noise from Percussive Piling.*

Under the existing provisions, there is no legal restriction on noise generated by construction activities (other than percussive piling) between the hours of 07.00 and 19.00 on normal weekdays. However, EPD's *Practice Note for Professional Persons PN 2/93* sets a non-statutory daytime noise limit of 75 dB(A) $L_{eq\ (30\ min)}$ at the facades of dwellings, and 70 dB(A) at the facades of schools (65 dB(A) during examinations).

For activities outside the hours of 07.00 to 19.00, as well as for percussive piling, the NCO applies and contractors are required to obtain a Construction Noise Permit (CNP) from the Noise Control Authority. CNPs are issued at the discretion of the Noise Control Authority, and conditions attached to such CNPs must be strictly complied with. Applicable noise limits depend on the Area Sensitivity Rating (ASR) of the area in which the activity takes place. The ASR is itself a function of the type of area, and the degree to which it is influenced by noise sources such as major roads and industry. The areas under consideration in the present assessment can be characterised as:

- ASR "A": rural, village, or low density residential areas not affected by noise from major roads or industry;
- ASR "B": rural, village, or low density residential areas in which noise from major roads is noticeable, but is not a dominant feature;
- ASR "C": urban area.

The applicable acceptable noise limits for evening, night-time and holiday works are shown in Table 4.1.

In addition, the NCO requires that hand-held percussive breakers over 10 kg and air compressors bear Noise Emission Labels, certifying that they comply with noise emission standards.

Percussive piling is subject to noise control in the daytime, and is prohibited between 19.00 and 07.00 on normal weekdays and all day on public holidays (including Sunday). Permitted hours of piling depend on the noise levels as received at the worst-affected noise sensitive receivers (NSR). The Acceptable Noise Level (ANL) for piling at these

NSRs is 85 dB(A), based on the assumption that the NSRs have windows and no central air conditioning. The permitted hours of piling are shown in Table 4.2. CNPs are required.

Table 4.1 Hong Kong construction noise level limits

Time Period	Acceptable Noise Level L_{eq} (dB(A)) at Facade of nearest NSR[3]		
	ASR = A	ASR = B	ASR = C
All days during the evening (1900 to 2300 hours) and general holidays during the daytime and evening (0700 to 2300 hours)[1]	60	65	70
All days during the night-time (2300 to 0700 hours)[1]	45	50	55
Non-holiday daytime (0700 to 1900 hours)[2]	75	75	75

NOTES: [1] From the NCO *Technical Memorandum on Noise from Construction Work other than Percussive Piling.*
[2] From EPD guidelines concerning daytime construction noise levels.
[3] Does not apply to noise from percussive piling.

Table 4.2 Construction noise: permitted hours of operation for piling

Amount by which noise from piling exceeds the ANL	Permitted hours of operation on any day not being a general holiday
More than 10 dB(A)	08.00 - 09.00 and 12.30 - 13.30 and 17.00 - 18.00
1 to 10 dB(A)	08.00 - 09.30 and 12.00 - 14.00 and 16.30 - 18.00
No exceedance	07.00 - 19.00

4.1.3 Noise Assessment (Operational Noise)

The HKPSG recommends that road traffic noise does not exceed the standards in Table 4.3. In accordance with the ExCo directive, *Equitable Redress for Persons Exposed to Increased Noise Resulting from the Use of New Roads,* equitable redress in the form of direct technical remedies must be provided to satisfy the noise limits contained in the HKPSG as far as practicable. Indirect technical remedies can only be provided to tackle the residual noise impact after all direct technical remedies are exhausted, subject to meeting the following eligibility criteria:

- the predicted overall noise level from the new or improved road, together with other trafffic noise in the vicinity, must be above the HKPSG criteria;

- the predicted noise level is at least 1.0 dB(A) more than the prevailing noise level, i.e., the total traffic noise level existing before the works to construct the road were commenced; and

- the contribution to the increase in the noise level from the new or improved road must be at least 1.0 dB(A).

It should be noted that the provision of indirect technical remedies for non-institutional buildings must be approved by ExCo.

Table 4.3 Hong Kong Planning Standards and Guidelines: road traffic noise

Use	Road Traffic Noise dB(A)
Domestic premises	70
Offices	70
Educational institutions including kindergartens and nurseries	65
Hospitals, clinics, convalescences and homes for the aged	55

Notes: ☐ The above standards apply to uses which rely on opened windows for ventilation.
☐ Facade noise levels in terms of L_{10} (peak hour)

Indirect technical remedies will take the form of acoustic insulation of the affected NSR. For this purpose, the HKPSG recommends an openable well-gasketted window with a 6 mm pane where road traffic noise exceeds the HKPSG standard by less than 10 dB(A). Where the road traffic noise exceedance is between 10 and 15 dB(A), the HKPSG recommends installation of an openable double-glazed window with a configuration of 6 mm/150 mm/6 mm (exterior glaze, air gap, interior glaze) in well-gasketted separate frames. Ventilation, usually in the form of air conditioning, must be provided.

4.2 Selected Sensitive Receivers

4.2.1 Existing Sensitive Receivers

A comprehensive survey was conducted to inventory sensitive receivers along the Route 3 alignment. Results of the survey are provided in the EM&A Manual for the Northern Section (Volume 2). From the results of this survey, noise sensitive receivers were selected in accordance with the definitions given in the HKPSG, which regards domestic premises, offices, educational institutions, and places of public worship as sensitive as long as they rely on opened windows for ventilation.

The PDS2EA stated that much of the development within the area consists of low-grade structures at which the installation of noise mitigation measures may be inappropriate. The NSR survey conducted for the present study confirms this finding. However, the HKPSG cites "temporary housing accommodation" as a noise sensitive use, and does not distinguish NSRs at which the installation of indirect technical remedies is inappropriate.

4.2.2 Sensitive Receivers for Noise Assessments

Representative NSRs selected for operational noise assessment were all residential properties currently in existence, with the exception of NSRs R350 (Pok Oi Hospital) and R1540 (St Joseph's School). After consultation with the Lands Office, it appears that there are no committed and approved developments and landuses that would be affected by Route 3. Representative NSRs were chosen to represent clusters of NSRs for which roadside barriers will be necessary. Some of the NSRs shown as representative receivers will be resumed prior to operation of Route 3, but are close or adjacent to NSRs that will remain in the operational phase and thus have representative value.

The choice of representative NSRs for the construction and operation phases depends on the mitigation strategy to be adopted. Since construction noise is to be mitigated by a combination of distance attenuation and sound power level reduction, the NSRs closest to the construction works were chosen. If mitigation is found to work at these NSRs, it will be expected to work at more distant NSRs. Since operational traffic noise is to be mitigated through the use of barriers, a geographically wider selection of NSRs was required. This is because the effectiveness of barriers varies greatly with geographical distance, barrier height, and relative source-receiver heights. Thus, NSRs further from Route 3 could be exposed to higher noise levels than closer NSRs, depending on relative elevations. Consequently, representatives of all major NSR groups were selected for the operational noise assessment.

Baseline noise measurements have been undertaken and will be provided in the Baseline Monitoring Report.

Representative receivers are summarized in Tables 4.4 and 4.5, and their locations are shown in Appendix B. The locations of the representative receivers in relation to the alignment of the route are illustrated schematically in Figures 4.1 and 4.2. The readers should refer to the survey maps in the appendix of the EM&A Manual for their exact locations relative to Route 3.

4.3 Construction Noise Assessment

4.3.1 Construction Noise Methodology

The methodology outlined in the *TM on Noise from Construction Works other than Percussive Piling* was used for the assessment of construction noise. The portions of the site closest to the representative NSRs were chosen as the notional source positions. All items of powered mechanical equipment (PME) were assumed to be located at these notional source positions unless otherwise stated. Where the actual measured sound power levels (SWL) of PME to be employed was not available, values were taken from Table 3 of the *TM*. However, British Standard BS5228 was used as a source of SWL in place of the *TM* where more specific information was required, for example, in the case of vibratory pokers.

Table 4.4 Representative noise sensitive receivers: operation phase impacts

NSR ID[1]	Characteristics		
	Storeys	Construction	Location
R 10	2	concrete	north of Au Tau Interchange
R 21	1	metal sheet and brick	north of Au Tau Interchange
R 73	1	metal sheet	north of Au Tau Interchange
R 79	1	metal sheet	north of Au Tau Interchange
R 93	1	uncertain	northeast of Shan Pin Tsuen
R 103	1	metal sheet	northeast of Shan Pin Tsuen
R 121	2	metal sheet	northeast of Shan Pin Tsuen
R 132 (PDS2 NSR R36)	2	metal sheet	northeast of Shan Pin Tsuen
R 148	2	metal sheet and concrete	Tung Shing Lei
R 163	1	metal sheet	Tung Shing Lei
R 174 (PDS2 NSR R33)	2	concrete	Tung Shing Lei
R 198	1	metal sheet	Tung Shing Lei
R 214 (PDS2 NSR R1)	1	concrete	Tung Shing Lei
R 247 (PDS2 NSR R17)	1	uncertain	Temple, Tung Shing Lei
R 258 (PDS2 NSR R13)	1	metal sheet	Tung Shing Lei
R 261	1	metal sheet and wood	Tung Shing Lei
R 281 (PDS2 NSR R5)	2	concrete	Tung Shing Lei
R 299	2	brick	west of Tung Shing Lei
R 338	3	concrete	southwest of Tung Shing Lei
R 350	8	concrete	Pok Oi Hospital
R 356 (PDS2 NSR R6)	1	brick	east of Pok Oi Hospital
R 373 (PDS2 NSR R7)	2	concrete	Small Traders New Village
R 382 (PDS2 NSR R8)	2	concrete	Small Traders New Village
R 402 (PDS2 NSR R11)	3	concrete	Tai Wai Tsuen
R 568	3	concrete	Wong Uk Tsuen
R 578 (PDS2 NSR R10)	3	concrete	Wong Uk Tsuen
R 585 (PDS2 NSR R9)	3	concrete	Wong Uk Tsuen
R 621	3	concrete	east of Wong Uk Tsuen
R 630 (PDS2 NSR R12)	1	metal sheet	N of Small Traders New Village
R 725	1	metal sheet and wood	northeast of Shan Ping Tsuen
R 733 (PDS2 NSR R37)	2	metal sheet and wood	east of Shan Ping Tsuen
R 740 (PDS2 NSR R38)	1	metal sheet and wood	east of Shan Ping Tsuen
R 766	2	brick/concrete	Fung Kat Heung

Note: [1] Corresponding NSR designation from PDS2EA provided where appropriate.

Table 4.4 (continued)

NSR ID[1]	Characteristics		
	No. of Storeys	Construction	Location
R 799	2	brick	Fung Kat Heung
R 832	3	concrete	southwest of Fung Kat Heung
R 896	1	concrete	northeast of Au Tau Roundabout
R 912 (PDS2 NSR R29/30)	1	concrete	east of Au Tau Roundabout
R 952	2	wood	north of Ha Ko Po Tsuen
R 981	3	concrete	Ha Ko Po Tsuen
R 1003	2	concrete	Ha Ko Po Tsuen
R 1026	3	concrete	north of Ha Ko Po Tsuen
R 1057	3	concrete	west of Ha Ko Po Tsuen
R 1107 (PDS2 NSR R20)	3	concrete	Ko Po Tsuen
R 1124	3	concrete	northwest of Ko Po San Tsuen
R 1149 (PDS2 NSR R28)	3	concrete	northwest of Ko Po San Tsuen
R 1174	1	metal sheet and concrete	north of Ko Po San Tsuen
R 1246	2	concrete	east of Ko Po San Tsuen
R 1293	1	wood	Ko Po San Tsuen
R 1319 (PDS2 NSR R42)	1	metal sheet	Ko Po San Tsuen
R 1374 (PDS2 NSR R27)	1	metal sheet	Ko Po San Tsuen
R 1383	1	metal sheet	Ko Po San Tsuen
R 1400	2	metal sheet and wood	Ko Po San Tsuen
R 1431	1	metal sheet and wood	east of Ko Po San Tsuen
R 1439	2	concrete	east of Ko Po San Tsuen
R 1469	1	concrete	Ko Po San Tsuen
R 1514	1	uncertain	St Joseph's School, Ko Po San Tsuen
R 1524	1	concrete and metal sheet	southeast of Ko Po Tsuen
R 1589	1	concrete	south of Kam Tin
R 2039	1	concrete	southwest of Kam Tin
R 2066	3	concrete	south of Kam Tin
R 2074	1	metal sheet and wood	southwest of Kam Tin
R 2168	2	concrete	south of Kam Tin
R 2194	1	metal sheet	south of Kam Tin
R 2215	1	concrete	south of Kam Tin

Note: [1] Corresponding NSR designation from PDS2EA provided where appropriate.

Table 4.5 Selected noise sensitive receivers, construction phase impacts

NSR ID[1]	Characteristics		
	No. of Storeys	Distance (m) to closest notional noise source	Location
R 90	2	81	East of Sha Po Tsuen
R 171	1	15	North East of Small Trades New Village
R 242	1	162	East of Small Traders New Village
R 350	8	93	Pok Oi Hospital
R 382	2	16	Small Traders New Village
R 587	3	19	West of Small Traders New Village
R 615D	3	19	North West of Small Traders New Village
R 742	1	33	North East of Small Traders New Village
R 1441	2	43	East of Ko Po San Tsuen
R 1512	1	51	South East of Ko Po San Tsuen
R1514[2]	1	47	South East of Ko Po San Tsuen
R 2155 (PDS2 NSR2)	1	94	Vicinity of Yuen Kong San Tsuen
R 2182	1	26	Vicinity of Yuen Kong San Tsuen

Note:: 1 Corresponding NSR designation from PDS2EA provided where appropriate.
2 Sensitive receiver only until relocation in July 1996

Construction noise levels were assessed at 13 representative NSRs along the length of the Northern Section of the alignment. One of these NSRs (R2155) was the receiver designated 'NSR 2' in the PDS2EA and was included for comparative purposes. R2155 is a residential building located approximately 1,200 m to the north of the Toll Plaza, near Yuen Kong San Tsuen. St Joseph's Primary School (R1514) located south east of Ko Po San Tsuen has been assessed on the basis of worst case construction activities scheduled prior to its relocation in July 1996.

4.3.2 Construction Noise Assumptions and Input Information

R3CC is committed to achieving construction noise levels within the 75 dB(A) non-statutory day time limit at NSRs in all cases where at all practical. The aim of the construction noise assessment was therefore to meet this objective.

The construction noise scenarios examined were based upon a prior analysis of the various construction operations. These are divided into two principal elements: earthworks and structural works.

Earthworks involve heavy plant intensive operations for excavation and embankment formation activities. This is a linear activity. For example, embankment construction will involve the progress of a spatially separated group of PME along the alignment. As the plant progresses fill will be deposited, spread and then compacted, until the required height is attained. Typically, each layer of fill will be between 400-500 mm in depth. However, the layering process will not be a continuous one; the installation of each individual layer of fill will take between one and two days, typically with a rest of approximately ten days until the next layer is laid down.

Structural works entail the construction of bridges, culverts, permanent operational phase noise barriers etc. These activities take place at specific fixed locations. For operational reasons earthworks and structural works will not take place concurrently at the same locations. For example, culverts will generally be constructed ahead of earthworks so as to allow prior diversion of streams. Bridge structures will require works areas adjacent to them for storage of reinforcement and bridge deck units, access for concrete, areas for formwork and offices for staff. Such requirements therefore preclude the simultaneous undertaking of major earthworks and structural works. The construction of permanent operational phase noise barriers will not entail the use of any PME in addition to that already listed in the tables below.

All construction activities to the north of the Toll Plaza area were included in the assessment in order to address cumulative noise impacts at the NSRs. Construction activities to the south of the Toll Plaza were considered too distant to exert any influence on cumulative construction noise impacts at NSRs in the Northern Section.

The worst case SWL experienced at a given NSR was calculated as the cumulative result of worst case construction activities assigned to specific alignment sections or areas.

The measurement of daytime construction noise is conducted over a 30 minute period. It should be noted that in reality it is uncommon for PME to operate for 100% of this measurement period under normal operational conditions. Consequently an attenuation in the SWL may be made. For example, since an excavator is normally operational for only 70% of the 30 minute measurement period, an attenuation in the SWL of 1.7 dB(A) is achievable (BS 5228: Part 1: 1984, Section A.3.4., Figure 4).

Consideration was also given to all other current or proposed construction activities under way which may have caused further cumulative impacts. None was considered to contribute any additional impact at representative receivers to the north of the Toll Plaza area on the basis of available information.

Construction Noise Mitigation Measures

Where required, physical mitigation measures such as the use of temporary acoustic screens at the NSR will be employed, provided it is practical to do so. Earth embankments may be used to screen specific receivers. These temporary acoustic barriers will be positioned to screen sensitive facades. These barriers must be absorptive, having a noise reduction capability of up to 10 dB(A) and must have no gaps. Barrier material should have a mass per unit surface area in excess of 7 kg/m^2. Earth embankments will satisfy these criteria. Any earth embankments used will be covered or hydro-seeded in such a way that dust generation is reduced as far is practically possible. Some sound will pass around the ends of a short barrier. To minimise this occurrence, the length of the barrier should be about five times its height, or the barrier should be curved around the noise source. The minimum height of the barrier should be such that no part of the noise source is visible from the NSR (BS 5228: Part 1: 1984, Appendix D4 & Table 15).

Construction Activities North of the Toll Plaza

To the north of the Toll Plaza Gammon Construction Limited (GCL) will be the only contractor operating. However, GCL is subdivided into two groups: GCL2 will conduct earthworks and GCL4 will conduct structural works. As previously stated, these two tasks will not run concurrently near NSRs. PME deployment for worst case construction activities affecting NSRs due to GCL2 and GCL4 works are provided in Tables 4.6 and 4.7 respectively. Worst case construction activities affecting St Joseph's Primary School prior to its relocation in July 1996 are presented in Table 4.8. These tables describe details of the normal operational spacing of PME items, and also the normal operational on-times used in the assessment calculations. These details represent normal operating practice and therefore should not be regarded as mitigation measures. Table 4.9 summarises these normal operating times for different items of PME. The tables represent worst case numbers of PME to be used between the specified chainages and sites. This assessment assumed all tasks associated with structural works to operate concurrently. Same assumption was applied to all tasks associated with earthworks.

Table 4.6 GCL2 worst case earthworks PME deployment

Item	No.	SWL per Item, dB(A)	Screening, dB(A)	% on-time & dB(A) reduction	Source
Chainages 280-680					
Excavator	1	112	0	70%, -1.7	CNP 081
Water pump, petrol	1	103	-10	100%, 0	CNP 282
Loader	1	112	0	70%, -1.7	CNP 081
Roller	1	108	0	60%, -2.3	CNP 186
Lorry (*a*)	3	112	0	6%, -12 (*b*)	CNP 141
Chainage 680 - various Link Roads					
Excavator (*c*)	2	112	0	70%, -1.7	CNP 081
Water pump, petrol	1	103	-10	100%, 0	CNP 282
Loader (*d*)	1	112	0	70%, -1.7	CNP 081
Bulldozer (*e*)	1	115	0	80%, -1	CNP 030
Dump truck (*a*)	1	117	0	6%, -12 (*b*)	CNP 067
Lorry[1]	2	112	0	6%, -12 (*b*)	CNP 141
Chainage 1212 - Link Roads G and H					
Excavator	2	112	0	70%, -1.7	CNP 081
Water pump, petrol	1	103	-10	100%, 0	CNP 282
Roller	2	108	0	60%, -2.3	CNP 186
Loader	1	112	0	70%, -1.7	CNP 081
Bulldozer	1	115	0	80%, -1	CNP 030
Dump truck	1	117	0	6%, -12 (*b*)	CNP 067
Lorry	2	112	0	6%, -12 (*b*)	CNP 141

Notes:
- *a* Haul traffic will operate along centre of alignment only
- *b* On-time dB(A) reduction in accordance with BS5228: Part 1: 1984: A.3.4 Mobile Plant
- *c* Excavators separated by 40 m
- *d* Loader separated from excavator by 40 m
- *e* Bulldozer separated from excavator by 40 m
- *f* Roller separated from excavator by 80 m
- *g* Mounted breaker sited at least 550 m from nearest NSR

Table 4.6 (Continued)

Item	No.	SWL per Item, dB(A)	Screening, dB(A)	% on-time & dB(A) reduction	Source
Cutting operations on Link Road F					
Mounted breaker	1	122	0	50%, -3	CNP 027
Rock drill, crawler mounted	1	128	0	40%, -4	CNP 181
Chainages 2159 - 2925					
Excavator	2	112	0	70%, -1.7	CNP 081
Water pump, petrol	2	103	0	100%, 0	CNP 282
Roller	1	108	0	60%, -2.3	CNP 186
Loader	1	112	0	70%, -1.7	CNP 081
Bulldozer	1	115	0	80%, -1	CNP 030
Dump truck	1	117	0	6%, -12 (*b*)	CNP 067
Lorry	4	112	0	6%, -12 (*b*)	CNP 141
Chainages 2440 - 2925					
Dump truck	2	117	0	6%, -12 (*b*)	CNP 067
Chainages 2925 - 3425					
Roller	2	108	0	60%, -2.3	CNP 186
Chainages 3425 - 3750					
Excavator	1	112	0	70%, -1.7	CNP 081
Loader (*d*)	1	112	0	70%, -1.7	CNP 081
Water pump, petrol	1	103	-10	100%, 0	CNP 282
Lorry (*a*)	2	112	0	6%, -12 (*b*)	CNP 141
Chainages 3750-4150					
Loader	2	112	0	70%, -1.7	CNP 081
Lorry (*a*)	2	112	0	6%, -12 (*b*)	CNP 141
Chainages 4150 - 4800					
Excavator	1	112	0	70%, -1.7	CNP 081
Bulldozer (*e*)	1	115	0	80%, -1	CNP 030
Water pump, petrol	1	103	-10	100%, 0	CNP 282
Roller (*f*)	1	108	0	60%, -2.3	CNP 186
Dump truck (*a*)	1	117	0	6%, -12 (*b*)	CNP 067
Lorry (*a*)	2	112	0	6%, -12 (*b*)	CNP 141
Chainages 4800 - 5600					
Excavator	4	112	0	70%, -1.7	CNP 081
Bulldozer (*e*)	2	115	0	80%, -1	CNP 030
Rock drill, crawler mounted	2	128	0	40%, -4	CNP 181
Loader (*d*)	2	112	0	70%, -1.7	CNP 081
Crane, crawler mounted	2	112	0	60%, -2.3	CNP 048
Mounted breaker (*g*)	1	122	0	50%, -3	CNP 027
Dump truck (*a*)	2	117	0	6%, -12 (*b*)	CNP 067
Lorry (*a*)	9	112	0	6%, -12 (*b*)	CNP 141

Notes:
- *a* Haul traffic will operate along centre of alignment only
- *b* On-time dB(A) reduction in accordance with BS5228: Part 1: 1984: A.3.4 Mobile Plant
- *c* Excavators separated by 40 m
- *d* Loader separated from excavator by 40 m
- *e* Bulldozer separated from excavator by 40 m
- *f* Roller separated from excavator by 80 m
- *g* Mounted breaker sited at least 550 m from nearest NSR

Table 4.7 GCL4 worst case structural works PME deployment

Item	No.	SWL per Item, dB(A)	Screening, dB(A)	% on-time & dB(A) reduction	Source
Bridges 1 a, G and H					
Bored piler, oscillatory (*a*)	4	115	0	80%, -1	CNP 165
Mobile crane	2	112	0	80%, -1	CNP 048
Launching gantry	1	100	0	100%, 0	Estimate (*c*)
Generator	1	100	0	100%, 0	CNP 102
Hand held breaker	2	111	-10 (*b*)	100%, 0	R3CC (*d*)
Compressor, silenced	2	100	0	100%, 0	CNP 002
Bridges 1b and F					
Bored piler, oscillatory (*a*)	1	115	0	80%, -1	CNP 165
Mobile crane	1	112	0	80%, -1	CNP 048
Generator	1	100	0	100%, 0	CNP 102
Hand held breaker	2	111	0	100%, 0	R3CC (*d*)
Compressor, silenced	1	100	0	100%, 0	CNP 002
Bridges 2 and 8					
Bored piler, oscillatory (*a*)	1	115	0	80%, -1	CNP 165
Mobile crane	1	112	0	80%, -1	CNP 048
Generator	1	100	0	100%, 0	CNP 102
Hand held breaker	1	111	0	100%, 0	R3CC (*d*)
Compressor, silenced	1	100	0	100%, 0	CNP 002
Bridge 3					
Bored piler, oscillatory (*a*)	1	115	0	80%, -1	CNP 165
Mobile crane	1	112	0	80%, -1	CNP 048
Generator	1	100	0	100%, 0	CNP 102
Bridge 4					
Bored piler, oscillatory (*a*)	1	115	0	80%, -1	CNP 165
Mobile crane	1	112	0	80%, -1	CNP 048
Generator	1	100	0	100%, 0	CNP 102
Hand held breaker	1	111	-10 (*e*)	100%, 0	R3CC (*d*)
Compressor, silenced	1	100	0	100%, 0	CNP 002
Bridges 5 and 7					
Mobile crane	1	112	0	80%, -1	CNP 048
Generator	1	100	0	100%, 0	CNP 102
Hand held breaker	1	111	0	100%, 0	R3CC (*d*)
Compressor, silenced	1	100	0	100%, 0	CNP 002
Toll Plaza Administration Building					
Hand held breaker	1	111	0	100%, 0	R3CC (*d*)
Compressor, silenced	1	100	0	100%, 0	CNP 002
Concrete batching plant	1	108	0	100%, 0	CNP 022
Beam Casting Yard #1					
Tower crane	3	95	0	100%, 0	CNP 049
Vibratory poker	2	98	0	100%, 0	BS5228 (*f*)
Bar bender/cutter	2	90	0	100%, 0	CNP 021
Beam Casting Yard #2					
Tower crane	3	95	0	100%, 0	CNP 049
Vibratory poker	2	98	0	100%, 0	BS5228 (*f*)
Bridge E					
Bored piler, oscillatory (*a*)	1	115	0	80%, -1	CNP 165
Mobile crane	1	112	0	80%, -1	CNP 048
Launching gantry	1	100	0	100%, 0	Estimate (*c*)
Generator	1	100	0	100%, 0	CNP 102
Hand held breaker	2	111	-10 (*b*)	100%, 0	R3CC (*d*)
Compressor, silenced	2	100	0	100%, 0	CNP 002

Notes:
- *a* Bored piling will not run concurrently with other activities
- *b* Mitigation required only within 100 m of R171
- *c* Not provided for in the *Technical Memorandum*
- *d* Based on Noise Emission Label
- *e* Mitigation required only within 60 m of R1512
- *f* BS 5228, Table 9, Item 40

Table 4.8 Worst case construction works affecting St. Joseph's Primary School (R1514) prior to relocation

Item	Number	SWL per item, dB(A)	Screening, dB(A)	% on-time & dB(A) reduction	Source
Lorry	6	112	0	6%, -12[1]	CNP 141

Note: 1 On-time calculated in accordance with BS5228: Part 1: 1984: A.3.4 *Mobile Plant*

Table 4.9 Summary of normal operational on-times for different items of PME

Item of PME	Percentage Normal Operational On-time in each 30-min period	Allowable Equivalent Reduction in SWL, dB(A)[1]
Excavator	70	1.7
Mounted breaker	50	3
Bulldozer	80	1
Rock drill, crawler mounted	40	4
Loader	70	1.7
Crane, crawler mounted	60	2.3
Roller	60	2.3

Note: 1 In accordance with BS 5228, Section A.3.3

Table 4.10 provides summarised details of committed mitigation measures required for earthworks. Table 4.11 provides summarised details of committed mitigation measures required for structural works.

Table 4.10 Summary of committed mitigation measures for earthworks

Area of Action	R3CC Committed Mitigation
Chainages 280 - 680	• haul traffic is confined to the centre of the alignment • water pumps are acoustically screened
CH680 - Various Link Roads	• haul traffic is confined to the centre of the alignment • water pumps are acoustically screened
CH4150 - 4800	• water pumps are acoustically screened
NSRs; R171, R1441, R1512, R2182	• Acoustic barrier provided at NSR to screen line of sight of construction activities, subject to agreement with occupants

Table 4.11 Summary of committed mitigation measures for structural works

R3CC Committed Mitigation
• Bored piling is not undertaken concurrently with other structural operations at the construction site nearest to the NSR[1]
• Hand held breakers used within 100 m of R171 are acoustically screened at source[2]
• Hand held breakers used within 60 m of R1512 are acoustically screened at source[2]

Note: 1 Mitigation only required for R90, R171, R1441 & R1512 if NSR not already screened
2 Mitigation only required if NSR not already screened

4.3.3 Construction Noise Predicted Impacts

Table 4.12 shows the worst facade noise level at St. Joseph's Primary School prior to its relocation in July 1996. The worst case facade noise levels experienced at representative receivers have been calculated and are presented in Table 4.13 for earthwork construction noise, and in Table 4.14 for structural construction noise. Appendix C presents the details of the distances and coordinates from each NSR to each notional noise source for both structural and earthworks.

Table 4.12 Worst case facade construction noise levels at St Joseph's Primary School prior to relocation

Distance to Haul Route (m)	dB(A), $Leq_{(30\ min)}$
47	69.3

Note: Non-statutory daytime limit at schools is 70 dB(A)

4.3.4 Construction Phase Conclusions

Based on worst case scenarios, the construction noise assessment has indicated that exceedances of the 75 dB(A) non-statutory daytime limit are expected to occur at NSRs R171, R382, R587, R615D, R742, R1441, R1512 and R2182. Compliance with the 75 dB(A) limit is expected at all other receivers. These findings are consistent with those of the PDS2EA, which predicted that "...dwellings adjacent to works boundaries, such as at the Small Traders New Village..., would be expected to experience noise levels exceeding acceptable limits" (ref. PDS2EA Section 18.2.5). Both the preceding and present assessments find that construction noise limits are exceeded in the area of the Small Traders New Village because the constrained alignment results in very short source-receiver distances during the construction phase. Exceedances of the 75 dB(A) daytime noise limits at the Small Traders New Village area are anticipated to occur for about 30 days over a 9-month period while formation of embankments is undertaken.

Table 4.13 Worst case facade construction noise levels (earthworks) at sensitive receivers

Area of Operation	NSR and Parameter											
	R90		R171		R242		R350		R382		R587	
	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)
CH1212 - Links G,H	227	63.3	704	53.5	830	52.1	1270	48.4	1162	49.2	1231	48.6
CH2159 - 2925	605	54.9	248	62.7	274	61.8	821	52.3	812	52.4	892	51.6
CH2440 - 2925	695	43.2	339	49.4	300	50.5	835	41.6	846	41.5	925	40.7
CH280 - 680	895	47.2	530	51.6	530	51.6	93	65.5	16	79.0	19	77.6
CH680 - various links	531	55.0	15	80.3	162	64.3	255	60.9	78	69.5	140	65.4
CH2925 - 3425	1178	39.3	788	42.8	687	44.0	1074	40.1	1160	39.4	1229	38.9
CH3425 - 3750	1637	41.5	1292	43.5	1193	44.2	1542	42.0	1648	41.4	1713	41.1
CH3750 - 4150	1994	39.7	1674	41.2	1577	41.7	1916	40.0	2028	39.6	2092	39.3
CH4150 - 4800	2387	40.9	2077	42.1	1979	42.6	2303	41.3	2422	40.8	2483	40.6
CH4800 - 5600	3041	50.9	2712	51.9	2607	52.2	2883	51.4	3017	51.0	3073	50.8
Cutting at Link F	643	60.6	N/A	N/A	N/A	N/A	770	59.1	770	59.1	850	58.3
Total cumulative impact, dB(A) Includes +3 dB(A) facade correction	69.2		83.4		69.9		70.8		82.5		80.9	

Note: N/A - Not Applicable as not in line of sight

Table 4.13 (Continued)

Area of Operation	NSR and Parameter											
	R615D		R742		R1441		R1512		R2155		R2182	
	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)
CH1212-Links G,H	1143	49.3	933	51.1	1868	45.0	1972	44.6	2597	42.2	2699	41.8
CH2159-2925	840	52.1	690	53.8	852	52.0	905	51.4	1537	46.8	1655	46.2
CH2440-2925	881	41.1	746	42.6	852	41.4	905	40.9	1537	36.3	1655	35.6
CH280-680	19	77.6	186	60.1	1974	40.5	2008	40.4	2616	38.1	2740	37.7
CH680-various links	65	70.8	33	75.1	1520	46.2	1587	45.8	2223	42.9	2339	42.5
CH2925-3425	1216	39.0	1142	39.6	380	49.1	424	48.2	1059	40.2	1176	39.3
CH3425-3750	1709	41.1	1646	41.4	120	64.2	154	62.0	791	47.8	903	46.6
CH3750-4150	2090	39.3	2030	39.5	43	73.0	51	71.5	294	56.3	385	54.0
CH4150-4800	2486	40.6	2431	40.8	493	54.6	428	55.8	94	68.8	26	79.9
CH4800-5600	3084	50.8	3048	50.9	1146	59.3	1061	59.9	425	67.7	312	63.3[1]
Cutting at Link F	802	58.8	663	60.4	1259	55.0	1327	54.5	1963	51.2	2079	50.7
Total cumulative impact, dB(A) Includes +3 dB(A) facade correction	81.5		78.4		76.9		75.5		74.5		83.0	

Note: 1 Assessment excludes rock drills and mounted breakers, which will not be in the line of sight of R2182

Table 4.14 Worst case facade construction noise levels (structural) at sensitive receivers

Area of Operation	NSR and Parameter											
	R90		R171		R242		R350		R382		R587	
	Distance(m)	dB(A)	Distance(m)	dB(A)	Distance(m)	dB(A)	Distance(m)	dB(A)	Distance(m)	dB(A)	Distance(m)	dB(A
Bridge 8	4325	37.2	3911	38.1	3784	38.4	3915	38.1	4080	37.7	4118	37.6
Toll Plaza admin. building	3932	31.5	3530	32.4	3407	32.7	3565	32.3	3725	31.9	3767	31.8
Bridge 7	3878	35.1	3491	36.0	3371	36.3	3552	35.8	3709	35.4	3753	35.3
Toll Plaza batching plant	3865	28.3	3487	29.2	3369	29.4	3562	29.0	3716	28.6	3762	28.5
Bridge 5	4065	34.7	3716	35.4	3604	35.7	3830	35.2	3978	34.8	4027	34.7
Bridge 1b & F	668	54.2	294	61.4	260	62.4	799	52.7	805	52.6	885	51.8
Bridge 2	1141	48.8	749	52.4	649	53.7	1042	49.6	1125	48.9	1195	48.4
Bridge 3	1521	45.2	1166	47.5	1066	48.3	1419	45.8	1522	45.2	1588	44.8
Bridge 4	1836	44.7	1504	46.4	1406	47.0	1746	45.1	1856	44.6	1921	44.3
Beam casting yard #1	252	47.8	605	40.2	720	38.7	1195	34.3	1106	34.9	1179	34.4
Beam casting yard #2	1771	26.8	1438	28.6	1340	29.2	1685	27.2	1793	26.7	1858	26.4
Bridge 1a, G & H	81[1] 106[2]	71.2* 71.5#	282[3]	65.7	382[3]	63.1	888[3]	55.8	827[3]	56.4	906[3]	55.6
Bridge E	439	58.0	78	67.0* 68.2#	218	64.1	591	55.4	505	56.8	582	55.5
Worst case total cumulative impact, dB(A) Includes +3dB(A) facade correction	74.8		73.8		71.3		63.4		64.0		63.1	

Note: Mitigation only required for R90 and R171
1 Distance to notional source for activities excluding bored piling
2 Distance to actual source of piling activities
3 Notional source assumed for all activities
* Nearest structural construction site to NSR - impacts excluding bored piling
\# Nearest structural construction site to NSR - impacts from bored piling only

Table 4.14 (Continued)

Area of Operation	NSR and Parameter											
	R615D		R742		R1441		R1512		R2155		R2182	
	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)	Distance (m)	dB(A)
Bridge 8	4155	37.6	4174	37.5	2491	42.0	2372	42.4	1789	44.9	1721	45.2
Toll Plaza admin. building	3799	31.7	3808	31.7	2084	37.0	1967	37.5	1378	40.5	1309	41.0
Bridge 7	3782	35.3	3782	35.3	2011	40.8	1901	41.3	1293	44.6	1214	45.1
Toll Plaza batching plant	3789	28.4	3785	28.4	1989	34.0	1882	34.5	1265	38.0	1180	38.6
Bridge 5	4049	34.7	4032	34.7	2172	40.1	2079	40.5	1444	43.6	1340	44.3
Bridge 1b & F	839	52.3	702	53.8	1118	49.8	1184	49.3	1820	45.5	1936	45.0
Bridge 2	1181	48.5	1104	49.1	556	55.0	601	54.4	1233	48.1	1351	47.3
Bridge 3	1582	44.9	1518	45.2	318	58.8	361	57.7	996	48.9	1112	47.9
Bridge 4	1919	44.3	1859	44.5	62	70.5* 70.2#	53	69.5* 71.5#	611	54.2	721	52.8
Beam casting yard #1	1096	35.0	890	36.8	1722	31.1	1824	30.6	2451	28.0	2554	27.7
Beam casting yard #2	1855	26.4	1793	26.7	179	46.7	217	45.0	854	33.2	969	32.0
Bridge 1a, G & H	835	56.3	646	58.5	1554	50.9	1638	50.4	2274	47.6	2385	47.2
Bridge E	508	56.7	321	60.7	1219	49.1	1297	48.6	1934	45.1	2047	44.6
Worst case total cumulative impact, dB(A) Includes +3 dB(A) facade correction	63.8		66.6		74.0		74.9		61.0		60.3	

Note: Mitigation only required for R1441 and R1512
* Nearest structural construction site to NSR - impacts excluding bored piling
\# Nearest structural construction site to NSR - impacts from bored piling only

Since R3CC is committed to providing mitigation where at all practical, acoustic screens in the form of earth embankments will be provided at NSRs R171, R1441, R1512 and R2182, in agreement with the residents concerned, in order to shield them from the line of sight of construction activities. These acoustic screens will be constructed to the specification described previously, and will therefore be capable of reducing the noise levels experienced at these NSRs by 10 dB(A). Noise levels at each of these NSRs will therefore be mitigated to below 75 dB(A) and may therefore be regarded as acceptable.

