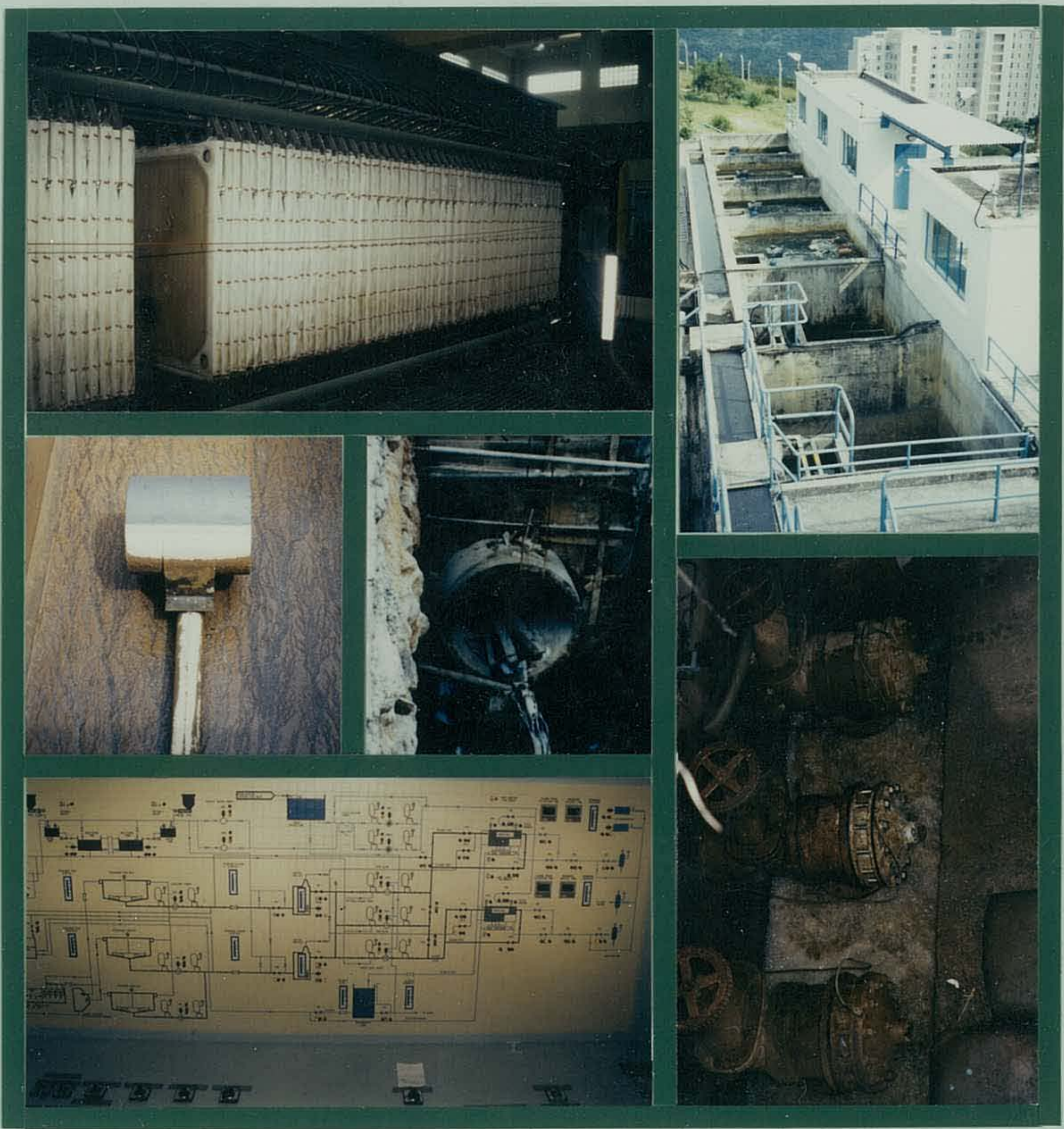
Hong Kong Government
Water Supplies Department

Agreement No. CE 30/94

Treatment and Disposal of Waterworks Sludge from Existing Water Treatment Works



Environmental Impact Assessment
Final Assessment Report

October 1995

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Hong Kong Government
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Improvement of Sludge Treatment and Disposal Facilities at Eastern, Red Hill, Shek Lei Pui, Tai Po Road, Tsuen Wan, Silvermine Bay, Tai O and Tuen Mun Water Treatment Works

Environmental Impact Assessment (EIA)

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" Checked in accordance with MWHKL QP22 ______ *"*
Project Manager

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SECTION 1
INTRODUCTION

1.1 Introduction

This report is the result of the Environmental Impact Assessment (EIA) of the construction and operation of proposed works at eight Water Treatment Works (WTW) sites. The EIA was carried out for the Government of Hong Kong, Water Supplies Department, by the Environmental Management Division of Montgomery Watson under Agreement No. CE 30/94, "Improvement of Sludge Treatment and Disposal Facilities at Eastern, Red Hill, Shek Lei Pui, Tai Po Road, Tsuen Wan, Silvermine Bay, Tai O and Tuen Mun Water Treatment Works".

1.2 Background

The majority of WTW sludge is currently disposed of by release into the sea either directly, through storm drains, or through fresh waterways. As this method of disposal does not meet discharge standards within Water Control Zones established under the Water Pollution Control Ordinance (WPCO), an urgent need to determine an environmentally acceptable means of sludge disposal was identified. A feasibility study was carried out in 1993 into the options available for sludge treatment at fourteen WTW sites. The "Feasibility Study of the Treatment and Disposal of Waterworks Sludge from Existing Treatment Works" involved a Best Environmental, Engineering, Cost and Planning Solution (BEECOPS) approach to the identification of the best method of sludge disposal across the sites. The BEECOPS were then subjected to an Environmental Review which identified seven sites (the EA Sites) as requiring Environmental Assessment due to potentially significant impacts, mostly from construction works but in a few cases from the completed developments. Identified as requiring EIA by the Environmental Review are the water treatment works at:

- Red Hill;
- Tsuen Wan;
- Shek Lei Pui;
- Tai Po Road;
- Tuen Mun;
- Silvermine Bay; and
- Tai O.

Further engineering examination of WTW sites resulted in the relocation of proposed facilities at Eastern WTW from an area of low environmental value, to an area within a forested slope. Therefore, developments at Eastern WTW were also included in the EIA Study.

1.3 Purpose

The purpose of the EIA study is to identify the nature and extent of environmental impacts arising from the construction and operation of the proposed works, and propose suitable mitigation measures to limit those impacts identified to acceptable levels. In addition, the EIA process also reviews the BEECOPS evaluation process in order to test and confirm the evaluation results. Where appropriate alternative options have been identified. Figure 1.1 shows the location of the proposed development sites and sludge disposal points. This report details the findings of the EIA study and presents proposals to mitigate identified impacts.

1.4 Scope and Structure of the Report

This study examines the impacts arising from construction and operation of the proposed sludge treatment facilities up to the point of the sludge either being released into an existing sewer, or being delivered, in a suitable form, to a licensed landfill site. In the case of release to sewer, assessment of the likely impacts of this disposal option are being carried out as part of the engineering study. Potential environmental impacts arising from thickened sludge deposited correctly in a licensed landfill are not examined by this study. The potential impact of alum in WTW sludge or of traces remaining in water once it has passed through a Sewage Treatment Plant (STW) after being released to sewer, was assessed in detail in the Feasibility Report in Appendices A and C.2.

In addition to this Introductory Section the report is divided into 12 main sections. These are:

Section 2 **Water Treatment Processes**

The general processes involved in producing water of potable (drinking) quality which are carried out at the EA Sites are described. The objectives for these treatments and how these objectives are met are given. WTW sludge is defined. Options considered for WTW sludge disposal from each of the EA Sites are presented and the BEECOPS solution from the feasibility study explained. Other technical information, generally applicable to the environmental assessment of all sites is also presented.

Section 3 **Methodology and Approach**

The approach to the EIA is explained and the methodology employed in the assessment of the potential impacts of the developments are described.

Section 4 **Legislation and Environmental Guidelines**

The legislative background for the developments and for the EIA is presented.

Sections 5 through 12 **Environmental Assessment of Sludge Treatment Development at .... Water Treatment Works**

Each of the Sections 5 through 12 examine an individual site in detail. Each Section is split into the following sub-sections:

Existing Environment
Proposed Works
Construction Phase Impacts and Mitigation Measures
Operational Phase Impacts and Mitigation Measures

Section 13 **Environmental Mitigation, Monitoring and Audit Requirements**

Section 13 sets out mitigation measures, proposed monitoring and audit requirements for the proposed works.

Section 14 **General Conclusions and Recommendations**

Section 14 gives the overall conclusions and recommendations of the report.

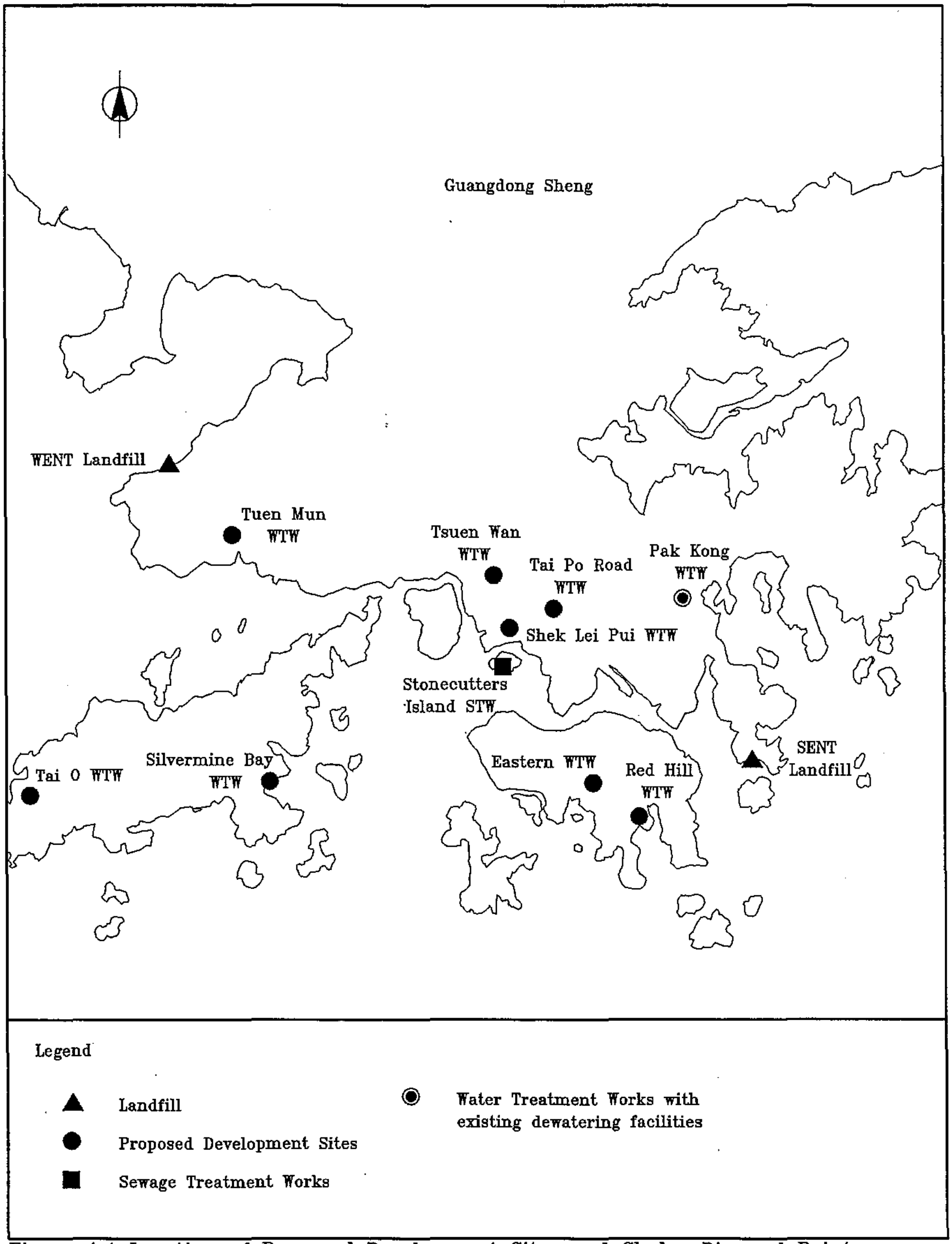

Figure 1.1 Location of Proposed Development Sites and Sludge Disposal Points

SECTION 2
WATER TREATMENT PROCESSES

Plate 2.1 **Alum prior to addition to raw water.**

Plate 2.2 **Lime powder stored prior to addition to raw water.**

2.1 Introduction

Water treatment is a vital process to ensure that water supplied to the consumer is of potable quality. It is the duty of the WSD to provide water which meets a series of criteria which ensure the water they supply is physically, biologically and chemically suitable to be safely consumed by its customers.

2.2 Water Supplies and Water Quality

"Raw" water (water prior to treatment) supplies utilised by WSD are either from reservoirs holding rain-water which has fallen on China or Hong Kong, or from pipelines bringing water from mainland China. Raw water contains the following types of impurities in greater or lesser amounts:

- Physical;
- Biological; and
- Chemical.

To ensure water of a suitable quality for drinking, the majority of these contaminants must be either prevented from entering the raw water or subsequently removed by treatment processes.

2.2.1 Physical Contaminants of Water Supplies

Physical contaminants of water supplies are largely solid particles of minerals, plants and animals, small enough to be held in the water (commonly known as "suspended solids"). Some of the plant and animal suspended solids are living and known collectively as plankton. These are described in section 2.2.2. The remaining material of this type would be small particles of dead plant and animal matter such as pieces of leaves and fragments of insects and dead plankton.

The solid mineral impurities in raw water are usually particles of rock eroded from the catchment by streams and rivers or stirred up from the floor of the reservoir by mixing. These can be of any size (a river in flood can move large boulders) but particles the size of beach sand are large enough to rapidly settle to the bottom of reservoirs. This results in solid particles of this type, which manage to get as far as the WTW, being generally much finer than sand, and tending towards the very fine particles which make up clay.

2.2.2 Biological Contaminants of Water Supplies

The major biological contaminants of raw water are made up of plankton. Plankton consists of phytoplankton (microscopic plants) and zooplankton (microscopic animals) which can improve or worsen the quality of the water depending on the types present and their numbers. Living zooplankton can swim in the water and move up and down the water column in response to light, water conditions and food availability. Phytoplankton drifts in the water and reproduces according to light, available nutrients and water temperature.

Raw water can contain a variety of very small biological contaminants such as bacteria and, in some cases, viruses. Due to their small size these contaminants can remain suspended in water independent of any gravitational influence on them. However, they do tend to be associated with larger particles and therefore, a reduction in suspended solids also normally results in a reduction of these contaminants.

2.2.3 Chemical Contaminants of Water Supplies

Chemical impurities in raw water include naturally occurring salts and dissolved gases, and man made contaminants such as fertilizers and insecticides. Some chemical impurities can be beneficial, e.g. "pure" mineral waters actually contain unique blends of dissolved chemicals giving a pleasant flavour to the water. Other chemical contaminants, especially man made and organic chemicals, can be harmful.

2.3 Water Treatment

Water treatment can be carried out in a number of different ways. Figure 2.1 shows the potable water producing processes currently carried out at the EA Sites. This includes:

- alternative treatment processes raw water is passed through to produce potable water;
- the materials commonly added to raw water to assist in the purification process; and
- where and in what form materials are removed from the processes, i.e. both "potable water" and the bi-product "Water Treatment Sludge".

Most of the treatment routes shown for sludge are only proposed. Current sludge disposal is by release onto land (where volumes are very low), and into nullahs, stream courses or the sea. The diagram reflects the processes which sludge will pass through if the proposed developments take place.

2.3.1 Water Treatment Processes

Industrial processes and use of fertilisers, insecticides and similar chemicals are prevented from taking place in reservoir "catchment" areas (the hill valleys from the sides of which rain water finds its way into the reservoir). This is to stop unwanted materials from being washed into the reservoir which subsequently would require expensive treatment to remove.

It is common practice for reservoirs to have outlet pipes which can take raw water from any depth in the reservoir. In this way the most suitable water (clearest, least algae, most oxygenated) for treatment can be taken to supply the WTWs.

Most water treatment relies on removing solid particles from water. This is due to the fact that the particles themselves are not wanted in potable water, and that the particles attract, for various chemical and physical reasons, many of the other smaller or dissolved unwanted materials which are described in Section 2.1.

To remove particles from raw water, most treatment processes rely on:

- holding water in tanks to allow the particles to settle to the bottom and then taking the clear water (the supernatant) from the surface or clarifiers ; and
- passing water through tanks with thick layers of fine sand or carbon (filter media) in the bottom, taking water from the bottom of the tanks when the particles have been trapped by the filter medium.

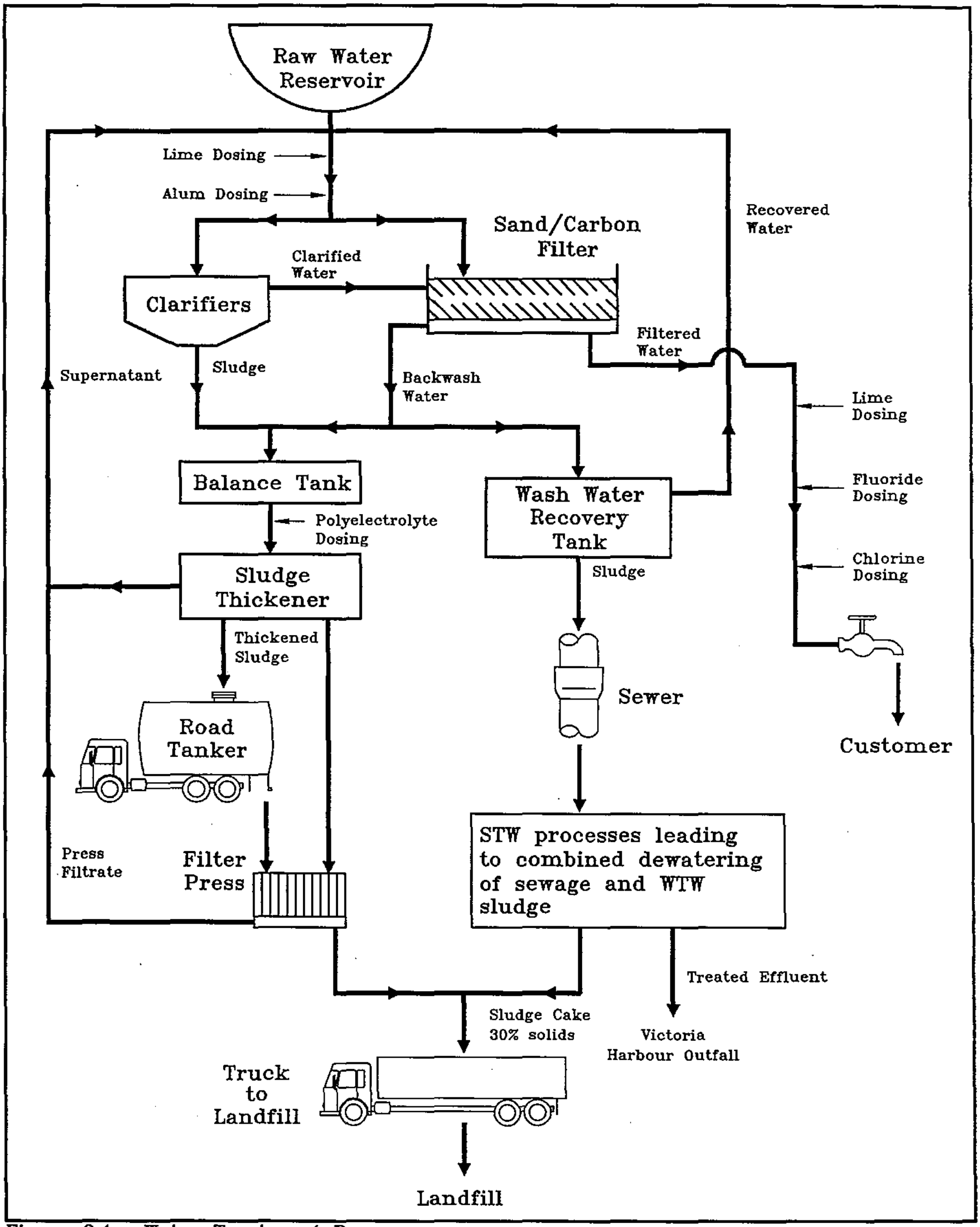

Figure 2.1 : Water Treatment Processes

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To make these treatment methods work most efficiently, it is of great benefit to make the particles in the raw water:

- join together into larger clumps (known as "flocs" in a process described as "flocculation") as these settle faster and are easier to physically filter; and

- have the correct chemical charges on particles as this causes them to attach to the filter media and also join into flocs more readily.

