AGREEMENT NO. 13/92

NEW EXPLOSIVES COMPLEX AT KAU SHAT WAN

ENVIRONMENTAL ASSESSMENT

FINAL REPORT
March 1993

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1. INTRODUCTION

1.1 Background

Hong Kong's central explosives depot is currently located on Stonecutters Island and requires to be resited before January 1997. In 1988, the findings of a full feasibility study concluded that the proposed site at Chi Ma Wan would be suitable for relocation of the facility. However since then the site has become unavailable and the alternative location at Kau Shat Wan is currently being investigated.

The present Study is charged with identifying potential environmental impacts arising either during construction and operation of both the explosives depot.

The Study Area (as shown on Figure 1.1) is situated on the east coast of Lantau Island midway between Discovery Bay and Silvermine Bay. The site is relatively inaccessible with land access only by a narrow footpath from the Trappist Haven Monastery to the north or from Man Kok to the south. With an eastern aspect to Peng Chau the site is, however, highly visible from the main ferry routes serving Peng Chau and Silvermine Bay and will be visible from the residential areas on Peng Chau.

1.2 Purpose of this Report

The purpose of this report is to detail the findings of the environmental assessment (EA) undertaken on the four layout options provided by Government and to propose measures to mitigate any impacts arising during either construction or operation.

The four layouts which are considered have been developed following an initial assessment and review of nearly twenty possible options.

The layout options, shown on Figures 1.2, 1.3, 1.4, and 1.5, which have been considered are as follows:

(a) aboveground option Layout C2(a);
(b) aboveground option Layout A4(a);
(c) underground option Layout 8(a); and
(d) hybrid option Layout D3.

Each of the layouts provide space for an explosives complex of sufficient size to meet present demands plus possible expansion in the future.

The two aboveground options would have all explosives storage built on a platform formed by reclamation. The underground option would have all explosives storage in caverns excavated beneath the hills behind Kau Shat Wan and would have a smaller platform on reclaimed land for administration buildings and berthing facilities. The hybrid option would have storage partially underground and partially above ground.

1.3 Key Objectives

The key objectives of the EIA may be summarised as follows:

(i) to establish an environmental baseline of existing conditions and identify baseline survey requirements;

(ii) to assess potential impacts on the existing environment during construction of each of the proposed layouts;

(iii) to propose suitable methods for the reduction of any impacts identified under (ii) above to ensure compliance with current environmental standards and guidelines;

(iv) to assess any impacts which could arise once the facility is operational and to recommend measures for their reduction to acceptable levels; and

(v) to propose an environmental monitoring and audit programme for the construction and operation phases to ensure the standards set are being achieved.

1.4 Scope of the Report

This report presents details of relevant environmental legislation, construction and operation activities and the environmental framework of the site in Chapters 2 to 5. Chapters 6, 7, 8 and 9 present an assessment of the impacts from each of the four layouts. Mitigation measures and recommendations for monitoring and audit are generally common to the four layouts and these are discussed in Chapters 10 to 11.

2. ENVIRONMENTAL LEGISLATION

2.1 Water Quality

The principal legislation governing marine water quality in Hong Kong is the Water Pollution Control Ordinance (Cap 358) (WPCO). Under an amendment to the original Ordinance of 1980, Territorial waters were subdivided into Water Control Zones (WCZ) with each WCZ being assigned a series of Water Quality Objectives (WQO). These WQO's relate to the Beneficial Uses (BU) and assimilative capacity of the particular water body or part thereof.

The Kau Shat Wan Study Area is in the Southern Water Control Zone (SWCZ), which was declared in 1988. Beneficial Uses are given in Table 2.1 below and the corresponding WQO's for the SWCZ are set out in Table 2.2 overleaf.

Table 2.1 Beneficial Uses Applied to Southern Water Control Zone

Beneficial Use	Applicability
BU1 Human Food	Applies to the food and not the water
BU2 Commercial Exploitation	Applies to fish culture areas
BU3 Marine Life	Applies throughout the territorial marine waters
BU4 Bathing	Applies to waters at gazetted and proposed beaches only
BU5 Secondary Contact Recreation	Applies in coastal waters where recreational activities could take place or where intakes may be located
BU6 Domestic/Industrial	Applies in coastal waters where recreational activities could take place or where intakes may be located
BU7 Navigation/Shipping	Applies throughout the territorial marine waters
BU8 Aesthetic	Applies throughout the territorial marine waters

Source : Sewage Strategy Study, November 1989, Watson Hawksley

In 1990, the prevailing right of existing dischargers to increase existing effluent discharges to WCZ's by up to 30% was terminated. In the same year a technical memorandum was prepared, which defined quality standards for the discharge of effluent into any foul sewers, stormwater drains, inland waters and coastal waters within the WCZ's. In January 1991 the Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters, (TMES), was issued.

Under the provisions of the TMES all discharges must be licensed. Tables included within the document identify standards attached to effluent flow rates ranging from $<10m^3$/day to $6,000m^3$/day thus providing guidance on a case by case basis.

Reference has been made to the TMES when assessing treatment and disposal options for liquid wastes arisings both during the construction and operation phases of the explosives complex.

Table 2.2 Summary of Water Quality Objectives for Southern Waters

Water Quality Parameter	Objective	Sub-zone
Offensive odour, tints 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 610 per 100ml, calculated as the geometric mean of all samples collected in a calendar year	Secondary contact recreation subzones and fish culture zones
	Not to exceed 180 per 100ml, calculated as the geometric mean of all samples collected between March and October inclusive in one calendar year	Bathing beach subzones
D.O. within 2m of bottom	Not less than 2mg/l for 90% samples	Whole zone
Depth average D.O.	Not less than 4mg/l for 90% samples during year	Marine waters except fish culture sub zone
	Not less than 5mg/l for 90% samples	Fish culture sub zone
Depth average D.O.	Waste discharges not to cause less than 4mg/l	Inland waters of the zone
pH	To be in the range 6.5 - 8.5, change due to waste discharge not to exceed 0.2	Marine waters except bathing beach subzones : Mui Wo (A, B, C, D, E, F)
Temperature change	Change due to waste discharge not to exceed 2°C	Whole zone
Salinity	Change due to waste discharge not to exceed 10% of natural ambient level	Whole zone
Suspended solids	Waste discharge not to raise the natural ambient level by 30% nor accumulation of suspended solids	Marine waters
Ammonia	Annual mean not to exceed 0.021mg/l calculated as the annual average, 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
BOD5	Waste discharges not to exceed 5mg/l	Inland waters of the zone
COD	Waste discharges not to exceed 30mg/l	Inland waters of the zone
Toxicants producing significant toxic effects	Not to be present	Marine waters

Sources : 1988 Ed. SWCZ Statement of Water Quality Objectives, WPCO Cap. 358 Section 5
SWCZ statement of Water Quality Objectives (Amendment) Statement 1991, WPCO Chapter 358

2.2 Noise

The Noise Control Ordinance (NCO), gazetted in 1988, is the main legislation controlling noise levels from industrial and commercial premises and from construction works. The Ordinance is enacted through three Technical Memoranda and two sets of Regulations.

The NCO imposes stringent controls on any construction work that is carried out in close proximity to any Noise Sensitive Receivers (NSR's). The activity of percussive piling is restricted and such work can only be undertaken within the limits of a Control Noise Permit (CNP) which is issued by the Environmental Protection Department (EPD). For construction work other than percussive piling, restrictions are enforced as shown in Table 2.3.

Table 2.3 Basic Noise Levels for Construction Activities Other than Percussive Piling dB(A)

Time Period	Area Sensitive Rating		
	A	B	C
All days during the evening (1900-2300 hrs) and general holidays (including Sundays) during the daytime and evening (0700-2300 hrs) (Period I)	60	65	70
All days during the night time (2300-0700 hrs) (Period II)	45	50	55

The Technical Memorandum on Noise from Construction work other than Percussive Piling (TM1) sets out standards for construction noise and the method of calculation of the noise impact. No work using powered mechanical equipment is allowed during Periods I and II (Table 2.3) unless a Construction Noise Permit (CNP) is issued by the Director of Environmental Protection. Basic Noise Levels (BNLs) are prescribed for areas according to their sensitivity rating. The Area Sensitivity Rating (ASR) of the Kau Shat Wan Study Area is 'A' as it is a rural area. The BNLs apply as the Acceptable Noise Levels following corrections for the duration of the CNP and for multiple site situations. The noise levels from items of powered mechanical equipment to be used on-site are then calculated and a CNP will be only issued if the calculated noise levels are less than those prescribed in the TM.

2.3 Air Quality

Air quality legislation is enacted under the Air Pollution Control Ordinance (APCO) (Cap 311) to control the emission of air pollutants from stationary sources. The Ordinance applies to all emissions from chimneys, engines, furnaces, ovens or industrial plant. Under the legislation, Government is empowered to declare Air Control Zones (ACZ), which it has done for the whole Territory.

Certain specified processes are named under the APCO which have specific controls attached. The Air Quality Objectives (AQOs) which are applied throughout the ACZ's are given in Table 2.4.

Concrete batching and rock crushing are specified processes under the APCO and the Contractor will therefore require a special permit in order to operate such plant.

Stationary sources of air emissions for this project will include excavation and loading and unloading of spoil. Mobile sources of emissions include vehicular movements for transportation of spoil and other materials.

Table 2.4 Hong Kong Air Quality Objectives

Pollutant	Concentration in Micrograms Per Cubic Metre (i)					Health Effects of Pollutant at Elevated Ambient Levels
	Averaging Time					
	1 Hour (ii)	8 Hours (iii)	24 Hours (iii)	3 Months (iv)	1 Year (iv)	
Sulphur Dioxide	800		350		80	Respiratory illness; reduced lung function; morbidity and mortality rates increase at higher levels.
Total Suspended Particulates			260		80	Respirable fraction has effects on health.
Respirable (v) Suspended Particulates			180		55	Respiratory illness; reduced lung function; cancer risk for certain particles; morbidity and mortality rates increase at higher levels.
Nitrogen Dioxide	300		150		80	Respiratory irritation; increased susceptibility to respiratory infection; lung development impairment.
Carbon Monoxide	30000	10000				Impairment of co-ordination; deleterious to pregnant women and those with heart and circulatory conditions.
Photochemical Oxidants (as Ozone) (vi)	240					Eye irritation; cough; reduced athletic performance; possible chromosome damage.
Lead				1.5		Affects cell and body processes; likely neuropsychological effects, particularly in children; likely effects on rates of incidence of heart attacks, strokes and hypertension.

Legend:

(i) Measured at 298°CK (25°C) and 101.325 kPa (one atmosphere)
(ii) Not to be exceeded more than three times per year.
(iii) Not to be exceeded more than once per year.
(iv) Arithmetic means.
(v) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometres and smaller.
(vi) Photochemical oxidants are determined by measurement of ozone only.

2.4 Solid Waste

The Waste Disposal Ordinance (WDO) (Cap 354) was enacted in 1980 and a strategic Waste Disposal Plan for Hong Kong was published in 1989.

Oil and fuel spills to coastal waters are controlled separately under the Shipping and Port Control Ordinance (Cap 313) and are the responsibility of the Marine Department whereby the Oil Pollution (Land Use & Requisition) Ordinance (Cap. 247) is used to regulate the requisition of vessels and equipment and the recovery of associated costs in clearing up a major oil spill.

Design of fuel storage facilities and chemical spillages on land are regulated by the Fire Services Department.

2.5 Ecology

Various legislative and regulatory controls are in place for the conservation of species and protection of the environment. The Forests and Countryside Ordinance (Cap 96) 1984, the Country Parks Ordinance (Cap 208) 1976, the Country Park Special Areas Regulations 1989, Wild Animals Protection Ordinance (Cap 170) 1980, Animals and Plants Protection of Endangered Species (Cap 187) 1988, the Antiquities and Monuments Ordinance (Cap 53) 1986, the Town Planning Ordinance (Cap 131) 1988, and the Town Planning Amendment Ordinance 1991 are particularly pertinent.

As the Study Area encompasses waterways frequented by small fishing boats, the Fisheries Protection Ordinance 1987 (Cap 171) is also relevant as it aims to protect fish and other aquatic life in addition to regulating fishing practices.

2.6 Hong Kong Planning Standards and Guidelines

In addition to the foregoing legislation, Chapter Nine of the Hong Kong Planning Standards and Guidelines (HKPSG) provides wide ranging guidance on environmental issues which should be considered in development and planning activities.

3. CONSTRUCTION ACTIVITIES

3.1 Introduction

The project is presently in the feasibility study stage and construction methods and programmes are not available. Schedules of construction activities have therefore been developed based on a preliminary activity chart. The activity chart is indicative only at this stage of the project and the time requirements for each activity will vary depending on the layout option finally adopted.

A summary of the main construction activities and the quantities involved for each layout is presented in Table 3.1.

Table 3.1 : Summary of Main Construction Activities

Activity	Layout			
	Aboveground		Underground	Hybrid
	C2(a)	A4(a)	8(a)	D3
Dredging : two options (i) all marine mud removed (ii) only remove mud to form seawall Programmed for 9 months	Both Kau Shat Wan and bay due north would be dredged. (i) 1.53Mm^3 spoil (ii) 0.49Mm^3 spoil	Dredging all of Kau Shat Wan extending 100m seaward of the headlands. (i) 0.85Mm^3 spoil (ii) 0.34Mm^3 spoil	Only dredging within Kau Shat Wan. (i) 0.60Mm^3 spoil (ii) 0.25Mm^3 spoil	Dredging of Kau Shat Wan to north of headland. (i) 1.30Mm^3 spoil (ii) 0.41Mm^3 spoil
Seawall Armouring Programmed for 9 months	Approximate length of seawall is 930m	Approximate length of seawall is 650m	Approximate length of seawall is 500m	Approximate length of seawall is 800m
Land Formation : two options (i) Reclaim between already formed seawall and existing coastline (ii) Reclaim from foreshore seawards Programmed for 15 months	Fill requirements : (i) Consolidation Option 2.23Mm^3 (ii) Dredged Option 3.27Mm^3	Fill requirements : (i) Consolidation Option 1.12Mm^3 (ii) Dredged Option 1.63Mm^3	Fill requirements : (i) Consolidation Option 0.68Mm^3 (ii) Dredged Option 1.28Mm^3	Fill requirements : (i) Consolidation Option 1.71Mm^3 (ii) Dredged Option 2.6Mm^3
Formation of Platform Programmed for 20 months	Rock Excavation 0.98Mm^3 Soil Excavation 0.275Mm^3	Rock Excavation 3.40Mm^3 Soil Excavation 0.74Mm^3	Rock Excavation 0.36Mm^3 Soil Excavation 0.17Mm^3	Rock Excavation 0.18Mm^3 Soil Excavation 0.08Mm^3
Cavern/Tunnel Excavation	-	-	0.09Mm^3 in Rock	0.05Mm^3 in Rock
Buildings, Admin Bldg, Utilities, Programmed for 9 months				

3.2 Dredging and Reclamation

Dredging works have been programmed for a period of nine months. A two month overlap with the land formation phase has been shown and for the purposes of this assessment it has been assumed that a single dredger would be employed, accompanied by two barges, a launch and a tugboat.

Two methods for reclamation have been considered in this assessment. The first involves the removal of all marine mud prior to land formation, the second assumes consolidation of the mud prior to reclamation using vertical wick drains. Quantities of spoil arising from the two methods are given in Table 3.1.

Dredging will also be required to form the seawall. This activity is programmed over a nine month period. It has been assumed that formation of the seawall for Layout 8(a) will take half as long to complete as for Layout C2(a) as the former is just over half the length of that shown in Layout C2(a).

Reclamation has been programmed over a fifteen month period. The duration of this activity is not only influenced by the reclamation area of each option but also the method of site preparation adopted. It has been assumed that two barges, with derricks, two tugboats and a launch will be used for the marine activities, with bulldozers, compactors and sand pumps for the land/marine aspects. Two barges, with derricks, and two tugboats will probably be required when forming the seawall.

3.3 Cutting and Excavation

Twenty months have been allowed for formation of the platform for each layout. As with other activities this will be determined by the layout finally adopted. Plant which have been assumed to be used for this activity include a drilling rig, pneumatic drills, bulldozers and excavators.

Spoil generation rates are given in Table 3.1 and it is evident that the underground option 8(a) will generate the smallest volume of rock spoil. Rates of spoil generation and disposal methods are discussed later in the text.

3.4 Concrete and Finishing

Construction of the buildings, provision of utilities, surfacing and finishing the site has been programmed for a nine month period. Plant used for these activities have been assumed to include a concrete batching plant and pump, a paver, poker vibrator and dump trucks.