However, in the area of the Small Traders New Village, the proximity of the buildings does not permit the construction of earth bunds. R3CC undertakes to provide the following as mitigation measures:

- Construct 2.4 m high hoardings on both sides of the expressway in the area in order to screen preparatory work.
- Construct retaining walls R10 and R11 prior to construction of the main embankment levels.
- Construct temporary noise barriers on top of retaining walls R10 and R11 during the upper embnakment construction.

The above measures are not expected to prevent all exceedances of the 75 dB(A) daytime target level. Some exceedances will still occur during the preparatory works, prior to completion of the retaining walls, and during embankment construction. The short source-receiver distance makes such exceedances inevitable. However, the exceedances will be for limited periods, and the above measures will mitigate their duration and frequency.

For daytime activities, the noise levels at NSRs will be confirmed in practice by a rigorous EM&A programme. For restricted hours activity, CNPs are required. In the application for these permits, R3CC will demonstrate compliance with statutory limits. R3CC will also adhere to CNP conditions. Operations requiring a CNP will also be subject to the EM&A programme.

The following provides a list of impact mitigation measures to be considered for adoption should construction noise monitoring detect any exceedance of the daytime non-statutory limit. R3CC is committed to implementing the construction noise mitigation measures identified in this DEIA. R3CC will make reference to EPD's *Recommended Pollution Control Clauses for Construction Contracts* and *Practice Note for Professional Persons (ProPECC PN 2/93)* to implement noise control measures wherever practicable.

Immediate Response

(a) Noisy equipment and activities to be sited by R3CC as far from sensitive receivers as is practical.

(b) Noisy plant or processes to be replaced by quieter alternatives where possible. For example, pneumatic concrete breakers can be silenced with mufflers and bit dampers. If appropriate, a concrete cruncher (hydraulically-powered jaws) may be used; the cruncher emits a sound power level about 20 dB(A) lower than that of an electric breaker. Silenced diesel and gasoline generators and power units, as well as silenced and super-silenced air compressors, can be readily obtained. Manual operations are

generally quietest, but may require long periods of time. The power units of non-electric stationary plant and earth-moving plant can be quietened by vibration isolation and partial or full acoustic enclosures for individual noise-generating components.

(c) Intermittent noisy activities to be scheduled to minimise exposure of nearby NSRs to high levels of construction noise. For example, noisy activities can be scheduled for midday, or at times coinciding with periods of high background noise (such as during peak traffic hours). Prolonged operation of noisy equipment close to dwellings will be avoided.

(d) Idle equipment to be turned off or throttled down. Noisy equipment to be properly maintained and used no more often than is necessary.

(e) Construction activities can be planned so that parallel operation of several sets of equipment close to a given receiver is avoided.

(f) If possible, reduce the numbers of operating items of powered mechanical equipment.

(g) Construction plant to be properly maintained and operated. Construction equipment often has silencing measures built in or added on, e.g., bulldozer silencers, compressor panels, and mufflers. Silencing measures should be properly maintained and utilised.

Screening of Fixed PME

Should further mitigation measures prove necessary to achieve compliance, the next course of action will be the installation of mobile noise barriers around fixed items of PME. Effective barriers are typically lined on the noise-generating side with a noise-absorbing material. Assuming that the barrier has no gaps, and that it blocks the line of sight between noise generator and receiver, reductions of 5 to 10 dB(A) can be achieved.

Early Implementation of Indirect Technical Remedies

NSRs identified as eligible for indirect technical remedies (in the form of appropriate glazing and air conditioning) due to anticipated operational phase impacts may be provided with these remedies during the construction phase.

4.4 Operational Noise Assessment

4.4.1 Operational Noise Methodology

Operational noise was predicted using the methodology provided in the UK DOT *Calculation of Road Traffic Noise (CRTN)*, 1988, and was based on projected worst case morning peak-hour flows in the year 2011. Facade noise levels at 64 representative receivers were assessed in terms of L_{10}(1 hr) dB(A).

Since most of the receivers were influenced by both new roads (Route 3 TLT & YLA) and old/existing roads (Castle Peak Road and Kam Tin Road), the methodology worked out the contributions from individual road links. The contribution from Route 3 and its slip roads and the contribution from roads other than Route 3 are presented separately to allow the review of the eligibility criteria relating to the ExCo directive mentioned above

in section 4.1.2.

4.4.2 Operational Noise Assumptions and Input Information

Existing Peak Traffic Flows

The existing traffic flows are based on 1993 peak hour traffic volumes reported in the Annual Traffic Census and on estimation and recent measurement of traffic flow at the Au Tau Interchange. The assessment was based on the predicted morning peak hour flows as shown in Table 4.15.

Table 4.15 Assumed prevailing morning peak hour traffic flows

Road Section	Two-way peak hour flows	
	Veh/hour	% heavy
Castle Peak Road (Yuen Long)	3370	44%
Castle Peak Road (NTCR)	2620	38%
Castle Peak Road (Tam Mi) (main road and service road)	2240	41%
Kam Tin Road (east of Au Tau)	1100	36%
Kam Sheung Road	400	36%

Future 2011 Peak Hour Traffic Flows

The traffic noise assessment was based on predicted 2011 morning peak hour design traffic flows reported in the Traffic Design Report submitted by the transport consultant to Highways Department in May 1995, and approved for the noise assessment by Highways Department and Transport Department in June 1995. In addition, flows on some local roads were predicted by the transport consultant.

The predicted vehicle mix was based on the analyses of the existing vehicle mixes on Tolo Highway and Tuen Mun Road, and the current vehicle mix of cross border traffic. Predictions of cross border and "local" traffic were made for Route 3 CPS, and an estimation was made of the different vehicle categories (including container vehicles). The resultant vehicle mix and traffic flows were used for this assessment.

The Route 3 and local road flows are summarised in Table 4.16, and are shown graphically in an excerpt from the traffic study in Figure D-1 (Appendix D).

Link Roads P and Q are local link roads and are not expected to accommodate significant traffic flows.

Table 4.16 Predicted 2011 morning peak hour traffic flows

2011 Morning Peak Hour Traffic							
Road	Flow (veh/hr) and proportion of heavy vehicles			Road	Flow (veh/hr) and proportion of heavy vehicles		
Route 3 north of Au Tau I'change	N/b	3260	64%	Kam Tin Road east of Link Roads I & J	E/b	800	69%
	S/b	2930	64%		W/b	800	69%
Link G	S/b	1480	64%	Link H near Small Traders New Village	N/b	3840	64%
Link H north of Links E and F	N/b	1740	64%		S/b	3440	64%
Route 3 south of Links G and H	N/b	1520	64%	Link Road I	S/b	360	64%
	S/b	1450	64%	Link Road J	N/b	440	64%
Castle Peak Road (Tam Mi)	N/b	1300	54%	Kam Tin Road west of Link Roads I & J	E/b	750	67%
	S/b	1550	61%		W/b	800	66%
Link E	S/b	2100	64%	Route 3 south of Links E and F	N/b	3480	64%
Link F	N/b	1960	64%		S/b	3550	64%
Castle Peak Road (Yuen Long) west of Au Tau Bypass	E/b	2140	62%	Castle Peak Road (Yuen Long) east of Au Tau Bypass	E/b	1120	72%
	W/b	1990	68%		W/b	1440	71%
Au Tau Bypass south of Castle Peak Road	N/b	2610	64%	Route 3 south of Links I and J	N/b	3910	64%
	S/b	2610	64%		S/b	3910	64%
Link K	S/b	960	67%	Link L	N/b	1360	71%

These flows differ from the flows assumed in the PDS2EA Report, which may be found in Table A1 of the Northern Link Supplementary Paper issued as part of that study. In the PDS2EA report, figures from Transport Department were used, which were based on different assumptions about "local" and cross border traffic. In addition, there was some misclassification in the TD figures between the medium and heavy category. The revised vehicle mix and forecasts above are based on a thorough review of the existing vehicle mixes on the main corridor of demand, and reflect the likely proportion of "local" and cross border traffic on Route 3. As an indication of the magnitude of the differences in the traffic assumptions, the two-way tunnel traffic in the PDS2EA was assumed to be 8,090 vehicles, of which 80 percent were heavy vehicles; the assumptions on which the present study was based were a two-way tunnel flow of 7,820 vehicles and a proportion of 64 percent heavy vehicles.

On the new roads, assumed speeds are 100 kph (main line), 85 kph (link roads), and 70 kph (ramps). A speed of 70 kph has been assumed on existing roads.

The Route 3 main line will have two carriageways, each 7.3 m or 11 m wide, with a 1-m marginal strip and 3.3 m hard shoulders. The main line, links and ramps will be paved with friction course. A 0.8-m solid concrete parapet wall has been assumed at the sides

of all new bridge structures. All barriers were assumed to be located on the outer edge of the paved road shoulder.

Scenarios Modelled

Eight scenarios were studied to review the existing (1993) and the future (2011) traffic noise impact, and to compare the effectiveness of various mitigation measures. These are described as follows:

Scenario 1 - "*Existing*" represents the prevailing (1993) situation with Castle Peak Road and Kam Tin Road.

Scenario 2 - "*Basic Unmitigated*" represents the situation with no mitigation other than the use of friction course surfacing on the whole of the Route 3 main line and all its link roads, and 0.8 m parapets on bridges.

Scenario 3 - "*Mitigation 1*" represents the situation with 0.8 m roadside barriers as shown in Figures 4.1 to 4.2.

Scenario 4 - "*Mitigation 2*" represents the situation with 1.25 m roadside barriers as shown in Figures 4.1 to 4.2.

Scenario 5 - "*Mitigation 3*" represents the situation with 3 m roadside barriers as shown in Figures 4.1 to 4.2.

Scenario 6 - "*Mitigation 4*" is the proposed mitigation scheme based on engineering design constraints, and represents the situation in which roadside barriers with heights ranging from 0.8 m to 4 m were tested in order to refine the barrier design in line with the suggestions put forward by PDS2EA (Figure 4.3).

Scenario 7 - "*Mitigation 5*" represents the situation in which barrier heights of up to 5 m were tested (Figure 4.4). This is not a practicable scenario, and is included here only as an indication of the effectiveness of further mitigation measures.

Scenario 8 - "*Mitigation 6*" represents the situation in which enclosures were used in conjunction with barriers, in areas where barriers cannot effectively protect NSRs from excessive noise impacts (Figure 4.5). This is not a practicable scenario, and is included here only as an indication of the effectiveness of further mitigation measures.

4.4.3 Operational Noise Results

Operation phase traffic noise impacts are discussed in the following areas: existing (1993) situation, future (2011) situation and the assessment of various mitigation measures. The term "Route 3" as stated in the text followed generally represents the Route 3 TLT & YLA and all associated slip roads. "Roads other than Route 3" refers to Castle Peak Road and Kam Tin Road. Details of the noise calculation results are given in Appendix D. A brief summary of the results is given in Tables 4.17 to 4.19.

Existing (1993)

Castle Peak Road and Kam Tin Road are the existing major traffic noise contributors. Calculations of prevailing noise levels show that NSR facades facing Kam Tin Road or Castle Peak Road are currently exposed to peak hour traffic noise levels in exceedance of the HKPSG limit of 70 dB(A). However, a large number of NSRs in the study area are distant from these roads, or are shielded by topography or other structures, and are not currently exposed to traffic noise levels of over 70 dB(A).

Future (2011)

After the completion of Route 3, it is expected that Route 3 will generally become the dominant traffic noise source in the area; though roads other than Route 3 will continue to contribute to the overall traffic noise. To determine future traffic noise impacts, Route 3 (both the Northern and Southern Sections) and roads other than Route 3 were considered cumulatively.

Future (2011) - Roads other than Route 3

This refers to traffic noise from Castle Peak Road and Kam Tin Road in year 2011. Noise contributions at representative NSRs due to roads other than Route 3 were predicted to be generally below 70 dB(A) although there would be several exceedances. For a number of receivers, the noise levels from roads other than Route 3 would also be less than the corresponding predictions for the existing (1993) traffic scenario. This is due to barrier effect of Route 3 embankments.

Future (2011) - Route 3 Only

Traffic noise levels at representative NSRs are greater than 70 dB(A) in most cases.

Future (2011) - all Roads

Widespread exceedances of the HKPSG standard were observed at representative NSRs for the "Basic Unmitigated" scenario, assuming no mitigation measures other than friction course on Route 3 and 0.8-m concrete profile barriers on Route 3 bridges. Fourteen of the 64 representative receivers were within the HKPSG standard.

Exceedances were found at receivers located close to Route 3 and its link roads, and at elevations above that of Route 3. Exceedances were also attributable to traffic noise from Castle Peak Road and Kam Tin Road. Some receivers with elevations lower than the Route 3 alignment (for example R1174, R1383, R1374 and R2215) are shielded from direct exposure to traffic noise by the embankment.

Assessment of Mitigation Measures

Potential direct technical measures including barriers and enclosures were studied in the six mitigation scenarios modelled, representing increasing levels of mitigation. Barriers ranging from 0.8 m profile barriers to 5 m barriers were investigated. For situations in which 5 m barriers could not provide adequate protection, enclosures were tested. Where the proposed mitigation measures were ineffective in reducing the overall noise level at the receiver to within HKPSG standards, the direct mitigation of existing roads or indirect

mitigation at the receiver was recommended.

Results of all modelled scenarios are given in Appendix D. The results are presented in terms of the noise contributions from Route 3 and from roads other than Route 3. "Contribution from Route 3" includes all noise contributions from Route 3 and associated link roads; "contribution from roads other than Route 3" includes contributions from Castle Peak Road and Kam Tin Road. These two parameters are important when considering the source of the main noise contribution at receivers.

Mitigation schemes 1 to 6 represent the full range of mitigation packages to assess the overall effects without reference to practicability and engineering constraints. Mitigation schemes 5 (Figure 4.4) and 6 (Figure 4.5) represent the maximum extent of mitigation in the form of noise barriers and enclosures in an attempt to meet HKPSG criteria. These mitigation scenarios are investigative only, since they entail measures that have unacceptable engineering and cost implications. Even with this maximum extent of noise barriers and enclosures there remains a small number of receivers who are not adequately shielded.

Mitigation scheme 4 is the proposed scheme and is based on the barrier arrangement considered reasonably practicable given a variety of constraints as discussed under "*Optimizing mitigation design*" at the end of this section. The engineering design for Mitigation 4 is provided in Appendix E.

Mitigation scheme 4 assumed barriers along the proposed alignment for the Northern Section of Route 3, and 1 m continuous roadside barriers along Castle Peak Road and Kam Tin Road. It is understood that 1 m high profile barriers have been proposed for the upgrading of Kam Tin Road and Castle Peak Road. This assumption was considered realistic, and actual barrier height will be determined during the EIA assessment that will be carried out for both widening schemes. A cross-section of the proposed alignment for the improvements to Kam Tin Road is shown in Highways/NT Region Drawing No. NH 7121. The drawing provided an indication of the proposed configuration of the profile barriers/planter boxes within the highway boundary, and was used as the basis to model Mitigation Scheme 4 (assuming profile barriers/planter boxes to be equivalent to a 1-m barrier). The proposed new alignments were not modelled since no finalised layout plans were available at the time of this assessment. Mitigation 4 was formulated on the basis of the existing alignment along Kam Tim Road and Castle Peak Road. The modelled results give an estimation of the benefit of the improvement, though the modelling results for Mitigation 4 may be further refined when Kam Tin Road and Castle Peak Road improvements are finalised.

The effectiveness of mitigation measures for the representative noise sensitive receivers is examined in terms of four general areas (northern and northwestern Au Tau Interchange, and northern and southern Yuen Long Approach). Representative NSRs which have significant influences on the barrier arrangement are discussed.

1. *North Au Tau Interchange (Survey Sheets 1, 2 and 5)*

This area covers the Route 3 main line and Link Roads G and H from Tung Shing Lei north to where it merges with Castle Peak Road, north of the existing Sha Po roundabout. The area also includes the northernmost sections of Link Roads E and F before they merge with the main line to the southeast of Tung Shing Lei and Au Tau.

The Route 3 alignment in this area is complex, made up of a series of embankments and bridges. Castle Peak Road is a significant noise source and is dominant for several receivers.

- R10, R21, R73, R79, R93, R103, R163, and R198 are in general exposed to exceedances of the HKPSG standard of less than 3 dB(A). These exceedances can therefore be easily mitigated through the provision of 0.8 m profile barriers along the mainline and link roads, as assessed for Mitigation scheme 1.

- R103 is likely to be resumed as part of the proposed floodway project. As this receiver is the closest, of a cluster, to the alignment there is potential to modify the barrier arrangement in this area once the resumption details of the floodway project are known.

- R174 is strongly affected by Link Road F. A combination of 2 m, 3 m and 4 m barriers are required to reduce the noise levels to below 70 dB(A).

- R766, R799 and R832 is expected to experience noise levels of around 71-72 dB(A) from Castle Peak Road alone. Direct mitigation measures on Route 3 alone cannot reduce the overall noise levels to 70 dB(A). It would therefore be more appropriate to apply direct mitigation to Castle Peak Road, though constraints of the site boundary and the verge width make it impracticable for R3CC to provide these barriers.

2. *Northwest Au Tau Interchange (Survey Sheets 3, 4, 6 and 7)*

This area covers the main Route 3 alignment and Link Roads E, F, G and H from Tung Shing Lei east to where it joins Castle Peak Road and the Yuen Long Southern Bypass at Pok Oi Hospital. Castle Peak Road is a significant noise source that dominates at several receivers.

- 3 m barriers along both sides of the Route 3 link roads in the Au Tau area can provide effective mitigation for most of the low lying and distant receivers.

- Three-meter barriers do not provide sufficient protection to R148, R382, R578, R585 and R621, since these NSRs are either close to the link roads with heavy traffic or have facades with elevations higher than the road. Four-meter barriers are necessary for R148, R382, R578 and R585, but would not achieve HKPSG compliance at the top floor of R621. The situation at R621 is essentially similar to that at R1124 (detailed in the following section), except that the noise barrier is supported on a retaining wall rather than a slope. However, the situation with regard to wind loading is the same, and with a 3 m high barrier the overturning momentum on the wall will be approximately doubled. The ground in this location is the weakest anywhere on the site, and the walls are constrained by tight site boundaries and the requirement to fit in other features such as culverts. Consequently constructing large toes to the walls to resist overturning and keep bearing pressures down to reasonable levels is not possible. The wall design is being investigated in detail, and it is hoped that a 4-m barrier can be supported in order to limit the number of NSRs subject to more than 70 dB(A) on the upper floors to a minimum. If this is not possible, indirect technical remedies may be required at the upper floors of some NSRs.

R148 may be resumed at a later date as it lies between the proposed Western Corridor Railway and Route 3 alignments (affecting related fishponds and access). The extent of the 4 m barriers will be refined once the resumption details of the Western Corridor Railway are known.

- R281, R299, R356 and R373 are influenced by both Route 3 and Castle Peak Road. Three-meter and 4 m barriers along Route 3 will be required to bring down the overall noise level to HKPSG standards.

- For the year 2011, representative NSR R338 will be affected by noise of up to 77 dB(A) from Castle Peak Road. Since direct technical measures on Route 3 alone will not reduce overall noise levels at R338 to HKPSG standards, it is recommended that direct technical remedies are applied to Castle Peak Road as well. If this is not feasible, indirect technical remedies should be applied at the receiver.

- R350 (Pok Oi Hospital) is exposed to substantial traffic noise levels from Castle Peak Road of up to 72 dB(A) at southern facades, exceeding the HKPSG standard of 55 dB(A) for hospitals. Direct mitigation on Route 3 alone cannot bring down noise levels at the hospital to within the HKPSG limit. In addition to 4 m barriers on Route 3, indirect technical remedies applied to the appropriate affected sensitive facades will be required, in line with the initial findings of the PDS2EA. A detailed noise assessment for Pok Oi Hospital facades is included in Appendix D. If noise barriers along the future flyover connecting Route 3 with the Yuen Long Southern Bypass as assumed in the present study are not included or are altered, additional noise impacts would result at the southern facades of Pok Oi Hospital, and at residential facades near the hospital, in Wong Uk Tsuen and in Tai Wai Tsuen. With regard to the proposed flyover to be built by others, it is reasonable to expect that when the flyover is constructed, adequate mitigation measures will be adopted to ensure that unacceptable noise levels do not occur at nearby sensitive receivers as a result of noise emanating from the flyover. A 3-m barrer along the flyover has been assessed as providing suitable mitigation.

3. *North Yuen Long Approach (Survey Sheets 8 to 11)*

This area covers the main alignment from Bridges 1b and F (bridging Castle Peak Road) southeast to Bridge 2 (bridging Kam Tin Road) and then further southeast to Link Roads I and J. The alignment runs close to villages and residential clusters such as Ha Ko Po Tsuen, Ko Po San Tsuen and Ko Po Tsuen. Kam Tin Road is a significant noise source and is dominant for several receivers.

- Kam Tin Road passes through sensitive receiver areas, producing noise levels of over 70 dB(A) at representative receivers R896, R912, R981, R1003, R1026, R1057, R1107 and R1124. In such circumstances, direct technical mitigation measures on Route 3 roads alone cannot bring down noise levels to below 70 dB(A). It is recommended that either direct technical mitigation is applied to Kam Tin Road and Castle Peak Road in addition to the mitigation on Route 3, or indirect technical remedies in the form of acoustic insulation and air conditioning are applied at the receivers. R981 and R1003 are likely to be resumed by the Western Corridor Railway project. The future barrier arrangement will be refined once the resumption details of the proposed alignment are known.

- R1124 is predominantly affected by the noise contribution from Route 3, although the noise from roads other than Route 3 is in excess of 70 dB(A). Though a 5 m barrier would reduce traffic noise levels at all floors at this representative NSR, it would fail to reduce noise to HKPSG standards and is considered infeasible at this location. The barrier has to be located on the crest of a slope at the back edge of the verge (it has to be behind the safety fences, street lighting, fire hydrants, road drainage, etc.) where it has little support from the ground. In order to be feasible at all, the noise barriers are proposed to be on piled foundations with piles every 2 m. However, even the pile foundations will be very flexible because of the lack of support near the ground surface. Under wind loading it is predicted that the movement of the piles will be such that they could open up a longitudinal crack in the crest of the slope into which rain driven by the wind could penetrate. As a result, a maximum barrier height of 3 m is considered practicable in order to keep the movement of the piles within reasonable limits. The momentum generated by the wind forces is proportional to the square of the barrier height, and so a barrier of 5 m height would be subject to almost three times the overturning momentum on a 3 m barrier, resulting in unacceptable movements. Since a 5 m barrier is not practicable and 3 m is the maximum that can reasonably be provided, the optimum barrier arrangement was taken to be one which provided adequate protection for other NSRs while not subjecting R1124 to any more noise than a continuous 3 m barrier would do. It was found that, because the 3 m barrier is too low to have any significant effect on R1124, a further reduction in barrier height could be adopted which would improve the visual and structural aspects without causing any increase at all in the predicted noise level at R1124. Consequently, the barriers on Bridge 2, which would cause structural problems even if 3 m high, were reduced to 1.25 m, and indirect mitigation is recommended for R1124.

- R1439, at a relatively high elevation, requires a 3 m barrier along Link Road I and 2 m and 3 m barriers along the Route 3 main line. The 3 m barrier along the main line (with an extension) also provides shielding for R2039. R2039 lies within the proposed Western Corridor Railway alignment and is likely to be resumed as part of this project. Therefore there is potential to refine the barrier arrangement in this area once the resumption details of the proposed alignment are known.

- R1514, St. Joseph's School, will be relocated during the construction of Route 3 and is therefore not considered in this assessment.

4. *South Yuen Long Approach (Survey Sheets 12 to 19)*

This area covers the alignment from Link Roads I and J south to the Toll Plaza. The Route 3 main line is the only significant source of road traffic noise in this area. Approximately 600 m of the alignment to the north of the Toll Plaza lies within a cutting.

- Noise levels at most of the receivers in this area are below the HKPSG standard for the "Basic Unmitigated" scenario.

- Since the Route 3 alignment is elevated relative to most NSRs in this area, barriers are effective. A 1.25 m barrier on the western side of Route 3, as assessed for Mitigation scheme 2, can protect receiver R2168 such that the HKPSG standard is met.

Receivers and Dwellings Affected

Estimates of the potential number of sensitive receivers exposed to noise levels over 70 dB(A) for different scenarios are shown in Table 4.17. Greater detail on the effectiveness of Mitigation schemes is provided in Appendix D (spreadsheet series "NSRCOU").

For the existing situation, based on 1993 traffic flow data, it is estimated that about 28 sensitive structures will be exposed to noise levels in exceedance of the HKPSG guidelines. With the introduction of Route 3 with 0.8 m parapets on bridges only ("Basic Unmitigated" scenario), this number will increase to about 532 structures.

For Mitigation scheme 1 (0.8 m parapets on extensive stretches of Route 3, as shown Figures 4.1 to 4.3), the number of structures potentially affected falls to 467. Increasing the parapet height to 1.25 m in most places (Mitigation 2) as shown in Figures 4.1 to 4.3, the number of sensitive receivers affected is reduced to 406. The use of 3 m barriers (Mitigation 3), as shown in Figures 4.1 to 4.3, causes the number of affected units to drop further to about 171. With Mitigation scheme 4 (which includes 1 m roadside barriers along Castle Peak Road and Kam Tin Road), 121 structures are affected. Mitigation scheme 5 (barrier heights up to 5m) further reduces the number of structures affected to 102. The final scenario (Mitigation 6), which employs full enclosures on two sections in conjunction with noise barriers of heights of up to 5 m, leaves 78 structures exposed to exceedances of 70 dB(A). These dwellings are affected greatly by noise from existing roads.

Table 4.17 Estimate of numbers of NSRs exposed to noise levels over the HKPSG criteria

Scenario	Estimated Number of Structures[1] subject to Facade Noise Levels over 70 dB(A)	
	Estimated Number of Structures[2]	As Percent of Total Surveyed Structures
Existing (1993)	28	3%
Basic Unmitigated (2011)	532	70%
Mitigation 1	467	61%
Mitigation 2	406	53%
Mitigation 3	171	22%
Mitigation 4	121	16%
Mitigation 5	102	13%
Mitigation 6	78	10%

Notes: 1 NSR survey conducted in February 1995. 2154 potential structures within 300 m of the proposed Route 3 alignment were surveyed, of which 1909 actually existed. Of these 1909 existing structures, 765 were noise sensitive. The above numbers of affected structures were estimated, based on the use of representative receivers (see preceding table) to represent all receivers in the area.

2 Structures are residential dwellings, with the exception of R350, which is Pok Oi Hospital.

For a number of representative receivers, the use of direct technical remedies on Route 3 roads alone cannot reduce levels to HKPSG standards, due to the noise contribution from Castle Peak Road and/or Kam Tin Road. If additional direct technical measures cannot be applied to Castle Peak Road and Kam Tin Road, these receivers may require indirect technical remedies in the form of window improvements and provision of air-conditioners, in accordance with the ExCo directive on *'Equitable Redress for Persons Exposed to Increased Noise Resulting from the Use of New Roads,'* and subject to ExCo's approval. Representative receivers have been assessed against the eligibility criteria using data of the Basic Unmitigated and Mitigation scheme 4. Tabulated results are given in Appendix D, and a summary of the estimated effectiveness of mitigation schemes over all surveyed structures is provided in Table 4.18. Summary of modelling results is shown in Table 4.19.

Table 4.18 Estimated effectiveness of Mitigation scheme 4

Area[1]	Number of Surveyed Structures[2]		
	Exceeding HKPSG Standard		Eligible for Indirect Technical Remedies (Scheme 4)
	without mitigation	with mitigation	
Area 1	45	9	0
Area 2	319	46	23
Area 3	128	66	25
Area 4	40	0	0
Total	**532**	**121**	**48**

Notes: 1. Areas are as follows:
Area 1: North Au Tau Interchange (Survey Sheets 1, 2 and 5)
Area 2: Northwest Au Tau Interchange (Survey Sheets 3, 4, 6 and 7)
Area 3: North Yuen Long Approach (Survey Sheets 8 to 11)
Area 4: South Yuen Long Approach (Survey Sheets 12 to 19)
2. Structures are residential dwellings, with the exception of R350, which is Pok Oi Hospital.

Optimizing mitigation design

The previous sections give an account of mitigation measures necessary for meeting the HKPSG standard at noise sensitive receivers, based on environmental benefit. Mitigation schemes 1 to 3 indicate that barriers up to a height of 3 m on the Route 3 road alignment were not sufficient to protect sensitive receivers. Mitigation schemes 5 (Figure 4.4) and 6 (Figure 4.5) demonstrated that, although it was possible to mitigate some receivers, substantial effort (5 m barriers and enclosures) was required and the benefit was marginal.

The previously endorsed PDS2EA stated that "the configuration of mitigation measures (barrier heights/receiver mitigation etc) depended on many factors including the nature and planning/legal status of the receivers". It was also stated that the "stringent and extremely costly mitigation measures such as full or partial enclosures are considered generally inappropriate given the nature of the housing stock in the area. In addition, the alignment constitutes a long length of road over which intrusive mitigation measures would have a high visual impact".

Further to the PDS2EA, the practicability of 5 m barriers and enclosures was discounted for engineering reasons. The primary structural loading on a cantilevered barrier is the wind loading and the overturning effect on the foundation increases with height. (The overturning momentum on a 5 m barrier would be 2.78 times that on a 3 m barrier.) Since the ground conditions are poor in the area, and many barriers are required on the crest of the embankments, substantial foundations are required to cater for this problem and would be extremely difficult. Similar cases are applied to enclosures. A number of problems need to be considered when using enclosures, e.g., visibility, air quality, obstruction of emergency services, foundation requirements, and maintenance requirements.

Consequently, Mitigation scheme 4 would be the most feasible design. Under Mitigation scheme 4, entailing barriers along Route 3 and mitigation along Castle Peak Road and Kam Tin Road as well, about 84 percent of the surveyed NSRs in the area would be expected to experience facade noise levels within HKPSG standards. Formulation of mitigation measures in Mitigation scheme 4 has taken into account the environmental benefit in the first instance, together with considerations of engineering practicability. A detailed assessment of the number and location of NSRs requiring indirect mitigation under this mitigation scenario, and the form of this mitigation, will be undertaken as a design package. The following notes present several issues of concern in optimising the mitigation design.

- *Practical restrictions on mitigation design*
  Barriers greater than 4 m and the use of enclosures would cause problems with the foundations and could jeopardise the stability of the embankments given the high wind loading. There would be sight distance problems, weight loading problems and maintenance problems. Safety issues such as emergency and fire services should be considered.

- *Mitigation of roads other than Route 3*
  A number of receivers have been identified where the contribution of roads other than Route 3 is either dominant or greater than 70 dB (A). Mitigation measures applied on these roads, in conjunction with appropriate measures on Route 3, would be more effective and more beneficial to these noise sensitive receivers.

- *Future influences by other projects*
  There will be several major development projects in the area, such as the Kam Tin Road and Castle Peak Road improvement schemes, the Kam Tin River Training Project, the Western Corridor Railway Project, and a proposed floodway in the Au Tau Area. Each of the above projects, particularly the Western Corridor Railway Project, will involve the resumption of receivers identified as NSRs in the present study. Where NSRs are to be resumed under other projects prior to implementation of Route 3 traffic noise mitigation measures, the need for those measures will be reassessed.

R3CC will undertake to implement all of the recommended mitigation recommendations under their control associated with this DEIA.

