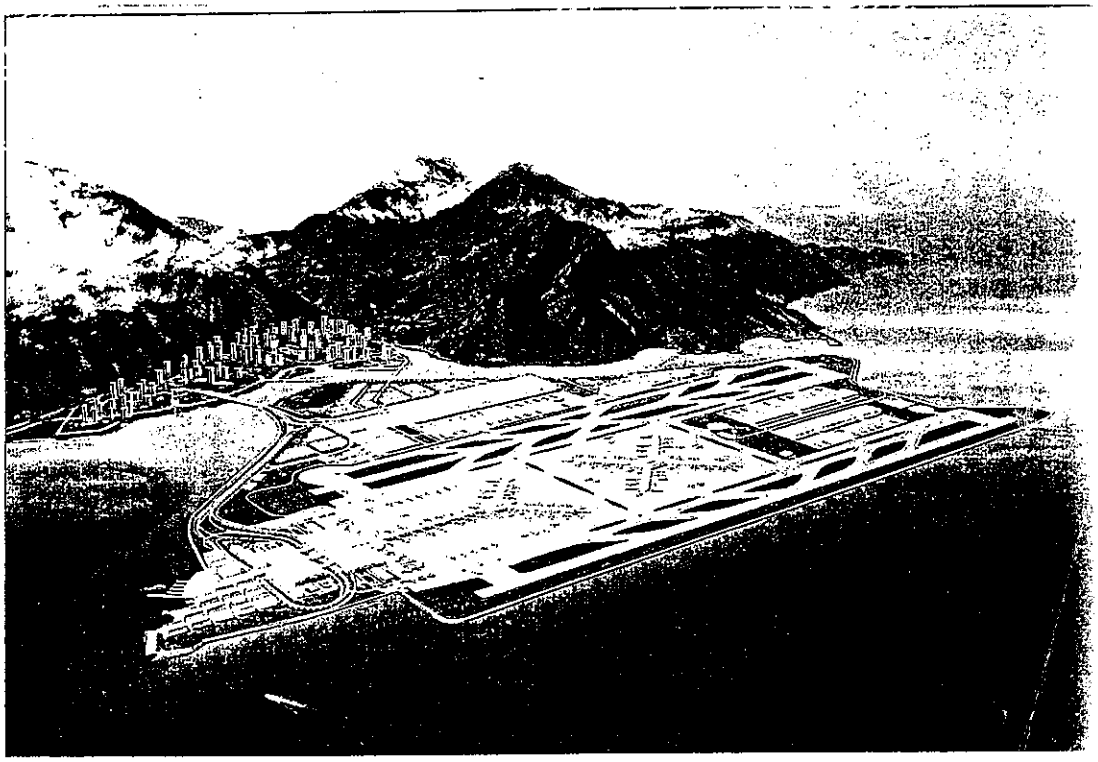
9/1/92

Provisional Airport Authority - Hong Kong

New Airport Master Plan

Environmental Impact Assessment



Greiner - Maunsell

Contents

			Page
PART A	**INTRODUCTION**		
1	**Introduction**		
	1.1	Background	1-1
	1.2	Purpose	1-2
2	**Implementation of the Airport Master Plan**		2-1
3	**Environmental Legislation and Guidelines**		
	3.1	Noise	3-1
	3.2	Air Quality	3-4
	3.3	Water Quality	3-5
	3.4	Ecology	3-8
	3.5	Waste and Hazardous Materials	3-9
PART B	**ISSUES RELATING TO AIRPORT CONSTRUCTION**		
4	**Noise**		
	4.1	Assessment Methodology	4-1
	4.1.1	Excavation and Reclamation	4-2
	4.1.2	Dredging and Dumping	4-4
	4.1.3	Building and Infrastructure Contract	4-4
	4.1.4	Percussive Piling	4-5
	4.2	Existing and Post Construction Environment	4-5
	4.3	Noise Impacts	4-5
	4.4	Mitigation Measures	4-8
	4.5	Monitoring	4-9
5	**Air Quality**		
	5.1	Assessment Methodology	5-1
	5.1.1	Emission Rates	5-2
	5.1.2	Atmospheric Dispersion Model	5-5
	5.1.3	Receptors	5-5
	5.1.4	Meteorological Conditions	5-6
	5.1.5	Complex Terrain	5-6
	5.2	Existing Environment	5-6
	5.3	Air Quality Impacts	5-7
	5.3.1	Worst Case Results	5-8
	5.3.2	Most Probable Results	5-11
	5.3.3	Contours	5-11
	5.3.4	Asphalt and Concrete Plants	5-23
	5.3.5	Construction Equipment Exhaust	5-23
	5.4	Mitigation Measures	5-23
	5.5	Monitoring	5-24
6	**Hydrodynamics**		
	6.1	Assessment Methodology	6-1
	6.1.1	Airport Reclamation Configuration	6-1
	6.1.2	Flushing Channel	6-1
	6.1.3	Sediment Dispersion from Dredging and Dumping Operations	6-1

Page

6.2	Hydraulic Impacts		6-3
	6.2.1	Airport Reclamation Configuration	6-3
	6.2.2	Flushing Channel	6-6
	6.2.3	Sediment Dispersion and Deposition	6-8
6.3	Mitigation Measures		6-16
	6.3.1	Airport Reclamation Configuration and Flushing Channel	6-16
	6.3.2	Sediment Dispersion and Deposition	6-16
7	**Water Quality**		
7.1	Assessment Methodology		7-1
	7.1.1	Identification of Sensitive Receivers	7-1
	7.1.2	Sources of Existing Water Quality Data	7-1
	7.1.3	Mathematical Modelling	7-4
	7.1.4	Assessment of Marine Mud Quality	7-4
7.2	Existing Environment		7-7
	7.2.1	Water Quality	7-7
	7.2.2	Marine Mud Quality	7-7
7.3	Water Quality Impacts		7-9
	7.3.1	Airport Reclamation Configuration	7-9
	7.3.2	Dredging and Mud Disposal	7-13
	7.3.3	Construction Site Runoff	7-23
	7.3.4	Sewage Flows and Loads	7-24
7.4	Mitigation Measures		7-24
	7.4.1	Airport Reclamation Configuration	7-24
	7.4.2	Dredging and Mud Disposal	7-25
	7.4.3	Construction Site Runoff	7-25
	7.4.4	Sewage Treatment and Disposal	7-25
7.5	Monitoring		7-26
8	**Marine Ecology**		
8.1	Assessment Methodology		8-1
8.2	Existing Environment		8-3
	8.2.1	Sublittoral	8-3
	8.2.2	Littoral	8-10
8.3	Marine Ecological Impacts		8-20
	8.3.1	Sublittoral Biota	8-20
	8.3.2	Littoral Communities	8-21
8.4	Mitigation Measures		8-22
8.5	Monitoring		8-23
9	**Terrestrial Ecology**		9-1
9.1	Assessment Methodology		9-1
	9.1.1	Terrestrial Flora and Fauna	9-1
	9.1.2	Avifauna	9-2

			Page
9.2	Existing Environment		9-2
	9.2.1	Terrestrial Flora and Fauna	9-2
	9.2.2	Avifauna	9-7
9.3	Terrestrial Ecological Impacts		9-13
	9.3.1	Terrestrial Flora and Fauna	9-13
	9.3.2	Avifauna	9-14
9.4	Mitigation Measures		9-15
	9.4.1	Terrestrial Flora and Fauna	9-15
	9.4.2	Avifauna	9-19
10	**Solid Waste**		
10.1	Waste Arisings		10-1
	10.1.1	Excavation	10-1
	10.1.2	Infrastructure	10-1
	10.1.3	Employee Domestic Waste	10-2
	10.1.4	Maintenance and Repair Wastes	10-3
10.2	Disposal Alternatives		10-3
	10.2.1	Excavation	10-3
	10.2.2	Infrastructure	10-4
	10.2.3	Employee Waste	10-4
	10.2.4	Maintenance	10-4
11	**Hazardous Materials**		
11.1	Assessment		11-1
11.2	Existing Environment		11-2
11.3	Mitigation Measures		11-3
12	**Land Use**		12-1
13	**Socioeconomics**		
13.1	Assessment/Existing Environment		13-1
13.2	Socioeconomic Impacts		13-1
	13.2.1	Social Impacts	13-2
	13.2.2	Economic Impacts	13-2
13.3	Mitigation Measures		13-3
14	**Archaeological and Historical Sites**		
14.1	Assessment/Existing Environment		14-1
14.2	Impacts/Mitigation Measures		14-3
15	**Aesthetics**		15-1

Page

PART C ISSUES RELATING TO AIRPORT OPERATION

16 Noise
16.1 Assessment Methodology 16-1
16.1.1 Airport Data 16-2
16.1.2 Aircraft Operational Data 16-2
16.1.3 Runway and Flight Track Utilisation Data 16-10
16.2 Existing and Post Construction Environment 16-18
16.3 Noise Impacts 16-18
16.3.1 Arrivals and Departures 16-18
16.3.2 Ground Operations 16-18
16.4 Mitigation Measures 16-21
16.5 Modelling, Monitoring and Audit 16-22

17 Air Quality
17.1 Assessment Methodology 17-1
17.1.1 Sources of Air Emissions 17-1
17.1.2 Models 17-5
17.1.3 Emission Factors 17-8
17.1.4 Receptors 17-9
17.1.5 Meteorological Conditions 17-10
17.1.6 Complex Terrain 17-12
17.2 Existing Environment 17-12
17.3 Air Quality Impacts 17-13
17.3.1 Emissions Inventory 17-13
17.3.2 Dispersion Modelling Results 17-16
17.4 Other Issues 17-19
17.4.1 Health Effects 17-19
17.4.2 Effects on Vegetation 17-19
17.4.3 Visible Emissions 17-20
17.4.4 Odour 17-20
17.4.5 Fuel Dumping 17-20
17.5 Mitigation Measures 17-20
17.5.1 Location and Layout 17-21
17.5.2 Terminal Area Location and Design 17-22
17.5.3 Access/Egress 17-22
17.6 Monitoring and Audit 17-22

18 Hydrodynamics
18.1 Assessment Methodology 18-1
18.2 Hydraulic Impacts 18-1
18.2.1 Siltation 18-1
18.3 Mitigation Measures 18-3

19 Water Quality
19.1 Assessment Methodology 19-1
19.1.1 Foul Sewage Loads 19-1
19.1.2 Storm Water Contamination 19-7
19.2 Water Quality Impacts 19-11
19.2.1 Foul Sewage 19-11
19.2.2 Contaminated Stormwater Runoff 19-12

			Page
19.3	Mitigation Measures		19-15
	19.3.1	Pre-treatment Prior to Discharge to Foul Sewer	19-15
	19.3.2	Stormwater Interception	19-18
	19.3.3	Operational Procedures	19-22
19.4	Monitoring and Audit		19-25
	19.4.1	Monitoring Requirements	19-25
	19.4.2	Audit Requirements	19-26
20	**Marine Ecology**		
20.1	Assessment Methodology		20-1
20.2	Existing Environment		20-1
	20.2.1	Sublittoral	20-1
	20.2.2	Littoral	20-1
	20.2.3	Post-Construction Environment	20-2
20.3	Marine Ecological Impacts		20-2
20.4	Mitigation Measures		20-3
20.5	Monitoring and Audit		20-4
21	**Terrestrial Ecology**		
21.1	Terrestrial Impacts		21-1
21.2	Landscaping		21-1
22	**Solid Waste**		
22.1	Waste Arisings		22-1
	22.1.1	Domestic Waste	22-1
	22.1.2	Commercial Waste	22-1
	22.1.3	Industrial Waste	22-2
	22.1.4	Putrescible Waste	22-2
	22.1.5	Miscellaneous Solid Wastes	22-2
22.2	Background to Strategy		22-3
22.3	Preferred Strategy		22-4
	22.3.1	Collection	22-4
	22.3.2	Transfer	22-4
	22.3.3	Disposal	22-4
22.4	Potential Environmental Impacts		22-5
	22.4.1	Impact on Disposal Facilities	22-5
	22.4.2	RTS Location and Land Use Considerations	22-5
	22.4.3	Air Quality	22-5
	22.4.4	Noise	22-5
	22.4.5	Water Quality	22-6
22.5	Mitigation Measures		22-6
	22.5.1	Air Quality	22-6
	22.5.2	Noise	22-7
	22.5.3	Water Quality	22-7
22.6	Compatibility with the North Lantau RTS		22-8
23	**Hazardous Materials**		
23.1	Assessment Methodology		23-1
	23.1.1	Sources and Characteristics	23-1
23.2	Existing Conditions		23-5

Page

23.3	Mitigation Measures		23-6
	23.3.1	Elimination, Substitution, Minimisation, Abatement	23-6
	23.3.2	Stormwater Interception	23-7
	23.3.3	Accidents and Emergencies	23-7
	23.3.4	Atmospheric Discharges	23-7
	23.3.5	On-Site Storage	23-8
	23.3.6	Off-Site Disposal	23-9
24	**Land Use**		**24-1**
25	**Socioeconomics**		**25-1**
26	**Archaeological and Historical Sites**		**26-1**
27	**Aesthetics**		
27.1	Assessment Methodology		27-1
27.2	Existing Environment		27-1
	27.2.1	Visibility	27-1
	27.2.2	Distant Views	27-1
	27.2.3	Middle Views	27-3
	27.2.4	Near Views	27-3
27.3	Visual Impact of Airport and Related Developments		27-3
	27.3.1	Distant Views	27-3
	27.3.2	Middle Views	27-4
	27.3.3	Near Views	27-4
27.4	Mitigation Measures		27-4
	27.4.1	Distant Views	27-4
	27.4.2	Middle Views	27-5
	27.4.3	Near Views	27-5
	27.4.4	Airport Views	27-6
PART D	**SUMMARY**		
28	**Summary and Recommendations**		
28.1	Noise Impacts		28-1
	28.1.1	Summary of Construction Impacts	28-1
	28.1.2	Recommendations	28-1
	28.1.3	Summary of Operational Impacts	28-2
	28.1.4	Recommendations	28-2
28.2	Air Quality		28-3
	28.2.1	Summary of Construction Impacts	28-3
	28.2.2	Recommendations	28-4
	28.2.3	Summary of Operational Impacts	28-5
	28.2.4	Recommendations	28-6
28.3	Tidal Flow and Water Quality		28-6
	28.3.1	Summary of Construction Impacts	28-6
	28.3.2	Recommendations	28-8
	28.3.3	Summary of Operational Impacts	28-8
	28.3.4	Recommendations	28-9

Page

28.4 Marine Ecology 28-10
28.4.1 Summary of Construction Impacts 28-10
28.4.2 Recommendations 28-11
28.4.3 Summary of Operational Impacts 28-12
28.4.4 Recommendations 28-13
28.5 Terrestrial Ecology 28-13
28.5.1 Summary of Construction Impacts 28-13
28.5.2 Recommendations 28-14
28.5.3 Summary of Operational Impacts 28-15
28.5.4 Recommendations 28-15
28.6 Solid Waste and Hazardous Materials 28-16
28.6.1 Summary of Construction Impacts 28-16
28.6.2 Recommendations 28-16
28.6.3 Summary of Operational Impacts 28-17
28.6.4 Recommendations 28-19
28.7 Aesthetics 28-20
28.7.1 Summary of Imparts 28-20
28.7.2 Recommendations 28-21
28.8 Environmental Monitoring and Audit Programme 28-21
28.8.1 Summary of Construction Phase Monitoring 28-21
28.8.2 Summary of Operational Phase Monitoring 28-22
28.8.3 Recommendations 28-22

Acknowledgements

Appendices

A Provisional Airport Authority Board Members

B List of Working Papers

C References

D Abbreviations

Page

PART A INTRODUCTION

3.1 Basic Noise Levels (BNLs) for Construction Noise from Activities other than Percussive Piling dB(A) 3-1
3.2 Acceptable Noise Levels (ANLs) for Percussive Piling 3-1
3.3 Land Use Compatibility Chart for Aircraft Noise 3-2
3.4 Summary of Noise Standards 3-3
3.5 Hong Kong Air Quality Objectives 3-4
3.6 Air Quality Legislation and Guidelines 3-5
3.7 Water Quality Objectives for the Proposed North Western Waters Control Zone 3-7
3.8 Hazardous Materials and Chemical Wastes Legislation 3-10

PART B ISSUES RELATING TO AIRPORT CONSTRUCTION

4.1 Area Sensitivity Ratings (ASRs) 4-1
4.2 Basic Noise Levels (BNLs) 4-1
4.3 Representative Equipment and Associated Sound Power Levels (SPLs) 4-2
4.4 Projected Worst Case Noise Impacts in Comparison to BNLs 4-6
4.5 NSRs Qualifying for Funding to Install and Operate Air Conditioners 4-8
4.6 Comparison of CNLs and ANLs 4-8

5.1 Excavation/Land Reclamation Operation Particulate Matter Emission Rates 5-4
5.2 Construction Related Particulate Matter Characteristics 5-5
5.3 Worst Case One Hour and 24-Hour Total Suspended Particulates (TSP) Levels (ug/m^3) 5-9
5.4 Worst Case One Hour and 24-Hour Respirable Suspended Particulates (RSP) Levels (ug/m^3) 5-10

7.1 Suspended Solids Statistics: Hourly Samples Taken Over Four 26-Hour Periods in 1990 7-8
7.2 Suspended Solids Statistics: Bimonthly Samples Taken Over the Period January 1989 - April 1990 7-8
7.3 Analytical Results for Surficial Samples of Marine Mud from the Chek Lap Kok Airport Reclamation Site and Marine Borrow Areas 7-9
7.4 Increases in Suspended Solids Concentrations Resulting from Dumping Operations at the Entrance to Deep Bay 7-18
7.5 Increases in Suspended Solids Concentrations at Deep Bay Oyster Beds Resulting from Fill Extraction at Urmston Road Borrow Area 7-20
7.6 Potential Increases in Suspended Solids Concentrations at Oyster Beds in Deep Bay Resulting from Dredging at Outer Deep Bay 7-20
7.7 Potential Increases in Suspended Solids Concentrations at Oyster Beds in Deep Bay Resulting from Dredging at the Northern Part of the Deep Bay Borrow Area 7-20
7.8 Potential Increases in Suspended Solids Concentrations at Oyster Beds in Deep Bay Resulting from Combined Cycle Dredging and Dumping at The Brothers and Deep Bay Borrow Areas 7-23

		Page
7.9	Sewage Flows and Loads Arising from Construction Workers at Chek Lap Kok	7-24
8.1	Metal Concentrations in Bulk Sediment Samples Collected by Van Veen Grab (Sites 1A to 16A).	8-3
8.2	Complete List of Fauna Collected by Grab North of Lantau, 5th to 7th November 1990	8-4
8.3	Complete List of Fauna Collected by Trawl North of Lantau, 5th to 8th November 1990	8-7
8.4	Reported Sightings of Chinese White Dolphin *Sousa Chinensis* in North Lantau, Deep Bay and Pearl River Estuary Area Between July 1980 and October 1991	8-11
8.5	Fauna and Flora List for Typical Rocky Cliff Community (Relatively Wave Exposed) in Region of Tung Chung, North Lantau (November 1990)	8-13
8.6	Fauna and Flora List for Typical Jetty Community in Region of Tung Chung, North Lantau (November 1990)	8-13
8.7	Fauna and Flora List for Typical Lower Shore Boulder Community in Region of Tung Chung, North Lantau (November 1990)	8-14
8.8	Fauna and Flora List for Typical Upper Shore Zoysia Community Near Tung Chung, North Lantau (November 1990)	8-15
8.9	Fauna and Flora List for Typical Sandy Shore Communities (Varying with Wave Exposure and Beach Particle Size) in Region of Tung Chung, North Lantau (November 1990)	8-15
8.10	Fauna and Flora List for Typical Mangrove Swamp Community in Region of Tung Chung, North Lantau (November 1990)	8-16
8.11	Fauna and Flora List for Typical Open Shore Communities Directly Adjacent to Mangrove Swamps in Region of Tung Chung, North Lantau (November 1990)	8-17
8.12	Biomonitoring Data	8-19
8.13	Range of Maximum Concentrations of Nickel, Chromium and Cobalt in Bodies of the Barnacle *Tetraclita squamosa* Collected from Four Sites in North Lantau in November 1990	8-19
9.1	Plant Species Encountered on Chek Lap Kok	9-4
9.2	Birds Recorded at Chek Lap Kok 1990/91	9-7
9.3	List of Birds Previously Recorded from Chek Lap Kok but Not Observed in the Period August 1990 - July 1991	9-9
9.4	Bird Habitats and Habitat Use on Chek Lap Kok	9-10
9.5	Birds Observed on West Brother Island	9-11
9.6	Birds Observed on Lung Kwu Chau	9-12
9.7	Birds Observed on Sha Chau	9-12
11.1	Sources and Characteristics of Potentially Hazardous Materials, Chemical Wastes and Dangerous Goods Used During Construction Operations	11-1
14.1	Archaeological and Historical Sites Impacted by Airport Construction and Electronic Equipment Siting	14-1

Page

PART C ISSUES RELATING TO AIRPORT OPERATION

16.1	Historical Aircraft Fleet Mix	16-4
16.2	Summary of Projected Aircraft Fleet Mix by Category	16-7
16.3	Year 2000 - Projected Aircraft Mix	16-7
16.4	Year 2030 - Projected Aircraft Mix	16-8
16.5	Refined Aircraft Mix by Category	16-8
16.6	Projected Busy-Day Aircraft Movements	16-9
16.7	Summary of City-Pair Aircraft Movement - Projections by Market	16-11
16.8	Departure Track Utilisation by Region	16-15
17.1	Operational Sources of Air Emissions	17-2
17.2	2040 Emissions Inventory - Average Year	17-14
17.3	2040 Emissions Inventory - Average Day	17-14
17.4	2040 Emissions Inventory - Busy Day	17-15
17.5	Worst Case and Most Probable one and 24-Hour NO_2 Concentrations	17-17
17.6	Worst Case and Most Probable one and 8-Hour CO Concentrations	17-17
17.7	Worst Case one and 24-Hour NO_2 Concentrations in the Terminal Area	17-18
17.8	Worst Case one and 8-Hour CO Concentrations in the Terminal Area	17-19
19.1	Estimates of Sewage Loads from the Airport for the Year 2010	19-2
19.2	Estimates of Sewage Loads from the Airport for the Year 2040	19-2
19.3	Chemicals Used during Maintenance Operations at Kai Tak	19-5
19.4	Aviation Fuel Spillage Incidents at Kai Tak Airport for the Past 18 Months	19-9
19.5	Reported Pollutant Concentrations in Stormwater	19-13
19.6	Potential Pollutant Loads in Airport Stormwater	19-13
19.7	Estimated Pollutant Concentrations in Catering Effluent	19-16
19.8	Estimated Pollutant Concentrations in Aircraft Washwater	19-17
19.9	Summary of Stormwater Discharges	19-20
20.1	Effects of Pollutants on Marine Organisms	20-3
22.1	Solid Waste Arisings	22-1
23.1	Potential Sources of Hazardous Materials and Chemical Wastes	23-2

		Page
PART A	**INTRODUCTION**	
1.1	Airport Location	1-1
2.1	Airport Layout Plan	2-2
2.2	Proposed Areas of Dredging/Dumping Activities - Reclamation, Sea Channel and Marine Borrow/Dumping Areas	2-3
2.3	Potential Off-Airport Site Requirements	2-5
PART B	**ISSUES RELATING TO AIRPORT CONSTRUCTION**	
4.1	Phasing Sequence and Distribution of PME	4-3
4.2	Impacted Noise Sensitive Areas and Corresponding Most Impacted Sensitive Receivers	4-7
4.3	Noise Monitoring Requirements	4-10
5.1	Quarter-2 One Hour Worst Case TSP from Blasting Operations	5-12
5.2	Quarter-7 One Hour Worst Case TSP from Blasting Operations	5-13
5.3	Quarter-2 One Hour Worst Case TSP from Excavation/Reclamation Operations	5-14
5.4	Quarter-2 24-Hour Worst Case TSP from Blasting and Excavation/ Reclamation Operations	5-15
5.5	Quarter-2 24-Hour Worst Case RSP from Blasting and Excavation/ Reclamation Operations	5-16
5.6	Quarter-2 One Hour Most Probable TSP from Blasting Operations	5-17
5.7	Quarter-2 One Hour Most Probable TSP from Excavation/ Reclamation Operations	5-18
5.8	Quarter-2 24-Hour Average Most Probable TSP from Blasting and Excavation/Reclamation Operations	5-19
5.9	Quarter-2 24-Hour Most Probable RSP from Blasting and Excavation/Reclamation Operations	5-20
5.10	Quarter-7 One Hour Most Probable TSP from Blasting Operations	5-21
5.11	Quarter-7 24-Hour Most Probable TSP from Blasting and Excavation/ Reclamation Operations	5-22
6.1	Wet Season Spring Tide: Peak Flood Velocities with and without the Airport Reclamation	6-4
6.2	Wet Season Spring Tide: Peak Ebb Velocities with and without the Airport Reclamation	6-5
6.3	Chek Lap Kok Channel - Existing Bathymetry	6-7
6.4	Chek Lap Kok Channel - Depth Contours in 100m Intervals	6-7
6.5	Four Trailer Dredgers Operating at Chek Lap Kok - Surface Sediment Concentrations at LLW	6-9
6.6	Four Trailer Dredgers Operating at Chek Lap Kok - Sediment Redeposition	6-10
6.7	Dredging for Fill in Deep Bay - Surface Sediment Concentrations at LLW	6-12
6.8	Worst Case Spoil Dumping at the Entrance to Deep Bay - Sediment Concentrations in the Lower Layer at LLW	6-13
6.9	Dredging for Fill in Deep Bay - Sediment Redeposition	6-14
6.10	Three Grab Dredgers Operating at Chek Lap Kok - Sediment Redeposition	6-15

Page

7.1 Location of Water Quality Sensitive Receivers in North Western Waters 7-2
7.2 Location of Water Quality Monitoring Stations for which Data are Available 7-3
7.3 Location of Marine Mud Sampling Stations for the Advanced and Main Reclamation Works Areas 7-5
7.4 Location of Marine Mud Sampling Stations for The Brothers, Deep Bay and Urmston Road Borrow Areas 7-6
7.5 Location of Time Series Points for WAHMO Modelling 7-10
7.6 Location of Oyster Beds and Fish Ponds in Deep Bay 7-16
7.7 Predicted Increases in Suspended Solids Concentrations Near Castle Peak Power Station Resulting from Spoil Dumping at the Entrance to Deep Bay 7-19
7.8 Predicted Increases in Suspended Solids Concentrations Near Deep Bay Oyster Beds Resulting from Dredging for Fill at Deep Bay Borrow Area 7-21

8.1 Location of Trawls Made North of Lantau Between 6th and 8th of November 1990 8-2
8.2 Location of Grab Sites 1 to 16 Made North of Lantau Between 5th to 7th of November 1990 8-2
8.3 Shore Survey of Littoral Communities, 9th to 11th November 1990 8-12
8.4 Sample Sites (A, B, C, D) for Collection of the Barnacle *Tetraclita squamosa* for Biomonitoring of Heavy Metals 8-18

9.1 Schematic Vegetation Map of Chek Lap Kok 9-3
9.2 Potential Terrain Cuts 9-6

14.1 Archaeological and Historical Sites Impacted by Airport Construction and Electronic Equipment Siting 14-2

PART C ISSUES RELATING TO AIRPORT OPERATION

16.1 Flight Tracks 16-13
16.2 NEF Noise Contours for Year 2000 16-19
16.3 NEF Noise Contours for Year 2030 16-20
16.4 Location of Maintenance Run-up Pad 16-21

17.1 Dispersion Modelling Source and Receptor Locations 17-7
17.2 Terminal Area Source and Receptor Locations 17-11

19.1 Stormwater Outfalls and Drainage Catchments 19-19

24.1 Existing Land Use within Year 2000 NEF Noise Contours 24-2
24.2 Existing Land Use within Year 2030 NEF Noise Contours 24-3

27.1 Zone of Visual Influence of The Airport and Related Developments 27-2

Provisional Airport Authority - Hong Kong

New Airport Master Plan

Final Report

Environmental Impact Assessment

December 1991

Greiner - Maunsell
a joint venture between
Greiner International Ltd & Maunsell Consultants Asia Ltd

in association with

- Maunsell Geotechnical Services Ltd
- J Roger Preston & Partners
- N & A/HOK - a joint venture
- CES Consultants (Asia) Ltd
- Balfours International (Asia) Ltd
- Widnell
- Coopers & Lybrand Associates Ltd
- Flight Transportation Associates
- KPMG Peat Marwick
- MVA Asia Ltd
- Lea & Elliott Inc
- AVSEC Inc
- TRA
- EMA Inc
- Avtel Pty Ltd
- Dredging Research Ltd
- RTZ Consultants
- Dr Gordon E Green
- EGS Ltd
- Bruce Hawley - TGC Consulting Services Ltd
- Hydraulics Research (Asia) Ltd
- WRc plc
- Dr R Corlett, University of Hong Kong
- Dr D Dudgeon, University of Hong Kong
- Mr D S Melville
- Centre for Research in Aquatic Biology
- Clouston
- Weather Information Technologies Inc
- Professor R de Neufville
- UK Civil Aviation Authority

The Consultants wish to thank the many people who have provided either original data or assistance during the study.

Provisional Airport Authority

Government Secretariat

Economic Services Branch
Education & Manpower Branch
Finance Branch
Planning, Environment & Lands Branch
Recreation and Culture Branch
Security Branch
Transport Branch
Trade & Industry Branch
Works Branch

City & New Territories Administration

Agriculture & Fisheries Department

Architectural Services Department

Buildings & Lands Department

Census & Statistics Department

Civil Aviation Department

Civil Engineering Department

Customs & Excise Department

Department of Health

Drainage Services Department

Electrical & Mechanical Services Department

Environmental Protection Department

Fire Services Department

Government Supplies Department

Highways Department

Immigration Department

Labour Department

Legal Department

Marine Department

Planning Department

Post Office

Radio Television Hong Kong

Rating & Valuation Department

Royal Hong Kong Auxiliary Air Force

Royal Hong Kong Police Force

Royal Observatory

Territory Development Department

Trade Department

Transport Department

Water Supplies Department

Associated Engineering Ltd.

Boeing Commercial Airplanes

British Airport Authority

British Broadcasting Corporation

Cathay Pacific Airways Ltd.

China Light & Power Co., Ltd.

Gilman Insurance

Heliservices (HK) Ltd.

Hong Kong Air Cargo Terminals Ltd.

Hong Kong Aircraft Engineering Co., Ltd.

Hong Kong Air Terminal Services Ltd.

Hong Kong & China Gas Co., Ltd.

Hong Kong Association of Freight Forwarding Agents Ltd.

Hong Kong Aviation Club

Hong Kong Telecom Co., Ltd.

Hong Kong Telecom International

Hong Kong Tourist Association

International Air Transport Association

Kowloon Canton Railway Corporation

LSG Catering Hong Kong Ltd.

Mass Transit Railway Corporation

McDonnell Douglas China Inc.

Oil Companies Tank Farm

Securair Ltd.

Swire Air Caterers Ltd.

Wardley Capital Ltd.

Wattie Food Services Ltd.

World Wide Fund for Nature Hong Kong

Part A

Introduction

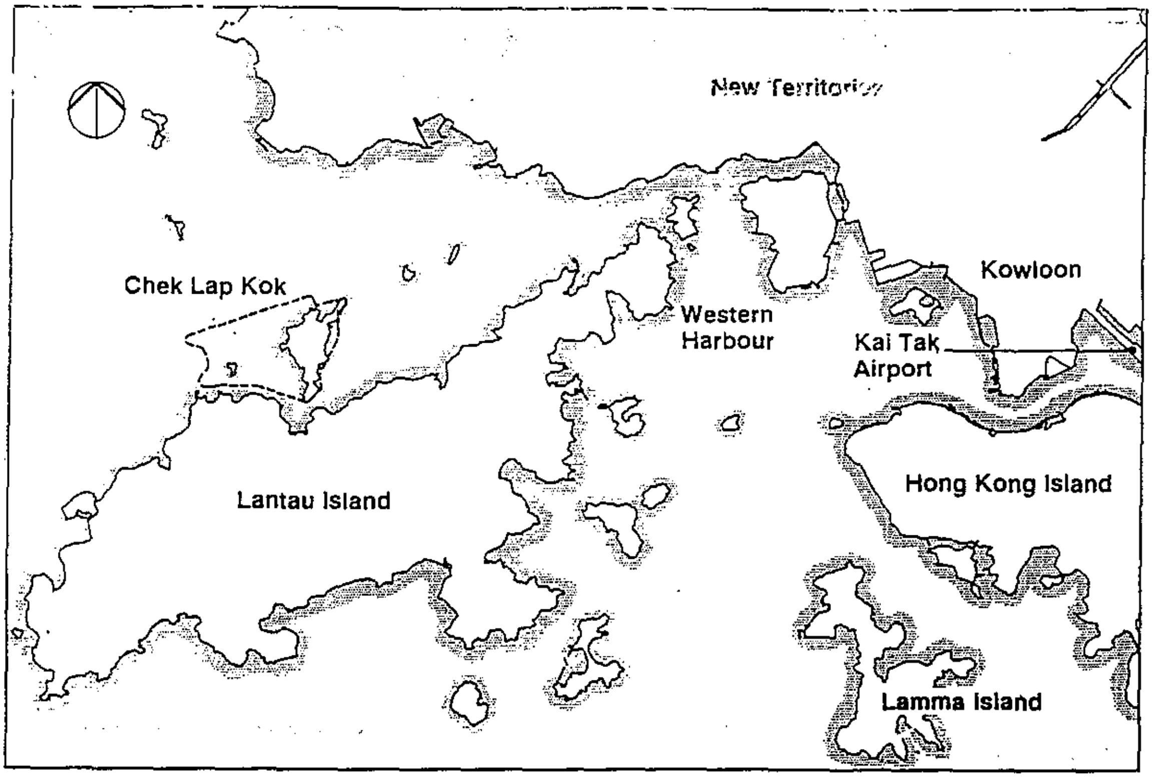
Introduction 1

1.1 Background

In its 150 year history, Hong Kong has grown from what was initially referred to as a barren rock to one of the world's most advanced and successful cities. It is one of the major financial centres of the world, a top manufacturing base, and a leading tourist destination in Asia.

Much of this growth and success has occurred over recent decades, and is largely attributable to an efficient communications and transportation network. Kai Tak Airport has served as a public commercial facility since the late 1930s and has played a pivotal role in this development.

The operational constraints of Kai Tak, a single runway airport, have however been recognized by Government for many years. In the recent past their resolve to continue to provide functional, cost efficient airport facilities with sufficient capacity to accommodate forecasted passenger and cargo demand has become increasingly evident. To this end, the Provisional Airport Authority (PAA) was established in April 1990. Greiner-Maunsell was selected by the PAA to conduct a New Airport Master Plan Study (Master Plan) that will provide a comprehensive and environmentally acceptable scheme for the planning and implementation of an operationally safe and efficient new Hong Kong International Airport. The study was initiated in 1990, several years after the Chek Lap Kok site was selected for the development of the new airport. The establishment of the PAA and the initiation of the Master Plan Study were followed by the signing of the Memorandum of Understanding by Great Britain and People's Republic of China in 1991. This agreement endorses and assures the replacement airport project. As indicated on Exhibit 1.1, the airport will be located on a site north of Lantau Island and will encompass the islands of Chek Lap Kok and Lam Chau.



Airport Location **Exhibit 1.1**

In Phase 1 of the Master Plan Study, numerous options for runway separation, orientation and configuration were developed for the Chek Lap Kok site and evaluated for environmental impacts. Results of studies in this phase are documented in the First Interim Report - Environmental Impact Assessment.

In Phase 2 of the Master Plan Study all but one of the many runway options were eliminated. The selected option was developed in greater detail and the environmental study focused on the assessment of construction impacts resulting from the implementation of this option. Results of studies in Phase 2 are described in Part B (Issues Relating to Airport Construction) of this Final Report - Environmental Impact Assessment.

During Phase 3 of the Master Plan Study various options were evaluated for the location of major airport components such as the terminals, maintenance facilities, and access roads. The selected option was evaluated to determine the extent of airport operation related impacts. These impacts and associated mitigation measures are described in Part C (Issues Relating to Airport Operation) of this document.

A detailed description of construction and operation related monitoring and audit programmes is presented in a separate Environmental Monitoring and Audit Operations Manual. The master planning and engineering issues relating to the Master Plan are discussed in the Final Report - Planning and Final Report - Civil Engineering.

A number of working papers were produced which addressed various environmental technical issues. A list of these working papers, as well as other environmental documents is presented in Appendix B. The final version of the respective working papers together with addenda, if issued, form part of the record of the decision making process throughout the study.

1.2 Purpose

The purpose of this Environmental Impact Assessment document is to describe construction and operation related environmental impacts, as well as recommended mitigation methods and monitoring programmes designed to ensure that impacts associated with the airport project are within acceptable levels.

The airport master planning process has produced an Airport Layout Plan (ALP) for the year 2040 which, in its current state of refinement, is represented on Exhibit 2.1. This ALP shows the size and configuration of the airport island as well as of the various airport components (e.g. runways, taxiways, aprons, terminals, maintenance facilities, and road, rail and marine access). The development of this ALP was a multidisciplinary effort which took environmental considerations into account during each stage of the development process.