Chemical Pretreatment

To assist in the flocculation process special chemicals are commonly used; in the case of Hong Kong alum solution (Aluminium Sulphate) is added to the raw water. This treatment works best under slightly alkaline conditions, so lime (Calcium Carbonate) is also added to the water. Plates 2.1 and 2.2 show alum and lime respectively, prior to their being dissolved in water and added to the raw water as a solution.

Clarification and Filtration

Depending on the WTW the water is then either fed directly into a sand or carbon filter, or into a clarifier. A clarifier is a large circular tank into which raw water is constantly trickled near the centre. Particles are allowed to settle to the bottom of the tank and the "clarified" water is taken from the surface of the clarifier through channels arranged around the tank like spokes on a wheel to the next process. The settling particles sink towards the base of the tank, which is sloped to make them slide to the centre. This process is assisted by a scraper which slowly moves round the tank near the bottom pushing the particles towards a drain hole at the centre of the tank. Together the particles can now be described as "sludge", which is a thin mud (see Plate 2.3). Clarifier sludge can be up to 4% solids.

If the WTW does not have clarifiers, the raw water is fed directly into a sand or carbon filter. If the WTW does have clarifiers, the cleaner water from them is fed to the filters. Again these are large tanks, in this case usually rectangular. Some of the particles are removed from the water by the surface of the thick layer of sand or carbon. Some of the particles are physically trapped in the filter medium but the process relies on the chemical attraction of the particles in the water (mostly caused by the alum treatment) to the filter medium particles.

Final Treatment

Filtered water is taken from the base of the filter. This is then:

- adjusted to the correct pH using lime if necessary;

- dosed with fluoride to allow children using the water to develop stronger teeth; and

- dosed with chlorine, a disinfectant which, when introduced into water, will kill the majority of potentially harmful organisms present.

Clarified, filtered and disinfected, the water can now be described as potable. It is often stored in covered service reservoirs before being fed into the distribution system for consumers to get, out of the tap, on demand. This forms the product which the water treatment process is used to deliberately produce.

After use for a period of time, the filter will start to be less efficient as the particles it has removed from the water clog it up. To prevent this situation arising the filter is "backwashed". In this process clean water is pumped back through the filter which carries most of the trapped particles back into the water overlying the filter. This "backwash water" is drained rapidly before the particles can re-settle, thus cleaning the filter.

Sludge Treatment

Backwash water contains approximately 0.06 % solids. To thicken the sludge waste from this process, and reclaim as much water as possible, the backwash water is fed to a sludge thickener (at those plants where they are available) or a washwater recovery tank.

The sludge thickener is a tank very similar to a clarifier and works in exactly the same way. A wash water recovery tank is simply a tank in which backwash water is held to allow sludge to settle to the bottom. The supernatant is piped off from the upper portion of the tank after a suitable period of time (approximately 30 minutes).

In the systems to be employed at the EA Sites there are two main routes for sludge treatment. These are:

- all sites for which sludge thickeners are proposed will also have clarifiers to which the supernatant is returned. Thickened sludge will either be tankered to a site with a filter press, or a filter press will be available on site.

  Thickened sludge is still over 90% water. Materials consisting of such a large amount of water are not readily acceptable at landfill sites. Therefore, a filter press is used to reduce the water content to approximately 70% or less. The proposed filter press systems have a number of metal plates, between which the sludge is piped. Cloth membranes and compressed air are used to squeeze water out of the sludge until it forms a clay like substance known as sludge cake (see Plate 2.4). By this time the chemicals used in the water treatment process have largely reacted with the particles in the water, and the sludge is mostly inert. It has a slight "earthy" smell which is not unpleasant and certainly could not be described as odiferous. The sludge cake can be transported by truck to a landfill site for final disposal.

  Water pressed from the sludge is piped to the inflow of the clarifiers at the WTW site the sludge press is located at; and

- all sites which will have washwater recovery tanks will return recovered water to a sand or carbon filter. Sludge from the bottom of the wash water recovery tanks will be discharged into the sewerage system.

  The water treatment works sludge released to the sewerage network will be mixed with sewage and subsequently treated at a sewage treatment works (in this case the new works at Stonecutters Island). Sewage treatment works have a number of processes which clean the water entering them. Some are similar to those used at water treatment works. The releases to the environment are treated effluent and sludge. Treated effluent will have to conform to EPD standards before release by outfall into Victoria Harbour. Sewage sludge will be filter pressed and disposed of to landfill.

Plate 2.3 WTW Sludge - 2-4% solids, 96-98% water from sludge clarifiers.

Plate 2.4 WTW Sludge - 30% soilds, 70% water from sludge filter press.

2.4 BEECOPS Sludge Disposal Strategy

The main objective of the Feasibility Study was to identify the preferred option for the treatment and disposal of waterworks sludge from water treatment plants whose current disposal methods do not meet discharge standards. The recommended option of the Integrated Sludge Disposal Strategy (ISDS) Study[1], considered to be an overall environmentally acceptable solution, was used as a basis of comparison for the alternative liquid and solids disposal options. The preferred option would be the Best Environmental, Engineering, Cost and Programming Solution (BEECOPS). In order to arrive at this solution, two main options for sludge treatment and disposal at each site were assessed. These were:

- the liquid disposal option; and
- the solid disposal option.

The liquid disposal option would involve either direct disposal of liquid sludge to sewer, or transfer of liquid or partially thickened sludge to a centralised facility by tanker or dedicated sludge transfer pipe for further treatment, giving a total of three main options for each site:

- the liquid disposal to sewer option
- the liquid transfer option
- the solid disposal (dewatering) option

These options are shown on Table 2.1, reproduced from the Main Report of the Final Report of the Feasibility Study of the Treatment and Disposal of Waterworks Sludge from Existing Treatment Works.

The solid disposal option would involve on-site sludge dewatering prior to landfill disposal with extracted water being returned to the water treatment process.

A two stage evaluation process was followed comprising of:

- Initial Screening
- Option Evaluation

The results of the evaluation process were then technically reviewed by an independent panel of experts in waterworks sludge treatment and disposal. The BEECOPS evaluation process is shown graphically on Figure 2.2.

2.4.1 Initial Screening

Initial screening was carried out to eliminate options which were not feasible from an environmental or engineering point of view. Options were judged for engineering feasibility using the following criteria:

- Sewer hydraulic capacities;
- Effects of water treatment sludge on sewage treatment processes;

[1] Watson Hawksley, Integrated Sludge Disposal Strategy Study, Final Report 1993.

Table 2.1 The Preferred Dewatering, Sewer and ISDS Options for each EA Site

	ISDS Option	Sewer Option	Transfer Option	Dewatering Option
Eastern	On-site dewatering using membrane press → transfer to SENT by road	Install washwater recovery facility and balancing tank. Discharge sludge from balancing tank to sewer within WSD boundary	Thicken sludge and transfer by road to Pak Kong WTW for dewatering and disposal to SENT Landfill	Same as ISDS Option
Red Hill	Dewater using mobile belt press during interim period → transfer cake to SENT by road. Discharge to Stanley sewerage system when available	No feasible sewer option due to likely impact of waterworks sludge on the treatment process and dewatering plant at Stanley STW.	Thicken sludge and transfer by road to Pak Kong WTW for dewatering and disposal to SENT Landfill	On-site dewatering using membrane press → transfer cake to SENT by road.
Tsuen Wan	On-site dewatering→transport cake to WENT by road.	Install washwater recovery facility and balancing tank. Discharge sludge from balancing tank through existing sludge pipe to a new sewer connection in Kwok Shui Road.	Road transfer options not considered feasible due to large quantity of sludge generated at this site.	Same as ISDS Option
Shek Lei Pui	Dewater on-site with tankered sludge from Tai Po Road WTW → transfer cake to SENT by road.	No local sewers nor adequate space for provision of washwater recovery facilities.	Pipe un-thickened washwater to Tai Po Road for washwater recovery and discharge to sewer.	No dewatering options recommended due to lack of available space on-site
Tai Po Road	Transport thickened sludge to Shek Lei Pui for dewatering.	Install washwater recovery tanks for both Tai Po Rd WTW and Shek Lei Pui WTW. Discharge sludge from balancing tank to sewer along King Lam St in Cheung Sha Wan.	Road transfer options not considered feasible due to limited site access.	Dewater sludge from Tai Po Road and Shek Li Pui WTW → landfill disposal at SENT
Tuen Mun	On-site dewatering→transfer cake to WENT by road	Expand existing washwater recovery facility for Stages I-IV. Discharge sludge from Stages I-IV and Stage V at separate sewer locations.	Road transfer options not considered feasible due to large quantity of sludge generated at this site.	Same as ISDS Option
Silvermine Bay	Tanker thickened sludge to Mui Wo STW dewatering plant→ barge to WENT	No feasible sewer option due to insufficient capacity of sewerage system and Mui Wo STW.	Pipe clarifier sludge to Mui Wo STW for combined dewatering with sewage sludge → barge to WENT or transport by road when access available.	Dewatering on-site along with sludge from Tai O WTW → barge to WENT or transport by road when access available.
Tai O	Tanker unthickened sludge to Mui Wo STW dewatering plant → barge to WENT	Install washwater recovery facility. Provide dedicated sludge pipeline to nearest sewer.	Tanker unthickened sludge to new Silvermine Bay WTW dewatering plant	Tanker unthickened sludge to Silvermine Bay WTW dewatering plant → barge to WENT.

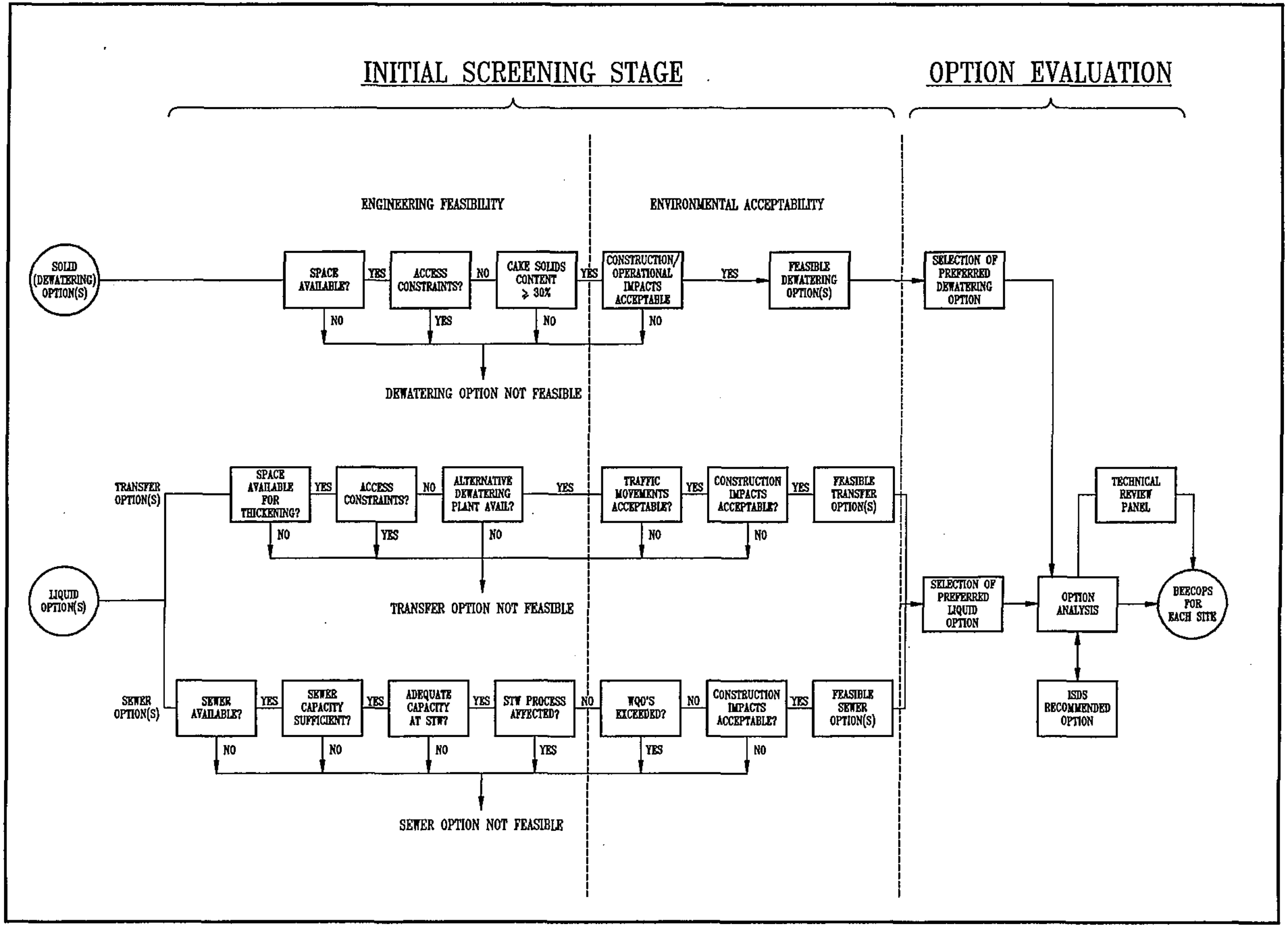

Figure 2.2 The BEECOPS Analysis Process

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- Site access;
- Land requirements;
- Allowing operation of Water Treatment Works during construction; and
- Equipment required to achieve sludge of high enough solids content to allow disposal to landfill.

A summary of the results of the engineering feasibility screening exercise is shown in Table 2.2. In terms of what is possible given the engineering constraints at each site, a sewer, thickened sludge transfer and a dewatering option are considered feasible at all sites except Shek Lei Pui and Tai O, for which un-thickened washwater must be transferred off-site. Shek Lei Pui does not have adequate space for dewatering facilities, access is limited, and capacity in the nearest sewer is insufficient. Tai O has insufficient space for dewatering facilities and severely limited access (no road access).

The environmental criteria used to judge environmental feasibility were limited to whether proposed discharges of sludge to Water Control Zones (established under the Water Pollution Control Ordinance) would meet Water Quality Objectives, and an initial assessment of the acceptability of construction impacts.

Should discharge to sewer be used as a sludge disposal method, final effluent quality (discharged from sewage treatment works) would meet water quality objectives for heavy metals in all cases analysed. For discharges from Eastern to sewer, there is a potential for exceedance of suspended solids objectives in Victoria Harbour. The North Lantau tidal stream has experienced a dramatic increase in pollution loading over the last 2-3 years and is currently the subject of an ongoing EPD monitoring programme. Discharge of waterworks sludge from Tuen Mun WTW will not be allowed during this testing. Construction impacts related to the discharge to sewer option were considered acceptable at all sites with appropriate mitigation. Discharge to sewer was therefore found unacceptable at Eastern and Tuen Mun.

The feasible options for each site determined in the initial screening exercise are summarised in Table 2.2.

Table 2.2 Summary of Results for the Engineering Screening Exercise

WTW	Thickening Facilities		Sewer Capacity Sufficient?	Sewage Treatment Works		Feasible Engineering Options
	Space Available?	Adequate Access?		Capacity Adequate?	Process Affected?	
Eastern	YES	YES	YES	YES	NO	Swr, Transfer, d/w
Red Hill	YES	YES	YES	YES	YES	Transfer, d/w
Tsuen Wan	YES	YES	YES	YES	NO	Swr, Transfer, d/w
Shek Lei Pui	NO	NO	NO	YES	NO	Transfer un-thickened sludge
Tai Po Road	YES	NO	YES	YES	NO	Swr
Tuen Mun	YES	YES	YES	YES	NO	Swr, Transfer, d/w
Silvermine Bay	YES	YES	NO	NO	YES	d/w
Tai O	NO	NO	YES	YES	YES	Transfer un-thickened sludge

Note: Swr = sewer disposal; Transfer = transfer thickened sludge by road; d/w = dewatering plant

2.4.2 Option Evaluation

The initial screening exercise eliminated a large number of potential options. The remaining options for each site were further subject to assessment under the following criteria:

Environment :
- Aquatic/Terrestrial Ecology
- Construction and Operational Impacts (air, noise and visual impacts)
- Transport
- Planning and land use

Engineering :
- Flexibility
- Reliability
- Operation and Maintenance

Costs :
- Capital costs
- Operating costs
- Transport costs
- Disposal costs

From this evaluation the BEECOPS for most sites became clear. Table 2.3 summarises the BEECOPS for each site.

The issues leading to the selection of the BEECOPS for each specific site are presented in further detail in each Proposed Development section (sections X.2 where X is 5 through 12) of the individual site Environmental Impact Assessments.

The EIA study shall test and confirm the appropriateness of the BEECOPS options shown in Table 2.3. The BEECOPS options are original proposals and where considered necessary, alternative options may be identified. This is particularly significant in the case of Tai O WTW where a 'do-nothing' option must be considered in view of further information collected during the review process.

Table 2.3 Summary of the Identified BEECOPS for each WTW Site

WTW	Option	Description of Sludge Treatment and Disposal Method
Eastern	Liquid Disposal Option	Install Thickeners and sludge holding tank. Tanker sludge to existing press facility at Pak Kong WTW for dewatering. Sludge cake transported from Pak Kong by road to SENT Landfill.
Red Hill	Liquid Disposal Option	Install Thickeners and sludge holding tank. Tanker sludge to existing press facility at Pak Kong WTW for dewatering. Sludge cake transported by road from Pak Kong to SENT Landfill.
Silvermine Bay	Solid Disposal Option	Provide thickening and dewatering on-site with enough capacity to include treatment of sludge from Tai O WTW. Sludge cake transported by barge to WENT Landfill.
Tai O	Liquid Disposal Option	Install washwater recovery facility and storage tank. Tanker unthickened sludge to Silvermine Bay WTW dewatering plant.
Shek Lei Pui	Liquid Disposal Option	Pipe washwater to Tai Po Road for washwater recovery. Sludge discharge to sewer. Sludge treatment at SISTW and disposal to WENT/SENT Landfill.
Tai Po Road	Liquid Disposal Option	Install washwater recovery tanks site with enough capacity to include treatment of sludge from Shek Lei Pui WTW. Discharge sludge from balancing tank to sewer. Sludge treatment at SISTW and disposal to WENT/SENT Landfill.
Tsuen Wan	Liquid Disposal Option	Install washwater recovery facility and balancing tank. Discharge sludge from balancing tank through existing sludge pipe to a new sewer connection in Kwok Shui Road. Sludge treatment at SISTW and disposal to SENT/WENT Landfill.
Tuen Mun	Solid Disposal Option	Provide thickeners and dewatering facility for all sludge arising from Stage I-IV and Stage V works. Sludge cake transport to WENT Landfill by road.