3.5 Restorative Works

Final works will include provision of a security fence with screening and planting which are necessary to reduce the visibility of the site.

4. OPERATION PHASE

4.1 Explosives Depot

Once operational the new explosives complex will be the central depot for the issue of explosives on a daily basis throughout the Territory.

It has been assumed that explosives will be issued twice in the morning and once in the afternoon. Once every three weeks there will be a delivery of explosives from the Dangerous Goods Anchorage in the Harbour to the explosives complex.

On the basis of the previous feasibility study for Chi Ma Wan it has been assumed that a maximum of 150 employees will be engaged on-site including security personnel. Employees will also require ferrying to and from the explosives complex.

4.2 Access

Access to the explosives complex will be restricted and limited to authorised personnel only who will arrive by boat. The shallow water close to the proposed explosives complex means than either jetties will have to be constructed to deeper water or access channels will have to be dredged. It is understood the latter is more likely and there may thus be a need for maintenance dredging in the future.

Land access to the site will be restricted by the relative inaccessibility of the site reinforced by security fences and security patrols.

5. EXISTING ENVIRONMENT, ASSESSMENT METHODOLOGY AND CRITERIA FOR ASSESSMENT

5.1 Water Quality

5.1.1 Sensitive Receivers

Beneficial Uses

As discussed in Section 2.1 all eight BU's are applicable in the SWCZ, although some of these apply to only part of the Zone. This assessment has focused upon those BU's relevant to the construction and operation of the explosives complex. These are BU2 (fisheries), BU3 (marine life), BU7 (navigation and shipping), and BU8 (aesthetic enjoyment). People who could be affected under BU8 will include ferry passengers, local fishing craft and people aboard pleasure vessels.

Fisheries and Marine Life

According to information supplied by the Marine Department about 30 small fishing vessels, mostly Class IV mechanised and non-mechanised vessels, are moored at Mui Wo. These vessels ply between Mui Wo, Peng Chau and Chi Ma Wan. It may be necessary for an exclusion zone to be established in front of the marine works area even during the construction phase.

Streams and Water Courses

Three small streams drain the hinterland into Kau Shat Wan. Visual inspection of these streams reveals relatively unpolluted waters but with few freshwater organisms. These streams are likely to require diversion and retraining during construction of the explosives complex.

5.1.2 Existing Environment

The main sources of existing data comprise the routine water quality monitoring data (Station SM11, 22.02.91 - 08.04.92) and bottom sediment sampling data (Station SS5, 27.08.91) in Silver Mine Bay provided by EPD. The monitoring locations are shown on Figure 5.1 and the data are summarised in Tables 5.1 and 5.2. Further details are included in Appendix A for reference.

Figure 5.2 shows the marine contour for the waters around Kau Shat Wan. Water depths in the Study Area are one to two metres only.

5.1.3 Baseline Survey Data

Water Quality Data

A baseline water quality monitoring survey was conducted on the 6th July 1992 at four locations (A1-A4) adjacent to the site. The sampling locations are shown on Figure 5.1.

In situ testing included dissolved oxygen and temperature, with laboratory analyses of total Kjeldahl nitrogen, total inorganic nitrogen, E.coli, oil and suspended solids levels.

Data obtained from the baseline survey are summarised in Table 5.1 along with EPD's routine monitoring data from station SM11.

Table 5.1 Summary of Water Quality Data at Kau Shat Wan (Depth Averaged)

Parameter	Station				
	A1	A2	A3	A4	SM11
Dissolved Oxygen (mg/l)	6.3	6.1	6.4	5.9	6.9
Dissolved Oxygen (% Sat)	95.3	91.6	94.8	89.4	88.2
Temperature (degree C)	28.3	28.3	28.3	29.4	20.6
Oil and Grease (mg/l)	19	19	17	14	-
Suspended Solids (mg/l)	8	15	19	11	9
E.coli (No/100ml)	2	4	3	1	33
Total Inorganic N (mg/l)	0.24	0.25	0.24	0.24	0.25
Total Kjeldahl N (mg/l)	0.5	0.4	0.4	0.3	0.27

Examination of these data indicates well oxygenated conditions in the inshore waters with dissolved oxygen levels around 6mg/l. Not unexpectedly there was little evidence of faecal contamination offshore at Kau Shat Wan.

Sediment Quality Data

In addition to water quality samples, two samples of surface sediments were collected just offshore of Kau Shat Wan at the locations S1 and S3 (17.07.92) shown on Figure 5.1. A summary of the results of sediment analyses are given in Table 5.2

Table 5.2 Summary of Sediment Sampling Data

Location	Parameter (mg/kg)						
	Cd	Cr	Cu	Pb	Ni	Zn	Hg
S1	<0.5	11	15	28	7.6	60	0.10
S3	<0.5	16	17	30	11	62	0.14
Trigger Level(1)	1.0	50	55	65	35	150	0.8
Action Level(1)	1.5	80	65	75	40	200	1.0

Notes : (1) Contaminated Spoil Management Study

Comparing the results shown in Table 5.2 with the Trigger and Action Levels, promulgated under the Contaminated Spoil Management Study 1991, it is apparent that the sediments sampled from Kau Shat Wan (S1 and S3) are uncontaminated. Thus, no special disposal methods will be required for disposal of any dredged material.

5.1.4 Effluent Flows and Loads

Existing domestic effluent flows and loads have been estimated based on population data collected during the Study, (Table 5.4) in conjunction with multiplication factors derived under the Sewage Strategy Study, 1989, It was also assumed that the residents of the area were all locally employed and there was no import of labour into the Study Area. The estimated existing effluent flows and pollution loads are presented in Table 5.3.

Table 5.3 Estimated Existing Effluent Flows and Pollutant Loads

Source	Population no.	Unit Flow	Unit Load (kg/day)						
		m^3/day	SS	BOD	COD	TKN	NH_3N	TTM	E.Coli
Factor :		0.140	0.040	0.042	0.090	0.0085	0.0050	0.0002	3.5E10
Tung Wan Tau	79	11.1	3.16	3.32	7.11	0.67	0.39	0.016	2.76E12
Ngau Hom Pai	15	2.1	0.60	0.63	1.35	0.13	0.08	0.003	5.25E11
Chuk Tsai Wan	7	1.0	0.28	0.29	0.63	0.06	0.04	0.001	2.45E11
Man Kok	18	2.5	0.72	0.76	1.62	0.15	0.09	0.004	6.3E11
Kau Shat Wan	2	0.3	0.08	0.08	0.18	0.02	0.01	0.0004	7.0E10
Tai Shui Hang	24	3.4	0.96	1.01	2.16	0.2	0.12	0.005	8.4E11
Total	145	20.4	5.8	6.09	13.05	1.23	0.73	0.029	9.27E10

Source : Sewage Strategy Study November 1989, Watson Hawksley

5.2 Noise

5.2.1 Sensitive Receivers

Noise sensitive receivers (NSRs) have been identified according to the HKPSG and a land use and population survey. Details of the NSRs including linear distances from each site layout measured as the distance between the NSR and the mid point between the centre of the site at the boundary are included in Table 5.4. The NSRs are shown on Figure 5.3 and determined as premises or land uses up to 1750m away from the site that could be affected by construction or operation of the depot.

The only property directly affected by the explosives complex will be the holiday home at Kau Shat Wan which will have to be resumed. The impacts on this property have therefore not been assessed.

The resident population in the Study Area that may be affected by construction and operation of the project has been estimated at 145.

Table 5.4 Noise Sensitive Receivers

Noise Sensitive Receiver and Identification Number		Number of Households	Population	Distance between the NSR and the mid point between the site centre and site boundary (m)			
				Layout C2 (a)	Layout A4 (a)	Layout 8 (a)	Layout D3
1.	Tung Wan Tau	35	79	1730	1520	1568	1745
2.	Ngau Hom Pai	3	15	1415	1195	1235	1337
3.	Chuk Tsai Wan	3	7	1080	920	920	1007
4.	Chuk Tsai Wan			1025	890	880	970
5.	Man Kok	8	18	540	473	445	472
6.	Trappist Monastery at Tai Shui Hang	1	20	640	740	790	825
7.	Farmhouse at Tai Shui Hang	1	2	457	690	755	670
8.	House Between Tai Shui Hang and Kau Shat Wan	1	2	325	515	575	565
9.	Kau Shat Wan	1	2	Located on site so will be resumed			
	Total	53	145				

5.2.2 Existing Data

Data on the ambient noise levels around the Study Area have been collated by previous studies at locations 3-9 shown on Figure 5.4. The data are summarised below in Table 5.5 and show very low background levels. Daytime noise levels ranged between 46 and 63 L_{90} dB(A), evening levels between 45 and 57 L_{90} dB(A), and night time levels between 42 and 50 L_{90} dB(A).

Table 5.5 Existing Background Noise Levels

Monitoring Locations	Range of Noise Levels L_{90}dB(A)		
	Day	Evening	Night
Discovery Bay	45 - 48	45 - 51	35 - 48
Peng Chau	50 - 57	46 - 53	42 - 50
Silvermine Bay	58.2 - 61.5	61.6 - 63.5	58.2 - 63.4
Hei Ling Chau	46.2 - 53	45 - 49	42 - 47
Chi Ma Wan	48.3 - 55.1	45.1 - 49.2	44.3 - 47.2
Cheung Chau	48 - 63	46 - 57	44 -

Source: Lantau Port and Western Harbour Development Studies, WP12A, Environmental Baseline, APH Consultants

5.2.3 Baseline Survey Data

From the 15th to the 16th of July 1992 a 24 hour noise monitoring survey was undertaken at the Trappist Haven Monastery at Tai Shui Hang (Location 2) and the settlement of Man Kok (Location 1), north and south of Kau Shat Wan respectively, as shown on Figure 5.4.

The results of the noise survey are shown in Table 5.6. Prevailing background noise levels ranged between 30 and 50 L_{90} dB(A). Full details of the noise survey are included in Appendix B.

Table 5.6 Summary of Baseline Survey Data

Monitoring Site	Background (L_{90}) dB(A)	L_{eq} dB(A)
Man Kok	36.8 - 48.3	43.4 - 74.3
Tai Shui Hang	32.9 - 49.9	38.3 - 58.7

These baseline noise levels are low apart from the L_{eq} at Man Kok, and fall within the range of the background data collected by others as shown in Table 5.5. During the baseline survey the main contributions to the ambient noise levels were observed to be from aircraft passing overhead, passing marine craft and vessels, and general neighbourhood noise. This was also confirmed from site investigation. Some of the higher readings occurred due to the intermittent barking of dogs, particularly at Man Kok.

Noise levels are measured in L_{eq} which is the A-weighted noise level averaged over the measurement period. L_{eq} can be defined as the continuous steady noise level which would have the same total A-weighted acoustic energy as the real fluctuating noise over the same period of time.

5.2.4 Assessment of Noise During Construction

The impacts from noise generated by the construction of each layout were predicted at each NSR by calculating the cumulative effects of distance attenuation, ground adsorption and topography on the sound power levels of the construction equipment assumed to be used. The distance between the site and each NSR was measured from the mid point between the centre and the boundary of the site in accordance with the methodology in TM1. The sound power levels for each item of powered mechanical equipment were supplied in TM1.

Distance attenuation was measured by calculating the correction factors from Table 5 of TM1 using the formula

$$PNL=A-(20\log R+8)$$

where,

PNL is the predicted noise level;

A is the sound power level in dB(A) of items of powered mechanical equipment; and

R is the distance from source to receiver in metres.

The correction for ground adsorption was calculated using the formula

$$5.2\log_{10}(3/\text{distance})$$

from the Calculation of Road Traffic Noise, by the Department of Transport, Welsh Office, HMSO Pubn, 1988.

The effect of the topography was determined from Redfearn's chart which calculates the attenuation provided by a thin screen, from Chapter 10, Factors Affecting Traffic Noise and Methods of Prediction by Bernard M Favre, in the Transportation Noise Reference Book edited by Paul Nelson, Butterworths, 1987. It is likely that this parameter was underestimated as the calculation was applied in a simplified form to topography rising to above 100 metres. However it has at least provided some indication of the attenuation that could be expected from such topography.

5.2.5 Assessment of Noise During Operation

Once the explosives depot is operational any noise will be minimal and short term. The main impact will be from the small 'Mines' Department' vessels as they pass NSRs on their way to and from the depot. The impacts will not be significant.

There could also be noise from detonation of explosives if a firing cell is included in the complex. However it is not possible to predict the quantities that could be fired or the frequency. Firing will only be during the daytime when noise impacts are not likely to be intrusive. The noise from firing will be reduced by blast walls at the firing cell.

5.3 Air Quality

5.3.1 Sensitive Receivers

Air Sensitive Receivers (ASRs) have been identified according to the HKPSG and land use and population surveys. The ASRs are the same as the NSRs but the distances were measured from the centre of the source area on site as given in Table 5.7 and shown on Figure 5.3.

Table 5.7 Air Sensitive Receivers

Air Sensitive Receiver and Identification Number		Number of Households	Population	Distance between the ASR and the centre of source area on site (m)			
				Layout C2 (a)	Layout A4 (a)	Layout 8 (a)	Layout D3
1.	Tung Wan Tau	35	79	1717	1540	1620	1685
2.	Ngau Hom Pai	3	15	1425	1225	1300	1365
3.	Chuk Tsai Wan	3	7	1155	935	995	1050
4.	Chuk Tsai Wan			1125	907	960	1010
5.	Man Kok	8	18	712	590	575	570
6.	Trappist Monastery at Tai Shui Hang	1	20	690	765	790	810
7.	Farmhouse at Tai Shui Hang	1	2	640	800	790	787
8.	House Between Tai Shui Hang and Kau Shat Wan	1	2	462	625	610	610
9.	Kau Shat Wan	1	2	Located on site so will be resumed			
	Total	53	145				

The holiday home at Kau Shat Wan will be resumed prior to commencement of construction and this property will therefore not be an ASR.

5.3.2 Existing Data

Existing data in the vicinity of the Study Area was collected by LAPH at Cheung Chau (14th - 30th November 1991) and Discovery Bay (4th - 21st December 1991) for TSP, RSP, SO_2, NO and NO_2. A summary of the data is included in Tables 5.8 and 5.9 and indicates good ambient air quality. The locations of the sampling stations are shown on Figure 5.5 and further details of the air quality data are included in Appendix C.

Table 5.8 Existing Mean Measured Pollutant Levels at Cheung Chau

Pollutant	Arithmetic Mean ($\mu g/m^3$)	Geometric Mean ($\mu g/m^3$)	Standard Deviation
SO_2	8.3	-	12.0
NO	2.4	-	6.9
NO_2	28.4	-	20.9
TSP	-	73.0	-
RSP	-	57.6	-

Table 5.9 Existing Mean Measured Pollutant Levels at Discovery Bay

Pollutant	Arithmetic Mean ($\mu g/m^3$)	Geometric Mean ($\mu g/m^3$)	Standard Deviation
SO_2	10	-	12.9
NO	3	-	10.5
NO_2	41	-	28.9
TSP	-	90.6	-
RSP	-	75.0	-

Source : Lantau Port & Western Harbour Development Studies, WP12A, Environmental Baseline, APH Consultants.

In view of the comprehensive nature of the data collected for LAPH it has been agreed with EPD that no further baseline monitoring surveys for air quality would be required for this EIA.

5.3.3 Assessment of Air Quality Impacts during Construction

Methodology

The Contractor will be required to comply with the 24 hour AQO of 260 μg/cu m. However a 24-hour concentration is not always the best measure for determining construction impacts as the levels can fluctuate significantly during the day. EPD therefore recommend a maximum 1-hour TSP level of 500 μg/cu m in addition to the AQO. The 1-hour level is normally the controlling criterion and this has been used to measure the impacts.

The impact from construction on air quality at each ASR in the Study Area has been modelled using the Industrial Source Complex Short Term Model (ISCST) assuming the meteorological conditions and emission factors discussed below.

Metereological Data

The following worst case metereological conditions for dust dispersion have been used for the modelling of construction impacts.

Wind Speed	:	2 m/s
Stability Class	:	D
Temperature	:	25°C
Mixing Height	:	1000 metres

Emission Factors

The emission factors for construction activities have been calculated using USEPA AP-42 4th edition, 1985 for the following activities which are expected to generate the greatest amounts of dust :

(a) concrete batching;
(b) open face rock blasting;

(c) quarry wet drilling;
(d) rock and soil excavation; and
(e) loading and unloading of spoil.

Calculations considered an eight hour working day.

Details of the emission factors for each activitiy are included in Appendix D.

5.3.4 Assessment of Air Quality Impacts during Operation

Once the depot is operational there will be no activities expected to generate any significant air quality impacts.