Table 4.19 Summary of traffic noise modelling results

NSR	Storey	Facade Noise Level L10 dB(A)							
		Existing	Basic	Mitigation scheme					
		1993	Unmitigated	1	2	3	4	5	6
10	1	65	71	69	68	68	68	65	65
10	2	66	71	69	69	69	69	66	66
21	1	66	73	70	70	70	69	67	67
73	1	64	71	69	68	68	67	66	66
79	1	65	71	70	70	69	69	68	68
93	1	63	71	69	69	68	68	66	66
103	1	65	72	71	70	69	69	69	68
121	1	62	69	68	68	67	66	65	65
121	2	62	69	69	68	68	67	66	66
132	1	61	69	68	68	67	66	64	64
132	2	61	70	69	68	67	67	65	65
148	1	60	77	73	72	69	68	66	66
148	2	60	79	76	74	71	69	68	68
163	1	60	73	70	69	67	67	64	64
174	1	62	73	71	70	67	68	65	65
174	2	63	74	72	71	69	69	67	67
198	1	64	71	70	69	69	69	67	67
214	1	61	69	69	68	68	67	68	68
247	1	62	70	69	68	67	67	65	65
258	1	61	69	68	68	67	67	65	65
261	1	61	69	68	67	66	65	64	64
281	1	60	76	73	72	68	67	65	60
281	2	61	77	74	73	69	68	65	60
299	1	60	70	68	67	64	62	62	61
299	2	60	71	69	67	64	63	63	61
338	1	73	75	74	74	74	70	74	74
338	2	75	77	76	76	76	74	76	76
338	3	76	77	77	77	77	77	77	77
350	1	67	75	73	73	71	70	67	66
350	4	69	76	75	75	73	72	70	70
350	8	70	78	77	77	76	74	72	71
356	1	69	75	73	73	70	70	67	66
373	1	65	77	75	74	69	69	67	64
373	2	66	77	76	75	71	70	67	65
382	1	61	76	74	73	69	68	66	60
382	2	61	84	80	78	72	70	68	63
402	1	64	72	70	70	69	67	64	63
402	2	65	72	71	70	69	67	65	64
402	3	65	73	71	71	69	68	65	65

Table 4.19 Summary of traffic noise modelling results (continued)

NSR	Storey	Facade Noise Level L10 dB(A)							
		Existing	Basic	Mitigation scheme					
		1993	Unmitigated	1	2	3	4	5	6
568	1	63	72	70	70	67	64	64	63
568	2	64	73	71	70	68	64	64	63
568	3	64	73	72	71	69	65	65	64
578	1	65	74	72	71	69	65	65	64
578	2	65	74	73	72	70	66	65	65
578	3	66	75	73	73	71	66	66	65
585	1	65	76	72	71	68	67	66	66
585	2	65	77	76	75	70	68	67	67
585	3	66	79	78	77	73	69	68	68
621	1	64	79	74	73	70	69	68	64
621	2	65	81	78	76	72	70	69	65
621	3	65	82	81	79	74	72	71	67
630	1	63	77	73	72	69	68	67	64
725	1	61	71	69	69	67	65	64	63
733	1	61	73	71	70	68	66	65	64
733	2	62	74	72	71	69	67	66	65
740	1	63	77	74	73	69	69	68	67
766	1	69	74	73	72	72	69	72	72
766	2	69	74	73	73	72	69	72	72
799	1	68	74	72	72	72	69	72	72
799	2	69	74	73	73	72	69	72	72
832	1	69	74	73	73	72	70	72	72
832	2	70	74	74	73	73	70	73	73
832	3	70	75	74	74	73	70	73	73
896	1	71	74	74	74	73	71	73	73
912	1	69	75	73	73	72	71	72	72
952	1	64	70	70	69	69	67	67	67
952	2	64	71	70	70	69	68	68	67
981	1	68	75	74	74	74	69	68	67
981	2	69	78	78	78	77	71	69	68
981	3	70	80	80	79	79	72	71	69
1003	1	67	74	73	73	72	70	69	68
1003	2	68	75	74	74	73	71	70	69
1026	1	67	74	73	72	71	68	71	71
1026	2	67	75	73	73	72	69	72	71
1026	3	68	75	74	74	73	69	72	72
1057	1	70	75	75	75	75	71	74	74
1057	2	72	78	76	76	76	71	76	76
1057	3	72	78	77	77	77	76	76	76

Table 4.19 Summary of traffic noise modelling results (continued)

NSR	Storey	Facade Noise Level L10 dB(A)							
		Existing	Basic	Mitigation scheme					
		1993	Unmitigated	1	2	3	4	5	6
1107	1	74	79	79	79	78	74	78	78
1107	2	76	80	80	80	80	79	80	79
1107	3	76	81	80	80	80	80	80	80
1124	1	67	77	77	75	72	73	71	70
1124	2	67	79	78	76	72	74	71	70
1124	3	67	79	79	79	75	78	71	70
1149	1	64	73	71	70	68	68	67	66
1149	2	65	74	72	71	69	69	67	66
1149	3	65	75	73	72	69	70	68	67
1174	1	66	70	69	69	66	66	63	59
1246	1	63	72	70	69	67	67	65	64
1246	2	64	72	71	70	67	67	66	65
1293	1	65	70	70	69	68	67	67	65
1319	1	60	70	67	67	65	65	63	62
1374	1	61	69	68	67	65	67	64	64
1383	1	65	69	68	68	66	66	64	64
1400	1	63	71	69	68	66	67	64	64
1400	2	63	72	70	69	67	68	65	64
1431	1	63	70	70	69	68	67	67	67
1439	1	63	73	73	72	71	68	65	65
1439	2	64	75	74	74	73	70	67	67
1469	1	64	71	71	71	69	70	67	67
1514	1	N/A*	N/A*	N/A*	N/A*	N/A*	N/A*	N/A*	N/A*
1524	1	61	72	70	69	67	69	65	65
1589	1	46	65	64	64	63	64	64	64
2039	1	57	79	76	75	73	70	68	68
2066	1	N/A	72	69	67	65	68	66	66
2066	2	N/A	72	69	68	65	68	66	66
2066	3	N/A	72	70	69	66	69	67	67
2074	1	52	74	71	70	68	67	67	67
2168	1	N/A	69	68	68	66	66	66	66
2168	2	N/A	73	71	70	68	68	68	68
2194	1	47	72	70	70	67	67	67	67
2215	1	55	70	69	68	66	69	68	68

Note:
1. [ ] border represents noise level greater than HKPSG 70 dB(A) standard.
2. For the "Basic Unmitigated" Scenario, underlined values represent the contribution of old/existing roads greater than 70 dB(A).
3. N/A means receivers currently not exposed to traffic noise
4. NSR 350 is Pok Oi Hospital having HKPSG standard of 55 dB(A).

* To be relocated.

4.4.4 Operational Phase Conclusions

The study area extends from north of the Toll Plaza to the roundabout junction with Castle Peak Road at Pok Oi Hospital and joins with the New Territories Circular Route at Sha Po. The Route 3 alignment bridges Kam Tin Road near Ha Ko Po Tsuen and Castle Peak Road north of the existing Au Tau Roundabout before its junction at Sha Po.

Assuming only the provision of friction course surfacing on new roads widespread exceedances of the HKPSG standards in year 2011 was predicted to occur at the representative NSRs. In order to reduce the noise impact of the new route, several mitigation scenarios were tested. The purpose of testing the various scenarios was to determine the effectiveness of increasing levels of mitigation, with the aim of providing the basis for a decision on barrier optimisation.

Not all the impacts at the sensitive receivers could be mitigated to satisfy the HKPSG standards of 70 dB(A) for dwellings and 55 dB(A) for the hospital. This applied to receivers which were already exposed to traffic noise impact from roads other than Route 3 in the vicinity, e.g., Castle Peak Road and Kam Tin Road. Some receivers would be eligible for indirect technical remedies in the form of window insulation and air conditioning under the three eligibility criteria, subject to ExCo's approval in cases where the receivers are dwellings. The indirect technical remedy package is subject to further detailed survey and assessment, and will be detailed in a separate Noise Insulation Works Study or Detailed Design Package.

Substantial mitigation measures were necessary for several receivers which experience high levels of traffic noise (but slightly less than 70 dB(A)) from local roads and/or that lie close to Route 3 and its associated link roads. For other receivers, an effective barrier height of 3 m or less along the roadside was often sufficient.

Traffic noise impacts at Pok Oi Hospital are expected to exceed the HKPSG criteria of 55 dB(A) $L_{10\,(1\,hr)}$, as shown in the detailed calculations attached at Appendix D. Indirect technical remedies, in the form of window insulation and air conditioning, will be provided to those noise sensitive rooms of Pok Oi Hospital that are predicted to be exposed to noise levels exceeding this HKPSG criterion. The required form of window insulation for the hospital is specified in Appendix D.

This assessment has also indicated the extent of mitigation measures which would be required for the HKPSG 70 dB(A) standard to be achieved. In assessing these higher barriers and full enclosures it was shown that the number of dwellings exceeding the HKPSG standard of 70 dB(A) was only marginally less than the proposed Mitigation scheme 4. The construction of such enclosures and high barriers was also considered to be impractical in the PDS2EA, which has subsequently been endorsed by Government. The practicability and mitigation effectiveness described indicate that the proposed Mitigation scheme 4 is the most practicable solution in reducing traffic noise levels in the Northern Section of the Route 3 Alignment.

Figure 4.1 Selected Noise Sensitive Receivers (Au Tau Interchange)

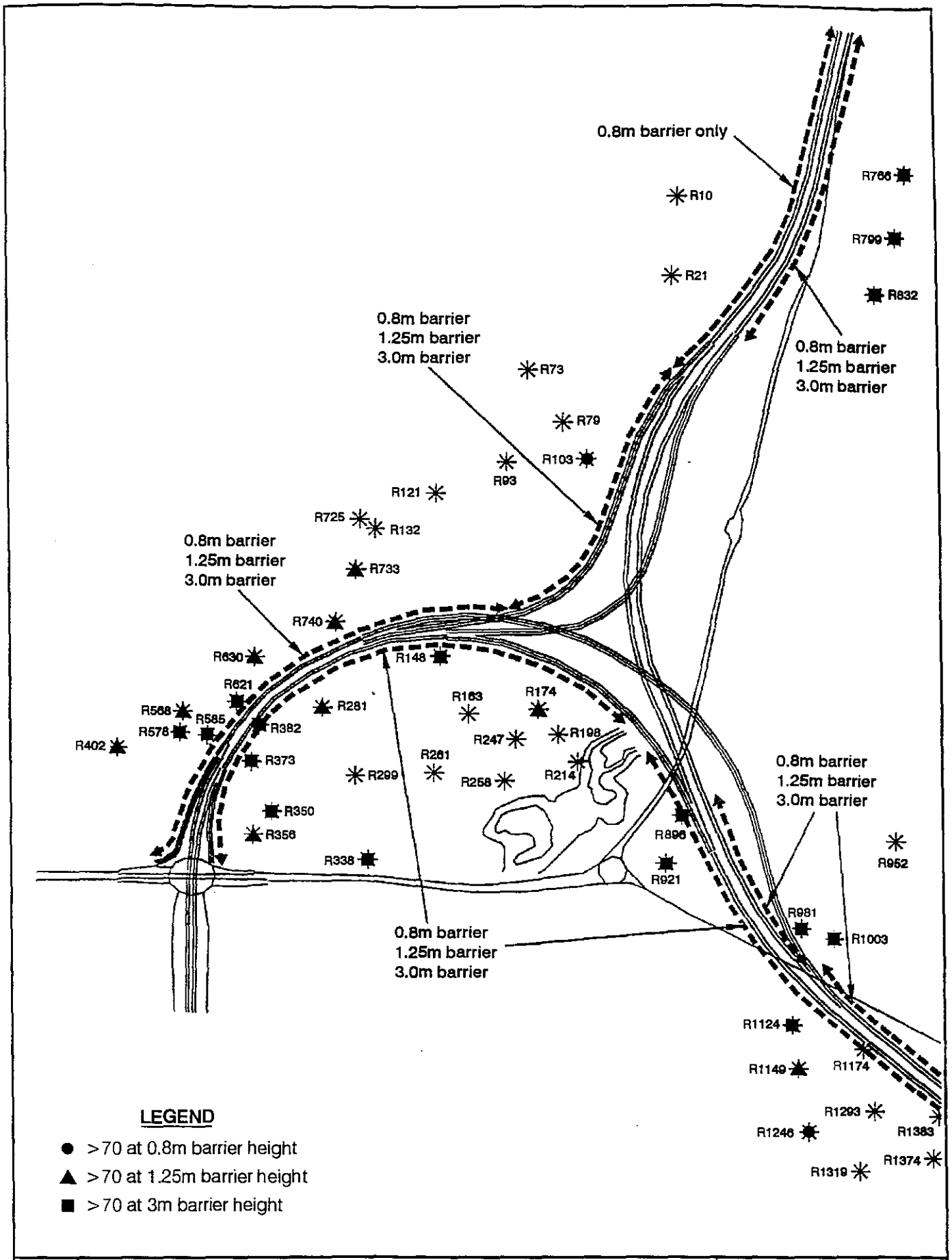


Figure 4.1 Selected Noise Sensitive Receivers (Au Tau Interchange)

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 4.2 Selected Noise Receivers (Main Cut to Au Tau)

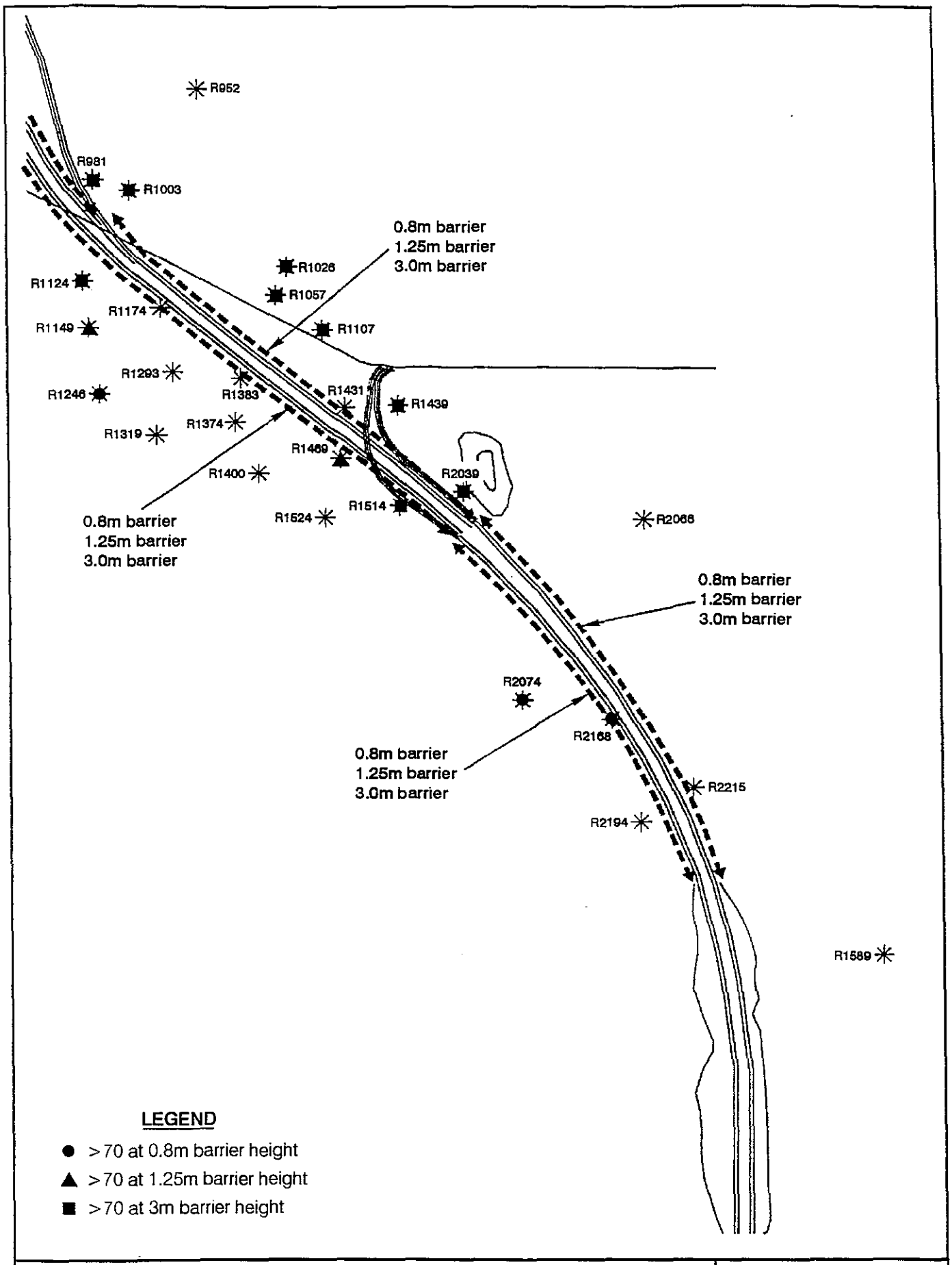


Figure 4.2 Selected Noise Sensitive Receivers (Main Cut to Au Tau)

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 4.3 Mitigation 4

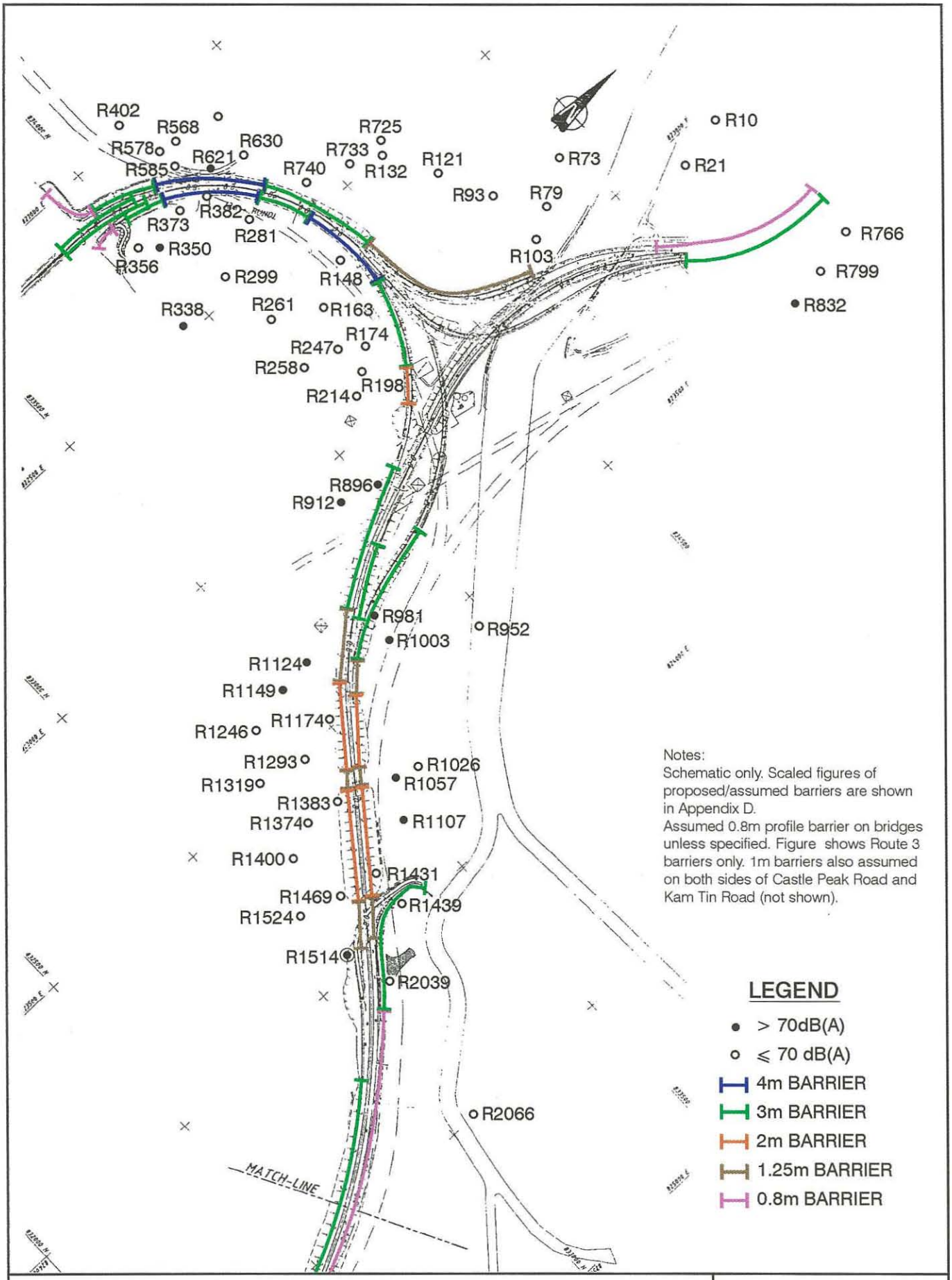


Figure 4.3 Mitigation 4

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

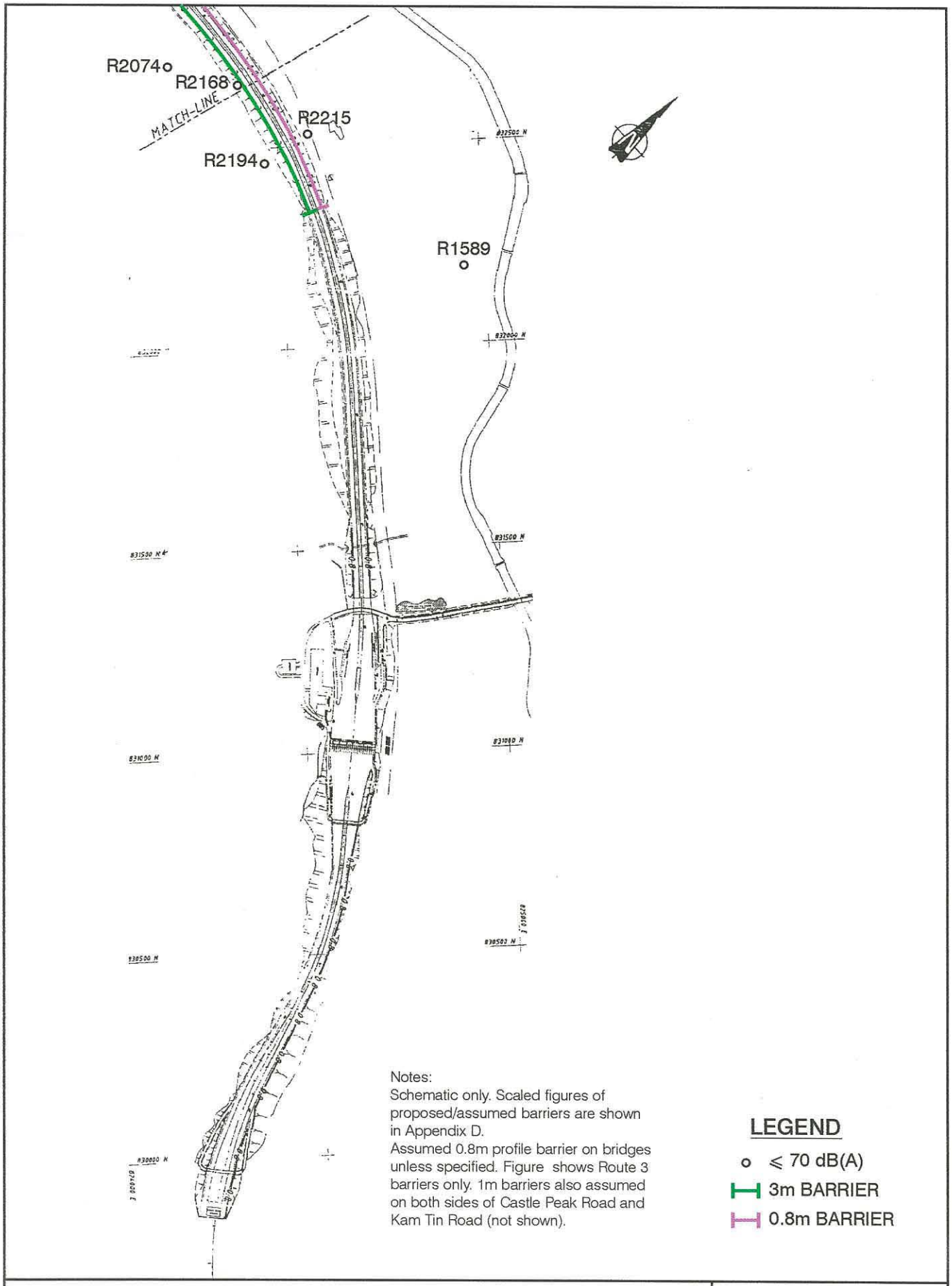


Figure 4.3 Mitigation 4 (continued)

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 4.4 Mitigation 5

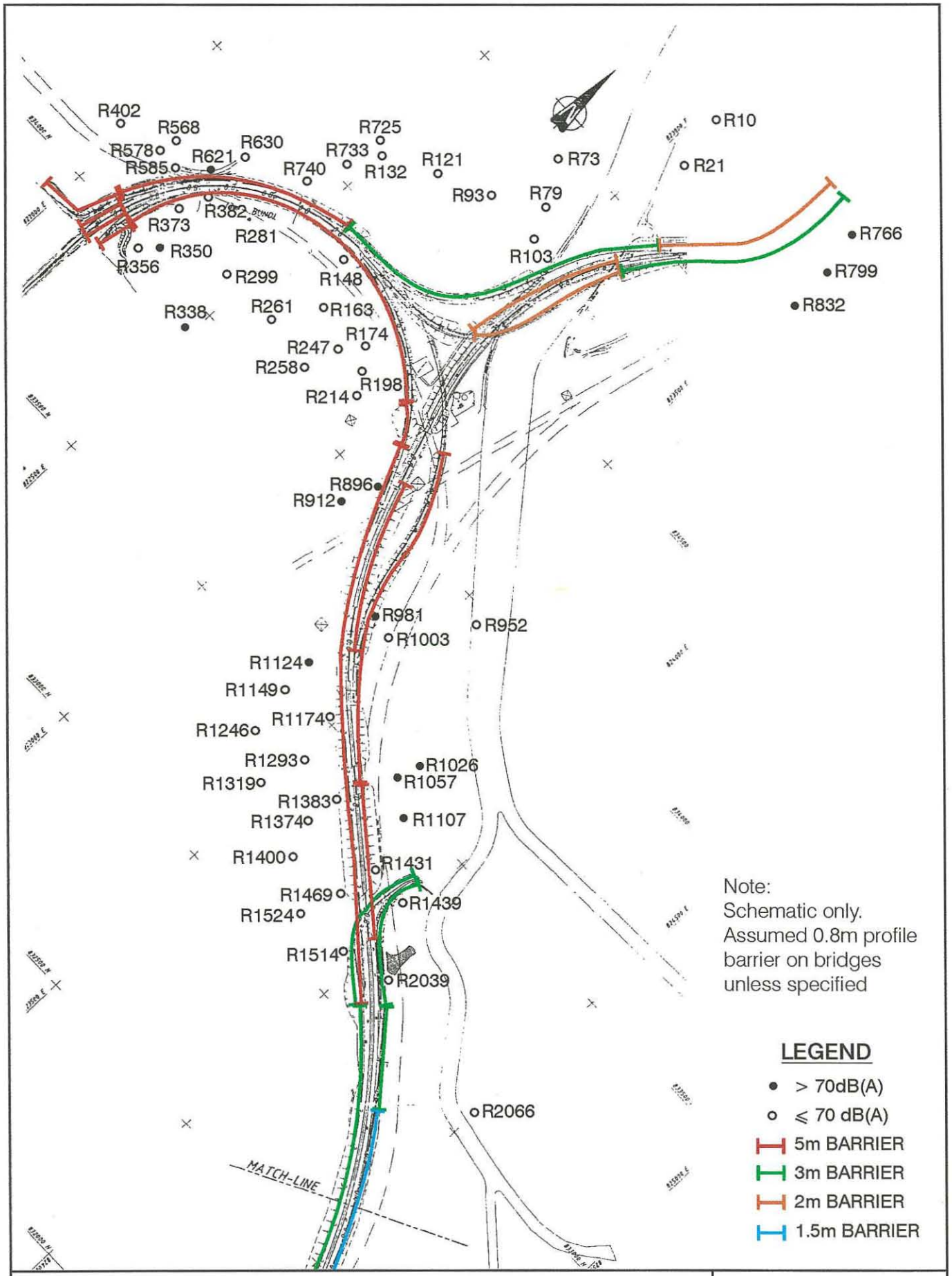


Figure 4.4 Mitigation 5

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

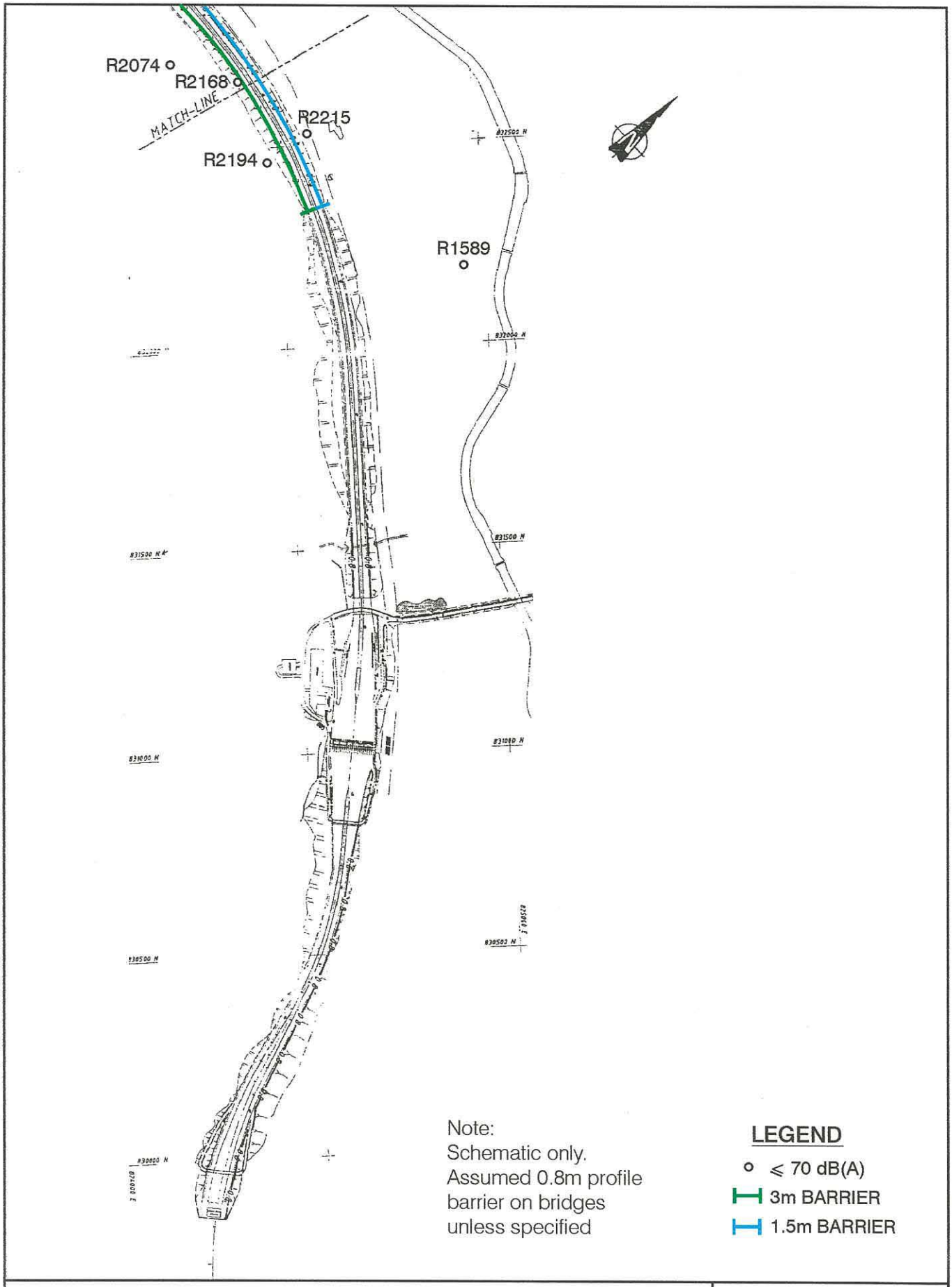


Figure 4.4 Mitigation 5 (continued)

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 4.5 Mitigation 6

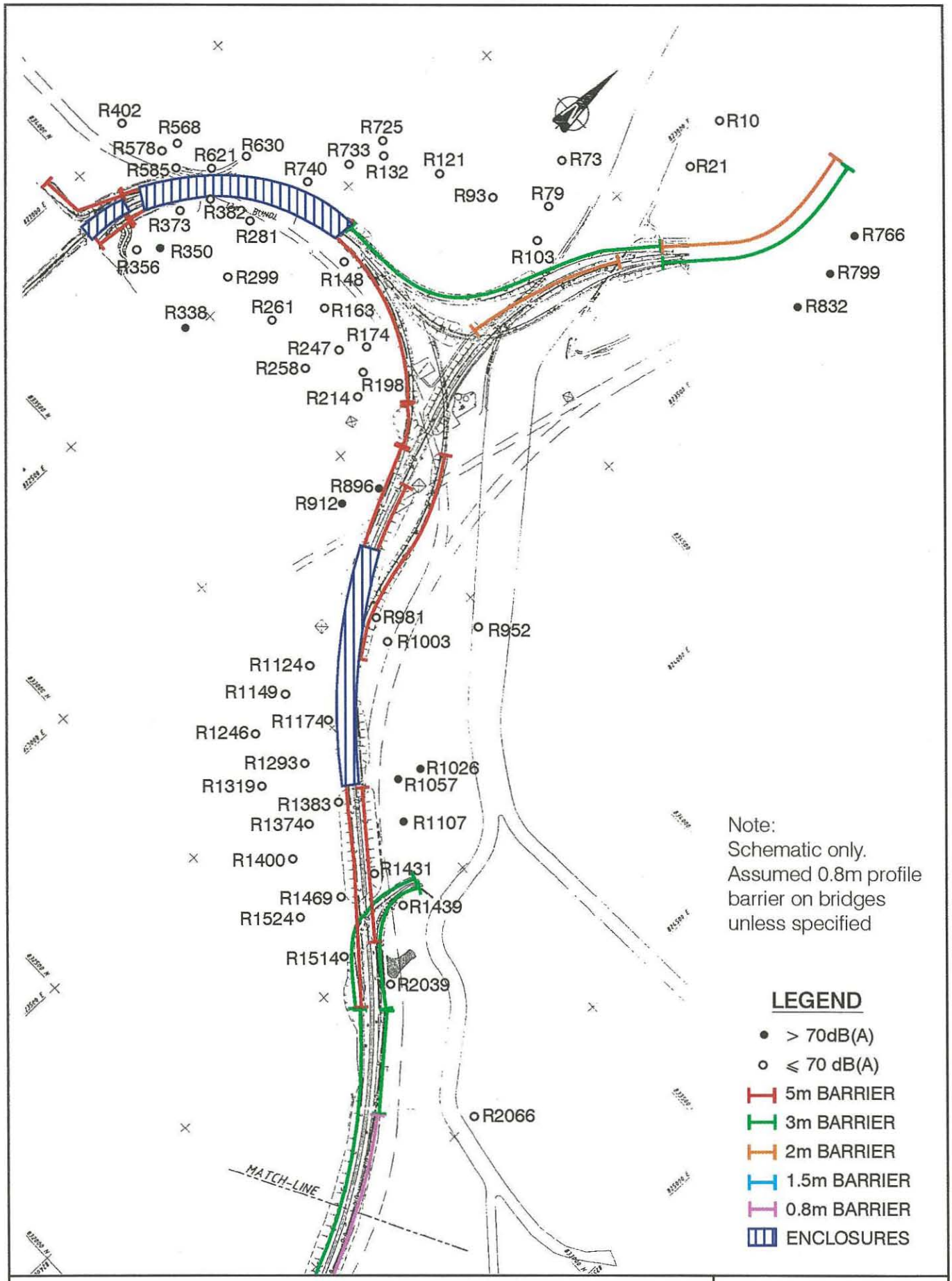


Figure 4.5 Mitigation 6

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

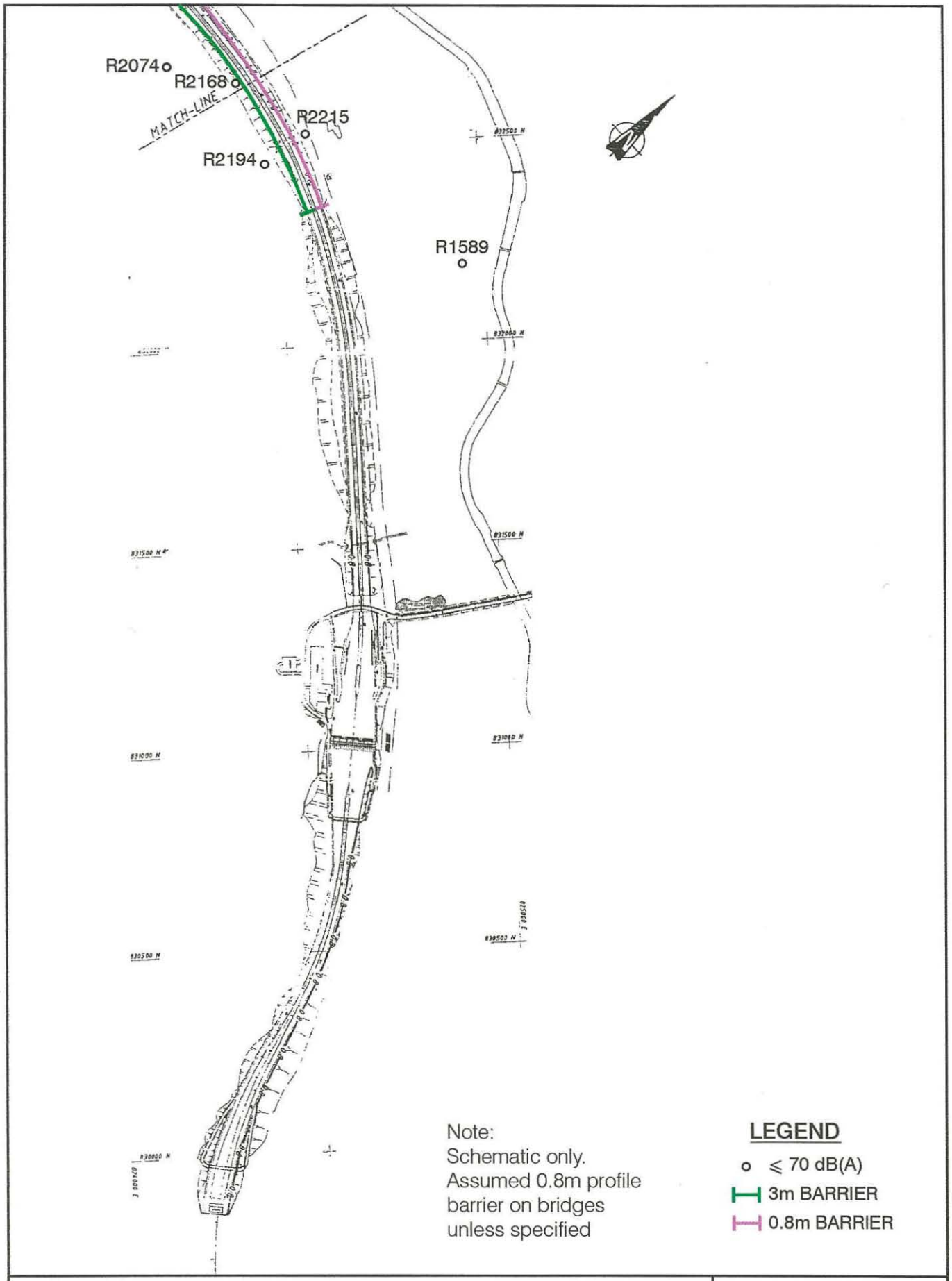


Figure 4.5 Mitigation 6 (continued)

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

5 AIR QUALITY

5 AIR QUALITY

5.1 Legislation and Guidelines

The Air Pollution Control Ordinance (Cap. 311, 1983) provides powers for controlling air pollutants from a variety of stationary and mobile sources, including fugitive dust emissions from construction sites. It encompasses a number of Air Quality Objectives (AQO). Currently AQOs stipulate concentrations for a range of pollutants, of which carbon monoxide (CO), nitrogen dioxide (NO_2) respirable suspended particulates (RSP) and total suspended particulates (TSP) are relevant to this study. The AQOs are listed in Table 5.1.