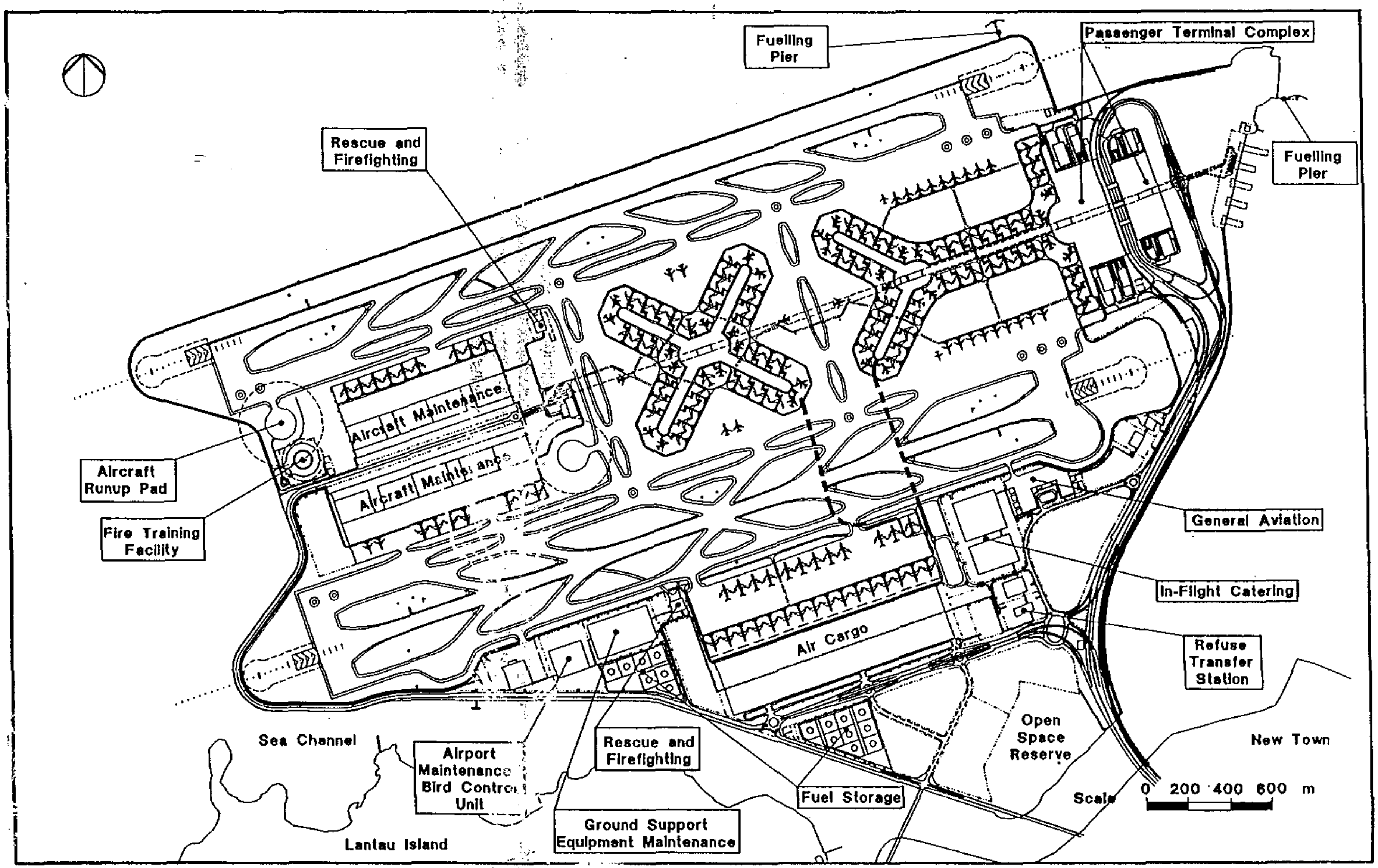
The first major task in implementing the ALP is site formation, which will be accomplished under the Site Preparation Contract (SPC) and will initially involve dredging of the soft mud on the seabed and clearance of remaining vegetation, demolition of remaining structures and disposal of unsuitable material from the islands. This will be followed by excavation and reclamation activities. Within limited constraints the successful tenderer will be free to establish his own working method and sequence of operations. The following description of method and sequence of operations was developed to estimate project costs and impacts and is indicative only; many other options are available.

Excavation of the islands will be assisted by blasting. The larger of the two islands, Chek Lap Kok (CLK) will be divided into three areas and the blasting will form benches of approximately 15-20 metres in height. Each blasting operation will involve approximately 140 blast holes, from 200 to 300mm in diameter containing a total charge of up to 70 tonnes of explosive. It is intended to blast the rock fill to size, approximately 1m-down, so that it can be loaded directly on to haul trucks and transported to the area to be filled.

Slightly in advance of the rock filling operation, dredging of soft mud will be carried out in the areas to be filled first. Thereafter, areas already dredged can be filled, while the dredging operation advances into new areas. Although the blasting and rock loading operations will be limited to the areas currently covered by CLK and Lam Chau, haulage and dumping will extend to the limits of reclamation as depicted on Exhibit 2.2. Therefore, some reclamation will take place within several hundred metres of the existing shoreline. Dredging will be required for the entire reclamation area, the area of the sea channel, and potentially in all marine borrow areas as also shown on Exhibit 2.2. Other than at gazetted dumping grounds such as South Cheung Chau, the main spoil disposal areas expected to be used during the airport construction are exhausted marine borrow areas.

The dredging and subsequent filling will commence to the north, south and west of CLK. Works on the east side of CLK will begin approximately one month after the commencement of the other areas. On the north and south sides, the reclamation will follow the outer limits of the final reclamation shape and progress westerly. Reclamation along the southwest shore of CLK will be required to provide access to the southern limits of the main reclamation area. In addition to the normal reclamation along the southern limits, a 10m high berm will be constructed as a noise barrier.

Reclamation will progress westward from CLK on the southern two thirds of the reclamation, toward Lam Chau. It is envisaged that fill material from sources other than the two islands may be incorporated into the reclamation. This will be placed in the northwest corner of the reclamation.



Airport Layout Plan *Exhibit 2.1*

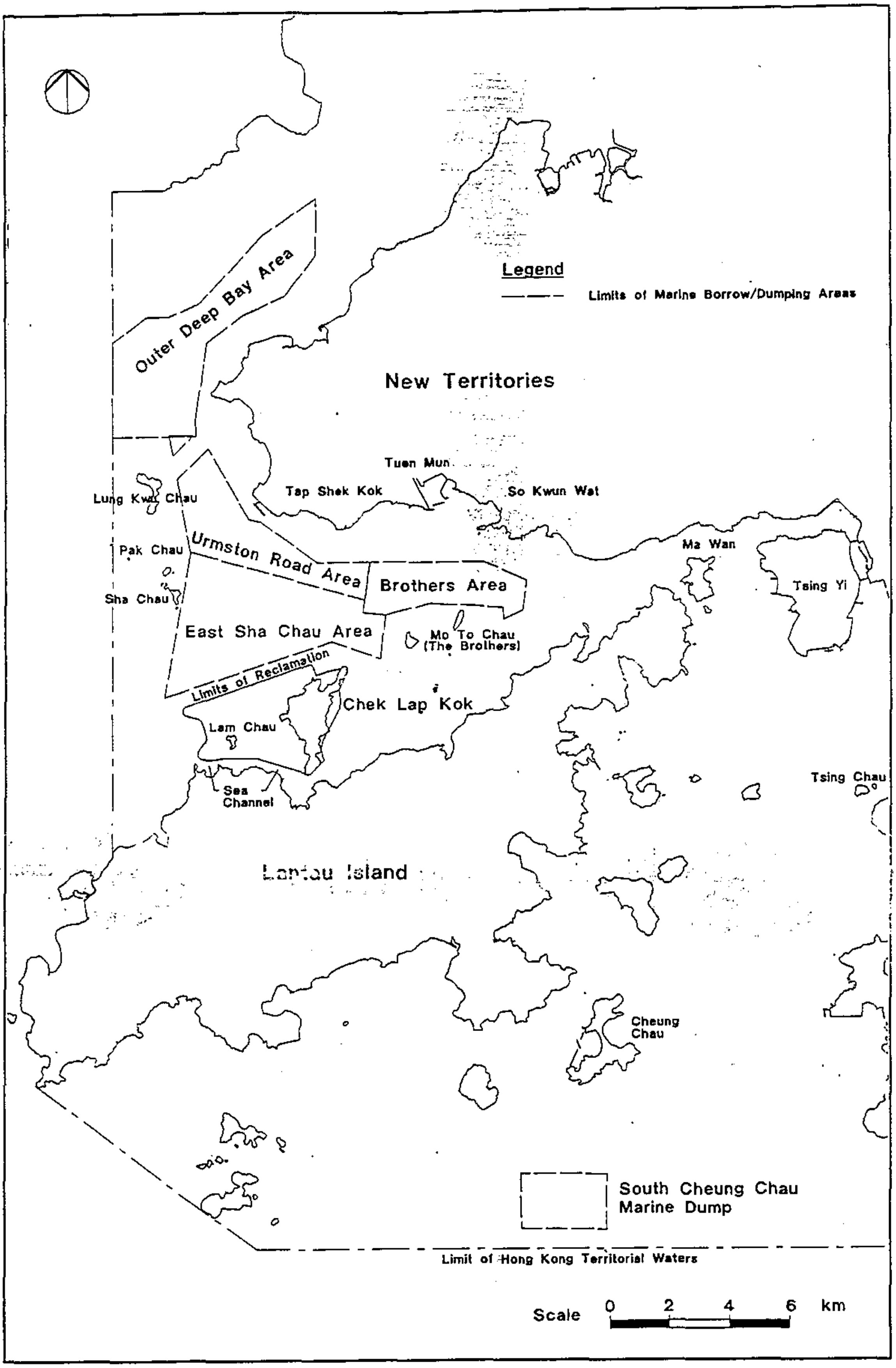


Exhibit 2.2

Proposed Areas of Dredging/Dumping Activities - Reclamation, Sea Channel and Marine Borrow/Dumping Areas

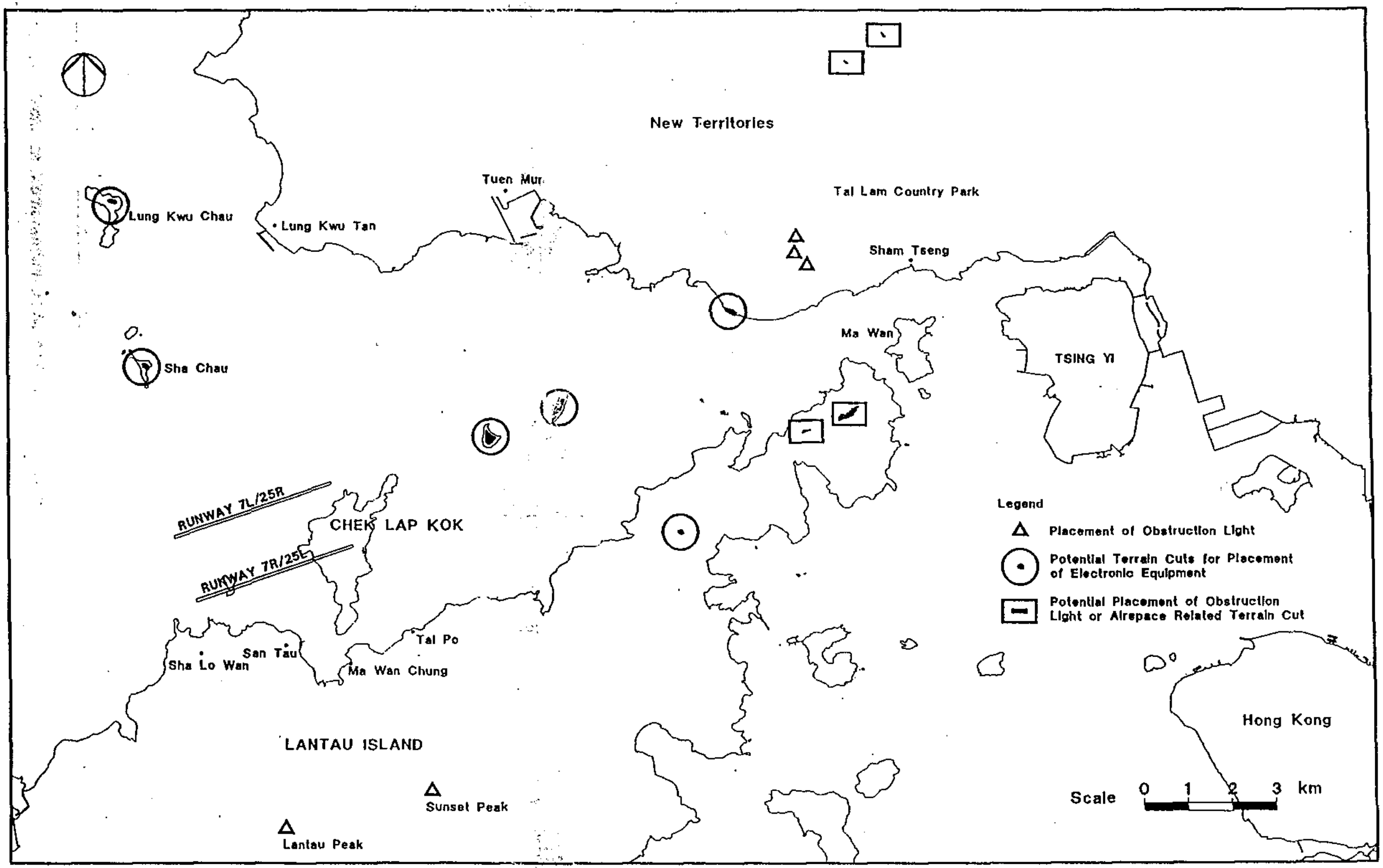
Airspace and electronic equipment siting requirements will necessitate some site work remote from the airport. Potential site requirements are shown on Exhibit 2.3. The airspace requirements of the new airport through the year 2005 have been estimated and, although no terrain cuts are required, obstruction lights have been recommended for Sunset and Lantau Peaks and three minor peaks in southern Tai Lam Country Park. In subsequent years, as airspace requirements and criteria are redefined subject to technological and operational changes, it may be necessary to install additional obstruction lighting or to make some limited terrain cuts at the sites shown. Sites for placement of electronic equipment have been selected as a result of a preliminary screening process and it has been determined that East and West Brothers will need to be excavated to +10.0 mPD. The other sites will be subjected to detailed site suitability analyses before the selection can be finalised.

~~As the site formation process proceeds towards completion, work will begin under the Building and Infrastructure Contracts~~ (BICs). Components of the contracts include items such as construction of utility services, roads, runways, taxiways, aircraft parking aprons, electronic instrument facilities on remote sites and terminal buildings. The activities of blasting and rock hauling will be replaced by concrete production, pile installation, and building erection. The location of many of these activities within the overall airport footprint is not yet determined, but some "worst case" assumptions were made in order to evaluate potential impacts.

The extent to which piling will be required is not yet known. Practice has shown that driven piling through 1m-down sized rockfill is impracticable and bored piling through this material is not desirable. In the areas where piling is required, the rock must be crushed to 220mm down material before placing, or marine sand will be placed instead of rock fill. A "worst case" piling scenario was assumed in order to evaluate impacts.

A more detailed description of the construction methods and programme required to complete the airport can be found in the Final Report - Civil Engineering.

When construction is completed, and the airport becomes operational, the first phase of the ALP will be in place. The environmental assessment of operational impacts, embodied in this document, is based on the currently projected, year 2040 ALP. However, ALPs are evolving planning documents which are routinely updated to reflect changing needs. Many of the environmental impacts are projected decades into the future and can be very sensitive to changes in technology, the economy, populations and political events. To compensate for this high degree of uncertainty, it is common to use conservative estimates (over-estimate impacts) and to update environmental assessments as the new airport Master Plan is periodically revised. This approach is utilised in this assessment. Conservative assumptions were used throughout, and the impact assessment will be periodically updated.



Potential Off-Airport Site Requirements *Exhibit 2.3*

3.1 Noise

The Noise Control Ordinance (NCO) (Cap. 400) was gazetted in 1988 and specific sections relating to percussive piling and general construction work were implemented in 1989. Strict controls are enforced over percussive piling activities and, in the event of work being carried out near to Noise Sensitive Receivers (NSRs), noise mitigation measures are necessary and limitations upon the permitted hours of working are imposed.

For general construction work, restrictions are imposed during evenings (1900 to 2300), night-time (2300 to 0700), Sundays and public holidays. The Basic Noise Levels (BNLs) for general construction noise, as defined in the *Technical Memorandum on Noise from Construction Work other than Percussive Piling* (TM), for Area Sensitivity Ratings (ASR) A, B or C are given in Table 3.1.

According to the *Technical Memorandum on Noise from Percussive Piling* (TMPP), piling is prohibited between 1900 and 0700 hours and on public holidays, unless permission is granted by the Governor in Council. Between the hours of 0700 and 1900 hours, piling is allowed under permit, subject to noise level limits. The Acceptable Noise Levels for percussive piling are shown in Table 3.2.

Table 3.1
Basic Noise Levels (BNLs) for Construction Noise from Activities other than Percussive Piling in dB(A)

Time Period \ ASR	A	B	C
All days during the evening (1900 to 2300 hours), and general holidays (including Sundays) during the day-time and evening (0700 to 2300 hours)	60	65	70
All days during the night-time (2300 to 0700 hours)	45	50	55

Source : Technical Memorandum on Noise for Construction Work other than Percussive Piling

Table 3.2
Acceptable Noise Levels for Percussive Piling

NSR Window Type or Means of Ventilation	Acceptable Noise Level (dB(A))
(i) NSR (or part of NSR) with no windows or other openings	100
(ii) NSR with central air conditioning system	90
(iii) NSR with windows or other openings but without central air conditioning system	85

Source : Technical Memorandum on Noise from Percussive Piling

For airport operational noise impacts the International Civil Aviation Organization (ICAO) has issued ~~land-use-compatibility-guidelines~~ for various Noise Exposure Forecast (NEF) levels as shown in Table 3.3. Although ICAO's guidelines indicate all land uses are compatible with noise levels under 30 NEF, the report *Environmental Guidelines for Planning in Hong Kong (April 1991)* identified slightly more stringent NEF limits by land use type as shown in Table 3.4. The latter set of guidelines are used in this study to assess aircraft noise impacts.

Table 3.3 Land Use Compatibility Chart for Aircraft Noise

Land Use Compatibility	Noise Exposure Forecast (NEF) Areas		
	Under 30	30–40	Over 40
Residential	Yes	(2)	No
Commercial	Yes	Yes	(3)
Hotel, Motel	Yes	(3)	No
Offices, Public Buildings	Yes	(3)	No
Schools, Hospitals, Churches	(3)	No	No
Theatres, Auditoriums	(1) (3)	No	No
Outdoor Amphitheatres, Theatres	(1)	No	No
Outdoor Recreational (Non-Spectator)	Yes	Yes	Yes
Industrial	Yes	Yes	(3)

Notes:

(1) A detailed noise analysis should be undertaken by qualified personnel for all indoor or outdoor music auditoriums and all outdoor theatres.

(2) Case history experience indicates that individuals in private residences may complain, perhaps vigorously. Concerted group action is possible. New single-dwelling construction should generally be avoided. For apartment construction, Note (3) applies.

(3) An analysis of building noise reduction requirements should be made, and the necessary noise control features should be included in the building design.

Source: ICAO Airport Planning Manual (DOC9184-AN/902); Part 2: Land Use and Environmental Control, 2nd Edition, 1985

Table 3.4 Summary of Noise Standards

Uses	Noise Sources					
	Aircraft Noise (Noise Exposure Forecast: NEF)		Helicopter Noise	Road Traffic Noise	Rail Traffic Noise	Fixed Noise Source
	Kai Tak Airport	New CLK Airport	Lmax dB(A)	L10 (1 hour) dB(A)		
All domestic premises including temporary housing accommodation	30	25	85	70	(a) Leq (24 hour) = 65 dB(A);and (b) Lmax (2300-0700) = 85 dB(A)	(a) 5dB(A) below the appropriate Acceptable Noise Levels shown in Table 3 of the Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites; and (b) The prevailing background noise levels.
Hotels and hostels	30	25	85	70		
Offices	30	30	90	70		
Educational institutions including kindergartens, nurseries and all others where unaided voice communication is required	30	25	85	65		
Places of public worship and courts of law	30	25	85	65		
Hospitals, clinics, convalescences and homes for the aged - diagnostic rooms - wards	30	25	85	55		
Amphitheatres, and auditoria, libraries, performing arts centres and Country Parks	depend on use, extent and construction		depend on locations and construction			

Notes: (1) The above standards apply to uses which rely on opened windows for ventilation.

(2) The above standards should be viewed as the maximum permissible noise levels at the external facade.

Source: Environmental Guidelines for Planning in Hong Kong, 1991

3.2 Air Quality

Under the Air Pollution Control Ordinance (APCO) (Cap. 311), the Government of Hong Kong has established a comprehensive air quality policy throughout the territory. Essentially, the objectives are:

(1) To achieve and maintain satisfactory ambient air quality conditions;

(2) To abate air pollutant nuisances; and

(3) To control specific toxic or other harmful substances emitted into the atmosphere.

A wide variety of programs and activities has been implemented to help achieve these objectives including: (1) air quality management plans for the ten designated Air Control Zones (ACZs); (2) an air quality monitoring station network; (3) mitigation of air quality impacts through land use planning and review of development proposals; (4) special assessments of potential air quality problem areas; and (5) compliance with the Air Quality Objectives (AQOs). These AQOs, established for seven primary air pollutants, are summarized in Table 3.5. Currently, the Environmental Protection Department (EPD) has the primary responsibility for implementing the APCO.

Table 3.5 Hong Kong Air Quality Objectives

Pollutant	Concentration in Micrograms per Cubic Metre[1]				
	Averaging Time				
	1 Hour (2)	8 Hours (3)	24 Hours (3)	3 Months (4)	1 Year (4)
Sulphur Dioxide (SO_2)	800	-	350	-	80
Total Suspended Particulates (TSP)	500[7]	-	260	-	80
Respirable Suspended Particulates (RSP)[5]	-	-	180	-	55
Carbon Monoxide (CO)	30,000	10,000	-	-	-
Nitrogen Dioxide (NO_2)	300	-	150	-	80
Photochemical Oxidants (as ozone)[6]	240	-	-	-	-
Lead	-	-	-	1.5	-

Notes:
(1) Measured at 298°K (25°C) and 101.325 kPa (one atmosphere).
(2) Not to be exceeded more than three times per year.
(3) Not to be exceeded more than once per year.
(4) Arithmetic means.
(5) Respirable suspended particulates means suspended particles in air with nominal aerodynamic diameter of 10 micrometres and smaller.
(6) Photochemical oxidants are determined by measurement of ozone only.
(7) This control limit has no statutory basis but is often included in contract clauses of construction projects in Hong Kong.

Source: Environmental Guidelines for Planning in Hong Kong, 1991

Under the APCO, emission control programs are also in effect for both stationary and mobile sources. As shown in Section 5 (Air Quality), aircraft and motor vehicles are the two primary mobile sources of air emissions associated with the new airport. A recent amendment to the APCO requires that motor vehicles in Hong Kong meet prescribed air pollution emissions standards. Provisions to limit air pollution from motor vehicles are also incorporated into the Road Traffic Ordinance (Cap. 374). By comparison, there is no similar ordinance for aircraft emissions.

Stationary sources of air emissions at the new airport will be limited to aircraft engine test cells, other select aircraft maintenance and repair operations, fuel storage facilities, the fire training facility and a few miscellaneous support services. In these cases, the APCO regulations that pertain to the control of smoke, dust and grit emissions; the design of smoke stacks and chimneys; licensing requirements; and the use of ozone depleting substances may apply.

The air quality ordinances, amendments and regulations that potentially apply to the new airport are summarised in Table 3.6.

Table 3.6 Air Quality Legislation and Guidelines

Legislation	Purpose	Applicability
. Air Pollution Control Ordinance (Cap. 311)	. Basis for air quality management programs and establishes AQOs	. All sources and territories
– (Vehicle Design Standards) (Emissions) Regulations	– Control HC, CO and NO_x emissions	– Motor vehicles
– Smoke Regulations	– Control of smoke	– Stationary sources
– Furnaces, Ovens and Chimney Regulations	– Location and design criteria	– Stationary sources
– Dust and Grit Regulations	– Control of dust and grit	– Stationary sources
– Specified Processes	– Registration and licensing	– Stationary sources
– Fuel Restriction Regulations	– Limit sulfur content of fuels	– Stationary sources
. Road Traffic Ordinance (Cap. 374)	. Control of motor vehicle emissions	. Motor vehicles
. Ozone Layer Protection Ordinance, 1989	. Control of ozone depleting substances	. Chlorofluorocarbons

Source: Greiner–Maunsell, 1990

3.3 Water Quality

The Water Pollution Control Ordinance 1980 (WPCO) (Cap. 358) is the principal legislation governing water quality of marine waters in Hong Kong. Under Sections 4 and 5 of the Ordinance, Water Control Zones (WCZs) may be declared and Water Quality Objectives (WQOs) established for each zone or subzone (for example the WQO for a Fish Culture Subzone may be more stringent than for marine waters generally). The site for the proposed airport lies within the North Western Waters Zone (NWWZ) which is due to be gazetted as a WCZ in 1991. The NWWZ is identified as having nine beneficial uses. These uses are:

(a) A source of food for human consumption.

(b) A resource for commercial exploitation.

(c) A habitat for marine life generally.

(d) Primary contact recreation - bathing.

(e) Secondary contact recreation - diving, sailing, windsurfing etc.

(f) Domestic and industrial supply.

(g) Navigation and shipping.

(h) Abstraction for water supply by desalination.

(i) Aesthetic enjoyment.

Proposed WQOs for the NWWZ are shown in Table 3.7 on the following page. These are tentative only, and will be reviewed by EPD prior to gazetted of the WCZ. For example, the reference to use of the zone for water supply by desalination will cease to have any operational significance in view of the decision to decommission the desalination plant at Siu Lam Sam Tsuen.

Construction activities at Chep Lap Kok are included within the definition of Civil Engineering Works (including all building works and reclamation) and are therefore classified as potentially polluting uses by the *Hong Kong Planning Standards and Guidelines (HKPSG)*. As such it is recommended that:

> "care should be taken in planning and implementation of works to avoid, minimise or ameliorate the occurrence of these adverse effects on water bodies, especially those in ...... areas used for commercial fisheries."

The relevant WQOs for the NWWZ have been taken into consideration when assessing construction impacts and the requirement for mitigation measures. However, whilst it is an offence under Section 8 of the WPCO to discharge polluting matter into a WCZ, discharges made under a Crown lease granted under the Foreshores and Sea Bed Ordinance (Cap. 127) are excluded. Therefore, the WQOs do not technically apply in the case of dredging and reclamation works.

These activities are covered by non-statutory guidelines, for example the *Deep Bay Guidelines on Dredging, Reclamation and Drainage Works (1989)*, which cover the temporary construction phase and the post-construction phase of projects. The guidelines contain recommendations for a performance-based specification rather than a methods-based approach to control water quality. Performance-based specifications, in the form of water quality compliance monitoring programmes, are routinely included in contract documents for dredging and reclamation works.

A Technical Memorandum to the WPCO was published in November 1990, which defines standards for effluents discharged to foul sewers, stormwater drains, inland and coastal waters within WCZs. The *Technical Memorandum on Effluent Standards* covers any discharge or deposit subject to control under the WPCO, which includes trade effluents and polluted surface waters, but excludes livestock wastes, dredging, dumping for land formation or solid waste disposal which are controlled under other regulations.

Flow weighted standards and a number of prohibited substances are specified for various categories of receiving water. Those relevant to the airport are standards for effluents discharged to foul sewers leading to Government sewage treatment plants (Tables 1 and 2 of the Technical Memorandum) and standards for effluents discharged into inshore waters (defined as coastal waters where the water depth is less than 6m at mean low tide or that are within 200m of the mean low water mark, whichever position is further from the shore) of the NWWZ. Standards for effluents discharged to inshore waters are given in Table 10a of the Technical Memorandum.

Table 3.7
Water Quality Objectives for the Proposed North Western Waters Control Zone

Water Quality Parameter	Objective	Sub-zone
Offensive odour, taints and colours	Not to be present	Whole Zone
Visible foam, oil grease, scum, litter	Not to be present	Whole Zone
E. coli	Not to exceed 1000/100ml in more than 60% samples. 5-day running median not to exceed 1000/100ml	Secondary Contact Recreation Zone Bathing Beaches
DO within 2m of bottom	Not less than 2mg/l for 90% samples	Whole Zone
Depth Average DO	Not less than 4mg/l for 90% samples	Whole Zone except Fish Culture Zone
	Not less than 5mg/l for 90% samples	Fish Culture Zone
pH	To be in the range 6.5-8.5. Change due to waste discharge not to exceed 0.2	Whole Zone except bathing beaches
Salinity	Change due to waste discharge not to exceed 10% of natural ambient level	Whole Zone
Temperature Change	Change due to waste discharge not to exceed 2°C	
Suspended Solids	Waste discharge not to raise the natural ambient level by 30% nor cause accumulation of suspended solids	Whole Zone
Toxicants producing significant toxic effects	Not to be present	Whole Zone
Ammonia	Annual mean not to exceed 0.021mg/l calculated as unionised form	Whole Zone
Nutrients	Quantity shall not cause excessive algal growth Annual mean depth average inorganic nitrogen not to exceed 0.1mg/l	Whole Zone

Source: Sewage Strategy Study, 1989

pH

3.4 Ecology

Legislation on ecology in Hong Kong provides protection of various types to both species and areas.

The Forests and Countryside Ordinance (Cap.96) gives general protection to vegetation on all Crown Land, while "Country Parks" and "Special Areas" (which may be inside or outside Country Parks) receive additional protection under the Country Parks Ordinance (Cap.208). The Wild Animals Protection Ordinance (Cap. 170) provides for the designation of "Restricted Areas" to which access is limited (e.g. Mai Po Marshes). This ordinance also provides for the protection of most mammals, (except wild pigs, the Small Indian Mongoose, rats and shrews), selected reptiles, the Birdwing Butterfly, all wild birds, their nests and eggs in Hong Kong, and prohibits hunting and the possession of hunting appliances. The destruction of animals during land formation works requires a Special Permit issued under Section 15 of the Ordinance. The Director of Agriculture and Fisheries is the Authority under this legislation.

The revised Town Planning Ordinance (Cap.131) provides for the designation of "coastal protection areas, Sites of Special Scientific Interest (SSSIs), green belts or other specified uses that promote conservation or protection of the environment". About 50 SSSIs have been designated and Government Departments are required to consult the Agriculture and Fisheries Department when considering a proposal that may affect an SSSI.

The Forestry Regulations (Cap.96, section 3) prohibit sale and possession of a number of named plant species, including all native orchids, camellias and rhododendrons. The Animals and Plants (Protection of Endangered Species) Ordinance (Cap.187) prohibits the possession of one additional plant species, *Nepenthes mirabilis*; and also provides for protection of threatened and endangered birds. Import, export and possession of listed species are controlled through a license system administered by the Director of Agriculture and Fisheries. This legislation enables Hong Kong to meet its obligations under the Convention on International Trade in Endangered Species of Wild Fauna and Flora - the "Washington" Convention

Hong Kong is also party to two international conventions which relate directly to conservation of wildlife and wildlife habitat :

a) The Convention on Wetlands of International Importance Especially as Waterfowl Habitat - the "Ramsar" Convention.

b) The Convention on the Conservation of Migratory Species of Wild Animals - the "Bonn" Convention.

The "Ramsar" Convention requires parties to promote wetland conservation and their "wise use". The definition of wetland includes "areas of marine water . the depth of which at low tide does not exceed six metres", thus a considerable part of the Chek Lap Kok reclamation falls within this definition.

The "Bonn" Convention aims to protect migratory species, including the safeguarding of habitats used by such species. For species which are considered to be both "migratory" and "endangered" the Convention requires parties to make special efforts to counteract factors that are dangerous or potentially dangerous to those species.

General ecological legislation which applies to marine species includes the Wild Animals Protection Ordinance which protects all cetaceans, and the Animals and Plants (Protection of Endangered Species) Ordinance which provides for protection of threatened and endangered species, and for Hong Kong would include all whales, dolphins and sea turtles.

In addition, legislation specific to marine ecology includes the The Fisheries Protection Ordinance 1987 (Cap.171) which is designed to promote the conservation of fish and aquatic life and regulates fishing practices. The Marine Fish Culture Ordinance 1983 (Cap.353) regulates and protects marine fish culture zones designated under the ordinance. Under this legislation it is an offence to deposit any substance which pollutes or is likely to cause pollution of a fish culture zone.

3.5 Waste and Hazardous Materials

The principal legislation governing the management of waste materials in Hong Kong, and the new airport, is the Waste Disposal Ordinance (WDO) (Cap. 354). Enacted in 1980, this ordinance generally encompasses all stages of the complex waste management chain from the place of arising to the final disposal point. Currently in the draft stage, the WDO Chemical Waste General Regulations will specifically address the storage, collection, treatment, transport and disposal of chemical wastes. This new regulation and associated codes of practice will be incorporated into the WDO in late 1992.

Another existing ordinance pertaining to hazardous materials is the Dangerous Goods Ordinance (Cap. 295). This ordinance and its subsidiary regulations provide for the control of Potentially Hazardous Installations (PHIs) and dangerous substances. Under this legislation the Commissioner of Mines regulates Category 1 materials (explosives) and the Director of Fire Services oversees most other materials. The exceptions include fuel gas (LPG, town gas) which is regulated by the Director of Electrical and Mechanical Services under the Gas Safety Ordinance and the Director of Marine that administers dangerous substances within the waters of Hong Kong.

Other legislation potentially affecting hazardous materials or chemical wastes at the new airport are the Air Pollution Control Ordinance (APCO) (Cap. 311) for air emissions and the Water Pollution Control Ordinance (WPCO) (Cap. 358) for water pollution. The Building Ordinance (Cap. 123), administered by the Director of Buildings and Lands, contains regulations pertaining to the design, construction and management of oil storage installations and mandates that all industrial wastewaters are discharged to foul sewers or wastewater treatment plants.

In more general terms, the *Hong Kong Planning Standards and Guidelines (HKPSG)* provide guidance for proper waste disposal associated with the planning and design of public and private projects.

Finally, fuel or oil spills on the coastal waters surrounding Hong Kong are currently regulated by the Marine Department under the Oil Pollution Ordinance (Cap. 247). In a similar fashion, the Fire Services Department is primarily responsible for handling chemical spills on land and is also involved in the design of fuel storage facilities.

These ordinances, regulations and guidelines are summarized in Table 3.8.

Table 3.8 Hazardous Materials and Chemical Wastes Legislation

Legislation/Regulation/Guideline	Applicability	Principal Responsibility
. Waste Disposal Ordinance (Cap. 354) - Chemical Waste Management Regulation (1)	. Framework for all waste management programmes . Storage, collection, treatment, transport and disposal of hazardous materials and chemical waste	. Environmental Protection Department
. Dangerous Goods Ordinance (Cap. 295)	. Category 1 PHI's . Dangerous Goods . Gas Safety . Dangerous goods on Hong Kong waters	. Commissioner of Mines (Category 1) . Director of Fire Services . Director of Electrical and Mechanical Services . Director of Marine
. Air Pollution Control Ordinance (Cap. 311)	. Industrial and toxic emissions	. Environmental Protection Department
. Water Pollution Control Ordinance (Cap. 358)	. Surface water discharges	. Environmental Protection Department
. Oil Pollution Ordinance (Cap. 247)	. Fuel and oil spills	. Marine Department
. Buildings Ordinance (Cap. 123)	. Oil Storage Installations and discharge of industrial wastewaters	. Buildings Department
. Planning Standards and Guidelines (HKPSG)	. Guidance for chemical waste producing industries	. Environmental Protection Department

Note : (1) In draft stage; adoption expected in 1991 or 1992.

Source: Greiner-Maunsell, 1991

Part B

Issues Relating To Airport Construction

4.1 Assessment Methodology

The construction noise impact assessment was performed in accordance with the methodology prescribed in *Technical Memorandum on Noise from Construction Work other than Percussive Piling* (TM), issued under Section 9 of the NCO. The ASRs and BNLs were determined based on current land use, background monitoring data, and the use of Table 4.1 and Table 4.2 which were extracted from the TM.

Table 4.1 Area Sensitivity Ratings (ASRs)

Type of Area Containing NSR \ Degree to which NSR is affected by IF	Not Affected	Indirectly Affected	Directly Affected
(i) Rural area, including country parks or village type developments	A	B	B
(ii) Low density residential area consisting of low-rise or isolated high-rise developments	A	B	C
(iii) Urban area	B	C	C
(iv) Area other than those above	B	B	C

Source: Technical Memorandum on Noise from Construction Work other than Percussive Piling

Table 4.2 Basic Noise Levels (BNLs)

Time Period \ ASR	A	B	C
All days during the evening (1900 to 2300 hours), and general holidays (including Sundays) during the day-time and evening (0700 to 2300 hours)	60	65	70
All days during the night-time (2300 to 0700 hours)	45	50	55

Source: Technical Memorandum on Noise from Construction Work other than Percussive Piling

SPC construction activities will take place over a large area as previously shown on Exhibit 2.2. Excavation activities will be restricted to Chek Lap Kok and Lam Chau, dredging and reclamation will occur in the remainder of the airport footprint, and additional dredging will occur between Lantau Island and the airport footprint, as well as at the numerous marine borrow areas. These activities will be phased to optimise the use of Powered Mechanical Equipment (PME). Within certain limited constraints the Contractor will be free to determine what PME he will utilise and what phasing sequence will be followed. BIC activities will then commence with construction activities scattered sequentially over much of the site.

4.1.1 Excavation and Reclamation

For the purpose of the excavation and reclamation portion of the SPC construction noise analysis, and for estimating construction costs, a representative list of PMEs which would be suitable for this contract and a potential phasing sequence were developed. The PME list with estimated numbers of each piece of equipment and with associated Sound Power Levels (SPLs) are shown in Table 4.3.

Table 4.3
Representative Equipment and Associated Sound Power Levels (SPLs)

PME Item	Number	dB(A)
Rock Drill	16	110
Blasthole Stemmer	2	108
Hydraulic Shovel	11	112
Front End Loader	4	114
170 Tonne Truck	40	121
Dozer/Ripper	20	115
Grader	3	113
Roller	4	108
Small Truck	8	112

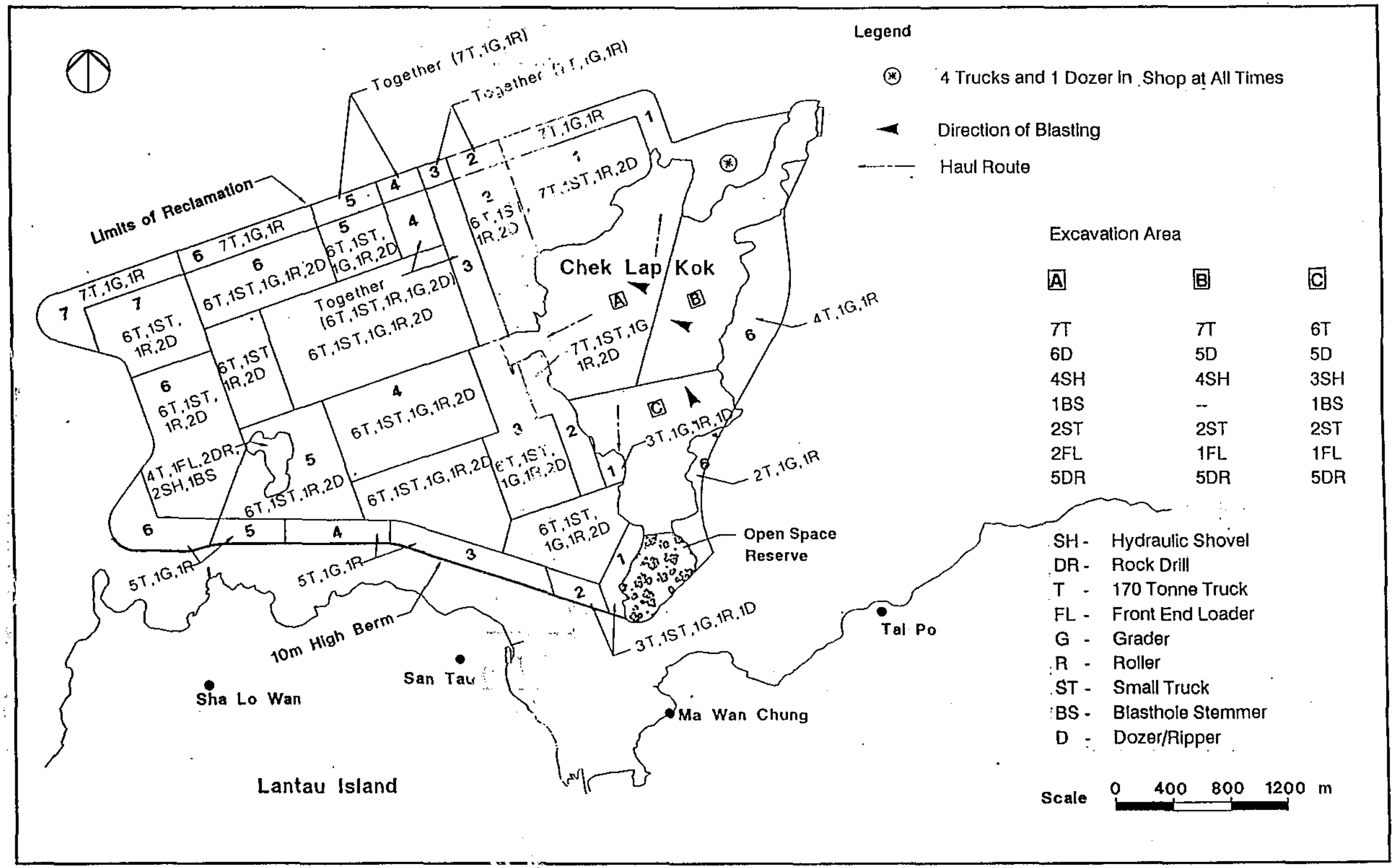
Source: Greiner-Maunsell, 1991

The potential phasing sequence shown on Exhibit 4.1 indicates how the PME would be distributed over the site. For each representative NSR the phase which would have the maximum noise impact on that receiver was then evaluated. Notional positions were established for the various work areas where PME was assumed to be located. The SPLs of the individual pieces of equipment where then combined by use of the formula:

combined SPL for items of PME

$$= 10 \times \{\log_{10} [10^{(L1/10)} + 10^{(L2/10)} + 10^{(L3/10)} + ...]\}$$

where L1, L2, L3, ... are the SPLs of individual PME.



