Binnie 賓尼

Agreement No. CE 41/94

Additional Treatment and Water Transfer Facilities for the Metropolitan Area and North-eastern New Territories Investigation Study

FINAL EIA REPORT

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Hong Kong Government
Water Supplies Department

Agreement No. CE 41/94

Additional Treatment and Water Transfer
Facilities for the Metropolitan Area
and North-eastern New Territories
Investigation Study

FINAL EIA REPORT

January 1996

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1 INTRODUCTION

Project Background

1.1 The Planning Division of Water Supplies Department (WSD) has carried out a study on the adequacy of treatment and transfer capacities for the existing Sha Tin group of Water Treatment Works. The Study reveals that there will be a shortage of treatment facilities by the end of 1999. A new treatment works in the north-eastern New Territories with associated water transfer facilities has been proposed and will need to be commissioned to meet the deficit capacity by 1999.

1.2 Binnie Consultants Limited (BCL) has been appointed by Water Supplies Department to carry out the Investigation Study of the proposed water treatment and transfer facilities.

1.3 A number of alternative designs and routes have been proposed for the raw water and the treated water aqueducts: these were evaluated and compared in terms of their likely environmental impacts in the Initial Assessment Report. This Final Environmental Impact Assessment (EIA) Study Report will consider the potential impacts and mitigation measures for the chosen scheme which represents the best practicable environmental option.

EIA Study Approach

1.4 The general approach to the EIA Study has been to identify all significant environmental impacts and constraints so that the findings can be translated into environmentally acceptable designs, construction methods and operational procedures for the facilities proposed.

1.5 The EIA Study has already contributed to route selection and site layouts for the preferred scheme. For example:

- all sites and route alignments have been chosen to minimise the need for land resumption;
- a 3.8 m internal diameter pipeline and tunnel has been proposed for the raw water aqueduct on environmental, technical and economic grounds. One of the alternative options had greater potential for adverse water quality, ecological and socio-economic impacts with substantial loss of working fishponds and agricultural land;

- the layout of Tai Po Water Treatment Works (TP WTW) site has been modified to minimise the impact of cutting into the most prominent slope and ridge;

- a Master Landscape Plan has been developed to ensure that any trees or areas of woodland lost at the TP WTW Site are more than compensated for by extensive planting of native woodland species elsewhere within the site boundary;

- the design and location of the TP WTW chlorine store and flow calibration centre has been modified to reduce potential environmental impacts;

- the engineering design has taken into account the need to provide unpolluted stream compensation flows for the environmentally sensitive She Shan Tsuen area;

- the intermediate access shaft/adit originally proposed to accelerate treated water aqueduct excavation and associated spoil removal has been subsequently rejected on environmental and economic grounds;

- the treated water aqueduct is to be lined. The prime reason for lining the aqueduct is public health: potable water cannot be allowed to become contaminated. Lining will remove the requirement for operational phase monitoring and treatment of potentially contaminated tunnel drainage water required if the pipe/pipes in tunnel options had been selected. It also removes the operational phase problems associated with radon and noxious gases associated with the pipe/pipes in tunnel options;

- the proposal to dispose of excavated spoil near the Shing Mun Reservoir within the Country Park boundary, thus forming a carpark for Park visitors, has been rejected on environmental grounds;

- the proposed location of the Butterfly Valley tunnel portal has been chosen for reasons including the desire to avoid clearance of any temporary residential structures in the area;

- the site formation of the Butterfly Valley Primary Service Reservoir (BVPSR) will retain the south facing embankment, reducing the visual impact of the works and, during the construction phase, functioning as a partial noise barrier;

- the access road to BVPSR is designed to minimise any impact on existing woodland;

- the BVPSR Master Landscape Plan recommends tree and shrub planting with appropriate native species around the Site and grassing of the reservoir roof.

1.6 The EIA Study has been carried out in close and continuing liaison with the engineering design team. As each environmental issue has arisen during the study phase, its impact on the engineering of the scheme has been discussed and any feasible adjustments incorporated into the design. In a similar manner, the engineering team have been regularly advising the EIA Study team on the engineering constraints and design criteria to which they have had to work. Working together in this integrated and iterative way has facilitated the development of the best practicable environmental option for the design, construction and operation of the project.

Study Area

1.7 Figure 2.1 shows the study area, the general location of the proposed water treatment works and service reservoir, and the alternative alignments for the treated water aqueducts. Details of the sites studied are outlined in Section 4 of this report.

EIA Study Objectives

1.8 The objectives of the EIA Study have been as follows:

- to describe the proposed project and associated works together with the requirements for carrying out the proposed project;
- to identify and describe the elements of the community and environment likely to affect or be affected by the construction and future operation of the project;
- to identify and quantify emission sources and determine the significance of impacts on sensitive receivers and potential affected uses;
- to identify and quantify any potential losses or damage to flora, fauna and natural habitats;
- to propose the provision of infrastructure or mitigation measures so as to minimise pollution, environmental disturbance and nuisance during construction and operation of the project;
- to identify, predict and evaluate the residual and cumulative environmental impacts (specifying whether these are transient, long term and/or irreversible) expected to arise during the construction and operation phases of the project in relation to sensitive receivers and potential affected uses;

- to identify, assess and specify practicable, effective and enforceable methods, measures and standards to be included in the detailed design, construction and operation of the project which are necessary to mitigate these impacts and reduce them to acceptable levels;

- to investigate the extent of side effects of proposed mitigation measures that may lead to other forms of impacts;

- to identify constraints associated with the mitigation measures recommended in the study;

- to identify any additional studies necessary to fulfil the requirements of the EIA; and

- to design and specify the environmental monitoring and audit (EM&A) requirements necessary to ensure the implementation and the effectiveness of the environmental protection and pollution control measures adopted.

Purpose of Report

1.9 The purpose of this Final EIA Report is to:

- fully satisfy the requirements of the Project Study Brief as outlined in 'EIA Study Objectives' in respect to the prediction and assessment of impacts, the identification of environmental mitigation measures and the associated residual impacts;

- describe the agreed schedules and programmes for monitoring and audit requirements;

- prescribe the specification for the detailed design, construction and operation requirements of the proposed project; and

- provide with the impacts summary, the Study findings, conclusions, recommendations and a mechanism for implementation.

Structure of Report

1.10 The structure of this Final Report is as follows:

Section 1: provides a general introduction to the study

Section 2: describes the main features of the project

Section 3: describes the applicable environmental legislation

Section 4: describes the various components of the project in terms of the existing environment and sensitive receivers

Section 5: identifies visual sensitive receivers and presents the results of the visual impact assessment in a photomontage

Section 6: identifies noise sensitive receivers and presents the results of the noise impact assessment

Section 7: identifies air sensitive receivers and presents the results of the air quality impact assessment

Section 8: identifies water quality sensitive receivers and presents the results of the water quality impact assessment

Section 9: presents the results of the solid waste impact assessment

Section 10: presents the results of the socio-economic impact assessment

Section 11: presents the results of the botanical and zoological surveys undertaken during the ecological impact assessment

Section 12: presents the results of the land contamination studies

Section 13: provides a summary of environmental impacts and recommendations identified in Sections 5-12

Comments and responses on the Draft Final EIA Report are presented in Appendix A.

The Master Landscape Plans are presented in Appendix B.

The Environmental Monitoring and Audit manual for the scheme, which is designed to ensure the implementation and effectiveness of the recommended environmental protection and pollution control measures, is presented as a separate document.

2 PROJECT COMPONENTS

Introduction

2.1 The proposed Tai Po Treatment Works and Aqueducts project has five main components:

- a major new water treatment works to be located near the existing Tai Po Tau water treatment works. The treatment works, which will include a chemical house, a sludge dewatering house and a control centre, is to have an initial capacity of 250,000 m^3/day and an ultimate capacity of not less than 1,200,000 m^3/day;
- a treated water pumping station for the above capacities;
- a 1.4 km raw water aqueduct for the transfer of the above capacities from the existing Tai Po Tau 'D' pumping station to the treatment works;
- a 12 km treated water aqueduct for the transfer of the above capacities from the treatment works to the primary service reservoir. This aqueduct is to have an entrance portal near the treatment works site and an exit portal in Butterfly Valley, an access shaft near the Shing Mun reservoir and a possible temporary construction access shaft/adit near Yuen Tun Ha;
- a primary service reservoir, to be located in Butterfly Valley. The service reservoir is to have an initial capacity of 40,000 m^3, but is to be designed for an ultimate capacity of not less than 190,000 m^3, with the possibility of adding an extra 75,000 m^3 to serve the function of a secondary reservoir if feasible.

2.2 Within the proposed scheme, a number of engineering alternatives have been considered. While the treatment works and service reservoir sites were previously identified by the Water Supplies Department, there are a number of alternative routes and construction methods for the raw water and treated water aqueducts.

2.3 Figure 2.1 shows the study area, the general location of the proposed water treatment works and service reservoir, and alternative alignments for the treated water aqueducts.

Raw Water Aqueduct Options

2.4 The alternative raw water aqueduct options were:

Route I - Pipeline from Tai Po Tau 'D' pumping station along the base of the hills to the east of the Lam Tsuen River and up the stream through the She Shan Tsuen village, hereafter referred to as the She Shan Tsuen stream, to the proposed treatment works site.

Route II - Pipeline from Tai Po Tau 'D' pumping station beneath the Lam Tsuen River to an area south of the Tai Po/Tai Wo and Tolo Highway intersection. From this area the pipeline follows a westerly alignment direct to the treatment works.

Route III - Pipeline and tunnel from Tai Po Tau 'D' pumping station in a direct alignment to the proposed treatment works.

2.5 The recommended raw water aqueduct option is:

Route III - Pipeline and tunnel from Tai Po Tau 'D' pumping station in a direct alignment to the proposed treatment works.

Treated Water Aqueduct Options

2.6 The alternative treated water aqueduct options studied were:

Route I - Direct alignment from the treatment works outlet to the proposed access shaft near Shing Mun reservoir;

Route II - Depending on geotechical investigations and constraints discovered during construction, it may be appropriate to follow an alignment between the two routes outlined above.

Route III - An easterly alignment via Yuen Tun Ha where an intermediate tunnel access shaft/adit would be excavated;

2.7 All of the treated water tunnel options converge at the Shing Mun access shaft from where they all follow the same route to the proposed service reservoir at Butterfly Valley.

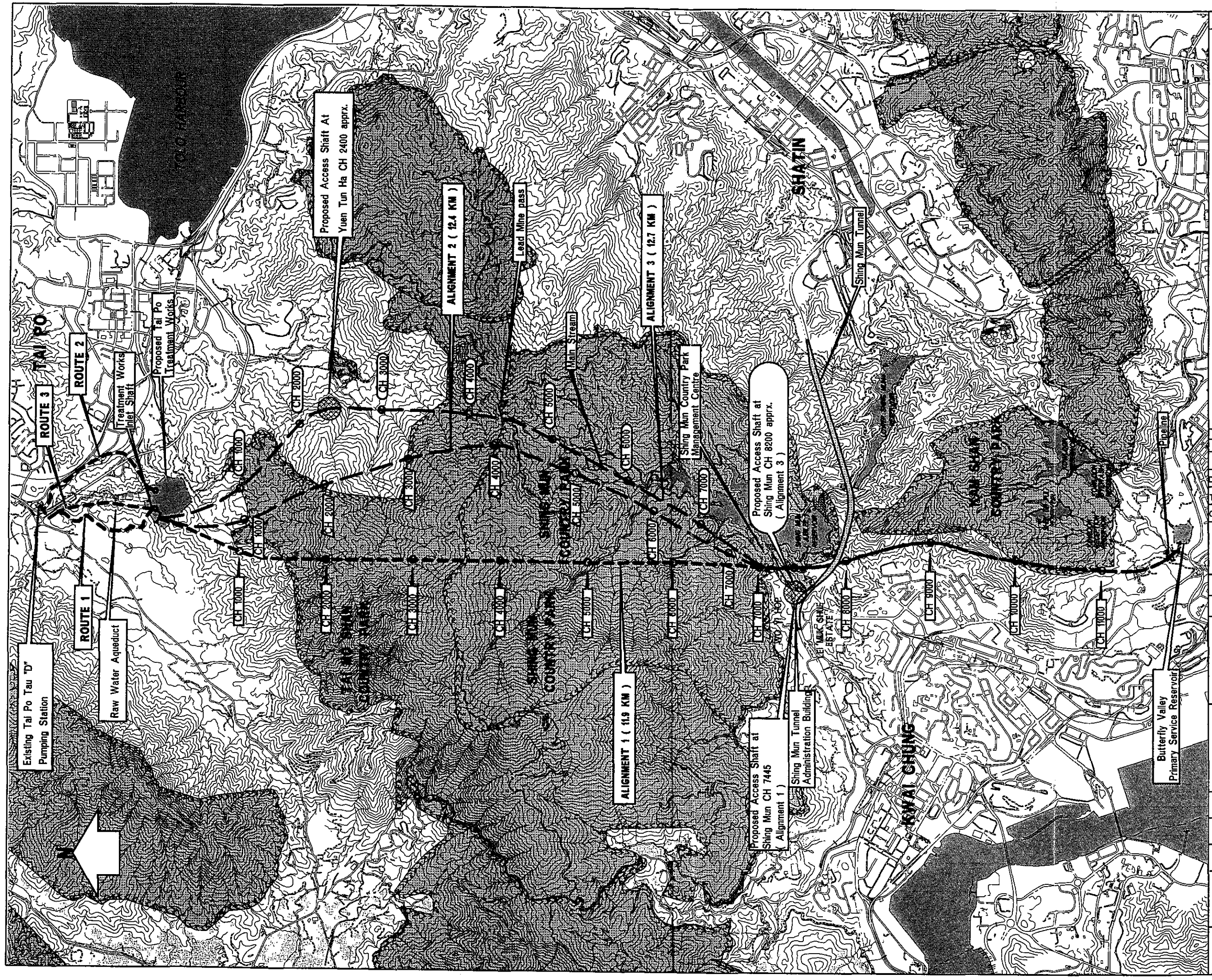
2.8 The recommended treated water option is:

Route I - Direct alignment from the treatment works outlet to the proposed access shaft near Shing Mun reservoir.

2.9 Further detailed information on the alternative routes and construction methods for the two aqueducts, together with associated cost and general environmental implications, is presented in four documents:

- Working Paper No. 3 - Treated Water Aqueduct (January 1995)
- Working Paper No. 5 - Raw Water Aqueduct (January 1995)
- EIA Initial Assessment Report (March 1995)
- Final Report (August 1995)

These documents were all prepared and issued as part of the Investigation Study by Binnie Consultants Ltd.



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Note

1. Length for different alignments adopted are :
   - Alignment 1 = 11.9 km
   - Alignment 2 = 12.4 km
   - Alignment 3 = 12.7 km
2. See Figure 15.8 for vertical alignment.

no.	date	description	initial

	name	date
Designed	JDW	4/95
Traced	KCC	4/95
Checked	HL	4/95

Approved

Agreement no. CE 41/94

Contract no.

Project title

ADDITIONAL TREATMENT AND WATER TRANSFER FACILITIES FOR THE METROPOLITAN AREA AND NORTH-EASTERN NEW TERRITORIES

SCHEME LAYOUT

Plan register no.
BCL1/home3/mapbase/TPWORK/ZF14/TPCOMP8

Figure 2.1

Scale 1 : 40000

Water Supplies Department

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼

3 ENVIRONMENTAL LEGISLATION AND PLANNING GUIDELINES

Introduction

3.1 One of the Hong Kong Government's overall policy objectives on environmental planning, as outlined in the 1989 *White Paper on Pollution in Hong Kong*, is "to avoid creating new environmental problems by ensuring the consequences for the environment are properly taken into account in site selection, planning and design of all new developments".

3.2 This section highlights the relevant environmental legislation and guidelines which are currently applicable to the proposed project.

Hong Kong Planning Standards and Guidelines

3.3 The *Hong Kong Planning Standards and Guidelines (HKPSG) Chapter 9: Environment* provides guidance for including environmental considerations in the planning of both public and private developments. The environmental suitability of a site for a certain land use is governed by such factors as:

(a) natural environmental characteristics including topography, climate, hydrological and hydrographical characteristics, vegetation, wildlife and habitat, and soil conditions;

(b) the nature, distribution and consequences of the residuals including aerial emissions, wastes, sewage or noise generated by land uses in the development area;

(c) the capacity of the environment to receive additional developments; and

(d) existing land uses.

Rural Areas

3.4 *HKPSG Chapter 10: Landscape and Conservation* states that:

"The primary aim of environmental planning in rural areas is to achieve a balance between the need for development and the need to minimise disruption of primary industries and loss of rural resources and amenity.

Planning in rural areas should recognise that the natural resources and primary industries of rural areas have important non-economic as well as economic values, which can be of local, regional and territorial significance.

Planning should aim therefore to identify, conserve and enhance these values through:

(a) The conservation, protection and enhancement of the physical, cultural and social environment of rural areas;

(b) The avoidance of encroachment of urban development on, and the protection of, land having a high actual or potential value for agriculture, outdoor recreation or conservation; and

(c) The prevention of sporadic urban or other incompatible development in rural areas."

Green Belt, Country Parks and 'Special Areas'

3.5 The major land uses within rural areas under statutory control are Green Belt (under the *Town Planning Ordinance [Cap 131]* (1988) and the *Town Planning Amendment Ordinance* of 1991) and Country Park (under the *Country Parks Ordinance [Cap 208]* of 1976).

3.6 Green Belt zoning is intended to limit development on the fringes of existing and proposed urban areas in order to maintain, and where possible enhance, their landscape and amenity values. Only certain types of developments are permitted in Green Belt areas: others are subject to approval by the Town Planning Board.

3.7 Country Parks are areas designated for provision of informal outdoor recreation and conservation of landscape, wildlife and historical features. 'Special Areas' of Government land may be gazetted for "the safeguarding of botanical, zoological, landscape and/or historical significance" under the *Country Park Special Areas Regulations* (1989). No new developments can be carried out in Country Parks and Special Areas without the approval of the Director of Agriculture and Fisheries.

Site of Special Scientific Interest

3.8 Sites of Special Scientific Interest (SSSI) are terrestrial or aquatic sites which because of their flora, fauna, geographical, geological or physiographical features are of particular scientific interest. SSSI are registered by the Planning Department upon the advice of the Director of Agriculture and Fisheries. Unlike Country Parks or Special Areas, the status of SSSI does not confer any statutory power to the Government nor imply any legal restrictions on the activities of the land owner.

Visual Assessment

3.9 There is no current legislation which specifically relates to landscape and visual impacts of developments in Hong Kong. However, the *HKPSG Chapter 10: Landscape and Conservation* referred to above does contain recommendations about developments in agricultural areas, woodlands, water gathering grounds, areas of freshwater fish culture, scenic and potential recreation areas.

3.10 This chapter of the HKPSG also provides guidelines for reducing adverse environmental effects of development in rural areas. Recommendations cover:

- *Topography and site information:*

  Developments on hill tops, scenic ridges and prominent positions should be avoided wherever possible. Site layout, road alignments, etc. should follow and relate to the natural contours. Overall, formation work and site disturbance should be minimised.

  In scenic areas, opportunities should be taken to use local landform and any excavated material available to "fit" the development into the ground form, soften the geometric outline of buildings, and screen ancillary features from view;

  Developments should be sited and planned to minimise long term visual impact.

- *Retention of existing vegetation:*

  Developments should be sited so as to retain existing woodlands, groups of trees and feature trees wherever possible.

Retention of trees on development sites is made easier if non-building areas are specified to include all significant tree features and suitable conditions to ensure these areas are protected and included in development proposals.

Advice should be sought from Agriculture and Fisheries Department, Buildings Department, Territory Development Department, Urban Services Department or Regional Services Department on regulations governing the felling of trees, the suitability of trees for retention and the possible occurrence of important flora and fauna.

- *Site layout, overhead services alignments, etc.:*

The appropriate siting and design of development is often crucial for the maintenance of the landscape in rural areas. Building layouts that avoid regular repetitive or geometric forms and that relate well to natural landforms are preferred.

Views from surrounding areas should be taken into account.

Overhead services should be aligned to minimise visual impact and below ground routes should be preferred in sensitive areas.

- *Building design and landscape treatment:*

In areas of scenic importance, building design should be sympathetic with the surrounding landscape and the general rural environment.

The preparation and implementation of landscape plans should be a requirement on all major developments and, as a general rule, for developments in scenic areas. Landscape Plans should include all or most of the following:

(i) A framework of tree planting to separate, screen and complement buildings;

(ii) Shrub and ground cover on the periphery of the site where this is open to public view;

(iii) Re-vegetation of excavated areas and formed slopes not built upon, consistent with geotechnical requirements; and

(iv) Proposals to ensure that the vegetation to be established is maintained or self-sustaining.

Noise

3.11 *HKPSG* states that "The basic role of planning against noise is to provide an environment whereby noise impacts on sensitive uses are maintained at acceptable levels."

3.12 Noise control legislation in Hong Kong comes under the *Noise Control Ordinance [Cap 400]* of 1988 regulations and associated Technical Memoranda (TM). The following TM have been issued on:

- *TM on The Assessment of Noise from Places other than Construction Sites, Domestic Premises or Public Places* (1988)
- *TM on Noise from Construction Works other than Percussive Piling* (1988)
- *TM on Noise from Percussive Piling* (1988)

3.13 New environmental legislation on noise control, the *Noise Control (Construction) Regulation* and the associated *TM on Noise from Work within a Designated Area*, is currently being drafted. This legislation is designed to control noise from the use of specified powered mechanical equipment and the carrying out of prescribed construction work on construction sites within a designated area during restricted hours.

3.14 An amendment to the *TM on Noise from Percussive Piling*, phasing out the use of diesel hammers, is also currently being drafted.

3.15 Noise Sensitive Receivers (NSRs) are defined by the *HKPSG* and *Noise Control Ordinance* as follows:

- all domestic premises, including temporary housing accommodation;
- hotels and hostels
- offices
- educational institutions, including kindergartens, nurseries and all others where unaided voice communication is required

- places of public worship and courts of law
- hospitals, clinics, convalescences and homes for the aged, diagnostic rooms and wards
- amphitheatres and auditoria, libraries, performing arts centres and Country Parks

3.16 The appropriate Acceptable Noise Level (ANL) for a particular NSR is dependent on the character of the area in which the NSR is located, and the time of day under consideration. The Area Sensitivity Rating (ASR) is a function of the type of area within which the NSR is located and the degree of the effect on the NSR of particular Influencing Factors (IFs). IFs include any industrial area, major roads (ie. those with a heavy and generally continuous flow of vehicular traffic) and the area within the boundary of Hong Kong International Airport. Table 3.1 shows the Area Sensitivity Ratings given by the *Noise Control Ordinance*.

Table 3.1 Area Sensitivity Ratings

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

Notes:

'Country Park' means an area that is designated as a country park pursuant to section 14 of the *Country Parks Ordinance*.

'Directly Affected' means that the NSR is at such a location that noise generated by the IF is readily noticeable by the NSR and is a dominant feature of the noise climate of the NSR.

'Indirectly Affected' means that the NSR is at such a location that noise generated by the IF, whilst noticeable at the NSR, is not a dominant feature of the noise climate of the NSR.

'Not Affected' means that the NSR is at such a location that noise generated by the IF is not noticeable at the NSR.

'Urban Area' means and area of high density, diverse development including a mixture of such elements as industrial activities, major trade or commercial activities and residential premises.

Construction Noise

3.17 There are no statutory criteria for noise from construction work other than percussive piling generated during the daytime hours of 07:00-19:00, Monday to Saturday, excluding public holidays. However, EPD normally recommends 75 dB(A) L_{eq}(30 min) as the acceptable noise level during daytime hours at the facade of residential sensitive receivers and 70 dB(A) at schools (65 dB(A) during examinations) as outlined in the ProPECC paper (PN 2/93) on *Noise from Construction Activities - Non-Statutory Controls.*

3.18 Noise restrictions are imposed during the evenings (19:00-23:00), night-time (23:00-07:00) and all day on Sunday and public holidays. For construction activities during these hours, a Construction Noise Permit (CNP) is required from the Environmental Protection Department (EPD). The CNP application will be assessed in accordance with the Basic Noise Levels (BNLs) given in the *TM on Noise from Construction Works other than Percussive Piling*, as shown in Table 3.2.

Table 3.2 Basic Noise Levels for General Construction Noise

ASR Time Period	A	B	C
All days during the evening (19:00-23:00), and general holidays (including Sundays) during the daytime and evening (07:00-23:00)	60	65	70
All days during the night-time (23:00-07:00)	45	50	55

3.19 Noise criteria applied to control the noise from percussive piling is detailed in the TM on Noise from Percussive Piling. Any percussive piling requires a CNP from EPD. When considering the issue of a CNP, EPD compares the corrected noise level (CNL) with the Acceptable Noise Level (ANL) for the area. Table 3.3 shows the ANLs for percussive piling.

Table 3.3 Acceptable Noise Levels for Percussive Piling

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

Note: 10 dB(A) is deducted from the ANLs shown above for NSRs such as hospitals, medical clinics, education and other NSRs considered to be particularly sensitive to noise.

3.20 The CNL relates to the tonality, impulsiveness and intermittency of the noise. In the event that the CNL exceeds the ANL, EPD will impose restrictions on the permitted hours of piling operation in accordance with Table 3.4.

Table 3.4 Permitted Hours of Percussive Piling Operation

Amount by which CNL exceeds ANL	Permitted hours of operation on any day not being a general holiday
more than 10 dB(A)	08:00-09:00 and 12:30-13:30 and 17:00-18:00
between 1 dB(A) and 10 dB(A)	08:00-09:30 and 12:00-14:00 and 16:30-18:00
no exceedance	07:00-19:00

3.21 The information required in an application for a Construction Noise Permit includes:

- a map (preferably 1:1000 scale) showing precise details of the site location, site limits and nearby noise sensitive receivers, eg. residential buildings, schools, hospitals; and
- location of any stationary powered mechanical equipment on site or, in the case of an application for a percussive piling permit, the piling zone or actual pile locations;
- details of the time period (time of day, duration in days/weeks/months) for which the CNP is required;
- a description, including two photographs and identification codes, and number of units of each item of powered mechanical equipment to be used or, in the case of piling, details of the piling method and pile type including number of units;
- details of any particularly quiet items of equipment or piling methods, special noise control measures to be employed on site, or any other information thought to be relevant.

3.22 During daytime works, EPD recommends that the advice in EPD's Practice Note ProPECC PN2/93 on *Construction Noise Abatement* practice is followed.

Operational Noise

3.23 *HKPSG* states that noise levels from a new fixed source should be 5 dB(A) below the relevant ANL presented in the *TM on The Assessment of Noise from Places other than Construction Sites, Domestic Premises or Public Places* or the prevailing background noise level, whichever is lower. The ANL from the TM for a given NSR is presented in dB(A) in Table 3.5 below.

Table 3.5 Acceptable Noise Levels during Operations

ASR / Time Period	A	B	C
Day (07:00-19:00) and Evening (19:00-23:00)	60	65	70
Night (23:00-07:00)	50	55	60

Air Quality

3.24 The principal legislation regulating air emissions in Hong Kong is the *Air Pollution Control Ordinance (APCO) [Cap 311]* of 1983 and its subsidiary regulations. The whole of the Territory has been covered by Air Control Zones. *HKPSG* states that "Air quality is affected by such factors as the emission rate of air pollutants, the separation distance between emission sources and receptors, topography, height and width of buildings as well as meteorology."

3.25 New environmental legislation entitled *Air Pollution Control (Construction Dust) Regulations* is currently under consultation. These regulations are to control the dust emission from construction sites by a notification and permit procedure. The *Air Pollution Control (Open Burning) Regulation* comes into effect on 26 February 1996. Open burning on site without a permit from EPD is an offence under this Regulation.

Operational Emissions

3.26 The Hong Kong Air Quality Objectives (AQOs) state the maximum acceptable concentration of air pollutants. The AQOs for one and 24 hour concentrations of five major pollutants are shown in Table 3.6. The Government aims to achieve the AQOs throughout the Territory as soon as 'reasonably practicable'. Efforts are being made to control and reduce air pollution emitters in areas where the AQOs are already exceeded, eg. by controlling new developments. The AQOs will apply to the operational phases of the project.

Table 3.6 Air Quality Objectives

POLLUTANT	Concentration ($\mu g/m^3$)	
	1 hour[1]	24 hour[2]
Carbon Monoxide (CO)	30,000	-
Nitrogen Dioxide (NO_2)	300	150
Sulphur Dioxide (SO_2)	800	350
Total Suspended Particles (TSP)	-	260
Respirable Suspended Particles[3] (RSP)	-	180

Notes: Concentrations measured at 298°K (25°C) and 101.325 kPA
1 One hour criteria not to be exceeded more than 3 times per year
2 24 hour criteria not to be exceeded more than once per year
3 Suspended particles in air with a nominal aerodynamic diameter of 10 μm or smaller

Construction Dust

3.27 During the construction phase of the project, an hourly average TSP limit of 500 $\mu g/m^3$ is recommended by EPD for assessing construction dust impacts. This limit is not statutory, but nonetheless has been used in many construction works in Hong Kong as a contractual requirement.

Cement and Concrete

3.28 Cement works in which the total silo capacity exceeds 50 tonnes and in which cement is handled fall under the Specified Processes under the *Air Pollution Control Ordinance*. A licence from EPD is required to operate such a works.

3.29 In order to obtain a licence to conduct a Specified Process, EPD may require the applicant to submit an air pollution control plan for the process. This will include:

- a description and technical particulars of the plant or equipment that may evolve an air pollutant;
- details of pollution control equipment or measures proposed to minimise emissions and comply with the requirement to use the best practicable means of controlling air pollution;
- a description (with maps) to identify sensitive receivers, eg. residential buildings. schools. hospitals:
- an assessment of the resulting air quality and risk to human health, including supporting calculations and information;
- a statement that the best practicable means of controlling air pollution has been adopted or is proposed. including supporting calculations and information:
- a plan for, or scheme of. monitoring the emission at source or the ambient concentration of any air pollutant.

3.30 The *HKPSG* recommends that any concrete batching plants and open storage areas should be located at least 100 m from any air sensitive receiver.

Water Quality

3.31 The principal legislation for controlling water pollution in Hong Kong is the *Water Pollution Control Ordinance (WPCO) [Cap 358]* of 1981 which allows for gazettal of Water Control Zones (WCZ) within which the discharge of liquid effluents and the deposit of matter into any water bodies, public sewers and drains are controlled. The WPCO is applicable for construction site discharges as well as for discharges during the operational phase.

3.32 The *TM on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* was issued in 1991. Under the provisions of this TM, all discharges must be licensed. Tables included within the document identify standards related to effluent flow rates ranging from <10 m^3/day to 6,000 m^3/day, providing guidance on a case-by-case basis.

3.33 Much of the project area (the treatment works site, raw water aqueduct and treated water aqueduct) falls within the supplementary water control zones which are the water gathering grounds for the Plover Cove, Shing Mun and Kowloon Group Reservoirs. Great care must be taken to ensure that the water courses are not affected by the works.

3.34 Table 3.7 lists the likely most stringent effluent requirements for discharges within the project area.

Table 3.7 Standards for Effluents discharged into Group A Inland Waters[1]

Flow rate (m^3/day) / Determinant	≤10	>10 to ≤100	>100 to ≤500	>500 to ≤1,000	>1,000 to ≤2,000
pH (pH units)	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
Temperature (°C)	35	35	30	30	30
Colour (lovibond units) (25 mm cell length)	1	1	1	1	1
Conductivity (μ/cm at 20°C)	1,000	1,000	1,000	1,000	1,000
Suspended solids	10	10	5	5	5
Dissolved oxygen	≥4	≥4	≥4	≥4	≥4
BOD	10	10	5	5	5
COD	50	50	20	20	10
Oil & Grease	1	1	1	1	1
Boron	2	2	1	0.5	0.5
Barium	2	2	1	0.5	0.5
Iron	2	2	1	0.5	0.5
Arsenic	0.05	0.05	0.05	0.05	0.05
Total chromium	0.05	0.05	0.05	0.05	0.05
Mercury	0.001	0.001	0.001	0.001	0.001
Cadmium	0.001	0.001	0.001	0.001	0.001
Selenium	0.01	0.01	0.01	0.01	0.01
Copper	0.2	0.2	0.2	0.2	0.1
Lead	0.1	0.1	0.1	0.1	0.1
Manganese	0.5	0.5	0.5	0.5	0.5
Zinc	1	1	1	1	1
Other toxic metals individually	0.1	0.1	0.1	0.1	0.1
Total toxic metals	0.3	0.3	0.2	0.2	0.15
Cyanide	0.05	0.05	0.05	0.05	0.02
Phenols	0.1	0.1	0.1	0.1	0.1
Hydrogen sulphide	0.05	0.05	0.05	0.05	0.05
Sulphide	0.2	0.2	0.1	0.1	0.1
Flouride	1	1	1	1	0.5
Sulphate	800	600	500	400	200
Chloride	800	500	500	200	200
Total reactive phosphorus	1	0.7	0.7	0.5	0.5
Ammonia nitrogen	1	1	1	1	0.5
Nitrate + nitrite nitrogen	15	15	15	15	15
E Coli (count/100 ml)	<1	<1	<1	<1	<1

Note: All units in mg/L unless otherwise indicated; all figures are upper limits unless otherwise indicated.

1 Group A inland waters are those used for abstraction for potable water supply.

Construction Site Discharges

3.35 Advice on the handling and disposal of construction site discharges, including site runoff and contaminated wastewaters, is provided in the ProPECC Paper (PN1/94) on *Construction Site Drainage*.

Waste Oil

3.36 The disposal of waste oil and other chemicals is controlled by the regulations for chemical waste control under the Waste Disposal Ordinance. Waste oil and other chemicals must be disposed of at the Government Chemical Waste Treatment Centre at Tsing Yi.

Solid Waste

3.37 Disposal of chemical, household, street, trade and livestock waste is controlled by the *Waste Disposal Ordinance [Cap 354]* of 1980. This legislation covers all aspects of the production, storage, collection and disposal, including the treatment, reprocessing and recycling of waste. In 1989, the formulation of a strategic Waste Disposal Plan for Hong Kong was founded on this legislation.

3.38 Construction waste generated during the construction phase should be sorted on site into inert and non-inert fraction for reuse and recycling as far as practical. The non-inert fraction containing no more than 20% by volume of inert content can be disposed of at landfills, whilst the inert fraction should be delivered to public dumps or other reclamation sites. Inert material means soil, rock, asphalt, concrete, brick, cement plaster/mortar, building debris, aggregates, etc.

3.39 The design of oil/fuel storage facilities is covered by the *Code of Practice for Oil Storage Installations* issued by the Building Authority. The handling of chemical spillages on land is regulated by the Fire Services Department.

Contaminated Land

3.40 The ProPECC guidelines PN 3/94 on *Contaminated Land Assessment and Remediation* prepared by EPD covers the disposal of contaminated land to landfill.

Ecology

Sites of Special Scientific Interest

3.41 There are various legislative and regulatory controls in place for the conservation of species and protection of the environment. Table 1.2 from *HKPSG's Chapter 9: Environment* highlights "ecologically sensitive areas such as Sites of Special Scientific Interest (SSSI) and areas with other particular vegetation and wildlife habitat characteristics" as Environmental Factors influencing Land Use Planning, and states that Nature Reserves and SSSI should be adequately protected from the effects of pollution and from the diversion of natural flows.

3.42 The *HKPSG* also highlight the need for care to be taken in planning and implementation of civil engineering construction works to avoid, minimise or ameliorate the occurrence of pollution from silt, oil and other sources on water bodies in unspoilt areas designated for conservation and in SSSI.

Wild Animals

3.43 Wild animals are protected by the *Wild Animals Protection Ordinance [Cap 170]* (1980), which fall under the Authority of the Director of Agriculture and Fisheries. The latest version of Cap 170 is the Second Schedule of the *Wild Animals Protection Ordinance [Cap 170]* which was revised in 1992. Protected wild animals listed under the Schedule include mammals, all wild birds, reptiles, amphibians and an insect.

Rare and Endangered Plant Species

3.44 Various species of plants are protected under the Forestry Regulations of the *Forestry and Countryside Ordinance [Cap 96]* (1950) and *Animals and Plants (Protection of Endangered Species) Ordinance [Cap 187]* (1976). The *Forestry and Countryside Ordinance [Cap 96]* and *Forestry Regulations [Cap 96 Sub. leg. A]* were revised in 1993. The *Animals and Plants (Protection of Endangered Species) Ordinance [Cap 187]* has been revised in 1995.

Tree Preservation

3.45 *Works Branch Technical Circular 24/94 (Planning, Environment and Lands Branch Circular 3/94) on Tree Preservation* states that:

"The need to preserve trees must be borne in mind particularly by those in charge of engineering, architectural and landscape projects ..... There are many projects such as ... service reservoirs, formation works and the like where virtually all trees and shrubs within the works area boundary may have to be destroyed. In these cases care should be taken to minimise the extent of the works area and thereby maximise the number of trees to be preserved."

3.46 According to *Lands Administration Office Instruction Section D-12 on Tree Preservation*, Government projects in particular should make "every effort to preserve as many trees as possible and in general, permission to lop or cut down any tree will not be granted unless good cause is shown". Agriculture and Fisheries Department keeps a register of 'Rare and Special Trees'.

Socioeconomic Issues

Agricultural Land

3.47 *HKPSG* states that "Abstraction of water and discharge of effluents should not be carried out in a manner that will cause detrimental effects on downstream agricultural uses." For fresh water fish ponds, "They should be located in areas with good water quality. Care should also be undertaken to minimise pollution from discharges which may be carried by ... natural watercourses into these sites, even from relatively remote locations."

Antiquities

3.48 Antiquities and monuments, which include any manmade structures dating back to before 1800, are protected under the *Antiquities and Monuments Ordinance [Cap 53]* (1986).

4 EXISTING ENVIRONMENT

Introduction

4.1 In order to determine the existing and proposed land use within all of the originally identified construction sites and neighbouring areas, and to identify the sensitive receivers, a series of desk studies and site visits were undertaken.

4.2 A literature review, including reference to the Outline Zoning Plans, 1:20,000, 1:10,000 and 1:1,000 maps, provided an overall appreciation of the existing land use within the administrative areas affected by the project. The Outline Zoning Plans (OZP) also provide an indication of future land use designations.

4.3 Discussion with Government Departments enabled sensitive sites to be identified and future development plans to be highlighted, in particular those which were not identified in published literature. Government Departments contacted include the Environmental Protection Department, Water Supplies Department, Planning Department, Agriculture and Fisheries Department, Geotechnical Engineering Office, Highways Department, Royal Observatory and the Antiquities and Monuments Office.

4.4 The areas affected by the scheme are covered by the following Outline Zoning Plans (OZPs), indicated in italics:

- raw water aqueduct site, *Tai Po S/TP/7* and *Lam Tsuen S/NE-LT/1* (see Figures 4.1-4.2);
- Tai Po Water Treatment Works (TP WTW) site, *Tai Po S/TP/7* and *Lam Tsuen SN/NE-LT/1* (see Figures 4.1-4.2);
- Yuen Tun Ha site, *Tai Po S/TP/7* (see Figure 4.3);
- Shing Mun tunnel access shaft and surrounding area, *Tsuen Wan S/TW/6* and *Kwai Chung (north) S/KC/10* (see Figures 4.4-4.5);
- Butterfly Valley tunnel portal and Butterfly Valley Primary Service Reservoir (BVPSR), *Kwai Chung (south) S/KW/10* (see Figures 4.6-4.7).

4.5 The maps and OZPs do not distinguish between types of industry, nor do they indicate recent temporary settlement or industrial development on Crown land. Site visits were therefore necessary to determine the actual land use within the areas affected by the scheme.

4.6 The following land use and community issues were identified as requiring particular attention:

- the nature of the proposed sites and neighbouring land in terms of both official designations (from OZPs) and actual land use;

- ease of access to the construction sites. In particular the potential sensitive receivers both within the construction sites and along proposed access routes;

- areas of local amenity and recreational value, including the identification of Country Parks, SSSIs and Conservation Areas;

- identification of grave sites, sites of archaeological interest and other cultural or religious sites.

4.7 The land use and community issues for each of the sites are outlined below. Details of the noise and air quality impacts of construction and operation of the proposed scheme on sensitive receivers are presented in Section 6: Noise and Section 7: Air Quality. Details of ecological surveys of the sites are presented in Section 11: Ecology.

South West of Tai Po Tau 'D' Pumping Station
(Location of the raw water pipeline and tunnel portal)

4.8 The area to the south west of Tai Po Tau 'D' pumping station, from where the raw water pipe will emerge, is enclosed on three sides; by the Lam Kam Road to the west, Tolo Highway to the east and the intersection of the two to the north. The southern area consists of low lying agricultural land within the flood plains of the Lam Tsuen River and Tin Liu Ha stream. Alongside the site is a bicycle track, a metal storage area, a town gas pressure reduction station, and a small busy canteen. The land to be used for the construction site is open flood plain which is derelict cultivated land.

4.9 According to the relevant OZPs, most of the immediate area is designated 'Government/Institution or Community' (G/IC) with 'Agricultural' land within the flat flood plain area to the south.

Lam Tsuen Valley
(Location of raw water pipeline option 2)

4.10 Along the length of Lam Tsuen river from the pumping station to the Tolo Highway - Tai Po Tai Wo Road interchange, there are three definite reaches:

(i) from the pumping station to the Fabridam the river is almost continuously inundated where water ponds up behind the dam;

(ii) from the Fabridam to the weir, the channel is flooded although levels can easily be lowered by dropping the weir. The channel in this section is concrete lined with rock gabions along the banks;

(iii) downstream of the weir the channel is in a canalised floodway. The concrete lined low flow channel opens out into the floodway which is lined with concrete armouring (grasscrete). This armouring is easily removed and replaced.

4.11 The OZP defines the river valley into three separate zones. Downstream of the pumping station area, which is classified as 'G/IC', the east bank is classed as 'Residential' and 'Village' and includes Tai Po Gardens, an area proposed for future residential development and the village area of Shui Wai. The west bank is classified as 'Open Space'; this is a popular suburban park with a cycle track, jogging track and well established vegetation base.

She Shan Tsuen Valley
(Alignment of WSD pipeline option)

4.12 The upper reaches of the She Shan Tsuen valley are confined and steep sided with dense woodland and scrub. The lower reaches open out into the flood plains of the Tin Liu Ha valley, a tributary of the Lam Tsuen river.

4.13 The She Shan Tsuen valley is relatively inaccessible other than via small concrete pathways from the Lam Kam road. The village of She Shan Tsuen lies at the base of the foothills above which the existing Tai Po Tau water treatment works is located. The village of She Shan Tsuen appears to be an agricultural community reliant on the rich alluvial soils for farming and on the She Shan Tsuen stream for aquaculture. The full extent of the agricultural/aquaculture activities can not be seen from the Lam Kam road.

4.14 The fish ponds are intensively managed commercial ponds culturing a high density of snakeheads (*Ophiocephlas maculatus*). The main activity within the agricultural areas is the cultivation of a variety of vegetables and seasonal flowers.

4.15 The OZP for this area designates the lower sections of this valley as 'Agricultural'. The upper reaches of the river runs through a 'Conservation Area' and adjacent to a Fung Shui Woodland which is a 'Site of Special Scientific Interest' (SSSI).

4.16 The She Shan Fung Shui Woodland SSSI is an area of dense relic woodland about four hectares in area. The site has a rich diversity of plant species including *Asplenium nidus*, a protected species of fern, and *Ardisia hanceana*, a shrub. Some of the trees are over 20 metres in height and over 40 cm DBH (Diameter at Breast Height). In addition, AFD has recorded a large *Cinnamonom camphora* tree with a basal diameter of about three metres in the woodland.

4.17 The SSSI and adjacent conservation areas are also important for the wide variety of over-wintering and migratory birds. Rare birds which are reported to breed in the woodlands in this area include the Jay and Rufous Woodpecker.

4.18 An investigation of the Fung Shui woodland found evidence of Barking Deer (*Muntiacus reevesi*) and Wild Boar (*Sus scrofa chirodonta*), the evidence being in the form of observed droppings. Barking Deer is one of the largest surviving mammal species in the wild within the territories of Hong Kong. It is a forest and scrubland species and hence the woodland habitat is important for its survival in the wild.

Proposed TP WTW Site
(Location and access to the WTW site)

4.19 The proposed treatment works site comprises a ridge and lower lying land to the north east contained by a small spur. The lower land contains steep 'V' shaped valleys. Visually, the ridge is most prominent, as it forms part of a larger ridge extending into the lower foothills of the Tai Mo Shan Country Park. Due to its location on the ridge line, the proposed treatment works will be visible from almost 360° around the site.

4.20 Some of the lower areas have been cultivated in the past although the farmland is now abandoned. Within the site there are also a number of graves.

4.21 The primary access route to this site is via the Water Supplies Department Road from the Tai Po road. The access road follows a tortuous route from the pumping station, over a bridge across Route 1 Tolo Highway and up the hill side to the works. The road is of single track width although there are passing bays along the route; despite this, large vehicles are likely to encounter problems passing other vehicles.

4.22 There are no residential areas within the site although there is a recently constructed residential building near the south east boundary of the proposed site.

4.23 The proposed area is relatively undisturbed and the vegetation is fairly dense on the lower slopes, thinning out to scrub at higher elevations. Woodlands exist on the steep slopes of the valleys within the proposed site, forming approximately 40% of the total site area. The woodlands are mixed forest typically found in the lower hills in Hong Kong. Within the site there are also a few bamboo colonies (eg. *Bambusa sinospinosa*) which is probably one of the largest bamboo species planted by old village communities.

4.24 Within the site, there are two streams which join together forming a main stream which runs down to Tai Po town and discharges into Tolo Harbour. A third stream discharges into She Shan Tsuen valley.

4.25 The existing treatment works site is within an area designated 'G/IC' in the OZP. The proposed TP WTW site, however, extends beyond boundary of this designated area into 'Green Belt'. As outlined above, the western boundary of the site is close to a 'Conservation Area' and 'SSSI' within the She Shan Tsuen valley.

Areas to the South of TP WTW Site
(Southern boundary of the WTW site)

4.26 This area is at the foothills of Tai Mo Shan Country Park and has fairly steep slopes and characteristic 'V' shaped valley. The proposed treatment works site can be easily seen from the Shek Lin road, which runs along the southern boundary of the site.

4.27 Access to the south west boundary of the proposed site is gained via the Shek Lin road from Tai Po. To access this road, vehicles must first pass through the centre of Tai Po Hui. From Kam Shan to Lin Au many sections of the road are very narrow and winding.

4.28 Shek Lin road is lined with a number of residential properties and at Pun Chun Yuen there is a large Temple which can be seen from the road. As outlined above, there is a large private residence being constructed on the south east boundary of the treatment works site. Further along the road to Lin Au there is a small school.

4.29 Lin Au is a small village community to the south west of the site. The land to the east of the village is shown as agricultural land although this land is not in production. Agriculture does not appear to be a significant activity within the village. The village of Lin Au is screened from the proposed site by a large hill.

4.30 The area around Kam Shek New Village and Shek Kwu Lung is designated as a 'Village' area as far as the Tolo Highway crossing. From Tolo Highway, the area south of the proposed site boundary is 'Green Belt' apart from a small 'Village' area around Lin Au.

Lai Chi Shan to Yuen Tun Ha
(Location of intermediate tunnel access shaft)

4.31 This area is within the Tai Po stream valley. The upper reaches are somewhat confined and dense vegetation limits the visual envelope. In the lower reaches, the valley opens out into flood plains where there are wide open vistas.

4.32 Lai Chi Shan is adjacent to Tolo Highway, on the outskirts of Tai Po Hui, and direct access can be gained to the Highway from the Lai Chi Shan to Yuen Tun Ha road. The Lai Chi Shan to Yuen Tun Ha road is narrow and winding and, in its present state, access for large volumes of traffic, particularly heavy plant, would be a problem. This road was built to give access to earlier WSD intakes to the Tai Po Tau/Sha Tin tunnels

4.33 Between Lai Chi Shan and San Uk Ka there are a significant number of houses along the road, most of which are three storey 'village style' apartment blocks. There is also a temple and a school in Sheung Wun Yiu although the school is apparently closed down. Beyond San Uk Ka there are only scattered dwellings and the abandoned village of Yuen Tun Ha. Access to Yuen Tun Ha can only be gained via a footpath located a few hundred metres from the road.

4.34 There appears to be no productive agricultural activity within the area although there are agricultural areas indicated on the maps. The area identified for a temporary vertical access shaft for the treated water aqueduct is demarcated on the maps as agricultural land but the area is completely overgrown.

4.35 Gaining access to the proposed shaft could be difficult as the road ends approximately 300-400 metres from the site and a river must be crossed: the river has very large boulders along the river bed, suggesting high flows during the wet season.

4.36 Generally speaking, most of this area is designated 'Green Belt' in the OZP. The main exception to this are a few 'Village' areas and an isolated area of 'Country Park'. The 'Village' areas are at Lai Chi Shan, Sheung Wun Yiu, San Uk Ka, Lo Lau Yuk and Pun Shan Chau. Yuen Tun Ha is also designated as a 'Village' area although, as discussed above, the houses there have been abandoned. The area identified as Country Park is close to the end of the Lai Chi Shan to Yuen Tun Ha road and is approximately 0.5 km from the Tai Mo Shan Country Park border.

4.37 The Agriculture and Fisheries Department has identified a well developed woodland behind Yuen Tun Ha and a nearby area of bamboo forest with botanical interest.

Wo Yi Hop and Shing Mun Road
(Location of the middle aqueduct access shaft)

4.38 This area is within a fairly confined valley within the foothills of Shing Mun Country Park. The steep facing slopes and tall trees within the valley limit the visual envelope of the area.

4.39 Adjacent to the proposed permanent shaft site is the car park and storage area at the rear of the Shing Mun Tunnel Administration Building. A gate at the rear of the Administration Building complex opens onto the area of the proposed shaft site.

4.40 The proposed site is not designated for future residential or industrial development. The site is Crown property and is currently leased for domestic use.

4.41 Access to the site is adequate. Shing Mun Road passes under the Cheung Pei Shan Road before joining the Wo Yi Hop road; approximately 400 m west of this junction the Wo Yi Hop Road joins the Cheung Pei Shan Road which is a two lane dual carriageway. Theoretically direct access to the site from Cheung Pei Shan Road could be gained via the tunnel administration building although this is unlikely to be acceptable.

4.42 The Shing Mun road is reported to be heavily used, particularly at weekends, by visitors to Shing Mun Country Park. The road is also used for access to the village of Wo Yi Hop and to garages and container storage areas along the road.

4.43 Wo Yi Hop is a small village with high density low rise buildings on a very steep slope. Tall trees interspersed between the buildings limit the view towards proposed access shaft site. The residential buildings are located up the hill side, ie. no houses face directly onto the Shing Mun road.

4.44 The OZPs for this area denote most of the land as 'Green Belt'. The exception is a 'Village' area on the left hand side of the Shing Mun Road between Wo Yi Hop and Shing Mun Reservoir. The tunnel access site is immediately adjacent to the boundary of Shing Mun Country Park.

Butterfly Valley
(Location of the tunnel portal and service reservoir site)

4.45 Butterfly Valley is a very steep sided densely vegetated valley within which there are a number of village type houses. This area is, however, classified as 'Green Belt' in the OZP and the houses may be illegal or temporary dwellings.

4.46 A single track road runs part way up the western side of Butterfly Valley giving access to a China Light and Power electricity sub-station, a Boys Home, two service reservoirs and the village of Tai Ching Cheung. This road is part way up the valley side and access down to the valley bottom is only possible by foot.

4.47 A similar road runs along the eastern side of the valley to a small village area with approximately 4-5 dwellings; these houses are immediately upstream of the proposed portal site. Although direct access to the river is not possible from this eastern route, the road is only a few metres from the valley bottom, so creating access should not be difficult.

4.48 The proposed service reservoir site is a steep sided, symmetrical hill which lies in the lower backdrop of hills surrounding Lai Chi Kok and Cheung Sha Wan. The site is enclosed to the west by Butterfly Valley, to the east by a Roman Catholic Cemetery, to the south by the Ching Cheung Road and to the north east by Caldecott Road. Caldecott Road is an access road to Sir Robert Black Education College and high rise Government housing blocks.

4.49 Although to the north of the Ching Cheung Road the most significant OZP designation is 'Green Belt', there are also three areas of 'G/IC'; a site in the northern section of the valley which belongs to Water Supplies Department and a Boys Home; on the western access road up Butterfly Valley there is a second 'G/IC' site which is a China Light and Power substation; and finally the area of high ground proposed for the service reservoir is also 'G/IC'.

4.50 South of the busy Ching Cheung Road there is the dense village area of Wai Man Tsuen. This village is very close to the road embankment which would screen the construction site from the village. The urban areas of Lai Chi Kok and Cheung Sha Wan are also south of the Ching Cheung Road; a hospital and school at Lai Chi Kok are in relatively close proximity to the proposed service reservoir site.

Summary

4.51 Table 4.1 provides a summary of the existing environmental conditions within the study area.

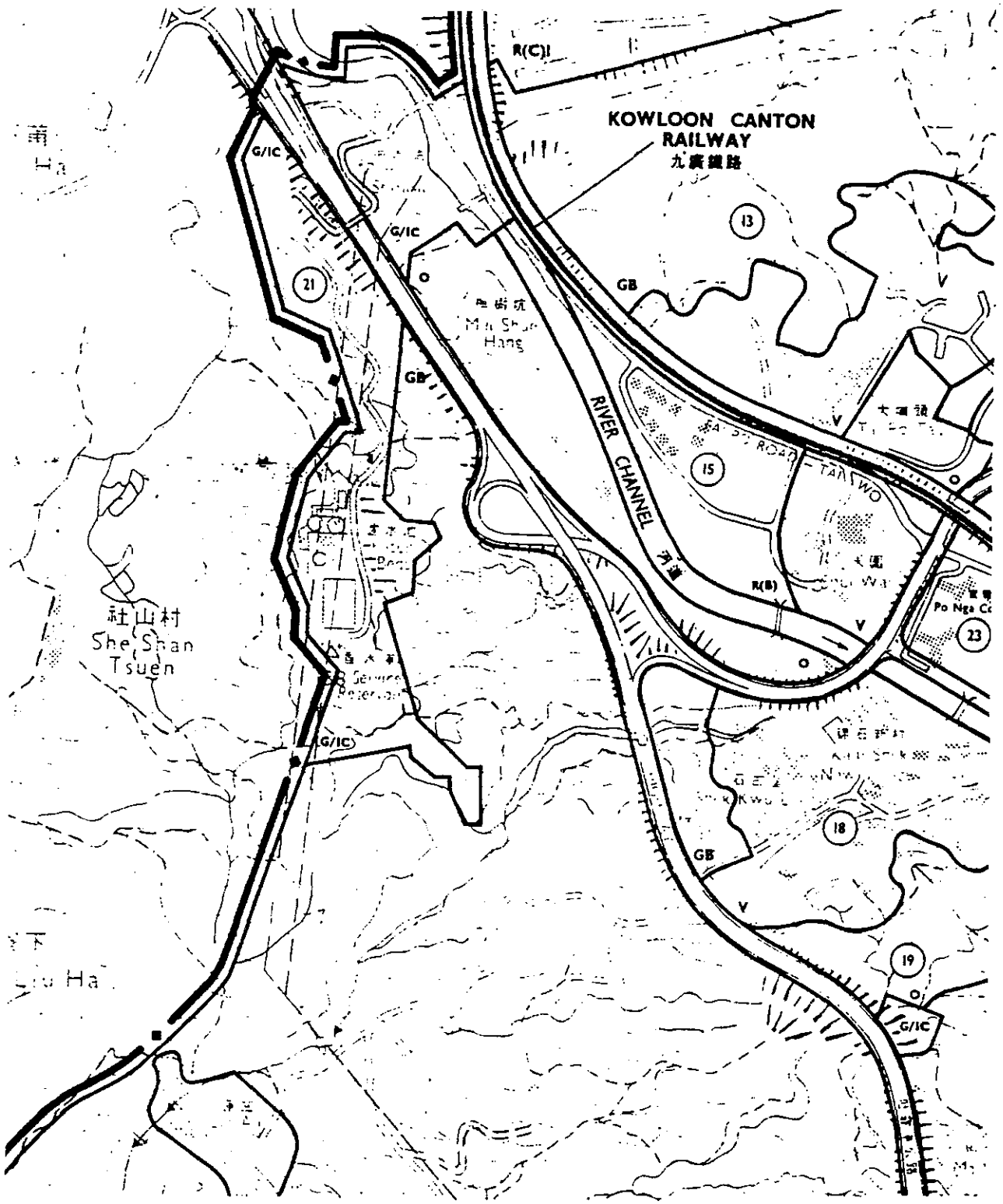
Table 4.1 Summary of Existing Environmental Conditions within the Study Area

Study area	Landscape description & visual envelope	Ecology	Built environment	Access	Possible sensitive receivers
Tai Po Tau 'D' Pumping Station	Located on the major flood plains of the Lam Tsuen River. Open landscape is broken by intrusive man-made structures. Visible from Tai Po road, Lam Kam road, Tolo Highway and cycle path.	Little natural vegetation. Lam Tsuen river is canalised in this reach and the river corridor ecology is sparse.	Infrastructure includes Tolo Highway & fly over, WSD pumping stations, CLP sub station and a small cafe along the bicycle track.	Access to site boundary good although limited from Lam Kam Road to the immediate construction area.	Cafe and cycle track beneath Tolo Highway-Lam Kam road interchange and a residential building in the flood plains close to the site.
She Shan Tsuen Valley	Confined steep sided upper valley opens out to wide flood plains in the lower valley. Restricted views of the lower valley from Lam Kam Road. Extensive visual envelope from She Shan Tsuen village.	Wooded slopes in upper reaches, parts of which are designated Conservation Areas plus an adjacent SSSI area. Aquaculture activities in the stream corridor with farming and horticulture in the lower reaches.	Village of She Shan Tsuen is only residential area in this section. The existing WTW overlooks the village but is screened by woodland.	Access is very poor, only a concrete footpath links She Shan Tsuen village and Lam Kam Road.	Village of She Shan Tsuen.
TP WTW site	Comprises a series of ridges with steep 'V' shaped valleys. Ridges extensively visible for almost 360°.	Scrubby fairly high hill tops with densely wooded valleys and an area of abandoned agricultural land.	No development within the proposed site. Nearest development is existing WTW and houses on Shek Lin road.	Access via single track WSD road.	Residential developments along the Shek Lin road.
South of TP WTW site	Foothills of Tai Mo Shan CP fairly steep slopes into 'V' shaped valley. Views up to proposed WTW site.	Mixed scrub & woodland vegetation interspersed between the steep slopes & narrow valleys.	Ribbon development along road. Mostly residential, plus a large temple and a small school.	Single track (Shek Lin road) has limited access due to tight bends and short lines of sight.	Residential areas and temple along Shek Lin road. Lin Au and the school should be unaffected.
Lai Chi Shan to Yuen Tun Ha	Valley of the Tai Po stream. Visual envelope of upper reaches restricted by confined valley and dense woodland. Lower reaches have extensive vistas across valley.	Mixed vegetation with scrub on the upper slopes and woodland on the lower slopes in the valley. Abandoned farmland and bamboo plantation near the stream at Yuen Tun Ha.	Ribbon development along road. Mostly single storey residential although there are some 3 storey blocks. Yuen Tun Ha is an abandoned village.	Access fairly good although - upper section is a single track road with passing points. Access in the upper valley from road to Yuen Tun Ha is limited to a footpath.	Residential areas along the length of the road to Yuen Tun Ha.
Wo Yi Hop and Shing Mun Road	Located at the foothills of Shing Mun CP site has a restricted visual envelope due to dense vegetation on steep facing slopes.	Foothills of Shing Mun CP. Mainly wooded steep valley slopes with grass/scrub in the valley bottom.	Village of Wo Yi Hop is on the hillside and container storage and garages are located along Shing Mun road. Immediately south of the site is the Shing Mun Tunnel Admin. Centre.	Access excellent although Shing Mun road is heavily used at weekends by visitors to the CP.	Wo Yi Hop possibly affected although buildings adjacent to the road are commercial. Visitors to CP may be disrupted.
Butterfly Valley	Steep very confined densely vegetated valley. High hill area at location of proposed service reservoir.	Dense vegetation mainly wooded valley & hill slopes with scrub & grasses on higher ground. Natural stream corridor in Butterfly Valley.	Scattered 'village' type dwellings within the lower valley slopes. Urban area of Lai Chi Kok (S) college & housing block (NE), and a cemetery (E).	Access from Ching Cheung Road via single track or from Tai Po road via Caldecott Road. No direct access down to valley bottom or reservoir site.	Village dwellings within Butterfly Valley; Sir Robert Black College, Govt. housing block on Caldecott Road; hospital and school in Lai Chi Kok.

Additional Treatment And Water Transfer Facilities For
The Metropolitan Area And North-Eastern New Territories

Agreement No. CE 41/94

Water Supplies Department



Note: Key to abbreviations is provided at the end of the land use figures

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Title **Tai Po land use designations**
Plan No. S/TP/7

Figure No.	Scale		Name	Date
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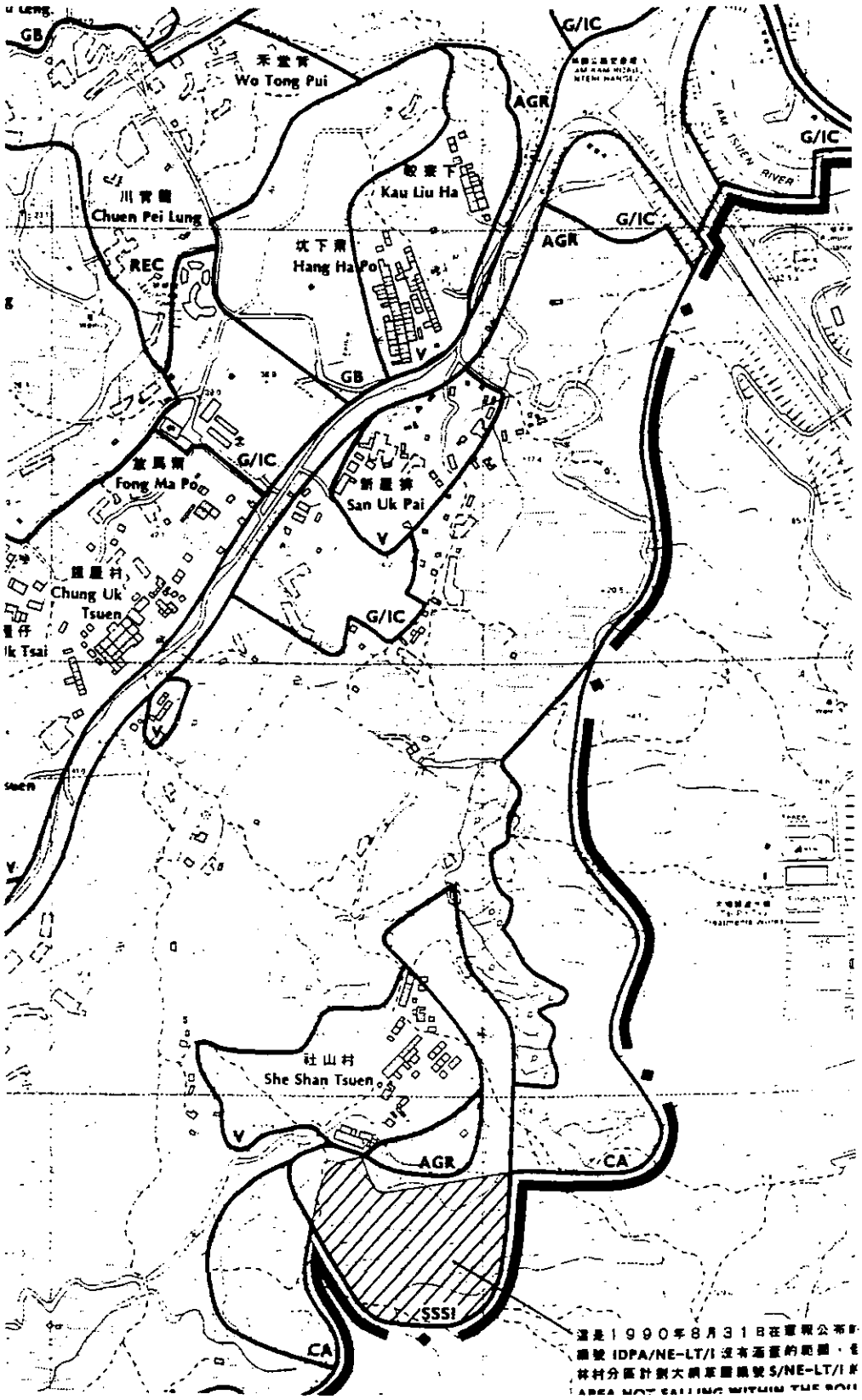

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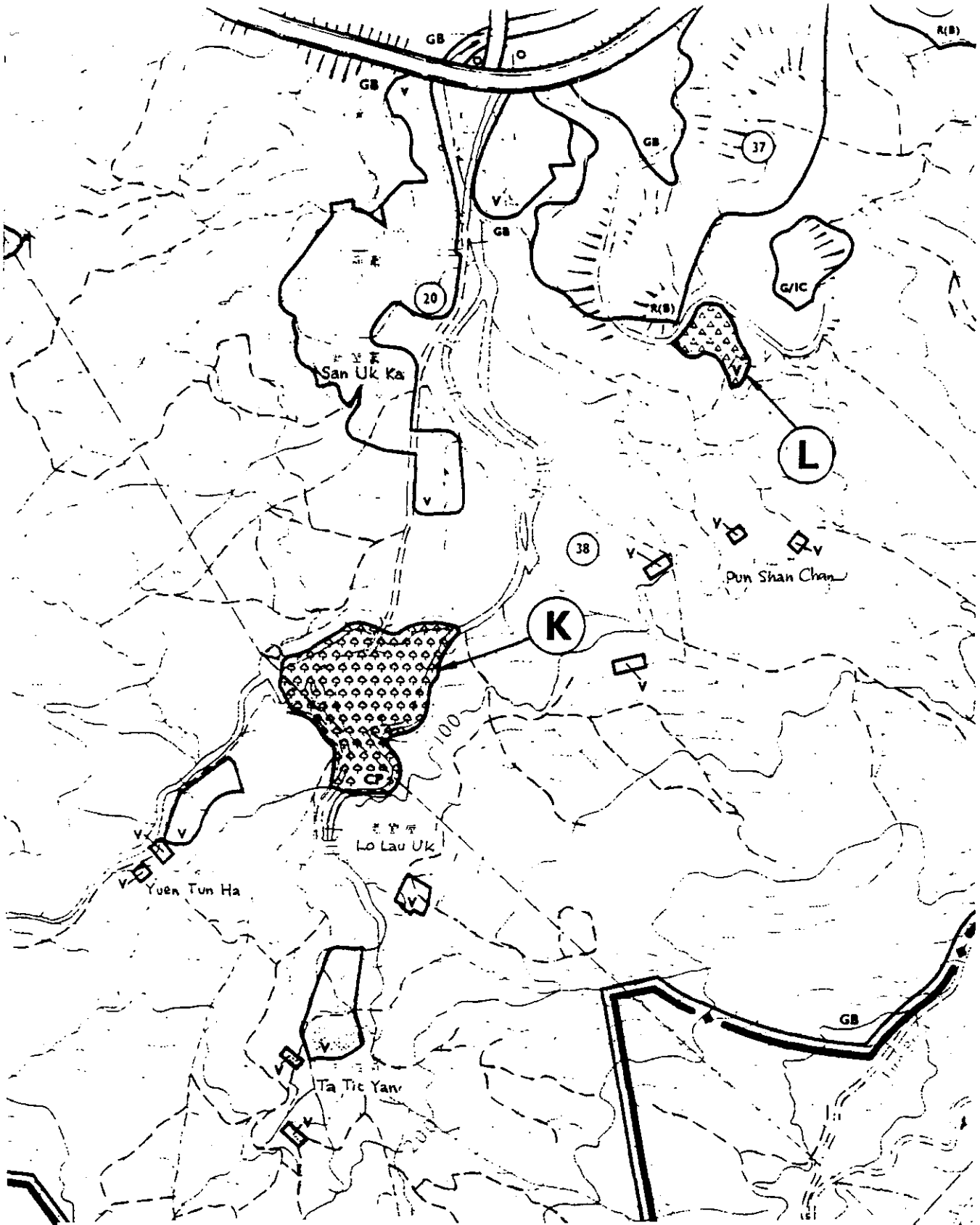

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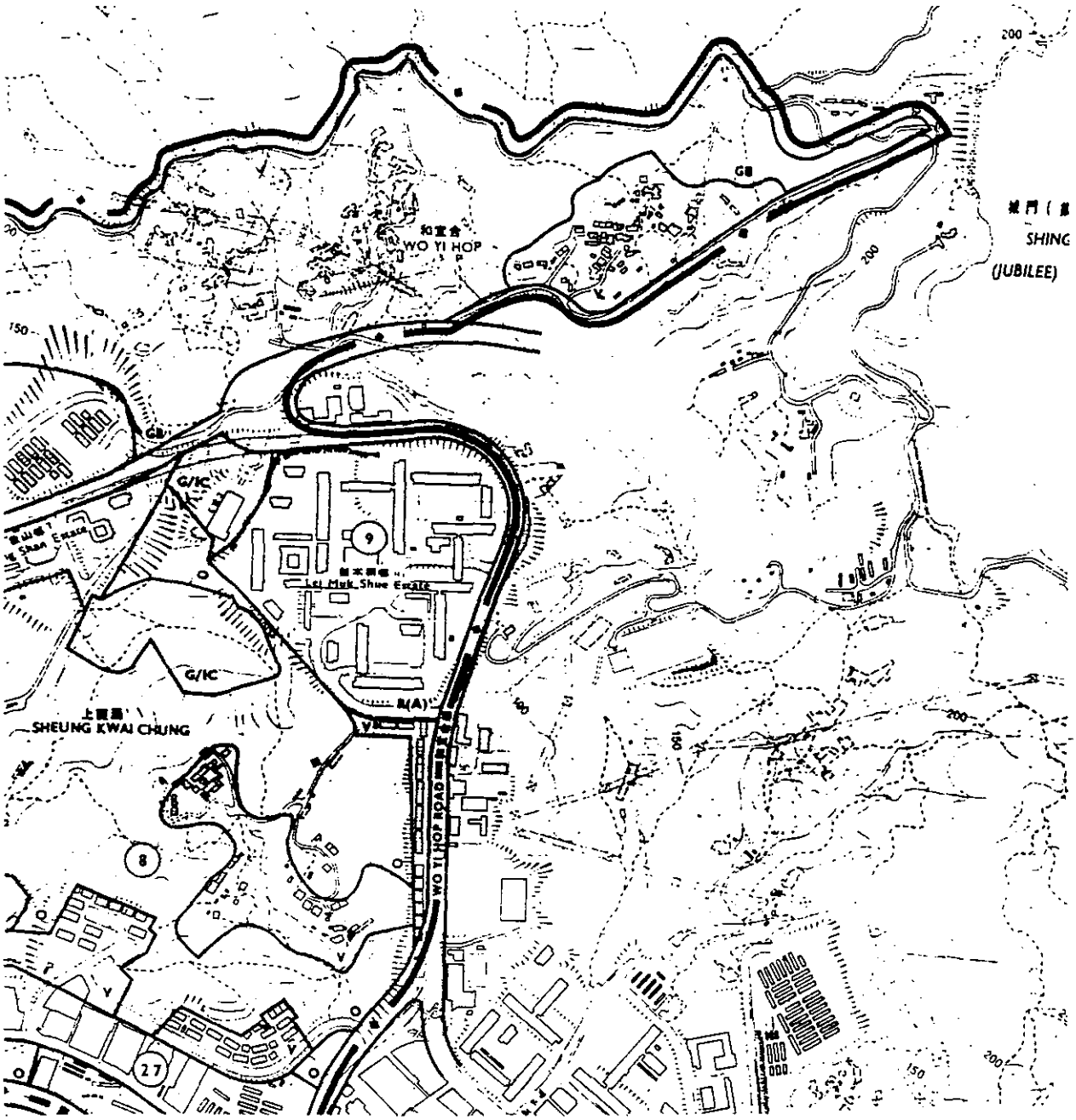

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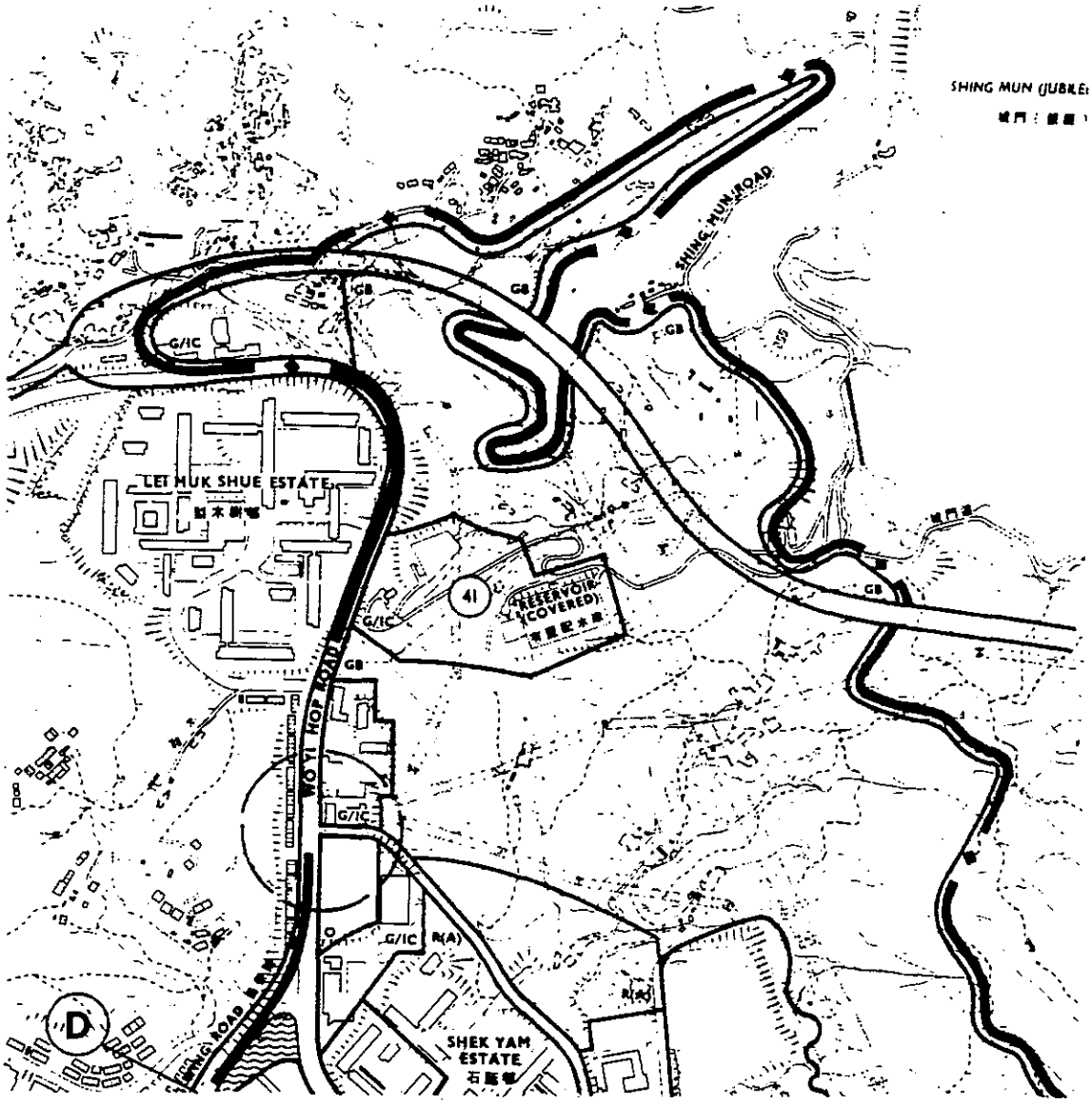

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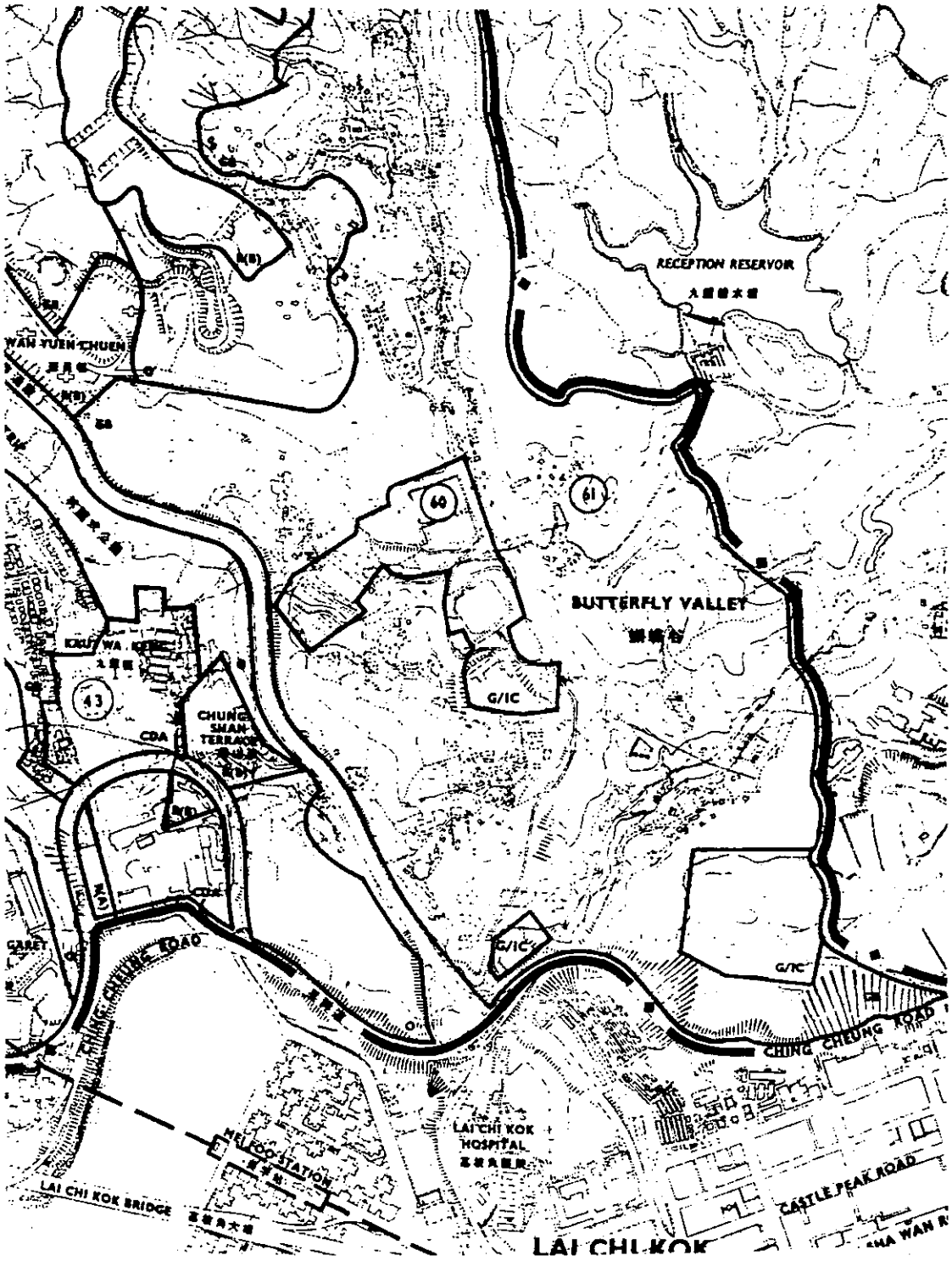

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Figure No. 4.6	Scale 1:10 000		Name / Date
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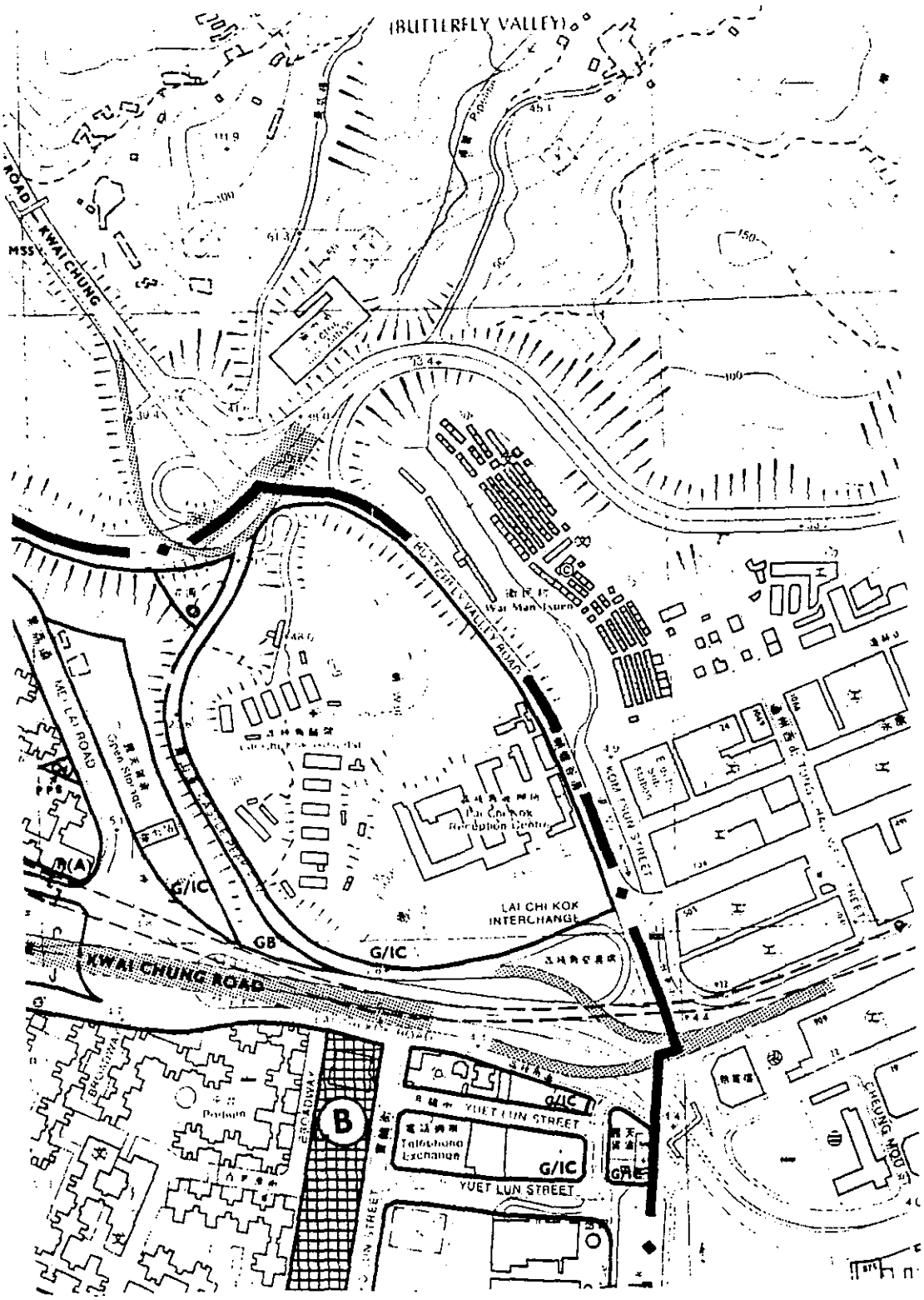

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Figure No.	Scale		Name	Date
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Key to designated land use classifications
(Based on Outline Zoning Plans)

▬◆	Planning Boundary
AGR	Agriculture
V	Village Type Development
G/IC	Government / Institution / Community
REC	Recreation
GB	Green Belt
O	Open Space
CA	Conservation Area
SSSI	Site of Special Scientific Interest
R(A)	Residential (Group A)
R(B)	Residential (Group B)
C/R	Commercial / Residential
I	Industrial
CDA	Comprehensive Development Area

5 VISUAL IMPACT ASSESSMENT

Introduction

5.1 This section comprises the visual impact assessment (VIA) for the proposed Tai Po Water Treatment Works (TP WTW) and the proposed Butterfly Valley Primary Service Reservoir (BVPSR). Where appropriate, measures have been recommended to reduce the visual intrusion of both facilities.

Approach to VIA

5.2 Initially, comprehensive appraisal of the existing visual setting for each facility and selection of representative viewpoints was undertaken. Both long and short view corridors toward each site were identified and, within these corridors, viewpoints were selected and graded according to prominence, importance and frequency of view. The viewpoints selected are considered representative of the many individual viewpoints within the corridor of view.

5.3 The intended building form and site formation levels were then projected into this context to identify the visual impacts of each facility.

5.4 The VIA assumes that the site boundary for each facility will not change. The assessment also assumes that internal land use arrangements within each site will remain as indicated in the Draft Preliminary Report and that all works will be contained within the formation area of each facility. It is also assumed that existing and committed land use within each visual envelope will remain as shown on the relevant Outline Zoning Plans.

5.5 Where appropriate, recommendations have been made on possible measures to mitigate the major elements of visual intrusion.

Tai Po Water Treatment Works

Visual Context

5.6 The site for the TP WTW, shown in Figure 5.1, consists of a ridge and lower lying land to the northeast which is contained by a small spur. It is directly south of the existing Tai Po Tau Water Treatment Works and is accessed from the existing WSD road. The highest point seen within the site is at +129 mPD and there is also a smaller, lower peak to the south west of the existing reservoir at +105 mPD.

5.7 Visually, the ridge is most prominent, as it forms part of a larger ridge extending into the foothills of the Tai Mo Shan Country Park. The main ridgeline within the site forms the southern site of Lam Tsuen Valley, which is an important natural scenic resource.

5.8 Due to its location along the ridgeline, the proposed treatment works site can be seen from almost 360° around the site. The only view corridor from which the site is not clearly visible is within 10° either side of due north of the site. Within this quadrant, views of the site are obscured by the ridge and treeline planted around the Tai Po Tau treatment works.

5.9 The spur which contains abandoned agricultural land (at +115.7 mPD) serves to visually separate much of the site from the valley immediately east which accommodates Shek Lin Road and Lin Au village. Much of the site cannot currently be viewed from Lin Au village.

5.10 Whilst from the west the site forms part of a distinctive ridge defining the Lam Tsuen Valley, it is less so when viewed from the east. From eastern view points, the spur, lower ridge and small peaks within the site blend into a more extensive backdrop of lower foothills which extend north east-south west between Lin Au and Wun Yiu.

5.11 The TP WTW site can be seen from the north-facing trails within the Tai Mo Shan Country Park. These views, however, are not extensive since the east-west paths in the Park are at a higher level and are not part of the primary Park network. There are also no formal outlook points along this secondary path. What views do exist are downward and include wide vistas, consequently the site is to some extent absorbed into the backdrop. Hence views from the Country Park are not primary view corridors. Consideration is given later in this section to colour and landscape treatment to blend the proposed works into the surrounding environment.

Primary View Corridors

5.12 Of critical importance in defining the visual impact is selection of the appropriate view corridors. Within these view corridors, selected view points are then identified and graded according to the importance of view. The importance of view is defined as the extent of visual intrusion likely to result from the development of the proposed facility. Such definition includes assessment of the number of persons affected by the change in view, the frequency with which such people look at such a view, and whether such view is static or serial. Such appraisal also provides the context within which measures to minimise various aspects of visual intrusion are recommended.

5.13 As stated earlier, the site can be viewed from virtually all view quadrats. Figure 5.2 shows the selected viewing points for the VIA. As evident from the site photographs in Figures 5.3 and 5.5, there are extensive view corridors of the site. The site is visible from She Shan Tsuen, Lam Kam Road and other villages in the Lam Tsuen Valley, high rise residential blocks in the north of Tai Po Town, parts of Tolo Highway and the Kowloon-Canton Railway and upper Hong Lok Yuen. Views from the latter area are, however, largely obscured by existing landform. Those from the upper east-west trail in the Country Park are also of secondary importance, due to distance and local context.

5.14 The primary views identified for the site are from:

- Lam Tsuen Valley (the western view corridor)
- Tai Po Tau and its environs (the eastern view corridor)
- Lin Au village.

Long Views

5.15 The western view corridor is illustrated in Figure 5.3. Lam Tsuen Valley enjoys wide uninterrupted views of the ridgeline affected by the proposed works. The viewing point selected at the northern end of Lam Kam Road is considered representative of the available views from many of the villages in the valley and along the Lam Kam Road.

5.16 From Tai Po Town West, view corridors differ from those experienced from Lam Tsuen Valley. However, it is views from the many public and private housing estates within Tai Po West which are considered the most important eastern view corridors. From surveys within this area, the view from Po Nga Court was identified as representative of such views. A viewpoint from the upper floor of this estate reflects the 'worst' view, since the view of the facility is uninterrupted as illustrated in Figure 5.5. It should be noted that from this viewpoint, the landscaping and treeplanting around the existing water treatment works contributes significantly to a softer visual image of this facility.

Visual Impact

5.17 The visual impact of constructing a new water treatment works adjacent to the existing works is summarised and illustrated in Figures 5.4 and 5.6. The engineering works currently envisaged involve substantial cut and fill operations. The buildings are mainly low rise, with only the proposed calibration tower appearing as a potential 'skyline' intrusion.

5.18 There are two elements in the present proposals for the TP WTW which, if sensitively treated, will help to produce an improved visual image from most of the viewpoints described earlier. The elements are:

- the extent of the cut and fill slopes
- the bulk and appearance of the plant facilities

5.19 The visual impact of the proposed treatment works is directly related to its position on the ridgeline and the extent of the site formation, dictated by engineering requirements. The land within the site boundary will be lowered to between +100 and +105 mPD. The extent of cut faces and formation works along the south eastern and north-facing slopes are a result of this requirement.

Extent of cut and fill slopes

5.20 Since north-facing slopes of the main ridge (+194.8 mPD) within the site can be generally seen from both eastern and western view corridors, extensive cutting of this slope will produce a major visual impact.

5.21 Proposed fill slopes along the south eastern and eastern edges of the site will be visible from Po Nga Court and from Shek Lin Road. While these slopes vary in height, they are shielded from direct views from Au Lin village by the intervening hillslopes.

Bulk of plant facilities

5.22 The bulk and geometric form of the low rise structures will be visible from the eastern, western and southern view corridors. Due to the number of people exposed to such views, the eastern viewpoint is considered the most important, especially from west facing residential blocks. The works structures are close together and therefore, at a distance, appear as an amalgamation of structures rather than a collection of individual structures.

5.23 From the Lam Tsuen Valley visual corridor, the natural appearance of the ridgeline within the site will replaced by 'box-like' structures which, while lower than the existing natural landform, generally follow the existing land profile.

5.24 The proposed calibration tower presents a potentially visually intrusive element on the ridgeline when viewed from Lam Tsuen Valley. While the height of the tower (+107 mPD) intrudes into the skyline from such a viewpoint, the effect is mitigated to some extent by the height and bulk of structures behind the tower and existing ridgeline, beyond the cut slopes.

TP WTW - Visual Mitigation Measures

5.25 The site offers several opportunities to reduce the visual impact of the proposed water treatment works:

- *Treatment of the cut and fill slopes to enable them to blend with the surrounding landscape*

  The cut and fill slopes proposed will have a considerable visual impact. Appropriate design and treatment of the slopes will enable grassing and planting with native tree species, which will help reduce visual intrusion from the main viewing corridors, in particular from Tai Po Town West.

- *Outdoor plant and buildings should be appropriately coloured to blend in with the surrounding landscape*

  With the treatment works clearly seen from almost all viewpoints around the site, it will be vital to ensure that all plant, buildings and surfaces are coloured appropriately (such as greens, browns and greys) to harmonise with the surroundings. The colour and texture treatment of buildings and structures should be correlated to enhance visual cohesion.

  The position of the calibration tower on the north west facing edge of the site could be integrated better with surrounding buildings by appropriate colour schemes.

- *Landscape Proposals for the site should be an integral part of the contract works*

  The Master Landscape Plan for TP WTW (appended to this Report) outlines how areas of existing woodland will be linked by extensive planting of native woodland species. This is critical in terms of mitigating the impact of the development on the ridgeline when viewed from Lam Tsuen Valley. Internal planting and the use of climbing plant species are also proposed to help break down the geometric outlines of building/plant.

Butterfly Valley Primary Service Reservoir

Visual Context

5.26 The site for the BVPSR is shown in Figure 5.7. The site is zoned Government/Institution/Community (G/IC) on the draft Kwai Chung Outline Zoning Plan No. S/KC/10.

5.27 The site comprises a steep sided, symmetrical knoll which lies in the lower backdrop of foothills surrounding Lai Chi Kok and Cheung Sha Wan. The knoll reaches a height of +150 mPD and is accessible only from Caldecott Road. The knoll is covered by a variety of mature vegetation. The south facing edge of this knoll has been cut back in the past to form Ching Cheung Road. The upper part of the western, northern and eastern sides of the knoll, however, remain largely in their natural state. However, along the eastern edge of the knoll below +95 mPD, the natural slope has been replaced by benches of concrete gravesites within the Catholic Cemetery (see Figure 5.11).

5.28 The knoll occupies a prominent position along Ching Cheung Road and forms a discrete but minor visual buffer between the Kowloon urban area and the Government Quarters and Sr Robert Black College of Education, which are located north east of the site.

5.29 South of the site is the industrial area of Cheung Sha Wan and to the south west is Mei Foo Sun Chuen. The industrial area is undergoing change, with old lower buildings being replaced by more modern industrial/office buildings.

5.30 Immediately west of the site is Butterfly Valley, an expansive 'Greenbelt' area accommodating several minor community uses and having only limited public access.

Primary View Corridors

5.31 Key long and short viewing points towards the reservoir site have been identified.

Long Views

5.32 Long views of the site are available from West Kowloon Reclamation, the existing Kowloon area and higher parts of Kam Shan Country Park. These long views exhibit two main characteristics. Firstly, such views are largely interrupted by intervening land use between the viewpoint and the site, which effectively reduces the angle of view. Secondly, as such viewing points are some distance from, and at lower levels than the site, the symmetrical knoll is seen to blend into the surrounding backdrop of foothills. The knoll is, therefore, less distinguishable from long views than appears from shorter (closer) views which are either level with, or higher than, the knoll. Therefore, it is considered that long views of the site are of less importance than short views of the site.