Table 5.1 Hong Kong Air Quality Objectives

Parameter	Maximum Average Concentration (μgm^{-3})[1]			
	1-Hour[2]	8-Hour[3]	24-Hour[3]	Annual[4]
CO	30000	10000	-----	-----
NO_2	300	-----	150	80
RSP	-----	-----	180	55
TSP	500[5]	-----	260	80

1 Measured at 298 K and 101.325 kPa.
2 Not to be exceeded more than three times per year.
3 Not to be exceeded more than once per year.
4 Arithmetic mean.
5 In addition to the above established legislative controls, it is generally accepted that an hourly average TSP concentration of 500 μgm^{-3} should not be exceeded. Such a control limit is particularly relevant to construction work and has been imposed on a number of construction projects in Hong Kong in the form of contract clauses.

5.2 Selected Sensitive Receivers

A comprehensive survey was conducted in March 1995 to identify all the sensitive receivers along the current Route 3 alignment. Results of the survey are provided in Appendix 1 of the EM&A Manual (Volume 2 of the Northern Section DEIA).

From the results of the survey, 63 representative air quality sensitive receivers were adopted for this assessment. They are the existing buildings located along the current Route 3 alignment and outside the construction site boundary of the Project, from north of Kam Sheung Access Road on the Yuen Long Approach to the Au Tau Interchange. Receivers are also situated in the area surrounding the Interchange and in the vicinity of Castle Peak Road and Kam Tin Road. The schematic location plan of the selected air quality sensitive receivers are shown in Figure 5.1 and are listed in Table 5.2. The receiver height used for the analysis was 1.5 metres above local ground level. This was selected as it is representative of the breathing zone. For those existing air quality sensitive receivers located within the construction site boundary of the Project, it is confirmed by R3CC that they will be resumed as part of the works.

Table 5.2 Selected representative air quality sensitive receivers

Receiver No.	Location
R10	North of Au Tau Interchange
R21	North of Au Tau Interchange
R73	North of Au Tau Interchange
R79	North of Au Tau Interchange
R93	Northeast of Shan Ping Tsuen
R103	Northeast of Shan Ping Tsuen
R121	Northeast of Shan Ping Tsuen
R132	Northeast of Shan Ping Tsuen
R163	Tung Shing Lei
R171	Tung Shing Lei
R174	Tung Shing Lei
R198	Tung Shing Lei
R214	Tung Shing Lei
R247	Tung Shing Lei
R258	Tung Shing Lei
R261	Tung Shing Lei
R281	Tung Shing Lei
R299	West of Tung Shing Lei
R338	Southwest of Tung Shing Lei
R350	Pok Oi Hospital, West of Au Tau Interchange
R356	East of Pok Oi Hospital
R372	Southwest of Small Traders New Village
R373	Small Traders New Village
R382	Small Traders New Village
R384	School in Small Traders New Village
R402	Tai Wai Tsuen
R568	Wong Uk Tsuen
R578	Wong Uk Tsuen
R585	Wong Uk Tsuen
R621	East of Wong Uk Tsuen
R630	North of Small Traders New Village
R725	Northeast of Shan Ping Tsuen

Table 5.2 (Continued)

Receiver No.	Location
R733	East of Shan Ping Tsuen
R766	Fung Kat Heung
R799	Fung Kat Heung
R832	Southwest of Fung Kat Heung
R849	Southwest of Fung Kat Heung
R912	East of Au Tau Roundabout
R937	South of Au Tau Roundabout
R952	North of Ha Ko Po Tsuen
R964	Northeast of Au Tau Roundabout
R1003	Ha Ko Po Tsuen
R1008	Southwest of Ha Ko Po Tsuen
R1026	North of Ko Po Tsuen
R1057	West of Ko Po Tsuen
R1107	Ko Po Tsuen
R1124	Northwest of Ko Po San Tsuen
R1149	Northwest of Ko Po San Tsuen
R1246	East of Ko Po San Tsuen
R1293	Ko Po San Tsuen
R1319	Ko Po San Tsuen
R1374	Ko Po San Tsuen
R1400	Ko Po San Tsuen
R1439	East of Ko Po San Tsuen
R1469	Ko Po San Tsuen
R1514	SKH St. Joseph School [1]
R1524	Ko Po San Tsuen
R1589	South of Kam Tin
R1622	Squatter Hut Near Toll Plaza[2]
R2066	South of Kam Tin
R2074	Southwest of Kam Tin
R2194	South of Kam Tin
R2224	West of Kam Tin

[1] St. Joseph's School will be relocated in July 1996 and was only assessed for construction air quality
[2] Squatter hut used for storage (non-sensitive use) and the assessment is for reference only

5.3 Methodology

5.3.1 Construction Phase

The major pollutant emission of concern during the construction phase of the project is particulate matter (dust). Vehicle and plant exhaust emissions from the site should not constitute a considerable source of air pollutants based on previous experience. To assess potential dust impacts on the sensitive receivers, dust emissions from the construction sites and plant during the most work intensive period were modelled.

The Northern Section of Route 3 (between the Au Tau Interchange and Kam Sheung Access Road) is predominantly rural, with a few scattered settlements. There are considerable numbers of scattered buildings around the Au Tau Interchange; both residential and commercial. The impact of dust from construction activities of the southern section of Route 3 has been taken into account in this assessment. However, no information on other major construction activities in the area is currently available. In view of the rural nature of the area, a background dust level of 40 μgm^{-3} was incorporated into the assessment to account for cumulative dust impacts.

5.3.2 Operational Phase

Vehicle Emissions

Impacts during the operational phase may result from vehicle emissions arising from traffic on the new road network as well as on existing roads. To assess the potential impact, 2011 traffic flow and vehicle mix predicted by the traffic consultant for this new road network were used for the assessment. Vehicle emissions from existing roads in close proximity to the R3 alignment were also included to incorporate the background pollutant concentrations in the area.

Traffic emissions are mainly from vehicles on open roads and air quality impacts would generally be higher with lower receiver height. The assessment considered the worst-case impacts at 1.5 m above local ground level, 1.5 m being the average height of the human breathing zone.

Air Quality Impact due to Presence of Noise Barriers

Dispersion modelling was also carried out to determine the effects of noise barriers on air pollutant dispersion, since noise barriers will be built to mitigate against road noise (see Section 4). Noise barrier heights and arrangements from the preferred Noise Mitigation Option 4 were chosen. Sensitive receptor heights of 1.5 m, 3 m, 4m and 5 m above local ground level were chosen to simulate the impact at receivers at, above and below the noise barrier heights. Further, extra sensitive receptors were chosen on the roof level of the Pok Oi Hospital where fresh air intakes are likely to be located.

5.4 Assumptions and Input Information

5.4.1 Construction Phase

Emissions Calculations

Dust emission sources during construction include the following:

- Drilling for blast charges
- Blasting
- Bulldozing blasted material and overburden
- Grading of embankment
- Loading and unloading of construction material
- Plant vehicles travelling on unpaved site roads
- Wind erosion of stockpiles and open site

The prediction of dust emissions was based on typical values and emission factors from USEPA *Compilation of Air Pollutant Emission Factors* (AP-42). Emission factors for general construction activities taken from AP-42 were used to incorporate all general road construction activities within the site, including bulldozing, grading, loading and unloading of materials, plant vehicles which travel on unpaved site roads and wind erosion. Cumulative impacts from construction activities in the Northern and Southern Sections have been taken into account.

As stated in AP-42, emission factors for general construction activities have already incorporated a large portion of emissions from traffic over temporary roads within the construction site. In view of the general road construction activities that will occur in the Northern Section, the emission factors for general construction activities are representative. The nature of the construction activities in the Northern and Southern Sections is different. The large emissions in the Southern Section are mainly due to plant vehicle movement from tunnelling activities.

During construction, it was assumed that a maximum of 30 percent of the site area would be actively operated at any one time. A 12-hour working day was assumed for road construction activities. No concrete batching plant or rock crushing plant was identified in the Northern Section in this assessment.

The material requiring blasting is mainly composed of granite. Since information on the silt content of granite material is not available, the silt content for blasted rock was taken as 1.6%, which is the geometric mean for crushed limestone in stone quarrying and processing from AP-42. It is likely that the actual silt content of the crushed granite will be lower. Site investigation undertaken by R3CC indicates that the majority of the rock has a moisture content of 3 - 4% and 3.5% was taken in this assessment for blasting and material handling operations. The blasting volume for the site north of the North Portal was taken as 7,500 m^3 per blast.

Rainfall data was obtained from the Royal Observatory weather records. Wind data from the Lau Fau Shan meteorological station was used in the assessment, which represent the closest station to the study area.

Committed Mitigation Measures

In this assessment, the following committed impact mitigation measures have been taken into account in the modelling analysis:

Site Practices

- Mean vehicle speed of haulage trucks at 20 $kmhr^{-1}$.
- Watering of all open site areas twice per day (AP-42 assumed 50% dust reduction).
- Wheel wash facilities.
- Suitable side and tailboards on haulage vehicles.
- Watering of temporary stockpiles.

Blasting

- Use of selected aggregate and fines to stem the charge within drill holes and watering of blast face (assumed 30% dust reduction).
- Vacuum extraction drilling methods (assumed emission factor for wet quarry drilling from AP-42).
- Carefully sequenced blasting.

The committed measures to be incorporated into the blasting methodology are described in more detail as follows:

- Blasting operations will be carried out with an "open face". This will have the effect of increasing the horizontal portion and decreasing the vertical portion of rock displacement. Subsequently the vertical emission of dust will be reduced. If the blast area was closed without an "open face", the fractured rock would be confined and forced to be displaced vertically.

- Vacuum filters on drill rigs will reduce dust associated with blasting preparation.

- Incombustible stemming will be used in the drill holes, where approximately 3 m of selected aggregates/granular material will be placed, which would confine the explosive and act as gas absorber.

- All blast holes will be filled with emulsion and detonation will be sequential with a delay of approximately 25 ms between two holes. As the explosive detonates, fractures and moves rock, dust is generated. The degree of interaction with adjacent blast-holes will influence the velocity of movement of the shattered rock and will subsequently effect the levels of dust generated. Closely spaced blast-holes fired simultaneously will result in higher velocities of displacement and hence higher dust emission than a single blast-hole. Through careful sequencing of the proposed detonator methodology, the velocity of the rock is reduced and dust emission minimized.

Calculations of dust emission factors for different dust generating activities are tabulated in Table N_AAA_EB.XLS in Appendix F. The predicted dust generated from different construction activities with the adoption of dust suppression measures were calculated and are listed in Table 5.3 below. General road construction activities and wind erosion of open site are by far the predominant dust sources.

Table 5.3 Predicted dust emissions during construction

Activity	TSP (kg day^{-1})
Blasting (unconfined)	39
Drilling	8
General road construction activities and wind erosion of open site	530

Dispersion Modelling

The dispersion of TSP was modelled using the CES developed AAQuIRE (Ambient Air Quality in Regional Environments) system. AAQuIRE performs multiple runs of the USEPA approved Fugitive Dust Model (FDM) to assess potential impacts from construction activities. TSP concentrations at the identified sensitive receivers were predicted for 1-hour, 24-hour and annual average time periods. Surface roughnesses of the terrain in the study area was taken as 1 metre in the FDM.

Sequential hourly data for wind speed and direction from the Lau Fau Shan meteorological station were combined with surface observations from the Royal Observatory to obtain the best available hourly sequential data set for years 1990 to 1992. Dispersion modelling was undertaken for 120 predefined separate meteorological categories. At each receptor point the 1-hour average concentration for TSP was predicted for each of the categories. The 120 meteorological categories were then compared with each sequential hourly meteorological data set to produce time-sequenced hourly pollutant concentrations. These sequential hourly concentrations allowed maximum 1-hour, 24-hour and annual averages to be generated at each receiver based on real meteorological data, rather than relying on the simplistic 'worst-case' approach. This approach has been used successfully on many other projects, such as Lantau Port Development, Sha Tin Trunk Road T3 and Port Passenger Line Tuen Mun Extension.

5.4.2 Operational Phase

Traffic Flow Predictions

The projected morning peak hour traffic flows for year 2011 provided by the traffic consultant were used in the assessment. The 24-hour profile of vehicle flows was also required to calculate the daily vehicle emissions and hence the 24-hour average pollutant concentrations. The traffic flow profile for Screenline R_R (north end of Tsuen Wan and Sha Tin) taken from the Traffic Census was used as the best estimate. Traffic was assumed to be free flowing with no queuing.

The assessment has included most of the roads within the area, including Castle Peak Road and Kam Tin Road. Hence, the air quality impact of the road network within the whole area has been assessed in the model.

Emissions Calculations

The composition of the vehicle fleet during morning peak hour for year 2011 provided by the traffic consultant was used. Emission factors for CO, NO_X and RSP were taken from the *'Fleet Average Emission Factors - EURO2 Model'* provided by EPD for year 2011. These are summarised in Table 5.4. No speed correction or other adjustments were made. 20% NO_X to NO_2 conversion was assumed, as normally adopted for such assessments.

The assessment for the Southern Section predicted the worst case impact to occur in year 2002, because the vehicle emission factor in year 2002 would be 10% higher than that in year 2011. Thus, impact in Year 2002 can be estimated as 110% of that in year 2011. This is a conservative estimate since year 2011 traffic flow was assumed for year 2002.

Table 5.4 Vehicle fleet composition and emission factors for year 2011 (AM peak hour)

Vehicle Type	Percentage	Emission Factor ($g\ km^{-1}\ vehicle^{-1}$)		
		NO_X	CO	RSP
P/E Motor Cycle	1.9	0.548	25.508	0.040
P/E Private Car	28.3	1.321	13.508	0.041
D/E Private Car	1.4	0.870	1.032	0.282
D/E Taxi	4.4	0.779	0.910	0.238
P/E Passenger/Goods Van D/E Passenger/Goods Van P/E Goods (4 wheels) D/E Goods (4 wheels) P/E Light Goods (6 wheels &+) D/E Light Goods	25.0	1.375	3.517	0.176
D/E Medium Goods	15.1	4.594	8.407	0.566
D/E Heavy Goods	2.5	7.061	8.410	0.566
D/E 6m Container	6.2	7.061	8.410	0.566
D/E 12m Container	12.2	7.061	8.410	0.566
D/E Public Light Bus D/E Non-franchised Bus	0.6	3.524	3.492	0.417
D/E One-decker Bus	0.2	8.578	9.017	0.894
D/E Double-decker Bus	0.2	8.578	9.017	0.894
D/E Double-decker Bus (3-axle)	2.0	8.578	9.017	0.894
Composite Emission Factor ($g\ km^{-1}\ vehicle^{-1}$)		3.171	8.506	0.299

Petrol vehicles contribute more carbon monoxide, while diesel-powered vehicles (particularly the heavy goods vehicles) emit more nitrogen oxides and particulates.

Current emission controls will reduce emissions from petrol vehicles as more vehicles will be fitted with catalytic convertors. Compared to NO_2, RSP has considerably lower composite emission rates (see Table 5.4) and CO has considerably higher statutory limits (see Table 5.1). NO_2 is therefore the key parameter of concern. If NO_2 levels comply with the AQOs, it is likely that both RSP and CO would also comply with their respective AQOs. The majority of air quality studies undertaken in Hong Kong, and the monitoring as undertaken by EPD, indicate this to be the case. This assessment therefore focused on predicting future NO_2 concentrations arising from the road network.

This assessment also took into account exhaust from the ventilation shaft of the northern ventilation building of the Tai Lam Tunnel and portal emissions from the Northern Portals of the tunnel. Emissions from tunnel ventilation have been assessed and presented in the Southern Section DEIA. Tunnel emission rates are tabulated in Table 5.5. The pollutant generation rates were calculated based on the worst-case scenario. The tunnel air quality guideline levels of 1,800 μgm^{-3} NO_2 and 115,000 μgm^{-3} CO were used to represent the pollutant levels of the tunnel air exhausted from the ventilation system and the tunnel portals. 10% NO_2/NO_x ratio was assumed for air exhausted from the tunnel. 20% NO_x to NO_2 conversion was assumed when considering impacts at sensitive receivers, as normally adopted for such assessments.

Table 5.5 Tunnel emission rates for year 2011 (AM peak hour)

Portal	Point of Exhaust	Maximum Exhaust Rate (m^3s^{-1})	NO_x (gs^{-1})	CO (gs^{-1})
South	Ventilation Shaft	950[1]	17.1	109
	Portal	350[2]	6.3	40
North	Ventilation Shaft	850[3]	15.3	98
	Portal	250[4]	4.5	29

1 700 m^3s^{-1} is extracted from the southbound tube and 250 m^3s^{-1} is extracted from the northbound tube.
2 All 350 m^3s^{-1} is exhausted from the southbound tube.
3 350 m^3s^{-1} is extracted from the southbound tube and 500 m^3s^{-1} is extracted from the northbound tube.
4 All 250 m^3s^{-1} is exhausted from the northbound tube.

Dispersion Modelling For Open Road

The dispersion of NO_X was modelled using the CES developed AAQuIRE (Ambient Air Quality in Regional Environments) system. AAQuIRE performs multiple runs of the USEPA approved CALINE4 and ISCST dispersion models. NO_2 concentrations at the sensitive receivers for open road emissions were calculated using the CALINE4 model. NO_2 emissions from the portals were predicted assuming the emissions behave as volume sources in accordance with the recommendations in the *1991 Permanent International Association of Road Congress Report (1991 PIARC Report)*. Dispersion of portal emissions and emissions from the exhaust stacks of the tunnel ventilation system were simulated using the ISCST model. The NO_2 concentrations predicted by both CALINE4 and ISCST models at each receptor point were then summed to produce the cumulative concentrations. A wind direction standard deviation of 12° was used in the CALINE4 model because of the rolling terrain in the area.

Sequential hourly data for wind speed and direction from the Lau Fau Shan meteorological station were combined with surface observations from the Royal Observatory to give the best available hourly sequential data set for years 1990-1992. Dispersion modelling was undertaken for 120 predefined separate meteorological categories. At each receiver location the 1-hour average concentration for NO_2 was predicted for each of the categories. The 120 meteorological categories were then compared with each sequential hourly meteorological data set to produce time-sequenced hourly pollutant concentrations. These sequential hourly concentrations allowed maximum 1-hour, 24-hour and annual averages to be generated at each receiver based on real meteorological data, rather than relying on the simple 'worst-case' approach. NO_2 concentrations were calculated at receiver heights of 1.5 metres above local ground level. This approach has been used successfully on many other projects, such as Lantau Port Development, Sha Tin Trunk Road T3 and Port Passenger Line Tuen Mun Extension.

Dispersion Modelling For Noise Mitigation Option 4

Noise mitigation option 4 is the preferred option to mitigate against traffic noise impact on noise sensitive receivers. Vertical barriers were proposed along Castle Peak Road, Kam Tin Road and Route 3. One metre high vertical barriers were proposed along Castle Peak Road and Kam Tin Road. Different barrier heights ranging from 0.8 to 4 m were proposed on the Northern Section of the R3 alignment..

Associated air quality impacts due to barriers constructed to mitigate against traffic noise were assessed based on the methodology agreed with EPD. Since the CALINE4 model is incapable of simulating the effects of noise barriers, a conservative approach was used.

In general, the temperature of the exhaust gas would be more than 250 °C. The exhaust plume will be uplifted to a higher level and dispersed due to the buoyancy effect. It is assumed that, with the installation of noise barriers, all traffic induced pollutants would be emitted from the top of the noise barriers. The emission from the barrier section would act as an elevated bridge. The elevation of the road section (with noise barrier constructed) was therefore set to the elevation of the barrier top. The width of the mixing zone employed in the model was set to the actual road width owing to the physical obstruction of the barrier wall. Bridge option was set in the CALINE4 modelling.

In view of the uplift effect of the hot exhaust gas from vehicles, road sections with barrier height of 0.8m or less were considered as At-Grade. No adjustment of the road elevations was necessary. The mixing width of the road was set to its actual width plus 3 m on both sides as suggested in the CALINE4 Manual.

5.5 Predicted Impacts

5.5.1 Construction Phase

Predicted maximum 1-hour, maximum 24-hour and annual average TSP concentrations at selected air quality sensitive receivers are tabulated in Table NACO2ZZ.XLS in Appendix G. All results are based on meteorological data for years 1990 to 1992. The ten highest maximum 1-hour average TSP levels are tabulated in Table 5.6. The 1-hour, 24-hour and annual TSP levels at the St. Joseph School were predicted to be 87%, 62% and 56% of the respective limits.

It should be noted that the model used has limitations, however a better alternative was not available. Since the FDM does not take into account the topography and in this case the topography would limit dispersion to the receivers to some extent, these predictions are therefore conservative. Modelling results indicate compliance with the maximum 1-hour average guideline TSP level and the maximum 24-hour average and annual average TSP AQOs at all selected sensitive receivers.

Table 5.6 Air quality sensitive receivers with the ten highest maximum 1-hour average TSP concentrations

Receiver	TSP Concentration (with background) (microgram per cubic metre)		
	Maximum 1-hour Average[1]	Maximum 24-hour Average[1]	Annual Average[1]
R2224	473	124	16
R1514	433	160	45
R382	386	176	41
R964	354	146	36
R585	288	127	27
R621	278	123	27
R1107	278	118	20
R171	274	115	29
R1469	272	125	32
R338	248	102	26
Limit	500	260	80

1 Predicted maximum values based on meteorological data for years 1990 to 1992.

5.5.2 Operational Phase (Open Road Design)

Predicted maximum 1-hour, maximum 24-hour and annual average NO_2 concentrations at selected air quality sensitive receivers are tabulated in Table RNOPA1XXE.XLS in Appendix H. All results are based on meteorological data for years 1990 to 1992. Sensitive receivers with the ten highest maximum 1-hour average NO_2 concentrations are tabulated in Table 5.7 below.

NO_2 levels at all selected sensitive receivers were predicted to comply with the maximum 1-hour average, maximum 24-hour average and annual average AQOs in year 2011.

Based on modelling results for year 2011 and a maximum 10% increase in NOx emissions in year 2002 over year 2011, NO_2 levels at selected sensitive receivers were predicted to comply with AQOs in year 2002. The 1-hour average NO_2 concentration at the worst affected location was predicted to be 95% of the AQO. This condition was predicted to occur 0.3% of the time in a year (approximately 24 hours in a year).

Table 5.7 Selected air quality sensitive receivers with the ten highest maximum 1-hour average NO_2 concentrations

Receiver	NO_2 Concentration at 1.5 m above ground ($\mu g\ m^{-3}$)					
	Maximum 1-hour Average[1]		Maximum 24-hour Average[1]		Annual Average[1]	
	Yr 2011	Yr 2002	Yr 2011	Yr 2002	Yr 2011	Yr 2002
R382	260	286[2]	96	106	36	40
R585	237	261	69	76	27	30
R2224	186	205	52	57	10	11
R171	183	201	53	58	22	24
R1469	180	198	47	52	20	22
R964	180	198	54	59	32	25
R621	168	185	72	79	28	31
R1107	167	184	50	55	14	15
R630	154	169	49	54	17	19
R912	147	162	40	44	18	20
AQO	300		150		80	

1 Predicted maximum values based on meteorological data for years 1990 to 1992.
2 The worst condition was predicted to occur 0.3% of the time in a year.

NO_2 levels at the hut (R1622) near the Toll Plaza area was also assessed for reference purpose. The hut was identified as being used for storage (non-sensitive use). NO_2 levels in years 2002 and 2011 were predicted to comply with the maximum 1-hour, maximum 24-hour and annual average AQOs.

As mentioned in the PDS2EA Northern Link Supplementary Paper, adverse air quality impact would be expected at some of the air quality sensitive receivers. However, some of those receivers located within the construction site boundary of the Project would be resumed and were discarded from the current assessment. Besides, the latest traffic compositions forecast has also indicated a lower portion of heavy vehicles when compared with the traffic projection made during the preliminary design stage and lower traffic impact would be expected. Therefore, modelling results of the current assessment showed that the predicted pollutants concentrations at those receivers such as Ha Ko Po Tsuen would no longer exceed the respective AQOs.

NO_2 levels at the roof level of the Pok Oi Hospital were also predicted to comply with the maximum 1-hour, 24-hour and annual average AQOs in year 2002. Concentrations would be 22%, 12% and 11% of the AQOs for 1-hour, 24-hour and annual average respectively

The 1-hour average NO_2 contour for year 2002 (worst affected year) is shown in Figure 5.2. The receiver heights were set at 1.5 m above local ground level.

5.5.3 Operational Phase (Air Quality associated with Noise Mitigation Option 4)

At a receptor height of 1.5 m above ground, and based on modelling results for year 2011 and a maximum 10% increase in NOx emissions in year 2002 over year 2011, NO_2 levels in year 2002 were predicted to comply with all NO_2 AQOs at all selected sensitive receivers. The maximum 1-hour average NO_2 concentration at the worst affected location was predicted to be 81% of the AQO. Results for the selected air quality sensitive receivers are tabulated in Table BNOP1XXE.XLS (Appendix I), based on meteorological data for years 1990 to 1992. The hut near the Toll Plaza area (R1622) was also included in the assessment.

Predictions for year 2002 were also made for receptor heights of 3 m, 4 m and 5 m above local ground level. Results are tabulated in Table BNOP2XXE.XLS and BNOP3XXE.XLS (Appendix J), and BNOP4XXE.XLS (Appendix K). At the worst affected location, maximum 1-hour, maximum 24-hour and annual average NO_2 concentrations at 3 m above local ground level were found to be 78%, 51% and 35% of the respective AQOs. Similarly for the sensitive receivers at 4m above local ground, the predicted concentrations are 76%, 49% and 35% of the respective NO_2 AQOs. Again, NO_2 concentrations at 5 m above ground were predicted to be 75%, 44% and 31% of the respective AQOs for NO_2.

NO_2 concentrations on the roof level of the Pok Oi Hospital were predicted to comply with the maximum 1-hour, maximum 24-hour and annual average NO_2 AQOs. NO_2 concentrations in year 2002 were predicted to be 21%, 11% and 11% of the AQOs for 1-hour, 24-hour and annual averaging periods respectively. No impact on fresh air intakes on the roof level of the hospital is expected.

Modelling results showed that the barrier arrangements under Noise Mitigation Option 4 was not predicted to result in NO_2 levels in exceedance of the AQOs at any sensitive receiver. The 1-hour average NO_2 contours for year 2002 (worst affected year) at 1.5 m, 3 m, 4 m and 5 m above local ground level are shown in Figures 5.3, 5.4, 5.5 and 5.6 respectively.

Table 5.8 shows the comparison of maximum 1-hr average NO_2 concentrations at the ten most affected sensitive receivers between the open road design and Noise Mitigation Option 4. Within the same sensitive receiver, NO_2 concentrations at different receptor heights under the Noise Mitigation Option 4 are similar, although the 1.5 m receptor height shows consistently slightly higher concentrations than other heights. Comparing NO_2 concentrations between the open road design and Noise Mitigation Option 4 at the 1.5 m receptor height at same sensitive receivers, the former shows considerably higher concentrations. Besides mitigating against road noise, the noise barriers in this case appear to also benefit the receivers by reducing potential air quality impacts.

Table 5.8 Comparison of the top ten highest maximum 1-hour average NO_2 concentrations between the open road design and noise mitigation 4

Open Road With SRs At		Noise Mitigation 4 With SRs At Heights							
1.5m Above Gd		1.5m		3m		4m		5m	
SR ID	1-hr Conc	SR ID	1-hr Conc	SR ID	1-hr Conc	SR ID	1-hr Conc	SR ID	1-hr Conc
R0382	286	R0382	242	R0382	235	R0382	228	R0585	226
R0585	260	R0585	229	R0585	228	R0585	227	R0382	219
R2224	204	R2224	204	R2224	204	R2224	203	R2224	202
R0171	201	R0171	178	R0171	177	R0171	175	R0171	173
R1469	198	R1469	173	R1469	172	R1469	171	R1469	170
R0964	198	R1107	165	R1107	164	R1107	162	R1107	160
R0621	185	R0964	163	R0621	160	R0621	159	R0621	159
R1107	184	R0621	161	R0964	160	R0964	156	R0964	151
R0630	170	R0630	152	R0630	151	R0630	150	R0630	150
R0912	162	R0912	151	R0912	151	R0912	150	R0912	150

5.6 Conclusions

5.6.1 Construction Phase

Modelling results indicate that TSP levels comply with the 1-hour average guideline limit and the 24-hour average and annual average AQOs at all sensitive receivers during construction. This agrees with the findings in the PDS2EA.

5.6.2 Operational Phase

Air quality impacts in the Northern Section (including portal emissions from Tai Lam Tunnel) resulting from the introduction of the Route 3 road network would be confined to the area in close proximity to the alignment. Modelling results show compliance with the 1-hour average, 24-hour average and annual average AQOs for NO_2 at all the selected sensitive receivers in years 2002 and 2011 under the current Open Road Design.

As some of the potential sensitive receivers are to be resumed and the future traffic compositions have been changed since the preliminary design stage, the overall impacts are less than those previously predicted in the PDS2EA.

The maximum 1-hour, maximum 24-hour and annual average NO_2 concentrations under the Noise Mitigation 4 scenario for years 2002 and 2011 were predicted to comply with the respective AQOs at the sensitive receivers.

Figure 5.1 Schematic Location Plan of Selected Air Quality Sensitive Receivers

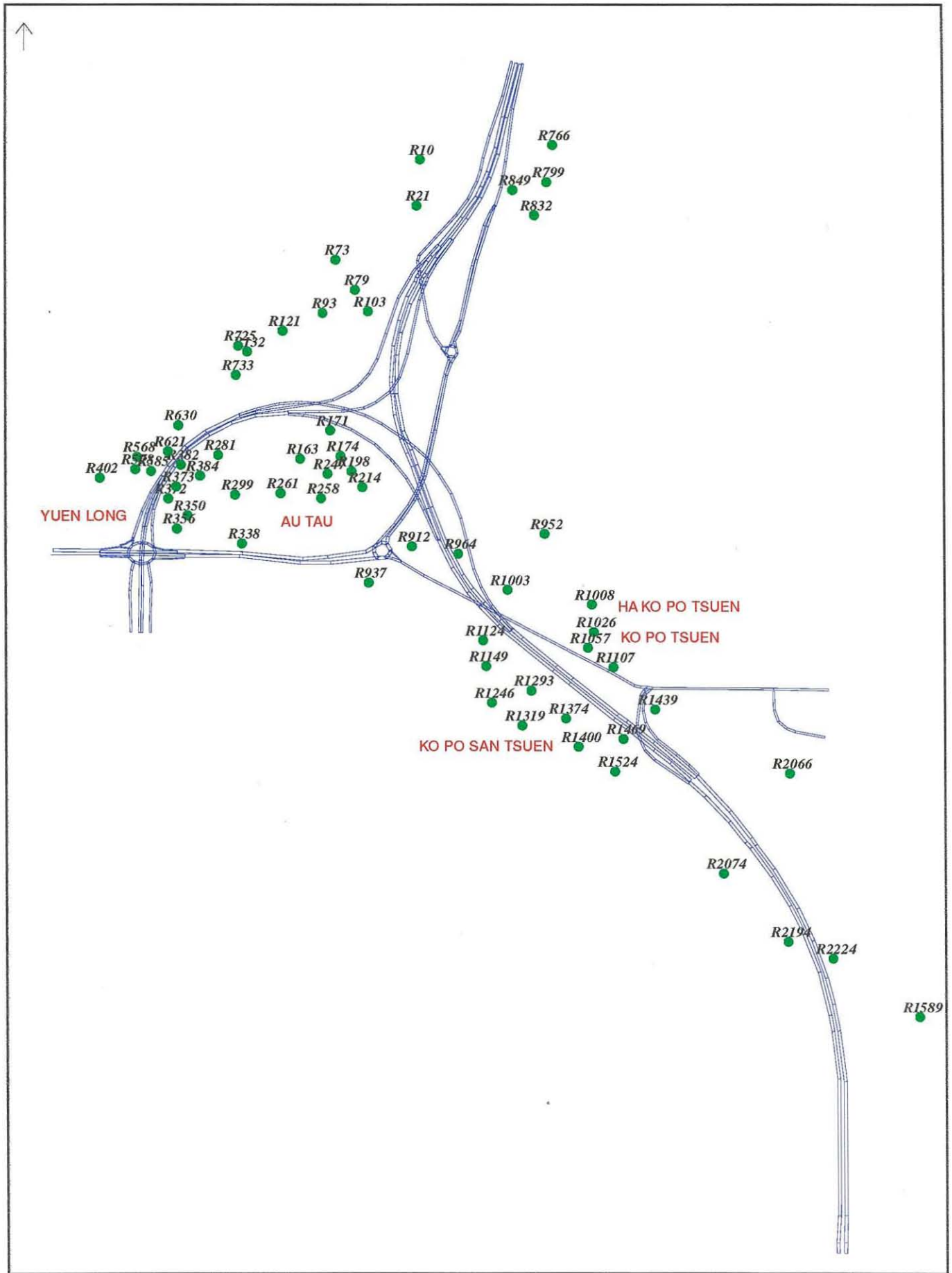


Figure 5.1 Schematic Location Plan of Selected Air Quality Sensitive Receivers

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 5.2 1-Hour Average NO_2 Contour at 1.5 m Above Local Ground Level (Open Road Design) in Year 2002

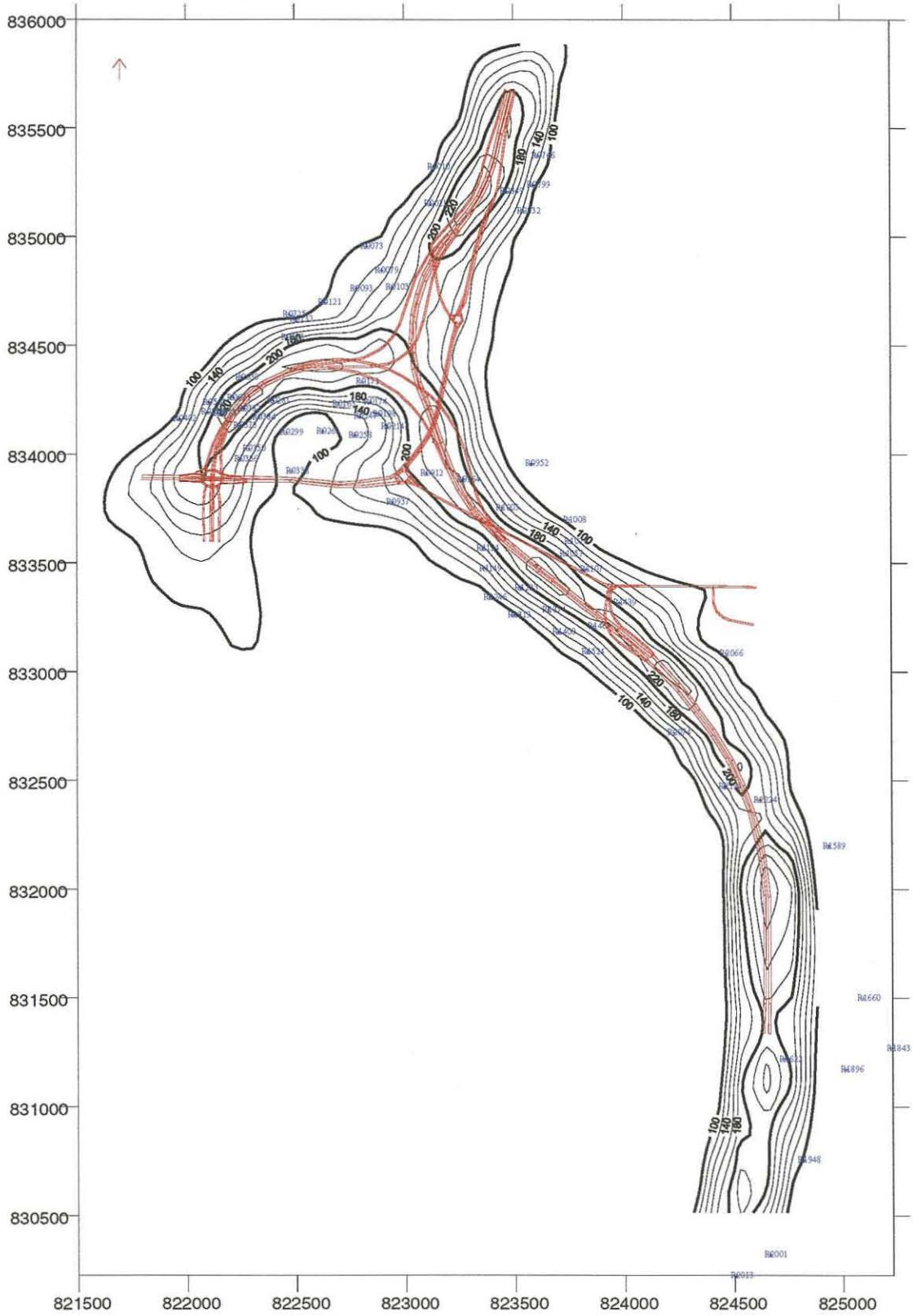


Figure 5.2 1-Hour Average NO_2 Contour at 1.5M above Ground Level (Open Road Design) in Year 2002