SECTION 3
ASSESSMENT METHODOLOGY

3.1 Introduction

Environmental Impact Assessment has been defined in a number of ways, both by what the process should achieve and how it should be carried out. One of the better definitions of what environmental impact assessment should be is:

"A systematic method of assessing the quantitative and qualitative effects of a development on the environment"

The term systematic is most important as it is only by being so that the assessment can ensure identifying and appropriately addressing all potential issues.

Environmental Impact Assessment is carried out to:

"... ensure a proper examination of the environmental consequences of development projects and programmes..."
Peter Pooley, Deputy DG, Directorate-General for Development, Commission of European Union;

and:

"... ensure that the development options under consideration are environmentally sound and sustainable and that environmental consequences are recognised early in the project cycle and taken into account in project design..."
World Bank EA Sourcebook, Volume 1.

The benefits of such assessments include the shortening of the planning process, reductions in adverse impacts, achievement of sustainable development and the balancing of the interests of the developer and the community as a whole.

3.2 Approach to EIA

This study used the following systematic steps.

Initially the environmental review and engineering proposals presented in the Feasibility Study of the Treatment and Disposal of Waterworks Sludge From Existing Treatment Works were examined as this document forms the baseline from which further work would develop.

Changes to the proposals presented in the Feasibility Study Report were discussed with the engineering team who, at this stage, were in the process of developing the preliminary engineering designs for the developments at each works.

A site visit was carried out to each of the sites to gain first hand experience of the location, layout, and surroundings of the existing WTWs, and of the proposed sites. Members of the engineering team accompanied the environmental team to provide information on the proposals. Requirements for detailed specific surveys were assessed during these initial visits.

To gather background information on issues which have been highlighted as potentially significant and to clarify the requirements for the study, initial discussions were held with EPD Strategic Planning Section who are overseeing this project. It was agreed that all environmental aspects should be assessed at each site. However, due to the EIA being required to address what are effectively eight separate developments of varying sizes, the depth of application of some aspects of the brief should be adjusted to reflect the potential for impacts of particular types at each site. Specific topics in this category include landscape impacts and fugitive dust emissions.

3.2.1 Key Issues

Using this approach allowed the identification of "Key Issues" for each site. Key Issues are those which are likely to produce the most significant environmental impacts. Each site has been assessed individually for Key Issues as, although the proposed developments are for similar purposes, their scale, components and relation to neighboring facilities, and therefore, their effects on the environment vary considerably.

3.3 Methodologies

It should be noted that the development project is currently at the initial design stage. This means that although the sizes for specific items (tanks, pipes, pumps) have been identified and a preferred layout designed, details such as the exact external dimensions of structures are not known. Similarly, the construction processes required to build the proposed developments are not known as this is dependent on the contractor hired to carry out the work, and the ground conditions found at the site (but can be partially controlled by contractual agreement). Therefore, the assumptions and estimates shown below have been made to allow the Environmental Assessment to be carried out. These assumptions and estimates are based on the current design level of detail, existing knowledge of the sites and the combined experience of the engineering and environmental teams.

- Estimates
  - Vehicle movements during construction period
  - Volume of waste materials generated during construction
  - Proportions of hard rock to soil excavations

- Assumptions
  - Construction techniques
  - Construction equipment used and numbers on site

3.3.1 Review of Existing Data

A broad range of existing data was reviewed during the EIA. This included published scientific papers, journals, reports, and books. A number of government organisations and non government organisations were also contacted during the course of the assessment to gather relevant information including data on weather, archaeology, flora and fauna and traffic.

Contour maps at 1:5000 scale were obtained. In some cases these were out of date and did not show all of the developments existing in an area. To ensure all developments were identified and that their positions could be accurately assessed, aerial photographs of all the proposed development sites were also obtained.

Suitable models and modeling methodologies were identified by discussions with representatives of the relevant departments of EPD, and the data required to utilise them collected.

3.3.2 Geology

The engineering team provided details of geology underlying the proposed developments sites as this is an important factor in considering construction techniques likely to be applied to the proposed developments.

3.3.3 Landscape Character and Visual Impacts

The landscape character for each site was assessed during site visits by identifying the existing developments and important natural features surrounding the proposed sites. This allowed a description of the site in relation to its surroundings to be produced. Other information which characterised the areas was also collected, for example, odours, noise and activities present. This information was then evaluated.

Visual evaluation involves the interpretation of the relationship between a site, the land uses which surround it and the intervening landscape filter of topography and planting. The main objective of the exercise is to identify the most significant views to the site and present the anticipated impact of development. As described above, the existing sites and their surroundings were examined during site visits. The potential for visual intrusion by the proposed developments was then initially assessed by considering the developments proposed sizes and positionings in relation to the existing landscape. Potential effects of necessary removal of screening vegetation and potential for mitigating landscaping of the developments was also considered. Where the potential for significant visual impacts was identified computer generated graphics were used to assist in the assessment process.

Visual Assessment Computer Graphics

Photographs were taken of the proposed developments positions from the most significant view points to the sites. The photographs were then scanned into a computer and the resulting computer files manipulated, using a photographic retouching package to produce as realistic representations of the proposed developments, as they are likely to appear post construction, as possible. Correctly proportioning and positioning of the proposed development structures onto the photographic images was achieved by:

i) taking measurements from engineering layouts of the proposed developments.

ii) measuring existing features during site visits.

iii) placing surveying staffs of known heights at points where building vertices are proposed. The staffs could then be seen in the photographs appearing at the correct locations for building vertices and giving known heights for objects at these points.

iv) scaling measurements of the proposed buildings against the number of "pixels" (dots making up the photographs in the computer images) the surveying staffs or building features of know size appeared to have in the computer images.

v) adding, using the tools in the photographic retouching package, representations of the proposed buildings to scale using the above measurements.

Using this method and considering the level of grain in the photographic package the representations of the proposed buildings should be accurate to within 50 cm. These image files were then printed out using a colour laser printer to assist in the visual impact assessment.

3.3.4 Ecological Assessment

Flora

An initial assessment of the likely impact on local ecology was made during the initial site visits. Due to the limited nature of the developments and the generally low ecological value of the areas affected, it was not considered necessary to investigate the ecology of the sites further.

Fauna

As in the case of flora, the limited scale of developments and the existing developed state of the proposed development locations precludes major effects on fauna. However, the Agriculture and Fisheries Department, Country Parks Division were consulted where significant impacts were thought possible.

3.3.5 Concurrent Developments

Outline Zoning Plans made under the Town Planning Ordnance were obtained for each proposed development area. In some case the developments do not fall within areas covered by these plans however, in these cases plans of the adjacent areas outline zoning plans were still obtained as they often referred to surrounding developed areas which might be potentially affected by the proposed developments. Developments were also noted during site visits.

3.3.6 Traffic and Transport Issues

During site visits the road infrastructure surrounding the proposed developments was characterised and any obvious limitations noted. Consultation with staff of the Transport Department was also carried out to identify any limiting factors on roads likely to be affected by construction and operation traffic.

Due to the limited volume of traffic likely to be generated by the proposed developments no road traffic counts were considered necessary.

3.3.7 Air Quality

Noise Modelling

Noise may simply be defined as unwanted sound. The human ear is not equally sensitive to noise at all sound pressures as the ear tends to be less efficient at converting sound pressure into loudness as the pressure rises. This means that a doubling of sound pressure will not produce a doubling of loudness; it would take a tenfold increase in pressure to double the loudness. To overcome this non linear effect a logarithmic scale was developed to provide a scale of numbers that are broadly similar to the ear's performance. The logarithmic units used are called decibels abbreviated to dB.

A further complication arises because the human ear is not equally sensitive to sound pressure at all frequencies. It is less efficient both at low frequencies and at very high frequencies. To overcome this problem a unit called dB(A) was developed. This scale "weights" sounds to match the sensitivity of the young undamaged human ear. dB(A) is usually used to assess industrial noise and the associated frequency spectra are used for the engineering design of noise control methods

The EPD has produced two Technical Memorandums detailing the methodologies which should be applied to noise assessment for construction work which take these properties of sound into account. These are:

- Technical memorandum on noise from construction works other than percussive piling; and

- Technical memorandum on noise from percussive piling.

These memorandums give typical noise levels for construction machinery. By assessing the activities which are likely to take place on site at any one time the appropriate noise levels can be amalgamated to give an overall noise level. This is subject to some adjustment factors and the resultant level can be compared with the acceptable noise limits for construction noise at the NSRs.

Fugitive Dust Modelling

At sites where the potential for fugitive dust emissions is significant, the United States Environmental Protection Agencies (USEPA) Fugitive Dust Emission Model (FDM) was applied. This model is commonly used to calculate the behavior of emissions of dust from areas such as construction sites, and the impact of these emission on the surrounding area. Potential impacts are calculated for one or more of what are known as Nearest Sensitive Receivers (NSRs). NSRs are usually dust sensitive adjacent land uses such as residential, school, or hospital buildings. If the impacts at the NSRs are found to be unacceptable, mitigation methods must be applied to ensure effects are reduced to within acceptable limits. If the impacts are made acceptable at the NSRs, it is considered that receivers further away will also not be unacceptably affected .

Under the current regulations the Air Quality Objectives for Total Suspended Particles (TSP) and Respirable Suspended Particles (RSP) are:

TSP 260 $\mu g/m^3$ average over 24 hours
TSP 80 $\mu g/m^3$ average over a year
TSP 500 $\mu g/m^3$ hourly average based on EPD guidelines

RSP 180 $\mu g/m^3$ average over 24 hours
RSP 55 $\mu g/m^3$ average over a year

The following information is entered into the model:

- Representative weather information, especially wind speed;

- Particle size;

- Size of site; and

- Relative locations of the site and the NSRs.

From this information the model can work out the airborne concentration and deposition rates for the proposed development.

The model is further described and the data used during the modeling exercise, together with justification for using that data, is presented in Appendix D. The result printouts from the model are also included in this Appendix.

3.3.8 Water Quality

The likely effects of the proposed developments on water quality were drawn from the Feasibility Study and scientific literature. The proposed schemes effects on water quality will be explored further by testing to be carried out as part of the next stage of the engineering study.

3.3.9 Archaeology and Cultural Heritage

Known areas of archeological and cultural heritage were identified through examination of existing maps and literature and through consultation with the Antiquities and Monuments Office.

3.4 Assessment of Significance of Impacts

Quantification of most environmental impacts, usually with the objective of placing monetary value on impact, is known to be a particularly difficult exercise to carry out effectively. This is due to the process of assessment of qualitative factors such as landscape value being necessarily subjective. Systems have been developed which award weighted numerical values to various impacts in an attempt to summarise the impacts significance. These systems can tempt the user to apply mathematics to resulting figures (e.g. adding impacts together to give a total value), which leads to meaningless and potentially misleading conclusions. This approach to environmental assessment has, therefore, fallen out of favour.

Apart from the quantitative assessments carried out to model fugitive dust emissions and noise levels the assessment of impacts in this report have been limited to qualitative methods. Indication of relative importance is given on a scale ranging from "Adverse, Long Term, Regional, Major Impact" to "Short Term, Local, Nil Significant Impact". The impacts and their levels of significance are presented on a site by site basis.

Each site specific section identifies the various potential environmental impacts of the proposed scheme and then, where possible, describes mitigation measures. The impacts of the construction period are addressed first, followed by those of the operational period. In each case beneficial impacts are also described.

SECTION 4
ENVIRONMENTAL LEGISLATION AND GUIDELINES

4.1 Introduction

The following section summarises the legislation, regulations and guidelines of relevance to the construction and operation of the proposed water treatment works sludge treatment facilities.

Statutory controls are issued by the Hong Kong Government as "Ordinances". Ordinances to address major pollution control issues affecting air, water and noise have been adopted.

In addition to these statutory controls, Government offices issue Controls, Standards and Guidelines. These do not have the legal standing of ordinances, but should be adhered to where-ever possible.

4.2 Ordinances

Major pollution control laws affecting air, water and noise in Hong Kong are contained in the main pollution control ordinances which provide statutory criteria and requirements to reduce pollution, and protect the environment.

4.2.1 Air Pollution Control Ordinance

The relevant legislation is contained in the Air Pollution Ordinance Cap. 311 (1983) and the Air Pollution Control Order 1986 (Air Control Zones Declaration).

The Air Pollution Control Ordinance Cap. 311 (1983) provides statutory Air Quality Objectives (AQOs) for seven main urban pollutants namely sulphur dioxide, total suspended particulate (TSP), respirable suspended particulate (RSP), nitrogen dioxide, carbon monoxide, photochemical oxidants (as ozone) and lead (see Table 4.1). The AQOs given for TSPs (generated during construction processes) are 260 $\mu g\ m^{-3}$ and 80 $\mu g\ m^{-3}$ when averaged over a 24 hour and a one year period respectively.

Table 4.1 Hong Kong Air Quality Objectives (HKAQOs)

Pollutant	Concentration ($\mu g/m^3$) [i]				
	1 hour [ii]	8 hours [iii]	24 hours [iii]	3 months [iv]	1 year [v]
Sulphur Dioxide	800		350		80
Total Suspended Particulates			260		80
Respirable Suspended Particulates			180		55
Nitrogen Dioxide	300		150		80
Carbon Monoxide	30,000	10,000			
Photochemical Oxidants (as ozone)	240				
Lead				1.5	

Note: [i] Measured at 298°C (25°C) and 101.325 kPa (one atmosphere).
[ii] Not to be exceeded more than three times per year.
[iii] Not to be exceeded more than once per year.
[iv] Arithmetic means.

EPD recommend an hourly average TSP limit of 500$\mu g/m^3$ for assessing construction dust impacts. This limit is not statutory but has been used as a guide for many construction works in Hong Kong,

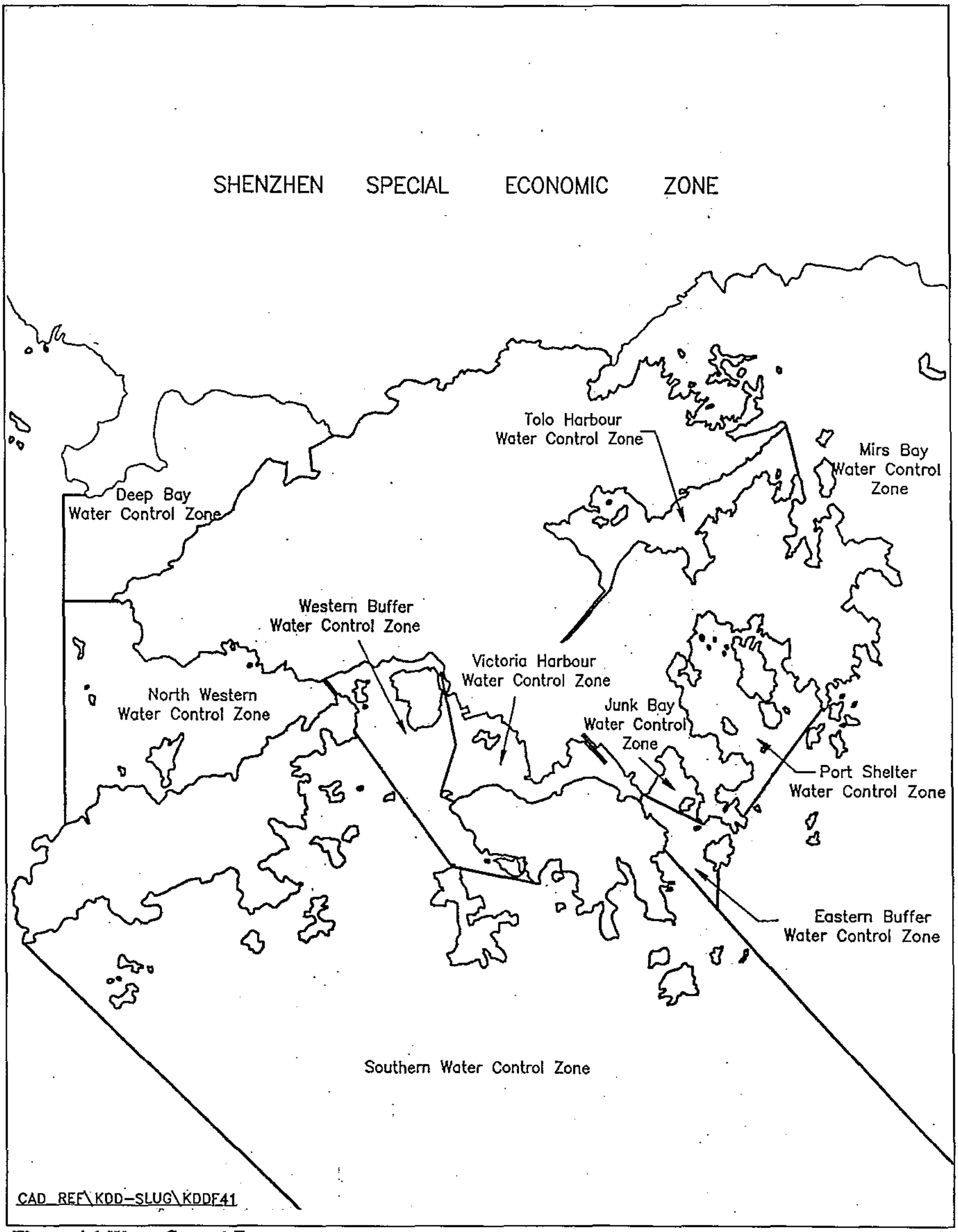


Figure 4.1 Water Control Zones

sometimes as a contractual requirement. Also of relevance are the Air Pollution Control (Construction Dust) Regulations which are currently under consultation but are expected to become effective in 1996.

4.2.2 Water Pollution Control Ordinance

Water pollution is addressed under the Water Pollution Control Ordinance (WPCO), which is applicable to all Water Control Zones (WCZ) (Figure 4.1) in the Territory except Phases 2 and 3 of Victoria Harbour Water Control Zone which are to be declared shortly. Water Quality Objectives (WQOs) are declared for each WCZ on the basis of the beneficial uses of the waterbodies therein. Discharges from the WTWs involved in the study may be to one of the following four Water Control Zones:

- Southern Water Control Zone (declared December 1990);
- North Western Water Control Zone (declared April 1992);
- Victoria Harbour (Phase 1)Water Control Zone (declared 1994); or
- Victoria Harbour (Phase 3) Water Control Zone (to be declared between 1995 and 1997).

Water Quality Objectives (WQOs) consist of limits on various environmental parameters which have been established for each WCZ. Appendix B presents a summary of selected water quality objectives of the Study Area.

Guidance for discharge standards is also given in the Technical Memorandum - "Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (Technical Memorandum on Effluent Standards)" issued under Section 21 of the Water Pollution Control (Amendment) Ordinance 1990.

Measures to avoid adverse effects on water bodies due to potentially polluting uses and activities such as civil engineering works, including the construction phases of major works, are also detailed under the Ordinance.

4.2.3 Noise Control Ordinance

Legislation for the control of noise is given under the "Noise Control Ordinance Cap. 400, 1988". Procedures for the assessment and control of noise from industrial and construction activities are given in three Technical Memoranda (TM) issued under this Noise Control Ordinance (NCO). They are:

- Noise from Construction Work other than Percussive Piling (TM1)
- Noise from Percussive Piling (TM2)
- Noise from Places Other than Domestic Premises, Public Places or Construction Sites (TM3)

The Environmental Protection Department have issued the "Professional Persons Environmental Consultative Committee (ProPECC) Practice Notes" PN 1/93 and PN 2/93. These also relate to noise matters.