Phasing Sequence and Distribution of PME ***Exhibit 4.1***

The SPLs of each site were then adjusted to compensate for distance from the NSR as follows:

correction factors to obtain Predicted Noise Level (PNL) from
Sound Power Levels (for distance (D) > 300m)

$= 57 + 23.25 \log_{10} (D/300)$.

The resulting PNL is then corrected for the effect of barriers and acoustic reflection. This is the Corrected Noise Level (CNL). The CNLs generated by all of the notional points are then combined using the same formula as for combining SPLs. This combined CNL estimates the maximum noise level generated by SPC excavation and reclamation activities as would be measured by a noise meter at the NSR if no other sources of noise are present.

Due to the need for 24-hour construction activity, initial calculations showed that unmitigated CNLs would substantially exceed BNLs at most NSRs. Numerous methods of mitigating the impacts were investigated and discussed with EPD. All prudent measures were adopted and noise calculations were made based on mitigated impacts.

In considering that this construction work, by virtue of its magnitude and purpose, qualifies as Construction Work Having Important Social Implications as defined in the TM, and because of the adopted mitigation measures, the BNLs and projected CNLs were reviewed by EPD and Allowable Noise Levels (ANLs) were established at levels higher than BNLs.

4.1.2 Dredging and Dumping

A screening analysis was done of SPC dredging and mud dumping activities. Dredgers will be operating 24 hours per day in the marine borrow and dumping areas. It is anticipated that trailing suction dredgers or dredgers with similar low noise generating characteristics [SPL < 110 dB(A)] will predominantly be used and that ANLs will not be exceeded at any of the NSRs. However, to assure that noise generated from dredging activities in the marine borrow and dumping areas will be at acceptable levels, a monitoring program for these activities was developed and is presented in Section 4.4 (Mitigation Measures). Noise levels from dredging the sea channel between the airport and Lantau Island will be less than those generated by SPC excavation and reclamation activities. The excavation and reclamation noise levels were thus used to represent "worst case" conditions in order to evaluate impacts and required mitigation.

4.1.3 Building and Infrastructure Contract

BIC activities were also evaluated. Those activities which do not involve percussive piling were evaluated using the same methods as for the SPC. An analysis of noise generating potential for construction sites most likely to impact NSRs was made. This study indicates that none of the BIC activities (excluding pile driving activities) will generate noise levels which exceed SPC noise levels at any of the NSRs. For subsequent evaluations and discussions the SPC noise impacts were therefore taken as representing "worst case" impacts for all construction activities except pile driving.

Table 4.4 *Projected "Worst Case" Noise Impacts in Comparison to BNLs*

Time Periods	Noise Sensitive Areas									
	Tai Po		Tung Chung		San Tau		Sha Lo Wan		Sha Lo Wan (Shore)	
	CNL	BNL	CNL	BNL	CNL	BNL	CNL	BNL	CNL	BNL
0700 - 1900 Holidays + 1900 - 2300 All Days	62	65	63	65	61	60	59	60	58	60
2300 - 0700 All Days	62	50	55*	50	60*	45	49*	45	58*	45
Estimated NSRs in Area	19		174		40		104		14	
Estimated Permanent Population in Area	28		450		37		120		15	
Estimated Holiday Population in Area	250		600		200		350		50	

* Assumes there are no berm construction activities within 1000m of these NSRs during this time period.

Source : EPD, Lantau and Islands District Office, Village Representatives and Greiner-Maunsell, April 1991

Based on this analysis approximately 350 NSRs, 650 permanent residents and 1450 holiday only residents will be impacted by noise levels in excess of the BNLs only.

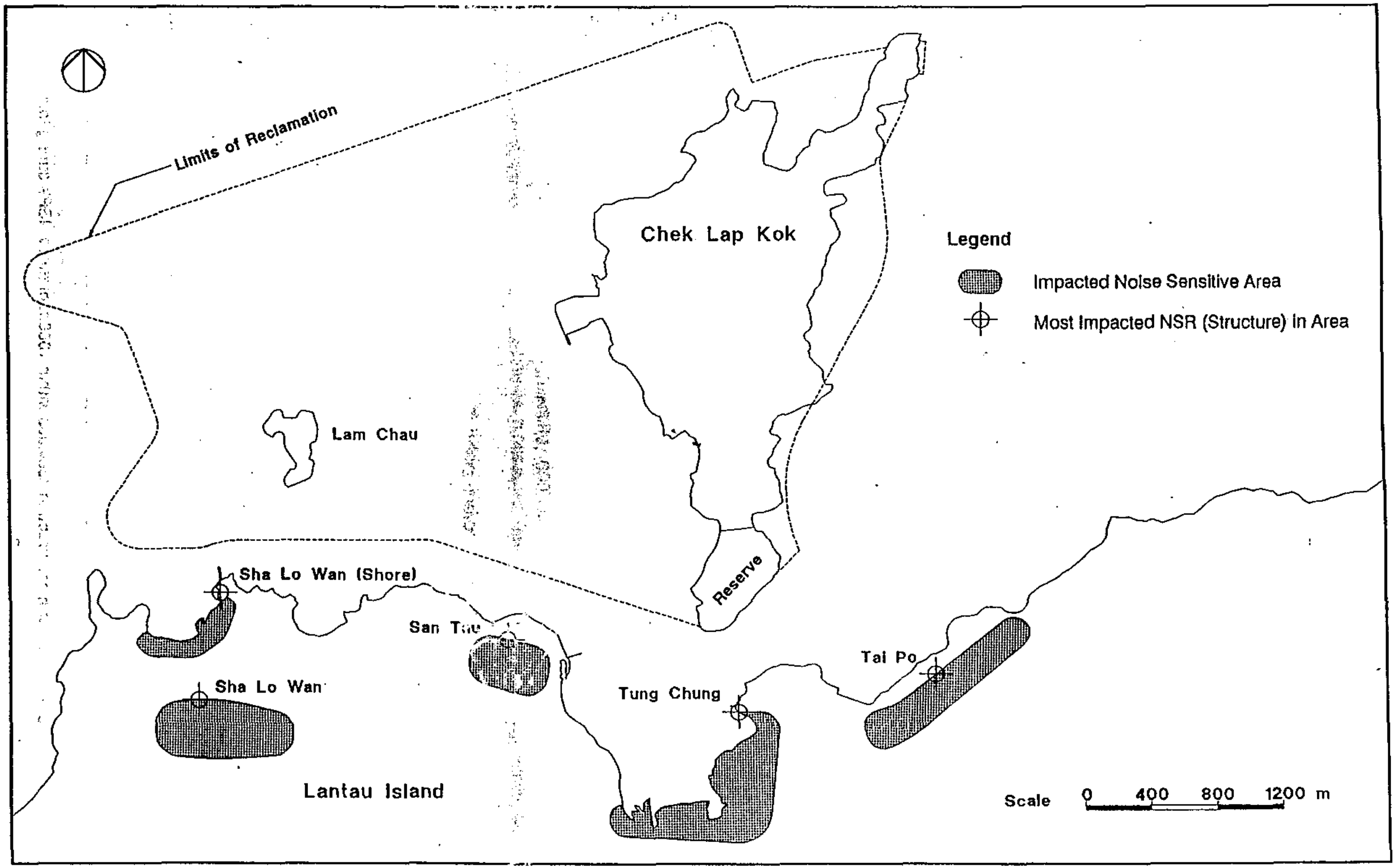
An analysis of noise impacts during daytime hours indicates that one NSR at Sha Lo Wan (Shore) may be exposed to a maximum noise level of 71 dB(A) during the construction of the noise reducing berm. At all other times, and at all NSRs, maximum noise levels are expected to be below 70 dB(A).

4.4 Mitigation Measures

In order to minimise the noise leaving the construction site a number of mitigation measures should be implemented. These mitigation measures consist of:

- Preserving the southern tip of Chek Lap Kok to act as a natural noise barrier;

- Southern berm to be constructed to +10mPD and sufficiently in advance of the main reclamation to break line of sight between NSRs and noise generating plant. The portions of the berm required to shield BIC activities will be retained until unmitigated noise from those activities will no longer exceed BNLs;



Impacted Noise Sensitive Areas and Corresponding Most Impacted Sensitive Receivers **Exhibit 4.2**

- Chek Lap Kok excavation plan should be developed so that all prudent measures are taken to shield Tai Po from noise generating plant; and

- Specifying the use of rock drills that have a Sound Power Level (SPL) of 110 dB(A) or less.

In addition to minimising noise generated from the site, it is recommended that some mitigation be provided at the NSRs. This requires funding for the acquisition and operation of air conditioners. With air conditioners in use, a portion of the dwelling unit can be closed and the walls can provide insulation from external noise. This form of mitigation was considered suitable only for NSRs which will be exposed to noise levels in excess of 55 dB(A) since the operating air conditioners themselves will generate noise levels of that magnitude. The NSRs which qualify for this mitigation measure are shown in Table 4.5.

Table 4.5 NSRs Qualifying for Funding to Install and Operate Air Conditioners

Noise Sensitive Areas	NSRs		
	Permanently Occupied	Weekend/Holiday Use Only	Total
Tai Po	10	9	19
San Tau	17	23	40
Sha Lo Wan *	8**	6	14
TOTALS	35	38	73

* Area within 300 metres of the shoreline only.
** Includes resident caretaker of the Tin Hau Temple.

Source: Greiner-Maunsell, 1991

The mitigation measures, both at the construction site and at the NSRs, as well as the social implications of this project, were considered in establishing ANLs. A comparison of CNLs and EPD approved ANLs is presented in Table 4.6.

Table 4.6 Comparison of CNLs and ANLs

Time Periods	Noise Sensitive Areas									
	Tai Po		Tung Chung		San Tau		Sha Lo Wan		Sha Lo Wan (Shore)	
	CNL	ANL	CNL	ANL	CNL	ANL	CNL	ANL	CNL	ANL
0700 - 1900 Holidays + 1900 - 2300 All Days	62	65	63	65	61	65	59	60	58	65
2300 - 0700 All Days	62	62	55*	55	60*	60	49*	55	58*	60

* Assumes there are no berm construction activities within 1000m of these NSRs during this time period.

Source: Greiner-Maunsell, 1991

However, to qualify for these ANLs funding will need to be provided so that air conditioner installation can be made before the BNLs indicated in Table 4.4 for Tai Po, San Tau and Sha Lo Wan (shore) are exceeded. Funding should also be provided to cover air conditioner operating costs for both SPC and BIC activities.

4.5 Monitoring

A monitoring programme has been designed to comply with the equipment and methodology requirements of the TM. Monitoring should be conducted under the supervision of the Engineer at the locations shown on Exhibit 4.3 under the following conditions:

Sha Lo Wan

When PME is operating within 1600m anywhere west of Lam Chau (area A of Exhibit 4.3) and outside the hours of 0700-1900 or on general holidays.

Sha Lo Wan (Shore)

When PME is operating in area A of Exhibit 4.3 outside the hours of 0700-1900 or on general holidays.

San Tau

When PME is operating within 1000m (area B of Exhibit 4.3) outside the hours of 0700-1900 or on general holidays, but not if plant from other projects is operating in closer proximity to San Tau.

Tung Chung

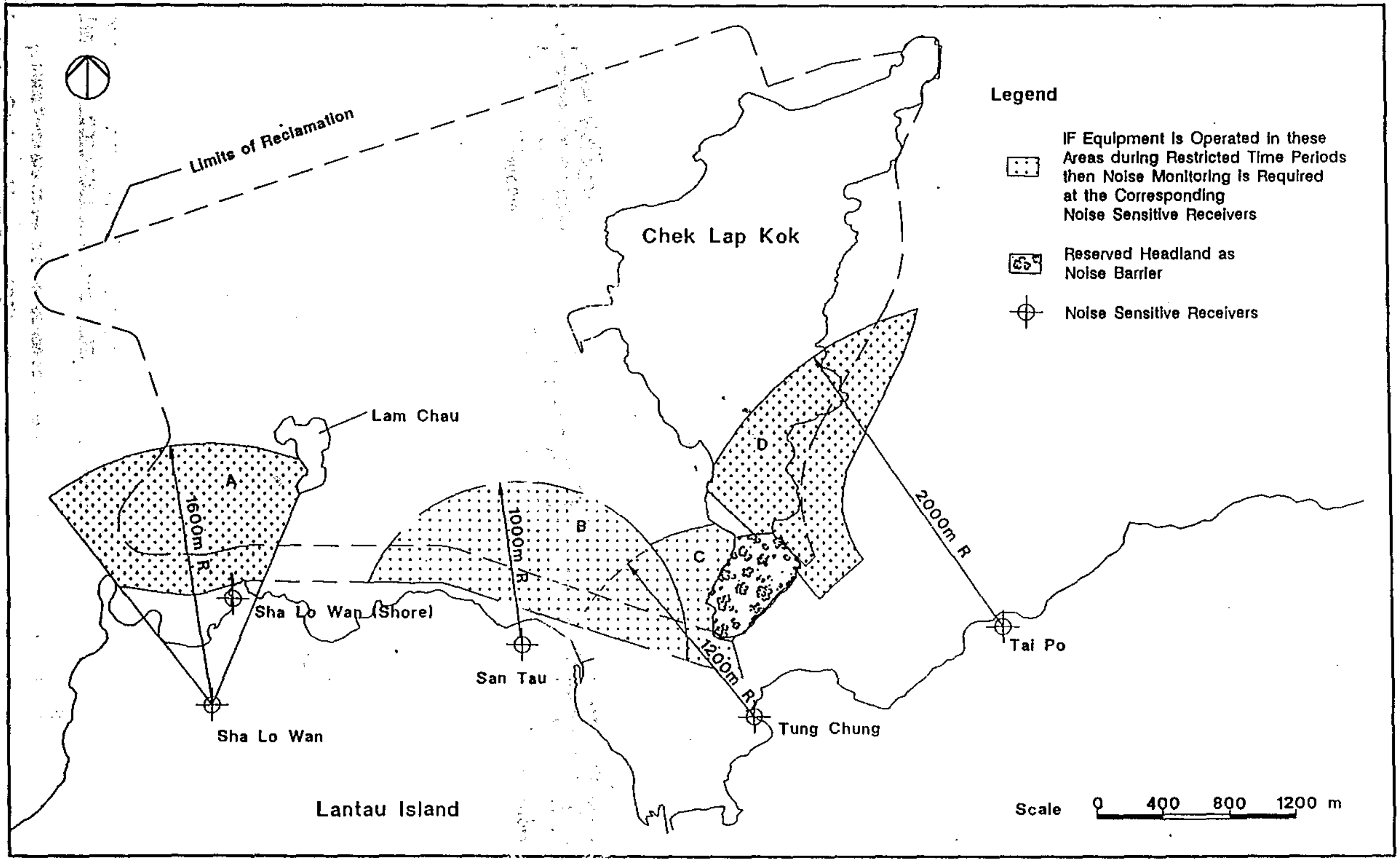
When PME is operating within 1200m (area C of Exhibit 4.3) outside the hours 0700-1900 or on general holidays, but not if plant from other projects is operating in closer proximity to Tung Chung.

Tai Po

When PME is operating within 2000m of Tai Po (area D of Exhibit 4.3) outside the hours 0700-1900 or on general holidays, but not if plant from other projects is operating in closer proximity to Tai Po.

At least one daily measurement should be made between 1900 and 2300 hours and between 2300 and 0700 hours. On general holidays at least one additional measurement should be made between 0700 and 1900 hours. Additional measurements may be taken in response to complaints or at the discretion of the Engineer. If at any time the ANL is exceeded, the Contractor should be required to adjust the use of his PME so that the monitored noise level does not exceed the ANL.

Additionally, when dredgers are operating within 1000m of an NSR outside the hours 0700-1900 or on general holidays, in any of the marine borrow areas, monitoring should be required at a location representative of the nearest NSR and at a frequency as described above. The ANLs for the periods 2300-0700 hours and 1900-2300 hours will be 55 dB(A) and 60 dB(A) respectively.



Noise Monitoring Requirements ***Exhibit 4.3***

Excavation and land reclamation activities associated with the new airport site at Chek Lap Kok can have a temporary impact on local air quality with particulate matter (dust) having the greatest potential impact. Blasting, excavation, loading, transport and the placement of fill material are the primary sources of dust associated with a project of this magnitude. Concrete/asphalt plants are also potential sources of air emissions. Unfortunately, similar to noise, the creation of dust during the airport construction phase is unavoidable. The open burning of waste material will be prohibited.

The effects of dust will vary in time, scale and location depending on local meteorological conditions; the level and nature of the construction activity; and the location of the source. Under most conditions, it is likely that dust generated by this project will be redeposited close to the source since the particles are generated low to the ground and are of relatively large diameter and weight. However, some of the dust particles will be transported through the atmosphere away from the project site and redeposited in other locations.

In order to determine the potential impact of this dust in the vicinity of Chek Lap Kok and Lantau Islands, an assessment was conducted using an atmospheric computer dispersion model and the general design principles of the site excavation/ reclamation plan. Both "worst case" and "most probable" meteorological conditions were examined in order to more fully evaluate the potential effects of this project.

5.1 Assessment Methodology

In general terms, the most significant sources of dust associated with the excavation of Chek Lap Kok Island and the land reclamation of the remainder of the airport footprint are the blasting, excavation, loading, hauling, and dumping of rock and other earth materials.

The following guidelines, from the excavation and fill plan, were adopted during this assessment in order to evaluate the effect of the project on the generation and dispersal of dust:

- Chek Lap Kok Island is excavated over a two year period to a final elevation of +5 mPD and will be backfilled with hydraulically placed marine sand where required to the same level as the land reclamation area. Approximately 90 million bank cubic metres of material will need to be excavated.

- The excavation plan is assumed to take place over nine 3-month periods (or quarters) which determines the location and level of production; the elevation of the work site; the type and number of construction equipment required; and the haul distances between the excavation and reclamation sites. Since almost all of the earth movement work will be completed by the end of the 7th quarter, the air quality impact assessment did not include the 8th and 9th quarters.

- The production schedule is based on the equipment capability and contractor production rates which are considered as conservative estimates. Blasting will occur once a day, six days a week. Excavation and material handling will occur seven days a week, 19.35 hours per day due to shift changes and stopped work periods associated with the blasting.

From this basis, particulate matter emission rates were computed for each excavation/reclamation operation by applying the project production rates to source emission factors obtained from U.S. Environmental Protection Agency (EPA) publications. The derivations of these operation-specific emission rates is summarized in the following paragraphs. Some of the emission rates and formulas are expressed in non-metric units as that is how they are presented in EPA publications.

5.1.1 Emission Rates

Blasting will be required on a large scale in order to excavate the 90 million bank cubic metres of earth material and to break the rock for hauling and placement. It is not anticipated that rock crushing will be required. The quantity of airborne particulates generated by the blasting operations was calculated based on the following:

- An average production schedule of 1 blast per day, 6 days per week.
- A complete blast event lasts approximately one hour.
- An average blast produces 150,000 bank cubic metres (405,000 tons) of material.
- An emission factor of 0.16 pounds/ton of particles less than 30 microns in diameter.

Utilising this information, a blast emission rate of 8164.[illegible]2 grams/second was computed.

Excavation and loading for this scale of operation will involve the operation of large hydraulic shovels and front end loaders. The quantity of particulate emissions generated by the excavation and load operations was calculated based on the following:

- A maximum production rate of 2,585 tons/hour for each excavator.
- A daily production schedule of 19.35 hours per day, 7 days per week.
- A particulate matter emission factor of 0.39 pounds/ton based on a loading capacity of 26.2 $yard^3$, silt content of 2 percent, moisture content of 0.5 percent, a drop height of 5.9 feet and a wind speed of 2 metres/second.

Utilising this information, an excavation/loading emission rate of 1.37 grams/second was computed.

Hauling of the material is closely linked to the excavation/loading production rates and the location of the disposal area. Therefore, the quantity of particulates generated by the hauling operations was calculated based on the following:

- Each excavator will load 330 trucks per day.

- A daily production schedule of 19.35 hours per day, 7 days per week.

- Average haul distances between the source and destination were calculated from the excavation plan.

- Average truck speed is limited to 20 mph.

Utilising this information, a haul emission rate of 4,271.12 grams/vehicle-mile was computed.

Unloading of the fill material at the reclamation area is also linked to the loading and hauling production rates. As such, the quantity of particulate emissions generated by the unloading of the material was calculated based on the following:

- A daily production schedule of 19.35 hours per day, 7 days per week.

- A particulate matter emission factor of 0.66 pounds/ton based on a dumping capacity of 136.8 $yards^3$ and a drop height of 17.1 feet.

Utilising this information, an unloading emission rate of 2.30 grams/ second was computed.

Drilling of blast holes will be accomplished using pull down rotary drills. The quantity of particulate matter generated from this operation was based on the following:

- Approximately 5 drill units drilling an average of 12 holes per day, 7 days per week.

- Each drill hole will produce 1,050m^3 of material.

- A particulate matter emission factor of 0.0008 pounds/ton.

Utilising this information, a drilling emission rate of 0.91 grams/second was computed.

Overburden removal will involve a wide range of heavy equipment including bull dozers, graders and trucks. The quantity of particulate matter generated from this operation was based on the following:

- Approximately 2,000 tons of overburden will be removed from each acre of disturbed land.

- An overburden removal schedule of 1.7 acres/day over a 19.35 hour production day.

- A particulate matter emission factor of 0.10 pounds/ton.

Utilising this information, an overburden removal emission rate of 2.27 grams/second was computed.

These emission rates for blasting, excavation/loading, hauling, unloading, drilling and overburden removal are computed for Total Suspended Particulates (TSP) up to 30 microns (um) in diameter and are listed in Table 5.1. Under a 5 m/s wind speed, the "most probable" excavation, loading and unloading emission rates resulted in only a 1 to 3 percent difference in the ISC model area source strengths compared to the "worst case" conditions. Therefore, for the purposes of this analysis these emission rates were held constant.

Table 5.1
Excavation/Land Reclamation Operation Particulate Matter Emission Rates

Operation	Factor
Blasting	8164.62 grams/second
Excavation/Loading	1.37 grams/second
Hauling	4,271.12 grams/vehicle-mile
Unloading	2.30 grams/second
Drilling	0.91 grams/second
Overburden Removal	2.27 grams/second

Source: Greiner-Maunsell, 1991

Under most conditions, particles larger than about 100um are likely to settle to the ground within 6 to 9 metres from the source. Particles in the 30 to 100um size range generally settle out within a few hundred metres from the source. Smaller particles, particularly those less than 30um, have much slower gravitational settling velocities and remain suspended in the atmosphere for longer periods of time. On this basis, the 30um diameter was determined to be the aerodynamic cut off diameter for dust particles potentially moving off the airport construction site.

Table 5.2 on the following page summarises the typical particle sizes, mass fraction distribution, settling velocities and reflection coefficients for construction-related dust particles in the less than 30um size range. From these and other previously presented data it is assumed that 23 percent of the TSP is in the Respirable Suspended Particulate (RSP) size range (<10 um).

The potential impacts from wind erosion over exposed surfaces and open storage piles were not included because: (1) these effects do not usually occur at the low wind speeds simulated in this analysis; (2) the dust particles tend to settle out relatively close to the source; and (3) they can be more effectively controlled than the other blasting and excavation/reclamation activities.

Table 5.2
Construction Related Particulate Matter Characteristics

Size Range (um)	Mass Fraction	Settling Velocity (cm/sec)	Reflection Coefficient
0- 5	0.04	0.788	85
6-10	0.19	3.153	67
11-15	0.32	7.096	57
16-20	0.19	12.614	42
21-25	0.16	19.710	25
26-30	0.10	28.383	5

Source: Greiner-Maunsell, 1991

5.1.2 Atmospheric Dispersion Model

The Industrial Source Complex (ISC) dispersion model was selected as the dispersion model for this assessment. ISC is an advanced Gaussian plume model which provides a substantial degree of flexibility and accuracy for modeling particulate matter from a complex source such as the airport excavation/reclamation project site.

Using the ISC area source algorithm, the project site, encompassing all of Chek Lap Kok Island, the Advance Works area and the land reclamation area, was subdivided into 18 individual square area sources, 500 to 1,500 metres on a side. The area source strengths by quarters were then developed. In this way, the excavation plan operations identified as blasting, excavation/loading, hauling, unloading, drilling and overburden removal could be more accurately simulated with the ISC model according to the individual three-month construction quarters.

5.1.3 Receptors

The dispersion of particulate matter from the project site was also evaluated using the ISC modelling grid. For the purpose of this analysis, a 14 by 20 kilometre grid covering Chek Lap Kok Island, the Reclamation Area and all of Lantau Island was established. Each square grid was 1,000 metres on a side thus producing 280 receptor points across the study area.

In addition, 13 discrete receptors located along the north-central coastline of Lantau Island were also individually evaluated. These receptors include three at Sha Lo Wan, one each at Kau Liu, Tin Sam, San Tau and Sha Tsui Tau, and two each at Tung Chung, Ma Wan Chung and Tai Po. The location elevations of these receptors, relative to the project site, were obtained from topographic maps.

5.1.4 Meteorological Conditions

In order to more fully evaluate the potential effects of the excavation plan on dust levels in the vicinity of Chek Lap Kok and Lantau Island, both "worst case" and "most probable" meteorological conditions were simulated.

Due to the fact that the project site on Chek Lap Kok is located northeast, north and northwest of Lantau Island, winds from 290° to 50° were considered "worst case". However, based on four years of meteorological data collected at Chek Lap Kok Island, wind angles from these directions occur less than 20 percent of the time. Other simulated "worst case" meteorological conditions include an atmospheric stability class D and an atmospheric mixing height of 500 metres. A wind speed of 2 metres/second (m/s) was also assumed for "worst case" conditions. Wind speeds less than 2 m/s have occurred on Chek Lap Kok but based on several years of wind measurements, this happens less than 2 percent of the time. Additionally, atmospheric dispersion models, such as the ISC model. usually yield the highest results at 2 m/s and tend to become far less reliable with simulated wind speeds of less than 2 m/s. Finally, it was assumed that under these "worst case" meteorological conditions, there was no variability in the wind direction, wind speed, atmospheric mixing height or stability class over the one hour or 24-hour modelling periods.

By comparison, meteorological measurements on Chek Lap Kok indicate that the "most probable" wind direction is from 80° to 130° which occurs approximately 44 percent of the time. Other (ISC) simulated "most probable" meteorological conditions included a 5 metres/second wind speed, atmospheric stability class 4 and an atmospheric mixing height of 819 metres. Again, it was assumed that these "most probable" meteorological conditions did not vary over the one hour or 24-hour modelling periods.

5.1.5 Complex Terrain

Under "most probable" meteorological conditions, or when the wind is from the east, west or south, the dispersion of airborne dust particles will essentially be over water or the relatively flat terrain of the land reclamation area. In contrast, when the wind is from the north, the mountainous terrain of Lantau Island will be encountered. However, these foothills, mountains and valleys are leeward from the 13 receptors located on north-central Lantau. Therefore, the potential influence of complex terrain on the ISC model results should be minor in the areas where the greatest dust impacts are expected to occur.

5.2 Existing Environment

The Hong Kong Air Pollution Control Ordinance contains Air Quality Objectives (AQOs) for the control of dust from a wide variety of stationary and area sources. These AQOs apply to both TSP and RSP. In addition the EPD has established construction-related guidelines for dust levels as part of their recommended Dust Suppression Measures. These AQOs and EPD construction guidelines for dust were summarized previously in Table 3.5.

Overall, Hong Kong's climate and that of the new airport site is generally considered sub-tropical. The winter months are characterized by periodic surges of cold air from the north or east; spring months by cloudy skies, humid conditions, and east-southeast winds; summer months by heavy rain and southwesterly winds; and the autumn months by sunny and dry conditions with variable winds.

Presently, the topography to the south of the airport site consists of a partial basin open on the north to the South China Sea. To the east and west the mountainous coast of Lantau Island flanks Tung Chung Valley, and to the south there are steep mountainous slopes.

Wind speed and direction, air temperature, precipitation, and cloud cover have been recorded by the Royal Observatory on Chek Lap Kok Island over the past four years. As stated in the previous section, these factors potentially affecting the dispersion of air pollutants at the new airport site have been used to model "most probable" meteorological conditions. The average wind speed is 4.75 metres/second. The prevailing wind direction is from the east southeast (80° - 130°) occurring approximately 44 percent of the time. The average air temperature is 22.8°C. Average rainfall is 1,405 millimetres (mm) per year and cloud cover occurs approximately 65 percent of the time. The average atmospheric mixing height is 819 metres.

The site of the new airport is essentially undeveloped and does not contain any traditional large scale sources of air emissions such as power source generation, incineration or processing of raw materials. The only existing nearby source of air emission is the Castle Peak Power Station located approximately 6 kilometres north of Chek Lap Kok. However, the marine environment can contribute heavily to atmospheric particulate matter levels by the natural generation and dispersal of sea salts.

No air quality monitoring data exists for the airport site at Chek Lap Kok or Lantau Island. The closest air monitoring stations are operated by EPD and are located at the Tsuen Wan site on the mainland and the Central/Western Hong Kong Island site, 18 kilometres northeast and 21 kilometres east of the airport, respectively.

Due to the fact that the airport site at Chek Lap Kok is surrounded by water, the only potentially sensitive air quality receptors in the vicinity of the excavation/land reclamation project are located along the north-central coastline of Lantau Island. These small villages are currently situated 0.5 to 3 kilometres southwest, south and southeast of Chek Lap Kok and include Sha Lo Wan, Kau Liu, Tin Sam, San Tau, Tung Chung, Sha Tsui Tau, Ma Wan Chung and Tai Po. Other areas of Lantau Island will likely remain shielded from the construction activities because of the barrier created by the very steep mountains to the east, south and west. Areas to the north of Chek Lap Kok such as Tuen Mun, and Lung Kwu Tan (Castle Peak) will also likely remain unaffected because of the distances separating these locations (13 kilometres).

5.3 Air Quality Impacts

As previously stated, the excavation/land reclamation plan for the new airport site will involve operations that will generate air emissions with particulate matter having the greatest potential impact. The most significant of these operations have been identified as blasting, excavation/loading, hauling, dumping, drilling and over burden removal. Under most conditions, this dust will be redeposited close to the source since it is generated low to the ground and has relatively large acrodynamic diameter and weight. However, some of the dust particles will be transported through the atmosphere away from the project site and redeposited in other locations.

Using the ISC dispersion model and project specific production parametres contained in the excavation/reclamation plan, the impact of these activities on dust levels in the vicinity of Chek Lap Kok and Lantau Island has been predicted. This assessment was conducted for both "worst case" and "most probable" conditions and the results are compared to the Hong Kong AQOs and EPD Dust Suppression Measures Guidelines for TSP and RSP.

5.3.1 Worst Case Results

Tables 5.3 and 5.4 contain the "worst case" one and 24-hour TSP and RSP levels predicted for the 13 receptor locations previously identified. The reported values represent the highest predicted levels for each receptor, for each construction period and for the potential "worst case" wind direction. Essentially, these wind directions are from the north, north-northwest and north-northeast, across the project site on Chek Lap Kok toward Lantau Island.

As shown in Table 5.3, the highest predicted "worst case" one hour TSP levels are expected to occur immediately following blasting operations. For example, during Quarter 1 the maximum blast-related TSP levels are predicted to range from 308 to 1,286 ug/m^3 at the 13 receptors on Lantau Island. During Quarter 2, the maximum blast-related TSP levels are predicted to increase to the range of 616 to 5,882 ug/m^3 at these same receptors in response to a corresponding increase in production rates and the work site moving further south on Chek Lap Kok. However, as the project progresses to Quarter 3, TSP levels following a blast are expected to decline significantly, ranging from 111 to 509 ug/m^3 by Quarter 7, as the elevation of Chek Lap Kok is lowered. Measured one hour TSP values in excess of 500 ug/m^3 exceed the EPD-recommended Dust Suppression Measures Guidelines for construction activities.

By comparison, the highest predicted "worst case" one hour TSP levels associated with the excavation/reclamation process range from 8 to 29 ug/m^3 in Quarter 1, 37 to 212 ug/m^3 in Quarter 2 and again diminish significantly to 9 to 46 ug/m^3 by Quarter 7. As shown, the values are within the EPD Dust Suppression Guidelines of 500 ug/m^3 for TSP.

The highest predicted "worst case" 24-hour TSP levels range from 24 to 73 ug/m^3 in Quarter 1, 35 to 416 ug/m^3 in Quarter 2, 27 to 311 ug/m^3 in Quarter 3 and then decline to the range of 13 to 37 ug/m^3 by Quarter 7. Based on these data, the Hong Kong AQOs and EPD 24-hour TSP Dust Suppression Measures Guidelines level of 260 ug/m^3 could be exceeded at two receptors in Quarter 2 and at one receptor in Quarter 3. However, there are no predicted exceedances of the 24-hour TSP AQO or the EPD guideline in Quarter 1 or Quarters 4 through 7.

Finally, as shown in Table 5.4, the "worst case" 24-hour RSP levels are predicted to decline from a high of 43 ug/m^3 in Quarter 2 to 7 ug/m^3 in Quarter 7 at the 13 receptors on Lantau Island. These 24-hour RSP values include contributions from both blasting and the excavation/reclamation operations. As shown, these values are well within the 24-hour AQO for RSP of 180 ug/m^3. No one hour AQO or EPD guideline exists for RSP.

Table 5.3 "Worst Case" One Hour and 24-Hour Total Suspended Particulates (TSP) Levels (ug/m³)

Receptor No. Location	Qtr. No. 1 Blast	Qtr. No. 1 Exv./Rec.	Qtr. No. 1 24-Hr	Qtr. No. 2 Blast	Qtr. No. 2 Exv./Rec.	Qtr. No. 2 24-Hr	Qtr. No. 3 Blast	Qtr. No. 3 Exv./Rec.	Qtr. No. 3 24-Hr	Qtr. No. 4 Blast	Qtr. No. 4 Exv./Rec.	Qtr. No. 4 24-Hr	Qtr. No. 5 Blast	Qtr. No. 5 Exv./Rec.	Qtr. No. 5 24-Hr	Qtr. No. 6 Blast	Qtr. No. 6 Exv./Rec.	Qtr. No. 6 24-Hr	Qtr. No. 7 Blast	Qtr. No. 7 Exv./Rec.	Qtr. No. 7 24-Hr
1. Sha Lo Wan	420	9	25	616	37	35	437	34	27	312	25	20	251	16	14	170	16	13	127	16	13
2. Sha Lo Wan	401	13	27	509	37	43	360	33	29	257	25	22	206	35	28	134	34	28	111	34	28
3. Sha Lo Wan	308	15	24	802	49	48	568	44	38	404	32	27	324	47	38	217	46	37	166	46	37
4. Kau Liu	1,205	29	73	3,343	103	187	2,334	103	144	1,633	87	97	1,268	44	71	784	20	43	346	19	23
5. Tin Sam	1,286	29	69	3,789	106	244	2,693	91	168	1,863	78	111	1,445	47	98	889	21	54	440	17	27
6. San Tau	855	25	44	3,592	101	205	2,545	80	156	1,758	65	104	1,364	46	79	843	23	45	400	14	27
7. Tung Chung (Ruin)	689	8	56	2,287	81	160	1,602	54	106	1,108	37	69	865	36	65	544	18	37	192	11	17
8. Tung Chung (Rec. Camp)	533	9	26	2,492	103	187	1,748	72	131	1,208	42	84	942	36	68	590	19	40	270	11	20
9. Sha Tsui Tau	667	9	35	2,488	109	191	1,750	56	142	1,209	55	95	941	39	70	586	19	39	253	11	17
10. Ma Wan Chung	1,026	11	51	4,533	171	327	3,246	130	240	2,247	84	155	1,740	60	118	1,066	27	66	418	14	29
11. Ma Wan Chung	1,193	13	59	5,882	212	416	4,292	164	311	2,987	111	208	2,313	79	156	1,404	33	85	509	17	35
12. Tai Po (Youth Camp)	748	14	43	3,666	124	222	2,600	83	164	1,796	60	115	1,393	51	88	860	17	47	393	9	24
13. Tai Po	1,035	16	51	3,399	95	200	2,403	81	150	1,660	46	106	1,289	38	80	798	16	45	423	9	24

Notes: (1) TSP size range 0 to 30 um.
(2) Reported values represent highest predicted levels for each receptor from all potential "worst case" wind directions. Background values not included.
(3) "Worst case" wind angles from the north across the project site.
(4) Blast levels based on a single one hour event per day.
(5) Exv./Rec. (Excavation/Reclamation) levels based on a single one hour combined contributions from excavation/loading, hauling, unloading, drilling and overburden removal.
(6) 24-Hr. (24-Hour) levels based on a single one hour blast event + 19.35 hours of Exv./Rec. operations.
(7) EPD-Dust Supression Guideline for TSP is 500 ug/m³.
(8) AQO 24-Hour standard for TSP is 260 ug/m³.