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 5.3 1-Hour Average NO_2 Contour at 1.5 m Above Local Ground Level (Noise Mitigation 4) in Year 2002

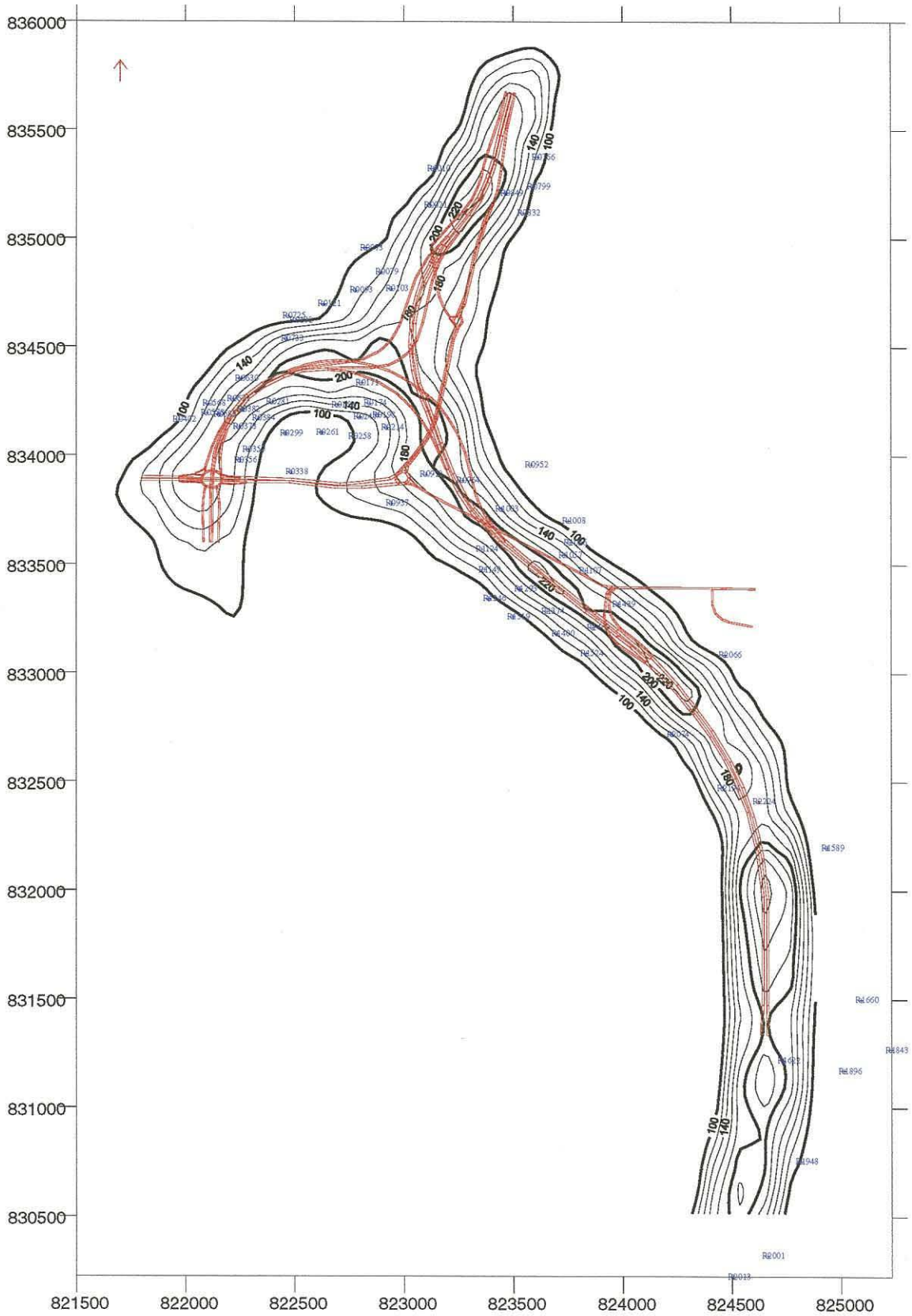


Figure 5.3 1-Hour Average NO_2 Contour at 1.5M above Ground Level (Noise Mitigation 4) in Year 2002

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 5.4 1-Hour Average NO_2 Contour at 3 m Above Local Ground Level (Noise Mitigation 4) in Year 2002

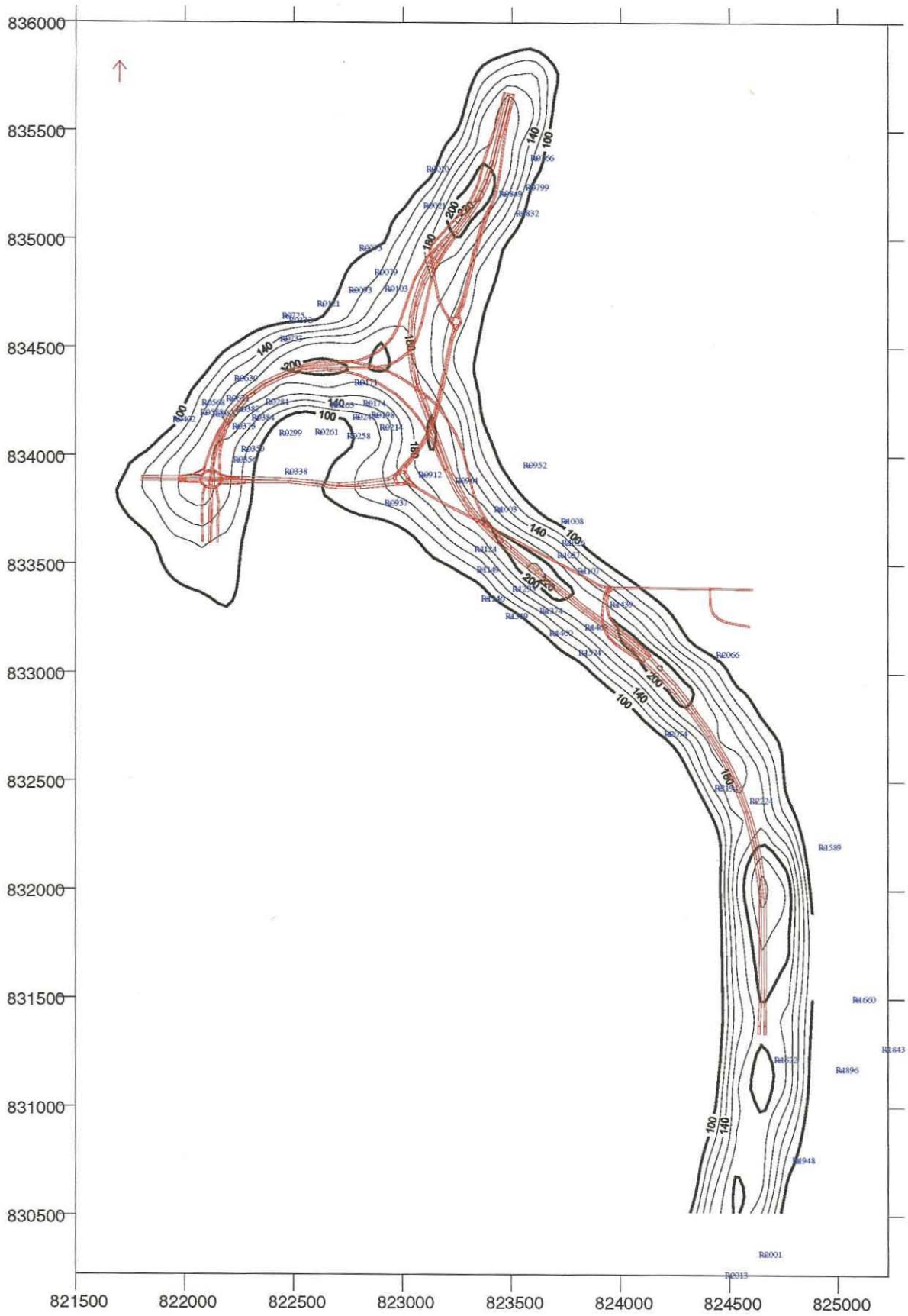


Figure 5.4 1-Hour Average NO_2 Contour at 3M above Ground Level (Noise Mitigation 4) in Year 2002

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 5.5 1-Hour Average NO_2 Contour at 4 m Above Local Ground Level (Noise Mitigation 4) in Year 2002

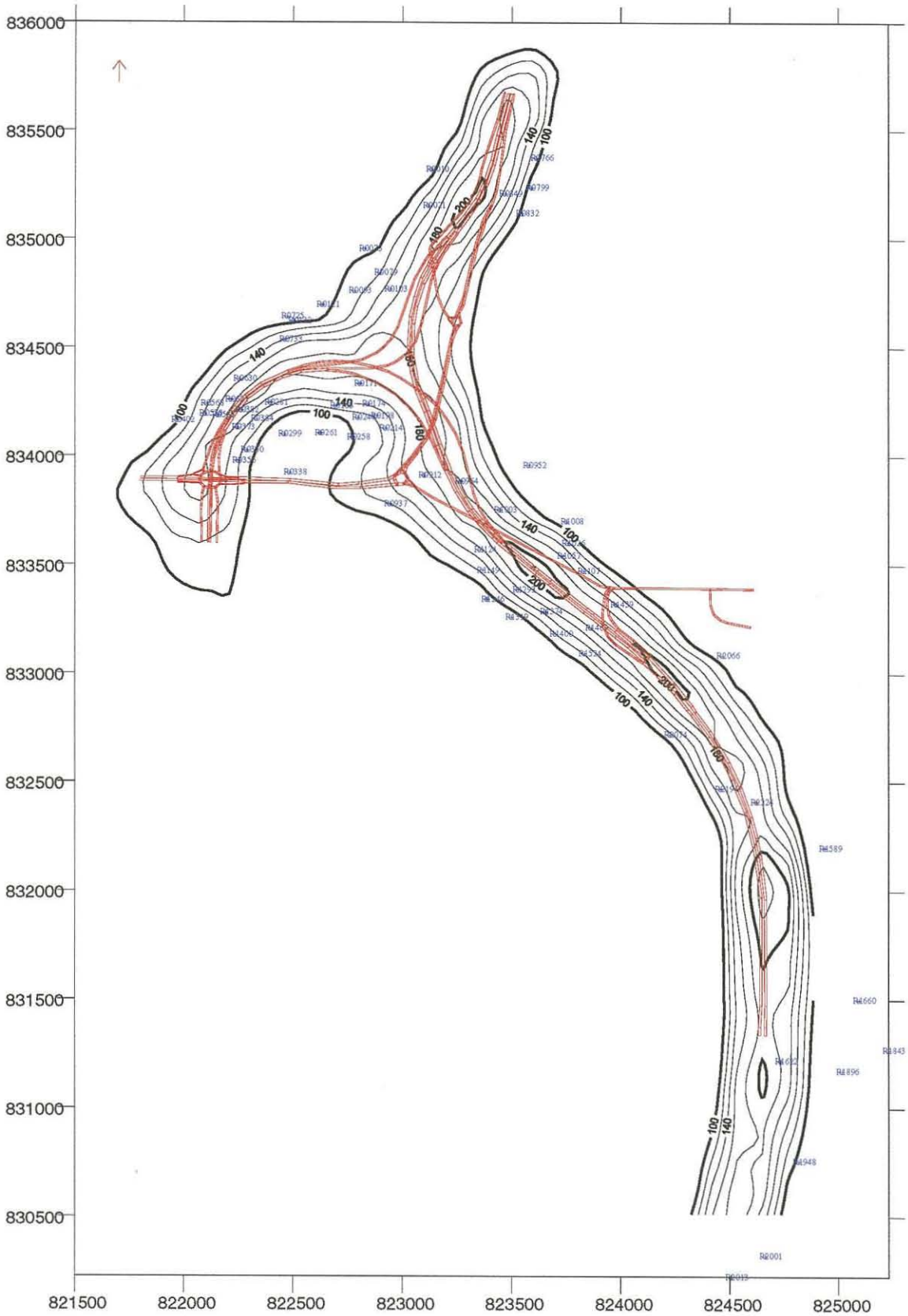


Figure 5.5 1-Hour Average NO_2 Contour at 4M above Ground Level (Noise Mitigation 4) in Year 2002

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 5.6 1-Hour Average NO_2 Contour at 5 m Above Local Ground Level (Noise Mitigation 4) in Year 2002

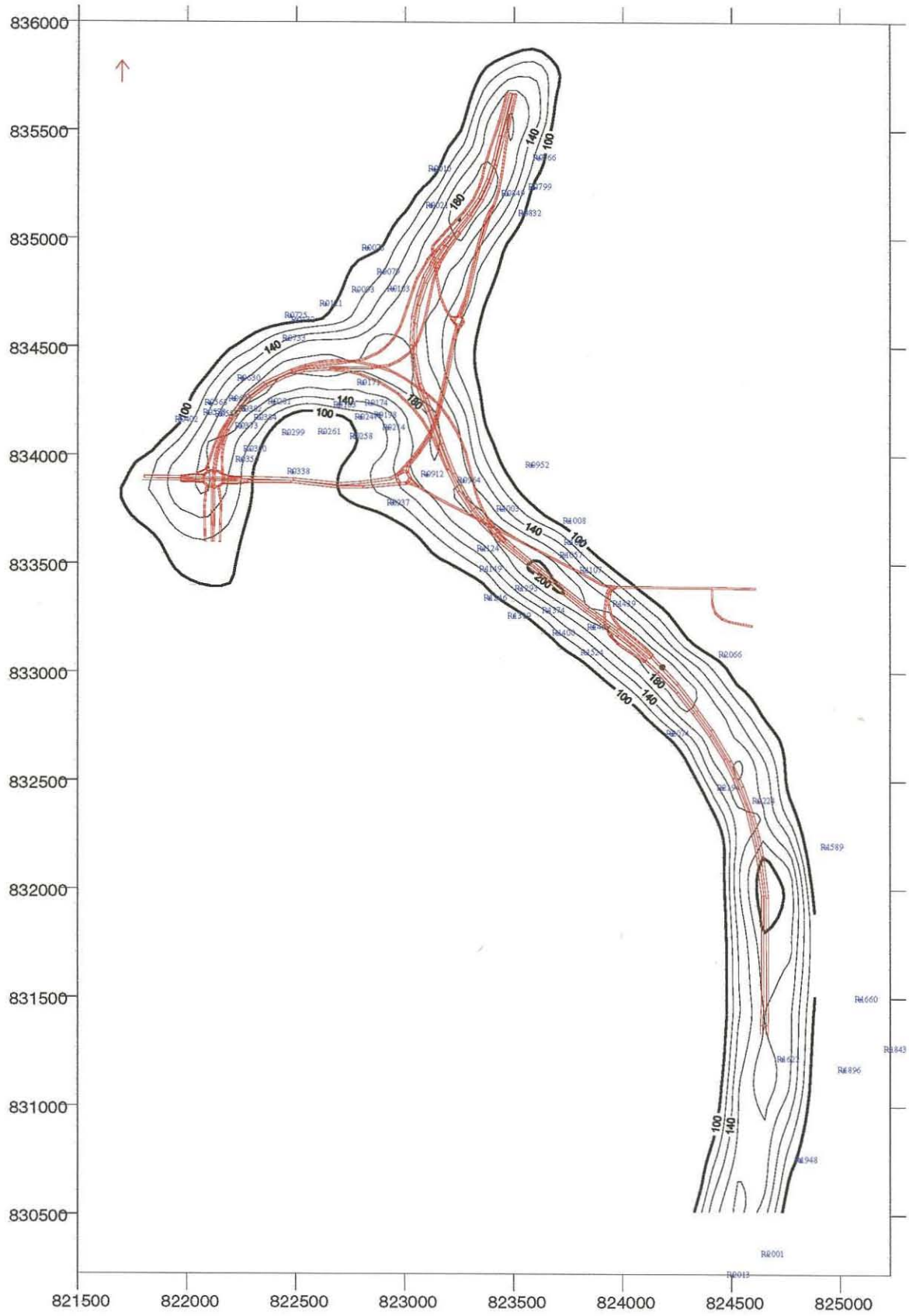


Figure 5.6 1-Hour Average NO_2 Contour at 5M above Ground Level (Noise Mitigation 4) in Year 2002

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

6 WATER QUALITY

6 WATER QUALITY

6.1 Legislation and Guidelines

The principal legislation which governs water pollution is the Water Pollution Control Ordinance [Cap. 358] (WPCO). This allows for Water Control Zones (WCZs) to be gazetted, within which discharge of liquid effluent and the deposit of matter into any water bodies, public sewers and drains are subject to licenced control. The Northern Section of R3 TLT & YLA falls within the Deep Bay WCZ. In principle, the WPCO controls water quality by controlling the quality of the effluent discharged into the environment. Even though the existing water quality in some areas may be poor, the effluent quality is still controlled under the Technical Memorandum (*TM*) - "*Standards for Effluent Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters*" promulgated under the WPCO. The *TM* sets standards for effluent to be discharged into the WCZ, other than for a discharge of domestic sewage into foul sewers.

For inland waters, the beneficial use of the receiving waters governs the quality of the effluent which is permitted to be discharged. The *TM* specifies four groups of beneficial use, namely Group A (abstraction for potable water supply), Group B (irrigation), Group C (pond fish culture) and Group D (general amenity and secondary contact recreation). Effluent standards for discharge into foul sewers and stormwater drains are also set in the *TM*.

In order to minimize construction impact on water quality, suggestions given in the Practice Note for Professional Persons PN 1/94 on "*Construction Site Drainage*" issued by EPD will be followed as far as possible.

6.2 Selected Sensitive Receivers

Figure 6.1 shows relative location of the major sensitive receiver, the Kam Tin River, and the alignment of R3. The streams and rivers in close proximity to the site are most likely to be affected (Figure 6.2). Although the river quality further downstream of the Kam Tin River is "very bad", care must be exercised to prevent further deterioration due to the works. It is also unlikely that the streams in the vicinity of Route 3 would be used by the pond operators due to the poor water quality. Based on discussions with pond operators in other studies, rain water has been the sole source for replenishing pond water. The remaining fish ponds outside the site boundary should be protected in terms of water quality as they provide important habitat for birds and amphibians. However, there will be no direct liquid discharge to these ponds from this project.

6.3 Assumptions and Input Information

Water quality impacts during both operational and construction phases of the project were discussed in the PDS2EA report. In general, the discussions in the PDS2EA remain valid but changes in the detailed design have been made to the alignment of the Au Tau Interchange and Link Road J (see Figure 2.1). Updated information on the operation and construction phases is included and discussed in this assessment.

6.3.1 Construction Phase

Updated information provided by R3CC regarding site drainage and construction methods was used for this assessment. Activities having potential water quality impacts are summarised in this section, followed by discussions on mitigation measures. Additional information includes:

- Temporary facilities including the site office, canteen workshop and precast yard will be provided on site.
- Maximum number of workers at peak is estimated to be approximately 350.
- Box culverts will be installed at the stream crossing along the road alignment (Figure 6.2).
- Settlement basins will be constructed as required for pond dewatering. Water quality will be monitored to ensure that it complies with the *TM* standards (Further details can be found in Section 6.4.2).

6.3.2 Operational Phase

For the operational phase, information was obtained from the construction proposal for the detailed design, which showed some changes in design and alignment from the PDS2EA. Design changes have been highlighted in Section 2.2.

6.4 Predicted Impacts

6.4.1 Committed Mitigation Measures

The following mitigation measures will be implemented, for the operational phase, as specified in the construction proposal:

- Sedimentation will be controlled by silt traps in gully inlets.
- Silt traps will be cleaned and maintained regularly to ensure that they function properly.
- Sedimentation basins will be provided at appropriate locations along the highway.

During the construction phase, R3CC is committed to take a pro-active approach to mitigate potential water quality impacts by implementing adequate mitigation measures prior to commencement of works affecting water quality. For example, settlement basins will be provided prior to the dewatering of fish ponds and commencement of major earthworks including adequate access arrangements. Other committed mitigation measures include the following:

- Temporary drains and stilling ponds will be installed prior to any major earthworks that expose bare soil.
- Drains will be constructed along the alignment of the access roads as well as around the temporary facilities and slope berms. Diversion ditches will also be installed to

collect run-off from areas of exposed soil. Water collected in drains and ditches will be diverted to temporary stilling ponds to allow for separation of sediment prior to discharge into the natural stream courses. The locations of the stilling pits are shown in Figure 6.2.

- All exposed areas will be hydroseeded as soon as possible to reduce the erosion potential and the levels of sediment laden run-off.
- Short-term stockpiles will be covered with tarpaulins to reduce sediment laden run-off, where possible. All run-off from the stockpiles will be collected in temporary drains and directed to the stilling ponds for desilting.
- Oil interceptors will be installed for the workshop and storage areas in compliance with EPD regulations. These will be emptied regularly and will have a by-pass to prevent flushing during periods of heavy rain.
- Office workshop and canteen facilities will be provided with appropriately sized septic tanks. Sewage and wastewater will be removed off-site to Sewage Treatment Works using a licensed contractor.
- Surface pond water and run-off liquor from pond mud will be treated prior to discharge where necessary. Surface pond water will be tested and if appropriate siphoned off and discharged into natural stream courses at a controlled rate. The remaining pond slurry will be pumped into adjacent settlement basins. The mud and settled slurry in the ponds and settlement basins will be mixed with completely decomposed granite to convert it into a suitable material for re-use on site.

6.4.2 Construction Phase

Potential water quality impacts during the construction phase are summarized below. The adequacy of the committed mitigation measures are discussed and further recommendations are made where appropriate. In general, effluent from the construction site, after suitable level of preliminary treatment, is likely to be of a better quality than that of the water in the existing Kam Tin River. The impact of construction activities on the water quality is therefore minimal, compared to the other sources of pollutants in the Kam Tin catchment.

Contamination of surface run-off from the construction sites

One potential water quality impact of construction activities is the increase of suspended solids, turbidity and sedimentation arising from the exposure of bare soil. Contamination of the surface run-off can be minimized by careful design of site drainage together with installation of stilling pits or detention ponds at appropriate locations. Ditches and drains will be provided to collect the storm water run-off and all the collected water will be diverted to stilling pits before discharging into natural streams. These ditches, channels and stilling pits will be maintained and the deposited silt and grit removed regularly, at the onset of and after each rainstorm to ensure that they function properly.

Locations of these stilling pits are shown in Figure 6.2. Due to the low lying, flat nature of the Au Tau area and the lack of natural stream courses, it is difficult to predict the exact discharge points for surface water. Only 1 stilling pit has been proposed at the Au

Tau Interchange area. In agreement with EPD's Local Control Office (LCO) stilling pits will be installed prior to the dewatering of the fishponds. Additional pits will be installed on an as required basis and all pits will be maintained for as long a period as necessary. The stilling pits will be sized based on 5 minute retention time, similarly to those between the North Portal and the Toll Plaza which met EPD (including their LCO) approval.

Increase of erosion due to exposure of earth

During cut and fill, erosion of exposed soil during rainy seasons would increase the suspended solids content in the run-off. The eroded gullies are also visually unpleasant. R3CC is committed to hydroseed exposed surfaces as soon as possible to keep the duration of impact to a minimum.

Sewage and other wastewater generated during construction

At peak, there will be about 350 workers employed at the site. Toilets and septic tanks will be provided for offices and workshops. There will be no discharge into watercourses. The septic tanks will be emptied regularly. Since the workers will be spread out on the site, chemical toilets will be provided and distributed over the site area.

Septic tanks will be provided for the wastewater from the canteens. Grease traps will also be installed to reduce the oil and grease content in the wastewater.

An oil interceptor will be installed in the workshops and storage areas in compliance with EPD requirements.

Contamination of surface waters during draining of fish ponds and excavation of pond mud

Construction works will involve dewatering of ponds and excavation of pond mud. Settlement basins will be constructed adjacent to the ponds to be dewatered. Approximately 55 ponds will be affected by the construction works, either permanently or temporarily. The total amount of water to be drained is estimated to be 682,000 m^3.

Surface water samples were obtained from five ponds in the Northern Section and two tributaries of the Kam Tin River (Figure 6.3) in July 1995 in order to compare the water quality of the pond water, existing river water and the discharge standards in the *TM*. Laboratory testings were completed and the detailed report is presented in Appendix L. Average water quality of the pond and river water is presented in Figure 6.4, which shows that most of the tested parameters for the pond water complied with the *TM* standards for discharges into Group D Inland Waters, and the pond water was much cleaner than the existing river water. Of the five ponds sampled, all showed compliance with *TM* standards on SS, BOD, chemical oxygen demand (COD), total phosphorus and ammonia nitrogen. Two ponds showed *E. coli* levels exceeding the *TM* standard and 4 ponds showed oil and grease levels considerably higher than the *TM* standard.

Since the water quality of the Kam Tin River is currently very poor (anoxic, nutrient rich, high oxygen demand and high bacteria content) and is unlikely to improve substantially in the near future, the comparatively cleaner surface water from the ponds will be pumped directly into the Kam Tin surface water. Consent to discharge the pond water will be obtained from EPD's Territory West Local Control Office for this type of one-off

dewatering. The licence is expected to be subject to the following conditions, same as those applied to the Southern Section:

- The discharge does not disturb the sediments both in the ponds and the receiving stream courses, resulting in raising suspended solids levels.
- The volume of water discharged would be controlled in order to avoid flooding of the stream courses.
- The discharge would not cause a discoloration to the water in the stream courses.
- Should there be any complaint from local residents downstream of the discharge point, the methods of discharge would be revised where practical.

Pond dewatering will be carried out as follows to reduce the impact:

- Discharge will be distributed over time to avoid large instantaneous discharges and to allow any disturbed sediment to settle. This would involve optimising the flow rate where necessary.
- Discharge will be distributed over the stream course to avoid large instantaneous discharges at one location in the stream course. This could be achieved by distributing the ponds to be discharged at any one time.
- Detention ponds will be suitably sized to allow disturbed sediments to settle prior to discharge of the water. Sediments would be allowed to settle for as long a time as practicable.
- A filter will be used at the point of pumping to trap sediment.

The near-bottom pond water and pond mud will form a slurry at the bottom of the dewatered pond. This slurry will be pumped into an adjacent settlement basin for settling. The supernatant water will be tested and further treated if required.

The remaining mud in the ponds and the settlement basins (approximately 0.2 Mm^3 in volume) will be allowed to dry out. The temporary stockpiling will be controlled to collect any run-off liquor. The run-off liquor will be tested for contamination and if necessary treated for discharge to the stream courses or sent to an approved disposal facility. Further details regarding handling of pond muds are discussed in Chapter 9.

Where ponds are not required for permanent flood protection or not covered by the permanent works, they will be re-instated as per the Construction Requirements. These specify that the ponds will be returned to their original condition, including water quality, and where appropriate to provide suitable enhancement measures to improve their ecological value. This aspect is discussed in detail in Section 7.0.

6.4.3 Operational Phase

Potential impacts during the operational phase are summarized below:

Change in the catchment area's characteristics

The introduction of Route 3 will inevitably change the characteristics of the catchment area. Fish ponds will be backfilled along the road alignment. Streams crossing the route will be connected by box or pipe culverts.

Road run-off

The major potential impact is the pollution of rivers and streams by run-off and washwater from the road and its associated link roads. Such run-off may contain an elevated suspended solids loading. Contamination of the run-off can also arise from the loss of oil and petroleum and associated heavy metals such as lead, zinc and cadmium from passing motor vehicles; accidental spillage; and/or road traffic accidents. Contaminant levels in road and urban area run-off have been measured in several studies. The concentrations of certain pollutants with the higher range of values have been reported from the 'first-flush' event. Pollutant concentrations typically decline rapidly during a rainstorm event. However, as concluded in the PDS2EA, contaminants found in the run-off from R3 would not be any different to those found in any other run-off derived from large scale, urban vehicular transport infrastructure.

Several preventative measures can be taken to reduce the concentration of trace contaminants in highway run-off. Provision of silt traps, as committed, will help to reduce the level of suspended solids in the run-off. Contaminants, for example, lead and zinc associated with the sediments will also be removed through the sedimentation process occurring in the silt pond. These silt traps will be cleaned and maintained regularly to ensure that they function properly.

As suggested in the PDS2EA, accidental spillages or leakages resulting from traffic accidents or run-off from fire-fighting, will be contained by the installation of 'close-off' valves at strategic points within the road drainage system. In the event of a spillage or leakage of hazardous/toxic compounds, the valves will be closed so as to retain the material in the drainage for collection and proper disposal. Oil absorbent media can also be used to trap oil and grease during accidental spillage. The necessary procedures to minimize pollution during accidents will be explicitly specified in the operation manuals or procedures. R3CC has included the installation of "close-off" valves in the design, the locations of which have not yet been finalised. Operation manuals for the highway will be produced at a later stage of the project.

The quantity of run-off resulting from fire fighting, accidental spillages of oil, and traffic accidents is unpredictable. However, the frequency of their occurrence is considered to be very low.

6.5 Conclusions

6.5.1 Construction Phase

Construction impacts relate mainly to surface run-off from the site. R3CC is committed to provide drains, ditches and stilling pits to mitigate against impact on water quality. Oil interceptors will be provided where necessary.

Wastewater generated from the site will be diverted to septic tanks. Chemical toilets will be provided at remote areas. Grease traps will be installed to reduce the oil and grease content in the wastewater from the canteens.

Consent from EPD's Local Control Office will be obtained for pond dewatering.

6.5.2 Operational Phase

Residual impacts are similar to those identified in the PDS2EA. The main residual impacts are related to the surface run-off from the highway. However, the run-off is not expected to be any different from that generated from any other large scale vehicular transport infrastructure. The impact will be reduced through the installation of silt traps at strategic locations and effective management in the case of spillages or traffic accidents. The silt traps will be regularly cleaned and maintained to ensure proper functioning.