Short Views

5.33 Five short viewpoints of the site have been recorded from the following positions:

- sections along Tai Po Road from the flyover above Ching Cheung Road to Caldecott Road (mainly serial views interrupted by landform and buildings);
- the northern blocks in Mei Foo Sun Chuen (mainly static views in which the knoll forms a strong contextual component);
- Cheung Hang Road (mainly static, intermittent views blocked by existing landforms);
- Caldecott Road Government Apartments (similar to views over the site from the Sir Robert Black College of Education);
- within the Catholic Cemetery (below and level with the site).

5.34 Of the five viewpoints, those from north Mei Foo Sun Chuen and Caldecott Road are considered representative of the key view corridors. The latter viewpoint also covers views of the site from the Cemetery.

5.35 The knoll is clearly viewed from the upper floors of flats in the north and north east facing blocks of Mei Foo Sun Chuen. Within this view corridor, the knoll appears as a prominent element in the lower ridgeline of Kam Shan Country Park. However, the vista is already punctuated by various visually intrusive features such as the China Light & Power electricity sub-station, 400 kVA pylons which extend up the ridge and Ching Cheung Road itself. Further south, the vista takes in glimpses of West Kowloon.

5.36 The Caldecott Road viewpoint forms a key view corridor towards the site. While these views are south and south west facing and vary between road level and block height level, the view from the existing reservoir site on Caldecott Road is considered representative of the view corridor. From this viewpoint, it is evident that the two most important visual functions of the knoll are:

- to form a natural visual block of parts of Cheung Sha Wan industrial area and Kwai Chung container port;

- to provide a soft 'cap' above the hard facing of gravesites within the Cemetery.

5.37 Whilst the number of people exposed to the Caldecott Road view corridor is generally limited to college visitors and Government servant families on Caldecott Road, views of the knoll will also be seen by visitors to the Cemetery. While such visits may be infrequent and the knoll lies outside the Cemetery, the contribution of the knoll to the ambience of the Cemetary should not be undervalued. Physically the knoll forms a natural enclosure to the Cemetery; visually it offers respite from the harshness of the benches of concrete gravesites.

5.38 Vistas of the site from Cheung Hang Road are intermittent as a result of the intervening landform and vegetation. However, where it can be viewed, the knoll appears a prominent feature. A similar view can be seen from the Boys Home at the top of Cheung Hang Road although, due to the serial nature of road views and vista from the Boys Home, the knoll is not an important element in the visual horizon.

5.39 Figure 5.8 shows the two chosen viewpoints for this part of the VIA, and the current views from these points are illustrated in Figures 5.9 and 5.11.

Visual Impact of Reservoir

5.40 The visual impact of the proposed BVPSR is summarised and illustrated in Figures 5.10 and 5.12. The current intention is to excavate the top of the knoll to form a platform upon which the reservoir will be constructed. The excavated platform remains for the most part within the G/IC zone boundary on the statutory plan.

5.41 The current engineering proposals include three components which will inevitably have a significant effect on the existing visual role of the site. These are:

- lowering the hill by 48 m (ie. from +150 mPD to +102 mPD finished level);
- elimination of much of the 'cap' of greenery above the Cemetery;
- replacement of the natural symmetrical form with a flat man-made form.

5.42 As is evident from Figures 5.12, lowering the existing knoll by almost one third will bring the city visually closer to Caldecott Road. At night, glare from the Kwai Chung container terminals is likely to be more pronounced than in the present setting. Removal of the existing mature vegetation on the knoll has greater impact when viewed from the north east compared to other views north of the site. In particular, the existing greenery above the Cemetery site, which forms a visually important protective 'cap' above the gravesites, will be removed. This will sharpen the hardness of view of, and to some extent within, the Cemetery resulting in a visually degraded environment.

5.43 Another component in this visual degradation is the necessary levelling of the existing knoll. Replacement of the natural symmetrical landform with a flat reservoir roof will produce a visually incongruous element in the surrounding landform which will be difficult to ameliorate. When viewed from the west and south west, flattening of the knoll for the reservoir will have less visual impact than when viewed from Caldecott Road. The main difference can be attributed to the hills forming the Eagles Nest, due east of the site. Such hills will help absorb the site's new lower, flat profile. This is clearly shown in Figure 5.10.

BVPSR - Visual Mitigation Measures

5.44 The location and shape of the site, being fixed by the site zoning, offer limited scope for major visual mitigation. The following visual enhancement measures are intended to reduce the aspects of visual intrusion mentioned above.

- *Utilise earth banks, where possible, around the sides of the reservoir walls*

  As indicated on the BVPSR Master Landscape Plan (appended to this Report), the sides of the reservoir will be formed into an undulating earth bund and grassed/landscaped to form a softer edge and help blend the development into the existing background.

- *Areas between the development boundary and natural features should be landscaped*

  Where land permits, the boundary of the site will be extended to the edge of the natural slope or tree line, so that the intervening areas can also be appropriately landscaped. This is particularly relevant along the southern and western boundaries where there are potentially wide areas available for landscaping.

- *The alignment and works area for the road extension from Caldecott Road should minimise disturbance of the existing environment*

  The road alignment will be designed to the minimum standards commensurate with operational and emergency access purposes, so as to avoid excessive clearance of the natural landscape.

- *Landscape Proposals for the site should be an integral part of the contract works*

  The Master Landscape Plan seeks to augment and extend surrounding planting through the use of generally taller wind resistent native tree species. This is particularly important on the Cemetery side of the reservoir, to replace the existing landscape 'cap', and along the access road. The surface of the reservoir will be grassed.

Summary

5.45 TPWTW and BVPSR are located in visually prominent locations and involve contrasting visual impact issues which can be mitigated, to some extent, by integrated landscaping and appropriate colour treatment. The two Master Landscape Plans indicate the locations of extensive planting of native woodland species around and within the sites. There is little opportunity to ameliorate visual impacts by changes to the site boundaries and works areas due to engineering and site constraints.

5.46 The two major elements of TP WTW to impact on the visual environment are the extensive cut and fill slopes and the bulky buildings which are visible from wide angle views around the site. The calibration tower has a high visual impact and appropriate measures are needed in the detailed design stage to site it appropriately close to the main cut slope and avoid visual intrusion.

5.47 The construction of BVPSR, which involves the removal of a strong symmetrical element in the natural environment, will have a major impact when viewed from Caldecott Road and the Catholic Cemetery. However in the wider context, the impact of removing the knoll will be lost in the views of the natural backdrop of foothills behind the site.

Additional Treatment And Water Transfer Facilities For
The Metropolitan Area And North-Eastern New Territories

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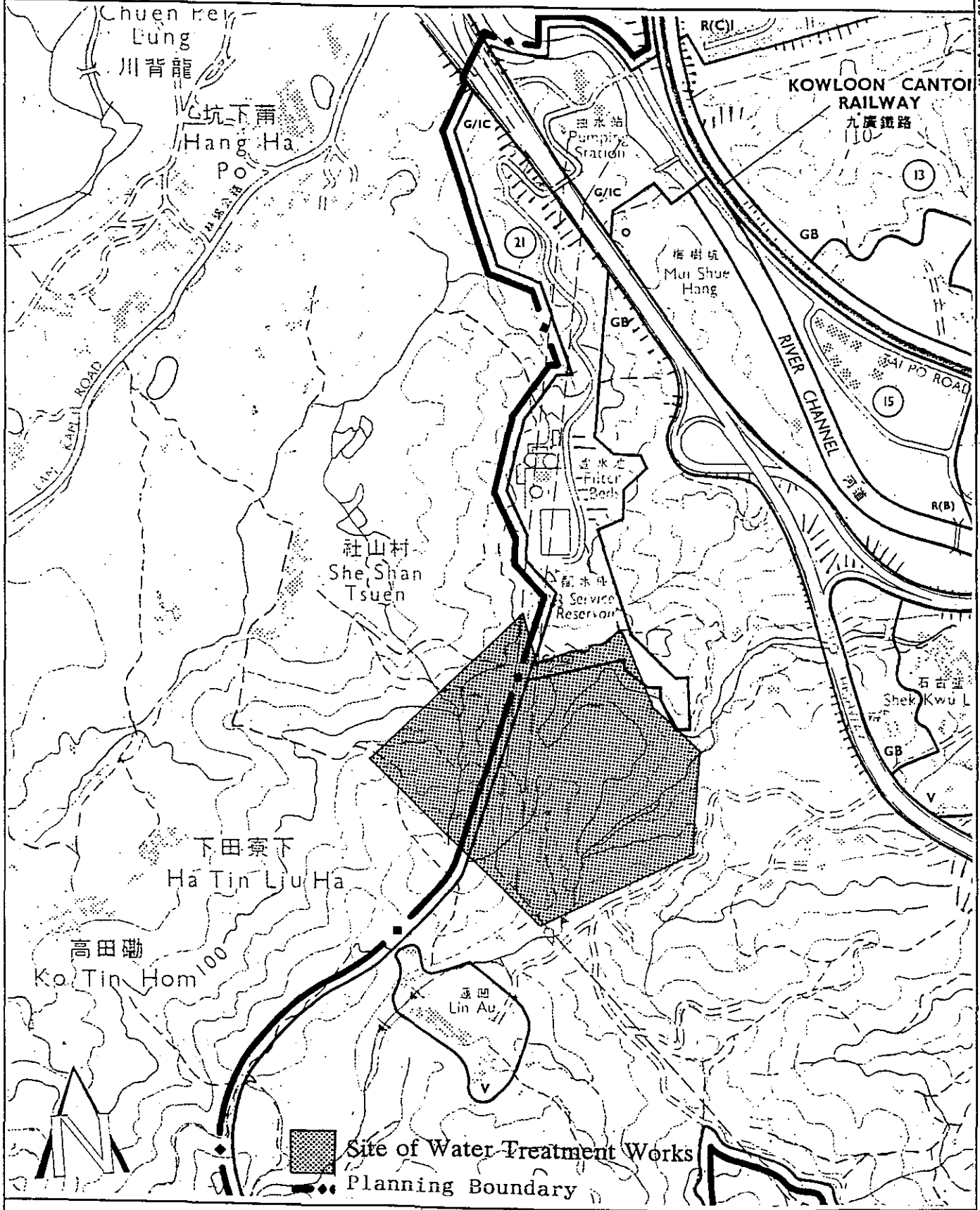

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Figure No. 5.1	Title: Extract from Draft Tai Po Outline Zoning Plan [Ref. S/TP/7]
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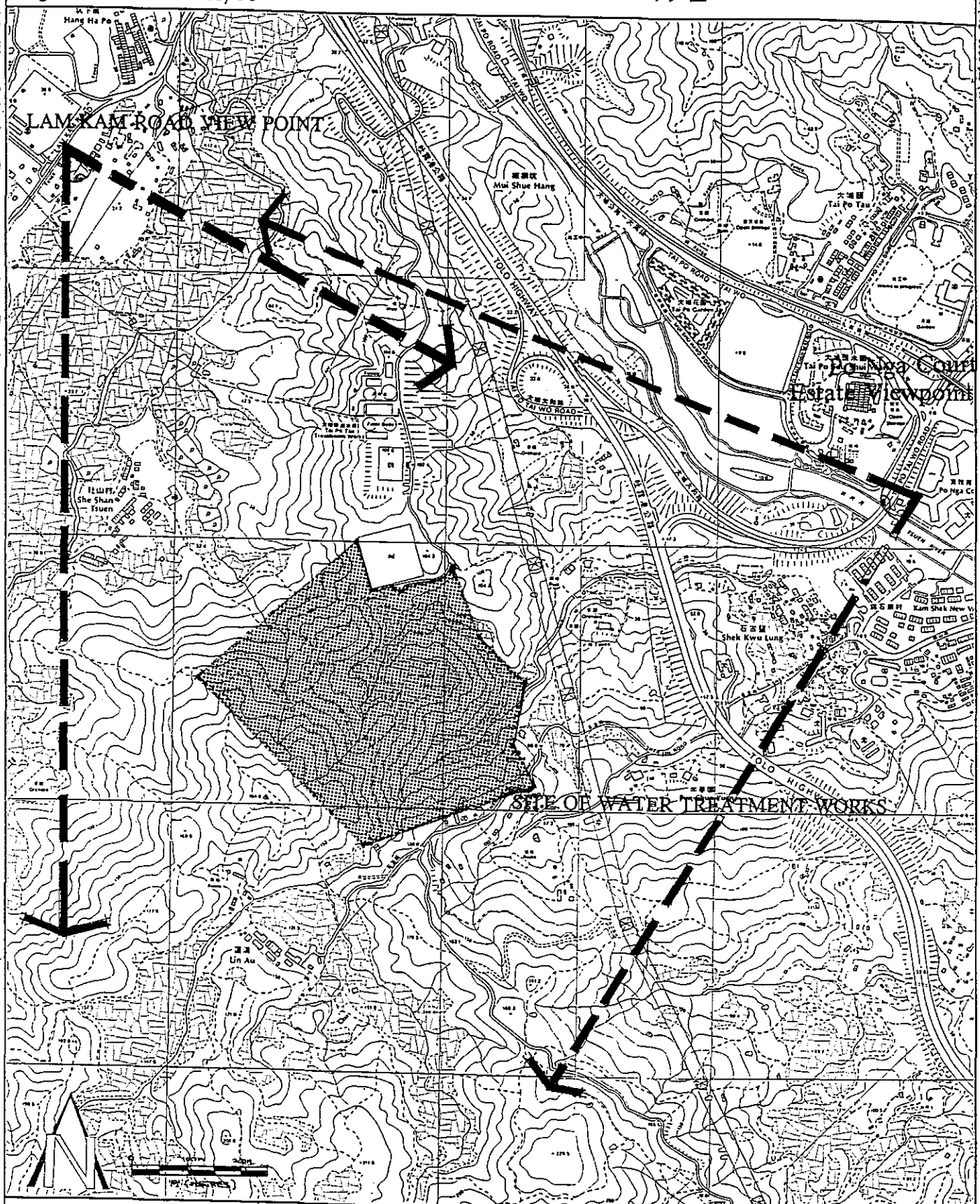

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Figure No. 5.2	Title: Tai Po Water Treatment Works: Viewing Points		
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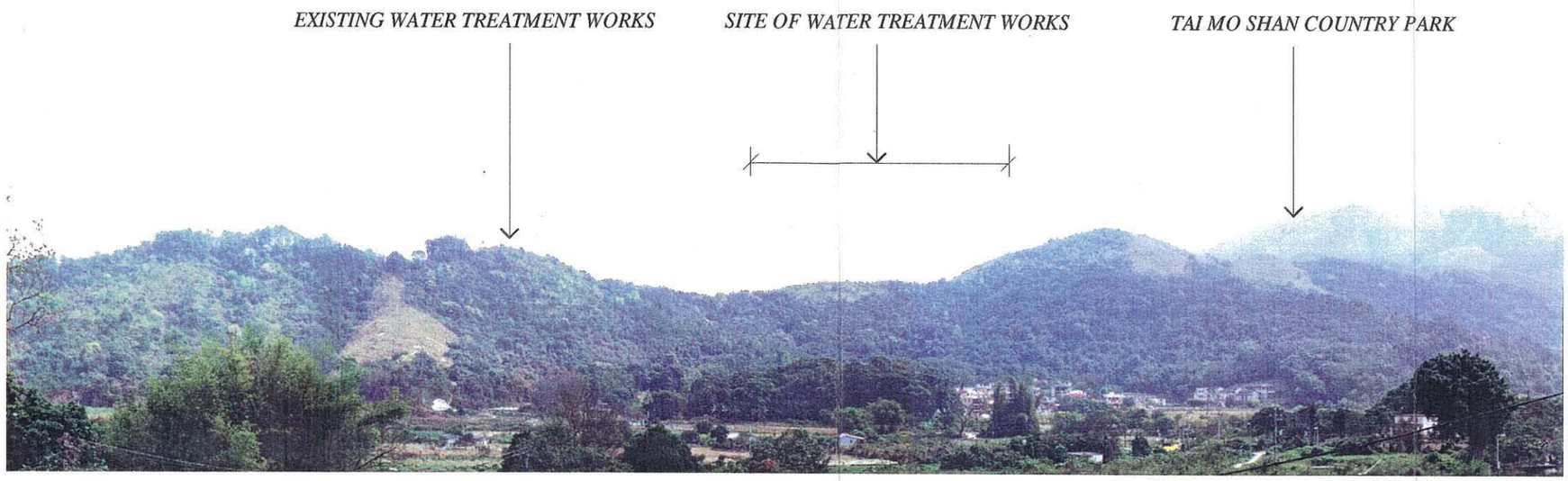
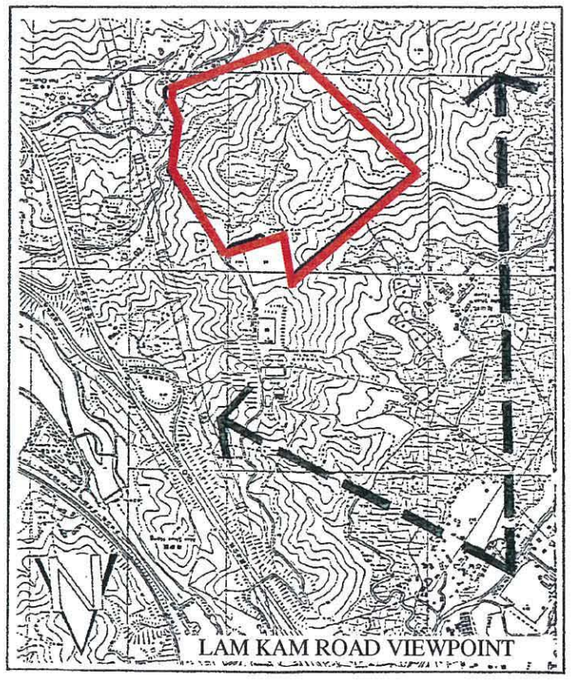
EXISTING VISUAL CONTEXT

Tai Po Water Treatment Works





LAM TSUEN VALLEY, LAM KAM ROAD : VISUAL CORRIDOR

- Lam Tsuen Valley enjoys wide uninterrupted views of the ridgeline affected by the plant.
- The view is considered representative of most available views from the many villages in the valley, and from along Lam Kam Road.
- The ridge, within which the site is located, is a long and lower part of more extensive ridge, which dominates southern views from the valley. The larger ridge extends up into the lower foot hills of Tai Mo Shan Country Park. The ridge is heavily vegetated on most of its north facing slopes.

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Contract no.

Project title: Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Title: TPWTW Existing Visual Context (view from southeast)

Plan register No.

Figure no. 5.3

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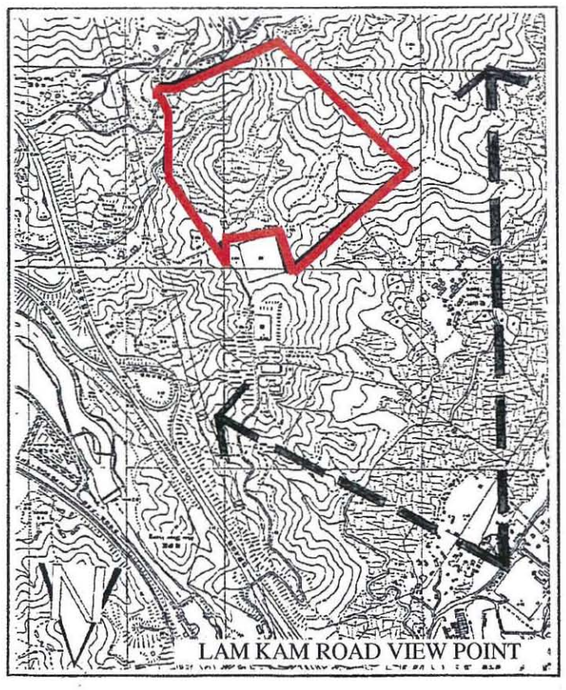
VISUAL IMPACT ASSESSMENT

Tai Po Water Treatment Works



LAM TSUEN VALLEY, LAM KAM ROAD : VISUAL CORRIDOR

- The extensive cutting of the north facing slopes will have a considerable visual impact.
- The bulk and geometric form of the low rise plant will interrupt the natural profile and lowers the existing ridgeline level.
- The siting of a tall calibration tower on the ridgeline if required will introduce a visual focal point. Such a vertical rather than horizontal structure may intrude into existing rigdeline and skyline views.

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Title: TPWTW Visual Impact Assessment (view from southeast)

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Figure no. 5.4

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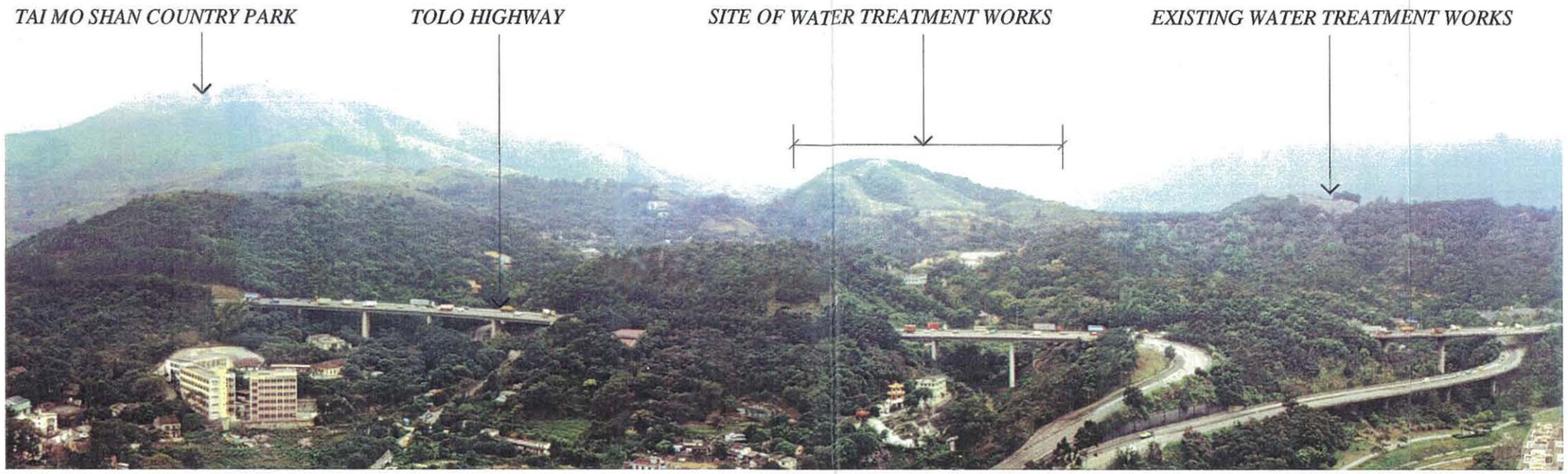
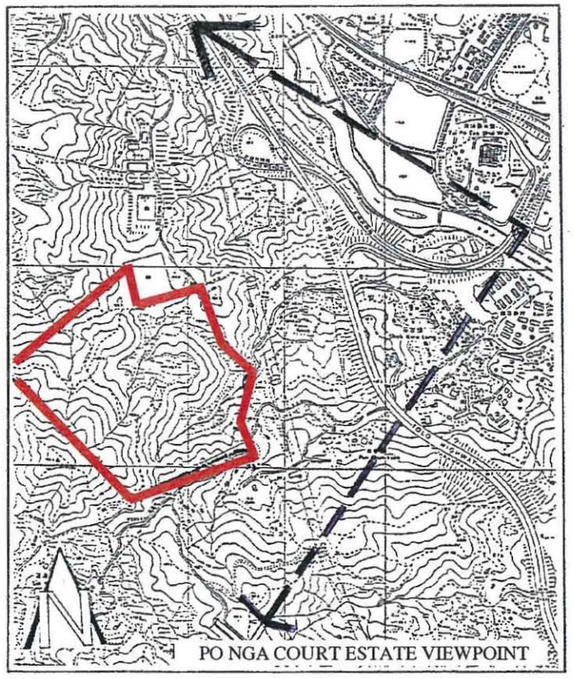
EXISTING VISUAL CONTEXT

Tai Po Water Treatment Works





TAI PO TOWN WEST, PO NGA COURT : VISUAL CORRIDOR

- The view from "Po Nga Court" is considered representative of the central western views available toward the site from the many public & private housing estates in the northern part of Tai Po New Town.
- This viewpoint on the upper floor of the block, encompasses the most "extreme" view, since it is from the highest viewing level and gives uninterrupted views of the site and its environs.
- Of note from this viewpoint is that landscape planted around the existing Water Treatment Plant on the same ridge has contributed significantly to absorption of the buildings into the general backdrop and a more pleasant view.

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TPWTW Existing Visual Context (view from northeast)

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Figure no. 5.5

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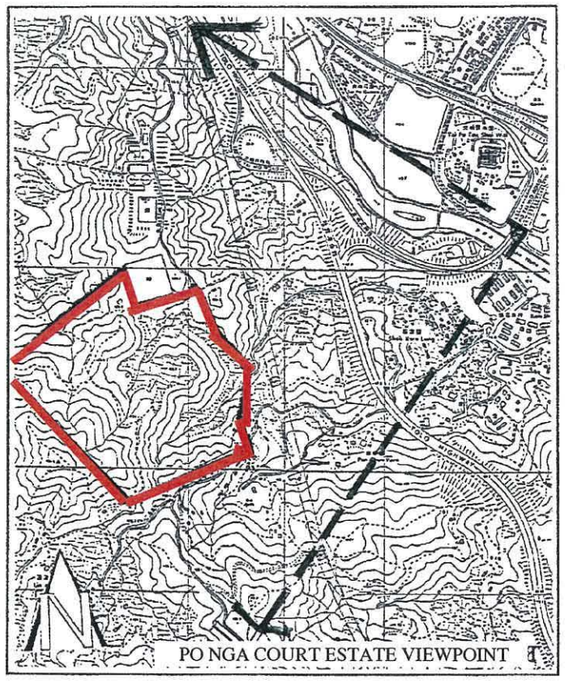
VISUAL IMPACT ASSESSMENT

Tai Po Water Treatment Works



TAI PO TOWN WEST , PO NGA COURT : VISUAL CORRIDOR

- Extensive cutting of the north slope and formation works along the southeastern boundary creates only limited visual impact, in that the area affected is part of a more extensive natural area which will not be disturbed by the works.
- The bulk and geometric form of the low rise plant will be clearly visibly from within this viewing corridor unless landscape mitigation measures are introduced. Retention of the higher peak behind the site will provide a natural backdrop to the plant, while the existing treatment plant landscape limits the northern extent of visual intrusion.
- The siting of a tall calibration tower on the ridgeline, if required, will introduces a visual focal point. Such a vertical rather than horizontal structure, may intrude into existing ridgeline and skyline views.

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TPWTW Visual Impact Assessment (view from northeast)

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Figure no. 5.6

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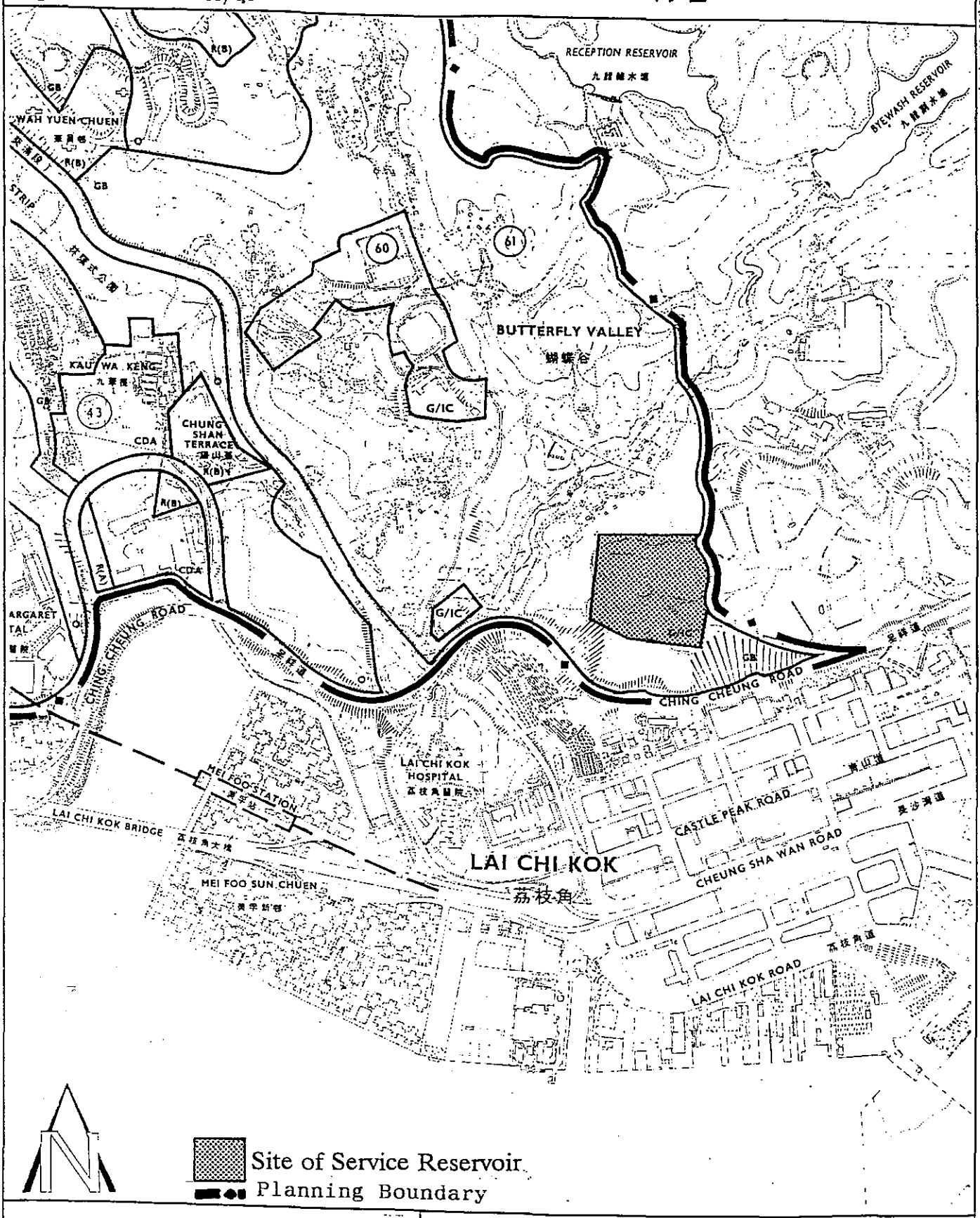

Site of Service Reservoir

Planning Boundary

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Figure No. 5.7

Title: Extract from Draft Kwai Chung Outline Zoning Plan [Ref. S/KC/10]

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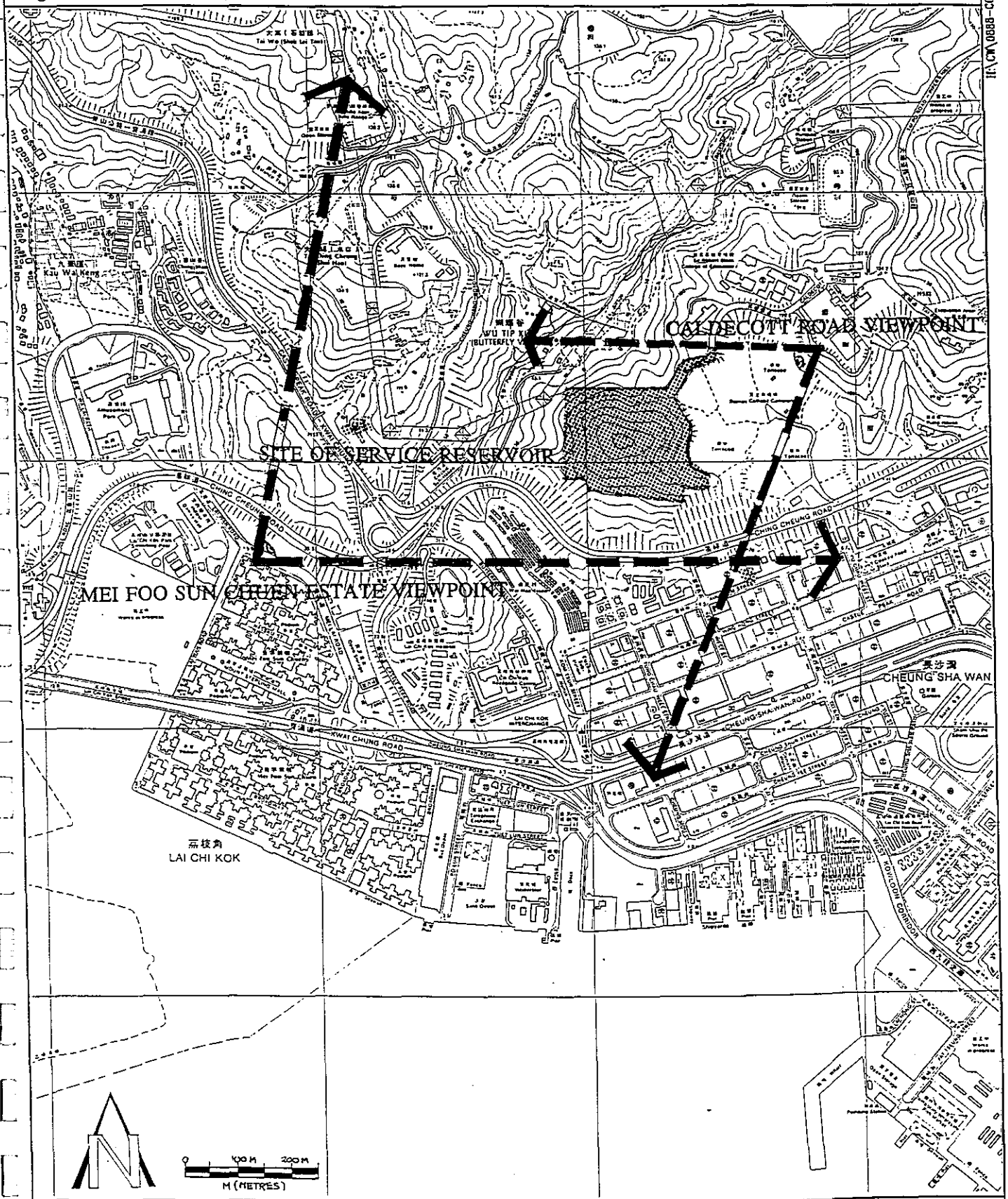

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Figure No. 5.8	Title Butterfly Valley Primary Service Reservoir: Viewing Points
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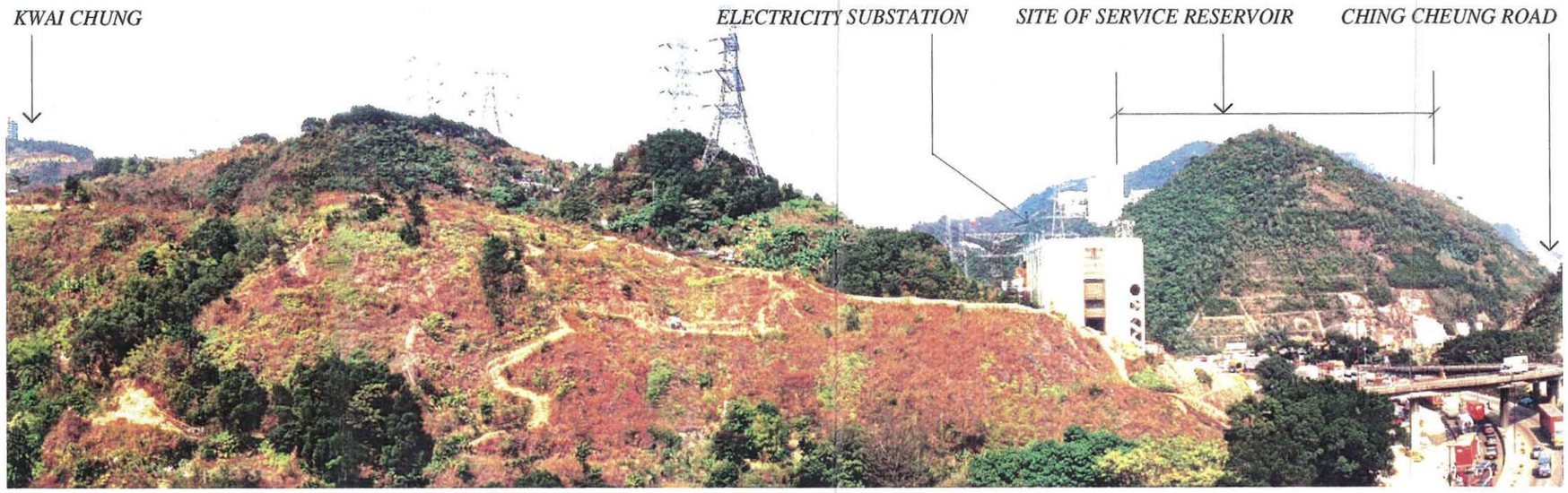
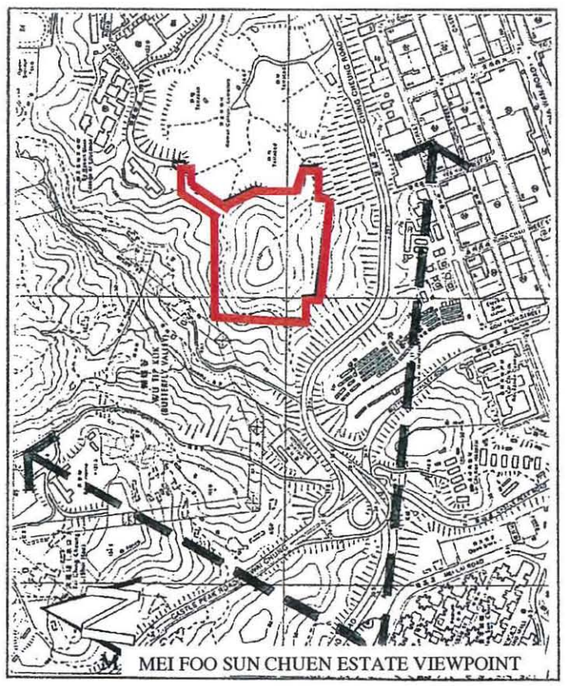
EXISTING VISUAL CONTEXT

Butterfly Valley Service Reservoir





MEI FOO ESTATE : VISUAL CORRIDOR

- This view is representative of resident views from the northern blocks of Mei Foo Sun Chuen Estate.
- The knoll is a prominent symmetrical element in the lower ridgeline of the Kam Shan Country Park.
- The vista is punctuated by various visually intrusive features such as the Electricity Substation, Pylons and Ching Cheung Road.

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Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Title

BVPSR Existing Visual Context (view from southwest)

Plan register No.

Figure no. 5.9

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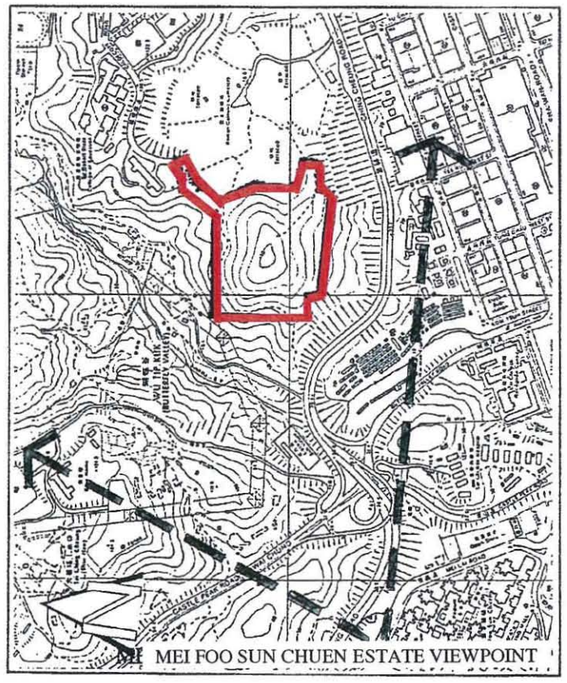
VISUAL IMPACT ASSESSMENT

Butterfly Valley Service Reservoir



MEI FOO ESTATE : VISUAL CORRIDOR

- When viewed from this corridor the visual impact resulting from the flattening of the knoll, is mitigated to some extent by the presence of background hills which form part of the Eagles Nest.

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BVPSR Visual Impact Assessment (view from southwest)

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Figure no. 5.10

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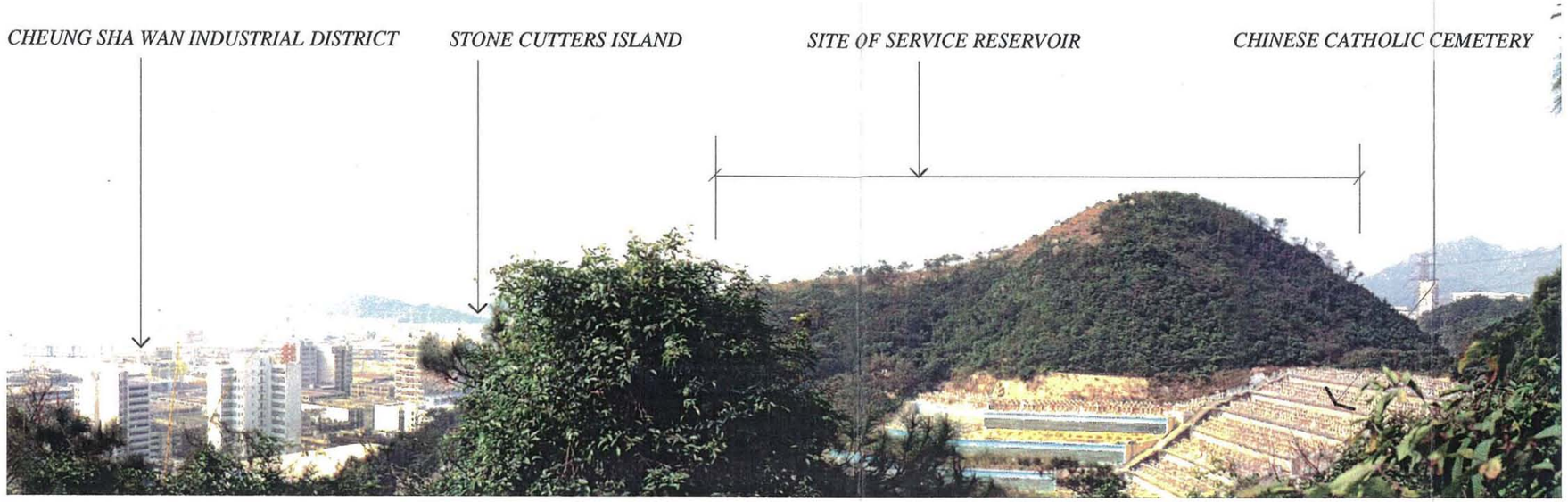
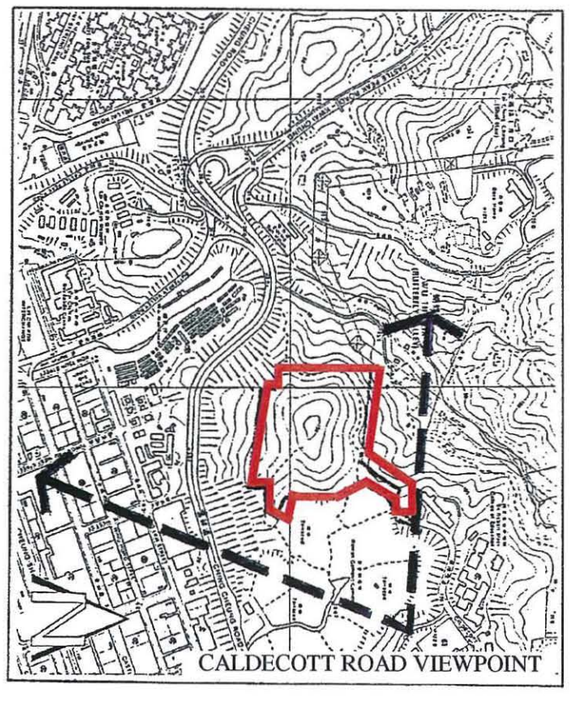
EXISTING VISUAL CONTEXT

Butterfly Valley Service Reservoir





CALDECOTT ROAD : VISUAL CORRIDOR

- While the primary viewing angle from this viewpoint is from the college and Government quarters, the knoll will also be viewed by visitors to the Chinese Catholic Cemetery, below. The site blocks part of the view panorama over parts of Cheung Sha Wan Industrial Area and Kwai Chung container port. In this role, it also serves as a major environmental buffer to road noise on Ching Cheung Road.

- The knoll provides a soft "CAP" above the hard facing of gravesites within the Cemetery.

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NOTES

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Designed	YY	02/95
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Checked	AL	02/95
Approved		

Agreement no. CE 41/94

Contract no.

Project title

Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Title

BVPSR Existing Visual Context (view from northeast)

Plan register No.

Figure no. 5.11

Scale

Water Supplies Department

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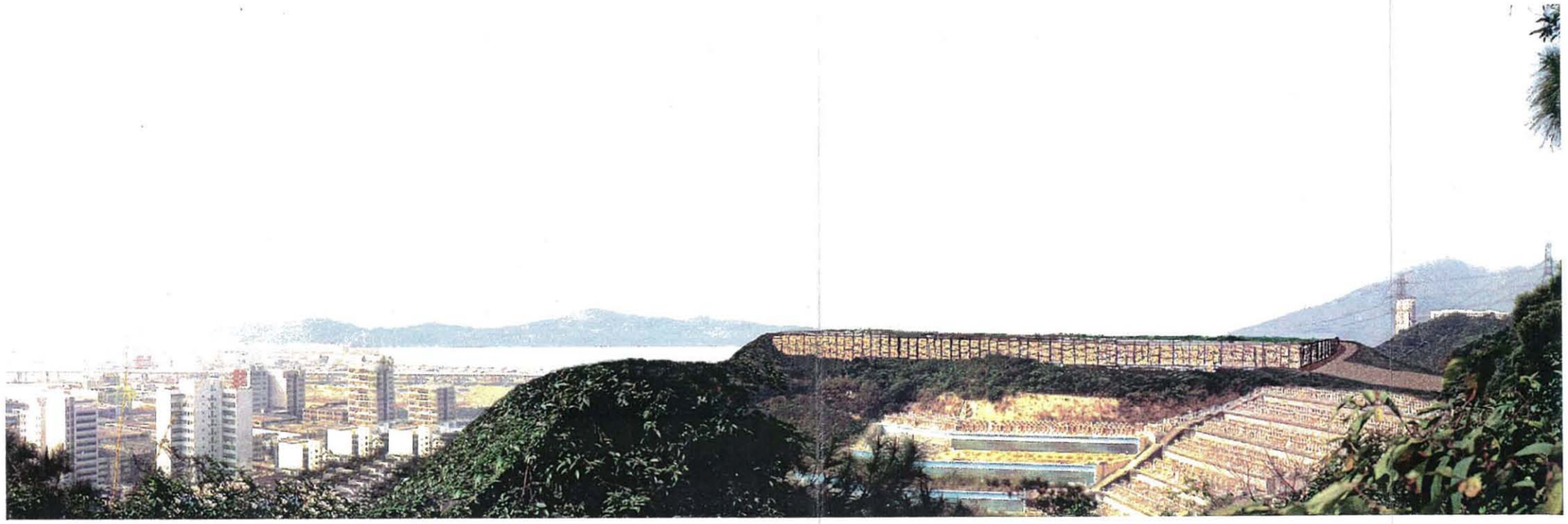
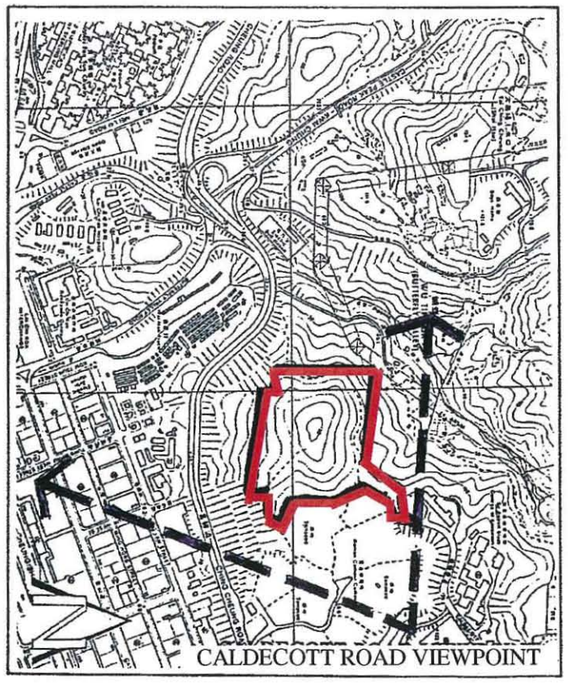
Pro Plan Asia Ltd
PPA 亞洲先創 Development Planning & Management Consultants

VISUAL IMPACT ASSESSMENT

Butterfly Valley Service Reservoir





CALDECOTT ROAD : VISUAL CORRIDOR

- The lowering of the existing knoll by almost a third will bring the city, visually closer to Caldecott Road.
- Night glare from the Kwai Chung container terminals is likely to be more pronounced.
- Removal of the visually important protective "CAP" above the Cemetery, sharpens the hardness of views of the Cemetery Site.

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NOTES

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	name	date
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Approved		

Agreement no. CE 41/94.

Contract no.

Project title: Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Title: BVPSR Visual Impact Assessment (view from northeast)

Plan register No.

Figure no. 5.12

Scale

Water Supplies Department

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CONSULTING ENGINEERS

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PPA Development Planning & Management Consultants

6 NOISE

Introduction

6.1 This section addresses the construction and operational noise impacts at Noise Sensitive Receivers (NSRs) adjacent to the sites and along access routes affected by the scheme. The construction noise impact assessment includes an evaluation of traffic movements and examines the effects of increased traffic on existing roads around the construction sites.

6.2 For completeness, the construction noise impacts associated with all of the raw water aqueduct options and the Yuen Tun Ha shaft/adit have been evaluated.

Noise - Construction Phase

6.3 During the construction period, the noise from construction activities and powered mechanical equipment could impact on the nearby noise sensitive receivers (NSRs). Construction Noise Permits will be required for percussive piling and construction work using powered mechanical equipment during restricted hours. In this section, the nearby NSRs for all options are identified and the impacts on the nearby NSRs will be assessed.

Sensitive Receivers & Area Sensitivity Ratings

6.4 The NSRs that will be exposed to the construction and operational noise impacts from the project are presented in Figures 6.1-6.5 and tabulated in Table 6.1.

Table 6.1 Noise Sensitive Receivers

NSR	Approx Height (mPD)	General Description	Estimated Number of People Affected
1(1)	16.1	Village house at San Uk Pai Tsuen	7
2(1)	17.4	Village house at San Uk Pai Tsuen	4
3(1),(2),(3)	35	Village house at She Shan Tsuen	currently empty
4(1),(2),(3)	33	Playground at She Shan Tsuen	5
5(2),(3)	125	Lin Hoi Public School	8
6(2),(3)	97	Village house at Shek Uk Tsai Tsuen	4
7(2),(3)	80.6	Villa along Shek Lin Road	4
8(2),(3)	65	House in Pun Chun Yuen	12 - 24
9(2),(3)	68	Ling Hing Monastery	2
10(2),(3)	40	Village house at Mui Shue Hang Tsuen	4
11(2)	7	Village house along Shek Lin Road	4
12(4)	47.2	Village house at San Uk Ka Tsuen (Wun Yiu)	4
13(4)	60	Village house at San Uk Ka Tsuen (Wun Yiu)	4
14(4)	60	Village house at San Uk Ka Tsuen (Wun Yiu)	4
15(4)	75	Village house at San Uk Ka Tsuen (Wun Yiu)	4
16(5)	143.6	Village house at Wo Yi Hop Tsuen	12
17(5)	141	Village house at Wo Yi Hop Tsuen	4
18(6)	47	Village house at Mui Kong Tsuen (Butterfly Valley)	4
19(6)	40	Village house at Mui Kong Tsuen (Butterfly Valley)	4
20(6)	28	Village house at Mui Kong Tsuen (Butterfly Valley)	4
21(6)	115	Government Staff Quarter, 8-10 Caldecott Road	192
22(6)	125	Sir Robert Black College of Education	100 - 200

Notes:

(1) - NSR affected by the construction of Raw Water Aqueduct Route 3
(2) - NSR affected by the construction of Tai Po Water Treatment Works
(3) - NSR affected by the operation of Tai Po Water Treatment Works
(4) - NSR affected by the construction of Yuen Tun Ha Shaft/Adit
(5) - NSR affected by the construction of Shing Mun Access Shaft
(6) - NSR affected by the construction of Butterfly Valley Primary Service Reservoir

6.5 The Area Sensitivity Rating (ASR) from the *Technical Memorandum on the Assessment of Noise from Places other than Construction Sites, Domestic Premises or Public Places* for the Tai Po Treatment Works (TP WTW), Yuen Tun Ha adit, Shing Mun tunnel access shaft, Butterfly Valley tunnel portal, Butterfly Valley Primary Service Reservoir (BVPSR), all options for the raw water aqueduct and the treated water aqueduct have been assessed and are shown in Table 6.2 below.

Table 6.2 Area Sensitivity Ratings for the Study Area

Area	Option	ASR Rating
Raw Water Aqueduct	Route I	A
	Route II	B
	Route III	A
Tai Po Treatment Works	-	A
Yuen Tun Ha adit	-	A
Shing Mun tunnel access shaft	-	A
Butterfly Valley Tunnel Portal & Service Reservoir	-	A

6.6 According to the Technical Memorandum, the Area Sensitivity Ratings A & B correspond to the following acceptable noise levels:

- all days during the evening (19:00-23:00) and general public holidays (including Sundays) during the daytime and evening, acceptable noise level for ASR (A) is 60 dB(A) and for ASR (B) is 65 dB(A);
- at night (23:00-07:00 hours) ASR(A) and ASR (B) acceptable noise levels are 45 dB(A) and 50 dB(A) respectively.

Assessment criteria

6.7 Currently, there are no restrictions for general construction noise during daytime hours (07:00-19:00 hours), Monday to Saturday. For the restricted hours (19:00-07:00 hours) and all day on Sunday and public holidays, the construction noise is controlled by the Construction Noise Permit System under the Noise Control Ordinance (NCO). Normally, EPD recommends 75 dB(A) as the acceptable noise level at residential sensitive receivers and 70 dB(A) at schools (65 dB(A) during examinations) during normal daytime hours, as outlined in the ProPECC Paper (PN 2/93) on *Noise from Construction Activities - Non-Statutory Controls.*

6.8 For the acceptable noise level of percussive piling, *Technical Memorandum on Noise from Percussive Piling* specifies 85dB(A) for the NSR with windows or other openings but without central air conditioning system.

Assessment methodology

6.9 The assessment methodology for general construction noise calculations follows the procedure stipulated in the relevant sections of the *Technical Memorandum on Noise from Percussive Piling* and the *Technical Memorandum on Noise from Construction Work other than Percussive Piling* published by EPD, Hong Kong.

6.10 The construction equipment is assumed to be located at a notional source, positioned mid-way between the approximate geographical centre of the construction site and its boundary nearest to the NSR. For the worst case scenario, all the construction equipment is assumed to be operated simultaneously at one point.

Distance attenuation

6.11 For construction noise, the correction of distance attenuation is based on the following formula:

$$SPL = SWL + 20LogD + 8$$

where:

SPL is the sound pressure level at the receiver
SWL is the total sound power level of all the equipment
D is the distance between the noise source and the receiver

6.12 For the noise generated from percussive piling, the correction for the distance attenuation is based on Table 4 - Correction Factors to Obtain the Predicted Noise Level from the Total Sound Power Level at Given Distance which listed in the *Technical Memorandum on Noise from Percussive Piling.*

Facade correction

6.13 A 3 dB(A) correction will be added for the facade reflection effect of the NSR.

Construction schedule and equipment

6.14 As the scheme is still at the preliminary design stage, no detailed construction schedule is available. In order to assess the construction noise impacts all of the assumptions have been based on a similar project.

6.15 At this stage, it is uncertain whether any piling will required at either the TP WTW or BVPSR sites. However, for the purposes of the noise impact assessment it has been assumed that one drop hammer driving concrete piling machine will be used at each site during TP WTW and BVPSR site formation. The sound power level of the piling machine is 116 dB(A).

6.16 The powered mechanical equipment likely to be used during various construction periods and their associated Sound Power Levels (SPL) are listed in Tables 6.3 to 6.18 at the end of this section.

6.17 An estimated 950,000 m^3 of rock and other material will have to be quarried and removed from the BVPSR site. Most of this will be excavated by drill and blast techniques. Some blasting will also be required at the TP WTW site.

6.18 Blasting will be an occasional event, carried out under the strictly controlled conditions enforced by the Mines and Quarries Division of the Civil Engineering Department, with due public information to alert nearby sensitive receivers to the timing of the explosions.

6.19 However, drilling of holes to insert the blast charges and loading will require extensive use of noisy powered mechanical equipment. Crawler mounted rock drills have the highest sound power levels per item of equipment of all the items of powered mechanical equipment listed in EPD's booklet *How to Apply for A Construction Noise Permit.* The listed sound power levels for crawler mounted rock drills are 123 dB(A) for hydraulic powered equipment and 128 dB(A) for pneumatic powered equipment.

Predicted noise levels

6.20 The predicted noise levels during piling period at TP WTW and BVPSR are presented in Tables 6.19 and 6.20 at the end of this section.

6.21 The predicted noise levels for the construction period at each of the sites are presented in Tables 6.21 to 6.36 at the end of this section.

Mitigation Measures - Construction Noise

6.22 The predicted noise levels from piling at TP WTW and BVPSR sites are well below the acceptable limit at nearby NSRs. Piling, if needed, will not therefore cause any adverse impact to nearby residents.

6.23 The predicted construction noise levels at nearby NSRs for most daytime activities are within acceptable limits. The activities identified as potentially exceeding the acceptable daytime noise levels are the site formation of BVPSR (by < 3 dB(A)), construction of the Shing Mun access shaft (by < 2 dB(A)), and tunnel excavation and locomotive operation at Butterfly Valley tunnel portal. However, the acceptable noise limit can easily be achieved at all sites through measures such as effective temporary noise barriers around noisy equipment or ensuring that all items of noisy equipment are not operated simultaneously.

6.24 At BVPSR, the impacts of blasting and associated construction activities can be mitigated to some extent by progressing the work face from the most westerly aspect of the hill as far away from the Caldecott Road sensitive receivers as possible, and that no construction activity takes place outside the normal daytime hours of 07:00-19:00, Monday to Saturday, excluding public holidays.

6.25 The staged excavation of the reservoir, effectively a quarrying operation, will mean that sensitive receivers will be partially shielded from the construction noise by the diminishing rock body acting as a noise barrier. Other noise mitigation measures could include use of silenced equipment and temporary noise barriers around noisy equipment where practicable.

6.26 Predicted noise levels from the proposed evening and night-time tunnelling activities exceed the acceptable noise limits for evening, night-time, Sunday and public holidays by at least 10 dB(A). As it is essential that tunnelling is undertaken on a 24-hour basis, it is recommended that all equipment and works are surrounded by an appropriate acoustic enclosure.

Noise - Construction Traffic

6.27 During the construction period, the transportation of the construction materials and spoil along the existing roads could also cause noise problems to nearby residents. Once again, all the options for both the raw water and treated water aqueducts have considered and their impacts assessed to determine the mitigation measures required.

Sensitive Receivers & Acceptable Noise Levels

6.28 The NSRs most affected by construction traffic for the different stages are identified and presented in Figures 6.1-6.5 and Table 6.37. According to the *Hong Kong Planning Standards and Guidelines*, the acceptable road traffic noise level is L_{10} (1 hour) 70 dB(A) and 65 dB(A) for all domestic premises and educational institutions respectively. It should be noted that at the time the noise impact assessment was undertaken, it was anticipated that construction traffic would access the TP WTW site via the WSD road and exit the site via the Shek Lin Road. This option has now been discounted and all traffic will travel to and from the site via the WSD road. Consequently, the impact of construction traffic noise at NSR 10 is considerably reduced.

Table 6.37 NSRs affected by Construction Traffic

NSRs	NSR Location	Traffic
2	At the ground floor of the village type house about 170 metres away from the Tai Po Tau 'D' Pumping Station internal access road	Generated by Tai Po Water Treatment Works construction site
10	Ground floor about 1 metre away from Shek Lin Road	Generated by Tai Po Water Treatment Works construction site
11	Ground floor about 8 metres away from the access road to Yuen Tun Ha Adit	Generated by Yuen Tun Ha adit site
15	At the ground floor of the building about 35 metres away from Shing Mun Road	Generated by Shing Mun tunnel access shaft
17	Ground floor about 30 metres away from the access road to Butterfly Valley Portal	Generated by Butterfly Valley portal site
20	At the ground floor of the Government building about 35 metres away from Caldecott Road	Generated by Butterfly Valley Service Reservoir

Assessment criteria

6.29 All the construction traffic calculations in this report are based on the procedures listed in the "*Calculation of the Road Traffic Noise*" published by the Department of Transport, U.K.

Existing traffic and traffic noise

6.30 In order to assess the impacts of the construction traffic on nearby residents, traffic flow survey and noise monitoring were carried out at rush hour at four different sites. The dates and times of the surveys are as follows:

Location	Date	Time
Tai Po (Shek Lin Road)	Monday 27th February 1995	07:00-10:00 hours
Tai Po (San Uk Ka)	Friday 10th March 1995	07:00-10:00 hours
Shing Mun (Wo Yi Hop Tsuen)	Wednesday 8th March 1995	17:00-20:00 hours
Butterfly Valley (Mui Kong Tsuen)	Thursday 9th March 1995	07:00-10:00 hours

The results are presented in Tables 6.38 and 6.39 below.

Table 6.38 Rush Hour Traffic Survey Results

Location	Traffic Flow Vehicle/hour	Heavy Vehicle (%)
Shek Lin Road to Tai Po Water Treatment Works	45	33 %
Access road to Yuen Tun Ha Shaft/Adit	25	16 %
Shing Mun Road to Shing Mun Shaft	122	53 %
Access road to Butterfly Valley Portal	4	0 %
Caldecott Road to Butterfly Valley Reservoir	40	25 %

Table 6.39 Traffic Noise Monitoring Results

NSRs	Location	L_{10} (1 hour) dB(A)
10	Ground floor about 1 metre away from Shek Lin Road	64.1 dB(A)
11	Ground floor about 8 metres away from the access road to Yuen Tun Ha adit	57.0 dB(A)
15	At the roof of the building about 35 metres away from Shing Mun Road	64.0 dB(A)
17	Ground floor about 30 metres away from the access road to Butterfly Valley portal	58.5 dB(A)
20	At the roof of the building about 35 metres away from Caldecott Road	60.0 dB(A)

Additional construction traffic

6.31 The predicted additional traffic generated during the construction periods are presented in Table 6.40. These figures are based on the estimated spoil generation and disposal figures presented in Table 7.8. The figures for TP WTW were revised, following the noise impact assessment, as follows:

Approx. Total Volume of Spoil	315,000 m^3
Approx. Spoil Disposal/Day	673 m^3
Average No. of Trucks/Day	112

This may increase the predicted noise levels at the affected NSRs by 3 dB(A), which is still within acceptable limits.

Table 6.40 Combined Traffic Flow during Construction Period

Location	Additional Traffic Flow Vehicle/hour	Total Traffic Flow Vehicle/hour	Total Heavy Vehicle %
Shek Lin Road to Tai Po Treatment Works	20	65	54%
Access road to Yuen Tun Ha Adit	4	29	28%
Shing Mun Road to Shing Mun Shaft	10	132	57%
Access road to Butterfly Valley Portal	8	12	75%
Caldecott Road to Butterfly Valley Reservoir	44	84	64%
Access road within the Tai Po Tau 'D' pumping station site	10	10	100%

Predicted Construction Traffic Noise Levels

6.32 Based on the information in Table 7.8, the predicted noise levels at the nearest NSRs are presented in Table 6.41.

Table 6.41 Predicted Construction Traffic Noise Levels at nearest NSRs

NSRs	Location	L_{10} (1 hour) dB(A)
10	Ground floor about 1 metre away from Shek Lin Road	66.7 dB(A)
11	Ground floor about 8 metres away from the access road to Yuen Tun Ha adit	61.6 dB(A)
15	At the ground floor of the building about 35 metres away from Shing Mun Road	65.5 dB(A)
17	Ground floor about 30 metres away from the access road to Butterfly Valley portal	58.5 dB(A)
20	At the ground floor of the Government building about 7.5 metres away from Caldecott Road	67.2 dB(A)
2	At the ground floor of the village type house about 170 metres away from the Tai Po pumping station internal access road	50.4 dB(A)

Mitigation Measures - Construction Traffic

6.33 The predicted noise levels in Table 6.41 reveal that during the construction period, the additional traffic movements along existing roads adjacent to the nearest NSRs at the different sites are within the acceptable noise limit 70 dB(A). No mitigation is required.

6.34 The Sir Robert Black College of Education, located at about the same distance from the BVPSR site as the Government building at Caldecott Road, is centrally air-conditioned, therefore no noise impacts are expected from the additional traffic.

Noise - Operational Phase

6.35 During the operation of TP WTW, noise will be generated by the powered equipment such as pumps, generator, transformer, ventilation system, vehicle movements and maintenance works. In this section, the nearby operation phase NSRs are identified and the impacts assessed.

6.36 As the noise assessment has been undertaken during the investigation study/preliminary design stage of TP WTW, information on issues such as the exact location of windows, doors and ventilation fans, details of pumping station and generator buildings or any built-in mitigation measures such as acoustic louvres has not been available. Consequently, all operational noise calculations are based on experience from the operation of similar sites.

Sensitive Receivers and Acceptable Noise Levels

6.37 The Area Sensitivity Rating for village-type development around TP WTW is rating A. This corresponds to the Acceptable Noise Level (ANL) of 60 dB(A) during daytime (07:00-19:00), evening (19:00-23:00), and general public holidays (including Sundays) during the daytime and evening. The acceptable noise level at night (23:00-07:00) is 50 dB(A).

6.38 Based on the survey map, the nearest NSRs around TP WTW have been identified and are shown in Figure 6.2.

Assessment Criteria

6.39 The *Hong Kong Planning Standards and Guidelines* states that noise levels from a new fixed source should be 5 dB(A) below the relevant ANL in the *TM for the Assessment of Noise from Places other than Construction Sites, Domestic Premises or Public Places* or the prevailing noise level, whichever is lower.

Existing Noise Conditions

6.40 The existing noise environment around the proposed TP WTW site is very quiet. The houses are all typical village-type houses and most of the farmland is abandoned. A baseline noise monitoring survey was conducted at NSR4 (She Shan Tsuen) and NSR5 (Lin Hoi Public School) in March 1995.

6.41 It is assumed that the monitoring results of the NSR4 represent the prevailing noise levels for the western area of the TP WTW site and that at NSR5 represents the prevailing noise levels for the eastern area. The monitoring results are presented in Tables 6.42 and 6.43.

Table 6.42 Baseline Noise Monitoring Results for NSR4 (She Shan Tsuen)

NSR 4 : She Shan Tsuen (7 March - 8 March 1995)			
Time	Leq	L10	L90
11:00	48.0	49.3	38.5
12:00	46.4	48.5	40.0
13:00	46.7	49.5	40.5
14:00	47.4	48.5	40.0
15:00	46.5	47.1	39.5
16:00	44.7	46.5	39.0
17:00	45.7	47.5	38.5
18:00	44.7	45.0	37.5
19:00	42.9	44.0	37.0
20:00	39.7	41.0	37.0
21:00	38.8	40.0	36.5
22:00	39.6	41.5	36.5
23:00	40.2	42.5	37.5
00:00	39.2	40.5	36.5
01:00	38.9	40.0	37.0
02:00	38.9	40.5	36.0
03:00	38.6	40.0	36.5
04:00	38.4	40.0	35.5
05:00	38.1	39.5	35.5
06:00	42.8	45.0	37.0
07:00	45.5	48.0	40.5
08:00	46.9	48.5	41.5
09:00	46.0	46.5	40.5
10:00	50.0	51.1	41.5

N.B. The increase in noise level during 10:00-11:00 was caused by a nearby worker sweeping and clearing vegetation.

Table 6.43 Baseline Noise Monitoring Results for NSR 5 (Lin Hoi Public School)

NSR 5 : Lin Hoi Public School (6 March - 7 March 1995)			
Time	Leq	L10	L90
10:00	54.0	55.8	50.0
11:00	51.9	53.0	49.0
12:00	51.8	53.0	49.5
12:59	52.9	53.5	50.5
13:59	52.8	53.5	50.0
15:00	54.0	55.5	50.0
15:59	55.3	56.5	51.0
16:59	52.0	53.0	50.0
18:00	50.3	51.5	48.0
19:00	49.8	51.0	47.5
20:00	49.1	50.5	46.0
21:00	49.4	51.0	45.5
22:00	47.6	49.0	43.5
23:00	45.6	48.0	41.5
00:00	45.4	48.0	41.0
01:00	43.1	45.5	38.0
02:00	43.4	46.0	38.5
03:00	43.1	46.0	38.0
04:00	44.5	46.0	38.0
05:00	47.1	49.0	40.5
06:00	48.5	50.5	45.0
07:00	50.8	52.0	48.5
08:00	75.4	80.0	50.5
09:00	77.2	82.5	51.0

N.B. During the period 08:00-10:00, the increase in noise level was caused by a helicopter frequently hovering overhead delivering site investigation equipment.

6.42 In line with the *HKPSG* guidelines mentioned above, the acceptable noise limit for NSRs near TP WTW are as listed in the Table 6.44.

Table 6.44 Acceptable Noise Limits for NSRs near TP WTW

NSR	Prevailing Mean Daytime Noise Level	Prevailing Mean Night-time Noise Level	Daytime Acceptable Noise Limit	Night-time Acceptable Noise Limit
Eastern Area	44.9 dB(A)	39.4 dB(A)	39.9 dB(A)	34.4 dB(A)
Western Area	54.1 dB(A)	45.1 dB(A)	49.1 dB(A)	40.1 dB(A)

TP WTW Potential Noise Sources

6.43 At the time of reporting, the detailed design of the scheme has not yet begun. All of the calculations are based on the preliminary design of the treatment works.

6.44 During the operational stage, the most noisy equipment will be the pumps within the pumping station, the generator (which will only be run during power failure events, therefore infrequently) and the transformer. At the pumping station, eight pumps will be installed and for the worst case scenario it is assumed that six of them will be running simultaneously. The detailed location and their sound power levels are presented in Table 6.45 and Figure 6.2.

Table 6.45 Operational Stage Equipment at TP WTW

Equipment	No. of equipment	Sound Power Level (SPL) dB(A)	Total Sound Power Level (SPL) dB(A)
Pump	6	89.0 dB(A)	96.8 dB(A)
Generator	1	110.0 dB(A)	110.0 dB(A)
Transformer	1	48.0 dB(A)	48.0 dB(A)

6.45 The noise generated from the inlet and exhaust air fans and the ventilation systems at TP WTW is relatively small and has not therefore been considered in the calculations.

Assessment Methodology

Distance attenuation

6.46 For a fixed noise, the correction for distance attenuation is based on the following formula:

$$SPL = SWL + 20LogD + 8$$

where:

SPL is the sound pressure level at the receiver
SWL is the total sound power level of the equipments
D is the distance between the noise source and the receiver

Facade correction

6.47 A 3 dB(A) has been added for the facade reflection correction.

Insulation effect for the building

6.48 As the detailed design of the treatment works has not yet been carried out, the exact location of the windows, doors and ventilation fans it is not known. Similarly the installation of mitigation measures such as acoustic louvres is not known. Therefore, it is assumed that the sound power levels at the opening of the building is the same as at the source.

Predicted Noise Levels

6.49 The predicted noise levels at the nearest identified Noise Sensitive Receivers (NSRs) are presented in Table 6.46.

Table 6.46 Predicted Operational Noise Levels at nearest NSRs

NSRs	Distance to Pump Station (m)	Distance to Generator Room (m)	Noise from Pump Station dB(A)	Noise from Generator room dB(A)	Combined Noise Levels
3	270	360	39.9	50.7	51.0
5	325	435	38.5	49.2	49.6
6	400	465	36.8	50.0	50.2
7	360	375	37.7	50.5	50.7
10	490	340	34.9	51.2	51.3

Mitigation Measures - Operational Phase

6.50 The predicted noise levels at the identified NSRs during both the daytime and night-time are above the acceptable limit. In the daytime, the predicted noise level at the nearest western NSR (NSR3) is 11 dB(A) higher than the acceptable limits and the predicted noise levels at the nearest eastern NSRs (NSRs 3, 5, 6, 7 and 10) are just above the acceptable limits. In addition, all the predicted noise levels exceed the acceptable limits for evening, all day on Sunday and public holidays by more than 10 dB(A).

6.51 The predicted noise levels in Table 6.47 indicate that it would be necessary to instal mitigation measures such as acoustic louvres at the openings, and absorbent materials within the pumping station and generator room to alleviate the noise nuisance from the operation of the site.

6.52 Once the detailed design of TP WTW has been developed, it is recommended that a detailed Noise Impact Assessment is undertaken. This will enable a more accurate prediction of operational noise levels and identification of appropriate noise mitigation measures.

6.53 In view of the acceptable noise levels being so low, especially the night-time limit, it is anticipated that significant capital expenditure may be necessary to achieve the required noise levels. It is recommended that the appropriateness of the acceptable noise levels for the area is discussed with EPD.

Summary

6.54 The noise impact study has identified Noise Sensitive Receivers (NSRs) adjacent to the sites and along the associated access roads. Predicted noise levels at the NSRs during the construction and operational phases of the scheme have been calculated, based on the limited information on equipment, plant and site layout available during the preliminary design stage. The construction noise assessment includes an evaluation of the impact of construction-related traffic on existing roads around the various sites.

Construction impacts

6.55 The predicted construction noise levels at nearby NSRs for most daytime activities are within acceptable levels. The activities identified as potentially exceeding the acceptable daytime noise levels are the site formation of BVPSR, construction of the Shing Mun access shaft (by <2dB(A)), tunnel excavation and locomotive operation at Butterfly Valley tunnel portal (exceedance of 1-9 dB(A)). However, the acceptable noise limit can easily be achieved at all sites through measures such as effective temporary noise barriers around noisy equipment or ensuring that all items of noisy equipment are not operated simultaneously.

6.56 At BVPSR, the impacts of blasting and associated construction activities can be mitigated to some extent by progressing the workface from the most westerly aspect of the hill, as far away from the Caldecott Road sensitive receivers as possible, and that no construction activity takes place outside the normal daytime hours of 07:00-19:00, Monday to Saturday, excluding public holidays.

6.57 The staged excavation of the reservoir, effectively a quarrying operation, will mean that sensitive receivers will be partially shielded from the construction noise by the diminishing rock body acting as a noise barrier. Other noise mitigation measures could include use of silenced equipment and temporary noise barriers around noisy equipment where practicable.

6.58 Predicted noise levels from the proposed evening and night-time tunnelling activities exceed the acceptable noise limits for evening, night-time, Sunday and public holidays by at least 10 dB(A). As it is essential that tunnelling is undertaken on a 24-hour basis, it is recommended that all equipment and works are surrounded by an appropriate acoustic enclosure.

6.59 Traffic noise predictions show that the noise levels generated by additional construction traffic movements along existing roads adjacent to NSRs are within acceptable limits. Sir Robert Black College of Education, located close to the Butterfly Valley Service Reservoir site, is centrally air-conditioned so no noise impact is anticipated from construction traffic.

Operational impacts

6.60 The *Hong Kong Planning Standards and Guidelines* states that noise levels from a new fixed source should be 5 dB(A) below the relevant Acceptable Noise Levels (ANLs) in the *Technical Memorandum for the Assessment of Noise from Places other than Construction Sites, Domestic Premises or Public Places* or the prevailing background noise level, whichever is lower.

6.61 The ANLs for TP WTW are 60 dB(A) for daytime and 50 dB(A) for night-time. However, baseline noise monitoring at two nearby NSRs has indicated that the prevailing mean daytime noise level is 45-54 dB(A) and the prevailing mean night-time level is 39-45 dB(A). These noise levels are very low.

6.62 As the noise assessment has been undertaken during the investigation study/preliminary design stage of TP WTW, information on issues such as the exact location of windows, doors and ventilation fans, details of pumping station and generator buildings or any built-in mitigation measures such as acoustic louvres have not been available.

6.63 Assuming no mitigation of plant and equipment noise whatsoever at TP WTW, and simultaneous operation of six of eight of the pumps, the predicted noise levels at the nearest NSRs exceed the acceptable daytime limits by between 1-11 dB(A). All predicted noise levels exceed the acceptable limits for evenings, night-time, Sundays and public holidays by more than 10 dB(A).

6.64 Once the detailed design of TP WTW has been developed and pump and power plant specifications are known, it is recommended that a detailed Noise Impact Assessment is undertaken. This will enable a more accurate prediction of operational noise levels and identification of appropriate noise mitigation measures.

6.65 In view of the acceptable noise limits being so low, especially the night-time limit, it is anticipated that significant capital expenditure may be required to achieve the required noise levels. It is recommended the appropriateness of the acceptable noise limits for the area is discussed with EPD.

Table 6.3 Tai Po Raw Water Portal - Tunnel Locomotives (Day-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Trucks (internal, licensed, delivery)	141	112	3	116.77	5E+11	120.87
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor (silenced)	002	100	1	100.00	1E+10	
Backhoe excavator	081	112	1	112.00	2E+11	
Pneumatic breaker, hand-held	023	117	1	117.00	5E+11	
Water pump, submersible	283	85	1	85.00	3E+08	
Ventilation fan	241	108	1	108.00	6E+10	
Tunnel locomotives*	-	95	1	95.00	3E+09	

* Due to the Tunnel Drilling machine being inside the tunnel, it is assumed the SWL at the calculation point is 95 dB(A).

Table 6.4 Tai Po Raw Water Portal - Trench Construction and Tunnelling Stage (Day-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Crawler crane	048	112	1	112.0	2E+11	123.42
Tower crane	049	95	1	95.00	3E+09	
Mixer truck	044	109	1	109.00	8E+10	
Concrete poker	170	113	1	113.00	2E+11	
Crane lorry	-	112	1	112.00	2E+11	
Trucks (internal, licensed, delivery)	141	112	6	119.78	1E+12	
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor (silenced)	002	100	2	103.01	2E+10	
Backhoe excavator	081	112	1	112.00	2E+11	
Concrete pump	047	109	1	109.00	8E+10	
Piling, large diameter bored, oscilla	165	115	1	115.00	3E+11	
Water pump, submersible	283	85	1	85.00	3E+08	
Ventilation fan	241	108	1	108.00	6E+10	
Substation	-	90	1	90.00	1E+09	

Table 6.5 Tai Po Raw Water Portal - Tunnelling Stage (Night-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Mixer truck	044	109	1	109.00	8E+10	117.79
Concrete poker	170	113	1	113.00	2E+11	
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor (silenced)	002	100	1	100.00	1E+10	
Backhoe excavator	081	112	1	112.00	2E+11	
Concrete pump	047	109	1	109.00	8E+10	
Water pump, submersible	283	85	1	85.00	3E+08	
Ventilation fan	241	108	1	108.00	6E+10	
Substation	-	90	1	90.00	1E+09	

Table 6.6 TP WTW - Site Formation (Day-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Trucks (internal, licensed, delivery)	141	112	10	122.00	2E+12	125.91
Generator (silenced)	102	100	4	106.02	4E+10	
Air compressor (silenced)	002	100	3	104.77	3E+10	
Backhoe excavator	081	112	6	119.78	1E+12	
Concrete pump	047	109	2	112.01	2E+11	
Pneumatic breaker, hand-held	023	117	1	117.00	5E+11	
Bulldozer	030	115	2	118.01	6E+11	

Table 6.7 TP WTW - Construction Period (Day-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Batching plant	022	108	1	108.00	6E+10	125.21
Crawler crane	048	112	2	115.01	3E+11	
Tower crane	049	95	2	98.01	6E+09	
Mixer truck	044	109	4	115.02	3E+11	
Concrete poker	170	113	4	119.02	8E+11	
Crane lorry	-	112	10	122.00	2E+12	
Generator (silenced)	102	100	4	106.02	4E+10	
Air compressor (silenced)	002	100	3	104.77	3E+10	
Concrete pump	047	109	2	112.01	2E+11	

Table 6.8 Yuen Tun Ha Adit - Adit Construction Period

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Crawler crane	048	112	1	112.00	2E+11	119.10
Crane lorry	-	112	1	112.00	2E+11	
Trucks (internal, licensed, delivery)	141	112	2	115.01	3E+11	
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor (silenced)	002	100	1	100.00	1E+10	
Backhoe excavator	081	112	1	112.00	2E+11	

Table 6.9 Yuen Tun Ha Adit - Tunnelling Stage (Day-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Mixer truck	044	109	1	109.00	8E+10	121.44
Concrete poker	170	113	1	113.00	2E+11	
Crane lorry	-	112	1	112.00	2E+11	
Trucks (internal, licensed, delivery)	141	112	4	118.02	6E+11	
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor (silenced)	002	100	1	100.00	1E+10	
Backhoe excavator	081	112	1	112.00	2E+11	
Concrete pump	047	109	1	109.00	8E+10	
Water pump, submersible	283	85	1	85.00	3E+08	
Ventilation fan	241	108	1	108.00	6E+10	

Table 6.10 Yuen Tun Ha Adit - Tunnelling Stage (Night-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Mixer truck	044	109	1	109.00	8E+10	117.78
Concrete poker	170	113	1	113.00	2E+11	
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor (silenced)	002	100	1	100.00	1E+10	
Backhoe excavator	081	112	1	112.00	2E+11	
Concrete pump	047	109	1	109.00	8E+10	
Water pump, submersible	283	85	1	85.00	3E+08	
Ventilation fan	241	108	1	108.00	6E+10	

Table 6.11 Shing Mun Tunnel Access Shaft - Shaft Construction (Day-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Crawler crane	048	112	1	112.00	2E+11	119.10
Crane lorry	-	112	1	112.00	2E+11	
Trucks (internal, licensed, delivery)	141	112	2	115.01	3E+11	
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor	002	100	1	100.00	1E+10	
Backhoe excavator	081	112	1	112.00	2E+11	

Table 6.12 Shing Mun Tunnel Access Shaft - Tunnelling Stage (Day-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Tower crane (electric)	049	95	1	95.00	3E+09	121.92
Mixer truck	044	109	1	109.00	8E+10	
Concrete poker	170	113	1	113.00	2E+11	
Crane lorry	-	112	1	112.00	2E+11	
Trucks (internal, licensed, delivery)	141	112	5	118.99	8E+11	
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor (silenced)	002	100	1	100.00	1E+10	
Backhoe excavator	081	112	1	112.00	2E+11	
Concrete pump	047	109	1	109.00	8E+10	
Water pump, submersible	283	85	2	88.01	6E+08	
Ventilation fan	241	108	1	108.00	6E+10	

Table 6.13 Shing Mun Tunnel Access Shaft - Tunnelling Stage (Night-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Tower crane (electric)	049	95	1	95.00	3E+09	117.81
Mixer truck	044	109	1	109.00	8E+10	
Concrete poker	170	113	1	113.00	2E+11	
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor (silenced)	002	100	1	100.00	1E+10	
Backhoe excavator	081	112	1	112.00	2E+11	
Concrete pump	047	109	1	109.00	8E+10	
Water pump, submersible	283	85	2	88.01	6E+08	
Ventilation fan	241	108	1	108.00	6E+10	

Table 6.14 Butterfly Valley Tunnel Portal - Tunnel Locomotives

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Trucks (internal, licensed, delivery)	141	112	2	115.01	3E+11	120.27
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor (silenced)	002	100	1	100.00	1E+10	
Backhoe excavator	081	112	1	112.00	2E+11	
Pneumatic breaker, hand-held	023	117	1	117.00	5E+11	
Water pump, submersible	283	85	1	85.00	3E+08	
Ventilation fan	241	108	1	108.00	6E+10	
Tunnel locomotives*	-	95	1	95.00	3E+09	

* Due to the Tunnel Drilling machine being inside the tunnel, it is assumed the SWL at the calculation point is 95 dB(A).

Table 6.15 Butterfly Valley Tunnel Portal - Tunnelling Stage (Day-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Crawler crane	048	112	1	112.00	2E+11	121.91
Mixer truck	044	109	1	109.00	8E+10	
Concrete poker	170	113	1	113.00	2E+11	
Crane lorry	-	112	1	112.00	2E+11	
Trucks (internal, licensed, delivery)	141	112	4	118.02	6E+11	
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor (silenced)	002	100	1	100.00	1E+10	
Backhoe excavator	081	112	1	112.00	2E+11	
Concrete pump	047	109	1	109.00	8E+10	
Water pump, submersible	283	85	2	88.01	6E+08	
Ventilation fan	241	108	1	108.00	6E+10	
Substation	-	90	1	90.00	1E+09	

Table 6.16 Butterfly Valley Tunnel Portal - Tunnelling Stage (Night-time)

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Mixer truck	044	109	1	109.00	8E+10	117.79
Concrete poker	170	113	1	113.00	2E+11	
Generator (silenced)	102	100	1	100.00	1E+10	
Air compressor (silenced)	002	100	1	100.00	1E+10	
Backhoe excavator	081	112	1	112.00	2E+11	
Concrete pump	047	109	1	109.00	8E+10	
Water pump, submersible	283	85	2	88.01	6E+08	
Ventilation fan	241	108	1	108.00	6E+10	
Substation	-	90	1	90.00	1E+09	

Table 6.17 Butterfly Valley Service Reservoir - Site Formation Stage

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Trucks (internal, licensed, delivery)	141	112	8	121.03	1E+12	130.3
Generator (silenced)	102	100	2	103.01	2E+10	
Air compressor (silenced)	002	100	2	103.01	2E+10	
Backhoe excavator	081	112	4	118.02	6E+11	
Pneumatic breaker, hand-held	023	117	1	117.00	5E+11	
Bulldozer	030	115	1	115.00	3E+11	
Hydraulic rock drill, crawler mounted	182	123	4	129.00		

Table 6.18 Butterfly Valley Service Reservoir - Construction Stage

Type of PME	CNP code	SWL (T.M.)	No. of units	SWL	Summation of SWL	T.SWL
Crawler crane	048	112	1	112.00	2E+11	123.99
Tower crane	049	95	2	98.01	6E+09	
Mixer truck	044	109	3	113.77	2E+11	
Concrete poker	170	113	2	116.01	4E+11	
Crane lorry	-	112	2	115.01	3E+11	
Trucks (internal, licensed, delivery)	141	112	8	121.03	1E+12	
Generator (silenced)	102	100	2	103.01	2E+10	
Air compressor (silenced)	002	100	2	103.01	2E+10	
Concrete pump	047	109	1	109.00	8E+10	

Table 6.19 TP WTW Piling: Predicted Noise Levels at nearby NSRs

NSR	Total SPL dB(A)	Distance metres	Distance Correction dB(A)	Facade effect dB(A)	Predicted noise Level dB(A)
NSR3	116 dB(A)	480 m	-67.7dB(A)	+2.5dB(A)	50.8 dB(A)
NSR4	116 dB(A)	533 m	-68.7dB(A)	+2.5dB(A)	49.8 dB(A)
NSR5	116 dB(A)	271 m	-61.9dB(A)	+2.5dB(A)	56.6 dB(A)
NSR6	116 dB(A)	315 m	-63.4dB(A)	+2.5dB(A)	55.1 dB(A)
NSR7	116 dB(A)	255 m	-61.3dB(A)	+2.5dB(A)	57.2 dB(A)
NSR8	116 dB(A)	476 m	-67.6dB(A)	+2.5dB(A)	50.9 dB(A)
NSR9	116 dB(A)	411 m	-66.1dB(A)	+2.5dB(A)	52.4 dB(A)
NSR10	116 dB(A)	429 m	-66.5dB(A)	+2.5dB(A)	52.0 dB(A)

Table 6.20 BVPSR Piling: Predicted Noise Levels at nearby NSRs

NSR	Total SPL dB(A)	Distance metres	Distance Correction dB(A)	Facade effect dB(A)	Predicted noise Level dB(A)
NSR18	116 dB(A)	170 m	-57.0dB(A)	+2.5dB(A)	61.5 dB(A)
NSR19	116 dB(A)	196 m	-59.0dB(A)	+2.5dB(A)	59.5 dB(A)
NSR20	116 dB(A)	233 m	-60.0dB(A)	+2.5dB(A)	58.5 dB(A)
NSR21	116 dB(A)	228 m	-60.0dB(A)	+2.5dB(A)	58.5 dB(A)
NSR22	116 dB(A)	370 m	-65.0dB(A)	+2.5dB(A)	53.5 dB(A)

Table 6.21 Tai Po Raw Water Portal - Tunnel Locomotives Stage (Day-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR1	120.87	140	-7.4	140.20	50.93	72.44	72.44
NSR2	120.87	260	-6.1	260.07	56.30	67.07	67.07

Table 6.22 Tai Po Raw Water Portal - Trench Construction and Tunnelling Stage (Day-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR1	123.42	140	-7.4	140.20	50.93	74.99	74.99
NSR2	123.42	260	-6.1	260.07	56.30	69.62	69.62

Table 6.23 Tai Po Raw Water Portal - Tunnelling Stage (Night-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR1	117.79	140	-7.4	140.20	50.93	69.36	69.36
NSR2	117.79	260	-6.1	260.07	56.30	63.99	63.99

Table 6.24 TP WTW - Site Formation Period (Day-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR3	125.91	475	-73.5	480.65	61.64	66.77	66.77
NSR4	125.91	525	-95.5	533.62	62.54	65.86	65.86
NSR5	125.91	270	26.5	271.30	56.67	71.74	71.74
NSR6	125.91	315	-1.5	315.00	57.97	70.44	70.44
NSR7	125.91	255	-17.9	255.63	56.15	72.26	72.26
NSR8	125.91	475	-33.5	476.18	61.56	66.85	66.85
NSR9	125.91	410	-30.5	411.13	60.28	68.13	68.13
NSR10	125.91	425	-58.5	429.01	60.65	67.76	67.76

Table 6.25 TP WTW - Construction Period (Day-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR3	125.21	475	-73.5	480.65	61.64	66.07	66.07
NSR4	125.21	525	-95.5	533.62	62.54	65.16	65.16
NSR5	125.21	270	26.5	271.30	56.67	71.04	71.04
NSR6	125.21	315	-1.5	315.00	57.97	69.74	69.74
NSR7	125.21	255	-17.9	255.63	56.15	71.55	71.55
NSR8	125.21	475	-33.5	476.18	61.56	66.15	66.15
NSR9	125.21	410	-30.5	411.13	60.28	67.43	67.43
NSR10	125.21	425	-58.5	429.01	60.65	67.06	67.06

Table 6.26 Yuen Tun Ha Adit - Adit Construction Period (Day-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR12	119.10	260	47.8	264.36	56.44	65.15	65.15
NSR13	119.10	185	35	188.28	53.50	68.10	68.10
NSR14	119.10	180	35	183.37	53.27	68.33	68.33
NSR15	119.10	185	20	186.08	53.39	68.20	68.20

Table 6.27 Yuen Tin Ha Adit - Tunnelling Stage (Day-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR12	121.44	260	47.8	264.36	56.44	67.49	67.49
NSR13	121.44	185	35	188.28	53.50	70.44	70.44
NSR14	121.44	180	35	183.37	53.27	70.67	70.67
NSR15	121.44	185	20	186.08	53.39	70.54	70.54

Table 6.28 Yuen Tun Ha Adit - Tunnelling Stage (Night-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR12	117.78	260	47.8	264.36	56.44	63.84	63.84
NSR13	117.78	185	35	188.28	53.50	66.79	66.79
NSR14	117.78	180	35	183.37	53.27	67.02	67.02
NSR15	117.78	185	20	186.08	53.39	66.89	66.89

Note: All NSR assume to be at Ground Floor level.
Equipment assumed to be the same as at Butterfly Tunnel Portal.