General Construction Work

For general construction work, no noise restrictions are imposed during day-time period (0700-1900) of the normal working days. A Construction Noise Permit (CNP) is required from EPD when there is night-time works or when percussive piling is required.

Acceptable noise levels are determined according to the Area Sensitive Rating (ASR) for the area within which Noise Sensitive Receivers (NSRs) are located and the presence of any influencing factors such as major roads (see Table 4.2).

Table 4.2 Area Sensitive Ratings

Type of Area Containing ASR	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 areas	B	C	C
iv) Area other than those above	B	B	C

TM1 defines NSRs as any domestic premises, hotel, hostel, temporary housing accommodation, hospital, medical clinic, educational institution, place of worship, library, court of law, or performing arts centre. Basic Noise Levels (BNLs) for a given NSR are shown in Table 4.3.

Table 4.3 Basic Noise Levels

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

EPD recommend that the maximum noise level should not exceed 75 dB(A) at any NSR during periods not restricted under the Noise Control Ordinance. In addition, ProPECC Practice Note 2/93 states that noise levels at the facade of a dwelling and school, during the period between 7 am -7 pm should not exceed 75 dB(A) Leq (30 mins) and 70 dB(A) Leq (30 mins) (65 dB(A) during examinations) respectively. These values represent recommended criteria for the assessment of daytime construction activities.

Noise from Percussive Piling

Percussive piling is prohibited between the restricted hours of 7am-7pm. A CNP is required for work at all other times. Construction Noise Permits may include restrictions on the hours during which percussive piling may take place depending on the calculated noise level. TM2 details the procedures to be followed for the determination of the permitted hours of operation for percussive piling. ANLs are provided for buildings with various types of windows or ventilation systems.

Operational Noise

Operational noise from pumping stations and water treatment works needs to meet the acceptable noise levels (ANL) stipulated under TM3 (Table 4.4). Acceptable noise levels are determined according to the Area Sensitive Rating (ASR) for the area within which Noise Sensitive Receivers (NSRs) are located and the presence of any influencing factors such as major roads.

Table 4.4 Acceptable Noise Levels for Operation

Time Period	ASR A	ASR B	ASR C
Day (0700 to 1900 hours) Evening (1900 to 2300 hours)	60	65	70
Night (2300 to 0700 hours)	50	55	60

Additional guidelines for operational noise are provided in Hong Kong Standards and Guidelines. The guidelines state that fixed noise sources should be ambient background level or at least 5 dB(A) below the appropriate ANL, whichever is the lower.

4.2.4 Waste Disposal Ordinance

The Waste Disposal Ordinance (Cap. 354) was enacted in 1980 and provides an overall management framework for the collection and disposal of all wastes in Hong Kong. Disposal of construction waste from the individual treatment works shall be disposed of in accordance with the Ordinance.

4.2.5 Waterworks Ordinance

The objectives of this Ordinance include the conservation of water and ensuring the proper administration and management of the waterworks. Under this Ordinance any property occupied, used or maintained by the Water Authority for the purpose of this Ordinance and any gathering ground is subject to pollution control.

4.2.6 Town Planning Ordinance

The Town Planning Ordinance (Cap. 131) was first enacted in 1939. Since then there have been a number of amendments to the Ordinance, the last ones being enacted in January and July 1991. Statutory Plans are prepared under the provisions of the Town Planning Ordinance. There are two types of statutory plans: outline zoning plans and development permission areas. Outline Zoning Plans (OZP) show the proposed land uses and major road systems of individual planning areas. For each zone permitted uses and uses for which planning permission is required are listed. Development Permission Areas (DPAs) are prepared after the enactment of The Town Planning

(Amendment) Ordinance 1991 for areas not previously covered by OZPs. The purpose of the DPA plans is to provide interim planning control and development guidance for selected areas pending the preparation of OZPs. The Town Planning Amendment Ordinance also encompasses Sites of Special Scientific Interest (SSSIs), coastal protection areas, or green belt (GB).

4.2.7 Country Parks Ordinance

The objectives of the Country Parks Ordinance, (Cap. 208) 1986 are 'to provide for the designation, control and management of the country parks and special areas, the establishment of the Country Parks Board and, and for the purposes connected therewith. Country Parks are designated for the purposes of nature conservation, countryside recreation and Education. Special Areas are areas of Government land with special interest and importance due to their flora, fauna geological, cultural or archaeological features.

4.2.8 Forests and Countryside Ordinance

The Forests and Countryside Ordinance (Cap. 96) (1984) provides a means of protecting flora and fauna.

4.2.9 Antiquities and Monuments Ordinance

The Antiquities and Monuments Ordinance (Cap.53) 1991 provides legislative controls for the protection of the environment under the jurisdiction of the Secretary for Recreation and Culture. Human artefacts, relics and building structures may be gazetted and protected as monuments under the Ordinance.

4.3 Relevant Controls, Standards and Guidelines

There are several applicable publications and interdepartmental guidelines, notes and procedures.

4.3.1 Environmental Impact Assessment

At present there is a set of administrative procedures for Environmental Impact Assessment (EIA) of major development projects in Hong Kong. These include:

EPD Advice Note 2/92 - Application of the Environmental Impact Assessment Process to Major Private Sector Projects.

EPD Advice Note 1/92 - Environmental Controls Relevant to Industrial Estates.
Planning, Environmental and Lands Branch Works Branch Technical Circular No. 2/92.

The EIA process is carried out in order to identify the likely environmental impacts of a project. This decision-making process allows provision for the avoidance, reduction and control of any adverse impacts. Mitigation and monitoring requirements are identified where necessary.

4.3.2 Planning

Planning Environment and Lands Branch Technical Circular No. 3/94 Tree Preservation

This Technical Circular concerns the need for planning and design projects to take the preservation of trees into account.

Hong Kong Planning Standards and Guidelines

This document sets out the criteria for determining the scale, location and site requirements of various land uses and facilities. The information is used in the formulation of development strategies and preparation of town plans.

Hong Kong Planning Standards and Guidelines, Chapter 9 Environment

This document provides planning guidance for projects that may have environmental impacts and facilities built for pollution control or environmental protection. Comments on environmental effects of a wide range of development projects are given including matters such as noise, air, water quality, visual impacts and waste disposal.

Hong Kong Planning Standards and Guidelines, Chapter 10 Conservation

Various measures are available to provide for conservation in land use plans in Hong Kong and for the enforcement of these measures. This document discusses conservation of natural landscapes and habitats, historic buildings, archaeological sites and other antiquities.

4.3.3 Hazardous Installations

In Hong Kong installations storing hazardous materials in quantities exceeding those laid down in the UK are listed under the Notification of Installations Handling Hazardous Substances Regulations 1982. Advice on the risks associated with non-fuel gas Potentially Hazardous Installations (PHIs), such as chlorine stores, is provided by EPD. A set of Risk Guidelines is also incorporated into the Hong Kong Planning Standards and Guidelines. These Risk Guidelines are integrated into the Government's decision making process for the siting of PHIs and for determining land use in their vicinity.

SECTION 5
EASTERN WATER TREATMENT WORKS
ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED DEVELOPMENT

5.1 Existing Environment

5.1.1 Background

The proposed site for development of sludge treatment facilities at Eastern WTW lies within the existing treatment works boundary. Figure 5.1 and Plate 5.1 show a plan and an aerial photograph of the area, respectively. Eastern WTW covers an area of 3.42 hectares and has a treated water output of 47 million litres per day (MLD).

Eastern WTW is situated on Hong Kong Island at the southern end of Happy Valley, map reference 837 813. The site is on the western side of the valley, bordered immediately on the hillside above to the south and west, by Stubbs and Bowen Roads. On the opposite side of this major dual carriageway intersection is the Hong Kong Adventist Hospital and twelve, medium to high rise, residential blocks. To the north, the site is separated from the adjacent, recently constructed, Royal Hong Kong Jockey Club, by a 50 metre wide belt of trees. This belt of trees continues to follow Stubbs Road to the south-west and is classified in the Wong Nai Chung Outline Zoning Plan as Green Belt. To the north of the Jockey Club is an area of dense residential developments. To the east a 20 metre wide densely vegetated slope leads down to Green Lane Hall and surrounding low and high rise residential developments.

5.1.2 Existing Works

The raw water source for Eastern WTW is Tai Tam reservoir. The main facilities currently on the site include:

- the main filter building; and
- two service reservoirs.

The main filter building, containing 22 sand media rapid gravity filters, is located on the western edge of the site. The filters have an average filter run time of 24 hours between backwashes consuming $44m^3$ of water per wash.

Existing Discharge Practice

Washwater ($850m^3$/day average) is currently discharged to a pool located at the top of Hawthorn Road via a nullah. Overflow from the pool is taken through a storm drain which flows into Victoria Harbour east of the Wan Chai Ferry Pier.

Eastern WTW is located within the Victoria Harbour Phase 3 (Hong Kong Island) Water Control Zone to be declared as statutory before 1997.

5.1.3 Geology

The geology of the general area is made up of igneous granite intrusions. The WTW is situated on medium to fine grained granites formed during the Mesozoic period. The surface of the solid bedrock is overlain by decomposed granite up to six metres deep.

5.1.4 Landscape Character and Visual Aspects

Eastern WTW is situated towards the head of Happy Valley. The northern end of the valley floor is the site of the Happy Valley Sportsground, associated stands and facilities. Five cemeteries of various religious denominations are located on the western valley side. All available land, level enough to be built upon, at the southern end of the valley is covered with residential developments. Where natural slopes are too great for easy construction they are covered by dense assorted trees and shrubs, or have been terraced.

The existing WTW is on two main levels, with the two service reservoirs approximately 100m mPD, while the water filter block and workers housing are 25 metres further up the slope. The WTW is surrounded by a border of trees, which are separated from the higher wooded slopes of Mount Cameron by ribbon development along Stubbs Road. The character of the land surrounding the WTW is therefore urban, dominated by residential housing developments and major roads. However, the WTW site itself, if the background noise from adjacent activities were removed, could be considered rural due to the almost complete ring of trees around the site. This appearance is enforced by the park-like expanses of rough grass over the reservoirs.

The scale of the proposed developments at Eastern WTW are relatively minor. However, due to the location of these developments, on a hillside, facing residential developments 80 metres away on the opposite hillside, visual intrusion, especially affecting residential developments, was considered a potential problem. The visual analysis was carried out to identify the major view of the site and assess the likely level of effect on them from the development.

5.1.5 Ecology

Due to the belt of sloping land within the site boundary surrounding Eastern WTW, a large number of trees are found on site. Around the main works buildings pines and ornamental species have been introduced, but below the works remnants of the broadleaf forest encouraged in the 1900's are found.

The vegetation surrounding the WTW encourages bird life and squirrels were observed on the site. A path through the proposed development site gave access to a number of bee hives.

5.1.6 Concurrent Developments

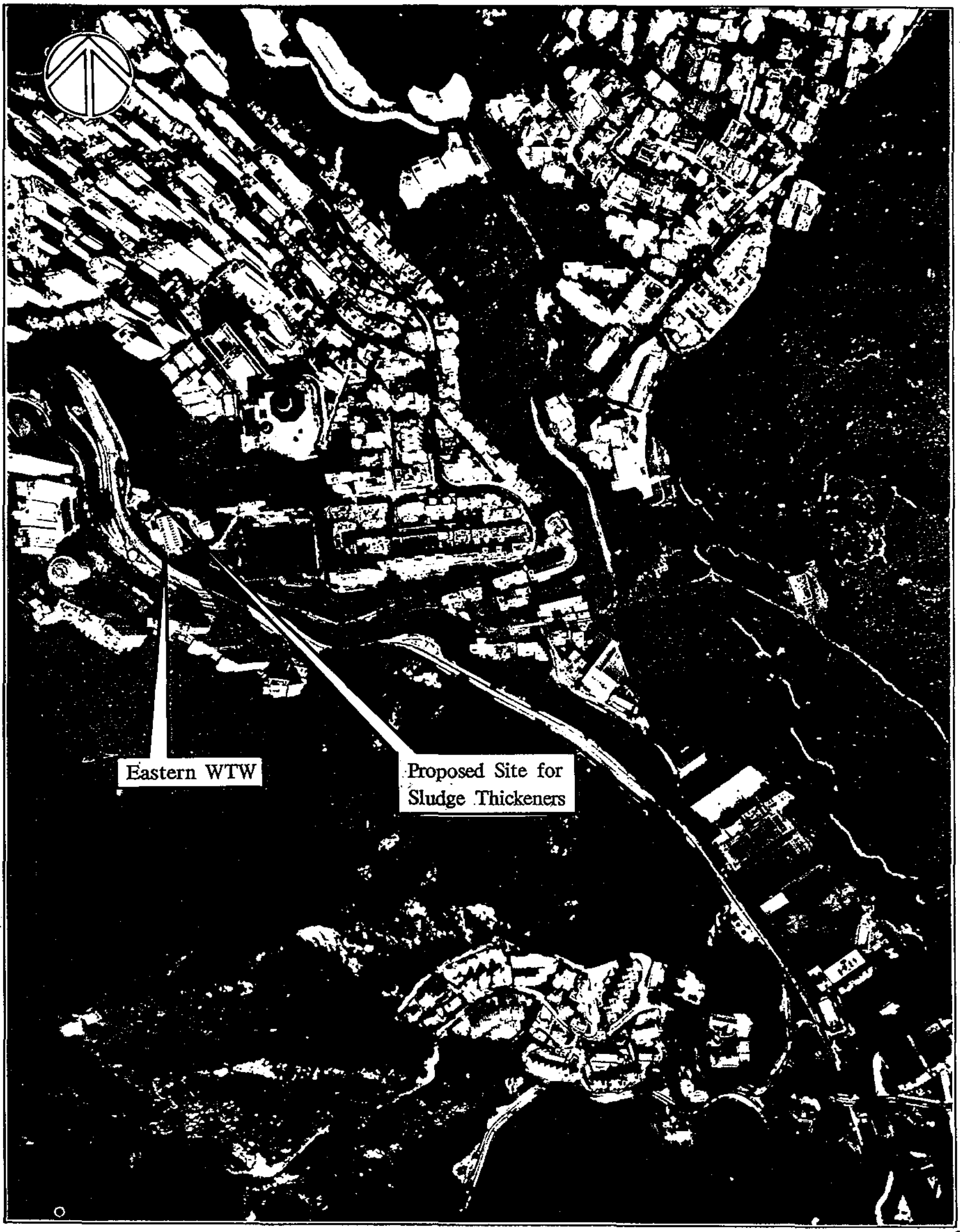
Happy Valley Sportsground is currently undergoing an expansion programme which will involve upgrading the existing race track to full international standards. Road re-alignment is also taking place on both sides of the Sportsground. No other developments were identified from the Wong Nai Chung Outline Zoning Plan, but this does not exclude the possibility of other developments taking place within the area during the proposed development construction period.

No other developments or significant maintenance tasks are programmed to take place on the WTW site during the development construction period.

5.1.7 Traffic

Access is suitable for heavy vehicles from the junction of Stubbs Road and Bowen Road. The interchange gives access to the main roads in both directions. These are major dual carriageway roads carrying large numbers of vehicles.

Plate 5.1
Eastern Water Treatment Works Location Plan



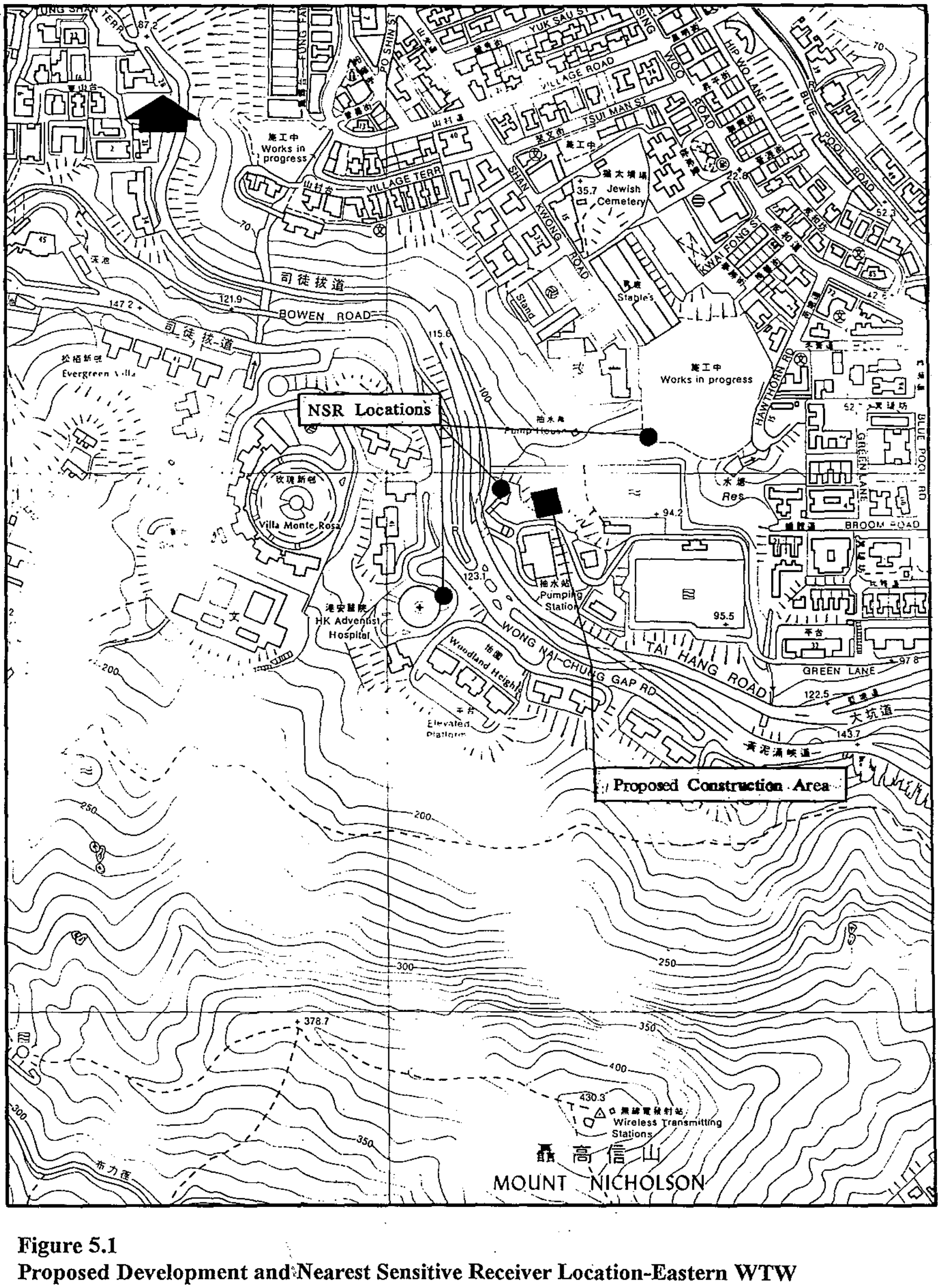


Figure 5.1
Proposed Development and Nearest Sensitive Receiver Location-Eastern WTW

5.1.8 Air Quality

Noise

The nearest sensitive receivers (NSR) to the centre of the proposed development site at Eastern WTW are:

- housing for WTW senior staff, (50 metres distant);
- Hong Kong Adventist Hospital, (180 metres distant); and
- Royal Hong Kong Jockey Club, (120 metres distant).

As described in Section 5.1.3, the area surrounding Eastern WTW is typically urban and this classification can be applied to the NSRs under the Technical Memorandum on Noise from Construction Work other than Percussive Piling.