Figure 6.1 Water Sensitive Receivers

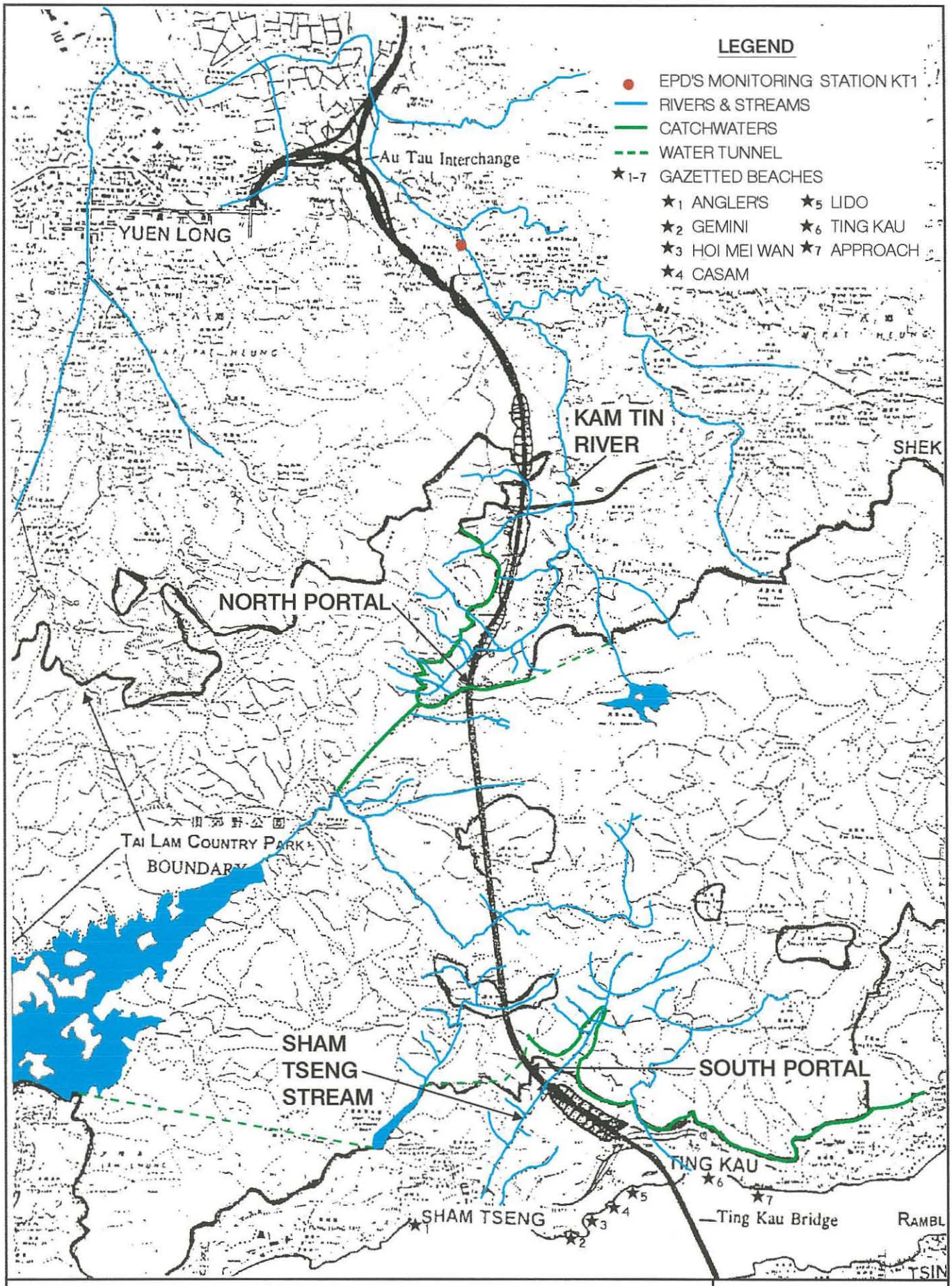


Figure 6.1 Water Sensitive Receivers

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 6.2 Existing Streams and Proposed Box Culverts at the Northern Section

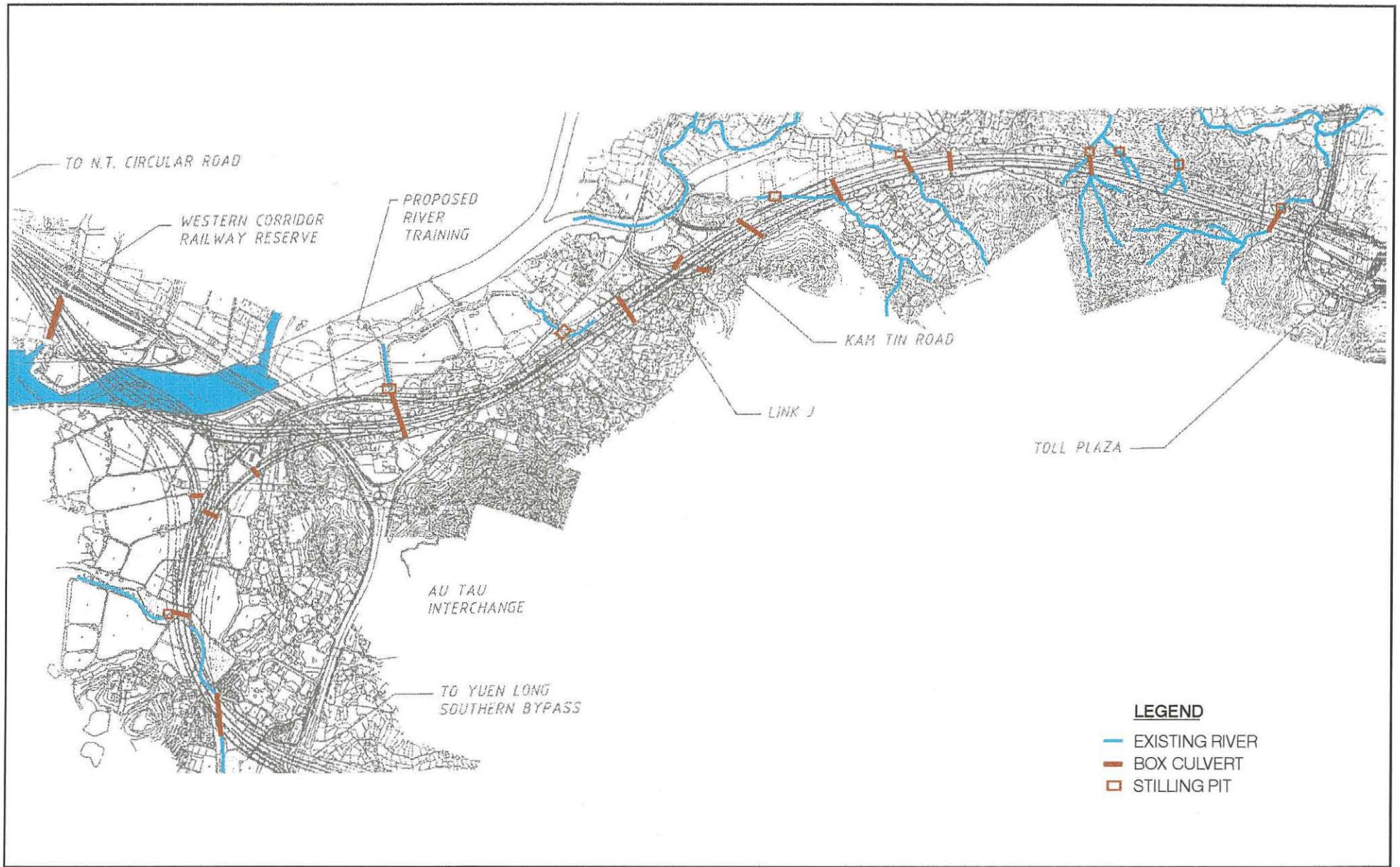


Figure 6.2 Existing Streams and Proposed box Culverts at the Northern Section

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 6.3 Sampling Location for Pond Water Testing

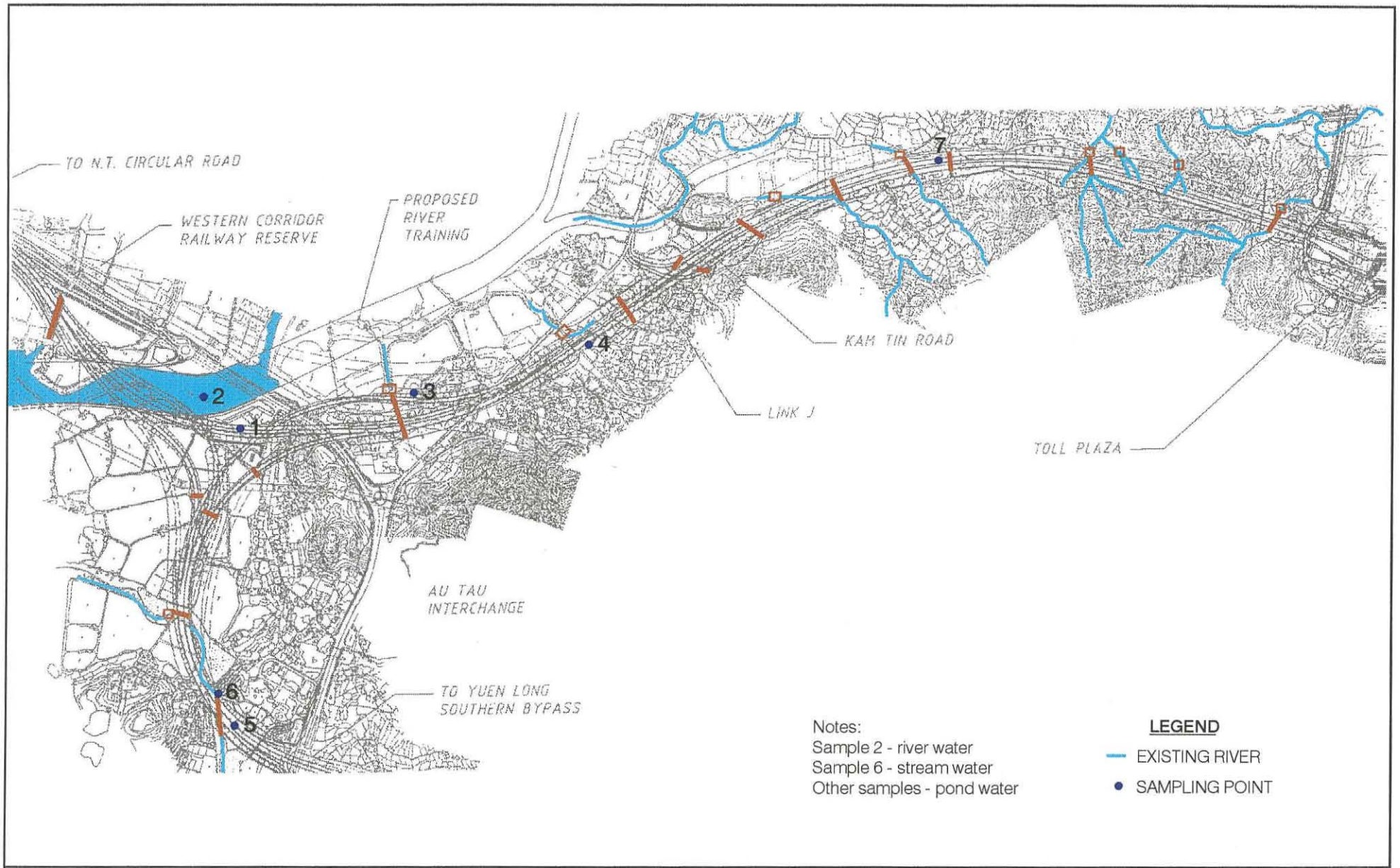
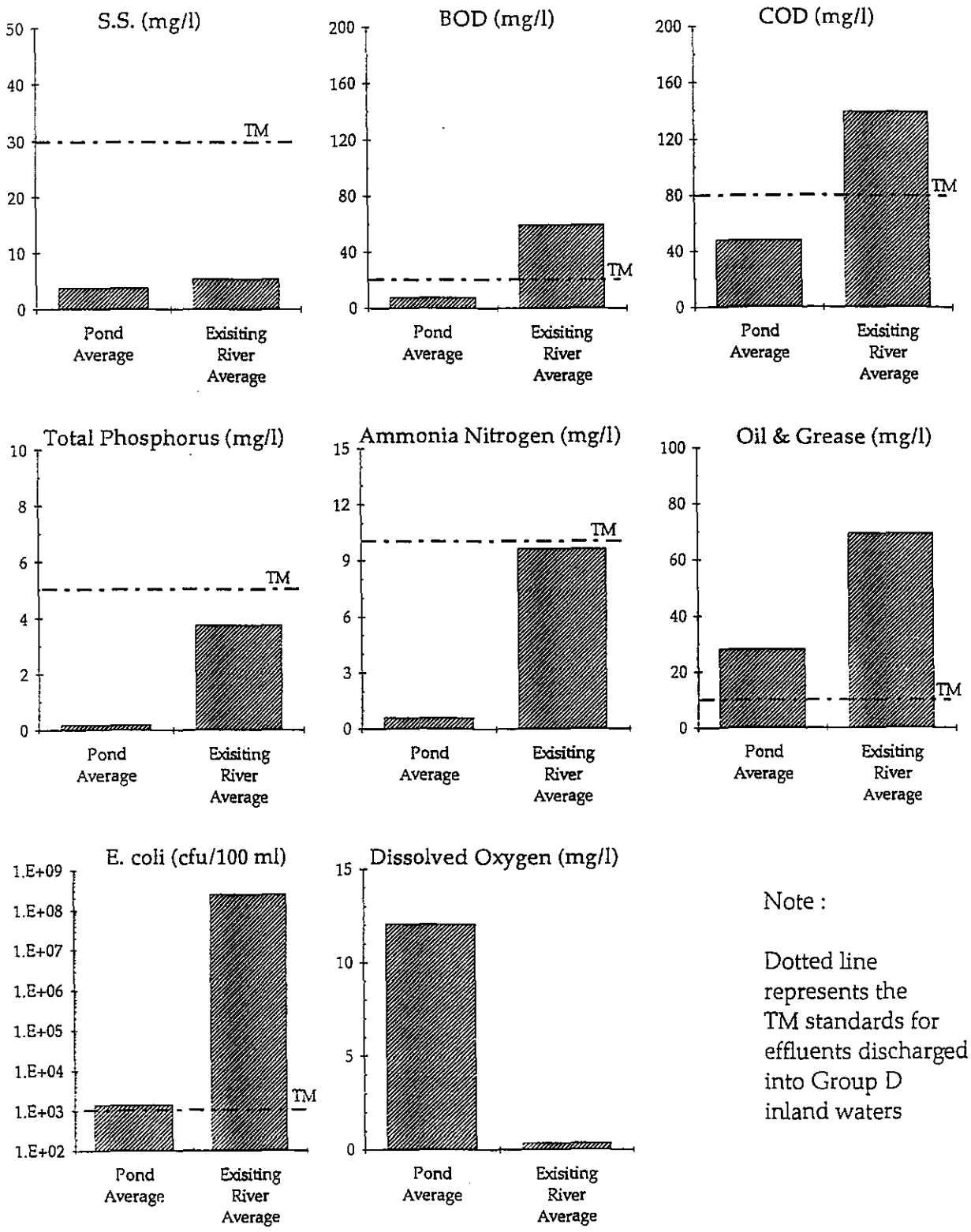


Figure 6.3 Sampling Location for Pond Water Testing

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 6.4 Water Quality in Ponds to be Drained



Note :

Dotted line represents the TM standards for effluents discharged into Group D inland waters

Figure 6.4 Water Quality in Ponds to be Drained

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

7 ECOLOGY

7 ECOLOGY

7.1 The Study Area

The study area for ecological impact assessment on the Northern Section of R3 TLT & YLA was defined as all land within the works boundary from the proposed Toll Plaza northward to Yuen Long. The PDS2EA (Freeman Fox Maunsell 1993a, 1993b) described the existing ecological resources and potential impacts in two areas, both of which overlapped the area named "Northern Area" in this report. The road section from the Toll Plaza north to Kam Tin Road was described in Freeman Fox Maunsell Volume 3A Part I (1993a), and in Freeman Fox Maunsell Volume 3B, Appendix A11 (1993b). The road section from Kam Tin Road north to the project boundary was described in Freeman Fox Maunsell Volume 3 Part II (1993a).

From the proposed Toll Plaza north to Au Tau, Kam Tin Valley has been densely populated and intensively developed for agriculture (vegetable and ornamental plant farming) and light industry. All habitats on the valley floor were man-made. The only areas retaining topography which have not been significantly re-contoured for development were the hill slopes between the R3 alignment and the Tai Lam Country Park boundary. Valley floor topography was mainly flat with an imperceptible northward slope along the gradient of the Kam Tin River.

The vicinity of Au Tau Interchange has been intensively developed for commercial fish culture, light industry, and limited farming. A portion of the Main Drainage Channel project was underway along Kam Tin River during Spring 1995. The only area retaining original topography was a small hill northwest of the existing Au Tau roundabout which supported shrub and tree cover. This hill is an important burial site on which the natural vegetation is frequently removed by hill fire.

7.2 Relevant Hong Kong Regulations

Hong Kong Government regulations relevant to this assessment include the following:

- the Forests and Countryside Ordinance (Cap. 96), which protects both natural and planted forests;
- the Forestry Regulations, which provide for protection of listed local wild plant species;
- the Wild Animals Protection Ordinance (Cap. 170), which provides for protection of listed species of wild animals (excluding fish and marine invertebrates) by prohibiting the disturbance, taking or removal of animals and/or their nests or eggs;
- the Animals and Plants (Protection of Endangered Species) Ordinance (Cap. 187), which controls the import, export and possession of specified endangered species; and
- the Country Parks Ordinance (Cap. 208), Part IV which regulates development within country parks.

7.3 Relevant International Conventions

Ramsar Convention

Through the United Kingdom, Hong Kong is a Party to the 1971 Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the *Ramsar Convention*). Contracting parties to the Ramsar Convention are required to recommend at least one wetland for inclusion in the Ramsar Convention "List of Wetlands of International Importance". Within Hong Kong Mai Po/Inner Deep Bay was designated as a Ramsar site on 4 September 1995.

Article 1 of the Ramsar Convention defines wetlands as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters." All streams and man-made fish ponds in the study area qualify as wetlands under this definition.

Ramsar Convention "Wise Use" Concept

Article 3.1 of the Ramsar Convention calls upon the Contracting Parties to formulate and implement their planning to achieve the "wise use" of wetlands in their territory. At the 1987 Third Meeting of the Conference of the Contracting Parties to the Ramsar Convention in Regina, Canada, "wise use" of wetlands was defined as "their sustainable utilization for the benefit of mankind in a way compatible with the maintenance of the natural properties of the ecosystem" (Davis 1993).

Although some wetlands within the project area have been created or altered by mankind (fish ponds in particular), there are important natural properties of these ecosystems (Melville *et al.* 1994, Chu 1995, Wilson 1995) which must be maintained to meet Hong Kong's obligations under the Ramsar Convention.

Bonn Convention

Also through the United Kingdom, Hong Kong is a Party to the convention on the Conservation of Migratory Species of Wild Animals (*The Bonn Convention*). The Bonn Convention has two major objectives:

- to provide strict protection for species listed in Appendix I of the Convention (migratory species in danger of extinction throughout all or a significant portion of their range); and
- to encourage Range States to conclude agreements for the conservation and management of Appendix I (defined above) and/or Appendix II species (migratory species which have an unfavourable conservation status and require international agreements for their conservation, or which have a conservation which would significantly benefit from international cooperation). At present no such agreement is relevant to Hong Kong.

The first objective above includes obligations to conserve and restore those habitats which are important in removing the species from danger of extinction, and to prevent, remove, compensate for or minimise the adverse effects of activities or obstacles that impede or

prevent mitigation of the species. None of the species recorded in the study area is listed in Appendix I of the Bonn Convention.

7.4 Agriculture & Fisheries Department Fish Pond Categories

Hong Kong fish ponds were categorized by the Agriculture & Fisheries Department (AFD) into three grades depending on size of ponds, proximity to other ponds, quality of management, security from development, and access (AFD undated map). Although this system is not contained within any body of regulation relative to conservation or development, it is a useful guide for assessing the nature of fish ponds in specific areas within Hong Kong. Therefore, this classification scheme is used in this study. Table 7.1 lists the AFD categories of fish ponds. It should be noted that conservation of native flora and fauna was not a criterion for AFD fish pond classification. There is, however, a general relationship between the classification scheme and the potential for ponds to provide foraging areas for birds: the better managed, more secure ponds (Grade A ponds) would be expected to provide larger and more reliable foraging areas over a longer time period than would the Grade C ponds, which are susceptible to conversion for other uses and are not as well managed.

Table 7.1 AFD categorization of fish ponds in Hong Kong

Grade	Classification Criteria
A	Well established pond fish culture areas with good potential for further development. Substantial amount of fish ponds is actively operated and well managed. Access to the site is good.
B	Established pond fish culture areas with small numbers of fish ponds most of which are actively operated and well managed. Further development is limited either by the remoteness of the site, availability of suitable land or vulnerability to flooding. Access to the site is fairly good.
C	Areas with scattered small fish ponds and substantial amount of fish ponds are either idle or filled. They are subject to high development pressure due to proximity to developments.

7.5 Vegetation

Based on the PDS2EA (Freeman Fox Maunsell 1993a), the only vegetation type considered to be subject to impacts that are potentially of conservation significance was woodlands. Shrubland and grassland habitats were found to support species which are locally common on upland sites which are subject to frequent disturbance by fire. Riparian and wetland vegetation were found to be typical of human-altered habitats. Therefore, for the purpose of this section only impacts to woodlands are addressed.

7.5.1 Woodland

The foothill southeast of Ko Po San Tsuen supported a Fung Shui Woodland covering an area of about 0.3 ha with trees including *Bridelia tomentosa, Pinus massoniana, Microcos paniculata, Phyllanthus emblica, Melia azedarach,* and *Macaranga tanarius*. The understorey was composed of shrubs including *Litsea rotundifolia, Psychotria rubra, Trema orientalis,* and *Ficus hirta* and climbers including *Smilax china, Tetracera asiatica* and *Stephania hernandifolia.*

The higher elevation portions and western slopes of the small foothill at the Au Tau Interchange were covered with fairly inaccessible woodland measuring about 0.5 ha in surface area. The vegetation consisted of tall grasses and well developed stands of trees including *Cinnamomun camphora, Litsea glutinosa, Leucaena leucocephala, Mallotus apelta, Pinus massoniana, Rhus chinensis, Rhus succedanea,* and *Sapium sebiferum.* Understorey consisted of shrubs including *Brucea javanica, Ficus hirta, Melastoma sanguineum, Rhodomyrtus tomentosa,* and *Wikstroemia indica.* Climbers included the exotics *Ipomea carica* and *Mikania micrantha,* and the native species *Lygodium japonicum* and *Rubus parvifolius.* The two exotic climbers are considered pest species in the New Territories.

Both woodlands will be reduced in area by the current alignment. Both sites were to be affected to a similar extent by the preliminary design stage 2 (PDS2) alignment. Therefore, there is no additional impact to woodland from the final design.

7.5.2 Endangered/Protected Species

No species of plant recorded on the proposed disturbance area is listed as rare or endangered in Hong Kong. *Rhododendron simsii* was reported in Freeman Fox Maunsell (1993a) as occurring on the northern study area. The reported location of *R. simsii* was south of Ho Pui Village in the foothills outside Tai Lam Country Park, and beyond the proposed disturbance limits of the project. *R. simsii* is protected under the Forestry Regulations (Cap. 96, section 3), and is the most common and widespread wild rhododendron in Hong Kong.

7.5.3 Vegetation/Habitat Impacts

Total loss of habitats due to the project is estimated in Table 7.2. The calculation is based on the following assumptions:

- All vegetation within the construction boundary (which was delineated only on the final design) will be destroyed.
- Fish ponds to be restored to fish or wildlife production following completion of construction are those indicated in Section 7.7 of this report.

There was an apparent increase in loss of shrubland, grassland, and agriculture/built-up habitats resulting from revisions to achieve the final design. There was no change in the predicted loss of woodland or marsh habitat from the PDS2 stage compared to the final design. The area of fish ponds to be permanently lost due to the project was reduced by 0.6 ha between preliminary and final designs. In the case of shrubland, grassland, and agriculture/built-up habitats, the increase in habitat loss is insignificant in scale, and could well be attributed to the greater degree of detail shown on the final plans (R3CPS/131/001 to 006 dated 3 April 1995) as compared to the PDS2 plans (92393/01/001 to 016 dated July 1993).

Table 7.2 Estimated loss of habitats (ha) in north study area

	Preliminary Design	Finalized Design
Woodland	0.8	0.8
Shrubland	2.3	3.0
Grassland	2.0	2.4
Agri-Disturbance[1]	24.9	34.0
Fish Ponds[2]	13.69	13.09
Marsh	0.44	0.44

1 Includes cultivated land, buildings and roads
2 Permanent loss only

7.5.4 Mitigation of Impacts to Vegetation

Impacts of cut and fill operations on upland grassland and shrubland sites will be mitigated by effective erosion control and revegetation. In addition to the fill areas and cut slopes within the works boundary, approximately 52 ha are available for compensatory planting outside the works area (Fig. 7.1). These areas were recommended by AFD for use in off-site mitigation. Planting in this area would not only aid in restoration of habitats lost due to construction of the highway but would also potentially enhance existing habitats along the boundaries of Tai Lam Country Park. Because of the conservation significance of the Country Park and the risk that nearby expressway traffic would degrade the overall conservation resource value, it is considered important to provide extensive compensatory planting in areas between the alignment and the Country Park boundary.

One location for off-site planting is the eroded hill slope west of Ma On Kong (52 ha) bordering onto the Route 3 alignment and proximate boundary of Tai Lam Country Park. This is an eroded hill slope which borders on the alignment of Route 3. Together with the fill areas and cut slopes, the generally accepted guideline in Hong Kong for native woodland habitat restoration in a 3:1 ratio (re-planted:lost) will be met. The loss of woodland on the northern area would be 0.8 ha. Re-planting in a 3:1 ratio would require 2.4 ha of the 52 ha available off-site total.

Revegetation of on-site and off-site areas will enhance vegetation establishment and succession. As specified in the PDS2EA (Freeman Fox Maunsell 1993a), plant species indigenous to the site which provide cover and forage value for wildlife should be selected for use in revegetation. A list of such species which occurred on the site prior to disturbance is given in Table 7.3. Additional tree and shrub species to be used for fill slope revegetation are *Melastoma sanguinea, Eurya chinensis,* and *Castanopsis fissa.*

Table 7.3 **Native plants recorded on the study area during 1993-1995 surveys which provide forage sources for birds and which are recommended for use in revegetation** (After Corlett 1992)

Species	Habitat	Birds	Attract	Period
Bridelia tomentosa	small tree	4	xxx	Dec-Mar
Celtis sinensis	tree	2	xxx	Jun-Aug
Cinnamomum camphora	large tree	5	xxx	Nov-Jan
Diospyros morrisiana	tree	2	xx	Dec-Jan
Ficus superba	tree	3	xx	irregular
Litsea rotundifolia	shrub	8	xxx	Oct-Dec
Macaranga tanarius	tree	5	xxx	Jun-Jul
Machilus breviflora	tree	1	x	Oct-Jan
Mallotus paniculata	small tree	3	xxx	Dec-Jan
Rhaphiolepis indica	shrub	6	xxx	Dec-Jan
Rhodomyrtus tomentosa	shrub	8	xxx	Aug-Nov
Rhus chinensis	small tree	12	x	Nov-Dec
Sapium discolor	tree	3	xxxx	Oct-Dec
Sapium sebiferum	tree	7	xx	Nov-Jan
Schefflera octophylla	tree	4	xxxx	Jan-Mar
Sterculia lanceolata	tree		xxxx	Jul-Sep

Note: Birds = number of birds species known to eat the fruit
Attract = relative attractiveness to birds
Period = main fruiting period

Wetland Habitat Restoration

Because habitat preservation through adjustment of the highway alignment is not possible, it will be important to contain construction works to the minimum possible land area to avoid unnecessary habitat destruction. Riparian habitats are particularly sensitive and will be avoided.

Mitigation for losses of shrubland, woodland, and fish pond bund habitats can be accomplished to some extent through revegetation of the fill slopes and embankments of restored fish ponds. This could provide important habitats which are currently sparse or lacking in the Au Tau area. Restoration of ponds is discussed in relation to impacts to avifauna in Section 7.7.6.

As indicated in Section 7.7.6, bamboo and riparian tree species will be included in the revegetation plan, particularly in association with restored fish ponds and drainage channels. This will promote long-term availability of preferred nesting substrates for herons and egrets in areas currently known to be used by breeding birds. As noted in Section 7.7.4, all heron nests in the northern area were constructed in stands of bamboo. Bamboo species recommended for revegetation of drainage channels and pond edges are:

- *Bambusa chungii*
- *Bambusa sinospinosa*
- *Bambusa texilis*
- *Dendrocalamus latiflorus*

The following tree species will be planted along channels and at pond edges in association with the above bamboo species:

- *Cleistocalyx operculata*
- *Syzigium jambos*
- *Sterculia lanceolata*
- *Sapium sebiferum*

7.6 Stream Ecology

The reach of Kam Tin River within the northern study area will be channelled under the Main Drainage Channel Project. Therefore, potential impacts of the Route 3 project on Kam Tin River stream ecology are not addressed by this report.

7.7 Birds

7.7.1 General Species Surveys

Birds were recorded visually and audially on the site between May 1993 and May 1995. The objective of birds surveys was to document occurrence of birds on the site, and to identify nests, perches, roosts, and other important habitats. Taxonomy and common nomenclature follow Viney *et al.* (1994).

7.7.2 Heronry Studies

Heronries or egretries are colonial nest sites of birds of the family Ardeidae, including herons and egrets. Heronries at Tung Shing Lei and Ko Po Tsuen were studied during March, April and May 1995 to assess winter use of the heronries and to quantify nest numbers. Heronry sites are shown in Fig. 7.2. The purpose of the studies was to determine the nature and magnitude of the potential impacts of the R3 TLT & YLA on ardeids which breed and/or winter in the vicinity of the two heronries.

The Tung Shing Lei heronry had not been previously reported because it was discovered during April 1995 during field studies for this project. The Ko Po Tsuen heronry was first discovered in summer 1994 (K. W. Cheung, Conservation Division, AFD), therefore was not described in earlier reports.

Nest counts were made at both heronries during April and May 1995. Birds and nests were observed with 10x binoculars and a 25-60x spotting scope. At Ko Po Tsuen heronry nest counts were made from the ground and from the top of three-storey apartment blocks which were adjacent to the heronry and were under construction during the study period.

7.7.3 Results of Bird Surveys

Birds recorded on the north study area during May 1993 and October 1994 through May 1995 are shown in Table 7.4. A total of 59 species was recorded, representing 27 families.

Although some species seen on the northern study area were uncommon in Hong Kong, most are common and widespread residents or seasonal visitors to the Territory. Nests recorded on the proposed disturbance area included those of the Chinese Pond Heron,

the Little Egret, the Cattle Egret, and the Magpie. Nests of passerine species were probably located within the disturbance boundaries but no specific search for such nests was conducted.

Habitats of greatest importance were riparian wetlands, fish ponds and associated bunds, and upland woodlands. Agricultural and village habitats were of little utility to birds other than the most common habitat generalists such as Tree Sparrows and Bulbuls. Wetlands near Au Tau were larger and less impacted by development of villages, roadways, and commercial or industrial firms than were those nearer the proposed Toll Plaza. Au Tau wetlands supported large numbers of water birds. Upland habitats near Tai Lam Country Park also supported large numbers of birds with diverse species representation. The wetland and wooded areas west of Shek Wu Tong Village supported abundant bird life. Pied, Common and White Breasted Kingfishers were recorded repeatedly on the fish ponds in this area together with Chinese Pond Herons and Little Egrets, which foraged on ponds and along Kam Tin River. No direct impact on the wetland area to the north of Kam Tin (the area described in Diskin and Pearse 1994, Birding Hong Kong) has been predicted from the Route 3 works.

7.7.4 Heronry Study Results

Ardeid Use of Ko Po Tsuen Heronry During Spring 1995

Ardeids used the Ko Po Tsuen heronry during spring 1995 as a breeding site. Only one species, the Chinese Pond Heron, was observed nesting. On 6 May 1995, 35 nests were active in 3 separate stands of bamboo. Three of the 35 total nests were in living bamboo, and the remaining 32 nests were in bamboo which flowered and died during summer 1994. No nests were located in species other than bamboo. Nestlings were not observed, but egg shell fragments were seen on the ground beneath the nests. Adults were incubating at all nest sites on 6 May 1995.

The heronry was first reported in 1994 when it supported approximately 27 nests (K.W. Cheung, Conservation Division, AFD, pers. comm). In 1994, 5 nests were occupied by Little Egrets, 2 by Chinese Pond Herons, and 20 by Cattle Egrets. Reasons for abandonment of the site by Little Egrets and Cattle Egrets are not known. These species may be less tolerant of human disturbance than Chinese Pond Herons.

The village of Ko Po Tsuen surrounds the heronry site, and residential construction was underway during the 1995 breeding season. A development of three-storey flats was partially completed, and interior finishing was in process some 30 m distant from nesting herons (Figure 7.3). Additional small construction projects including installation of fencing were in process less than 20 m from nests in the western stand of bamboo.

The western bamboo stand was located 170 m from the nearest proposed Route 3 works area, and the eastern stand was 200 m from the nearest works area. Both nest sites were located 130 m distant from Kam Tin Road. Both nest sites were subject to frequent disturbance by humans and domestic dogs, but this appeared to have no effect on nesting birds. No attempt to directly disturb nests was observed, although villagers and construction workers were aware of the nests. Vehicle traffic was infrequent, but increasing due to completion and occupancy of the nearby housing project.

Table 7.4 Birds recorded on the north study area during 26-27 May 1993 and October 1994 to May 1995

COMMON NAME (Latin Name)	STATUS
Little Grebe (*Tachybaptus ruficollis*)	R
Grey Heron (*Ardea cinerea*)	R
Chinese Pond Heron (*Ardeola bacchus*)	R
Little Egret (*Egretta garzetta*)	R
Cattle Egret (*Bubulcus ibis*)	R
Night Heron (*Nycticorax nycticorax*)	R
Black-eared Kite (*Milvus lineatus*)	R
Crested Serpent Eagle (*Spilornis cheela*)	R
Bonelli's Eagle (*Hieraaetus fasciatus*)	R
Northern Sparrowhawk (*Accipiter nisus*)	WV
Black Baza (*Aviceda leuphotes*)	SV
Chinese Francolin (*Francolinus pintadeanus*)	R
White-breasted Waterhen (*Amaurornis phoenicurus*)	R
Spotted Dove (*Streptopelia chinensis*)	R
Rufous Turtle Dove (Streptopelia orientalis)	PM, WV, R(?)
Feral Pigeon (*Columba livia*)	I
Indian Cuckoo (*Cuculus micropterus*)	SV
Large Hawk-cuckoo (*Cuculus sparverioides*)	SV
Plaintive Cuckoo (*Cacomantis merulinus*)	SV
Koel (*Eudynamis scolopacea*)	R
Greater Coucal (*Centropus sinensis*)	R
Lesser Coucal (*Centropus bengalensis*)	R
Eurasian Wryneck (*Jynx torquilla*)	WV
Pied Kingfisher (*Ceryle rudis*)	R
Common Kingfisher (*Alcedo atthis*)	R
White-breasted Kingfisher (*Halcyon smyrnensis*)	R
House Swift (*Apus affinis*)	R
Barn Swallow (*Hirundo rustica*)	SV
Tree Sparrow (*Passer montanus*)	R
Richard's Pipit (*Anthus richardi*)	R, M, WV
Olive-backed Pipit (*Anthus hodgsoni*)	WV
Grey Wagtail (*Motacilla cinerea*)	WV
White Wagtail (*Motacilla alba*)	R
Crested Bulbul (*Pycnonotus jocosus*)	R
Chinese Bulbul (*Pycnonotus sinensis*)	R
Red-vented Bulbul (*Pycnonotus aurigaster*)	R
Magpie Robin (*Copsychus saularis*)	R
Siberian Stonechat (*Saxicola maura*)	WV
Grey Bushchat (*Saxicola ferrea*)	WV
Grey-backed Thrush (*Turdus hortulorum*)	WV
Blackbird (*Turdus merula*)	WV
Yellow-bellied Prinia (*Prinia flaviventris*)	R
Plain Prinia (*Prinia inornata*)	R
Common Tailorbird (*Orthotomus sutorius*)	R
Black-faced Laughing-thrush (*Garrulax perspicillatus*)	R
Great Tit (*Parus major*)	R
Fork-tailed Sunbird (*Aethopyga christinae*)	R
Japanese White-eye (*Zosterops japonica*)	R
Rufous-backed Shrike (*Lanius schach*)	R
Black Drongo (*Dicrurus macropterus*)	SV
Magpie (*Pica pica*)	R
Jungle Crow (*Corvus macrorhynchus*)	R
White-cheeked Starling (*Sturnus cineraceus*)	WV
Black-necked Starling (*Sturnus nigricollis*)	R
Crested Mynah (*Acridotheres cristatellus*)	R
Common Mynah (*Acridotheres tristis*)	I
Masked Bunting (*Emberiza spodocephala*)	WV
Little Bunting (*Emberiza pusilla*)	PM, WV
Spotted Munia (*Lonchura punctulata*)	R

Key to symbols:
R = resident
SV = summer visitor
R(?)=possible resident, breeding unconfirmed
WV = winter visitor
I = introduced

Birds were observed flying to and from the heronry in a northeasterly direction. They were presumably moving between the heronry and feeding areas along Kam Tin River which is adjacent to Ko Po Tsuen Village on the northeast. Birds also frequently foraged in the abandoned paddies and fish ponds immediately west of the heronry. These areas were small (approximately 0.5 ha), and were surrounded by residences. However, human use of the area was not observed, and it appeared that farming and fish culture had not been practiced for two years or more.

Ardeid Use of Tung Shing Lei Heronry During Spring 1995

The Tung Shing Lei heronry consisted of two stands of bamboo on either side of a fish pond at the site of the China Gas Co. Ltd. pigging station near the village of Tung Shing Lei (Figure 7.4). The heronry was first located in April 1995 during field studies for this report, therefore, there are no historic records of occupancy and nest numbers. Villagers at the heronry site indicated that herons (or egrets) had nested there for many years. Only Chinese Pond Herons were observed nesting at the heronry, but one Little Egret was observed perching atop the western bamboo stand on 6-May-95.
Chinese Pond Heron nests numbered 11 at the western bamboo stand and 6 at the eastern stand on 6 May 1995. Egg shell fragments were located at the base of the western stand, and the resident of the house beneath the egretry commented that these dropped from a nest on 3 May 1995. No nestlings were observed, suggesting that similar to the Ko Po Tsuen site, nesting chronology at Tung Shing Lei lags behind that at Shan Pui where nestlings were present in early May 1995.

The western bamboo stand was surrounded on 3 sides by a home on the bank of the fish pond. The home was occupied by a family and 8 dogs. Nesting herons appeared unaffected by activities at the house below. The house and its residents seemed similarly unaffected by the presence of the nesting birds.

The eastern bamboo stand was subject to disturbance by construction works on the Main Drainage Channel project which was underway some 30 m to the east of the heronry. The potential disturbance consisted mainly of construction workers and equipment which were active along the river channel and the site access road east of the channel. This appeared to have little impact on nesting herons.

7.7.5 Potential Impacts on Ardeids Using Ko Po Tsuen and Tung Shing Lei Egretries

Fish ponds are more important as foraging areas for Chinese Pond Herons than for other local ardeids, and fish pond use by Pond Herons peaks during breeding season (Young 1993). Therefore, losses of fish ponds could be particularly important to Pond Heron breeding ecology.

Potential impacts on heronries at Ko Po Tsuen and Tung Shing Lei were not assessed in earlier reports because the heronries were not known to exist. The PDS2 and final alignments in the vicinity of Ko Po Tsuen heronry do not differ significantly in terms of potential impacts to the heronry or to wetlands which could be used by foraging herons. The final alignment at the Au Tau Interchange required less surface area than did the PDS2 alignment. This resulted in a 0.6 ha reduction in the amount of fish pond area to be lost due to this project. However, Tung Shing Lei heronry would be affected to a greater extent by the current alignment than by the PDS2 alignment. Potential impacts are discussed below in terms of wetland area losses and with specific reference to the two

unacceptable nesting substrates or increased levels of human disturbance (or both) were responsible for abandonment of Ko Po Tsuen by Cattle and Little Egrets.

To assess levels of human disturbance near egretries each known nesting site in the Deep Bay area was evaluated using Hong Kong Government 1:5000 scale topographic maps (1980 grid, 1994 partial revision). Each egretry site was taken as the point of origin about which four 10 x 10 cm grids were marked to cover a square area of 400 cm^2 on each map, or 1 km^2 of actual land surface. Within each of the 400 cell blocks habitat occurrence frequency was tallied for pond, stream, paddy, marsh, and hill habitats. Disturbance types were tallied as building or road. Frequencies of habitats and disturbance types were summed, and the total for habitats was divided by the total for disturbance types. This yielded a quantitative scale on which disturbance levels at various egretries could be compared. Results greater in value than 1.0 indicate that natural vegetation, agriculture, and pisciculture make up a greater proportion of the landscape surrounding an egretry than do roads and buildings. Results less than 1.0 suggest the opposite. For 7 egretries in the Deep Bay area results are shown in Table 7.6.