Table 6.29 Shing Mun Tunnel Access Shaft - Shaft Construction (Day-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR16	119.10	100	12.6	100.79	48.07	73.53	73.53
NSR17	119.10	110	1	110.00	48.83	72.77	72.77

Table 6.30 Shing Mun Tunnel Access Shaft - Tunnelling Stage (Day-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR16	121.92	100	12.6	100.79	48.07	76.35	76.35
NSR17	121.92	110	1	110.00	48.83	75.59	75.59

Table 6.31 Shing Mun Tunnel Access Shaft - Tunnelling Stage (Night-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR16	117.81	100	12.6	100.79	48.07	72.24	72.24
NSR17	117.81	110	1	110.00	48.83	71.48	71.48

Table 6.32 Butterfly Valley Tunnel Portal - Tunnel Locomotives: Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR18	120.27	125	7	125.20	49.95	72.81	72.81
NSR19	126.70	105	0	105.00	48.42	80.78	80.78
NSR20	126.70	80	-12	80.89	46.16	83.04	83.04
NSR21	126.70	340	81	349.52	58.87	70.33	70.33

Table 6.33 Butterfly Valley Tunnel Portal - Tunnelling Stage (Day-time): Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR18	121.91	125	7	125.20	49.95	74.46	74.46
NSR19	121.91	105	0	105.00	48.42	75.99	75.99
NSR20	121.91	80	-12	80.89	46.16	78.25	78.25
NSR21	121.91	340	81	349.52	58.87	65.54	65.54

Table 6.34 Butterfly Valley Tunnel Portal - Tunnelling Stage (Night-time): Predicted Noise Levels at NSRs

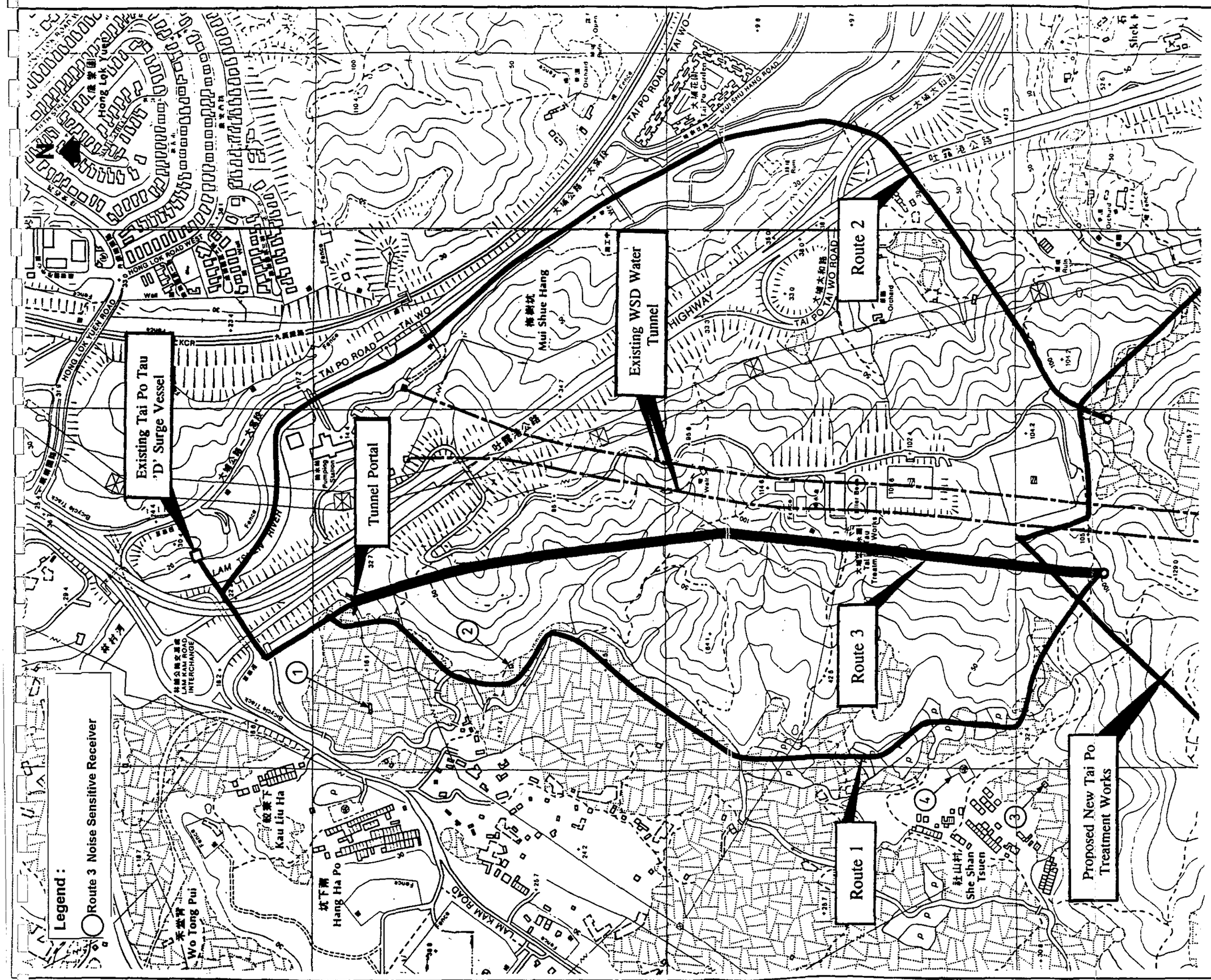
	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR18	117.79	125	7	125.20	49.95	70.34	70.34
NSR19	117.79	105	0	105.00	48.42	71.87	71.87
NSR20	117.79	80	-12	80.89	46.16	74.13	74.13
NSR21	117.79	340	81	349.52	58.87	61.42	61.42

Table 6.35 BVPSR - Site Formation Stage: Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR18	124.41	160	-58	170.19	52.62	77.38	77.38
NSR19	124.41	185	-65	196.09	53.85	76.15	76.15
NSR20	124.41	220	-77	233.09	55.35	74.65	74.65
NSR21	124.41	228	16	228.56	55.18	74.82	74.82
NSR22	124.41	370	22	370.65	59.38	70.62	70.62

Table 6.36 BVPSR - Construction Stage: Predicted Noise Levels at NSRs

	SWL	Hori. Dist.	Vert. Dist.	Actual Distance	Distance Correction	CNL 1	Unmitigated CNL
NSR18	123.99	160	-58	170.19	52.62	73.87	73.87
NSR19	123.99	185	-65	196.09	53.85	72.64	72.64
NSR20	123.99	220	-77	233.09	55.35	71.14	71.14
NSR21	123.99	228	16	228.56	55.18	71.31	71.31
NSR22	123.99	370	22	370.65	59.38	67.11	67.11



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Agreement no. CE 41/94

Contract no.

Project title

Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Raw Water Aqueduct : Noise Sensitive Receivers

Plan register No.

Drawing no. 6.1

Scale 1 : 5000

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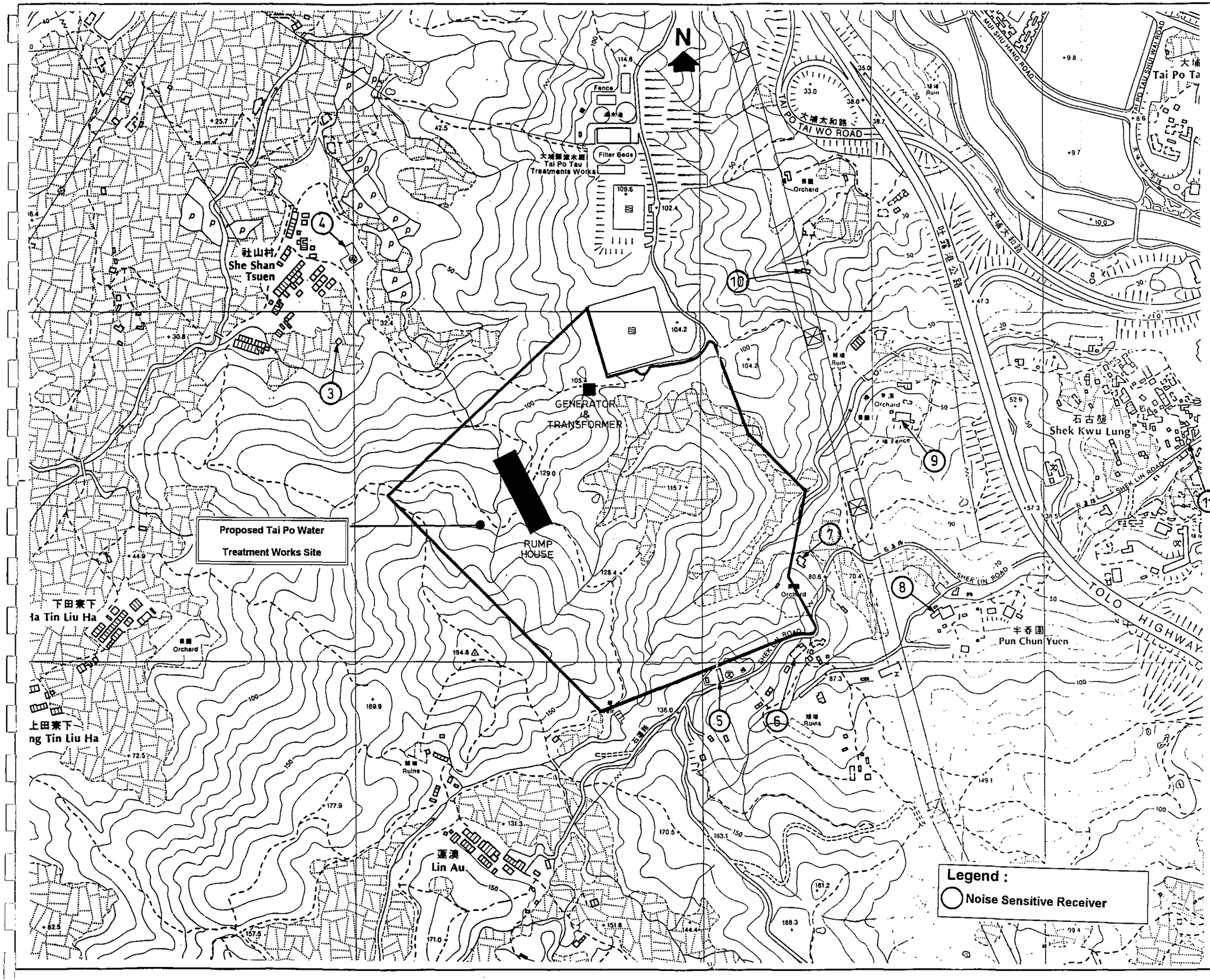

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Contract no.

Project title

Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Water Treatment Works : Noise Sensitive Receivers

Plan register No.

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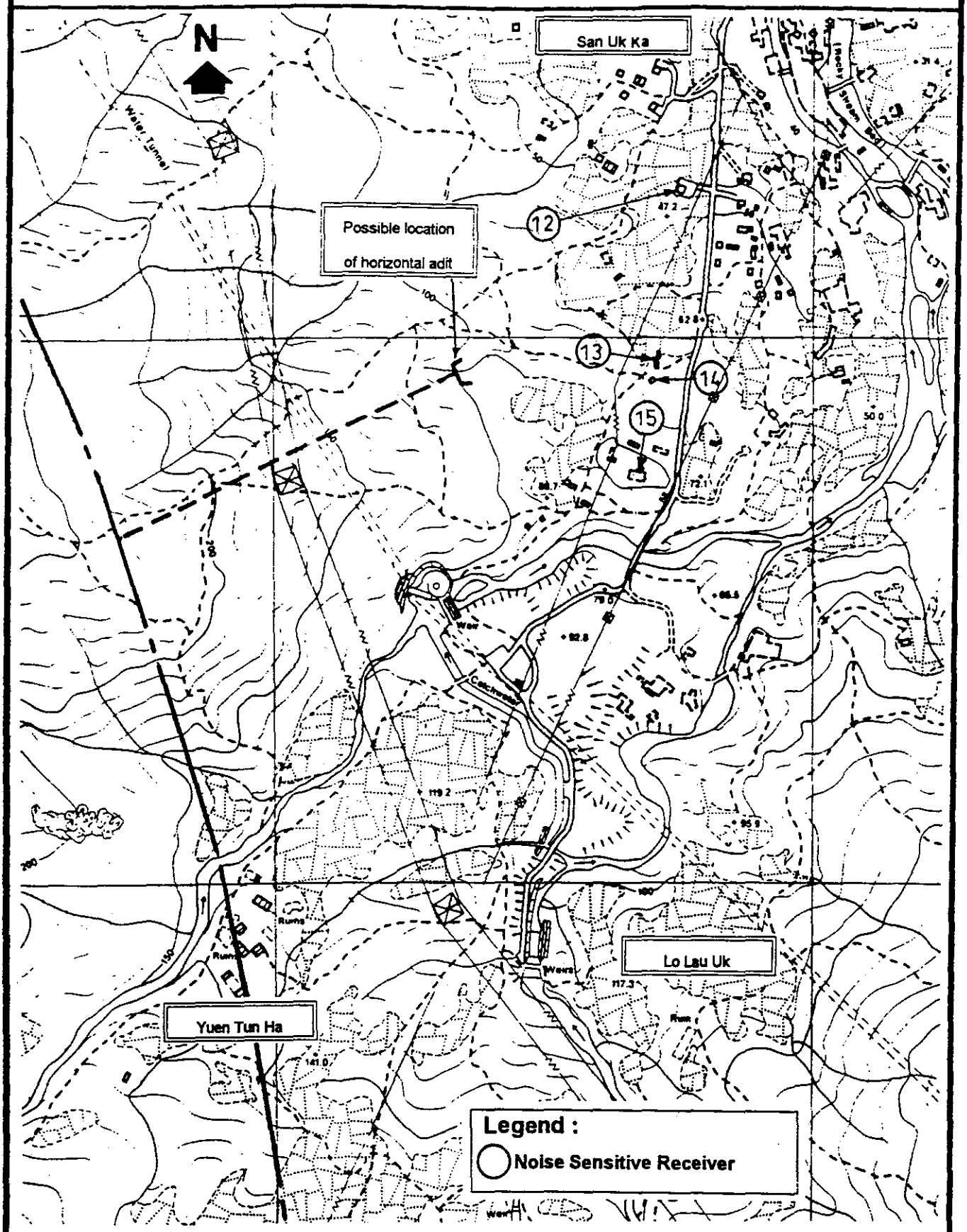

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**Yuen Tun Ha Shaft/Adit :
Noise Sensitive Receivers**

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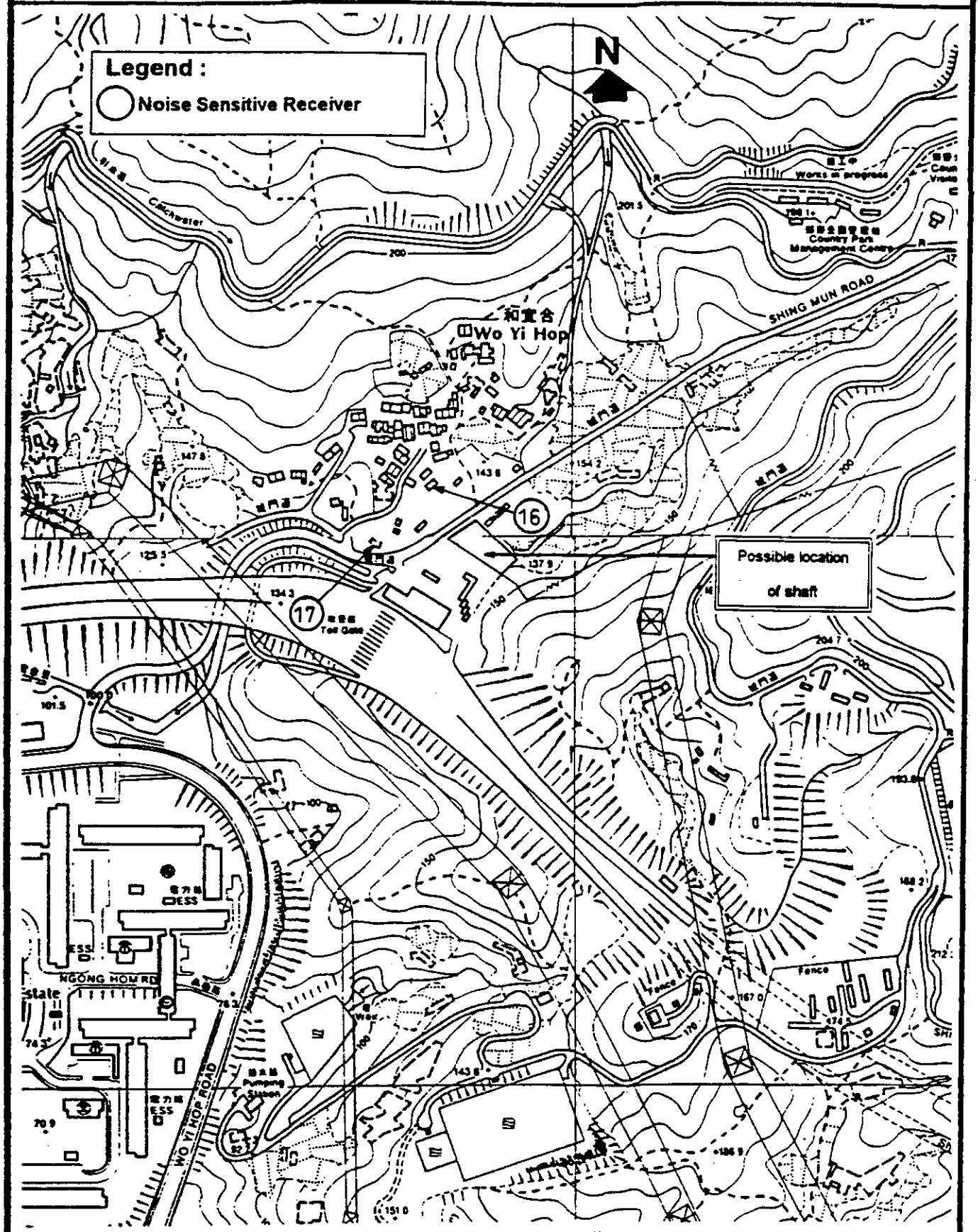

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Shing Mun Access Shaft : Noise Sensitive Receivers

Drawing No.	Scale		Name	Date
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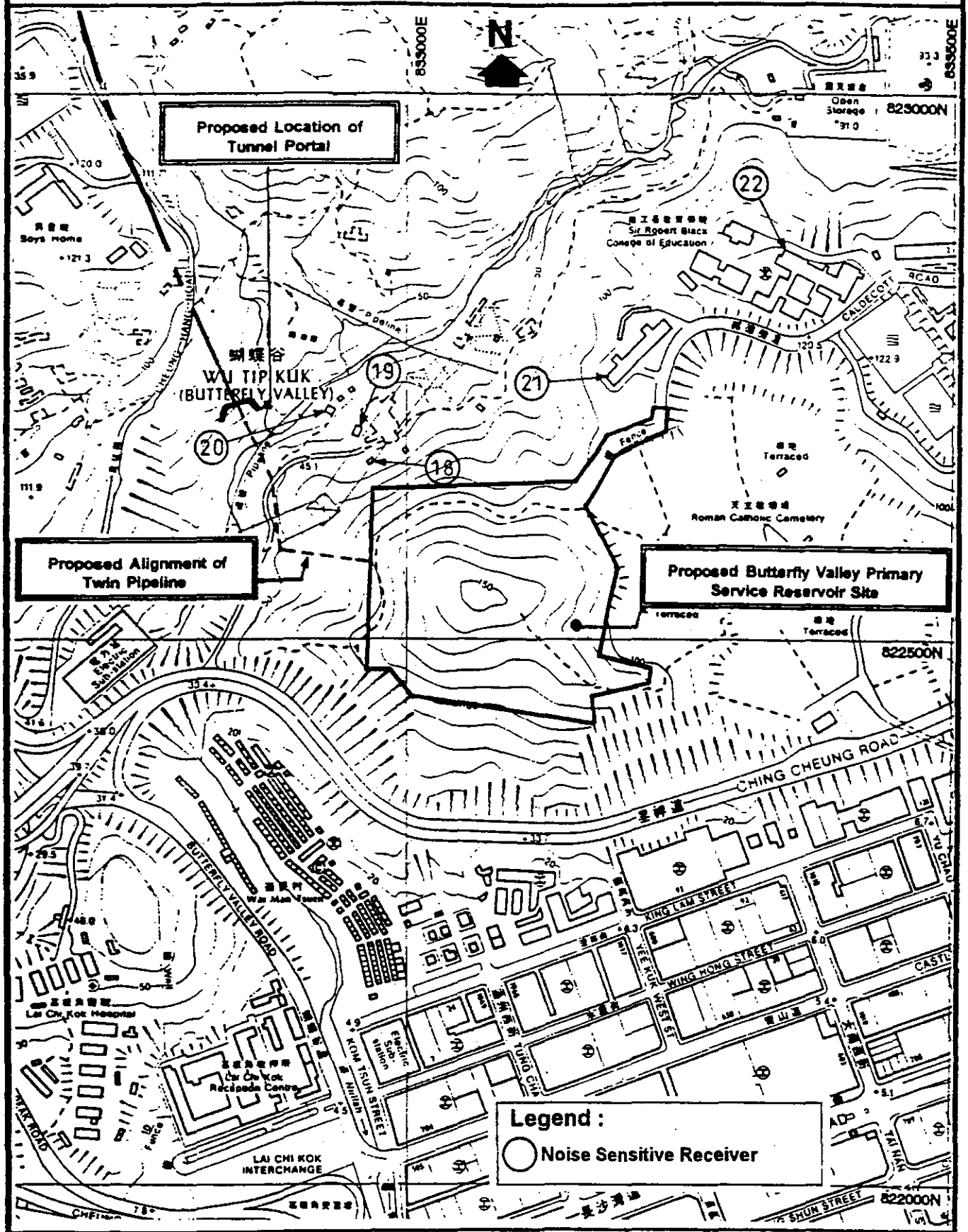

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Butterfly Valley Reservoir
Noise Sensitive Receivers

Drawing No	Scale		Name	Date
6.5	1 : 5000	Designed	HL	5/95

7 AIR QUALITY

Introduction

7.1 This section presents an air quality impact assessment of the construction and the operation phases of the Tai Po Water Treatment Works (TP WTW), Butterfly Valley Primary Service Reservoir (BVPSR) and associated raw and treated water aqueducts. This assessment is based on the preferred tunnelled option for the raw treatment aqueduct and the 'worst case' treated water aqueduct layout (alternative Alignment 3) with an shaft/adit at Yuen Tun Ha.

Air Quality - Construction Phase

Air Quality Impact Assessment Criteria

7.2 The Hong Kong Air Quality Objectives (AQO) stipulate maximum acceptable concentrations of pollutants in air. The acceptable dust concentrations are shown in Table 7.1:

Table 7.1 Hong Kong Air Quality Objectives

Pollutant	Concentration ($\mu g/m^3$)		
	1 hour	24 hours[1]	1 year
Total Suspended Particulates (TSP)	500[2]	260	80
Respirable Suspended Particulates (RSP)	Nil	180	55

Notes:

Concentrations measured at 298°K (25 °C) and 101.325 kPa.

1 24-hour criteria not to be exceeded more than once per year

2 This control limit has no statutory basis but is a guideline recommended by EPD

Air Sensitive Receivers

7.3 The nearest air sensitive receivers that will be exposed to the construction dust impacts from the construction of the project are tabulated in Table 7.2. They are chosen according to the selected raw water aqueduct option (tunnel) and the 'worst case' treated water aqueduct option (with intermediate access shaft/adit at Yuen Tun Ha). The locations of the sensitive receivers can be referred to the respective figures.

Table 7.2 Air Sensitive Receivers

Construction Area	ASR	Approx Height (mPD)	General Description	Estimated Number of People affected
Raw Water Aqueduct[1]	1	20	Village house at Kau Liu Ha	4
	2	18.5	Village house at San Kiu Tsuen (Yau's families)	16
	39	16.1	Village house at San Uk Pai Tsuen	7
	41	25	Tai Po Tau Treatment Works Staff Quarters	10 - 20
Tai Po Water Treatment Works[2]	5	33	Playground at She Shan Tsuen	0 - 10
	6	35	Village house at She Shan Tsuen (currently empty)	0
	8	110	Office - Tai Po Tau Treatment Works	15
	12	40	Village house at Mui Shue Hang Tsuen	4
	13	45	Village house opposite Ling Hing Monastery (currently empty)	0
	14	80.6	Villa along Shek Lin Road	4
	15	65	House in Pun Chun Yuen	12 - 24
	16	80	Pen factory (Elegant) near Pun Chun Yuen	6
	17	97	Village house at Shek Uk Tsai Tsuen	4
	18	135	Village house at Lin Au Tsuen	4
	42	68	Ling Hing Monastery	2
	44	125	Lin Hoi Public School	8
	45	130	Village house at Lin Au Tsuen	4
Shing Mun Access Shaft[3]	19	140	Shing Mun Tunnel administration building	20 - 30
	20	143.6	Village house at Wo Yi Hop Tsuen	4
	21	141	Village house at Wo Yi Hop Tsuen	4
	22	78	Block 8, Lei Muk Shue Estate (currently under redevelopment)	0
	23	101.5	Ho Fung College	800 - 1,000

Construction Area	ASR	Approx Height (mPD)	General Description	Estimated Number of People affected
	24	101.5	Shing Kung Hui Li Ping Secondary School	800 - 1,000
	S1	177	Snack kiosk at Shing Mun Reservoir	2 - 10
	S2	198	Country Park Management Centre (Shing Mun Reservoir)	5
	S3	184.5	Country Park Visitor Centre (Shing Mun Reservoir)	2 - 10
Butterfly Valley Service Reservoir[4]	25	121.3	Boy's Home (Butterfly Valley)	20 - 30
	26	28	Village house at Mui Kong Tsuen (Butterfly Valley)	4
	27	47	Village house at Mui Kong Tsuen (Butterfly Valley)	4
	28	115	Government Staff Quarter, 8-10 Caldecott Road	192
	29	125	Sir Robert Black College of Education	100 - 200
	30	93.3	Sports ground	30
	31	30	Caritas Medical Centre	1,000 - 1,500
	32	30	Nam Wah Catholic Secondary School	900 - 1,000
	33	20	Dragon Industrial Building	1,000 - 1,200
	34	20	Village house at Wai Man Tsuen	4
	35	65	Lai Chi Kok Hospital	20 - 40
	B1	45	Roman Catholic Cemetery office	5 - 10
	B2	40	Village house at Mui Kong Tsuen (Butterfly Valley)	4
Yuen Tun Ha Shaft/ Adit[5]	36	48	Village house at San Uk Ka (Wun Yiu)	4
	37	86.7	Village house at San Uk Ka (Wun Yiu)	4
	38	90	Village house at San Uk Ka (Wun Yiu)	4
	Y3	60	Village house at San Uk Ka (Wun Yiu)	4
	Y4	60	Village house at San Uk Ka (Wun Yiu)	4
	Y5	75	Village house at San Uk Ka (Wun Yiu)	4

Notes:

1 see Figure 7.1
2 see Figure 7.2
3 see Figure 7.3
4 see Figure 7.4
5 see Figure 7.5

Baseline Conditions

Existing conditions

7.4 Data on existing air quality has been based on EPD monitoring stations and previous environmental studies undertaken close to the project area. The project areas have been divided into three locations, namely Tai Po Area, Shing Mun Area and Butterfly Valley Area.

7.5 For the Tai Po Area, the EPD's latest data from air quality monitoring station at Tai Po has been used to estimate the baseline Total Suspended Particulates (TSP) and Respiratory Suspended Particulates (RSP) levels in this project area. Based on the 1994 record (Table 7.3), a geometric mean of the monthly averaged 24-hr TSP is about 83 $\mu g/m^3$ which is below the daily AQO, and the annual average AQO. The geometric mean is used instead of the arithmetic mean for the background concentration because the geometric mean is better able to account for the meteorological fluctuation, which is not linear in nature.

7.6 For the Shing Mun Area, the air quality monitoring results from EPD at Kwai Chung fixed site air quality monitoring station has been used to estimate the baseline level in Shing Mun project area. At Kwai Chung station, the geometric mean of the monthly average 24-hr TSP level in 1994 is about 85 $\mu g/m^3$.

7.7 It is a common practical approach that the baseline RSP is assumed to be 50% of the TSP value. Thus RSP levels for Tai Po and Kwai Chung are 42 and 43 $\mu g/m^3$ respectively. It is also common practice to artificially set the hourly average equal to the daily average when hourly monitoring data is not available. In rural areas where pollution levels are not acute, the 1-hour average reading and the daily average reading are not substantially and quantitatively different; thus the 1-hour average can be approximated to the daily average.

Table 7.3 TSP Data for Tai Po and Kwau Chung Air Monitoring Stations, 1994

Month (1994)	Monthly Mean TSP ($\mu g/m^3$)	
	Tai Po	Kwai Chung
January	142	124
February	104	83
March	119	130
April	64	65
May	83	94
June	46	56
July	55	60
August	75	74
September	69	98
October	104	112
November	102	98
December	78	63
Geometric Mean	83	85

Source: EPD

7.8 For Butterfly Valley Area, the baseline level can be roughly described by the results of the monitoring stations along West Kowloon Reclamation. The baseline air quality monitoring results in the Chinese New Year period from Environmental Project Office (ENPO) - West Kowloon Project Area at the air quality monitoring station on the roof of Mei Foo Block 112 has been used to estimate the baseline TSP level in this area. The construction activities were stopped during the Chinese New Year festival and thus the TSP levels recorded in this period can provide an indication of the likely baseline level for the area. The actual TSP data is listed in the Table 7.4 and the geometric mean is about 65 $\mu g/m^3$. The RSP is assumed to be 33 $\mu g/m^3$ and the hourly average is set to 65 $\mu g/m^3$.

Table 7.4 Baseline TSP Monitoring Results, Mei Foo (Station A11)

Date	Daily TSP level ($\mu g/m^3$)
28/1/95	39
29/1/95	47
30/1/95	47
31/1/95	70
1/2/95	66
2/2/95	77
3/2/95	88
4/2/95	85
5/2/95	74
6/2/95	79
7/2/95	70
Geometric Mean	65.4

Source: ENPO II

Future Conditions

7.9 For the Butterfly Valley Area, the construction of Ching Cheung Road Extension has started and is expected to be finished in June 1997. Therefore, the air quality in this area is expected to be affected. For the Shing Mun Area and Tai Po Area, as no other concurrent activities are anticipated, air quality is not expected to be getting worse.

Construction Phase Scenarios

7.10 Two worse case scenarios have been selected based on the following criteria:

- proximity of dusty processes to the sensitive receivers; and
- relatively high dust emission from individual processes in a day.

Scenario 1 - Blasting

7.11 Blasting is likely to be required during initial rock excavation for the tunnel as well as the site formation of BVPSR. Little, if any, blasting is expected at the TP WTW site. For the worst case scenario, the locations of blasting have been selected and shown in Figures 7.8 and 7.13 respectively.

Scenario 2 - Excavations

7.12 This scenario will mainly concern the dust levels associated with all construction activities other than blasting. The construction activities include tunnelling activities such as use of Tunnel Boring Machines (TBM), removal of material, handling of debris, movement of dusty materials on-site, wind erosion of dry materials stored on-site, operation of concrete batching plant on site and movement of vehicles on site. For the worst case scenario, the locations of these activities are illustrated in Figures 7.9, 7.10, 7.11, 7.12 and 7.14.

FDM Assessment Methodology

7.13 In order to assess the impact of the construction dust (TSP and RSP) emissions on the surrounding area, the Fugitive Dust Model (FDM) is used. A detailed description of the model is given by the User's Guide (TRC, 1990). Briefly, FDM which is an atmospheric dispersion model is specifically designed for the analysis of fugitive dust sources. The model is based on the widely used Gaussian Plume formulation for estimating pollutant concentrations, but has been adapted to incorporate a gradient-transfer deposition algorithm which accounts for the settling out of dust particles, and to include the wind dependence factor on the dust emission rates.

7.14 The construction areas are divided into five domains which fully cover the impacts on the sensitive receivers. The domains shown in Table 7.5 are the raw water aqueduct, TP WTW, Yuen Tun Ha Adit and the Shing Mun Access Shaft of the 12 km tunnel as well as BVPSR. The grid spacing of 100 m is the same for all domains. The ground mPD shown in the Table 7.5 is the level of the contour plot. The levels have been chosen for the residential areas nearby other than the sensitive receivers that have been selected in the Section of Air Sensitive Receivers. The assessments are based on the 1993 sequential meteorological data collected at the Tai Po Kau and Tsim Sha Tsui Stations containing the hourly wind direction, wind speed, stability and temperature. The surface roughness of 1 m has been chosen for the rural areas.

Table 7.5 Construction Dust Assessment Gridding Areas

Domain	Number of grid		Ground (mPD)
	x	y	
Raw Water Aqueduct	10	10	19.0
Tai Po Water Treatment Works	20	15	30.0
Yuen Tun Ha Adit	10	10	50.0
Shing Mun Access Shaft	15	10	75.0
Butterfly Valley Service Reservoir	15	15	5.0

Dust Sources

7.15 The dust sources associated with the construction activities have been identified as following:

(i) Loading and unloading
(ii) Unpaved roads and haul routes
(iii) Blasting
(iv) Aggregate storage
(v) Concrete batching plant
(vi) Top soil removal
(vii) Wind erosion of the whole exposed area
(viii) Tunnelling

7.16 The dust sources due to the disposal of spoil on-site and off-site, and the transportation of construction materials including tunnel lining have been included in the processes of loading and unloading as well as traffic on unpaved roads. The dust emission rates have been calculated separately for the five construction areas. The detailed calculation is presented below as a illustration for TP WTW.

Tai Po Water Treatment Works

Loading and unloading

7.17 The dust sources associated with the loading and unloading at the excavation sites will be considered as area sources. The quantity of particulate emissions generated by a batch drop or continuous drop operation, per ton of material transferred, may be estimated with an emission factor rating of C (USEPA, 1994; p.2.2-3) using the following empirical expression:

$$E=k(0.0016)\frac{(\frac{U}{2.2})^{1.3}}{(\frac{M}{2})^{1.4}}(kg/Mg)...(7.1)$$

where:

E = emission factor,
k = particle size multiplier (dimensionless),
U = mean wind speed, m/s, (mph)
M = material moisture content (%),

7.18 Equation (7.1) can be rewritten as following:

$$E'=Q_o U'^{w}.....(7.2)$$

where Q_o is the "unadjusted" emission factor which does not consider the change of hourly wind speed and direction, U is hourly wind speed and w is the wind dependent factor. E is the mean value of E's. It is noted that equation (7.2) is a general equation for all emission factors. In equation 7.1, the power of U is 1.3, ie. w is 1.3.

7.19 Using equations (7.1) and (7.2), the emission factors for TSP and RSP can be estimated by the required data listed in Table 7.6.

Table 7.6 Physical Data for Evaluation the Impact of Loading and Unloading

Parameters of Equation[1]	TSP	RSP
Particle Size Multiplier (k)	0.74 (USEPA, 1994: page 13.2.2-3)	0.35 (USEPA, 1994: page 13.2.2-3)
Material Moisture Content (M)	2% (USEPA, 1994: page 13.2.2-3)(1)	2% (USEPA, 1994: page 13.2.2-3)(1)

Note:

1 2% moisture content is assumed for very dry environment (BCL borehole data is not available at the time of writing this report)

7.20 By the use of equation (7.1), the "unadjusted" emission factor for TSP becomes:

$$Q_o = 0.74(0.0016)\frac{(\frac{1}{2.2})^{1.3}}{(\frac{2}{2})^{1.4}}(kg/Mg)...(7.3)$$

$$= 4.25\times10^{-4}\ kg/T$$

The "unadjusted" emission factor for RSP becomes:

$$Q_o = 0.35(0.0016)\frac{(\frac{1}{2.2})^{1.3}}{(\frac{2}{2})^{1.4}}(kg/Mg)...(7.4)$$

$$= 2.01\times10^{-4}\ kg/T$$

The wind dependent factor, w, in this case is 1.3.

7.21 Assuming a density of 1.987 x10^3 kg/m^3 and 12 hour working day, 24 days a month and 468 days, the material to be shifted per hour is assumed to be the cut volume, estimated as 570,000 m^3, at a rate of 201.6 T/hr, ie.

$$\frac{570000m^3\ x\ 1.987\ x\ 10^3 kg/m^3}{468x12hr} = 201672.0\ (kg/hr)...(7.5)$$

The unadjusted emission rate for TSP is 0.023 g/sec,

$$\frac{4.25x10^{-4}kg/Tx201.6T/hr}{3.6} = 0.023\,(g/\text{sec})...(7.6)$$

where 3.6 is the conversion factor for the change of kg/hr to g/sec. The unadjusted emission rate for RSP is 0.011 g/sec.

$$\frac{2.01x10^{-4}kg/Tx201.7T/hr}{3.6} = 0.011\,(g/\text{sec})...(7.7)$$

7.22 An area of 22,842 m^2 has been estimated as the loading area for the TP WTW site. Consequently, the unadjusted emission rate per unit area can be calculated from equation (7.6) and (7.7) and then substituted into equation (7.2). The emission rate for:

TSP: = 1.04 X 10^{-6} g/s/m^2,
RSP: = 4.93 X 10^{-7} g/s/m^2.

Unpaved road and haul routes

7.23 The top soil and other fill materials at the excavation site will be transported by dump trucks that will cause dust emission when they travel over unpaved roads and haul routes. The emission factor to be used is from AP-42 (USEPA, 1985; equation 1, p 2.1-1) with emission factor rating A:

$$E=k(1.7)(\frac{s}{12})(\frac{S}{48})(\frac{W}{2.7})^{0.7}(\frac{w}{4})^{0.5}(\frac{365-p}{365})(kg/VKT)..(7.8)$$

where:

E	=	emission factor
k	=	particle size multiplier (dimensionless)
s	=	silt content of road surface material (%)
S	=	mean vehicle speed, km/hr
W	=	mean vehicle weight, Mg(ton)

w = mean number of wheels
p = number of days with at least 0.254 mm of precipitation per year.
VKT = vehicle kilometre travelled

7.24 The data for estimating the emission rates of unpaved road and haul routes due to construction are summarized in Table 7.7.

Table 7.7 Physical Data for Evaluating the Impact of Unpaved and Haul Roads

Parameters	TSP	RSP
Particle size Multiplier (k)	0.8	0.36
Silt content of Road Surface Material (s)	16%[1]	16%[2]
Mean Vehicle Speed (S) km/hr	15	15
Mean vehicle Weight (W) tonnes	35	35
Mean number of Wheels (w) (Nissan Motor Co. and Caterpiller Inc. USA)	10	10
Number of Rainy Days per year (Royal Observatory)	100 days	100 days

Notes:
1,2 Site Investigation data is not available. BCL's experience suggests the 16% figure.

7.25 Vehicles travelling to and from the TP WTW site will use the existing WSD road. The safe speed for the vehicles travelling on haul roads within the site is suggested as a maximum speed of 15 km/h. The maximum distance that the dump trucks travel on this site is the haul road distance which is roughly 0.8 km for a round trip. These doubled distances have been simulated by modelling the line sources twice in the FDM run.

7.26 At the time when FDM was run, it was planned that there would be an additional one way road (see Figure 7.2). Construction traffic would enter the site via the WSD road and leave the site via the Shek Lin Road. The distance of the one way traffic would have been about 0.7 km, and the dust source due to this traffic was identified as a line source. This option has since been discounted, which means that the predicted impacts on the sensitive receivers closest to the site have been considerably reduced.

7.27 When the FDM model was run, the anticipated spoil generation and disposal rates were as indicated in Table 7.8. The figures for TP WTW cut and fill volumes have subsequently been revised as follows:

Approx. Total Volume of Spoil	315,000 m^3
(assumes cut volume = 670,000 m^3 and fill volume =	355,000 m^3)
Approx. Spoil Disposal/Day	673 m^3
Average No. of Trucks/Day	112

However, provided that adequate watering of haul roads is maintained, the dust levels experienced at sensitive receivers will still be within acceptable limits.

Table 7.8 Spoil Generation and Disposal Routing

Activity	Scenario		Approx. Total Volume of Spoil (m^3)	Approx. Spoil Disposal/day (m^3)	Spoil Disposal Per Portal, Shaft or Access Route/day[1]	Average Number of Trucks/day[2]
Raw Water Aqueduct Option III[3]	(a)	Tunnel option, shaft and 1 portal	13,400	43[4]	43	7
Treated Water Tunnel Excavation	(a)	2 portals, Shing Mun shaft Tunnel diameter 5.5 m^5	283,300	454[7]	151	26
	(b)	2 portals, Shing Mun and Yuen Tun Ha shafts Tunnel diameter 3.4 m^6	116,000	186[7]	46	8
Tai Po Water Treatment Works[8]	(a)	1 site access route (WSD road)	160,000	342[9]	342	57
Butterfly Valley Service Reservoir	(a)	1 access route (Butterfly Valley road)	950,000	1,522[10]	1,522	253

Notes:

1 Assumes spoil disposal is divided equally between portals/shafts (in reality a larger proportion would come out of the shaft(s))
2 Average number of trucks per day based on m^3 per truck
3 Assumes tunnel is 1.4 km long
4 Assumes spoil is disposed of 6 days per week over 1 year (312 days)
5 Option with 1 shaft = 11.8 km tunnel
6 Option with 2 shafts = 12.3 km tunnel
7 Assumes spoil is disposed of 6 days per week over 2 years (624 days)
8 Assumes cut volume = 570,000 m^3 and fill volume = 410,000 m^3
9 Assumes spoil is disposed of 6 days per week over 1.5 years (468 days)
10 Assumes spoil is disposed of 6 days per week over 2 years (624 days)

Shing Mun Shaft - Total spoil arisings approximately 3,080 m^3 (7 m diameter x 80 m deep)
Yuen Tun Ha Shaft - Total spoil arisings approximately 1,160 m^3 (7 m diameter x 30 m deep)

7.28 VKT can be expressed as total vehicle movement per hour. Construction vehicle movement per hour has been calculated by dividing the total material to be moved by 6.0 m^3 dump truck. This is the average load carried by the dump trucks planned for the site. In addition, delivery lorries would be required to carry pipes, batching materials and reinforcement. Consequently, the number of vehicle round trips per hour is roughly 20 veh/hr. For construction dust, the wind dependent factor is zero. So the emission factor becomes:

$$E=0.8(1.7)(\frac{16}{12})(\frac{15}{48})(\frac{35}{2.7})^{0.7}(\frac{10}{4})^{0.5}(\frac{365-100}{365})(kg/VKT)..(7.9)$$

ie. E = 3.9 kg/VKT.

7.29 With 20 veh/hr and kg/VKT in terms of g/m/s by a conversion factor of:

$$(\frac{vehicle/hour}{3.6\ x\ 1000}),$$

the emission rate for TSP is:

$$(\frac{3.9}{3.6x1000})x20 = 0.021\,g/m/s..(7.10)$$

7.30 For RSP, the emission rate is 0.009 g/m/s. For one way traffic, the emission rate for TSP and RSP would be 0.01 g/m/s and 0.004 g/m/s respectively.

7.31 Previous EIAs using only one category of particle size for unpaved roads, namely particles less than 30 microns, are likely to have underestimated the TSP impact. A more realistic particle size distribution for haul roads (SENES, 1992; Table 6.1) is used for the FDM as given below in Table 7.9.

Table 7.9 Particle Size Distribution

Particle mass mean diameter (μm)	Haul Roads Dust Distribution %
0.630	0.0
1.554	7.5
5.107	8.5
5.633	11.5
587	8.5
15.536	28.0
31.072	23.0
55.331	9.0
85.873	4.0

7.32 The simulation of paved and unpaved road sources are run separately. The two results are then added together to show the dust concentration level associated with the excavation plus the dust due to the haul road.

Aggregate Storage

7.33 For emissions from wind erosion of active storage piles, the emission rate for TSP is from AP-42 (USEPA, 1985; equation 3, p 2.3-5) with rating C for sand and gravel material:

$$E=1.9(\frac{s}{1.5})(\frac{f}{15})(\frac{365-p}{235})(kg/day/hectare)..(7.11)$$

where:

E	=	emission rate
s	=	silt content of aggregate (%)
f	=	percent of time that wind speed exceeds 5.4 m/s at mean pile height
p	=	number of days with at least 0.254 mm of precipitation per year.

7.34 The parameter f requires some modification. Royal Observatory (RO) measures the wind speed at a height of 10 m above ground level. In case of height less than 10 m, a log wind profile (Roland, 1988) can be used to estimate the wind speed at the pile height (Appendix A). The ratio between the wind speed at 10 m and that at pile height is the conversion factor that converts the percentage provided by RO to the percentage at pile height. For example, with a pile height of 5 m the conversion factor is 83%. Given the RO percentage of 11.44% that wind speed exceeds 5.4 m/s at mean pile height, the percentage at pile height is thus 11.44% x 0.83 = 7.0 %.

7.35 With this 7.0 % percentage and 1.6 % silt content of aggregate, based on Table 11.2.3-1 in AP-42 (mean value for stone processing), the emission rate is 1.06 kg/day/hectare,

$$E=1.9(\frac{1.6}{1.5})(\frac{7}{15})(\frac{365-100}{235})=1.06(kg/day/hectare)..(7.12)$$

Given that 1 hectare = 10^4 m^2, the emission rate is for TSP = 1.2 E-6 g/s/m^2.

7.36 Since there is no specified emission rate for RSP given in AP-42, 50% TSP is assumed as the emission for RSP. Thus, the emission rate is for RSP = 0.6 E-6 g/s/m^2.

Concrete Batching Plant

7.37 There is one concrete batching plant planned to be located at the centre of the TP WTW site with the emission rate of 0.12 kg/m^3 (uncontrolled operations) and 0.012 kg/m^3 (controlled operations) (AP-42, USEPA; Tables 11.10-1). Given that the likely planned capacity of the batching plant is 60 m^3/hr, its uncontrolled emission rate will be 2.0 g/s, a very high value that would significantly worsen air quality without the application of fixed mitigation equipment. The batching plant will only be operated with the appropriate licenses and will be properly controlled through the use of fixed mitigation. Therefore, the worse case scenario will be modelled as the controlled plant with the mandatory mitigation. The controlled emission rates for the concrete batching plant is tabulated below in Table 7.10.

Table 7.10 Concrete Batching Plant Data and Emission Rates

Concrete Batching Plant	Area (m^2)	Capacity (m^3/hr)	Emission rate (g/s)[2]		Emission rate (g/s/m^2)[2]	
			TSP	RSP[1]	TSP	RSP[1]
Tai Po Water Treatment Works	2000	60.0	2.E-1	1.E-1	1.E-4	5.E-5

Notes:
(1) Since there is no specified emission rate for RSP given in AP-42, 50% TSP is assumed as the emission for RSP
(2) Controlled operation

Top Soil Removal

7.38 The emission factor for top soil removal is 0.02 kg/Mg (USEPA, 1985; Table 11.24-4). For example, the surface area of site area is 22,482 m^2. Assuming the depth of top soil to be 1 metre, the volume of top soil is 22,842 m^3. Assuming the relative density of topsoil is 1.987 x 10^3 kg/ m^3, then the mass of the soil removed is given by:

$$Mass(T) = (\frac{22842x1987}{1000}) = 45387.1(T)..(7.14)$$

7.39 The time required to remove spoil from TP WTW is 468 days (refer to Table 7.8, note 9). So the rate of removal is:

$$(\frac{45387.1}{468\ x\ 24}) = 4.04\ (T/hr)..(7.15)$$

and the TSP emission rate is:

0.02 kg/T X 4.04 T/hr = 0.02 g/s

7.40 The emission rates per unit area at TP WTW site are :

TSP : 9.83 E-7 g/s/m^2
RSP: 4.91 E-7 g/s/m^2

Wind erosion of the whole exposed area

7.41 The TSP emission factor of wind erosion of exposed areas (USEPA, 1985; Table 24-4) is 0.85 Mg/hectare/yr. Given that 1 hectare = 10^4 m^2, the emission rate for TSP becomes:

$$\frac{0.85x1000}{10^4x365x24x3.6} = 2.69E\text{-}6g/s/m^2 .....(7.16)$$

Since the emission rate of RSP is not available in AP-42, 50 % of TSP is assumed to be the emission rate of RSP. Thus the emission rate of wind erosion of the whole exposed area is :

RSP: 1.34 x 10^{-6} g/s/m^2.

Blasting

7.42 Blasting is likely to be conducted during the construction of the tunnel and the site formation. The quantity of particulate emissions (TSP, assuming the particle size range less than 30 μm) generated by a batch blasting operation, per ton of material transferred, may be estimated, with a rating of B, using the following empirical expression (USEPA, 1985; Table 24-1)

$$E = \frac{344(A)^{0.8}}{(D)^{1.8}(M)^{1.9}} (Kg/blast) .....(7.17)$$

and RSP is:

$$E = \frac{811(A)^{0.6}}{(D)^{1.5}(M)^{2.3}} (Kg/blast) \quad .....(7.18)$$

where:

A = area blasted (m^2)
D = hole depth (m)
M = material moisture content (%)

7.43 Area blasted (A) is equal to the maximum area blasted, 900 m^2, and the hole depth (D) is 5 m. Material moisture content (M) is 7.2 % (which is the lowest value applicable to the blasting equations). By assuming the "unit" of emission rate, kg/blast, equal to kg/hour, the estimated emission rates for TSP is calculated as follows:

$$E = \frac{344(900)^{0.8}}{(5)^{1.8}(7.2)^{1.9}} (Kg/hr) \quad .....(7.19)$$

7.44 This gives a TSP emission rate of 28.61 g/s, and a unit area emission rate of 0.031 g/s/m^2. Similarly, RSP unit area emission rate is 0.014 g/s/m^2.

Tunnelling

7.45 In order to save time, it is likely that Tunnel Boring Machines (TBM) will be used for the excavation of the raw and treated water tunnels. In general, dust will be generated throughout the process of excavation. This dust will be removed from the tunnel by a ventilation system with a filtering device. The TBM will also have a filtering device to ensure a safe working environment for the worker at the tunnel face. This filtering system has been assumed to have a control efficiency of 70%.

7.46 The emission rate of tunnelling can be approximated as a primary crushing of wet material. Wet materials are considered because water spray are activated when the TBM is in operation. From AP-42 (USEPA Table 8.19.2.1), the emission factor for TSP is 0.009 kg/T whereas RSP is not available. Based on the density of rock (granite in particular) of 2,600 kg/m^3 and the normal tunnelling rate of 100 m/week, the tunnelling capacity can be calculated as follows:

diameter of tunnel = 4 m
radius of tunnel = 2 m
cross-sectional area of the tunnel = 4 x 3.1416 m^2

7.47 Capacity of TBM = 2,600 kg/m x 400 m^3 x 3.1416/7/h = 19,447.9 kg/hr = 19.5 T/hr. So the emission rate = 0.009 kg/T x 19.5 T/hr = 0.17 kg/hr = 0.048 g/s. Given the filtering efficiency of 70%, thus the TSP value becomes 0.0144 g/s. As RSP is not available, 50 % of the TSP value is taken for RSP value, ie. 0.0072 g/s.

Other Construction Areas

7.48 The procedures of calculation are similar for the other areas. Their results are listed in the Appendix B for easy reference. It should be noted that the dust sources in each area are different.

7.49 Particular attention should be made to the amount of spoil at the areas of Shing Mun Shaft and Yuen Tun Ha Shaft/Adit, as shown in Table 7.8. FDM calculations at Yuen Tun Ha Shaft/Adit, have been based on the assumption that the volume of spoil moved is 29,000 m^3, 25% of the total tunnel spoil volume (the remaining 75% is assumed to have been moved from the two tunnel portals and the Shing Mun Shaft). FDM calculations for the Shing Mun Shaft have been based on the preferred route, ie. the Yuen Tun Ha Shaft/Adit is **not** used, and the assumption that the volume of spoil moved is 94,433 m^3, 33% of the total tunnel spoil volume (the remaining 67% is assumed to have been moved from the two tunnel portals).

Model Results

7.50 The predicted maximum (unmitigated and mitigated) annual, 24-hr and 1-hr average dust levels at individual sensitive receivers obtained for TSP and RSP are discussed below for the five different project areas. It is noted that all the tabulated results and contour figures have included the baseline dust levels. FDM assumes a flat terrain. Also, for the worst case scenario, it is assumed that during excavation, the activities of construction take place concurrently. Figures and Tables referred to are presented at the end of this section.

Tai Po Water Treatment Works

Scenario 1 Blasting

7.51 The dust level associated with the blasting at the centre of TP WTW site constitutes a minor dust impact within the vicinity of the site. Tables 7.11 and 7.12 shows that all the sensitive receivers including Lin Hoi Public School (SR44) experience tolerable dust level.

7.52 It is unlikely that blasting will be required at TP WTW site. However, should blasting be required close to the school, the contractors should erect fencing about 2 m high to prevent flying rock from reaching the school premises to eliminate any potential hazard. However, this measure may not be necessary if the blasting is conducted after 1997. The principal (Mr. Lo) of the elementary school has indicated the likelihood of the school closure in the year of 1997. Presently there are only five students studying at the primary school and the last student is expected to graduate within next two years.

Scenario 2 Excavation

7.53 During excavation, the activities of drilling, loading and unloading, stockpiling, concrete batching and the use of haul roads area have been assumed to take place concurrently. Table 7.11 shows that dust generated from the truck movement on dirt roads on the site leads to the dust concentrations. Other dust sources including rock drilling due to TBM, concrete batching plant, loading and unloading, stockpiling, wind erosion and top soil removal generate a minor dust concentration.

7.54 Figures 7.15 to 7.19 illustrate the dust isopleths on the Shek Kwu Lung ground level where villages are clustered. Due to the dominant easterly (Figure 7.6, wind rose for Tai Po Kau station), the dust concentrations in this area are not expected to exceed the AQO.

7.55 Use of haul roads leads to the most dust generation. However, Table 7.13 and Figures 7.20 and 7.21 illustrate that twice-daily watering of haul roads can reduce the haul road emission rate by half, thereby lowering the dust level concentration by 50% (Jutze et al, 1974). Sufficient haul road watering will ensure that the AQO can be met at all sensitive receivers, and maintenance of continuous watering capacity at the site should be specified.

Tunnel Ventilation

7.56 In order to save time, it is likely that Tunnel Boring Machines (TBM) will be used for the excavation of the raw and treated water tunnels. In general, dust will be generated throughout the process of excavation. This dust will be removed from the tunnel by a ventilation system with a filtering device. The TBM will also have a filtering device to ensure a safe working environment for the worker at the tunnel face. This filtering system has been assumed to have a control efficiency of 70%.

7.57 The tunnel will be adequately ventilated to remove both TSP and noxious light and heavy gases. TSP in displaced air emerging from the tunnel will be removed by a suitable filter on the ventilation system.

7.58 During the EIA, the issue of radon has been raised as a potential cause of concern. Radon is hazardous because of its radioactivity, and can be released from minerals via transport by water or with gases such as ventilation air. A geological survey conducted by GEO indicates radioactivity in the Tai Mo Shan and Shing Mun areas due to the nature of the granite host rock. This is a general problem in Hong Kong, not one specific to the study area. The danger of radon to the health of workers involved in tunnelling is not expected to be significant because the concentration of radon is not likely to be high. Due to its inert nature and low concentrations, radon produces none of the potential hazard exhibited by other geological gases such as carbon dioxide and sulphur dioxide (Ball et al., 1991). Further study of the potential for radon and other noxious substances, including lead in groundwater, is recommended as part of the detailed site investigations for the aqueducts. Regardless of whether these studies are undertaken, monitoring and mitigation measures will be incorporated into the detailed design and construction programme.

Raw Water Aqueduct

7.59 TBM may be used to excavate the raw water aqueduct rather than the more conventional drill and blast methods. As such, the worst dust levels are presented in Table 7.14 and 7.15, showing that most of the dust levels for the sensitive receivers are within the allowable TSP and RSP level. The worst dust level is due to the haul road traffic.

7.60 The dust level associated with the TBM is minor provided that proper installation of the ventilation system equipped with filter of 70% efficiency is assumed to be operated. With a well maintained ventilation system, the air quality in terms of radon gas concentration inside the tunnel will be kept below the acceptable level of 200 becquerel/m^3. Once the radon gas is emitted from the tunnel portal to open space, the gas will be diluted rapidly by the ambient wind, thereby posing no environmental hazard to the nearby residences.

7.61 The minor dust sources due to stockpiling, wind erosion and top soil removal constitute negligible dust impacts. Figures 7.22 to 7.26 illustrate the dust levels on the ground level of Kau Liu Ha village. These figures show high concentrations within the vicinity of the site area of raw water aqueduct.

7.62 The village house at Kau Liu Ha (SR1) is subject to the worst haul road traffic dust impact. The high dust concentration is due to its proximity to the haul road (see Figure 7.1). In order to overcome this dust nuisance, watering of the haul road should be done after starting work each day and at least once every three hours thereafter during the operation day to attain the requirement for no visible dust emissions. In this way, compliance with the AQO for all the sensitive receivers shown in Table 7.16, Figures 7.27 and 7.28 will be achieved.

Yuen Tun Ha Shaft/Adit

7.63 Yuen Tun Ha Shaft/Adit is an intermediate tunnel access for the 'worst case' route of the treated water aqueduct. The shaft/adit would be used as an exit of transporting the spoil material excavated from the tunnel. If this route, which is not part of the preferred scheme, is ever considered, Figure 7.4 shows the likely construction activities including the haul road movement, loading and unloading as well as top soil removal.

7.64 Tables 7.17 and 7.18 show that the likely dust concentration associated with the operation of Yuen Tun Ha Shaft/Adit is mainly due to the transportation of the spoil material. The SRY3 and SRY4, the two village houses at Wun Yiu just adjacent to the haul road, experience the high dust level that exceeds the AQO limits. Table 7.19 shows that twice watering the haul road daily would mitigate the dust nuisance with respect to the SRY3 and SRY4.

7.65 Figures 7.29 to 7.33 illustrate the acceptable dust concentration at the ground level of San Uk Ka. The dust level is even lower with the implementation of twice watering the haul road (Figures 7.34 and 7.35).

Shing Mun Access Shaft

7.66 Shing Mun Access Shaft is part of the preferred scheme. It will be utilized as one of the points for removing and transporting the excavated spoil from the tunnel. During the course of the EIA, it has been suggested that some of the spoil materials may be transported via Shing Mun Road and then used to infill part of the valley adjacent to Country Park Visitor Centre to form a parking lot for park visitors. This scenario has been modelled as part of the air impact assessment, but this option has been discounted.

7.67 The major construction activities involve the loading and unloading, top soil removal, stockpiling and a small segment of haul road within the shaft area. Tables 7.20 and 7.21 show that the dust concentration associated with these construction activities is not expected to be above the AQO limits. Figures 7.36 to 7.40 show the acceptable dust level as a result of a short haul road traffic movement.

Butterfly Valley Primary Service Reservoir

Scenario 1 Blasting

7.68 Table 7.22 shows that the worst dust associated with blasting at the Butterfly Valley will not worsen the 1 hr, 24 hr and annual TSP and RSP significantly in relation to the AQO for the residential area. The fact that blasting is likely to take place at an elevation well above 140 mPD and the predominance of easterly (Figure 7.7, wind rose of Star Ferry station) will 'protect' the sensitive receivers such as Sir Robert Black College of Education, Caritas Medical Centre and Nam Wah Catholic Secondary School from excessive dust exposure.

Scenario 2 Excavation

7.69 One of the construction constraints is the limited access to Butterfly Valley. Caldecott Road is the only existing roadway to and from the site and no other access road has been built around the valley. Disposal of almost 960,000 m^3 excavated material within two years will require about truck movements of around 44 vehicle/hr.

7.70 The dust associated with the haul road traffic constitutes the greatest dust concentration. In fact, Tables 7.22 and 7.23 show that SR25, SR28, SR29 and SR30 will experience high dust levels that exceed the AQO. The proximity of SR28, SR29 and SR30 to the haul road shown in Figure 7.4 plus the high traffic volume result in these high dust levels.

7.71 Other dust sources such as loading and unloading, stockpiling, top soil removal, wind erosion and TBM excavation constitute only minor dust levels. Figures 7.41-7.45 illustrate the low dust contour for the ground level of Mei Foo Sun Chuen.

7.72 It is expected that four times daily watering the haul road (i.e. every three hours for a working day of 10-12 hours) will be required to reduce the dust emission rate by 90%. Tables 7.24 and 7.25 show the compliance of the AQO for all the SRs within the vicinity of the Butterfly Valley when using such mitigation methods. Figures 7.46 to 7.48 similarly demonstrate the reduced dust levels for the area. Maintenance of continuous watering capacity at the site should be specified.

Mitigation Measures - Construction Phase

7.73 The construction of TP WTW, the raw and treated water aqueducts and BVPSR is not expected to cause significant dust impact according to AQO standard provided the following good site practices are fully implemented. The recommendations are presented in the format of contractual clauses.

7.74 The Contractor shall implement dust suppression measures which shall include, but not be limited to, the following:

(a) Regular watering of unpaved areas, access roads, construction areas and dusty stockpiles shall be undertaken after starting work each day and at least once every three hours thereafter during the operation day to attain the requirement for no visible dust emissions. Water sprays may be either fixed or mobile to allow individual areas to be wetted as and when required.

(b) Effective water sprays shall be used during the delivery and handling of all raw sand and aggregate, and other similar materials, when dust is likely to be created.

(c) Stockpiles of sand and aggregate greater than 30 m^3 shall be enclosed on three sides, with walls extending above the pile and 2 metres beyond the front of the pile. Where possible, storage and handling facilities shall be hardstanding in order to facilitated cleaning and minimise dust generation.

(d) Suitable chemical wetting agents and/or temporary/permanent hydroseeding shall be used, where appropriate, on completed cuts and fills to reduce wind erosion.

(e) Areas within the Site where there is a regular movement of vehicles shall have an approved hard surface and be kept clear of loose surface material.

(f) Should a conveyor system be used, the Contractor shall implement the following precautionary measures. Conveyor belts shall be fitted with windboards, and conveyor transfer points and hopper discharge areas shall be enclosed to minimize dust emission. All conveyors under the Contractor's control and carrying materials which have the potential to create dust shall be totally enclosed and fitted with belt cleaners.

(g) Where dusty materials are being discharged to vehicle from a conveying system at a fixed transfer point, a three-sided roofed enclosure with a flexible curtain across the entry shall be provided. Exhaust fans shall be provided for this enclosure and vented to a suitable fabric filter system.

(h) The Contractor shall restrict all motorized vehicles within the Site excluding those on public roads to a maximum speed of 15 km per hour and confine haulage and delivery vehicles to designated roadways inside the Site.

(i) All vehicles entering and leaving the Site shall have their loads covered.

(j) Construction working areas will be restricted to a minimum practicable size.

(k) The Contractor shall provide a wheel washing station at the exits of the Site to the satisfaction of the Supervising Officer and to the requirements of the Commissioner of Police. All vehicles leaving the Site should pass through the wheel wash. Water in wheel wash shall be changed at frequent intervals and sediments shall be removed regularly.

(l) The Contractor shall ensure that no earth, rock or debris is deposited on public or private rights of way as a result of his activities, including any deposits arising from the movement of plant or vehicles.

(m) In the event of any spoil or debris from construction works being deposited on adjacent land or seabed or any silt washed down to any area, then all such spoil, debris or material and silt will be immediately removed and the affected land or seabed and areas restored to their natural state by the Contractor to the satisfaction of the Supervising Officer.

(n) The Contractors shall investigate the use of blasting techniques that would minimize dust generation including the use of good stemming materials, limiting the quantity of charges, fencing wire mesh, sandbag and non-blasting agents.

(o) Blasting activities shall be postponed until any strong wind dies down.

(p) If spoil cannot be immediately transported out of the Site, stockpiles shall be stored in sheltered areas.

(q) Plant and vehicles shall be regularly inspected to ensure that they are operating efficiently and that exhaust emissions are not causing a nuisance. All site vehicle exhausts should be directed vertically upwards or directed away from ground.

Concrete Batching Plant

7.75 Should the Contractor operate any crushing plant in the Site with an annual output exceeding 5,000 tonnes, or any concrete batching plant with total silo capacity exceeding 50 tonnes, he shall be responsible for obtaining the necessary licence under Section 14 of the *Air Pollution Control Ordinance* before operation and for complying with all statutory regulations. The Contractor shall apply for the licence at least 60 days prior to the anticipated operation date and be responsible for payment of all Government fees connected with this operation.

7.76 At any concrete batching plant or crushing plant operated by the Contractor within the Site, the following additional conditions shall be complied with:

(a) The Contractor shall at all times prevent dust nuisance as a result of his activities. The Contractor shall follow the Best Practical Means (BPM) when operating the plant. The Contractor will be made aware of the BPM when he applies for his licence to operate the plant. An air pollution control system shall be installed and shall be operated whenever the plant is in operation.

(b) The Contractor shall frequently clean and water the concrete batching plant and any crushing plant works areas and ancillary areas to minimize any dust emissions.

(c) Dry mix batching shall be carried out in a totally enclosed area with exhaust to suitable fabric filters.

(d) Cement and other such fine grained materials delivered in bulk shall be stored in closed silos fitted with a high level alarm indicator. The high level alarm indicators shall be interlocked with the filling line such that in the event of the hopper approaching an overfull condition, an audible alarm will operate, and the pneumatic line to the filling tanker will close. All air vents on cement silos shall be fitted with suitable fabric filters provided with either shaking or pulse-air cleaning mechanisms. The fabric filter area shall be determined using an air-cloth ratio (filtering velocity) of 0.01-0.03 metre/sec.

(e) Weigh hoppers shall be vented to a suitable filter.

(f) The filter bags in the cement silo dust collector shall be thoroughly shaken after cement is blown into the silo to ensure adequate dust collection for subsequent loading.

Air Quality - Operational Phase

Introduction

7.77 This section assesses air quality impact associated with the operation of TP WTW. No operational phase air quality impacts have been identified for BVPSR.

7.78 The potential impacts on air quality during operation of TP WTW are likely to include the odour arising from:

- the storage, transport and use of chemicals such as chlorine, lime and alum;

- operations related to the treatment and disposal of sludge.

Odour Limits

7.79 Assessment has been undertaken on the basis of the existing legislation, in particular the *Air Pollution Control Ordinance (APCO) [Cap 311]* and its associated regulations and Technical Memoranda.

7.80 Odour limits are not strictly defined under Cap 311. Nevertheless, EPD generally recommends that:

"The predicted odour level at receptor should be less than 5 odour units based on prediction averaging time of 5 seconds. For odour measurement or monitoring, the odour level should not exceed 2 odour units as measured at the site boundary of the plants"

7.81 Odour units are defined on a site specific basis by an Odour Panel. Two Odour Units may be equivalent to Identifiable Odour, Moderate.

Source of emissions

7.82 Chlorine Works in which chlorine is handled fall under the Specified Processes under the APCO. A licence from EPD is required to operate such a works.

Chlorine

7.83 Chlorine is a greenish yellow gas with an irritating odour, or present in liquid solutions. Its physical characteristics are listed in Table 7.26. The primary objective of water supply chlorination is disinfection.

Table 7.26 Chlorine Characteristics

Chemical	Operation	Characteristics
Chlorine	Chlorination	USEPA Odour threshold: 0.93 mg/m^3 OEL-TWA[1] level: 1.5 mg/m^3 Vapour Pressure: 4800 mmHg at 20C

Note:

1 OEL-TWA is Hong Kong Occupational Exposure Limits - Time-Weighted Average

7.84 The Chlorine Hazard Assessment Report deals with issues relating to the storage and handling of chlorine at TP WTW. Chlorine HAZOP (hazard and operability) and Hazard Studies have been carried out for the Chlorine Store. The buildings where chlorine is stored and handled will be totally enclosed and fully ventilated. The Chlorine Store will have a 'contain and absorb' system to minimise any risk of chlorine release. Special attention will be given to safety aspects of the Chlorine Store during the detailed design stage.

7.85 The emission rate of the chlorine store can be estimated from AP-42 (USEPA, 1984; Table 5.5-1). The emission factor for loading of chlorine in storage tank vents is about 600 kg/100 MT. Given the traditional method of treatment, the average volume of chlorine used is 216 kg/month or 0.00008 g/s based on the latest plant specification. The emission rate of the chlorine is very low indeed and the estimated chlorine loss rate is close to zero.

7.86 Thus, it is considered highly unlikely that odour concentrations would reach the chlorine odour limit because the discharge rate is expected to be very low, even under emergency conditions. In addition, the shortest distance between the chlorine contact tank and the nearest sensitive receiver is around 100 m, which will create a buffer zone to aid dispersion and ensure that odour units at the site boundary are less than the recommended limit of 2 Odour Units.

Lime, Alum and Sludge

7.87 Lime is a dry powder. Aluminium sulphate, in solid form, is frequently referred to as "alum" in waterworks practice. During the process of water treatment, lime is added to remove the temporary hardness of water and alum is used as aluminium coagulant (Twort et al., 1994, p284). The odour impact associated with the storage and handling of lime and alum is expected to be negligible.

7.88 The odour impact of sludge from China water, which will be supplied for 11 months per year, is also expected to be negligible. However, minor odour nuisance has been noticed at other water treatment works with sludges from Plover Cove water, due to the algal content. Contingency plans for dealing with potential minor odour nuisance will be devised during the detailed design stage when the final layout of TP WTW, and thus points of generation of any such nuisance, have been confirmed. The preliminary draft layout of TP WTW locates the first stage of the sludge press house some 100 m from the nearest sensitive receiver.

Vehicular emissions

7.89 Regarding the vehicular emissions such as RSP (Respirable Suspended Particulates), NO_X, SO_2, dark smoke or other fumes to the environment during the operation of TP WTW, it is expected that the number of vehicles used on the site is few.

Mitigation Measures - Operational Phase

7.90 Although no significant air quality impacts are anticipated in the operation of TP WTW, the following comments are made to ensure that this would be the case.

Ventilation

7.91 Ventilation is the most effective method of reducing the odour levels inside buildings. Particular attention should be paid to the location and direction of ventilation exhausts. They should not be allowed to face any sensitive receivers directly. Consideration should always be given to the location of windows, doors and the direction of prevailing winds (Keddie, 1980). At Tai Po, the prevailing winds are easterly. As many odorous gases are heavier than air, it is necessary to extract them at a low level of the building. Also, the control areas should be provided with positive pressure ventilation supplied with fresh and not recycled air.

Other methods

7.92 Some of other methods for the removal of tastes and odours in raw water are summarized below (Twort et al., 1994, p305):

(a) Oxidation and adsorption on to activated carbon are considered to be the most effective methods available for reduction of tastes and odours associated with organic compounds.

(b) Ozone is very effective in destroying some of the taste and odour producing compounds. Ozone when coupled with hydrogen peroxide increases the oxidation efficiency of ozone and can be more effective in reducing tastes and odour.

Summary

7.93 The air quality study has identified Air Sensitive Receivers (ASRs) who may be affected by construction-related dust emissions or by TP WTW operational emissions. Air quality impacts for the sites have been modelled using the EPD approved Fugitive Dust Model (FDM), and are presented in the form of pollution contour maps.

Construction impacts

7.94 Two worst case scenarios, blasting and excavation, have been selected for investigation on a site-by-site basis. 'Excavation' includes tunnelling, handling of spoil, movement of dusty materials on-site, wind erosion of dusty materials on site, operation of a concrete batching plant and movement of construction vehicles.

7.95 The construction dust assessment has concluded that:

- blasting will not cause significant deterioration in air quality at any site;
- the impact of dust in displaced air discharged from the tunnel is unlikely to be significant and can be further controlled by use of proprietary filters on the ventilation system, providing they are properly operated and maintained;
- the impact of dust associated with the movement of construction materials and disposal of spoil on- and off-site is minor, and is mainly associated with the vehicular movements on unpaved haul roads;
- if good construction site practice is maintained, particularly regular watering of haul roads, airborne dust levels can be held well within the Air Quality Objectives. Watering of haul roads may need to be undertaken four times a day during dry conditions and periods of heavy haul road usage.

7.96 During the EIA, the issue of radon has been raised as a potential cause of concern. While radon is not currently expected to be a problem, further study of the potential for radon and other noxious substances, including lead in groundwater, is recommended as part of the detailed site investigations for the aqueducts. Regardless of whether these studies are undertaken, monitoring and mitigation measures will be incorporated into the detailed design and construction programme.

Operational impacts

7.97 The operational impacts of the scheme on air quality have been assessed. Potential sources of odour nuisance at TP WTW are identified as:

- the storage, transport and use of chemicals such as chlorine, lime and alum;
- the treatment and disposal of sludge.

7.98 The Chlorine Hazard Assessment in the Final Report, Chapter 12, deals with issues relating to the storage and handling of chlorine at TP WTW. The Chlorine Store will be fully enclosed and extract ventilated, with a 'contain and absorb' system to minimise any risk to chlorine release. Other locations where chlorine is handled will be enclosed and fully ventilated. It is highly unlikely that odour concentrations would reach the chlorine odour limit because the discharge rate is expected to be very low, even under emergency conditions. In addition, the shortest distance between the chlorine contact tank and the nearest sensitive receiver is around 100 m, which will create a buffer zone to aid any dispersion and ensure that odour units at the site boundary are less than the recommended 2 Odour Units.

7.99 The odour impact associated with the storage and handling of lime and alum is expected to be negligible. The odour impact of sludge from China water, which will be supplied for 11 months per year, is also expected to be negligible. However minor odour nuisance has been noticed at other water treatment works with sludges from Plover Cove water due to the algal content. Contingency plans for dealing with potential minor odour nuisance will be developed during the detailed design phase.

Table 7.11: Predicted TSP Maximum Hourly, Daily and Yearly TSP ($\mu g/m^3$) Concentrations from Tai Po Water Treatment Works (Unmitigated)

Air SR	Total hourly impacts (except blasting and unpaved roads) - (1)	Trucks movements over unpaved roads (hourly impact)	Blasting (hourly impact)	Total Hourly Impacts (except blasting) - (2)	Cumulative Hourly Impacts - (3) (Total Hourly Impacts + background) - (4)	Cumulative Daily Impacts - (5) (Total Daily Impacts + background) - (4)	Cumulative Yearly Impacts - (6) (Total Yearly Impacts + background) - (7)
8	3.82	455.14	149.51	458.96	541.96*	241.77	42.05
5	3.37	134.85	110.40	138.22	221.22	125.93	41.10
6	3.76	159.66	131.02	163.42	246.42	143.23	44.00
12	3.79	185.72	132.75	189.51	272.51	118.58	30.51
13	3.86	184.41	167.23	188.27	271.27	142.88	35.69
42	4.02	405.67	162.21	409.69	492.69	232.06	52.91
14	3.34	507.63	34.64	510.97	593.96*	217.39	49.59
17	3.01	708.12	136.96	711.13	794.13*	160.00	34.50
44	2.42	248.76	119.30	251.18	334.18	120.81	28.98
45	3.72	183.90	164.89	187.62	270.62	111.01	27.80
18	2.77	137.59	114.43	140.36	223.36	100.70	26.67
15	3.54	280.03	155.19	283.58	366.58	151.29	34.96
16	2.82	408.87	156.26	411.69	494.69	153.50	32.44

Note (1) Total hourly impact included emissions due to loading & unloading, concrete batching process, stock piling, top soil removal, wind erosion and TBM.
(2) Total hourly impact is the sum of all hourly impacts except blasting (including unpaved roads).
(3) Cumulative hourly impact is the sum of the total hourly impact (except blasting) and the background TSP level.
(4) The background TSP level is taken to be 83 $\mu g/m^3$ for both hourly and daily TSP impacts.
(5) Cumulative daily impact is the sum of the total daily impact (except blasting) and the background TSP level.
(6) Cumulative yearly impact is the total yearly impact (except blasting).
(7) The background TSP level is taken to be 25.5 $\mu g/m^3$ for yearly TSP impacts.
(*) Exceedance of the hourly TSP limit of 500 $\mu g/m^3$.

Table 7.12 : Predicted Maximum Daily and Yearly RSP ($\mu g/m^3$) Concentrations from Tai Po Water Treatment Works (Unmitigated)

Air SR	Total daily impacts (except blasting and unpaved roads) - (1)	Trucks movements over unpaved roads (daily impact)	Blasting (daily impact)	Total Daily Impacts (except blasting) - (2)	Cumulative Daily Impacts - (3) (Total Daily Impacts + background) - (4), (*)	Cumulative Yearly Impacts - (5) (Total Yearly Impacts + background) - (6), (*)
8	0.22	71.23	6.81	71.45	113.45	20.24
5	0.29	19.03	9.23	19.31	61.31	19.81
6	0.33	26.76	11.69	27.09	69.09	21.12
12	0.29	15.72	11.92	16.02	58.02	15.05
13	0.28	26.68	9.73	26.96	68.96	17.39
42	0.29	66.80	9.21	67.10	109.10	25.13
14	0.26	60.22	0.81	60.48	102.48	23.64
17	0.29	34.37	5.56	34.66	76.66	16.85
44	0.21	16.81	4.10	17.02	59.02	14.37
45	0.14	12.46	6.43	12.60	54.60	13.83
18	0.14	7.83	4.19	7.97	49.97	13.33
15	0.33	30.40	9.77	30.73	72.73	17.05
16	0.30	31.44	10.11	31.74	73.74	15.92

Note (1) Total daily impact included emissions due to loading & unloading, concrete batching process, stock piling, top soil removal, wind erosion and TBM.
(2) Total daily impact is the sum of all daily impacts except blasting (including unpaved roads).
(3) Cumulative daily impact is the sum of the total daily impact (except blasting) and the background RSP level.
(4) The background RSP level is assumed to be 42 $\mu g/m^3$ for both daily RSP impacts.
(5) Cumulative yearly impact is the total yearly impact (except blasting).
(6) The background RSP level is assumed to be 12.8 $\mu g/m^3$ for yearly RSP impacts.
(*) No exceedance of the daily RSP AQO of 180 $\mu g/m^3$ or yearly RSP AQO of 55 $\mu g/m^3$.

Table 7.13 : Predicted TSP Maximum Hourly, Daily and Yearly TSP ($\mu g/m^3$) Concentrations from Tai Po Water Treatment Works (Mitigated)

Air SR	Total hourly impacts (except blasting and unpaved roads) - (1)	Trucks movements over unpaved roads (hourly impact with 50% reduction)	Blasting (hourly impact)	Total Hourly Impacts (except blasting) - (2)	Cumulative Hourly Impacts - (3) (Total Hourly Impacts + background) - (4)	Cumulative Daily Impacts - (5) (Total Daily Impacts + background) - (4)	Cumulative Yearly Impacts - (6) (Total Yearly Impacts + background) - (7)
8	3.82	227.57	149.51	231.39	314.39	162.62	33.80
5	3.37	67.42	110.40	70.80	153.80	104.79	33.41
6	3.76	79.83	131.02	83.59	166.59	113.50	34.89
12	3.79	92.86	132.75	96.65	179.65	101.11	28.03
13	3.86	92.20	167.23	96.07	179.07	113.24	30.63
42	4.02	202.83	162.21	206.86	289.86	157.83	39.24
14	3.34	253.81	34.64	257.15	340.15	150.48	37.57
17	3.01	354.06	136.96	357.07	440.07	121.81	30.02
44	2.42	124.38	119.30	126.80	209.80	102.13	27.25
45	3.72	91.95	164.89	95.67	178.67	97.16	26.67
18	2.77	68.79	114.43	71.56	154.56	92.00	26.10
15	3.54	140.02	155.19	143.56	226.56	117.51	30.27
16	2.82	204.44	156.26	207.25	290.25	118.56	29.00

Note (1) Total hourly impact included emissions due to loading & unloading, concrete batching process, stock piling, top soil removal, wind erosion and TBM.

(2) Total hourly impact is the sum of all hourly impacts except blasting (including unpaved roads with 50% reduction).

(3) Cumulative hourly impact is the sum of the total hourly impact (except blasting) and the background TSP level.

(4) The background TSP level is taken to be 83 $\mu g/m^3$ for both hourly and daily TSP impacts.

(5) Cumulative daily impact is the sum of the total daily impact (except blasting) and the background TSP level. (Daily impact due to unpaved roads is reduced by 50%).

(6) Cumulative yearly impact is the total yearly impact (except blasting). (Yearly impact due to unpaved roads is reduced by 50%.)

(7) The background TSP level is taken to be 25.5 $\mu g/m^3$ for yearly TSP impacts.

Table 7.14 : Predicted TSP Maximum Hourly, Daily and Yearly TSP ($\mu g/m^3$) Concentrations from Raw Water Aqueduct (Unmitigated)

Air SR	Total hourly impacts (except unpaved roads) - (1)	Trucks movements over unpaved roads (hourly impact)	Total Hourly Impacts (including unpaved roads) - (2)	Cumulative Hourly Impacts - (3) (Total Hourly Impacts + background) - (4)	Cumulative Daily Impacts - (5) (Total Daily Impacts + background) - (4)	Cumulative Yearly Impacts - (6) (Total Yearly Impacts + background) - (7)
1	3.90	684.94	688.84	771.84*	287.95*	100.12*
2	2.27	159.81	162.08	245.08	136.09	30.76
39	5.30	375.20	380.51	463.51	157.72	33.61
41	3.24	132.48	135.72	218.72	120.06	30.87

Note
(1) Total hourly impact included emissions due to loading & unloading, stock piling, top soil removal, wind erosion and TBM.
(2) Total hourly impact is the sum of all hourly impacts (including unpaved roads).
(3) Cumulative hourly impact is the sum of the total hourly impact and the background TSP level.
(4) The background TSP level is taken to be 83 $\mu g/m^3$ for both hourly and daily TSP impacts.
(5) Cumulative daily impact is the sum of the total daily impact and the background TSP level.
(6) Cumulative yearly impact is the total yearly impact.
(7) The background TSP level is taken to be 25.5 $\mu g/m^3$ for yearly TSP impacts.
(*) Exceedance of the hourly TSP limit of 500 $\mu g/m^3$, daily TSP AQO of 260 $\mu g/m^3$ or yearly TSP AQO of 80 $\mu g/m^3$.

Table 7.15 : Predicted Maximum Daily and Yearly RSP ($\mu g/m^3$) Concentrations from Raw Water Aqueduct (Unmitigated)

Air SR	Total daily impacts (except unpaved roads) - (1)	Trucks movements over unpaved roads (daily impact)	Total Daily Impacts (including unpaved roads) - (2)	Cumulative Daily Impacts - (3) (Total Daily Impacts + background) - (4), (*)	Cumulative Yearly Impacts - (5) (Total Yearly Impacts + background) - (6), (*)
1	0.77	91.50	92.28	134.28	46.40
2	0.39	23.54	23.92	65.92	15.17
39	0.73	32.95	33.68	75.68	16.46
41	0.60	16.12	16.72	58.72	15.22

Note
(1) Total daily impact included emissions due to loading & unloading, stock piling, top soil removal, wind erosion and TBM.
(2) Total daily impact is the sum of all daily impacts (including unpaved roads).
(3) Cumulative daily impact is the sum of the total daily impact and the background RSP level.
(4) The background RSP level is assumed to be 42 $\mu g/m^3$ for both daily RSP impacts.
(5) Cumulative yearly impact is the total yearly impact.
(6) The background RSP level is assumed to be 12.8 $\mu g/m^3$ for yearly RSP impacts.
(*) No exceedance of the daily RSP AQO of 180 $\mu g/m^3$ or yearly RSP AQO of 55 $\mu g/m^3$.

Table 7.16 : Predicted TSP Maximum Hourly, Daily and Yearly TSP ($\mu g/m^3$) Concentrations from Raw Water Aqueduct (Mitigated)

Air SR	Total hourly impacts (except unpaved roads) - (1)	Trucks movements over unpaved roads (hourly impact with 50% reduction)	Total Hourly Impacts (including unpaved roads) - (2)	Cumulative Hourly Impacts - (3) (Total Hourly Impacts + background) - (4)	Cumulative Daily Impacts - (5) (Total Daily Impacts + background) - (4)	Cumulative Yearly Impacts - (6) (Total Yearly Impacts + background) - (7)
1	3.90	342.47	346.37	429.37	186.27	63.10
2	2.27	79.91	82.17	165.17	109.94	28.18
39	5.30	187.60	192.90	275.90	121.11	29.71
41	3.24	66.24	69.48	152.48	102.15	28.27

Note
(1) Total hourly impact included emissions due to loading & unloading, stock piling, top soil removal, wind erosion and TBM.
(2) Total hourly impact is the sum of all hourly impacts (including unpaved roads with 50% reduction).
(3) Cumulative hourly impact is the sum of the total hourly impact and the background TSP level.
(4) The background TSP level is taken to be 83 $\mu g/m^3$ for both hourly and daily TSP impacts.
(5) Cumulative daily impact is the sum of the total daily impact and the background TSP level. (Daily impact due to unpaved roads is reduced by 50%.)
(6) Cumulative yearly impact is the total yearly impact.
(7) The background TSP level is taken to be 25.5 $\mu g/m^3$ for yearly TSP impacts. (Yearly impact due to unpaved roads is reduced by 50%.)

Table 7.17 : Predicted TSP Maximum Hourly, Daily and Yearly TSP ($\mu g/m^3$) Concentrations from Yuen Tun Ha Adit (Unmitigated)

Air SR	Total hourly impacts (except unpaved roads) - (1)	Trucks movements over unpaved roads (hourly impact)	Total Hourly Impacts (including unpaved roads) - (2)	Cumulative Hourly Impacts - (3) (Total Hourly Impacts + background) - (4)	Cumulative Daily Impacts - (5) (Total Daily Impacts + background) - (4)	Cumulative Yearly Impacts - (6) (Total Yearly Impacts + background) - (7)
36	0.0333	126.4771	126.5104	209.5104	119.5951	30.10
37	0.0067	250.97	250.9767	333.9767	115.844	29.72
38	0.0283	97.7862	97.8145	180.8145	94.6143	26.27
Y3	0.0228	473.0411	473.0639	556.064 *	276.267 *	78.79
Y4	0.0187	594.8273	594.846	677.846 *	278.821 *	91.51*
Y5	0.0245	232.335	232.3595	315.3595	121.6838	30.91

Note
(1) Total hourly impact included emissions due to loading & unloading, stock piling, top soil removal and wind erosion.
(2) Total hourly impact is the sum of all hourly impacts (including unpaved roads).
(3) Cumulative hourly impact is the sum of the total hourly impact and the background TSP level.
(4) The background TSP level is taken to be 83 $\mu g/m^3$ for both hourly and daily TSP impacts.
(5) Cumulative daily impact is the sum of the total daily impact and the background TSP level.
(6) Cumulative yearly impact is the total yearly impact.
(7) The background TSP level is taken to be 25.5 $\mu g/m^3$ for yearly TSP impacts.
(*) Exceedance of the hourly TSP limit of 500 $\mu g/m^3$, daily TSP AQO of 260 $\mu g/m^3$ or yearly TSP AQO of 80 $\mu g/m^3$.

Table 7.18 : Predicted Maximum Daily and Yearly RSP ($\mu g/m^3$) Concentrations from Yuen Tun Ha Adit (Unmitigated)

Air SR	Total daily impacts (except unpaved roads) - (1)	Trucks movements over unpaved roads (daily impact)	Total Daily Impacts (including unpaved roads) - (2)	Cumulative Daily Impacts - (3) (Total daily Impacts + background) - (4), (*)	Cumulative Yearly Impacts - (5) (Total Yearly Impacts + background) - (6), (*)
36	0.0029	16.4667	16.4696	58.4696	14.87
37	0.0004	14.7809	14.7813	56.7813	14.70
38	0.0033	5.2239	5.2272	47.2272	13.15
Y3	0.0011	86.9781	86.9792	128.9792	36.78
Y4	0.001	88.1277	88.1287	130.1287	42.51
Y5	0.0013	17.4083	17.4096	59.4096	15.23

Note
(1) Total daily impact included emissions due to loading & unloading, stock piling, top soil removal and wind erosion.
(2) Total daily impact is the sum of all daily impacts (including unpaved roads).
(3) Cumulative daily impact is the sum of the total daily impact and the background RSP level.
(4) The background RSP level is assumed to be 42 $\mu g/m^3$ for daily RSP impacts.
(5) Cumulative yearly impact is the total yearly impact.
(6) The background RSP level is assumed to be 12.8 $\mu g/m^3$ for yearly RSP impacts.
(*) No exceedance of the daily RSP AQO of 180 $\mu g/m^3$ or yearly RSP AQO of 55 $\mu g/m^3$.

Table 7.19 : Predicted TSP Maximum Hourly, Daily and Yearly TSP ($\mu g/m^3$) Concentrations from Yuen Tun Ha Adit (Mitigated)

Air SR	Total hourly impacts (except unpaved roads) - (1)	Trucks movements over unpaved roads (hourly impact with 50% reduction)	Total Hourly Impacts (including unpaved roads) - (2)	Cumulative Hourly Impacts - (3) (Total Hourly Impacts + background) - (4)	Cumulative Daily Impacts - (5) (Total Daily Impacts + background) - (4)	Cumulative Yearly Impacts - (6) (Total Yearly Impacts + background) - (7)
36	0.0333	63.23855	63.27185	146.27185	101.3006	27.80
37	0.0067	125.485	125.4917	208.4917	99.4224	27.61
38	0.0283	48.8931	48.9214	131.9214	88.81055	25.89
Y3	0.0228	236.52055	236.54335	319.54335	179.63475	52.14
Y4	0.0187	297.41365	297.43235	380.43235	180.91165	58.51
Y5	0.0245	116.1675	116.192	199.192	102.34325	28.20

Note
(1) Total hourly impact included emissions due to loading & unloading, stock piling, top soil removal and wind erosion.
(2) Total hourly impact is the sum of all hourly impacts (including unpaved roads with 50% reduction).
(3) Cumulative hourly impact is the sum of the total hourly impact and the background TSP level.
(4) The background TSP level is taken to be 83 $\mu g/m^3$ for both hourly and daily TSP impacts.
(5) Cumulative daily impact is the sum of the total daily impact and the background TSP level. (Daily impact due to unpaved roads is reduced by 50%.)
(6) Cumulative yearly impact is the total yearly impact. (Yearly impact due to unpaved roads is reduced by 50%.)
(7) The background TSP level is taken to be 25.5 $\mu g/m^3$ for yearly TSP impacts.

Table 7.20 : Predicted TSP Maximum Hourly, Daily and Yearly TSP ($\mu g/m^3$) Concentrations from Shing Mun Access Shaft (Unmitigated)

Air SR	Total hourly impacts (except unpaved roads) - (1)	Trucks movements over unpaved roads (hourly impact)	Total Hourly Impacts (including unpaved roads) - (2)	Cumulative Hourly Impacts - (3) (Total Hourly Impacts + background) - (4), (*)	Cumulative Daily Impacts - (5) (Total Daily Impacts + background) - (4), (*)	Cumulative Yearly Impacts - (6) (Total Yearly Impacts + background) - (7), (*)
22	0.0418	1.4175	1.4593	86.4593	85.5196	26.25
23	0.0437	3.4408	3.4845	88.4845	85.8167	26.36
24	0.0482	3.7817	3.8299	88.8299	85.8629	26.42
S1	0.0333	1.7944	1.8277	86.8277	85.5652	26.27
S2	0.0311	0.7095	0.7406	85.7406	85.2249	26.24
S3	0.0334	1.2595	1.2929	86.2929	85.4152	26.26
19	0.0191	175.4085	175.4276	260.4276	164.2528	33.49
20	0.0217	186.5294	186.5511	271.5511	139.9943	31.08
21	0.0201	205.5485	205.5686	290.5686	146.2787	47.17

Note
(1) Total hourly impact included emissions due to loading & unloading, stock piling, top soil removal and wind erosion.
(2) Total hourly impact is the sum of all hourly impacts (including unpaved roads).
(3) Cumulative hourly impact is the sum of the total hourly impact and the background TSP level.
(4) The background TSP level is taken to be 85 $\mu g/m^3$ for both hourly and daily TSP impacts.
(5) Cumulative daily impact is the sum of the total daily impact and the background TSP level.
(6) Cumulative yearly impact is the total yearly impact.
(7) The background TSP level is taken to be 26.2 $\mu g/m^3$ for yearly TSP impacts.
(*) No exceedance of the hourly TSP limit of 500 $\mu g/m^3$, daily TSP AQO of 260 $\mu g/m^3$ or yearly TSP AQO of 80 $\mu g/m^3$.

Table 7.21 : Predicted Maximum Daily and Yearly RSP ($\mu g/m^3$) Concentrations from Shing Mun Access Shaft (Unmitigated)

Air SR	Total daily impacts (except unpaved roads) - (1)	Trucks movements over unpaved roads (daily impact)	Total Daily Impacts (including unpaved roads) - (2)	Cumulative Daily Impacts - (3) (Total Daily Impacts + background) - (4), (*)	Cumulative Yearly Impacts - (5) (Total Yearly Impacts + background) - (6), (*)
22	0.0056	0.2285	0.2341	43.2341	13.12
23	0.0044	0.3633	0.3677	43.3677	13.17
24	0.0059	0.3827	0.3886	43.3886	13.20
S1	0.0048	0.2499	0.2547	43.2547	13.13
S2	0.004	0.0974	0.1014	43.1014	13.12
S3	0.0051	0.182	0.1871	43.1871	13.12
19	0.0023	35.6616	35.6639	78.6639	16.38
20	0.0016	24.7459	24.7475	67.7475	15.30
21	0.0019	27.5736	27.5755	70.5755	22.54

Note
(1) Total daily impact included emissions due to loading & unloading, stock piling, top soil removal and wind erosion.
(2) Total daily impact is the sum of all daily impacts (including unpaved roads).
(3) Cumulative daily impact is the sum of the total daily impact and the background RSP level.
(4) The background RSP level is assumed to be 43 $\mu g/m^3$ for daily RSP impacts.
(5) Cumulative yearly impact is the total yearly impact.
(6) The background RSP level is assumed to be 13.1 $\mu g/m^3$ for yearly RSP impacts.
(*) No exceedance of the daily RSP AQO of 180 $\mu g/m^3$ or yearly RSP AQO of 55 $\mu g/m^3$.

Table 7.22 : Predicted TSP Maximum Hourly, Daily and Yearly TSP ($\mu g/m^3$) Concentrations from Butterfly Valley Service Reservoir (Unmitigated)

Air SR	Total hourly impacts (except blasting and unpaved roads) - (1)	Trucks movements over unpaved roads (hourly impact)	Blasting (hourly impact)	Total Hourly Impacts (except blasting) - (2)	Cumulative Hourly Impacts - (3) (Total Hourly Impacts + background) - (4)	Cumulative Daily Impacts - (5) (Total Daily Impacts + background) - (4)	Cumulative Yearly Impacts - (6) (Total Yearly Impacts + background) - (7)
25	1.43	778.27	52.63	779.70	844.70*	324.47*	65.48
26	0.75	172.88	13.01	173.63	238.63	149.01	34.75
27	1.69	195.12	0.41	196.81	261.81	128.91	31.53
28	0.91	3565.56	17.46	3566.47	3631.47*	1481.02*	278.79*
29	0.86	2464.81	48.01	2465.67	2530.67*	808.38*	90.33*
30	0.79	832.65	55.24	833.44	898.44*	292.20*	42.55
31	0.88	158.44	61.59	159.31	224.31	97.94	23.54
32	0.84	163.90	62.08	164.73	229.73	94.35	22.27
33	0.79	176.37	39.99	177.16	242.16	90.97	21.68
34	0.91	180.21	17.09	181.12	246.12	107.21	23.39
35	1.14	350.38	57.27	351.52	416.52	184.73	32.08
B1	1.01	235.75	56.25	236.76	301.76	100.32	22.18
B2	1.27	318.86	3.99	320.12	385.12	231.16	43.69

Note
(1) Total hourly impact included emissions due to loading & unloading, stock piling, top soil removal, wind erosion and TBM.
(2) Total hourly impact is the sum of all hourly impacts except blasting (including unpaved roads).
(3) Cumulative hourly impact is the sum of the total hourly impact (except blasting) and the background TSP level.
(4) The background TSP level is taken to be 65 $\mu g/m^3$ for both hourly and daily TSP impacts.
(5) Cumulative daily impact is the sum of the total daily impact (except blasting) and the background TSP level.
(6) Cumulative yearly impact is the total yearly impact (except blasting).
(7) The background TSP level is taken to be 20 $\mu g/m^3$ for yearly TSP impacts.
(*) Exceedance of the hourly TSP limit of 500 $\mu g/m^3$, daily TSP AQO of 260 $\mu g/m^3$ or yearly TSP AQO of 80 $\mu g/m^3$.