Senior staff housing and the Hong Kong Adventist Hospital are both directly effected by traffic noise from Stubbs Road. Stubbs Road can be considered as an influencing factor (IF) on both of these NSRs for normal daytime hours, as the road carries a heavy and generally continuous flow of traffic over the daytime and evening periods, (a traffic flow rate in excess of 30,000 vehicles per day).

Senior site staff housing is screened from the proposed development site by the slope of the valley side. The Hong Kong Adventist Hospital is shielded from the proposed development site by the raised portion of Stubbs Road, the senior site staff housing, vegetation, and the slope of the valley side. The Royal Hong Kong Jockey Club is screened from the proposed development site by the terrace formed by the service reservoir, vegetation and the slope of the valley side.

Dust

The only air pollution monitoring station for which data was available on Hong Kong Island was Central/Western at Upper Level Police Station, 1 High Street, Sai Ying Pun. The area is classified by the EPD as Urban/Residential. This site is in an adjacent valley approximately 4 km from the proposed development site. However, as the monitoring station is also on the northern side of the island and located within an area of similar developments the data from this monitoring station can be taken to be indicative of the air quality at Eastern WTW.

Annual means of Total Suspended Particulates (TSPs) have been measured to vary between 75 and 87 micrograms per cubic metre ($\mu g/m^3$) at the Central/Western monitoring station. The Air Quality Objective for the annual mean is $80\mu g/m^3$. Therefore, any additional dust emitted into the environment can be considered to have a significant impact on the air quality.

5.1.9 Water Quality

Sludge from the WTW is currently discharged to a nullah and then to a pool situated at the top of Hawthorn Road. The water overflowing from this pool empties into a storm drain which flows into Victoria Harbour east of the Wanchai Ferry Pier.

The major perceived impact of discharge of WTW sludge to the marine environment is the introduction of raised levels of suspended solids, and smothering of benthic marine organisms by high sediment settlement adjacent to outfalls. Victoria Harbour's Water Quality Objective for discharges containing suspended solids are that they will not raise the natural ambient suspended solid loading in excess of 30%, nor cause the accumulation of solids leaving suspension which may adversely affect aquatic communities.

Heavy metals in WTW sludge and their effects on WQO are addressed in detail in Appendix C.3 of the "Feasibility Study of the Treatment and Disposal of Waterworks Sludge from Existing Treatment Works". The study concluded that the levels of heavy metals in WTW sludge were, "so low as to not contribute to any significant deterioration of the marine environment..." .

5.1.10 Cultural Heritage and Archaeology

No graves, cemeteries or areas, sites or structures of cultural heritage or archaeological value have been identified as present at the Eastern WTW site.

5.2 Proposed Development

5.2.1 BEECOPS Evaluation for WTW Disposal

The screening exercise showed that the overall increase in suspended solids concentrations within the central harbour area could exceed the WQO for suspended solids if WTW sludge was discharged to sewer. Therefore, the sewer disposal option was eliminated.

On site dewatering was considered but a centralised dewatering plant for sludge from Eastern and other Hong Kong Island WTWs was found to be desirable since it provided for complete removal of waterworks sludge from the marine environment at a lower cost than on-site dewatering at the separate WTWs.

The investigation considered three possible sites for a centralised dewatering facility:

- Sai Wan;
- Eastern; and
- Pak Kong.

Sai Wan WTW is to be decommissioned in 1996, and the site has been allocated for other Government uses and is therefore unavailable. There is little available space at other existing WTWs on Hong Kong Island. A second possible site at Eastern WTW is currently occupied by senior staff residence and its relocation would create further land allocation problems. The new dewatering facility at Pak Kong WTW, in the process of being commissioned, has been designed to cater to maximum future demands, and so has ample spare capacity to accommodate additional sludge from the WTWs in the short term. Sufficient flexibility has also been built into the plant design so that future expansion, such as the addition of a third press, can be easily accommodated in the existing press house. This centralised option has been carried forward as the BEECOPS option for Eastern and the other Hong Kong Island WTW for which a sewer disposal option was not considered feasible.

5.2.2 Proposed Development at Eastern

It is proposed to provide washwater recovery and sludge thickening facilities at Eastern WTW. The development is therefore, limited to a pair of balance tanks, a pair of thickeners and a sludge

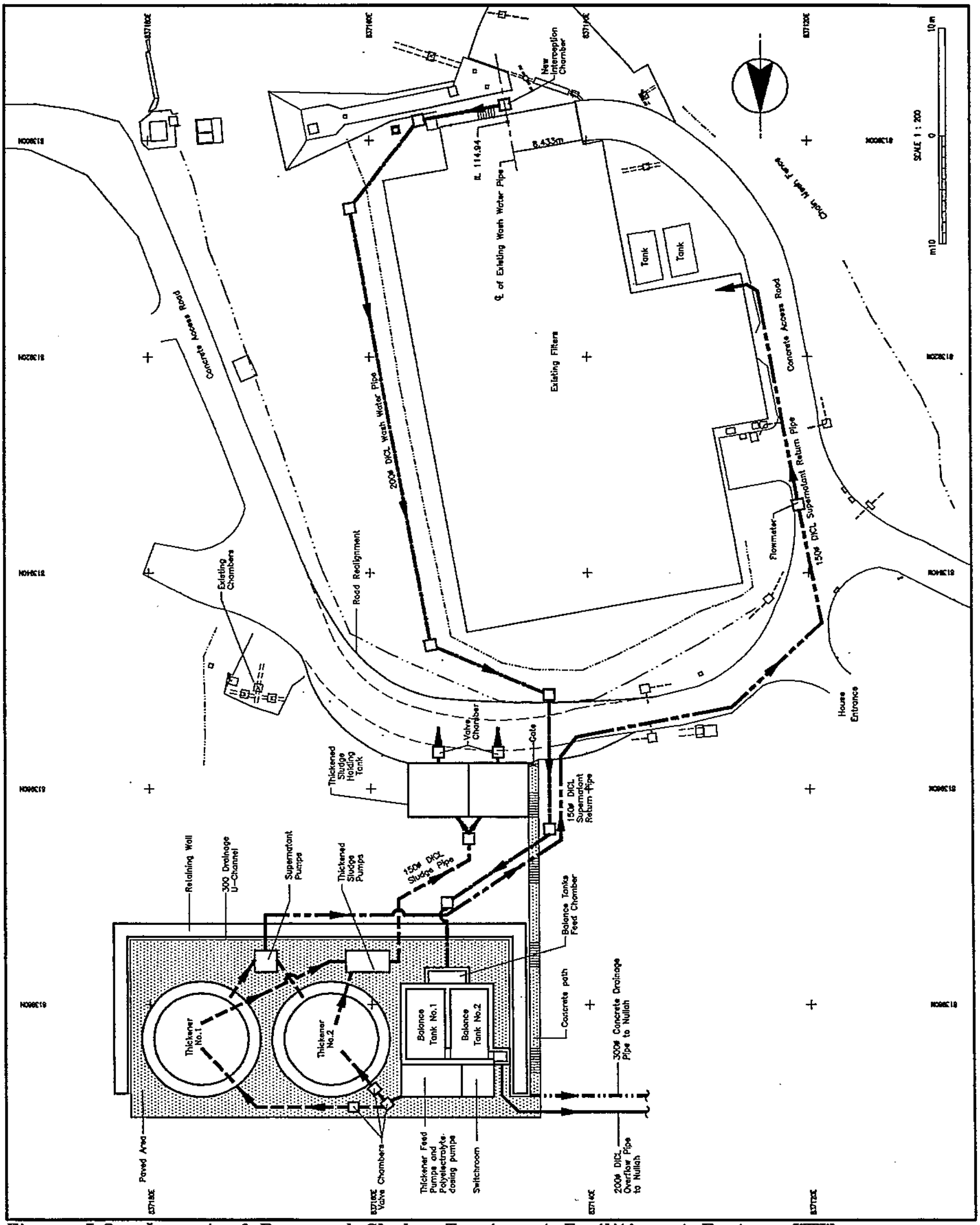


Figure 5.2 : Layout of Proposed Sludge Treatment Facilities at Eastern WTW

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holding tank. The details of these are shown in Table 5.1 Approximately 330 metres of pipes, ranging in diameter from 125 mm to 200 mm, would also be installed together with necessary pumps and mechanisms. The proposed layout is shown on Figure 5.2.

Due to space constraints on the existing treatment works site the proposed site for the washwater recovery facilities have been relocated from the site proposed in the Feasibility Study. A view of the proposed site from the service reservoir looking west is shown in Plate 5.2. A closer view of the site is shown in Plate 5.3.

Table 5.1 Proposed Equipment to be Installed or Constructed at Eastern WTW

Item Description	Item Size	Material	Unit	Quantity
Balance tanks	66 m^3	Reinforced concrete	no.	2
Thickener tanks	8.5 m dia. internal	Reinforced concrete	no.	2
Sludge holding tank	165 m^3	Reinforced concrete	no.	2
Thickener mechanisms	8.5 m dia.	Steel	no.	2
Supernatant pumps	22.0 l/s		item.	2
Sludge draw-off pumps	4.1 l/s		item	2

5.2.3 Construction

The construction process is likely to take approximately 10 months. The first month of this period will involve site clearance and preparation. During the following 9 months the necessary structures will be built on site. Finally, the installation of pumps, mechanisms and electrical equipment, and testing of the new works will take place. Work is scheduled to commence on site on 3/7/96.

Materials and equipment would be brought to the site by road as required due to limited storage space available on site. No special routes have been identified for transport of materials to or from the site, which has direct access to the main road system.

Construction will require the creation of a level area of land, measuring approximately 20 metres by 30 metres, on the hillside north of the existing WTW. It is likely that a crane will be used to move equipment and materials on and off site as access to the site is limited and the retention of as much of the tree cover surrounding the actual site is required.

Following site preparation a retaining wall will be constructed to support the slope above the cutting. It is likely that this retaining wall will be formed from sheet steel or concrete piles.

Plate 5.2 **Distant View of Site for Proposed Sludge Thickeners - Eastern WTW**

Plate 5.3 **Site for Proposed Sludge Thickeners - Eastern WTW**

Foundations for the structures would be piled as necessary. The concrete tanks would be formed from concrete produced at an existing concrete batching plant and steel re-bar. Steel tanks may be fabricated on site.

Pipe routes are likely to be excavated using hand operated pneumatic drills and a back-hoe excavator.

Table 5.2 shows the likely activities involved in the construction process, estimates of materials and equipment required, and wastes generated.

Table 5.2 Likely Construction Process, Estimates of Materials and Equipment Required, and Wastes Generated for Proposed Development at Eastern WTW.

General Activity	Specific Activity	Equipment and Use	Time Period for Activity	Time Used on Site
General	Site access	Tower Crane - equipment and materials movement	All of construction period	Constant
Site Clearance	Tree removal	Trucks - removal of 20 loads of felled trees/branches/undergrowth	6 days	Visits during working hours
		Tracked Excavator - root removal/topsoil removal	5 days	Working hours
		2 hand- held Chain saws - felling and cutting up trees	5 days	Working hours
	Excavation	Breaker and compressor (hand held pneumatic) - rock removal	60 days	Working hours
		Breaker (excavator mounted pneumatic)	60 days	Working hours
		Tracked Excavator - soil and rock moving	60 days	Working hours
		Skip Trucks - soil and rock removal	60 days	Visits during working hours
Construction	Slope support and foundations	single acting hammer - driving 150 - 200 sheet piles	30 days	Working hours
		trucks - delivery of 6 lorry loads of shoring	250 days	Visits during working hours
	Tank construction	Concrete lorries - delivery of 1500 tonnes of concrete	5 months	Visits during working hours
		Flatbed trucks - delivery of 400 tonnes of re-bar	5 months	Visits during working hours
		Trucks - delivery of approximately 10 - 20 loads of form work and scaffolding	5 months	Visits during working hours
	Pipelaying	Trucks - delivery of 5 loads of piping	3 months	Visits during working hours
		Tracked excavator - excavating pipe run trenches and refilling after pipe laying	3 months	Working hours
		Breaker (hand held pneumatic) - rock removal	3 months	Working hours
	Mechanical and electrical installation	Trucks - delivery of 15 loads of equipment	2 months	Working hours

5.2.4 Operation

Figure 5.3 shows a schematic representation of the water and sludge treatment path, once this development is in service. New equipment will be electrically operated.

The Eastern WTW thickening facility is sized to process a peak of 1840 kg/day of sludge (dry solid weight). Thickened sludge will be tankered by road to the existing filter membrane press facility at Pak Kong WTW for dewatering and disposal to SENT landfill.

Transfer of thickened sludge to Pak Kong WTW for dewatering will require approximately 4 tanker trips per day at 3% dry solids.

5.2.5 Key Issues

From the data collected concerning the proposed Development at Eastern WTW, the key issues were identified as:

- ecological damage, due to the necessary loss of tree cover;
- construction noise, due to the nearby hospital NSR; and
- fugitive dust emissions, due to the nearby hospital NSR.

5.3 Construction Phase Impacts and Mitigation Measures

This section examines the potential environmental impacts of the proposed development at Eastern WTW, along with potential mitigation measures. Special attention is paid to Key Issues.

5.3.1 Visual Impacts

Close views of the wooded area in which the development is proposed are not available from above or below the site. This is due to screening effects of:

- Stubbs Road which lies between the site and adjacent buildings up-slope of the site; and
- the level storage reservoir and surrounding vegetation which lie between the site and adjacent buildings down-slope of the site.

Views from further away are only available from the eastern side of Happy Valley, approximately 700 metres away from the site. Views from buildings along Sing Woo Road and Blue Pool Road are obstructed by intervening buildings due to the depth of the valley. Views are intermittently available from Tai Hang Road, however, no buildings are present on this road. The nearest vantage point from which the site can be seen from buildings is from the western end of Wilson Road and along Cooper Road approximately 600 m from the site.

The views of the site afforded from these vantage points will not be significantly affected during the construction process. It is likely that the only visible evidence of the construction process will be the tops of cranes used on the site.

Visual impact from the construction process is therefore, considered to be minor.

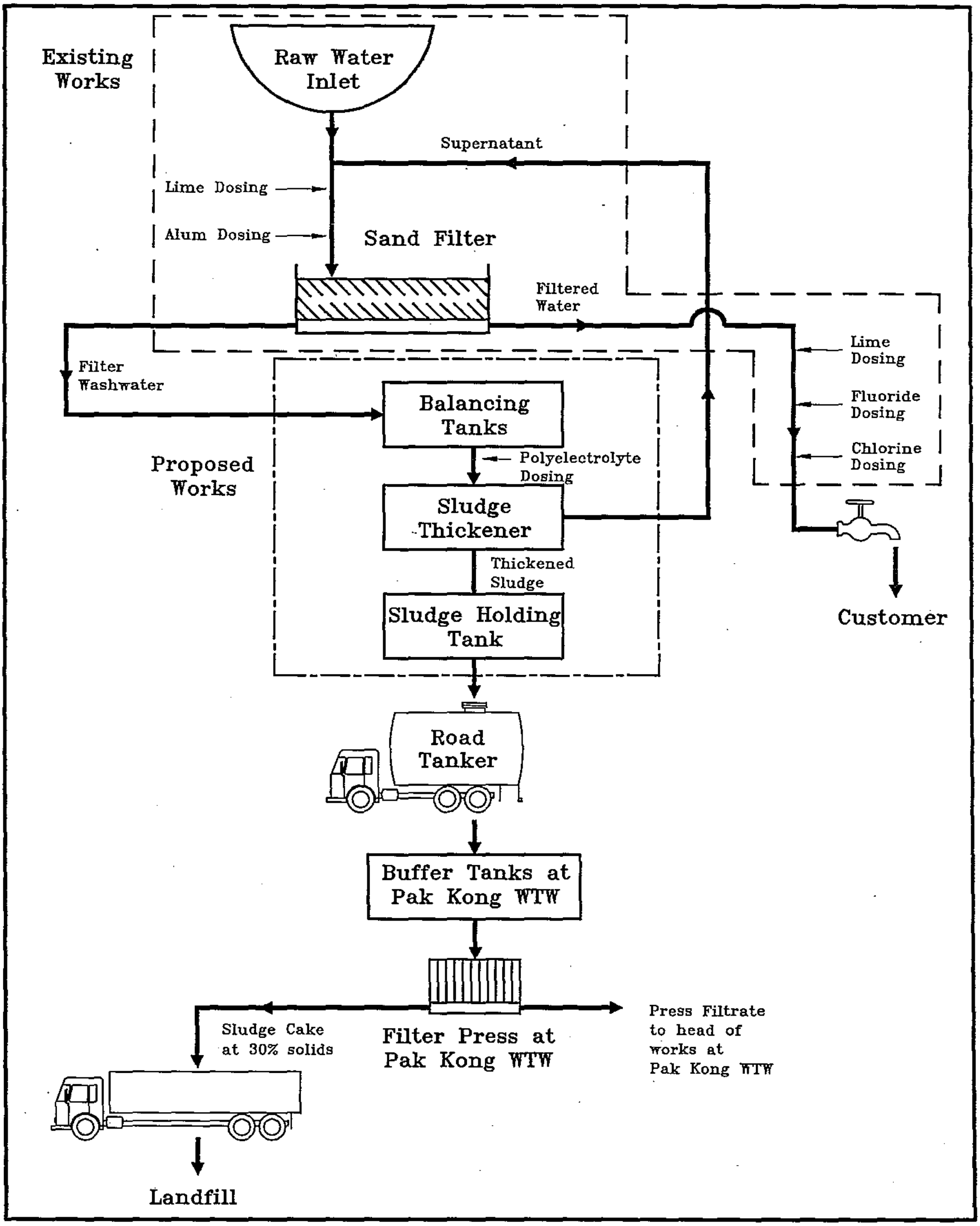

Figure 5.3 : Water Treatment Processes and Proposed Works at Eastern WTW

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5.3.2 Ecology

The most important ecological impact of the proposed development is the loss of a 600m^2 area of assorted trees. This represents the loss of approximately 20 trees. Trees are treated with high regard in Hong Kong as demonstrated by the need to seek permission to remove trees with trunk diameters above 95 mm DBH (diameter at breast height). However, as the site is the westerly extreme of the afforested strip and the area is not great the loss of these trees can only be considered of medium significance. From an ecological point of view, as none of the trees are particularly exceptional specimens, and the area is limited, impacts are really of minor significance. It is recommended that a detailed tree survey be carried out in the area.

Birds and other wildlife are likely to migrate from the area around the development site due to the disturbance caused during construction. Due to the limited area of the development, numbers of affected wildlife will be small limiting the significance of this impact.

Care by the contractors building the development will ensure impacts are kept to a minimum by preventing vegetation beyond the completed works boundary being damaged accidentally. This would also minimise the disturbance to wildlife in the surrounding area by confining the disturbance. There is little scope at the Eastern site to plant trees to replace those being removed, so any "replacement" trees, would have to be planted at another site.

5.3.3 Traffic

No specific problems have been identified for construction traffic entering or leaving the development. By looking at the estimated volumes of wastes and construction materials required to complete the development it can be estimated that approximately 600 vehicle trips will be required during the 10 month construction period. At peak construction times approximately 40 vehicle movements a day would be made.

As the site has direct access to the main Hong Kong road system, this number of vehicles is unlikely to cause significant impacts.

5.3.4 Noise

A noise assessment for the construction of the proposed development has been carried out. As percussive piling is likely to take place on this site, assessments for both percussive piling and from other construction work were carried out following the methodologies described in the EPD Technical Memoranda concerning, "Noise from Percussive Piling" and "Noise from Construction Work other Than Percussive Piling" respectively.