Source: Greiner-Maunsell, 1991

Table 5.4 "Worst Case" One Hour and 24-Hour Respirable Suspended Particulates (RSP) Levels (ug/m³)

Receptor No.	Location	Qtr. No. 1 Blast	Qtr. No. 1 Exv./Rec.	Qtr. No. 1 24-Hr	Qtr. No. 2 Blast	Qtr. No. 2 Exv./Rec.	Qtr. No. 2 24-Hr	Qtr. No. 3 Blast	Qtr. No. 3 Exv./Rec.	Qtr. No. 3 24-Hr	Qtr. No. 4 Blast	Qtr. No. 4 Exv./Rec.	Qtr. No. 4 24-Hr	Qtr. No. 5 Blast	Qtr. No. 5 Exv./Rec.	Qtr. No. 5 24-Hr	Qtr. No. 6 Blast	Qtr. No. 6 Exv./Rec.	Qtr. No. 6 24-Hr	Qtr. No. 7 Blast	Qtr. No. 7 Exv./Rec.	Qtr. No. 7 24-Hr
1.	Sha Lo Wan	105	2	6	136	8	8	113	8	7	89	7	5	76	4	4	57	2	3	47	2	3
2.	Sha Lo Wan	95	3	6	108	8	9	90	7	6	71	6	5	60	5	5	45	2	3	39	2	3
3.	Sha Lo Wan	70	3	5	164	10	9	137	9	9	108	7	7	92	5	5	68	2	4	56	2	4
4.	Kau Liu	215	3	12	407	14	23	375	16	23	303	15	18	255	10	17	176	5	10	89	2	6
5.	Tin Sam	224	3	11	426	14	28	401	15	25	327	16	20	277	11	20	190	5	12	110	3	7
6.	San Tau	156	3	8	427	14	25	395	13	24	320	12	19	270	11	16	186	6	10	103	3	7
7.	Tung Chung (Ruin)	149	2	8	336	14	[illegible]	296	12	20	235	10	15	197	10	16	137	6	10	57	3	5
8.	Tung Chung (Rec. Camp)	114	2	6	353	18	29	315	14	24	249	10	19	209	10	16	145	5	10	79	3	6
9.	Sha Tsui Tau	139	2	7	333	18	28	299	17	26	239	13	21	201	10	16	140	6	10	72	3	5
10.	Ma Wan Chung	193	2	10	477	23	39	457	21	36	376	18	28	319	14	23	219	7	14	107	3	7
11.	Ma Wan Chung	213	2	11	538	26	43	537	24	41	453	22	35	386	17	29	265	8	17	122	3	7
12.	Tai Po (Youth Camp)	136	3	8	428	18	29	399	15	26	324	13	22	274	13	17	188	4	11	101	2	6
13.	Tai Po	181	3	9	415	16	25	382	16	24	308	10	20	260	9	17	179	4	10	108	2	6

Notes: (1) RSP size range 0 to 10 um.
(2) Reported values represent highest predicted levels for each receptor from all potential "worst case" wind directions. Background values not included.
(3) "Worst case" wind angles from the north across the project site
(4) Blast levels based on a single one hour event per day.
(5) Exv./Rec. (Excavation/Reclamation) levels based on a single one hour combined contributions from excavation/loading, hauling, unloading, drilling and overburden removal.
(6) 24-Hr. (24-Hour) levels based on a single one hour blast event + 19.35 hours of Exv./Rec. operations.
(7) AQO 24-Hour standard for RSP is 180 ug/m³.

Source: Greiner-Maunsell, 1991

5.3.2 Most Probable Results

Under "most probable" meteorological conditions, or when the wind is from the east across Chek Lap Kok Island, the dispersion of TSP and RSP is towards the west and the dust plume will likely remain distributed over water and the land reclamation area. The highest ISC-predicted one hour TSP impacts at the 13 receptors on Lantau Island are not expected to exceed 22 ug/m^3 following a blast and are less than 1 ug/m^3 during the excavation/reclamation process. These values are well within the EPD-recommended one hour guideline of 500 ug/m^3. Similarly, the highest predicted 24-hour TSP impact at the 13 receptors on Lantau Island will not be more than 1 ug/m^3 under the "most probable" meteorological conditions. Again, this is well within the 24-hour AQO and EPD guideline of 260 ug/m^3.

The RSP modelling results, under "most probable" meteorological conditions, also indicate that the potential impact to receptors on Lantau Island will be minor when the wind direction is from the east.

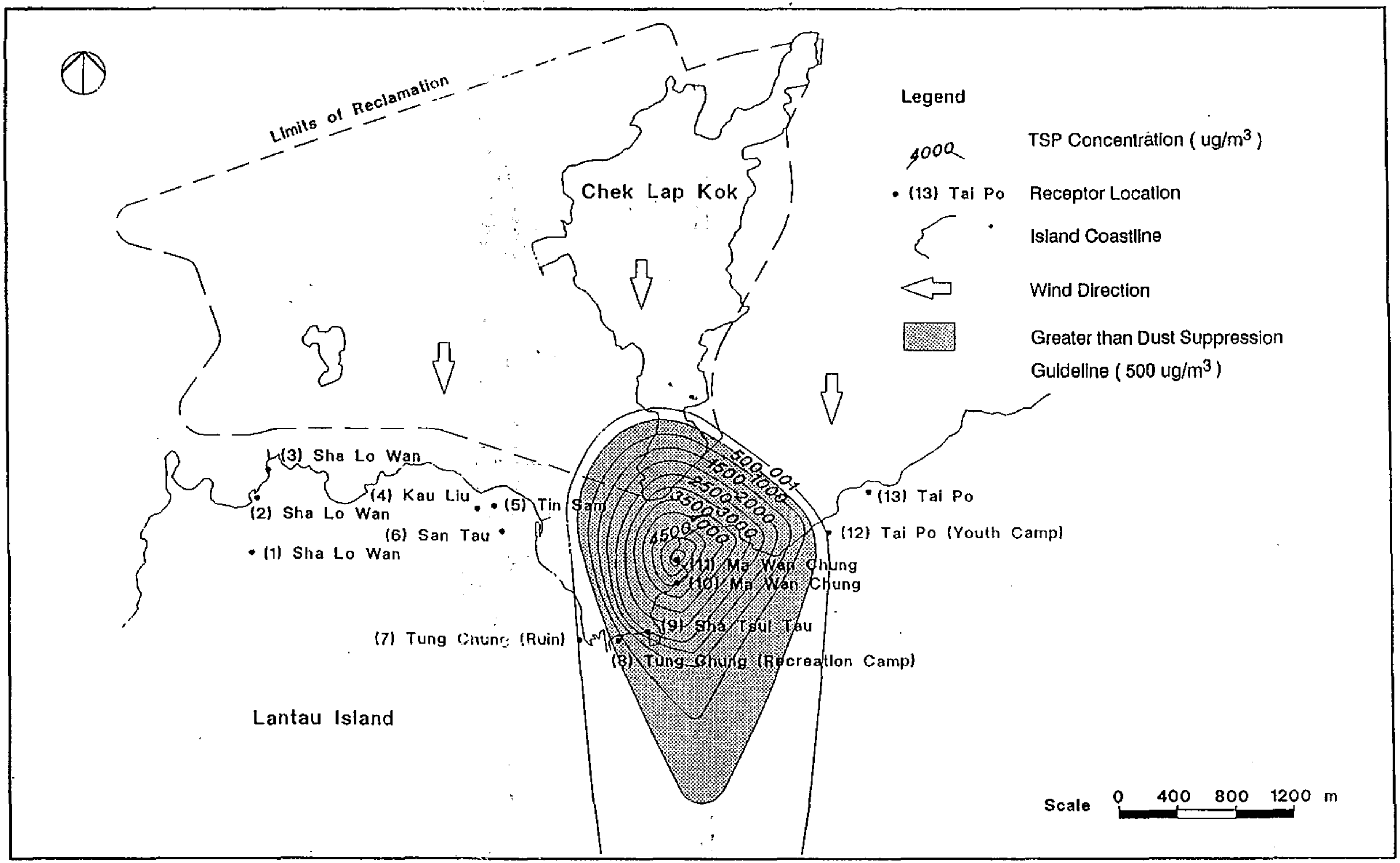
5.3.3 Contours

Exhibits 5.1 through 5.5 illustrate the dispersion of TSP and RSP under "worst case" meteorological conditions represented by contours of equal particulate matter concentrations. Again, "worst case" meteorological conditions are when the wind direction is from the north, north-northwest and north-northeast across the project site on Chek Lap Kok towards the receptors on Lantau Island.

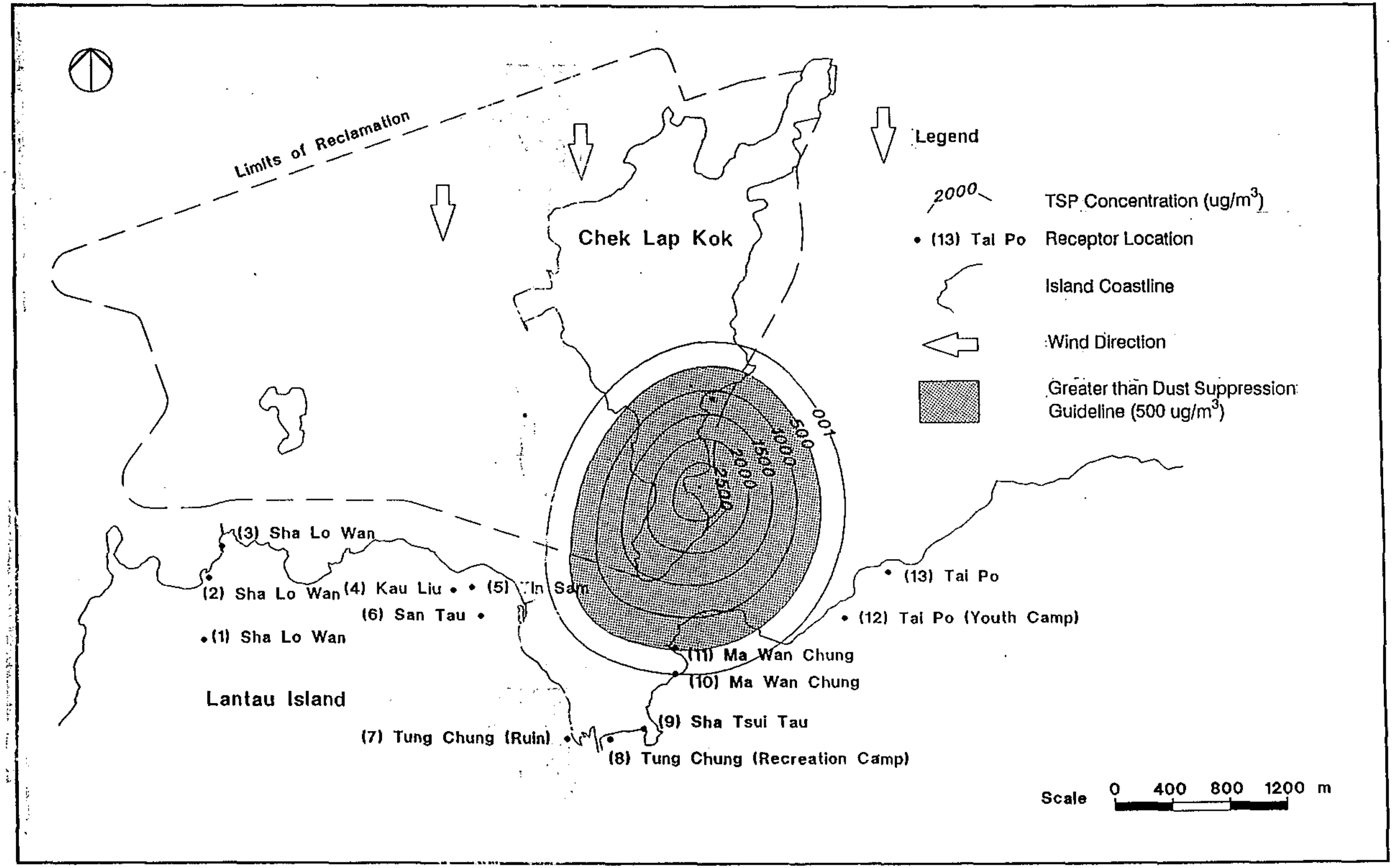
Specifically, Exhibits 5.1 and 5.2 show the distribution of "worst case" one hour TSP levels during Quarters 2 and 7 immediately following blasting operations. As shown, when the wind is from the north, the dust plume will likely disperse over the southern end of Chek Lap Kok Island and small portions of north-central Lantau Island. Exhibit 5.3 illustrates that a similar southerly TSP dispersion pattern would occur associated with the excavation/reclamation operations. Exhibit 5.4 shows the resultant "worst case" 24-hour TSP distribution from the combined impact of both blasting and excavation/reclamation operations during Quarter 2. Finally, Exhibit 5.5 shows the Quarter 2, 24-hour RSP contours resulting from the blasting and excavation/reclamation operations.

For comparison, Exhibits 5.6 through 5.9 illustrate the dispersion of TSP and RSP during Quarter 2 under "most probable" meteorological conditions, or when the wind is from the east over the project site. Shown on Exhibits 5.6, 5.7 and 5.8 is the westerly dispersion pattern for one and 24-hour TSP associated with the blasting and excavation/reclamation operations. Exhibit 5.9 shows the same westerly dispersion pattern for RSP in Quarter 2. Under these "most probable" conditions, the dust plume is situated over water and the land reclamation area, essentially avoiding the receptors on Lantau Island.

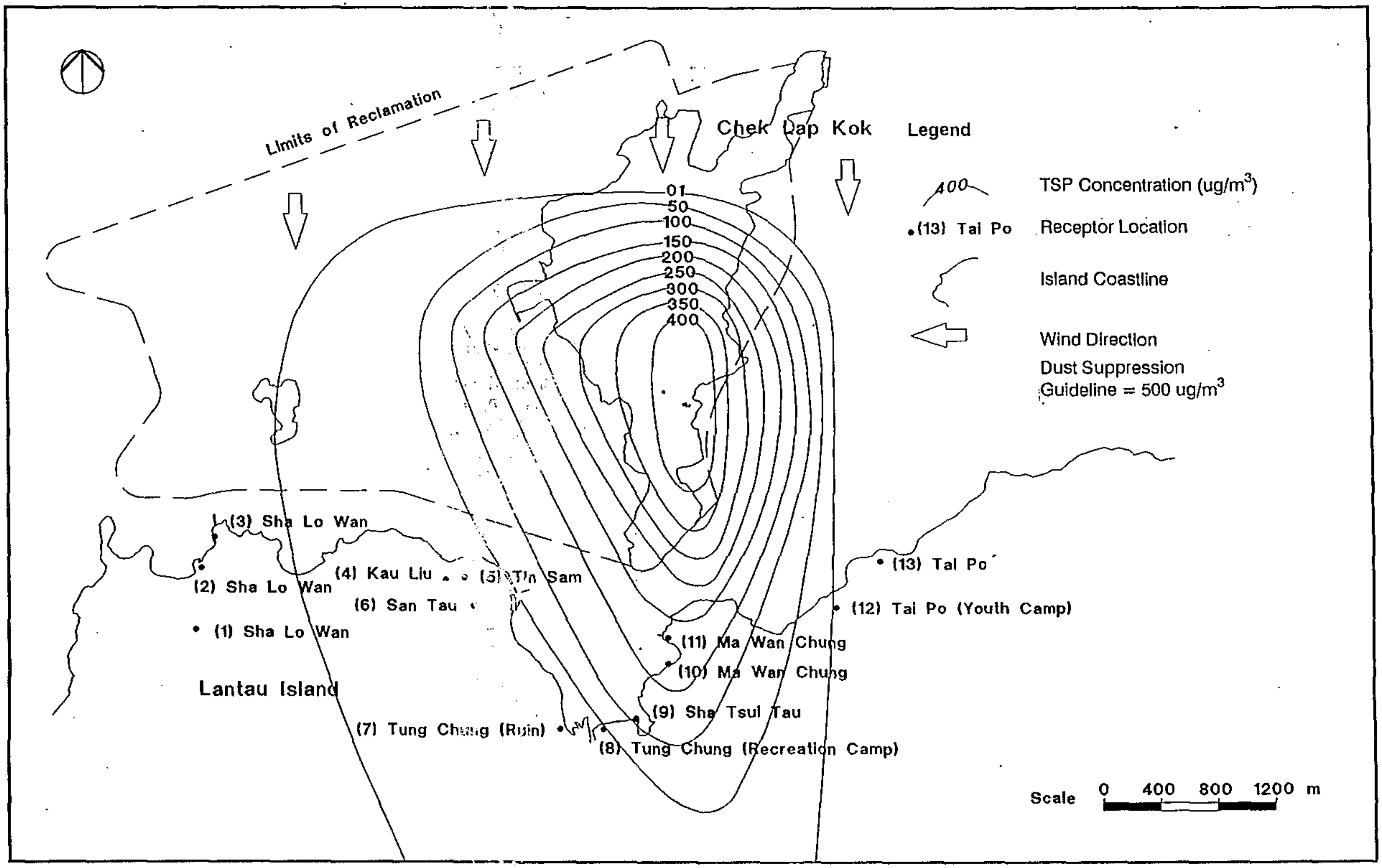
Finally, Exhibits 5.10 and 5.11 show the one and 24-hour TSP dispersion patterns during Quarter 7. Again, the westerly pattern prevails with the dust plume distributed over water or the land reclamation area.



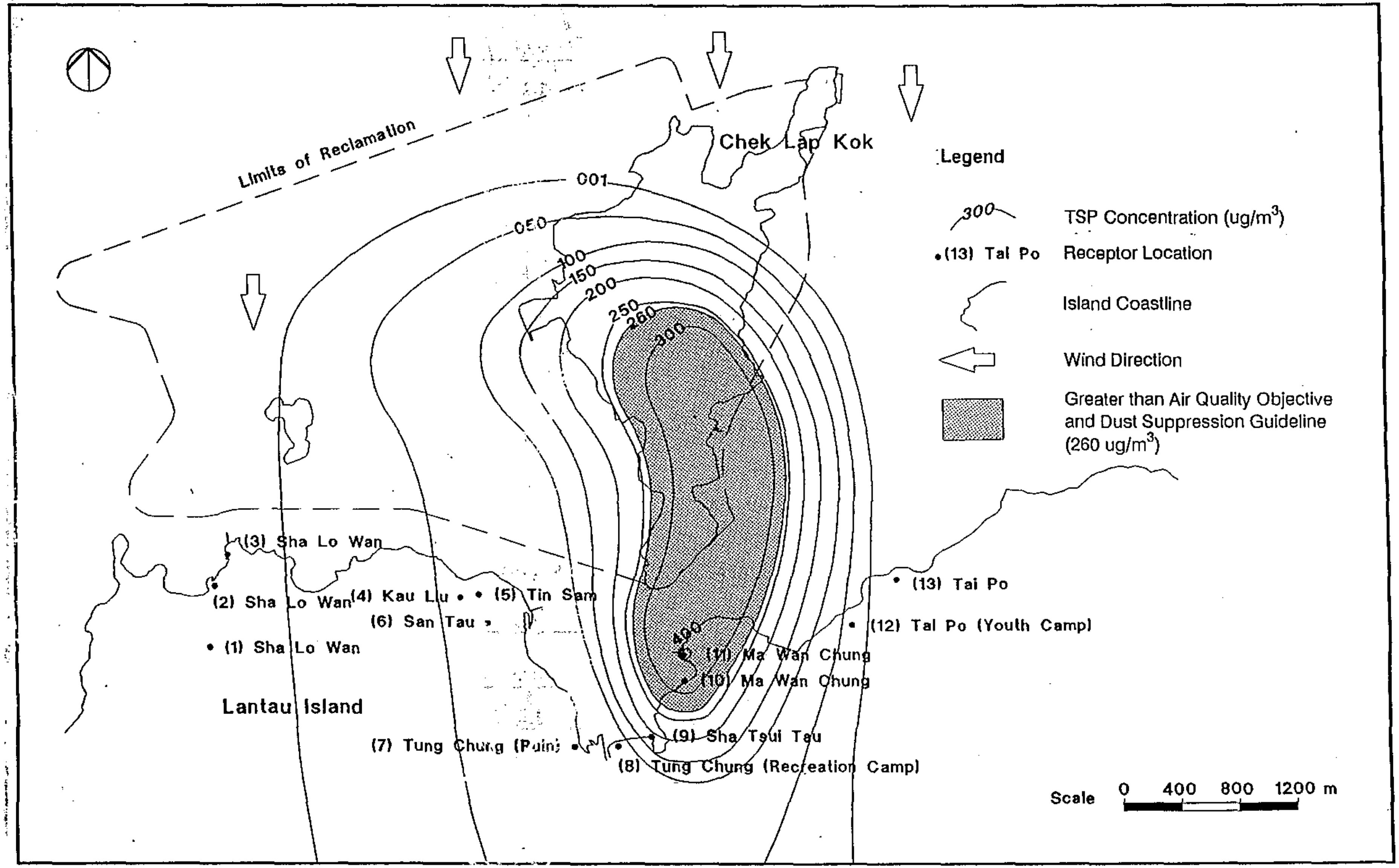
Quarter-2 One Hour Worst Case TSP from Blasting Operations ***Exhibit 5.1***



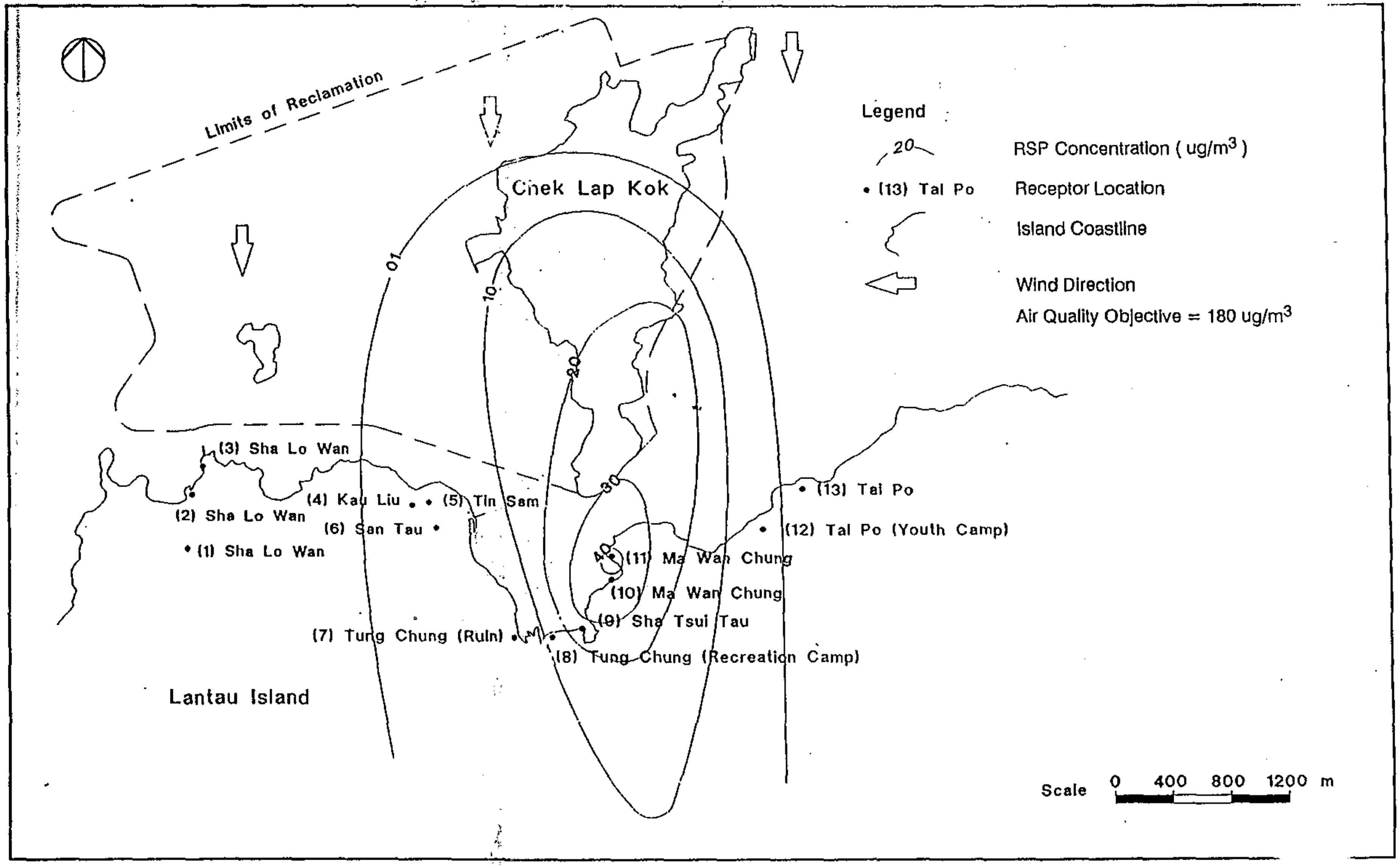
Quarter-7 One Hour Worst Case TSP from Blasting Operations Exhibit 5.2



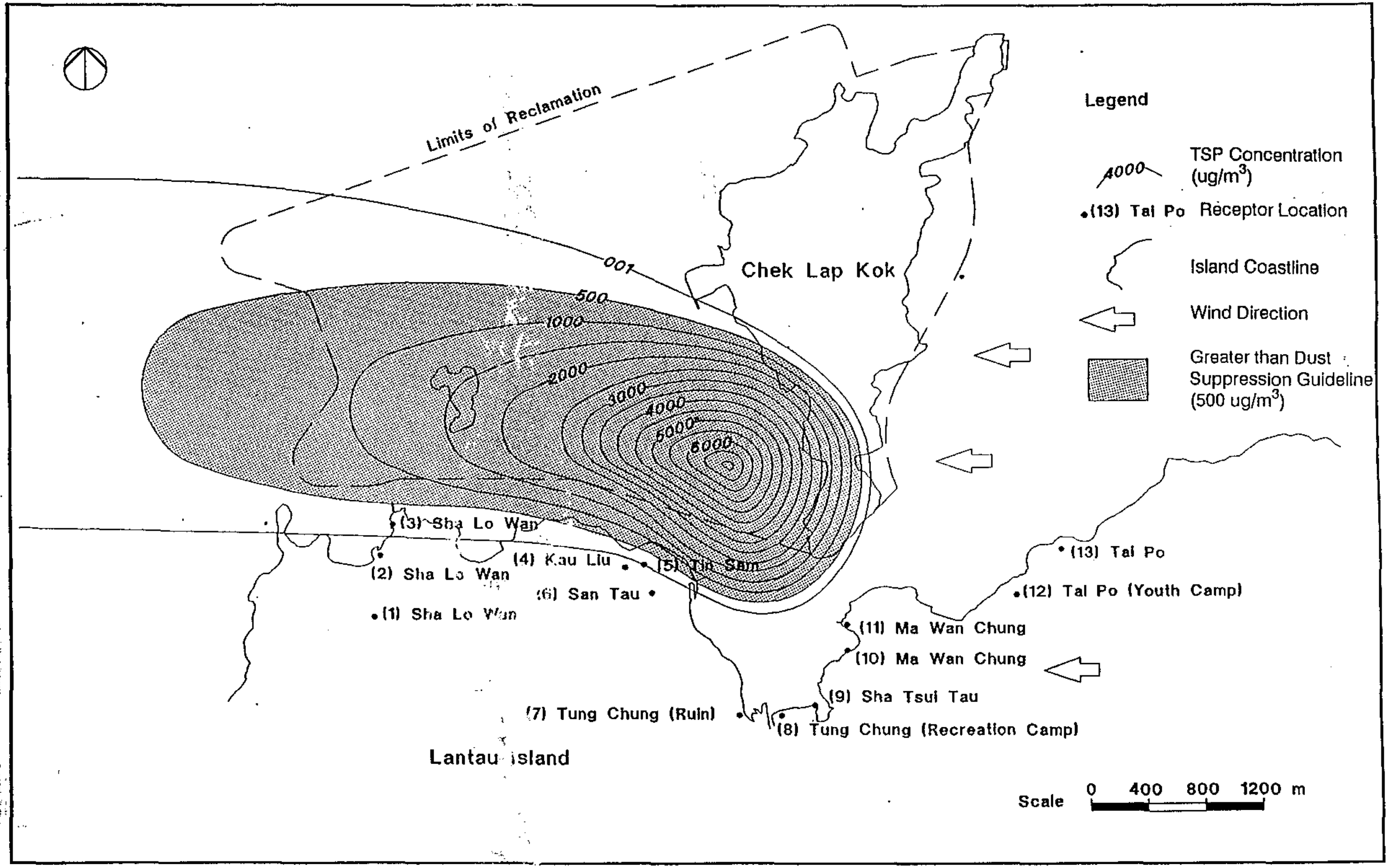
Quarter-2 One Hour Worst Case TSP from Excavation/Reclamation Operations Exhibit 5.3



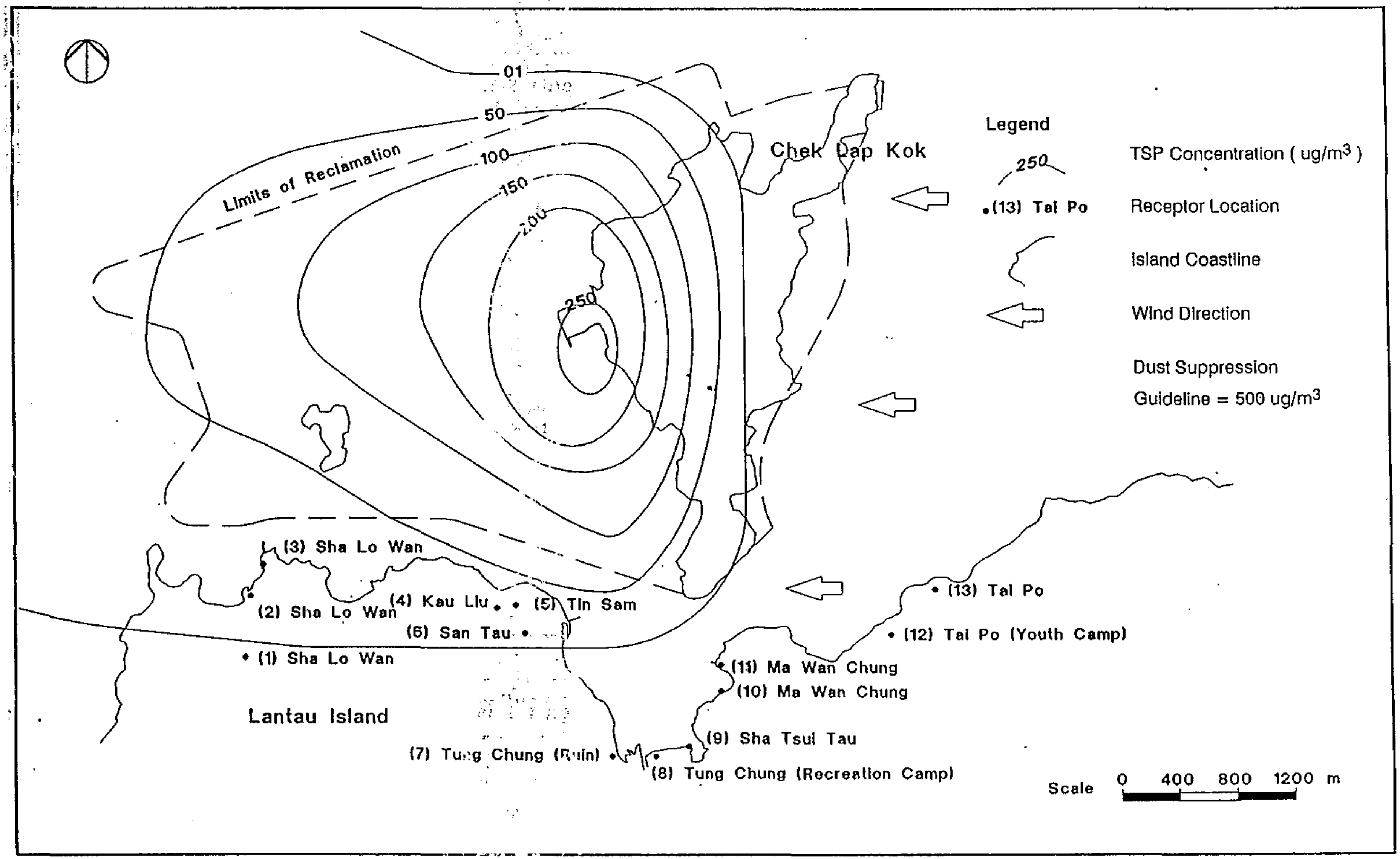
Quarter-2 24-Hour Worst Case TSP from Blasting and Excavation/Reclamation Operations **Exhibit 5.4**



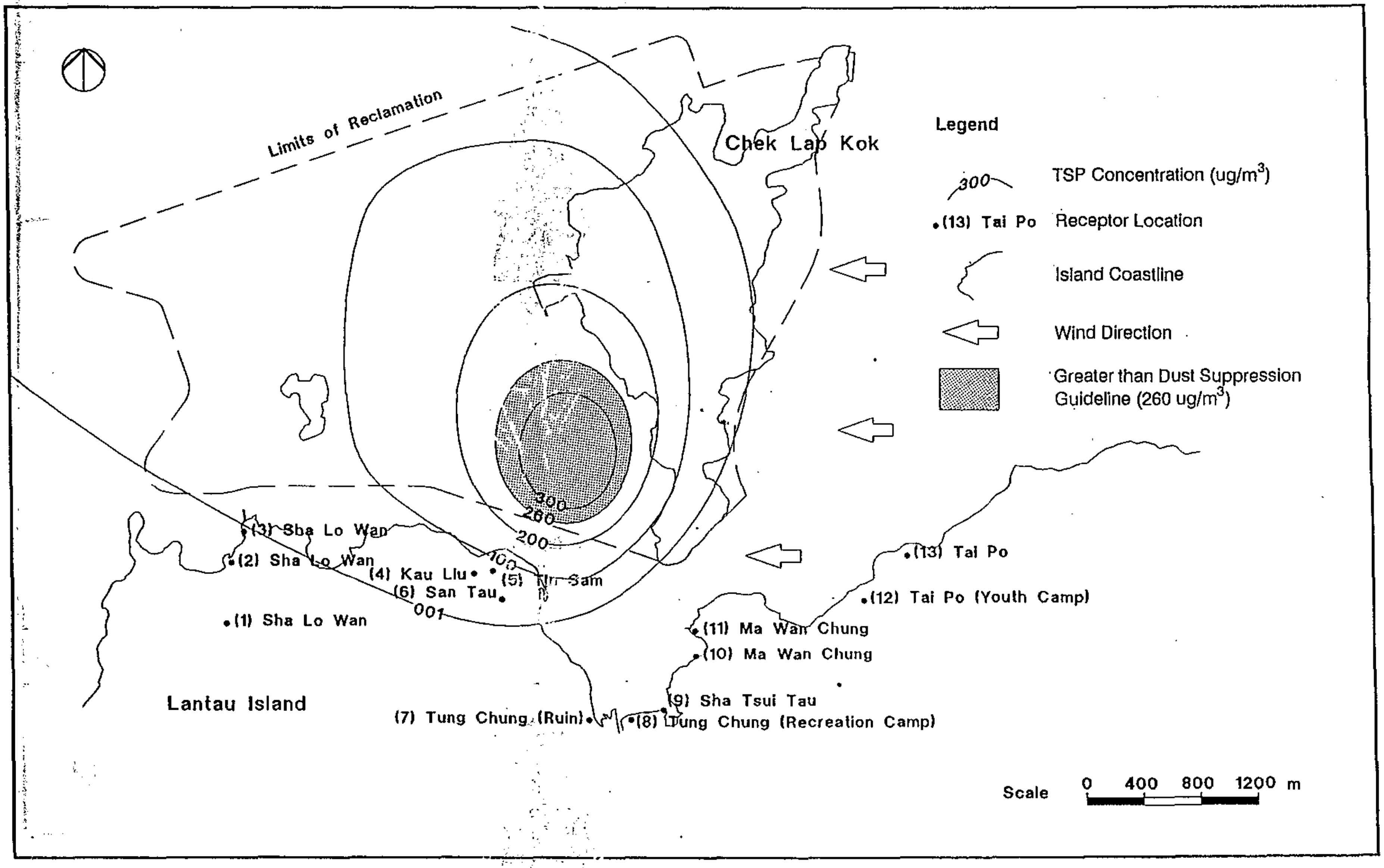
Quarter-2 24-Hour Worst Case RSP from Blasting and Excavation/Reclamation Operations ***Exhibit 5.5***



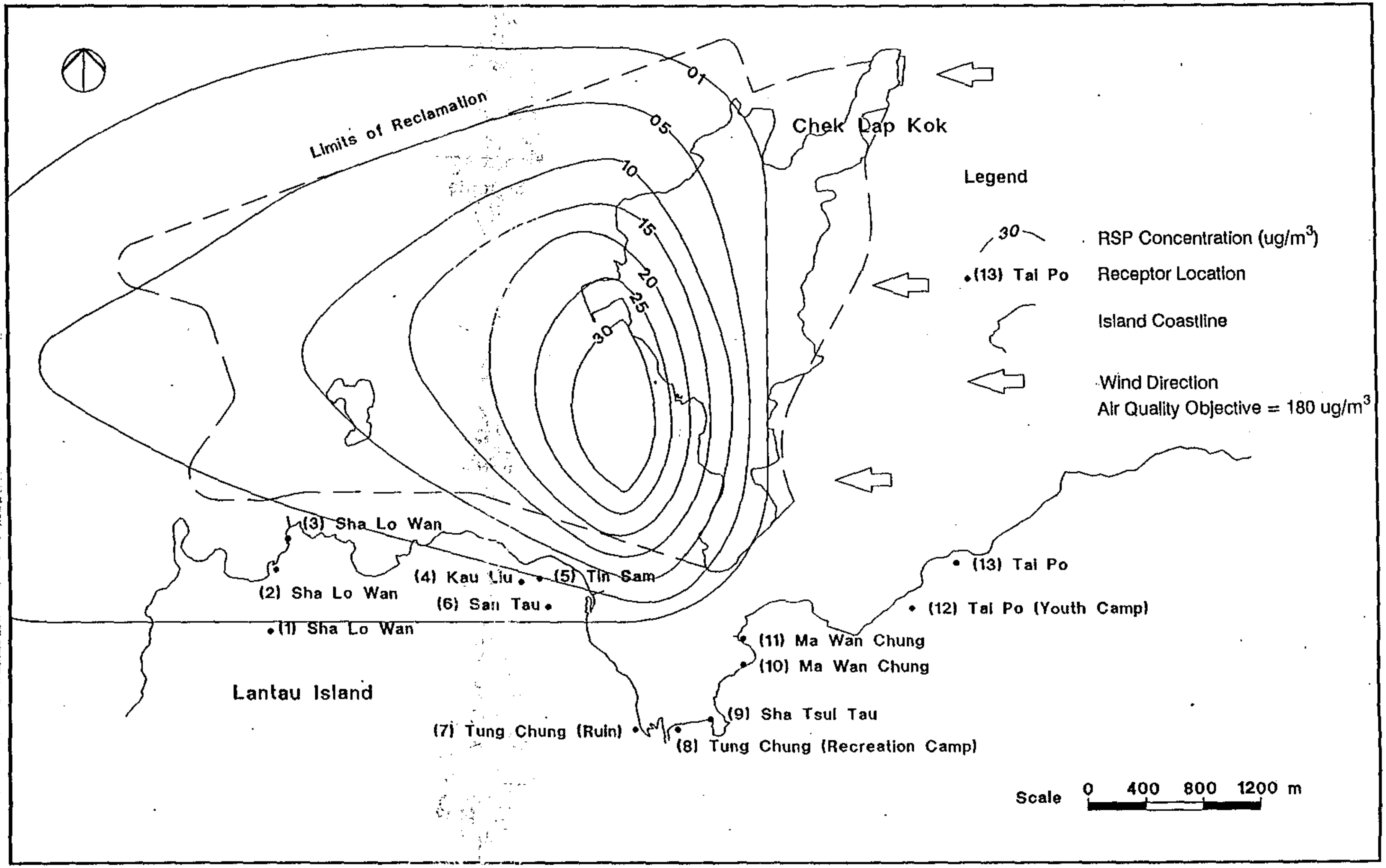
Quarter-2 One Hour Most Probable TSP from Blasting Operations Exhibit 5.6