5.4 Solid Waste

5.4.1 Existing Environment

Domestic wastes are currently collected from the outlying islands by barge, operated by RSD, for onward disposal at designated landfill sites (Monitoring of Municipal Solid Waste, 1988).

During site visits to Man Kok, it was observed that putrescible materials are used as fertiliser for the agricultural crops. Large household objects and non degradable materials were found scattered around the villages.

It is estimated that approximately one kg of domestic refuse is produced per capita per day. On this basis, approximately 131 kg of solid waste requires disposal in the Study Area each day. In reality the amount of solid waste for disposal will be much less due to reuse and recycling.

5.5 Landuse, Landscape and Visual Aspects

5.5.1 Existing Aspects

Kau Shat Wan is framed by two headland spurs to the north and south rising to form a secondary ridgeline which bounds the Study Area to the west at around 200 mPD. The slopes falling from the ridge and spurs towards the bay are relatively steep with small streams flowing into the valley irrigating a small flood plain and eventually discharging into the sea via the bay.

The coastline is predominantly rocky and rugged comprising small bays and headlands with granitic outcrops on the hillsides all providing visual interest. Kau Shat Wan is the most sheltered and self-contained of the bays between Tai Shui Hang and Man Kok. In comparison with adjacent bays and hillsides, which comprise mainly scrub vegetation with isolated pockets of woodland, the Kau Shat Wan valley is particularly well vegetated and scenic with its sheltered valley and lower slopes supporting mature mixed woodland as well as an extensive belt of well-established woodland plantation on the lower to middle slopes. Above the high tide mark is a typical fringe of tangled coastal thicket which acts as a shelter belt for the valley floor which comprises a combination of wetlands, former rice paddy and semi cultivated areas.

Extending up the hillsides from the valley floor is a belt of dense broadleaf woodland. This is replaced by monospecies plantation which extends up to the 100 mPD contour. Beyond this altitude the vegetation reverts to transitional scrub and grassland. Many of these upland areas in Lantau have regularly experienced hill fires, and much of the scrubland comprises immature regrowth.

The isolated location of Kau Shat Wan with land access restricted to small footpaths connecting to the nearby village of Man Kok and the Trappist Monastery at Tai Shui Hang contributes to the high visual interest of the site. The intervening ridgelines to the north, west and south block views out of the valley other than to seaward, thus enhancing the seclusion and special, lush landscape character of Kau Shat Wan.

The lush landscape character of Kau Shat Wan is particularly significant when seen from the public ferries that sail between Hong Kong and Peng Chau/Silvermine Bay. Accordingly, the visual impact of the proposed development of military and civil explosives depots requires careful consideration and sensitive treatment.

The landscape and visual aspects are shown on Figure 5.6.

5.5.2 Existing Land Uses

Existing land uses in the Study Area include two camp sites at Tung Tau Wan, chicken farming at Chok Tsai Wan, market gardening at Man Kok, a Trappist Haven Monastery at Tai Shui Hang, and a holiday home at Kau Shat Wan.

Whichever site layout is adopted the only existing land use to be directly affected is the holiday home at Kau Shat Wan which will need to be cleared early in the construction phase.

5.6 Ecology

5.6.1 Existing Ecology

Flora

The dense coastal thicket fringing Kau Shat Wan and the adjacent bays comprises typical stabilising vegetation including Pandonus, Derris, Clerodendron, Hisbicus, Ipomoeia and Vitex species. The density of the vegetation fringing Kau Shat Wan reflects the perennial freshwater supply from the streams discharging to the bay, the relatively fertile soil of the valley bottom, and the limited disturbance to which the area has been subjected in recent years. Immediately behind are established mature stands of bamboo, Casuarina and Acacia species. The valley floor at Kau Shat Wan, formerly cultivated, has largely reverted to typical marshland vegetation.

The dense broadleaf woodland on the lower slopes surrounding Kau Shat Wan, also occurs in the Man Kok valley and at Tai Shui Hang and includes a large number of mature trees, species including Schleffera octophylla, Sterculia lanceolata, Litsea glutinbisa, Macoraga tanaria, and Vitis vinifera.

The density and quality of woodland reflect the feng shui significance of the woodland which has assisted in minimising disruption to the woodlands, thereby increasing diversity and bringing about corresponding ecological benefits.

The slopes above the natured mixed woodland are covered by a well established extensive belt of monospecies (Melaleuca sp) plantation which assists in erosion control/slope stability.

The scrub and grassland above 100 mPD comprise relatively recent re-growth following fire damage. In common with many of the fire-maintained grasslands which cover much of the Territory, these areas show a much reduced diversity of plants and animals. The key species of shrub occurring in the transitional zone between the plantation woodland and the upland grasslands include Brucea javonica, Ryodomertus tormentosa, Gleichenia leneariees, Ficus sp and other members of the Tea family.

The diversity and abundance of vegetation at Kau Shat Wan typifies that of similar areas throughout the New Territories reflecting the limited human disturbance in the Study Area due to lack of easy access and the availability of water all year round.

Fauna

The dense woodland habitat in the Study Area appears to provide the type of condition where it might be expected to find such species as the Civets (Paguma larvata and Viverricula indica), Ferret Badger (Melogale moschata) and Chinese Pangolin (Manis pentadactyla). However, no definitive sightings have been made.

Aquatic Ecology

The streams that enter the sea at Kau Shat Wan, Tai Shui Hang and Man Kok are typical of upland streams in Lantau. They are free from pollution sources, are in areas where flows persist throughout the year, and are the basis for a rich stream ecology. Of particular interest are the invertebrates, especially the freshwater shrimp, (Machrobrachium japonicus) which undertake seasonal migrations to brackish water for spawning.

Substantial numbers of juvenile fish, probably bream (Mylio, Rhadosarga), utilise the lower reaches of the streams as nursery areas.

Marine Ecology

The beaches at Kau Shat Wan and Man Kok are examples of the habitat referred to as "Donax beaches". This term has been applied to mobile beaches typified by bay-head sand crescents, a gentle gradient and characterised by the presence of their typical bivalves, Donax semigranosus and D. cuneatus. Other than these bivalves, fauna in the littoral zone is generally limited.

The rocky headland between the bays also provide a distinct but not unusual habitat on this part of the Lantau coast. Dominant species are characterised by strong holdfast mechanisms such as the barnacles Tetraclita and Pollicipes.

Data on species composition common to the shoreline types described, and previously identified in the Study Area have been included as Appendix E.

5.7 Antiquities

5.7.1 Existing Environment

The identification of sites at Man Kok and Kau Shat Wan as being of potential archaeological interest has been discussed in Working Papers No.1 and No.2. As of this date site investigations have not yet commenced but are expected to begin in the near future.

6. LAYOUT C2(a)

6.1 Impacts during Construction

6.1.1 Water Quality

Impacts on water quality which may arise as a consequence of construction include those from dredging and spoil disposal, reclamation, site drainage, discharges such as oily wastes, concrete batching plant washout water, domestic effluent from the construction workers and impacts from the diversion and retraining of existing stream courses.

Dredging and Spoil Disposal

Two options for dredging and land formation were discussed in Chapter 3. It has been assumed that rates of dredging could be similar for both options and therefore the daily or weekly impacts would be similar. The difference between the options would be that the fully dredged option would have an impact for a longer period of time. It has been assumed that a single dredger would be employed for both dredging options. Assuming marine mud is dredged during a six day working week, the daily rate would be of the order of 6,500m^3.

Water depths are only one to two metres in most of the dredging area and the dredging works will create extremely turbid conditions in the immediate vicinity of the works. Nearshore current velocities are very low and thus resuspended sediments are likely to settle close to the dredging area.

Bottom sediments have been defined as uncontaminated and no special disposal arrangements will be necessary prior to disposal at a designated spoil dumping ground. It is likely that the Cheung Chau spoil dumping ground will be used due to its proximity of the site. The Contractor will however be required to apply to the Director of Environmental Protection (DEP) for a dumping licence and the Fill Management Committee (FMC) will need to be approached for permission to use the dumping area.

Water quality impacts associated with spoil disposal include fly tipping of the load and increased turbidity as the load is discharged at the disposal ground. Both are short term impacts and can be controlled.

Reclamation

Reclamation between the existing coastline and a seawall will have a lesser impact on water quality compared with reclaiming seawards from the shore. Impacts on water quality may arise from the disturbance of bottom sediments as the fill is placed, if the mud is still in place. This is of minor significance and will only impact on water quality for a very short period of time.

Site Drainage

Rock and soil excavation (0.98 million cu m and 0.275 million cu m respectively) is likely to take about 20 months. Mitigation measures such as silt traps will need to be installed to prevent storm runoff from the site becoming contaminated with silt. However particle sizes will be large and inshore velocities are small and it is expected that most of the material released will be deposited on the seabed close to the site and will thus have limited impact. There could be some sediment deposition in existing water courses when cutting and excavation takes place. This will have an impact on stream life but will not be significant downstream of the excavation as streams will be channelled into the new drainage system. Runoff from works areas should not be allowed to enter stream courses upstream of the site to avoid impacts on stream life.

Offsite Discharges

Runoff from concrete batching, spillages and domestic effluent from the workforce could all have impacts on water quality.

These impacts could result in increased suspended solids levels and decreased dissolved oxygen levels in the vicinity of the site and depending on the magnitude of the impact could be felt further along the coastline resulting in deposition of sediment away from the site.

6.1.2 Noise Impacts

The impact from construction noise has been predicted on the eight NSRs discussed in Chapter 5.

Table 6.1 presents the predicted impacts from construction activities on the NSRs. The numbers and items of powered mechanical equipment and their sound power levels are also included for each construction activity.

Table 6.1 Predicted Noise Levels from Construction of Layout C2(a)

Activity	Items and Numbers of PME		SPL dB(A)	Predicted Noise Levels (dB(A)) at the NSRs							
				1	2	3	4	5	6	7	8
Dredging	grab dredger	1	112	0	0	0	1	12	16	10	23
	suction dredger	1	112	0	0	0	1	12	16	10	23
	hopper barge and tug	2	110	0	0	0	0	10	14	8	21
	small crane	1	95	0	0	0	0	0	0	0	6
	derrick barge and tug	1	110	0	0	0	0	10	14	8	21
Reclamation	derrick barge and tug	2	110	0	0	0	0	10	14	8	21
	dump truck	2	117	5	2	4	6	17	21	15	28
	bulldozer	2	115	3	0	2	4	15	19	13	26
	compactor	2	105	0	0	0	0	5	9	3	16
	sand pump	2	103	0	0	0	0	3	7	1	14
Armour Seawall	derrick barge and tug	2	110	0	0	0	0	10	14	8	21
Rock Cutting	pneumatic drilling rig	2	128	16	13	15	17	28	32	26	39
	pneumatic drill	2	128	16	13	15	17	28	32	26	39
	bulldozer	2	115	3	0	2	4	15	19	13	26
	excavator	2	112	0	0	0	1	12	16	10	23
	dump truck	2	117	5	2	4	6	17	21	15	28
Paving/ Buildings	batching plant	1	108	0	0	0	0	8	12	6	19
	concrete pump	1	106	0	0	0	0	6	10	4	17
	paver	1	109	0	0	0	0	9	13	7	20
	dump truck	2	117	5	2	4	6	17	21	15	28
	poker vibrator	2	113	1	0	0	2	13	17	11	24

The predicted noise levels clearly show that construction of Layout C2(a) will generate very limited noise impacts. The predicted noise levels do not exceed any of the acceptable noise levels and so 24 hour working would be possible throughout the whole construction period. The noise at receivers will be less than ambient levels and the construction work will be barely discernable.

Excavation of the 0.98 million cu m of rock will create most noise but even this activity will only cause noise of 39 dB(A) at NSR-8. This activity will use pneumatic drilling rigs and drills and will probably be undertaken for about 12 months preceded by about eight months for excavation of the softer overlaying material. Layout C2(a) will require excavation of more material than Layouts 8(a) and D3 but less than A4(a).

Dredging, reclamation, seawall armouring, and work for the site paving and buildings are not anticipated to cause any significant impacts.

NSRs 1, 2, 3 and 4 are over one kilometre away from the site and have been predicted to receive very little, if any, construction noise with levels below 17 dB(A). This is well below ambient levels and most of the construction activities will not be heard at all.

Some blasting may be required but the noise impacts are not likely to be significant.

6.1.3 Air Quality

The impacts on air quality during construction of Layout C2(a) have been modelled for ASRs 1 to 8 as shown in Table 5.4. The activities modelled were concrete batching, rock drilling, excavation, loading and unloading. The results from the predictions are shown in Table 6.2 as the one hour average concentration of TSP $\mu g/m^3$ for each ASR.

Table 6.2 Predicted Air Quality Impacts from Construction of Layout C2(a)

ASR	One Hour Average Concentration TSP $\mu g/m^3$				
	Concrete Batching	Rock Drilling	Rock and Soil Excavation	Rock and Soil Loading	Rock and Soil Unloading
1	<10	<10	<10	<10	<10
2	<10	<10	<10	<10	<10
3	<10	<10	<10	<10	<10
4	<10	<10	<10	<10	<10
5	<10	20	<10	<10	<10
6	<10	10	<10	<10	<10
7	<10	20	<10	<10	<10
8	<10	30	<10	<10	<10

The predicted air quality levels show indiscernable impacts. Rock blasting will have some impact but this will be of short duration and is not likely to have a significant impact in view of the distance to the receivers. Immediately after blasting the dust levels in the proximate area to the blast will be very high with rapid settling of the larger dust particles close to the source. The remaining smaller dust particles will quickly dissipate within the valley as the topography is likely to contain most of the dust generated.

Stationary sources of dust arising from construction activities primarily include drilling and blasting, handling of materials and concrete batching and pumping.

Vehicular movements and transport of materials are the main mobile sources of air pollution. These are likely to be of minor significance.

6.1.4 Solid Waste

Solid waste arisings at the site will include dredged spoil, disused formwork, vegetation from site clearance, materials associated with repair and maintenance of machinery and equipment in addition to domestic wastes arising from the workforce. There will be much less vegetation to clear for this option than for Layout A4 (a) although possibly similar requirements to Layout 8(a). On-site burning of vegetation will not be permitted.

Impacts from domestic solid waste are unlikely to be significant so long as an adequate collection system is installed.

Layout C2 (a) will generate more spoil than the other three options even when dredging is only carried out for the seawall.

6.2 Impacts during Operation

Operation of the depot is expected to cause some impacts on local water movements, water quality, landscape, and ecology as discussed below. Conversely, operation is unlikely to generate any impact on the air quality and noise levels in the area.

6.2.1 Water Movements

The proposed alignment of the southeastern seawall for the Civilian Depot could create minor and localised alterations to water movements. The impact is not likely to be significant but it would be better if a smoother, more rounded, shape could be provided at the south eastern corner of the site.

There is also a small partial embayment formed at the northern end of the seawall of the military depot. Again the impact will be small but it would be preferable if a smoother seawall alignment could be provided.

6.2.2 Water Quality

Spillages

In the event of a spillage occurring during handling of explosives, it would be the responsibility of the operator to ensure that streams and drains are blocked to prevent any discharge to the sea. Spillages and any contaminated water would need to be collected, treated and disposed of according to the degree and nature of the contamination. The drainage system should be designed so that suitable traps are available which can be easily closed in the event of a spillage.

Effluent Flows and Loads

An estimate of the potential effluent flow and pollutant load arising from the workforce at the explosives complex has been made assuming a maximum of 150 people employed at the facility and it has been assumed that all of these could be on site at any given time. This employed population is based on the best information available at the present time but this figure together with the estimates of effluent flows and loads will need review during the detail design of the facility. The facility is only for storage and materials transfer and it has been assumed to fall within the "commercial premises" category identified in the Sewage Strategy Study. Estimated effluent flows and pollutant loads are given in Table 6.3.

Table 6.3 Estimated Domestic Effluent Flows and Pollutant Loads During Operation

	Unit Flow (m^3/d)	Unit Load kg/d						
		SS	BOD	COD	TKN	NH_3N	TTM	E.Coli
Employed Population								
Factor	(0.060)	(0.034)	(0.034)	(0.070)	(0.0067)	(0.0040)	(0.00015)	($3.5x10^{10}$)
	9.0	5.10	5.10	10.50	1.01	0.60	0.0225	$5.25x10^{12}$
Commercial								
Factor	(0.25)	(0.025)	(0.053)	(0.103)	(0.0025)	(0.0008)	(0.00015)	-
	37.5	3.75	7.95	15.45	0.375	0.12	0.0225	-
TOTAL	46.5	8.85	13.05	25.95	1.385	0.72	0.045	$5.25x10^{12}$
Standards for Effluents discharged into SWCZ	>10 and <200	30	20	80			2	1000/100 ml

Comparison of the estimated flows and loads shown in Table 6.3 with the guidelines given in the Technical Memorandum on Effluent Standards indicates that the standards would be achieved. However, it is recommended that on-site treatment is provided which could be in the form of septic tanks or a small packaged treatment plant.