The technical detail of calculation of potential noise levels from both operations is shown in Appendix C.

Noise From Percussive Piling

It was found that during percussive piling the calculated noise levels (CNL) were 78 dB(A) and 66 dB(A) at the Senior Staff Housing and the Hong Kong Adventist Hospital respectively. As these noise levels do not exceed the Allowable Noise Level (ANL) in either case, piling operations should be permitable for working hours (09:00 to 17:00) without use of special noise reduction equipment or shortened working hours. The Royal Hong Kong Jockey Club is further from the proposed development than the Senior Staff Housing and is not considered more sensitive to noise than the housing. Therefore, construction noise due to piling would be below the ANL level at the Royal Hong Kong Jockey Club.

Noise impacts from piling operations are therefore, not considered to be significant.

Noise From Other Construction Activities

The period of construction which will have the largest number of noise generating activities and pieces of equipment on site was chosen to assess the impact of noise from construction activities other than percussive piling at the proposed site. The noisiest period is likely to be during site clearance, when a range of excavating machinery and supporting equipment is likely to be operating simultaneously.

The Corrected Noise Level calculated for the Hong Kong Adventist Hospital is 10 dB(A) and 6 dB(A) below the ProPECC recommended daytime level and Acceptable Noise Level respectively. Therefore, construction noise should not significantly affect the hospital.

Corrected Noise Levels for the Senior Staff Housing and the Royal Hong Kong Jockey Club exceed the Acceptable Noise Levels by 6 dB(A) and 3 dB(A) respectively. Noise levels at the Senoir Staff Housing also exceed ProPECC recommended daytime noise levels by 1 dB(A). Use of equipment which has been effectively silenced should be incorporated wherever possible to minimise construction noise. Use of a silenced breaker would acheive corrected noise levels at the Senior Staff Housing below ProPECC recommended daytime levels.

5.3.5 Airborne Emissions

The FDM was applied to the proposed development to calculate the potential total suspended particulates at the three identified NSRs. The technical details of the way the FDM was applied is described in Appendix D to this document. The model provides a worst case as though dust creating construction activity is taking place on the entire area of the proposed development site for 24 hours and the wind is blowing constantly towards NSRs. The FDM calculated dust concentration values (rounded to the nearest microgram) are shown Table 5.3, together with factors which will tend to reduce the actual TSPs found at the NSRs and an estimation of their likely effects.

Table 5.3 Modeled Dust Concentrations at NSRs and Correction Factors

NSR	FDM 24 hour average concentration (μg/m³)	Time wind is in quarter towards NSR	Barriers (e.g. topography, vegetation)	Actual Working Hours	% of site likely to be open for dust generation	Realistic 24 hour Concentration at NSR due to Development (μg/m³)
Hong Kong Adventist Hospital	156	20%	Surrounding trees Slope of hillside (up to NSR) Stubbs Road	8	70%	20
Royal Hong Kong Jockey Club	264	35%	Surrounding trees Supply reservoir	8	70%	30
Eastern WTW Staff Residence	276	15%	Surrounding trees	8	70%	30

It should be noted that the model does not allow for the topography of the site (it assumes a flat site with the NSRs at the same level as the site) or for the effects of vegetation around the site. In this case, the sloping site and screen of trees which will remain around the site will cut dust generation and its movement towards the NSRs significantly.

The results of the modeling exercise show that the fugitive dust emissions from the site might approach, and even pass, the AQO TSP of 260 μg/m³ average over 24 hours, only if construction activity was to continue for 24 hours a day, the local topography was completely flat, and the local weather conditions blew dust from the site to the NSRs constantly over the 24 hour period. The results of the modeling exercise, when considered with the "real world" site specific factors, such as shielding vegetation and prevailing winds, has shown that the site is unlikely to cause the 24 hour AQO for TSPs to be exceeded at the NSRs.

Air quality data from the nearest monitoring station in Central/Wanchai is too remote to this site to be of any relevance. Emissions from the development should be reduced to the lowest possible levels by appropriate mitigation measures. These are shown in Table 5.4.

Table 5.4 Fugitive Dust Control Measures

Development Stage and Control Methods	Comments
Land Clearing/Earth Moving	The major source of dust from this development
Watering	Water should be applied over the site prior to conducting any land clearing. this will increase the moisture content of the soil, thereby increasing its stability. Clay soil should be kept above 8% water to prevent dust generation. Water should be re-applied as necessary over the period that bare soil areas are exposed. Water can be applied by sprinklers or hoses.
Minimise Loading Drop Height	Mechanical excavator drivers should ensure that the height spoil is dropped from into haul vehicles is minimised, thus reducing dust generation.
Cover Haul Vehicles	Haul vehicles should be tarpaulined to prevent dust being generated from their loads as they move along the highway.
Paved Road Track Out	Not a major source of dust in this case as haul vehicles will not have access to the site.
Sweep/clean roadways	The access road should be swept or water flushed clean to prevent re-entertainment of deposited dust.
Cover Haul Vehicles	Covered haul vehicles prevent the road from being contaminated with dust.

With these mitigation measures employed during the construction period and the establishment of vegetation as soon as possible over areas of exposed ground once construction is complete, suspended particulates from the construction process should be kept within acceptable limits.

5.3.6 Water Quality

Due to the small area of the site volumes of run-off generated will not be large enough to reach local watercourses and produce a potential for raised levels of sediments. Run off will be stopped by surrounding vegetation.

5.3.7 Cultural Heritage and Archaeology

No areas of cultural or archaeological value will be affected by the development at Eastern WTW.

5.3.8 Safety

The use of a crane to provide access for all construction materials and equipment provides a potential for accidents related to this operation. Special care will be required during the movement of loads between the site and the access point from the existing WTW.

The existing WTW is classified as a Potentially Hazardous Installation (PHI) due to the storage of chlorine on site for use in the water treatment process. The construction activities at Eastern should not cause any increased hazard to the stored chlorine. Where a conflict could potentially arise would be during delivery of chlorine, should a chlorine transporter be involved in an accident due to the presence of construction machinery or operations.

Normal site safety practices should be followed.

Contractors should be advised in advance of chlorine deliveries. All construction activities, which could potentially affect a delivery, should be suspended until the delivery is complete. Should the construction process have caused any affects which might increase the likelihood of an accident during a chlorine delivery, e.g. piles of materials stored on roadways, dirt on access roads, these matters should be addressed prior to the delivery. Delivery drivers should be warned of the construction process happening at the WTW to enable them to exercise additional care.

5.3.9 Waste Disposal

Wastes produced by the construction process will be inert. They will be made up of cleared vegetation, soil, rock, and unusable or used building materials. Waste disposal is therefore straightforward. As long as these wastes are disposed of at a suitably licensed landfill they should cause no significant environmental impacts.

5.4 Operational Phase Impacts and Mitigation Measures

5.4.1 Visual Impacts

As stated in Section 5.3.1, the proposed development site is largely hidden by existing vegetation, and the most important views of the site are in the middle distance. The tanks and pumping stations proposed are low buildings. This, together with the screening effects of topography and vegetation leads to very low visual impact. Some re-establishment of vegetation is likely around the edges of the proposed development post completion which would further reduce views of the development post-construction.

The visual impacts of the proposed development at Eastern WTW are not thought to be significant.

5.4.2 Ecology

Operation of the proposed development will have no negative ecological impacts further to the permanent loss of 600m^2 of hillside under the development as described in Section 5.3.2. Wildlife displaced by the noise and activity during the construction phase is likely to return to the area once this activity ceases.

Negative ecological impacts of operation are not thought to be significant, so mitigation is not necessary.

The operation of the proposed development will remove an average of 23 m^3 of water treatment works sludge which would otherwise be released into local watercourses and finally the Victoria Harbour Water Control Zone. This will help reduce smothering of bottom fauna and the effects on aquatic organisms of reduced light penetration due to high turbidity.

5.4.3 Traffic

The operation of the proposed sludge treatment facilities will generate 4 sludge tanker journeys to Pak Kong WTW per day. This additional traffic is insignificant compared with the current traffic levels and traffic carrying capacity of the main roads from Eastern WTW to Pak Kong WTW.

5.4.4 Noise

None of the activities involved in operating the proposed development generate significant noise levels. The current WTW is closer to NSRs and contains similar pumps and tanks to those which are proposed. These currently cause no noticeable noise on site. Therefore, operational noise is not considered significant.

5.4.5 Airborne Emissions

The operational activities of the Proposed development will not generate any significant levels of air emissions. The most important source of air contamination connected with the new plant will be from the exhausts of tankers removing sludge, and this is not considered significant.

As WTW sludge from Eastern WTW is low in algae, it is not odiferous, and has no potential to generate nuisance odours.

5.4.6 Water Quality

The operation of the proposed development will remove at peak level of operation 61 m^3/day of water treatment works sludge which would otherwise be released into local watercourses and finally the Victoria Harbour Water Control Zone. Water quality in these areas will therefore, be improved by a reduction in turbidity and suspended solids.

5.4.7 Cultural Heritage and Archaeology

The operation of the proposed developments would have no effects on Cultural Heritage and Archaeology.

5.4.8 Safety

Operation of the proposed development would have no specific safety implications on site.

Tanker transportation of WTW sludge is no more hazardous than transport of raw water. Tankers are sealed and the sludge is not odiferous, therefore, no effects on the tankers surrounding's will take place during the journey to Pak Kong, even through confined areas such as the cross harbour tunnel.

Should a tanker be involved in a road traffic accident, any spilled sludge could simply be flushed into the street drainage system. No special protective clothing would be required for emergency services.

5.4.9 Waste Disposal

The operation of the proposed development will produce approximately 21000 kg of thickened sludge per month. This will be transported to Pak Kong WTW where the volume will be greatly reduced by the removal of water. The remaining sludge cake will be disposed of to a licensed landfill site. Following this disposal route, waste disposal is not thought to present significant environmental impacts.

5.5 Summary of Impacts and Mitigation Measures

Tables 5.5 and 5.6 show summaries of the potential construction and operational impacts of the proposed development at Eastern WTW, and also proposed mitigation measures.

5.6 Conclusions

Environmental impacts resulting from the construction and operation of the proposed development at Eastern can be reduced to acceptable levels provided that the proposed mitigation measures are fully implemented.

Noise from construction noise is considered to be of medium significance due to the close proximity of Senior Staff Housing to the site (50 metres distance), however noise control measures including the use of a silenced breaker at all times will enable noise impacts to fall below ProPECC recommended daytime levels.

Vegetation loss due to construction activities at Eastern is also considered to be of medium significance. A detailed Tree Survey shall be carried out in the area. The survey shall indicate the species present, the height and circumference of the trunk, tree spread and the condition of each tree. A tree survey plan shall show trees to be retained, transplanted and felled. This will allow the impact of the development on the existing trees to be fully assessed.

Once operational, the proposed development at Eastern will have no significant impacts.

TABLE 5.5 EASTERN WTW - SUMMARY OF CONSTRUCTION PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual impact of construction site	Adverse	Short term	Local	Minor	Retention of as much existing vegetation as possible.
Ecology	Vegetation loss due to construction	Adverse	Long Term	Local	Medium	Undertaking by contractors to minimise damage to existing vegetation.
	Disturbance of natural habitats	Adverse	Short Term	Local	Minor	Undertaking by contractor to restrict disturbance as much as possible to the site.
Traffic	Increase in construction traffic on main roads	Adverse	Short Term	Local	Minor	N/A
Noise	Construction noise	Adverse	Short Term	Local	Medium	Noise monitoring during construction. Use of silenced breaker at all times.
Airborne Emissions	Dust from construction work	Adverse	Short Term	Local	Minor	Fugitive dust control measures.
	Exhaust emissions	Adverse	Short Term	Local	Minor	-
Water Quality	Site runoff and erosion	Adverse	Short Term	Local	Negligible	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage	No Impact			Nil	N/A
Safety	Potential for accidents on construction site	Adverse	Short Term	Local	Minor	Care in use of plant machinery . Contractors briefed on dangers of chlorine, delivery plan formulated and followed.
	Potential for accidents off site	Adverse	Short Term	Regional	Minor	-
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Minor	-

TABLE 5.6. EASTERN WTW - SUMMARY OF OPERATION PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES						
Environmental Issue	**Impact Description**	**Impact Type**	**Nature**	**Effects**	**Significance**	**Proposed Mitigation Measures**
Visual Impact	Visual intrusion	Adverse	Long Term	Local	Minor	Re-establish vegetation as appropriate.
Ecology	Removal of natural habitats	Adverse	Long Term	Local	Minor	-
Traffic	Increase in operational traffic on main roads	Adverse	Long Term	Regional	Minor	-
Noise	Operational noise	Adverse	Long Term	Local	Negligible	-
Airborne Emissions	Dust from operation	Adverse	Long Term	Local	Negligible	-
	Odour from operation	Adverse	Long Term	Local	Negligible	-
Water Quality	Marine water quality	Beneficial	Long Term	Regional	Medium	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage.	No Impact			Nil	N/A
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Minor	-

SECTION 6
RED HILL WATER TREATMENT WORKS
ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED DEVELOPMENT

6.1 Existing Environment

6.1.1 Background

The proposed site for development of sludge treatment facilities at Red Hill WTW lies within the existing treatment works boundary. Figure 6.1 and Plate 6.1 show a plan and an aerial photograph of the area, respectively. Red Hill WTW covers an area of 1.45 hectares and has treated water output of 13MLD.

Red Hill WTW is situated on the southern side of Hong Kong Island, map reference 841 810. The site is located on Red Hill Peninsula (Pak Pat Shan) which is bordered by Tai Tam Harbour to the east and Turtle Cove to the west. The area is adjacent to the Tai Tam Country Park and Tai Tam Tuk reservoir in the north west. Access to the site is via Red Hill Road leading from Tai Tam Road which lies in a valley to the west of the site at the base of Notting Hill.

The Red Hill peninsula has been subject to an intense period of construction over the past two years including residential development and local sewerage improvement works. Residential housing development is currently occurring 300 metres to the south of the site which shares the same access road as the WTW. The peninsula is ringed by Pak Pat Shan Road located 50 metres below the WTW. New luxury residential housing lies 200 metres to the east and 100 metres below the treatment works. Due to its elevated position and bordering vegetation cover, the WTW is screened from the surrounding developments except for Phase IV of the Red Hill Peninsula development which overlooks the eastern portion of the WTW. Hong Kong International School lies 400 metres to the north of the site along Pak Pat Shan Road. Low rise residential development lies 300 metres to the south west of the works adjacent to the popular Turtle Cove beach.

6.1.2 Existing Works

The main raw water source for Red Hill WTW is Tai Tam Reservoir 500 metres to the north. The main facilities currently on the site include:

- the main filter building;
- two flocculation tanks;
- two washwater recovery tanks; and
- a service reservoir.

Nine sand media rapid gravity filters with an average filter run time of 23 hours between backwashes, consuming 35m^3 of water per wash, are located in the main building. Two flocculation tanks situated on the western side of the works are desludged once every 5 days for 5 minutes. Filter washwater is recovered in two washwater recovery tanks situated on the eastern edge of the site.

Existing Discharge Practice

The treatment works has two distinct sludge sources: the largest quantity is from the washwater recovery tanks and a small amount of sludge is produced in the flocculation tanks. The two sludge sources are discharged from opposite sides of the plant. The WTW washwater recovery system discharges approximately 40m^3 of sludge per day eastwards down the hill to Tai Tam Bay via a

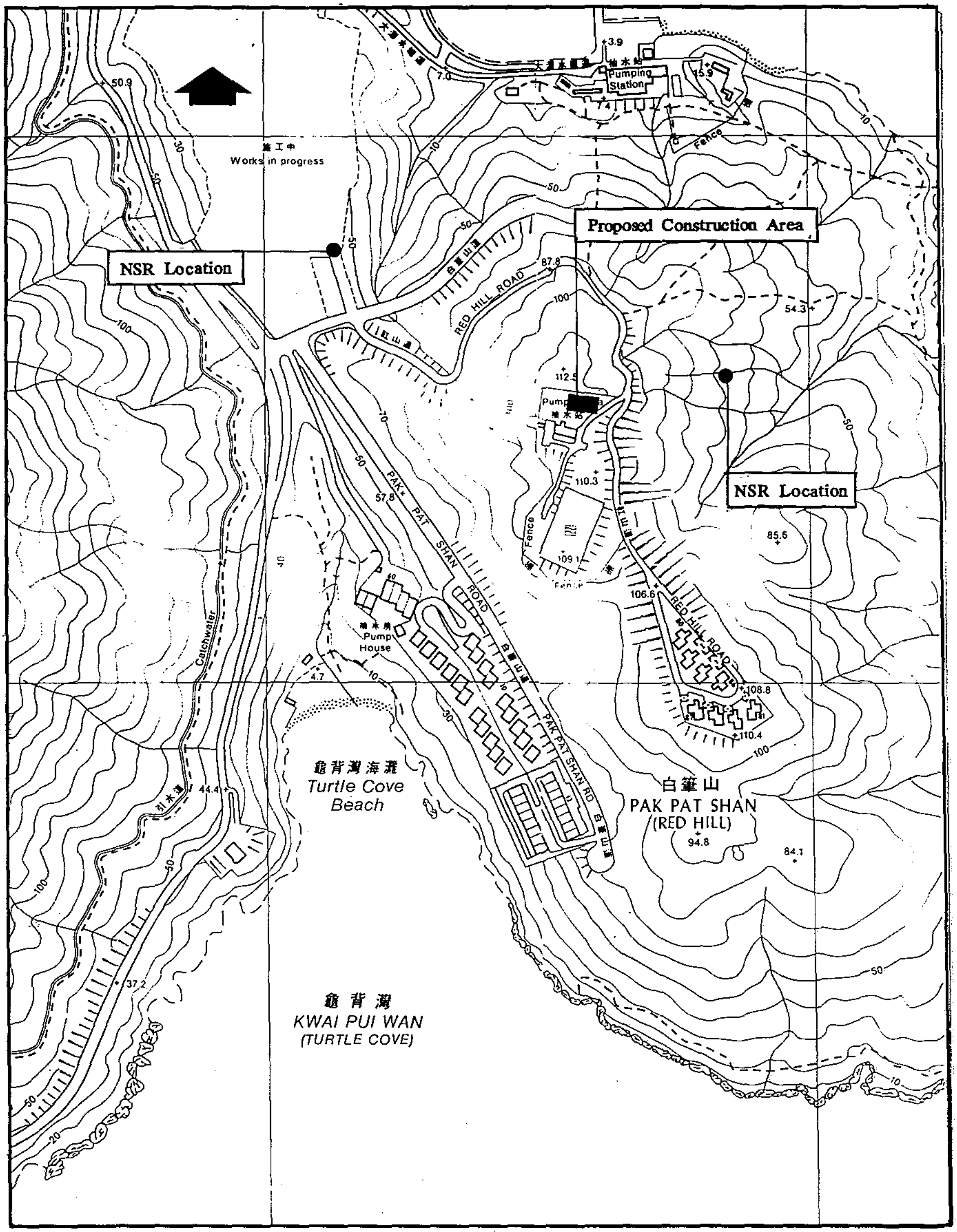
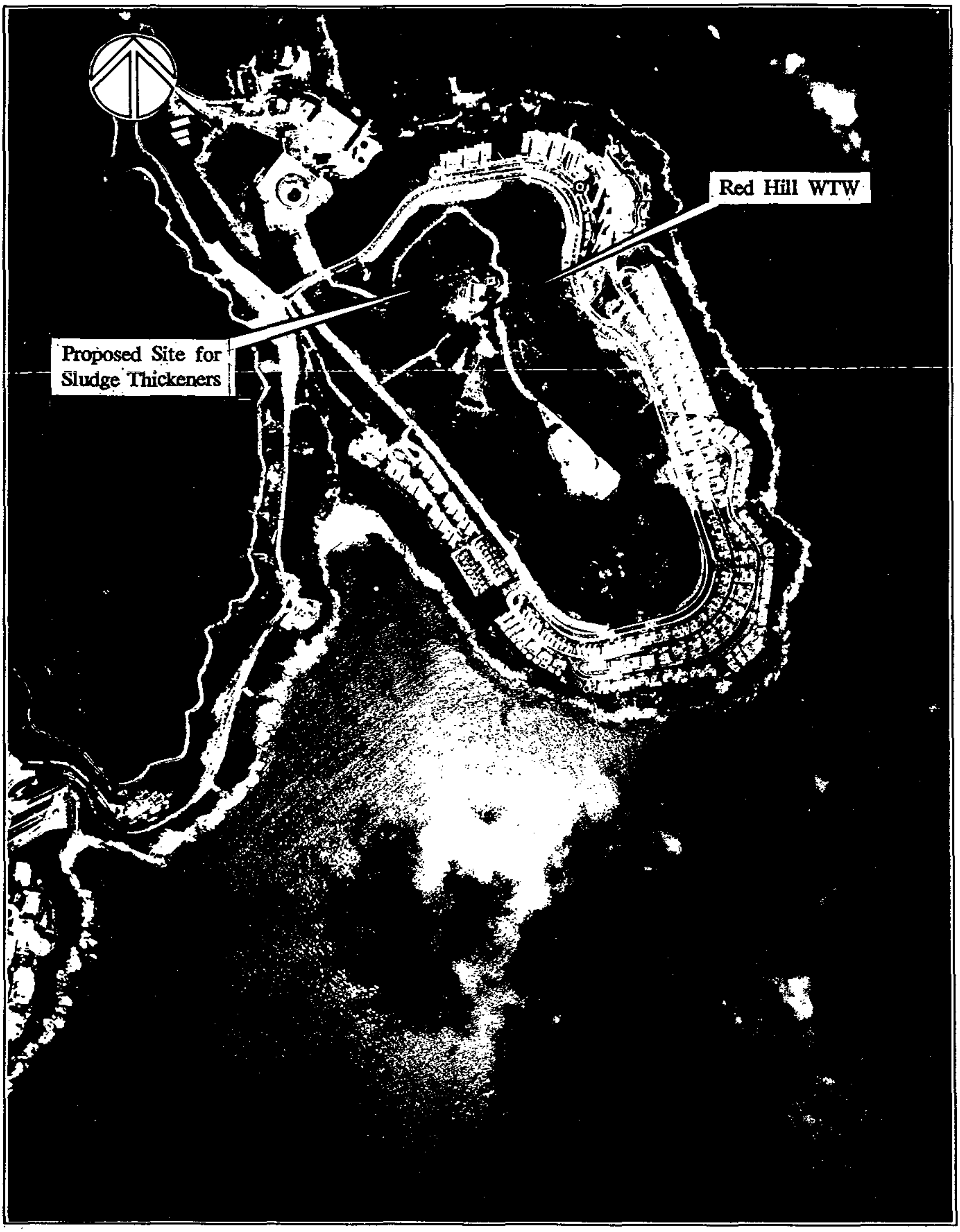