Table 7.23 : Predicted Maximum Daily and Yearly RSP ($\mu g/m^3$) Concentrations from Butterfly Valley Service Reservoir (Unmitigated)

Air SR	Total daily impacts (except blasting and unpaved roads) - (1)	Trucks movements over unpaved roads (daily impact)	Blasting (daily impact)	Total Daily Impacts (except blasting) - (2)	Cumulative Daily Impacts - (3) (Total Daily Impacts + background) - (4)	Cumulative Yearly Impacts - (5) (Total Yearly Impacts + background) - (6)
25	0.17	116.61	23.42	116.77	149.77	30.47
26	0.07	37.74	12.55	37.81	70.81	16.64
27	0.21	28.56	0.18	28.78	61.78	15.19
28	0.29	636.93	7.77	637.22	670.22*	126.46*
29	0.24	334.30	21.36	334.53	367.53*	41.65
30	0.17	102.08	24.58	102.25	135.25	20.15
31	0.13	14.70	27.41	14.83	47.83	11.60
32	0.10	13.11	7.63	13.22	46.22	11.02
33	0.05	11.64	17.79	11.69	44.69	10.76
34	0.22	18.80	7.60	19.01	52.01	11.53
35	0.27	53.63	25.48	53.90	86.90	15.44
B1	0.08	15.82	25.03	15.90	48.90	10.98
B2	0.16	74.64	1.78	74.79	107.79	20.48

Note (1) Total daily impact included emissions due to loading & unloading, stock piling, top soil removal, wind erosion and TBM.
(2) Total daily impact is the sum of all daily impacts except blasting (including unpaved roads).
(3) Cumulative daily impact is the sum of the total daily impact (except blasting) and the background RSP level.
(4) The background RSP level is assumed to be 33 $\mu g/m^3$ for both daily RSP impacts.
(5) Cumulative yearly impact is the total yearly impact (except blasting).
(6) The background RSP level is assumed to be 10 $\mu g/m^3$ for yearly RSP impacts.
(*) Exceedance of the daily RSP AQO of 180 $\mu g/m^3$ or yearly RSP AQO of 55 $\mu g/m^3$.

Table 7.24 : Predicted TSP Maximum Hourly, Daily and Yearly TSP ($\mu g/m^3$) Concentrations from Butterfly Valley Service Reservoir (Mitigated)

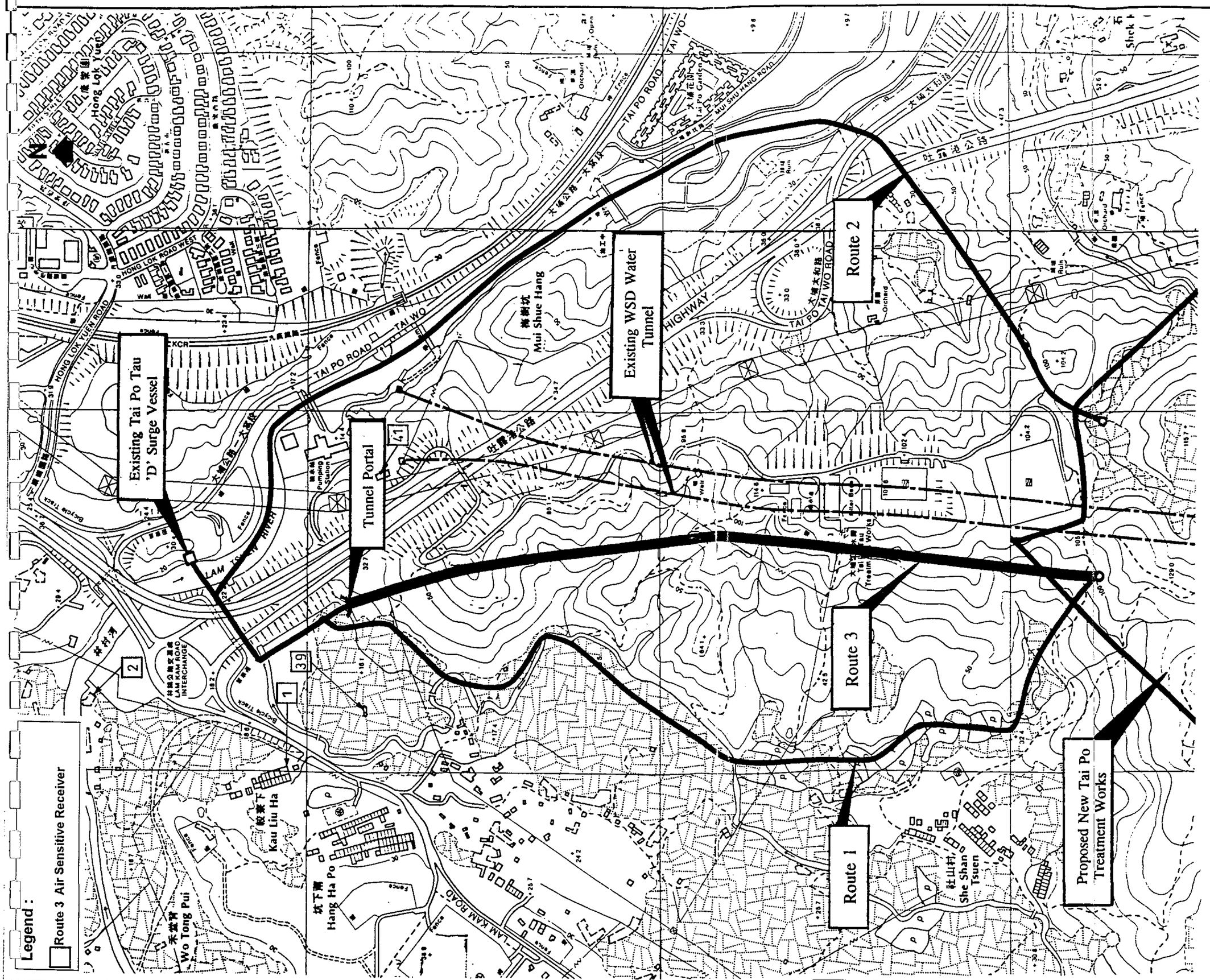
Air SR	Total hourly impacts (except blasting and unpaved roads) - (1)	Trucks movements over unpaved roads (hourly impact with 90% reduction)	Blasting (hourly impact)	Total Hourly Impacts (except blasting) - (2)	Cumulative Hourly Impacts - (3) (Total Hourly Impacts + background) - (4)	Cumulative Daily Impacts - (5) (Total Daily Impacts + background) - (4)	Cumulative Yearly Impacts - (6) (Total Yearly Impacts + background) - (7)
25	1.43	77.83	52.63	79.26	144.26	91.25	24.58
26	0.75	17.29	13.01	18.03	83.03	73.54	21.49
27	1.69	19.51	0.41	21.20	86.20	71.79	21.20
28	0.91	356.56	17.46	357.47	422.47	207.14	45.95
29	0.86	246.48	48.01	247.34	312.34	139.78	27.10
30	0.79	83.27	55.24	84.05	149.05	88.04	22.30
31	0.88	15.84	61.59	16.72	81.72	68.54	20.38
32	0.84	16.39	62.08	17.23	82.23	68.13	20.25
33	0.79	17.64	39.99	18.43	83.43	67.69	20.17
34	0.91	18.02	17.09	18.93	83.93	69.62	20.37
35	1.14	35.04	57.27	36.18	101.18	77.47	21.26
B1	1.01	23.58	56.25	24.59	89.59	68.68	20.23
B2	1.27	31.89	3.99	33.15	98.15	81.91	22.40

Note
(1) Total hourly impact included emissions due to loading& unloading, stock piling, top soil removal, wind erosion and TBM.
(2) Total hourly impact is the sum of all hourly impacts except blasting (including unpaved roads with 90% reduction).
(3) Cumulative hourly impact is the sum of the total hourly impact (except blasting) and the background TSP level.
(4) The background TSP level is taken to be 65 $\mu g/m^3$ for both hourly and daily TSP impacts.
(5) Cumulative daily impact is the sum of the total daily impact (except blasting) and the background TSP level. (Daily impact due to unpaved roads is reduced by 90%.)
(6) Cumulative yearly impact is the total yearly impact (except blasting). (Yearly impact due to unpaved roads is reduced by 90%.)
(7) The background TSP level is taken to be 20 $\mu g/m^3$ for yearly TSP impacts.

Table 7.25 : Predicted Maximum Daily and Yearly RSP ($\mu g/m^3$) Concentrations from Butterfly Valley Service Reservoir (Mitigated)

Air SR	Total daily impacts (except blasting and unpaved roads) - (1)	Trucks movements over unpaved roads (daily impact with 90% reduction)	Blasting (daily impact)	Total Daily Impacts (except blasting) - (2)	Cumulative Daily Impacts - (3) (Total Daily Impacts + background) - (4)	Cumulative Yearly Impacts - (5) (Total Yearly Impacts + background) - (6)
25	0.17	11.66	23.42	11.83	44.83	12.06
26	0.07	3.77	12.55	3.85	36.85	10.67
27	0.21	2.86	0.18	3.07	36.07	10.54
28	0.29	63.69	7.77	63.98	96.98	21.68
29	0.24	33.43	21.36	33.67	66.67	13.20
30	0.17	10.21	24.58	10.38	43.38	11.04
31	0.13	1.47	27.41	1.60	34.60	10.17
32	0.10	1.31	27.63	1.41	34.41	10.11
33	0.05	1.16	17.79	1.21	34.21	10.08
34	0.22	1.88	7.60	2.10	35.10	10.17
35	0.27	5.36	25.48	5.63	38.63	10.57
B1	0.08	1.58	25.03	1.66	34.66	10.11
B2	0.16	7.46	1.78	7.62	40.62	11.07

Note (1) Total daily impact included emissions due to loading & unloading, stock piling, top soil removal, wind erosion and TBM.
(2) Total daily impact is the sum of all daily impacts except blasting (including unpaved roads).
(3) Cumulative daily impact is the sum of the total daily impact (except blasting) and the background RSP level. (Daily impact due to unpaved roads is reduced by 90%.)
(4) The background RSP level is assumed to be 33 $\mu g/m^3$ for both daily RSP impacts.
(5) Cumulative yearly impact is the total yearly impact (except blasting).
(6) The background RSP level is assumed to be 10 $\mu g/m^3$ for yearly RSP impacts. (Yearly impact due to unpaved roads is reduced by 90%.)



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NOTES

no.	date	description	initial
REVISION			

	name	date
Designed	RVC	5/95
Traced		
Checked	AL	5/95
Approved		

Agreement no. CE 41/94

Contract no.

Project title

Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Raw Water Aqueduct : Air Sensitive Receivers

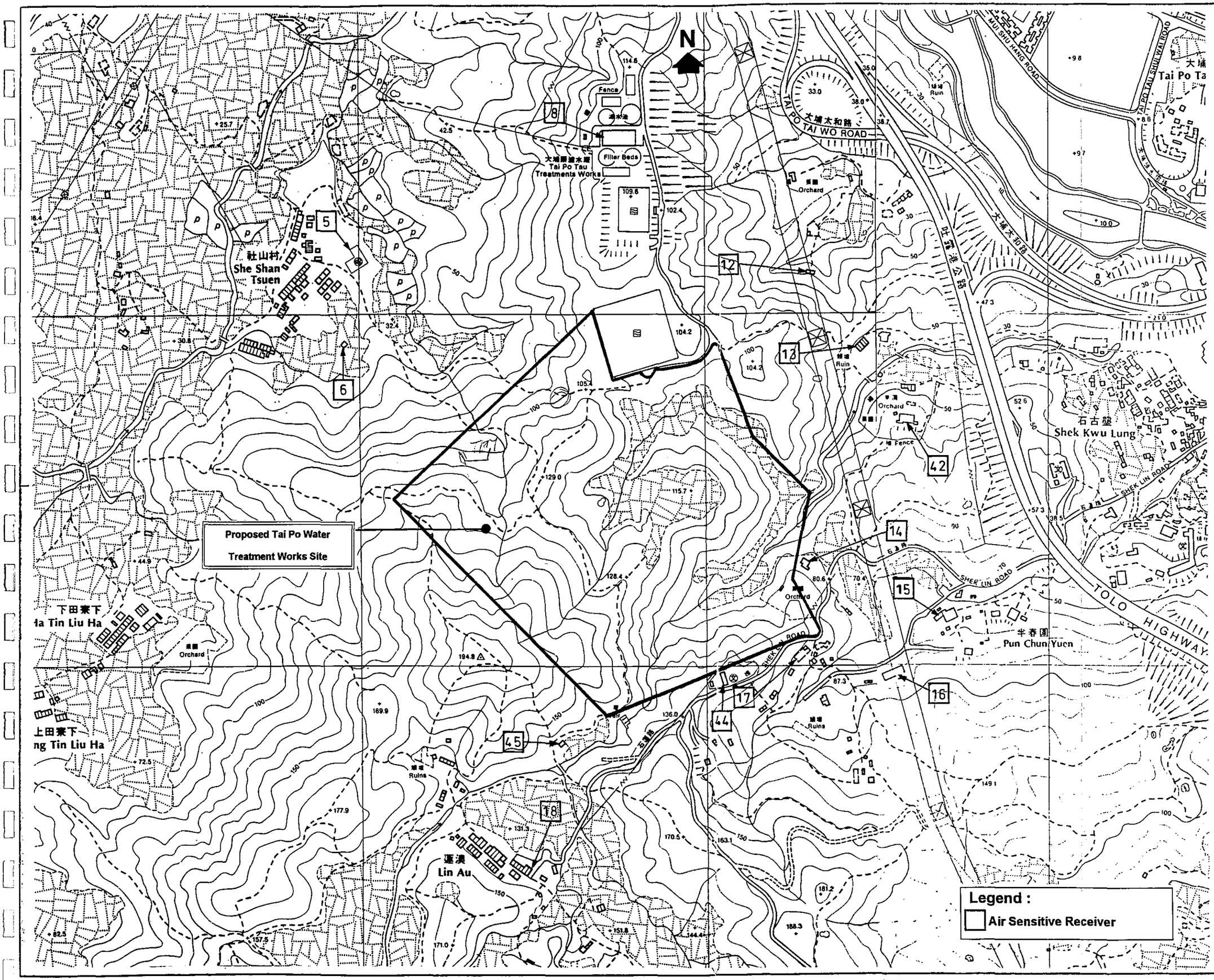
Plan register No.

Figure no. 7.1

Scale 1 : 5000

Water Supplies Department

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼



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no.	date	description	initial
REVISION			

	name	date
Designed	RVC	5/95
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Approved		

Agreement no. CE 41/94

Contract no.

Project title

Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Water Treatment Works : Air Sensitive Receivers

Plan register No.

Figure no. 7.2

Scale 1 : 5000

Water Supplies Department

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼

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NOTES

城門（銀禧）水塘
SHING MUN (JUBILEE) RESERVOIR

Possible location of shaft

Legend :
Air Sensitive Receiver

no.	date	description	initial
REVISION			

	name	date
Designed	RVC	5/95
Traced		
Checked	AL	5/95
Approved		

Agreement no. CE 41/94

Contract no.

Project title

Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Shing Mun Access Shaft : Air Sensitive Receivers

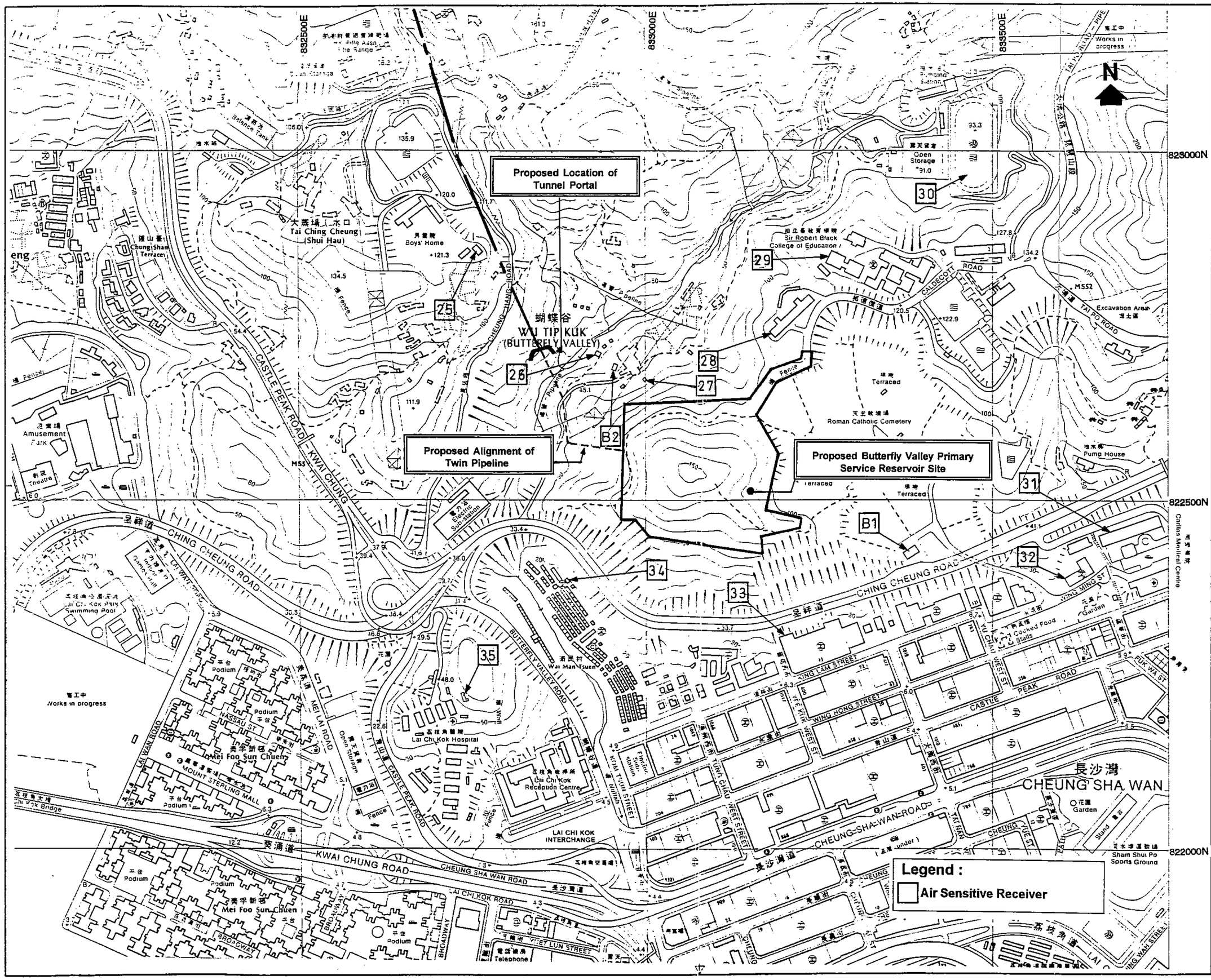
Plan register No.

Figure no. 7.3

Scale 1 : 5000

Water Supplies Department

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS



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NOTES

no.	date	description	initial
REVISION			

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Designed	RVC	5/95
Traced		
Checked	AL	5/95
Approved		

Agreement no CE 41/94

Contract no.

Project title

Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Butterfly Valley Reservoir : Air Sensitive Receivers

Plan register No.

Figure no. 7.4

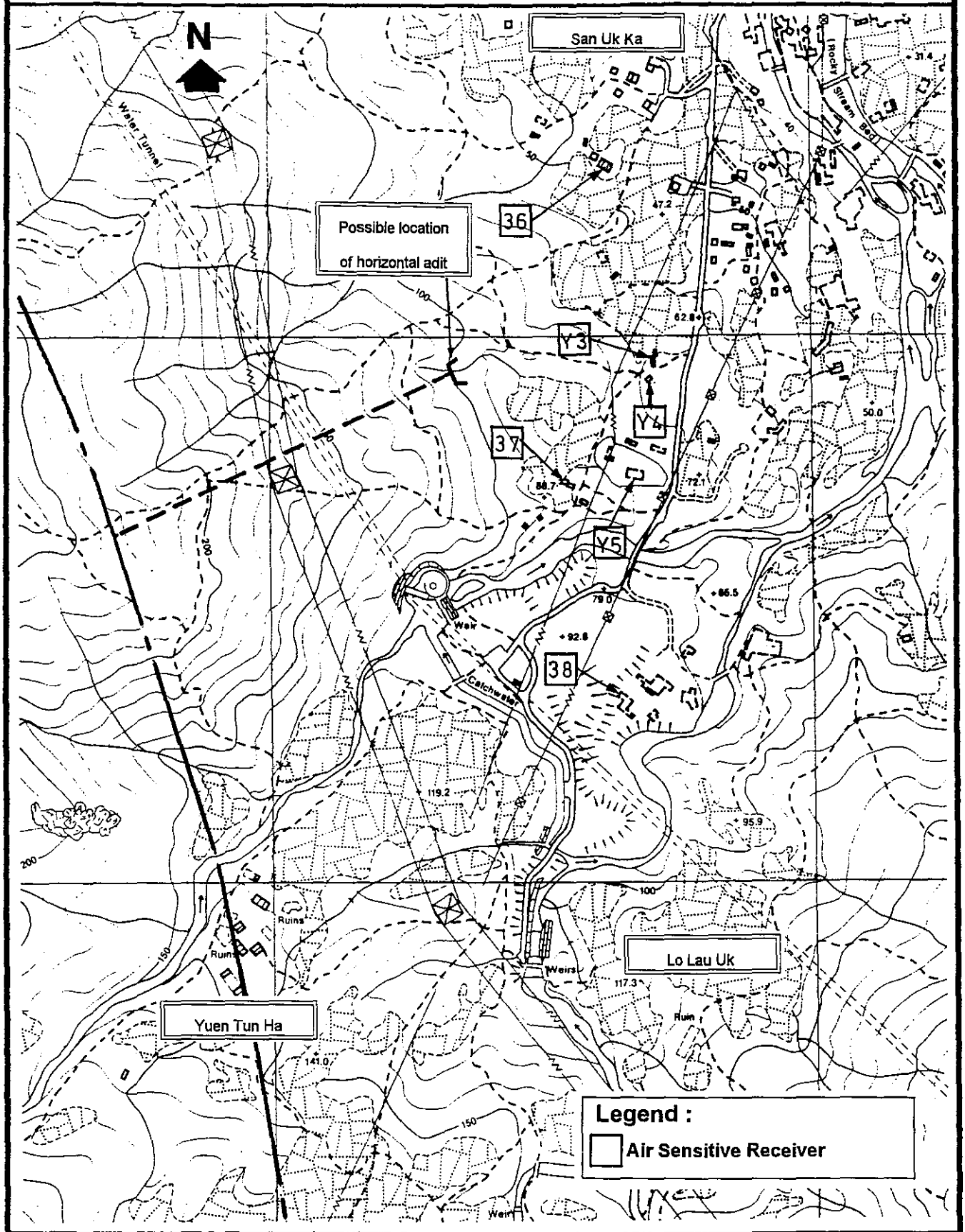
Scale 1 : 5000

Water Supplies Department

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS

Additional Treatment And Water Transfer Facilities For
The Metropolitan Area And North-Eastern New Territories
Agreement No. CE 41/94

Water Supplies Department



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CONSULTING ENGINEERS
賓尼

Yuen Tun Ha Shaft/Adit : Air Sensitive Receivers

Figure no.	Scale		Name	Date
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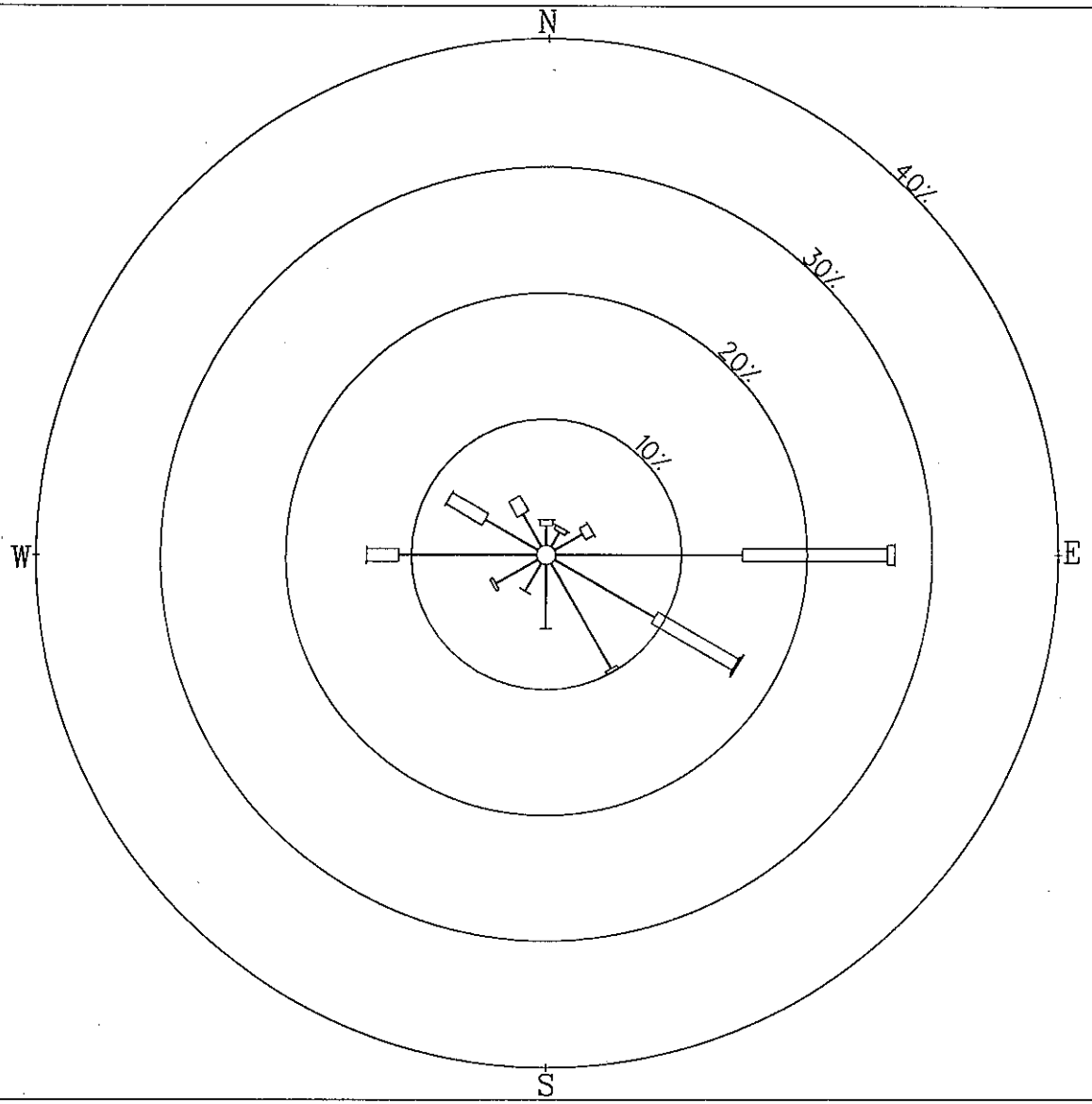
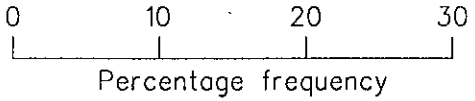


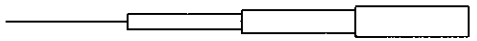
JAN 1991 - DEC 1993

No. of observations = 23582

No. of variable winds = 3 (.0%)

No. of calm winds = 0 (.0%)





2-12	13-30	31-51	>51	km/h
0.1-3.2	3.3-8.2	8.3-14.2	>14.2	m/s
1-2	3-4	5-6	>6	Beaufort force

Wind speed

Title :

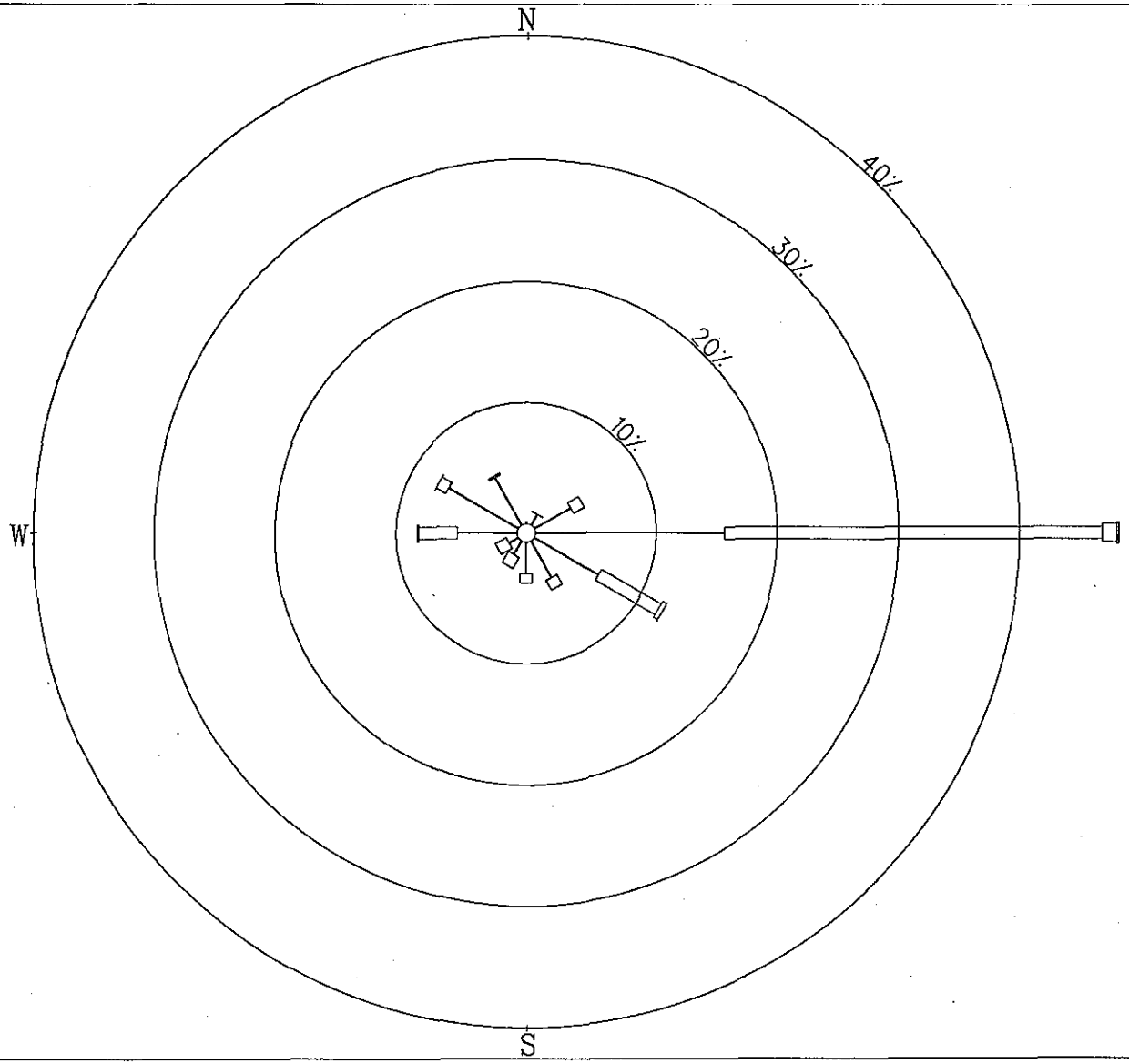
WIND ROSE FOR TAI PO KAU AWS STATION

Date : Apr. 95

Scale : -

BINNIE CONSULTANTS LIMITED

Figure No. 7.6



JAN 1989 - DEC 1993

No. of observations = 41216

No. of variable winds = 3 (.0%)

No. of calm winds = 0 (.0%)

0 10 20 30

Percentage frequency

2-12	13-30	31-51	>51	km/h
0.1-3.2	3.3-8.2	8.3-14.2	>14.2	m/s
1-2	3-4	5-6	>6	Beaufort force

Wind speed

Title :

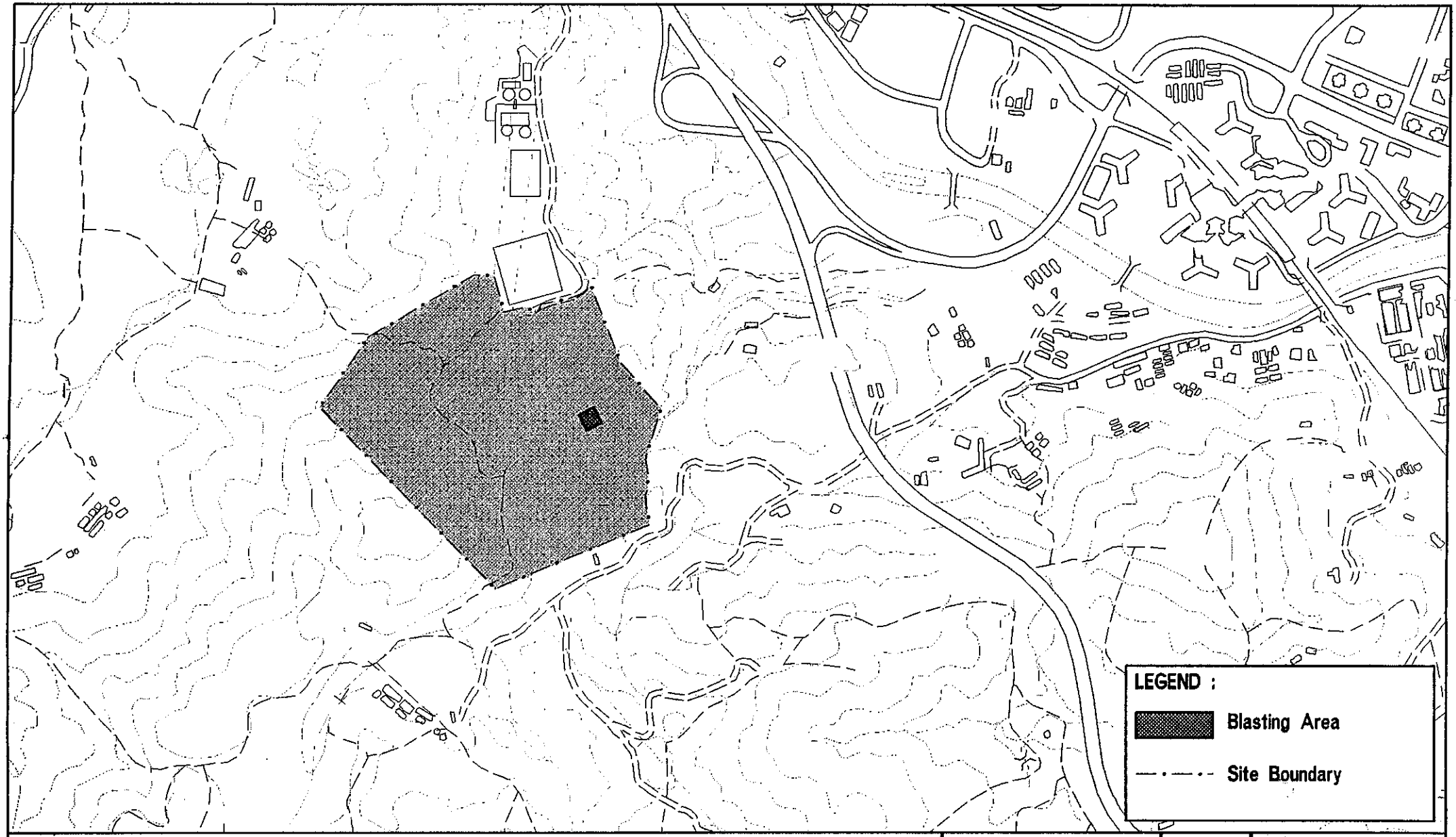
WIND ROSE FOR STAR FERRY AWS STATION

Date : Apr. 95

Scale : -

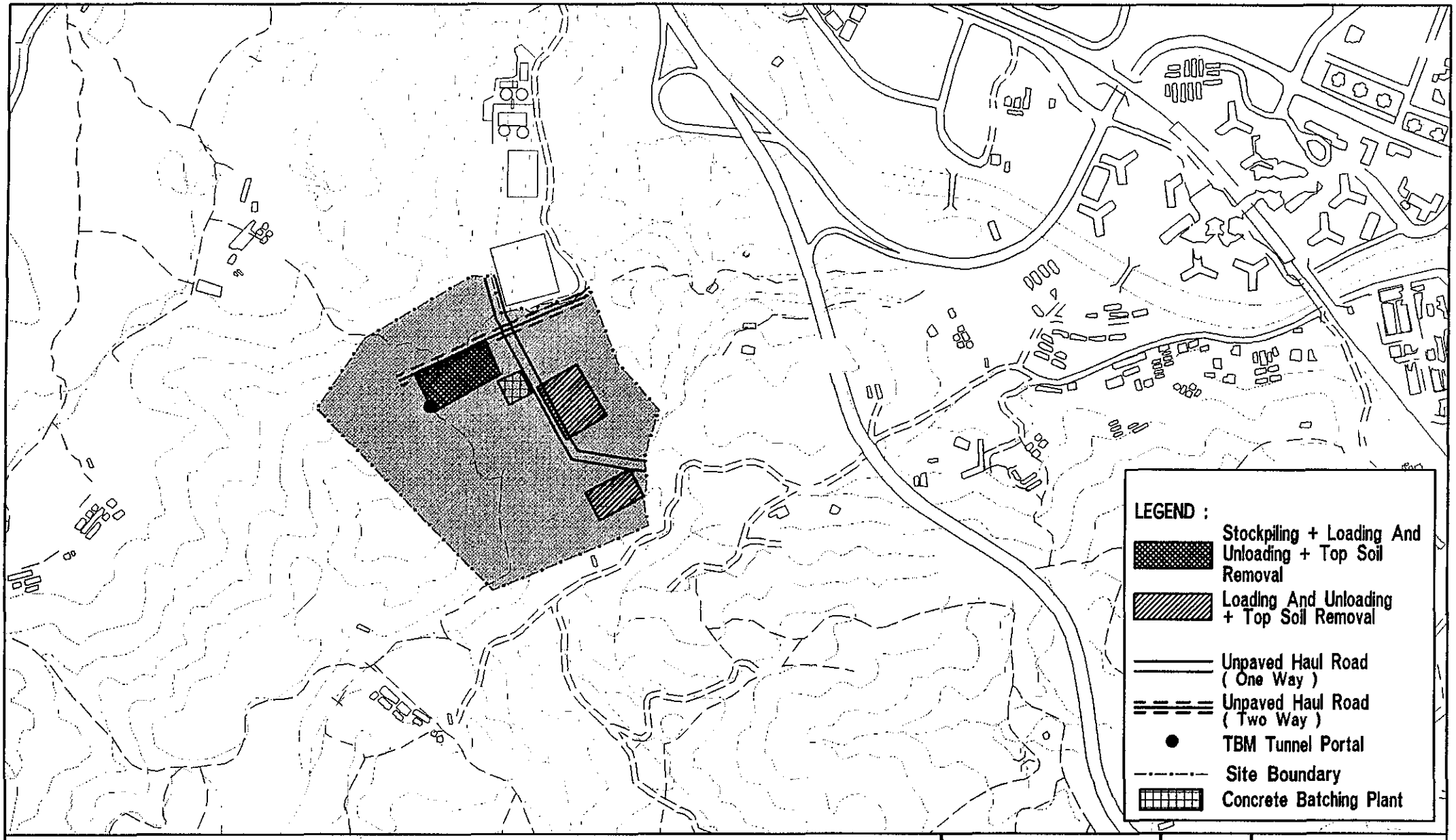
BINNIE CONSULTANTS LIMITED

Figure No. 7.7



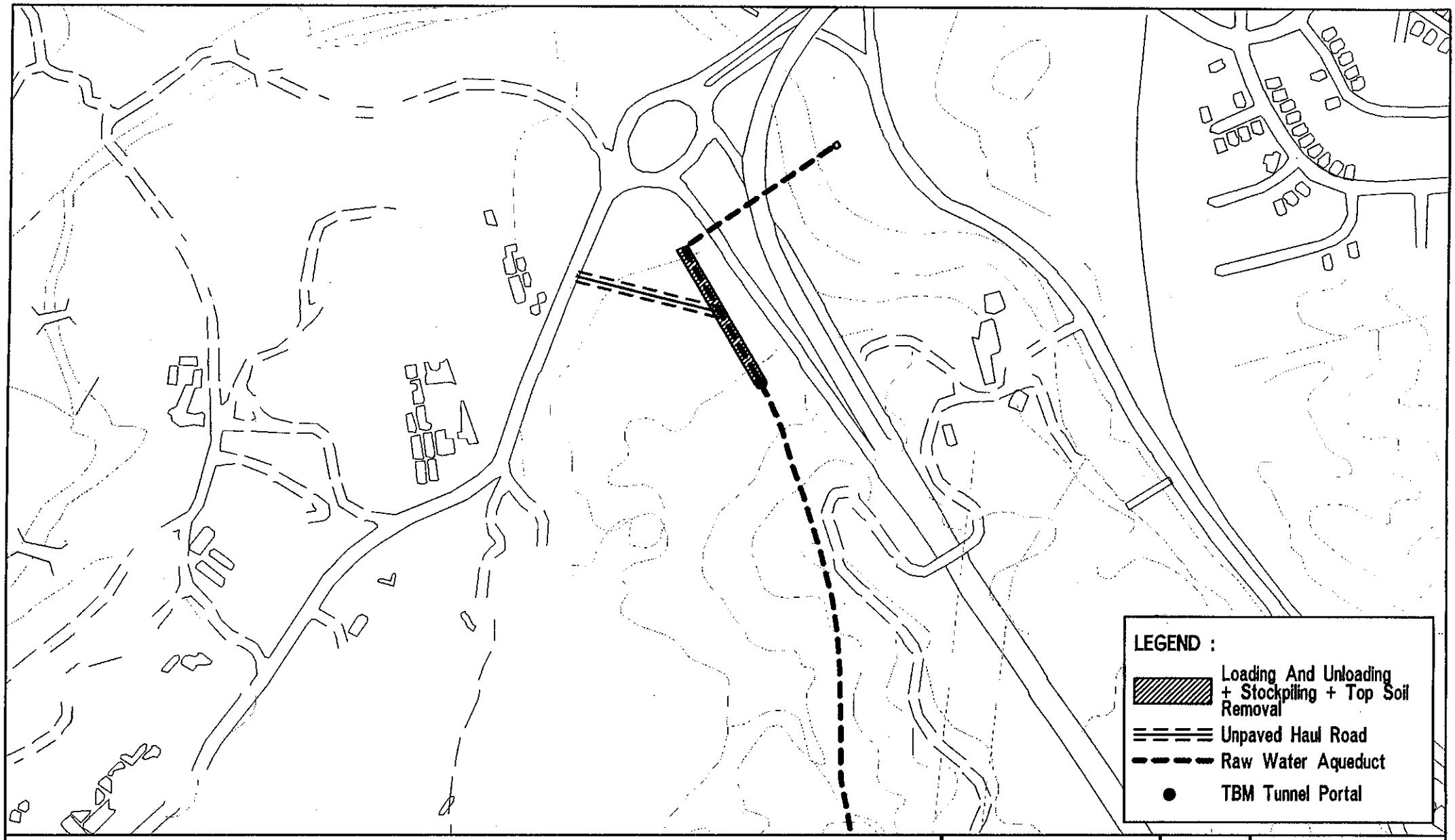
TAI PO WATER TREATMENT WORKS
SCENARIO 1 - BLASTING

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date March 95	Scale 1 : 9 000
Water Supplies Department	Initial WKY	Drawing No. 7.8



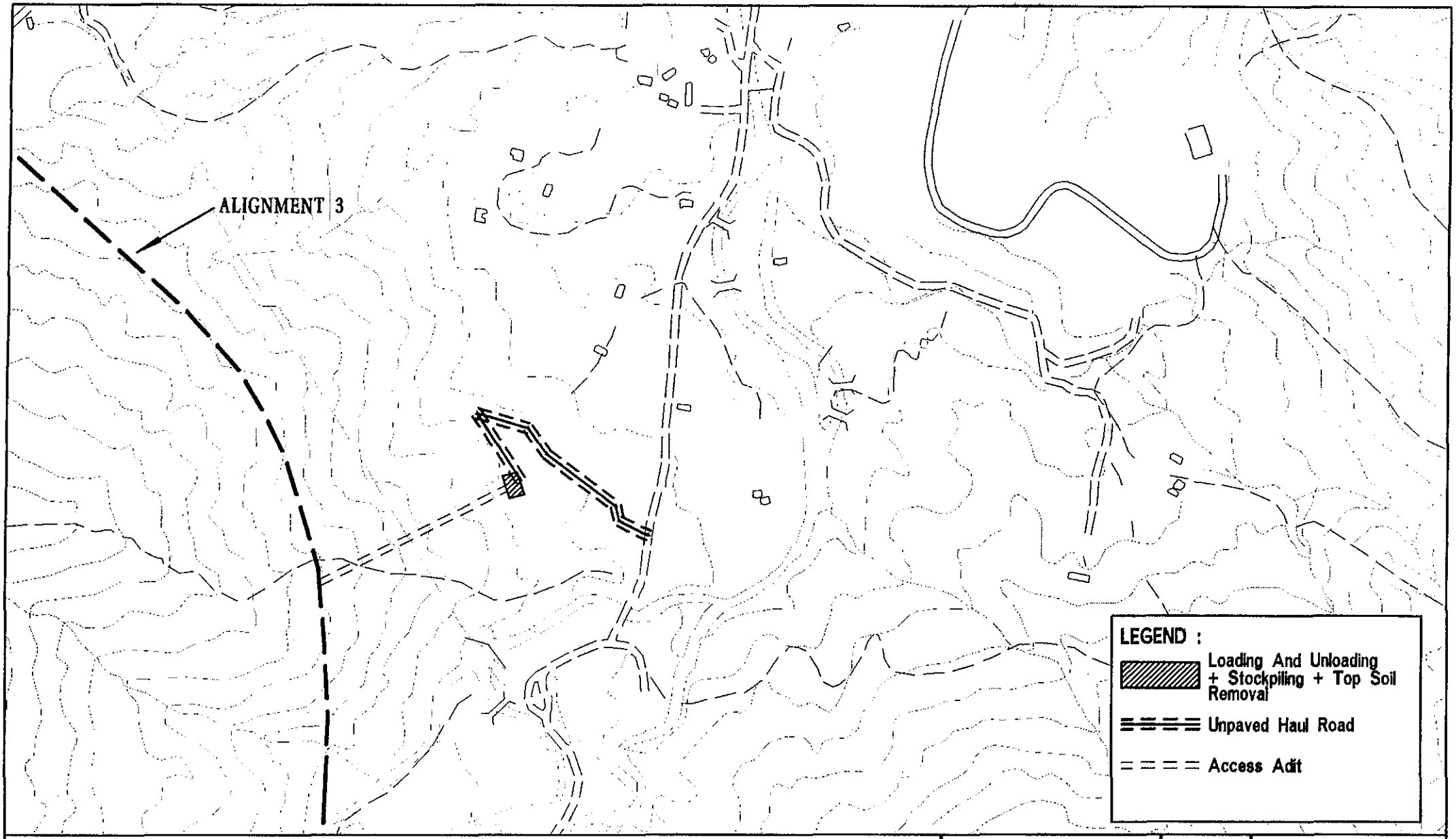
TAI PO WATER TREATMENT WORKS
SCENARIO 2 - EXCAVATION

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.9



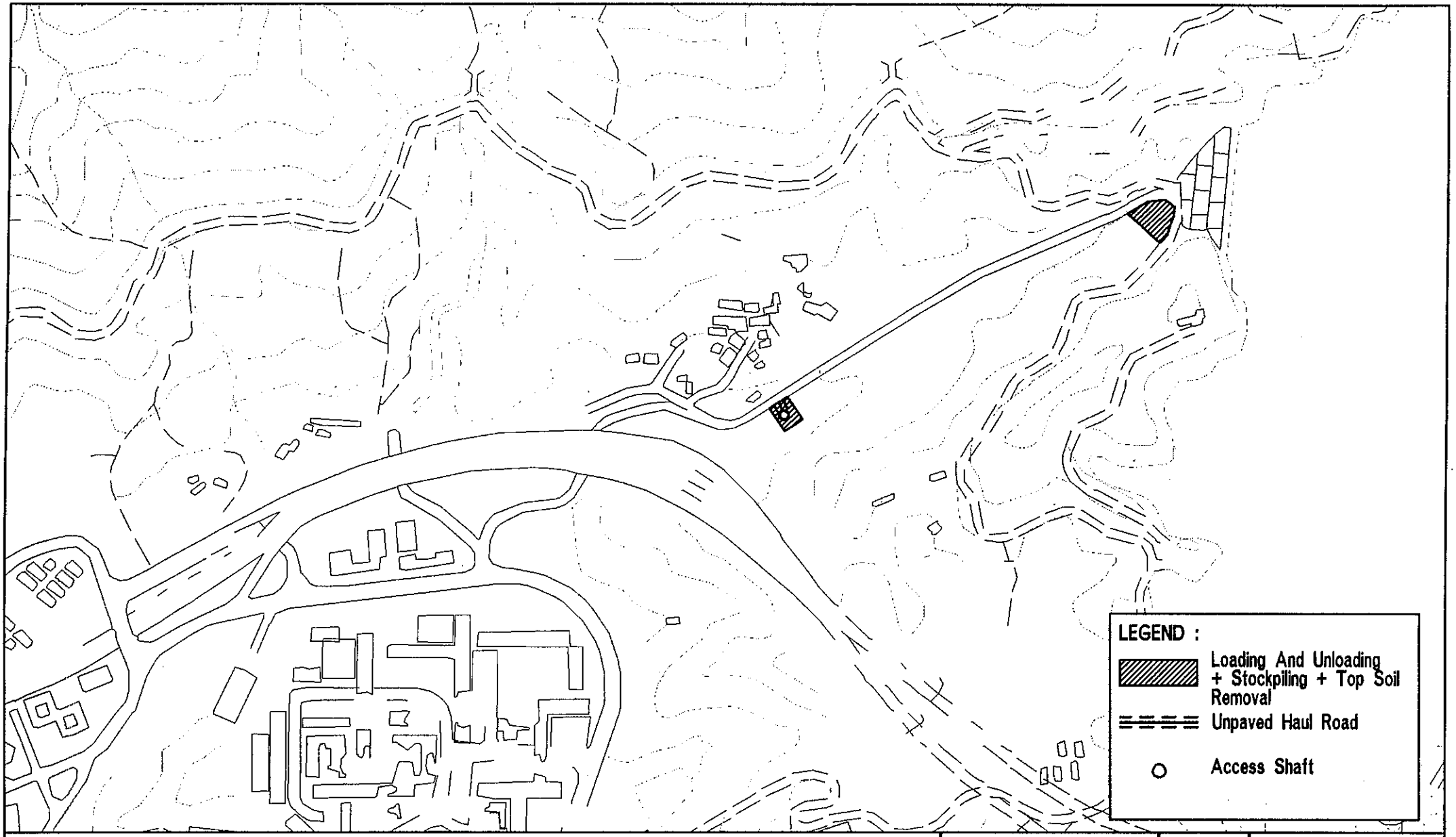
RAW WATER AQUEDUCT

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.10



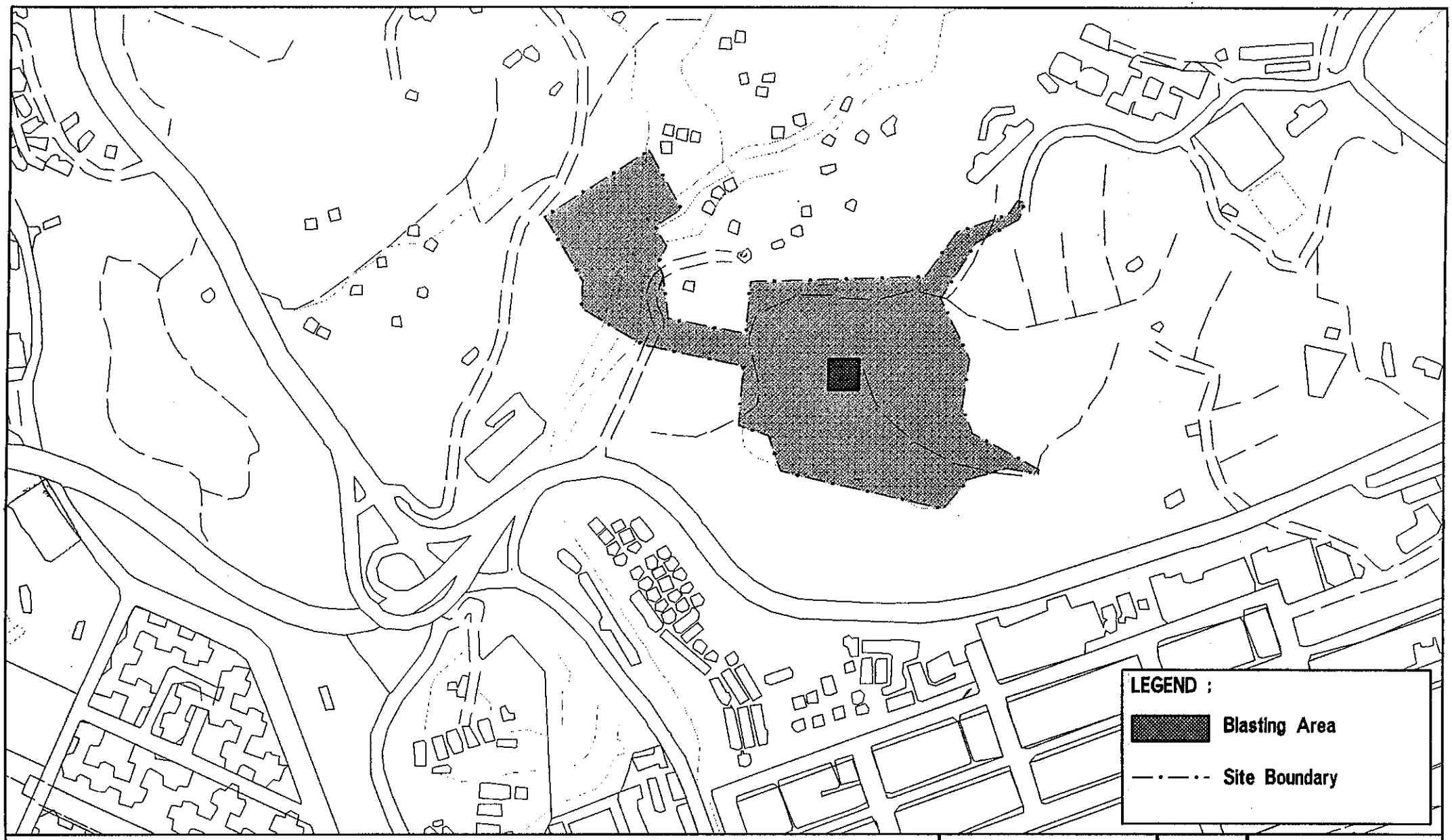
YUEN TUN HA ADIT

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 7 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.11



SHING MUN ACCESS SHAFT

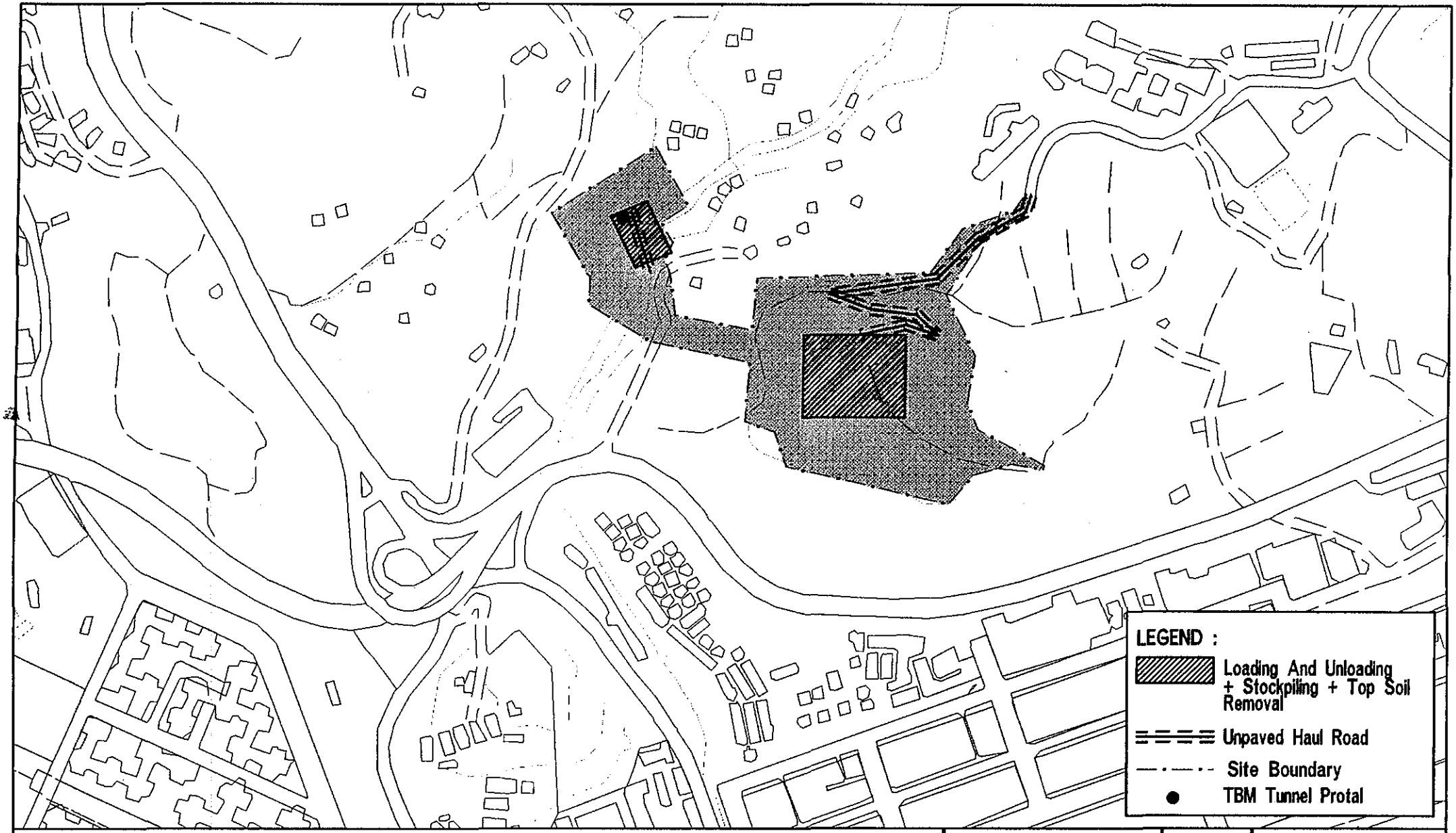
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 6 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.12



BUTTERFLY VALLEY SERVICE RESERVOIR

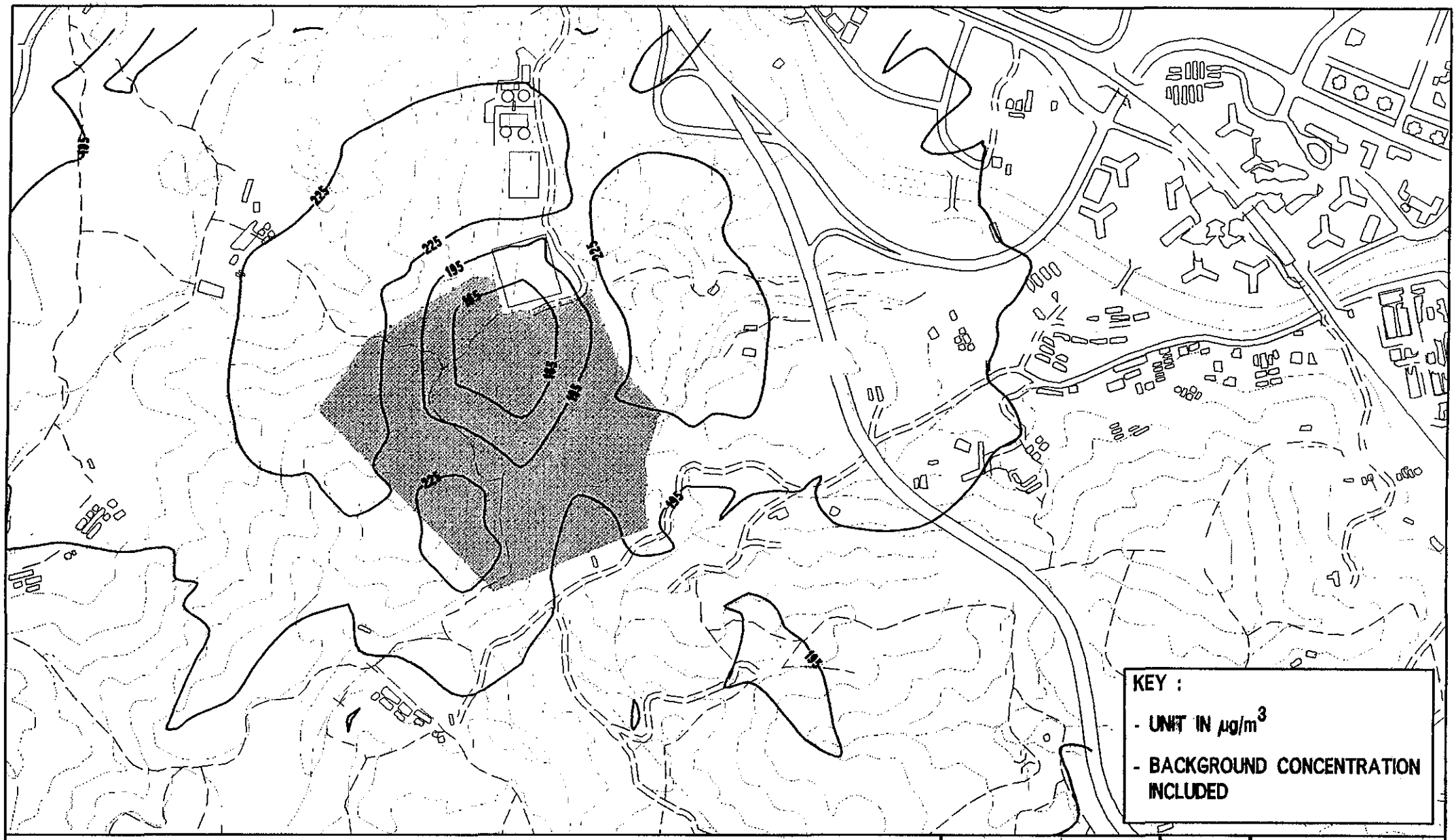
SCENARIO 1 - BLASTING

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.13



BUTTERFLY VALLEY SERVICE RESERVOIR
SCENARIO 2 - EXCAVATION

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.14

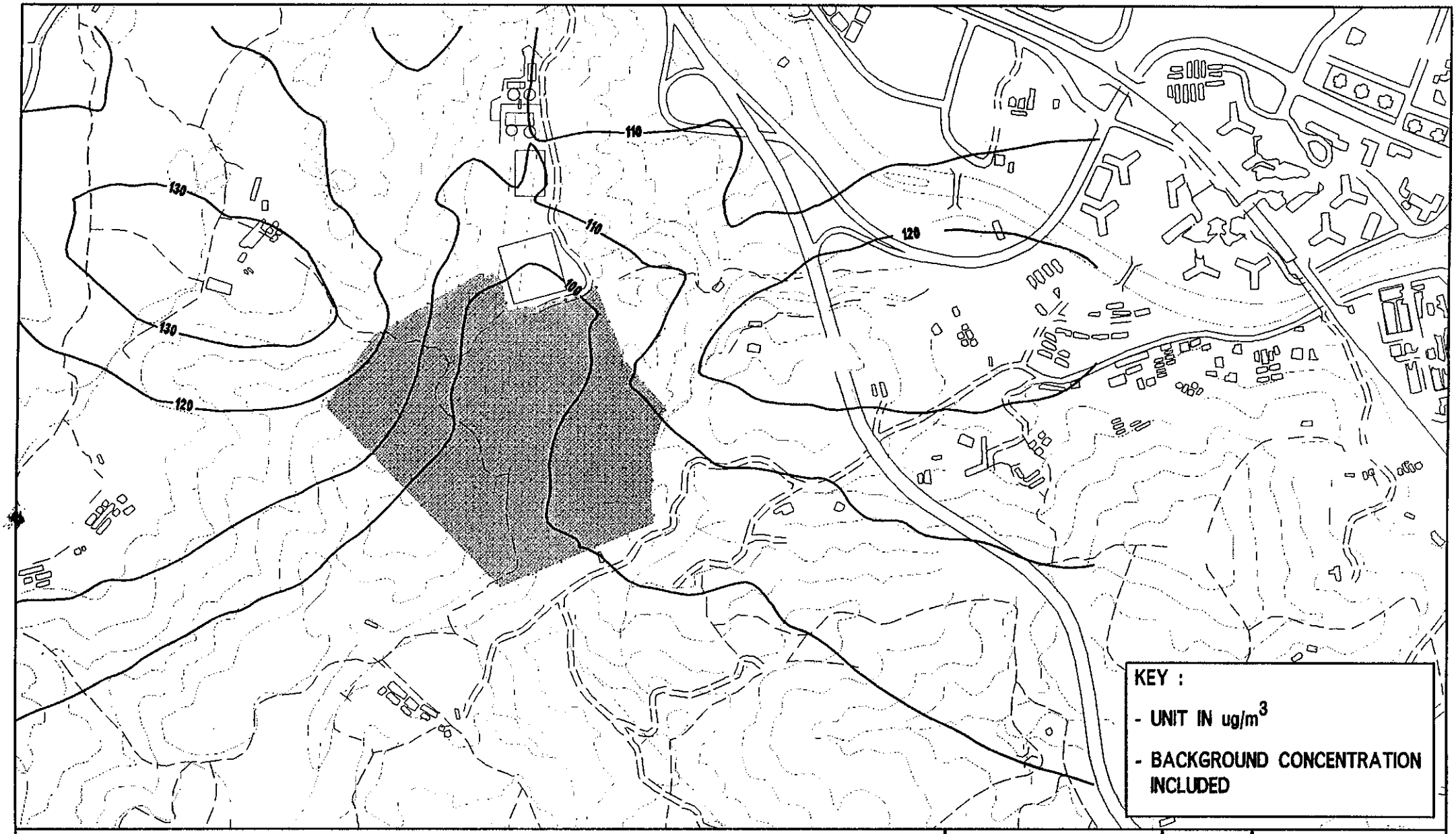


TAI PO WATER TREATMENT WORKS

1 HOUR TSP AT 30 mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.15

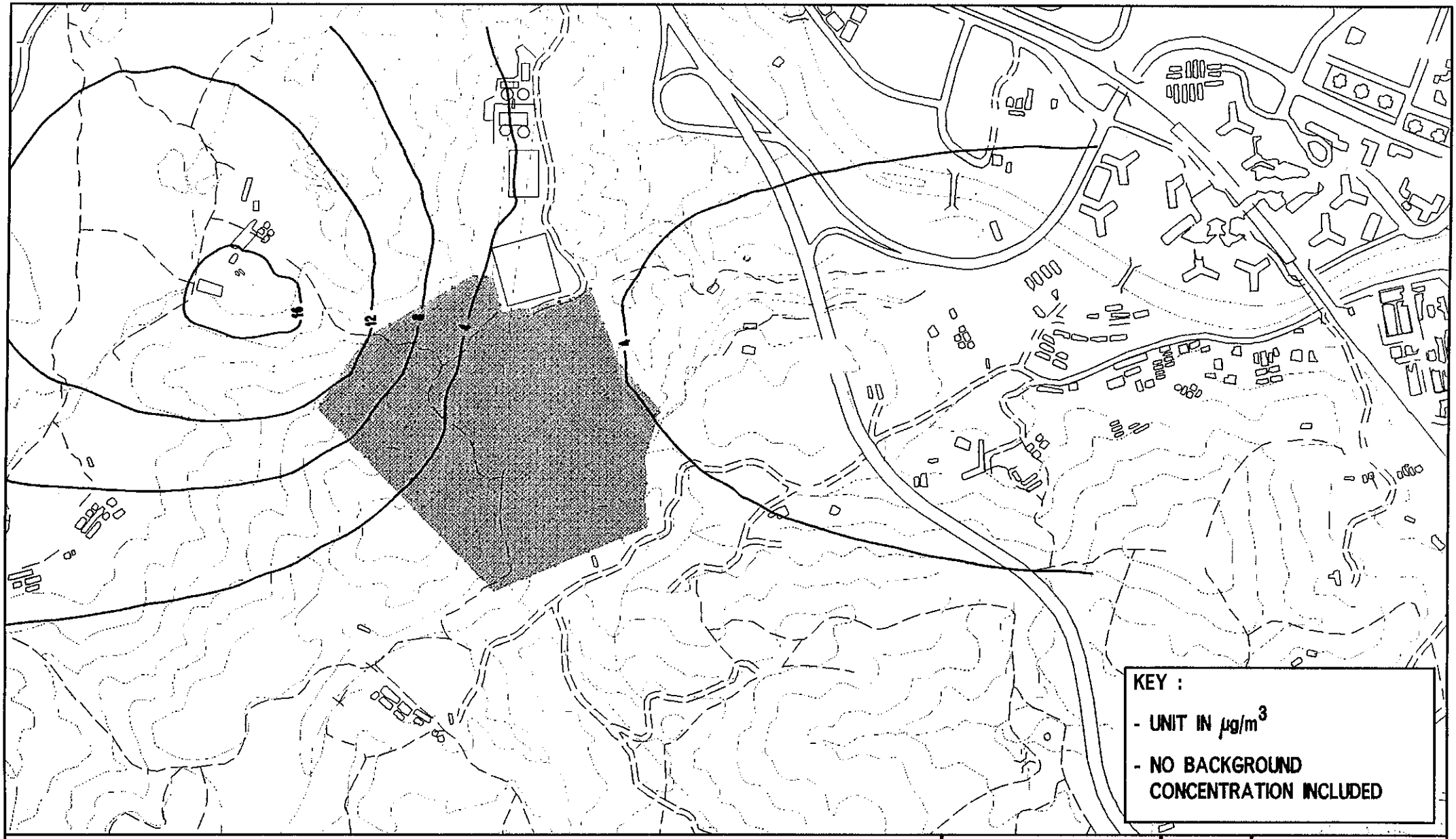


TAI PO WATER TREATMENT WORKS

24 HOUR TSP AT 30mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.16

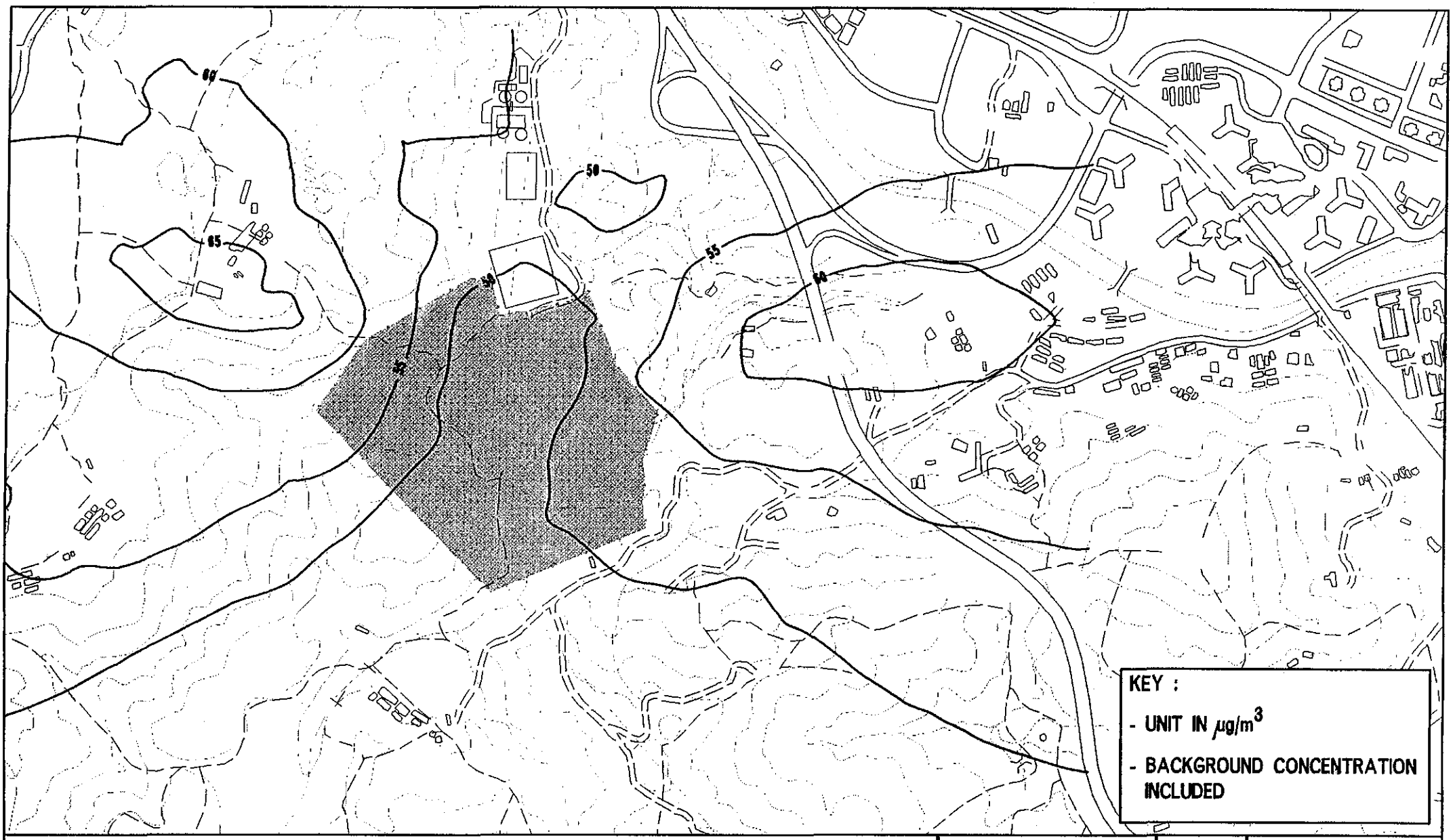


TAI PO WATER TREATMENT WORKS

ANNUAL TSP AT 30mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.17

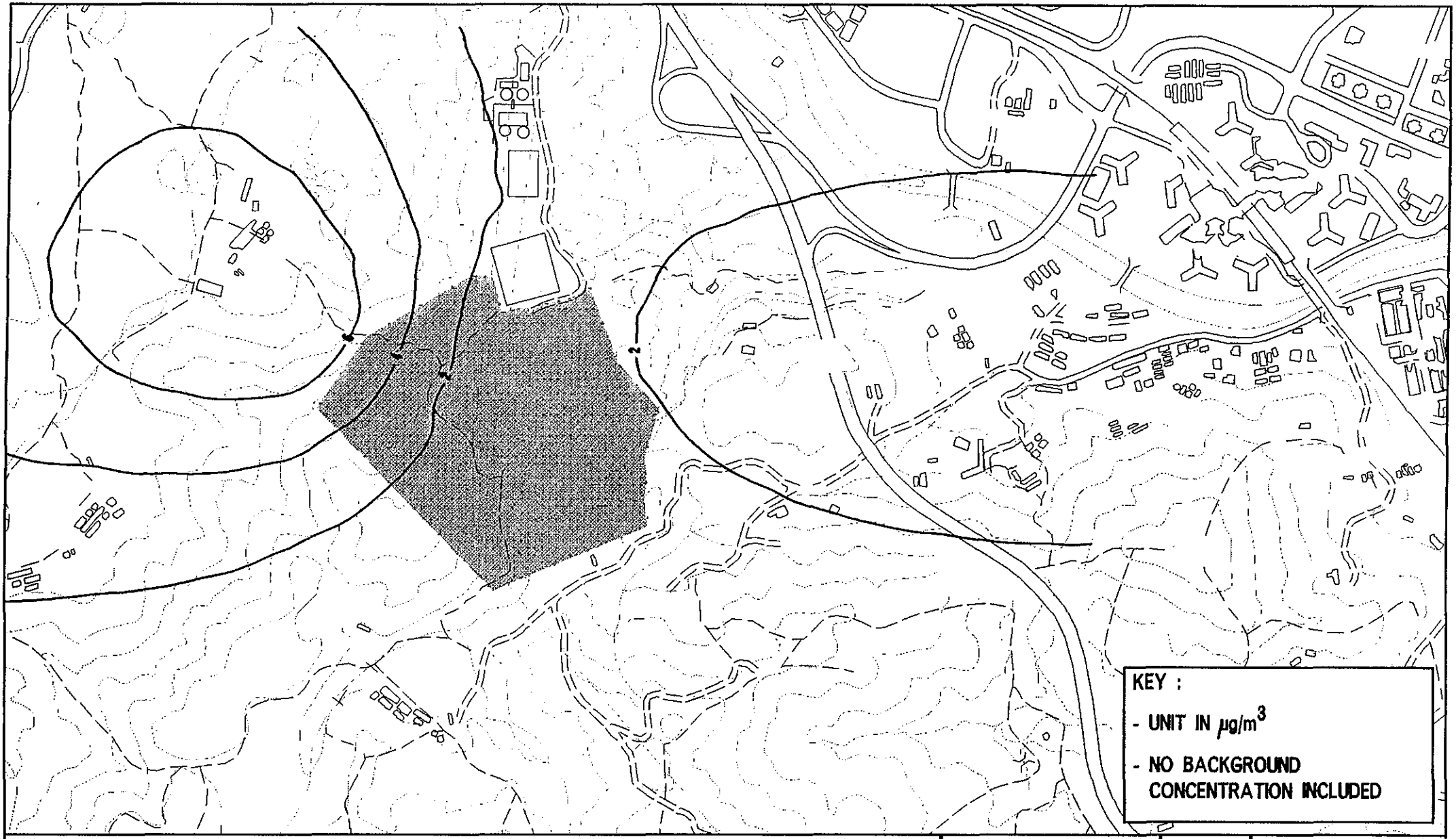


TAI PO WATER TREATMENT WORKS

24 HOUR RSP AT 30mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.18

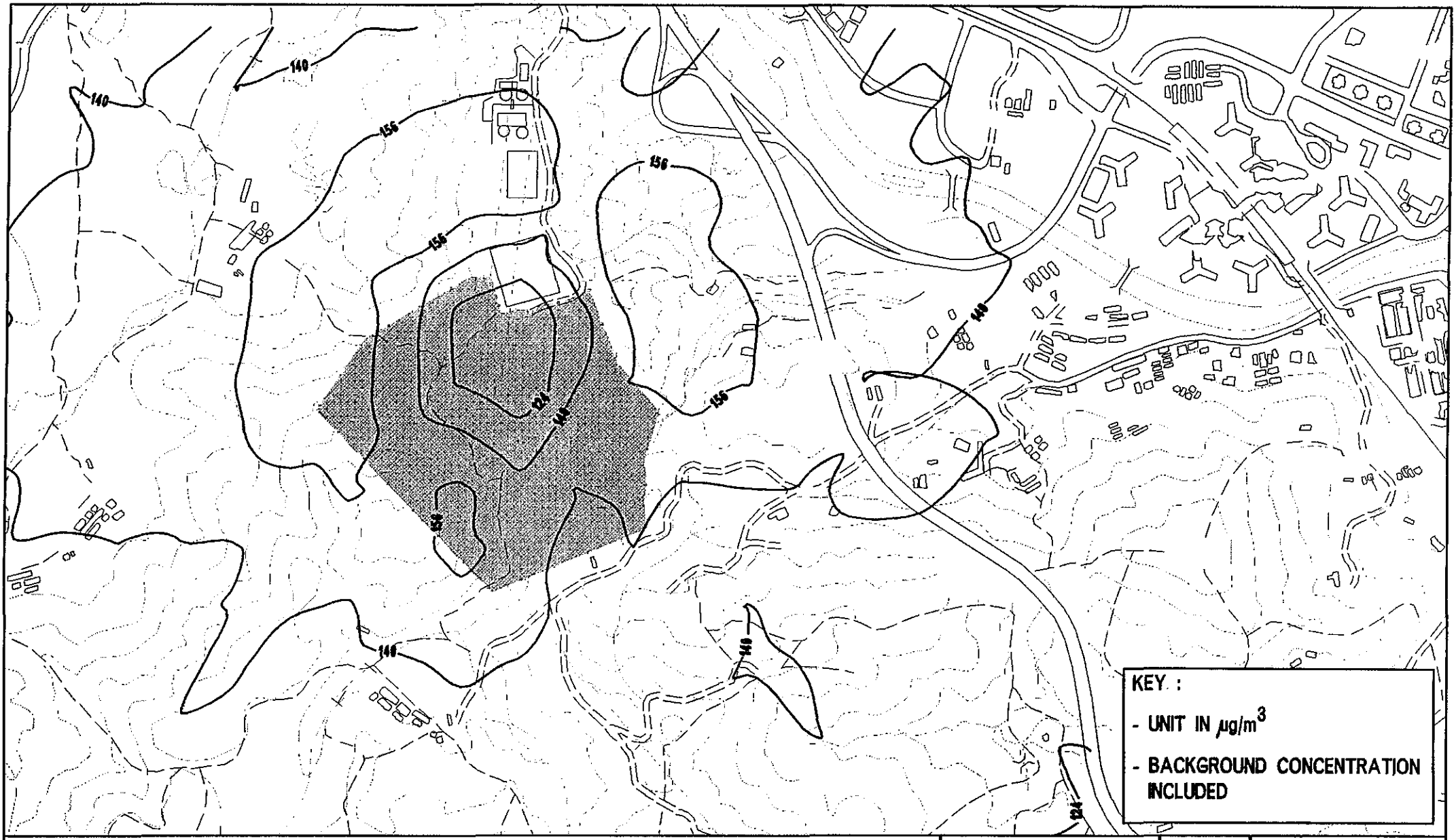


TAI PO WATER TREATMENT WORKS

ANNUAL RSP AT 30mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.19

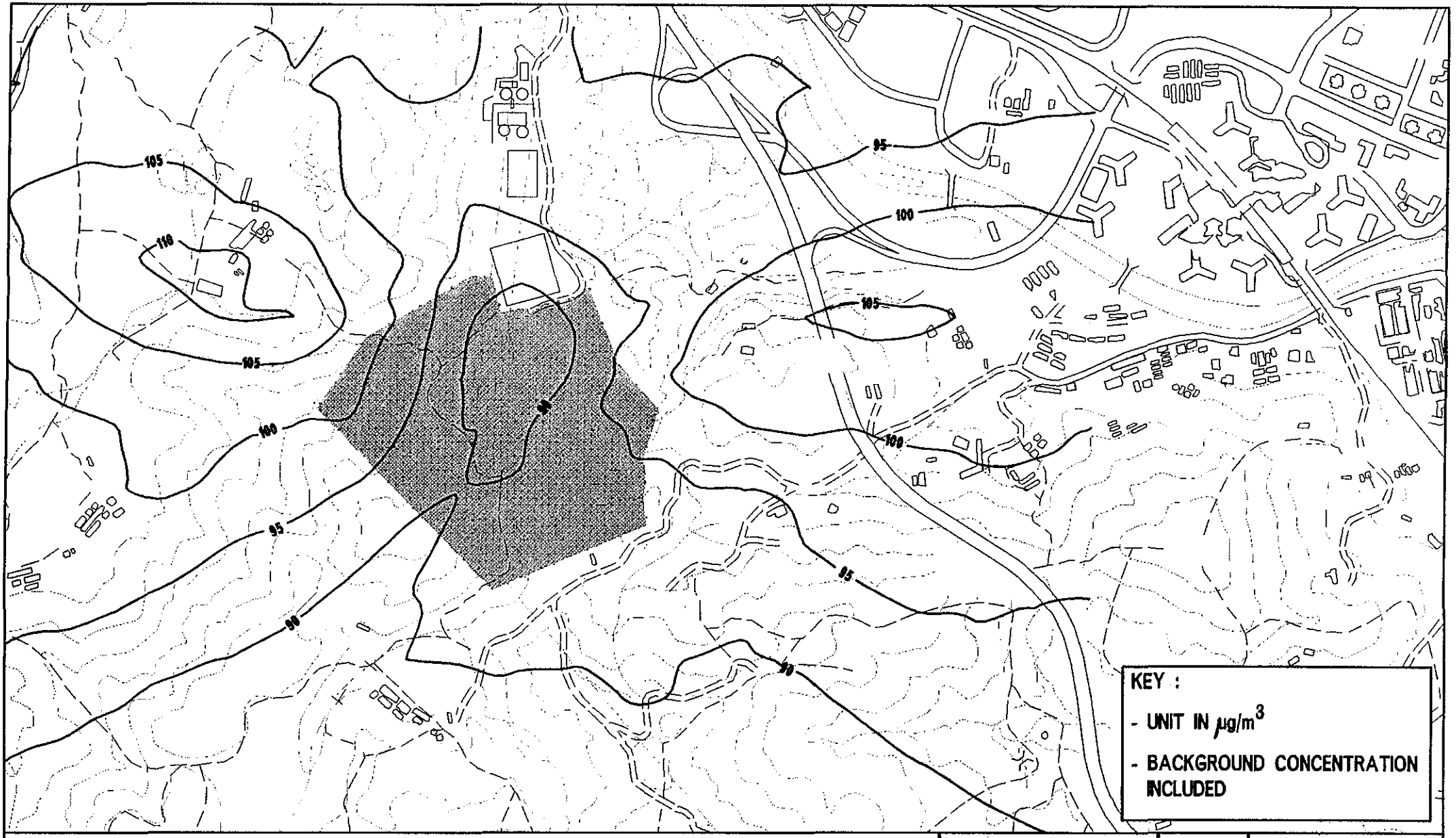


TAI PO WATER TREATMENT WORKS

1 HOUR TSP AT 30mPD

(ALL SOURCES EXCEPT BLASTING, WITH 50% REDUCTION IN DUST FROM DIRT ROAD)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date March 95	Scale 1 : 9 000
Water Supplies Department	Initial WKY	Drawing No. 7.20

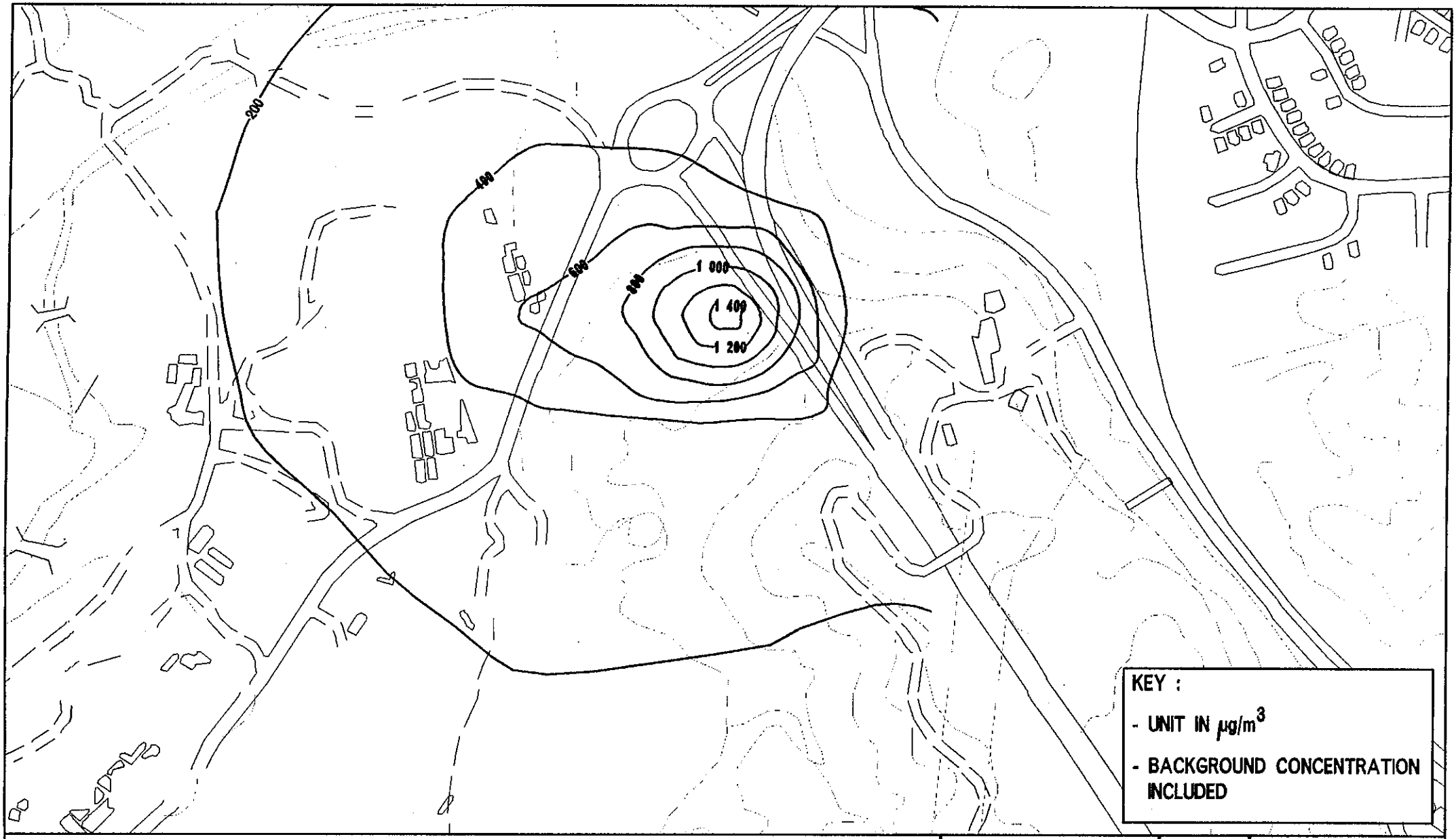


TAI PO WATER TREATMENT WORKS

24 HOUR TSP AT 30mPD

(ALL SOURCES EXCEPT BLASTING, WITH 50% REDUCTION IN DUST FROM DIRT ROAD)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼		Date: March 95	Scale: 1 : 9 000
Water Supplies Department		Initial: WKY	Drawing No.: 7.21

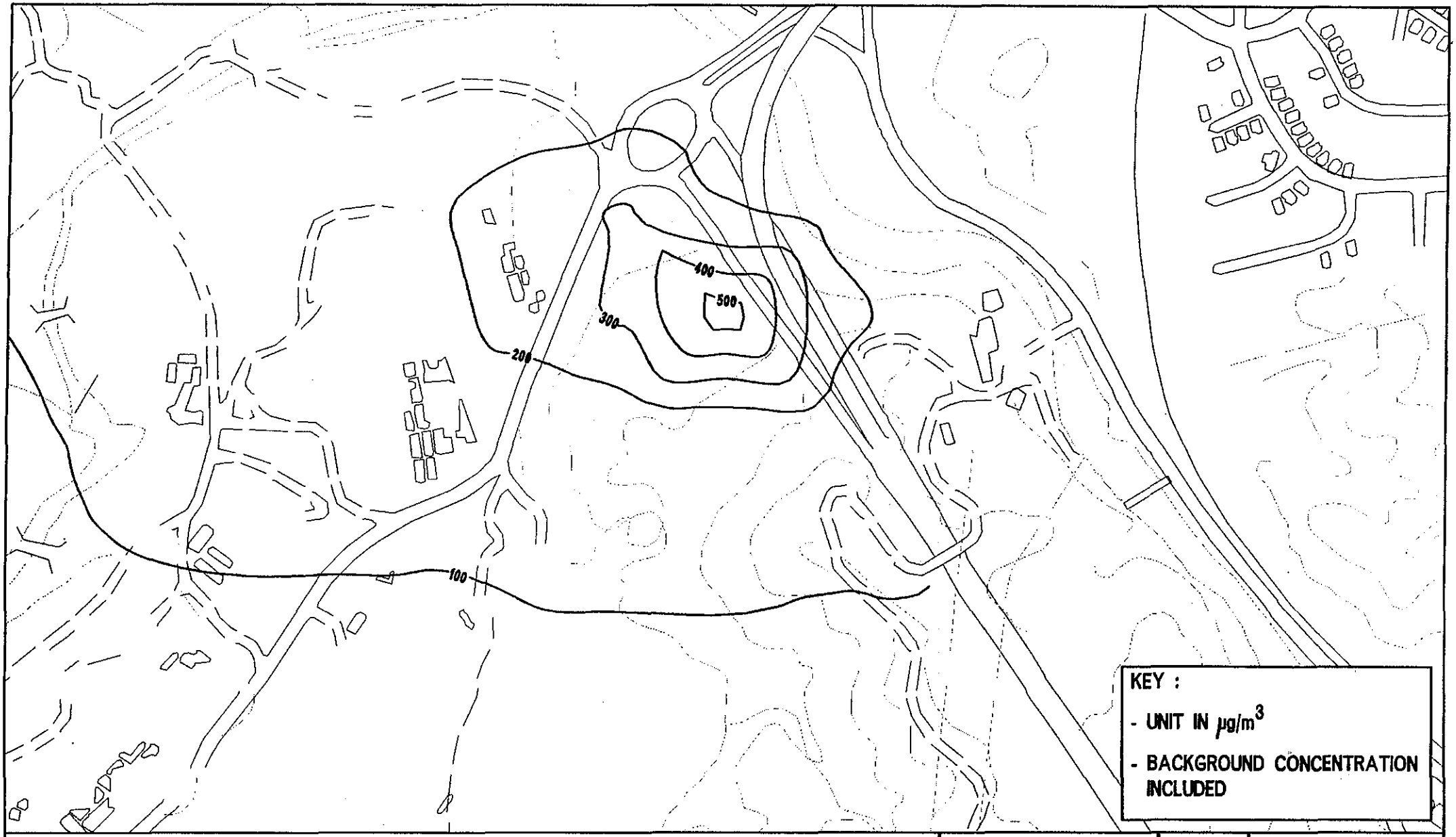


RAW WATER AQUEDUCT

1 HOUR TSP AT 19mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.22



KEY :