6.2.3 Landuse, Landscape and Visual Aspects

The small house at Kau Shat Wan will be resumed before the start of construction. The footpaths along the coast are not heavily used but may be relocated further inland away from the site. No other land uses will be affected.

Visual impacts are summarised on Figure 6.1 This option requires the most extensive reclamation works of the four layouts. The reclamation extends over two bays with removal of the intervening headland. Considerable slope cutting is envisaged with loss of woodland vegetation. The seawall is approximately 930 metres long and it would be difficult to provide bund and screen planting to the seaward edge due to the proximity of the igloos. It is considered that this option would be highly visible from passenger ferries and affect a long section of coastline.

This layout will be highly visible from the water with the 930 metre seawall and cut slopes replacing the northern headland of Kau Shat Wan bay.

Careful landscaping of the slopes will reduce the visual impact.

6.2.4 Ecology

Only the northern headland of Kau Shat Wan will be removed, thus having a limited impact on terrestrial ecology. This plan envelopes Kau Shat Wan and the bay immediately to the north and both of these beaches will be reclaimed.

Streams will be channelled once they enter the explosives complex and there will be no opportunity for regeneration of the stream ecology in these sections. Upstream there should be no disturbance to the stream courses.

6.3 Conclusions

The predictions of noise impacts have shown that 24 hour working would be possible for the construction of Layout C2(a) as the predicted noise levels easily comply with the required noise level criteria. Impacts during operation are not anticipated.

Air quality impacts are unlikely to be significant during construction or operation.

There will be some impacts from suspended sediments during construction but these are not likely to be significant as there are no sensitive receivers in the immediate vicinity of the works site. Effluent discharges from the explosives complex are likely to be within the standards recommended for the Southern Waters Control Zone but on-site treatment is still recommended. Impacts from spillages will not be significant so long as the drainage system is designed to contain pollutants.

Waste materials during construction will include dredged marine muds, spoil from slope excavation and construction waste. The marine muds are not contaminated and so no special disposal techniques will be needed. Spoil from slope excavation will be used in the reclamation and will not cause environmental impacts. The contractor will need to provide collection systems for solid wastes and ensure that liquid wastes do not cause pollution.

Visual impact will be significant with large cut slopes and can only partly be mitigated.

7. LAYOUT A4(a)

7.1 Impacts during Construction

7.1.1 Water Quality

Dredging and Spoil Disposal

Potential water quality impacts due to dredging and spoil disposal are similar to those outlined for Layout C2(a) discussed in Chapter 6.

Assessment of construction has assumed one dredger operating at the site working a six day week. If all marine mud is removed prior to land formation, dredging works could be completed in 22 weeks. Layout A4(a) will generate smaller quantities of marine mud than Layout C2(a) and the impact on water quality will therefore be less.

With water depths offshore of only one to two metres dredging is likely to create extremely turbid conditions in the immediate vicinity of the works. The resuspended sediment is likely to resettle close to the dredging area given the low current velocities nearshore.

As discussed in Chapter 6 the bottom sediments are uncontaminated and special arrangements will not be necessary for disposal which is likely to be at the Cheung Chau dumping ground. Prior permission, however, will have to be granted by the DEP and the FMC.

Impacts from spoil disposal could occur from fly tipping of the load and turbidity plumes as the load is discharged into the dumping ground. Both impacts are short lived and can be controlled.

Reclamation

Impacts from reclamation will be similar to those for Layout C2(a). However reclamation quantities for Layout C2(a) will be about twice those for Layout A4(a) and the impacts will last over a longer period.

Site Drainage

Layout A4(a) requires a significantly greater amount of excavation of rock and soil (3.40 million cu m, 0.74 million cu m respectively) compared to the other layouts. Consequently the potential impact from runoff water polluted with sediment discharging into the local waters is greater if washout of sediment from exposed excavation faces is not controlled.

Offsite Discharges

As with Layout C2(a) discharges from concrete batching, spillages and domestic effluent from the workforce all have the potential to adversely impact on water quality. This may lead to increased turbidity and decreased dissolved oxygen levels in the adjacent inshore waters and deposition away from the site.

7.1.2 Noise Impacts

The impact of construction noise has been predicted on the eight NSRs discussed in Chapter 5.

Table 7.1 shows the predicted noise levels for layout A4(a) together with the items and numbers of powered mechanical equipment and sound power levels for each construction activity.

Table 7.1 Predicted Noise Levels for the Construction of Layout A4(a)

Activity	Items and Numbers of PME		SPL dB(A)	Predicted Noise Levels (dB(A)) at the NSRs							
				1	2	3	4	5	6	7	8
Dredging	grab dredger	1	112	0	0	7	2	14	10	10	8
	suction dredger	1	112	0	0	7	2	14	10	10	8
	hopper barge and tug	2	110	0	0	5	0	12	8	8	6
	small crane	1	95	0	0	0	0	0	0	0	0
	derrick barge and tug	1	110	0	0	5	0	12	8	8	6
Reclamation	derrick barge and tug	2	110	0	0	5	0	12	8	8	6
	dump truck	2	117	1	3	12	7	19	15	15	13
	bulldozer	2	115	0	1	10	5	17	13	13	11
	compactor	2	105	0	0	0	0	7	3	3	1
	sand pump	2	103	0	0	0	0	5	1	1	0
Armour Seawall	derrick barge and tug	2	110	0	0	5	0	12	8	8	6
Rock Cutting	pneumatic drilling rig	2	128	12	14	23	18	30	26	26	24
	pneumatic drill	2	128	12	14	23	18	30	26	26	24
	bulldozer	2	115	0	1	10	5	17	13	13	11
	excavator	2	112	0	0	7	2	14	10	10	8
	dump truck	2	117	1	3	12	7	19	15	15	13
Paving/ Buildings	batching plant	1	108	0	0	3	0	10	6	6	4
	concrete pump	1	106	0	0	1	0	8	4	4	2
	paver	1	109	0	0	4	0	11	7	7	5
	dump truck	2	117	1	3	12	7	19	15	15	13
	poker vibrator	2	113	0	0	8	3	15	11	11	9

The predicted noise levels do not exceed any of the relevant noise criteria and 24 hour working would be possible as for layout C2(a).

The greatest impact has been predicted from rock cutting and excavation using pneumatic rock drilling equipment with noise levels ranging between 12 dB(A) at NSR-1 and 30 dB(A) at NSR-5. Both of these noise levels are below ambient noise and hence the noise from the construction work will not be discernible. Layout A4(a) requires the excavation of 3.4 million cu m of rock and 0.74 million cu m of soil, a considerably greater amount than the other layouts. This activity is therefore likely to carry on for a greater length of time than for other layouts.

Dredging, reclamation, seawall armouring and concreting will not generate any significant impacts.

Overall, the greatest impact has been predicted at NSR-5, 445 metres away from the site. The impact from this layout also slightly exceeds that predicted from Layout C2(a). NSRs 2, 3 and 4 also receive greater impacts from option A4(a). The impact for NSR-7 is similar and the impact at NSRs 6 and 8 has been predicted to be less.

NSRs 1, 2 and 4, more than 900 metres away from the site, will hear very little of the construction activities with noise levels below 18 dB(A). Again this is below ambient noise levels so the noise from the construction will not be discernible.

7.1.3 Air Quality

Impacts on the air quality during construction of Layout A4(a) have been predicted for ASRs 1 to 8 as shown in Table 5.4.

The impacts were modelled for concrete batching, rock drilling, excavation, loading and unloading construction activities. The dust impacts generated are presented in Table 7.2 to represent the average one hour TSP $\mu g/m^3$ concentrations at each ASR.

Table 7.2 Predicted Air Quality Impacts from Construction of Layout A4(a)

ASR	One Hour Average Concentration TSP $\mu g/m^3$				
	Concrete Batching	Rock Drilling	Rock and Soil Excavation	Rock and Soil Loading	Rock and Soil Unloading
1	<10	10	<10	<10	<10
2	<10	10	<10	<10	<10
3	<10	20	<10	<10	<10
4	<10	20	<10	<10	<10
5	<10	30	<10	<10	<10
6	<10	20	<10	<10	<10
7	<10	20	<10	<10	<10
8	<10	30	<10	<10	<10

The dust levels predicted to be generated from construction of Layout A4(a) are barely detectable but will be generally higher than those for Layout C2(a).

There may be some impacts at from rock blasting but these will be of short duration as the topography of the Kau Shat Wan valley will contain most of the dust. Immediately after each blast the area close to the blast source will be very high in dust but this will settle out and dissipate rapidly.

It is unlikely that the ASRs will receive any significant dust impacts from the construction activities.

As with noise, this option has a greater potential for creating dust impacts than other layouts due to there being more blasting and excavation. About 3.4 million cu m of rock and 0.74 million cu m of soil will be excavated to form a platform. This is almost five times the quantity to be removed for Layout C2(a) and eightfold increase when compared with Layout 8(a). Clearly not all the excavated material can be used in the reclamation and some material will need to be hauled off-site which will add to the potential dust impacts.

7.1.4 Solid Waste

Solid waste arisings will have similar characteristics to those given for Layout C2(a) although the quantities will differ. Solid waste will include dredged spoil, excavated rock and soil, cleared vegetation, disused formwork, materials associated with repair and maintenance of machinery and equipment, and domestic waste arising from the workforce.

The spoil disposal requirements will be less than for Layout C2(a) although there will be more cleared vegetation that will require disposal. Burning on site will not be permitted. Spoil from cut slopes will be used in the reclamation.

7.2 Impacts during Operation

The only impact likely to occur during operation of the depot will be from spillages, effluent flows and loads, water movements, visual aspects and ecology. Impacts on noise levels or air quality will not be significant.

7.2.1 Water Movements

The final alignment of the 650 m seawall for layout A4(a) does not extend as far north as for Layout C2(a) but stays within the headlands north and south of the bay. The bay to the north of Kau Shat Wan will become partially embayed and there is the potential for floating refuse to collect in the new bay.

There will be some minor and localised changes to water movements but there will be no significant impact on small vessel handling. Water movements could be improved by smoothing the sharp corners of the reclamation.

7.2.2 Water Quality

Spillages

If a spillage should occur during the handling of explosives streams and drains should be blocked immediately to prevent the migration of materials into the receiving coastal waters as discussed in section 6.2.

Spillages and any contaminated water would need to be collected, treated and disposed of according to the degree and nature of the contamination.

Effluent Flows and Loads

The potential operational impacts from effluent flows and loads have been estimated in Table 6.3 of Section 6.2. The calculations for the effluent flow and pollutant load assumed a maximum of 50 people employed on site at any given time.

Subsequent comparison of the estimated flows and loads with the guidelines in the Technical Memorandum on Effluent Standards demonstrated that no treatment would be required. However, it is recommended that a small packaged treatment plant is installed to minimise potential impacts on water quality and avoid contributing to the general conditions.

7.2.3 Landuse, Landscape and Visual Aspects

The property at Kau Shat Wan will need to be relocated before construction starts. No other properties will be affected but the coastal footpath will need to be diverted.

Visual impacts are summarised on Figure 7.1. This option requires less reclamation work but would still result in removal of the majority of the northern headland of Kau Shat Wan bay creating large areas of highly visible cut slopes up to the 80 m PD contour. The level area of Kau Shat Wan valley would also be developed with the loss of the majority of mature mixed woodland. The seawall is approximately 650 m long and will project beyond the existing headlands. The layout shown for the igloos will make screening by bunding and screen planting difficult.

It is considered that, although the extent of coastline affected by this option is less than for Layout C2(a), the greater loss of mature woodland and necessary cutting of slopes to the northern headland would still have considerable visual impact on the landscape.

Other visual impacts from the site will be the bund along the seafront, the slopes at the back of the site and the woodland above the site and any buildings that are not screened from the water.

Slopes will need to be landscaped to reduce the visual impact. The buildings can be screened by construction of landscaped bunds or screen planting.

7.2.4 Ecology

A greater area of secondary vegetation will be destroyed under this option than either of the others. Only Kau Shat Wan will be reclaimed, and although streamlife in the water courses draining into the bay will be severely impacted, the impact on coastal populations will by comparison, be reduced.

Much of the lower courses of existing streams in the Kau Shat Wan valley will be excavated and the drainage channelled through the new facility resulting in the destruction of much of the stream bed and the stream life existing within.

The woodland around the site and streams should be maintained and kept clear of debris.

7.3 Conclusions

Noise levels during construction of layout A4(a) are not anticipated to exceed the relevant noise criteria thus allowing for 24 hour working if necessary. Impacts on the air quality are also unlikely to be significant.

The impacts from noise and air pollution during operation are expected to be virtually non existent.

There will be localised water quality impacts during construction of the reclamation but these will not be significant so long as adequate controls are included in the construction contracts. Marine deposits are uncontaminated and may be disposed of without special treatment.

The ecology of Kau Shat Wan will be destroyed as a result of construction of the reclamation. The impact from Layout A4(a) on the coastal ecology will be less than from Layout C2(a) but the impact on the Kau Shat Wan hinterland will be more significant. Streams through the reclamation will be channelled but the impact outside the site can be minimised by controls during construction and maintenance thereafter.

The visual impact of the cut slopes will be significant.

8. LAYOUT 8(a)

8.1 Impacts during Construction

8.1.1 Water Quality

Dredging and Spoil Disposal

Dredging works required for this option will only take fifteen weeks, assuming the same daily rates as for the previous two options. Layout 8(a) only requires a seawall of 0.5 km, with reclamation confined to Kau Shat Wan between the two headlands. Potential impacts on the water body during dredging and spoil disposal will be similar to those for the other two layouts but will be of shorter duration.

If land is formed on consolidated mud then only 250,000 cu m of marine mud will need to be disposed of. Only a small volume of rock excavation is required for this option compared with Layout A4(a) and the volume of rock excavation required for the caverns is comparatively small.

Impacts from fly tipping and dumping of spoil will also be relatively small.

Reclamation

Fill requirements for this option are less than for the previous two options (Table 3.1) and the reclamation will be completed faster or at a slower rate. In either case the impacts on water quality will be less assuming that similar controls are applied to contract activities.

Site Drainage

Volumes of fill and rock and soil excavation will be significantly less than the two previous options and impacts from runoff from the site are likely to be less. Stoplogs and silt traps in stream courses will still be necessary to minimise the impacts.

Off site Discharges

Impacts from discharges during construction will be similar to the two layouts considered above.

8.1.2 Noise Impacts

The impact of single working activities during the construction phase of Layout 8(a) has been predicted for the eight NSRs discussed in Chapter 5.

Table 8.1 Predicted Noise Levels from Construction of Layout 8(a)

Activity	Items and Number of PME		SPL dB(A)	Predicted Noise Levels (dB(A)) at the NSRs							
				1	2	3	4	5	6	7	8
Dredging	grab dredger	1	112	0	3	2	2	15	8	8	12
	suction dredger	1	112	0	3	2	2	15	8	8	12
	hopper barge and tug	2	110	0	1	0	0	13	6	6	10
	small crane	1	95	0	0	0	0	0	0	0	0
	derrick barge and tug	1	110	0	1	0	0	13	6	6	10
Reclamation	derrick barge and tug	2	110	0	1	0	0	13	6	6	10
	dump truck	2	117	1	8	7	7	20	13	13	17
	bulldozer	2	115	0	6	5	5	18	11	11	15
	compactor	2	105	0	0	0	0	8	1	1	5
	sand pump	2	103	0	0	0	0	6	0	0	3
Armour Seawall	derrick barge and tug	2	110	0	1	0	0	13	6	6	10
Rock Cutting	pneumatic drilling rig	2	128	12	19	18	18	31	24	24	28
	pneumatic drill	2	128	12	19	18	18	31	24	24	28
	bulldozer	2	115	0	6	5	5	18	11	11	15
	excavator	2	112	0	3	2	2	15	8	8	12
	dump truck	2	117	1	8	7	7	20	13	13	17
Paving/ Buildings	batching plant	1	108	0	0	0	0	11	4	4	8
	concrete pump	1	106	0	0	0	0	9	2	2	6
	paver	1	109	0	0	0	0	12	5	5	9
	dump truck	2	117	1	8	7	7	20	13	13	17
	poker vibrator	2	113	0	4	3	3	16	9	9	13

The predicted noise levels along with the items and numbers of powered mechanical equipment and sound power levels for each construction activity are shown in Table 8.1.