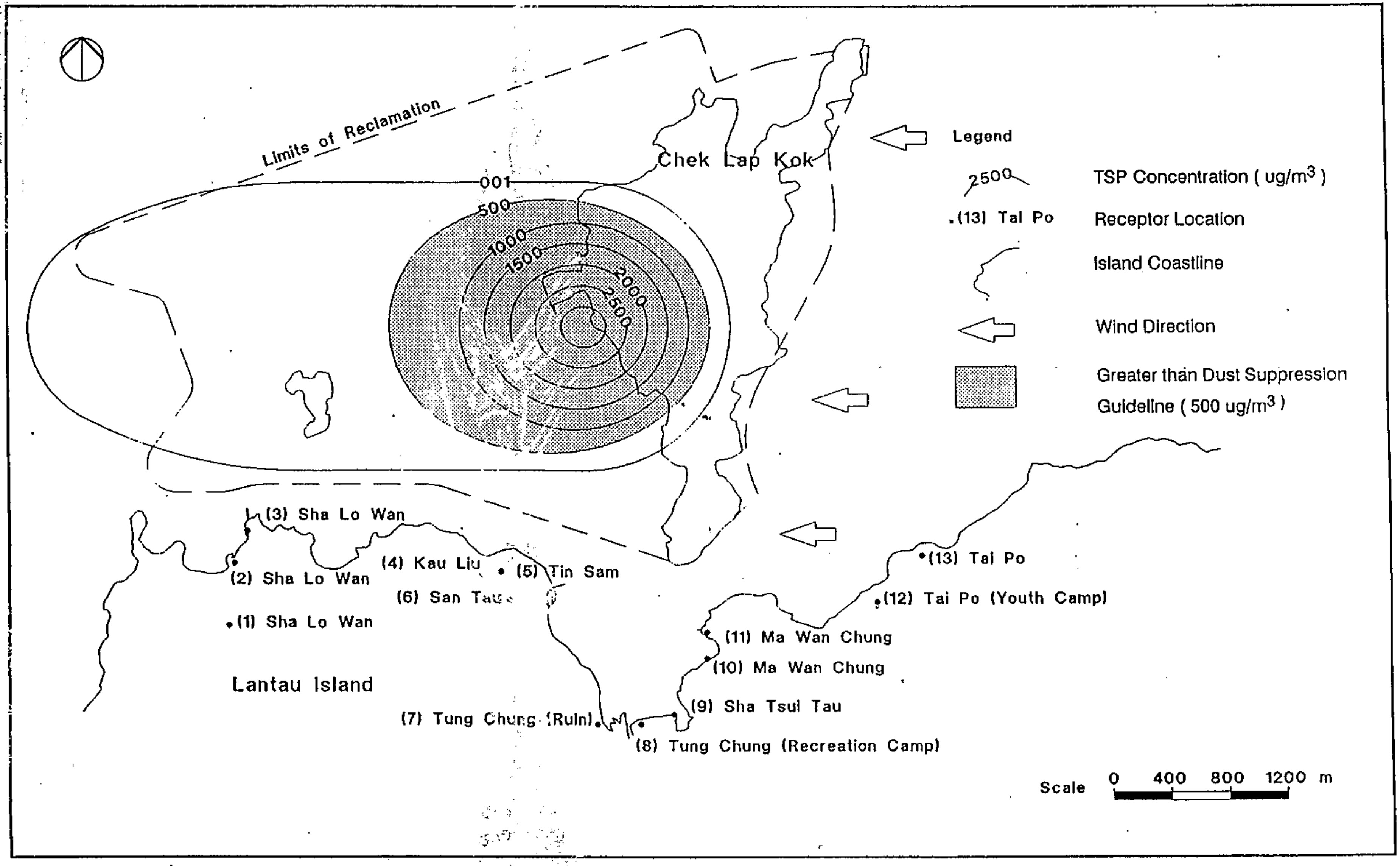
Quarter 2 One Hour Most Probable TSP from Excavation/Reclamation Operations **Exhibit 5.7**



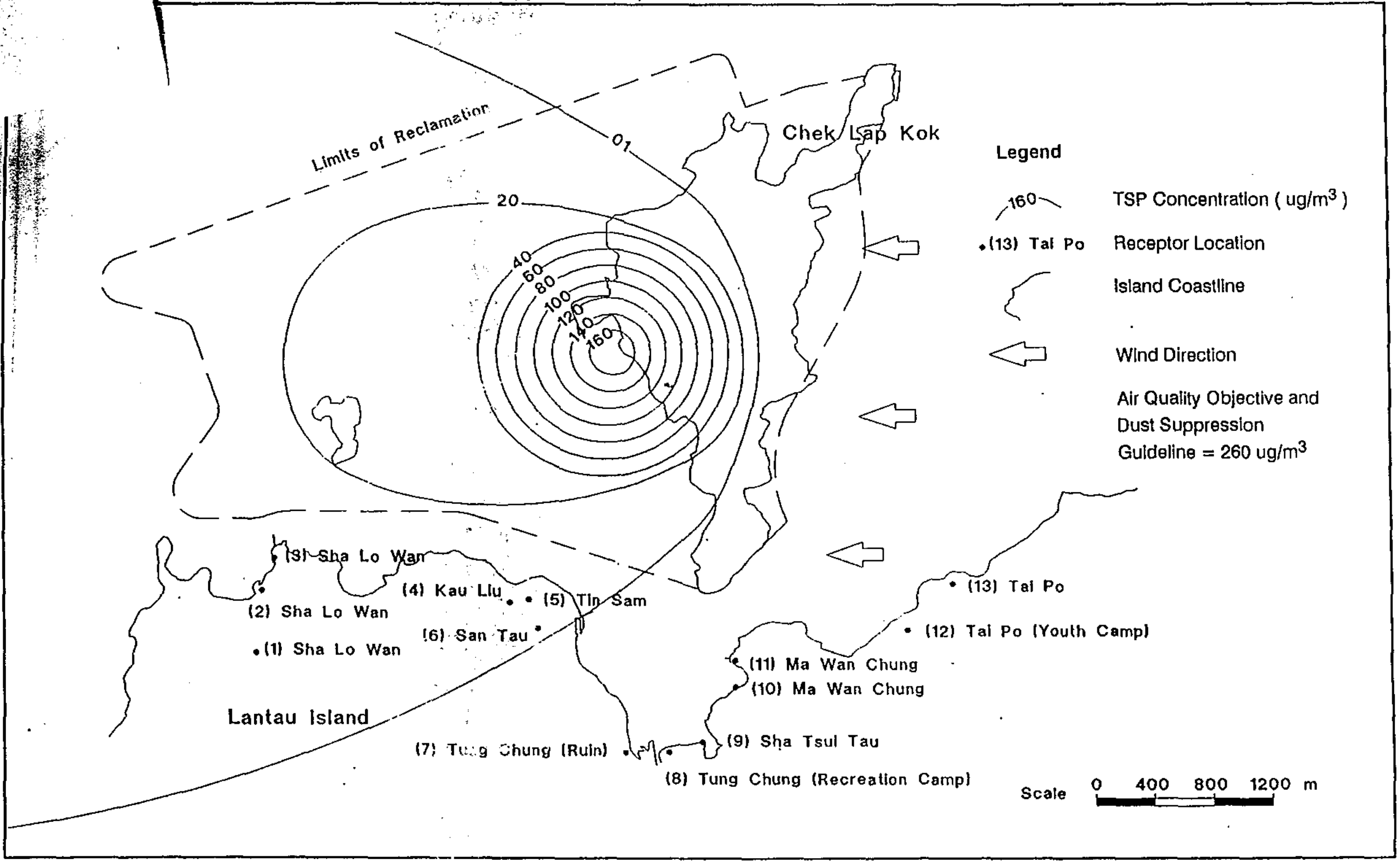
Quater-2 24-Hour Average Most Probable TSP from Blasting and Excavation/Reclamation Operations Exhibit 5.8



Quarter-2 24-Hour Most Probable RSP from Blasting and Excavation/Reclamation Operations *Exhibit* **5.9**



Quarter-7 One Hour Most Probable TSP from Blasting Operations Exhibit 5.10



Quarter-7 24-Hour Most Probable TSP from Blasting and Excavation/Reclamation Operations *Exhibit 5.11*

5.3.4 Asphalt and Concrete Plants

Other potential sources of dust associated with the airport construction project are asphalt and concrete plants. Conventionally, these plants produce pavement materials through either a "batch" or continuous process. Essentially, the process involves transferring aggregates, consisting of sand and gravel, from storage piles with conveyor belts or front end loaders to hoppers attached to the plant. From the hoppers, the material is weighted, screened and for an asphalt plant transported into a gas or oil fired rotary dryer to drive off any excess moisture. The material is then dropped into a mixer along with the asphalt or cement. The mix is then dumped into a truck and hauled to the job site.

Potential emission points for particulate matter from asphalt and concrete plants include (1) wind erosion over storage piles, (2) unloading of aggregate and cement into storage bins, (3) aggregate screening and drying operations, (4) mixing of the material and (5) the transfer of the mix into trucks.

Nearly all asphalt and concrete plants use dust collection equipment such as settling chambers, cyclone scrubbers and/or fabric collectors. The collected material is often returned to the dry aggregate load. Fugitive dust from aggregate storage piles is most effectively controlled when the moisture content is stabilized to approximately 5 percent by weight. Asphalt, a solid at ambient temperatures, is usually pumped from heated storage tanks and bulk cement should be stored in closed silos.

Preliminary plans call for two asphalt plants and three concrete plants to be located in the Advanced Works area of the airport site. Prior to operation, the plants will need to be reviewed and permitted by the Air Control Group of EPD in accordance with the Air Pollution Control Ordinance.

5.3.5 Construction Equipment Exhaust

Discharges from excavation and construction equipment exhausts are unavoidable during the airport site excavation/reclamation and construction process. These exhaust products include emissions of carbon monoxide, hydrocarbons, nitrogen oxides and particulate matter. Similar discharges will be associated with the operation of asphalt and concrete plant heating and drying units. These discharges can be minimised by the proper maintenance of equipment. Due to the distance between the work site and the nearest receptors on Lantau Island, these exhaust products are expected to disperse to nondetectable levels prior to reaching these areas.

5.4 Mitigation Measures

Similar to noise, the creation of dust during the airport site preparation project is unavoidable. Fortunately, the remote location of the project site and the prevailing wind patterns will limit the potential impacts at receptors on Lantau Island. Based on the ISC computer modelling results, the greatest potential impacts are limited to the initial construction period and when the wind is from the north over Chek Lap Kok. In particular, under these "worst case" conditions, the dust plume created by the blasting operations could unavoidably contribute heavily to elevated TSP levels along the coastline of North Lantau Island in the vicinity of Tung Chung, Sha Tsui Tau and Ma Wan Chung.

The SPC Contractor will at all times be required to minimise dust nuisance resulting from his non-blasting activities and shall keep available adequate plant including water bowsers and spray bars for this purpose, and in the absence of suitable rainfall any exposed area will be wetted down as far as is practicable to meet the Air Quality Requirements (AQRs). AQRs for the SPC and BICs will be defined as the Air Quality Objectives for TSP and RSP, and the EPD Dust Suppression Measures Guidelines. The Contractor will also be required to properly manage, to the extent possible, the blasting and excavation operations during periods of "worst case" meteorological conditions, when the wind is from the north over Chek Lap Kok, so as to minimise the generation of dust.

If AQRs are exceeded despite these mitigation measures, the Contractor will be required to identify the source of the dust generation and implement operational controls for activities, other than blasting, such as:

- Adjust his method of working to minimise the generation of dust.

- Limit, to the extent possible, the surface area of potentially erodible earth material exposed by clearing, grubbing, excavation, and fill operation.

- Place dust collectors on drill rigs.

- To the extent practicable: 1) treat material, which when handled is causing the AQR to be violated, with water or watering agent sprays prior to being loaded into a vehicle; and 2), for stockpiles of sand and aggregate, use water sprays to dampen stored materials and when receiving raw material as necessary.

- Where dusty materials are being discharged to vehicles from a conveying system at a fixed transfer point, a three-sided roofed enclosure with a flexible curtain across the entry shall be provided where necessary.

- Where necessary fit conveyor belts with windboards and conveyor transfer points and hopper discharge areas with enclosures to minimize emission of dust, and enclose all conveyors carrying materials which have the potential to create dust and install belt cleaners.

The SPC Contractor is likely to establish his principal site of operations in the vicinity of the AWC reclamation, but the BIC Contractors may well carry out activities at locations closer to sensitive receptors. For cement handling and batching in close proximity to sensitive receptors the following clauses will be mandatory:

- Store cement or pulverised fuel ash delivered in bulk in closed silos fitted with high level alarm indicators. Fit all air vents on cement silos with EPD approved fabric filters provided with either shaking or pulse-air cleaning mechanisms. The fabric filter area shall be determined using the air to cloth ratio (filtering velocity) of 0.01 to 0.03 m/s.

- For dry mix batching have the truck batching aperture shrouded and fitted with water suppression sprays.

5.5 Monitoring

High Volume TSP monitoring will be conducted by the Engineer at the closest downwind receptors on Lantau Island, namely the villages of Sha Lo Wan, Tung Chung and Tai Po. The monitoring will be undertaken to measure compliance with the AQRs.

6.1 Assessment Methodology

6.1.1 Airport Reclamation Configuration

In August 1990, two preliminary reclamation layouts for the airport were simulated using the Government's WAHMO tidal flow models in order to assess their large scale impact on existing tidal flows, siltation and water quality, and to determine any effects on local flow conditions which the model resolution might permit. Following these initial studies, the mathematical model of tidal flows in the North West New Territories was recalibrated using a large set of field data collected for this purpose for wet and dry season spring and neap tides.. The tidal conditions simulated in the studies as described in this report were therefore different to those simulated initially.

The recalibrated model was validated by simulating observed existing conditions, and then run to simulate the two final airport reclamation layouts, where one layout had an open channel between the airport reclamation and the North Lantau Development reclamation. The modelling was carried out by Port Works Division of Civil Engineering Services Department (CESD).

6.1.2 Flushing Channel

The resolution of the WAHMO model was too coarse to simulate flows in the proposed channel. In order to examine the impact an open channel between the airport reclamations and North Lantau would have on tidal flows, siltation and flushing of East Tung Chung Bay, a separate assessment was carried out. In the absence of any field data and without the help of any high resolution mathematical models, the assessment had to be based on the existing bathymetry in the area and the expected behaviour of the local marine muds in tidal flows together with the results from the relatively coarse resolution (300m) mathematical models.

6.1.3 Sediment Dispersion from Dredging and Dumping Operations

A large amount of dredging and disposal of soft marine muds and dredging for fill material will be required during the construction of the airport. During these dredging and dumping operations fine sediments will be lost to suspension in the water column; either unavoidably as a result of the dredging activities themselves or as a result of overflowing of barges to wash fine sediments from fill material.

The sediment lost to the water column will be carried by the tidal currents and could be dispersed over a large area before settling on the sea bed. Depending on the dredging or dumping site, local sensitive areas such as beaches, fish culture zones and water supplies for existing users could be affected by increased suspended solids for the duration of the work.

The main dredging of spoil would take place at the airport site, although dredging of overburden from the borrow areas would also be required. Other than at South Cheung Chau, the main spoil dumping grounds expected to be used during the airport construction are exhausted marine borrow areas, including the worked out pits at the entrance to Deep Bay. Several sources of fill have been identified including Outer Deep Bay (Deep Bay), Urmston Road and The Brothers, as previously shown on Exhibit 2.2. It was important to determine the fate of the sediment lost to suspension at each site. In order to do this, use was made of existing mathematical models of tidal flows and sediment transport and a new high resolution sediment plume model was applied.

a) Mathematical Models

The WAHMO two-dimensional depth averaged model and the North West New Territories two-dimensional two-layer model of wet and dry season tidal flows were employed to provide the basic water movement data to the WAHMO model of suspended sediment transport and a new sediment plume model.

The sediment plume model was designed to simulate relatively narrow sediment plumes which can be generated during dredging and dumping operations. It has a higher resolution than the tidal flow models which provide the water velocities in order to resolve the suspended sediment concentrations which, in many circumstances, vary more rapidly than the tidal velocities. Having a higher resolution, it is most applicable to situations where the sediment is not dispersed over a large area but where there may be local sensitive areas to be examined and fine detail is required. For the sites where large tidal excursions are found and the sediment is dispersed over a large area, the WAHMO sediment transport model was more useful and was applied.

b) Sediment Losses

Based on research at Hydraulics Research Ltd involving field experiments the losses during dumping operations were estimated at 5 percent of the total mass dumped. Based on initial information provided by the dredging engineers, it was assumed that losses during dredging by grab dredgers would be 3 percent of the wet mass dredged while losses from trailer dredgers would be 5 percent of the wet mass dredged. In order to convert these losses to a rate of loss of dry mass of sediment, it was necessary to use available information on the density structure of the marine muds at the dredging sites. These data came from an analysis of bed samples and previous in-situ measurements made using a radio-active transmission probe during field work carried out for the PADS Study (1990). Data from bed samples indicated that the material available for fill could typically be assumed to have a 30 percent fines content which would have to be reduced to 10 percent by overfilling and washing the fines back to the water column at the borrow area.

Data on the programme for dredging, including dredger capacities, likely dredging rates and numbers of dredgers of different types which would be required, were provided by the dredging engineers. Based on this information and the assumptions outlined above, it was possible to determine sediment losses for the range of dredging operations anticipated.

Following completion of the Revised Dredging and Filling Programme combined cycle operations with dredging for fill and spoil dumping both being carried out simultaneously at The Brothers and Deep Bay were simulated as a potential "maximum activity" case. Sediment losses simulated were 68.8 kg/s at The Brothers and 30.5 kg/s at Deep Bay. The sediment plumes from each site would tend to overlap and it was considered important to examine the combined loss rate of 99.3 kg/s, which represents over twice the previous loss rate simulated.

In practice, most sediment disturbed during dredging of spoil will occur near the bed with sediment being distributed over the water column. Much of this sediment, especially that lost near the bed, will be re-deposited on the bed relatively quickly. In order to examine "worst case" conditions, however, it was assumed that all losses would occur near the water surface which would keep the sediment in suspension longer. This would be realistic for dumping operations and for washing of fines from fill material but would result in an overestimate of the dispersion of sediment lost during dredging of the marine muds.

6.2 Hydraulic Impacts

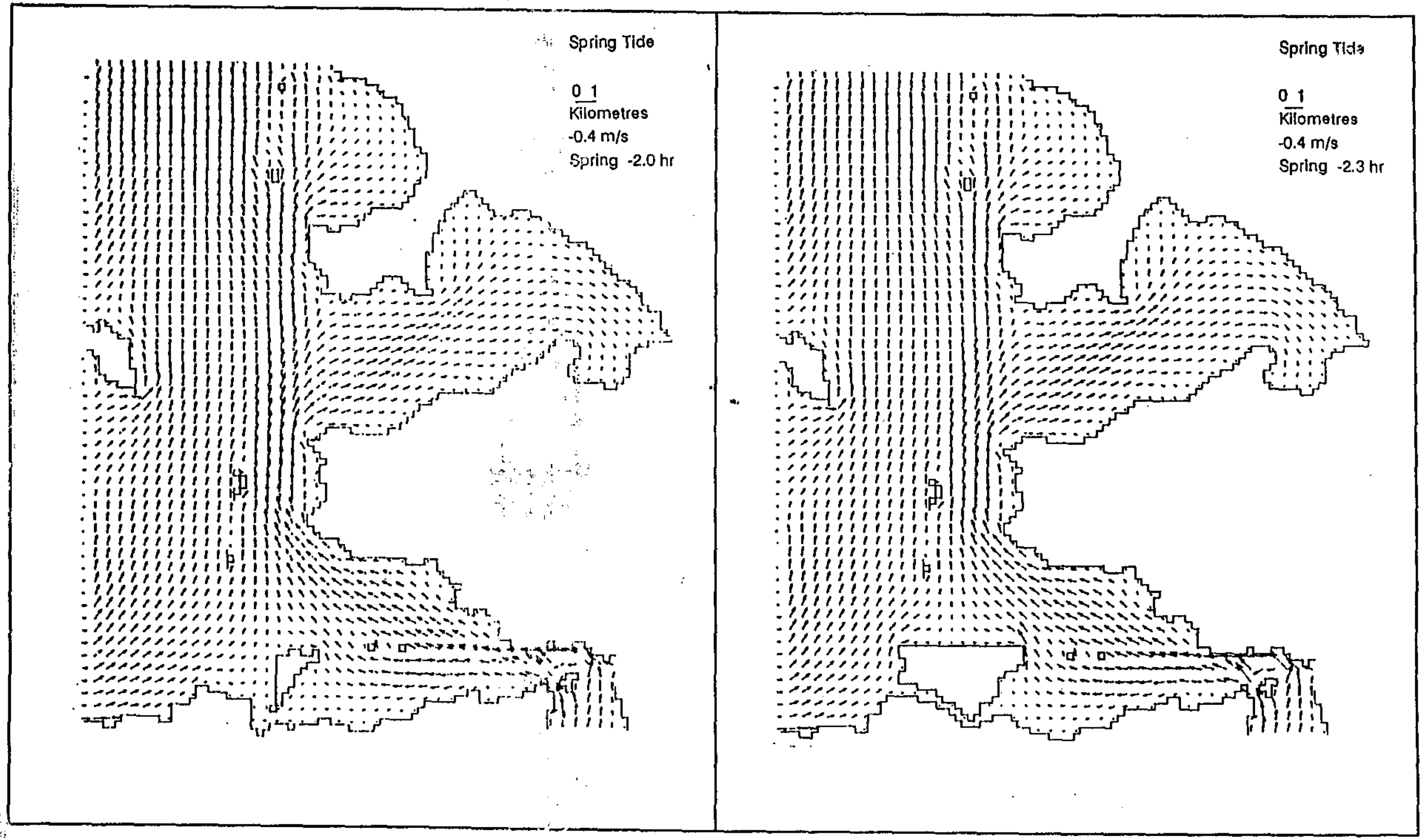
6.2.1 Airport Reclamation Configuration

The final revised airport reclamation configuration was very similar to the maximum reclamation previously simulated. The revised reclamation simulated extended further westward at its northern limit than the previously simulated maximum reclamation. From examination of the layout, it was not considered that its impact on existing large scale tidal flows would be significantly different from that of the maximum reclamation previously examined.

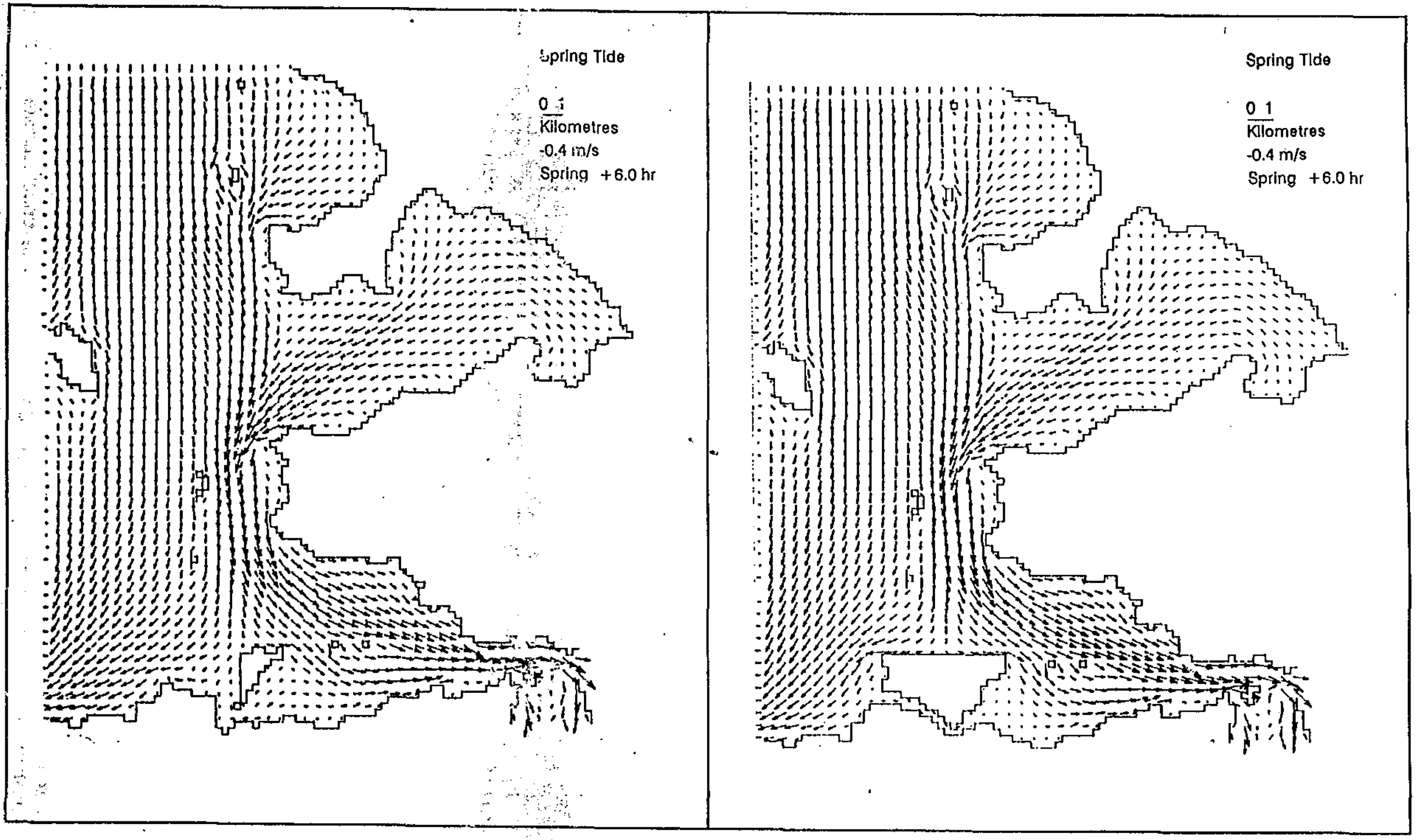
As in the initial study, in order to examine the effects of the reclamations on tidal flows, water velocities over the tides simulated were plotted at various points within the study area. It was found that the reclamation had little impact on flows remote from the reclamation, such as at Urmston Road or Ma Wan Gap as shown on Exhibits 6.1 and 6.2.

As before, however, significant increases were predicted in the channel between West Brothers Island and the reclamation as a result of constricting the flow. The model resolution did not allow detailed examination but increases in speeds of around 100 percent were predicted which would result in local erosion of any soft marine muds. This erosion would continue until either the water velocities reduced to stable values or inerodible bed material was exposed.

To the west of the reclamation, flows locally were predicted to reduce significantly (from 0.8m/s on wet season spring tides to around 0.2m/s) which could result in increased siltation locally and, should any pollutants be introduced into this area, a reduction in tidal flushing and hence local water quality.



Wet Season Spring Tide: Peak Flood Velocities with and without the Airport Reclamation Exhibit 6.1



Wet Season Spring Tide: Peak Ebb Velocities with and without the Airport Reclamation *Exhibit* **6.2**

As in the initial study, velocities in East Tung Chung Bay were predicted to reduce significantly from their existing low values which would result in increased siltation and a possible reduction in water quality.

These relative changes to the flow patterns were reflected in both wet and dry seasons and on spring and neap tides. Overall, the final reclamation would have a similar impact to that of the maximum reclamation examined previously.

The resolution of the model did not allow an accurate simulation of the open channel between the airport and the North Lantau reclamations. As a result, the tidal discharges which would pass through such a channel will have been underestimated. Consequently, it was not possible to identify the impact of the open channel on the simulated tidal flows locally. In order to examine the effect of leaving an open channel, additional desk studies were carried out and are described below.

6.2.2 Flushing Channel

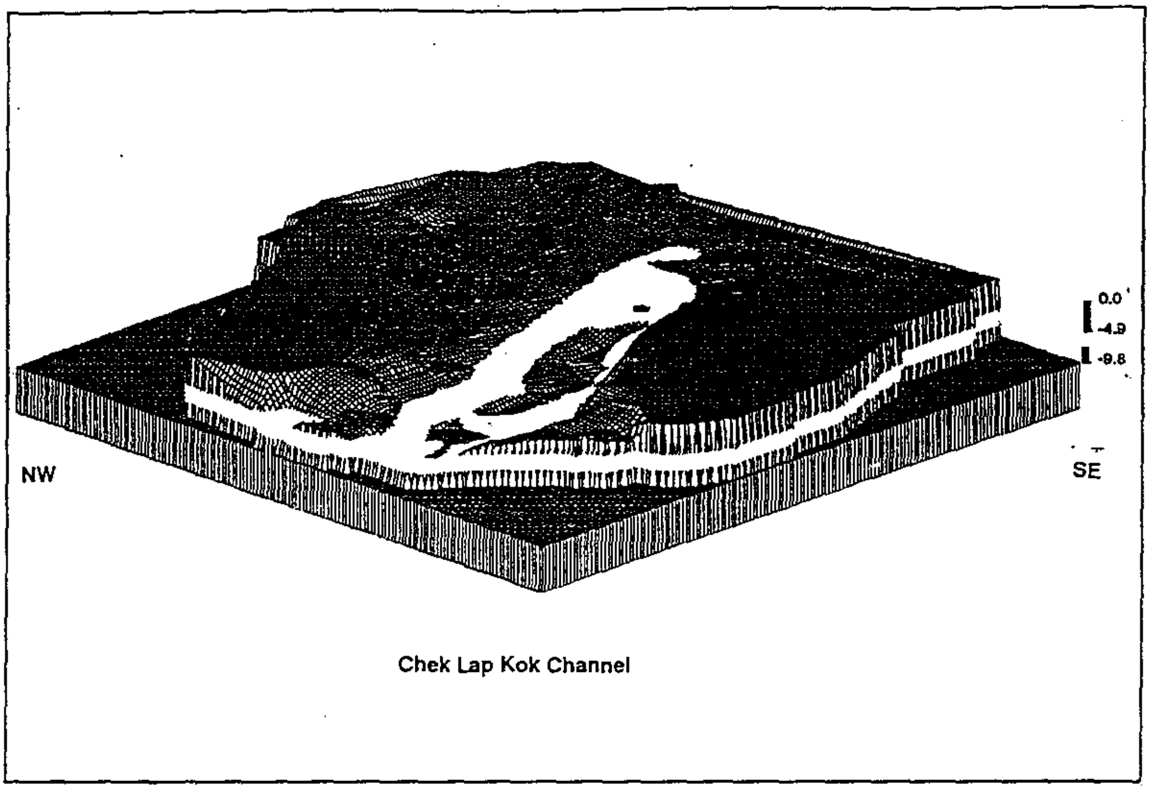
For many estuaries with mud beds, including the Pearl River Estuary, the patterns of deposition and erosion and peak tidal flows are such that, in the main flow channels, water depths adjust naturally as a result of deposition and erosion to result in peak (depth averaged) tidal speeds of the order of 1m/s. In areas where peak velocities are observed to exceed this value by a significant amount, the soft mud deposits will probably have been removed completely leaving a more consolidated or inerodible bed exposed which prevents further erosion and deepening of the flow channels.

Available bathymetric data depicted on Exhibits 6.3 and 6.4 showed that between Chek Lap Kok and North Lantau, there exists a relatively deep area approximately 9m below datum. Additional data on the bed sediments showed that while relatively thick mud deposits are found immediately to the East (20m) and West (8m) of Chek Lap Kok, no soft marine muds were present in this deeper area. This suggests that existing tidal flows of the order of 1m/s should be encountered in the existing narrow channel and that the existing tidal flows would probably have the capacity to further erode the bed if soft marine muds were present.

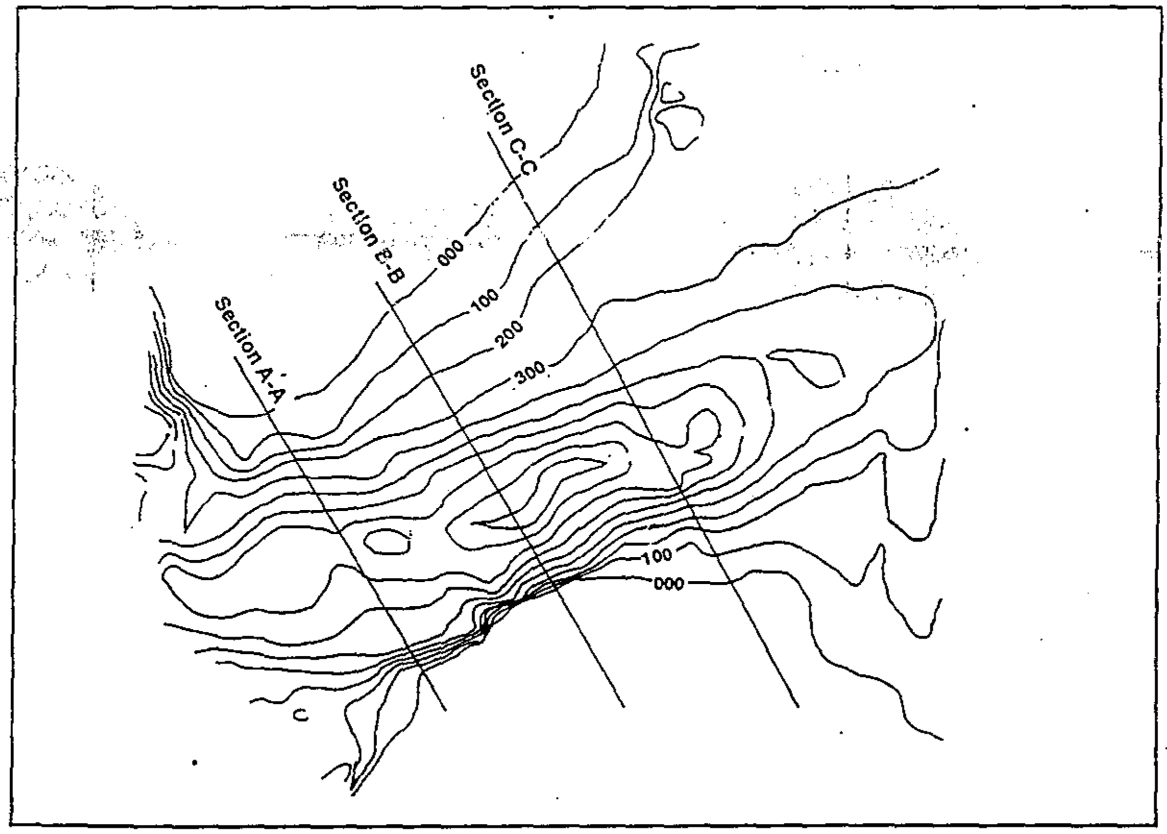
No observations of the water velocity were available in the channel to the south of Chek Lap Kok and so some preliminary results from the existing North West New Territories WAHMO mathematical model were examined. It should be noted that the model used a 300m grid and so the resolution of the channel would be poor. In such cases, it is to be expected that the model will underestimate tidal discharges. However, the model results for a dry season spring tide indicated discharges as follows:

Peak Flood Discharge	630 cumecs (east->west)
Peak Ebb Discharge	1150 cumecs (west->east, main ebb)
	590 cumecs (west->east, small ebb)
Tide Averaged Discharge	170 cumecs (west->east)

A plot of the local water depths (assumed relative to low low water) is shown on Exhibit 6.4. This, on Section B-B, assuming that the depth mean velocity varies with the square root of the depth across the section (a good approximation assuming the water surface is horizontal across the section), resulted in a peak ebb velocity of approximately 0.7m/s in the deepest areas for a discharge of 1150 cumecs. The calculation was based on one particular tide, on a probable underestimate of the peak discharge and did not take into account the curvature of the flow around southern Chek



Chek Lap Kok Channel - Existing Bathymetry **Exhibit 6.3**



Chek Lap Kok Channel - Depth Contours in 100 Metre Intervals **Exhibit 6.4**

Lap Kok which could accelerate the flow in the deeper section. This expected underestimated peak speed of 0.7m/s for a large spring tide, therefore, was not inconsistent with an anticipated peak speed in this area of the order of 1m/s.

The residual discharge given above was calculated on a single 26 hour spring tidal cycle and it was found that the residual flow was from west to east. On different tide types in the wet and dry season, it would be expected that the tidal residual flow will change in magnitude and possibly direction. The bathymetry, however, with the shallower area to the east where bed mud thicknesses are greatest, could be consistent with a persistent residual flow from west to east.

The predicted residual discharge is equivalent to a total daily volume of approximately $15Mm^3$. This discharge is equivalent to a volume of water covering the entire bay to the east of Chek Lap Kok ($6Mm^2$) to a depth of 2.5m, very roughly the natural depth of this area. The tidal mixing and flow patterns in this shallow area will be relatively complex and the residual flow will not just replace this volume of water each day. However, this simple analysis did suggest that the shallow area to the east of Chek Lap Kok is in fact quite well flushed by the flows coming around the south of the island at present. Provided flows of this order of magnitude and the existing water quality in the area to the west of the airport site are maintained, water quality conditions and siltation patterns following construction of the reclamation should not change significantly unless new effluent loads are introduced to the bay. It will therefore be important to ensure that no polluted flows are discharged into this area.

6.2.3 Sediment Dispersion and Deposition

The sediment transport and sediment plume models were used to simulate several different dredging and dumping operations including:

- Dredging mud at the airport site (2 cases) and in the Urmston Road (1 case)
- Dredging for fill in the borrow areas (4 sites)
- Dumping of spoil (4 cases)
- Combined cycle dredging of mud and fill plus spoil dumping (1 case)

It was found that :

- Dredging at the airport site shown on Exhibit 6.5 would have a small impact (generally less than 10 mg/l) on far-field suspended solids concentrations when taken in the context of the natural background variability. Tidal currents at the site are such that much of the sediment losses would be re-deposited locally as shown on Exhibit 6.6 and probably re-dredged.

- Dredging of overburden in the Urmston Road just off Castle Peak Power Station resulted in the sediment losses being dispersed over a large area as a result of the large tidal excursions in this area. Locally, concentrations would increase by the order of 10 mg/l in a narrow plume close to the dredger with lower concentration increases over a wider area.