- UNIT IN $\mu g/m^3$
- BACKGROUND CONCENTRATION INCLUDED

RAW WATER AQUEDUCT

24 HOUR TSP AT 19mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 000
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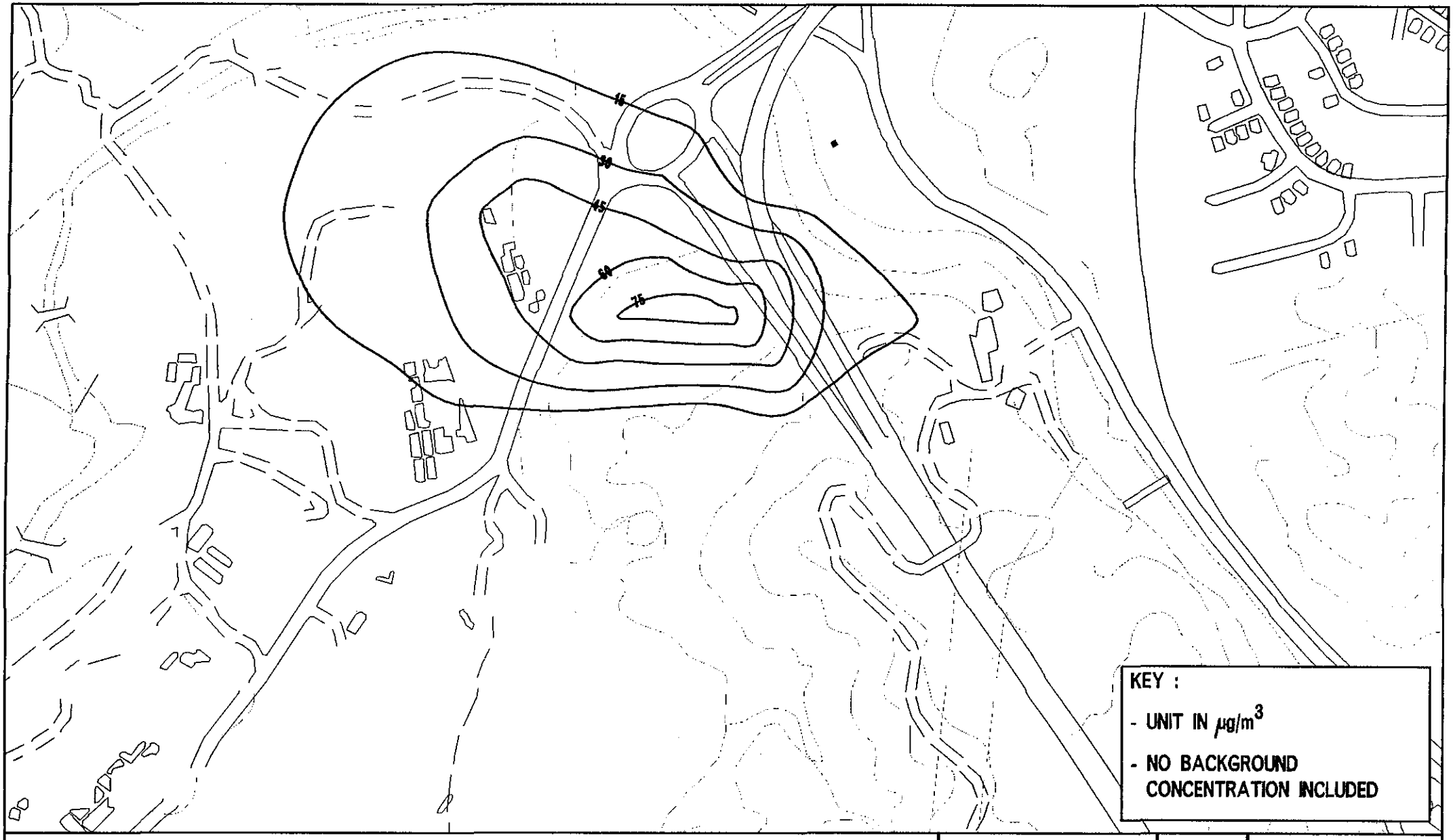

RAW WATER AQUEDUCT

ANNUAL TSP AT 19mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 000
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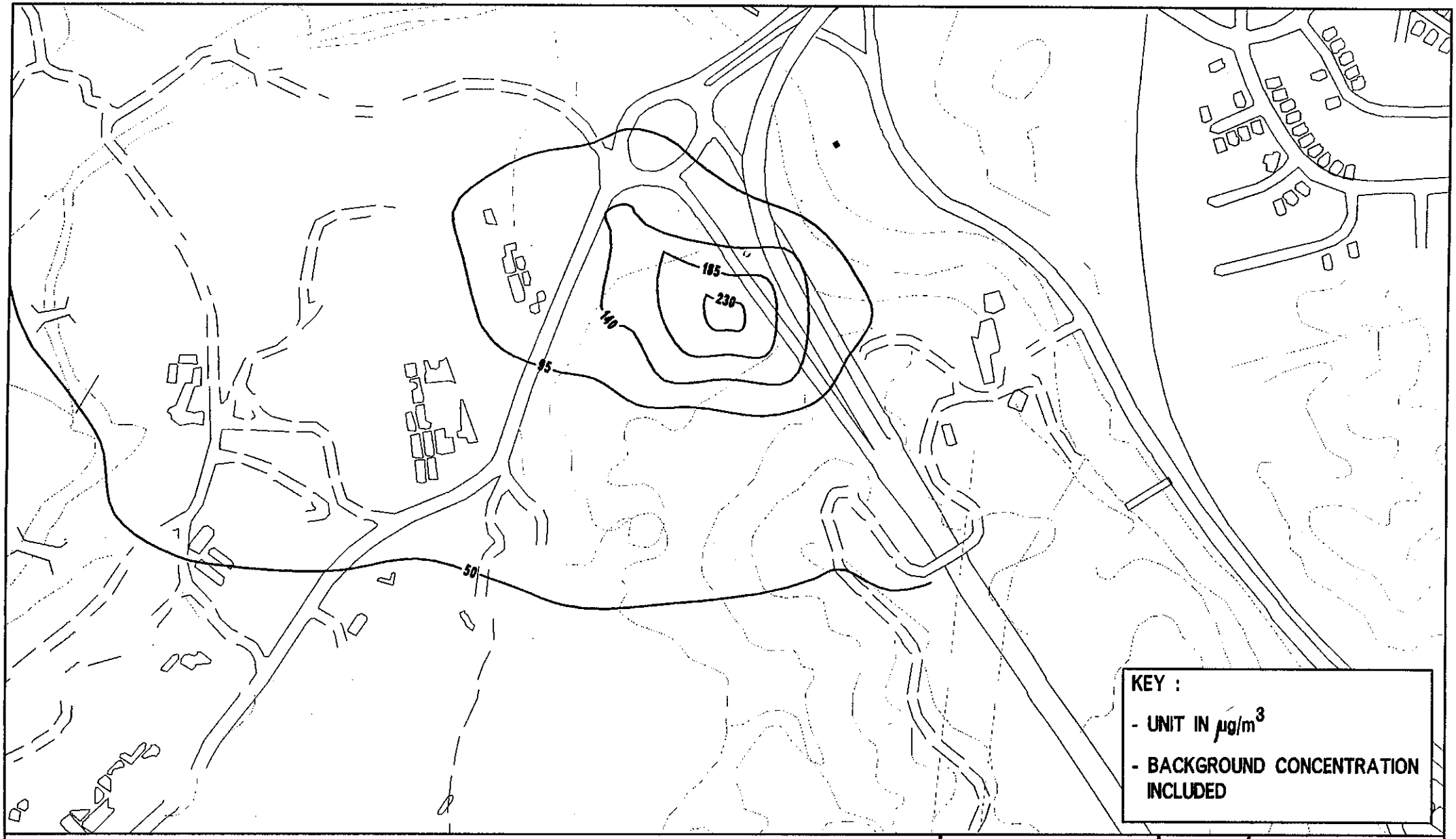

RAW WATER AQUEDUCT

24 HOUR RSP AT 19mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

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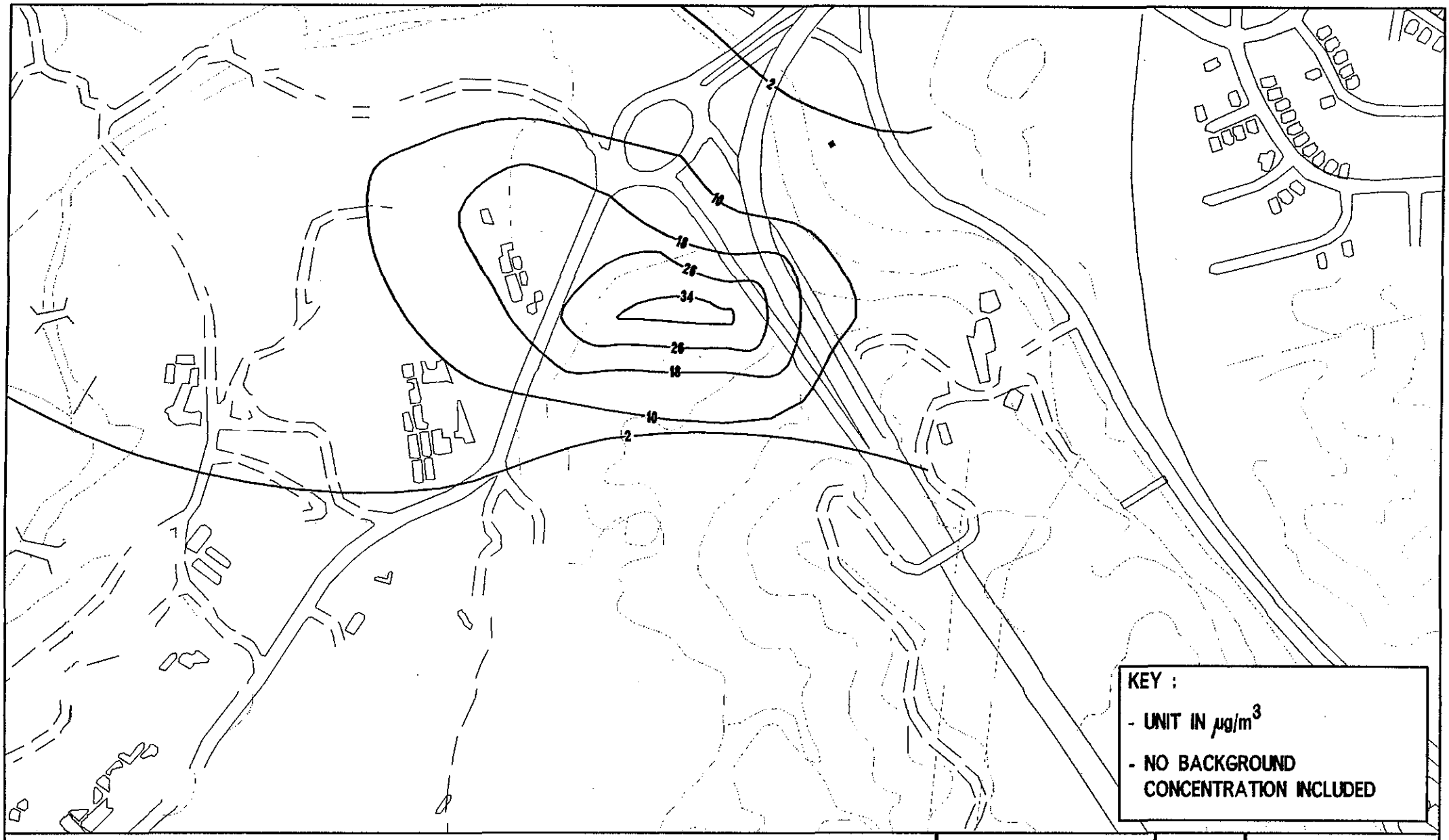

RAW WATER AQUEDUCT

ANNUAL RSP AT 19mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

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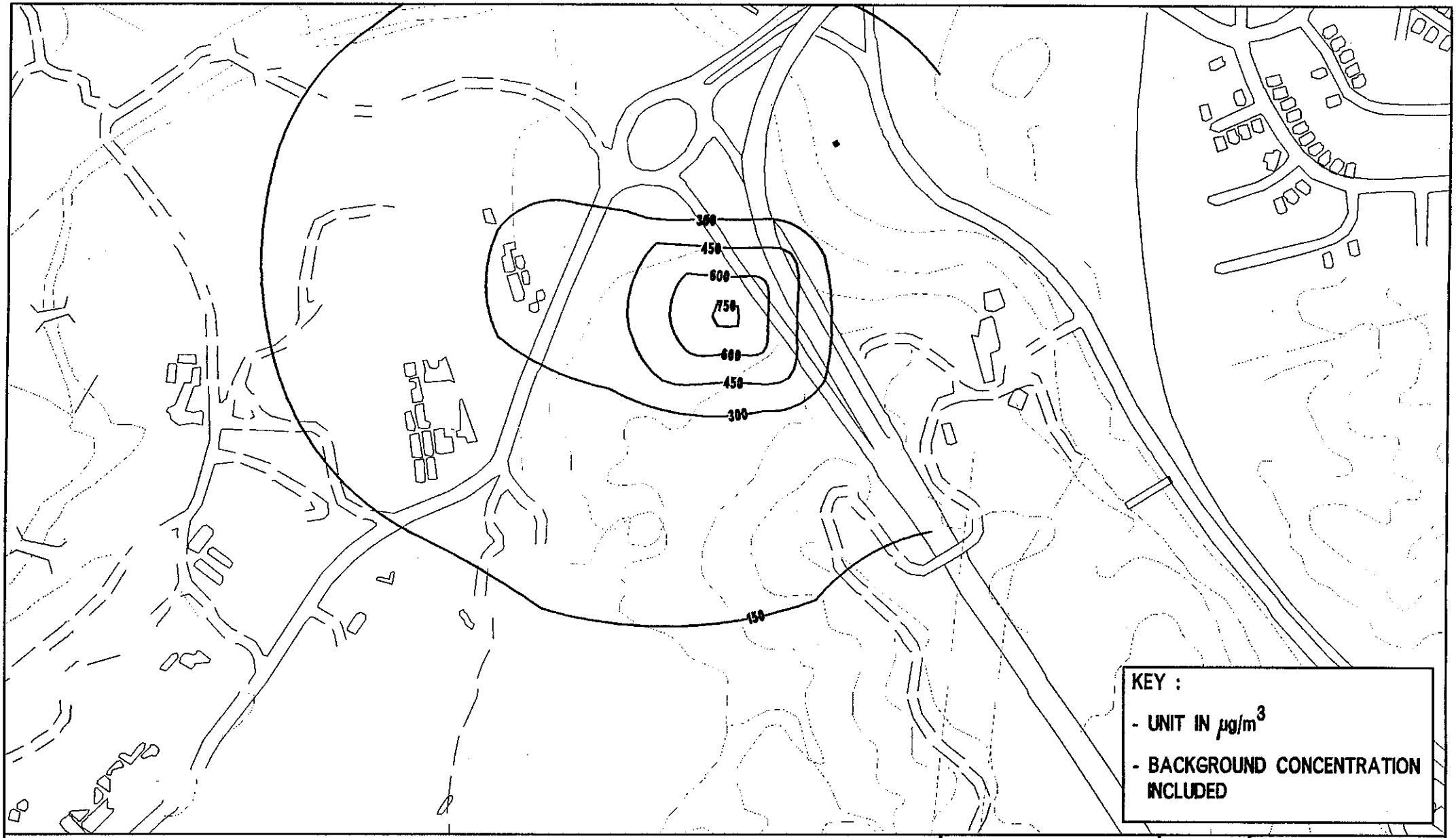

KEY :

- UNIT IN $\mu g/m^3$
- BACKGROUND CONCENTRATION INCLUDED

RAW WATER AQUEDUCT

1 HOUR TSP AT 19mPD

(ALL SOURCES EXCEPT BLASTING, WITH 50% REDUCTION IN DUST FROM DIRT ROAD)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 000
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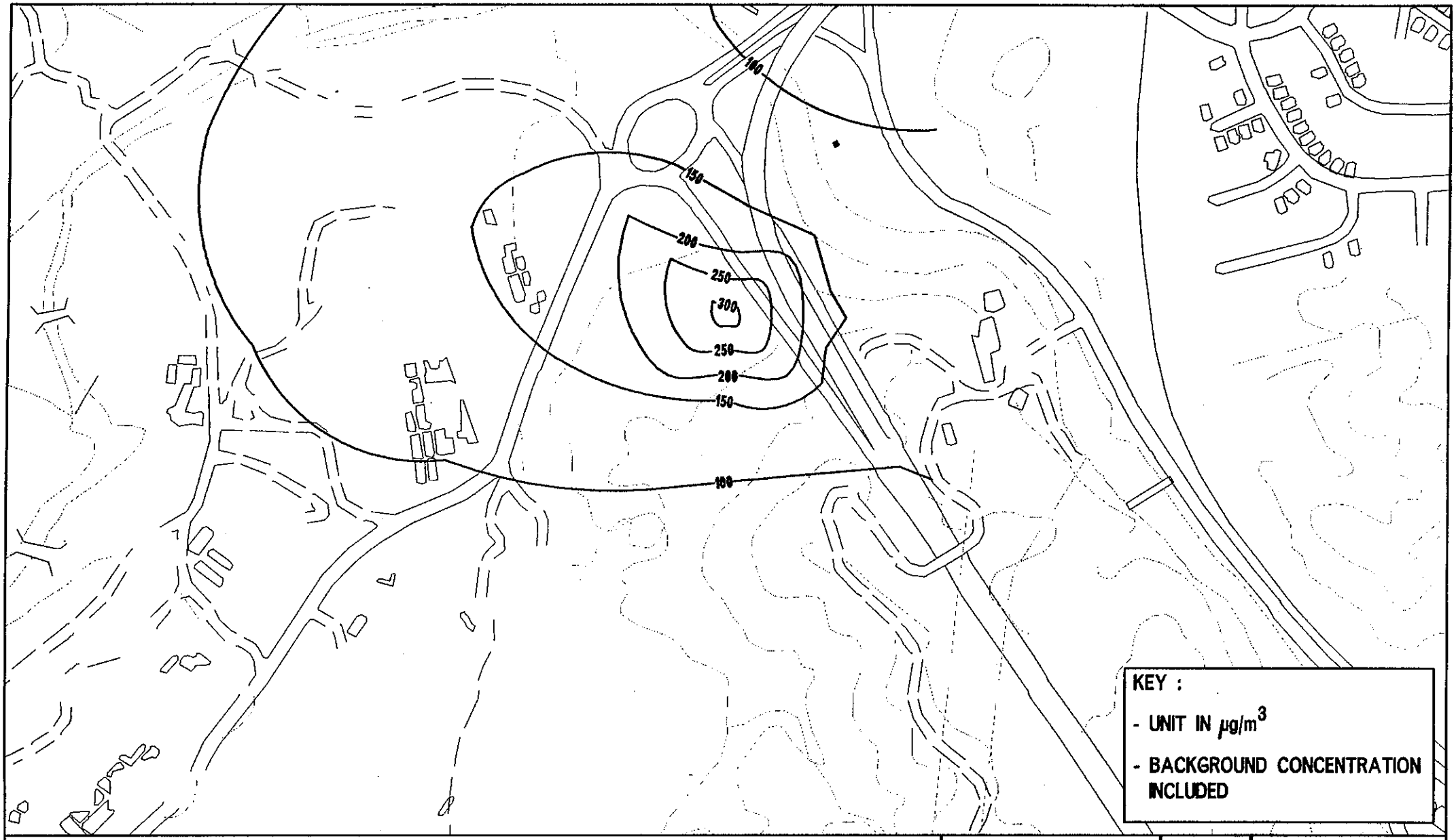
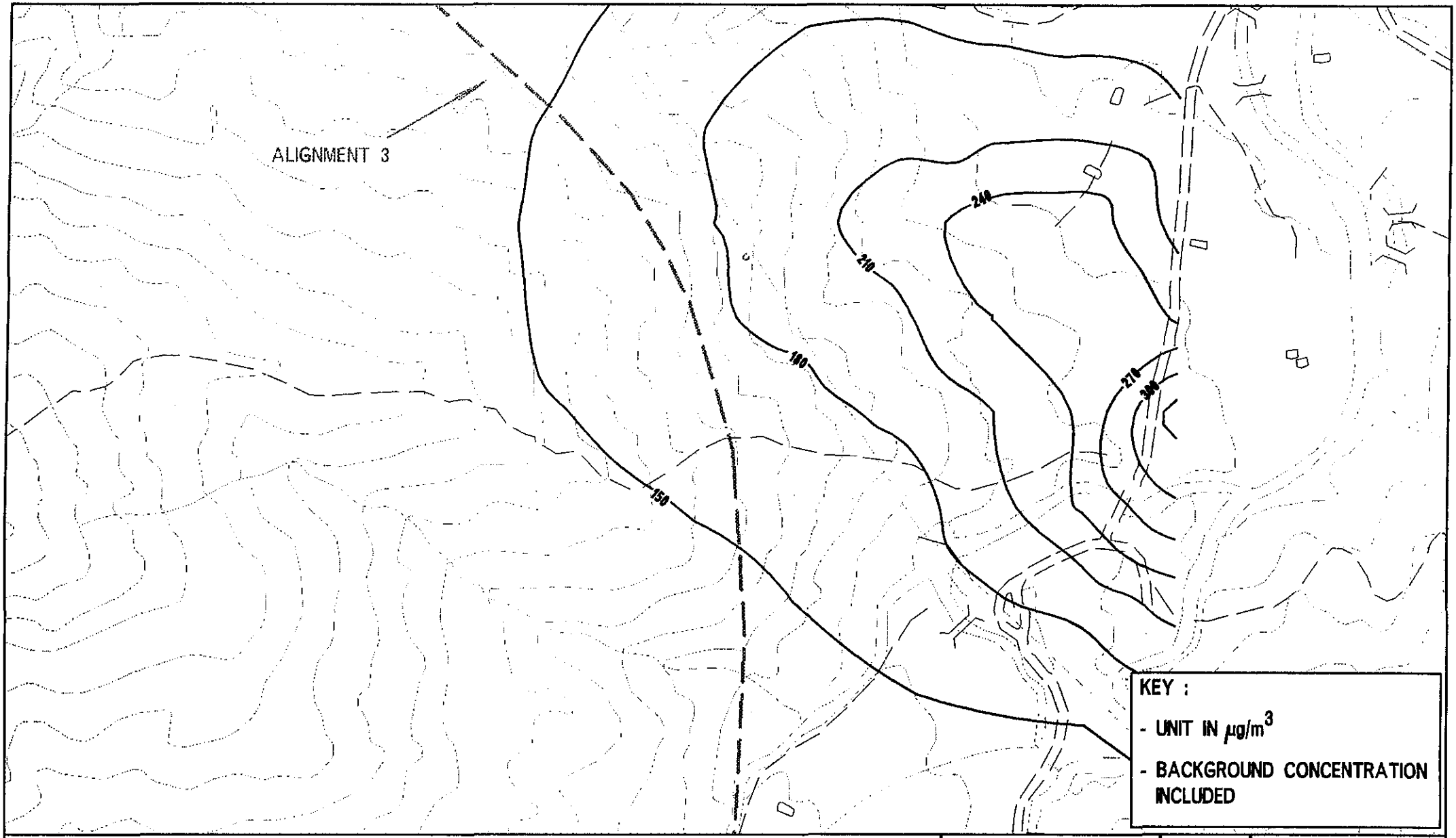


RAW WATER AQUEDUCT

24 HOUR TSP AT 19mPD

(ALL SOURCES EXCEPT BLASTING, WITH 50% REDUCTION IN DUST FROM DIRT ROAD)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.28



YUEN TUN HA ADIT

1 HOUR TSP AT 50mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 500
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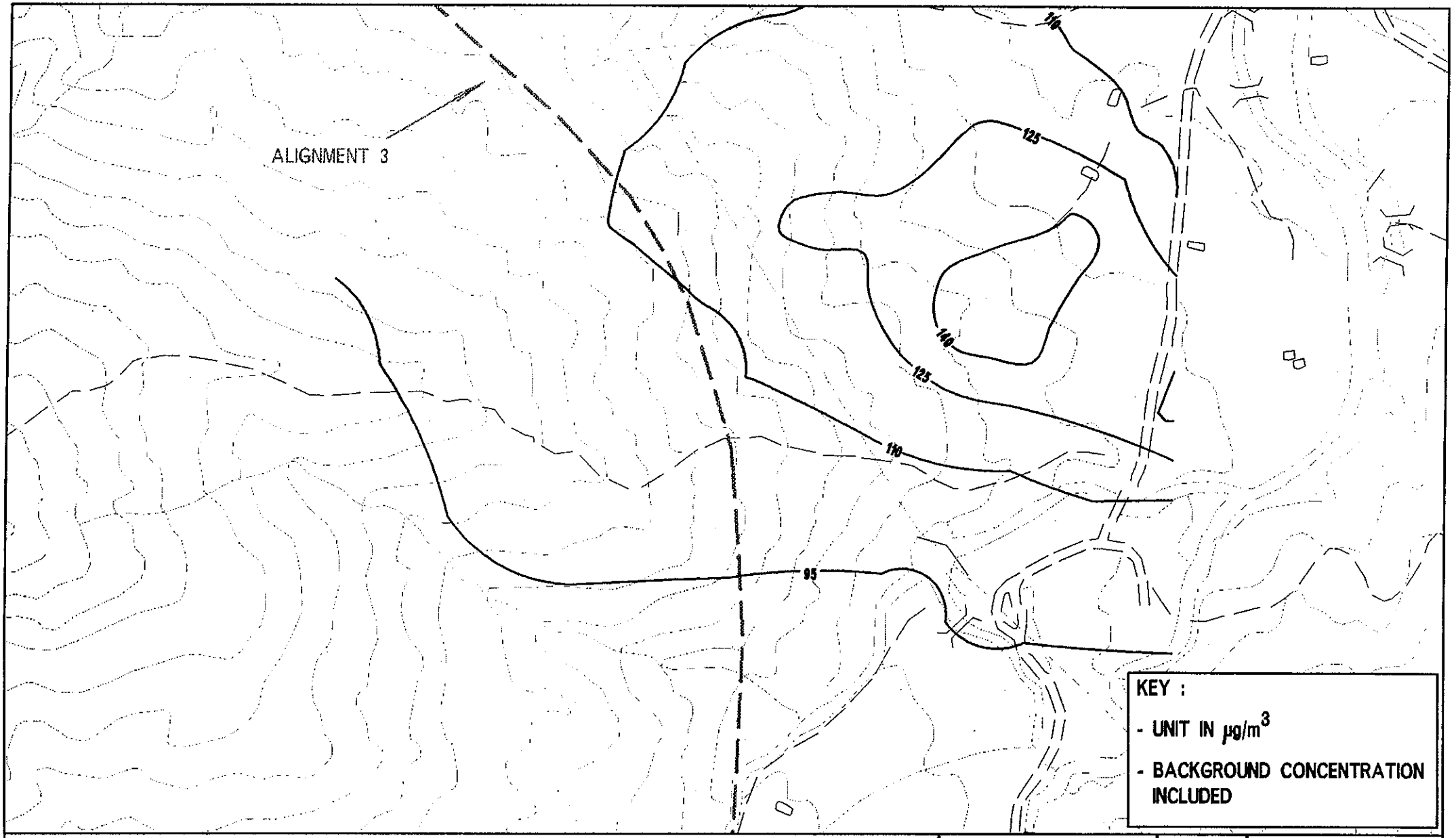


KEY :

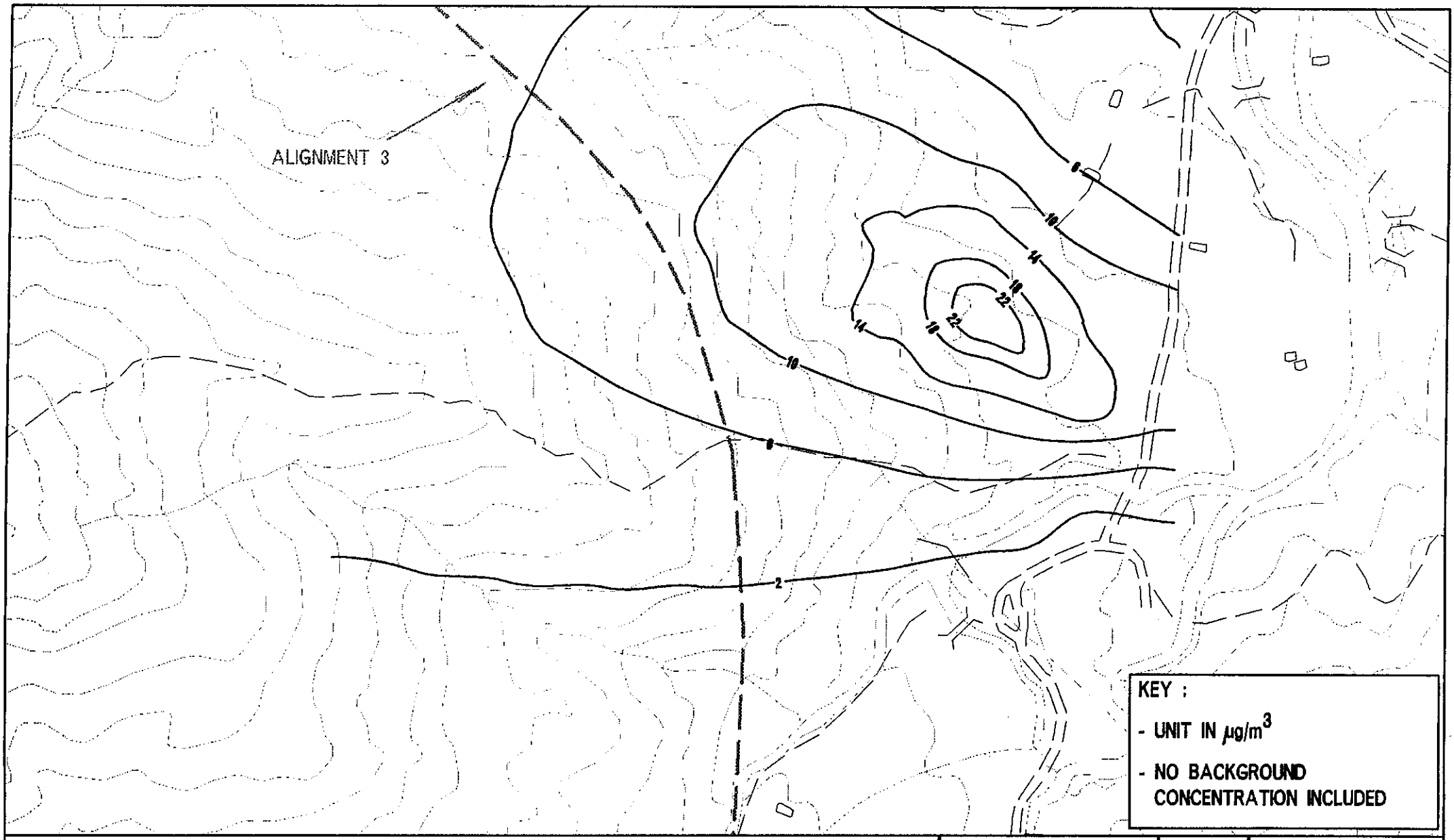
- UNIT IN $\mu g/m^3$
- BACKGROUND CONCENTRATION INCLUDED

YUEN TUN HA ADIT

24 HOUR TSP AT 50mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 500
Water Supplies Department	Initial: WKY	Drawing No.: 7.30



YUEN TUN HA ADIT

ANNUAL TSP AT 50 mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 500
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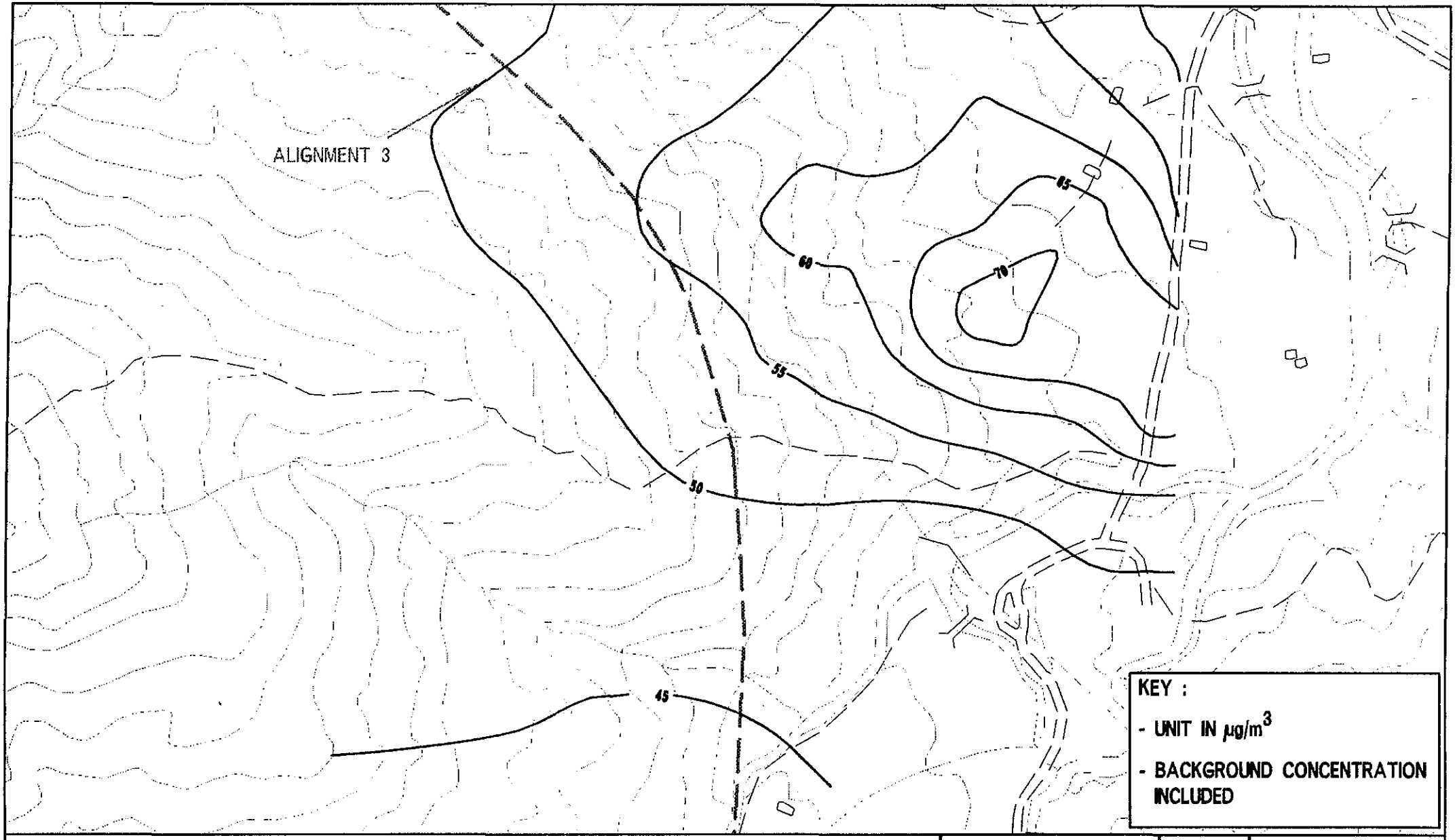


KEY :

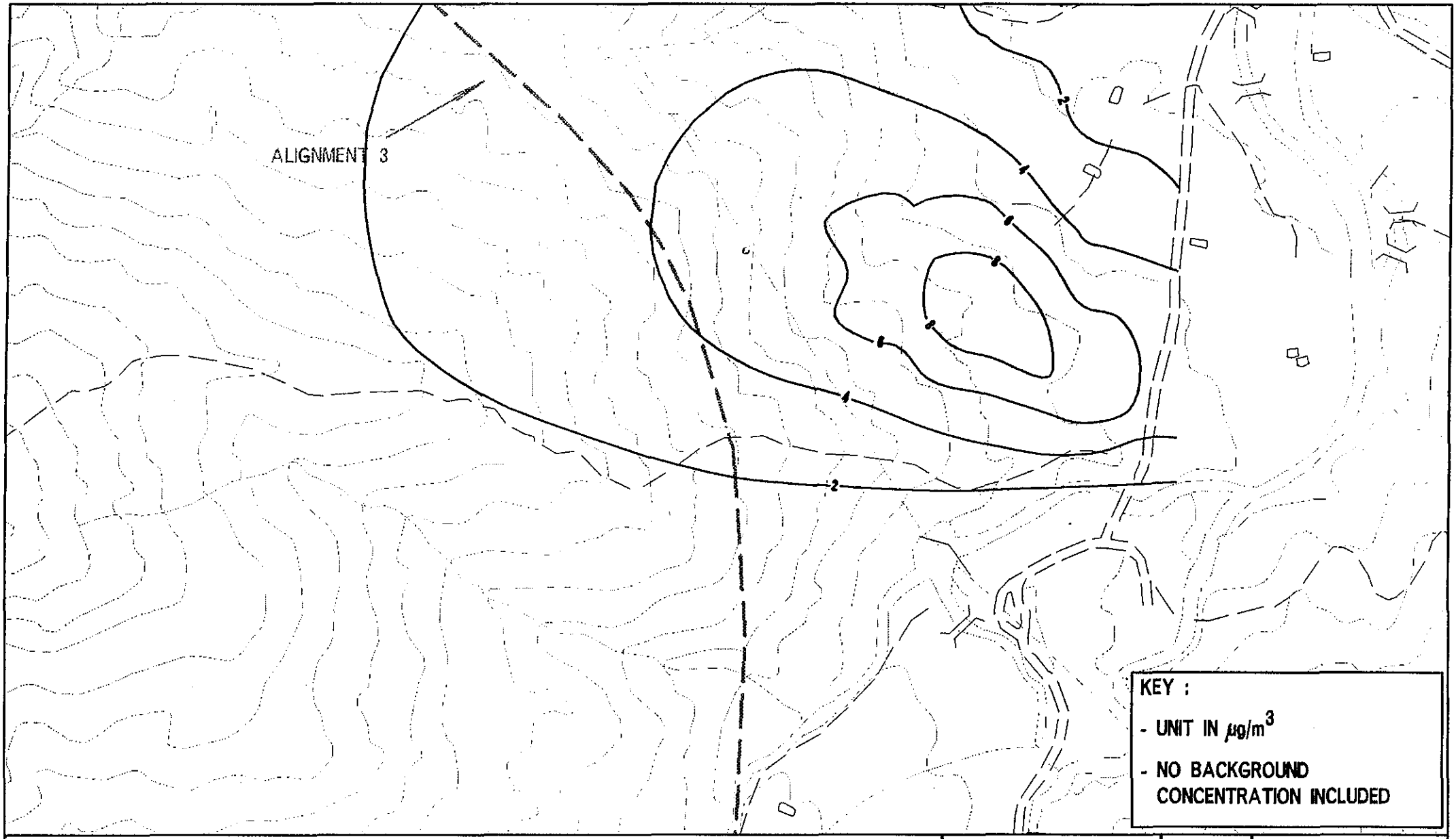
- UNIT IN $\mu g/m^3$
- BACKGROUND CONCENTRATION INCLUDED

YUEN TUN HA ADIT

24 HOUR RSP AT 50mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

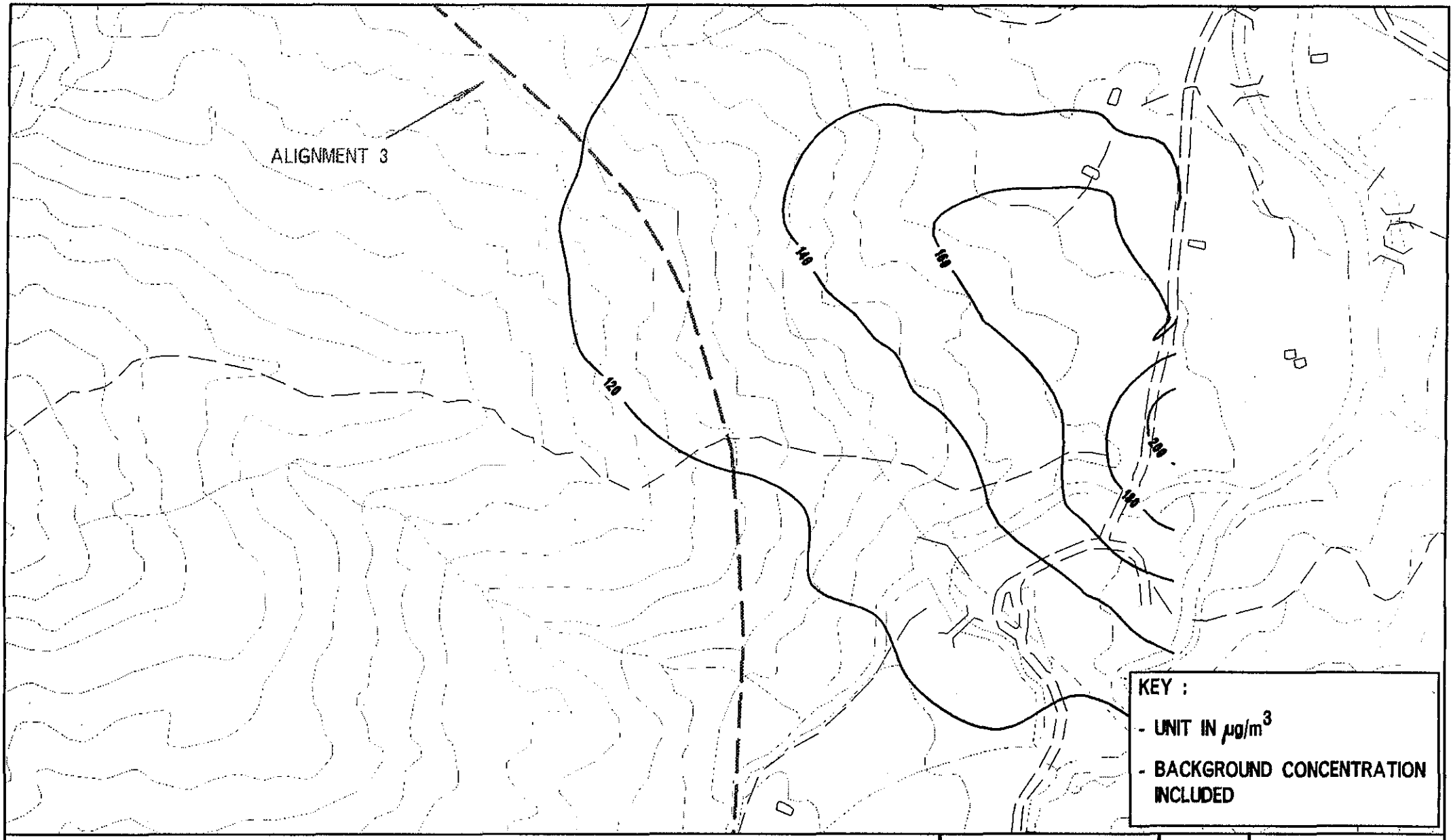
BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 500
Water Supplies Department	Initial: WKY	Drawing No.: 7.32



YUEN TUN HA ADIT

ANNUAL RSP AT 50mPD (UNMITIGATED)
(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 500
Water Supplies Department	Initial: WKY	Drawing No.: 7.33

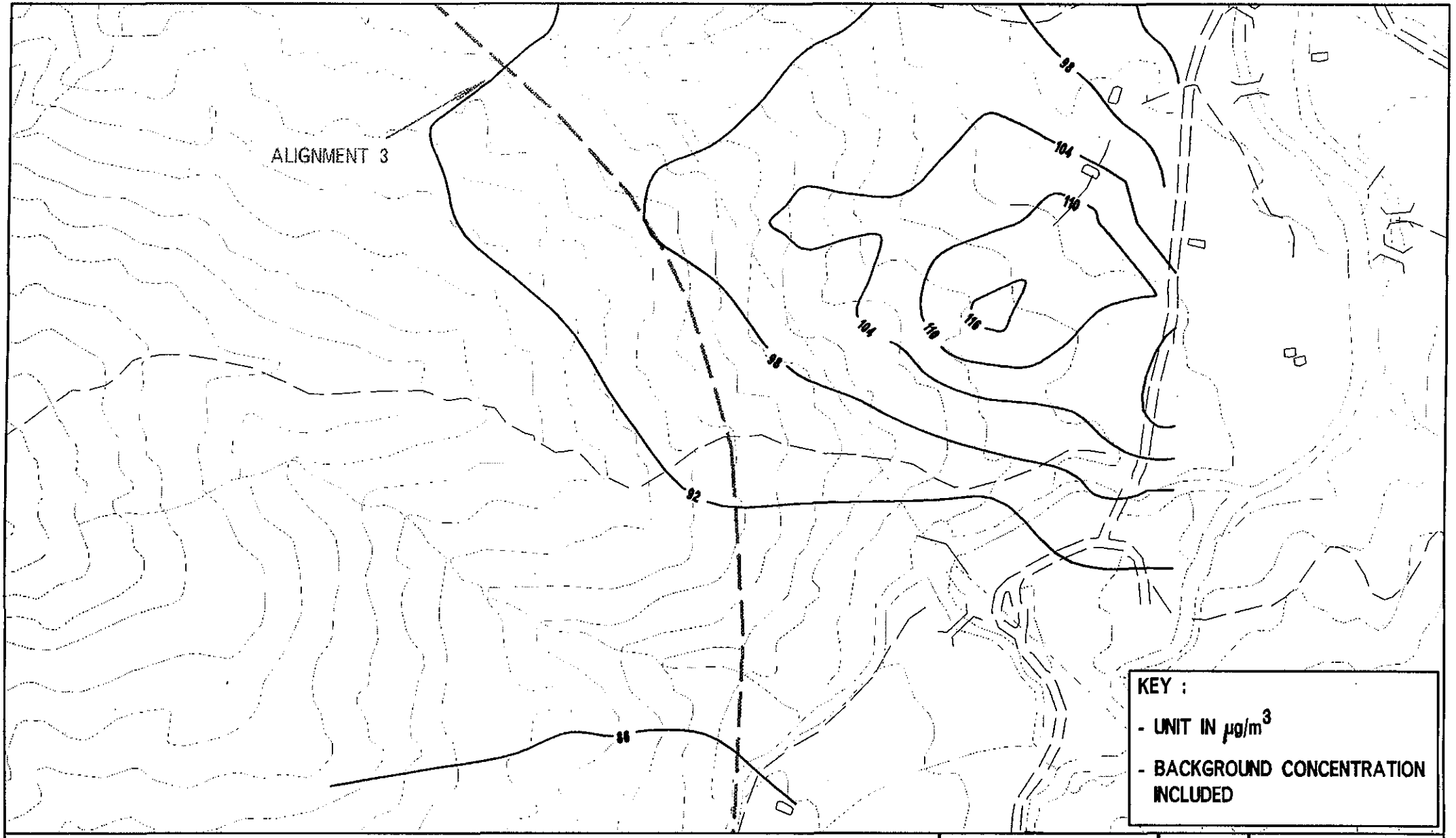


YUEN TUN HA ADIT

1 HOUR TSP AT 50mPD

(ALL SOURCES EXCEPT BLASTING, WITH 50% REDUCTION IN DUST FROM DIRT ROAD)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 500
Water Supplies Department	Initial: WKY	Drawing No.: 7.34

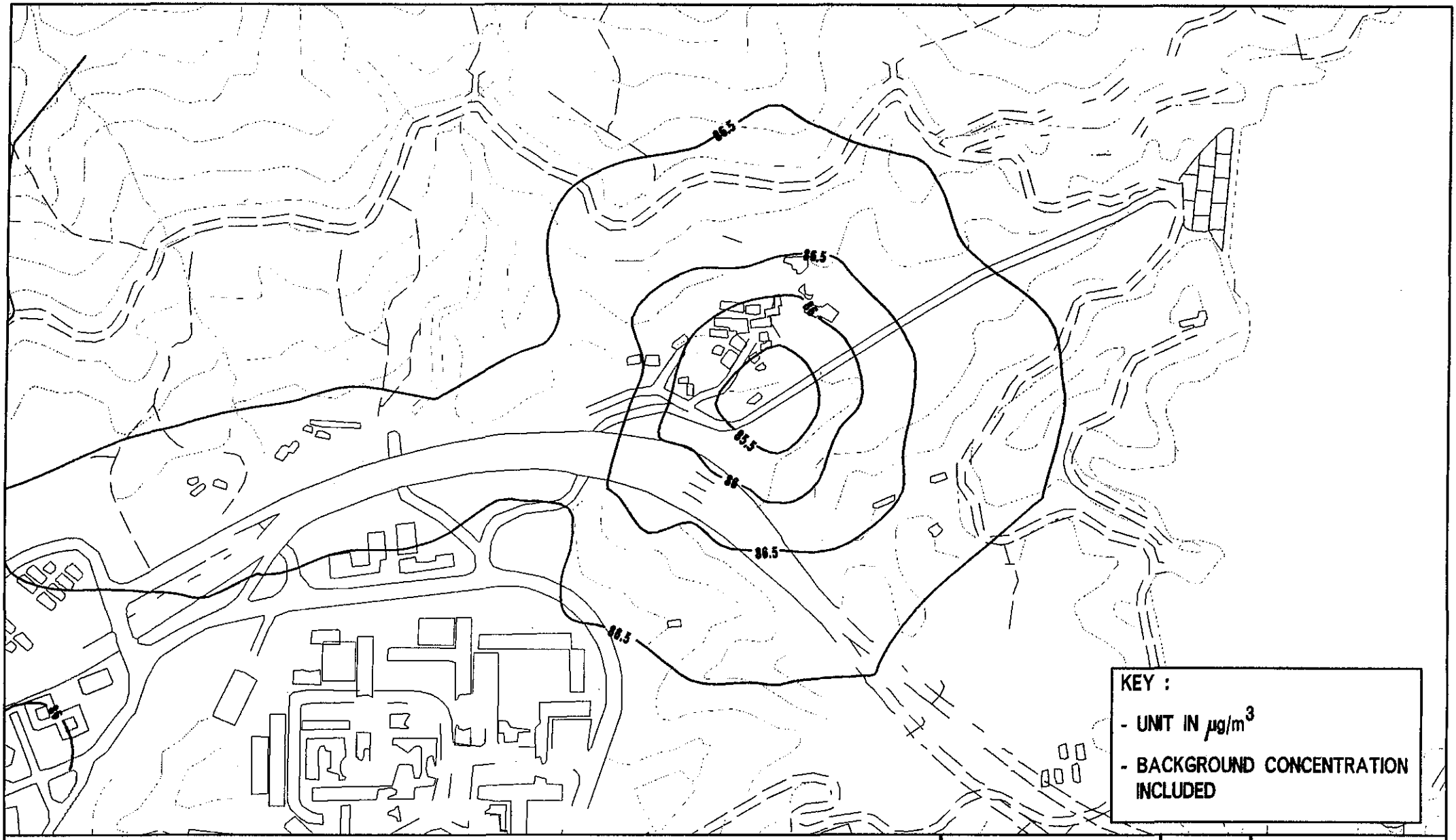


YUEN TUN HA ADIT

24 HOUR TSP AT 50mPD

(ALL SOURCES EXCEPT BLASTING, WITH 50% REDUCTION IN DUST FROM DIRT ROAD)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 5 500
Water Supplies Department	Initial: WKY	Drawing No.: 7.35



SHING MUN ACCESS SHAFT

1 HOUR TSP AT 75mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 6 000
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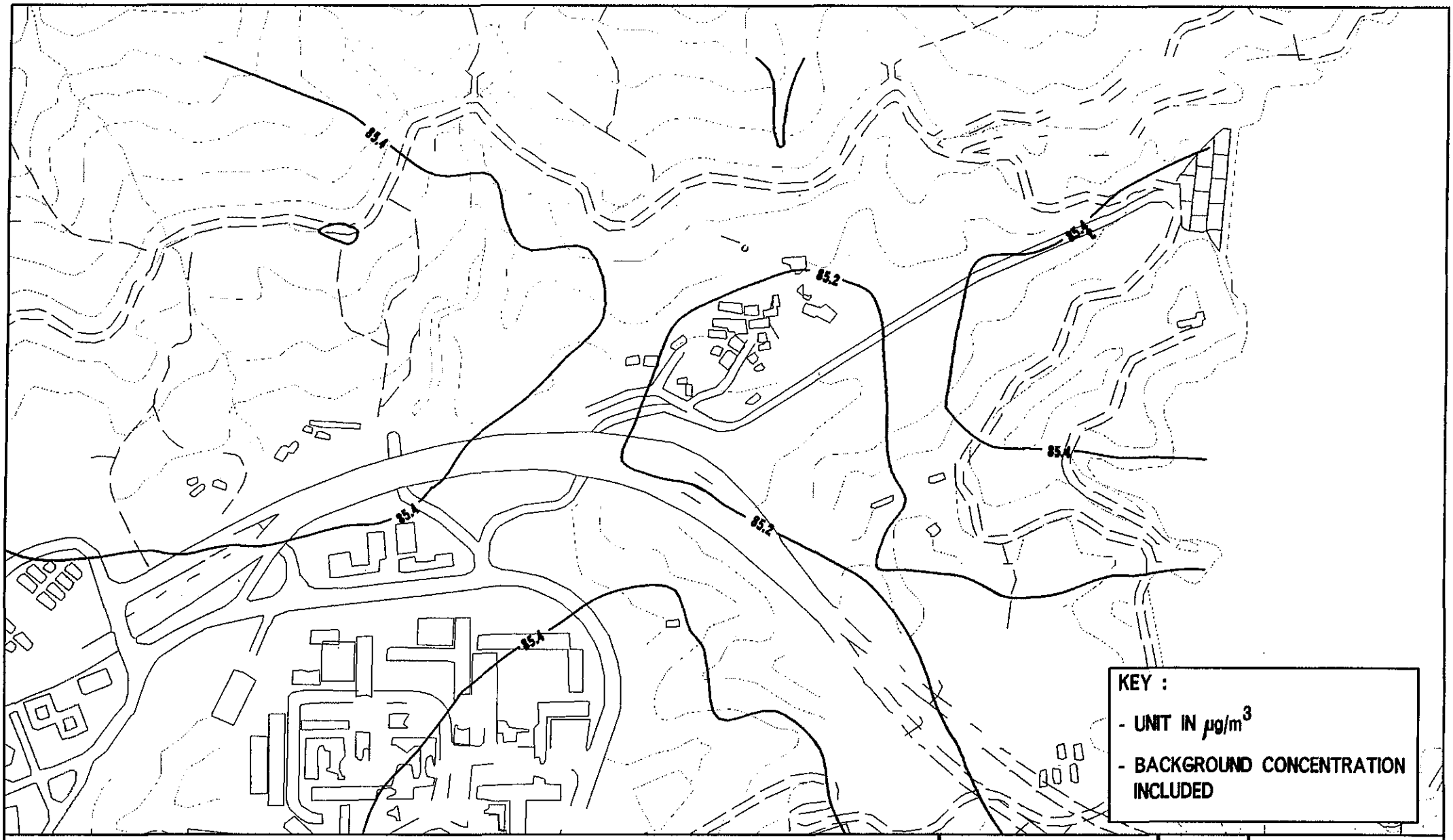
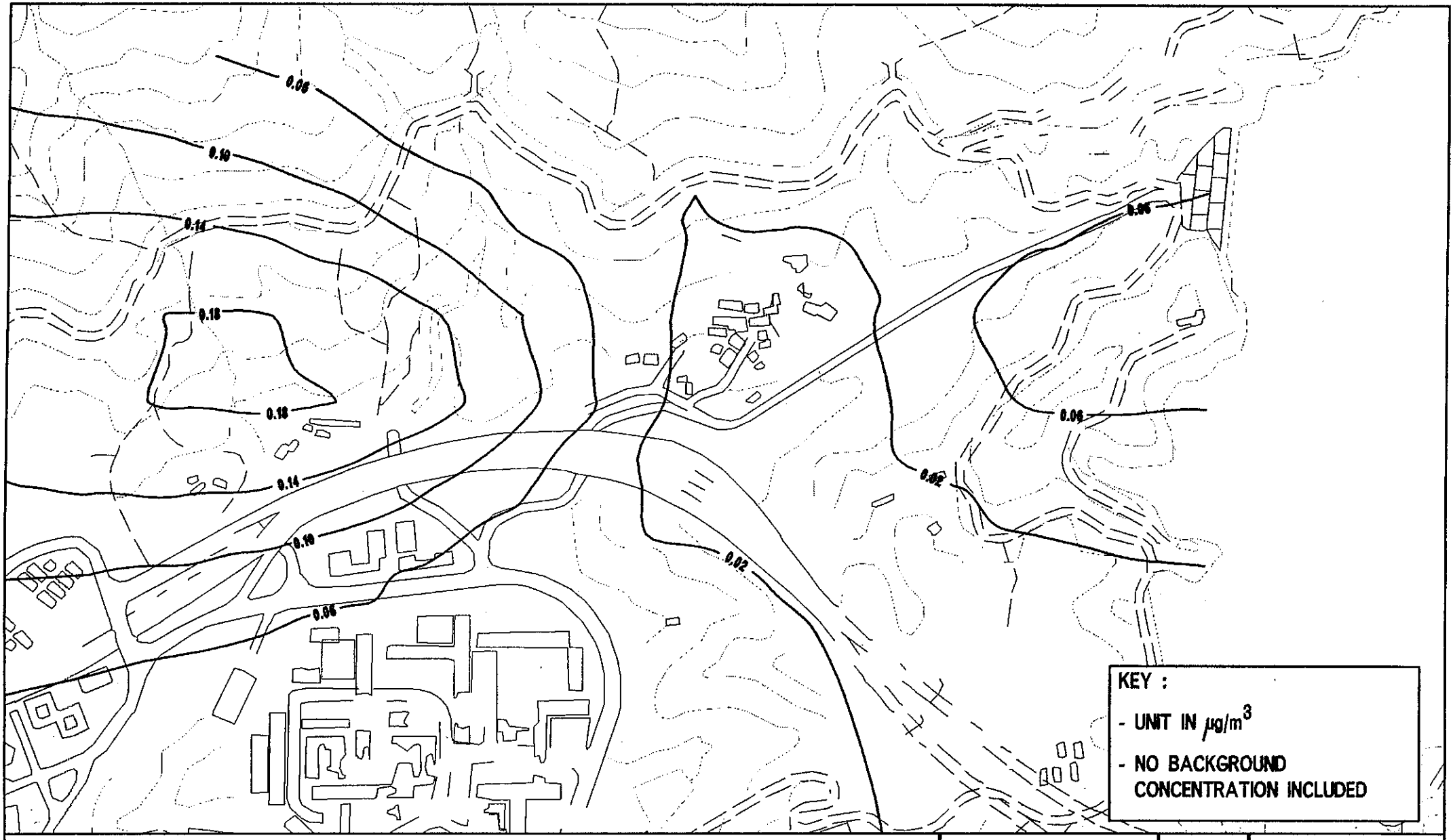


SHING MUN ACCESS SHAFT

24 HOUR TSP AT 75mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BMME CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 6 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.37



SHING MUN ACCESS SHAFT

ANNUAL TSP AT 75mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 6 000
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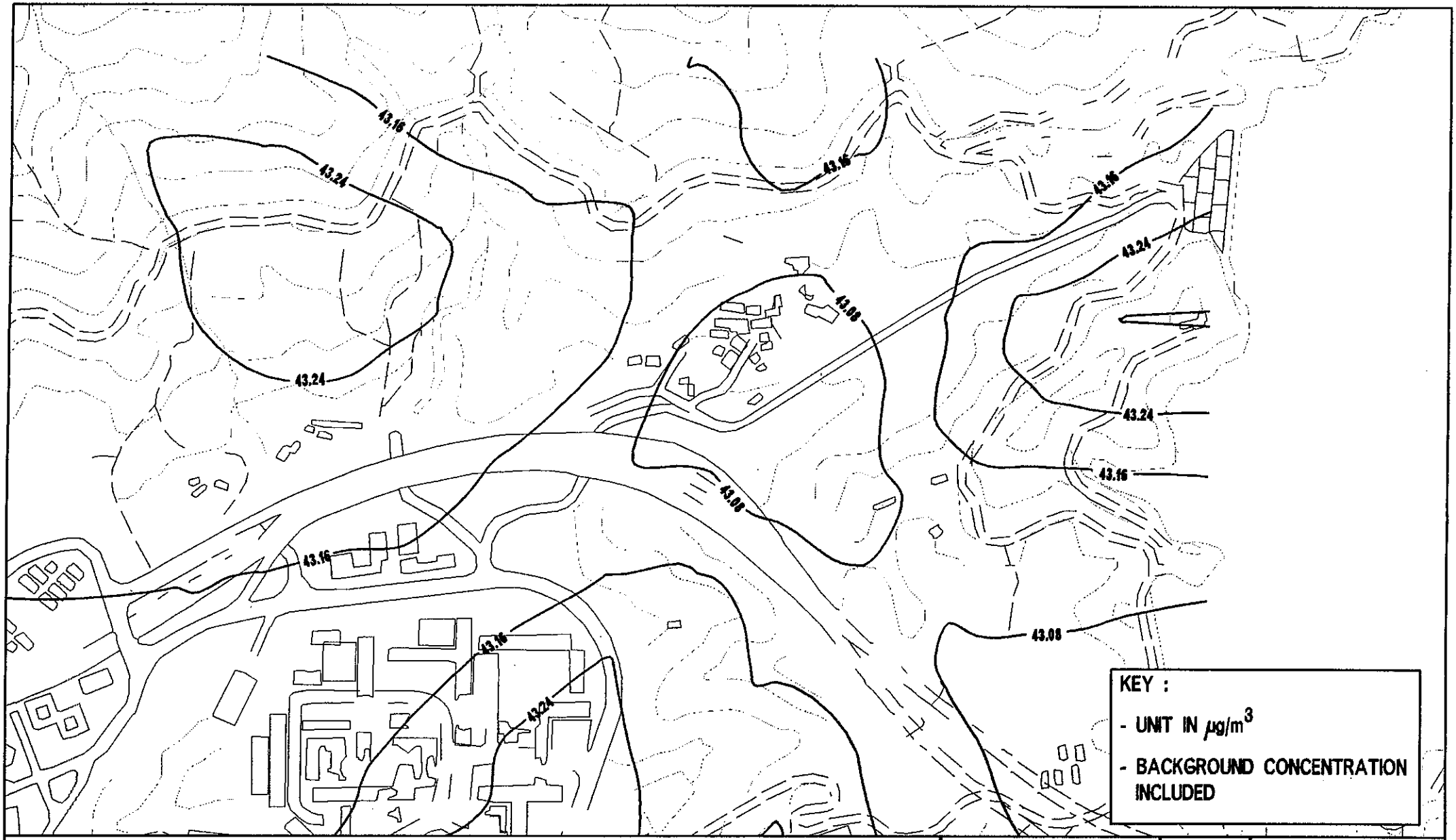

SHING MUN ACCESS SHAFT

24 HOUR RSP AT 75mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 6 000
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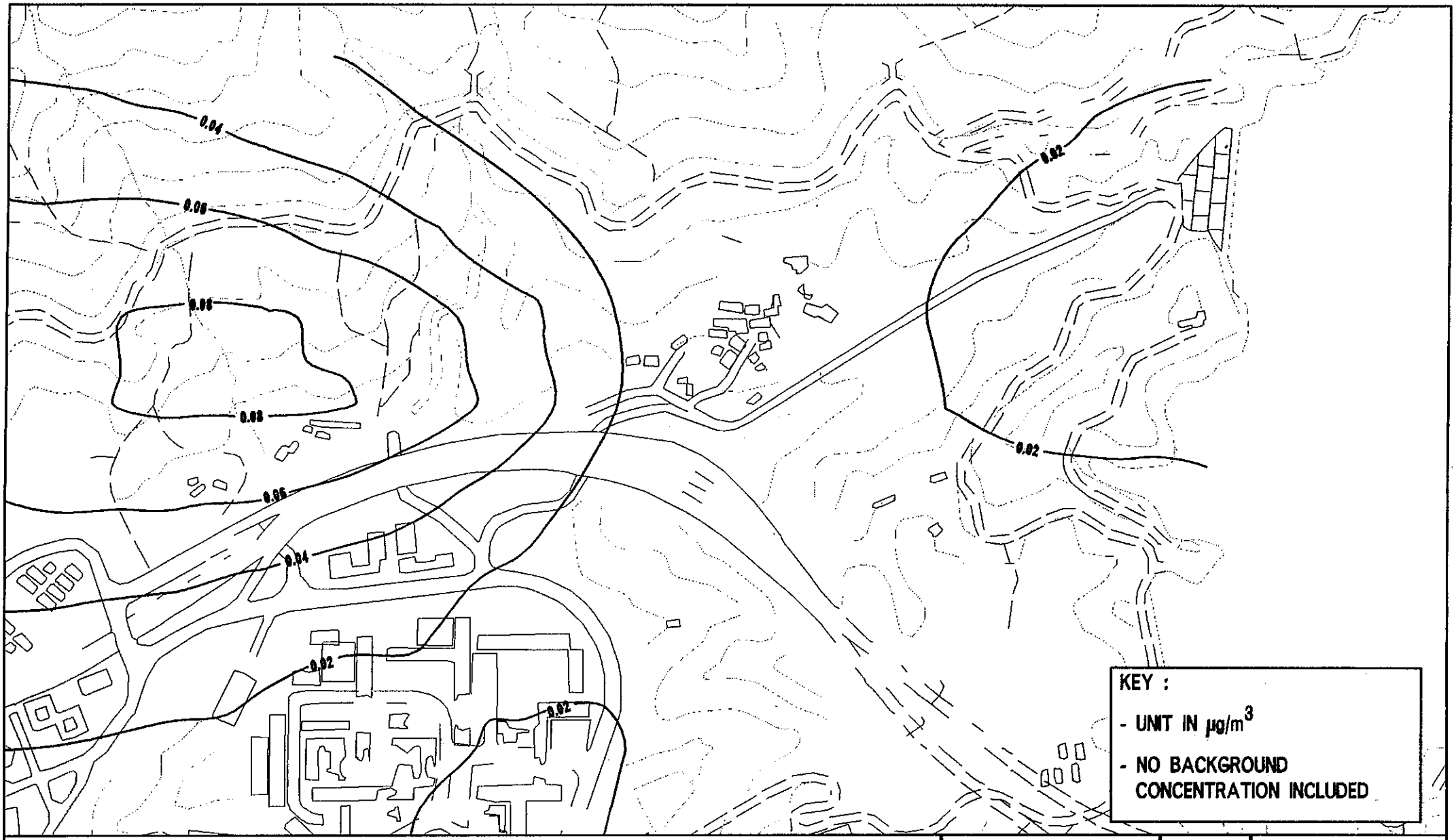

SHING MUN ACCESS SHAFT

ANNUAL RSP AT 75mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

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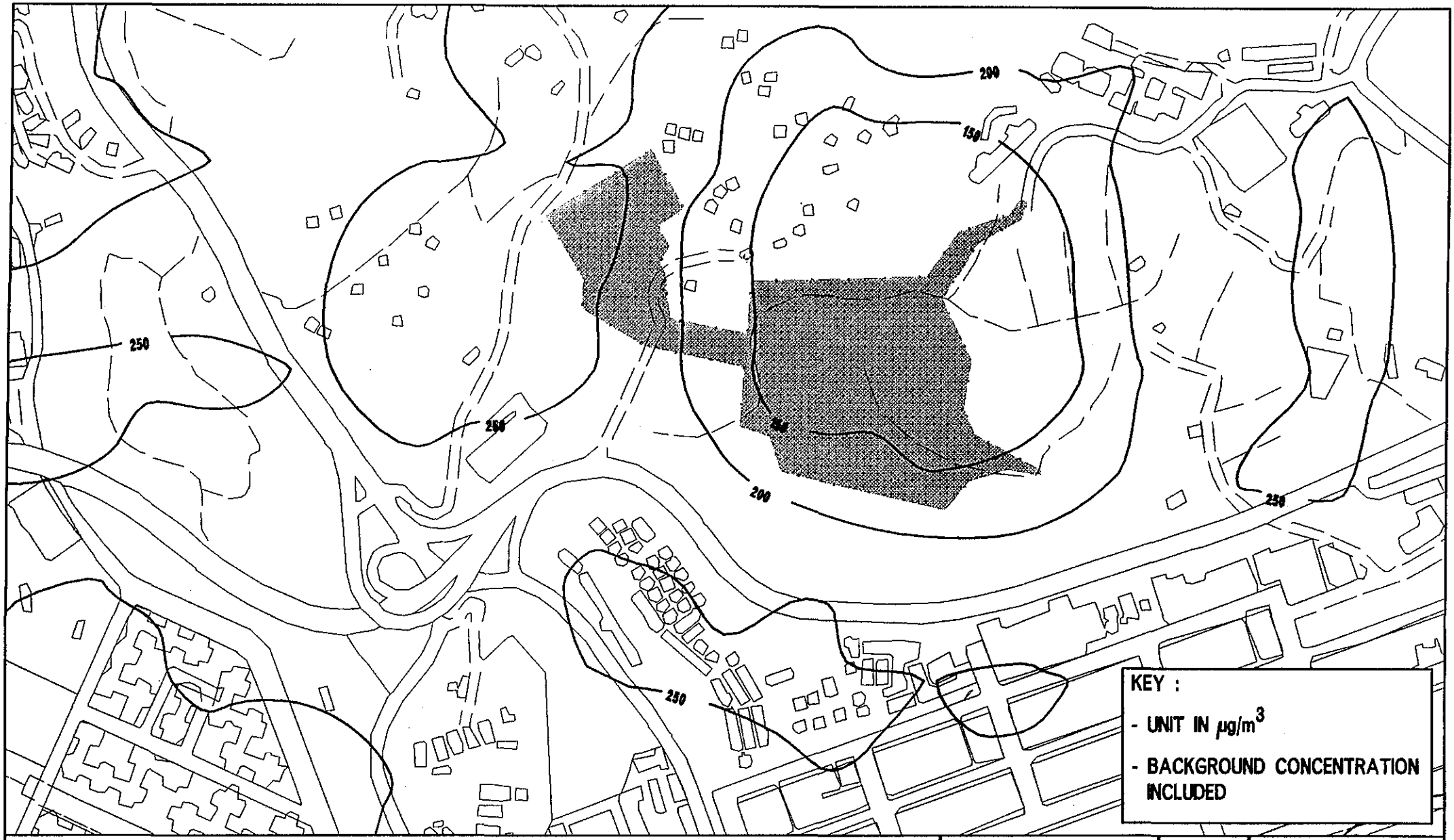

KEY :

- UNIT IN $\mu g/m^3$
- BACKGROUND CONCENTRATION INCLUDED

BUTTERFLY VALLEY SERVICE RESERVOIR

1 HOUR TSP AT 5mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
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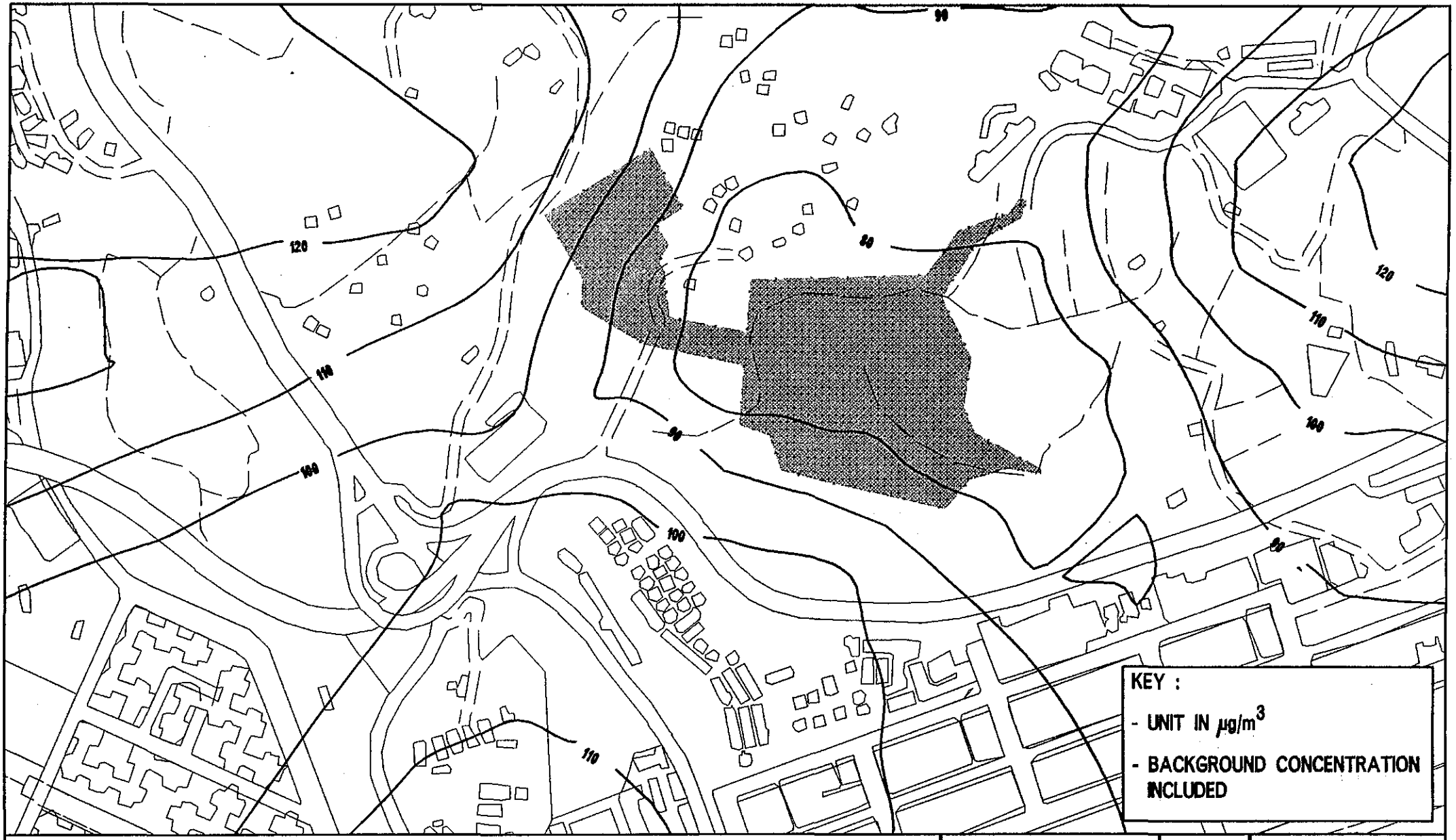

BUTTERFLY VALLEY SERVICE RESERVOIR

24 HOUR TSP AT 5mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

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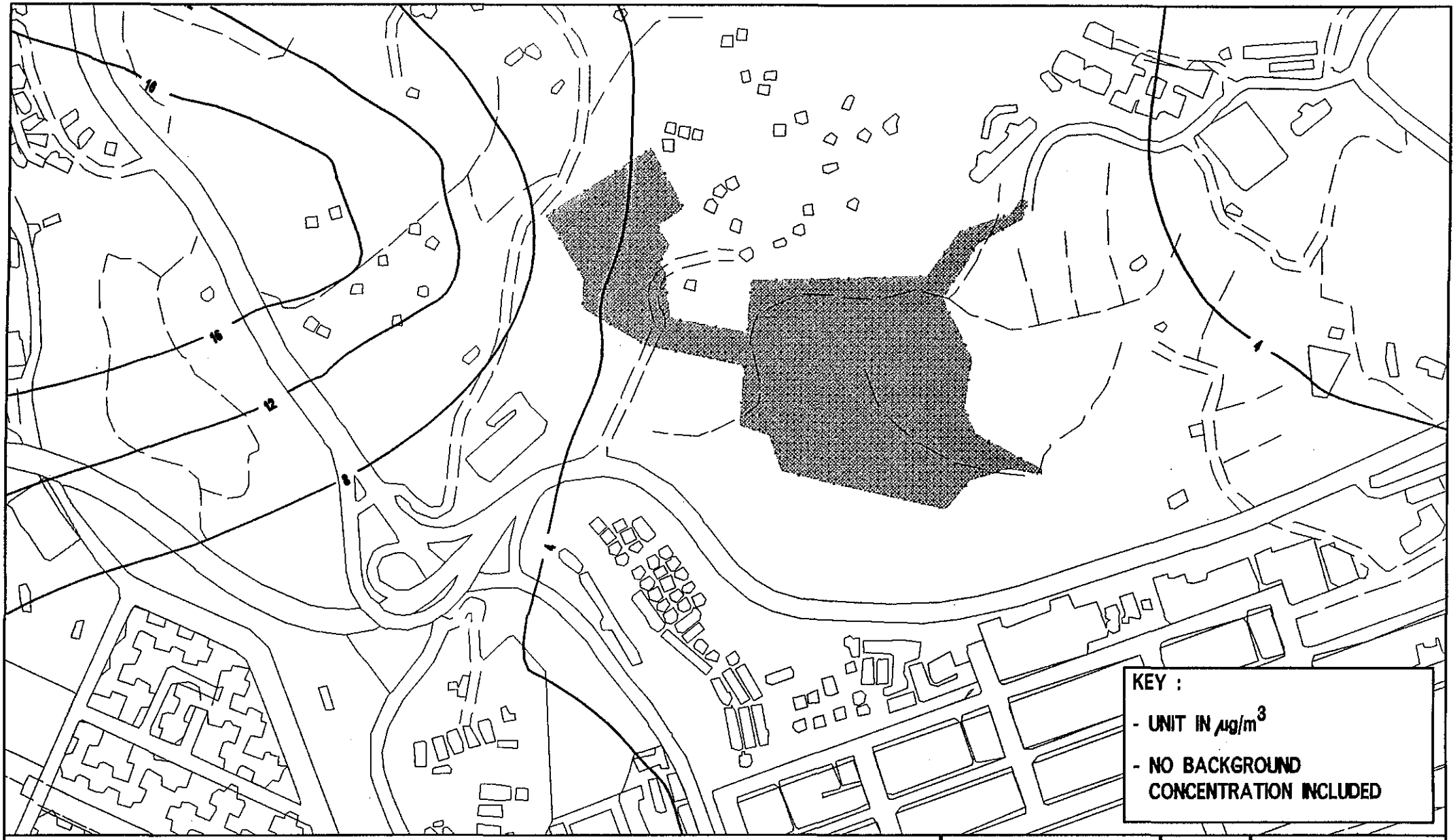

BUTTERFLY VALLEY SERVICE RESERVOIR

ANNUAL TSP AT 5mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
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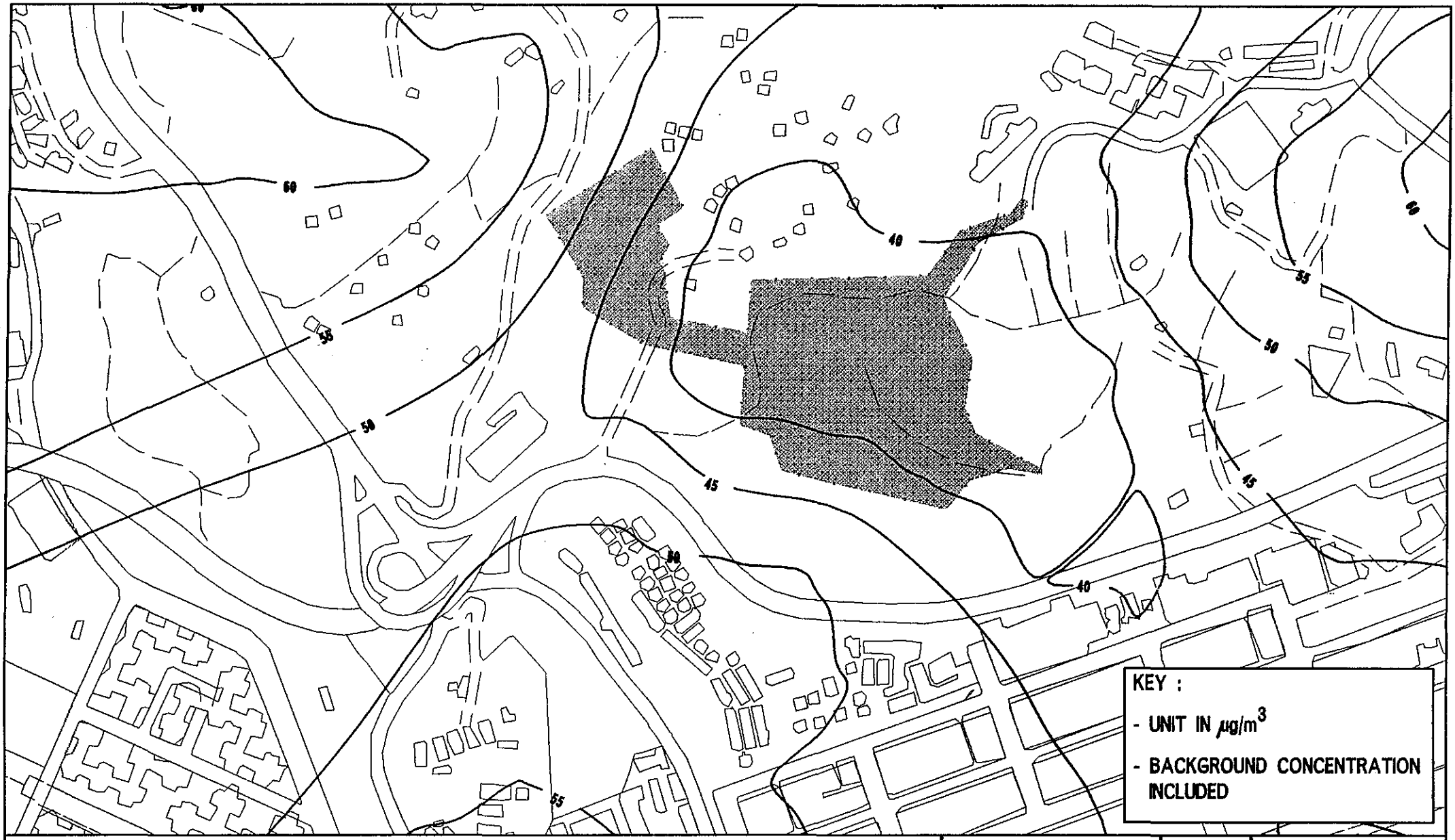

BUTTERFLY VALLEY SERVICE RESERVOIR

24 HOUR RSP AT 5mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BMME CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
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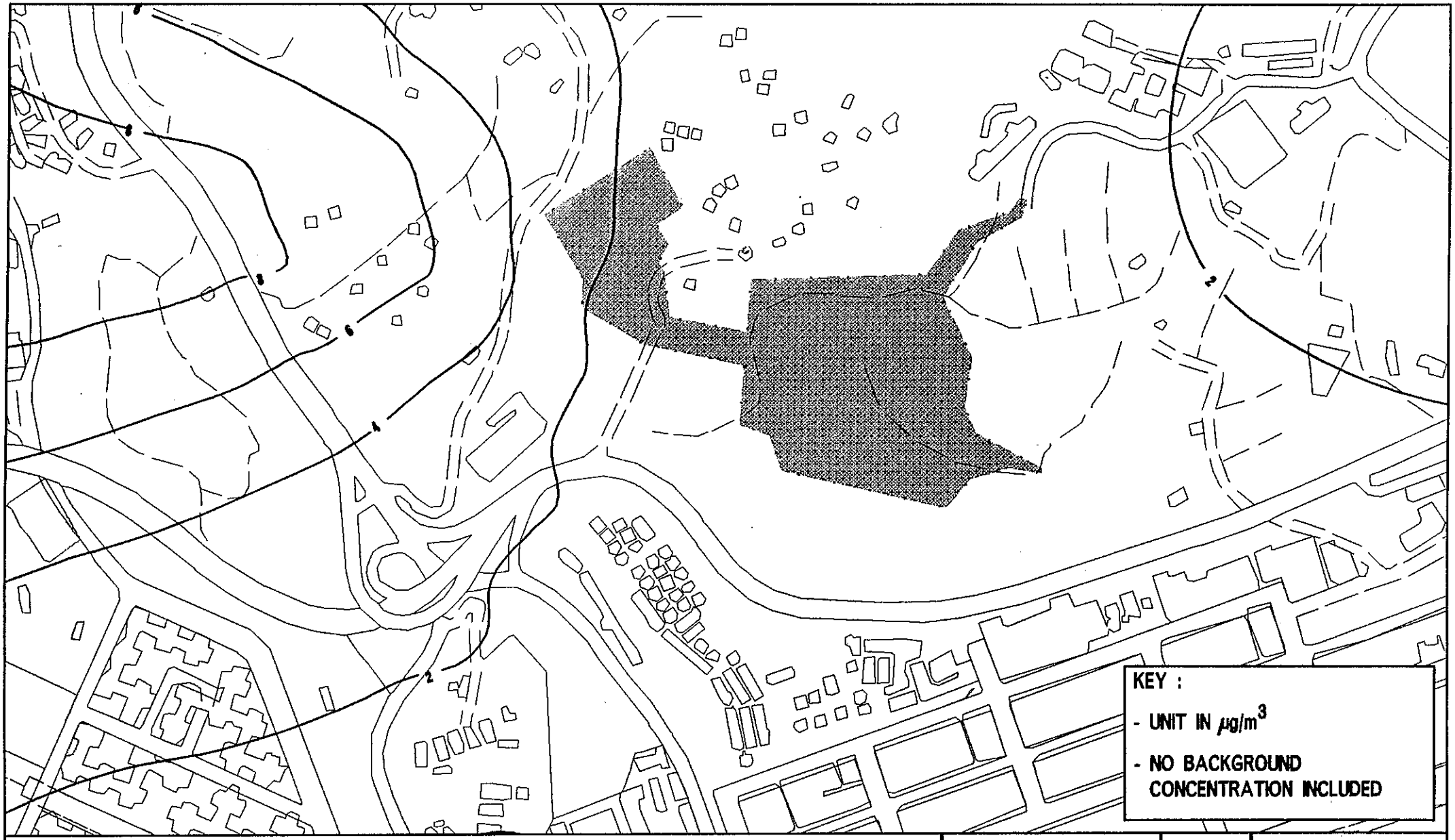

BUTTERFLY VALLEY SERVICE RESERVOIR

ANNUAL RSP AT 5mPD (UNMITIGATED)

(ALL SOURCES EXCEPT BLASTING)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
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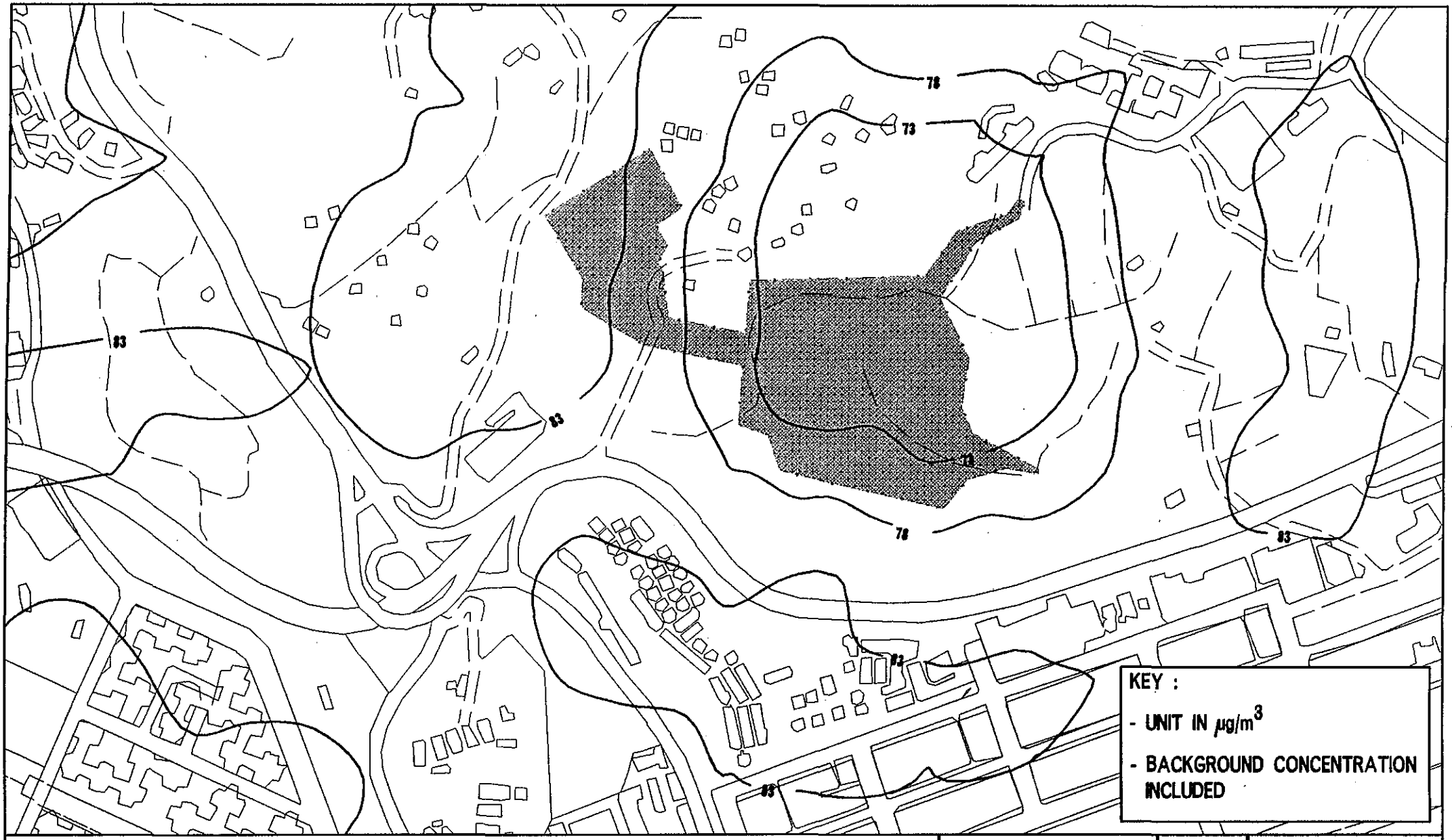
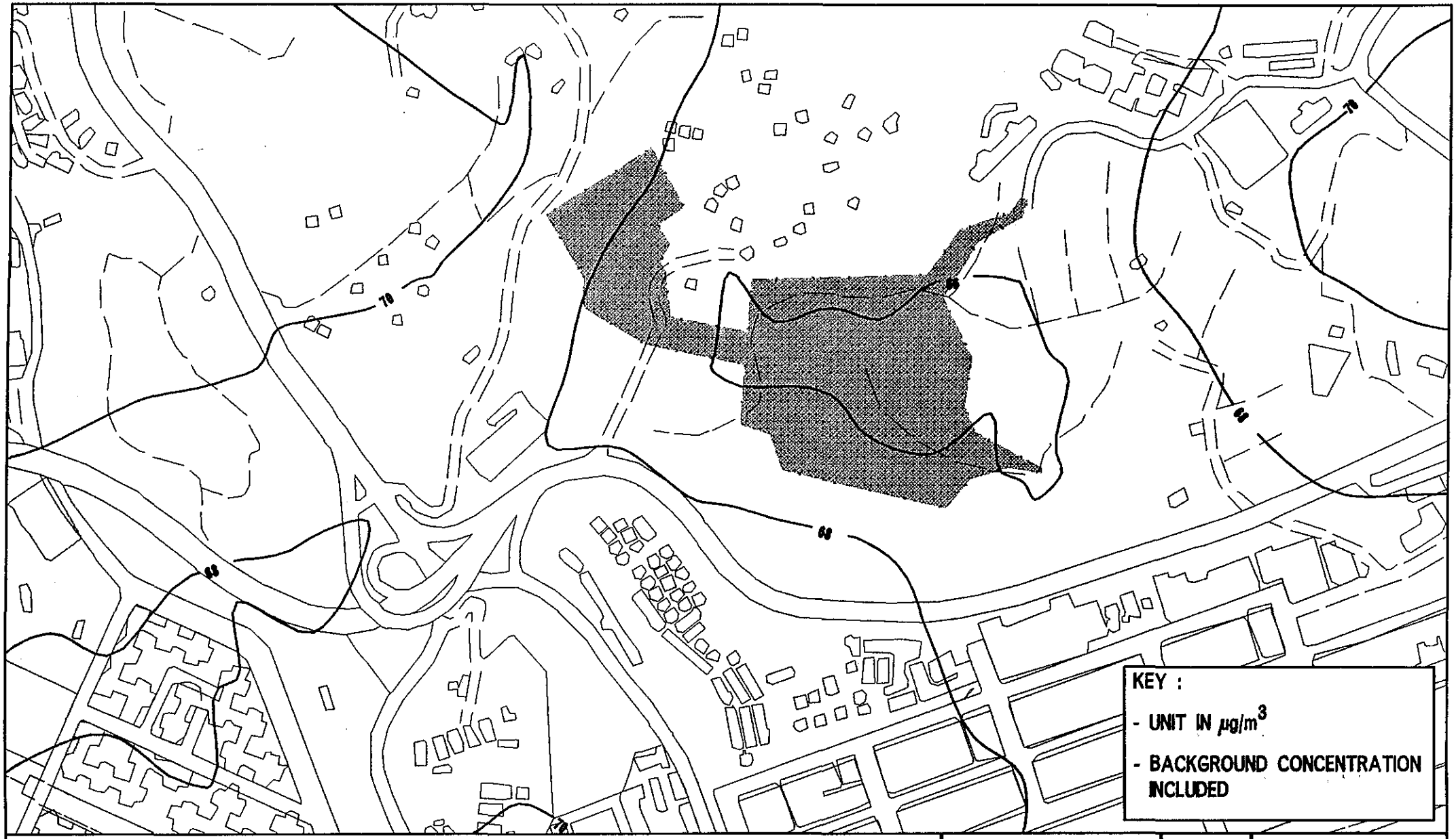


BUTTERFLY VALLEY SERVICE RESERVOIR

1 HOUR TSP AT 5mPD

(ALL SOURCES EXCEPT BLASTING, WITH 90% REDUCTION IN DUST FROM DIRT ROAD)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.46

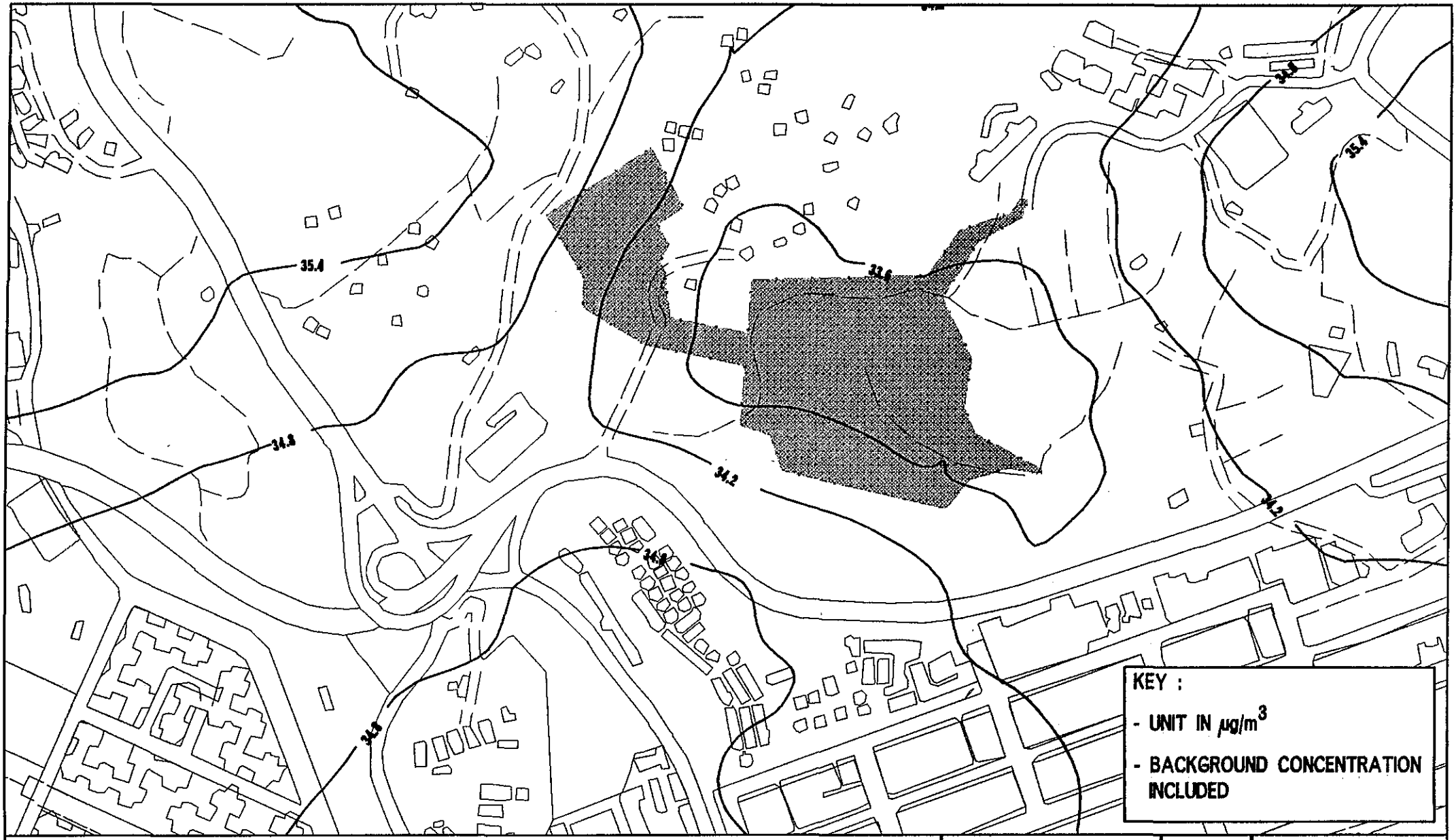


BUTTERFLY VALLEY SERVICE RESERVOIR

24 HOUR TSP AT 5mPD

(ALL SOURCES EXCEPT BLASTING, WITH 90% REDUCTION IN DUST FROM DIRT ROAD)

BMNE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date March 95	Scale 1 : 9 000
Water Supplies Department	Initial WKY	Drawing No. 7.47



BUTTERFLY VALLEY SERVICE RESERVOIR

24 HOUR RSP AT 5mPD

(ALL SOURCES EXCEPT BLASTING, WITH 90% REDUCTION IN DUST FROM DIRT ROAD)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: March 95	Scale: 1 : 9 000
Water Supplies Department	Initial: WKY	Drawing No.: 7.48

Appendix A: Log Wind Profile

To estimate the mean wind speed as a function of height z, we use a logarithmic relationship (log wind profile) as following:

$$U = \frac{U_*}{k} \ln \frac{z}{z_o} \quad \text{.....(A.1)}$$

where

U* = friction velocity,
k = von Karman constant, 0.4 (dimensionless),
z_o = roughness length (10 cm).