Predicted noise levels are within the Acceptable Noise Levels and 24 hour working will be possible if required.

In common with the previous layouts discussed the greatest noise levels have been predicted from rock cutting using pneumatic rock drilling equipment. The impacts will range between 12 dB(A) at NSR-1 and 31 dB(A) at NSR-5. These are below ambient noise levels and so there will be no impact at the NSRs. The amount of rock requiring excavation in this option is the least of all the layouts and so should proceed for a shorter time.

The impacts from dredging, reclamation, seawall armouring, and concreting for the paving and buildings will be minor even for the closest receiver, NSR-5, 445 metres away from the site.

NSRs 1, 2, 3 and 4 are more than 900 metres away from the site and are predicted to receive very little noise from construction activities.

Option 8(a) may also requires excavation for caverns and tunnels. Noise impacts will be confined underground once work has moved away from the portal and will therefore have no significant impact on NSRs.

8.1.3 Air Quality

The potential air quality impacts from construction of Layout 8(a) were predicted for eight ASRs as in the previous layout options. The air quality was modelled from construction activities including concrete batching, rock drilling, excavation, loading and unloading as the one hour average concentration of TSP $\mu g/m^3$. The results are presented in Table 8.2.

Table 8.2 Predicted Air Quality Impacts from Construction of Layout 8(a)

ASR	One Hour Average Concentration TSP $\mu g/m^3$				
	Concrete Batching	Rock Drilling	Rock and Soil Excavation	Rock and Soil Loading	Rock and Soil Unloading
1	<10	<10	<10	<10	<10
2	<10	<10	<10	<10	<10
3	<10	<10	<10	<10	<10
4	<10	<10	<10	<10	<10
5	<10	10	<10	<10	<10
6	<10	10	<10	<10	<10
7	<10	10	<10	<10	<10
8	<10	10	<10	<10	<10

As with the previous options the air quality impacts have been predicted as virtually non existent.

Some impacts may be generated from rock blasting but these are unlikely to be significant due to the short term nature of the activity, the rapid settling and dispersion of dust particulates that can be expected, the topography of the Kau Shat Wan valley, and the distance of the ASRs from the blast source as discussed for the previous layouts.

The ASRs are therefore not expected to receive any significant air quality impact from construction of Layout 8(a). Rock blasting may generate some limited impacts but the duration will be short.

8.1.4 Solid Waste

Of the four Layouts 8(a) will involve the least amount of spoil, soil or surplus rock to be disposed of. In view of the constraints on the capacities of existing gazetted spoil disposal grounds this is a potential benefit of the design.

8.2 Impacts during Operation

As discussed in previous options the noise and air quality impacts from operation of the depot will not be significant but some impacts are anticipated for water movement and water quality, visual aspects and the ecology local to the site.

8.2.1 Water Movements

The seawall alignment is parallel to prevailing currents and this layout is not likely to have a significant impact on water movements except locally. There is a small extension of the headland to the north of Kau Shat Wan which could affect water movements in the southern part of the bay to the north. A smoothing or sounding of the north east corner of the reclamation would reduce the possibility of local effects on water quality.

8.2.2 Water Quality

Impacts from this layout will be similar to those for the previous two layouts.

8.2.3 Landuse, Landscape and Visual Aspects

As with the other options, the house at Kau Shat Wan is the only dwelling directly impacted by the construction works.

Visual impacts are summarised on Figure 8.1 This option utilises tunnel storage facilities which reduces the need for reclamation. As a result, slope cutting is reduced and the vegetation clearance in Kau Shat Wan is limited mainly to the level cultivated portion of the valley. The seawall is approximately 500 metres long and is less visually prominent than those of the first two options.

8.2.4 Ecology

Ecological impacts will be similar to those outlined for Layout A4 (a).

8.3 Conclusions

The noise impacts from construction of the underground Layout 8(a) will not be significant. The relevant noise criteria will not been exceeded and 24 hour working will be possible if necessary.

As with the other layouts construction impacts on air quality will be negligible. The operational impacts on noise levels and air quality are also expected to be insignificant.

There will be some impacts on local water quality from construction activities such as dredging, land formation, spoil dumping, site runoff and drainage but these can be effectively controlled if the correct measures are imposed. The amount of reclamation required is less than for the other options and so the impacts on water movements should also be less.

The ecology inland and along the shore of Kau Shat Wan will be destroyed during construction but the impact should be less than for Layouts C2(a) and A4(a). Streams running into Kau Shat Wan will require diversion but the impact can be minimised.

The visual impact will be significant and can only be partly mitigated.

9. LAYOUT D3

9.1 Impacts during Construction

9.1.1 Water Quality

Dredging and Spoil Disposal

Volumes of material to be dredged for this option will be nearly as large as for Layout C2(a) and well in excess of volumes for Layouts A4(a) and 8(a). The seawall length (800 metres) is longer than Layouts A4(a) and 8(a) but less than Layout C2(a).

The impacts during dredging and spoil disposal will be similar to the other options although the impacts will last for a longer time than the impacts from Layouts A4(a) and 8(a). The dredging area for this option also extends further from the shore and there is more potential for sediment to be suspended in the relatively faster moving waters offshore from Kau Shat Wan. The impacts will, however, not be significant since there are no sensitive receivers close by.

Reclamation

Construction of the reclamation will also have a relatively larger impact than for the other options since the quantities of material are relatively large and the reclamation will extend further from the shore. However the impacts are still not likely to be significant.

Site Drainage

This option has the smallest volume of rock and soil excavation and there is therefore less potential for sediment discharge with runoff from the site. Controls will still be required to avoid sediment washout from the reclaimed area before the surface is sealed.

Offshore Discharge

Impacts from offsite discharges will be similar to the other options.

9.1.2 Noise Impacts

Noise levels were predicted at eight of the nine NSRs as discussed in Chapter 5.

Table 9.1 presents the predicted noise levels from construction activities. The items and numbers of powered mechanical equipment and sound power levels for each construction activity are also included.

Table 9.1 Predicted Noise Levels from Construction of Layout D3

Activity	Items and Numbers of PME		SPL dB(A)	Predicted Noise Levels (dB(A)) at the NSRs							
				1	2	3	4	5	6	7	8
Dredging	grab dredger	1	112	0	0	1	1	14	13	10	17
	suction dredger	1	112	0	0	1	1	14	13	10	17
	hopper barge and tug	2	110	0	0	0	0	12	11	8	15
	small crane	1	95	0	0	0	0	0	0	0	0
	derrick barge and tug	1	110	0	0	0	0	12	11	8	15
Reclamation	derrick barge and tug	2	110	0	0	0	0	12	11	8	15
	dump truck	2	117	0	2	6	6	19	18	15	22
	bulldozer	2	115	0	0	4	4	17	16	13	20
	compactor	2	105	0	0	0	0	7	6	3	10
	sand pump	2	103	0	0	0	0	5	4	1	8
Armour Seawall	derrick barge and tug	2	110	0	0	0	0	12	11	8	15
Rock Cutting	pneumatic drilling rig	2	128	11	13	17	17	30	29	26	33
	pneumatic drill	2	128	11	13	17	17	30	29	26	33
	bulldozer	2	115	0	0	4	4	17	16	13	20
	excavator	2	112	0	0	1	1	14	13	10	17
	dump truck	2	117	0	2	6	6	19	18	15	22
Paving/ Buildings	batching plant	1	108	0	0	0	0	10	9	6	13
	concrete pump	1	106	0	0	0	0	8	7	4	11
	paver	1	109	0	0	0	0	11	10	7	14
	dump truck	2	117	0	2	6	6	19	18	15	22
	poker vibrator	2	113	0	0	2	2	15	14	11	18

As with the other three options the predicted noise levels are within the noise level criteria and low enough to allow 24 hour working if necessary.

The highest noise levels have been predicted from rock excavation using pneumatic rock drills ranging between 11 dB(A) at NSR-1 and 33 dB(A) at NSR-8. The other construction activities such as dredging, reclamation, seawall armouring, and concreting will generate only minor noise impacts throughout the construction phase.

NSR-8, 565 metres away from the site, is expected to receive only a slight impact and NSRs 1, 2, 3 and 4, over one kilometre from the site, are predicted to hear very little of the construction noise apart from some limited noise during rock excavation.

There will be no noise impacts from the cavern or tunnel excavations once the works have moved away from the portal.

9.1.3 Air Quality

The air quality impacts from construction of Layout D3 were predicted from concrete batching, rock drilling, excavation, loading and unloading for the eight ASRs included in Table 5.4.

The results are shown below in Table 9.2 as the one hour average concentration of TSP in $\mu g/m^3$.

Table 9.2 Predicted Air Quality Impacts from Construction of Layout D3

ASR	One Hour Average Concentration TSP $\mu g/m^3$				
	Concrete Batching	Rock Drilling	Rock and Soil Excavation	Rock and Soil Loading	Rock and Soil Unloading
1	<10	<10	<10	<10	<10
2	<10	<10	<10	<10	<10
3	<10	<10	<10	<10	<10
4	<10	<10	<10	<10	<10
5	<10	<10	<10	<10	<10
6	<10	<10	<10	<10	<10
7	<10	<10	<10	<10	<10
8	<10	<10	<10	<10	<10

As for the other three layouts the air quality impacts have been predicted as being negligible. Although the impacts from rock blasting have not been calculated the impact from this activity will be limited considering the short lived duration of the blast, the dispersion and settling rate of particulates, the topography of the Kau Shat Wan valley which will contain any impacts, and the distance of the ASRs from the blast source.

Construction of Layout D3 is therefore not expected to produce any significant impacts on air quality at any of the ASRs.

9.1.4 Solid Waste

Impacts from solid waste will be similar to the previous four options. This option will generate relatively large amounts of spoil and up to 1.3 million cu m may have to be dumped at the dumping ground.

9.2 Impacts during Operation

As discussed in the previous options there will be minimal noise or air pollution impacts from operation of the explosives depot.

9.2.1 Water Movements

Layout D3 extends further from the shore than the previous three options and there will be relatively large impact on local water movements. The headland to the north of Kau Shat Wan will be extended by about 400 metres and there will be local changes in water movements in the bay to the north. It is likely that an anticlockwise eddy will form in the bay on flood tides and there is a possibility that a clockwise eddy could form during ebb tides. The ebb tide eddy is likely to be weaker.

This option also forms a new bay to the south of Kau Shat Wan where new eddies could form on flood and ebb tides. The eddies in this bay would be clockwise on ebb tides and anticlockwise on flood tides. The flood tide eddy would be weaker and might only form on spring tides.

The changes in water movements would not affect local craft but could affect erosion/deposition patterns in the two bays.

9.2.2 Water Quality

The impacts from spillages and effluents would be similar to the previous three options.

9.2.3 Landuse, Landscape and Visual Impacts

Visual impacts are summarised on Figure 9.1. This option is a combination of tunnel and igloo storage facilities and therefore requires additional land reclamation compared with the third option (section 8.1.5 above). As with the first two options, A4(a) and C2(a), the reclamation extends beyond the adjacent headlands and would be visually prominent along the coastline. Slope cutting is also necessary and would be highly visible particularly on the northern headland. The igloo configuration would require rearrangement to allow adequate reserve for mounding and screen planting along the seaward boundary of the site.

9.2.4 Ecology

There would be less disturbance to the Kau Shat Wan hinterland than with previous options. However diversions to the stream courses and impacts on stream life could be more significant.

9.3 Conclusions

Construction noise levels have been predicted to be within the relevant noise criteria and 24 hour working would be possible if necessary. Operational impacts are not anticipated.

The impacts on air quality will not be significant during construction and operation.

As with the other options there will be impacts on the water quality during construction but these can be avoided or reduced if the correct mitigatory measures are employed.

Layout D3 requires less excavation of the shore area than the other layouts as the reclaimed area extends further from the shore. This layout would therefore have less impact on the ecology of Kau Shat Wan and a relatively minor visual impact from the slopes.

Partially enclosed bays will be formed at the north and south of the reclamation possibly affecting the local water movements to a greater extent than the other layouts.

10. MITIGATION PROPOSALS

10.1 Introduction

The previous sections of the report have discussed the environmental framework of the Study Area, environmental standards and impacts that could arise from the construction and operation of the explosives complex. The impacts have been discussed separately for the four layouts. Mitigation measures that would be appropriate for the project are discussed in this section. These are generally common to the four layouts and this section therefore does not differentiate between layouts.

Chapters 6, 7, 8 and 9 discussed the impacts from each layout and concluded that none of the impacts will be unacceptable. There are, however, a number of areas where the scope or degree of impacts may be reduced following the application of suitable mitigation measures.

10.1 Construction Phase

10.1.1 Water Quality

Dredging and Spoil Disposal

Impacts on water quality during dredging and disposal of marine mud could result from:

(a) spills from the bucket of grab dredgers or from around the inlet of suction dredgers;

(b) overflowing of hoppers;

(c) fly tipping

(d) partially closed hopper doors when the hoppers are full and on their way to the disposal site; and

(e) spills from hoppers while discharging or from partially closed hopper doors while returning to the site.

These impacts may be mitigated by careful control during the construction and by good standard practice. Suitable mitigation measures are as follows:

(a) mechanical grabs should be designed and maintained to avoid spillage and should seal tightly while being lifted;

(b) all vessels used should be of a size such that adequate clearance of the vessel with the seabed is maintained at all states of the tide thereby minimising turbidity generation by vessel movement or propeller wash;

(c) all pipe leakages should be repaired immediately;

(d) visible scum, foam, oil, litter or other objectionable matter should be avoided;

(e) barges and hopper dredgers should be fitted with tight fitting seals to their bottom openings to prevent leakage of materials;

(f) excess material should be removed from the decks and exposed fittings of barges and hopper dredgers before the vessel is moved;

(g) loading of barges and hoppers should be controlled to prevent splashing of dredged material to the surrounding water; and

(h) barges and dredgers should not be filled to a level that will cause overflowing.

Reclamation

Fill for the reclamation will be partly borrow from the cut slopes to form the land sections of the platform with some imported fill. The cut and fill should be balanced if possible to avoid large quantities of imported fill.

It will be preferable, but not essential, to construct the sea wall before the reclamation so as to minimise washout of sediment from the end slopes of the reclamation. However if marine fill is used and placed hydraulically then settlement lagoons should be constructed to settle out suspended sediments before the tailwaters are discharged to the sea. One effective way of doing this will be to construct the sea wall before placing the marine fill.

Offsite discharges

The contract should included controls on all discharges and should state that the standards set in the TMES should be adhered to.

Spillages

The contract should specify that the contractor should prepare a spill action plan and keep suitable clean-up materials on site.

10.1.2 Noise

The assessment of impacts from noise has concluded that there will be no disturbance at sensitive receivers. No specific mitigation of noise is considered necessary. The contractor will be required to comply with the provisions of the Noise Control Ordinance if he wished to work in restricted periods and the contract should include a maximum noise level of 75 dB(A) at the nearest sensitive receiver for all non-restricted periods.

10.1.3 Air Quality

No special mitigation for construction dust is considered necessary. The contract should specify a maximum one hour dust level of 500 μg/cu m at the nearest sensitive receiver and at the site boundary.

The contract should specify dust mitigation measures whereby the Contractor is required to implement dust suppression measures which could include, but not be limited to the following:

(a) stockpiles of sand and aggregate greater than $20m^3$ for use in concrete manufacture should be enclosed on three sides, with walls extending above the pile and 2 metres beyond the front of the pile;

(b) effective water sprays should be used during the delivery and handling of all raw sand and aggregate, and other similar materials, when dust is likely to be created and to dampen all stored materials during dry and windy weather;

(c) areas within the site where there is a regular movement of vehicles should have a hard surface and be kept clear of loose surface material;

(d) conveyor belts should be fitted with windboards, and conveyor transfer points and hopper discharge areas should be enclosed to minimize dust emissions. All conveyors carrying materials which have the potential to create dust should be totally enclosed through all stages of the process and fitted with belt cleaners;

(e) cement and other such fine grained materials delivered in bulk should be stored in closed silos fitted with a high level alarm indicator. The high level alarm indicators should be interlocked with the filling line such that in the event of the hopper approaching an over-full condition, an audible alarm will operate, and the pneumatic line to the filling tanker will close;

(f) all air vents on cement silos should be fitted with suitable fabric filters provided with either shaking or pulse-air cleaning mechanisms. The fabric filter area should be determined using an air-cloth ratio (filtering velocity) of 0.01 - 0.03m/s;

(g) weigh hoppers should be vented to a suitable filter;

(h) the filter bags in the cement silo dust collector should be thoroughly shaken after cement is blown into the silos to ensure adequate dust collection for subsequent loading;

(i) dust suppression plant including water bowsers with spray bars should be provided;

(j) areas of reclamation should be completed including final compaction as quickly as possible, consistent with good practice, to limit the creation of wind blown dust;

(k) all motorised vehicles on the site should be restricted to a maximum speed of 15km per hour and where possible haulage and delivery vehicles should be confined to designated roadways inside the site. For lengths of roadway longer than 100 metres where vehicle movements exceed 100 movements/day, hard pavement surfacing should be provided;

(l) the Contractor should arrange his blasting techniques so as to minimise dust generation;

(m) any vehicle with an open load carrying area used for moving potentially dust producing materials should have properly fitting side and tail boards. Materials having the potential to create dust should not be loaded to a level higher than the side and tail boards, and should be covered by a clean tarpaulin in good condition. The tarpaulin should be properly secured and should extend at least 300mm over the edges of the side and tail boards; and

(n) the location of dust producing plant or facilities, either fixed or temporary, should be subject to the agreement of the Engineer.