Table 7.6 Disturbance indices for Deep Bay area egretries (ranked from least disturbance to greatest disturbance)

Egretry	Disturbance Index[1]
Mai Po	7.4
Ngam Pin	1.8
Ho Pui	1.7
Tung Shing Lei	1.6
Lok Ma Chau[2]	1.6
Mai Po Lo Wai	1.2
Ko Po Tsuen	0.9

1 Values less than 1.0 indicate disturbance types outnumber habitat types near an egretry.
2 Abandoned in 1995 breeding season.

Ko Po Tsuen heronry was surrounded to a greater extent by roads and buildings than any other site evaluated. Relatively high levels of existing disturbance would suggest that Ko Po Tsuen may be the most likely of the 7 evaluated egretries to be subject to risk of abandonment due to increased levels of disturbance.

Although human activity levels increased at Ko Po Tsuen in 1994 and 1995 due to new housing construction, there have been no substantial reductions in wetland area in the immediate vicinity of the egretry since the 1994 breeding season. In spite of retention of existing wetlands, two of the three 1994 nesting species abandoned the heronry. This is presumed to be a response to death of the bamboo nest substrates or increased human disturbance levels. Future losses of wetlands could compound the impacts of these factors by reducing prey availability. Loss of wetlands combined with increased disturbance levels could cause complete abandonment of the nesting site.

heronries located nearest the Northern Section works boundaries.

Potential Impacts of Fish Pond Losses

The importance of fish ponds to birds of the Ardeidae family (herons and egrets) in the Deep Bay area was reviewed by Melville *et al.* (1994). They concluded that fish ponds are important foraging habitats for ardeids and that continued loss of fish ponds in Deep Bay poses a threat to local ardeid populations. They also noted that accelerating losses of fish ponds in south China contribute to the increasing conservation importance of Hong Kong fish ponds. Loss of fish ponds due to project construction is important ecologically because of the habitat provided by the ponds to water birds which feed in the ponds, and other species which use associated habitats such as pond bunds and nullahs.

Estimated loss of fish pond area and area to be reinstated due to construction in the Northern Section is shown in Table 7.5. Most of the ponds to be lost will be in the vicinity of the Au Tau Interchange (37 ponds), although 18 ponds would be affected east of Castle Peak Road. Details of ponds to be lost or reinstated are listed in Appendix M to this report. Ponds are listed individually by drawing number, area to be resumed, area to be reinstated, and area to be permanently lost.

AFD classified 1,760 ha of actively managed fish ponds in Hong Kong in 1992 (AFD unpublished data), based on the categorisation criteria set forth in Table 7.1. Of these, 1,330 ha (75.6%) were assigned to Grade A, 185 ha (10.5%) to Grade B, and 245 ha (13.9%) to Grade C. Chu (1993) cited AFD's 1994 annual report (AFD 1994) which tallied 1,620 ha of active ponds and 270 ha of abandoned ponds in 1992. The currently estimated Hong Kong total is closer to 1,200 ha (K. Wilson, Fisheries Officer, AFD, pers. comm.).

The current alignment would result in a permanent loss of 0.60 ha of Grade B fish ponds and 12.49 ha of Grade C ponds in the Northern Section. The total of 13.09 ha may represent up to 1.1% of the remaining total fish pond area in the Territory. Assuming the proportional area of Grade B ponds remained constant since 1992, the losses of 0.6 ha of Grade B ponds constitutes 0.4% of the remaining estimated total (0.6 ha of 126 ha remaining). Assuming the proportional area of Grade C ponds remained constant since 1992, the loss of 12.49 ha would constitute 7.5% of the remaining estimated total (12.49 ha of 167 ha remaining).

From a cumulative perspective, the loss of 13.09 ha of fish ponds would be added to the loss of 3.9 ha from the Southern Section of Route 3, 122.3 ha from the Main Drainage Channel project, and 11 ha from the Shenzhen River Regulation project, for a total loss due to infrastructure projects of 150.29 ha. The Nam Sang Wai residential development would remove an additional 98.8 ha of fish ponds, increasing the total to 249.09 ha. If 1,200 ha of fish ponds remain in the Territory, the above listed projects would destroy 21% percent of the total. It is inevitable that this degree of loss of wetland habitat would result in losses of wetland wildlife in Hong Kong on seasonal and annual bases.

Table 7.5 Fish pond loss and reinstatement due to Route 3 north area works (areas in hectares)

Drawing Number	Number of Ponds Affected	Area Temporarily Affected	Area Reinstated	Area Permanently Lost	AFD Classification of ponds to be lost
R3CPS/131/001	2[1]	1.80	1.78	0.02	C
R3CPS/131/002	16[2]	13.69	7.37	6.32	C
R3CPS/131/003	7[3]	4.04	3.44	0.60	B
R3CPS/131/004	12	1.23	0.40	0.83	C
R3CPS/131/005	8	2.60	1.18	1.42	C
R3CPS/131/006	14	10.72	6.82	3.90	C
TOTAL	**55**	**34.08**	**20.99**	**13.09**	

[1] Assumes one pond would be lost due to MDC works
[2] Three ponds are duplicated on drawing 006
[3] One pond is duplicated on drawing 004

Potential Impacts on Ko Po Tsuen Heronry

R3 construction works near Ko Po Tsuen heronry will overlap at least one breeding season, and possibly 2 based on the 38 month programme for the project. Works in the vicinity of the heronry will cause increased disturbance levels in areas which are currently used for agriculture or fish culture. This may be particularly important during the breeding season (March to September).

Fasola and Alieri (1992) documented a significant difference between disturbance index values at egretries versus unoccupied but apparently suitable sites in Italy. Their disturbance index was "based on the presence and utilization of roads and paths and on the presence of tracks within the [egretry] sites." They also documented a significant difference between "building" indices at occupied versus unoccupied sites. Their building index was based on the extent of roads, buildings and other man-made structures within 700 m of the centre of each egretry (or patch of vegetation at unoccupied sites). In both cases occupied sites had considerably lower levels of human disturbance than did unoccupied sites.

These results suggest that there is a threshold of human activity beyond which ardeids will not occupy an egretry. Because there is no historical database for ardeid nesting at the Ko Po Tsuen site it is not possible to determine the relationship between nesting and levels of human disturbance. However, continued Chinese Pond Heron breeding, in spite of existing levels of disturbance at the heronry, would suggest that nesting herons are accustomed to relatively intense human activity. Abandonment of the nest site by Cattle and Little Egrets could be attributed to rejection of dead bamboo as a nest substrate, to levels of human disturbance which were excessive, or possibly to a combination of the two factors. Continued nesting by Chinese Pond Herons suggests that prey availability was adequate to support breeding. This lends credence to the hypothesis that

unacceptable nesting substrates or increased levels of human disturbance (or both) were responsible for abandonment of Ko Po Tsuen by Cattle and Little Egrets.

To assess levels of human disturbance near egretries each known nesting site in the Deep Bay area was evaluated using Hong Kong Government 1:5000 scale topographic maps (1980 grid, 1994 partial revision). Each egretry site was taken as the point of origin about which four 10 x 10 cm grids were marked to cover a square area of 400 cm^2 on each map, or 1 km^2 of actual land surface. Within each of the 400 cell blocks habitat occurrence frequency was tallied for pond, stream, paddy, marsh, and hill habitats. Disturbance types were tallied as building or road. Frequencies of habitats and disturbance types were summed, and the total for habitats was divided by the total for disturbance types. This yielded a quantitative scale on which disturbance levels at various egretries could be compared. Results greater in value than 1.0 indicate that natural vegetation, agriculture, and pisciculture make up a greater proportion of the landscape surrounding an egretry than do roads and buildings. Results less than 1.0 suggest the opposite. For 7 egretries in the Deep Bay area results are shown in Table 7.6.

Table 7.6 Disturbance indices for Deep Bay area egretries (ranked from least disturbance to greatest disturbance)

Egretry	Disturbance Index[1]
Mai Po	7.4
Ngam Pin	1.8
Ho Pui	1.7
Tung Shing Lei	1.6
Lok Ma Chau[2]	1.6
Mai Po Lo Wai	1.2
Ko Po Tsuen	0.9

1 Values less than 1.0 indicate disturbance types outnumber habitat types near an egretry.
2 Abandoned in 1995 breeding season.

Ko Po Tsuen heronry was surrounded to a greater extent by roads and buildings than any other site evaluated. Relatively high levels of existing disturbance would suggest that Ko Po Tsuen may be the most likely of the 7 evaluated egretries to be subject to risk of abandonment due to increased levels of disturbance.

Although human activity levels increased at Ko Po Tsuen in 1994 and 1995 due to new housing construction, there have been no substantial reductions in wetland area in the immediate vicinity of the egretry since the 1994 breeding season. In spite of retention of existing wetlands, two of the three 1994 nesting species abandoned the heronry. This is presumed to be a response to death of the bamboo nest substrates or increased human disturbance levels. Future losses of wetlands could compound the impacts of these factors by reducing prey availability. Loss of wetlands combined with increased disturbance levels could cause complete abandonment of the nesting site.

Approximately 1.11 ha of commercial fish ponds, 200-300 m from the heronry, would be permanently lost due to the current alignment. Herons nesting at Ko Po Tsuen were not observed flying to or from fish ponds or other wetlands west of Kam Tin Road. Suitable foraging sites were located to the north and east of the heronry (along Kam Tin River), and these appeared to be the favoured foraging sites. Because the general area surrounding the heronry is either developed or has various construction projects underway, it appears that the nesting Chinese Pond Herons have habituated to high levels of disturbance and may not be affected by additional construction which does not remove preferred foraging sites. Absence of Cattle and Little Egrets in 1995 suggests that the tolerance thresholds for those species have already been exceeded by recent developments.

Neither egrets nor herons were observed using the Ko Po Tsuen heronry as a roost site during winter 1994-5. Therefore, it is unlikely that the fish ponds west of Kam Tin Road provide preferred foraging habitat during winter when herons and egrets are most abundant in Hong Kong (Young 1993), or during spring when the heronry is active as a nesting site.

The above scenario could change due to the combined disturbances of R3 TLT & YLA and Main Drainage Channel construction. The Kam Tin River immediately northeast of the heronry is to be channelled under the 43CD works of the Main Drainage Channel project. It is likely that the programmes for the two projects will overlap, possibly resulting in cumulative construction impacts due to noise, human activity, equipment activity, and wetland loss on all sides of the heronry.

Potential Impacts on Tung Shing Lei Heronry

Although the heronry had not been reported, the PDS2 designs coincidentally avoided direct impacts to the two nesting sites at Tung Shing Lei. Both sections of roadway which would have been nearest the two nesting sites were to be constructed on elevated structures at elevations of approximately 12.9 m (eastern nest site) and 19.5 m (western nest site). Horizontal distances from the elevated roadway sections to the nest sites would have been 15 m in both cases.

The final design was also developed without knowledge of the locations of the two nesting sites at Tung Shing Lei. However, due to a change in the horizontal alignment (to reduce the area of fishpond losses) and a change from construction on structures to construction on fill, the western nesting site lies within the proposed disturbance area of the final design. The toe of a fill slope would reach within 10 m of the eastern nest site, and a fill slope would cover the western nest site (Figure 7.4). The fish pond which lies between the two nest sites would be filled, and no portion of it would remain following construction for reinstatement.

In addition to the Route 3 roadway, Drainage Services Department has advised that a proposed sewage treatment plant would be constructed within approximately 5 years under a separate project within 10 m of the eastern nest site. The combined impacts of the two projects, together with loss of the adjacent fish pond could possibly preclude continued use of the eastern nest site even though the bamboo stand could be retained intact.

Nesting could not continue at the western nest site because the bamboo stand would be removed (and transplanted to the east eastern nest site, see below) to accommodate the fill slope below the new access road to the gas line pigging station.

7.7.6 Impact Avoidance and Mitigation Measures

Upland Birds

Revegetation according to proposals submitted in the PDS2EA will partially address requirements of upland birds. As recommended in Sections 7.5.4 and 7.10 of this report, off-site enhancement of shrub-woodland habitats between the completed Route 3 alignment and Tai Lam Country Park will be beneficial for upland birds. Use of tree and shrub species as suggested Table 7.3 will ensure provision of long-term forage sources and cover for birds as well as some mammals.

Wetland Birds

Commercially operated fish ponds are the man-made wetland habitat of greatest conservation concern in the northwest New Territories (NWNT). This is due to the rapid rate of conversion of fish ponds to other land uses such as residences or light industry. Government infrastructure and private developments in NWNT currently pose a threat to approximately 21 percent of the remaining fish ponds in the area (see Section 7.7.5). For all these projects mitigation of impacts caused by wetland habitat losses will be constrained by the lack of wetlands which are available for enhancement or lack of suitable areas for creation of wetland habitat.

The requirements for R3CC to restore wetland areas that are either required temporarily for construction, or are not required but lie within the work site limits, are fully documented in Clauses 9.3.2 and 9.3.3 of the Construction Requirements. These clauses are reproduced as follows:

9.3.2 The Franchisee shall be responsible for maintaining during the Construction Period those portions of ponds which form part of the Works Area and are not required for construction of the Works. Government is to hand these portions of ponds back to their former owners on completion of the Construction Period and the Franchisee is required to return the ponds to their original condition including the quality of the water.

9.3.3 The Franchisee shall be responsible for maintaining during the Construction Period all other ponds within the Works Sites which are not required for the Works. Ponds required temporarily during construction of the Works but not required for the on-going maintenance and operation of the Constructed Facilities shall be reinstated to their original conditions including provision of suitable enhancements to improve their ecological value as determined by the Detailed Environmental Impact Assessment. As part of his construction proposals the Franchisee shall also design and re-provide permanent access equivalent to that in existence at the date of the execution of the Project Agreement, to these ponds at his own cost.

The contribution of Route 3 to the cumulative loss of wetlands in the New Territories has been fully discussed with government (AFD, ACE, EPD, HyD) during the approval

process for the Southern Section DEIA. It is the understanding of R3CC that this issue and associated off-site wetland compensation through either restoration, creation or enhancement is being addressed as a separate matter through the development of a policy on wetland loss mitigation. Three studies are being carried out to assist in the development of this policy:

- "Ecological study on Hong Kong freshwater wetland habitats" commissioned by AFD;
- "Study on the conservation management of the Ramsar Site" commissioned by AFD (to be started in 1996);
- "Study on the ecological value of fish ponds in Deep Bay area" commissioned by Planning Department.

Off-site compensation for the net loss of 13.09 ha of wetland from the Northern Section of R3 TLT & TLA is beyond the contractual obligations of R3CC and is not further addressed in this report.

Within the Route 3 Northern Section works boundaries virtually all lands would be occupied by permanent works. A strategy is proposed for restoration of ponds in this area, which consists of restoration of fish ponds which are to be resumed and temporarily used for other purposes during project construction. The total hectarage to be restored is 20.99 ha as shown in Table 7.5. As a result of discussions with ACE members concerning the Southern Section DEIA, a restoration and maintenance plan to these ponds has been developed and is included as an appendix to the EM&A Manual (Volume 2 of the Northern Section DEIA).

In some cases small portions of ponds remain outside permanent works limits. Wherever practicable such small ponds will be joined during restoration to form larger ponds of a size adequate to be commercially viable. Examples of such situations exist immediately west of Link Road H. In two cases small triangular ponds would be restored from formerly large rectangular ponds. In both cases the remnant ponds could be joined with adjacent ponds to the north to form single larger ponds. Similar situations exist north of Link Road E.

Restoration of ponds within the Au Tau Interchange will be combined with "stream" channel construction, revegetation, and landscaping of fill slopes (Figure 7.5). The objective will be to form short "stream" channels which will be revegetated with bamboo and other riparian species to provide a variety of habitats suitable for use by a diversity of bird species. The channels would collect surface water only from land areas between road segments. Therefore, they would flow only during the wet season. It is anticipated that these habitats would support natural colonisation by lowland and wetland vegetation which would enhance habitat value.

Bioaccumulation of contaminants, specifically metals, is an important concern regarding creation of wildlife habitats in stormwater detention ponds near highways. Kehoe (1993) summarised studies documenting the removal efficiency of wet-detention stormwater ponds for suspended solids, metals, and nutrients "...because the water column of wet-detention basins removes pollutants through sedimentation, degradation, vegetative uptake, and other physical and biological processes (Whalen and Callum 1988, Stahre and Urbonas 1990)." Demora (1993) conducted studies of metal concentrations in tissue

samples taken from three species of fish caught in stormwater treatment ponds where wetlands had been created to attract wildlife. She documented the occurrence of "biologically significant" concentrations of cadmium, lead, copper, nickel, and zinc in Redear Sunfish (*Lepomis microlophus*); of nickel, copper, and lead in Largemouth Bass (*Micropterus salmoides*); and of cadmium, nickel, lead, and zinc in Bluegill Sunfish (*Lepomis macrochirus*). She defined the phrase "biologically significant" to mean that the metal concentrations found in fish living in stormwater treatment ponds were significantly higher than concentrations found in fish living in uncontaminated (control) environments. Demora did not investigate the affect on piscivorous birds of eating fish contaminated by biologically significant concentrations of metals. However, she noted that research is needed to answer this question.

It must be noted that Demora (1993) conducted research on ponds which were established specifically to hold and biologically treat stormwater run-off. The ponds proposed for mitigation of impacts due to wetland losses in the Au Tau Interchange are not specifically designed for this function, although they would naturally capture and hold run-off from adjacent highway segments.

The extent to which run-off from paved highway surfaces will accumulate in Ponds 1 and 2 will be limited by the drainage design of the highway. Run-off from paved surfaces will be directed through engineered drains to drainage channels for discharge. Most paved surface drainage in the Au Tau Interchange will reach Kam Tin River via a Type 3 drainage ditch parallel to the northwest side of Link Road H. Preventive measures to mitigate against road surface run-off during the operational phase of R3 has been described in Section 6.4.3 of this report.

A second measure which will limit accumulation of contaminants is the drainage design of the ponds (Figure 7.6). Pond 2 will receive surface run-off from a nearby nullah via Box Culvert C24 beneath Link Road F. Overflow from Pond 2 will then be channelled by underground pipe designed according to best engineering practice to Pond 1. From Pond 1 overflow will be discharged to Kam Tin River. Movement of large volumes of water between the two ponds may only occur during the wet season. However, wet season flows may be adequate to maintain contaminant concentrations in pond biota at levels prevailing in surrounding environments. Maintenance of these ponds and the drainage system is described in the restoration and maintenance plan attached as an appendix to the EM&A Manual (Volume 2 of the Northern Section DEIA).

Because contaminated run-off from paved surfaces would enter the surface water system at some point in the Au Tau vicinity, and because Au Tau lies within the Deep Bay catchment, the wetlands in Inner Deep Bay might be better served should Ponds 1 and 2 serve as sinks for contaminant retention and biological treatment rather than as uncontaminated wetland habitats. The logic of this argument is that the Inner Deep Bay wetlands supply forage to abundant and diverse water bird communities which are of documented international conservation importance. These wetlands have been designated as Hong Kong's first Ramsar Site under the requirements of the Ramsar Convention. The "wise use" concept of the Ramsar Convention implies that threats of chemical contamination of the water bird prey base in Inner Deep Bay should be minimised. Use of upstream detention ponds to minimise contamination risks to Deep Bay wetlands is, therefore, in agreement with the intent of the Ramsar Convention. This may be particularly true due to the fact that the detention ponds are sited near the proposed highway and may not, therefore, develop into important water bird habitats. Use of such ponds to help reduce contaminant concentrations in waters flowing to Deep

Bay may be seen as a conservation gain greater than that achievable through intensive management of the ponds as wildlife habitats.

To safeguard against the possibility that contaminants from highway run-off posing a risk to birds feeding in the ponds shown on Figure 7.5, water quality monitoring will be conducted as part of the post-construction ecological monitoring and audit programme described in Section 4.10 of the EM&A Manual.

Tung Shing Lei Heronry

Loss of the western nesting site will eliminate nesting opportunities for 11 pairs of Chinese Pond Herons. To partially mitigate this loss the bamboo stand at the western nesting site will be relocated at the outset of construction to a location adjacent to the eastern nesting site, at the eastern limit of the works boundary (see Figure 7.4). If necessary, the relocation could be made within the works boundary. Prior to relocation the mature bamboo will be cut off at approximately 1 m above ground level. The remaining basal portion of the stand will then be translocated as a single stand using an end loader or trackhoe. Early spring is the best time for transplantation.

Additional stands of bamboo will be planted in the drainages leading to Ponds 2 and 3 as mentioned under *Wetland Birds*. These will be planted together with light standard trees of the following species:

- *Sterculia lanceolata*
- *Celtis sinensis*
- *Sapium sebiferum*
- *Cleistocalyx operculata*
- *Syzygium jambos*

The objective of planting the above species near the ponds to be created in Au Tau Interchange is to provide nesting habitat for Chinese Pond Herons displaced due to the loss of the Tung Shing Lei heronry and for birds possibly displaced by cumulative disturbances to the Ko Po Tsuen heronry.

7.8 Reptiles and Amphibians

Reptiles and amphibians which were recorded on the study area were reported in the PDS2EA (Freeman Fox Maunsell 1993a). One additional reptile, the Common Cobra (*Naja naja*), was observed north of the proposed Toll Plaza during May 1995. Impact avoidance and habitat restoration measures proposed in the PDS2EA (Freeman Fox Maunsell 1993a) and in this report are considered adequate to address potential impacts to reptiles and amphibians.

7.9 Mammals

7.9.1 Survey Methods

Small mammal occurrence and relative abundance was documented by mark-recapture sampling using H.B. Sherman® live traps. Traps were baited with a mixture of rolled oats, fruits and peanut butter, provided with shredded paper for bedding material, and set for 3 consecutive nights in representative habitats. Traps were constructed of

aluminium sheet and measured 3" x 3" x 10" (length). Traps were placed in linear transects at 10 pace intervals. Transects were located west of Shek Wu Tong in upland grassland, shrubland, and woodland habitats along the alignment. Traps were placed on the ground in all cases. Where grasses or other ground vegetation cover was particularly dense, a space was cleared to ensure placement of the trap firmly on the ground. Trapping was conducted under AFD Permit Ref. AF CON 09/51 issued to Thomas D. Dahmer.

Large mammals were surveyed non-systematically by searching for signs of burrows, droppings, scrapes, or tails. Taxonomy follows Wilson and Reeder (1993).

7.9.2 Results

A total of 300 trap nights was sampled in upland grassland, shrubland, and woodland habitats. All habitats were undisturbed at the time of sampling except for grave worship ceremonies.

No captures were recorded on the northern study area. Two species were recorded on the southern study area as reported in Freeman Fox Maunsell (1995). These were the Eastern Spiny-haired Rat (*Niviventer fulvescens* Gray 1847) and the Field House Mouse (*Mus musculus homourus* Hodgson 1845). Both species could also occur on the northern area based on similarities in habitat types and geographic proximity.

The only large mammal recorded was the civet (probably the small Indian civet *Viverricula indica* Desmarest 1804). Scats of civets (again, probably the small Indian civet) were seen on grave sites and trails in many areas north of the proposed North Portal. It is possible that civets occur in good numbers in this area near Tai Lam Country Park due to the relative seclusion of the site and the abundance of forage sources (fruit-bearing shrubs).

The barking deer (*Munticaus reevesi* Ogilby 1839) was recorded by its vocalisations, tracks, and faeces during summer 1993 and winter 1994-5 on the southern area. It was not recorded on the northern area.

7.9.3 Potential Impacts to Mammals

Based on trapping results discussed above, small mammal species are not expected to occur in large numbers or to be of particular conservation significance on the project areas. Mitigation and habitat restoration measures proposed in the PDS2EA (Freeman Fox Maunsell 1993a) and in this report would be adequate to address potential impacts to mammal communities in general.

Burrowing mammals such as the civets and the ferret badger could be destroyed during earth moving operations. Therefore, any burrow systems encountered will be excavated by hand, and any captured animals will be released unharmed in areas secure from disturbance. Preferred release sites would be near Tai Lam Country Park. Burrow excavation will be supervised by a qualified ecologist on the environmental monitoring and audit team.

It is recognised that information on the ecology of burrowing mammals in the project area is limited, and that release of captured mammals would necessarily take place without detailed knowledge of the habitat suitability in areas chosen for release.

However, given that accumulation of such knowledge in advance of project commencement would not be possible due to prevailing time constraints, it is considered reasonable to attempt capture and release in the short-term interest of avoiding suffocating or crushing animals in their burrows. Should extensive, active burrow systems be encountered, the option of radio-instrumenting captured animals prior to release will be considered. Telemetric monitoring could contribute to developing knowledge of the fate of released animals, and would be useful in guiding future attempts at impact mitigation.

7.10 Summary of Impact Avoidance and Mitigation Measures

Loss of woodland habitats (0.8 ha) can be restored over the long term in a ratio of 3:1 (replacement area to lost area). Native species are recommended for use in woodland restoration. Woodland restoration will take place within the project boundaries on upland cut and fill slopes. Outside the project area woodland restoration will take place between the road alignment and the Tai Lam Country Park boundary west of Ma On Kong.

The impacts of habitat loss would be significant in terms of wetland. Wetland habitats to be lost are primarily fish ponds in the Kam Tin valley. Reinstatement would restore 20.99 ha of fish ponds or wetlands, leaving 13.09 ha as residual permanent losses. Replacement of fish pond surface area is not available in proportion to losses.

7.11 References

AFD. 1994. Agriculture and Fisheries Annual Departmental Report 1992-1993, Hong Kong Government, Hong Kong

Chu, K. 1993. An evaluation of the ecological importance of fish ponds in the inner Deep Bay wetland system. World Wide Fund for Nature Hong Kong, unpub. report.

Chu, W. H. 1995. *Fish ponds in the ecology of the inner Deep Bay wetlands of Hong Kong.* Asian J. Env. Manage. 3(1): 13-36.

Corlett, R.T. 1992. Plants attractive to frugivorous birds in Hong Kong. Mem. H.K. Nat. Hist. Soc. 19:115-116.

Davis, T.J. 1993. *The Ramsar Convention Manual: A Guide to the Convention on Wetlands of International Importance Especially as Waterfowl Habitat.* Ramsar Convention Bureau, Gland.

Dudgeon, D. and Corlett R. 1994. *Hills and Streams. An Ecology of Hong Kong.* Hong Kong University Press, Hong Kong.

ERM. 1995. Yuen Long-Kam Tin-Ngau Tam Mei main Drainage Channel Environmental Impact Assessment.

Fasola, M. and R. Alieri. 1992. Conservation of heronry Ardeidae sites in North Italian agricultural landscapes. Biological Conserv. 62:219-228.

Freeman Fox Maunsell. 1993a. Route 3 Country Park Section and Ting Kau Bridge,

Preliminary Design Stage 2, Country Park Section - Tai Lam Tunnel and Yuen Long Approach Road. Volume 3A, Environmental Assessment - Technical Report.

Freeman Fox Maunsell. 1993b. Route 3 Country Park Section and Ting Kau Bridge, Preliminary Design Stage 2, Country Park Section - Tai Lam Tunnel and Yuen Long approach Road. Volume 3B, Environmental Assessment - Appendices.

Freeman Fox Maunsell. 1995. Supplementary Ecological Survey for Route 3 Project: Surveys Through Winter 1994-5.

Hill, D.S. & K. Phillipps. 1981. *Hong Kong Animals.* Government Printer, Hong Kong.

Kentula, M.E., R.P. Brooks, S.E. Gwin, C.C. Holland, A.D. Sherman, and J.C. Sifneos. 1992. *An Approach to Improving Decision Making in Wetland Restoration and Creation.* Edited by A.J. Hairston. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon, USA. 151pp.

Melville, D.S., L. Young, and P.J. Leader. 1994. *Birds of Hong Kong South China.* Government Printer, Hong Kong. 244pp.

Wilson, D.E. & D.M. Reeder. 1993. *mammal Species of the World: A Taxonomic and Geographic Reference*. Smithsonian Institution Press, Washington, D.C., USA, 1206 pp.

Young, L. 1991. Conservation of Wildlife in the Deep Bay area: with particular reference to heron species. In Boxall, J. (ed) 1991. *Polmet '91: Pollution in the Metropolitan and Urban Environment.* Hong Kong Inst. Engineers, Hong Kong.

Young, L. 1993. *The Ecology of Hong Kong Ardeidae.* Ph.D. thesis, Univ. Hong Kong, Faculty of Science.

Figure 7.1 Locations of Eroded Hillsides Available for Compensatory Planting

Figure 7.1 Locations of the Eroded Hillsides Available for Compensatory Planting

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 7.2 Locations of Ko Po Tseun and Tung Shing Lei Heronries

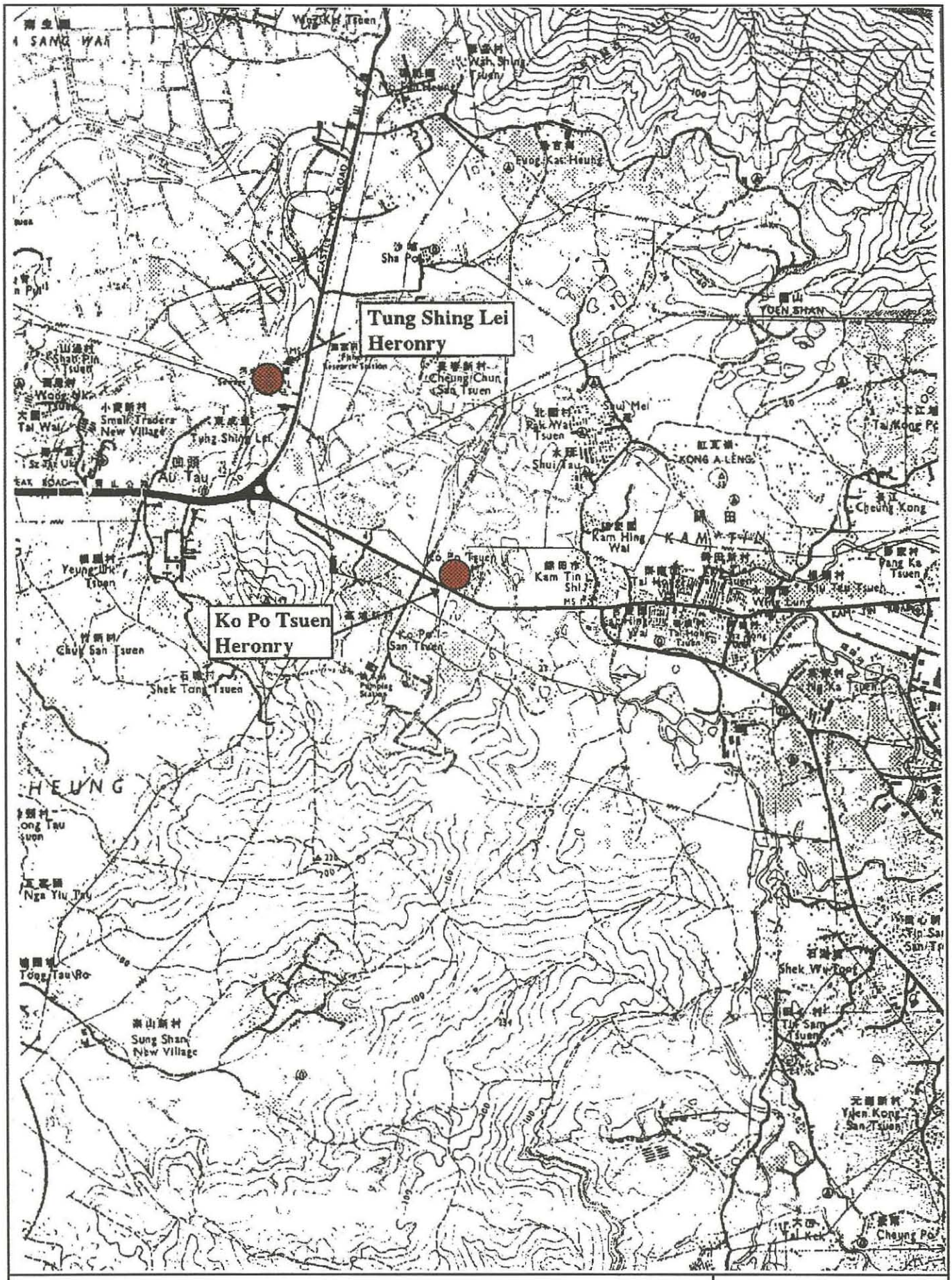


Figure 7.2 Locations of Ko Po Tsuen and Tung Shing Lei Heronries

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 7.3 Ko Po Tseun Heronry Location in Relation to Route 3 Works

Figure7.3 Ko Po Tsuen Heronry Location in Relation to Route 3 Works

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 7.4 Tung Shing Lei Heronry Location in Relation to Route 3 Works

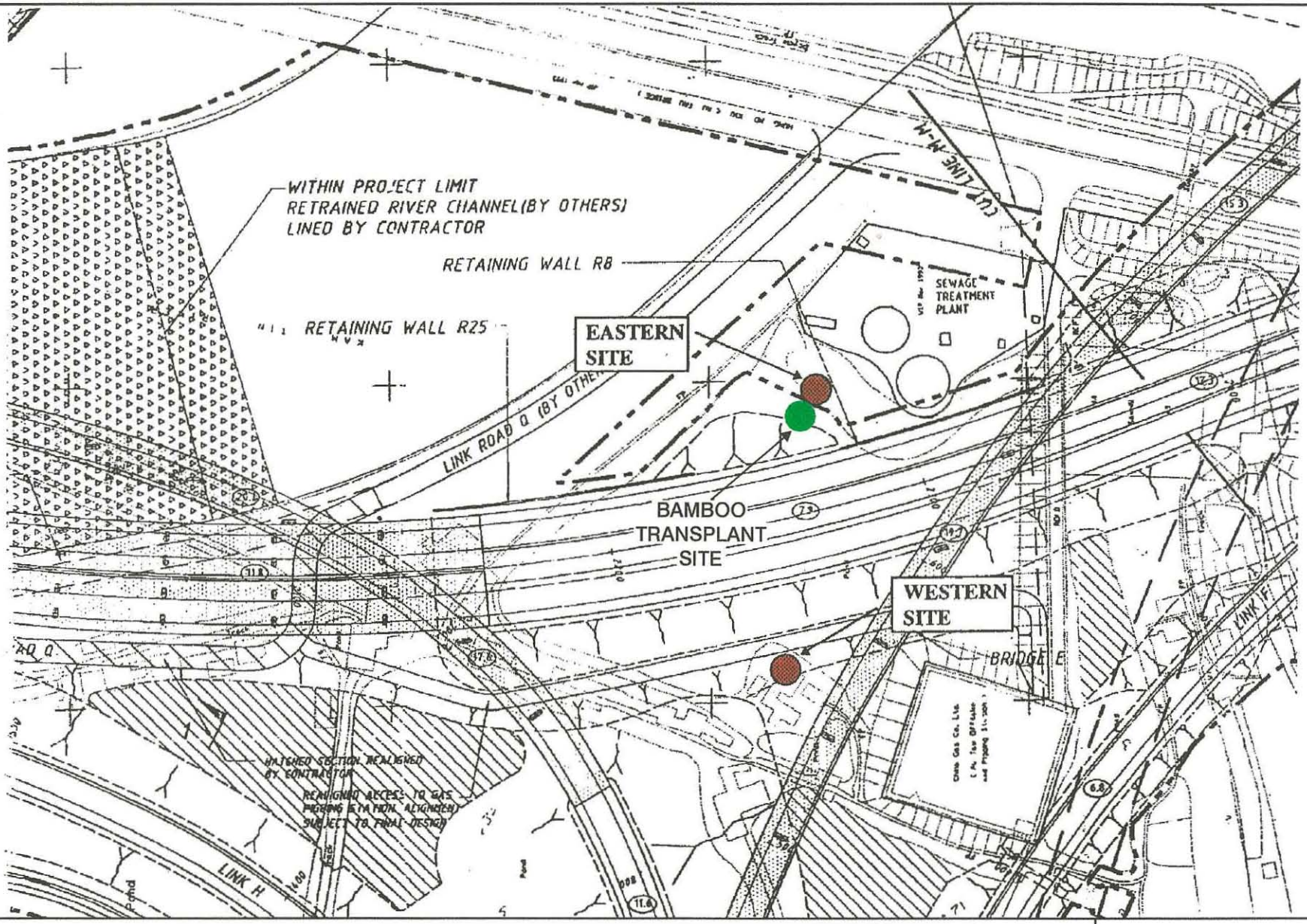


Figure7.4 Tung Shing Lei Heronry Location in Relation to Route 3 Works and Bamboo Transplant Site