The friction velocity can be recalculated from equation (A.1) by substituting U = 5.4 m/s, z = 10 m in equation (A.1). The friction velocity is thus 0.46 m/s.

For example, if the pile height is 5 m, then the mean velocity is thus 4.49 m/s. Hence, the conversion factor is (4.49/5.4) x 100% = 83%. This conversion factor will be used to convert the percentage provided by Royal Observatory to the value (f) used in pile height.

Appendix B: Emission Rates For Dust Sources

Air Quality Impact Assessment - Dust

Raw Water Aqueduct

Loading & Unloading (excavation of trench for raw water aqueduct)

	TSP	RSP
particle size multiplier, k	0.74	0.35
mean wind speed (m/s), U	1	1
material moisture content (%), M	2	2
Unadjusted emission rate (kg/T), Qo	0.000425	0.000201
Volume of material (m)	3000	3000
Density of material (kg/m)	1987	1987
Days of work	53	53
Working hours	12	12
Unadjusted emission rate (g/s)	0.001106	0.000523
Surface area (m2)	1500	1500
Unadjusted emission rate (g/s/m2)	7.37e-07	3.49e-07

Loading & Unloading of spoil from tunnel portal

	TSP	RSP
particle size multiplier, k	0.74	0.35
mean wind speed (m/s), U	1	1
material moisture content (%), M	2	2
Unadjusted emission rate (kg/T), Qo	0.000425	0.000201
Volume of material (m)	13400	13400
Density of material (kg/m)	1987	1987
Days of work	312	312
Working hours	12	12
Unadjusted emission rate (g/s)	0.000839	0.000397
Surface area (m2)	1500	1500
Unadjusted emission rate (g/s/m2)	5.59e-07	2.65e-07

Unpaved road and haul routes

	TSP	RSP
particle size multiplier, k	0.8	0.36
silt content of road surface material (%), s	16	16
mean vehicle speed (km/hr), S	15	15
mean vehicle weight (T), W	35	35
mean number of wheels, w	10	10
number of days (rainfall < 0.254 mm) per year, p	100	100
number of vehicle round trips per hr	6	6
E (kg/VKT)	3.909702	1.759366
E (g/s/m)	0.006516	0.002932

Stock Piling

silt content of aggregate (%), s	1.6
% of time with wind speed > 5.4 m/s at mean pile height	7
number of days (rainfall < 0.254 mm) per year, p	100
E (kg/day/hectare)	1.066515
E (g/s/m2) for TSP	1.23e-06
E (g/s/m2) for RSP	6.17e-07

Top Soil Removal

Depth of top soil (m)	1
Surface area (m2)	1500
Density of material (kg/m)	1987
Mass of material (T)	2980.5
Days of work	312
Working hours	24
Rate of removal (T/hr)	0.398037
E (g/s) for TSP	0.002211
E (g/s) for RSP	0.001106
E (g/s/m2) for TSP	0.000001
E (g/s/m2) for RSP	7.37e-07

Wind Erosion

E (g/m/s) for TSP	0.000003
E (g/m/s) for RSP	0.000001

Air Quality Impact Assessment - Dust

Shing Mun Shaft

Loading & Unloading at the location of shaft

	TSP	RSP
particle size multiplier, k	0.74	0.35
mean wind speed (m/s), U	1	1
material moisture content (%), M	2	2
Unadjusted emission rate (kg/T), Qo	0.000425	0.000201
Volume of material (m)	94433.33	94433.33
Density of material (kg/m)	1987	1987
Days of work	624	624
Working hours	12	12
Unadjusted emission rate (g/s)	0.002957	0.001399
Surface area (m2)	600	600
Unadjusted emission rate (g/s/m2)	4.93e-06	2.33e-06

Loading & Unloading at the location of proposed parking lot

	TSP	RSP
particle size multiplier, k	0.74	0.35
mean wind speed (m/s), U	1	1
material moisture content (%), M	2	2
Unadjusted emission rate (kg/T), Qo	0.000425	0.000201
Volume of material (m)	6000	6000
Density of material (kg/m)	1987	1987
Days of work	40	40
Working hours	12	12
Unadjusted emission rate (g/s)	0.002931	0.001386
Surface area (m2)	800	800
Unadjusted emission rate (g/s/m2)	3.66e-06	1.73e-06

Unpaved road and haul routes

	TSP	RSP
particle size multiplier, k	0.8	0.36
silt content of road surface material (%), s	16	16
mean vehicle speed (km/hr), S	15	15
mean vehicle weight (T), W	35	35
mean number of wheels, w	10	10
number of days (rainfall < 0.254 mm) per year, p	100	100
number of vehicle roundtrips per hr	10	10
E (kg/VKT)	3.909702	1.759366
E (g/s/m)	0.01086	0.004887

Stock Piling

silt content of aggregate (%), s	1.6
% of time with wind speed > 5.4 m/s at mean pile height	7
number of days (rainfall < 0.254 mm) per year, p	100
E (kg/day/hectare)	1.066515
E (g/s/m2) for TSP	1.23e-06
E (g/s/m2) for RSP	6.17e-07

Top Soil Removal at the location of shaft

Depth of top soil (m)	1
Surface area (m2)	600
Density of material (kg/m)	1987
Mass of material (T)	1192.2
Days of work	624
Working hours	24
Rate of removal (T/hr)	0.079607
E (g/s) for TSP	0.000442
E (g/s) for RSP	0.000221
E (g/s/m2) for TSP	7.37e-07
E (g/s/m2) for RSP	3.69e-07

Top Soil Removal at the location of proposed parking lot

Depth of top soil (m)	0.06
Surface area (m2)	800
Density of material (kg/m)	1987
Mass of material (T)	95.376
Days of work	40
Working hours	24
Rate of removal (T/hr)	0.09935
E (g/s) for TSP	0.000552
E (g/s) for RSP	0.000276
E (g/s/m2) for TSP	6.90e-07
E (g/s/m2) for RSP	3.45e-07

Wind Erosion

E (g/m/s) for TSP	0.000003
E (g/m/s) for RSP	0.000001

Air Quality Impact Assessment - Dust

Tai Po Water Treatment Works

Loading & Unloading

	TSP	RSP
particle size multiplier, k	0.74	0.35
mean wind speed (m/s), U	1	1
material moisture content (%), M	2	2
Unadjusted emission rate (kg/T), Qo	0.000425	0.000201
Volume of material (m)	570000	570000
Density of material (kg/m)	1987	1987
Days of work	468	468
Working hours	12	12
Unadjusted emission rate (g/s)	0.023798	0.011256
Surface area (m2)	22842	22842
Unadjusted emission rate (g/s/m2)	1.04e-06	4.93e-07

Unpaved road and haul routes (2 way)

	TSP	RSP
particle size multiplier, k	0.8	0.36
silt content of road surface material (%), s	16	16
mean vehicle speed (km/hr), S	15	15
mean vehicle weight (T), W	35	35
mean number of wheels, w	10	10
number of days (rainfall < 0.254 mm) per year, p	100	100
number of vehicle roundtrips per hr	20	20
E (kg/VKT)	3.909702	1.759366
E (g/s/m)	0.021721	0.009774

Unpaved road and haul routes (one way)

	TSP	RSP
particle size multiplier, k	0.8	0.36
silt content of road surface material (%), s	16	16
mean vehicle speed (km/hr), S	15	15
mean vehicle weight (T), W	35	35
mean number of wheels, w	10	10
number of days (rainfall < 0.254 mm) per year, p	100	100
number of vehicle roundtrips per hr	10	10
E (kg/VKT)	3.909702	1.759366
E (g/s/m)	0.01086	0.004887

Stock Piling

silt content of aggregate (%), s	1.6
% of time with wind speed > 5.4 m/s at mean pile height	7
number of days (rainfall < 0.254 mm) per year, p	100
E (kg/day/hectare)	1.066515
E (g/s/m2) for TSP	1.23e-06
E (g/s/m2) for RSP	6.17e-07

Top Soil Removal

Depth of top soil (m)	1
Surface area (m2)	22842
Density of material (kg/m)	1987
Mass of material (T)	45387.05
Days of work	468
Working hours	24
Rate of removal (T/hr)	4.04087
E (g/s) for TSP	0.022449
E (g/s) for RSP	0.011225
E (g/s/m2) for TSP	9.83e-07
E (g/s/m2) for RSP	4.91e-07

Wind Erosion

E (g/s/m2) for TSP	2.70e-06
E (g/s/m2) for RSP	1.35e-06

Concrete Batching Plant

Capacity (m/hr)	60
Area (m2)	2000
E (g/s) for TSP	2.00e-01
E (g/s) for RSP	1.00e-01
E (g/s/m2) for TSP	1.00e-04
E (g/s/m2) for RSP	5.00e-05

Blasting

Area Blasted (m2), A	900
Hole depth (m), D	5
Material moisture content (%), M	7.2
E (g/s) for TSP	28.61358
E (g/s) for RSP	12.73339
E (g/s/m2) for TSP	0.031793
E (g/s/m2) for RSP	0.014148

Air Quality Impact Assessment - Dust

Yuen Tun Ha Shaft/Adit

Loading & Unloading

	TSP	RSP
particle size multiplier, k	0.74	0.35
mean wind speed (m/s), U	1	1
material moisture content (%), M	2	2
Unadjusted emission rate (kg/T), Qo	0.000425	0.000201
Volume of material (m)	29000	29000
Density of material (kg/m)	1987	1987
Days of work	624	624
Working hours	12	12
Unadjusted emission rate (g/s)	0.000908	0.00043
Surface area (m2)	600	600
Unadjusted emission rate (g/s/m2)	1.51e-06	7.16e-07

Unpaved road and haul routes

	TSP	RSP
particle size multiplier, k	0.8	0.36
silt content of road surface material (%), s	16	16
mean vehicle speed (km/hr), S	15	15
mean vehicle weight (T), W	35	35
mean number of wheels, w	10	10
number of days (rainfall < 0.254 mm) per year, p	100	100
number of vehicle roundtrips per hr	4	4
E (kg/VKT)	3.909702	1.759366
E (g/s/m)	0.004344	0.001955

Stock Piling

silt content of aggregate (%), s	1.6
% of time with wind speed > 5.4 m/s at mean pile height	7
number of days (rainfall < 0.254 mm) per year, p	100
E (kg/day/hectare)	1.066515
E (g/s/m2) for TSP	1.23e-06
E (g/s/m2) for RSP	6.17e-07

Top Soil Removal

Depth of top soil (m)	1
Surface area (m2)	600
Density of material (kg/m)	1987
Mass of material (T)	1192.2
Days of work	624
Working hours	24
Rate of removal (T/hr)	0.079607
E (g/s) for TSP	0.000442
E (g/s) for RSP	0.000221
E (g/s/m2) for TSP	7.37e-07
E (g/s/m2) for RSP	3.69e-07

Wind Erosion

E (g/m/s) for TSP	0.000003
E (g/m/s) for RSP	0.000001

Air Quality Impact Assessment - Dust

Butterfly Valley Service Reservoir

Loading & Unloading

	TSP	RSP
particle size multiplier, k	0.74	0.35
mean wind speed (m/s), U	1	1
material moisture content (%), M	2	2
Unadjusted emission rate (kg/T), Qo	0.000425	0.000201
Volume of material (m)	950000	950000
Density of material (kg/m)	1987	1987
Days of work	624	624
Working hours	12	12
Unadjusted emission rate (g/s)	0.029748	0.01407
Surface area (m2)	8000	8000
Unadjusted emission rate (g/s/m2)	3.72e-06	1.76e-06

Unpaved road and haul routes

	TSP	RSP
particle size multiplier, k	0.8	0.36
silt content of road surface material (%), s	16	16
mean vehicle speed (km/hr), S	15	15
mean vehicle weight (T), W	35	35
mean number of wheels, w	10	10
number of days (rainfall < 0.254 mm) per year, p	100	100
number of vehicle roundtrips per hr	44	44
E (kg/VKT)3.909702 1.759366 E (g/s/m)	0.047785	0.021503

Stock Piling

silt content of aggregate (%), s	1.6
% of time with wind speed > 5.4 m/s at mean pile height	7
number of days (rainfall < 0.254 mm) per year, p	100
E (kg/day/hectare)	1.066515
E (g/s/m2) for TSP	1.23e-06
E (g/s/m2) for RSP	6.17e-07

Top Soil Removal

Depth of top soil (m)	1
Surface area (m2)	8000
Density of material (kg/m)	1987
Mass of material (T)	15896
Days of work	624
Working hours	24
Rate of removal (T/hr)	1.061432
E (g/s) for TSP	0.005897
E (g/s) for RSP	0.002948
E (g/s/m2) for TSP	7.37e-07
E (g/s/m2) for RSP	3.69e-07

Wind Erosion

E (g/s/m2) for TSP	2.70e-06
E (g/s/m2) for RSP	1.35e-06

Blasting

Area Blasted (m2), A	900
Hole depth (m), D	5
Material moisture content (%), M	7.2
E (g/s) for TSP	28.61358
E (g/s) for RSP	12.73339
E (g/s/m2) for TSP	0.031793
E (g/s/m2) for RSP	0.014148

Butterfly Valley - Tunnel Portal

Loading & Unloading

	TSP	RSP
particle size multiplier, k	0.74	0.35
mean wind speed (m/s), U	1	1
material moisture content (%), M	2	2
Unadjusted emission rate (kg/T), Qo	0.000425	0.000201
Volume of material (m)	15600	15600
Density of material (kg/m)	1987	1987
Days of work	53	53
Working hours	12	12
Unadjusted emission rate (g/s)	0.005751	0.00272
Surface area (m2)	2500	2500
Unadjusted emission rate (g/s/m2)	2.30e-06	1.09e-06

Unpaved road and haul routes

	TSP	RSP
particle size multiplier, k	0.8	0.36
silt content of road surface material (%), s	16	16
mean vehicle speed (km/hr), S	15	15
mean vehicle weight (T), W	35	35
mean number of wheels, w	10	10
number of days (rainfall < 0.254 mm) per year, p	100	100
number of vehicle roundtrips per hr	8	8
E (kg/VKT)	3.909702	1.759366
E (g/s/m)	0.008688	0.00391

Stock Piling

silt content of aggregate (%), s	1.6
% of time with wind speed > 5.4 m/s at mean pile height	7
number of days (rainfall < 0.254 mm) per year, p	100
E (kg/day/hectare)	1.066515
E (g/s/m2) for TSP	1.23e-06
E (g/s/m2) for RSP	6.17e-07

Wind Erosion

E (g/s/m2) for TSP	2.70e-06
E (g/s/m2) for RSP	1.35e-06

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8 DRAINAGE IMPACT AND WATER QUALITY ISSUES

Introduction

8.1 During both the construction and operation phases of the scheme there is the potential for water quality deterioration of both surface and ground water systems. The potential for deterioration in water quality mainly results from construction site run off and drainage, or uncontrolled discharge from operational plant. There may also be a risk of groundwater contamination due to the tunnelling activities, particularly if the tunnel enters a contaminated aquifer.

8.2 This section identifies the sensitive uses which may be affected by a deterioration in water quantity and quality, addresses the specific water quality impacts and identifies mitigation measures which should be incorporated into the construction and operation of the scheme.

Existing Water Quality

8.3 EPD regularly monitors river water quality at a large number of rivers throughout Hong Kong. In total there are approximately 7 regular monitoring stations in the study area although these are all limited to the Lam Tsuen river catchment, ie. the Tai Po Water Treatment Works (TP WTW) area. There are no regular data available for the Butterfly Valley catchment.

8.4 The 1992 water quality data for the stations in the TP WTW area are reproduced in Table 8.1 below. The approximate locations of the water quality stations are provided on Figure 8.1.

Table 8.1 River Quality in Lam Tsuen River Catchment, 1992

Parameter	TR12B	TR12C	TR12I	TR12G	TR12F	TR12C	TR12E
Dissolved oxygen (mg/l)	7.3 (4.1-11.8)	8.8 (6.9-14.6)	2.9 (1.6-6.3)	7.1 (4.8-9.1)	6.4 (3.5-7.7)	7.5 (5.1-9.1)	8.2 (7.1-9.8)
Biochemical Oxygen Demand (mg/l)	2 (1-11)	4 (2-10)	9 (4-17)	5 (1.0-9.0)	7 (3-19)	8 (2.0-13.0)	3 (1.0-14.0)
Suspended solids (mg/l)	7 (1-610)	12 (1-120)	7 (1-28)	6 (3.0-29.0)	8 (4-12)	71 (16-390)	3 (1.0-8.0)
Ammoniacal-N (mg/l)	0.18 (0.06-0.62)	0.27 (0.07-0.48)	1.3 (0.58-1.9)	0.05 (0.01-0.10)	1.59 (0.62-3.51)	0.80 (0.39-3.36)	0.07 (0.01-0.29)
pH	7.4 (6.4-7.8)	7.8 (7.1-9.3)	7.2 (6.9-8.2)	7.0 (6.8-7.6)	6.9 (6.4-7.5)	7.3 (6.9-11.1)	7.2 (6.6-7.5)
Aluminium (µg/l)	50 (50-1600)	225 (50-760)	50 (50-90)	50 (50-60)	50 (50-80)	3250 (90-45,000)	50 (50-50)
Cadmium (µg/l)	0.10 (0.1-0.4)	0.10 (0.1-0.6)	0.4 (0.1-1.2)	0.10 (0.10-0.3)	0.10 (0.10-0.50)	0.10 (0.10-0.40)	0.1 (0.10-0.60)
Chromium (µg/l)	1.0 (1.0-1.0)	1.0 (1.0-1.0)	1.0 (1.0-12.0)	1.0 (1.0-2.0)	1.0 (1.0-1.0)	2.5 (1.0-51.0)	1.0 (1.0-1.0)
Copper (µg/l)	2.5 (1.2-10.0)	2.5 (1.0-77)	3.0 (1.0-17.0)	2.0 (1.0-16.0)	2.0 (1.0-12.0)	7.5 (2.0-43.0)	1.0 (1.0-5.0)
Lead (µg/l)	1.5 (1.0-7.9)	3.0 (1.0-12.0)	1.0 (1.0-57.0)	2.0 (1.0-6.0)	2.0 (1.0-6.0)	5.0 (1.0-21.0)	2.0 (1.0-13.0)
Zinc (µg/l)	10 (10-90)	10 (10-20)	10 (10.0-30.0)	10 (10-20)	10 (10-20)	20 (10-140)	10 (10-30)
E.Coli (no. per 100 ml)	NM	NM	NM	NM	NM	NM	NM
Flow (L/s)	252 (35-4829)	57 (16-216)	NM	27 (10-66)	30 (1-99)	56 (20-325)	23 (8-155)

Source: *River Water Quality in Hong Kong, Results from the EPD River Water Quality Monitoring Programme for 1992*; EPD, 1994

Notes:

Figures are the annual median values of monthly samples, except *E.Coli* which is represented as the geometric mean.

Figures in brackets are the ranges

NM indicates that no measurement was taken

8.5 Overall, the monitoring results for the Lam Tsuen catchment indicate that the water quality in the catchment is good (based on EPD guidelines). There are, however, a number of anomolies.

8.6 The lower reaches of the Lam Tsuen river flow through the urban area of Tai Po. The water quality in this section of the river typically has low dissolved oxygen and high BOD. This can be seen on examination of the results at monitoring station TR12I.

8.7 It can be seen that at TR12C, Tin Liu Ha stream, there are significant concentrations of aluminium. EPD reports that this is a result of alum discharges from the Tai Po Tau Water Treatment Works. The alum discharge is not believed to pose a threat to public health and aluminium is not specifically addressed in the TM, although legislation from the European Commission does place limits on the discharge of alum/aluminium due to perceived risks. This monitoring station also recorded very high levels of suspended solids and high concentrations of other metals, namely chromium, copper, zinc and lead. WSD is currently taking appropriate steps to minimise these discharges.

8.8 Although there are no data available for the Butterfly Valley stream there is visible evidence of dumping and it is likely that the villagers along the valley discharge domestic and sewage waste directly into the stream. The poor water is illustrated in the stream macrobenthos survey results; the species found in the stream and the population structure of the animals are indicators of fairly poor water quality.

Sensitive Receivers

8.9 The main water quality sensitive receivers adjacent to the construction sites are the villages which are reliant on the surface water systems for aquaculture and agriculture. The main village reliant on surface water is the village of She Shan Tsuen to the north-north west of the TP WTW site where there are 6-7 farms. The She Shan Tsuen stream originates from the south west of the TP WTW site and flows north west across the site to the village of She Shan Tsuen. The stream feeds a series of fishponds and flows through two Conservation Areas and is therefore sensitive to adverse changes in water quality and quantity. Any detrimental impact on water quality and quantity could have an adverse effect on the aquaculture farming and activities, and on the natural value of the designated Conservation Areas.

8.10 The tunnel route passes beneath the water gathering grounds for Plover Cove, Shing Mun and Kowloon Group reservoirs; any adverse effect on water quality, or availability, would have significant implications and should be avoided. These issues are discussed further in the Draft Preliminary Report, Chapter 5, extracts from which are presented in the following paragraphs.

8.11 A total of 28 main streams could be crossed by the proposed treated and raw water tunnel. Some of these streams feed agricultural areas, fish ponds, villages and reservoirs. Details of the streams and receiving areas are shown in Figures 8.1 to 8.5 and listed in Table 8.2.

8.12 Where the tunnel intersects extensive open rock joints, it is conceivable that it will act as a drain to the local groundwater. In such circumstances (which are not common in Hong Kong), it is possible that the water table could be lowered locally and, as a result, flow in some stream courses could be affected. With the information available at this time, it is possible to make only a qualitative assessment to identify those areas with potential to be affected in this way as a result of inflows to the tunnel. This potential arises where the tunnel passes beneath a valley bottom, and, in doing so, has relatively little ground cover.

Table 8.2 Existing Significant Streams Along Proposed Raw Water Tunnel & Treated Water Tunnel

Stream No.	Tunnel Alignment	Potentially affected by tunnel alignment	Approximate Chainage[1]	Length (km)	No. of Main Branches	Size of Stream	Estimated Flow at End of Dry Season 1994/95	Receiving Area	Location of Affected Area	Remarks	Risk
a	Raw water	-	650	0.4	No	Small	Small	Agriculture area and fish ponds	Nr Tai Po Tau	Feeds agricultural area & Lam Tsuen River	Low
b	Raw water	-	880	0.3	No	Small	Small		Nr Tai Po Tau	Feeds agricultural area & Lam Tsuen River	Low
c	Raw water	-	1030	0.35	No	Small	Small		Nr Tai Po Tau	Feeds agricultural area & Lam Tsuen River	Low
1	Treated water	1,2,3	500-1600	3	4	Moderate	Moderate	Agriculture area & village	Lin Au	Feeds agricultural area & village	Moderate
2	Treated water	3	1000 (3)	0.8	4	Moderate	Moderate	Agriculture area & village	Lin Au	One of the main branches of Stream 1	Low
3	Treated water	2,3	1700 (2) 1400 (3)	2	4	Moderate	Moderate	Agriculture area & village	Lin Au	Feeds agricultural area & village	Low
4	Treated water	2,3	1900 (2)	1.8	1	Small	Small	Agriculture area	Lower Lin Au	Feeds agricultural area	Low
5	Treated water	1,2,3	2500-3500	2.8	> 10	Moderate	Moderate	Agriculture area & village	Yuen Tun Ha	Feeds agricultural area & village rocky stream bed	Low
6	Treated water	2,3	3100 (2)	0.25	2	Small	Small	Agriculture area & village	Yuen Tun Ha	Feeds agricultural area & village	Low
7	Treated Water	2,3	3200 (2)	0.8	2	Small	Small	Agriculture area & village	Yuen Tun Ha	Feeds agricultural area & village	Low
8	Treated water	2,3	3400-3900 (2)	2	6	Small	Small	Agriculture area & village	Yuen Tun Ha Ta Tit Yan	Feeds agricultural area & village rocky stream bed	Low
9	Treated water	2,3	4600-5200 (2)	2.7	> 10	Moderate	Moderate	Reservoir catchment	Shing Mun Reservoir	Flows to reservoir	Moderate
10	Treated water	1,2,3	4500-5800	3	> 10	Large	High	Reservoir catchment	Shing Mun Reservoir	Flows to reservoir	Moderate
11	Treated water	1,2,3	5950	1	No	Small	Small	Reservoir catchment	Shing Mun Reservoir	Flows to reservoir	Low
12	Treated water	1,2,3	6260 & 6700	1	2	Small	Small	Reservoir catchment	Shing Mun Reservoir	Flows to reservoir	Low
13	Treated water	2	7200 (2)	0.5	1	Small	Small	Reservoir catchment	Shing Mun Reservoir	Flows to reservoir	Low
14	Treated water	1	7300	0.5	No	Small	Small	Agriculture area & houses	Wo Yi Hop	Feeds agricultural area & houses flows from reservoir	Low
15	Treated water	1	7800	0.3	No	Small	Small	Agriculture area & houses	Wo Yi Hop	Feeds agricultural area & houses	Low
16	Treated water	1	8200	0.6	4	Moderate	Moderate	Agriculture area & houses	Shek Yam	Feeds agricultural area & houses	High
17	Treated water	1	8350	0.3	1	Small	Small	Agriculture area & houses	Shek Yam	Feeds agricultural area & houses	Moderate
18	Treated water	1	8500	0.3	No	Moderate	High	Agriculture area & houses	Shek Lei	Feeds agricultural area	Moderate
19	Treated water	1	8750	1	5	Moderate	High	No	None	None	None
20	Treated water	1	8900	0.4	1	Small	Small	Agriculture area & houses	Shek Lei	Feeds agricultural area & houses	High
21	Treated water	1	9100	0.5	No	Small	Small	Agriculture area & houses	Shek Lei	Feeds agricultural area & houses	Moderate
22	Treated water	1	9250	0.5	No	Small	Small	Agriculture area & houses	Shek Lei	Feeds agricultural area & houses	Moderate
23	Treated water	1	9400	0.75	2	Moderate	Moderate	Agriculture area & houses	Shek Lei	Feeds agricultural area & houses	Moderate
24	Treated water	1	10650	0.8	No	Small	Small	Reservoir catchment	Kowloon Reception Reservoir	Flows to reservoir	High
25	Treated water	1	11400	1.5	5	Big	High	Urban drainage	Cheung Sha Wan	None	None

Notes: 1. Chainages of treated water tunnel are that of alignment 1 except where marked otherwise. Numbers in bracket refers to alternative alignments.

8.13 The raw water tunnel may affect streams which feed agricultural lands and fish ponds in the She Shan Tsuen area. Areas along the treated water tunnel with such potential to be affected have been identified and are mainly located close to Lin Au, Yuen Tun Ha, Ta Tit Yan, Wo Yi Hop, Shek Yam and Shek Lei. The existing Shing Mun and Kowloon Group reservoirs could also be affected.

8.14 At She Shan Tsuen, the villagers are actively involved in agriculture and aqua-culture. Fish ponds are formed by damming streams at the foot of the hill. Geological logs of the Plover Cove Stage 1 and the Duplicate tunnels which runs about 100 m to the east of the proposed raw water tunnel show that the tunnels were excavated in relatively dry conditions with only minor seepage at joints and no major geological features were encountered. However, the cover over the new tunnel will be less than over the existing tunnels due to the slope of the hill into the Lam Tsuen Valley. Hence, although the risk of encountering significant inflows is considered to be low, the consequences, if near the aquaculture areas, could be significant.

8.15 At Lin Au, only a small agricultural area was found to be used for irrigation. Most of the farm land is abandoned or planted with fruit trees. The minimum ground cover is approximately 80 m. Any influence on water rights in the area is expected to be insignificant.

8.16 At Yuen Tun Ha and Ta Tit Yan, the tunnel alignment 3 cuts the upstream water courses that feed the agricultural area. However, both the villages and agricultural areas are abandoned. Any effect is expected to be insignificant.

8.17 At Wo Yi Hop, Shek Yam and Shek Lei, irrigation and fruit trees occur along the hillside. The common alignments pass under these areas and cut the streams that feed the agricultural area. Although the streams are small, the ground cover is low in some places, so any influence on water rights in these areas may be significant.

8.18 A number of WSD water catchments are at risk, namely Shing Mun Reservoirs and Kowloon Reception Reservoir.

8.19 Details of possibly affected agricultural areas, villages and WSD water bodies are given in Table 8.2 together with the assessed risk. The assessment of risk of inflow is based on information gained from previous experience of the design and supervision of a large number of tunnels in Hong Kong, available published information, and other known geological and hydrogeological conditions.

Table 8.3 Assessment of Potential Hydrogeological High Risk Areas Based on Known Geological Features and Low (< 100 m) Ground Cover

Raw Water Tunnel Chainage	Treated Water Tunnel Chainage (Alignment 1)	Estimated Length for Probing Ahead	Reason	Affects
300 - 450	-	150 m	Low cover	Public
550 - 800	-	250 m	Low cover	Public
-	0 - 940	940 m	Low cover	Public
-	2000	30 m	Fault	Public
-	3840	20 m	Fault	Public
-	4180	10 m	Fault	Public
-	4300 - 4400	100 m	Fault zone	Public
-	4800	30 m	Fault zone & Geological Boundary	Public
-	5010	30 m	Fault & Geological Boundary	Public
-	7130 - 7500	380 m	Low cover & major Fault	Shing Mun Reservoir (WSD)
-	7530 - 8160	620 m	Low cover & major fault	Shing Mun Reservoir (WSD)
-	8850 - 9050	200 m	Low cover	Public
-	10870 - 11800	930 m	Low cover & major shear/ fault zones	Public & WSD (Kowloon Reservoirs)

Water Quality - Construction Phase

Surface water impacts

8.20 Potential impacts on surface water quality as a result of the construction activities include:

- construction run off and drainage;
- general construction activities;
- sewage from construction workforce.

These sources have the potential to increase sediments, other suspended solids, biochemical oxygen demand (BOD), pH and other contaminants.

Groundwater impacts

8.21 Prior to the installation of the tunnel lining, the volume of groundwater seepage from the tunnel drainage is dependant on whether water bearing stratum is encountered. Based on previous experience in similar geological conditions it is estimated that normal tunnel drainage is likely to be the order of 0.25 m^3/s, although it could be as much as 0.5 m^3/s for a few days if water bearing strata is encountered.

8.22 An assessment of areas that would probably be at risk from ingress of groundwater during construction has been carried out during the Drainage Impact Assessment and is detailed in Table 8.3.

8.23 Discharge of groundwater into adjacent water courses could have one of two effects. Firstly the increase in flow could improve water quality by providing additional dilution to water courses which are used to carry domestic and possibly livestock waste. However, if the groundwater is contaminated, discharge into water courses may have adverse ecological impacts and may pose a threat to public health.

8.24 There is no readily available information on the potential for groundwater contamination in the area although there are scattered, possibly flooded, mine workings. However, the recent series of sediment analysis undertaken by GEO identified areas of high mineralisation in the Tai Mo Shan and Shing Mun areas, which may also indicate areas where there could be contamination. Groundwater contamination may occur where chemical processes have enabled minerals contained in the bedrock to dissolve into soluble mineral salts. Mineralisations include lead and zinc in Tai Mo Shan to the north and tin and wolframite in the Shing Mun area. The survey also highlights the areas where anomalies occur in the sediment findings. These anomalies are potentially man made contamination pockets which may require specialist remediation.

8.25 Sediments have been discovered during dredging operations in Tolo Harbour that are contaminated with such high concentrations that the muds have required removal to the contaminated mud pits at East Sha Chau.

Mitigation Measures - Construction Phase

Surface Water

8.26 Construction site runoff has the potential to cause the most damaging effects on the adjacent water courses. Site runoff will contain suspended solids and may contain more toxic contaminants such as fuels, oils, lubricants and concrete. Accidental spillages on site may also be carried in surface water runoff.

8.27 Good site management practice should ensure that construction impacts on water quality are minimised. Prevention of surface water contamination during construction involves two basic elements. Firstly, minimising the quantity of water which might become contaminated by high levels of suspended solids from exposed and disturbed ground surfaces. Secondly, collection and treatment of potentially contaminated water.

8.28 The potential for erosion and sedimentation can be limited by the following means outlined in EPD's Practice Note ProPECC 1/94 on *Construction Site Drainage* which include the following:

- areas of excavation should be minimised and exposed surfaces stabilised by methods such as covering with aggregate or hydroseeding;
- boundaries of earthworks should be surrounded by temporary flood protection works;
- the use of drainage channels, bunding and sediment traps to prevent construction site runoff from draining directly to streams and waterways;
- local temporary grading of the construction site ground surface should direct runoff towards regularly cleaned and maintained silt traps and oil/grease separators. The silt and oil/grease traps should be of sufficient capacity to hold a one in five year event, and of appropriate design for proper treatment of effluent prior to the application for a *Water Pollution Control Ordinance (WPCO)* effluent discharge licence;
- wastewater generated from the washing down of mixer trucks and drum mixers and similar equipment should wherever practicable be recycled. Water used in ground boring and drilling for site investigation or rock/soil anchoring should as far as practicable be recirculated after sedimentation. The discharge of wastewater should be kept to a minimum;
- a slurry collection and recycling system for spent bentonite and other grouts should be operated;

- where appropriate permanent drainage works should be accommodated within temporary works;

- solid materials, litter or wastes should not be dumped in any surface water course.

8.29 To minimise the risk of contamination from oil, diesel, lubricants and solvents:

- compounds in the works area should be designed to take account of contaminated surface water. Oil and fuel bunkers, which should be locked and sited in sealed areas, should be enclosed by bunds capable of holding 110% of the bunker capacity in order to prevent discharges due to the accidental spillage or breaching of storage tanks;

- layers of sawdust or, other absorbent inert material, should be laid underneath or around any construction plant or equipment that leaks oil. The polluted clean up materials should be replaced by clean material on a regular basis and disposed of properly.

8.30 Construction workforce staff will be required to use the toilet facilities provided on site. Where the municipal sewerage system cannot be accessed these facilities should be in the form of chemical toilets.

8.31 All polluted water should be treated to ensure compliance with the *TM on Effluents discharged into Drainage and Sewerage Systems, Inland and Coastal Waters.*

Groundwater

8.32 To allow a meaningful comparison between flow in key streams before and after construction, it is recommended that monitoring stations are set up downstream of tunnel alignment on streams considered to be at possibly moderate and high risk of having their flow to the public reduced by groundwater inflow into the tunnel. These include the streams no. 1, 16-18 and 20-23 crossing the tunnel at approximate chainages shown in Table 8.2. WSD has confirmed that a monitoring station will be set up in stream no. 1 upstream of the Lin Au village. Monitoring of the streams no. 9, 10 and 24 are not considered as necessary as these discharge into WSD reservoirs.

8.33 As part of detailed design site investigation, it is recommended that known geological structural features which connect to major WSD water bodies are further characterised with respect to location, trend, dip, material characteristics and permeability.

8.34 To obtain advance warning of the random and unknown geological features, it is recommended that probing ahead be carried out during construction. Naturally, this would not be economical for the whole tunnel lengths, but rather should be concentrated in those areas considered to be at greater risk as part of the hydrogeological assessment and detailed in Table 8.3. This would necessitate probing ahead for 35% of the raw water tunnel and approximately 25% of the treated water tunnel. In addition, it is recommended that advance ground treatment be specified to be mandatory where flows through probe holes above 20 l/min are encountered (or 50 l/min at the tunnel face and within 25 m of the tunnel face or over any 50 m length of tunnel). This should reduce the effect of any changes to the existing hydrological and hydrogeological regimes along the raw water and treated water tunnels.

8.35 During construction, tunnel drainage water should be tested for contaminants including lead, zinc, silver and tin.

Water Quality - Operational Phase

8.36 Operational impacts on water quality potentially include:

- Surface water impacts from wastewaters including washwater and sludge from regular maintenance of TP WTW and BVPSR;
- overflows from TP WTW and BVPSR;
- site runoff;
- groundwater seepage into tunnel.

Mitigation Measures - Operational Phase

Surface Water Impacts

8.37 Washwater from TP WTW will be recovered and recycled and will not be disposed of to the existing stream courses adjacent to the site. There will, therefore, be no detrimental impacts on stream water quality as a result of washwater discharge. Washwater from the cleansing of Butterfly Valley Primary Service Reservoir (BVPSR) will be treated prior to discharge.

8.38 Sludges from the treatment works and service reservoir maintenance will be disposed of as outlined in Section 9 of this Report. Sludge from the TP WTW clarifiers and settled sludge from the used filter washwater tanks will be treated by solid-liquid separation processes to a dry solids content acceptable for landfill with supernatant discharge to the used washwater recovery tanks.

8.39 With regard to sludges from cleaning the BVPSR, it is proposed that provision should be made in the detailed design for such on-site facilities as recommended in the Reservoir Cleansing Consultancy under Agreement CE 19/94 for service reservoir cleansing to be discharged to sewer. The cleansing effluents for this service reservoir will be discharged into the sludge pipeline from Tai Po Road Treatment Works before it discharges into the foul sewer in King Lam Road in Cheung Sha Wan. While the sludge from the treatment works will be discharged on a semi-continuous basis, the BVPSR will only be cleansed every 1-2 years, or such period as found appropriate. Discharge from BVPSR will be coordinated with the treatment works operation and controlled so as not to exceed the permitted discharge rate from the treatment works. All discharges have to be licensed under WPCO and will comply with the requirements of the *TM on the Standards of Effluent Discharged into Drainage and Sewage Systems, Inland and Coastal Waters.*

8.40 As discussed in the Draft Drainage Impact Assessment under emergency conditions, overflow from TP WTW will be directed down the existing stream to the Lam Tsuen floodway opposite Tai Po Gardens, and overflow from Butterfly Valley down the existing Butterfly Valley stream. These unpolluted overflows should not cause water quality problems as the overflow would either consist of the raw water from China or Plover Cove (in the case of TP WTW overflow) or treated water (in the cases of both TP WTW and BVPSR).

8.41 To prevent possible accidental discharge of polluted site runoff into the She Shan Tsuen stream, the headwaters of the She Shan Tsuen stream will be diverted into the stream to the east of the site. On-site observations in August-September 1995 indicate that most of the water in the stream originates as groundwater seepage rather than surface runoff. The base flow head of the stream starts below the formation level of the proposed treatment works platform at 90 mPD. In view of this, the effect of the diversion of the upper reach of the stream (above 90 mPD) on the ecosystem is likely to be minimal. Every effort will be made to keep the extent of the stream diversion to the minimum.

Groundwater impacts

8.42 The recommended treated water aqueduct option is fully lined and consequently there will be no seepage during the operational phase.

8.43 Runoff from areas within TP WTW where chemicals or fuels are stored should be separated from the general site runoff. The detailed design of concrete aprons used for the chemical unloading bays and around the chemical and fuel storage tanks, should ensure that any wash down is routed into settlement tanks. Also, chemical and fuel storage areas should be enclosed by a bund which can hold 110% of the chemical/fuel storage capacity.

8.44 In the detailed design of the proposed TP WTW, the opportunities for combining the existing works discharge with the new works discharge should be examined, as outlined in the Draft Preliminary Report, Chapter 13. This would enable the discharge to be treated and prevent any further alum discharge into the Tin Lui Ha stream.

Summary

8.45 The main surface water quality sensitive receivers are villages reliant on the surface water systems for fish farming and agriculture, and natural stream habitats. The main village reliant on stream water is She Shan Tsuen in the Lam Tsuen Valley. The tunnel route also passes beneath the water gathering grounds for the Plover Cove Reservoir, Shing Mun and Kowloon reservoirs.

8.46 During both the construction and operational phases of the scheme there is the potential for adverse impacts on both surface and ground water systems. The potential for deterioration in water quality mainly results from:

- construction site runoff, which may be contaminated with sediments and/or fuel and chemicals;
- site drainage (including tunnel drainage during the construction phase);
- sewage from construction or WSD works personnel;
- site runoff, drainage and washwater discharges during the operation of TP WTW and BVPSR.

8.47 Good site management practices, such as those outlined in EPD's ProPECC Paper on *Construction Site Drainage* coupled with monitoring of contaminants in tunnel drainage water, will ensure that any impacts on water quality are prevented or minimised. Special measures will be needed to ensure that sediment does not wash into the culvert system where heavy siltation would result.

8.48 The Drainage Impact Assessment has studied the existing surface drainage and assessed the potential impact of the scheme at TP WTW and BVPSR including the issues of:

- additional surface runoff due to change in land use;
- compensation flow of unpolluted runoff to the She Shan Tsuen catchment;
- emergency overflows of unpolluted raw or treated water from the treatment/pumping facilities or reservoir

8.49 Detailed preventative measures will be incorporated into the temporary and permanent works to ensure that construction and operation of the TP WTW will not have any adverse impact on the She Shan Tsuen village and its agriculture and aquaculture activities.

8.50 There is a risk of the tunnel alignment crossing a highly permeable or contaminated aquifer, discharges from which could adversely impact on water quality and water supply.

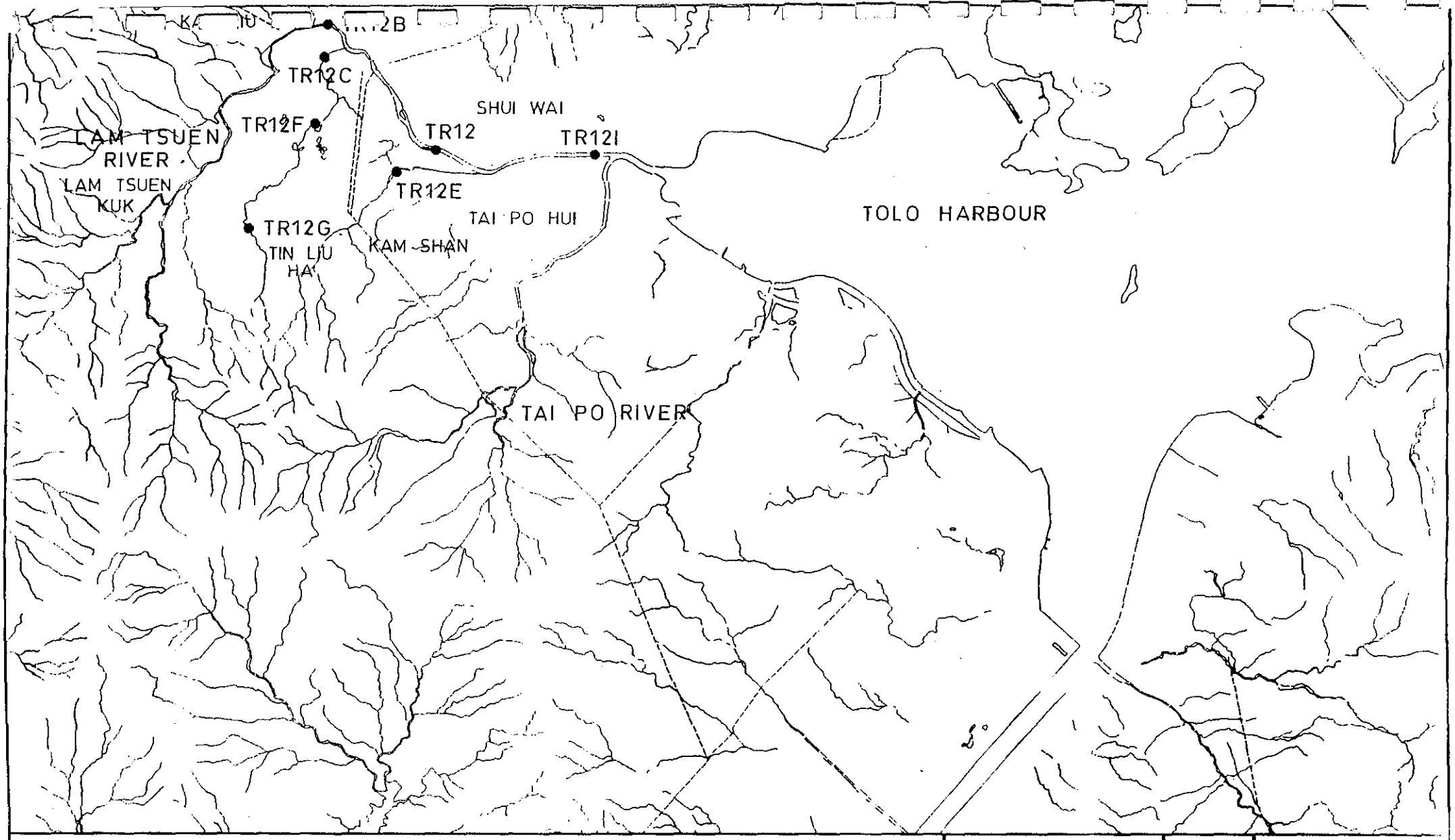
8.51 The potential issue of leakage into the treated water tunnel during construction has been assessed. The tunnel will be fully lined so there will be no leakage during the operational phase.

8.52 Measures to minimise the operational water quality impact of TP WTW and BVPSR include:

- separating runoff from areas where chemicals or fuels are stored from general site runoff;
- treating washwater prior to reuse or discharge; and
- appropriate treatment and disposal of sludges.

8.53 Appropriate measures should be taken to ensure that the discharge of any wastewater generated from construction or operation related activities comply with WPCO discharge standards to inland waters, storm drains and foul sewers, as appropriate.

8.54 Issues relating to the treatment and disposal of sludges from TP WTW and BVPSR are dealt with more fully in Chapter 13 of the Draft Preliminary Report.



EPD WATER QUALITY MONITORING STATIONS

ENNIE CONSULTANTS LIMITED Engineers and Scientists	Date APR. 95	Scale N.T.S.
Water Supplies Department	Initial RVC	Figure No. 8.1

9 WASTE AND SPOIL MANAGEMENT

Introduction

9.1 Wastes will be produced during both the construction and operation phases of the scheme. In order to minimise the waste production, the potential for reuse and recycling have been considered for both phases in order to achieve good environmental conservation practice.

9.2 This waste and spoil assessment consists of:

- identification of the sources of solid waste, waste generation, characterisation and separation;
- investigation into any secondary or cumulative impacts such as odour, gaseous emissions and noxious leachates;
- evaluation of the proposed waste management strategy and waste handling, treatment and disposal methods, and;
- incorporation of waste reduction, reuse and recycling by any practical means.

Construction Waste Management

9.3 Wastes arise from numerous construction activities, of which the main ones include:

- vegetation clearance;
- excavated material;
- wooden material;
- chemical waste;
- aqueous wastes;
- domestic municipal wastes and sewage;
- concrete waste;
- site clearance.

9.4 The overall principles of construction waste management are minimisation of waste generation, coupled with maximum reuse of construction materials.

Vegetation clearance

9.5 Vegetation cover will need to be removed from working areas before construction work can commence. The density and nature of the vegetation cover and the surface areas which require clearance varies between each of the surface construction sites. A description of the vegetative cover and an assessment of the volumes of waste generation for each site is outlined below:

- The proposed Tai Po Water Treatment Works (TP WTW) site is covered with shrubs, grass and some mature trees. The area of abandoned farmland in the centre of the site is overgrown with tall grass and shrubs. The total estimated volume of vegetative waste from this site is 130,000m^3.

- The Butterfly Valley Primary Service Reservoir (BVPSR) site is mostly covered with grass although there are also scattered shrubs and a few fairly young trees. The total estimated volume of vegetative waste from this site is 27,800m^3.

- The tunnel access shaft and portal sites at Tai Po, Shing Mun and in Butterfly Valley are small sites with sparse vegetation cover. The total estimated volume of vegetative waste from these sites therefore contributes little in terms of the overall total and has not therefore been assessed.

Management of vegetative material

9.6 Disposal of vegetative material would involve transport off site by private contract trucks to the nearest public landfill site. The most appropriate landfill sites for the disposal of vegetative wastes are WENT and SENT. It is worth noting that some of the current landfill sites will not accept vegetative material mixed with more than 20% inert material.

9.7 Burning of vegetative material and other wastes on construction sites is prohibited.

Excavated material

9.8 The construction of the scheme will involve excavations at four sites. These are:

- excavation of the raw water tunnel;

- site formation for TP WTW for which stepped platforms with levels falling from 105 mPD are required;
- excavation of the treated water tunnel;
- excavation for the BVPSR.

9.9 Due to the tight construction programme, tunnelling activities will be carried out 24 hours per day, which will therefore produce spoil 24 hours per day. Movement of the spoil off site will not be permitted during the evenings, night-time or on Sundays and public holidays, and will therefore require stockpiling on site.

9.10 Table 9.1 below shows the projected spoil generation figures for TP WTW, BVPSR and associated aqueducts as available when the waste and spoil management assessment was carried out. The TP WTW site cut/fill volumes and consequently the spoil generation figures have since been revised as follows:

Approx. Total Volume of Spoil	315,000 m^3
(assumes cut volume = 670,000 m^3 and fill volume = 355,000 m^3)	
Approx. Spoil Disposal/Day	673 m^3
Average No. of Trucks/Day	112

This revision does not alter the findings of the waste and spoil management assessment.

Table 9.1 Spoil Generation and Disposal Routing

Activity	Scenario		Approx. Total Volume of Spoil (m^3)	Approx. Spoil Disposal/day (m^3)	Spoil Disposal Per Portal, Shaft or Access Route/day[1]	Average Number of Trucks/day[2]
Raw Water Aqueduct Option III[3]	(a)	Tunnel option, shaft and 1 portal	13,400	43[4]	43	7
Treated Water Tunnel Excavation	(a)	2 portals, Shing Mun shaft Tunnel diameter 5.5 m^5	283,300	454[7]	151	26
	(b)	2 portals, Shing Mun and Yuen Tun Ha shafts Tunnel diameter 3.4 m^6	116,000	186[7]	46	8
Tai Po Water Treatment Works[8]	(a)	1 site access route (WSD road)	160,000	342[9]	342	57
Butterfly Valley Service Reservoir	(a)	1 access route (Butterfly Valley road)	950,000	1,522[10]	1,522	253

Notes:

1 Assumes spoil disposal is divided equally between portals/shafts (in reality a larger proportion would come out of the shaft(s))
2 Average number of trucks per day based on 6 m^3 per truck
3 Assumes tunnel is 1.4 km long
4 Assumes spoil is disposed of 6 days per week over 1 year (312 days)
5 Option with 1 shaft = 11.8 km tunnel
6 Option with 2 shafts = 12.3 km tunnel
7 Assumes spoil is disposed of 6 days per week over 2 years (624 days)
8 Assumes cut volume = 570,000 m^3 and fill volume = 4[illegible]0,000 m^3
9 Assumes spoil is disposed of 6 days per week over 1.5 years (468 days)
10 Assumes spoil is disposed of 6 days per week over 2 years (624 days)

Shing Mun Shaft - Total spoil arisings approximately 3,080 m^3 (7 m diameter x 80 m deep)
Yuen Tun Ha Shaft - Total spoil arisings approximately 1,160 m^3 (7 m diameter x 30 m deep)

Management of excavated material

9.11 At TP WTW, site investigations have revealed that there is little, if any, rock at the depths to which the site will be formed. Excavated spoil would be reused as fill material although it is inevitable that some excess will be generated. Two site investigations have been undertaken for this project at the BVPSR site, but the site is likely to yield around 950,000 m^3, mainly of rock. Granite material, particularly that from the treated water aqueduct, is high grade rock and in high demand. The Fill Management Committee (FMC) has already been notified of the spoil availability as a result of this scheme, in order for FMC to organise and make use of the excess excavated material in reclamation projects. Provided the spoil is uncontaminated, it can be put into good use and reduces the requirements for commercial rock excavation elsewhere.

9.12 The opportunity exists for advance construction of the platform by a third party so as to make the best use of the excavated spoil in the form of rock fill.

9.13 The issues associated with the stockpiling and remote disposal of spoil, ie. removal off site to a designated landfill or to a FMC site, are addressed elsewhere in this Report.

9.14 The key issues associated with stockpiling and transport of spoil are:

- the handling of dry materials could result in increased dust generation and as a result public nuisance;
- noise impacts due to the movement of spoil both within the construction sites and off site:
- increased road traffic on local roads could lead to significant public disruption which may have an adverse effect on day to day business and cause general inconvenience;
- surface water runoff from stockpiles could result in increased turbidity, siltation and slower flows in surface water courses and culvert systems which would have a detrimental impact on aquatic habitats.

9.15 Excavated spoil would be reused as fill material although it is inevitable that some excess will be generated. Mitigation measures to alleviate these impacts have been identified in the relevant sections.

9.16 Further details on the radioactive and mineral properties of the granite in this area are provided in the section on contaminated land.

Wooden material

9.17 The use of various kinds of wooden materials is essential during the construction phase. Such items include wooden boards for formwork, erection of site boundaries, and bamboo in slope protection works. It is Government's Policy that Tropical Hard Wood shall not be used for site hoarding and trench shoring. Wooden materials are a valuable resource and options for the reuse and recycling of discarded wooden waste in order to conserve resources are discussed below.

Scaffolding

9.18 Scaffolding is required to provide platforms for workers on the construction site. In order to assess the quantity of bamboo required during construction, the following assumptions have been made:

- bamboo diameter of 60 mm;
- 800 mm distance between bamboo poles;
- the surface area of an average 3 storey building is estimated to be 4,194 m^2.

9.19 Based on these assumptions, the total length of bamboo per 3 storey building is estimated to be 13,007 m which represents a total volume of 37 m^3. Assuming a 25% wastage rate, this results in a 9 m^3 generation of waste per assumed building size. The total volume of bamboo wastage will be proportional to the surface area of buildings requiring scaffolding.

9.20 In other countries, it is generally common practice to use metal scaffolding which, like bamboo, has a very high reuse rate.

Formwork

9.21 Wood is generally used as formwork for concrete structures although reusable steel shutters are a preferred alternative. In order to estimate the waste volume of wooden boards and shutter ply which may be required if steel shutters are not used, the following assumptions have been made:

- wooden boards are assumed to be 0.02 m thick
- it is assumed that the wooden boards can be reused five times, therefore the wastage rate of the wooden boards is assumed to be 20%.

9.22 Wooden board usage at TP WTW and BVPSR is estimated in Table 9.2.

Table 9.2 Estimated Wooden Board Usage

Activity	Total use of wooden boards (m^3)	Total volume of wooden boards (m^3)	Total volume of wooden boards waste (m^3)
TPWTW construction	52,649	1,053	211
Slope drainage at TPWTW site	625	12.5	2.5
Formwork at Butterfly Valley (Phase 1)	14,190	284	57

9.23 All wooden materials used on site should be sorted from other wastes. Wooden boards can be reused on site although the reusability and quantity of final waste depends the shape and quality of the boards. Timber which can not be reused should be sorted and stored separately from all inert waste before being disposed of to landfill. Opening burning for the disposal of construction waste or the clearance of a site in preparation for construction work is prohibited under the *Air Pollution Control (Open Burning) Regulation.* A number of private contractors will collect used formwork materials for local reuse or export to China.

9.24 Reusable steel shutters can be used as a preferred alternative.

Site fencing

9.25 Site fencing is necessary to separate the construction works from the public and to reduce construction nuisance such as noise to nearby sensitive receivers.

9.26 It is likely that metal fencing or Building Panels will be used to provide site fencing. Building Panels are cement structures with a light weight concrete core. The material provides good sound insulation and thermal insulation as well as being both water proof and fire resistant. These panels are easily recycled and reduce wastage of timber. However, wooden panels may be used and the following calculations are based on this assumption.

9.27 It is assumed that wooden fencing will be 20 mm thick with a height of height 2 m. The volume of waste generated is assumed to be 20% of the total volume. Based on these figures, the approximate fencing requirements are:

- Raw water tunnel portal - length of fencing will be approximately 220 m which produces a waste volume of approximately 9 m^3;
- TP WTW - a total fencing length of 1,809 m which will produce an approximate waste volume of 72 m^3;
- Shing Mun access shaft site - total fence length 180 m which will produce an approximate waste volume of 7m^3;
- Butterfly Valley tunnel portal - total fence length 140m which will produce an approximate waste volume of 6m^3;
- BVPSR - a total fencing length of 832 m will produce an approximate waste volume of 33 m^3.

9.28 Based on these assumptions, the total waste volume of wooden fencing materials could be in the order of 127 m^3 if all the fencing is dumped on completion of the construction. This type of wooden board is valuable for reuse on other construction sites and should not therefore be disposed of to landfill. On completion of the construction phase, the boards should be sorted and grouped then redistributed to other construction sites.

9.29 The sorting and separate collection of wooden boards. timber and bamboo is common practice on Hong Kong construction sites.

Chemical waste

9.30 Where the construction processes produce chemical wastes, the Contractor must register with EPD as a Chemical Waste Producer. EPD requires information on the particulars of the waste generation processes including the types of waste produced, location of waste arisings, quantities and generation rates. In addition, a nominated contact person must be provided.

9.31 Wastes which are classified as chemical wastes are listed in the Waste Disposal (Chemical Waste) (General) Regulation. These wastes are subject to stringent disposal routes.

9.32 The major chemical waste types arising from the construction sites are oils, lubricants, paints and solvents. Oil waste may be in the form of raw waste or as sundries such as spent oil filters or materials used to absorb oil leaks. Storage and disposal of these wastes are discussed below.

9.33 Any construction plant which is likely to leak oil should have absorbent inert material such as sawdust or sand placed beneath it. This material should be replaced on a regular basis and the contaminated material should be stored in a designated place prior to disposal. Such relatively inert material is suitable for landfill disposal and can be disposed of via the normal waste stream.

9.34 Lubricants and waste oils are likely to be generated from the maintenance of vehicles and mechanical equipment. Used lubricants will be collected and stored in individual containers which are fully labelled. The containers shall be stored in a designated secure place. If possible such waste should be sent to a company that recycles used oils; a number of companies also collect empty oil drums for reuse or refill.

9.35 Oil and lubricant wastes are classified as chemical wastes, and if not recycled, should be treated at the Chemical Waste Treatment Centre.

9.36 In the past, empty paint cans have been melted down and recycled although now they are collected as waste. Any dry paint waste should be swept up and collected in containers for disposal.

9.37 Some paints and solvents are classified as chemical waste and if used ons site will be subject to the stringent requirements of the *Waste Disposal (Chemical Waste) (General) Regulation.*

9.38 No lubricants, oils, solvents or paint products should be allowed to discharge into water courses either by direct discharge or as contaminants carried in surface water runoff from the construction site.

Aqueous wastes

9.39 All vehicles leaving the construction site will pass through a wheelwash at the site exit. The wheelwash requires regular cleaning to remove sediment which would produce a large volume of wastewater. The tunnel boring machines required for the tunnel excavations also produce significant volumes of wastewater. To prevent excess sedimentation, and possibly contamination of local streams and water courses, these wastewaters should be directed into large settlement lagoons. The wastewater may then be reused on the construction site for washing, drilling, etc.

'Domestic' municipal wastes and sewage

9.40 Municipal and domestic wastes such as paper and food stuffs, and liquid wastes such as sewage, (collectively referred to as commercial waste) will be generated by the construction workforce.

9.41 The quantity of municipal waste generated is estimated to be 1.29 kg per employee per day. A refuse collection station should be set up for the collection and temporary storage of this waste. The waste, which should be stored in black refuse bags, should be regularly delivered to and disposed of at, an approved landfill.

9.42 As there is no available sewer at TP WTW and BVPSR sites, sewage generated the workforce should be disposed of via temporary chemical toilets. Sewage is characterised by high BOD and suspended solids, and is enriched with nutrients and high bacteriological counts.

9.43 All polluted waters, including sewage and site runoff, should comply with the appropriate standards in the *TM on Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* prior to discharge.

Concrete waste

9.44 Concrete is a major construction material in the construction of TPWTW, the tunnel portals, raw water tunnel linings and BVPSR. To assess the volume of concrete required, it has been assumed that approximately 3% of the concrete used would be lost to waste (see Table 9.3).

Table 9.3 Volume of Concrete arising from Construction Activities

Activity	Total volume of concrete required (m^3)	Total volume of concrete wastes (m^3)
Raw water aqueduct	5,000	150
TP WTW	125,000	3,750
Treated water tunnel	50,000	1,500
BVPSR	10,000	300

9.45 The concrete waste should be recycled for reuse or sorted for disposal at public dumps.

Site clearance

9.46 The materials from the construction site clearance will be sorted on Site into inert and non-inert materials. Non-inert material such as wood, and materials such as glass, steel or other metals will be taken to landfill. It should be noted that at the strategic landfill sites, construction waste must contain no more than 20% inert material by volume. Inert materials such as soil, rock, sand, concrete and debris will be sorted before disposal as much as possible and used at other building sites if this can be arranged. The most appropriate landfill sites for the disposal of vegetative wastes are SENT and NENT landfill sites.

Operational Waste Management

9.47 Two main categories of waste will be generated during the operation of TP WTW: chemical waste and domestic sewage.

Chemical waste

9.48 Where an operational process produces chemical wastes, the operator must register with EPD as a Chemical Waste Producer. EPD requires information on the particulars of the waste generation processes including the types of waste produced, location of waste arisings, quantities and generation rates. In addition a nominated contact person must be provided. Wastes which are classified as chemical wastes are listed in the *Waste Disposal (Chemical Waste) (General) Regulation*. These wastes are subject to stringent disposal routes.

9.49 A number of chemicals are required for the water treatment process at TP WTW. These chemicals include alum, lime, polyelectrolyte, potassium permanganate, chlorine and, possibly, ozone. Chlorine and ozone will be used in highly controlled and fully enclosed environments. It is not anticipated that there will be any residual chlorine release and any excess ozone will be broken down to oxygen before being vented to atmosphere.

9.50 The packaging of the solid chemicals is often returned to the supplier for reuse or recycling, as are the chlorine storage cylinders. If the chemical packagings are not taken away for recycling, they must be disposed of at the Chemical Waste Treatment Centre as they are classed as chemical waste. Any chemical spillages will be neutralised appropriately and disposed of as above. Chemical wastes from laboratory testing of water quality will be collected and disposed of appropriately.

Sludge

9.51 The issue of sludge treatment and disposal from TP WTW and BVPSR is discussed fully in Chapters 13 and 16 of the Draft Preliminary Report (DPR) respectively.

9.52 Sludge from TP WTW will be discharged on a semi-continuous basis. Chemical residuals which collect at the bottom of TP WTW treatment tanks will be periodically removed by opening desludging valves. The contents of the sludge include the precipitate of aluminium hydroxide ($Al(OH)_3$), calcium carbonate ($CaCO_3$), sand and mud.

9.53 The quantity of sludge produced may be as high as 2% of the initial volume of wastewater, depending on the treatment process used. Since sludge can be as much as 97% water, and since the cost of disposal is related to the volume of sludge being processed, one of the primary aims of sludge treatment is to separate as much of the water from the solids as possible. Another aim is to stabilise the solids so that they are no longer objectionable or environmentally damaging.

9.54 Sludge from the TP WTW clarifiers and settled sludge from the used filter washwater tanks will be treated by solid-liquid separation processes to a dry solids content acceptable for landfill. The sludge should be collected and removed by a licensed sludge disposal contractor and disposed of to landfill under agreement with EPD.

9.55 As described in Chapter 16 of the DPR, BVPSR will only be cleared every 2 years or so. It is proposed that sludge is discharged into foul sewers leading to the proposed Sewage Treatment Works at Stonecutter's Island.

Sewage

9.56 Domestic sewage will be generated from workers on the operational site. As described earlier, sewage is characterised by high BOD, suspended solids and high nutrient and bacteriological content. A permanent foul water system should be established to treat the sewage, or provision should be made to link the system to the municipal sewerage network.

Summary

9.57 Wastes will be produced during both the construction and operation of the scheme. The EIA waste and spoil management section examines the types and volumes of waste and considers methods of waste minimisation, reuse and recycling. It is recommended that the use of wooden materials is minimised by alternative materials such as reusable steel shutters, metal fencing or Building Panels.

9.58 Chemical wastes produced on site will require special handling and administration. Sewage wastes will require treatment and municipal waste will require regular collection and disposal at a designated Regional Services refuse collection point.

9.59 Some 1.7 Mm^3 of spoil will be generated during the construction of the scheme, some of which may be contaminated with high levels of lead and other minerals. In the case of the tunnel construction there will be 24 hour production of spoil. The issues associated with the stockpiling and remote disposal of spoil are:

- dust impacts from the handling of dry materials;
- noise impacts from to the movement of spoil both within the construction sites and off site;
- water quality impacts from surface water runoff from stockpiles could result in increased turbidity and siltation in surface water courses which may have a detrimental impact on aquatic habitats;
- increased traffic on local roads.

9.60 Good waste management practice, in addition to the noise, dust and water quality control measures outlined above, will ensure that adverse impacts from the project are minimised.

10 SOCIO-ECONOMIC ISSUES

Introduction

10.1 As a result of the potentially adverse impacts associated with major infrastructure schemes, local communities have an increasing voice in the decision making process. The importance of land use and community, socio-economic, issues in the planning of new developments has been recognised in the *Hong Kong Planning and Standards Guidelines*, Chapter 9 (Environment). These guidelines address the biological and physicochemical impacts of a scheme and consider the overall effects of these impacts on existing land use and communities.

10.2 The potential impacts of the proposed scheme on the community are an important aspect of this environmental assessment, most significantly during the construction of the scheme. Both the immediate construction areas and the communities along the alignments of access roads to the construction sites are likely to be affected by the scheme. This Section is intended to address the socio-economic issues associated with the scheme and provide:

- a description of the planning designations within the areas affected by the scheme and any implications arising from specific designations;
- an assessment of the existing land use within and around the areas affected by the scheme;
- identification and evaluation of the key geographical areas and community issues affected by the scheme; and
- identification of mitigation measures to alleviate the adverse impacts identified.

Planning Implications

10.3 The areas affected by the preferred scheme layout are covered by the following Outline Zoning Plans (OZPs), indicated in italics;

- raw water aqueduct site, *Tai Po S/TP/7* and *Lam Tsuen S/NE-LT/1* (see Figures 4.1-4.2);
- TP WTW site, *Tai Po S/TP/7* and *Lam Tsuen SN/NE-LT/1* (see Figures 4.1-4.2);

- Shing Mun tunnel access shaft, *Kwai Chung (north) S/KC/10* (see Figure 4.5);

- Butterfly Valley tunnel portal and Butterfly Valley Primary Service Reservoir (BVPSR), *Kwai Chung (south) S/KW/10* (see Figures 4.6-4.7).

10.4 The OZPs listed above provide the land use zoning categories for the areas affected by the scheme. There are statutory controls applicable to each land use category which limit the types of development in certain designated areas. These land use categories and statutory controls are designated and administered by the Planning Department under the direction of the Town Planning Board.

10.5 The OZPs indicate that the proposed sites for TP WTW, Shing Mun Tunnel access shaft area and the tunnel portal in Butterfly Valley are designated Green Belt, where certain types of development may be permitted, subject to approval by the Town Planning Board. The sites for TP WTW and BVPSR had already been reserved by WSD prior to the commencement of the Investigation Study.

- The current Tai Po OZP (S/TP/7, November 1994) designates the TP WTW site as Green Belt.

- The Kwai Chung OZP (S/KC/10, October 1994) shows the proposed Shing Mun Tunnel Access shaft area as Green Belt. The administration building for the Shing Mun Tunnel Plaza is shown on the Tsuen Wan OZP (S/TW/6, October 1993).

- The Kwai Chung OZP (S/KC/10, October 1994) demarcates the portal site in Butterfly Valley as Green Belt.

10.6 According to the Tsuen Wan and Kwai Tsing Development Statement, the location of the BVPSR and a portion of the raw water aqueduct sites fall into the proposed Butterfly Valley Urban Fringe Park. The Butterfly Valley Urban Fringe Park is still a long term planning concept, and has not yet been translated into the OZP. However, for any proposed development within the proposed Park, conservation of the landscape and protection of the scenic value is desirable.

10.7 The implications for development within Green Belt areas in Hong Kong differ between the administrative zones. Land use of public installations such as the treated water aqueduct within the 'Green Belt' zone in Kwai Chung and Tai Po would be permitted with or without conditions on application to the Town Planning Board. In addition, land use of public utilities within the Kam Shan Country Park are subject to the control and approval of the Country Parks Authority.

10.8 The BVPSR site is already designated Government/Institution/Community (G/I/C) which as the name suggests, is planned for existing or proposed Government, community and infrastructure projects.

10.9 In addition to the designated residential areas adjacent to the construction sites, there are also illegal developments within Government or Crown land. This is most notable along Shing Mun Road, where there are a number of garages and scrap yards, and in Butterfly Valley, where there are around ten residential structures near the tunnel portal. It should be noted that none of the residential structures in Butterfly Valley will be required to be cleared. Both there areas are designated as Green Belt.

Existing Land Use

10.10 In order to determine the existing and proposed land use within the construction sites and neighbouring areas, a series of desk studies and site visits were undertaken. The literature review included reference to the 1:20,000 and 1:5,000 maps and examination of published literature on the areas affected by the scheme.

10.11 Discussion with relevant Government Departments enabled sensitive sites to be identified and future development plans to be highlighted.

10.12 The maps and OZPs do not distinguish between types of industry, nor do they indicate illegal settlement or industrial development on Crown land. Site visits were undertaken to determine the actual land use within the areas potentially affected by the scheme.

10.13 The results of the desk study and site reconnaissance enabled the following land use and community issues to be identified:

- the nature of the construction site and neighbouring land both in terms of official designations (from OZPs) and actual land use;
- ease of access to the construction sites and the potential sensitive receivers within the neighbouring communities;
- areas of local amenity and recreational value. This includes the identification of Country Parks, SSSIs and Conservation Areas;
- identification of grave sites, sites of archaeological interest and other culturally significant sites.

General site descriptions

10.14 There are four main areas directly affected by the scheme:

- the raw water pipeline and tunnel portal site;
- Tai Po Water Treatment Works (TP WTW) site and the area immediately south of TP WTW site;
- Shing Mun access shaft site;
- and Butterfly Valley.

Raw Water Aqueduct

10.15 The proposed route and design of the raw water aqueduct (Route 3) was selected as the option having the least environmental impact.

10.16 The Route 1 option would have transferred the water via a pipe in trench along the base of the Tai Mo Shan foothills and up Tin Liu Ha and She Shan Tsuen valleys. For most of the route, the pipeline would have followed the general alignment of the She Shan Tsuen stream. Part of the upper catchment of this stream is within the She Shan Tsuen Fung Shui Woodland (SSSI) and the northern She Shan Tsuen Conservation Area. In the lower reaches, there are actively farmed fishponds and agricultural land, areas of which would have required resumption. Sections of the stream would have required diversion before pipe laying commenced, with the potential for significant adverse impacts on water quality, stream ecology and agricultural/aquacultural activities.

10.17 The Route 2 option would have involved routing a raw water pipeline beneath the Lam Tsuen River and along the floodway downstream of the Fabridam for the Plover Cove intake. Beyond the intersection of the Tai Po - Tai Wo Road and the Tolo Highway, the pipe alignment would have followed a direct route uphill to the northern boundary of TP WTW. This route could have had ecological and socio-economic impacts, particularly the pipeline up the hillside, which would have passsed through an attractive, densely vegetated valley with orange groves on the lower slopes which is located close to a popular riverside park.

10.18 The Route 3 option, as illustrated in Figure 10.1, comprises twin pipes from the Tai Po Tau 'D' pumping station under the Lam Tsuen River (already installed) and Tolo Highway to a tunnel portal close to the road embankment. This option would minimise the amount of land take of agricultural land required and also minimise the ecological impact.

10.19 The proposed raw water pipeline and tunnel portal are located within an essentially man made environment beneath the elevated Tolo Highway and opposite a China Light & Power (CLP) substation and Tai Po Tau 'D' pumping station. Immediately south of this area is agricultural land, a significant proportion of which does not appear to be in production at present. The area is enclosed on three sides by the Lam Kam road to the west, Tolo Highway to the east and the intersection of, the two to the north.

Tai Po Water Treatment Works

10.20 The proposed TP WTW site is within a rural area at the foothills of Tai Mo Shan Country Park and there is evidence of previous agricultural activity in the area although the terraces have long since been abandoned. The only existing vehicular access route to the site is from the Tai Po road via the (restricted) Water Supplies Department (WSD) road. This road crosses Tolo Highway then follows a narrow, steep and winding route up the hill to the Tai Po Tau Water Treatment Works (TPT WTW). The north west edge of the site overlooks the agricultural village of She Shan Tsuen and, over a longer distance, the Lam Tsuen valley.

10.21 The south east boundary of the proposed water treatment works site is essentially demarcated by the Shek Lin road which links Kam Shan (and Tai Po) with Lin Au in the Tai Mo Shan foothills. Along the length of this road there are numerous residential developments, most notably a large newly constructed private residence on the south east boundary of the site.

Shing Mun Access Shaft

10.22 The area identified for the tunnel access shaft at Shing Mun is immediately adjacent to the Shing Mun Tunnel Toll Plaza and administration building, about 200 m from the southern boundary of Shing Mun Country Park. The village of Wo Yi Hop is located on the slope to the west of the site. The site is next to the Shing Mun road which joins the two carriageway Cheung Pei Shan Road. The Shing Mun road is heavily used at weekends by visitors to the Country Park.

Butterfly Valley

10.23 The Butterfly Valley area is immediately north of the Ching Cheung Road and urban areas of Lai Chi Kok and Cheung Sha Wan, and located some 700 m south of the Kam Shan Country Park boundary. Within the valley itself there are a number of temporary dwellings. To the north east of the valley is a high rise block of Government housing and Sir Robert Black College of Education. On the valley slope north west of the site there is a CLP substation, service reservoirs and the village of Tai Ching Cheung.

Sensitive Land Uses

10.24 There are existing land uses either within or adjacent to the sites affected which will require careful treatment in the design, construction and operation of the scheme. These land uses are outlined below and their implications addressed in detail later in this Section and elsewhere in this Report:

- residential areas and sensitive uses adjacent to the construction sites which would be affected by the scheme are individually identified in the sections on Noise, Air Quality and Visual impacts;
- graves and burial sites within the TP WTW site;
- Fung Shui issues at TP WTW and Shing Mun access shaft.

A detailed breakdown of the existing land use components in the four areas affected by the scheme is provided below.

10.25 Highways Department is currently undertaking a feasibility study for Route 16 from West Kowloon to Sha Tin. One of the alignment options details tunnels passing directly below the proposed BVPSR site.

Local Communities/Settlements

10.26 As outlined above there are communities and settlements at least adjacent to most of the sites affected by the scheme. The main communities and settlements identified in the land use assessment are given in Table 10.1.

Table 10.1 Sensitive Uses within and adjacent to Construction Areas

Settlement	Location	Description
Lam Tsuen valley	300 m south west of raw water aqueduct site	Single dwelling
Lam Tsuen valley	Tai Po Tai Wo Road / Shui Wai	High and low-rise residential blocks, existing and under construction
Shek Kwu Lung	Immediately west of TP WTW site; drains into Lam Tsuen floodway	An occupied squatter development and several village houses
She Shan Tsuen	Immediately north west of TP WTW site	Village area with significant agriculture and aquaculture activities
Pun Chun Yuen	Immediately south east of WTW site	Residential area, including a new development on TP WTW site boundary. Small school. Temple in valley.
Wo Yi Hop	West of Shing Mun access shaft site	Dense village area on the valley slope with small dwellings. No residential areas immediately adjacent to Shing Mun Road.
Tai Ching Cheung	Western slope of Butterfly Valley	Village area and Boys Home
Butterfly Valley	North of treated water aqueduct portal site	Scattered dwellings in the valley bottom and up the slopes of the valley
Caldecott Road	North east of BV PSR	Sir Robert Black Education College and a high rise block of Government housing
Lai Chi Kok / Cheung Sha Wan	Immediately south of the Butterfly Valley, separated by busy Ching Cheung Road	Dense urban area with a mixture of high rise residential blocks, industrial land, schools and a hospital. Also includes a dense village area (Wai Man Tsuen)

Government, infrastructure and industrial land use

10.27 There are a number of infrastructure developments and areas of Government land use along the scheme alignment. At the northern limit, in the Lam Tsuen valley, there is a significant WSD complex which comprises part of the Plover Cove abstraction scheme and a number of pumping stations, including the new Tai Po Tau 'D' pumping station. In addition, there is a CLP electricity substation. There is restricted access road to the TPT WTW which is located on the hill top due west of the Tai Wo estate. WSD has constructed a new salt water service reservoir to the south east of the existing works.

10.28 South of the Shing Mun tunnel access shaft site there is a significant area occupied by the Shing Mun Tunnel toll plaza and administration building. As outlined above, this land use does not appear on the OZP for the area. In addition, there are a number of junk yards and garages along the Shing Mun road.

10.29 On the western side of Butterfly Valley there is a WSD service reservoir site and a CLP complex. South of the Butterfly Valley is the busy Ching Cheung road which is currently undergoing improvements. To the east of the Butterfly Valley hill there is a large cemetery.

Recreation and amenity

10.30 The treated water aqueduct passes beneath three Country Parks: from north to south these parks are Tai Mo Shan, Shing Mun and Kam Shan.

10.31 Under the Country Parks Ordinance, Country Parks are designated for the purpose of providing informal outdoor recreation and conserving landscape, wildlife and historical features. There are tight controls on development within Country Parks with most development being prohibited.

10.32 Visitor numbers for these parks are provided in Table 10.2 below. These figures were extracted from the *Countryside Development Division (AFD), 8/1993, Hong Kong Country Parks Visitor Statistics 1992/93, Annual Summary.* These figures illustrate that, whilst there are a significant number of visitors to these parks, their relative popularity is less than many of the other Country Parks within Hong Kong. The busiest time of year for the Country Parks is October-December, and the busiest days for visits are Sundays and Saturdays.

Table 10.2 Country Park Visitor Numbers

Country Park	Visitor numbers 1991/92	Visitor numbers 1992/93
Sai Kung	2,026,000	1,869,000
Lantau	1,833,000	1,844,000
Ma On Shan	1,786,000	1,808,000
Plover Cove	946,000	910,000
Aberdeen	602,000	743,000
Quarry Bay	702,000	693,000
Pat Sin Leng	346,000	309,000
Clear Water Bay	242,000	290,000
Tai Tam	253,000	284,000
Shing Mun	302,000	283,000
Tai Lam	248,000	276,000
Tai Mo Shan	225,000	232,000
Kam Shan	210,000	218,000
Pok Fu Lam	198,000	178,000
Lion Rock	148,000	145,000
Tai Po Kau	36,000	32,000

Conservation Areas

10.33 Other than the Country Park areas identified above, there are no other designated conservation within the boundaries of the study area. There are however designated conservation areas adjacent to the site, most notably the Site of Special Scientific Interest (SSSI) and Conservation Areas in the She Shan Tsuen valley. The conservation value of these areas is described in the Ecology section.

Stream Flows and Water Rights

10.34 The impact of the aqueducts on stream flows and water rights, which could have significant effects on village water supplies and agricultural activities, is discussed in Section 8.

Sites of archaeological, cultural and religious value

10.35 Information regarding sites of archaeological, historical and cultural interest within and around the study area was requested from the Antiquities and Monuments Office (AMO). The sites recorded by AMO are listed in Table 10.3 below.

Table 10.3 AMO recorded Sites of Historic or Archaeological Interest

Item	Construction date	AMO Ref.	Grade
Kowloon Reservoir	1910	940567	
(1) Valve House & 2 dams			1
(2) Valve house off Tai Po Road			2
Shek Lei Pui Reservoir	1925	940568	
(3) Valve house and 2 dams			1
Kowloon Reception Reservoir	1926	940569	
(4) Valve house and dam			2
Kowloon Bywash Reservoir	1931	940570	
(5) Valve house and dam			2
Shek Lei Pui Treatment Works	1928	940571	
(6) 2 treatment works buildings connected together	1936-1937		3
(7) Chemical house	1936		3
Upper Shing Mun (Jubilee) Reservoir	1936	940572	
(8) Valve tower, steel bridge, valve house, bellmouth overflow and Gorge dam (main dam)			1
(9) Memorial stone	1937		1
Lower Shing Mun (Jubilee) Reservoir			
(10) Valve tower, steel bridge, bellmouth overflow, gate staff and the Pineapple Pass dam			1
(11) Supply basin and weir			1
(12) Lei Uk Tsuen and Cheng Uk Tsuen, Lin Au, Tai Po	17th Century	830309	Nil
(16) Lo Kong Study Hall, Mui Shui Hang (Tai Po)	1922	830319	3

10.36 Although there are no recorded sites of interest in areas where earth works would be undertaken, there has been very little excavation work undertaken in this part of the New Territories.

10.37 A number of graves and burial sites have been identified on the hill slopes where TP WTW is proposed. Graves are carefully located on the hill sides for spiritual reasons, their location being dependant on the principles of Fung Shui. Approximate grave positions are illustrated on Figure 10.2; there may also be a number of unrecorded graves and bone pot sites.

10.38 Local inhabitants' traditional customs relating to Fung Shui issues may arise in the TP WTW area due not only to the potential impact of the proposed works on the ridgeline and trees, but also to the proximity of the treatment works to the village. In addition, an area of Fung Shui woodland has been identified on the north north east facing slope of TP WTW site, which is adjacent to the SSSI. This is a stand of natural woodland selectively maintained, enriched with desirable plant species and preserved by local villagers for economic purposes and superstitious reasons. Considerable efforts have been made to ensure that the woodland will not be adversely affected by the Scheme.

10.39 Other Fung Shui implications associated with the scheme are likely to be claimed by the villagers of Wo Yi Hop resulting from construction work at Shing Mun access shaft and the presence of an underground aqueduct near the village. These issues will be need to be discussed during public consultation with the relevant communities.

10.40 There is a large temple located in the valley at Pun Chun Yuen and a large Catholic Cemetery next to the service reservoir site at indicated in Figure 10.3. Both these religious sites are outside the construction site boundaries.

Assessment of Socio-Economic Impacts

Land take

10.41 The loss of land from a community is perhaps the most tangible impact associated with major development schemes. Land take may be temporary, eg. for construction material storage, or may be permanent, eg. for the siting of an operational facility. Compulsory land take for the development of a scheme may result in socio-economic implications if the previous land owners were heavily reliant on the land. This is particularly relevant where the land is owned and farmed by a family for both economic needs and self-sustenance; loss of such land will result in a loss of livelihood, particularly if those affected had no other means of income or skills for gaining alternative employment.

10.42 The engineering options identified in this study were formulated following a series of earlier studies examining the effects of a number of alternative options. As a result of these studies, the preferred option minimises the land take and avoids productive agricultural farm land apart from a small area which will need to be resumed for the raw water aqueduct as indicated in Figure 10.3.

Disruption and public nuisance

10.43 Disruption of daily activities and general mobility is often associated with construction works. Roads may be temporarily closed off, temporary diversions may be put in place and general increased traffic movements can have a significant effect on the passage of traffic, particularly along single track roads and at busy intersections.

10.44 The raw water aqueduct site is immediately adjacent to the Lam Kam road near to the Tolo Highway interchange although there is currently no access to the site from the Lam Kam road. The Lam Kam road is a wide two lane road and Tolo Highway is an arterial dual carriageway with two lanes in each direction. Construction traffic may cause disruption at the interchange during peak hours although, in general, it is unlikely to cause a significant impact.

10.45 The only access to the TP WTW site is via an existing WSD road to the existing TPT WTW site. This access road follows a tortuous route from the WSD pumping station on Tai Po road, over a bridge across Tolo Highway and up the hillside to the treatment works. The road is single track although there are passing bays; additional bays or road widening will probably be required for the construction of the scheme. There may also be some disruption to the public on the Tai Po Road when vehicles are entering and leaving the WSD site. To minimise traffic disruption on Tai Po Road, excessive vehicle movements should be avoided during peak traffic hours.

10.46 Access to the Shing Mun tunnel access shaft is via Shung Mun Road which joins Cheung Pei Shan road. At the southern end, Shing Mun Road is fairly wide and it should be possible for two vehicles to pass each other with few problems. Cheung Pei Shan road has two lanes and construction vehicle access along this road should not, in general, present problems. As outlined above, excessive vehicle movements should avoid the peak traffic hours to minimise traffic disruption.

10.47 The Butterfly Valley aqueduct portal area can be accessed from the Ching Cheung road via an existing single lane tarmacked road, although there is no vehicular access into the bottom of the valley. This road provides access to the dwellings within Butterfly Valley, and during construction local access into and out of this road will be disrupted. The improvements to the Ching Cheung road should be completed by the time the tunnel excavation work commences; this should ease the construction traffic movements into and out of the valley.

10.48 Access to the north eastern side of the site can be gained via Caldecott road which has a Government Housing Block and the Sir Robert Black College of Education. The traffic signals out of Caldecott road onto the old Tai Po road are currently on a very short time phase which only allows one or two vehicles onto Tai Po road. Increased traffic movements during the construction of BVPSR will cause significant disruption to the residents, students and staff of Caldecott Road. Excessive construction traffic movements should be restricted during peak traffic hours.

10.49 An apparently rarely used footpath which currently traverses the TP WTW site will be lost as a direct result of the scheme. Public access through the site will be prohibited during the construction and operational phases. Provision will be made for an alternative footpath around the site boundary.

10.50 Noise, dust, visual and other issues likely to affect the public are dealt with elsewhere in this Report.

Degradation of recreation and amenity areas

10.51 Construction impacts which alter the character or facilities of an area can cause a degradation in recreational and amenity value. Local people and visitors, for example, may experience a temporary severance of footpaths which could affect access and recreational activities. Similarly, visual intrusion or increased background levels of noise and dust may affect the natural appeal of an area and hence its recreation or amenity value.

10.52 Although none of the proposed surface structures are located within any of the Country Parks, some of the construction sites may be visible from the parks. Most notably, on a clear day, TP WTW site may will be visible from high ground in the north east of Tai Mo Shan Country Park. The Shing Mun tunnel access shaft will be visible to all visitors travelling to the Shing Mun Country Park Visitors Centre along Shing Mun Road.

10.53 Similarly the TP WTW site is visible from the village of She Shan Tsuen and the Lam Tsuen valley.

10.54 Careful planting and landscaping of the TP WTW site will significantly reduce the visual intrusion afforded by the development. In addition to these measures, the colour and texture of building materials used on site can also reduce the visual intrusion.

10.55 The impact of construction activities at Shing Mun access shaft can be alleviated by good site practice, ie. ensuring the site is kept in a clean and tidy state, ensuring that vehicles coming off the site do not deposit mud or spoil on to local roads, and minimising dust and noise emissions from the site.

10.56 In the long term the Shing Mun shaft site will be either re-instated to its previous condition or could possibly remain as hard standing for use as a car park for the Country Park.

Loss of sites of local, regional or national importance

10.57 As discussed above, the only known sites of cultural or archaeological interest located in any of the construction sites are the graves within TP WTW site. Prior to construction, the exact location of the graves will need to be determined and the relatives informed and compensated for the exhumation and relocation of these graves. The location of all recorded graves can be obtained from the District Lands Office. Other unrecorded graves and bone pot sites will need to be determined by consultation with local communities during the detailed design phase.

10.58 Despite there being no records of archaeological interest within any of the sites requiring earthworks, it would be prudent to prepare a watching brief to be implemented in the event of any artifacts being uncovered. The watching brief would ensure that an archaeologist was available for consultation during the construction phase and would ensure that all findings were fully documented.

10.59 The SSSI and Conservation Areas in the She Shan Tsuen valley could be adversely affected as a result of the scheme through degradation in the aquatic habitat due to water quality deterioration and disturbance of wildlife due to construction noise. The SSSI is designated for its national conservation importance, and the loss of such a site would be unacceptable. Mitigation measures to prevent any deterioration in water quality and noise impacts have been identified in other sections of this Report.

10.60 Fung Shui issues will need to be discussed with the relevant Rural Committees and village representatives during the forthcoming public consultation.

Community severance

10.61 The main community severance issues identified in this study are related to the loss of the footpath and grave sites at the TP WTW. There may however be significant problems associated with any change in surface or groundwater regimes where a community is reliant on that source. The tunnel route passes beneath a number of stream courses which may be affected by the tunnel excavation work. These streams may dry up or groundwater levels may be lowered due to seepage through the tunnel. Provision should be made to investigate and treat in advance areas likely to result in significant inflow into the tunnel and hence a drop locally in the ground water regime. The tunnel will be lined, so there will not be a problem of leakage during the operational phase.

10.62 A sudden increase in river flows during the dry season due to overflows at TP WTW could potentially pose a risk to life: local people have been observed washing clothes, playing and fishing in the channels along which the overflow would discharge. Public education about this danger, and the use of an audible alarm system, may help reduce the impact of such an event.

10.63 The issue of compensation flow for streams serving fish farming, agricultural and conservation areas is addressed in the Drainage Impact Assessment.

10.64 It should be noted that overall the scheme is designed to benefit a large section of the population of Hong Kong's Metropolitan Area, ensuring that the treated water supply deficit situation currently anticipated as early as the year 1999, with existing water treatment and transfer facilities, is avoided.

Summary

10.65 There are existing land uses either within or adjacent to the sites affected which will require careful treatment in the design, construction and operation of the scheme. Residential areas and sensitive uses adjacent to the construction sites which would be affected by the scheme are individually identified in the sections on Noise, Air Quality and Visual key issues reports in the EIA.