At any concrete batching plant being operated on the site the following additional conditions should be complied with:

(a) the Contractor should undertake at all times to prevent dust nuisance as a result of his activities. An air pollution control system should be installed and shall be operated whenever the plant is in operation;

(b) 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 should be provided. Exhaust fans should be provided for this enclosure and vented to a suitable fabric filter system;

(c) the Contractor should frequently clean and water the concrete batching plant site and ancillary areas to minimize any dust emissions; and

(d) dry mix batching should be carried out in a totally enclosed area with exhaust to suitable fabric filters.

10.1.4 Solid Waste

The Contractor should be instructed through the contract to implement a solid waste collection system. All solid wastes should be collected and delivered to landfill or other destination if directed by Government.

The design of the complex should be progressed with a view to minimising the amount of dredging if possible. This can be done firstly by allowing sufficient time for a drained reclamation rather than by excavating the mud and secondly to designing the facility with a minimum area of reclamation and avoiding areas of relatively deep mud. All excavated mud should be dumped at a gazetted dumping ground.

10.2 Operational Phase

10.2.1 Water Movements

The study has concluded that none of the layouts would have an unacceptable impact on water quality. However, the final layout adopted should nevertheless be designed to avoid embayments to the north and south of Kau Shat Wan and to smooth the flow of water in the north/south and south/north directions across the front of the facility.

10.2.2 Water Quality

Effluent discharges from the explosives complex should comply with the TMES under normal circumstances although it is recommended that on-site treatment in the form of a septic tank or a small package treatment plant is installed.

Spillages of chemicals or explosives could have a significant impact although they are not likely to be frequent. The drainage system of the complex should be designed so that the outlets can be sealed in the event of a spill. A spill action plan should be developed by the operators of the facility.

10.2.3 Noise and Air Pollution

Noise and air pollution are not likely to be significant and no special mitigation measures are needed.

10.2.4 Solid Waste

No special mitigation measures will be needed for solid waste. Disposal of any explosives waste will be in accordance with explosive regulations and other waste will be collected and taken to landfill.

10.2.5 Landuse, Landscape and Visual Aspects

The following landscape objectives are proposed to minimise the visual impact and loss of existing landscape resources.

(a) Avoid slope cutting which would result in loss of mature woodland vegetation and create a visual scar on the hillside. Although it may be possible to grass and eventually replant cut slopes, depending upon the rock/soil depths and angle of slope, the regularity of the cutting and associated drainage works remain visible and are difficult to blend with the surrounding natural contours and vegetation cover satisfactorily. Initial studies suggest it is likely that slope cutting would create steep rock slopes that could not be properly revegetated.

(b) Soften the seaward edge of landfill to blend with the irregular bay and headland coastline. A straight seawall is necessary for operational requirements. However, it is strongly recommended that, where possible, the seawall can be gently curved, particularly at the interface with adjoining headlands.

(c) Provide earth bund and planting to the perimeter of the landfill. By so doing the majority of the development can be screened from passing passenger ferries enhancing the continuity and visual amenity of the coastline.

10.2.6 Ecology

Water courses upstream from the facility should be protected from disturbance and pollution avoided. The channelling of streams through the reclamation should be designed to avoid restricting water flows.

11. ENVIRONMENTAL AND MONITORING AUDIT

11.1 Introduction

Monitoring and audit proposals are outlined below. These are preliminary guidelines for design purposes only and should be subject to further review during the design stage and approval by EPD.

11.2 Water Quality Monitoring and Audit

11.2.1 Baseline Monitoring

The insitu baseline conditions of the Study Area should be established for the various water quality parameters at least one month prior to the commencement of any marine works. Future data may then be compared against this data set to assess compliance with the requirements of the standards within the WPCO and the Contract. Assessment of the baseline conditions will also allow for determination of any deterioration in the water quality at an early stage so that remedial action may be taken if deemed necessary.

Baseline monitoring should be conducted over a two week period at three monthly intervals. Within the two week period baseline monitoring should be undertaken at least five times a week on the mid ebb and mid flood tide each day at three depths. The three depths are one metre above the seabed (lower), one metre below sea level (upper) and at mid depth (middle) for depths over five metres. If the sea depth is less than five metres then only the middle depth should be measured.

Three monitoring locations should be established for baseline monitoring; about 500 metres upstream of the marine works, about 500 metres downstream of the works and about 200 metres offshore from the works; so that the source of water pollution may also be determined.

Insitu monitoring should be undertaken for the following parameters:

- suspended solids (mg/L);
- turbidity (NTU);
- dissolved oxygen (mg/L and % sat); and
- temperature.

The annual baseline conditions are not static and will need reassessing every three months from control stations immediately outside the influence of the project.

11.2.2 Impact Monitoring and Audit

Impact monitoring will be required throughout the duration of the marine works at least three times a week on the mid ebb and mid flood tide each day at three depths as discussed above.

The monitoring stations should be located within the works area itself, with the control stations located away from the influence of the area. The location of the monitoring stations should be designated during the detail design stage when details of the reclamation layout are available.

Recommendations for trigger, action and target levels for water quality are given in Table 11.1 and a recommended action plan to be implemented should any of these be exceeded is given in Table 11.2.

Table 11.1 Trigger, Action and Target Levels Recommended for Water Quality Audit

Impact	Trigger	Action	Target
Suspended Solids	30% increase above baseline level	15% increase above the maximum level recorded upstream of the works on that sampling day	30% increase above the maximum level recorded upstream of the works on that sampling day
Dissolved Oxygen	As for suspended solids but 30% decrease	As for suspended solids but 15% decrease	As for suspended solid by 30% decrease

Table 11.2 Proposed Action Plan for Water Quality

Event	Action	
	Engineer	Contractor
Trigger level exceeded for one sample	Repeat measurement as soon as possible	-
Trigger level exceeded for more than one consecutive sample	Repeat measurements Notify contractor	-
Action level exceeded for one sample	Repeat measurement as soon as possible Notify contractor	-
Action level exceeded for more than one consecutive sample	Increase frequency of monitoring to at least daily Notify contractor Require contractor to make proposals to reduce water pollution	Review plant and methods Submit proposals for improving water quality to Engineer Implement remedial actions to improve water quality
Target level exceeded for one sample	Repeat measurement as soon as possible Notify contractor	-
Target level exceeded for more than one sample	Increase frequency of monitoring to at least daily Notify contractor Notify EPD Require contractor to implement immediate steps to improve water quality	Review plant and methods Submit proposals to improve water quality to the Engineer Implement measures to improve water quality immediately Notify Engineer of action taken

11.3 Noise Monitoring and Audit

11.3.1 Baseline Monitoring

Baseline noise monitoring will be required for a period of at least 24 hours during the month prior to the commencement of any construction activities to establish the ambient levels at NSRs.

Baseline monitoring should be in $Leq_{(5\ min)}$ and will be required during the periods in which construction is scheduled or expected, at the following NSRs or those greatest affected by specific works:

- o Tai Shui Hang Trappist Haven Monastery;
- o farmhouse at Tai Shui Hang;
- o residence between Tai Shui Hang and Kau Shat Wan; and
- o Man Kok.

Noise measurements should be taken at the facades of each NSR in the A-weighted equivalent continuous sound level using precision integrating sound levels metres which comply with IEA:651:1989 (Type I) and 804:1985 (Type II).

11.3.2 Impact Monitoring and Audit

Impact monitoring should not be required as the predicted noise levels are well within the required NCO criteria to the extent that NSRs will receive virtually no impact.

However it is recommended that the Engineer is provided with sufficient noise monitoring equipment to measure $Leq_{(5\ min)}$ at the commencement of each activity to determine if the noise levels exceed any of the required noise criteria and in the case of any complaints. One suitable noise meter should suffice.

To enable the Contractor to work within the NCO requirements and to ensure contractual compliance, trigger, action and target levels for the project have been calculated and are included below in Table 11.3. Should any of these levels be exceeded then action should be taken in accordance with the proposed action plan outlined in Table 11.4.

Table 11.3 Trigger, Action and Target Levels for Construction Noise dB(A) for NSRs

Time Period	Trigger Levels	Action Levels	Target Levels
Period I	50	55	55
Period II	35	40	45
Unrestricted Daytime	65	70	75

Note: Period I includes all evenings (1900 - 2300 hours), and general holidays and Sundays (0700 - 2300 hours).
Period II includes all night times (2300 - 0700 hours).

Table 11.4 **Proposed Construction Noise Action Plan**

Event	Action	
	Engineer	Contractor
Time Period I or II trigger levels exceeded. Daytime trigger or action levels exceeded.	Notify Contractor.	Review plant and working methods. Implement noise mitigation.
Period I or II action levels exceeded. Daytime target level exceeded	Notify Contractor. Require Contractor to propose measures to reduce noise. Increase monitoring frequency to at least two measurements per daytime Period I/II as appropriate.	Submit noise mitigation proposals to Engineer. Implement noise mitigation proposals.
Period I or II target level exceeded.	Notify Contractor. Require Contractor to implement mitigation measures. Increase monitoring frequency to hourly	Implement mitigation measures. Advise Engineer of measures applied.

11.4 Air Quality Monitoring and Audit

11.4.1 Baseline Monitoring

Air quality monitoring of total suspended particulates (TSP) should be carried for a period of two weeks during the month prior to the commencement of construction activities to establish the ambient conditions in the Study Area.

Baseline dust levels should be monitored at stations located at the site boundary nearest to the ASRs such as Man Kok and the Trappist Monastery in order to measure the one hour and 24 hour TSP background levels.

Monitoring should be undertaken for seven days each week for the 24 hour TSP and three times each day for the one hour TSP using high volume air samplers in accordance with Part 50 of Chapter 1, Appendix B of Title 40 of the Code of Federal Regulations of the USA.

To identify any variation in the ambient conditions the baseline should be reassessed every six months when no construction activities are proceeding on site.

11.4.2 Impact Monitoring and Audit

Assessment of the air quality impacts indicates that there will be limited impact on ASRs and so impact monitoring may not be necessary since it is improbable that the compliance standard of 500 $\mu g/m^3$ will be exceeded.

However it is recommended that one hour dust levels are measured using a direct reading dust meter in case at Man Kok and the Trappist Monastery and at the site boundary.

To ensure compliance with the APCO criteria and the construction contract, trigger, action and target levels have been established and are included in Table 11.5. Should any of these levels be exceeded then action should be taken in accordance with the proposed action plan outlined in Table 11.6.

Table 11.5 Trigger, Action and Target Levels Proposed for Dust

Parameter	Trigger $\mu g/m^3$	Action $\mu g/m^3$	Target $\mu g/m^3$
1 hour TSP	Background level plus 30%	Average of trigger and target level	500
24 hour TSP	Background level plus 30%	Average of trigger and target level	260

Table 11.6 Proposed Action Plan for Dust

Event	Action	
	Engineer	Contractor
Trigger level exceeded for one sample	Repeat measurement immediately	-
Trigger level exceeded for more than one consecutive sample	Repeat measurements Notify contractor	Review plant and methods Implement remedial actions Notify Engineer of action taken
Action level exceeded for one sample	Repeat measurement immediately Notify contractor	-
Action level exceeded for more than one consecutive sample	Increase frequency of monitoring to daily Notify contractor Require contractor to make proposals to reduce dust	Review plant and methods Submit proposals for reducing dust to Engineer Implement remedial actions Notify Engineer of action taken
Target level exceeded for one sample	Repeat measurement immediately Notify contractor	-
Target level exceeded for more than one sample	Increase frequency of monitoring to at least daily Notify contractor Notify EPD Require contractor to implement immediate steps to reduce dust	Review plant and methods Submit proposals for reducing dust to Engineer Implement measures to reduce dust immediately Notify Engineer of action taken

12. SUMMARY AND RECOMMENDATIONS

The site proposed for the explosives complex appears to be well suited for its purpose and the project may be constructed and operated without any major environmental impacts. However a number key issues have been identified during the assessment. These are:

(a) disposal of marine mud. It is recommended that engineering and layout options which minimise dredging of marine mud should be adopted. This implies that marine mud should be left in place beneath the reclamation and the layout with the least quantity of dredging for sea walls should be selected.

(b) the construction contract should specify methods of minimising water pollution.

(c) air, water and noise pollution should be monitored throughout construction.

(d) the final layout should be designed to avoid creating local embayments and to encourage water movements in the existing flood and ebb tide directions.

(e) landscape. In terms of visual impact and conservation of existing landscape resources, the third option (Figure 8(a)) is the most favourable. However, it is considered that even this option would require important modifications to avoid creating a scar on the coastal landscape and ensure the development is integrated with the landscape satisfactorily. The critical visual impacts are those relating to cut rock slopes, straight, angular seawalls and any built form out of scale with the typical small village development along this portion of the Lantau coastline.

The proposed layout options are ranked in order of preference as follows:

(a) underground layout 8(a)

(b) hybrid layout D3

(c) aboveground layout A4(a)

(d) aboveground layout C2(a)

Recommended Alternative Layout

An alternative layout to those assessed has been developed which meets the layout recommendations. This is shown on Figure 12.1 and views of the complex are shown in Figure 12.2. This layout has been designed to achieve the following:

(a) Avoid all slope cutting since the resulting steep rock slopes could not be satisfactorily revegetated.

(b) Complement the irregular "scallop" coastline by avoiding a totally straight and angular seawall. Curves can be provided in strategic positions such as the interface with the coastline to merge the seawall more sensitively with the landscape without adversely affecting the functioning of the depot.

(c) Avoid embayments to the north and south.

(d) Render the complex relatively inconspicuous by means of the earth and grass cover on storage igloos. However, to complete the screening effect it is recommended that earth mounding and screen planting is provided along the seaward perimeter of the site. The bund treatment should not be of continuous height or width but allow for more natural contouring. The planting should be tolerant to wind and salt spray and could include a selection from the following tree species:

Casuarina equisetifolia	Hibiscus tiliaceus
Acacia confusa	Macaranga tanarius
Cerbera manghas	

This is not an exhaustive list but contains the type of species suitable for exposed areas.

It is important that the areas within the site around the ancillary buildings and access roads should all receive adequate landscape treatment and that the open space areas should contain appropriate active and passive recreation facilities for the depot workforce. Attention should also be given to careful site planning of buildings and their colour scheme. A master landscape plan for the site should be prepared as an integral component of the development to allow proper consideration and co-ordination of the above points and allow comprehensive landscape treatment to be provided.