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 7.5 Pond Restoration at Au Tau Interchange Showing Proposed Stream Configuration

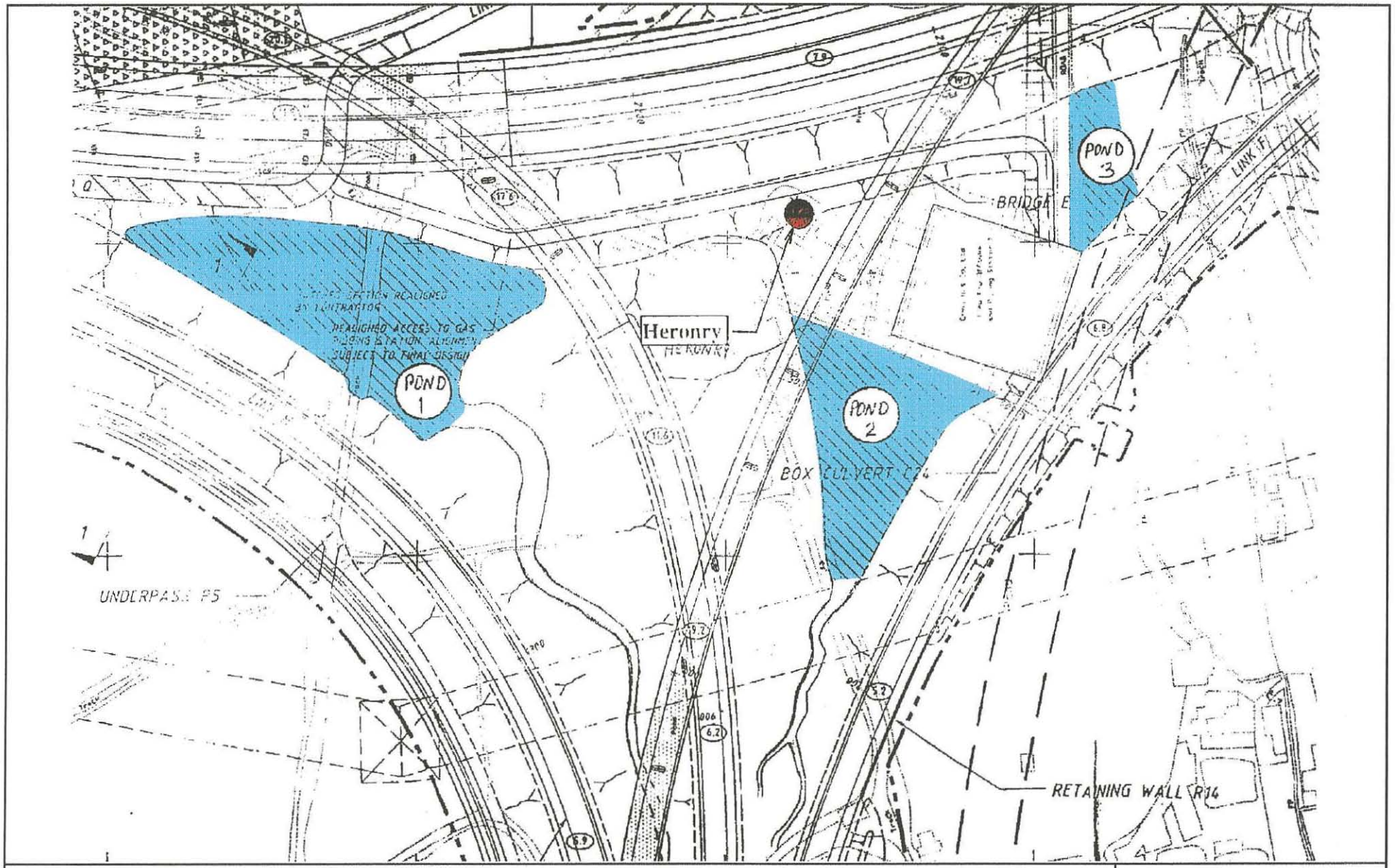


Figure7.5 Pond Restoration at Au Tau Interchange Showing Proposed Stream Configuration

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

Figure 7.6 Pond Restoration at Au Tau Interchange Showing Proposed Stormwater Flow

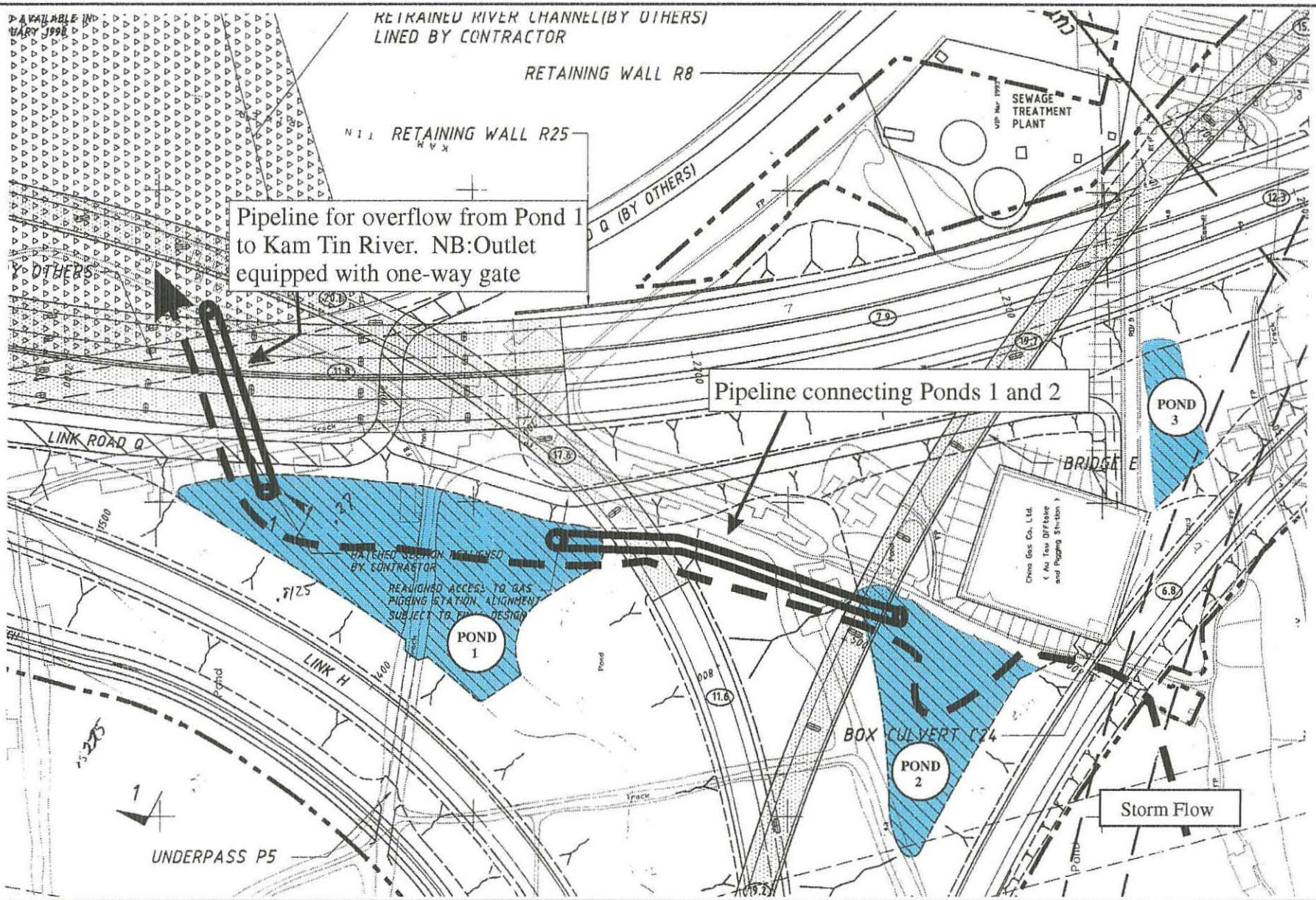


Figure 7.6 Pond Restoration at Au Tau Interchange Showing Proposed Stormwater Flow

CONSULTANTS IN ENVIRONMENTAL SCIENCES (ASIA) LTD

8 VISUAL AND LANDSCAPE IMPACT

8 VISUAL AND LANDSCAPE IMPACT

Detailed assessment of the visual and landscape impacts of Route 3 (TLT&YLA) were carried out in the PDS2EA. The evaluation included an assessment of positive and negative impacts at three points in time. These were during construction, on day of opening and in year 15 of operation. Receivers were identified in a visual envelope within which views of the road will be possible. Receivers included residents, users of recreational and community facilities, travellers and employees within business and industrial areas. Baseline conditions were described in detail and the degree of impact was categorised into severe, moderate, low and insignificant. The most affected receivers were considered to be those located on elevated areas within the upper Kam Tin valley. The elevated sections of road in the vicinity of Au Tau will also be visible to nearby residential areas.

Since the PDS2EA evaluation, regular site visits have been carried out and the changing nature of the landscape has been assessed. The changes have included:

- a large structure in the vicinity of the China Light and Power Substation to the southwest of Au Tau;
- some minor pondfilling and residential/minor commercial (for example car yards) developments;
- the initial stages of construction of the Kam Tin River Main Drainage Channel Protection Works to the north of Castle Peak Road.

The changes in the local landscape and the detailed road design have been minor and should not alter the conclusions of the PDS2EA with respect to landscape and visual impacts during construction or operation. The most notable design change has been a reduction in the size of the Au Tau Interchange and this should not alter the landscape and visual profile predicted in the PDS2EA.

The conclusions of the PDS2EA therefore remain valid, and have been built upon for the detailed design of the Landscape AIP Package (Design Element No. 190) which is currently being discussed through the AIP process. The detailed landscaping proposals take account of any changes in the visual environment that have occurred over the time since the PDS2EA evaluation. Information on changes in the ecological component of the visual environment over the past twelve months is also contained in the Four Seasons Ecological Survey, and has been drawn upon during development of detailed landscaping proposals.

The landscape in the vicinity of the Northern Section of Route 3 (TLT & YLA) is expected to change in the future through the construction of the Western Corridor Railway Reserve and the Kam Tin River Main Drainage Channel Project. Where possible the detailed Landscape AIP Package has taken these future developments into account.

Construction Phase

The majority of the recommendations of the PDS2EA remain directly applicable. Committed impact mitigation measures comprise the following:

- restrict volume of construction traffic on local road network;
- restrict the construction working areas to a minimum, siting them if possible in visually isolated positions;
- enclose the working areas, where possible, to define boundary edge and screen low level construction activities from surrounding receivers;
- restrict heights of storage materials, stock piles and spoil heaps to low levels;
- minimise night time working and lighting;
- hydroseed bare ground as soon as possible to establish a "green" vegetative cover;
- use slow-release fertilizers incorporated into the backfill to establish vegetative cover as quickly as possible.

Operational Phase

The following design criteria have been used as a basis for the detailed Landscaping AIP (Design Element 190), and are in accordance with Construction Requirements Clause 12.1:

- the basic design philosophy is to upgrade the visual and ecological value of the route through well designed landscape mitigation measures including extensive tree planting, designed to blend the road and its associated earthworks into the surrounding environment;
- plant species shall be selected to maximize plant establishment, responding to the local conditions as well as the existing vegetation types;
- filled embankments will be used for planting to screen the road as well as mitigate the impact of street lighting at night from the existing villages and sensitive receivers such as Pok Oi Hospital.

Vegetation will be established as quickly as possible on the completed embankment slopes. Planting will typically extend three metres beyond the limit of the slope formation to ensure that the new planting blends in with the surrounding landscape. Details of the proposed vegetation on fill slopes, soft cut slopes and the road median are fully described in the Landscape AIP. Where possible, the native plant species listed for inclusion in the offsite woodland compensation planting (see Table 7.3) will be used as part of the slope revegetation.

Once the Landscape AIP has been approved detailed planting plans and specifications will be prepared. The final landscape treatments will be dependent on final earthworks design and site conditions.

9 WASTE MANAGEMENT

10 CONCLUSIONS

9 WASTE MANAGEMENT

Construction Phase

Construction work will involve: the installation of access roads, construction of temporary structures (including offices, and stores), the setting up and commissioning of a pre-casting yard and the construction of road alignment (including Au Tau Interchange) and dewatering of ponds.

In the PDS2EA, waste arisings in terms of types, their environmental impacts, mitigation measures and disposal options have been described in detail. To avoid repetition of the previous work, the following section will focus on the quantification of wastes to be generated and waste handling/minimisation procedures proposed by R3CC which have not been addressed due to the lack of confirmed construction details at the preliminary design stage.

Operational Phase

The general road operation should not generate refuse, human waste and chemical waste. Thus waste management during the operational phase will not be discussed in this report as all the administration and ventilation buildings will be located in the Southern Section. Waste issues associated with the operation of the administration and ventilation buildings have been fully addressed in the Southern Section DEIA.

9.1 Legislation

The principal legislation governing waste materials in Hong Kong is the Waste Disposal Ordinance [Cap.354] (WDO). Enacted in 1980, this Ordinance aims to encompass all stages of the complex waste management chain, from the place of arising to the final disposal point.

Under the WDO, provisions for dealing with certain types of waste are available. They include the Waste Disposal (Chemical Waste) (General) Regulation, which is relevant to this project. Enacted in 1992, it controls all aspects of chemical waste disposal. These include storage, collection, transport, treatment and final disposal.

Another Ordinance pertaining to hazardous materials is the Dangerous Goods Ordinance [Cap 259](DGO). This Ordinance provides for the definition of dangerous goods by category and controls their storage and transport.

Guidelines which provide information on compliance with regulations are:

- *Waste Disposal Plan for Hong Kong (December 1989)*, Planning, Environment and Lands Branch Government Secretariat.
- *Environmental Guidelines for Planning in Hong Kong (1990)*, Hong Kong Planning Standards and Guidelines, Hong Kong Government.
- *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes.*

A guideline, ProPECC PN3/94 "*Contaminated Land Assessment and Remediation*" has been issued by EPD. This guideline makes reference to criteria developed in the Netherlands and has been applied to the assessment and remediation of contaminated land sites in Hong Kong.

The Dutch system provides reference values for soil at three levels: *A*, *B* and *C*. The *A* value is the normal background level. The *B* value is set at the "delimiting value for soil having the potential for causing adverse effects to human health or the environment and requiring further investigation". The C value delimits "heavy pollution and requirement for remedial action". The Dutch criteria for judging the significance of soil contamination for selected relevant parameters are presented in Appendix N. These criteria will be used to determine pond mud contamination in this project.

9.2 Waste Generation and Handling During Construction Phase

As described in the PDS2EA, construction activities will generate various types of wastes including:

- Rock and soft spoil (including fish/duck pond mud) derived from site clearance and excavation
- Construction waste from construction materials and processes
- Workforce waste
- Wastes from plant and equipment maintenance

These will be described in more detail below.

9.2.1 Waste from Site Clearance and Excavation

Spoil Generation

Rock and Soft Spoil: Rock and soft material will be generated from three main cuttings for the approach road alignment. R3CC estimates the total quantity to be approximately 3.41 Mm^3. Estimated monthly generation rates during the construction period are summarised in Table 9.1. All vegetation within the site area will be progressively cleared ahead of the major excavation works. If possible, suitable topsoil will be stockpiled for final landscaping activities.

The rock excavation, processing and handling will generally be carried out in the following sequence:

- Drill and blast
- Blasted rock will be transported to rock crusher location
- The crushed rock will be used on site as fill material

Because large scale excavation and a large volume of spoil handling will take place, noise and dust impacts would occur. Thus mitigation measures will be adopted to minimise these impacts. Details of their impact assessment and mitigation measures have been described in Sections 4 (noise) and 5 (air) of this report.

Pond Mud: There are fish/duck ponds along the road alignment, mainly in the Au Tau area, that will be affected by the Works. R3CC estimates that approximately 200,000 m^3 of pond mud will be removed from the ponds.

Spoil Utilisation

The alignment has been designed so as to achieve an optimum balance of cut and fill requirements. Throughout construction, fill material will be required from time to time at various locations for the formation of roads, road embankments, etc. Approximately 92% of the excavated spoil (3.14 Mm^3), will be re-used as fill material. The remaining 8% (0.27 Mm^3) will be disposed of off-site. R3CC is currently investigating re-use of the spoil on other projects. Table 9.2 gives a summary of spoil utilisation.

Excavated material from construction activities will comprise of rock, gravel, sand, clay, soil and hard surface material. Thus the spoil is unlikely to be contaminated.

Of the 200,000 m^3 of excavated pond mud, R3CC estimates that 65,000 m^3 will be mixed with rockfill for re-use on the embankment. Another 65,000 m^3 will possibly be mixed with completely decomposed granite (CDG) for landscaping and/or the formation of noise barriers. Thus approximately 70,000 m^3 of mud (representing 35% of total mud) will be disposed of off-site. R3CC is investigating mixing the mud with CDG and re-using it on another project as the preferred disposal option.

The above pond mud utilisation scenario is based on the assumption that the pond mud is uncontaminated according to the criteria described in Section 9.1. Should the mud be found to be contaminated and re-use on another project prove not to be viable, R3CC will make appropriate disposal arrangement. Mud samples will be taken to test for contaminant levels at a later stage. R3CC has consulted EPD on possible disposal options. Contaminated mud and surplus mud will be disposed of at the Pillar Point landfill before its closure or at a strategic landfill (e.g. WENT) after the Pillar Point landfill is closed. The decision on the disposal route will be addressed at the appropriate time in the Monthly Environmental Monitoring and Audit Report.

9.2.2 Waste from Construction Material and Process

Waste arisings from construction activities include:

- Wood from formwork
- Waterproofing and curing materials
- Bitumen
- Cement and grout from on site concreting activities

R3CC estimates that construction wastes generated such as concrete, debris and used timber would average approximately 20 m^3 per month in the areas for bridge construction (structural work) and 30 tonnes per month for earthworks mainly from the Au Tau Interchange area.

Procedures for the handling these construction wastes will follow the New Disposal Arrangement for Construction Waste (EPD 1991), which is described in Section 9.3.1.

Table 9.1 Monthly rock and soft spoil generation rates

Material x 1,000 m³	1995			1996												1997									
	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10
Excavation Main Cut																									
CH4800 - CH5600			68.5	68.5	122	122.6	136.4	158.6	201.9	198.7	204.1	220.1	220.1	220.1	220.1	220.1	220.1	197	142.4	130	97.8	67	36.3	36.3	37.2
CH3650 - CH4800						19	14																		
Link Road F										21.4	16														
TOTAL			68.5	68.5	122	141.6	150.4	158.6	201.9	220.1	220.1	220.1	220.1	220.1	220.1	220.1	220.1	197	142.4	130	97.8	67	36.3	36.3	37.2

Table 9.2 Rock spoil utilisation

Location/ Material x 1,000 m³	1995			1996												1997									
	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10
Main Road																									
CH4800 - Kam Tin Rd					30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	15.7							
CH3350 - CH3130					8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	4					
CH3650 - CH3425					15	15	15	15	15	15	15	15	15	15	15	15	15	7							
CH2925 - CH2598						19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6					
CH840 - Link E							8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	4.6					
CH2440 - CH2159								8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	3.6					
CH1212 - Link G, H										18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	9.6			
CH280 - Link G,E,F,H									43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	21.1			
Crusher/Stockpile/ Surcharge/ Rock Capping			61.7	61.7	61.7	61.7	61.7	61.7	61.7	61.7	51.7	51.7	51.7	51.7	51.7	51.7	51.7	51.7	24.5	24.5	24.5	24.5	24.5	24.5	26.8
TOTAL UTILISATION			61.7	61.7	115.2	134.8	143.6	151.8	195.1	213.3	203.3	203.3	203.3	203.3	203.3	203.3	203.3	181	130.6	118	86	56.2	24.5	24.5	26.8
DISPOSAL QUANTITY			6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	11.8	11.8	11.8	11.8	11.8	11.8	10.4

9.2.3 Workforce Waste

The workforce engaged in construction will generate general refuse comprising of food scraps, paper, empty containers etc. With reference to EPD's domestic waste generation rate (1994) of 1.04 kg/cd and considering the fact that only one shift will be present, a load factor of 0.35 kg/cd was used in predicting refuse generation by the workforce. The estimated quantities of daily waste arisings are presented in Table 9.3.

Table 9.3 Number of employees and refuse arisings at different work sites

Workforce	No. of Employees	Waste Arising (kg/d)
Structural work	120	42
Earthwork	350	123

In addition to the above waste arisings, human waste will be generated on the construction sites by the workforce. Such waste is characterised by high BOD, high nutrient contents and low DO. If discharged directly into water courses or allowed to seep into the groundwater, it would lead to a deterioration in water quality. Thus mitigation measures will be undertaken to prevent this impact.

9.2.4 Maintenance Waste

Construction plant and equipment will require regular maintenance and servicing. This will generate waste. Substances likely to be generated by construction activities, will for the most part, arise from the maintenance of equipment including some chemical wastes such as cleaning fluids, solvents, lubrication oil, batteries and fuel.

Based on R3CC's estimates, waste generation rates for structure and earth works are presented in Table 9.4. Such waste will be reused where possible. Waste listed in Table 9.4 which are classified as chemical waste will be segregated, stored, transported and disposed of in accordance with the Waste Disposal (Chemical Waste) (General) Regulation. If they enter into the water courses or groundwater due to inappropriate storage, it could cause to a deterioration in water quality. Thus appropriate chemical waste handling will be considered to protect the environment (Section 9.3).

Table 9.4 Generation of waste from structure and earthwork teams

Waste	Generation Rates Per Month	
	Structural Work	Earthwork
Fuel lubricating and oil	250 litre	200 litre*
Used types	-	4 nos
Filter, solid	-	1kg
Waste batteries	2	

* Including solvents

9.3 Mitigation Measures and Recommendations

R3CC will comply with the following mitigation measures and recommendations.

9.3.1 Waste Collection and Disposal

If pond mud is disposed of at a strategic landfill, R3CC will ensure that its moisture content must be no more than 70%. If off-site disposal of contaminated pond mud is required (to be determined), it will be delivered to the Pillar Point Valley Landfill prior to its closure. R3CC will ensure that the spoil is properly collected, transported and disposed of according to EPD's requirements.

As expressed by EPD, one of their criteria to decide the disposal route for contaminated pond mud is its quantity. Thus, without knowing the quantity of the contaminated pond mud, it is not feasible to determine the disposal route at this stage. However, R3CC will:

- Determine the quantity of contaminated pond mud when appropriate
- Submit pond mud sampling and testing proposal for EPD's approval
- Carry out mud testing and present results to EPD
- Discuss and consult with EPD for the final disposal route based on the estimated quantity of contaminated pond mud
- Identify mitigation measures where appropriate to ensure that contamination will not occur during temporary stockpiling on site and transportation between the sources and disposal point. These measures will be described in the EM&A monthly report when appropriate.

R3CC will ensure that waste arisings from site clearance will be sorted and disposed of according to the New Disposal Arrangement for Construction Waste (EPD 1991). Such waste will be sorted on-site to separate the inert and non-inert portions. Non-inert materials (such as wood, glass plastic, steel and other putrescible wastes) will be disposed of at landfills. Inert materials (such as concrete, rubble, soil cement/grout) if not reused on-site will be disposed of at public dumps or other reclamation sites.

R3CC will ensure that no on-site burning of wooden waste will occur as it can cause excessive emissions of smoke and create a fire hazard. This waste that cannot be recycled will be disposed of at a landfill.

Refuse collection points will be established. Collected refuse will be disposed of at a suitable landfill (eg. WENT and/or Pillar Point) by private contractors. The management of general refuse will be discussed with the contractors as part of R3CC's Environmental Induction programme.

Wastes listed in Table 9.4 which are classified as chemical wastes will be collected by authorised collectors. Reclaimed oil from accidental leaking/spillage requiring disposal will be regarded as chemical waste. All chemical waste will be delivered to the Chemical Waste Treatment Facility at Tsing Yi. Sludge from septic tanks will be collected regularly by hygiene services companies.

9.3.2 On-site Storage

For human waste, septic tanks will be provided and cleaned regularly. If necessary,

temporary on-site portable chemical toilets will be provided for workers at particular areas of the site. Sludges will be removed regularly by an approved contractor. Sludge/waste will be stored in enclosed containers to prevent odour emission.

Wastes listed in Table 9.4 which are classified as chemical wastes will be segregated on site. They will be stored in accordance with EPD's *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes,* namely:

- the storage area will be used for chemical waste only
- the storage area will be enclosed on at least 3 sides
- adequate passive ventilation will be provided
- adequate space will be provided for workers to handle the waste containers
- the storage area will be secured
- the store will have a roof and be kept clean and dry
- the store will have an impermeable floor and will be designed to retain the contents of the largest liquid container or 20% of the liquid storage volume capacity, whichever is greater
- incompatible wastes will be stored separately.

For instance, lubricants and other oils will be collected and stored in designated containers in a secure place with suitable containment (e.g. bunding).

9.3.3 Transportation

Issues related to the transportation of contaminated pond mud and R3CC's commitment is this aspect have been identified in Section 9.3.1. R3CC will make proper arrangements for the transportation of contaminated pond mud to ensure that no mud or supernatant will be lost between sources and the final disposal point.

If transportation of hazardous materials is necessary, R3CC will ensure that hazardous materials, chemical wastes and fuel are packed or stored in containers or vessels of a suitable design and construction to prevent uncontrolled release.

R3CC will undertake measures at all times to prevent the uncontrolled release of hazardous materials and chemical waste to the environment.

9.3.4 Waste Minimisation and Recycling:

R3CC will re-use as much of the excavated spoil and pond mud as possible to minimise off-site fill material requirement and the disposal of spoil as previously explained. In addition, R3CC will make provision for the re-use of waste materials where possible. Examples are:

- R3CC is currently discussing the possibility of providing the used oil to private recycling contractors

- Wood material will be stored separately from other wastes and re-used (e.g. for formwork) where possible

- Where slope protection works are carried out in stages, the bamboo can be re-used on site. Fatigued bamboo will however be disposed of to landfill.

10 CONCLUSIONS

The findings of this report are broadly similar to those of the PDS2EA. As is the normal practice in Hong Kong, construction impacts have been predicted on the basis of conservative worst case modelling. Representative worst case receivers that are closest to the construction sites were selected for assessment, since impacts at more distant receivers will be lower. R3CC has committed to meeting statutory environmental requirements and will endeavour to meet guideline limits wherever practicable. Commitments have also been made to a number of impact mitigation measures and these were used as a basis for modelling. However, since the modelling is based on worst case, and in reality impacts are likely to be lower than those predicted, the need for additional mitigation will be based on the results of the Environmental Monitoring and Audit (EM&A) programme. In addition, an on-site Environmental Manager from R3CC is included on the project team to ensure that the necessary mitigation measures are carried out.

With the implementation of committed mitigation measures, residual environmental impacts during construction and operation of the R3 TLT & YLA Northern Section should be acceptable. Air quality impacts (TSP and NO_2) were predicted to comply with all guideline and statutory limits during construction and operation. Residual impacts on water quality, ecology, visual and landscape, and waste were predicted to be acceptable with the implementation of the mitigation measures.

Based on the worst case scenario under actual construction methodology, the assessment of construction noise has indicated that some mitigation measures will be required to reduce the noise during construction. Mitigation will generally involve distance separation of PME items and the use of acoustic barriers. Sensitive receivers in the vicinity of the Small Traders New Village was predicted to be exposed to construction noise in excess of 75 dB(A) for approximately 30 days over a 9-month period during embankment formation. This confirms the findings in the PDS2EA. R3CC will shield sensitive receivers at this location with hoardings, retaining walls and temporary barriers. Close monitoring and implementation of additional mitigation measures when needed have been proposed, including the use of quieter equipment, screening of fixed PME items and forward planning of intermittent noisy activities. CNPs will be required for restricted hours activity.

For operational noise, it was estimated that 532 dwellings will be affected by noise levels in excess of the HKPSG standard from traffic on Route 3 if no mitigation is provided. A comprehensive noise barrier arrangement has been proposed for the Route 3 alignment north of the Toll Plaza. However, an estimated 121 dwellings will remain affected by noise levels in excess of the HKPSG standard. This is attributable to the existing roads (Castle Peak Road and Kam Tin Road) as well as the proximity and elevation of the receivers in relation to the Route 3 alignment. Of these, 48 dwellings were estimated to be eligible for indirect technical remedies in accordance with the ExCo directive on "*Equitable Redress for Persons Exposed to Increased Noise resulting from the Use of New Roads*", and subject to ExCo's approval.

Construction of the Northern Section of R3 TLT & YLA will result in losses of 20.99 ha of fish ponds temporarily and 13.09 ha of fish ponds permanently. The 20.99 ha of fish ponds lost temporarily will be reinstated according to the requirements set forth in Clauses 9.3.2 and 9.3.3 of the Construction Requirements. A fish pond reinstatement and maintenance plan has been provided in the EM&A Manual for this Northern Section

DEIA. The issue of permanent fish pond loss from this project (13.09 ha from the Northern Section and 3.9 ha from the Southern Section) and cumulatively from this and other projects in the New Territories (249.09 ha, or 21% of the total fish pond hectarage in Hong Kong) was highlighted in the report. Compensation for permanent loss off-site is beyond the contractual requirement of R3CC and the Franchisee. The issue of off-site compensation of wetland loss from this and other projects can best be dealt with on the policy level by government.

Committed mitigation measures are summarised below.

Noise

Earthworks

- Between CH 280-680, haul traffic is confined to the centre of the alignment and water pumps are acoustically screened
- Between CH 680 and various link roads, haul traffic is confined to the centre of the alignment and water pumps are acoustically screened
- Between CH 4150-4800, water pumps are acoustically screened
- Near NSRs R171, R1441, R1512 and R2182, acoustic barrier in form of earth bund provided at NSR to screen line of sight of construction activities, subject to agreement with occupants
- Near the Small Traders New Village, use of hoardings (2.4 m high), retaining walls and temporary barriers to shield sensitive receivers

Structural works

- Bored piling is not undertaken concurrently with other structural operations at the construction site nearest to R90, R171, R1441 and R1512 if NSR not already screened
- Hand held breakers used within 100 m of R171 are acoustically screened at source if NSR not already screened
- Hand held breakers used within 60 m of R1512 are acoustically screened at source if NSR not already screened

Air Quality

Site Practices

- Mean vehicle speed of haulage trucks at 20 $kmhr^{-1}$.
- Twice daily watering of all open site areas (assumed 50% dust reduction as from *AP-42*).
- Wheel wash facilities.
- Suitable side and tailboards on haulage vehicles.
- Watering of temporary stockpiles.

Blasting

- Use of select aggregate and fines to stem the charge within drill holes and watering of blast face (assumed 30% dust reduction).
- Vacuum extraction drilling methods (assumed emission factor for wet quarry drilling from *AP-42*).
- Carefully sequenced blasting.

- The blasting operations will be carried out with an "open face". This will have the effect of increasing the horizontal portion and decreasing the vertical portion of rock displacement. Subsequently the vertical emission of dust will be reduced. If the blast area is closed without an "open face", the fractured rock would be confined and forced to be displaced vertically.
- Vacuum filters on drill rigs will reduce dust associated with blasting preparation.
- Incombustible stemming will be used in the drill holes, where approximately 3 m of selected aggregates/granular material will be placed, which would confine the explosive and act as gas absorber.
- All the blast holes will be filled with emulsion and detonation will be sequential with a delay of approximately 25 ms between two holes. As the explosives detonate, fracture and move rock, dust is generated. The degree of interaction with adjacent blastholes will influence the velocity of movement of the shattered rock and will subsequently affect the quantity of dust generated. Closely spaced blastholes fired simultaneously will result in higher velocities of displacement and hence higher dust emission than a single blasthole. Through careful sequencing of the proposed detonator methodology, the velocity of the rock is reduced and dust emission minimized.

Water Quality

Operational Phase

- Sedimentation will be controlled by silt traps in gully inlets and the provision of sedimentation basins at appropriate locations along the highway.
- Silt traps will be cleaned and maintained regularly to ensure that they function properly.

Construction Phase

- Temporary drains and stilling ponds will be installed prior to any major earthworks that expose bare soil.
- Drains will be constructed along the alignment of the access roads as well as around the temporary facilities and slope berms. Diversion ditches will also be installed to collect run-off from areas of exposed soil. Water collected in drains and ditches will be diverted to temporary stilling ponds to allow for separation of sediment prior to discharge into the natural stream courses. The locations of the stilling pits are shown in Figure 6.2.
- All exposed areas will be hydroseeded as soon as possible to reduce the erosion potential and the levels of sediment laden run-off.
- Short-term stockpiles will be covered with tarpaulins to reduce sediment laden run-off, where possible. All run-off from the stockpiles will be collected in temporary drains and directed to the stilling ponds for desilting.
- Oil interceptors will be installed for the workshop and storage areas in compliance with EPD regulations. These will be emptied regularly and will have a by-pass to prevent flushing during periods of heavy rain.
- Office workshop and canteen facilities will be provided with appropriately sized septic tanks. Sewage and wastewater will be removed off-site to Sewage Treatment Works using a licensed contractor.
- Surface pond water and run-off liquor from pond mud will be treated prior to discharge where necessary. Surface pond water will be tested and if appropriate

siphoned off and discharged into natural stream courses at a controlled rate. The remaining pond slurry will be pumped into adjacent settlement basins. The mud and settled slurry in the ponds and settlement basins will either be mixed with completely decomposed granite to convert it into a suitable material for reuse on site or suitably disposed of off-site.

Ecology

- Sedimentation and erosion control measures to prevent adverse impacts on the stream and riparian vegetation, including hydroseeding of temporary works cut and fill slopes, use of earthen berms to control overland flow and other measures.
- Compensation planting of native woodlands permanently lost by the works through off-site planting three times the area affected with the same species of woodland to the satisfaction of the Directors Representative in consultation with the Agriculture and Fisheries Department (as specified in the Construction Requirements).
- Reinstatement of vegetation on the temporary construction areas within the Works Boundary according to a comprehensive reinstatement plan to be developed in consultation with the government authorities; and specialist terrestrial ecologist.
- Minimize incursion into areas within the Works Limits that are not directly required for either temporary or permanent work.
- Restoration of fish ponds which are to be resumed and temporarily used for other purposes during project construction. Reprovisioning of fish ponds at Au Tau Interchange.
- Relocation of bamboo stand and additional planting at Au Tau Interchange to provide nesting habitat for Chinese Pond Herons displaced due to the loss of the Tung Shing Lei heronry. This may also provide habitat for birds possibly displaced by construction disturbance close to the Ko Po Tseun heronry.
- Where practical, excavate by hand, any burrow systems encountered during construction and release captured animals unharmed in areas secure from disturbance. The practicality of the commitment including the effect of translocating animals will be discussed with AFD and methods developed to carry out hand excavation and relocation of captured animals occurs where possible.

Visual and Landscape during Construction

- Restrict volume of construction traffic on local road network.
- Restrict the construction working areas to a minimum, siting them if possible in visually isolated positions.
- Enclose the working areas with hoardings to define boundary edge and screen low level construction activities (e.g. car/truck movement) from surrounding receivers.
- Restrict heights of storage materials, stock piles and spoil heaps to low levels.
- Minimise night-time working and lighting.

Waste Management

- Different types of wastes will be segregated, stored, transported and disposed of separately in accordance with EPD's required procedures.
- As only a small amount of sludge will be produced on sites requiring periodic disposal, temporary on-site storage facilities may be required. Sludge/waste will be stored in enclosed containers to prevent odour emission.

- R3CC will ensure that hazardous materials, chemical wastes and fuel are packed or stored in containers or vessels of suitable design and construction to prevent leakage, spillage or escape.
- R3CC will prevent the uncontrolled release of hazardous materials and chemical waste to the air, soil, surface waters, groundwaters and coastal waters.
- Dangerous materials including fuel, oil and lubricants as defined under the DGO will be stored in specially designed areas and properly labelled on site. If leak, spill or discharge occurs, it can be contained more effectively in these specially built areas.
- Refuse containers such as open skips will be provided at every work site for use by the workforce.
- R3CC will re-use excavated spoil and pond mud as much as possible to minimise off site disposal of spoil. In addition, provision will be made for the reuse of other waste material where possible.