10.66 The EIA Study has already contributed to route selection and site layouts for the preferred scheme. For example:

- all sites and route alignments have been chosen to minimise the need for land resumption;
- a 3.8 m internal diameter pipeline and tunnel has been proposed for the raw water aqueduct on environmental, technical and economic grounds. One of the alternative options had greater potential for adverse water quality, ecological and socio-economic impacts with substantial loss of working fishponds and agricultural land;
- the layout of Tai Po Water Treatment Works (TP WTW) site has been modified to minimise the impact of cutting into the most prominent slope and ridge;
- a Master Landscape Plan has been developed to ensure that any trees or areas of woodland lost at the TP WTW Site are more than compensated for by extensive planting of native woodland species elsewhere within the site boundary;
- the design and location of the TP WTW chlorine store and flow calibration centre has been modified to reduce potential environmental impacts;
- the engineering design has taken into account the need to provide unpolluted stream compensation flows for the environmentally sensitive She Shan Tsuen area;
- the intermediate access shaft/adit originally proposed to accelerate treated water aqueduct excavation and associated spoil removal has been subsequently rejected on environmental and economic grounds:
- the treated water aqueduct is to be lined. The prime reason for lining the aqueduct is public health: potable water cannot be allowed to become contaminated. Lining will remove the requirement for operational phase monitoring and treatment of potentially contaminated tunnel drainage water required if the pipe/pipes in tunnel options had been selected. It also removes the operational phase problems associated with radon and noxious gases associated with the pipe/pipes in tunnel options;
- the proposal to dispose of excavated spoil near the Shing Mun Reservoir within the Country Park boundary, thus forming a carpark for Park visitors, has been rejected on environmental grounds;

- the proposed location of the Butterfly Valley tunnel portal has been chosen for reasons including the desire to avoid clearance of any temporary residential structures in the area;

- the site formation of the Butterfly Valley Primary Service Reservoir (BVPSR) will retain the south facing embankment, reducing the visual impact of the works and, during the construction phase, functioning as a partial noise barrier;

- the access road to BVPSR is designed to minimise any impact on existing woodland;

- the BVPSR Master Landscape Plan recommends tree and shrub planting with appropriate native species around the Site and grassing of the reservoir roof.

10.67 The options identified in this study minimise land take, avoid clearance of permanent or temporary residential structures, compensate for loss of trees and other habitat, and generally avoid productive agricultural farm land. The issue of compensation flow for streams serving fish farming, agricultural and conservation areas is addressed in the Drainage Impact Assessment.

10.68 Disruption of daily activities and general mobility is often associated with construction works. Roads and footpaths may be temporarily closed off and temporary diversions put in place. Increased vehicle movements can have a significant effect on traffic congestion, particularly along single track roads and at busy intersections.

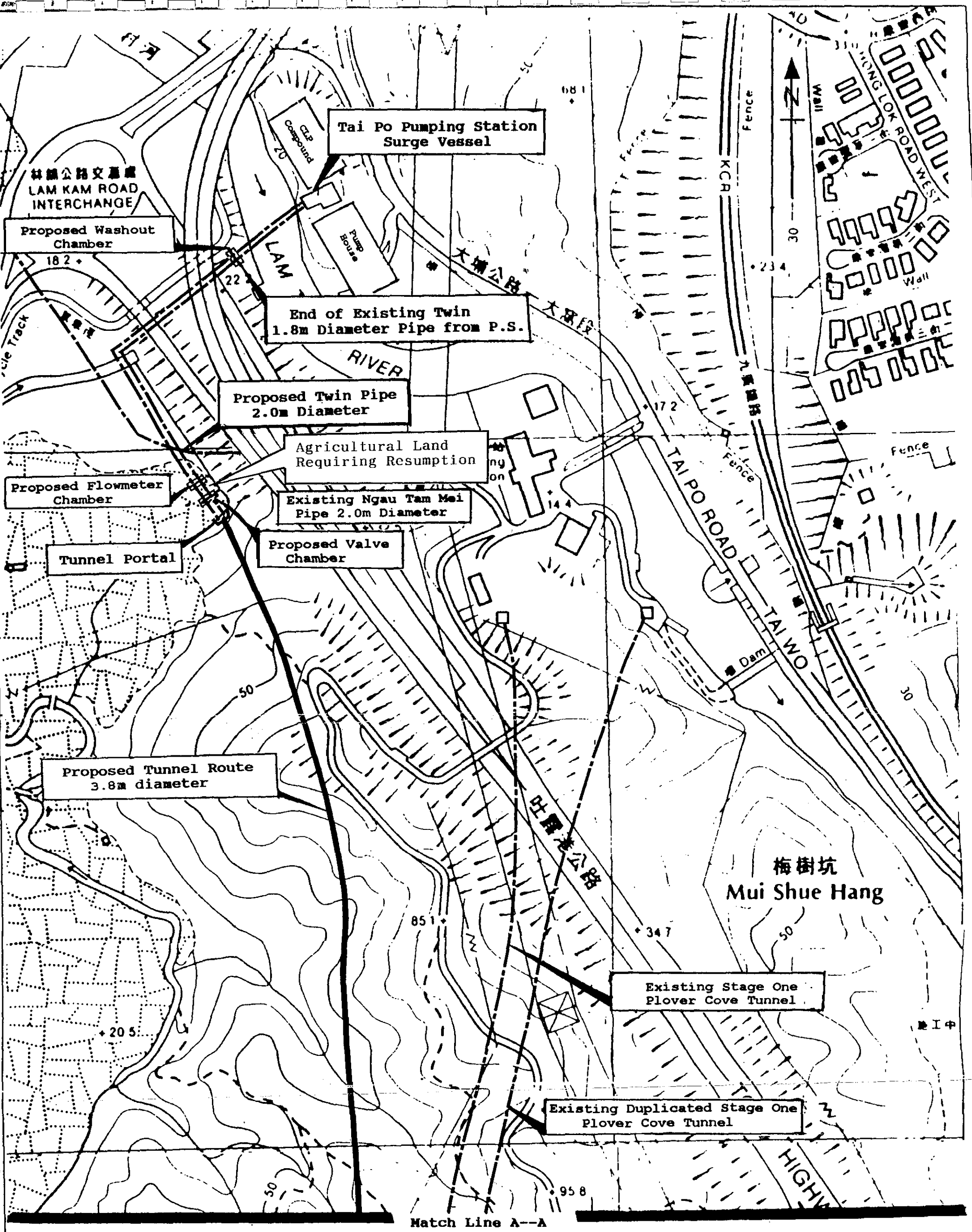
10.69 Construction impacts which alter the character or facilities of an area can cause a degradation in recreational and amenity value. For example, visual intrusion or increased background levels of noise and dust may affect the natural appeal of an area and hence its recreation or amenity value. Although none of the proposed surface structures are located within any Country Parks, part of the construction sites will be visible from within the parks.

10.70 An area of Fung Shui woodland has been identified close to the TP WTW site. Fung Shui issues are likely to become significant in this area due not only to the potential impacts of the proposed works on the ridgeline and trees but also to the proximity of the treatment works to the village. At the Shing Mun site, villagers at Wo Yi Hop may claim disruption of Fung Shui due to the construction of a water tunnel near the village.

10.71 The only known sites of cultural or archaeological interest directly affected by the scheme are the graves within the TP WTW site.

10.72 Public consultations with relevant Rural Committees and village representatives will ensure that any impact of the Project on local habitants' traditional customs is avoided or minimised.

10.73 Construction and operation of the water treatment and transfer facilities will benefit a large section of the population of Hong Kong's Metropolitan Area, an area which is currently facing a treated water supply deficit by the end of 1999.



Raw Water Aqueduct -Plan of Alignment- (part)	Agreement no CE 41/94	no.	description
Additional Treatment And Transfer Facilities For The Metropolitan Area And North-Eastern New Territories	Contract no	REVISION	
	Project title		
	Approved		
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	Designed RVC 5/95		
	Plan register No		
Water Supplies Department	Figure No 10.1	Scale 1:2500	

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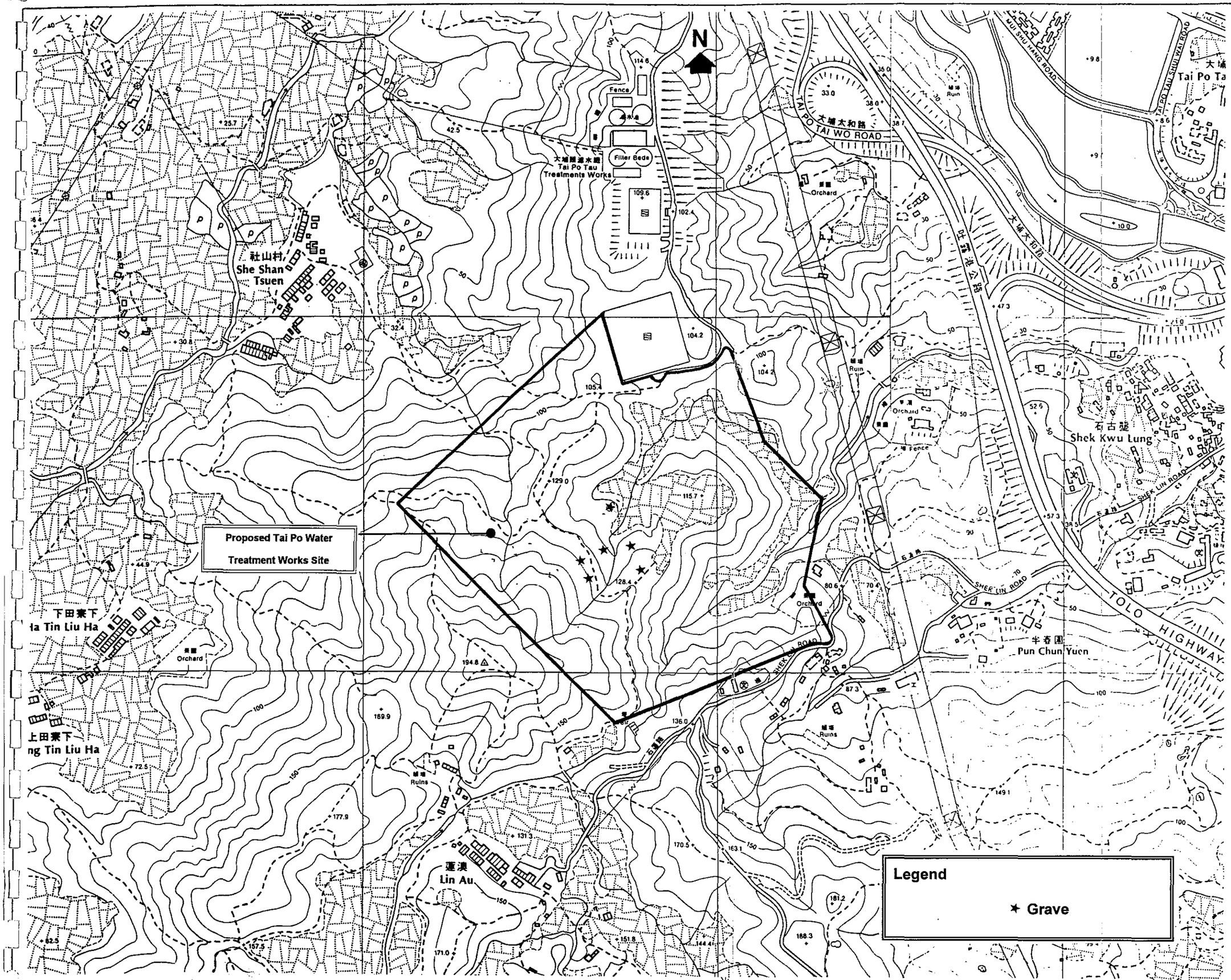

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Agreement no CE 41/94

Contract no.

Project title

Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Grave Sites Near the Proposed Water Treatment Works

Plan register No.

Figure No 10.2

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Scale 1 : 5000

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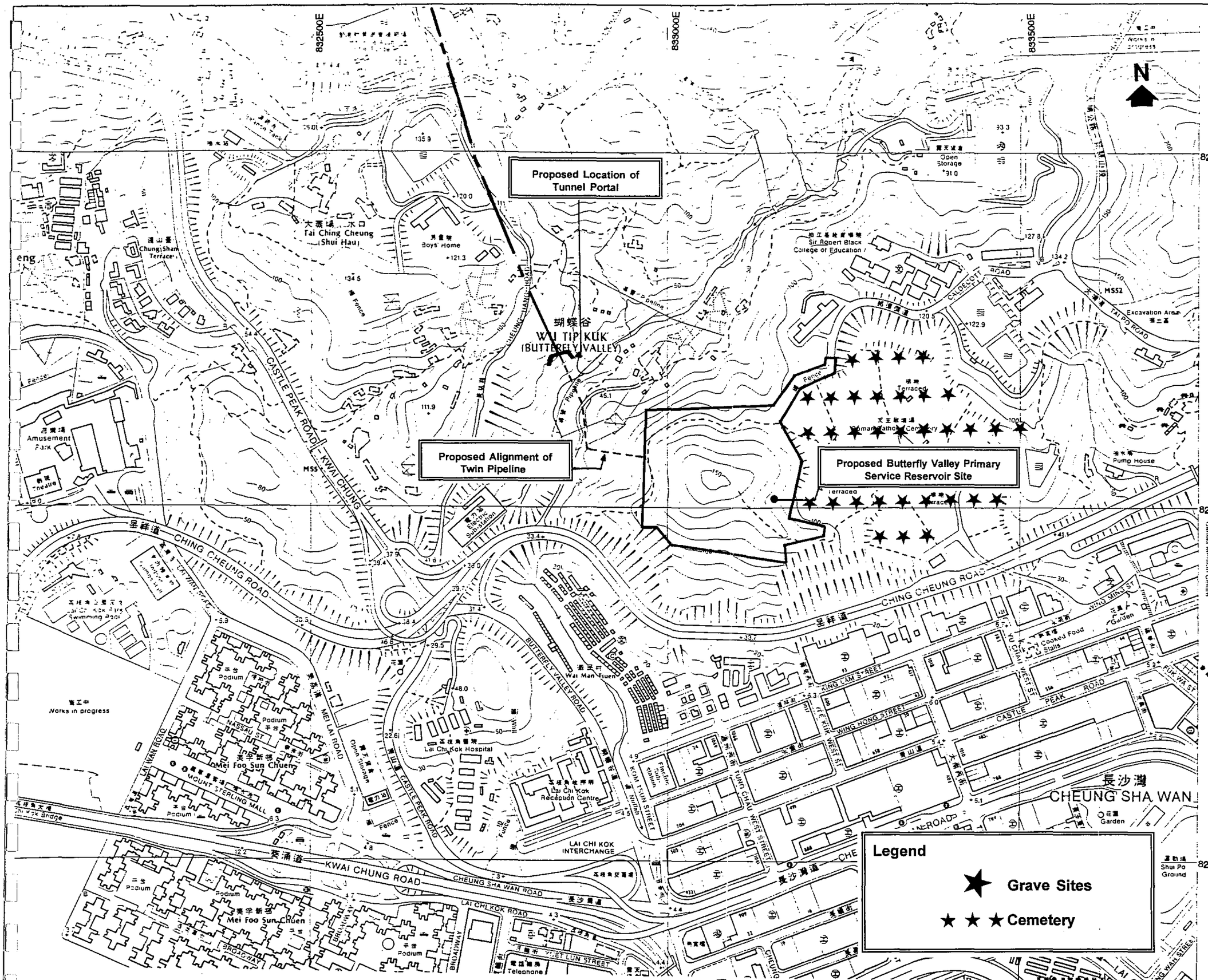

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Agreement no CE 41/94

Contract no

Project title

Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

Grave Sites and Cemeteries Near the Proposed Service Reservoir

Plan register No.

Figure No 10.3

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Scale 1 : 5000

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11 ECOLOGICAL ASSESSMENT

Introduction

11.1 In order to assess the conservation value of the sites affected by the scheme, a series of field assessments and desk studies were undertaken. The surveys undertaken were to assess the general habitats of the areas affected by the scheme and to evaluate the populations of stream fauna, terrestrial fauna and avifauna at the sites affected by the preferred scheme. Given the temporary nature of much of the site disruption, it was not considered necessary to carry out an insect survey. The objective of the ecological assessment was to evaluate the conservation interest at the sites affected and identify any plant or animal species which are protected either under Hong Kong legislation or international convention.

11.2 This section will describe each of the sites in terms of the botanical interest and overall habitat type, and assess the conservation value. The tunnel access sites at Yuen Tun Ha are included in the descriptions although these are not affected by the preferred scheme. The final part of this section describes and evaluates the fauna surveys undertaken at the areas affected by the preferred option only.

Tai Po Water Treatment Works

Botanical assessment

11.3 The total area of this site is approximately 20 ha, which comprises of a few different vegetation types, namely: abandoned cultivated land, hillside grassland and scrubland, wooded areas along ravines and streams, and Fung Shui wood.

11.4 Abandoned cultivated land occupies the central north part of the study area. The original natural vegetation has been cleared off for cultivation. Since it has been abandoned, the land is now completely covered with grasses such as *Neyraudia reynaudiana*, *Arundinella* spp., and *Imperata cylindrica*. There are also some tall trees of *Machilus thunbergii* and *Liquidamber formosana* scattering around on the abandoned cultivated land and they seem to be either planted or selectively preserved by the farmers in the past. Although it is of little interest from a botanical point of view, these grasslands may support a specialised fauna community (eg. insects and associated predators).

11.5 Hillside grassland/fernland and scrubland is found on the south western part of the study area and extended to the ridges as well. The ground vegetation coverage is 100% and grass/fern layer is about 60 cm tall. It is dominated by the rhizomatous fern *Dicranopteris linearis*, grasses such as *Ischaemum* spp., and shrubs such as *Rhodomyrtus tomentosa*, *Litsea rotundifolia* var. *oblongifolia* and *Melastoma* spp. There are also saplings and small trees such as *Cinnamomum porrectum*, *Archidendron* spp. and *Glochidion* spp. invading into these hillside grasslands. However, evidence shows that hill fire is a frequent event there which keeps the vegetation at grassland and shrubland stages.

Fung Shui woodland

11.6 There is a stand of Fung Shui wood on a north/north east facing slope at the western end of the study site. Smaller patches of wooded areas were also found along ravines and streams. Most of the trees in these woods are native species (see Tables 11.1, 11.2 & 11.3). The Fung Shui wood is very substantial in area and is actually connected to the She Shan Fung Shui Wood, which is a designated SSSI (Site of Special Scientific Interest) by Agriculture and Fisheries Department. The SSSI is shown in Figure 4.2.

11.7 The top canopy of this Fung Shui wood is about 20 m tall and the canopy average is from 80-95%. A quantitative survey of the tree species in this Fung Shui wood was done in two quadrats, located on Figure 11.1, which were 10 m x 10 m each in size. Within each quadrat, all trees or shrubs with a diameter of greater than 2 cm at 1.3 m above ground (dbh = diameter at breast height) were recorded and an importance value for each species was worked out. The results are shown in Tables 11.1 and 11.2. In both quadrats, *Schima superba* and *Schefflera octophylla* were the most dominant species. *Machilus thunbergii* and *Psychotria rubra* were high on the list of one quadrat but not the other. Observations made in the field showed that some other tree species such as *Aporusa dioica*, *Castanopsis fissa*, *Cinnamomum porrectum* and *Liquidamber formosana* were also commonly found in other parts of the Fung Shui wood.

11.8 All of these tree species are native but some of them were probably planted or specifically maintained by the villagers. For instance, the most dominant species, *Schima superba* is a very good fire wood so it is commonly planted in Fung Shui woods in Hong Kong to provide fuel for local consumption.

11.9 Seventeen species were recorded in the two quadrats and eight species were found in both plots. The number and size (dbh) of trees in these two quadrats also showed some differences. There were more trees in quadrat 2 than in quadrat 1, but most of which are the smallest ones. Moreover, quadrat 2 has a few very large trees (>30 cm) but there is none in quadrat 1. On the other hand, quadrat 1 has more individuals of the medium sized trees. The size distribution showed that quadrat 1 is more uniform than quadrat 2 (see Figure 11.2).

11.10 In summary, the two quadrats are similar in species composition but differ in structure and physiognomy. This may probably be due to the result of differences in previous disturbance (by human activity) or simply a difference in local topography or edaphic composition.

11.11 Although there are some variations between the quadrats, field observations suggested that this Fung Shui wood as a whole is quite uniform in appearance. Due to time constraints only two quadrats were studied so the quantitative results presented here are far from complete or conclusive. A larger plot size (eg. 20 m x 20 m) and more quadrats are needed to give a better picture of the structure and composition of this Fung Shui wood.

11.12 There are some trees along the streams and ravines in the study area. They are mostly confined to the ravines where fire usually stops spreading down because of the topography and moisture level. The size of these trees varies a lot and is not uniform. A few individuals reach a height of 12 m but most of them are shorter, between 5 to 10 m only.

11.13 A list of all plant species recorded at various habitats is given in Table 11.3.

Conservation issues

11.14 A Fung Shui wood is basically a stand of natural woodland selectively maintained, enriched with desirable plant species, and preserved by local villagers for economic purposes and superstitious reasons.

11.15 However over the last few decades, there has been much change in rural activities. Much of the rural population, especially youngsters, moved to the cities and new towns for jobs, etc. Therefore many villages in the New Territories were abandoned. In addition, the improvement in living standards makes the rural people depend less and less on the surrounding environment for subsistence. As a result, Fung Shui woods and other secondary vegetation types in the territory have been suffering less from human disturbance.

11.16 *Schima*, the most dominant tree species in this woodland, is actually a very good fire wood. These large trees (*Schima*) must have been planted/preserved by villagers in the past. The second most dominant species - *Schefflera* - is comparatively small in size. They are most likely to have taken root over the last few decades when there was little or no human interference.

Protected/rare species

11.17 The Fung Shui wood in the study area together with the adjacent She Shan Fung Shui Wood provides an excellent habitat to woodland birds. During the study period (mid-March) quite a volume of bird songs were heard in the Fung Shui wood. Moreover, burrows for small animals were often seen in the Fung Shui wood.

11.18 Only one plant species found in the Fung Shui wood study area, *Asplenium nidus*, is protected under the *Forests and Countryside Ordinance (Cap. 96) Forestry (Amendment) Regulation*, 1993. Other rare or interesting plants include *Hoya carnosa* and *Ardisia hanceana*, both of which were found in the Fung Shui wood, and one *Elaeocarpus* sp. tree was found in one of the ravines.

Yuen Tun Ha Horizontal Adit

Botanical assessment

11.19 This site is shrubland with grasses and fern (*Dicranopteris*) on a north east facing slope. The ground vegetation coverage is 100%. It is characterised by a layer of fern about 60 cm tall and mixed species of medium sized shrubs about 1.5 m tall. There are 34 plant species recorded on site, most of which are native species, see Table 11.4. The most dominant species is *Dicranopteris linearis*, other common species include *Rhodomyrtus*, *Miscanthus sinensis*, *Litsea rotundifolia* var. *oblongifolia*. There are also a few trees scattered around. They are of different heights from 1 to 7 m, however most of them are only 3 m tall or less.

11.20 A list of plant species recorded at various habitats is given in Table 11.4.

Conservation issues

11.21 This is a very typical hill side secondary cover in most of the Hong Kong countryside. The original vegetation must have been cleared off some 500 years ago and has been suffering from continued human interference such as fuel wood collection, cattle ranging and hill fire since then. However this kind of disturbance, except hill fire, has been reduced significantly over the last two decades, therefore the vegetation is recovering reasonably well. Judging from the size of the dominant shrubs, there has not been any fire for at least five years. Almost all species found are native to Hong Kong (except *Acacia confusa*) and all of them are commonly found in similar habitats in many places in Hong Kong.

Protected/rare species

11.22 No species recorded in this study site is protected or rare in Hong Kong.

Yuen Tun Ha Shaft

Botanical assessment

11.23 This site is on abandoned agricultural land which is adjacent to a clear, running water stream. It is now replaced by weeds and other wild plants that completely cover up the area. The most dominant species is the grass *Microstegium ciliatum* which covers some 80% of the abandoned fields. There are also several clumps of *Miscanthus floridulus*, around 25 *Ficus hispida* trees from 2 to 5 m tall, and some individuals of the weedy shrub *Lantana camara*.

11.24 Next to the field, on the banks of the stream, the riparian flora is much more interesting. There are some individuals of the primitive fern *Equisetum* sp. on the upper part of the banks, amongst the sand and rocks. There are also many trees on both sides of the bank. The most common trees are *Cleistocalyx operculata* and *Sterculia lanceolata*. There are also vines climbing on trees and shrubs, the commoner ones include *Byttneria aspera* and *Pueraria phaseoloides*.

11.25 A list of all plant species recorded at various habitats is given in Table 11.5.

Conservation issues

11.26 As marked on the survey maps, this site is on agricultural land. According to verbal information from local villagers, it was still a paddy field some 20 years ago. Then it was changed to grow cash crops and cut flowers, and has been farmed intermittently over the past two decades. The vegetation on the abandoned field is mainly of weedy species, poor in diversity and of little botanical interest. The riparian vegetation is much more rich in diversity and is representative of the original floristic composition in lowland streams. Should any engineering work be done at this site, extra attention must be paid to the riparian vegetation to avoid any damage.

11.27 No species recorded in this study site is protected or particularly rare in Hong Kong.

Shing Mun Shaft

Botanical assessment

11.28 This site is a piece of flattened, highly artificially altered urban open area. It is right next to a side gate of the Shing Mun Tunnel maintenance depot/storage area. About half of the area is used by the staff of the tunnel company for general maintenance work and open storage/disposal of unwanted old machinery.

11.29 The original vegetation has been removed completely and now it is covered with weedy and opportunistic species, most of them exotic species. The most common species are grasses *Panicum maximum* and *Cynadon dactylon.* Other common species include *Biden bipinata* and *Mikania micrantha.* All these four are exotic weeds. There are a few saplings of exotic trees such as *Acacia confusa*, *Lophostemon confertus* and *Eucalyptus* sp. There are also a few Chinese Banyan trees (*Ficus microcarpa*) from 1 to 3 m tall, and some *Ligustrum sinense* and Banana trees (*Musa* sp.) by the side of Shing Mun Road.

11.30 A list of all plant species recorded at the various habitats is given in Table 11.6.

Conservation issues

11.31 There is a small area (20 m x 25 m) of mostly planted exotics or weeds, therefore it is of little ecological significance.

Rare/endangered species

11.32 No species recorded in this study area is protected or rare in Hong Kong.

Butterfly Valley Aqueduct Portal

Botanical assessment

11.33 This site is on a steep slope facing south east in the Butterfly Valley. It is covered by trees of about 5 to 8 m tall. The most dominant tree species are *Microcos paniculata*, *Sterculia lanceolat*a, *Aporusa dioica*, *Schefflera octophylla* and *Pinus massoniana*. There are also vines climbing on the tree canopy. The most common vines and climbers are *Gnetum montanum*, *Diploclisia glaucescens* and the exotic weed *Mikania micrantha*. On the floor, the common ground vegetation is herbs such as *Liriope spicata*, *Dianella ensifolia* and *Pteris semipinnata*, and shade tolerant shrubs such as *Psychotria ruba* and *Desmos cochinchinensis*.

11.34 A list of all plant species recorded at the various habitats is given in Table 11.7.

Conservation issues/Rare or endangered species

11.35 The site is only a part of the whole wooded area on a steep slope. Due to its steep topography, human disturbance in this area is relatively little apart from a recent illegal dumping of industrial/construction waste. The whole area is characterised by a diversified native species. However, no species found is protected or particularly rare: they are all common in similar habitats in Hong Kong.

Butterfly Valley Primary Service Reservoir

Botanical assessment

11.36 This site covers a small peak at the fringe of urban Kowloon with an area of approximately 4 ha. The study area is composed of several vegetation types. In the north is a densely wooded area of mainly native tree species. The most common trees in the wooded area in the north are *Microcos paniculata*, *Aporusa dioica* and *Schefflera octophylla*. The floristic composition and community structure of the woodland here is quite similar to the Butterfly Valley portal site.

11.37 To the west is a terraced slope of plantation with mainly exotic trees from Australia (*Eucalyptus robusta*, *E. citriodora* and *Acacia confusa*). On the floor there are some grasses such as *Pennisetum* sp. and ferns such as *Pteris vittata.*

11.38 In the south and east of the study area are mainly tall shrubs and small trees in more protected and/or sheltered sites (topographically) and grasses and small shrubs on more exposed places. As in many other similar habitats in Hong Kong, the most common shrubs are *Rhodomyrtus tomentosa*, *Eurya japonica*, *Rhaphiolepis indica* and *Litsea rotundifolia* var. *oblongifolia*. The commoner trees are *Litsea glutinosa*, *Machilus* spp., *Cratoxylon ligustrinum* and *Pinus massoniana*. The dominant grasses here are *Ischaemum* spp., *Miscanthus sinensis, Arundinella* spp. and *Eragrostis* spp.

11.39 A list of all plant species recorded at the various habitats is given in Table 11.8.

Conservation issues

11.40 The site provides different habitats for various animals. For instance, animal tracks were observed quite often in almost inaccessible parts in the northern woodland. Several Black Eared Kites (*Milvus lineatus*) were observed to make use of the study area as their hunting ground and most likely their nesting place as well. Since there are drastic changes occurring in the Stonecutters Island area, this area in the north of the Kowloon Peninsular will become more important to those Kites who used to nest on Stonecutters.

Rare/endangered species

11.41 No species recorded in this study site are protected in Hong Kong. However, in the northern woodland, several individuals of the tree *Artocarpus hypargyrea* were recorded, which is regarded as vulnerable in China and is protected there.

Assessment of Botanical Impacts

11.42 The main botanical impacts arising from the scheme are associated with the construction phase. At the Tai Po Water Treatment Works (TP WTW) site, the main impact is the destruction of surface habitats due to the extensive cut and fill requirements for site formation. Similar impacts will arise during the Butterfly Valley Primary Service Reservoir (BVPSR) site formation. The loss of areas of vegetation at these sites cannot be avoided. It should be noted that virtually all of the works on the She Shan Tsuen side of the ridgeline will be constructed on areas of scrub and grassland above the current treeline. The extent of areas permanently impacted are shown by the layout of the treatment works and primary service reservoir on the Master Landscape Plans in Appendix B. However, as indicated on the Master Landscape Plans, the areas of woodland and shrubland lost will be compensated for by extensive areas to be planted with native woodland species at both sites, by the internal planting at the TP WTW site and the grassing of the roof of the BVPSR.

11.43 The main impacts associated with the raw water tunnel portal at Tai Po, the Shing Mun access shaft and the tunnel portal at Butterfly Valley, are the temporary destruction of habitats due to the required construction site landtake. The ecological impacts here should not be significant and the sites can be reinstated following construction. All areas of woodland and shrubland disturbed during construction of the pipeline link between the treated water portal and BVPSR will be reinstated and planted with native species.

11.44 Any replanting and landscaping will be undertaken with advice from the Department of Agriculture and Fisheries to ensure that compatible native species are selected.

Stream Fauna Surveys

Sampling locations

11.45 In total, five stations in two streams, one which flows through the TP WTW site and one which flows through the BVPSR site, were sampled for the aquatic fauna surveys. Henceforth, these streams are referred to as the Shek Kwu Lung and Butterfly Valley streams respectively. At the time of the survey, the She Shan Tsuen stream could not be sampled as during the dry season the upper reaches virtually run dry leaving insufficient water in the stream to have allowed adequate samples to be taken.

11.46 As illustrated on Figure 11.3, there were four sampling stations in the Shek Kwu Lung stream; two within the proposed construction site; one in the upper reaches of the stream course; and another in the lower reaches of the stream. The station in the upper reaches will not be directly impacted by construction, whereas the stream in the lower reaches is could be impacted by sediments and pollutants from the construction site runoff.

11.47 One sampling location was chosen in the Butterfly Valley stream, adjacent to the proposed BVPSR site shown on Figure 11.4.

Sampling methodology

11.48 Stream macrobenthos were collected from these five locations by using a 'Kick' sampler at stream riffle habitats and a hand net at stream pool habitats. Five 'Kick' samples for freshwater benthos were collected at each location. The sampling method involved placing a 0.25 m wide net, of mesh size 0.2 mm, on the stream bed with the mouth of the net facing towards the current. The substrates directly upstream of the net were then disturbed by stirring actions for a few minutes causing the fauna, sand and detritus to dislodge and collect in the net. The contents of the net were then transferred to a plastic bag and preserved in 70% alcohol for subsequent laboratory examination.

11.49 In the laboratory all the macroinvertebrates were sorted, counted and identified to the lowest practicable taxonomic unit (Morse, *et al.*, 1994). Diptera larvae were identified to family or subfamily in most cases and to genus in a few instances. A few planarian and oligochaete were collected in the samples but could not be identified; the unidentified animals were treated as a single taxon as they were morphologically similar.

Stream fauna composition and abundance

Shek Kwu Lung stream

11.50 Of the Shek Kwu Lung stream sampling stations the benthos were most diverse in the lower reaches (station T1) where 349 organisms belonging to 35 taxa were collected (Table 11.9). Snails, shrimps, mayflies, caddisflies and diptera larvae were the most abundant species.

11.51 Aquatic organisms recorded in the upper reaches of the Shek Kwu Lung stream (station MU) were similar to those recorded at in the lower reaches in term of species composition and relative abundance (Table 11.9).

11.52 Benthic sampling was only undertaken at two stream pools at the station in the middle reach of Shek Kwu Lung stream (station MM), ie. within the proposed construction site. This was because the stream comprised of a series of pools and water falls, therefore there were no suitable stream riffle habitats to be sampled. The organisms collected from the stream pools in this section mainly comprised of snails (*Brotia hainanensis*) and two species of shrimps (*Neocaridina serrata* and *Macrobrachium hainanense*) (Table 11.9). As is the usual case, the benthos were less diverse in the pool samples than that at the riffle sample. The stream benthic organisms collected in this study indicated that the water quality in Shek Kwu Lung stream was good and they were comparable with the other unpolluted streams in Hong Kong (Dudgeon & Corlett, 1984; Shea, 1984).

Butterfly Valley stream

11.53 In total, 88 animals belonging to 21 taxa were collected from a small tributary near the service reservoir currently under construction (sampling station T1, Table 11.9). Mayfly larvae, damselfly larvae and diptera larvae were the dominant taxa at the tributary. Benthos at the Butterfly Valley station were less abundant than at the other sampling stations due to the small discharge in the stream and limited aquatic habitat.

11.54 Benthic organisms recorded at the Butterfly Valley stations were poor in number of taxa, although a few pollution tolerant species (eg. chironomids) were found to be more abundant than in the Shek Kwu Lung stream (B1, Table 11.9). In total, 1,265 organisms belonging to 14 taxa were collected. Pulmonate snails (*Radix* sp. and c.f. *Thraulus* sp.) and diptera larvae were the dominant taxa at the study site, which indicated a poor water quality of the stream. The stream was polluted by oil, rubbish and probably sewage from local residents. Rubble, plastic, fabric wastes and organic deposits on the stream substrates were seen at the sampling site.

Assessment of Stream Fauna Impacts

General impacts

11.55 In streams adjacent to construction works, construction site runoff discharging into water courses has the potential to cause sedimentation, increased turbidity and pollutant loadings which will have direct impact on stream ecology. Increased turbidity can cause blockage of fish gills and invertebrate respiratory systems, and reduces the amount of light penetration and therefore the rate of plant growth. Sedimentation causes plants and benthic animals to become smothered preventing photosynthesis, transpiration and respiration.. Attrition due to suspended particles battering the rocks along the river bed and banks can cause stream organisms to become dislodged. Growth and primary production of algae and other plants can also be adversely affected by excessive sedimentation which will induce indirect impacts on stream fauna changing the natural habitats and microhabitats.

She Shan Tsuen stream

11.56 The She Shan Tsuen stream feeds a significant number of fish ponds near the village of She Shan Tsuen. Degradation in water quality would adversely impact the operation of these ponds and result in fish kills or reduced reproduction and growth rates. To avoid any detrimental impacts on the ecology of this stream, the preliminary design has been formulated to ensure that no polluted construction site drainage or runoff is discharged to this stream.

11.57 Detailed measures have been specified in the EM&A Manual to ensure that the She Shan Tsuen is not adversely affected by the construction and operation of TPWTW.

Shek Kwu Kung stream

11.58 Shek Kwu Lung stream flows from Lin Au, through the proposed TP WTW site, where it is joined by a small tributary, towards Tai Wo and into the Lam Tsuen floodway which discharges into Tolo Harbour. The destruction of the stream habitats and the aquatic fauna within the site is unavoidable as the landform for the treatment works involves a significant amount of cut and fill, with the valleys on the site being filled with spoil excavated from higher ground. There could also be an impact on the habitats downstream if runoff contaminated with sediment and other pollutants is allowed to flow from the site.

11.59 Excessive sedimentation may also result in blockage of the culvert from which the Shek Kwu Lung discharges into the Lam Tsuen river. This would result in flooding and could cause stream fauna to become displaced out of the channel once the flooding receded.

11.60 The middle section of the stream under the TP WTW site will be culverted and thus protected from adverse impacts. The undisturbed upper stream habitats in the Shek Kwu Lung stream will continue to function as organism pools, providing resources for recolonisation of the lower stream course which may have been affected by construction runoff.

Butterfly Valley

11.61 The conservation value of the lower reaches of Butterfly Valley stream is low as the water quality is poor and stream flows irregular, thus preventing a stable animal community. Any detrimental impacts on water quality from site runoff contaminated with sediment or other pollutants could adversely affect the aquatic fauna of Butterfly Valley stream, although the significance of the impact would be limited.

Contamination from Tunnel Drainage

11.62 The potential contamination of groundwater in the Tai Mo Shan and Shing Mun areas has already been addressed in the section on water quality. The ecological impact associated with heavy metal contamination of surface waters is somewhat ambiguous as there has been few studies of this in Hong Kong. High concentrations of heavy metals are toxic although at lower concentrations the degree of toxicity is more vague. The quality of drainage water from the tunnel should be regularly monitored, and if it is significantly contaminated, it should be prevented from discharging to surface water courses.

11.63 Mitigation measures to reduce the discharge of site runoff and tunnel drainage containing sediments and pollutants into adjacent water courses should be adopted by the Contractor. Mitigation measures have been addressed in the section on water quality.

Terrestrial Fauna

Survey methodology

11.64 In order to identify mammals to be found in the study areas, a series of field investigations were undertaken to observe and identify animal tracks and faeces.

11.65 Amphibians and reptiles were not systematically surveyed as most of these animals were in hibernation during the field study period (November 1994 - March 1995). An amphibian/reptile survey should be carried out during the detailed design phase.

11.66 Three daytime surveys allowed bird identification and counts to be carried out in the variety of habitats within the study areas including woodland, scrubland, grassland, abandoned agricultural land and residential areas. The Hong Kong Bird Watching Society was also consulted to obtain bird species lists and recorded sightings within and adjacent to the study areas.

Large mammals

11.67 Evidence of Barking Deer (*Muntiacus reevesi*) and Wild Boar (*Sus scrofa chirodonta*) has been found in the woodland adjacent to She Shan Tsuen village in the form of observed droppings and tracks. Barking Deer is one of the largest surviving mammal species in the wild in the territories of Hong Kong and has a high conservation value. It is a forest/scrubland species and hence the woodland habitat at the She Shan Tsuen site is important for this species. Wild boars are common in some woodlands in New Territories and occasionally been reported destroying farmland properties. The Wild Boar has little conservation value. Moreover, burrows for small animals were often seen in the Fung Shui wood.

Birds

11.68 Birds recorded at the TP WTW site and areas around She Shan Tsuen in the Lam Tsuen valley on 18 November 1994 and 26 January 1995 are given in Table 11.10.

11.69 In total, fifteen species of birds were seen, Bulbuls being the most abundant species with no rare species being seen at the either the TP WTW or Butterfly Valley sites. The overall abundance of birds was far less at Butterfly Valley than in the Lam Tsuen Valley, indeed on the 25 February 1995 twenty-three species of birds were recorded at Golden Triangle and in the area around She Shan Tsuen village in the Lam Tsuen valley whereas only two/three species were noted at Butterfly Valley.

11.70 No detailed data was available from the Hong Kong Bird Watching Society regarding the avifauna at the TP WTW site or Butterfly Valley. An indication of the type of species to be expected in the Lam Tsuen valley is provided in David Diskin's document *Birding Hong Kong*. The species list compiled by Diskin is reproduced on Table 11.11. It can be seen that some rare and scarce species have been observed in the area.

Assessment of Impacts on Terrestrial Ecology

11.71 Construction works at the proposed TP WTW and BVPSR sites will result in the permanent loss of vegetation and the associated habitats within the site boundaries. However, as outlined in the Master Landscape Plans, extensive compensatory planting will be undertaken within and around the sites. Construction works at the other sites will result in temporary loss of habitat; at Shing Mun the environment is essentially disturbed/manmade already.

11.72 Lam Tsuen valley is one of the important areas in terms of ornithological interest in Hong Kong as it supports a relatively rich avifauna both for resident species, summer/winter visitors and passage migrants. However, there will be no blasting required at TP WTW site, and any disturbance to birds and mammals in the nearby Fung Shui woodland due to construction activities at the site is likely to be temporary.

11.73 Measures to reduce the impacts on terrestrial fauna include fencing the sites to hinder children and animals entering the sites. Any animals found trapped within the sites following the fencing operation will be caught and released outside the site boundary.

11.74 Field surveys were undertaken at the sites affected by the scheme to assess the overall conservation importance and general wildlife interest of the areas. This has enabled the significance of impacts to be assessed to determine the overall acceptability of the scheme.

Summary

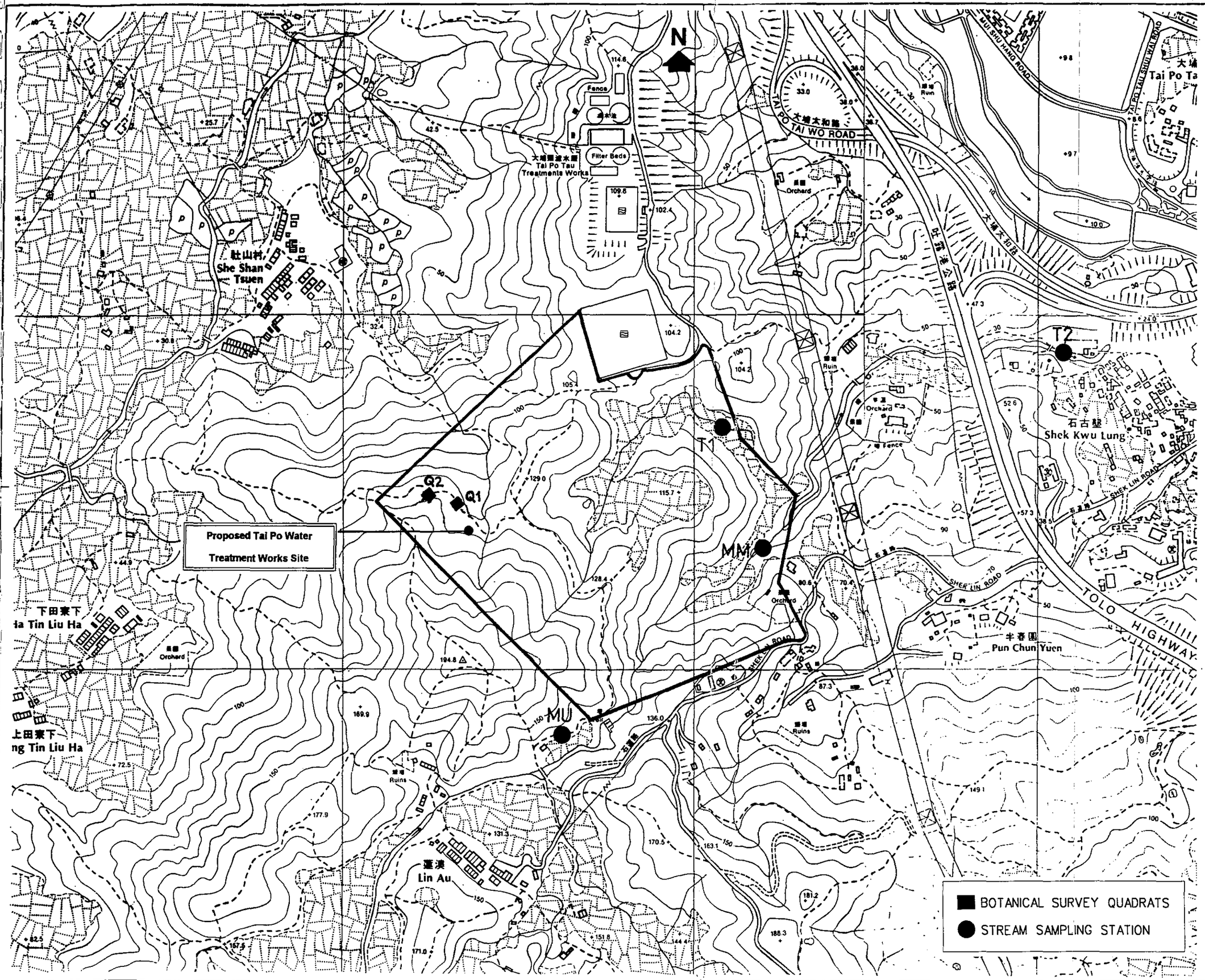
11.75 The most significant ecological impacts associated with scheme are related to the potential effects of major site clearance and formation activities at TP WTW and BVPSR: no mitigation measure can completely restore the environment to its original state. However, measures including extensive compensatory planting with appropriate native species within and around the two sites will ensure that impacts are mitigated as far as possible.

11.76 The TP WTW site forms part of the catchment area for the She Shan Tsuen stream which flows through two Conservation Areas and a Fung Shui woodland which is a Site of Special Scientific Interest (SSSI). The valley is also extensively used for fish farming. Deterioration of water quality in this stream must be prevented as this would have detrimental impacts on stream ecology which could have implications on the SSSI and on the viability of the fish farming activities. Temporary and permanent facilities can be engineered to ensure that the works have no adverse impact on the stream.

11.77 The cut and fill required at the TP WTW site, will result in the alteration of a ridgeline, loss of an area of mixed habitats including abandoned agricultural land, hillside grassland and scrub, and wooded areas along ravines and streams. Within the study area on the N/NE facing slope, there is also an area of Fung Shui woodland which is connected to the SSSI. The areas of woodland and other habitat lost will be compensated for by planting with native woodland species to the south and east of the site.

11.78 The BVPSR site has a number of different habitats for various animals and is becoming increasingly important for Black Eared Kites (*Milvus lineatus*). In addition, several species of the tree *Artocarpus hypargyrea* were recorded on the northern slope of the site; this species is regarded as vulnerable in China and is protected there. Careful reinstatement and compensatory planting around the site will help mitigate the ecological impacts of the works.

11.79 The main impacts associated with the raw tunnel portal site at Tai Po, the tunnel access shaft at Shing Mun and the tunnel portal at Butterfly Valley, are the temporary destruction of habitats due to the required construction site land take. The ecological impacts should not be significant and the sites can be reinstated following construction.



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NOTES

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REVISION			

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Designed	RVC	5/95
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Additional Treatment And Transfer Facilites For The Metropolitan Area And North-Eastern New Territories

STREAM MACROBENTHOS AND BOTANICAL SURVEY SAMPLING STATIONS

Plan register No.

Figure No 11.1

Scale 1 : 5000

APR.95

Water Supplies Department

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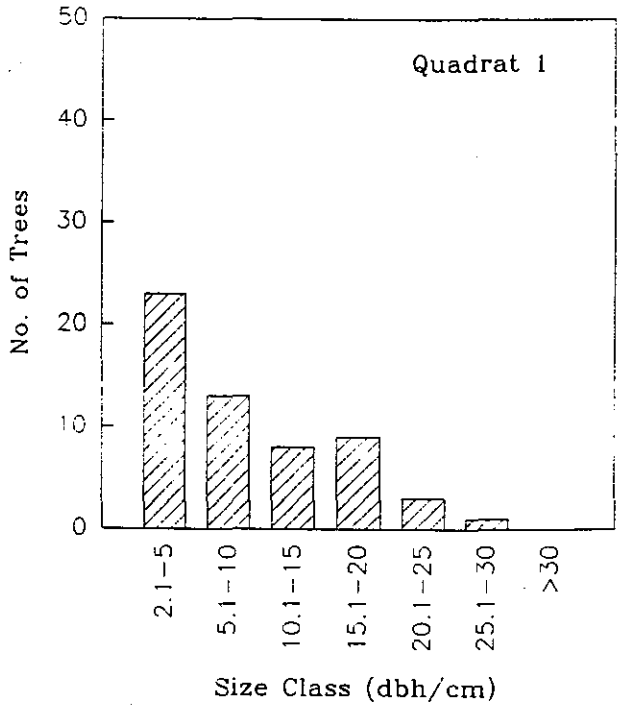
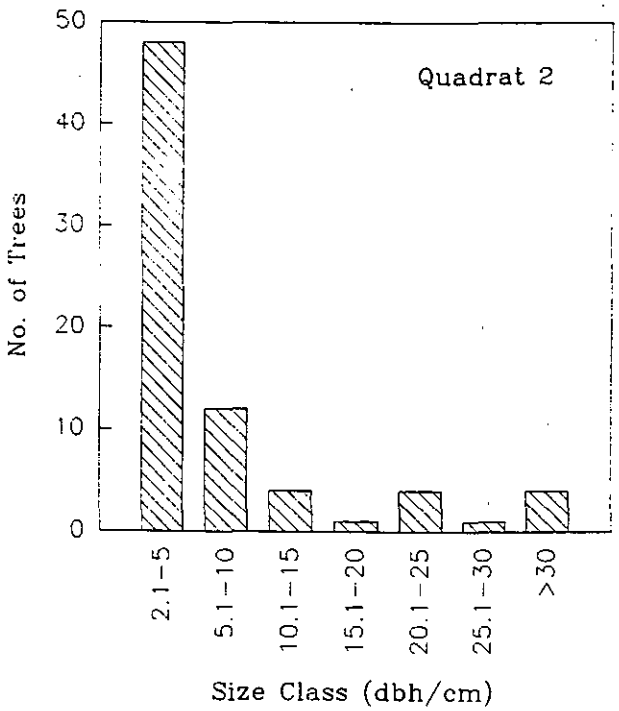
Figure 11.2 Distribution of Tree Size in Lin Au Fung Shui Wood





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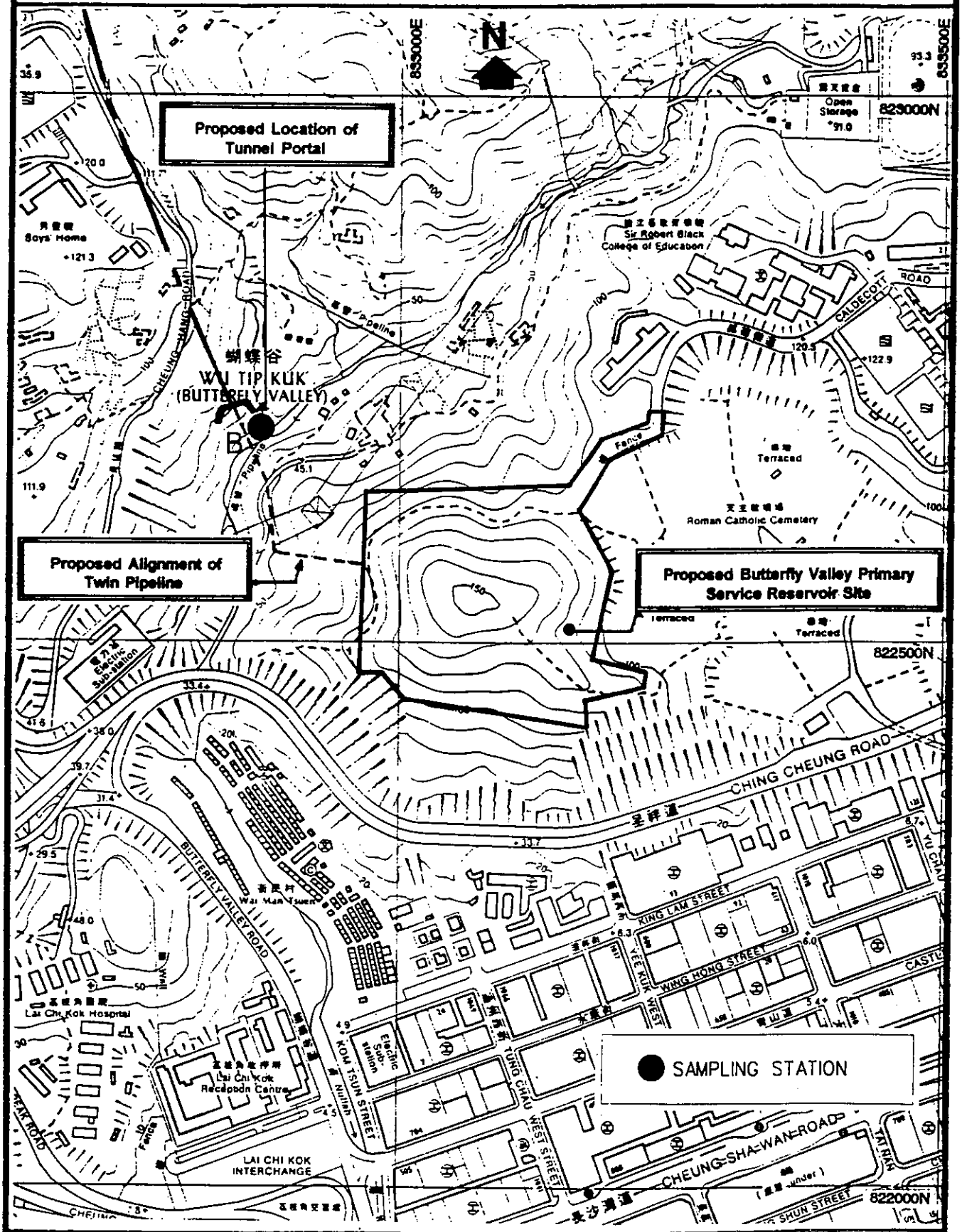

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STREAM MACROBENTHOS SAMPLING STATIONS

Figure No	Scale		Name	Date
11.3	1 : 5000	Designed	HL	APR.95

Table 11.3 Plants recorded at TP WTW site

	Plant Species	Family / Fern Group	Abund.	Exotic/?
TREES	Acronychia pedunculata	RUTACEAE	F	Native
	Alangium chinense	ALANGIACEAE	R	Native
	Aporusa dioica	EUPHORBIACEAE	C	Native
	Aquilaria sinensis	AQUILARIACEAE	R	Exotic
	Archidendron clypearia	MIMOSACEAE	O	Native
	Archidendron lucidum	MIMOSACEAE	F	Native
	Bridelia tomentosa	EUPHORBIACEAE	F	Native
	Canthium dicoccum	RUBIACEAE	R	Native
	Castanopsis fissa	FAGACEAE	O	Native
	Casuarina equisetifolia	CASUARINACEAE	O	Exotic
	Celtis sinensis	ULMACEAE	F	Native
	Cinnamomum camphora	LAURACEAE	O	Native
	Cinnamomum porrectum (C. parthenoxylon)	LAURACEAE	F	Native
	Cleistocalyx operculata	MYRTACEAE	C	Native
	Cratoxylum ligustrinum	HYPERICACEAE	C	Native
	Cunninghamia lanceolata	TAXODIACEAE	O	Native
	Daphniphyllum calycinum	DAPHNIPHYLLACEAE	O	Native
	Diospyros eriantha	EBENACEAE	R	Native
	Diospyros morrisiana	EBENACEAE	O	Native
	Elaeocarpus sp.	TILIACEAE	R	Native
	Ficus hispida	MORACEAE	F	Native
	Glochidion lanceolarium	EUPHORBIACEAE	O	Native
	Itea chinensis	ESCALLONIACEAE	O	Native
	Leucaena leucocephala	MIMOSACEAE	F	Native
	Liquidambar formosana	HAMAMELIDACEAE	F	Native
	Litsea cubeba	LAURACEAE	F	Native
	Litsea glutinosa	LAURACEAE	C	Native
	Machilus ichangensis	LAURACEAE	F	Native
	Machilus oreophila	LAURACEAE	O	Native
	Machilus thunbergii	LAURACEAE	C	Native
	Machlius velutina	LAURACEAE	R	Native
	Phoenix hanceana	ARECACEAE	O	Native
	Phyllanthus emblica	EUPHORBIACEAE	F	Native
	Pinus massoniana	PINACEAE	O	Native
	Psidium guajava	MYRTACEAE	O	Exotic
	Rhus chinensis	ANACARDIACEAE	F	Native
	Rhus succedanea	ANACARDIACEAE	O	Native
	Sapium discolor	EUPHORBIACEAE	O	Native
	Saurauia tristyla	SAURAUIACEAE	O	Native
	Schefflera octophylla	ARALIACEAE	A	Native
	Schima superba	THEACEAE	A	Native
	Sterculia lanceolata	STERCULIACEAE	A	Native
	Symplocos chinensis	SYMPLOCACEAE	O	Native
	Symplocos glauca	SYMPLOCACEAE	O	Native
	Viburnum odoratissimum	CAPRIFOLIACEAE	F	Native
SHRUBS	Adina pilulifera	RUBIACEAE	F	Native
	Ardisia crenata	MYRSINACEAE	F	Native
	Ardisia hanceana	MYRSINACEAE	R	Native
	Ardisia quinquegona	MYRSINACEAE	F	Native
	Berchemia racemosa	RHAMNACEAE	O	Native
	Breynia fruticosa	EUPHORBIACEAE	F	Native

Table 11.1 Results of tree survey in the first quadrat (10 m x 10 m) in Lin Au, Tai Po

Plant Species	N	Range of dbh (cm)	Relative Abundance	Dominance	Relative Dominance	Importance Value
* Schima superba	9	6.4 - 27.7	25.71	3944.82	66.31	92.02
* Machilus thunbergii	3	9.2 - 21.0	8.57	1358.9	22.84	31.41
Schefflera octophylla	6	2.2 - 5.4	17.14	52.44	0.88	18.02
* Lindera communis	3	3.5 - 7.6	8.57	149.21	2.51	11.08
Aporusa dioica	3	3.8 - 4.1	8.57	38.356	0.64	9.22
* Syzygium hancei	2	3.2 - 14.0	5.71	177.62	2.99	8.70
* Ilex asprella	2	2.2 - 4.1	5.71	51.725	0.87	6.58
* Ardisia quinquegona	2	2.2 - 3.5	5.71	18.621	0.31	6.03
* Antidesma bunius	1	5.4 - 7.6	2.86	68.83	1.16	4.01
Zanthoxylum avicennae	1	8.3	2.86	53.79	0.90	3.76
Syzygium handeli	1	5.4	2.86	23.00	0.39	3.24
* Uvaria grandiflora	1	2.2	2.86	7.80	0.13	2.99
Psychotria rubra	1	2.2	2.86	3.90	0.07	2.92
Total	35		100	5949.012	100	

Table 11.2 Results of tree survey in the second quadrat (10 m x 10 m) in Lin Au, Tai Po

Plant Species	N	Range of dbh (cm)	Relative Abundance	Dominance	Relative Dominance	Importance Value
* Schima superba	8	7.0 - 38.2	13.11	4426.34	60.60	73.72
* Schefflera octophylla	27	2.2 - 20.7	44.26	1810.47	24.79	69.05
* Psychotria rubra	9	2.2 - 4.5	14.75	94.22	1.29	16.04
Delonix regia	1	30.9	1.64	748.75	10.25	11.89
Aporusa dioica	4	2.6 - 4.5	6.56	40.11	0.55	7.85
* Syzygium hancei	4	2.2 - 7.3	6.56	60.72	0.83	7.39
* Castanopsis fissa	2	3.2 - 3.5	3.28	25.54	0.35	3.63
* Ilex asprella	2	1.6 - 3.5	3.28	20.93	0.29	3.57
Adina pilulifera	1	6.7	1.64	35.09	0.48	2.12
* Lindera communis	1	4.1 - 4.8	1.64	31.35	0.43	2.07
Antidesma bunius	1	2.6	1.64	5.09	0.07	1.71
Canthium dicoccum	1	2.6	1.64	5.09	0.07	1.71
Total	61		100	7303.71	100	

Remarks:

* = multi-trunk

Dominance = total trunk area at breast height (cm2).

Dominance, Relative Abundance, Relative Dominance and Importance Value follow Muller-Dombois and Ellenberg (1974). Aims and methods of vegetation ecology. John Wiley & Sons. New York.

Table 11.3 Plants recorded at TP WTW site (continued)

	Plant Species	Family / Fern Group	Abund.	Exotic/?
SHRUBS (cont.)	Callicarpa loureiri	VERBENACEAE	O	Native
	Desmos cochinchinensis	ANNONACEAE	C	Native
	Diploclisia glaucescens	MENISPERMACEAE	F	Native
	Elaeagnus loureiri	ELAEAGNACEAE	O	Native
	Eurya chinensis	THEACEAE	F	Native
	Ficus hirta	MORACEAE	O	Native
	Glochidion eriocarpum	EUPHORBIACEAE	F	Native
	Glochidion wrightii	EUPHORBIACEAE	O	Native
	Helicteres angustifolia	STERCULIACEAE	F	Native
	Inula cappa	ASTERACEAE	F	Native
	Lantana camara	VERBENACEAE	F	Exotic
	Litsea rotundifolia	LAURACEAE	O	Native
	Litsea rotundifolia var. oblongifolia	LAURACEAE	C	Native
	Maesa perlarius	MYRSINACEAE	O	Native
	Melastoma candidum	MELASTOMATACEAE	F	Native
	Melastoma sanguineum	MELASTOMATACEAE	F	Native
	Pandanus sp.	PANDANACEAE	F	Native
	Phyllodium elegans	PAPILIONACEAE	O	Native
	Psychotria rubra	RUBIACEAE	A	Native
	Rhaphiolepis indica	ROSACEAE	C	Native
	Rhodomyrtus tomentosa	MYRTACEAE	C	Native
	Sageretia theezans	RHAMNACEAE	O	Native
	Sarcandra glabra	CHLORANTHACEAE	O	Native
	Strophanthus divaricatus	APOCYNACEAE	O	Native
	Symplocos crassifolia	SYMPLOCACEAE	R	Native
	Uvaria grandiflora	ANNONACEAE	F	Native
	Uvaria microcarpa	ANNONACEAE	O	Native
	Viburnum sempervirens	CAPRIFOLIACEAE	O	Native
	Zanthoxylum nitidum	RUTACEAE	O	Native
CLIMBERS	Abrus mollis	PAPILIONACEAE	O	Native
	Bauhinia championi	CAESALPINIACEAE	F	Native
	Byttneria aspera	STERCULIACEAE	F	Native
	Calamus latifolius	ARECACEAE	F	Native
	Dalbergia millettii	PAPILIONACEAE	O	Native
	Embelia laeta	MYRSINACEAE	C	Native
	Embelia ribes	MYRSINACEAE	F	Native
	Ficus pumila	MORACEAE	O	Native
	Hedyotis hedyotidea	RUBIACEAE	O	Native
	Hoya carnosa	ASCLEPIADACEAE	R	Native
	Melodinus suaveolens	APOCYNACEAE	O	Native
	Merremia umbellata	CONVOLVULACEAE	F	Native
	Mikania micrantha	ASTERACEAE	C	Exotic
	Millettia speciosa	PAPILIONACEAE	O	Native
	Psychotria serpens	RUBIACEAE	F	Native
	Pueraria lobata	PAPILIONACEAE	F	Native
	Rubus parvifolius	ROSACEAE	O	Native
	Rubus reflexus	ROSACEAE	C	Native
	Rubus sp.	ROSACEAE	R	Native
	Smilax china	SMILACACEAE	C	Native
	Tetracera asiatica	DILLENIACEAE	C	Native
	Zanthoxylum scandens	RUTACEAE	F	Native

Table 11.3 Plants recorded at TP WTW site (continued)

	Plant Species	Family / Fern Group	Abund.	Exotic/?
HERBS	Aster baccharoides	ASTERACEAE	F	Native
	Centella asiatica	APIACEAE	O	Native
	Chrysanthemum indicum	ASTERACEAE	F	Native
	Emilia sonchifolia	ASTERACEAE	F	Native
	Hedyotis uncinella	RUBIACEAE	O	Native
	Liriope spicata	LILIACEAE	C	Native
	Spermacoce semierecta	RUBIACEAE	R	Native
	Youngia denticulata	ASTERACEAE	O	Native
GRASSES	Arundinaria sinica	POACEAE	A	Native
	Arundinella nepalensis	POACEAE	C	Native
	Arundinella setosa	POACEAE	C	Native
	Imperata cylindrica	POACEAE	C	Native
	Ischaemum aristatum var. meyenianum	POACEAE	C	Native
	Ischaemum indicum	POACEAE	C	Native
	Miscanthus floridulus	POACEAE	C	Native
	Miscanthus sinensis	POACEAE	C	Native
	Neyraudia reynaudiana	POACEAE	C	Native
	Thysanolaena maxima	POACEAE	F	Native
FERNS	Adiantum flabellulatum	ADIANTUM Group	C	Native
	Asipenium nidus	ASPLENIACEAE	R	Native
	Blechnum orientale	BLECHNUM Group	A	Native
	Christella parasitica	THELYPTERIDACEAE	A	Native
	Cibotium barometz	DICKSONIACEAE	O	Native
	Dicranopteris linearis	GLEICHENIACEAE	A	Native
	Lycopodium cernuum	LYCOPODIACEAE	O	Native
	Lygodium japonicum	SCHIZAEACEAE	F	Native
	Lygodium microphyllum	SCHIZAEACEAE	O	Native
	Pronephrium simplex	THELYPTERIDACEAE	F	Native
	Pteridium aquilinum	DENNSTAEDTIA Group	O	Native
	Pteris semipinnata	PTERIS Group	C	Native
	Pteris vittata	PTERIS Group	C	Native
	Schizoloma orbiculatum	LINDSAEA Group	F	Native
	Selaginella uncinata	SELAGINELLACEAE	F	Native

Remarks: Abund. = Relative on-site abundance
A = Abundant
C = Common
F = Frequent
O = Occational
R = Rare

Table 11.4 Plants recorded at Yuen Tun Ha horizontal adit site

	Plant Species	Family / Fern Group	Abund.	Exotic/?
TREES	Acacia confusa	MIMOSACEAE	O	Exotic
	Aporusa dioica	EUPHORBIACEAE	F	Native
	Cinnamomum porrectum (C. parthenoxylon)	LAURACEAE	O	Native
	Cratoxylum ligustrinum	HYPERICACEAE	F	Native
	Glochidion lanceolarium	EUPHORBIACEAE	R	Native
	Liquidambar formosana	HAMAMELIDACEAE	F	Native
	Pinus massoniana	PINACEAE	O	Native
	Schima superba	THEACEAE	F	Native
	Symplocos laurina	SYMPLOCACEAE	O	Native
SHRUBS	Dalbergia benthami	PAPILIONACEAE	O	Native
	Eurya japonica	THEACEAE	C	Native
	Ficus hirta	MORACEAE	O	Native
	Ficus variolosa	MORACEAE	O	Native
	Glochidion wrightii	EUPHORBIACEAE	O	Native
	Ilex asprella	AQUIFOLIACEAE	F	Native
	Ilex pubescens	AQUIFOLIACEAE	O	Native
	Litsea rotundifolia var. oblongifolia	LAURACEAE	C	Native
	Maesa perlarius	MYRSINACEAE	O	Native
	Melastoma candidum	MELASTOMATACEAE	F	Native
	Melastoma sanguineum	MELASTOMATACEAE	F	Native
	Psychotria rubra	RUBIACEAE	F	Native
	Rhaphiolepis indica	ROSACEAE	F	Native
	Rhodomyrtus tomentosa	MYRTACEAE	C	Native
	Viburnum sempervirens	CAPRIFOLIACEAE	O	Native
CLIMBERS	Cassytha filiformis	LAURACEAE	O	Native
	Embelia laeta	MYRSINACEAE	F	Native
	Embelia ribes	MYRSINACEAE	O	Native
	Smilax china	SMILACACEAE	C	Native
	Smilax glabra	SMILACACEAE	O	Native
	Tetracera asiatica	DILLENIACEAE	O	Native
GRASSES	Miscanthus sinensis	POACEAE	F	Native
FERNS	Dicranopteris linearis	GLEICHENIACEAE	A	Native
	Lygodium japonicum	SCHIZAEACEAE	O	Native

Remarks: Abund. = Relative on-site abundance
A = Abundant
C = Common
F = Frequent
O = Occational
R = Rare

Table 11.5 Plants recorded at Yuen Tun Ha shaft site

	Plant Species	Family / Fern Group	Abund.	Exotic/?
TREES	Aporusa dioica	EUPHORBIACEAE	O	Native
	Bridelia tomentosa	EUPHORBIACEAE	F	Native
	Cinnamomum porrectum (C. parthenoxylon)	LAURACEAE	O	Native
	Cleistocalyx operculata	MYRTACEAE	C	Native
	Ficus hispida	MORACEAE	F	Native
	Ficus microcarpa	MORACEAE	O	Native
	Meliosma rigida	SABIACEAE	R	Native
	Saurauia tristyla	SAURAUIACEAE	O	Native
	Sterculia lanceolata	STERCULIACEAE	C	Native
	Syzygium jambos	MYRTACEAE	O	Exotic
SHRUBS	Adina pilulifera	RUBIACEAE	O	Native
	Alchornea trewioides	EUPHORBIACEAE	R	Native
	Breynia fruticosa	EUPHORBIACEAE	O	Native
	Cansjera rheedii	OPILIACEAE	R	Native
	Dalbergia benthami	PAPILIONACEAE	O	Native
	Ficus pyriformis	MORACEAE	O	Native
	Ficus variolosa	MORACEAE	F	Native
	Lantana camara	VERBENACEAE	F	Exotic
	Merremia umbellata	CONVOLVULACEAE	O	Native
	Zanthoxylum nitidum	RUTACEAE	R	Native
CLIMBERS	Bauhinia glauca	CAESALPINIACEAE	O	Native
	Byttneria aspera	STERCULIACEAE	F	Native
	Calamus latifolius	ARECACEAE	O	Native
	Celastrus orbiculatus	CELASTRACEAE	R	Native
	Mikania micrantha	ASTERACEAE	F	Exotic
	Pueraria phaseoloides	PAPILIONACEAE	F	Native
	Tetracera asiatica	DILLENIACEAE	O	Native
HERBS	Polygonum chinense	POLYGONACEAE	C	Native
	Procris laevigata	URTICACEAE	O	Native
GRASSES	Microstegium ciliatum	POACEAE	A	Native
	Miscanthus floridulus	POACEAE	F	Native
	Neyraudia reynaudiana	POACEAE	O	Native
	Thysanolaena maxima	POACEAE	O	Native
FERNS	Christella acuminata	THELYPTERIDACEAE	O	Native
	Christella parasitica	THELYPTERIDACEAE	C	Native
	Equisetum sp.	EQUISETACEAE	C	Native
	Lygodium japonicum	SCHIZAEACEAE	F	Native
	Pteris semipinnata	PTERIS Group	O	Native

Remarks: Abund. = Relative on-site abundance
A = Abundant
C = Common
F = Frequent
O = Occational
R = Rare

Table 11.6 Plants recorded at Shing Mun shaft site

	Plant Species	Family / Fern Group	Abund.	Exotic/?
TREES	Acacia auriculaeformis	MIMOSACEAE	R	Exotic
	Acacia confusa	MIMOSACEAE	R	Exotic
	Albizia lebbek	MIMOSACEAE	O	Native
	Eucalyptus citriodora	MYRTACEAE	R	Exotic
	Eucalyptus robusta	MYRTACEAE	O	Exotic
	Ficus hispida	MORACEAE	R	Native
	Ficus microcarpa	MORACEAE	F	Native
	Leucaena leucocephala	MIMOSACEAE	R	Native
	Lophostemon confertus (Tristania conferta)	MYRTACEAE	O	Exotic
	Macaranga tanarius	EUPHORBIACEAE	R	Native
	Musa sp.	MUSACEAE	C	Exotic
SHRUBS	Lantana camara	VERBENACEAE	F	Exotic
	Ligustrum sinense	OLEACEAE	F	Native
	Ricinus communis	EUPHORBIACEAE	R	Exotic
	Urena lobata	MALVACEAE	R	Native
CLIMBERS	Ipomoea cairica	CONVOLVULACEAE	F	Exotic
	Mikania micrantha	ASTERACEAE	C	Exotic
	Pueraria lobata	PAPILIONACEAE	R	Native
HERBS	Alocasia macrorrhiza	ARACEAE	R	Native
	Bidens bipinnata	ASTERACEAE	C	Native
	Conyza bonariensis	ASTERACEAE	R	Exotic
	Elephantopus tomentosa	ASTERACEAE	O	Native
	Emilia sonchifolia	ASTERACEAE	R	Native
	Gynura bicolor	ASTERACEAE	R	Native
	Hymenocallis americaca	AMARYLLIDACEAE	R	Exotic
GRASSES & SEDGES	Cynodon dactylon	POACEAE	A	Native
	Cyperus alternifolius	CYPERACEAE	R	Exotic
	Microstegium ciliatum	POACEAE	O	Native
	Miscanthus floridulus	POACEAE	R	Native
	Neyraudia reynaudiana	POACEAE	R	Native
	Panicum maximum	POACEAE	A	Exotic

Remarks: Abund. = Relative on-site abundance
A = Abundant
C = Common
F = Frequent
O = Occational
R = Rare

Table 11.7 Plants recorded at Butterfly Valley tunnel portal site

	Plant Species	Family / Fern Group	Abund.	Exotic/?
TREES	Aporusa dioica	EUPHORBIACEAE	A	Native
	Bridelia tomentosa	EUPHORBIACEAE	O	Native
	Celtis sinensis	ULMACEAE	O	Native
	Cleistocalyx operculata	MYRTACEAE	O	Native
	Cratoxylum ligustrinum	HYPERICACEAE	F	Native
	Ficus fistulosa	MORACEAE	R	Native
	Ficus hispida	MORACEAE	F	Native
	Garcinia oblongifolia	CLUSIACEAE	R	Native
	Litsea glutinosa	LAURACEAE	C	Native
	Macaranga tanarius	EUPHORBIACEAE	O	Native
	Machilus thunbergii	LAURACEAE	F	Native
	Mallotus paniculatus	EUPHORBIACEAE	F	Native
	Microcos paniculata	TILIACEAE	A	Native
	Pinus massoniana	PINACEAE	C	Native
	Schefflera octophylla	ARALIACEAE	A	Native
	Sterculia lanceolata	STERCULIACEAE	A	Native
	Syzygium handelii	MYRTACEAE	R	Native
	Zanthoxylum avicennae	RUTACEAE	R	Native
SHRUBS	Ardisia crenata	MYRSINACEAE	O	Native
	Corchorus acutangulus	TILIACEAE	R	Native
	Desmos cochinchinensis	ANNONACEAE	O	Native
	Diospyros vaccinioides	EBENACEAE	R	Native
	Eurya japonica	THEACEAE	O	Native
	Ficus hirta	MORACEAE	F	Native
	Lantana camara	VERBENACEAE	O	Exotic
	Lasianthus chinensis	RUBIACEAE	O	Native
	Ligustrum sinense	OLEACEAE	F	Native
	Litsea rotundifolia var. oblongifolia	LAURACEAE	F	Native
	Maesa perlarius	MYRSINACEAE	O	Native
	Melastoma sanguineum	MELASTOMATACEAE	O	Native
	Phyllanthus cochinchinensis	EUPHORBIACEAE	O	Native
	Psychotria rubra	RUBIACEAE	C	Native
	Rhaphiolepis indica	ROSACEAE	F	Native
	Tithonia diversifolia	ASTERACEAE	O	Exotic
CLIMBERS	Dalbergia benthami	PAPILIONACEAE	O	Native
	Dalbergia hancei	PAPILIONACEAE	O	Native
	Diploclisia glaucescens	MENISPERMACEAE	A	Native
	Embelia laeta	MYRSINACEAE	F	Native
	Gnetum montanum	GNETACEAE	A	Native
	Mikania micrantha	ASTERACEAE	F	Exotic
	Millettia nitida	PAPILIONACEAE	O	Native
	Paederia scandens	RUBIACEAE	R	Native
	Smilax corbularia	SMILACACEAE	R	Native
	Smilax glabra	SMILACACEAE	O	Native
	Smilax lanceaefolia	SMILACACEAE	R	Native
	Tetracera asiatica	DILLENIACEAE	O	Native
HERBS	Dianella ensifolia	LILIACEAE	O	Native
	Elephantopus tomentosa	ASTERACEAE	O	Native
	Liriope spicata	LILIACEAE	F	Native

Table 11.7 Plants recorded at Butterfly Valley tunnel portal site (continued)

	Plant Species	Family / Fern Group	Abund.	Exotic/?
GRASS	Miscanthus floridulus	POACEAE	F	Native
FERNS	Lygodium japonicum	SCHIZAEACEAE	O	Native
	Pteris semipinnata	PTERIS Group	F	Native

Remarks: Abund. = Relative on-site abundance
A = Abundant
C = Common
F = Frequent
O = Occational
R = Rare

Table 11.8 Plants recorded at BVPSR site

	Plant Species	Family / Fern Group	Abund.	Exotic/?
TREES	Acacia confusa	MIMOSACEAE	C	Exotic
	Aporusa dioica	EUPHORBIACEAE	A	Native
	Artocarpus hypargyrea	MORACEAE	O	Native
	Bauhinia purpurea	CAESALPINIACEAE	O	Native
	Bridelia tomentosa	EUPHORBIACEAE	F	Native
	Brucea javanica	SIMAROUBACEAE	R	Native
	Carallia brachiata	RHIZOPHORACEAE	R	Native
	Casuarina equisetifolia	CASUARINACEAE	O	Exotic
	Cinnamomum porrectum (C. parthenoxylon)	LAURACEAE	F	Native
	Cratoxylum ligustrinum	HYPERICACEAE	C	Native
	Eucalyptus citriodora	MYRTACEAE	C	Exotic
	Eucalyptus robusta	MYRTACEAE	C	Exotic
	Ficus hispida	MORACEAE	F	Native
	Ficus superba var. japonica	MORACEAE	R	Native
	Ficus variegata var. chlorocarpa	MORACEAE	O	Native
	Glochidion zeylanicum	EUPHORBIACEAE	O	Native
	Gordonia axillaris	THEACEAE	F	Native
	Itea chinensis	ESCALLONIACEAE	F	Native
	Leucaena leucocephala	MIMOSACEAE	F	Native
	Litsea cubeba	LAURACEAE	F	Native
	Litsea glutinosa	LAURACEAE	C	Native
	Machilus thunbergii	LAURACEAE	C	Native
	Mallotus paniculatus	EUPHORBIACEAE	C	Native
	Microcos paniculata	TILIACEAE	A	Native
	Phyllanthus emblica	EUPHORBIACEAE	C	Native
	Pinus massoniana	PINACEAE	F	Native
	Reevesia thyrsoidea	STERCULIACEAE	F	Native
	Rhus chinensis	ANACARDIACEAE	F	Native
	Rhus succedanea	ANACARDIACEAE	F	Native
	Sapium discolor	EUPHORBIACEAE	F	Native
	Schefflera octophylla	ARALIACEAE	A	Native
	Sterculia lanceolata	STERCULIACEAE	C	Native
	Trema orientalis	ULMACEAE	O	Native
SHRUBS	Alchornea trewioides	EUPHORBIACEAE	R	Native
	Ardisia crenata	MYRSINACEAE	F	Native
	Breynia fruticosa	EUPHORBIACEAE	F	Native
	Desmodium heterocarpon	PAPILIONACEAE	F	Native
	Desmos cochinchinensis	ANNONACEAE	C	Native
	Diospyros vaccinioides	EBENACEAE	O	Native
	Eurya japonica	THEACEAE	C	Native
	Ficus hirta	MORACEAE	F	Native
	Ficus variolosa	MORACEAE	F	Native
	Gardenia jasminoides	RUBIACEAE	O	Native
	Glochidion eriocarpum	EUPHORBIACEAE	F	Native
	Glochidion wrightii	EUPHORBIACEAE	F	Native
	Ilex asprella	AQUIFOLIACEAE	C	Native
	Ilex memecylifolia	AQUIFOLIACEAE	R	Native
	Ilex pubescens	AQUIFOLIACEAE	F	Native
	Inula cappa	ASTERACEAE	C	Native
	Lantana camara	VERBENACEAE	C	Exotic
	Lasianthus chinensis	RUBIACEAE	F	Native
	Lasianthus cyanocarpus	RUBIACEAE	O	Native
	Ligustrum sinense	OLEACEAE	F	Native

Table 11.8 Plants recorded at BVPSR site (continued)

	Plant Species	Family / Fern Group	Abund.	Exotic/?
SHRUBS (cont.)	Litsea rotundifolia var. oblongifolia	LAURACEAE	C	Native
	Maesa perlarius	MYRSINACEAE	F	Native
	Melastoma sanguineum	MELASTOMATACEAE	F	Native
	Phyllanthus cochinchinensis	EUPHORBIACEAE	F	Native
	Psychotria rubra	RUBIACEAE	C	Native
	Rhaphiolepis indica	ROSACEAE	C	Native
	Rhodomyrtus tomentosa	MYRTACEAE	C	Native
	Sageretia theezans	RHAMNACEAE	O	Native
	Strychnos angustiflora	STRYCHNACEAE	O	Native
	Syzygium buxifolium	MYRTACEAE	O	Native
	Tricalysia dubia	RUBIACEAE	R	Native
	Uvaria grandiflora	ANNONACEAE	F	Native
	Zanthoxylum nitidum	RUTACEAE	O	Native
CLIMBERS	Alyxia sinensis	APOCYNACEAE	O	Native
	Celastrus hindsii	CELASTRACEAE	R	Native
	Dalbergia benthami	PAPILIONACEAE	O	Native
	Dalbergia hancei	PAPILIONACEAE	O	Native
	Embelia laeta	MYRSINACEAE	F	Native
	Gnetum montanum	GNETACEAE	C	Native
	Mikania micrantha	ASTERACEAE	C	Exotic
	Millettia nitida	PAPILIONACEAE	F	Native
	Millettia speciosa	PAPILIONACEAE	O	Native
	Mussaenda pubescens	RUBIACEAE	O	Native
	Paederia scandens	RUBIACEAE	F	Native
	Passiflora foetida	PASSIFLORACEAE	O	Native
	Smilax china	SMILACACEAE	C	Native
	Smilax glabra	SMILACACEAE	F	Native
	Tetracera asiatica	DILLENIACEAE	F	Native
	Tylophora ovata	ASCLEPIADACEAE	O	Native
HERBS	Alocasia macrorrhiza	ARACEAE	F	Native
	Dianella ensifolia	LILIACEAE	F	Native
	Elephantopus tomentosa	ASTERACEAE	C	Native
	Hedyotis acutangula	RUBIACEAE	F	Native
	Liriope spicata	LILIACEAE	C	Native
	Oxalis corymbosa	OXALIDACEAE	C	Native
	Stachytarpheta jamaicensis	VERBENACEAE	O	Native
	Youngia japonica	ASTERACEAE	O	Native
GRASSESS	Apluda mutica	POACEAE	R	Native
	Arundinella nepalensis	POACEAE	F	Native
	Arundinella setosa	POACEAE	C	Native
	Eragrostis pilosa	POACEAE	C	Native
	Ischaemum indicum	POACEAE	F	Native
	Ischaemum rugosum var.segetum	POACEAE	F	Native
	Miscanthus sinensis	POACEAE	C	Native
	Neyraudia reynaudiana	POACEAE	F	Native
	Panicum maximum	POACEAE	F	Exotic
	Pennisetum sp.	POACEAE	F	Exotic
FERNS	Adiantum flabellulatum	ADIANTUM Group	C	Native
	Lygodium japonicum	SCHIZAEACEAE	F	Native
	Pteris vittata	PTERIS Group	F	Native
	Schizoloma orbiculatum	LINDSAEA Group	F	Native

Table 11.9 Stream macrobenthus collected from Tai Po and Butterfly Valley (Sampling Date 26.1.1995)

	Taxa \ Stream	T1	T	B	M	MM
TURBELLARIA						
	planarians				3	
ANNELIDA						
	Oligochaeta		6			
	UNID leeches			3		
MOLLUSCA						
	Brotia hainanensis	1	12		41	84
	Radix sp.		21	27		
	c.f. Thraulus sp.		7	31		
CRUSTACEA						
	Ostracoda	4		1		
	Neocaridina serrata		26			63
	Macrobrachium hainanense					21
EPHEMEROPTER						
	Baetis #1		13	2	31	5
	Baetis #2		3		15	
	Baetis #3		2		12	
	Baetis #3				4	
	Indobaetis sp.	15	6		6	2
	Psudocleon sp.		1	7	4	
	Heptagenia sp.	1	1		2	
	Cinygmina sp.		3		5	4
	Serratella sp.	1	12		13	2
	Ephemerella sp.		5		3	
	Choroterpes sp.				4	1
	Caenis #1		5	4	2	
	Caenis spp.		84			
ODONATA						
	c.f. Deielia sp.	2				
	Copera c.f. marginipes	11	3			
	Zygonix iris		11			
PIECOPTERA					4	
HETEROPTERA						
	Notonectidae #1	5				
	Notonectidae #2	4				
	Notonectidae #3	1				
	Metrocoris stali	8	3			3
	c.f.Rhyacobates sp.		1			
	c.f. Neogerris sp.				1	
	UNID Heteroptera				1	
DIPTERA						
	Orthocladiinae	12	68	820	40	14
	Chironominae	7	10	240	46	8
	Tanitarsinae		2		24	4
	Tanipodinae	5	18	120	35	2
	Hemerodromia sp.				5	
	Simulium sp.			3	7	
	c.f. Aedes sp.	2				
	c.f. Atrichopogon sp.	1	2			
	Dixella sp.				7	
	Pedicia sp.				12	
TRICHOPTERA						
	Hydropsyche #1		6	6	1	
	Hydropsyche #2		2	1		
	Anisocentropus spp.	2	1			
	Psilotreta sp.	1				
	Hydroptila sp.	1	6			
	Setodes c.f. incertus	2				
	Lepidostoma sp.	2	2		1	
	Agapetus sp.		4			1
	Pseudoneureclipsis sp.		1		3	
	Xiphocentron sp.		1		2	1
	Rhyacophila sp.				1	
	Helicoptyche sp.					1
COLEOPTERA						
	Psephenus sp.		1			
	Elmidae #1				1	
	Elmidae #2				1	
	Elmidae #3				1	
FISH						
	Ctenogobius duospilus		6			
	Gambusia affinis			12		
	No of taxa	21	35	14	33	16
	No of individuals	88	349	1265	338	196

Abbreviation:
T1: small stream near Tai Po salt water reservor
T2: main stream under bridge, Tai Po highway
B1: stream down a water fall I in Butterfly Valley
MU: main stream upper site
MM: main stream middle site
UNID: unidentified species

Table 11.10 Bird observations in Lam Tsuen Valley

A. She Shan Tsuen area (18 November 1994)	*B. Golden Triangle and near She Shan (25 February 1995)*
Richard's Pipit	Night Heron
Yellow Wagtail	Spotted Dove
White Wagtail	Chinese Bulbul
Spotted Dove	Crested Bulbul
Black-necked Starling	Chinese Pond Heron
Chestnut Bunting	Little egret
Warbler	Brown Flycatcher
Fantail Warbler	Grey-Backed Thrush
Daurian Redstart	Grey Wagtail
Red Vented Bulbul	Great Tit
Chinese Bulbul	Yellow-Belled Prinia
Crested Bulbul	White-Breasted Waterhen
Chinese Pond Heron	Tree Sparrow
Greater Coucal	Magpie Robin
Tree Sparrow	Common Magpie
	Richard's Pipit
	Black-Faced Laughing Thrush
	Arctic Warbler
	Verditer Flycatcher
	Crested Mynah
	Plain Prinia
	Ruffus-Backed Shrike
	Long-Tailed Tailor-Bird

Table 11.11 Birds recorded in Lam Tsuen Valley. (Data source: *Birding Hong Kong*, July 1994, David Diskin)

ALL YEAR
Chinese Pond Heron
Little Egret
Intermediate Egret (rare)
Black Kite
Serpent Eagle
Crested Goshawk
Bonelli's Eagle (scarce)
Chinese Francolin
White-breasted Waterhen
Koel
Lesser Coucal
Collared Scops Owl
Barred Owlet
House Swift
White-breasted Kingfisher
Black-capped Kingfisher
Common Kingfisher
Great Barbet
Red-vented Bulbul
Chestnut Bulbul
Violet Whistling Thrush
Fantail Warbler
Plain Prinia
Greater Necklaced Laughing Thrust (rare)
Hwamei
White-cheeked Laughing Thrush (rare)
Pekin Robin
Yellow-cheeked Tit (rare)
Fork-tailed Sunbird
Scarlet-backed Flowerpecker
Rufous-backed Shrike
Blue Magpie
White-backed Munia
Spotted Munia

RARITIES
Northern Goshawk
Crested Kingfisher
Black-naped Green Woodpecker
Rufous Woodpecker
Rosy Minivet
Hume's
Yellow-browed Warbler (*P.i.Humei*)
Japanese Waxwing
Ruddy Sparrow
Japanese Grosbeak

SUMMER VISITORS
Red-winged Crested Cuckoo
Large Hawk Cuckoo
Plaintive Cuckoo
Swallow
Black Drongo
Hair-crested Drongo
Crested Bunting (rare)

WINTER VISITORS
Little Green Heron (scarce)
Buzzard
Imperial Eagle (rare)
Kestrel
Fantail Snipe
Woodcock
Green Sandpiper
Common Sandpiper
Rufous Turtle Dove
Richard's Pipit
Olive-backed Pipit
Buff-bellied Pipit (rare)
Grey Wagtail
White Wagtail
Black-winged Cuckoo Shrike
Scarlet Minivet (rare)
Black Bulbul (rare)
Rubythroat
Red-flanked Bluetail
Daurian Redstart
Plumbeous Water Redstart (scarce)
Stonechat
Grey Bushchat (rare)
White's Thrush
Grey Thrush
Blackbird
Brown Thrush (rare)
Grey-backed Thrush
Short-tailed Bush Warbler
Chinese Bush Warbler
Mountain Bush Warbler (scarce)

PASSAGE MIGRANTS
Chestnut Bittern (rare)
Black Baza (scarce)
Besra (rare)
Chinese Goshawk (scarce)
Japanese Quail
Oriental Cuckoo
Pacific Swift
White-throated Needletail
White-vented Needletail
Blue-tailed Bee-eater (rare)
Broad-billed Roller
Wryneck
Sand Martin
Red-rumped Swallow
Asian House Martin
Forest Wagtail (rare)
Yellow Wagtail
Ashy Minivet
Siberian Blue Robin (rare)
Siberian Thrush (rare)
Eye-browed Thrush
Black-browed Reed Warbler (scarce)
Eastern Crowned Warbler
Pale-legged Leaf Warbler
Arctic Warbler
Radde's Warbler (rare)
Blue and White Flycatcher (scarce)
Sooty Flycatcher (scarce)
Grey-streaked Flycatcher
Brown Flycatcher
Red-breasted Flycatcher
Mugimaki Flycatcher
Yellow-rumped Flycatcher
Asian Paradise Flycatcher
Japanese Paradise Flycatcher
Black-naped Oriole
Brown Shrike
Purple-backed Starling (rare)
Chinese Starling
Chinese Greenfinch (rare)
Grey-headed Bunting
Chestnut Bunting
Yellow-breasted Bunting
Russet Bush Warbler (scarce)
Bright-capped Cisticola
Yellow-eyed Flycatcher Warbler (scarce)
Blyth's Leaf Warbler
Two-barred Greenish Warbler
Pallas's Warbler
Yellow-browed Warbler
Dusky Warbler
Verditer Flycatcher (scarce)
Grey-headed Flycatcher
Black-naped Monarch Flycatcher
Yellow-bellied Tit (scarce)
Fire-breasted Flowerpecker
Grey Treepie
Silky Starling
Common Rosefinch (scarce)
Black-tailed Hawfinch
Black-faced Bunting
Tristram's Bunting (rare)
Little Bunting

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12 LAND CONTAMINATION

Introduction

12.1 There are no published records of previous land contamination in the study area. The main sources of land contamination would arise from activities such as:

- dumping of chemicals and other toxic waste;
- previous land use may have resulted in the gradual contamination of an area, eg. small scale industries using solvents, fuels and oils or paints which may have leaked out of the containers and accumulated in soils/subsoils;
- accidental spillage of chemicals at existing facilities or along roads;
- contaminated sediments from previous mining activities, eg. lead, and from natural mineralisation.

The potential contamination from these sources is outlined below.

Dumping of Chemical and Toxic Waste

12.2 There are no records of landfill or public dumping areas within the study area, therefore the potential for contamination from this source is negligible. Areas of illegal dumping, if they exist at all, are not recorded and thus cannot be identified. During site visits undertaken between November 1994 and March 1995, no significant dumping areas were identified other than the usual domestic tipping along roadsides and within water courses. Dumping of domestic refuse also occurs within Country Park areas, particularly at barbecue sites. Most of this rubbish is fairly regularly cleared away and, in any case, is unlikely to cause contamination.

Previous Land Use

12.3 The Tai Po Water Treatment Works (TP WTW) and Butterfly Valley Primary Service Reservoir (BVPSR) sites are relatively inaccessible rural areas which are unlikely to have been used for the storage of chemicals. Similarly, the raw and treated water aqueducts pass over, or beneath, rural land or Country Park areas: in these areas industrial activities are either not feasible or are prohibited. The potential for contamination as a result of previous activities is therefore negligible.

12.4 There are a number of small scale industrial or commercial sites along the Shing Mun Road which may use and store chemicals including fuels and oils on site. The site at Shing Mun is currently used as a general storage area for the Shing Mun Tunnel administration building and previously may have been used as a storage area during construction of the Shing Mun Tunnel and toll plaza complex. The potential for soil contamination should be considered during the initial site formation, and it may be appropriate to test the soils for contamination prior to reuse or disposal. If there is significant contamination, the material may require disposal at a chemical disposal site. Care will need to be taken to check the made ground at this site.

Accidental Chemical Spillage

12.5 No records of accidental chemical spillages within the areas requiring earthworks have been identified. Water Supplies Department has reported that there have been no significant spillages from the existing Tai Po Tau Water Treatment Works.

Mining Activities and Mineralisations

12.6 Between the areas of Tai Po and Kwai Cheung there are two distinct geological formations:

- The northern formations are the Shing Mun and Tai Mo Shan volcanic formations which comprise significant areas of granodiorite. Thoroughout the granodiorite intrusions there is significant host mineralisation.