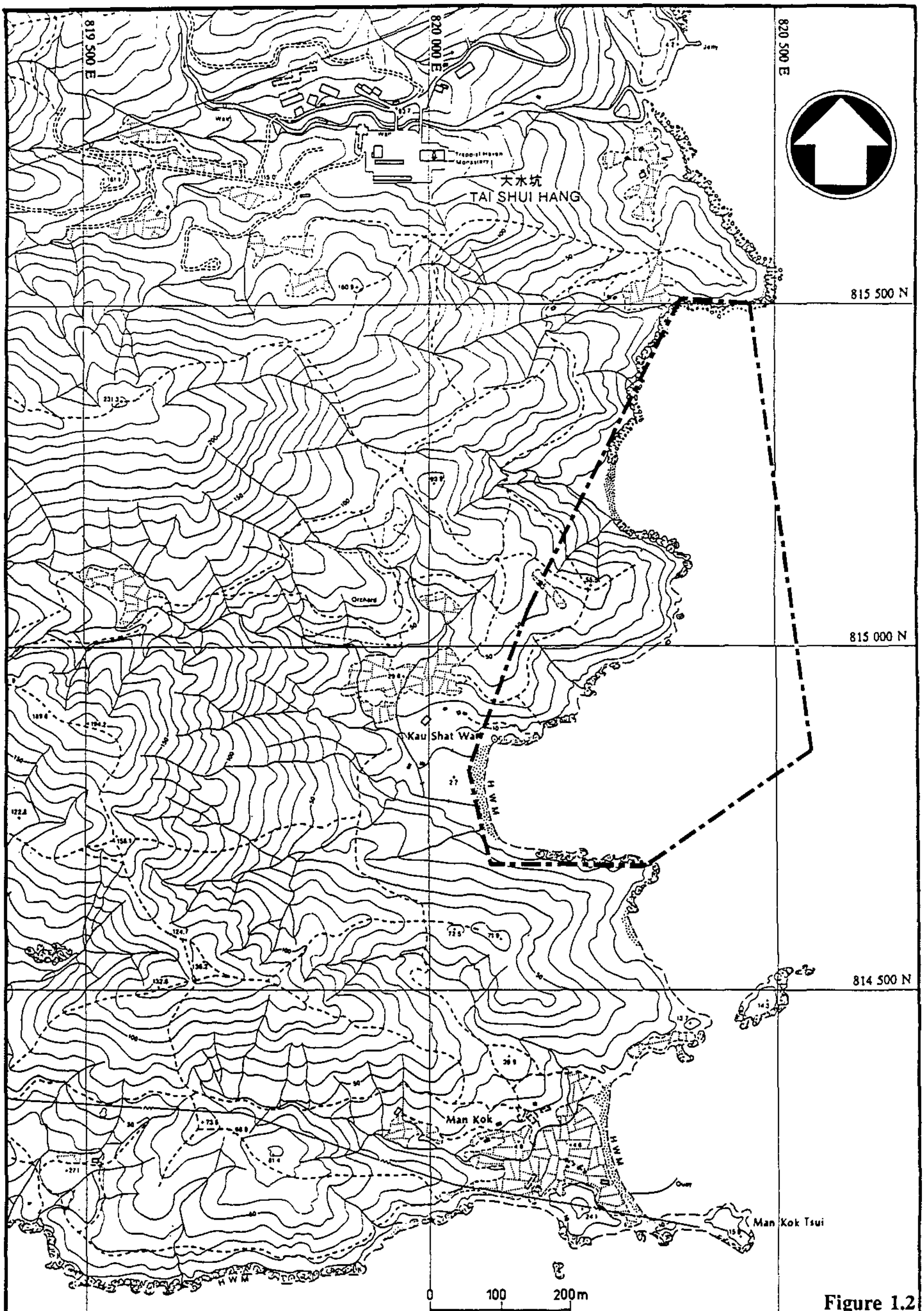

Figure 1.2
Layout C2(a)

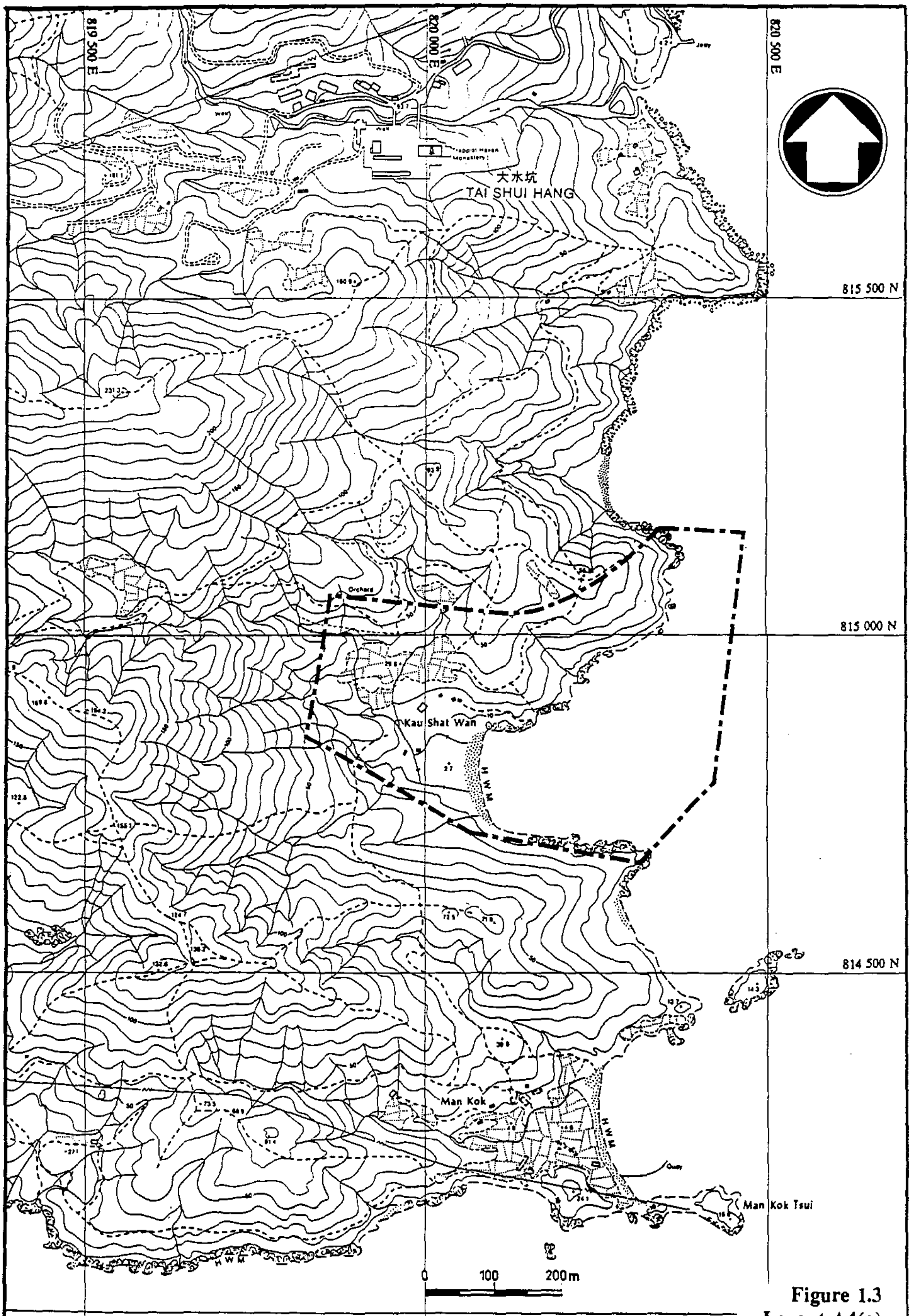

Figure 1.3
Layout A4(a)

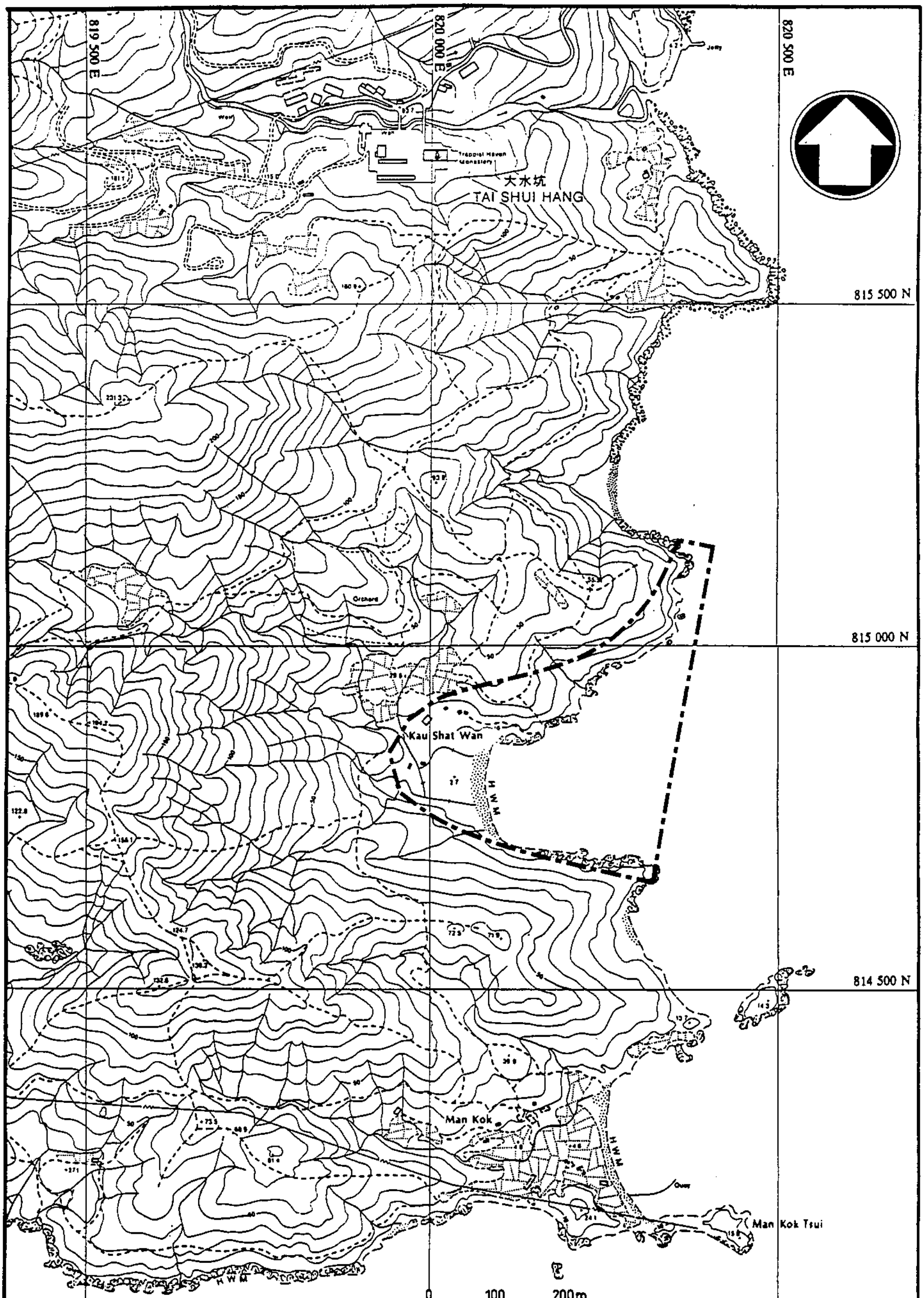

Figure 1.4
Layout 8(a)

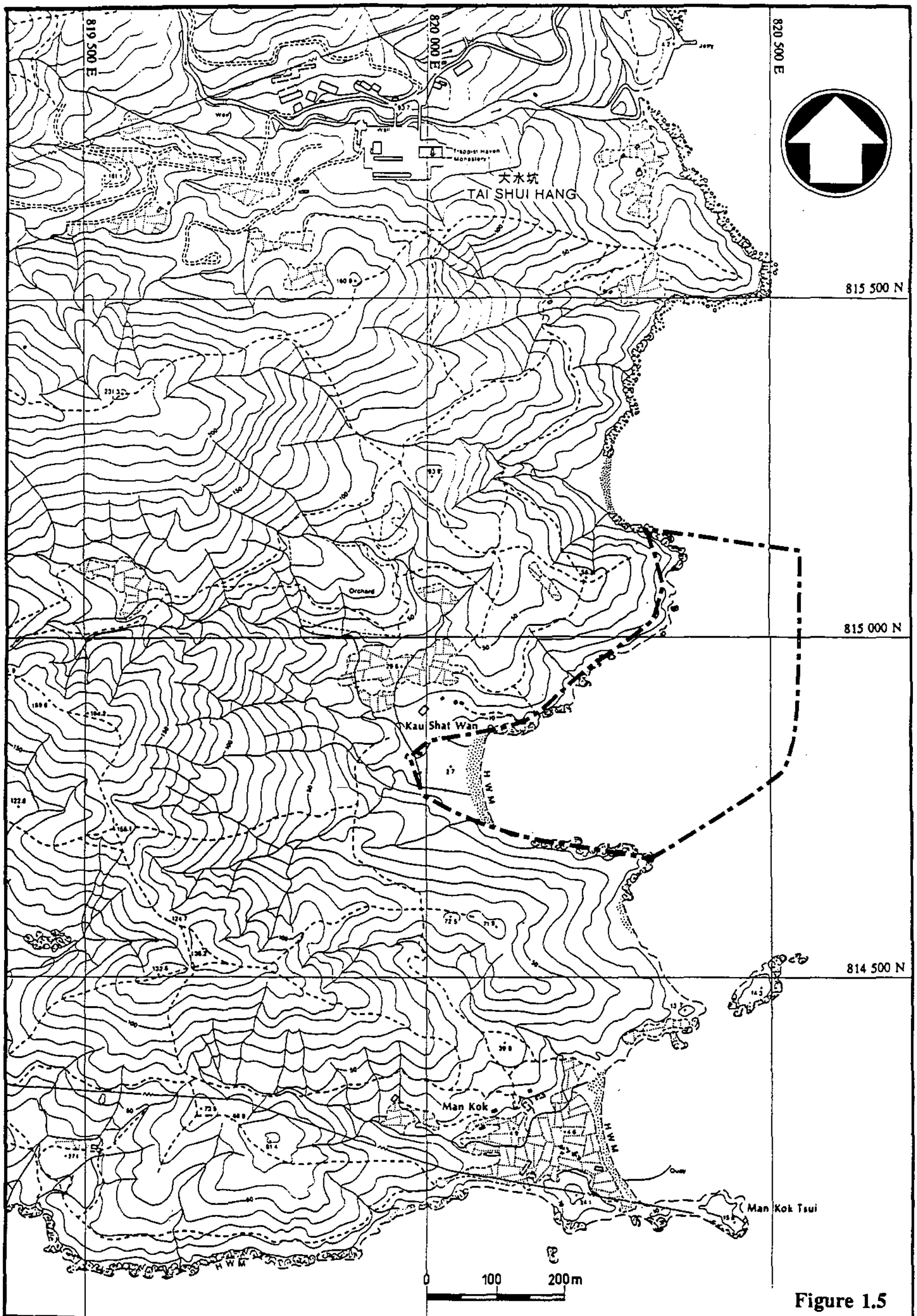

Figure 1.5
Layout D3

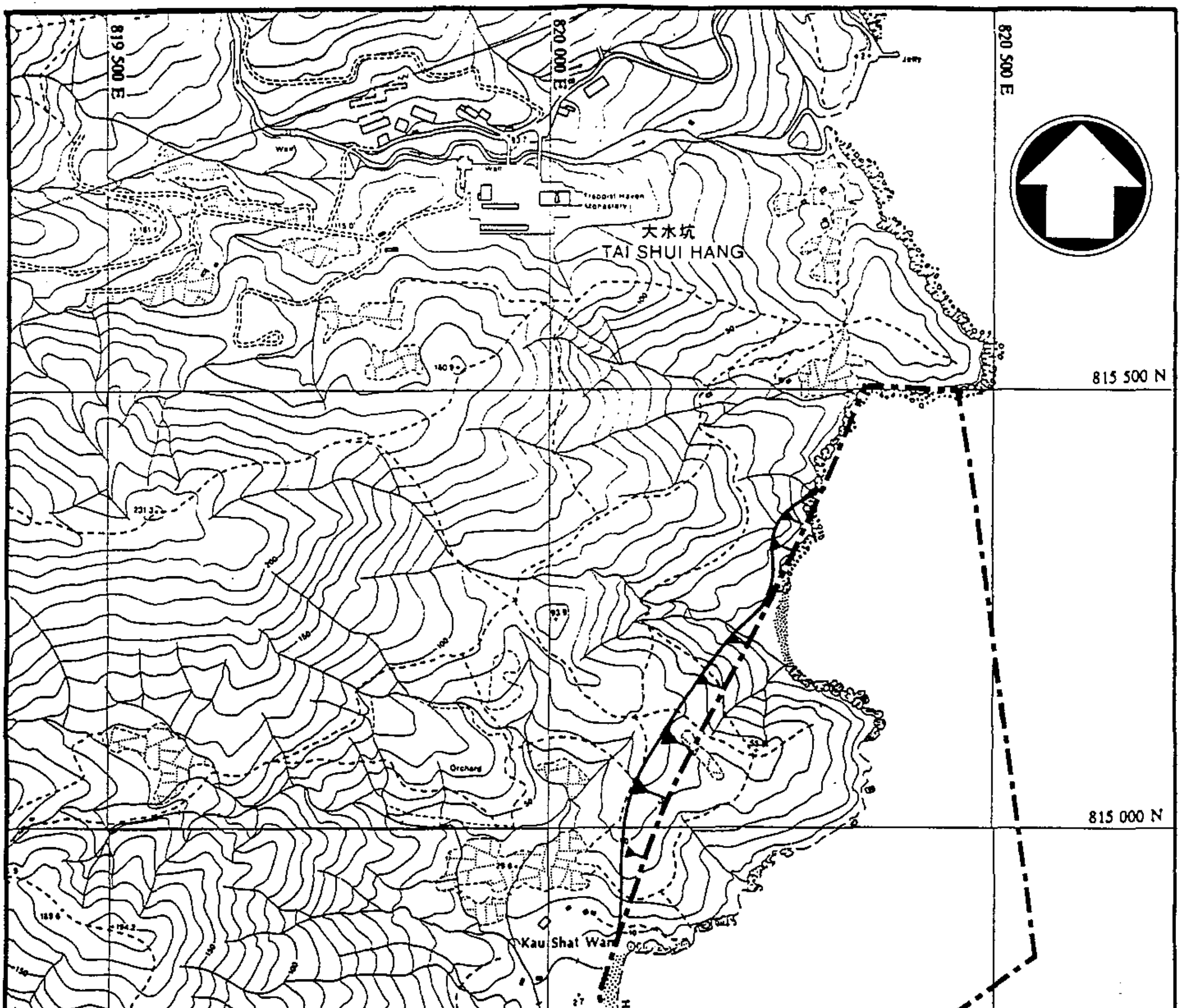

Figure 6.1
Visual Impacts from Layout C2(a)