Figure 6.1
Proposed Development and Nearest Sensitive Receiver Location-Red Hill WTW

Plate 6.1
Red Hill Water Treatment Works Location Plan



submarine outfall. Sludge from the flocculation tanks is discharged to the west of the works via an open water course towards Turtle Cove.

Red Hill WTW is located in the Southern Water Control Zone which was declared in August 1989.

6.1.3 Geology

The geology of the general area consists of volcanic and intrusive rocks. The WTW is situated on fine ash vitric tuff formed during the Upper Jurassic period. Moderately strong fine grained tuff is overlain by sandy silt (completely decomposed tuff) up to 4 metres deep.

6.1.4 Landscape Character and Visual Aspects

Red Hill WTW is situated on the south eastern side of Hong Kong Island. The site is surrounded by high peaks to the west including Kwai Shan (216m) and Lin Fa Tseng Shan (256m) which are located in Tai Tam Country Park. Stanley Peninsula lies to the south-west, including Stanley Village which is an important tourist centre. Tai Tam Harbour lies to the east of the Red Hill peninsula separating the area from Shek O Peninsula.

The existing WTW is located approximately 110 mPD and is surrounded by vegetated slopes effectively screening the site from the surrounding development which lies approximately 50 metres below the site. The character of the land surrounding the WTW is dominated by low density, low and high-rise residential housing and areas of vegetated hillslopes which are steep enough to discourage development. The WTW site itself can be considered as rural due to the relatively low levels of development in the area around the site.

6.1.5 Ecology

The proposed development site is within the boundary of the existing WTW. The proposed site has already been affected by the development of the existing works and part of the area is currently undergoing minor construction works. The area is partially covered by a turf of low rough grasses, but as can be seen from Plate 6.2 and Plate 6.3, existing construction work has already removed a great deal of the vegetative cover.

6.1.6 Concurrent Developments

The Red Hill Peninsula is currently undergoing a significant amount of construction work. Development is currently taking place at Red Hill WTW itself within the WSD site boundary. The works, which involve the laying of a 300mm sludge diversion pipe, are scheduled for completion in March 1995. Construction work for a shopping centre development is also occurring adjacent to the International School near to the junction of Tai Tam Road and Pak Pat Shan Road. Tai Tam and Shek O Outline Zoning Plan indicates that the development, which is intended to serve the local residents in the Red Hill Area, may also include a number of other commercial facilities such as a bank, barber shop, and restaurant.

Residential development is taking place to the south of the WTW at the end of Red Hill Road. This area is shown on the Zoning Plan as Residential (C) 2 indicating that the area is intended for low density residential development subject to a control on building height of 3 storeys. The Zoning Plan shows that Red Hill peninsula is ringed by Residential Zoning, R (C) 6 to the north-east (permitting a maximum of 19 storeys) some of which, as yet, have not been developed, and R (C) 2 to the south-east.

Plate 6.2 **Site of Proposed Sludge Thickeners - Red Hill WTW**

Plate 6.3 **Site of Proposed Sludge Thickeners - Red Hill WTW**

6.1.7 Traffic

Access to the WTW is via a winding single lane road (Red Hill Road) leading from Pak Pat Shan Road at the base of the hill off Tai Tam Road. The area is linked with other districts by Tai Tam Road which runs from Chai Wan in the north to Stanley in the south west. Tai Tam Road is the main road, with two lanes of reasonable standard giving adequate additional capacity for construction traffic. Access from the north is made difficult for heavy vehicles due to the narrow stretch of Tai Tam Road running across Tai Tam Reservoir Dam.

6.1.8 Air Quality

Noise

The nearest sensitive receivers (NSR) to the centre of the proposed development site at Red Hill WTW are:

- residential housing at Red Hill, (200 metres distance); and

- Hong Kong International School, (400 metres distance).

As described in Section 6.1.3, the area surrounding Red Hill WTW is typically rural in nature with only low density residential housing in the surrounding vicinity. This area classification can be applied to the NSRs under the Technical Memorandum on Noise from Construction Work other than Percussive Piling. No IFs affect the NSRs, and therefore an Area Sensitive Rating of Category A can be applied.

The Hong Kong International School is screened from the proposed development site by the slope of the hill and associated vegetation. The majority of the floors of the Red Hill luxury residential development are also screened from the proposed development site by the hillside to the east of the site, however the upper floors of Phase IV of the development overlook the WTW and may be affected by construction noise.

Dust

The only air pollution monitoring station for which data were available on Hong Kong Island is Central/Western at Upper Level Police Station, 1 High Street, Sai Ying Pun. The area is classified by the EPD as Urban/Residential. This site lies approximately 10km from the proposed development site on the northern side of Hong Kong Island. The monitoring station is located within an area of urban/residential development, in comparison to the Red Hill site which is located in a more rural area. It can therefore, be assumed that data from the Central/Western monitoring station will give higher TSP air quality values than those likely at Red Hill.

Measured annual means of TSPs vary between 75 and 87 $\mu g/m^3$ at the Central/Western monitoring station. The Air Quality Objective for the annual mean is $80 \mu g/m^3$. Therefore, any additional dust emitted into the environment is likely to have a significant impact on local air quality.

6.1.9 Water Quality

Sludge from the WTW is currently discharged via a recently constructed (1987) submarine outfall into Tai Tam Harbour. This outfall was constructed to reduce visual plumes during sludge discharge. Inspection during the site investigation for the Feasibility Study confirmed that discharge does not cause a visual plume.

The major perceived impact of discharge of WTW sludge to the marine environment is the introduction of raised levels of suspended solids, and smothering of benthic marine organisms by high sediment settlement adjacent to outfalls. Southern Water Control Zone Water Quality Objectives for discharges containing suspended solids are that they will not raise the natural ambient suspended solid loading in excess of 30%, nor cause the accumulation of solids leaving suspension which may adversely affect aquatic communities.

Heavy metals in WTW sludge and their effects on WQOs are addressed in detail in Appendix C.3 of the "Feasibility Study of the Treatment and Disposal of Waterworks Sludge from Existing Treatment Works". The study concluded that the levels of heavy metals in WTW sludge were, "so low as to not contribute to any significant deterioration of the marine environment..."

6.1.10 Cultural Heritage and Archaeology

No graves, cemeteries or areas, sites or structures of cultural heritage or archaeological value have been identified as present at the Red Hill WTW site.

6.2 Proposed Development

6.2.1 BEECOPS Evaluation for WTW Disposal

Discharge directly to the nearest sewer was screened out as an option due to the possible impact waterworks sludge would have on the extended aeration treatment process and dewatering plant at the Stanley WTW which would receive the sludge. Construction work for the long pipe route required for this connection would potentially cause severe traffic and noise disruption. Therefore, the sewer disposal option was eliminated.

On site dewatering was considered but a centralised dewatering plant for sludge from Red Hill and other Hong Kong Island WTWs was found to be desirable since it provided for complete removal of waterworks sludge from the marine environment at a lower cost than on-site dewatering at each individual WTW.

The investigation into possible sites for a new dewatering facility and final choice of dewatering at Pak Kong WTW is described in Section 5.2.1. This centralised option has been carried forward as the BEECOPS option for Red Hill and the other the Hong Kong Island WTW for which a sewer disposal option was not considered feasible.

6.2.2 Proposed Development at Red Hill

It is proposed to provide washwater recovery and sludge thickening facilities at Red Hill WTW. The development is therefore, limited to the addition of one balance tank and the modification of an existing washwater tank to a balance tank, a thickener feed pumping station, duty and standby thickeners and a sludge holding tank. The details of these are shown in Table 6.1. Approximately 210 metres of pipes, ranging in diameter from 80 mm to 250mm, would also be installed together with necessary pumps and mechanisms. The demolition of a small media recovery shed is also required.

The development is limited to the northern end of the existing site. The proposed layout is shown on Figure 6.2.

Table 6.1 Proposed Equipment to be Installed or Constructed at Red Hill WTW

Item Description	Item Size	Material	Unit	Quantity
Balance tanks (new)	69 m^3	Reinforced concrete	no.	1
Balance tanks (conversion)	74 m^3	Reinforced concrete	no.	1
Thickener tanks	5 m dia. internal	Reinforced concrete	no.	2
Sludge holding tank	22 m^3		no.	2
Thickener mechanisms	5 m dia.	Steel	item	2

6.2.3 Construction

The construction process is likely to take approximately 12 months. The first month of this period will involve site clearance and preparation. During the following 11 months the necessary structures will be built on site. Finally, the installation of pumps, mechanisms and electrical equipment, and testing of the new works will take approximately 12 months. Work is scheduled to commence on site on 19/4/96.

Materials and equipment would be brought to the site by road as required, due to limited storage space available on site.

A gently sloping area of land is available for the proposed development north of the existing WTW measuring approximately 20 metres by 10 metres. The area is shown in Plate 6.2 looking east to the neighbouring recently constructed high rise residential blocks, and in Plate 6.3 looking north-west to the Hong Kong International School. There are no special on site access problems. Only turf and limited amounts of topsoil will have to be removed prior to commencement of construction.

Following site preparation, foundations for the structures would be laid. Piling is not thought to be necessary. The concrete tanks would be formed from concrete produced at an existing concrete batching plant, and steel re-bar.

Pipe routes are likely to be excavated using hand operated pneumatic drills and a back-hoe excavator.

Table 6.2 shows the likely activities involved in the construction process, estimates of materials and equipment required, and wastes generated.

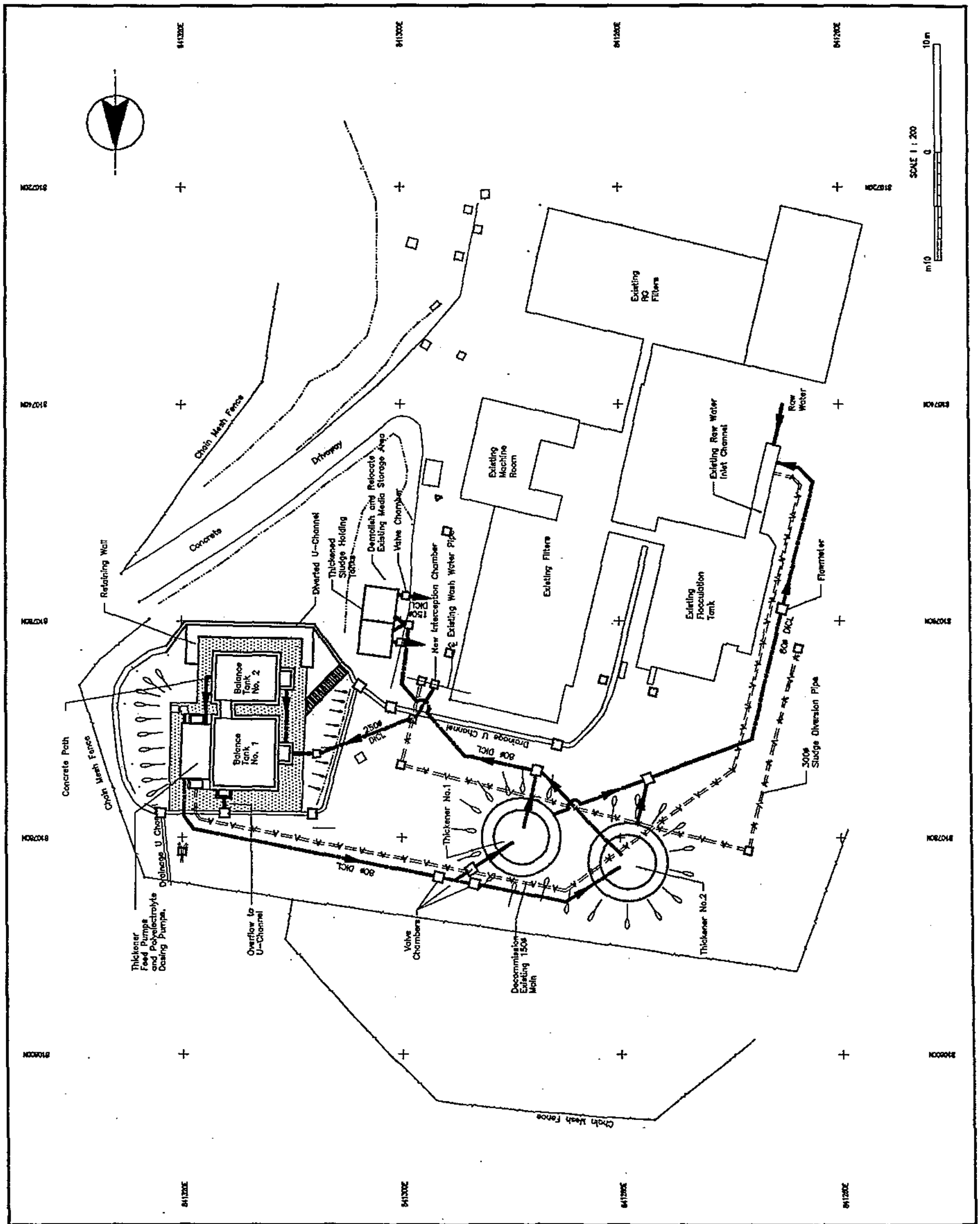


Figure 6.2 : Layout of Proposed Sludge Treatment Facilities at Red Hill WTW

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Table 6.2 Likely Construction Process, Estimates of Materials and Equipment Required, and Wastes Generated for Proposed Development at Red Hill WTW.

General Activity	Specific Activity	Equipment and use	Time period for activity	Time used on site
Site Clearance	Topsoil Removal	Trucks - removal of turf and topsoil	6 days	Visits during working hours
		Tracked Excavator - top soil removal	2 day	Working hours
	Excavation	Tracked Excavator - under soil and rock moving	25 days	Working hours
		Trucks - soil removal	25 days	Visits during working hours
Construction	Tank construction	Concrete lorries - delivery of 650 tonnes of concrete	75 days	Visits during working hours
		Flatbed trucks - delivery of 160 tonnes of re-bar	75 days	Visits during working hours
		Trucks - delivery of approximately 6 loads of form work and scaffolding	75 days	Visits during working hours
	Pipelaying	Trucks - delivery of 2 loads of piping	1 month	Visits during working hours
		Tracked excavator - excavating pipe run trenches and refilling after pipe laying	2 month	Working hours
		Breaker and compressor (hand held pneumatic) - rock removal	2 month	Working hours
	Mechanical and electrical installation	Trucks - delivery of 6 loads of equipment	2 months	Working hours

6.2.4 Operation

Figure 6.3 shows a schematic representation of the water and sludge treatment path once this development is in service. New equipment will be electrically operated.

The Red Hill WTW thickening facility is sized to process a peak of 920 kg/day of sludge (dry solid weight). Thickened sludge will be tankered by road to the existing filter membrane press facility at Pak Kong WTW for dewatering and disposal to SENT landfill.

Transfer of thickened sludge to Pak Kong WTW for dewatering will require approximately 1 tanker trip per day (average) at 3% dry solids.

6.2.5 Key Issues

From the data collected concerning the proposed Development at Red Hill WTW, the key issues were identified as:

- construction noise, due to the nearby high rise residential development NSRs; and
- fugitive dust emissions, for the same reason.