- The southern formation, near Needle Hill, is an area of major intrusive igneous granite which also has significant host mineralisation.

12.7 A recent stream sediment survey of the Tai Mo Shan/Shing Mun area has identified pockets of both naturally occurring and anomalous (possibly man made) mineralisations. The survey was undertaken by GEO but is not yet available in the public domain; a general summary of the findings is provided below.

12.8 The Tai Mo Shan and Shing Mun geological formations contain significant lead/zinc mineralisations with some arsenic; GEO's survey recorded maximum stream sediment concentrations of arsenic at 34.6 ppm. This sediment survey highlighted two anomalous pockets of lead and zinc mineralisation approximately north and south of Lead Mine Pass. GEO indicates that there is evidence of early lead mining near to Lead Mine Pass, although this was limited to shallow mining down to depths no greater than 30 m below surface level.

12.9 Lead in Tolo Harbour sediments is in sufficient concentrations for all muds excavated in the Tai Po sewerage export scheme to require disposal to the East Sha Chau contaminated mud disposal pits. This may be indicative of natural lead deposits which may be encountered in any part of the tunnel route, and should be the subject of particular study as part of the detailed site investigations.

12.10 In the Needle Hill area, there are north west trending quartz veins which contain a significant amount of wolframite (tungsten) and tin mineralisation. Evidence of previous mining activities in this area can be seen on the geological maps which show wolframite mining adits around Needle Hill. GEO reports that the quartz veins marked on the geological map for this area are now known to extend beyond the limits illustrated, in particular towards Kowloon.

12.11 Other minerals recorded at high concentrations in the stream sediments within this area include bismuth, uranium and thorium. It has been suggested that the bismuth in this area, which has a maximum concentration of 62.6 ppm, could be a man made anomaly.

12.12 Shing Mun reservoir straddles the lead and zinc mineralisation zone. There are no reported public health problems in terms of heavy metal contamination of Shing Mun reservoir potable water supply, therefore it may be appropriate to assume that there are no significant health risks associated with the release of lead or zinc in groundwater, and into tunnel drainage, from mineral veins in the area.

12.13 The GEO survey is limited to the Tai Mo Shan and Shing Mun areas and there is no information south of there. The potential for mining or mineralisation related contamination in Kam Shan Country Park or at Butterfly Valley is therefore unknown.

12.14 The granite host rock in the Tai Mo Shan and Shing Mun areas is known as "Hot Rock" (displaying similar characteristics to the granite found in SW England). This granite contains high levels of thorium and uranium the daughter products of which include thoron (Rn-220) and radon (Rn-222) respectively; these radioactive gases were discovered during a series of soil gas analyses.

12.15 Radon is hazardous because of its radioactivity, and can be released from minerals via transport by water or with gases such as ventilation air. This is a general problem in Hong Kong, not one specific to the study area. The danger of radon to the health of workers involved in tunnelling is not expected to be significant because the concentration of radon is not likely to be high. Due to its inert nature and low concentrations, radon produces none of the potential hazard of other geological gases such as carbon dioxide and sulphur dioxide. However, further studies should be undertaken at the detailed design stage, and monitoring and mitigation measures will be incorporated into the detailed design and construction programme.

Summary

12.16 There are no published records of previous land contamination in the study area. However, a recent stream sediment survey of the Tai Mo Shan/Shing Mun area has identified pockets of both naturally occurring and anomalous (possibly man made) mineralisations. The survey was undertaken by GEO but is not yet available to the public; a general summary of the findings is however provided below.

12.17 The Tai Mo Shan and Shing Mun geological formations contain significant lead/zinc mineralisations with some arsenic. The GEO sediment survey highlighted two anomalous pockets of lead and zinc mineralisation approximately north and south of Lead Mine Pass. GEO also indicates that there is evidence of early lead mining near to Lead Mine Pass.

12.18 In the Needle Hill area there is wolframite (tungsten) and tin mineralisation. Evidence of previous mining activities in this area can be seen on the geological maps which show wolframite mining adits around Needle Hill. GEO report that the quartz veins marked on the geological map for this area are now known to extend beyond the limits illustrated, in particular towards Kowloon.

12.19 Other minerals recorded at high concentrations in the stream sediments within this area include bismuth, uranium and thorium. It has been suggested that the bismuth in this area could be a man made anomaly.

12.20 Shing Mun reservoir straddles the lead and zinc mineralisation zone. There are no reported public health problems in terms of heavy metal contamination of Shing Mun reservoir potable water supply, therefore it may be appropriate to assume that there are no significant health risks associated with the release of lead or zinc in groundwater, and into tunnel drainage, from mineral veins in the area.

12.21 The granite host rock in this area is known as "Hot Rock". This granite contains high levels of thorium and uranium the daughter products of which include thoron (Rn-220) and radon (Rn-222) respectively; these radioactive gases were discovered during a series of soil gas analyses. The danger of these gases to health is not expected to be significant because the concentrations are not likely to be high. However, further studies are recommended during the detailed design stage.

13 IMPACTS SUMMARY AND MITIGATION RECOMMENDATIONS

Introduction

13.1 The requirements of an environmental impact assessment of the project are detailed in Appendix 1 of the Brief. In accordance with these requirements, an Inception Report[1] and an Initial Assessment Report[2] (IAR) were submitted to WSD and EPD during the early stages of the investigation study. These reports outline the approach and methodology that are to be adopted in the environmental impact assessment. The draft EIA Report follows the approach outlined in the IAR and incorporates the comments received from EPD and other interested parties on the earlier reports.

13.2 This Section summarises the findings of the detailed environmental impact assessment. The summary is intended to provide an overall appreciation of the key issues associated with the proposed scheme. The process of option selection and the impacts of the preferred scheme are outlined below, presented in approximate order of relative importance.

Identification of Preferred Scheme

13.3 The EIA Study has been carried out in close liaison with the engineering design team. As each environmental issue has arisen during the study, its impact on the engineering of the scheme has been discussed and any feasible adjustments incorporated into the design. In a similar manner, the engineering team has advised the EIA Study team on the engineering constraints and design criteria to which they have to work.

13.4 Working together in an integrated and iterative way has contributed to the elimination of two previously considered engineering options: the raw water pipeline along the She Shan Tsuen Valley and the treated water tunnel intermediate access shaft/adit at Yuen Tun Ha. The chosen layout for the scheme is considered to be the best practicable option with the least environmental impacts.

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[1] *Environmental Impact Assessment Study Inception Report - December 1994.*

[2] *Environmental Impact Assessment Study Initial Assessment Report - February 1995.*

13.5 Even with the adoption of the best practicable environmental option, the construction and operation of the scheme will inevitably lead to some adverse effects. Any one impact can have secondary effects on another component of the environment, for example, a detrimental impact on water quality may affect stream habitats and fish farming activities, which in turn could affect the community. However, with adequate mitigation, the scheme chosen is considered to have the least temporary and residual impacts of all the available scenarios considered during the Study.

Noise Impacts

13.6 The noise impact study has identified Noise Sensitive Receivers (NSRs) adjacent to the sites and along the associated access roads. Predicted noise levels at the NSRs during the construction and operational phases of the scheme have been calculated, based on the limited information on equipment, plant and site layout available during the preliminary design stage. The construction noise assessment includes an evaluation of the impact of construction-related traffic on existing roads around the various sites.

Construction impacts

13.7 The predicted construction noise levels at nearby NSRs for most daytime activities are within acceptable levels. The activities identified as potentially exceeding the acceptable daytime noise levels are the site formation of BVPSR (by < 2.5 dB(A)), construction of the Shing Mun access shaft (by <2dB(A)), tunnel excavation and locomotive operation at Butterfly Valley tunnel portal (exceedance of 1-9 dB(A)). However, the acceptable noise limit can easily be achieved at all sites through measures such as temporary noise barriers around noisy equipment or ensuring that all items of noisy equipment are not operated simultaneously.

13.8 Predicted noise levels from the proposed evening and night-time tunnelling activities exceed the acceptable noise limits for evening, night-time, Sunday and public holidays by at least 10 dB(A). As it is essential that tunnelling is undertaken on a 24-hour basis, it is recommended that all equipment and works are surrounded by an appropriate acoustic enclosure.

13.9 Traffic noise predictions show that the noise levels generated by additional construction traffic movements along existing roads adjacent to NSRs are within acceptable limits. Sir Robert Black College of Education, located close to the Butterfly Valley Service Reservoir site, is centrally air-conditioned so no noise impact is anticipated from construction traffic.

Operational impacts

13.10 The *Hong Kong Planning Standards and Guidelines* states that noise levels from a new fixed source should be 5 dB(A) below the relevant Acceptable Noise Levels (ANLs) in the *Technical Memorandum for the Assessment of Noise from Places other than Construction Sites, Domestic Premises or Public Places* or the prevailing background noise level, whichever is lower.

13.11 The ANLs for TP WTW are 60 dB(A) for daytime and 50 dB(A) for night-time. However, baseline noise monitoring at two nearby NSRs has indicated that the prevailing mean daytime noise level is 45-54 dB(A) and the prevailing mean night-time level is 39-45 dB(A). These noise levels are very low.

13.12 As the noise assessment has been undertaken during the investigation study/preliminary design stage of TP WTW, information on issues such as the exact location of windows, doors and ventilation fans or any built-in mitigation measures such as acoustic louvres has not been available.

13.13 Assuming no mitigation of plant and equipment noise whatsoever at TP WTW, and simultaneous operation of six of eight of the pumps, the predicted noise levels exceed the acceptable daytime limits at the nearest NSRs by between 1-11 dB(A). All predicted noise levels exceed the acceptable limits for evenings, night-time, Sundays and public holidays by more than 10 dB(A).

13.14 Once the detailed design of TP WTW has been developed and pump and plant specifications are known, it is recommended that a detailed Noise Impact Assessment is undertaken. This will enable a more accurate prediction of operational noise levels and identification of appropriate noise mitigation measures.

13.15 In view of the acceptable noise limits being so low, especially the night-time limit, it is anticipated that some capital expenditure may be required to achieve the required noise levels. It is recommended that the appropriateness of the acceptable noise limits for the area is discussed with EPD.

Impact mitigation - Recommendations

It is recommended that:

13.16 A system of noise monitoring and auditing of the construction and operational phases is established to ensure that construction of all works, and operation of the water treatment works, takes place with a minimum of adverse impact on nearby sensitive users.

13.17 The environmental monitoring and auditing of noise levels should:

- determine the essential environmental background and control data;
- collect the data necessary to monitor significant impacts;
- evaluate and report on the quality and significance of the data
- compare the measured effects with the acceptance criteria;
- identify any measures necessary to mitigate unacceptable effects (action plans); and
- report the details of the above on a regular monthly basis.

13.18 The Contractor should comply with the *Noise Control Ordinance (Cap 400)* (NCO) and with any Regulations made under the ordinance. Before the commencement of work which requires a Construction Noise Permit, the Contractor should obtain the relevant documentation and should provide a copy of the application and permit to the Engineer. Construction noise should not exceed the terms and conditions defined in Construction Noise Permits obtained for the site.

13.19 Rock breakers should not be used within 125 m of Noise Sensitive Receivers unless permitted by the Engineer in writing.

13.20 Blasting should be carried out in strict accordance with the conditions of the blasting permit.

13.21 Immediately prior to the excavation of the treated water tunnel section from Shing Mun to Butterfly Valley, the residents of the Shek Lei Estate in Kwai Cheung should be informed of the construction work to allay any concerns residents may have regarding minor structural vibrations due to drill and blast. Similarly residents at Caldecott Road should be informed of blasting at the Butterfly Valley Service Reservoir site.

13.22 Site formation and blasting work at the Butterfly Valley service reservoir site should be undertaken as soon as possible to avoid conflicting activities between the construction of the service reservoir and the ensuing construction of Route 16 which will be in tunnel approximately 40-50 m below the bottom of the service reservoir.

13.23 Construction plant should be effectively sound-reduced by the use of, for example, mufflers, silencers and freestanding movable screens and acoustic linings or shields.

13.24 Hand held percussive breakers and air compressors should comply with the *Noise Control (Hand-held Percussive Breakers) Regulations* and *Noise Control (Air Compressors) Regulations* under the NCO.

13.25 Noise control monitoring procedures should comply with the *Technical Memorandum on Noise from Construction Work other than Percussive Piling*, issued under Section 9 of the NCO, and with the procedures outlined in this EM&A manual.

13.26 Silenced equipment and quieter construction methods should be chosen whenever possible. Particular care should be taken to ensure that equipment is well-maintained. Some equipment (e.g. compressors) require noise labels under the NCO. For these classes of equipment, only items with the appropriate labels should be used on Site.

Air Quality Impacts

13.27 The air quality study has identified Air Sensitive Receivers (ASRs) who may be affected by construction-related dust emissions or by TP WTW operational emissions. Air quality impacts for the sites have been modelled using the EPD approved Fugitive Dust Model (FDM), and are presented in the form of pollution contour maps in the EIA Report.

Construction impacts

13.28 Two worst case scenarios, blasting and excavation, have been selected for investigation on a site-by-site basis. 'Excavation' includes tunnelling, handling of spoil, movement of dusty materials on-site, wind erosion of dusty materials on site, operation of a concrete batching plant and movement of construction vehicles.

13.29 The construction dust assessment has concluded that:

- blasting will not cause significant deterioration in air quality at any site;
- the impact of dust in displaced air discharged from the tunnel is unlikely to be significant and can be further controlled by the use of

proprietary filters on the ventilation system, providing they are properly operated and maintained;

- the impact of dust associated with the movement of construction materials and disposal of spoil on- and off-site is minor, and is mainly associated with the vehicular movements on unpaved haul roads;

- if good construction site practice is maintained, particularly regular watering of haul roads, airborne dust levels can be held well within the Air Quality Objectives. Watering of haul roads may need to be undertaken four times a day during dry conditions and periods of heavy haul road usage.

13.30 During the EIA, the issue of radon has been raised as a potential cause of concern. Radon is hazardous because of its radioactivity, and can be released from minerals via transport by water or with gases such as ventilation air. A geological survey conducted by GEO indicates radioactivity in the Tai Mo Shan and Shing Mun areas due to the nature of the granite host rock. This is a general problem in Hong Kong, not one specific to the study area. The danger of radon to the health of workers involved in tunnelling is not expected to be significant because the concentration of radon is not likely to be high. Due to its inert nature and low concentrations, radon produces none of the potential hazard of other geological gases such as carbon dioxide and sulphur dioxide. However, further study of the potential for radon and other noxious substances, including lead in groundwater, is recommended as part of the detailed site investigations for the aqueducts. Monitoring and mitigation measures will be incorporated into the detailed design and construction programme.

Operational impacts

13.31 The operational impacts of the scheme on air quality have been assessed. Potential sources of odour nuisance at TP WTW are identified as:

- the storage, transport and use of chemicals such as chlorine, lime and alum;

- the treatment and disposal of sludge.

13.32 The Chlorine Hazard Assessment in the Final Report, Chapter 12, deals with issues relating to the storage and handling of chlorine at TP WTW. The Chlorine Store will be fully enclosed and extract ventilated, with a 'contain and absorb' system to minimise any risk to chlorine release. Other locations where chlorine is handled will be enclosed and fully ventilated. It is highly unlikely that odour concentrations would reach the chlorine odour limit because the discharge rate is expected to be very low, even under emergency conditions. In addition, the shortest distance between the chlorine contact tank and the nearest sensitive receiver is around 100 m, which will create a buffer zone to aid any dispersion and ensure that odour units at the site boundary are less than the required 2 Odour Units.

13.33 The odour impact associated with the storage and handling of lime and alum is expected to be negligible. The odour impact of sludge from China water, which will be supplied for 11 months per year, is also expected to be negligible. However minor odour nuisance has been noticed at other water treatment works with sludges from Plover Cove water due to the algal content. Contingency plans for dealing with potential minor odour nuisance will be developed during the detailed design phase.

Impact mitigation - Recommendations

It is recommended that:

13.34 A system of dust monitoring and auditing of the construction works should be established to ensure that construction takes place with a minimum of adverse impact on nearby sensitive users.

13.35 The environmental monitoring and auditing of dust pollution should:

- determine the essential environmental background and control data;
- collect the data necessary to monitor significant impacts;
- evaluate and report on the quality and significance of the data
- compare the measured effects with the acceptance criteria;
- identify any measures necessary to mitigate unacceptable effects (action plans); and
- report the details of the above on a regular monthly basis.

13.36 Work should be carried out in such a manner that dust is not generated. Regular watering of unpaved areas, access road, construction areas and dusty stockpiles shall be undertaken after starting work each day and at least once every three hours thereafter during the operation day to attain the invisible dust emission level. Screens, dust sheets, tarpaulins or other methods agreed by the Engineer should be used to prevent generation of dust. Materials, including earthworks material, from which dust may be generated when being transported to or from the Site should be sprayed with water or covered.

13.37 The Contractor should ensure that necessary equipment for water spraying, such as water bowsers and spray bars, is available on site at all times. The Contractor should provide sufficient bowsers to achieve a minimum of five passes per day on all haul roads.

13.38 The Contractor should ensure that areas within the site where there are regular movements of vehicles, particularly access roads from the construction sites to public roads, should have a hard core surface and be kept clear of loose surface material. Storage and handling areas in particular should be located on a hard surface to facilitate cleaning and minimise dust generation.

13.39 Earth, rock or debris should not be deposited on public or private Rights of Way as a results of the Contractor's activities, including any deposits arising from the movement of plant or vehicles. Wheel washing and vehicle cleaning facilities should be provided for all site vehicles at the exit of the construction sites and be used to wash mud from the wheels and bodywork of all vehicles leaving the site. Cement and concrete trucks in particular should be thoroughly cleaned prior to leaving the site.

13.40 In the event of any spoil or debris resulting from the Contractor's activities being deposited on public or private Rights of Way, then all such material shall be immediately removed to the satisfaction of the Engineer.

13.41 Stockpiles of sand, aggregate, excavated spoil and other fine material which are greater than 30 m^3 should be fully enclosed and screens should extend 2 m beyond the front of the stockpile area. All stockpiles of aggregates with a nominal size of less than 5 mm should be stored in a totally enclosed structure. Stockpiles less than 30 m^3 should be enclosed on three sides with screens extending above the stockpile to prevent wind whipping.

13.42 Earth moving operations should be carefully controlled when winds are strong particularly when blowing towards nearby sensitive receivers. Sheltered areas of the site should be used for dusty operations during these periods. During high winds, earth moving activities may need to be curtailed unless all materials handled and transport routes are very damp.

13.43 Cement delivered in bulk should be stored in closed silos fitted with a high level alarm indicator. The high level alarm indicators should be linked to the filling line such that in the event of a hopper approaching its storage capacity an audible alarm will sound and the delivery line will automatically close.

13.44 If any dry mix batching is undertaken on the site, the truck batching aperture should be shrouded and fitted with water suppression sprays.

13.45 Vehicles with an open load carrying area for moving spoil, debris and other dust generating material should have properly fitted side and tail boards and should not be loaded to a level higher than these boards. Dust generating material should be covered by a well secured, properly fitting tarpaulin which extends at least 300 mm over the edges of the sides and tail boards.

13.46 Conveyor belts should be fitted with wind boards and conveyor transfer points and hopper discharge areas should be enclosed to minimise dust emission. Conveyors which carry materials with particularly fine particulates and which are likely to generate a significant dust problem, should be totally enclosed and fitted with belt washers.

13.47 Motorised vehicle movement on the construction sites should be subject to a speed limit of 15 km per hour.

13.48 All vehicles should be regularly inspected to ensure that they are operating efficiently and that the exhaust emissions are not causing an air quality nuisance. Exhaust systems on site dump trucks should be routed vertically upwards behind the cab.

13.49 Furnaces, boilers, and other similar construction plant which uses fuel which may produce air pollution should not be used without the prior written consent of the Director of Environmental Protection. Wastes and other materials should not be burned on the site.

13.50 Throughout the tunnel excavations, forced ventilation should be maintained to ensure noxious or asphyxiating gases do not accumulate within the tunnels. At the tunnel access shafts or portals the expelled air will require venting to atmosphere ensuring adequate diffusion of gases. Expelled ventilation air should be directed away from nearby buildings.

13.51 Tunnel ventilation will also contain high levels of TSP and should therefore be filtered prior to being vented to atmosphere. The filters should be regularly changed to ensure blockages, which are likely to affect the performance of the system, do not occur.

13.52 Although the EIA did not identify radon as being a particular hazard as the tunnel will be well ventilated, it is considered that monitoring should be conducted within the tunnel at regular intervals to ensure that the workers are not exposed to excessive levels which may be harmful.

13.53 Radon monitoring during construction of the tunnel shafts and portals should be conducted weekly. In addition, continuous monitoring should be undertaken to determine the long term build up of radon gas and the associated exposure levels of the workers.

13.54 Odour emissions are not considered to cause a major problem during operation of the water treatment works. However, the EIA has identified that some slight sludge odour may occur during under certain conditions.

13.55 The extent of odour nuisance from the water treatment works is likely to be dependant on the length of time sludge is stored on site which should be minimised. Odour monitoring should be carried out in the form of an odour patrol to ensure that no odour nuisance occurs beyond the site boundary of the water treatment works.

Water Quality Impacts

13.56 The main surface water quality sensitive receivers are villages reliant on the surface water systems for fish farming and agriculture, and natural stream habitats. The main village reliant on stream water is She Shan Tsuen in the Lam Tsuen Valley. The tunnel route also passes beneath the water gathering grounds for the Plover Cove Reservoir, Shing Mun and Kowloon Group Reservoirs.

13.57 During both the construction and operational phases of the scheme there is the potential for adverse impacts on both surface and ground water systems. The potential for deterioration in water quality mainly results from:

- construction site runoff, which may be contaminated with sediments and/or fuel and chemicals;
- site drainage (including tunnel drainage during the construction phase);
- sewage from construction or WSD works personnel;
- site runoff, drainage and washwater discharges during the operation of TP WTW and BVPSR.

13.58 Good site management practices, such as those outlined in EPD's ProPECC Paper on *Construction Site Drainage*, coupled with monitoring of contaminants in tunnel drainage water, will ensure that any potential temporary impacts on water quality are prevented or minimised. Special measures will be needed to ensure that sediment does not wash into the culvert system where heavy siltation would result.

13.59 The Drainage Impact Assessment[3] has studied the existing surface drainage and assessed the potential impact of the scheme at TP WTW and BVPSR including:

- additional surface runoff due to change in land use;
- compensation flow of unpolluted runoff to the She Shan Tsuen catchment;
- emergency overflows of unpolluted raw or treated water from the treatment/pumping facilities or reservoir

13.60 Detailed preventative measures will be incorporated into the temporary and permanent works to ensure that construction and operation of the TP WTW will not have any adverse impact on the She Shan Tsuen village and its agriculture and aquaculture activities.

13.61 There is a risk of the tunnel alignment crossing a highly permeable or contaminated aquifer, discharges from which could adversely impact on water quality and water supply.

13.62 The potential issue of leakage into the treated water tunnel during construction has been dealt with in Chapter 5 of the Final Report[4]. The tunnel will be fully lined so there will be no leakage during the operational phase.

13.63 Measures to minimise the operational water quality impact of TP WTW and Butterfly Valley Primary Service Reservoir (BVPSR) include:

- separating runoff from areas where chemicals or fuels are stored from general site runoff;

[3] *Drainage Impact Assessment Draft Report - March 1995.*

[4] *Final Report - August 1995.*

- treating washwater prior to reuse or discharge; and
- appropriate treatment and disposal of sludges.

13.64 Appropriate measures should be taken to ensure that the discharge of any wastewater generated from construction or operation related activities comply with Water Pollution Control Ordinance discharge standards to inland waters, storm drains and foul sewers, as appropriate.

13.65 Issues relating to the treatment and disposal of sludges from TP WTW and BVPSR are dealt with more fully in Chapters 13 and 16 of the Draft Preliminary Report.

Impact mitigation - Recommendations

It is recommended that:

13.66 A system of water quality monitoring and auditing of the works should be established to ensure that construction and operation takes place with a minimum of adverse impact on surface waters and any associated environs.

13.67 To allow a meaningful comparison between flow in key streams before and after construction, it is recommended that monitoring stations are set up downstream of tunnel alignment on streams considered to be at possibly moderate and high risk of having their flow to the public reduced by groundwater inflow into the tunnel.

13.68 As part of detailed design site investigation, it is recommended that known geological structural features which connect to major WSD water bodies are further characterised with respect to location, trend, dip, material characteristics and permeability.

13.69 To obtain advance warning of the random and unknown geological features, it is recommended that probing ahead be carried out during construction. Naturally, this would not be economical for the whole tunnel lengths, but rather should be concentrated in those areas considered to be at greater risk as part of the hydrogeological assessment. In addition, it is recommended that advance ground treatment be specified to be mandatory where flows through probe holes above 20 l/min are encountered (or 50 l/min at the tunnel face and within 25 m of the tunnel face or over any 50 m length of tunnel). This should reduce the effect of any changes to the existing hydrological and hydrogeological regimes along the raw water and treated water tunnels.

13.70 Water quality should be monitored in three main areas:

- construction site runoff;
- tunnel drainage discharge; and
- treatment works discharge.

13.71 Construction site drainage at all construction sites should be tested for the following parameters:

- pH (pH units);
- Temperature (°C);
- Dissolved Oxygen (mg/l and % saturation);
- Biochemical Oxygen Demand (BOD mg/l);
- Chemical Oxygen Demand (COD mg/l);
- Ammoniacal Nitrogen (mg/l);
- Grease and Oil
- Suspended Solids

13.72 During excessive groundwater bleeding into the tunnel drainage during tunnel excavation, samples of the drainage water should be taken to be tested for the following determinands:

- Lead (mg/l)
- Zinc (mg/l)
- Silver (mg/l)
- Tin (mg/l)

13.73 Treatment works site runoff should be tested for:

- Biochemical Oxygen Demand (BOD mg/l);
- Chemical Oxygen Demand (COD mg/l);
- Grease and Oil

13.74 The environmental monitoring and auditing programme of surface water quality should:

- determine the essential environmental background and control data;
- collect all data necessary to monitor significant impacts:
- evaluate the quality and significance of the data;

- compare the measured effects with acceptance criteria and any licences issued;
- identify any measures necessary to mitigate unacceptable effects;
- determine any extra monitoring necessary to assess the effectiveness of the mitigation measures;
- ensure that construction and operation is undertaken in the most environmentally acceptable way and in such a manner as to cause as little nuisance as possible to the general public or any sensitive uses;
- assess compliance with the Environmental and Pollution Control Requirements; and
- issue reports on the above procedures on a regular monthly basis.

13.75 The Contractor should comply with the *Buildings Ordinance,* the *Water Pollution Control Ordinance* and the Technical Memorandum on *Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters.*

13.76 The Contractor should take all such necessary measures as may be reasonably required by and to the satisfaction of the Engineer to ensure that the operation of all plant and construction processes on site will not cause unnecessary or unacceptable pollution of Hong Kong Waters.

13.77 The Contractor should ensure that the water quality at the specified monitoring locations is within the acceptable range as proposed by the Engineer and approved by DEP. The Contractor should take action as set out in the Action plans as quickly as possible in the event that any TAT levels are exceeded.

13.78 Water and liquid waste products arising from the construction sites, and which do not contain levels of contamination which exceed the defined action levels, should be collected and removed by a suitable and adequately designed temporary drainage system. Where possible permanent drainage works should be accommodated within temporary works. The site drainage system should be designed to accommodate a one in five year rainfall event. The Contractor should construct, maintain, remove and reinstate any temporary drainage facilities. Maintenance requirements to be undertaken by the Contractor include the regular removal of solids from sand traps, wheel washes, manholes and stream beds.

13.79 The Water Pollution Control Ordinance requirements specify that any effluent discharged from the site into waters of Hong Kong, will require to be licensed. The Contractor should apply for the WPCO license before discharging any effluent from the construction site, including those from any concrete batching plant. The content of effluent to be discharged into the waters near the site should strictly comply with the limits set in the WPCO.

13.80 Wastewater due to construction activities will include runoff from silt and dust suppression activities, washout from concrete mixing/batching, runoff from soil/spoil and fuel and lubricating oil spillage. To prevent the wastewater from any concrete mixing/batching plant from contaminating the operation area or the surrounding streams, the concrete mixing/batching plant area should be properly bunded off from the operation area. Wastewater within the bunded plant area should be conveyed to an similarly appropriate system and disposal facility.

13.81 Discharges from concrete batching should be settled and necessary pH adjustments should be made to the supernatant liquor. If settlement alone is insufficient to settle colloidal materials further treatment with settlement agents should be undertaken prior to discharge.

13.82 All other wastewater and runoff should be routed to an appropriate treatment system and disposal facility. The treatment system and disposal facility should ensure that effluent released to the environment complies with limits set out in the *Technical Memorandum on Standards for Effluent Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters.*

13.83 The drainage system will be adequately supplied with silt traps. Any muddy and silty water collected from cleaning activities should be conveyed to a treatment system for settlement/filtering before being discharged.

13.84 The Contractor should maintain all sanitary facilities in good condition.

13.85 The Contractor should prevent fuel and lubricating oil leakage from plant and storage sites contaminating the construction site. The Contractor should prepare and submit to the Engineer's Representative a spill action plan and keep suitable clean-up materials on-site. Layers of sawdust, sand or equivalent material should be laid underneath and around any construction plant and equipment that may possibly leak oil. The polluted clean-up materials should be replaced with some clean materials on a regular basis. Any polluted material should be disposed of in an acceptable and regular manner. Plant and storage sites for fuel and lubricating oil should be formed on bunded and impervious ground. Adequate numbers of oil/petrol interceptors should be provided.

13.86 The Contractor should operate a slurry collection and recycling system for spent bentonite or other grouts.

13.87 Boundaries of earth works should be surrounded by temporary flood protection works.

13.88 Storage areas for hazardous materials such as fuels, chemicals etc. should be bunded to a capacity 110% of the storage capacity and the storage areas should be securely locked.

13.89 Emergency procedures for chemical spillages should be established between the Engineer, Engineer's Representative, the Contractor and the Environmental Management Team.

13.90 Under no circumstances should contaminated construction site drainage, wastewater or site runoff be allowed to discharge into the She Shan Tsuen stream. The detailed Method Statement for Site clearance, tree removal, excavation and drainage of the ridge overlooking She Shan Tsuen Village should be agreed with the Engineer prior to commencement of work. All materials arising from this task and the tunnel waste from the north-west portal of the treated water tunnel should be withdrawn via the main area of the treatment works site.

13.91 Provision should be made for the collection, treatment and, if necessary, the removal off site of contaminated tunnel drainage. Under no circumstances should tunnel drainage containing high concentrations of metals be allowed to discharge into natural watercourses.

13.92 Water courses and drains intercepted by the works should be trained or diverted and, where possible, reinstated to their original courses on completion of the works.

13.93 Existing water courses and drains within and adjacent to the construction sites should be kept free from debris arising from the construction works.

13.94 Areas of surface excavation work should be minimised. Suitable chemical wetting agents shall be used, where appropriate, on completed cuts and fills to reduce wind erosion. Exposed surfaces should be stabilised as soon as possible by means such as hydroseeding, compaction, covering with aggregate etc.

13.95 The detailed design of the concrete aprons used for the unloading bays and around the chemical and fuel storage tanks will ensure that all spillages and surface water runoff from any washdown would be rerouted into settlement tanks and passed into the sewerage system for treatment.

13.96 General site runoff will be rerouted eastwards towards the Kam Shan stream and ultimately into the Lam Tsuen floodway. This will avoid site runoff to the She Shan Tsuen Stream. Under no circumstances should contaminated water treatment works drainage or runoff be allowed to discharge into the She Shan Tsuen stream.

Waste and Spoil Management

13.97 Wastes will be produced during both the construction and operation of the scheme. The EIA waste and spoil management section examines the types and volumes of waste and considers methods of waste minimisation, reuse and recycling. It is recommended that the use of wooden materials is minimised by alternative materials such as reusable steel shutters, metal fencing or Building Panels.

13.98 Chemical wastes produced on site will require special handling and administration. Sewage wastes will require treatment and municipal waste will require regular collection and disposal at a designated Regional Services refuse collection point.

13.99 A substantial quantity of spoil estimated at around 1.7 Mm^3 will be generated during the construction of the scheme, some of which may be contaminated with high levels of lead and other minerals. In the case of the tunnel construction there will be 24 hour production of spoil. The issues associated with the stockpiling and remote disposal of spoil are:

- dust impacts from the handling of dry materials;
- noise impacts from the movement of spoil both within the construction sites and off site;
- water quality impacts from surface water runoff from stockpiles could result in contamination, increased turbidity and siltation in surface water courses which may have a detrimental impact on aquatic habitats;
- increased traffic on local roads: traffic on the Caldecott Road at BVPSR will be doubled from a current figure of around 40 vehicles during 'rush hour' to an estimated 84 vehicles per hour, 12 hours per day.

13.100 Good waste management practice, in addition to the noise, dust and water quality control measures outlined above, will ensure that any temporary adverse impacts from the scheme are minimised.

Impact mitigation - recommendations

It is recommended that:

13.101 The materials from the construction site clearance are sorted on Site into inert and non-inert materials. Non-inert material such as wood, and materials such as glass, steel or other metals should be taken to landfill. It should be noted that at the strategic landfill sites, construction waste must contain no more than 20% inert material by volume. Inert materials such as soil, rock, sand, concrete and debris should be sorted before disposal as much as possible and used at other building sites if this can be arranged.

13.102 The use of wooden materials should be minimised by alternative materials such as reusable steel shutters, metal fencing or Building Panels.

Waste Storage and Disposal

13.103 The Contractor should comply with the *Waste Disposal Ordinance*, *Public Health and Municipal Services Ordinance*, *Water Pollution Control Ordinance* and the *Air Pollution Control (Open Burning) Regulation.*

13.104 Spoil, debris and construction materials which are stored on adjacent land should be effectively removed following construction and the land area should be reinstated to its natural state.

13.105 Wastes and other materials shall not be burned on the site.

13.106 Waste collected from grease traps should be collected and disposed of by a licensed contractor.

13.107 Layers of sawdust, or a similar inert absorbent material, should be laid underneath or around any construction plant or equipment that leaks oil. Absorbent material contaminated with fuel or oil should be regularly replaced.

13.108 The Contractor should provide a refuse storage area at each construction site. Adequate temporary toilet facilities will be provided at each site and at tunnel portals.

13.109 Tunnel and site formation spoil should only be taken off site during daytime hours between 07.00 and 19.00 except on Sundays and Public Holidays when no material should be transported off site. Spoil generated in evening or on Sundays or Public Holidays should be temporarily stored on site until the designated disposal time. Material from the formation of the water treatment works may be taken off site at any time as access from this site is via a private (WSD) road along which there are no residences.

13.110 Waste material, in particular tunnel and site formation spoil, which is suitable for use in any of the Fill Management Committee projects should be segregated and disposed of at site requested by FMC. Material which is deemed unsuitable for reclamation or construction should be disposed of at the Contractor's tip or at a public landfill.

Cleared Vegetation

13.111 On site incineration is prohibited under the *Air Pollution Control (Open Burning) Regulation.*

Domestic-Type Sewage

13.112 Sewage generated from toilets, washing facilities and any temporary canteen provided for staff should be separately collected and suitable treatment should be provided before discharge. It should not be discharged into the local water courses. The Contractor should be responsible for supplying adequate. suitable temporary arrangements such as sufficient chemical toilets and ensuring the waste generated is properly handled.

13.113 Should any washwaters or other wastewaters be discharged into the local water courses, it is necessary for their composition to comply with the requirements specified by the *Technical Memorandum on Effluent Standards.*

Domestic-Type Solid Waste

13.114 A refuse collection station should be established for the collection and temporary storage of municipal waste. All municipal waste should be collected in black refuse bags and delivered to, and disposed of at, an approved landfill.

13.115 Waste oil and other chemicals will be required to be disposed of at the Government Chemical Waste Treatment Centre at Tsing Yi. Sludge from the clarifiers and from the clearance of the service reservoir, should be dewatered and disposed of to landfill in accordance with the Government's Waste Management Strategy.

13.116 Wastes and other materials must not be burned on the site.

Visual Impacts

13.117 TP WTW and BVPSR are located in visually prominent locations and involve contrasting visual impact issues which can be mitigated, to some extent, by integrated landscaping and appropriate colour and texture treatment. The two Master Landscape Plans indicate the locations of extensive planting of native woodland species around and within the sites. There is little opportunity to ameliorate visual impacts by changes to the site boundaries and works areas due to engineering and site constraints.

13.118 The two major elements of TP WTW to impact on the visual environment are the extensive cut and fill slopes and the bulky buildings which are visible from wide angle views around the site. The calibration tower has a high visual impact and appropriate measures are needed in the detailed design to site it appropriately close to the main cut slope and avoid visual intrusion.

13.119 The construction of BVPSR, which involves removal of a strong symmetrical element in the natural environment, will have a major visual impact when viewed from Caldecott Road and the Catholic Cemetery. However in the wider context, the impact of removing the knoll will be lost in the views of the natural backdrop of foothills behind the site.

Impact mitigation - Recommendations

Tai Po Treatment Works Site

13.120 The Master Landscape Plan for TP WTW (appended to this Report) outlines how areas of existing woodland should be linked by extensive planting of native woodland species. This will be critical in terms of mitigating the impact of the development on the ridgeline when viewed from Lam Tsuen Valley. Internal planting and the use of climbing plant species are also proposed to help break down the geometric outlines of building/plant.

13.121 All artificial slopes should be graduated and excavated so as to blend in as best as possible with the adjacent landscape; no artificial slopes should appear angular. Appropriate design and treatment of the slopes should enable grassing and planting with native tree species, which would help reduce visual intrusion from the main viewing corridors, in particular from Tai Po Town West.

Butterfly Valley Primary Service Reservoir Site

13.122 As indicated on the BVPSR Master Landscape Plan (appended to this Report), the sides of the reservoir should be formed into an undulating earth bund and grassed/landscaped to form a softer edge and help blend the development into the existing background.

13.123 Where land permits, the boundary of the site should be extended to the edge of the natural slope or tree line, so that the intervening areas can also be appropriately landscaped. This is particularly relevant along the southern and eastern boundaries where there are potentially wide areas available for landscaping.

13.124 The road alignment should be designed to the minimum standards commensurate with operational and emergency access purposes, so as to avoid excessive clearance of the natural landscape.

13.125 The Master Landscaping Plan seeks to augment and extend surrounding planting through the use of generally taller wind resistent native tree species. This is particularly important on the Cemetery side of the reservoir, to replace the existing landscape 'cap', and along the access road. The surface of the reservoir will be grassed.

13.126 The external colours and textures of all visible buildings should be designed to blend into the surrounding landscape. The specification for landscaping will be devised by a qualified landscape architect.

13.127 Operational and security lighting at the water treatment works and service reservoir sites should be minimised. Where such lighting is necessary the lights should be suitably cowled and directed away from residential areas.

13.128 Construction sites should be adequately reinstated to a condition as close as possible to the original landform prior to construction.

Socio-economic Impacts

13.129 There are existing land uses either within or adjacent to the sites affected which will require careful treatment in the design, construction and operation of the scheme. Residential areas and sensitive uses adjacent to the construction sites which would be affected by the scheme are individually identified in the sections on Noise, Air Quality and Visual key issues reports in the EIA.

13.130 The options identified in this study minimise land take, avoid clearance of permanent or temporary residential structures, and generally avoid productive agricultural farm land. The issue of compensation flow for streams serving fish farming, agricultural and conservation areas is addressed in the Drainage Impact Assessment.

13.131 Disruption of daily activities and general mobility is often associated with construction works. Roads and footpaths may be temporarily closed off and temporary diversions put in place. Increased vehicle movements can have a significant effect on traffic congestion, particularly along single track roads and at busy intersections.

13.132 Construction impacts which alter the character or facilities of an area can cause a degradation in recreational and amenity value. For example, visual intrusion or increased background levels of noise and dust may affect the natural appeal of an area and hence its recreation or amenity value. Although none of the proposed surface structures are located within any Country Parks, parts of the construction sites will be visible from within the parks.

13.133 An area of Fung Shui woodland has been identified close to the TP WTW site. Fung Shui issues are likely to become significant in this area due not only to the potential impact of the proposed works on the ridgeline and trees but also to the proximity of the treatment works to the village. At the Shing Mun site, villagers at Wo Yi Hop may claim disruption of Fung Shui due to the construction of a water tunnel near the village. These issues will be addressed in public consultation.

13.134 The only known sites of cultural or archaeological interest directly affected by the scheme are the graves within the TP WTW site.

13.135 Operation of the water treatment and transfer facilities will benefit a large section of the population of Hong Kong's Metropolitan Area, an area which is currently facing a treated water supply deficit by the end of 1999.

Impact mitigation - Recommendations

It is recommended that:

13.136 The Contractor should comply with the Public Cleansing and Prevention of Nuisances Bye-law 1972.

13.137 The site should be maintained in a clean and tidy condition. Materials, including materials required for temporary works should be stored in an orderly manner. Rubbish and debris should be removed from the site at a frequency agreed by the Engineer.

13.138 Earth, rock or debris should not be deposited on public or private Rights of Way. This includes deposits arising from the movement of construction plant. Wheel washing and vehicle cleaning facilities should be provided for all site vehicles at the exit of the construction sites and be used to wash mud from the wheels and bodywork of all vehicles leaving the site. Cement and concrete trucks in particular should be thoroughly cleaned prior to leaving the site.

13.139 Where the construction work temporarily affects any public roads, private roads, footpaths and other Public Rights of Way, the Contractor should provide alternative access. Where construction movements cause an unacceptable increase in local road traffic, sufficient to cause regular inconvenience to local residents, the Contractor should ensure that only essential vehicles and plant use the affected road(s) during the local peak traffic times. This is particularly relevant at Caldecott Road which is a proposed access route for the service reservoir site.

13.140 If during excavation and earthwork the Contractor unearths materials which may be of archaeological value, the finds must be reported to the Antiquities and Monuments Office (AMO). Where it is deemed appropriate the AMO may wish to undertake a watching brief of any further excavation work in that area to ensure that the archaeology of the site is adequately recorded. In this instance the Contractor should comply with the requests of the AMO representative.

13.141 All provisions for the relocation of graves and burial grounds should be strictly adhered to. This will involve arranging notification and exhumation through RSD in the usual way and will be subject to discussions with the people affected.

13.142 All construction sites should be securely fenced off to prevent members of the public from accidentally entering the site.

13.143 An adequate fire break should be maintained between the water treatment works site and the surrounding area.

13.144 The 24 hour tunnelling programme will require the tunnel portal and access areas to be floodlit during the evening and night-time. Screens should be provided around parts of the site which are adjacent to residential areas. Floodlights should be cowled to prevent direct glare.

13.145 The area of hardstanding created for the Shing Mun access shaft could be turned over to the Agriculture and Fisheries Department for use as a parking area for Shing Mun Country Park. This park is very popular with day trippers and parking is often a major problem. The provision of a parking area would alleviate the pressure and access problems currently experienced along Shing Mun Road during public holidays and weekends. The tunnel access shaft at Shing Mun would require stringent security measures to ensure public safety.

Ecological Impacts

13.146 Field surveys were undertaken at the sites affected by the scheme to assess the overall conservation importance and general wildlife interest of the areas. This has enabled the significance of impacts to be assessed to determine the overall acceptability of the scheme.

13.147 The most significant ecological impacts associated with scheme are related to the potential effects of major site clearance and formation activities at TP WTW and BVPSR: no mitigation measure can completely restore the environment to its original state. However, measures including extensive compensatory planting with appropriate native species within and around the two sites will ensure that impacts are mitigated as far as possible.

13.148 The TP WTW site forms part of the catchment area for the She Shan Tsuen stream which flows through two Conservation Areas and a Fung Shui woodland which is a Site of Special Scientific Interest (SSSI). The valley is also extensively used for fish farming. Deterioration of water quality in this stream must be prevented as this would have detrimental impacts on stream ecology which could have implications on the SSSI and on the viability of the fish farming activities. Temporary and permanent facilities can be engineered to ensure that the works have no adverse impact on the stream.

13.149 The cut and fill required at the TP WTW site, will result in the alteration of a ridgeline, loss of an area of mixed habitats including abandoned agricultural land, hillside grassland and scrub, and wooded areas along ravines and streams. Within the study area on the N/NE facing slope, there is also an area of Fung Shui woodland which is connected to the SSSI. The areas of woodland and other habitat lost will be compensated for by planting with native woodland species to the south and east of the site.

13.150 The BVPSR site has a number of different habitats for various animals and is becoming increasingly important for Black Eared Kites (*Milvus lineatus*). In addition, several species of the tree *Artocarpus hypargyrea* were recorded on the northern slope of the site; this species is regarded as vulnerable in China and is protected there. Careful reinstatement and compensatory planting around the site will help mitigate the ecological impacts of the works.

13.151 The main impacts associated with the raw tunnel portal site at Tai Po, the tunnel access shaft at Shing Mun and the tunnel portal at Butterfly Valley, are the temporary destruction of habitats due to the required construction site land take. The ecological impacts should not be significant and the sites can be reinstated following construction.

Impact mitigation - Recommendations

It is recommended that:

13.152 A system of ecological monitoring and auditing of the works construction should be established to ensure that construction of the works takes place with a minimum of adverse impact on terrestrial and stream ecology.

13.153 Measures to address the impact of the works on water quality, potentially the most important impact on ecology apart from the actual loss of vegetation due to site clearance, have been addressed in the water quality section.

13.154 As part of the works, a tree survey will be undertaken at TP WTW and BVPSR sites in order to identify any rare or special trees. Any such trees identified will be preserved in situ or relocated in consultation with AFD. Care will be taken to minimise the extent of all works areas and to maximise the number of trees preserved.

13.155 The Environmental Management Team should have a watching brief to ensure that the She Shan Tsuen Fung Shui woodland, stream and conservation area are not adversely affected by construction of TP WTW. Three particular items to be noted on a regular basis will be:

- water quality of the She Shan Tsuen stream;
- damage to vegetation, particularly trees, within and adjacent to the site boundary;
- deposition of any construction materials, e.g. spoil, packaging, within and adjacent to the site boundary.

13.156 All mitigation measures to minimise detrimental impacts on surface water quality should be strictly adhered to avoid adverse effects on aquatic ecology. Weekly inspections are needed to ensure that conditions are upheld.

13.157 The loss of mature trees should be minimised by means of avoiding established woodland where such areas are not necessary to the site formation. Site clearance and in particular the removal of trees lying between the Limit of Works and Limit of Site should not be undertaken without consultation and approval of the Engineer. Mature trees in this zone should be identified, marked and considered individually for site clearance with the consent of the Engineer.

13.158 Where possible, mature trees will be left *insitu* or transplanted within a short period of their being uprooted. Where this is not possible, the trees should be replaced with saplings of the same or other native species to be planted elsewhere on the Site as indicated in the Master Landscape Plan.

13.159 Following construction, site reinstatement should include replanting using native species which are appropriate to each particular site.

13.160 Landscaping of the water treatment and service reservoir sites should be undertaken during the construction period. Where possible, material excavated from the site should be used for this landscaping as it will be compatible with remaining soil/subsoil and is likely to contain a similar organic content, chemical composition and seed bank.

13.161 Compensation flow in the form of unpolluted runoff should be provided into the She Shan Tsuen stream.

13.162 All revegetation and landscaping should be undertaken under the supervision of a qualified ecologist/botanist with advice from AFD to ensure that appropriate native species are selected. Aftercare of trees planted will be required for an appropriate period to ensure that they become properly re-established.

Land Contamination

13.163 There are no published records of previous land contamination in the study area. However, a recent stream sediment survey of the Tai Mo Shan/Shing Mun area has identified pockets of both naturally occurring and anomalous (possibly man made) mineralisations. The survey was undertaken by GEO but is not yet available to the public; a general summary of the findings is provided below.

13.164 The Tai Mo Shan and Shing Mun geological formations contain significant lead/zinc mineralisations with some arsenic. The GEO sediment survey highlighted two anomalous pockets of lead and zinc mineralisation approximately north and south of Lead Mine Pass. GEO also indicates that there is evidence of early lead mining near to Lead Mine Pass, and high levels of lead contamination have been found in sediments in Tolo Harbour, necessitating disposal at the East Sha Chau confined disposal facility.

13.165 In the Needle Hill area there is wolframite (tungsten) and tin mineralisation. Evidence of previous mining activities in this area can be seen on the geological maps which show wolframite mining adits around Needle Hill. GEO report that the quartz veins marked on the geological map for this area are now known to extend beyond the limits illustrated, in particular towards Kowloon.

13.166 Other minerals recorded at high concentrations in the stream sediments within this area include bismuth, uranium and thorium. It has been suggested that the bismuth in this area could be a man made anomaly.

13.167 Shing Mun reservoir straddles the lead and zinc mineralisation zone. There are no reported public health problems in terms of heavy metal contamination of Shing Mun reservoir potable water supply, therefore it may be appropriate to assume that there are no significant health risks associated with the release of lead or zinc in groundwater, and into tunnel drainage, from mineral veins in the area.

13.168 The granite host rock in this area is known as "Hot Rock". This granite contains high levels of thorium and uranium, the daughter products of which include thoron (Rn-220) and radon (Rn-222) respectively; these radioactive gases were discovered during a series of soil gas analyses. The danger of these gases to health is not expected to be significant because the concentrations are not likely to be high.

Impact mitigation - Recommendations

13.169 Further studies of the potential for radon and other noxious substances, including lead in groundwater, are recommended during the detailed site investigations for the aqueducts. Radon levels will be monitored during the construction of the tunnels.

Environmental Monitoring and Audit

13.170 It is inevitable that construction of the scheme will impact on the environment. Where potentially adverse impacts from the construction and operation of the scheme have been identified in the EIA, a series of mitigation measures have been set out to prevent, or at least alleviate to an acceptable level, adverse environmental effects. Most of these mitigation measures are what may be termed 'good construction practice'.

13.171 An Environmental Management and Audit Manual has been developed as part of the EIA report to ensure that good construction practice and monitoring of environmental effects is carried out systematically. The manual also provides a schedule of post project evaluation to allow the identification of unforseen detrimental impacts.

Conclusion

13.172 The chosen layout for the proposed Additional Treatment and Water Transfer Facilities for the Metropolitan Area and North-eastern New Territories is considered to be the best practicable option. Provided that the requirements of the Environmental and Monitoring Manual are carried out diligently, the Scheme can be constructed and operated with a minimum of impact on the environment.

End of Text

APPENDIX A

COMMENTS AND RESPONSES

Agreement No. CE 41/94
Additional Treatment and Water Transfer Facilities for the Metropolitan Area and North-eastern New Territories - Investigation Study
EIA Study - Draft Final Assessment Report

Responses to Comments

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1. **District Officer (Tsuen Wan)'s comments in memo of 31st May 1995 reference (22) in TW DS/12A/24**

Comments	Responses
I have no comment on the Draft Final Assessment Report for the EIA Study	Noted.

2. **Project Manager/NT North's comments in memo of 5th June 1955 reference (4) in NTN 4/6/66 II**

Comments	Responses
I refer to your above quoted memo and have no comment.	Noted.

3. **District Officer (Sham Shui Po)'s comments in memo of 6th June 1995 reference (15) in SSP/D/1/11 XIII**

Comments	Responses
I have no comment to add on the captioned report.	Noted.

4. **District Lands Officer (Tsuen Wan)'s comments in letter of 6th June 1995 reference (78) in DLO/TW/WGS/88**

Comments	Responses
Please be advised that this office has no comment on the Draft Final Assessment Report.	Noted.

5. **Chief Engineer/Mainland South, Drainage Services Department's comment in memo of 7th June 1995 reference ( ) in MS 17/103/28**

Comments	Responses
I have no adverse comments on the draft Final Assessment Report for the Environmental Impact Assessment (EIA) of the captioned project for the project area within Kwai Tsing District.	Noted.
Comments relevant to the project area within Tai Po District will be sent to you by the Chief Engineer/Mainland North of DSD direct.	Noted.
When further submissions in respect of the above project are sent to this Department for comment, I should be grateful if you could send one more set of the documents to Chief Engineer/Mainland North, DSD direct.	Noted.

6. **District Officer (Kwai Tsing)'s comments in memo of 7th June 1995 reference (28) in KC L/12/7 III**

Comments	Responses
I have no comments on the above report.	Noted.

7. **District Officer (Tai Po)'s comments in letter of 8th June 1995 reference (6) in TP 407/181/92 II**

Comments	Responses
I notice that the proposed Tai Po Water Treatment Works (TPWTW) will have substantial visual impact on the ridgeline as viewed from Lam Kam Road/Lam Tsuen Valley. The extensive ridge cutting, size of the plant and the possible siting of a tall calibration tower which protrudes above the ridgeline may all be objected to by villagers on 'Fung Shui' grounds. Furthermore, the necessity to remove grave at the TPWTW site may also cause objections. Villagers views will no doubt be expressed at the consultation meeting with the Tai Po Rural Committee scheduled to be held on 13 June 1995.	We note your comments, which reiterate the findings already outlined in the Final Assessment Report. While there has been considerable effort applied by the engineering design team to retain the ridgeline and minimise the area used for the TPWTW, we have been unable to avoid some visual impacts on the area due to site and engineering constraints. The 'Fung Shui' issues have been discussed at the meeting with the Tai Po Rural Committee on 13 June 1995 and at subsequent meetings.

8. **District Officer (Shatin)'s comments in letter of 8th June 1995 reference (10) in ST 29/69**

Comments	Responses
We have no comments on the Report.	Noted.

9. **District Lands Officer, Tai Po's comments in memo of 12th June 1995 reference(3) in WWO 4724/R/52 II**

Comments	Responses
No comments, please.	Noted.

10. **Principal Government Geotechnical Engineer's comments in memo of 13th June 1995 reference ( ) in GCP 1/7/440**

Comments	Responses
I have no comments on the above captioned draft final EIA report.	Noted.

11. **Director of Agriculture & Fisheries's comments in memo of 13th June 1995 reference (35) in AF CPA 05/65**

Comments	Responses
My comments to the report are as follows: Tai Po Water Treatment Works (Para. 11.3-18, 13.50 & 13.52)	
The woodland at the western end of the proposed site contains a high diversity of species with some protected/rare species, and hence should be preserved.	Noted. The importance of the woodlands at She Shan Tsuen have been recognised since the Tender stage of this project; a major constraint on the engineering design of the project has been the need to keep the raw water aqueduct route and TPWTW site boundary away from the woodland as much as possible. A small area of existing woodland is likely to be encroached on by the TPWTW site: however, as indicated on the Master Landscape Plan, the area lost will be more than compensated for by the extensive area to be planted with native woodland species to the south and east of the site.
The consultant should recommend mitigation measures to address the loss of habitat and woodland as mentioned in para. 13.50.	As outlined above, the loss of habitat and woodland at TPWTW has been minimised by design, and there will be extensive compensatory planting of native species both around and within the treatment works.
The consultant should indicate the locations where permanent ecological impact would take place as mentioned in para. 13.52 and details of the landscaping proposal.	Figures indicating the locations where permanent ecological impact would take place and copies of the Master Landscape Plans for the TPWTW and BVPSR sites will be included with the final version of the EIA report.
Butterfly Valley Primary Service Reservoir (Para. 11.36-41 & 13.51-52)	
Mitigation measures for loss of plant species and animal habitat should be recommended by the consultant.	As described in Section 11.36-39, there is an area of woodland to the north of the site, with the rest of the side mainly covered in grasses and shrubs. The Master Landscape Plan for BVPSR site illustrates the ways in which the loss of habitat and vegetation will be mitigated: • the access road will be designed to have minimum impact on the existing woodland;

Comments	Responses
	• the undulating earth bund around the perimeter of the reservoir will be planted with appropriate native tree and shrub species: • all areas of woodland and shrubland disturbed during construction of the pipeline link between the treated water aqueduct portal and BVPSR will be reinstated and replanted with native species; • the roof of the service reservoir will be grassed
<u>Assessment of Botanical Impacts</u> (Para. 11.42-44, 14.109 & 14.182)	
Loss of woodland at the western end of the TPWTW should be avoided. Details of site reinstatement proposal, replanting programme especially the use of native species should be provided.	As outlined above, the TPWTW site layout has been designed to minimise the impacts on the woodland; and measures to compensate for loss of woodland habitat with planting of native woodland species have been made in the Master Landscape Plan.
<u>Shek Kwu Lung Stream</u> (Para. 11.50-52 & 11.58-60)	
The assessment made by the consultant indicated that the Shek Kwu Lung Stream is rich in species diversity and unpolluted the stream should therefore be preserved as far as possible. Otherwise, adequate justification and mitigation measures to address the ecological impacts should be provided.	As outlined in Para. 11.60, the middle section of the stream under the TPWTW site will be culverted and protected from adverse impacts. The section to be culverted represents less than 10% of the total length of the stream.
<u>Terrestrial Fauna</u> (Para. 11.64-73)	
Surveys on amphibian and reptiles should be conducted and reported.	During the study period, most of the amphibians and reptiles were in hibernation (November 1994-March 1995).
Mitigation measures to address the impacts on terrestrial fauna should be provided.	No blasting is expected at the TP WTW site which is close to a Site of Special Scientific Interest, classified for its large populations of native and migratory birds. In addition, the sites will be fenced to hinder both children and terrestrial fauna, eg. deer and wild pigs, from entering the site and possibly being injured during site operations. Animals found trapped within the site following enclosure will be released safely outside of the site fence.

Comments	Responses
Ecology and the Natural Environment (Para. 14.179)	
It is not advisable to uproot and store mature trees for transplanting after the construction works completed.	Noted. Where possible, mature trees will be left *in situ* or transplanted within a short period of their being uprooted. If this is not possible, the trees will be replaced by saplings of the same or other native species to be planted elsewhere on the site as indicated in the Master Landscape Plan.
Other comments	
My comments/concern expressed in my memo of 13 April 1995 had not been taken into account fully, for example: - Ecological habitat maps have not been provided. - Details of replanting programme (including species, numbers, area, location, etc.), and implementation/ restoration plan have not been provided.	Most of the recommendations, eg. outline ecological habitat maps, were incorporated into the final version of the Initial Assessment Report. It should also be noted that this project is at the Investigation Study/Outline Design stage, consequently the replanting scheme and implementation/restoration plan are only at the Master Landscape Plan stage. The detailed design of the scheme may differ significantly from that proposed at this stage: consequently it would be premature to indicate more precise details. Additional information on the number and species of trees affected will be available when the Tree Survey is carried out as part of the Detailed Design.
Detailed plan for creation of wetland habitat and wildlife corridor as suggested in para. 6.65 of the EIA Study - Initial Assessment Report had not been provided.	Following AFD's comments on the Initial Assessment Report, it was decided not to proceed further with the plan for creation of the wetland habitat and wildlife corridor.
The She Shan Tsuen (para. 8.40) is important in supplying water for irrigation and aquaculture purposes. The proposed diversion of the stream to prevent accidental discharge of polluted site runoff is not an ecological friendly measure. Moreover, it is doubtful whether the proposed mitigation measure could provide sufficient compensatory flow. Other alternative without damaging the stream should be explored.	The importance of the She Shan Tsuen stream has been recognised since the Tender stage of the project: a major constraint on the engineering design of the project has been the need to keep the raw water aqueduct route and TPWTW site boundary away from the stream and fishponds as much as possible, and also avoid adverse impacts on both the quantity and quality of water in the stream. It should be noted that the original proposal outlined a raw water pipeline route up the She Shan Tsuen valley and through the woodland. The Drainage Impact Assessment study assessed that the compensation flows from a surface channel to be constructed along the southwest edge of the site would be adequate.

Comments	Responses
	There are a number of structural and non-structural techniques available to restore or create stream ecosystems where stream diversions or replacement are unavoidable. These include: - use of grasscrete for formation of the channel sides; - placing rocks into the channels to focus the current to protect banks or provide a refuge for fish; - planting trees, brush, herbaceous vegetation and grasses along the banks; - angling tree trunks and branches along the banks to reduce water velocity. These measures could be investigated more fully during the detailed design stage.

12. **District Planning Officer/Tsuen Wan & Kwai Tsing's comments in letter of 14th June 1995 reference (6) in PD/TW G/WWO/4 (II)**

Comments	Responses
Paragraph 10.3	
The Kwai Chung district is covered by the Kwai Chung OZP No. S/KC/10 only, therefore, the text in para. 10.3 and the descriptions in the related figures should be amended accordingly.	Noted. The text in the final version will be amended.
Paragraph 10.5	
The land use zonings stipulated in the OZP, which show the existing and proposed land uses in the area, has been established and gazetted long before the proposal of the Additional Treatment and Water Transfer Facilities, and it is one of the objectives of this consultancy study to find out the suitable alignments for the aqueducts, and the location of the primary reservoir and the water treatment works, which would have minimum impact on the existing and committed developments. Besides, control over underground uses such as aqueduct installation would not be reflected in the OZP. Moreover, the affected area in my district is mainly zoned "Green Belt" on the OZP, where the proposal may be permitted subject to town planning permission. Therefore, the "apparent conflict" arising from the OZPs as described in para. 10.5 is somewhat misleading and should be revised taking into account my comments.	The locations of treatment works and service reservoirs were already identified and reserved by WSD prior to the commencement of the Investigation Study, as outlined on Page 2 of the Brief. The study was responsible for establishing suitable routes for the aqueducts, and the interaction between the environmental and engineering design teams in exploring alternative aqueduct alignments has been documented in both the Initial Assessment and Final EIA Reports. The relevant text in the final version of report will be amended.
Please note that the existing administration building for the Shing Mun Tunnel is covered by the Tsuen Wan OZP No. S/TW/6, but not the Kwai Chung OZP No. S/KC/10.	Noted. The text will be revised in the final version of the report.

Comments	Responses
Paragraph 10.6 In order not to jeopardise the future implementation of the Urban Fringe Park concept, I have in my previous comments requested you to take into account the proposal in your assessments. I therefore suggest to revise the paragraph as follows: "According to the Tsuen Wan and Kwai Tsing Development Statement, the location of the BVPSR and a portion of the raw water aqueduct sites fall into the proposed Butterfly Valley Urban Fringe Park is still a long term planning concept, and has not yet been translated into the OZP. However, for any proposed development within the proposed Park, conservation of the landscape and protection of the scenic value should be achieved."	Noted. The text will be revised in the final version of the report. Although formation of the BVPSR site requires cutting down the existing hill be 50 m to about 97 mPD, which will inevitably have a visual impact on the surroundings, mitigation measures including landscaping will be incorporated into the design to minimise the impact.
Paragraph 10.7 The paragraph should be revised to read: "The implications for development within Green Belt areas in Hong Kong differ between administrative zones. However, land use of public facilities installations such as treated water aqueduct within "Green Belt" zone in Kwai Chung and Tai Po would be permitted with or without conditions on application to Town Planning Board. In addition, land use of public utilities installations within the Kam Shan Country Park are subject to the control and approval of the Country Parks Authority."	Noted. The text in the final version of the report will be revised.
Paragraph 10.8 In the Kwai Chung District, only the BVPSR site is zoned as "Government/ Institution/Community", therefore, please consider deleting "the raw water aqueduct" from the text.	Noted. The text of the final version will be amended accordingly.

Comments	Responses
Figure 21.3 - Tai Po Treatment Works and Associated Aqueduct - Programme There is a figure showing the programme of the proposed scheme, though I do not know how it relates to the text. However, as stated in the revised paragraph 10.7 above, additional time may need to be reserved for the process of application for the land use of public facilities on "Green Belt" zone and Country Park to Town Planning Board and Country Parks Authority respectively. Therefore, the work programme should be revised accordingly.	The programme relates to, and is referred to in, the Environmental Monitoring & Audit Manual (Section 14.8 in Draft Final EIA Report). The memo dated 23 June 1995 Ref (18) in WWO 4724/R/52 II from CE/CW, WSD comments: "I note from your letter that most of the land within your district is zoned "Green Belt" and as such planning permission is required for use of the land for waterworks installations. As discussed Tam/Hui on 23.6.95, I would be grateful for your advice on the procedures to follow for the planning application and also on the tentative schedule for the Town Planning Board Meetings for our construction works to start in 6.96. I understand from our discussion that 2 months' lead time is required from submission of the application to consideration by the Board."

13. **Project Manager/NTW's comments in memo of 14th June 1995 reference (39) in NTW 2/140 WF/O**

Comments	Responses
I have no comments on the Draft Final EIA Report, other than those on Wo Yi Hop Village given to you via my previous memo (28) in this series dated 26.4.1995.	As noted in responses to previous comments, the treated water tunnel will be constructed at least 60 m east of the village development and should not pass any constraint on the design of the project.
Please however noted that the future development of this village will provide for 61 village type house sites, with an estimated population of about 450.	Noted.

14. **District Lands Officer (Shatin)'s comments in letter of 22nd June 1995 reference (18) in LND/ST 75/160**

Comments	Responses
I have no comments on the captioned report.	Noted.

15. **Environmental Protection Officer, Environmental Protection Department's comments in letter of 30th June 1995 reference ( ) in EP2/N5/17**

Comments	Responses
Chapter 3 Environmental Legislation and Planning Guidelines Section 3.25 Please note that Air Pollution Control (Construction Dust) Regulations is not expected to be effective in mid-1995. Please amend accordingly.	Noted. Text will be amended in the final version of the report.
Table 3.6 24-hour HKAQO limits are not arithmetic mean. Footnote '3 Arithmetic Mean' should be deleted.	Noted. The text of the final version of the report will be amended.
Section 3.30 In HKPSG, dusty uses and concrete batching plants should be located at least 100 metres from air sensitive receivers. Please clarify this point.	Noted. Text will be amended in the final version of the report.
Chapter 6 Noise Please be advised that Construction Noise Permits are required for percussive piling and construction work using powered mechanical equipment during restricted hours.	Noted. The text of the final version of the report will be amended.
Chapter 7 Air Quality Sections 7.5, 7.6 & 7.8 For the background dust concentrations at Tai Po Area, Shing Mun Area and Butterfly Valley Area, justification should be given for why geometric mean is used instead of arithmetic mean.	For the background noise concentration, the geometric mean is used instead of the arithmetic mean because the former is better able to account for the meteorological fluctuation which is basically not linear in nature.
Section 7.7 Consultants should give view on "it is also a common practice to artificially set the hourly average equal to the daily average when hourly data is not available."	In the case of rural areas where pollutant levels are not acute, the 1 hour average reading and the daily average reading are not substantially and quantitatively different; thus we can approximate the 1 hour average to the daily average.

Comments	Responses
Compilation of emission factors Section 7.21	
Please clarify whether the total volume of material to be shifted is assumed to be 57000 m^3.	The total volume of material to be shifted is assumed to be the cut volume, estimated as 570,000 m^3. The text in the final version of the report will be amended.
Section 7.38	
When calculating TSP emission factor for top soil removal, consultants assumed that surface area of the site area was 228420 m^2 whereas surface area of the site area given in equation 7.14 is 22842 m^2. Please explain the discrepancy.	The correct surface area of the site is 22,842 m^2. The text in the final version of the report will be amended. Revised calculation is not required as Appendix B uses the correct data.
Modelling results (Tables 7.11-7.25)	
For cumulative annual impact, background annual average TSP, RSP concentrations should be included as appropriate.	Noted. However, no annual background data is available.
Units for TSP, RSP concentrations should be given in $\mu g/m^3$ instead of $\mu g/m$.	Noted. Units will be amended in final version of the report.
Tai Po Treatment Works - Impact Analysis	
Justification should be given as to why the hourly TSP concentration for Truck movement over unpaved road with 50% reduction given in Table 7.13, p. 7-38 is not exactly 50% of the corresponding value given in Table 7.11, p.7-36.	A slight discrepancy between Tables 7.11 and 7.13 is due to a mistake in format conversion from EXCEL to WordPerfect. Revised tables will be included in the final version of the report.
Raw Water Aqueduct Section 7.62	
Watering should be done after starting work on a day and at least once every three hours thereafter during the operation day to attain invisible dust emission level.	Noted. The text in the final version of the report will be amended.

Comments	Responses
Butterfly Valley Service Reservoir - Impact Analysis Table 7.24	
Hourly TSP concentrations for truck movements over unpaved road is 5% of the corresponding values given in 7.22, which is 95% reduction of dust emission instead of 90% as stipulated in S7.72. Please explain the discrepancy and review the modelling results if necessary.	Noted. The corrected emission reduction is 90% and the tables have been amended accordingly.
Please give views with justification on four times daily watering the dirt road will reduce dust emission by 90%.	Watering the dirt road twice daily can reduce the emission rate of dirt roads by 50% (Jutze *et al*, 1974). For a very dry day or worst dust situation, it is recommended that watering should be conducted as many times as possible. EPD's comments above state that watering at least once every three hours during the operation day can attain invisible dust emission level. It is thus interpolated that if watering four times a day is carried out, the emission rate would be dramatically reduced, assumed to reach 90% efficiency.
Mitigation Measures - Construction Phase Section 7.74	
Please note that watering should be done after starting work on a day and at least once every three hours thereafter during the operation day to attain invisible dust emission level. This requirement should be spelt out in the report.	Noted. The text in the final version of the report will be amended.
Section 7.76	
Apart from conditions given in this section, respective BPM (Best Practical Means) should also be followed by the contractor.	Noted. The text in the final version of the report will be altered accordingly.

Comments	Responses
Chapter 8 Drainage Impact and Water Quality Issues	
Regarding the Butterfly Valley Primary Service Reservoir, it was stated that the wash water sludge and sewage from operators will be treated to meet Technical Memorandum standards before discharge to sewers. Please clarify which system of sewer the report was referring to, and check whether the sewage system has sufficient capacity to accept the additional flow. Also, please advise whether you meant to treat the waste water to a standard suitable for direct discharge to local water bodies, or it would be necessary to provide a temporary storage tank to equalise the flow before discharge.	The BVPSR site will be unmanned: there will be no operators to generate sewage. It is proposed that provision should be made in the detailed design for such on-site facilities as recommended in the Reservoir Cleansing Consultancy under Agreement CE 19/94 for service reservoir cleansing effluents to be discharged to sewer. The cleansing effluents for the BVPSR will be discharged into the sludge pipeline from Tai Po Treatment Works before it discharges into the foul sewer in King Lam Street in Cheung Sha Wan. While the sludge from the treatment works will be discharged on a semi-continuous basis, the BVPSR will only be cleaned every 1-2 years or such period as found appropriate. Discharge from BVPSR will be coordinated with treatment works operation and controlled so as not to exceed the permitted discharge rate from the treatment works.
Section 8.28	
3rd bullet, last sentence, it is not our (EPD's) practice to agree the design of treatment facilities with the dischargers. We aim at the treatment standards of the facilities to meet the requirements of WPCO. As such, please amend to: "... and of appropriate design for proper treatment of effluent prior to the application for a Water Pollution Control Ordinance (WPCO) effluent discharge licence."	Noted. The text will be amended in the final version of the report.
Section 8.29	
2nd bullet, last sentence, please amend to: "... The polluted clean up materials should be replaced by clean material on a regular basis and disposed of properly.	Noted. The text in the final version of the report will be amended accordingly.
Section 8.38	
Last sentence, please amended to "All discharges have to be licensed under WPCO and will comply with..."	Noted. The relevant text will be altered in the final version of the report.

Comments	Responses
Chapter 14 EM&A Manual	
Since it is agreed that the EM&A Manual is a stand alone document, it is preferable to detach it from the bulky EIA report in the future for the sake of management and operation.	Noted. The final version of the EM&A Manual will be issued as a detachable Appendix with the final version of the Final EIA Report.
Sections 14.9 & 14.20	
The Environmental Management Team (EMT) shall be an independent body and should be clearly spelt out. In view of scale and nature of the project, the Environmental Management Team shall provide a full-time Environmental Site Supervisor (ESS) responsible for the implementation of the environmental monitoring programme on site. It is anticipated that the ESS shall carry out regular site inspections.	Noted. The text in the final version of the EM&A Manual will be amended accordingly.
Section 14.27	
The complaint handling procedure is preferably in graphical presentation and the proponent should indicate a time limit from the receipt of complaint to the written reply. We would suggest that the reply should be done within 1 week.	Noted. A diagram illustrating the Complaints Handling Procedure, and amended text, will be included in the final version of the EM&A Manual.
After Section 14.39	
Exact report format should be agreed with EPD.	Noted. The text in the final version of the EM&A Manual will be amended.
Table 14.1	
There is no need to inform EPD formally for trigger exceedances.	Noted. The text in the final version of the EM&A Manual will be altered accordingly.
Table 14.3	
We suggest "Arrange meeting with ER/Contractor (but not EPD) to discuss the remedial actions to be taken." for (6) in the first Action Column.	Noted. The text in the final version of the EM&A Manual will be amended.
Tables 14.1 to 14.3	
Guidelines for dust monitoring issued by EPD/AMG should be strictly followed, eg. the repeated daily dust measurements and prompt action for carrying out dust mitigation measures as appropriate.	Noted. Comment added to Tables in the final version of the EM&A Manual.

Comments	Responses
Section 14.66 The 24 hours sample should be done once every 6 days; additional sampling will not only be done on receipt of complaint but exceedance of TAT stipulated in Action Plan as well.	Noted. The text in the final version of the EM&A Manual will be amended.
Section 14.70 Baseline monitoring should be done for at least two consecutive weeks for 24 hour TSP.	Noted. The text in the final version of the EM&A Manual will be amended.
Section 14.71 As the accuracy of data provided by portable equipment is doubtful, use of such equipment is not encouraged. The short periods should be specified as less than two months.	Noted. The text in the final version of the EM&A Manual will be amended.

16. **Director of Agriculture & Fisheries's comments in memo of 5th July 1995 reference AF CPA 05/65**

Comments	Responses
There are 6-7 farms at She Shan Tsuen. The farmers rely on the She Shan Tsuen water for their ponds. It is therefore essential that the water supply is maintained for the fish farmers' use. Appropriate mitigatory measures must be identified to prevent disturbances, damages caused to fish farms and to prevent the diversion of stream water from the area.	As outlined above in the response to AFD's earlier comments, every effort will be made to minimise the impact of the construction and operational phases of the project on the quantity and quality of water in the She Shan Tsuen stream.

Agreement No. CE 41/94
Additional Treatment and Water Transfer Facilities for the Metropolitan Area and North-eastern New Territories - Investigation Study
EIA Study - Draft Final Assessment Report

Responses to Comments

(Expanded Text)

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12. **District Planning Officer/Tsuen Wan & Kwai Tsing's comments in letter of 14th June 1995 reference (6) in PD/TW G/WWO/4 (II)**

Comments	Responses
Paragraph 10.3 The Kwai Chung district is covered by the Kwai Chung OZP No. S/KC/10 only, therefore, the text in para. 10.3 and the descriptions in the related figures should be amended accordingly.	Noted. The text in the final version has been amended. [See para 10.3]
Paragraph 10.5 The land use zonings stipulated in the OZP, which show the existing and proposed land uses in the area, has been established and gazetted long before the proposal of the Additional Treatment and Water Transfer Facilities, and it is one of the objectives of this consultancy study to find out the suitable alignments for the aqueducts, and the location of the primary reservoir and the water treatment works, which would have minimum impact on the existing and committed developments. Besides, control over underground uses such as aqueduct installation would not be reflected in the OZP. Moreover, the affected area in my district is mainly zoned "Green Belt" on the OZP, where the proposal may be permitted subject to town planning permission. Therefore, the "apparent conflict" arising from the OZPs as described in para. 10.5 is somewhat misleading and should be revised taking into account my comments.	The locations of treatment works and service reservoirs were already identified and reserved by WSD prior to the commencement of the Investigation Study, as outlined on Page 2 of the Brief. The study was responsible for establishing suitable routes for the aqueducts, and the interaction between the environmental and engineering design teams in exploring alternative aqueduct alignments has been documented in both the Initial Assessment and Final EIA Reports. The relevant text in the final version of report has been amended. [See para 10.5]
Please note that the existing administration building for the Shing Mun Tunnel is covered by the Tsuen Wan OZP No. S/TW/6, but not the Kwai Chung OZP No. S/KC/10.	Noted. The text has been revised in the final version of the report. [See para 10.5]

Comments	Responses
Paragraph 10.6 In order not to jeopardise the future implementation of the Urban Fringe Park concept, I have in my previous comments requested you to take into account the proposal in your assessments. I therefore suggest to revise the paragraph as follows: "According to the Tsuen Wan and Kwai Tsing Development Statement, the location of the BVPSR and a portion of the raw water aqueduct sites fall into the proposed Butterfly Valley Urban Fringe Park is still a long term planning concept, and has not yet been translated into the OZP. However, for any proposed development within the proposed Park, conservation of the landscape and protection of the scenic value should be achieved."	Noted. The text has been revised in the final version of the report. Although formation of the BVPSR site requires cutting down the existing hill be 50 m to about 97 mPD, which will inevitably have a visual impact on the surroundings, mitigation measures including landscaping will be incorporated into the design to minimise the impact. [See para 10.6]
Paragraph 10.7 The paragraph should be revised to read: "The implications for development within Green Belt areas in Hong Kong differ between administrative zones. However, land use of public facilities installations such as treated water aqueduct within "Green Belt" zone in Kwai Chung and Tai Po would be permitted with or without conditions on application to Town Planning Board. In addition, land use of public utilities installations within the Kam Shan Country Park are subject to the control and approval of the Country Parks Authority."	Noted. The text in the final version of the report has been revised. [See para 10.7]
Paragraph 10.8 In the Kwai Chung District, only the BVPSR site is zoned as "Government/ Institution/Community", therefore, please consider deleting "the raw water aqueduct" from the text.	Noted. The text of the final version has been amended accordingly. [See para 10.8]

Comments	Responses
Figure 21.3 - Tai Po Treatment Works and Associated Aqueduct - Programme There is a figure showing the programme of the proposed scheme, though I do not know how it relates to the text. However, as stated in the revised paragraph 10.7 above, additional time may need to be reserved for the process of application for the land use of public facilities on "Green Belt" zone and Country Park to Town Planning Board and Country Parks Authority respectively. Therefore, the work programme should be revised accordingly.	The programme relates to, and is referred to in, the Environmental Monitoring & Audit Manual (Section 14.8 in Draft Final EIA Report). The memo dated 23 June 1995 Ref (18) in WWO 4724/R/52 II from CE/CW, WSD comments: "I note from your letter that most of the land within your district is zoned "Green Belt" and as such planning permission is required for use of the land for waterworks installations. As discussed Tam/Hui on 23.6.95, I would be grateful for your advice on the procedures to follow for the planning application and also on the tentative schedule for the Town Planning Board Meetings for our construction works to start in 6.96. I understand from our discussion that 2 months' lead time is required from submission of the application to consideration by the Board."

15. **Environmental Protection Officer, Environmental Protection Department's comments in letter of 30th June 1995 reference ( ) in EP2/N5/17**

Comments	Responses
Chapter 3 Environmental Legislation and Planning Guidelines Section 3.25	
Please note that Air Pollution Control (Construction Dust) Regulations is not expected to be effective in mid-1995. Please amend accordingly.	Noted. Text has been amended in the final version of the report. [See para 3.25]
Table 3.6	
24-hour HKAQO limits are not arithmetic mean. Footnote '3 Arithmetic Mean' should be deleted.	Noted. The text of the final version of the report has been amended. [See footnote to Table 3.6]
Section 3.30	
In HKPSG, dusty uses and concrete batching plants should be located at least 100 metres from air sensitive receivers. Please clarify this point.	Noted. Text has been amended in the final version of the report. [See para 3.30]
Chapter 6 Noise	
Please be advised that Construction Noise Permits are required for percussive piling and construction work using powered mechanical equipment during restricted hours.	Noted. The text of the final version of the report has been amended. [See para 6.3]
Chapter 7 Air Quality Sections 7.5, 7.6 & 7.8	
For the background dust concentrations at Tai Po Area, Shing Mun Area and Butterfly Valley Area, justification should be given for why geometric mean is used instead of arithmetic mean.	For the background noise concentration, the geometric mean is used instead of the arithmetic mean because the former is better able to account for the meteorological fluctuation which is basically not linear in nature.
Section 7.7	
Consultants should give view on "it is also a common practice to artificially set the hourly average equal to the daily average when hourly data is not available."	In the case of rural areas where pollutant levels are not acute, the 1 hour average reading and the daily average reading are not substantially and quantitatively different; thus we can approximate the 1 hour average to the daily average.

Comments	Responses
Compilation of emission factors Section 7.21	
Please clarify whether the total volume of material to be shifted is assumed to be 57000 m^3.	The total volume of material to be shifted is assumed to be the cut volume, estimated as 570,000 m^3. The text in the final version of the report has been amended. [See para 7.21]
Section 7.38	
When calculating TSP emission factor for top soil removal, consultants assumed that surface area of the site area was 228420 m^2 whereas surface area of the site area given in equation 7.14 is 22842 m^2. Please explain the discrepancy.	The correct surface area of the site is 22,842 m^2. The text in the final version of the report has been amended. Revised calculation is not required as Appendix B uses the correct data. [See para 7.38]
Modelling results (Tables 7.11-7.25)	
For cumulative annual impact, background annual average TSP, RSP concentrations should be included as appropriate.	Noted. However, no annual background data is available. Please refer to the responses to EPD's letter reference (4) in EP 2/N5/17 IV dated 19th September 1995.
Units for TSP, RSP concentrations should be given in $\mu g/m^3$ instead of $\mu g/m$.	Noted. Units will be amended in final version of the report.
Tai Po Treatment Works - Impact Analysis	
Justification should be given as to why the hourly TSP concentration for Truck movement over unpaved road with 50% reduction given in Table 7.13, p. 7-38 is not exactly 50% of the corresponding value given in Table 7.11, p.7-36.	A slight discrepancy between Tables 7.11 and 7.13 is due to a mistake in format conversion from EXCEL to WordPerfect. Revised tables will be included in the final version of the report.
Raw Water Aqueduct Section 7.62	
Watering should be done after starting work on a day and at least once every three hours thereafter during the operation day to attain invisible dust emission level.	Noted. The text in the final version of the report has been amended. [See para 7.62]

Comments	Responses
Butterfly Valley Service Reservoir - Impact Analysis Table 7.24	
Hourly TSP concentrations for truck movements over unpaved road is 5% of the corresponding values given in 7.22, which is 95% reduction of dust emission instead of 90% as stipulated in S7.72. Please explain the discrepancy and review the modelling results if necessary.	Noted. The corrected emission reduction is 90% and the tables have been amended accordingly.
Please give views with justification on four times daily watering the dirt road will reduce dust emission by 90%.	Watering the dirt road twice daily can reduce the emission rate of dirt roads by 50% (Jutze *et al*, 1974). For a very dry day or worst dust situation, it is recommended that watering should be conducted as many times as possible. EPD's comments above state that watering at least once every three hours during the operation day can attain invisible dust emission level. It is thus interpolated that if watering four times a day is carried out, the emission rate would be dramatically reduced, assumed to reach 90% efficiency.
Mitigation Measures - Construction Phase Section 7.74	
Please note that watering should be done after starting work on a day and at least once every three hours thereafter during the operation day to attain invisible dust emission level. This requirement should be spelt out in the report.	Noted. The text in the final version of the report has been amended. [See para 7.74]
Section 7.76	
Apart from conditions given in this section, respective BPM (Best Practical Means) should also be followed by the contractor.	Noted. The text in the final version of the report has been altered accordingly. [See para 7.76]

Comments	Responses
Chapter 8 Drainage Impact and Water Quality Issues Regarding the Butterfly Valley Primary Service Reservoir, it was stated that the wash water sludge and sewage from operators will be treated to meet Technical Memorandum standards before discharge to sewers. Please clarify which system of sewer the report was referring to, and check whether the sewage system has sufficient capacity to accept the additional flow. Also, please advise whether you meant to treat the waste water to a standard suitable for direct discharge to local water bodies, or it would be necessary to provide a temporary storage tank to equalise the flow before discharge.	The BVPSR site will be unmanned: there will be no operators to generate sewage. It is proposed that provision should be made in the detailed design for such on-site facilities as recommended in the Reservoir Cleansing Consultancy under Agreement CE 19/94 for service reservoir cleansing effluents to be discharged to sewer. The cleansing effluents for the BVPSR will be discharged into the sludge pipeline from Tai Po Treatment Works before it discharges into the foul sewer in King Lam Street in Cheung Sha Wan. While the sludge from the treatment works will be discharged on a semi-continuous basis, the BVPSR will only be cleaned every 1-2 years or such period as found appropriate. Discharge from BVPSR will be coordinated with treatment works operation and controlled so as not to exceed the permitted discharge rate from the treatment works.
Section 8.28 3rd bullet, last sentence, it is not our (EPD's) practice to agree the design of treatment facilities with the dischargers. We aim at the treatment standards of the facilities to meet the requirements of WPCO. As such, please amend to: "... and of appropriate design for proper treatment of effluent prior to the application for a Water Pollution Control Ordinance (WPCO) effluent discharge licence."	Noted. The text has been amended in the final version of the report. [See para 8.28]
Section 8.29 2nd bullet, last sentence, please amend to: "... The polluted clean up materials should be replaced by clean material on a regular basis and disposed of properly.	Noted. The text in the final version of the report has been amended accordingly. [See para 8.29]
Section 8.38 Last sentence, please amended to "All discharges have to be licensed under WPCO and will comply with..."	Noted. The relevant text has been altered in the final version of the report. [See para 8.38 and 8.39]

Comments	Responses
Chapter 14 EM&A Manual	
Since it is agreed that the EM&A Manual is a stand alone document, it is preferable to detach it from the bulky EIA report in the future for the sake of management and operation.	Noted. The final version of the EM&A Manual will be issued as a detachable Appendix with the final version of the Final EIA Report.
Sections 14.9 & 14.20	
The Environmental Management Team (EMT) shall be an independent body and should be clearly spelt out. In view of scale and nature of the project, the Environmental Management Team shall provide a full-time Environmental Site Supervisor (ESS) responsible for the implementation of the environmental monitoring programme on site. It is anticipated that the ESS shall carry out regular site inspections.	Noted. The text in the final version of the EM&A Manual has been amended. [See para 18]
Section 14.27	
The complaint handling procedure is preferably in graphical presentation and the proponent should indicate a time limit from the receipt of complaint to the written reply. We would suggest that the reply should be done within 1 week.	Noted. A diagram illustrating the Complaints Handling Procedure, and amended text, has been included in the final version of the EM&A Manual. [See para 27 - 31]
After Section 14.39	
Exact report format should be agreed with EPD.	Noted. The text in the final version of the EM&A Manual has been amended. [See para 39]
Table 14.1	
There is no need to inform EPD formally for trigger exceedances.	Noted. The text in the final version of the EM&A Manual has been altered accordingly. Please refer to Table 1.
Table 14.3	
We suggest "Arrange meeting with ER/Contractor (but not EPD) to discuss the remedial actions to be taken." for (5) in the first Action Column.	Noted. The text in the final version of the EM&A Manual has been amended. Please refer to Table 3.

Comments	Responses
Tables 14.1 to 14.3 Guidelines for dust monitoring issued by EPD/AMG should be strictly followed, eg. the repeated daily dust measurements and prompt action for carrying out dust mitigation measures as appropriate.	Noted. Comment has been added to Tables in the final version of the EM&A Manual. [See Tables 1 - 3]
Section 14.66 The 24 hours sample should be done once every 6 days; additional sampling will not only be done on receipt of complaint but exceedance of TAT stipulated in Action Plan as well. Section 14.70 Baseline monitoring should be done for at least two consecutive weeks for 24 hour TSP. Section 14.71 As the accuracy of data provided by portable equipment is doubtful, use of such equipment is not encouraged. The short periods should be specified as less than two months.	Noted. The text in the final version of the EM&A Manual has been amended. [See para 66] Noted. The text in the final version of the EM&A Manual has been amended. [See para 70] Noted. The text in the final version of the EM&A Manual has been amended. [See para 71]

Agreement No. CE 41/94
Additional Treatment and Water Transfer Facilities for the Metropolitan Area and North-eastern New Territories
Environmental Impact Assessment - Further Comments

Responses to EPD's letter reference (4) in EP2/N5/17 IV dated 19th September 1995

	Comments	Responses
A)	**General Comments**	
	Based on your assumed annual TSP and RSP levels, there are a number of predicted exceedances. As such, further mitigation measures are required. On the other hand, you may review if your proposed background levels are appropriate.	No annual average background levels for TSP and RSP are available for the study. In our previous responses to comments, we suggested inclusion of baseline TSP levels of 63 $\mu g/m^3$ and RSP levels of 45 $\mu g/m^3$. These were based on EPD's figures from *Hong Kong: Environment* for Sha Tin, and were the best data available at the time. In subsequent discussions with EPD's Air Group, it was suggested that a more appropriate approach would be to use a simple factor to convert the daily dust concentration to an annual value. These factors, namely 80/260 for TSP and 55/180 for RSP, are based on the AQO value. This approach was agreed with EPD. There will be no predicted exceedance of the recommended levels if the new figures are adopted, provided that wetting of road surfaces and limitation of vehicle speeds is diligently carried out.
B)	**Specific Comments**	
	Modelling Results (Table 7.11-7.25)	
i.	Table 7.11: by adding the assumed annual background TSP concentration, there is exceedance of annual TSP AQO limit at Air SR 6, 42 and 14.	Tables 7.11-7.25 (attached) have been recalculated with the new baseline TSP and RSP figures to identify the cumulative impacts of construction dust on each sensitive receiver. The results indicate that regular wetting of surface and restriction of vehicle speeds are essential to ensure that air quality impacts are kept within the recommended limits.
ii.	Table 7.12: by adding the assumed annual background RSP concentration, there is exceedance of annual RSP AQO limit at Air SR 42, and 14.	
iii.	Table 7.15: by adding the assumed annual background RSP concentration, there is exceedance of annual RSP AQO limit at Air SR 1.	

Comments		Responses
iv.	Table 7.16: by adding the assumed annual background TSP concentration, there is exceedance of annual RSP AQO limit at Air SR 1. Hence additional mitigation measures to bring down annual TSP level at Air SR 1 to within TSP AQO limit is required.	
v.	Table 7.17, 7.18 and 7.19: by adding assumed annual TSP background concentration in Table 7.17, 7.19 and adding assumed annual RSP background concentration in Table 7.18, there is exceedance of annual TSP AQO limit at Y3, and Y4 (both mitigated and unmitigated conditions) and exceedance of annual RSP AQO limits at Y3, and Y4. Hence, additional mitigation measures to bring down annual TSP level at Air SR Y3, and Y4 to within TSP AQO limit is required.	
vi.	Table 7.20: the annual TSP level at Air SR 21 exceeds TSP AQO limit when assumed annual TSP background level is added. Hence mitigation measures should be proposed to bring down annual TSP level at it to within TSP AQO limit.	
vii.	Table 7.22: by adding assumed annual TSP background concentration, annual average TSP level at Air SR 25, 28, 29 and B2 exceeds annual TSP AQO limit.	
viii.	Table 7.23: similarly annual average RSP level at Air SR 25, 28, 29, and B2 exceeds annual RSP AQO limit if assumed annual RSP background concentration is added.	
ix.	Table 7.24, 7.25: annual average TSP level and annual average RSP level at Air SR 28 still exceed annual TSP AQO limit and annual RSP limit if assumed annual background concentrations are added. Hence, further mitigation measures should be implemented in order to bring down annual average TSP and RSP levels at it to within AQO limits.	

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EIA Study - Draft Final Assessment Report

Further Comments

Response to EPD's letter (17) in EP2/NS/17 IV dated 16th November 1995

Comments	Responses
Thank you for your letters dated 23.10.1995 and 6.11.1995. The EIA Final Report (FR) can now be finalised subject to the incorporation of our previous comments and the following minor comments:-	
A) **Air Aspects**	
(1) General Comments	
a) Though we do not agree to the approach to convert daily dust concentration to an annual value as given in the responses, we accept that there would be no predicted exceedance as the site is in a rural setting and the available monitoring results are all for the urban setting, which usually has higher concentration.	Your comments are noted.
b) There are a number of prove-reading mistakes in the responses attached with your letter dated 6.11.1995. It is your responsibility to ensure that the revised text be amended as stipulated in the following paragraphs before release of the FR for the Environmental Study Management Group endorsement.	Please refer to the relevant text of the Final EIA Report.
(2) Specific Comments	
By adopting your responses numbering system in your letter of 6.11.1995, we have the following comments:-	
a) Sections 7.5, 7.6 & 7.8	
As already commented and noted by you, 'noise' in the response should be replaced by 'air'.	Your comments are noted.

Comments		Responses
b)	Section 7.21	
	In addition to amending the total volume of material to 570000 m^3, the typo error in equations 7.6 should also be amended, i.e. '0.0023 g/s' is amended as '0.023 g/s'.	Please refer to Section 7.21 of the Final Report.
c)	Section 7.38	
	It is noted that the text has not been amended. In addition, the type error '228420' appears in equation 7.14 of the attached amended pages, which should be amended as '22842'. We are concerned on carelessness in preparing the amended text.	Please refer to Section 7.38 of the Final Report.
d)	Modelling results (Tables 7.11-7.25)	
	Tables 7.11-7.25 in the DFR should be replaced by the revised Tables 7.11-7.25 as given in the responses to comments which is attached in your letter with ref.: AL/RVC/0888/0/132, dated 23/10/95.	Please refer to Tables 7.11-7.25 of the Final Report.
e)	Table 7.24	
	In view of item (d) of the responses to comments which is attached in your letter with ref.: AL/RVC/088/0/132, 8/9/95, the first sentence of Section 7.72 should be amended as 'It is expected that four times daily watering the dirt road (i.e. every three hours for a working day of 10-12 hours) will be required to reduce the dust emission rate by 90%'.	Please refer to Section 7.72 of the Final Report.
B)	**Water Aspects**	
It would be advisable to include in Section 8.28 an additional measure to reduce silty runoff by proper draining and recycling.		Please refer to Section 8.28 of the Final Report.
C)	**Environmental Monitoring & Audit Aspects**	
(1)	The Figure 14, which summarises complaints handling procedure in diagrammatic form as mentioned in Section 27, is not enclosed.	Please refer to Figure 14 of the EM&A Manual.

Comments	Responses
(2) Section 31 - only acknowledging receipt of complaint is not enough. The complainant should also be informed by any initial findings and/or subsequent actions if any.	Please refer to Section 32 of the EM&A Manual.

APPENDIX B

MASTER LANDSCAPE PLANS