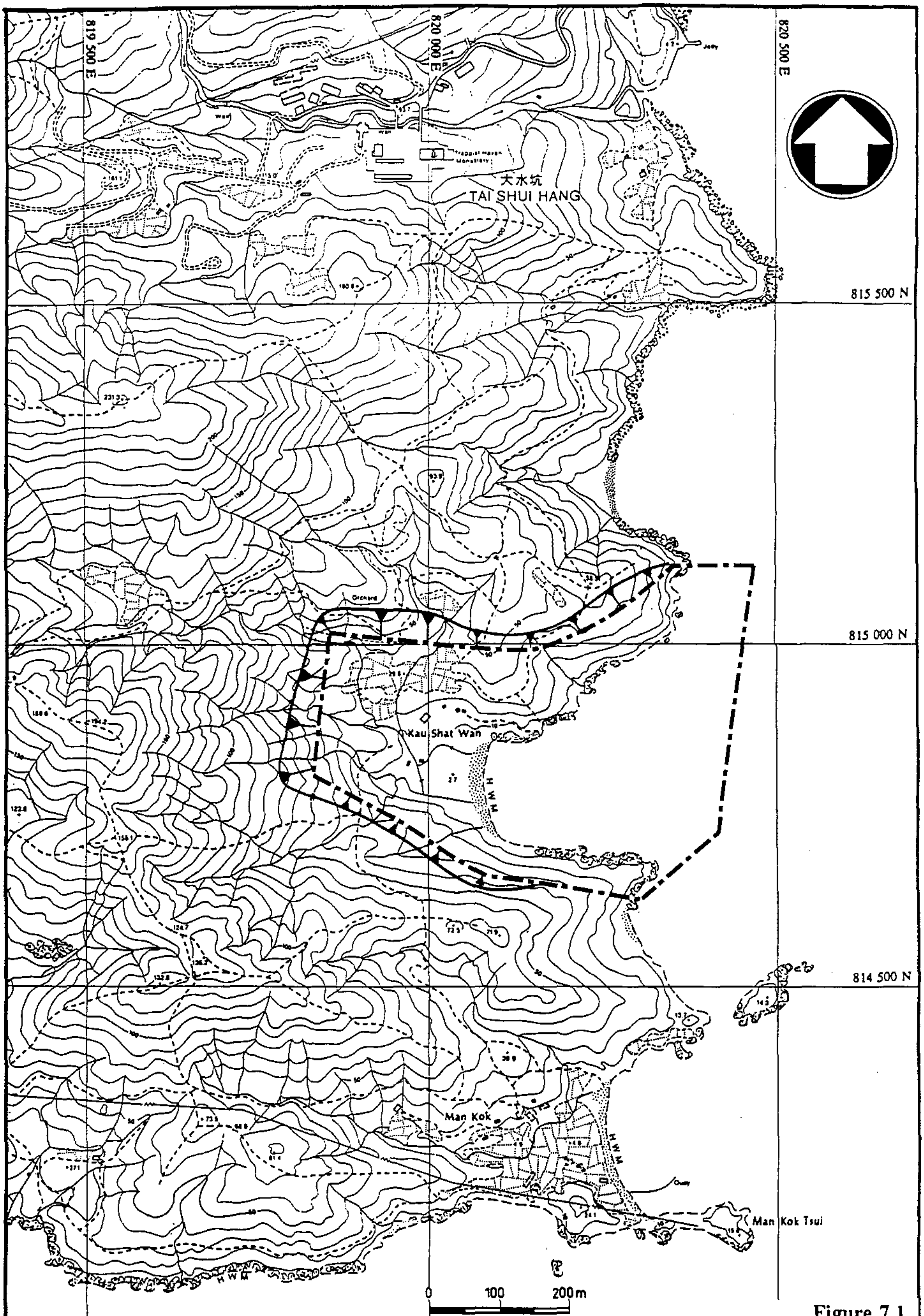

Figure 7.1
Visual Impacts from Layout A4(a)

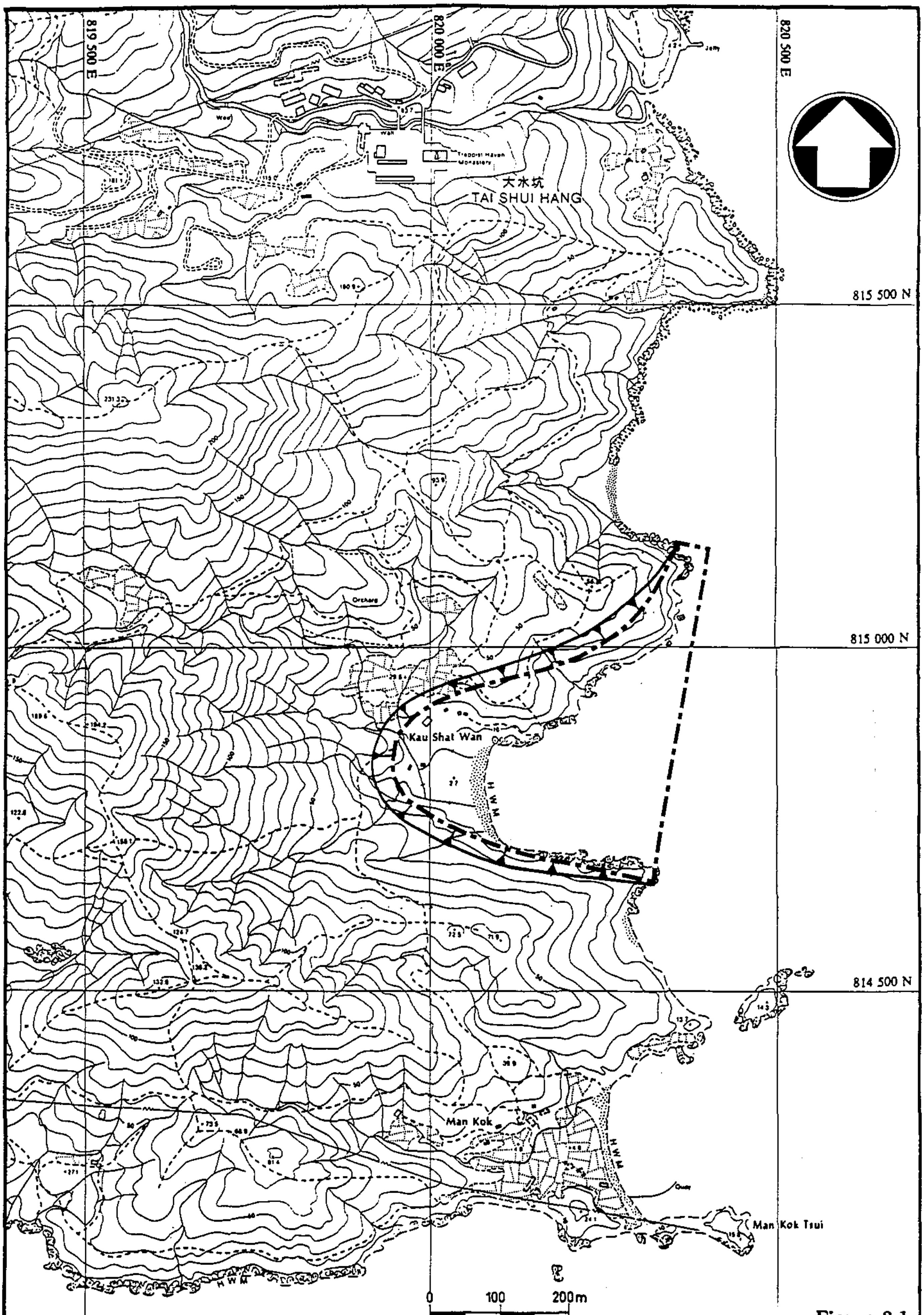

Figure 8.1
Visual Impacts from Layout 8(a)

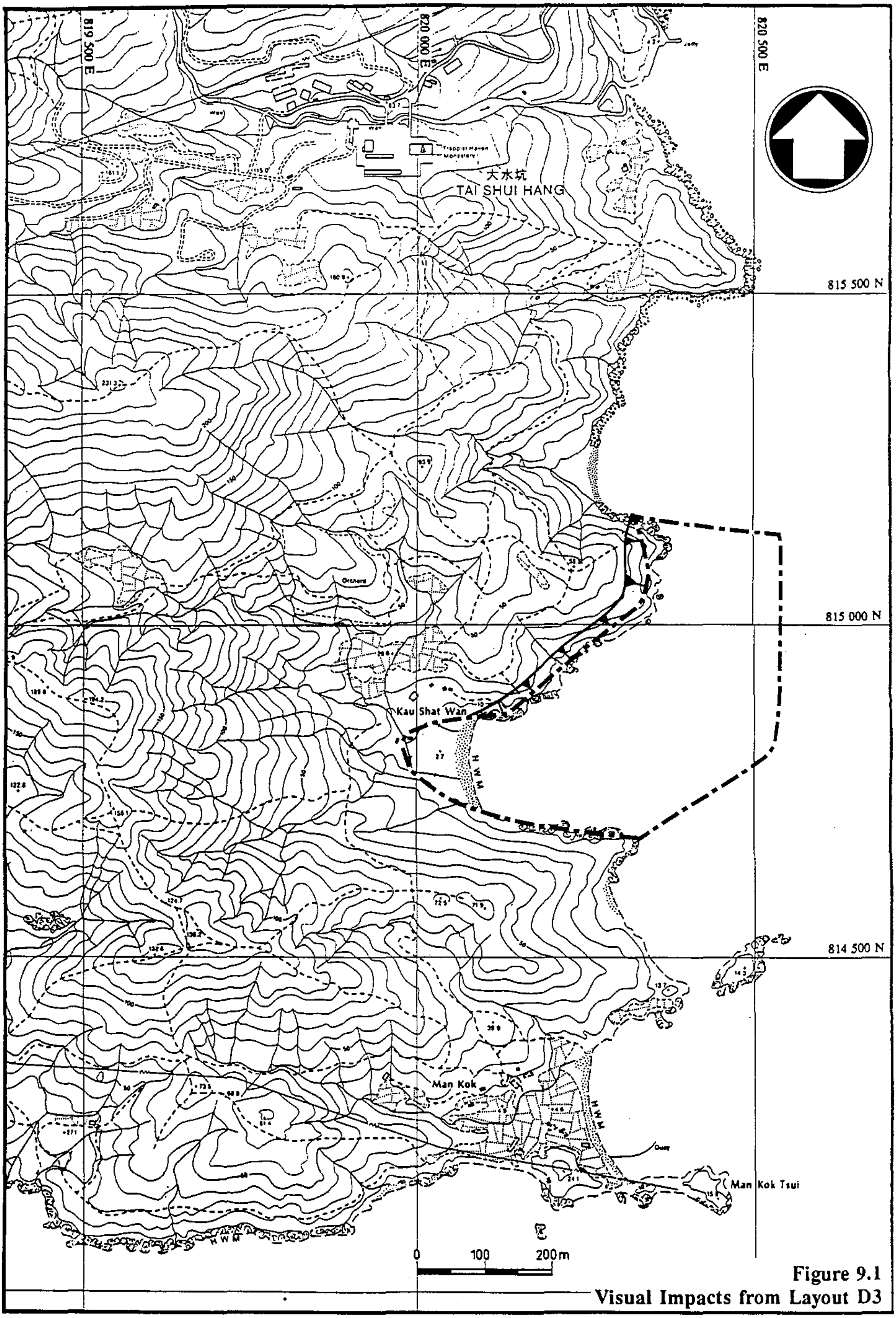

Figure 9.1
Visual Impacts from Layout D3

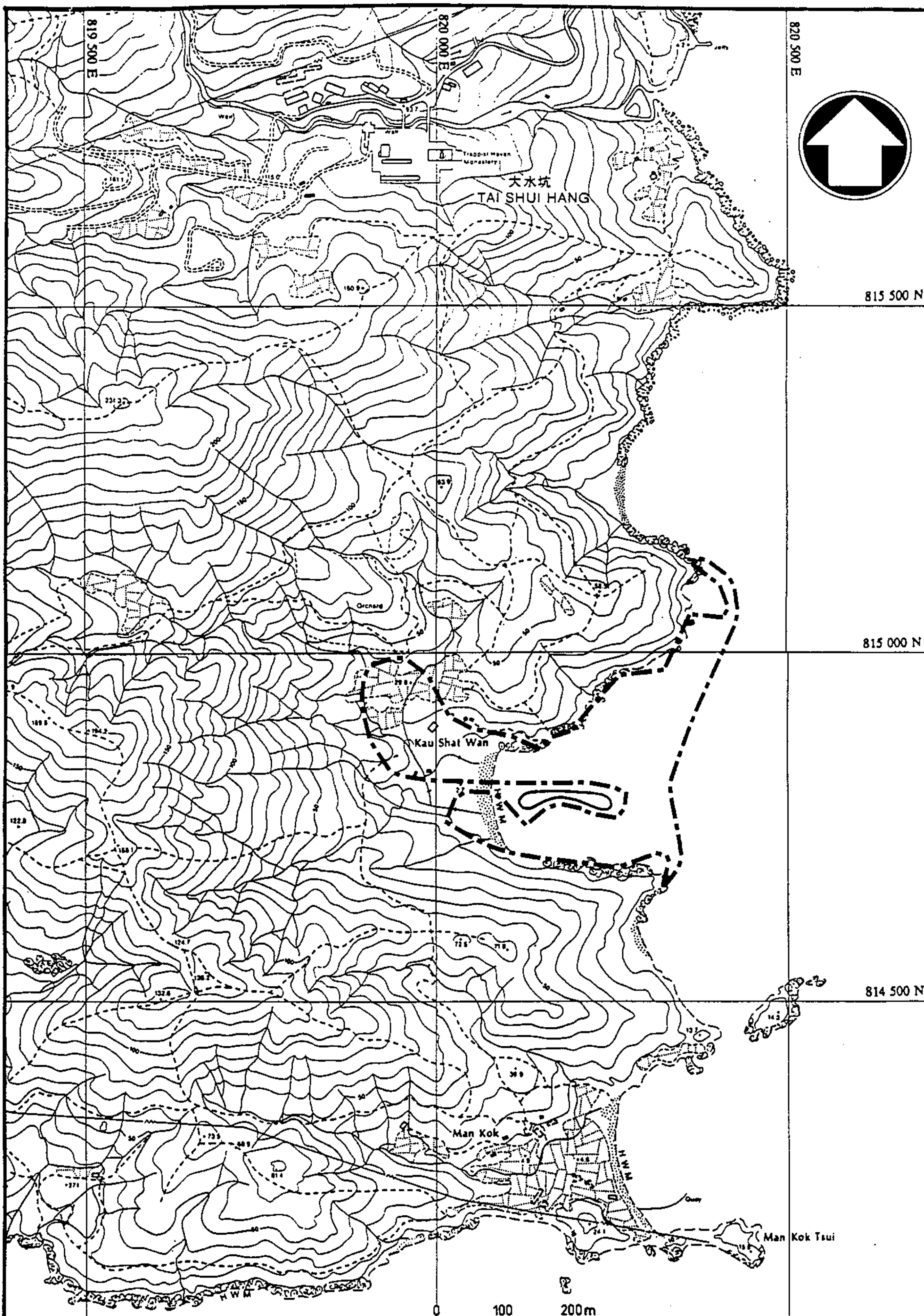

Figure 12.1
Visual Impacts from the Recommended Layout