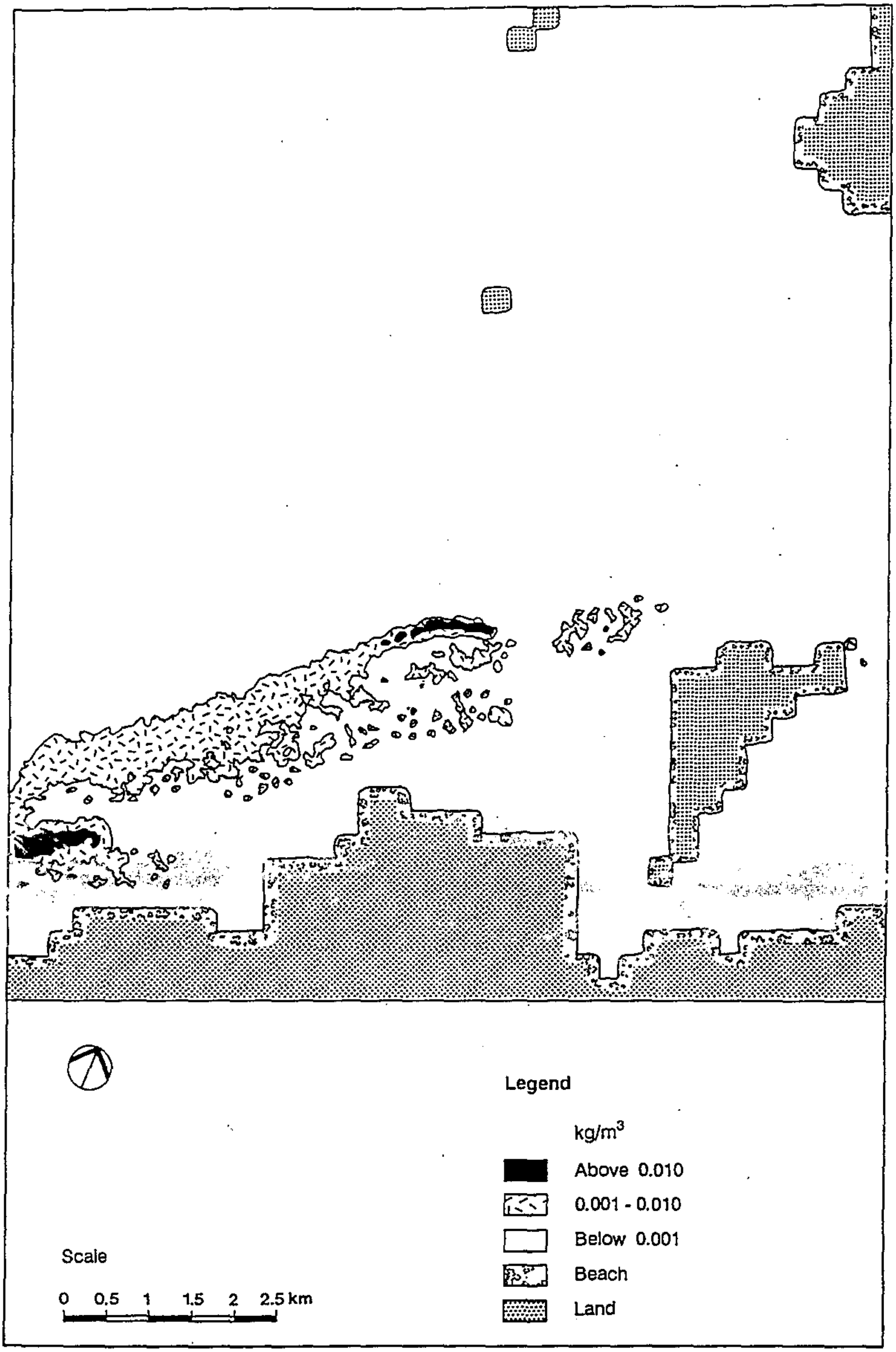


Exhibit 6.5

Four Trailer Dredgers Operating at Chek Lap Kok - Surface Sediment Concentrations at LLW

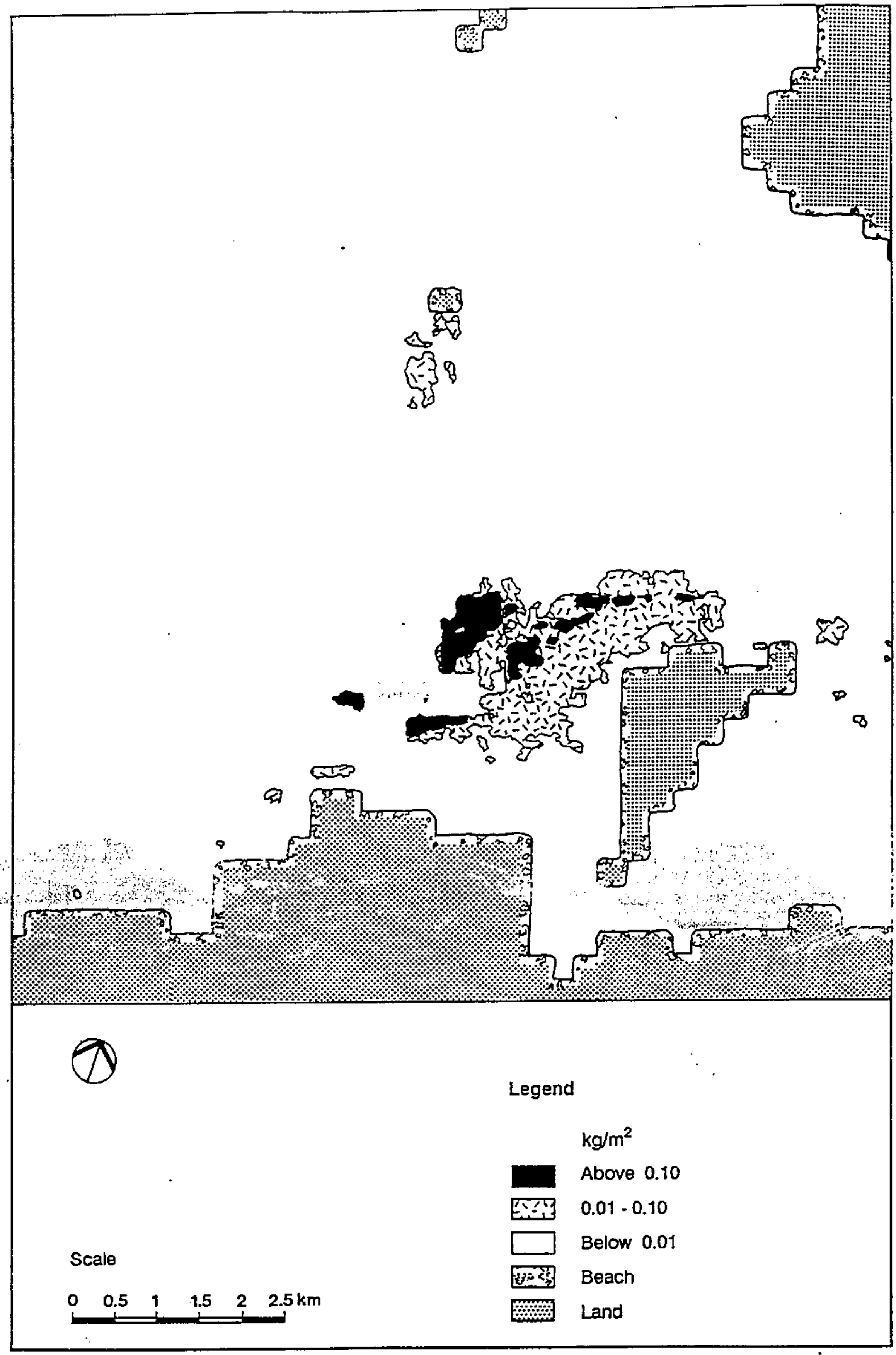


Exhibit 6.6

Four Trailer Dredgers Operating at Chek Lap Kok - Sediment Redeposition

- Dredging for fill and washing the fines from the natural material would result in the greatest rate of sediment input to the water column. Sites were examined at Deep Bay, Urmston Road and The Brothers. In all cases, the sediment losses were dispersed over a large area at low concentration. Exhibit 6.7 illustrates the results of dredging for fill in the northern part of the Deep Bay borrow area. At the Urmston Road site just off Castle Peak it was found that the dredging activities would increase suspended solids concentrations by the order of 30 mg/l, which would double the mean concentration in the lower layers of the water column.

- Spoil dumping in disused borrow pits at the entrance to Deep Bay was examined. Wet and dry season simulations were carried out to determine which tidal conditions could result in the worst conditions in the local water body. The highest dumping rate expected was then simulated and it was found that, again, the sediment losses were rapidly dispersed over a large area at low concentration as illustrated on Exhibit 6.8.

- Combined cycle operations involving dredging mud and fill while spoil dumping in exhausted borrow pits was examined. Overall loss rates were greatest and the sediment plumes from the different dredging sites overlapped. The simulations examined a dry season tide which was expected to keep the sediment in suspension and to disperse it over a large area. It was found that the higher loss rates simulated resulted in higher concentrations local to the dredging sites but, in the larger scale and in the vicinity of the known sensitive areas, suspended sediment concentrations were similar to those previously simulated when examining each site in turn.

The impacts of sediment dispersion in terms of water quality and its effect on sensitive receivers in the vicinity of the airport and borrow areas is considered in Section 7.

In all the simulations, the models were run to simulate several successive tides in order to allow the sediment plume to become established. Sediment could settle to the sea bed and, if flow conditions allowed, be subsequently re-eroded. It was necessary to simulate several tides to allow this re-working of the sediment losses and to identify any areas subject to net deposition. In all the simulations, net areas of accretion were identified usually in the shallower coastal areas as shown on Exhibit 6.9 or, for example, on Chek Lap Kok Bank or in the airport site as shown on Exhibit 6.10.

Considering the near coastal waters at Castle Peak when dredging for fill immediately nearby in the Urmston Road, deposition rates were predicted to average approximately 0.05kg/m^{2}d. Using the dry density of the bed material (488 kg/m^3) and assuming the same deposition rate throughout a year results in a predicted increase in siltation rates of approximately 30mm per year.

It is expected that in the near coastal zone the model will underestimate water velocities because of the lack of resolution of the 300m grid. The model, in addition, did not include the reduction in deposition rates which can be expected as a result of wave activity in shallower waters. Both these factors lead to the model over-predicting siltation rates. The sample calculation has been carried out for the dredging activity which would result in the largest impact at Castle Peak. The predicted deposition rate of 30mm per year is considered to be negligible in comparison to the natural variability in siltation rates which occur.

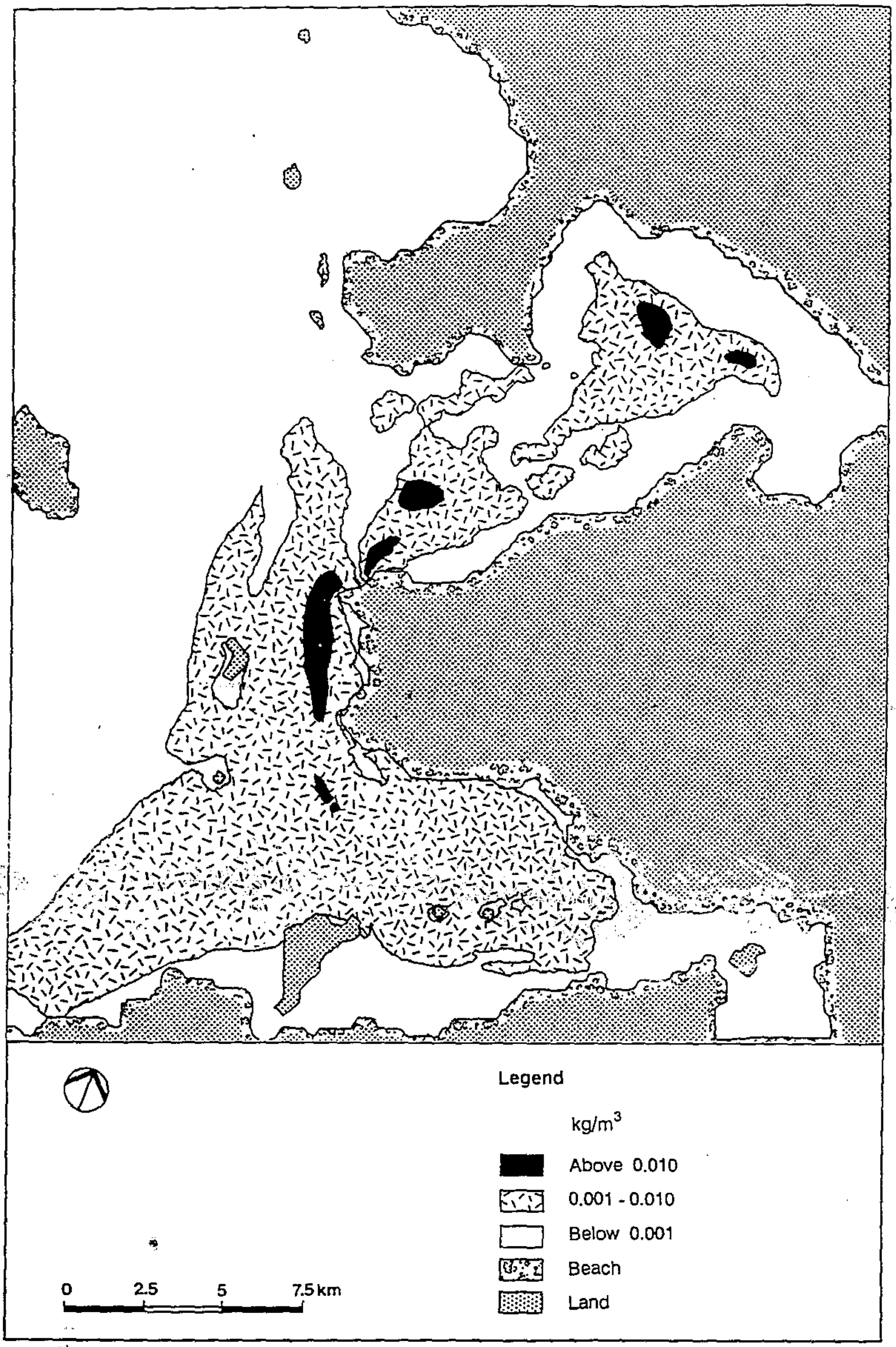


Exhibit 6.7
Dredging for Fill in Deep Bay - Surface Sediment Concentrations at LLW

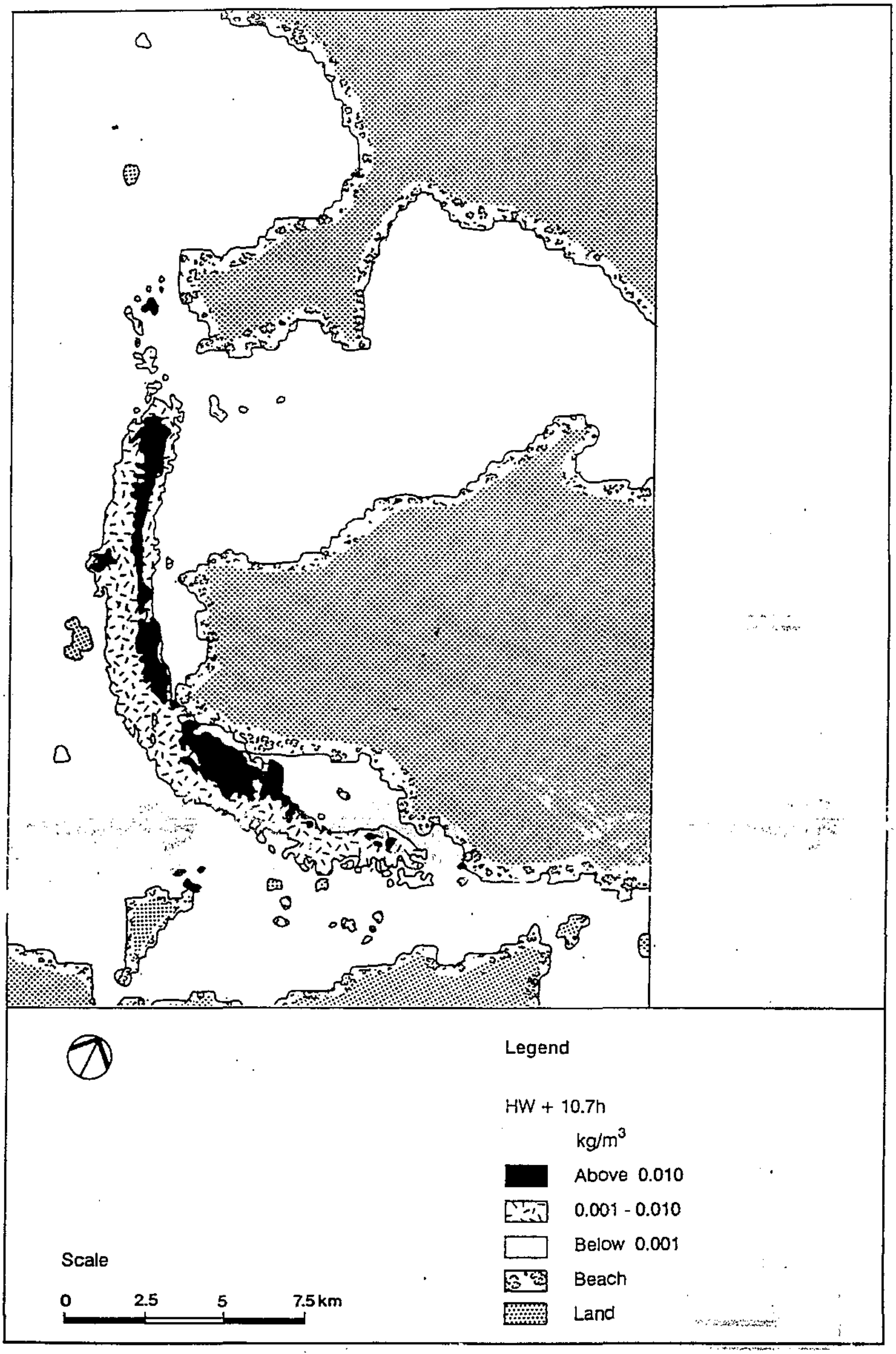


Exhibit 6.8

Worst Case Spoil Dumping at the Entrance to Deep Bay - Sediment Concentrations in the Lower Layer at LLW

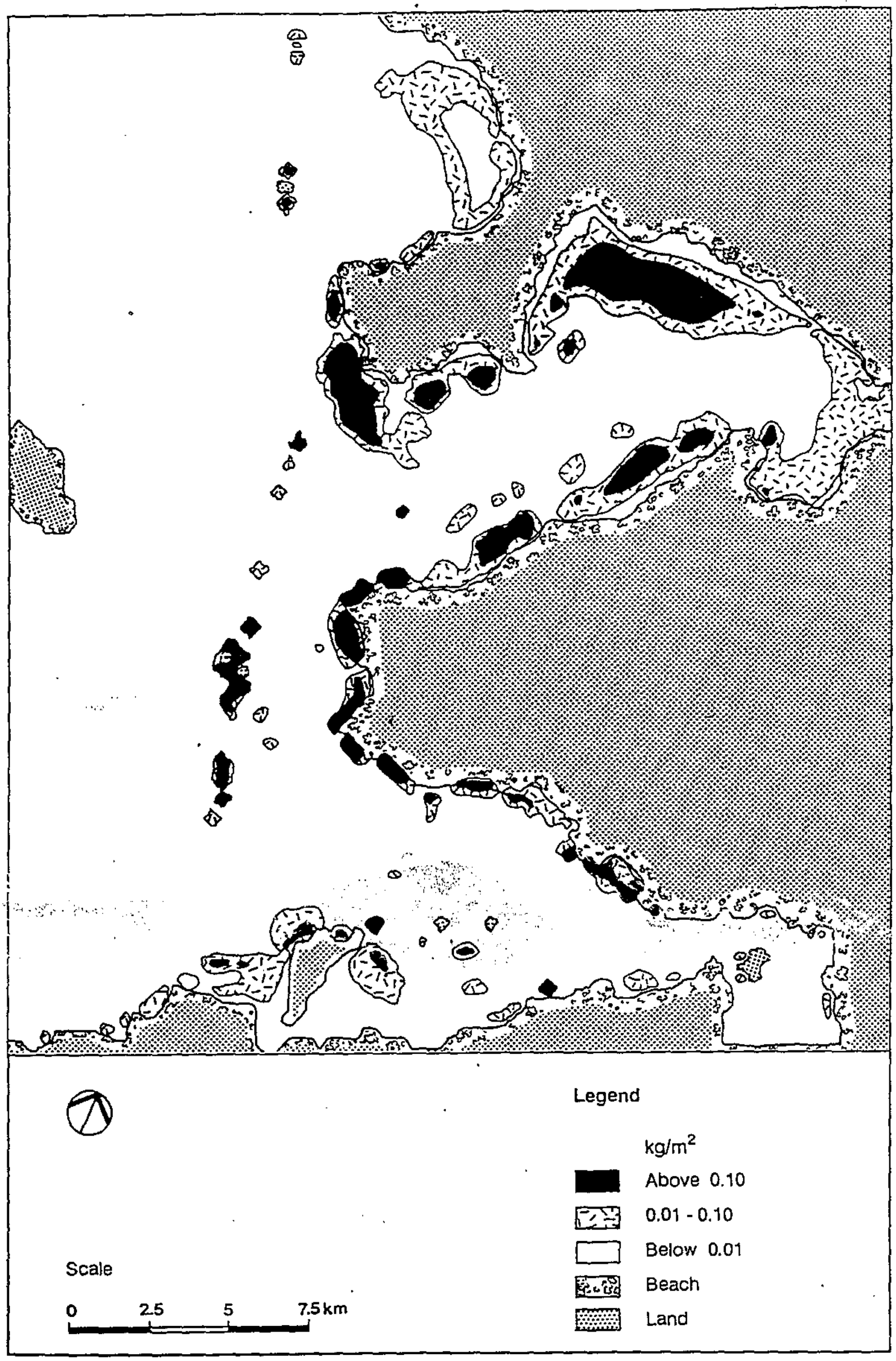


Exhibit 6.9
Dredging for Fill in Deep Bay - Sediment Redeposition

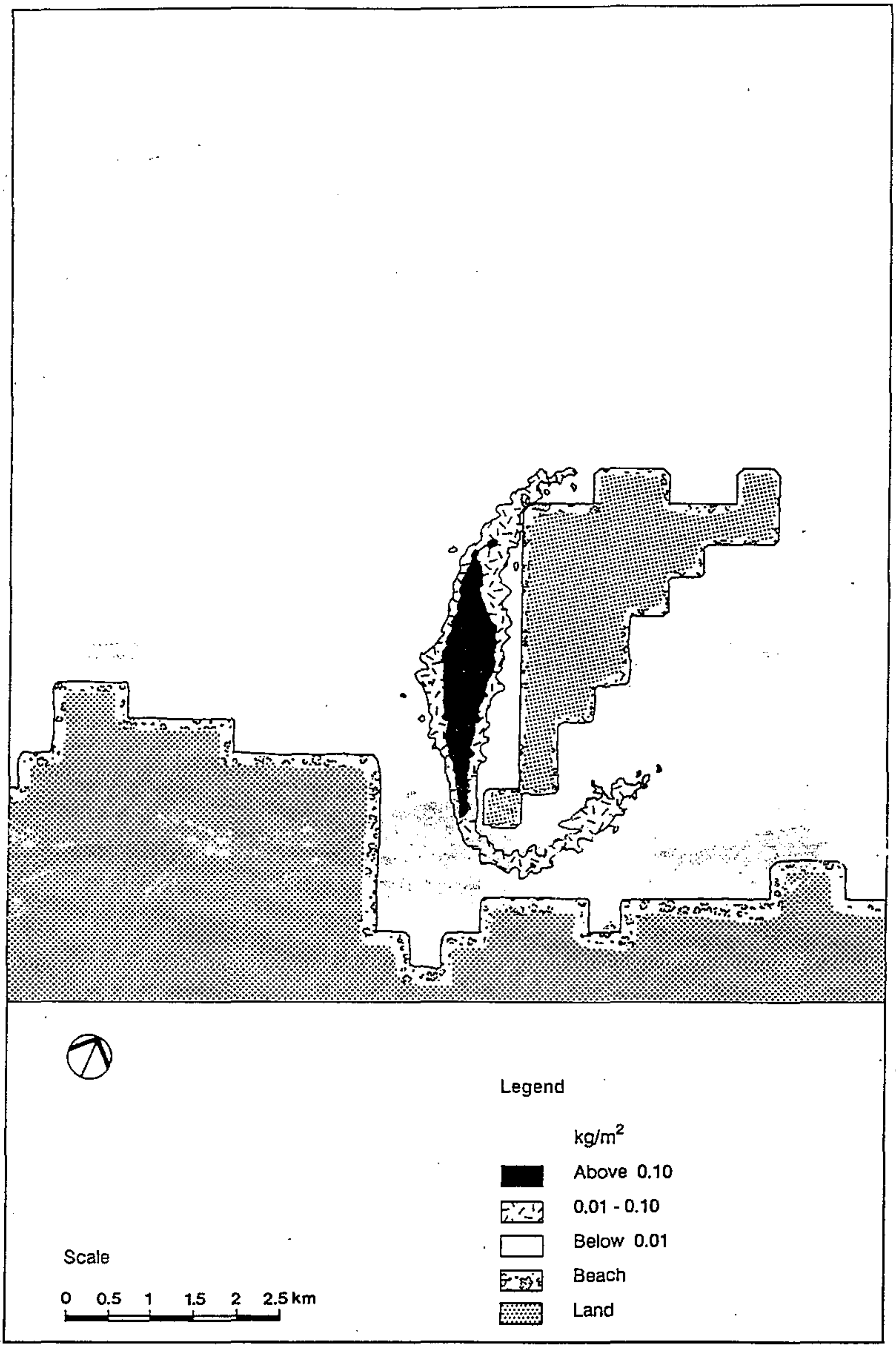


Exhibit 6.10

Three Grab Dredgers Operating at Chek Lap Kok - Sediment Redeposition

6.3 Mitigation Measures

6.3.1 Airport Reclamation Configuration and Flushing Channel

The analysis of the impact of an open channel was based on results from a single tidal simulation using a coarse grid mathematical model, inferences drawn from existing bathymetric and bed sediment data, and the approximate relationship between peak tidal currents and equilibrium water depths in a muddy estuary such as the Pearl River Estuary. On this basis, it appeared that the existing open channel between Chek Lap Kok and North Lantau will experience peak water speeds of around 1m/s and will carry sufficient tidal volumes to flush East Tung Chung Bay efficiently for the existing water depths in the bay.

In order to minimise the impact of the airport reclamations on existing siltation patterns and water quality in East Tung Chung Bay, it was concluded that an open channel which could maintain tidal flows and water speeds similar to those at present would be beneficial. Maintaining the water speeds would also inhibit deposition of suspended sediments and siltation of the channel would not be a problem. Maximum natural water depths in the main channel between Chek Lap Kok and Lantau Island are of the order of 9m below low low water and the channel has a flow area of approximately 1700m^2. The existing channel is significantly shorter than the one proposed following the reclamation. An artificial channel which will maintain flow areas and water depths as at present is considered to be acceptable, providing that no additional effluent loads are introduced.

A study to determine the required channel configuration has subsequently been carried out by the North Lantau Development consultants, and a flushing channel has been included in the reclamation layout plan for the New Town development.

6.3.2 Sediment Dispersion and Deposition

The potential impacts and recommended mitigation measures relating to sediment dispersion are detailed in Section 7.

7.1 Assessment Methodology

7.1.1 Identification of Sensitive Receivers

The site for the proposed airport lies within the EPD's North Western Waters Zone (NWWZ). The water quality in the zone is influenced by a number of factors, significant among them being discharges and activities in the zone itself and the quality of the adjacent water bodies. These are the Pearl River at the western edge and to the south, Deep Bay to the north, Victoria Harbour and the Western Buffer Zone in the east. Within this and the adjacent Western Buffer Zone there are a number of identifiable areas or users (sensitive receivers) that could be affected by changes in water quality. These are shown on Exhibit 7.1 and include:

- Castle Peak Power Station
- Gazetted Bathing Beaches : Butterfly, Castle Peak, Kadoorie, Old and New Cafeteria, and Anglers
- Non-gazetted Bathing Beaches : Yuen Long and Upper and Lower Lung Kwu
- Fish Culture Zones at Tung Chung and Ma Wan.

The area proposed for the reclamation site will include the present Tung Chung fish culture zone. The mariculturalists in Tung Chung are to be given the opportunity to relocate and some are expected to move their operations to the Ma Wan fish culture zone.

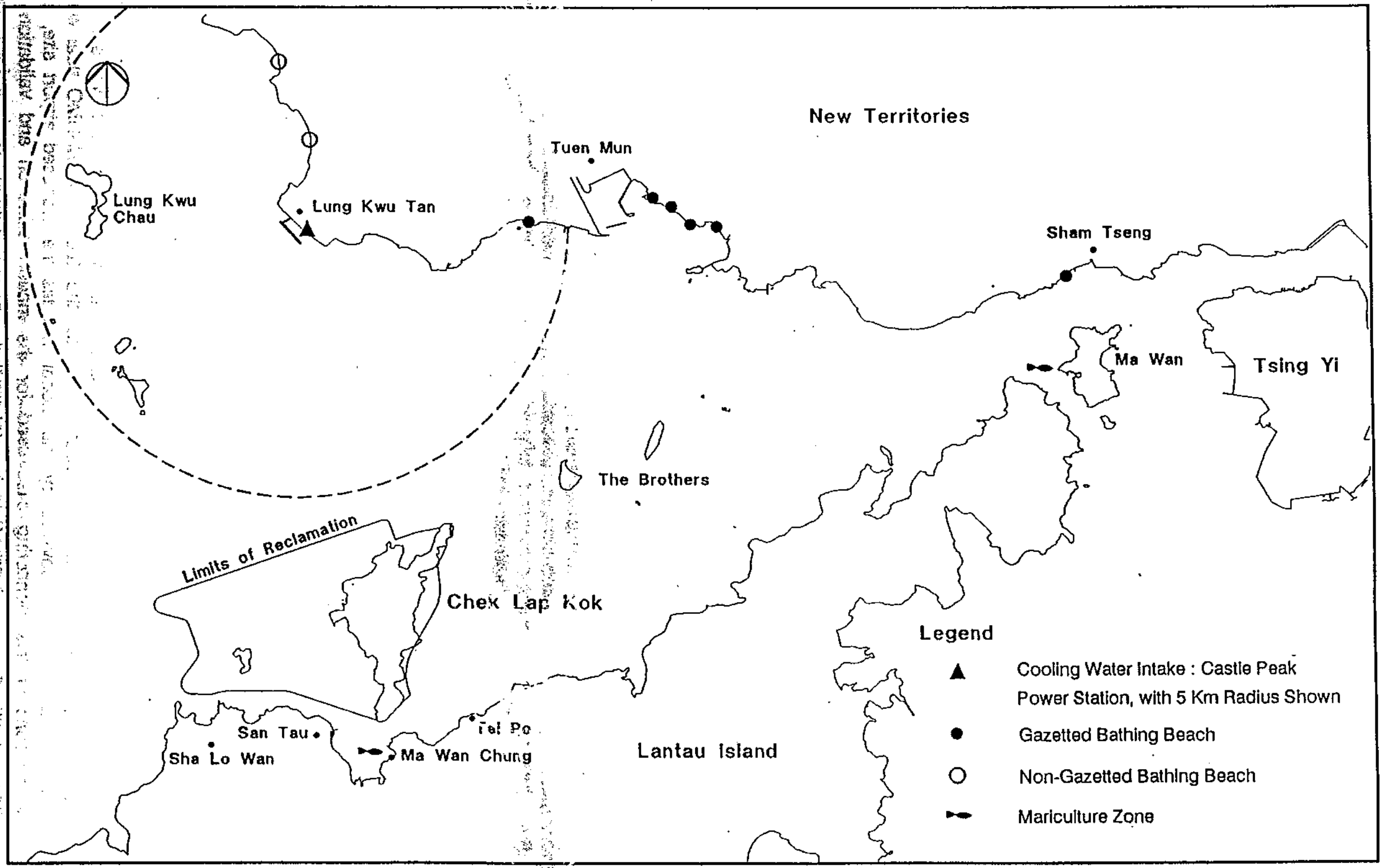
Beyond the NWWZ, the oyster culture beds around the margin of Deep Bay represent a further group of sensitive receivers which should also be considered in relation to the dredging and spoil disposal activities which may take place in the Urmston Road and Deep Bay. Inner Deep Bay and Mai Po Marshes are classified as Sites of Special Scientific Interest (SSSI).

Clearly any consideration of impact on water quality should consider the specific impact on these identifiable users in addition to the broader impact on the area as a whole.

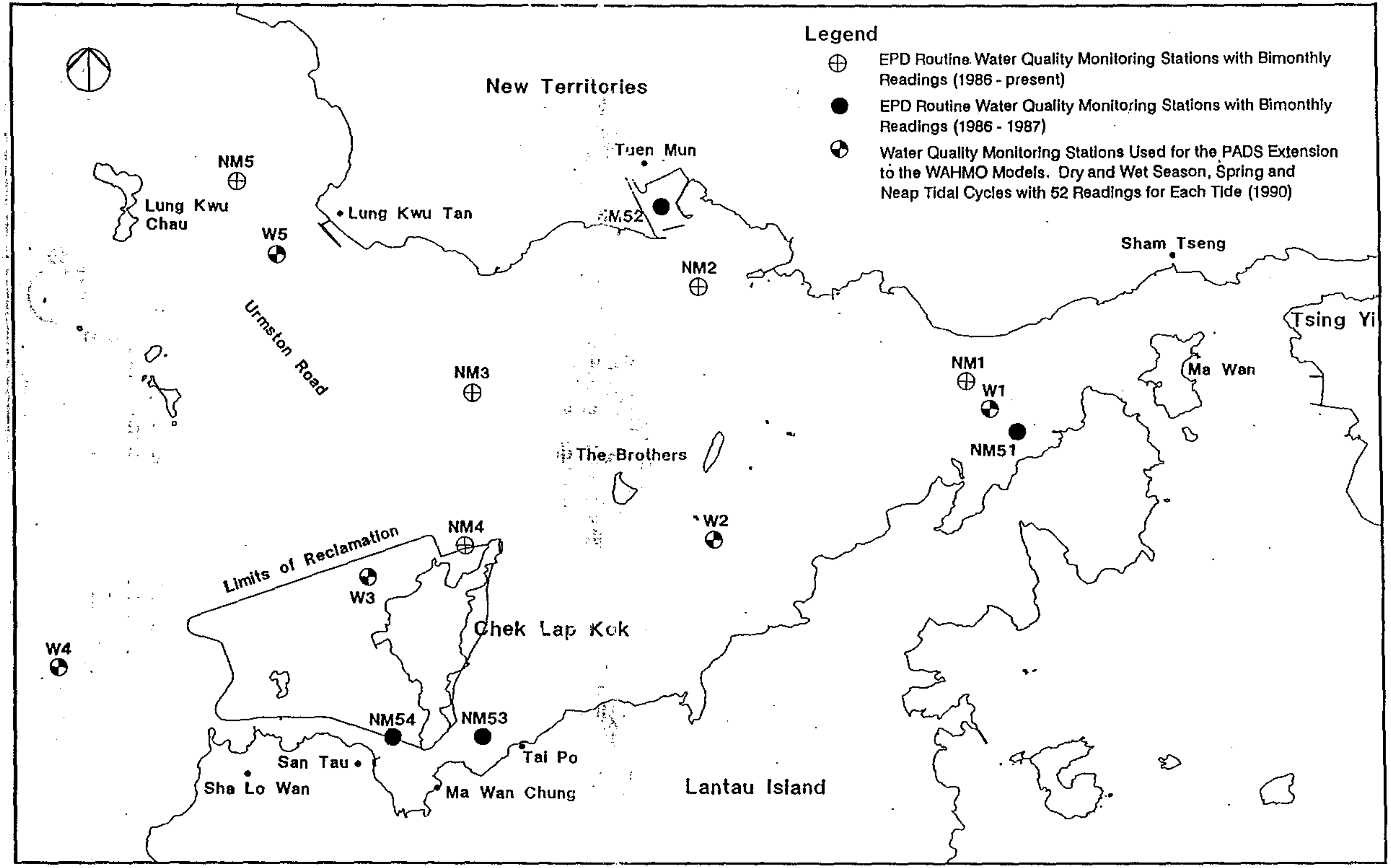
7.1.2 Sources of Existing Water Quality Data

Marine water quality has been monitored by EPD since 1986. As part of their routine bi-monthly marine water quality survey programme a number of locations within the NWWZ have been monitored and data on a range of water quality parameters collated; summaries of these data are published annually by EPD. The locations of the monitoring stations are shown on Exhibit 7.2. The annual reports and the listings of the raw data held in EPD water quality archives have been used, with other data, to establish the present water quality conditions.

In addition to EPD's bi-monthly sampling programme, intensive tidal cycle water quality data have been collected during spring and neap tides in both the 1990 wet and dry seasons to provide calibration and validation data for the 300m grid WAHMO tidal water quality model. The area covered by this model includes the proposed airport site, and the locations of the monitoring sites used for the model calibration and validation as shown on Exhibit 7.2. The EPD data and the WAHMO model validation data have been used



Location of Water Quality Sensitive Receivers in North Western Waters *Exhibit* 7.1



Location of Water Quality Monitoring Stations for which Data are Available *Exhibit* 7.2

to establish the baseline water quality in terms of the annual range and mean values and also the variation within the tidal cycle.

7.1.3 Mathematical Modelling

Several mathematical models have been used to investigate the potential impact on various aspects of water quality, including sediment transport and dispersion models as described in Section 6 and a two-layer tidal water quality model. The tidal water quality model simulates the "steady state" variations in water quality during the period of a single spring tide or two neap tides allowing the effects of diurnal phytoplankton activity to be observed. The model calculates the concentrations of dissolved oxygen, salinity, temperature, BOD, organic nitrogen, ammonia, oxidised nitrogen, chlorophyll *a*, suspended solids and *E. coli* in a uniform grid of cells. The original WAHMO model was based on 250m grid which had a boundary approximately 2km to the west of the Ma Wan Gap, thus excluding the proposed airport site. However a second hydrodynamic model, based on a 300m grid, and including the area to the north of Lantau Island (including the proposed airport site) has been developed. The tidal water quality model can be driven by this new hydrodynamic model and has been calibrated by EPD using the data referred to in Section 7.1.2.

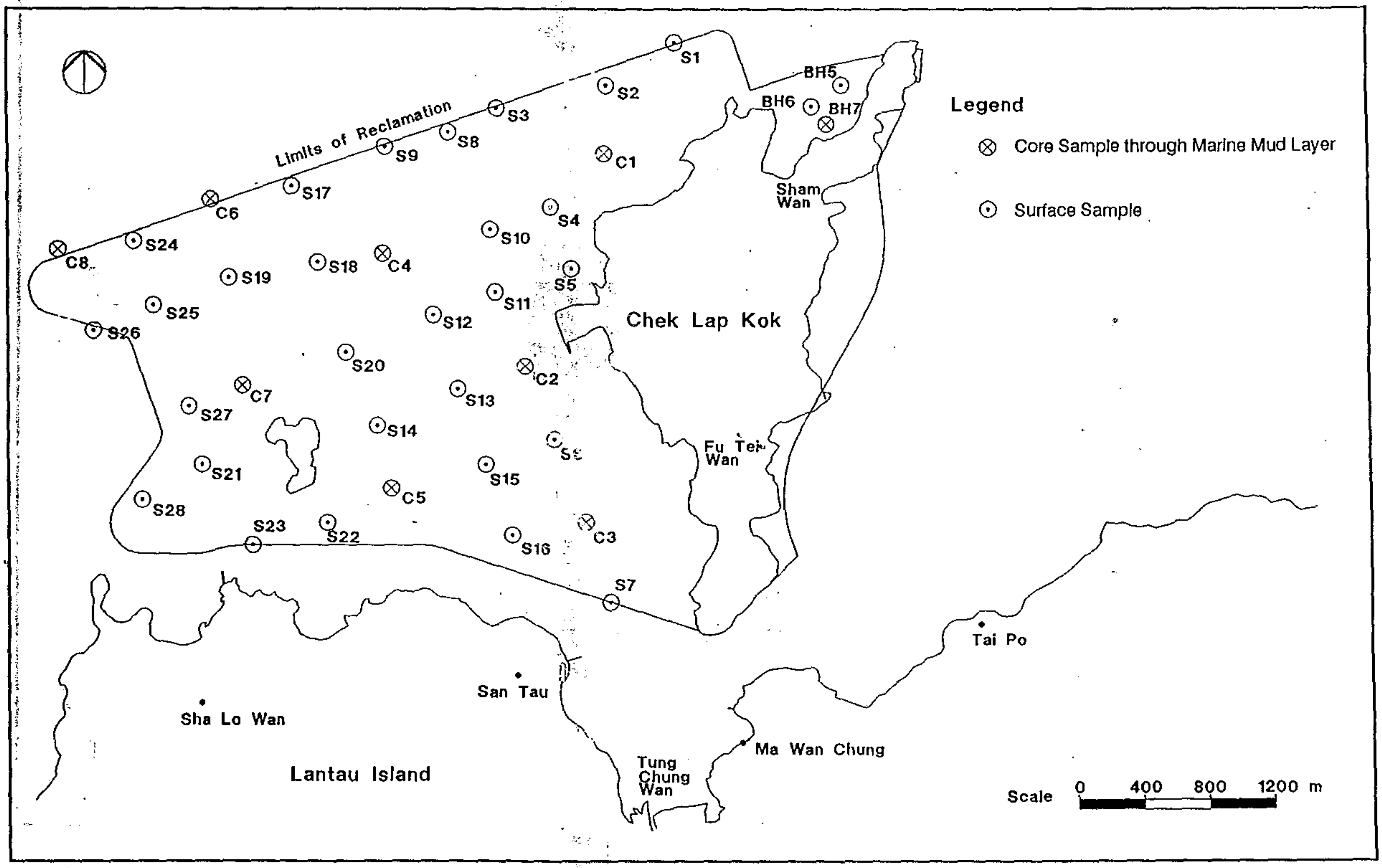
The tidal water quality model has been used to simulate the effect of the presence of the reclamation area on the water quality in the NWWZ. An initial comparison was made of the water quality under the scenarios 1987 loads, 1996 loads and 1996 loads with the maximum reclamation area. Following the decision on the runway separation distance, the then recalibrated model was used to compare the water quality under the 1987 load condition and the 1996 load in association with the proposed reclamation.

7.1.4 Assessment of Marine Mud Quality

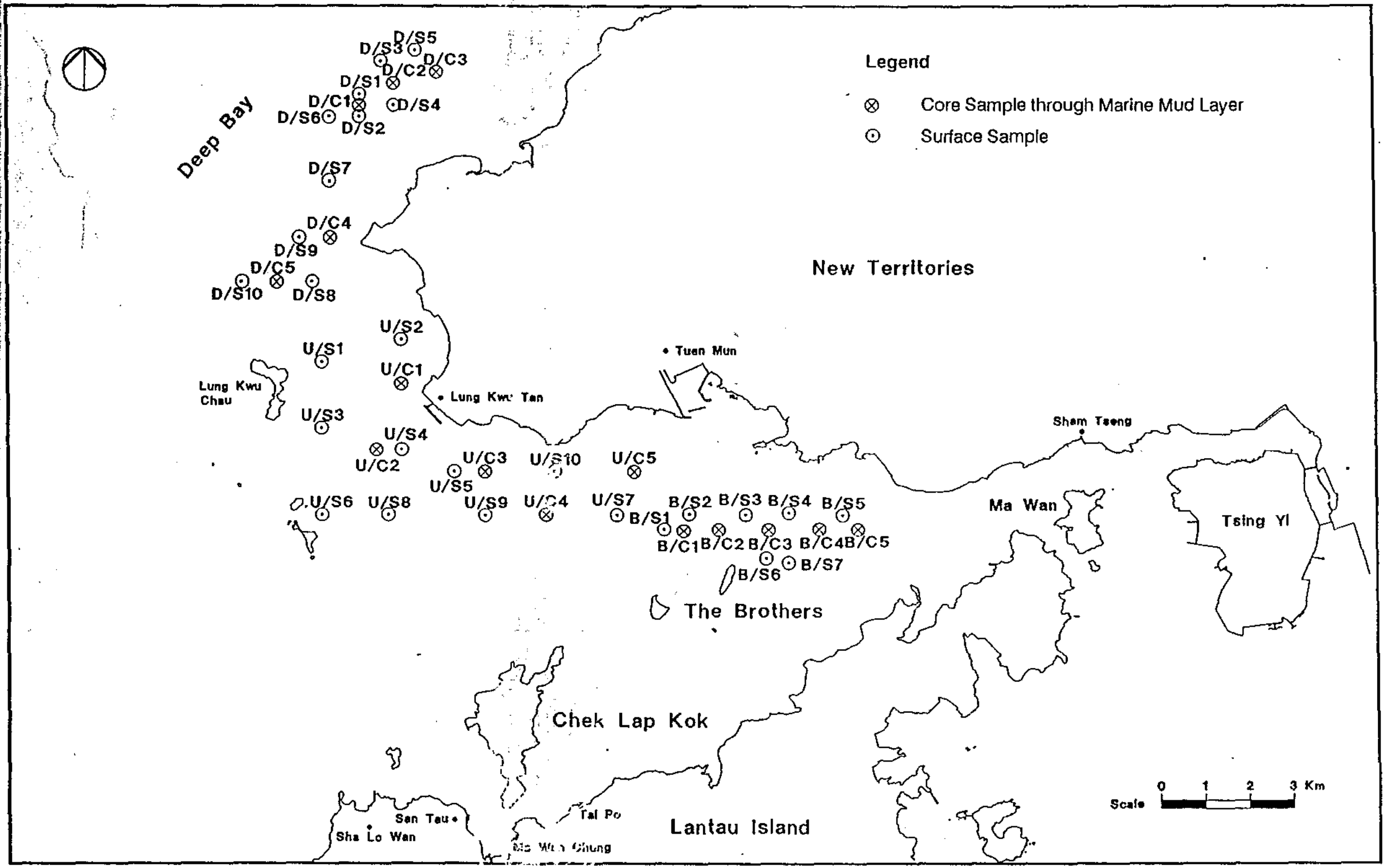
Since the major impact of the dredging and reclamation works arises as a result of sediment suspension and dispersion, the quality of marine mud to be dredged is important. Information on contaminant concentrations is also required in order to obtain approval for the spoil to be disposed of at a gazetted dumping ground.

Samples of marine mud from the airport reclamation area and from The Brothers, Urmston Road and Deep Bay gazetted marine borrow areas were taken by vibrocoring. The locations of the sampling stations are shown on Exhibits 7.3 and 7.4. Surface samples were collected from the top 0.5m of shallow cores, and a smaller number of full cores were taken through the marine mud layer with samples abstracted at 2m intervals down the vertical profile. The samples were analysed for heavy metals and total kjeldahl nitrogen (TKN) concentrations according to American Society for Testing of Materials (ASTM) standard methods. Surface samples were analysed initially, while duplicates of surface samples and all core samples were frozen for future analysis as necessary.

Site investigations for one other potential borrow area, East Sha Chau, excluded marine mud sampling. It was considered unnecessary because the surrounding areas (see Exhibit 2.2) had previously been shown to be uncontaminated.



Location of Marine Mud Sampling Stations for the Advanced and Main Reclamation Works Areas Exhibit 7.3



Location of Marine Mud Sampling Stations for The Brothers, Deep Bay and Urmston Road Borrow Areas Exhibit 7.4

7.2 Existing Environment

7.2.1 Water Quality

A comparison of the maximum values reported from the EPD monitoring stations NM1-NM5 for 1989/1990 with the Water Quality Objectives (WQOs) in Table 3.7 suggests that the zone generally complies with the objectives except for pH and total inorganic nitrogen. There are occasions when the pH at the EPD monitoring sites has exceeded the value of 8.5. On one occasion, 11/9/89, a pH value of 8.87 at NM1 was associated with an elevated chlorophyll *a* concentration; such a link is commonly observed at times of high photosynthetic activity. The other non-compliant parameter is depth averaged annual average concentration for total inorganic nitrogen, with all stations exceeding the objective value of 0.1 mg N/l. Reported values range between 0.2 mg N/l at NM1 and 0.4 mg N/l at NM5. It is therefore important to ensure that neither the construction activities nor the shape and size of the reclamation result in increases in the concentrations of inorganic nitrogen, which is considered to be one of the major factors influencing the development of phytoplankton blooms in Hong Kong coastal waters.

As indicated in Section 7.3, construction activities are likely to increase the concentration of suspended solids in the water adjacent to Chek Lap Kok. The pattern of suspended solids concentrations at any one particular location is complex and varies between wet and dry seasons, between spring and neap tides, between flood and ebb, slack and peak flow and with water depth. In order to examine the variations in relation to the influencing factors, the data collected during the intensive water quality surveys and the EPD data were examined. The ranges, means and 95 percent values were calculated for each of the season/tide combinations and are shown in Table 7.1, whilst the data collected for 1989/90 from the EPD monitoring stations is shown in Table 7.2. These two data sets are consistent and the values can be used as a baseline against which the results of the mathematical modelling of the dredging and mud disposal simulation can be compared.

The gazetted bathing beaches on the southern coast of the New Territories have been previously classified as barely acceptable or unacceptable. Remedial measures are underway to improve the water quality at these beaches such that, in the 1990 EPD report on the *Bacteriological Water Quality of Bathing Beaches in Hong Kong,* Butterfly and New Cafeteria Beaches were classified as acceptable. The non-gazetted beaches have also been monitored and are classified as acceptable.

7.2.2 Marine Mud Quality

The results of the marine mud analyses are summarised in Table 7.3. The results show that the concentrations of heavy metals in all samples were below the Interim Guideline Values for significant sediment contamination. The spoil from these areas, and from the potential borrow area at East Sha Chau, has therefore been approved by EPD for disposal at a gazetted dumping ground.

Concentrations of total nitrogen in samples from the airport reclamation area were relatively high, with a mean value of 580mg/kg dry weight.

Table 7.1
Suspended Solids Statistics: Hourly Samples Taken Over Four 26-Hour Periods in 1990

Location		Surface Suspended Solids Concentrations (mg/l)			
		Wet Season		Dry Season	
		Spring Tide	Neap Tide	Spring Tide	Neap Tide
W1	Range	3 - 12	2 - 12	0 - 20	6 - 15
	Mean	7	7	7	9
	Upper 95%ile	14	12	36	16
W2	Range	0 - 12	7 - 12	2 - 23	4 - 20
	Mean	5	10	12	11
	Upper 95%ile	20	14	23	20
W3	Range	0 - 10	0 - 13	15 - 119	6 - 89
	Mean	2	9	41	27
	Upper 95%ile	8	25	133	224
W4	Range	8 - 65	6 - 21	0 - 157	0 - 45
	Mean	19	12	13	16
	Upper 95%ile	62	21	131	38
W5	Range	0 - 42	7 - 20	0 - 35	0 - 14
	Mean	11	12	11	8
	Upper 95%ile	78	18	91	21

Source : 1990 WAHMO Survey Data

Table 7.2
Suspended Solids Statistics: Bimonthly Samples Taken Over the Period Jan 1989-Apr 1990

Location		Suspended Solids Concentrations (mg/l)		
		Surface	Middle	Bottom
NM1	Range	0.5 - 17	2 - 17	2 - 18
	Mean	3.0	4.5	5.8
NM2	Range	1.5 - 12	0.5 - 24	1 - 33
	Mean	5.3	3.4	7.5
NM3	Range	0.5 - 20	1 - 13	3.5 - 27
	Mean	4.3	4.6	9.3
NM4	Range	2.5 - 13	2 - 23	2.5 - 30
	Mean	5.6	6.5	8.5
NM5	Range	1.5 - 13	1 - 18	1.5 - 40
	Mean	5.8	5.4	8.8

Notes: (1) Where zero values occurred in the data set a value of 0.5 mg/l (half of the laboratory LOD) was used in the calculation of the mean.
(2) Station locations are shown on Exhibit 7.2.
(3) Data were log-transformed to normalise the distribution.

Source : EPD

Table 7.3
Analytical Results for Surficial Samples of Marine Mud from the Chek Lap Kok Airport Reclamation Site and Marine Borrow Areas

Site	No. of Stations	Copper	Cadmium	Chromium	Nickel	Lead	Zinc	Mercury	TKN (mgN/kg)
Chek Lap Kok Advanced Works Area	4	11 (7–16)	0.7 (0.4–1)	13 (11–15)	20 (15–25)	40 (32–58)	66 (55–77)	<0.1 (<0.1)	--
Chek Lap Kok Main Reclamation Area	36	15 (7.8–35)	0.8 (0.4–1.3)	20 (11–28)	23 (8.5–28)	41 (24–63)	76 (26–103)	0.08 (0.02–0.15)	580 (130–1000)
Brothers Marine Borrow Area	10	19 (6.8–34)	1.3 (0.4–2.2)	13 (7–22)	21 (14–27)	50 (37–59)	53 (30–82)	0.1 (0.03–0.25)	600 (280–1000)
Urmston Road Marine Borrow Area	15	22 (8–49)	0.6 (0.4–1.1)	18 (13–27)	24 (16–29)	45 (29–61)	63 (39–83)	0.18 (0.11–0.33)	731 (430–990)
Deep Bay Marine Borrow Area	15	17 (7–33)	0.6 (0.5–0.9)	19 (14–23)	20 (16–24)	47 (39–55)	70 (53–92)	0.14 (0.05–0.46)	677 (450–1000)
Interim Guideline Limits*	--	500	15	500	500	200	2000	5	--

Note: Data given are mean and range of concentrations expressed as mg/kg dry weight.

*Sources: Greiner-Maunsell, 1991 and *Hong Kong Planning Standards and Guidelines, 1991*

7.3 Water Quality Impacts

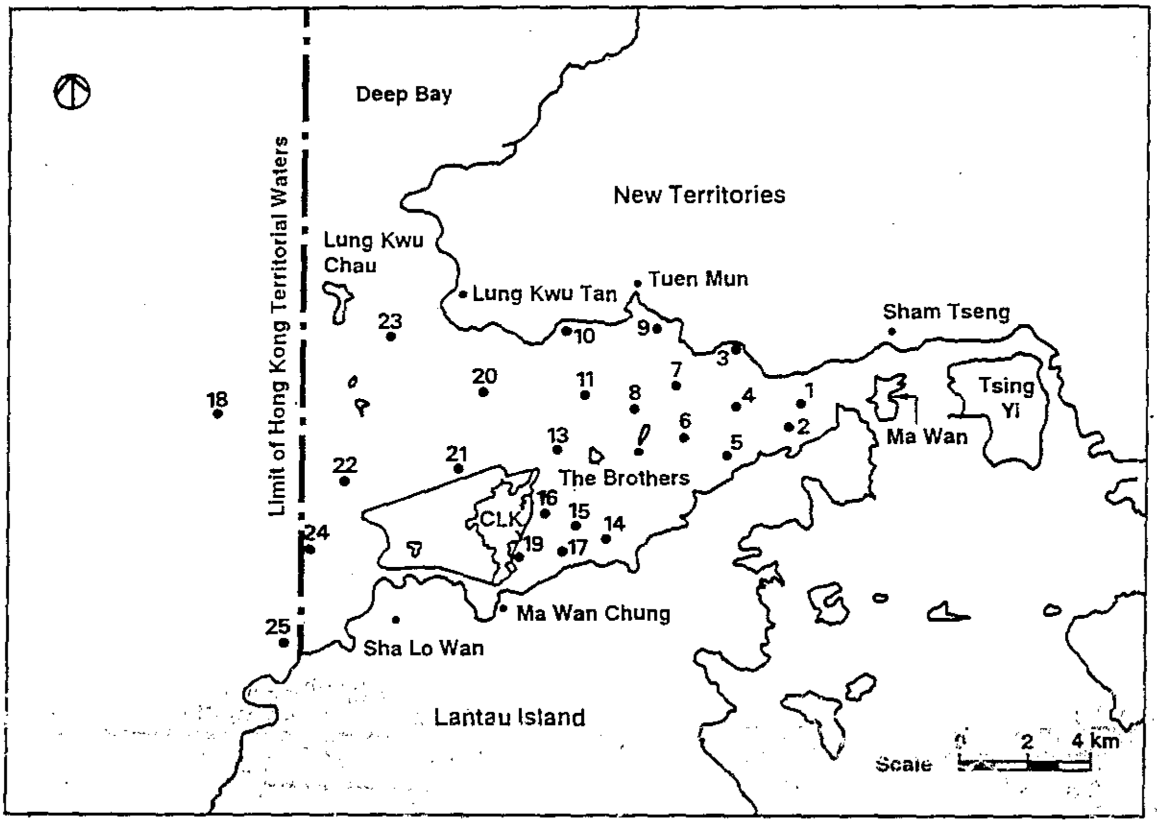
7.3.1 Airport Reclamation Configuration

An intital assessment of the effects of the maximum and minimum airport reclamation configurations on water quality was carried out early in the study in order to assist in the decision on the runway separation distance. The recalibrated water quality model was subsequently applied to simulate the effects of the final reclamation configuration. The simulation series compared the 1987 baseline and the pollutant load for the 1996 Metroplan prediction, including the Western Harbour and Lantau Port developments. Pollutant loads from the airport and New Town development were excluded, since the objective of the modelling at this stage was to assess the physical effects of the airport reclamation rather than operational impacts such as sewage discharge. The reclamation was modelled without a flushing channel between the southern boundary and North Lantau, to simulate "worst case" conditions.

The recalibrated water quality model was thus re-run for wet and dry season conditions to simulate the following scenarios:

Scenario 1 - 1987 loads without the airport reclamation.
Scenario 2 - 1996 loads with the North Lantau development and the final 1525m runway separation reclamation.

The model calculates the concentration of a number of water quality parameters; in this comparison the common indicators of water quality, dissolved oxygen (DO), biochemical oxygen demand (BOD), oxidised nitrogen, the faecal bacterium *E. coli* and chlorophyll *a* were used to highlight differences between the test scenario (Scenario 2) and the baseline water quality condition (Scenario 1). The modelling results for each water quality parameter at given locations within the study area as shown on Exhibit 7.5 are described in the following sections.



Location of Time Series Points for WAHMO Modelling *Exhibit 7.5*

a) Dissolved Oxygen (DO)

The general pattern under dry season neap tide conditions was for the DO concentrations in both the upper and lower layers to decrease in Scenario 2. The maximum decrease was of the order of 5 percent saturation. On no occasion were the predicted concentrations below the WQO values in either the upper or lower layers of the model. Dry season spring tides gave small increases in DO throughout most of the area with the airport reclamation. The exception to this was in East Tung Chung Bay (positions 14-17 and 19) where the saturation values fell by a similar figure to that during the neap tide. Despite the decline, the water quality would remain above the WQO limit.

For the wet season neap tide simulation, both the baseline and airport conditions showed no evidence of the strong dry season semi-diurnal variation in DO saturation. However, the common feature of a reduction in the percentage saturation was maintained in the wet season under the conditions of Scenario 2. These decreases were as high as 10 percent at positions 14-17 and 19 but since the baseline condition predicted approximately saturation condition, the decrease did not result in the value falling below the WQO value of 4mg/l DO in the surface layer. Only at positions 11 and 23 were there relatively low values in the lower layer, but these values were common to both scenarios. Under wet season spring tide conditions, small increases in DO throughout most of the northeastern part of the area were predicted. This reflected the improvements proposed for controlling discharges in the areas adjacent to Victoria Harbour. The sites adjacent to the airport site showed no significant change from the baseline condition.

b) Biochemical Oxygen Demand (BOD)

Small increases and decreases in BOD occurred with the airport reclamation under dry season neap tide conditions. The changes were small, of the order of 0.1-0.2 mg/l, and similar in magnitude to the limit of practical measurement of BOD. Most of the increases occurred in the east and north of the area. The decreases were found in the closed embayment created by closing the channel between Chek Lap Kok and Tung Chung. An overall improvement in water quality was predicted under dry season spring tide conditions. The predicted values for the reclamation scenario were lower than for the baseline except at locations 20, 21 and 23, where water quality would be influenced strongly by the discharge from North West New Territories (NWNT).

The reclamation simulation under wet season neap tide conditions predicted a small overall reduction in the BOD value for the zone. The most significant reductions were found at positions 14-17 and 19 in East Tung Chung Bay. As indicated above, the level of DO in this bay was also reduced. These coincident reductions suggest that the flushing of the bay will be reduced allowing a longer period for the organic material to be metabolised. As with DO, under wet season spring tide conditions, there was an overall improvement in water quality particularly in the north easterly part of the area. There was no deterioration associated with the the airport reclamation.

c) Oxidised Nitrogen

Under dry season neap tide conditions, there was a general increase in oxidised nitrogen concentrations of 0.01mg/l throughout the area, with the exception of the four most westerly locations (18, 22, 24 and 25) where there was no change. The predicted increase was small, being within the accuracy of analytical techniques used for marine water quality monitoring. The concentrations predicted in both scenarios were lower than those observed in the field and reported by EPD. Similarly for the dry season spring tide, there was an increase in the concentrations although smaller in magnitude (<0.01mgN/l). In East Tung Chung Bay, the predicted increases were even smaller.

The concentrations of oxidised nitrogen in the wet season were strongly influenced by the concentrations in the Pearl River. Examination of the concentrations at positions 18, 24 and 25 showed wet season values of 0.1mgN/l compared with the dry season values of 0.05mgN/l. There was no evidence of a diurnal or semi-diurnal pattern at these positions while at positions 1-8, 21 and 22 a marked semi- diurnal pattern existed. The high values, similar to those in the far western (Pearl River) positions, occur at low water indicating that it is Pearl River water which gives rise to the high values. At positions 14-17 and 19 the values fell to less than 0.01mg/l and these were associated with high levels of oxygen saturation indicative of elevated phytoplankton productivity.

Small decreases in concentration were predicted for the wet season spring tide condition at the northeastern end of the area where water from Victoria Harbour flows in. The concentrations in the bay formed at Tung Chung were low compared with those in the more open part of the zone.

d) *E. coli*

The general pattern under dry season neap tide conditions was for numbers of *E. coli* in the eastern half of the area to decrease and those in the western half to increase, this being associated with the increased loading from the planned outfalls from the NWNT. The significant positions with regard to numbers of *E. coli* were 3, 9 and 10, the latter being adjacent to the gazetted Butterfly Beach. Butterfly Beach would meet the Bathing Beach Bacterial Count Criterion of <1000 *E. coli*/100ml (although the criterion is only applicable during the bathing season of March to October). Location 3 would also comply but 9 would fail.

For the dry season spring tide and under wet season conditions, the overall effect was a decrease in concentration of faecal bacteria, but with positions 20-23 showing increases due to the NWNT outfalls. When the three beach locations 3, 9 and 10 were examined only location 3 was found to comply with the beach standard in the dry season while locations 3 and 9 would comply in the wet season.

e) Chlorophyll *a*

The area showing the most significant increases in this parameter under dry season neap tide conditions was that containing locations 14-17 and 19, East Tung Chung Bay. In this area the concentrations increased by up to a factor of 3.5 in the inner part of the bay; rising from a tidally averaged value of 2 *u*g/l to 7 *u*g/l. Increases also occurred in East Tung Chung Bay during spring tides. Because the flushing of the bay would be greater with a spring tide, the effects were less marked; with only the two innermost locations, 17 and 19, showing significant increases.

The effects seen in the dry season neap tide case were also seen in the wet season. The greatest increases were found at locations 17 and 19 in the inner part of the bay. At position 17 the inceases were in the region of 2-3 *u*g/l while at position 19 the maximum concentration increased from 20 to 30 *u*g/l.

As in the case of the wet season neap tide, the concentrations in the area as a whole were elevated on spring tides due to the increased water temperature, solar radiation and nutrient input from the Pearl River. The differences between the baseline and post airport reclamation concentrations which were seen in the inner part of Tung Chung Bay were not evident with the spring tide, again due to the greater flushing of the bay in comparison to a neap tide.

Significant Effects

The most important effect which may give rise to significant changes in water quality is the increase in chlorophyll *a* which was predicted to occur in the newly formed East Tung Chung Bay. The increases in chlorophyll *a* were predominantly associated with neap tides rather than spring tides. In the case of the former, the flushing of the bay will be less than with a spring tide and may result in a longer residence time allowing the phytoplankton to grow to higher numbers. The concentrations predicted during the wet season neap tides are high for coastal waters. At the present time there exists no mathematical model which is capable of predicting, with any degree of certainty, the succession of species of phytoplankton which will develop in response to changes in loadings or retention times.

Hong Kong's near shore waters are known to have the potential for the development of "red tides", some of which are known to contain species of phytoplankton which are toxic. The possibility that such blooms of algae could develop in the bay must not be discounted.

The major sources of dissolved inorganic nitrogen, the nutrient considered to be the main factor controlling phytoplankton growth in Hong Kong waters, comprise a large number of both diffuse and point sources outwith the East Tung Chung Bay. These are difficult to control. Furthermore examination of the nitrogen and chlorophyll *a* predictions for other parts of the zone do not indicate that there is an overall increase in the nitrogen loading to the area. Apparently as a result of the decreased flushing in the bay due to the closure of the channel between Tung Chung and Chek Lap Kok there is an increase in chlorophyll a.

7.3.2 Dredging and Mud Disposal

Increases in concentrations of suspended solids will be the most significant impact arising from dredging, borrowing and disposal operations during the construction phase. Increased suspended solids concentrations will also be generated by land-based construction work, but to a lesser extent. Potential impacts associated with increased suspended solids concentrations include stimulation of phytoplankton growth due to increased nutrient availability from disturbed soils and sediments; toxicity arising from release of heavy metals or other contaminants from dredged spoil; elevation of particulate matter in the seawater supply to Castle Peak Power Station which could block filters and damage cooling water intake pumps; and impairment of feeding and growth efficiency of commercial stock at oyster beds in Deep Bay and the fish culture zone at Ma Wan.

Nutrient Loading

Disturbance of Chek Lap Kok's existing soils will mobilise fine solids which may be carried either by streams or direct run-off into the nearshore waters. The soils in the cultivated areas at Fu Tei Wan and between Cheung Sha Lan and Sham Wan Tsuen (Exhibit 9.1, areas designated 5 and 6) will contain elevated levels of nutrients and in particular nitrogen. The streams draining the area at Fu Tei Wan discharge into a section of open coastline which will allow significant dilution of any nutrients released from the disturbed soils. The surface waters draining the northern area discharge into the relatively enclosed Sham Wan where an increased nutrient level could stimulate the development of a localised red tide.

During dredging, the disturbance of the existing fine marine sediments will mix the interstitial waters with the main water column. Where sediments are contaminated through eutrophication or industrial activity the interstitial waters may be contaminated. The impact may be in the form of the release of nutrients which may stimulate phytoplankton growth or the release of toxic substances such as heavy metals. Results of analysis of sediment samples taken in the region of the airport site indicate that the sediments are uncontaminated. Nutrient concentrations, however, are relatively high and the potential impact on water column nutrient concentrations from disturbance of the sediments has therefore been assessed.

Calculations were based on the mean value of 580mg/kg TKN and best estimates by the dredging engineers of the type and number of dredgers and the associated dredging rates and losses. Nitrogen loadings of 3,767 kg/month were calculated for early phases of the reclamation, when up to three grab dredgers could be working in shallow water, and up to 17,328 kg/month for later stages when four trailer hopper dredgers could be operating. The significance of these loading rates in terms of potential phytoplankton stimulation, represented by chlorophyll a concentrations, was determined using an empirical model developed in studies commissioned by EPD on the environmental impacts of fish culture zones. The model relates the annual area loading of nitrogen into a bay to a flushing-corrected annual depth-average inorganic nitrogen concentration and thence to an annual chlorophyll a concentration.

The flushing correction factor, "F", is calculated from simply derived morphometric parameters of the bay; width at its mouth, length, average depth and the maximum tidal range.

In examining the effect of additional nitrogen loading from the dredging activity it was assumed that two separate bays existed. The seaward ends of the bays were defined by lines connecting the NE tip of Chek Lap Kok and Pak Mong to form the east bay and the NW tip of the island to a peninsula west of Sha Lo Wan to form the western bay; there was no hydraulic connection assumed at Ma Wan Chung. The "F" value for these two bays was computed as about 1.5, indicative of being well flushed.

The nitrogen loading from the existing fish culture zone at Tung Chung was computed for the previous study and represents an annual areal load, if applied to either of the two bays, of 2.0 g/m^2y. The loadings due to release of nitrogen from three grab dredgers and four trailer dredgers are calculated to be 6.3 and 28.8 g/m^2y respectively. Using the relationship between loading and flushing-corrected concentration of total inorganic nitrogen, these loadings represent annual depth average concentrations of 0.2, 0.33 and 0.62 mg/l respectively.

The previous studies indicated that there was a critical region in which existed a threshold for stimulation of enhanced phytoplankton production; this region lies between the values of 0.4 and 1.0 mg/l. The loadings from the existing fish culture zone and from the three grab dredgers both result in concentrations which lie below this threshold region.

The effect of four trailer hopper dredgers operating would be to produce concentrations which lie within, but not above, the threshold region. However, the assumption of no hydraulic connection at Ma Wan Chung represents a "worst case" scenario and there will thus be a greater degree of flushing than is allowed for in the model, which will reduce the magnitude of the loading. This will move the effect of the additional loading towards the lower end of the threshold region reducing the risk of increasing phytoplankton growth.

Suspended Solids Concentrations

The most significant construction activities which will impact on water quality are associated with the removal of the unconsolidated marine deposits followed by their replacement with marine sands. In addition to local effects resulting from dredging and backfilling, there will be effects at the locations from where the marine fill is extracted and the borrow pits which are backfilled with the surface sediments removed from the reclamation area. The locations of the borrow areas were previously shown on Exhibit 2.2. These possible effects have been investigated using a sediment dispersion, transport and deposition model, the results of which are summarised in Section 6 of this report.

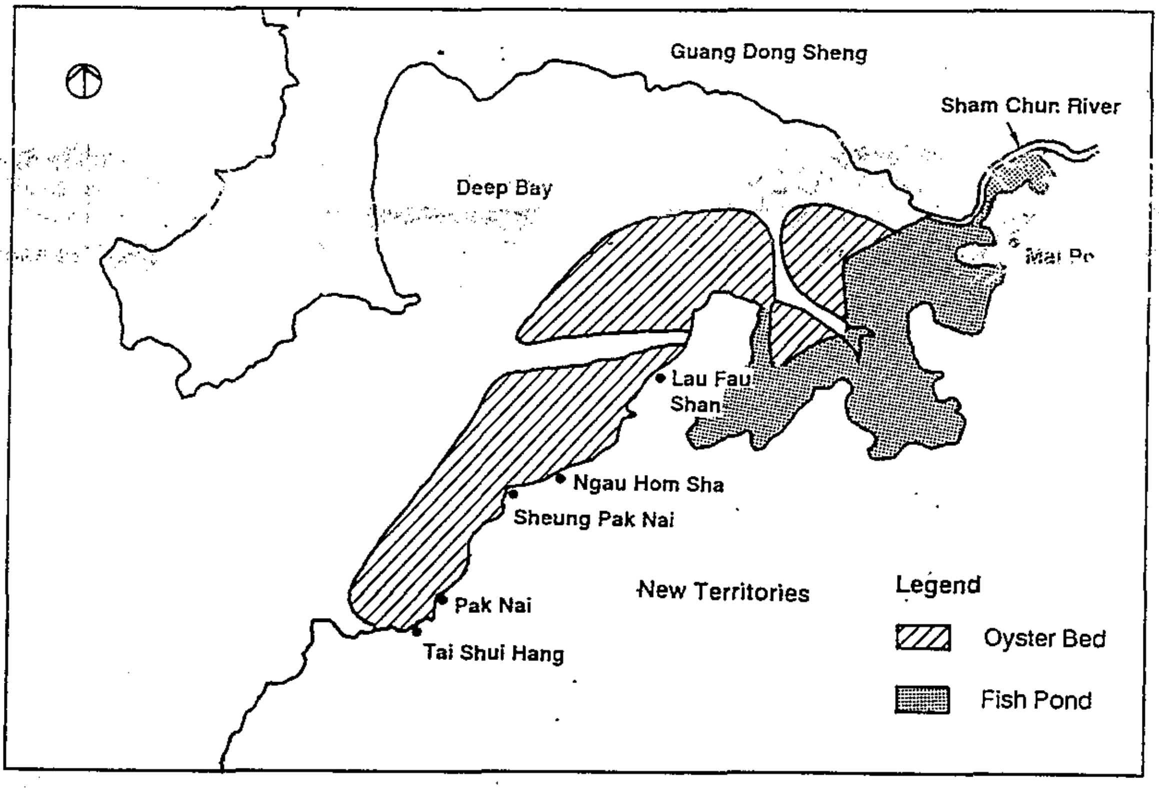
Model simulations of the following dredging, dumping and borrowing activities were carried out:

- Three grab dredgers operating at the airport site in shallow water.
- Four trailer dredgers operating at the western end of the airport site.
- Dumping at the entrance to Deep Bay from three grab dredgers.
- Dumping at maximum rate at the entrance to Deep Bay.
- Dredging of overburden in Urmston Road borrow area.
- Overflowing of silt from hoppers or barges during dredging for fill at Urmston Road, Deep Bay and The Brothers borrow areas.
- Simultaneous overflowing of silt from hoppers or barges during dredging for fill, and dumping of marine mud, at different pits within The Brothers and Deep Bay borrow areas.

The principal sensitive receiver in the area which is likely to be affected by increases in suspended solids is the China Light and Power (CLP) Power Station at Castle Peak. CLP have expressed particular concern over activities within a 5km radius of the power station and have specified a tolerable threshold limit of 150 mg/l suspended solids concentration for their cooling water supply. Exhibit 7.1 shows the waters contained within a 5km radius of the cooling water intake at Castle Peak together with the position of the airport reclamation associated with the maximum 1525m runway separation. These two areas do not overlap. Of the simulations above, only dredging of overburden and overflowing of barges during loading of fill at Urmston Road fall well within the 5km radius of the power station cooling water intake.

The monitoring location closest to the power station for which within-tide suspended solids concentration data are available in the present data set is W5, as shown previously on Exhibit 7.2. The range of values observed together with the statistics have been given previously in Table 7.1. These values were used in conjunction with the sediment plume model predictions for the wet season spring tide to determine the ultimate water column concentrations in the vicinity of the cooling water intakes.

Concentrations were also simulated at a point in Deep Bay in the area occupied by the commercial oyster beds which are shown on Exhibit 7.6. The feeding rate of filter feeders, of which oysters and mussels are typical examples, is influenced by the concentration of suspended solids in the surrounding water. Large mussels (7cm), which would be expected to behave in a similar way to oysters, begin to show a reduced feeding response when exposed to water containing suspended solids in excess of 100mg/l and inhibition of feeding in excess of 200mg/l. The potential for inhibition of filter feeding by the oysters in Deep Bay was therefore also considered.



Location of Oyster Beds and Fish Ponds in Deep Bay ***Exhibit 7.6***

Dredging Activities at the Airport Site

Two dredging scenarios at the airport site were considered, the first involving three grab dredgers working in the shallow waters immediately to the west of Chek Lap Kok and the second four trailer dredgers working in the deeper waters further west (see Exhibit 6.5). With the three grab dredgers working in shallow water, the contour bounding the 2.5 mg/l increase in suspended solids in the surface waters remained close to Chek Lap Kok and predominantly within the reclamation area. At no state of the tide did the plume approach within 5km of the power station. Sediment deposition was predicted to occur predominantly within the footprint of the airport reclamation and so would be removed during the normal dredging operations (see Exhibits 6.6 and 6.10).

The area of impact represented by simulating four trailer dredgers was much more extensive since the working area lay further to the west in an area of stronger currents. The concentration contours indicated that the disturbed sediment would be carried into the 5km zone but at no state of the tide did the 0-2.5 mg/l contour approach the power station intakes. The plume however did move in a southwesterly direction along the coast towards the village of Tai O. The contours indicated that at peak ebb flow, concentrations in the region of Tai O could increase by up to 2.5 mg/l.

Dumping at the Entrance to Deep Bay

These activities also lay outside the 5km limit but because the dumping was simulated within about 1km of the limit, and also in an area of strong currents which pass adjacent to the power station site on the ebb tide, the sediment plume did enter the zone (see Exhibit 6.8). Three "spot" locations were selected at which to plot the within-tide variation in suspended solids. These were the monitoring station W5 (see Exhibit 7.2) and two arbitrary locations selected immediately adjacent to the power station site (referred to as A and B). The predicted concentration increases which would take place at these three locations can be compared with the observed concentrations at station W5 as depicted in Table 7.4. Predicted diurnal suspended solids concentration at locations A and B are illustrated on Exhibit 7.7.

It is clear that the predicted maximum concentration increases in the surface layer, typically 8m, are comparable to the ambient maximum values; the tidally averaged increases will be less than the maximum predicted values and would not be expected to cause suspended solids concentrations near the power station to exceed the tolerable limit of 150 mg/l.

The simulations of dumping at Deep Bay indicated no significant movement of the sediment plume or areas of increased sediment deposition in the vicinity of the oyster beds.

Dredging in the Urmston Road and Deep Bay Borrow Areas

Parts of these borrow areas lie within the 5km radius of Castle Peak and as such have greater potential for causing impact on water quality at the power station. The level of the cooling water intakes is -7.2m thus they lie within the surface layer of the model.

Table 7.4
Increases in Suspended Solids Concentrations Resulting from Dumping Operations at the Entrance to Deep Bay

Operation	Season/Tide	Observed Suspended Solids Concentrations at W5 (mg/l)		Maximum Predicted Increases in Suspended Solids Concentrations (mg/l)					
				W5		A		B	
		mean	range	surface layer	bottom layer	surface layer	bottom layer	surface layer	bottom layer
Dumping from three grab dredgers	wet spring	11	0-42	0	2	2	2	1	2
	wet neap	12	7-20	0	0	0	0	0	0
	dry spring	1	0-35	0	0	0	0	0	0
Maximum dumping rate	wet spring	11	0-42	2	15	23	28	4	8

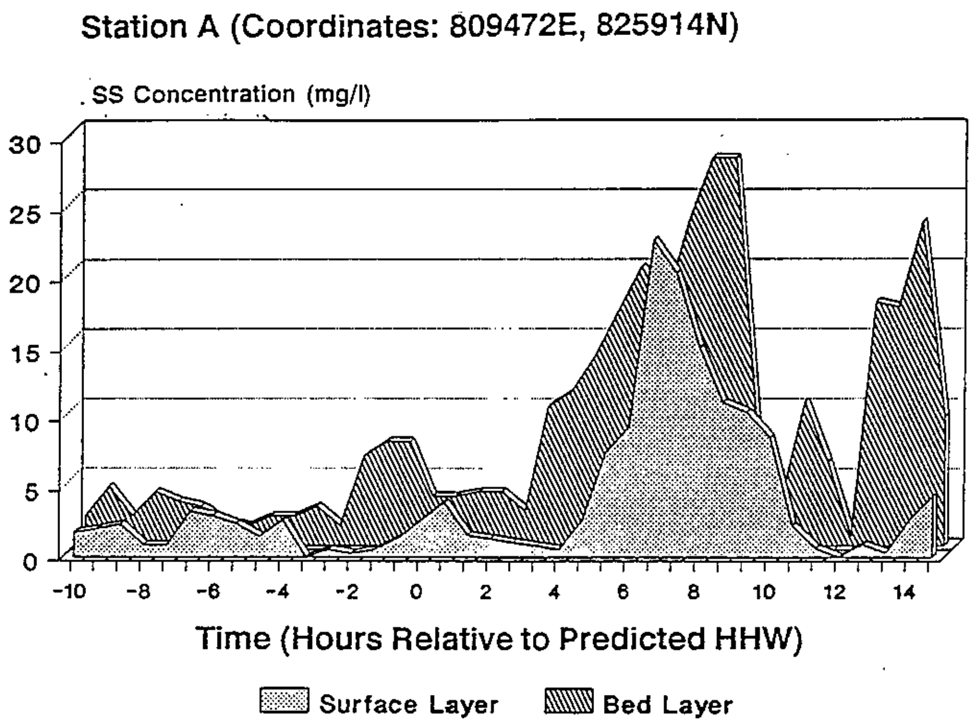
Source: Greiner-Maunsell, 1991

Dredging of the overburden in Urmston Road had little effect on the concentration of suspended solids at locations A and B. The increase in the surface layer due to the activity was generally less than 2.5mg/l; the increases in the lower layer were greater. For a period of 6 hours during the peak ebb, the concentrations increased in the lower layer to 5mg/l, and approached 15mg/l for a very short period. This level of increase in the upper layer lies well within the variations which occur naturally. However, during sand dredging operations at Urmston Road, where silt was simulated overflowing from the barge, the increases were predicted to be greater and to persist for a longer period.

At both locations A and B the average increase over the the tidal period in the upper layer was of the order of 5mg/l with maximum increases of 10mg/l during the peak ebb tide. The increases in the lower layer were higher reaching 35 mg/l at the peak of the ebb. Since the cooling water intakes are in the upper layer, the general increase of 5mg/l should not cause significant adverse effects on operations at the power station.

Similar operations in the southern part of the Deep Bay borrow area were predicted to give increases in the upper layer of approximately 2 mg/l with increases of up to 8 mg/l at the peak of the ebb tide. The corresponding increases in the lower layer would reach a maximum of 25mg/l. Dredging at the northern end of the Deep Bay borrow area would have a similar effect on the suspended solids concentrations with a maximum increase in the upper layer at the peak of the ebb tide of 12mg/l.

With regard to possible effects on the oyster beds in Deep Bay, the dredging of sand in the Urmston Road and Deep Bay borrow areas indicated movement of sediment into Deep Bay. Concentrations of suspended solids in the water column over parts of the oyster beds showed increases as indicated in Tables 7.5, 7.6 and 7.7 respectively. Diurnal concentrations of suspended solids predicted at the oyster beds in Deep Bay during dredging for fill in the northern part of the Deep Bay borrow area are shown on Exhibit 7.8.



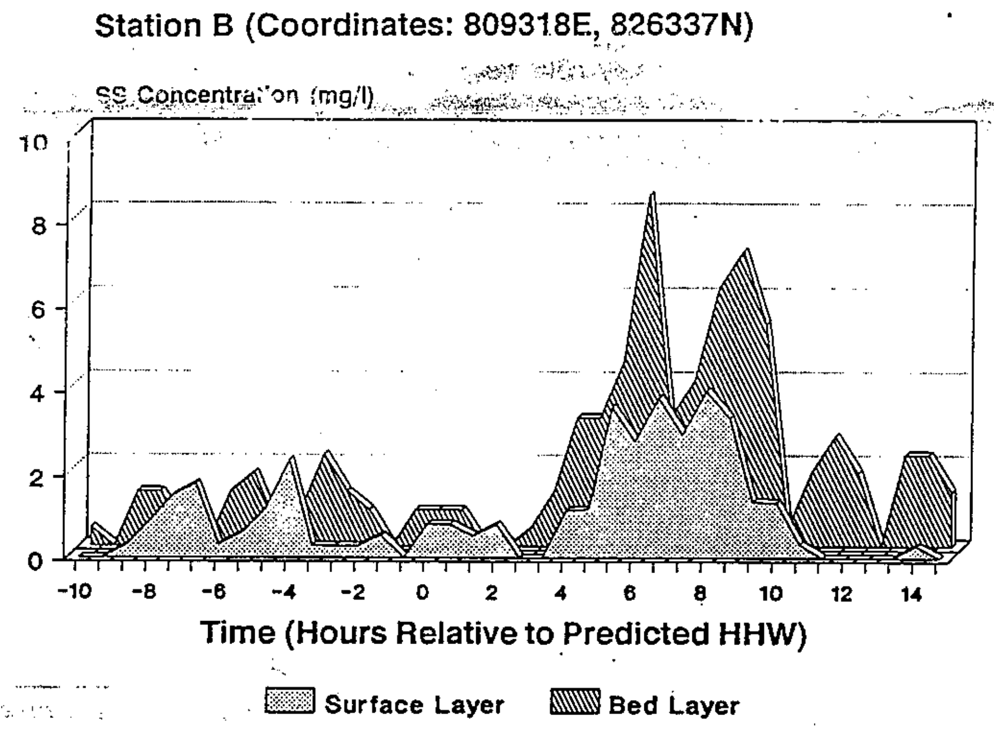


Exhibit 7.7

Predicted Increases in Suspended Solids Concentrations Near Castle Peak Power Station Resulting from Spoil Dumping at the Entrance to Deep Bay

Table 7.5
Increases in Suspended Solids Concentrations at Deep Bay Oyster Beds Resulting from Fill Extraction at Urmston Road Borrow Area

State of Tide	Layer	Increase in Suspended Solids Concentration (mg/l)	Areas Affected
HHW	surface	0	None
	bottom	0	None
Peak Ebb	surface	2.5	Several at head of Deep Bay Small areas off Pak Nai and Lau Fau Shan
	bottom	>10	Small offshore area between Tai Shui Hang and Sha Kong Miu
LLW	surface	0	None
	bottom	2.5	Small offshore area between Tai Shui Hang and Ngau Hom Sha
Peak Flood	surface	2.5 - 5	Most of offshore area
	bottom	>10	Small offshore area between Tai Shui Hang and Sha Kong Miu

Source: Greiner-Maunsell, 1991

Table 7.6
Potential Increases in Suspended Solids Concentrations at Oyster Beds in Deep Bay Resulting from Dredging at Outer Deep Bay

State of Tide	Layer	Increase in Suspended Solids Concentration (mg/l)	Areas Affected
HHW	surface	0	None
	bottom	0	None
LLW	surface	0	None
	bottom	2.5	Small offshore area between Tai Shui Hang and Ngau Hom Sha

Source: Greiner-Maunsell, 1991

Table 7.7
Potential Increases in Suspended Solids Concentrations at Oyster Beds in Deep Bay Resulting from Dredging at the Northern Part of the Deep Bay Borrow Area

State of Tide	Layer	Increase in Suspended Solids Concentration (mg/l)	Areas Affected
HHW	surface	<10	Small offshore area between Ngau Hom Sha and Lau Fau Shan
	bottom	<10	Small offshore area between Tai Shui Hang and Sha Kong Miu
LLW	surface	<10	Small offshore area between Tai Shui Hang and Sha Kong Miu
	bottom	<10	Narrow offshore area between Tai Shui Hang and Ngau Hom Sha

Source: Greiner-Maunsell, 1991

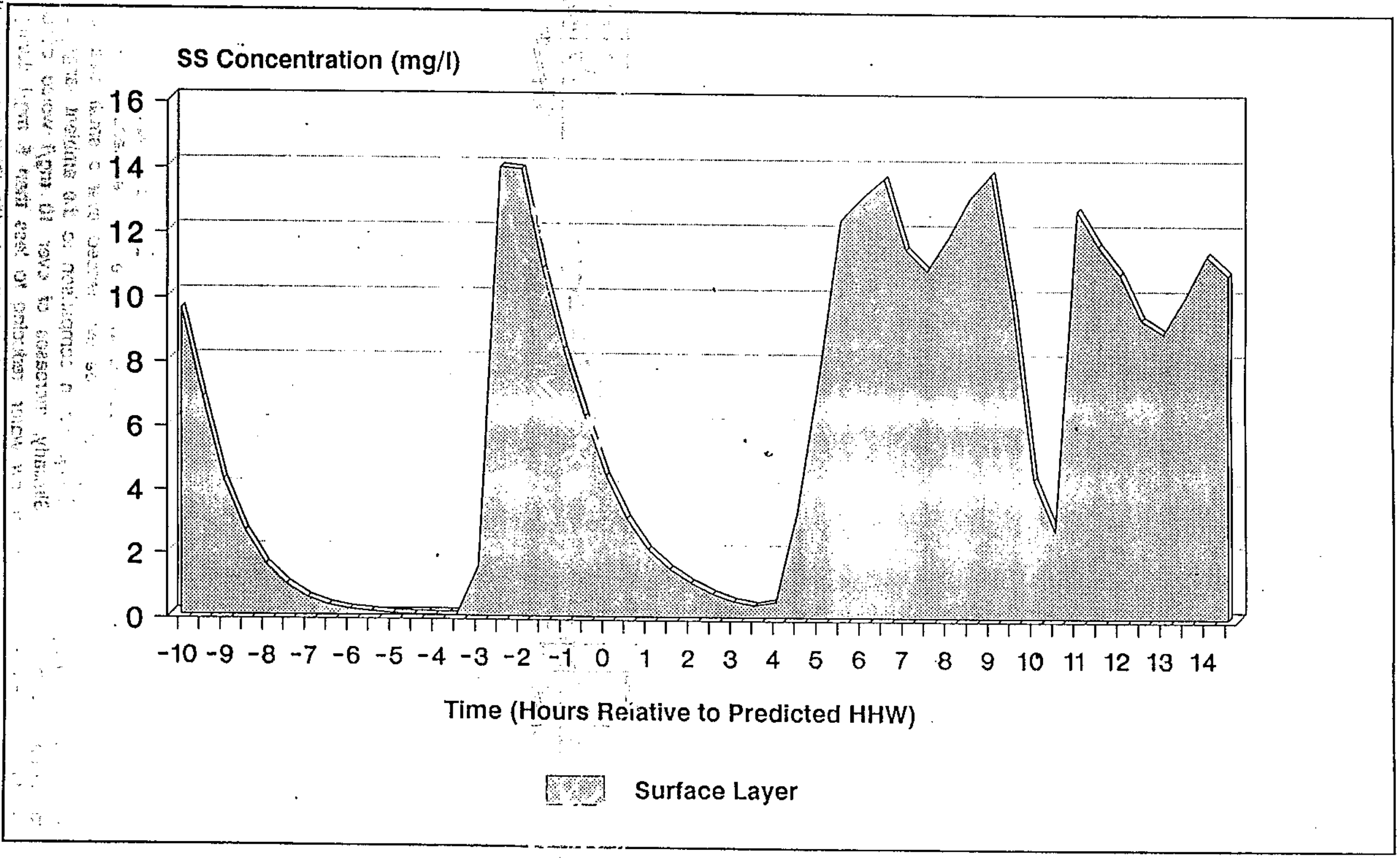


Exhibit 7.8

Predicted Increases in Suspended Solids Concentrations Near Deep Bay Oyster Beds Resulting from Dredging for Fill at Deep Bay Borrow Area

Depth averaged concentrations of suspended solids in Deep Bay for 1988 reported by EPD are as follows:

Inner Deep Bay	Range 6.5 - 210	Annual mean 40.8 mg/l
Outer Deep Bay	Range 2.5 - 31	Annual mean 13.5 mg/l

From these data it is clear that the concentrations in inner Deep Bay are at times in the range which is likely to be inhibitory to the maximum feeding efficiency of oysters, while in outer Deep Bay the concentrations are satisfactory. The predictions of the sediment transport model indicated that there will be increases in suspended solids concentrations but these occur for only part of the tidal cycle and in magnitude are insignificant when compared with the maximum concentrations which occur in the absence of the dredging activities.

Dredging at The Brothers Borrow Area

Dredging at The Brothers borrow area, which is outside the 5 km radius of Castle Peak Power Station, was predicted to cause transient increases at the power station cooling water intakes of less than 5mg/l, which are not regarded as significant.

Impacts from dredging on the Ma Wan fish culture zone would also be unlikely to be significant. Dredging of marine sand at the borrow area would increase ambient concentrations by less than 10 mg/l on the ebb tide when the dredger was working at the eastern end of the borrow area. This can be compared with measured background concentrations ranging from 0-20 mg/l. It is understood from discussion with AFD that an upper threshold limit of 100 mg/l suspended solids is appropriate for the species of fish cultivated. Thus, although local suspended solids concentrations may increase over part of the tidal cycle, they would not be expected to approach the critical threshold limit. The fish culture zone at Ma Wan, even with additional cage rafts relocated from Tung Chung Wan, should not therefore be subject to unacceptable adverse effects.

Combined Dredging and Dumping at The Brothers and Deep Bay Borrow Areas

Simulation of simultaneous dredging and dumping within different pits in The Brothers and Deep Bay borrow areas showed that suspended solids concentrations at stations A and B would increase by less than 10 mg/l, averaged over the water column. This would not be expected to cause adverse effects on the cooling water intakes at Castle Peak Power Station.

Suspended solids concentrations in Deep Bay were predicted to increase by less than 10 mg/l although higher concentrations would occur over part of the tidal cycle in the vicinity of the dredgers and in the north western part of Deep Bay. The elevated suspended solids concentrations in the north west are attributed to deposition of sediment in shallow water at some stages of the tide and subsequent resuspension once the tidal currents are sufficiently strong.

Simultaneous dredging and dumping at Deep Bay and The Brothers borrow areas would not be expected to cause adverse effects on the oyster beds in Deep Bay. Concentrations of suspended solids showed increases as indicated in Table 7.8, i.e. generally less than 10 mg/l. Increases of over 10 mg/l would be experienced over a small area of the oyster beds for part of the tidal cycle, but in comparison to the ambient range, these are unlikely to be significant. Similarly, increases of over 10 mg/l would occur at the Ma Wan fish culture zone at low water, reducing to less than 5 mg/l during the flood tide. In consideration of the tolerable threshold of 100 mg/l for caged fish, this would not be expected to cause adverse effects.

Table 7.8
Potential Increases in Suspended Solids Concentrations at Oyster Beds in Deep Bay Resulting from Combined Cycle Dredging and Dumping at The Brothers and Deep Bay Borrow Areas

State of Tide	Layer	Increase in Suspended Solids Concentration (mg/l)	Areas Affected
HHW	surface	5 - 7.5	Offshore area between Tai Shui Hang and Ngau Hom Sha
Peak Ebb	surface	5 - 7.5	Small offshore area at Tai Shui Hang
LLW	surface	<5	Offshore area between Tai Shui Hang and Lau Fau Shan
Peak Flood	surface	>10	Small area offshore from Sheung Pak Nai
		1 - 10	Most of offshore area

Source: Greiner-Maunsell, 1991

7.3.3 Construction Site Runoff

During the site preparation and subsequent infrastructure development, local water quality may be affected by drainage from the following sources:

- rainfall runoff from excavated areas of Chek Lap Kok and new reclamation areas; and

- water derived from dust suppression equipment at concrete batching plants and general haul/site roads.

The most likely pollutant from the above sources will be suspended solids, but accidental discharges of fuel, oil, grease, lubricants and solvents from construction plant and storage/maintenance areas may occur occasionally. Control of such hazardous materials is addressed in Section 11.

It is probable that two dedicated batching plants will be required on site at the Advanced Works area to meet the demands for concrete during the early phases of construction. Additional batching plants will be sited on the reclamation as BIC activities are initiated. Water will be used in large volumes for dust suppression purposes at these plants and for damping of paved areas, rinsing of truck exteriors and as washwater for mixer truck interiors. The amount of suspended solids in the water may cause potential turbidity problems in open water and blockages in closed drainage systems. Runoff from excavated slopes and exposed site areas is also likely to cause elevated turbidity in nearshore areas, especially during heavy rainfall.

7.3.4 Sewage Flows and Loads

During site preparation, there will be about 500 workers per shift on site, with approximately 100 accommodated at Chek Lap Kok. During construction of the airport buildings and infrastructure, it is estimated that up to 10,000 workers will be on site daily. Estimates of the sewage flows and loads which will be generated by these two groups of workers are given in Table 7.9. The values were obtained using 1996 flow and load factors from the *Sewage Strategy Study (1989)*.

Table 7.9
Sewage Flows and Loads Arising from Construction Workers at Chek Lap Kok

Source	Flow (m^3/d)	BOD (kg/d)	TKN (kg/d)	*E. coli* (count/d)
Site Preparation Contract Workers	95	52	10	5×10^{13}
Building and Infrastructure Contract Workers	600	340	67	3.5×10^{14}

Sources : Sewage Strategy Study, 1989 and Greiner-Maunsell, 1991

The pollutant loads arising from the site preparation workforce will be of a similar order of magnitude to those previously generated by the inhabitants and livestock on Chek Lap Kok. A resident population of 200 people and, say, 200 pigs would have produced BOD loads of approximately 40 kg/d and TKN loads of approximately 8 kg/d.

7.4 Mitigation Measures

7.4.1 Airport Reclamation Configuration

Maintenance of the present flushing regime of East Tung Chung Bay must be considered as the most effective means of controlling the growth of phytoplankton in the bay. This could be achieved by the construction of a suitably designed channel between the existing coastline and the airport reclamation. The preliminary calculations carried out to determine the peak ebb and flood discharges and also the residual discharge through the existing channel as shown in Section 6 indicated that the existing bay is quite well flushed by the flow between the mainland and Chek Lap Kok. Providing those flows are not reduced by more than 15 percent following the construction of the reclamation, siltation patterns and water quality are unlikely to be affected. It is therefore recommended that an artificial channel be included in the overall design of the reclamation to maintain the present flows and prevent enhancement of phytoplankton growth.

7.4.2 Dredging and Mud Disposal

Simulation of the effects of dredging, borrowing and disposal operations suggests that water quality at sensitive receivers will not deteriorate beyond tolerable limits. Predicted impacts are generally within the range which would be experienced under ambient conditions. Nevertheless, it is recommended that water quality is monitored during the course of the works to ensure that unacceptable conditions are not generated. The recommended monitoring programme is described in Section 7.5.

A restriction on sand dredging at Urmston Road and Deep Bay during the peak of the ebb tide would minimise the potential for adverse effects at the power station, and could be considered as a remedial measure if the water quality monitoring programme suggests that suspended solids concentrations are likely to approach the threshold limit.

7.4.3 Construction Site Runoff

To minimise construction site runoff and its associated impacts, it is recommended that drainage from exposed site areas should be channelled to a series of sediment traps comprising below ground tanks separated by baffles that reduce water velocity sufficiently to permit the majority of the solids to be deposited. Maintenance of the sediment traps on a regular basis through frequent digging out is essential, since progressive volume reduction reduces their removal efficiency.

No water from the batching plant should be discharged directly to sea. All areas surrounding the batching plants will be concrete paved (thus enabling easier dust suppression); with all hard standing areas being laid to fall to specially constructed settlement tanks. Washing down of haul vehicles or wheel wash facilities will also be located in areas where collection and subsequent sedimentation of suspended solids is possible. All water should be recycled and used for further dust suppression and rinsing purposes. Depending upon the volume of concrete being produced and the size of the settlement tanks, disposal of accumulated solids to the upper layers of the reclamation or later to landfill will be required once every one to four weeks. The sedimentation and water recycling systems must be maintained on a regular basis to ensure that they are effective.

Should any washwaters or other wastewaters be discharged to sea, they will require to be licensed under the WPCO and to comply with quality limits specified in the *Technical Memorandum on Effluent Standards* (TMES).

7.4.4 Sewage Treatment and Disposal

The sewage treatment works serving the airport and New Town will not be commissioned until 1997. Temporary sewage treatment facilities will therefore be required during the construction period.

Portable facilities have been provided for under the Advanced Works Contract, and will be extended to cater for the additional workforce under the SPC. For the BIC, each contractor involved should be required to provide portable sewage facilities and to arrange appropriate collection and disposal facilities, i.e. pumping out into collection vehicles and barging to an off-site disposal facility. It is possible that the Site Preparation Contractor may provide a co-ordinated service for collection and disposal to the individual BIC contractors.

7.5 Monitoring

An EPD-approved water quality monitoring programme should be carried out by the Engineer's environmental site staff, using facilities and equipment provided under the SPC. This should involve monitoring of dissolved oxygen, temperature and turbidity at three depths at 4-6 sites around each gazetted area to establish background conditions prior to works commencing; compliance during the progress of the works; and as a final check on water quality once the scheme has been completed. Monitoring should be carried out on mid-flood and mid-ebb tides, when the extent of sediment plumes would be expected to be greatest, at a frequency of three days per week. Monitoring stations should be located to reflect the positions of sensitive receivers relative to the impact zones and should permit sampling to be carried out both inside and outside areas affected by sediment plumes. This will give an indication of the natural variation in local water quality in unaffected areas "up current" of operational vessels. Where results from the monitoring programme indicate a deterioration in water quality, the Engineer should instruct the Contractor to adjust the operation of his plant and his working methods, if necessary, to ensure that his actions are not contributing to the deterioration.

Additional monitoring should also be carried out when dredging or dumping vessels are active within the 5km radius of Castle Peak Power Station, in order to ensure that the works do not cause adverse impacts on the cooling water systems. CLP have indicated a preferred form of monitoring for this purpose. On this basis, it is recommended that monitoring should also be carried out at two points 100m offshore from the A and B main cooling water intakes; on a direct line between each intake and any dredging or dumping vessel operating at the time of monitoring. Turbidity should be determined daily at 3m intervals down the vertical profile at each station, and where a reading equivalent to 150mg/l suspended solids or greater is recorded and confirmed by a second reading within ten minutes, the Engineer should initiate immediate action to minimise the suspended solids concentrations arising from airport related dredging and dumping operations.

PROVISIONAL AIRPORT AUTHORITY

Board Members

Chairman: The Hon. N.W.H. Macleod JP - Financial Secretary

Chief Executive: Mr. Richard Allen

Mr. James Blake - Secretary for Works

Mrs. Anson Chan JP - Secretary for Economic Services

Mr. Thomas T.T. Chen

Mr. David Gledhill JP

Mr. John Gray JP

Mr. Ho Sai-chu OBE JP

Mr. Antony Leung

Mr. Michael Leung Man-kin JP - Secretary for Transport

Mr. Vincent H.S. Lo

Mr. Peter Lok ISO JP - Director of Civil Aviation

Mr. David Nendick JP - Secretary for Monetary Affairs

Mr. Shu Tse-wong

New Airport Master Plan Study

Environmental Working Papers and Reports

Number	Title
1	Environmental Assessment - Methodologies, Baseline Data and Survey Requirements
7	Initial Environmental Impact Assessment
14	Progress on Environmental Baseline/Data Survey
23	Environmental Assessment of Construction Impacts (2 Volumes)
23	Appendix A (Revised) - Air Quality
26	Progress on Environmental Baseline Survey
34	Environmental Assessment of Operational Impacts
34	Section 5 and Appendix A (Revised) - Air Quality
35	Environmental Monitoring and Audit Operations Manual
41	Simulation of Sediment Losses during Dredging Activities
42	Noise Modelling Data and Assumptions
46	Bird Hazard Control Programme

First Interim Report EIA

Second Interim Report: Environmental Assessment of Construction Impacts

Summary and Recommendations: Environmental Assessment of Construction Impacts

Hong Kong's New Airport at Chek Lap Kok: Environmental Review

1. Environmental Legislation and Guidelines

ERL (Asia) Ltd (1989) Deep Bay Guidelines on Dredging, Reclamation and Drainage Works: Final Report.

Hong Kong Government (1990) Hong Kong Planning Standards and Guidelines, Revised Chapter 9: Environment, Planning Department.

Hong Kong Government (1991) Environmental Guidelines for Planning in Hong Kong, Environmental Protection Department.

Hong Kong Government (1990) Technical Memorandum on Effluent Standards.

Hong Kong Government (1989) Technical Memorandum on Noise from Construction Work Other than Percussive Piling.

Hong Kong Government (1989) Technical Memorandum on Noise from Percussive Piling.

International Civil Aviation Organization (1985) Airport Planning Manual: DOC 9184-AN/902, Part 2 Land Use and Environmental Control, 2nd Edition.

Watson Hawksley Asia et al (1989) Sewage Strategy Study: Final Report.

2. Noise

Environmental Assessment and Pollution Control Consultants (February 1991) Background Noise Survey for the North Lantau Development Project.

ERL (Asia) Ltd (1988) Study of the Noise Impact of Ground Operations at Hong Kong International Airport (Kai Tak).

Greiner Engineering, Inc. - Wyle Laboratories (Ohio) (1991) Aircraft Maintenance Run-Up Pad and Noise Suppression System Phase 1 Planning at Port Columbus International Airport.

International Civil Aviation Organization (1987) Airport Planning Manual: DOC 9184 - AN/902, Part 1 Master Planning.

International Civil Aviation Organization (1986) Procedures for Air Navigation Services, Aircraft Operations: DOC 8168 - OPS/611, Volume 1 Flight Procedures, 3rd Edition.

RMP Encon Ltd (1982) Replacement Airport at Chek Lap Kok - Master Plan Consultancy: Working Paper No. 16, Noise Impact and Land Use Compatibility.

RMP Encon Ltd (1988) Chek Lap Kok Airport Master Plan Review: Final Report, Appendix 2, Noise Impact Review.

U.S. Department of Transportation/Federal Aviation Administration (1983) Advisory Circular No. 150/5060-5, Airport Capacity and Delay.

Wyle Research Laboratories (1991) Aircraft Maintenance Run-Up Noise Impact at Dallas-Fort Worth International Airport. Wyle Research Report WR 91-1 (Final).

3. Air Quality

Mott MacDonald Hong Kong Ltd (1991) North Lantau Development Study: Study Report, North Lantau Air Quality Survey.

Mott MacDonald Hong Kong Ltd et al (1989) Port and Airport Development Strategy: Technical Paper No.13, Air Quality Studies: Emissions and Baseline Concentrations Calculations.

Royal Observatory (1982) Chek Lap Kok Meteorological and Oceanographic Investigations 1979-1982.

Sullivan, D.A. and B.A. Woodcock (1982) Gravitational Settling and Dispersion Modelling of Fugitive Dust Sources, Presentation at the 75th Annual Meeting of the Air Pollution Control Association.

Sutter, S.L. (1981) Potential Aerodynamic Entrainment of Soil from Excavation Operations in a Contaminated Area. Nuclear and Chemical Waste Management Volume 2.

U.S. Environmental Protection Agency (1977) Technical Guidance for Control of Industrial Process Fugitive Particulate Emissions.

U.S. Environmental Protection Agency (1979) Industrial Source Complex (ISC) Dispersion Model User's Guide EPA Report No. 450/4-79-030.

U.S. Environmental Protection Agency (1986) Compilation of Air Pollutant Emission Factors (AP-42), 4th Edition.

4. Hydrodynamics and Water Quality

Carleton, M.G. (1990) Comparison of overflows from separate and combined sewers - quantity and quality. Water Sci. Technol., 22, (10/11), 31-38.

CES Ltd (1990) Airport Drainage Strategy Studies - Clients confidential.

Electronic and Geophysical Surveys Ltd (1990) Port and Airport Development Strategy: Report HK48990, Enhancement of WAHMO Mathematical Models: Hydrographic and Oceanographic Surveys - Water Sampling and Analysis.

Ellis, J.B. (1985) The management and control of urban runoff quality. In "Pollution in the Urban Environment" ed. Chan M.W.H., Hoare, R.W.M., Holmes, P.R., Law, R.J.S. and Reed, S.B., Elsevier Appl. Sci. Pub., Essex.

Ellis, J.B. (1986) Pollutional aspects of urban runoff. In "Urban Runoff Pollution" ed. Torno, H.C., Marsalek, J. and Desbordes, M. NATO ASI Series Vol G10. Springer Verlag, Berlin, Heidelberg.

Ellis, J.B. (1989) The management and control of urban runoff quality. J. IWEM, 3, (2), 116-123.

Hong Kong Government (1990) Bacteriological Water Quality of Bathing Beaches in Hong Kong, EPD Water Policy Group.

Hydraulics Reasearch Ltd (1990) Port and Airport Development Strategy: Report EX 2179, Enhancement of WAHMO Mathematical Models: 1990 Wet Season Depth Profiles of Water Properties and Bed Density Measurements.

Marsalek, J. (1990) Evaluation of pollutant loads from urban non-point sources. Water Sci. Technol., 22, (10/11), 23-30.

Mott MacDonald Hong Kong Ltd (1991) North Lantau Development Study: Topic Report No. 10, Environmental Assessment.

Oil Companies International Marine Forum, International Oil Tanker and Terminal Safety Guide (IOTTSG), 2nd Edition.

Perry R (1989) Concentrations of pollutants in urban runoff. Pers. Comm.

8. Marine Ecology

Boorman, L.A. and D.S. Ranwell (1977) Ecology of Maplin Sands and the coastal zones of Suffolk, Essex and North Kent. NERC Institute of Terrestrial Ecology, Norwich.

Chan, H.M., P.S. Rainbow and D.J.H. Phillips (1990) Barnacles and mussels as monitors of trace metal bio-availability in Hong Kong waters. In Proceedings of the Second International Marine Biological Workshop: The Marine Flora and Fauna of Hong Kong and Southern China, Hong Kong, 1986. (B.S. Morten, ed.), pp. 1239-1268. Hong Kong University Press, Hong Kong.

Hodgkiss, I.J. and B.S. Morton (1978) *Zostera nana Roth.* (Potamogetonaceae) - a new record for Hong Kong. Memoirs of the Hong Kong Natural History Society 13, 23-27.

Melville, D.S. (1989) Hong Kong. In Scott, D.A. A Directory of Asian Wetlands, IUCN, Gland., pp. 283-294.

Morton, B.S. and S.S. Wu (1975) The hydrology of the coastal waters of Hong Kong. Environ. Res. 10, 319-347.

Richards, J. and R.S.S. Wu (1985) Inshore fish community structure in subtropical estuary. Asian Mar. Biol. 2, 57-68.

Saayman, G.S. and Tayler, C.K. (1979) The socioecology of humpback dolphins (*Sousa*sp.). In Behaviour of Marine Animals, Current Perspectives in Research, Volume 3, Cetaceans. (Wilnn, H.E. and Olla, B.L., eds) Plenum Press, New York, pp. 165-226.

Shin, P.K.S. (1989) Natural disturbance of benthic infauna in the offshore waters of Hong Kong. Asian Mar. Biol. 6, 193-207.

Shin, P.K.S. and G.B. Thompson (1982) Spatial distribution of the infaunal benthos of Hong Kong. Mar. Ecol. Prog. Ser. 10, 37-47.

US Office of the Federal Register of National Archives and Records Administration (1990) "Code of Federal Regulations", 40.

Wu, R.S.S. and J. Richards (1981) Variations in benthic community structure in a sub-tropical estuary. Mar. Biol. 64, 191-198.

6. Avifauna, Terrestrial Flora and Fauna

Chalmers, M.L. (1986) Annotated checklist of the birds of Hong Kong. Hong Kong Bird Watching Society, Hong Kong

Disney, R.H.L. (1981) Oriental Insects 15, 201-206.

Hilgerloh, G. (1990) Ungewöhnliches Verhalten ron Zugvögeln in Gibraltar: Störung durch Flugzeuge. J. Orn. 131, 311-316.

Lofts, B. (1982) Further Replacement Airport Studies : Faunal Survey of Chek Lap Kok.

Melville, D.S. (1982) Further Replacement Airport Studies : Study of Bird Populations in the Chek Lap Kok/North Lantau/Castle Peak Area. Report to the Director of Civil Aviation.

Simberloff, D. (1990) Reconstructing the ambiguous: can island ecosystems be restored? In Towns, D.R., Daugherty, C.H. and Atkinson, I.A.E. Ecological restoration of New Zealand islands. Conservation Services Publication No.2. Department of Conservation, Wellington, pp. 37-51.

7. Waste and Hazardous Materials

Hong Kong Government (1989) Waste Disposal Plan for Hong Kong, Planning, Environment and Lands Branch, Government Secretariat.

U.S. Department of Transportation/Federal Aviation Administration (1991) Management of Airport Industrial Waste, Advisory Circular No. 150/5320-15.

8. Socioeconomics

Mott MacDonald Hong Kong Ltd et al (December 1989): Port and Airport Development Strategy: Final Report.

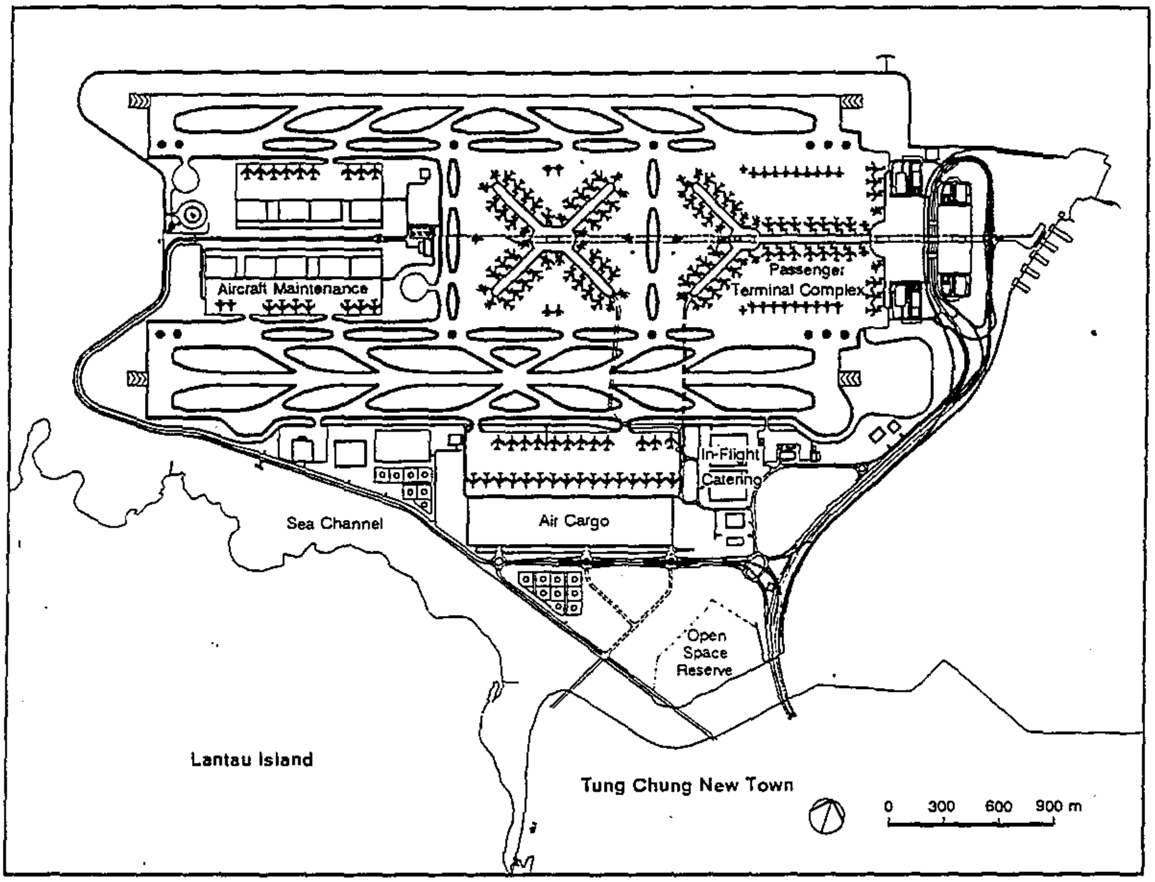
Shankland Cox (1991) Study of Industries and Commercial Enterprises that Need Relocation with the Airport: Final Report.

9. Archaeological and Historical Sites

Hong Kong Government (1990) Listed Items of Archaeological or Historical Interest in Hong Kong, Antiquities and Monuments Office: Recreation and Culture Branch.

ACZ	Air Control Zone
AFD	Agriculture and Fisheries Department
AFFF	Aqueous Film Forming Foam
ALP	Airport Layout Plan
ANL	Allowable Noise Level
APCO	Air Pollution Control Ordinance
AQO	Air Quality Objective
AQR	Air Quality Requirement
ASR	Area Sensitivity Rating
ATC	Air Traffic Control
AWC	Advance Works Contract
BIC	Building and Infrastructure Contract
BNL	Basic Noise Level
BOD	Biochemical Oxygen Demand
CAD	Civil Aviation Department
CFC	Chloroflorocarbons
CLK	Chek Lap Kok
CLP	China Light and Power Co Ltd
CNL	Corrected Noise Level
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
dB(A)	Decibel(s) A - weighted
DO	Dissolved Oxygen
EDTA	Ethylenediamine Tetraacetic Acid
EPA	U.S. Environmental Protection Agency
EPD	Environmental Protection Department
FAA	U.S. Federal Aviation Administration
HC	Total Hydrocarbons
HKPSG	Hong Kong Planning Standards and Guidelines
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
INM	Integrated Noise Model
ISC	Industrial Source Complex
NB	Narrow Bodied
NCO	Noise Control Ordinance
NEF	Noise Exposure Forecast
NH_3-N	Ammonia-Nitrogen
NH_4-N	Ammonium-Nitrogen
NLD	North Lantau Development
NLDS	North Lantau Development Study
NLE	North Lantau Expressway
NM	Nautical Air Miles
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NSR	Noise Sensitive Receiver
NTA	Nitrilotracetic Acid
NWNT	North West New Territories
NWWZ	North Western Waters Zone
OWB	Other Wide Bodied
PAA	Provisional Airport Authority
PAH	Polyaromatic Hydrocarbons
PAL	Point-Area-Line Sources Model
PCB	Polychlorinated Biphenyls
PHI	Potentially Hazardous Installation
PME	Powered Mechanical Equipment
PNL	Predicted Noise Level
RFF	Rescue and Firefighting

RSD	Regional Services Department
RSP	Respirable Suspended Particulates
RTS	Refuse Transfer Station
SEL	Sound Exposure Level
SIR	Second Interim Report
SO_x	Sulfur Oxides
SPC	Site Preparation Contract
SPL	Sound Power Level
SS	Suspended Solids
SSS	Sewage Strategy Study
SSSI	Site of Special Scientific Interest
TKN	Total Kjeldahl Nitrogen
TM	Technical Memorandum on Noise from Construction Work other than Percussive Piling
TMES	Technical Memorandum on Effluent Standards
TMPP	Technical Memorandum on Noise from Percussive Piling
TSP	Total Suspended Particulates
TTM	Total Toxic Metals
USD	Urban Services Department
WAHMO	Water Quality and Hydraulic Model
WCZ	Water Control Zone
WDO	Waste Disposal Ordinance
WENT	Western New Territories
WPCO	Water Pollution Control Ordinance
WQO	Water Quality Objective



Master Plan for Year 2040

- Airport site: 1,248 hectares
  - one quarter former islands;
  - three quarters reclaimed.
- Two parallel runways
  - 3,800m length;
  - 60m width;
  - 1,525m separation.
- Taxiway system between and south of runways.
- Midfield passenger terminal complex.
- Centralized terminal processing building.
- Attached and satellite terminal concourses.
- 120 aircraft parking positions.
- Road, rail and ferry access along eastern site boundary.
- Three road bridges to the site.
- Midfield aircraft maintenance facility.
- Air cargo, catering, ground support and air mail centre south of airfield.
- Airport maintenance, police and fuel storage facilities south of airfield.
- General aviation and Government Flying Services Department south of airfield.
- Planned to satisfy forecast demand in 2040
  - 87.3 million passengers;
  - 8.9 million tonnes of air cargo;
  - 375,500 aircraft movements.