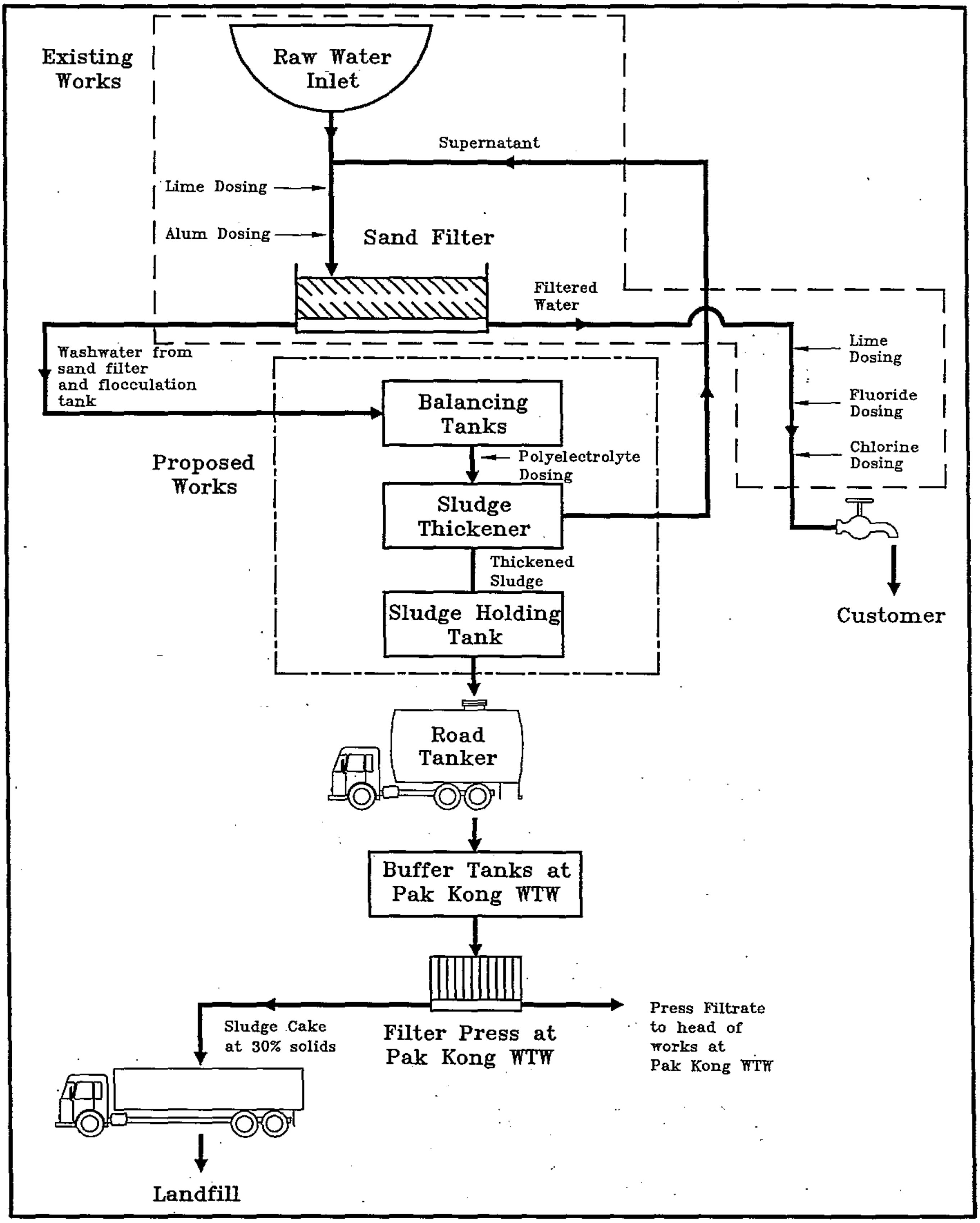

Figure 6.3 : Water Treatment Processes and Proposed Works at Red Hill WTW

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6.3 Construction Phase Impacts and Mitigation Measures

This section examines the potential environmental impacts of the proposed development at Red Hill WTW, along with potential mitigation measures. Special attention is paid to Key Issues.

6.3.1 Visual Impacts

The existing WTW has a limited visual impact due to views of the site from developments at lower levels being prevented by the shielding effect of the slopes of Red Hill and vegetation around the site. Views of the site are only available from south-west facing upper floors of the Red Hill Peninsula high-rise development 200 metres away.

The scale of the proposed development at Red Hill WTW is minor and does not involve construction of facilities above the height of the existing works. On completion of the development the appearance of the site from the limited available views will not change greatly, therefore. visual impact is not considered to be a significant issue at this site.

6.3.2 Ecology

Most of the natural ground cover has already been destroyed by previous developments. No trees will be lost during the construction process. Due to these factors and the small scale of developments on this site, the development will have very little negative impact on flora.

There is relatively little bush and tree cover. around the WTW due to its exposed position. Therefore, birds and other wildlife are not in evidence in significant numbers around the site. Those that are present may be scared away from the area around the development site by the disturbance caused during construction. But due to the limited area of the development and the low value of the surrounding area of the works to wildlife, numbers affected will be small, limiting the significance of impacts on fauna.

Ecological impacts of construction are considered of minor significance

Care by the contractors building the development will ensure impacts are kept to a minimum by preventing vegetation beyond the completed works boundary being damaged accidentally. This would also minimise the disturbance to wildlife in the surrounding area by confining the disturbance.

There is some scope at the Red Hill site to establish an improved vegetative cover around the edges of the proposed development. However, to enable a large enough area to be used in landscaping to be effective, rather than simply decorative, land would have to be acquired outside the existing works boundary.

6.3.3 Traffic

By looking at the estimated volumes of wastes and construction materials required to complete the development, it can be estimated that approximately 200 vehicle trips will be required during the 10 month construction period. This means that at peak construction times approximately 15 vehicle movements a day would be made.

The site has limited access to the main Hong Kong road system, as heavy vehicles are precluded from approaching from the north across Tai Tam Reservoir Dam. However, previous construction projects, far larger than that proposed, have been carried our at Red Hill so traffic impacts, while significant, would not prevent the project going ahead.

Construction traffic entering or leaving the development will have to use Red Hill Road which is narrow and winding. Construction vehicle drivers should be made aware of this poor access road and where possible other road users should be made aware of the possibility of construction traffic traveling to and from the development site. This could be carried out by a limited leafleting exercise of the properties accessed from Red Hill Road.

6.3.4 Noise

A noise assessment for the construction of the proposed development has been carried out. Percussive piling will not take place on this site as the geology provides a suitable foundation without piling. The noise assessment was carried out following the methodology described in the EPD Technical Memorandum concerning, "Noise from Construction Work Other Than Percussive Piling".

The technical detail of calculation of potential noise levels is shown in Appendix C.

It was found that during construction the CNLs at the Residential Housing and Hong Kong International School would be 63.5 dB(A) and below 70.5 dB(A) respectively. It is not possible to be specific for the levels at the International School as a correction factor for distance attenuation over a distance greater than 300 metres is not given in the Technical Memorandum concerning, "Noise from Construction Work Other Than Percussive Piling". With regard to schools EPD's Practice Note ProPECC N2/93 recommends that the maximum daytime noise levels should be 70 dB(A) (65 dB(A) during examinations). Use of equipment which has been effectively silenced should be incorporated wherever possible to minimise construction noise. Use of a silenced breaker would achieve corrected noise levels at the Hong Kong International School of <68 dB(A).

There is potential for noise nuisance from the site, but it is not thought to be highly significant.

6.3.5 Airborne Emissions

The FDM was applied to the proposed development to calculate the potential total suspended particulates at the two identified NSRs. The technical details of the way the FDM was applied is described in Appendix D to this document. The model provides a worst case as though dust creating construction activity is taking place on the entire area of the proposed development site for 24 hours and the wind is blowing constantly towards NSRs. The FDM calculated dust concentration value is shown Table 6.3, together with the factors which will, in a real case, make the actual TSPs found at the NSRs lower. It should be noted that the model does not allow for the topography of the site (it assumes a flat site with the NSRs at the same level as the site) or for the effects of vegetation around the site. In this case, the calculated value for maximum concentration may not occur at the ground on the residential block NSR, but some way up the building. There is little screening vegetation around the site to influence dust generation and its movement towards the NSRs.

Table 6.3 Modeled Dust Concentrations at NSRs and Correction Factors

NSR	FDM 24 hour average concentration ($\mu g/m^3$)	Actual time wind in quarter towards NSR	Barriers (e.g. topography, vegetation)	Actual Working Hours	% of site likely to be open for dust generation	Realistic 24 hour Concentration at NSR due to Development ($\mu g/m^3$)
Housing Development	193	45	N/A	8	70	20
Hong Kong International School	63	10	Slope of Hillside	8	70	10

The results of the modeling exercise show that the fugitive dust emissions from the site are unlikely to approach the AQO TSP of 260 $\mu g/m^3$ average over 24 hours at either of the NSRs, even if construction activity were to continue for 24 hours a day, the local topography was completely flat, and the local weather conditions blew dust from the site to the NSRs constantly over the 24 hour period. The results of the modeling exercise, when considered with the "real world" site specific factors has shown that the site is unlikely to cause the 24 hour AQO for TSPs to be exceeded at the NSRs.

Table 6.4 Fugitive Dust Control Measures

Development Stage and Control Methods	Comments
Land Clearing/Earth Moving	the major source of dust from this development
Watering	Water should be applied over the site prior to conducting any land clearing. This will increase the moisture content of the soil, thereby increasing its stability. Clay soil should be kept above 8% water to prevent dust generation. Water should be re-applied as necessary over the period that bare soil areas are exposed. Water can be applied by sprinklers or hoses.
Minimise Loading Drop Height	Mechanical excavator drivers should ensure that the height spoil is dropped from into haul vehicles is minimised, thus reducing dust generation.
Cover Haul Vehicles	Haul vehicles should be tarpaulined to prevent dust being generated from their loads as they move along the highway.
Paved Road Track Out	Not a major source of dust in this case as haul vehicles will not have access to the site.
Sweep/clean roadways	The access road should be swept or water flushed clean to prevent re-entrainment of deposited dust.
Cover Haul Vehicles	Covered haul vehicles prevent the road from being contaminated with dust.

However, as reliable background TSP counts are not available for the immediate area, it is preferable that fugitive emissions from the development should be reduced to the lowest possible levels by appropriate mitigation measures. These are shown in Table 6.4.

With these mitigation measures employed during the construction period and the establishment of vegetation as soon as possible over areas of exposed ground, once construction is complete, suspended particulates from the construction process should be kept within acceptable limits.

6.3.6 Water Quality

Due to the small area of the site volumes of run-off generated will not be large enough to reach local watercourses and produce a potential for raised levels of sediments. Run off will be stopped by surrounding vegetation.

6.3.7 Cultural Heritage and Archaeology

No areas of cultural or archaeological value will be affected by the development at Red Hill WTW.

6.3.8 Safety

Apart from the road safety issues already discussed in Section 6.3.3 construction of the proposed development will not give rise to any other specific safety issues

The existing WTW on this site is also classified as a PHI due to the storage of chlorine on site. The same care should be exercised to prevent increased danger from chlorine deliveries at this site during the construction period as that described in Section 5.3.8

Normal site safety practices should be followed.

Contractors should be advised in advance of chlorine deliveries. All construction activities, which could potentially affect a delivery, should be suspended until the delivery is complete. Should the construction process have caused any affects which might increase the likelihood of an accident during a chlorine delivery, e.g. piles of materials stored on roadways, dirt on access roads, these matters should be addressed prior to the delivery. Delivery drivers should be warned of the construction process happening at the WTW to enable them to exercise additional care.

6.3.9 Waste Disposal

Wastes produced by the construction process will be inert. They will be made up of cleared vegetation, soil, rock, and unusable or used building materials. Waste disposal is therefore straightforward. As long as these wastes are disposed of at a suitably licensed landfill they should cause no significant environmental impacts.

6.4 <u>Operational Phase Impacts and Mitigation Measures</u>

6.4.1 Visual Impacts

As stated in Section 6.3.1, the proposed development site is largely hidden by its position at the top of the hill. The development site will be overlooked as a middle distance view by a number of flats in the residential block to the east of the development. The tanks and pumping stations proposed are low buildings, below the height of the existing WTW. This, together with the screening effects of topography and vegetation leads to a low visual impact. Some re-establishment of vegetation is likely around the edges of the proposed development post-completion which would further reduce views of the development post-construction.

The visual impacts of the proposed development at Red Hill WTW are not thought to be significant.

6.4.2 Ecology

Operation of the proposed development will have no negative ecological impacts further to the permanent loss of under $400m^2$ of hilltop under the development as described in Section 6.3.2. Wildlife displaced by the noise and activity during the construction phase is likely to return to the area once this activity ceases.

Negative ecological impacts of operation are not thought to be significant, so mitigation is not necessary.

The operation of the proposed development will remove an average of 40 m^3 of water treatment works sludge which would otherwise be released into Tai Tam Bay which is part of Southern Water Control Zone. This will help reduce smothering of bottom fauna and the effects on aquatic organisms of reduced light penetration due to high turbidity.

6.4.3 Traffic

The operation of the proposed sludge treatment facilities will generate 1 sludge tanker journey to Pak Kong WTW per day.

This additional traffic is insignificant compared with the current traffic levels and traffic carrying capacity of the main roads from Red Hill WTW to Pak Kong WTW, though new drivers should be advised of the bad access road to the WTW site.

6.4.4 Noise

None of the activities involved in operating the proposed development generate significant noise levels. The current contains similar pumps and tanks to those which are proposed. These currently cause no noticeable noise on site. Therefore, operational noise is not considered significant.

6.4.5 Airborne Emissions

The operational activities of the proposed development will not generate any significant levels of air emissions. The most important source of air contamination connected with the new plant will be from the exhausts of tankers removing sludge, and this is not considered significant.

As WTW sludge from Red Hill WTW is low in algae, it is not odiferous, and has no potential to generate nuisance odours.

6.4.6 Water Quality

As mentioned in Section 6.4.2 the operation of the proposed development will remove an average of 40 m^3 of water treatment works sludge which would otherwise be released into Tai Tam Bay. Water quality in this area will therefore, be improved by a reduction in turbidity and suspended solids.

6.4.7 Cultural Heritage and Archaeology

The operation of the proposed developments would have no effects on Cultural Heritage and Archaeology.

6.4.8 Safety

Operation of the proposed development would have no specific safety implications on site.

Tanker transportation of WTW sludge is discussed in Section 5.4.8. This will cause no significant impacts.

6.4.9 Waste Disposal

The operation of the proposed development will produce approximately 4760 kg of thickened sludge per month. This will be transported to Pak Kong WTW where the volume will be greatly reduced by the removal of water. The remaining sludge cake will be disposed of to a licensed landfill site. Following this disposal route waste disposal is not thought to present significant environmental impacts.

6.5 Summary of Impacts and Mitigation Measures

Tables 6.5 and 6.6 show summaries of the potential construction and operational impacts of the proposed development at Red Hill WTW, and also proposed mitigation measures.

6.6 Conclusions

Environmental impacts resulting from the construction and operation of the proposed development at Red Hill can be reduced to acceptable levels provided that the proposed mitigation measures are fully implemented.

Traffic impacts at Red Hill are considered to be of medium significance, due to the narrow access road to the WTW. In addition, access from the north is restricted for heavy vehicles due to the narrow crossing along Tai Tam Reservoir Dam. Construction vehicle drivers should be made aware of the potential dangers in order to reduce potential impacts to a minimum.

Noise from construction at Red Hill is also considered to be of medium significance, however noise control measures including the use of a silenced breaker at all times and other silenced powered mechanical equipment (PME) where possible, will enable noise levels to fall below ProPECC recommended daytime levels. With regard to the Hong Kong International School, scheduling of work to avoid sensitive periods such as examinations should be carried out in order to meet ProPECC recommended noise levels during examinations (65 dB(A)).

Once operational, the proposed development at Red Hill will have no significant impacts.

TABLE 6.5 RED HILL WTW - SUMMARY OF CONSTRUCTION PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual impact of construction site	Adverse	Short term	Local	Minor	-
Ecology	Vegetation loss due to construction	Adverse	Long Term	Local	Negligible	-
	Disturbance of natural habitats	Adverse	Short Term	Local	Negligible	-
Traffic	Increase in construction traffic on access road	Adverse	Short Term	Local	Medium	Contractors briefed on dangers of narrow access road. Leafleting of properties accessed by Red hill Road to warn of construction traffic.
	Increase in construction traffic on main roads	Adverse	Short Term	Regional	Minor	Routing to avoid crossing dam.
Noise	Construction noise	Adverse	Short Term	Local	Medium	Noise monitoring during construction. Use of a silenced breaker. Use of other silenced PME where possible.
Airborne Emissions	Dust from construction work	Adverse	Short Term	Local	Minor	Fugitive dust control measures.
	Exhaust emissions	Adverse	Short Term	Local	Minor	-
Water Quality	Site runoff and erosion	Adverse	Short Term	Local	Negligible	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage	No Impact			Nil	N/A
Safety	Potential for accidents on construction site	Adverse	Short Term	Local	Minor	Care in use of plant machinery. Contractors briefed on the dangers of chlorine, delivery plan formulated and followed.
	Potential for accidents off site	Adverse	Short Term	Regional	Minor	As road safety above.

TABLE 6.6 RED HILL WTW - SUMMARY OF OPERATIONAL PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual intrusion	Adverse	Long Term	Local	Minor	Re-establish vegetation as appropriate.
Ecology	Removal of natural habitats	Adverse	Long Term	Local	Negligible	-
Traffic	Increase in operational traffic on WTW access road	Adverse	Long Term	Local	Minor	-
	Increase in operational traffic on main roads	Adverse	Long Term	Regional	Minor	-
Noise	Operational noise	Adverse	Long Term	Local	Negligible	-
Airborne Emissions	Dust from operation	Adverse	Long Term	Local	Negligible	-
	Odour from operation	Adverse	Long Term	Local	Negligible	-
Water Quality	Marine water quality	Beneficial	Long Term	Regional	Medium	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage..	No Impact			Nil	N/A
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Minor	-

SECTION 7

ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED SLUDGE TREATMENT DEVELOPMENT AT TSUEN WAN WATER TREATMENT WORKS

7.1 Existing Environment

7.1.1 Background

The proposed site for development of sludge treatment facilities at Tsuen Wan lies within the existing WTW boundary, apart from the proposed modification of a connection between an existing washwater pipeline and a sewer which is proposed on Kwok Shui Road, adjacent to Lot 736 (Chung Nam Industrial Building). Figure 7.1 and Plate 7.1 show a plan and an aerial photograph of the area, respectively. Tsuen Wan WTW covers an area of 5.34 hectares and has a designed output of 317 MLD.

Tsuen Wan WTW is situated in North Kowloon on the peak of a hilly ridge at Sheung Kwai Chung, map reference 831 826. The ridge runs south-west to north-east with little development on either of its flanks due to the steepness of its slopes. The slopes are covered in dense vegetation and trees. The floor of Shing Mun Valley to the north is currently being developed (see Section 7.1.6). On the south facing slope of the valley are the high rise residential developments of Shek Wai Kok Estate and Cheung Shan Estate, with Cheung Pei Shan Road visible between these developments directly north of the site. Low rise developments at Loi Wai are visible beyond this. To the south-west, largely screened from the site by steep cliffs, are residential developments. There is a narrow band of recreational land between Kwok Shui Road and Castle Peak Road, beyond which is the mixed commercial and residential area of Kwai Chung.

7.1.2 Existing Works

Tsuen Wan WTW takes raw water from Plover Cove, Tai Lam Chung and Jubilee reservoirs as well as waters from China. The main facilities currently on the site include:

- the main filter building;
- three washwater recovery tanks; and
- a service reservoir.

Two blocks of 12 sand media rapid gravity filters are located in the main filter building. The filters have an average filter run time of 16 hours/day between washes. Each backwash uses 220m^3 washwater. Washwater from the western filters is taken from the filter beds to three washwater recovery tanks. The eastern filters have no washwater recovery facilities and washwater is discharged onto the northern slope of the site.

Existing Discharge Practice

Sludge (1900 m^3/day average) is drawn from the washwater recovery tanks fed by the western filters to a sludge balancing tank on the south-east slope and is discharged through a pipe to a sewer in Kwok Shui Road to the south. Previously, sludge flows from the WTW have caused manhole covers to lift and flooding to occur in Kwok Shui Road. A throttling valve was introduced to reduce the head at the sewer connection although this causes the sludge balancing tank to overflow instead. The washwater balancing tanks overflow to a surface channel leading to Ham Tin Tsuen situated to the south of the works. Washwater from the eastern filters (4350m^3/day average) discharges to Shing Mun Road storm drain.

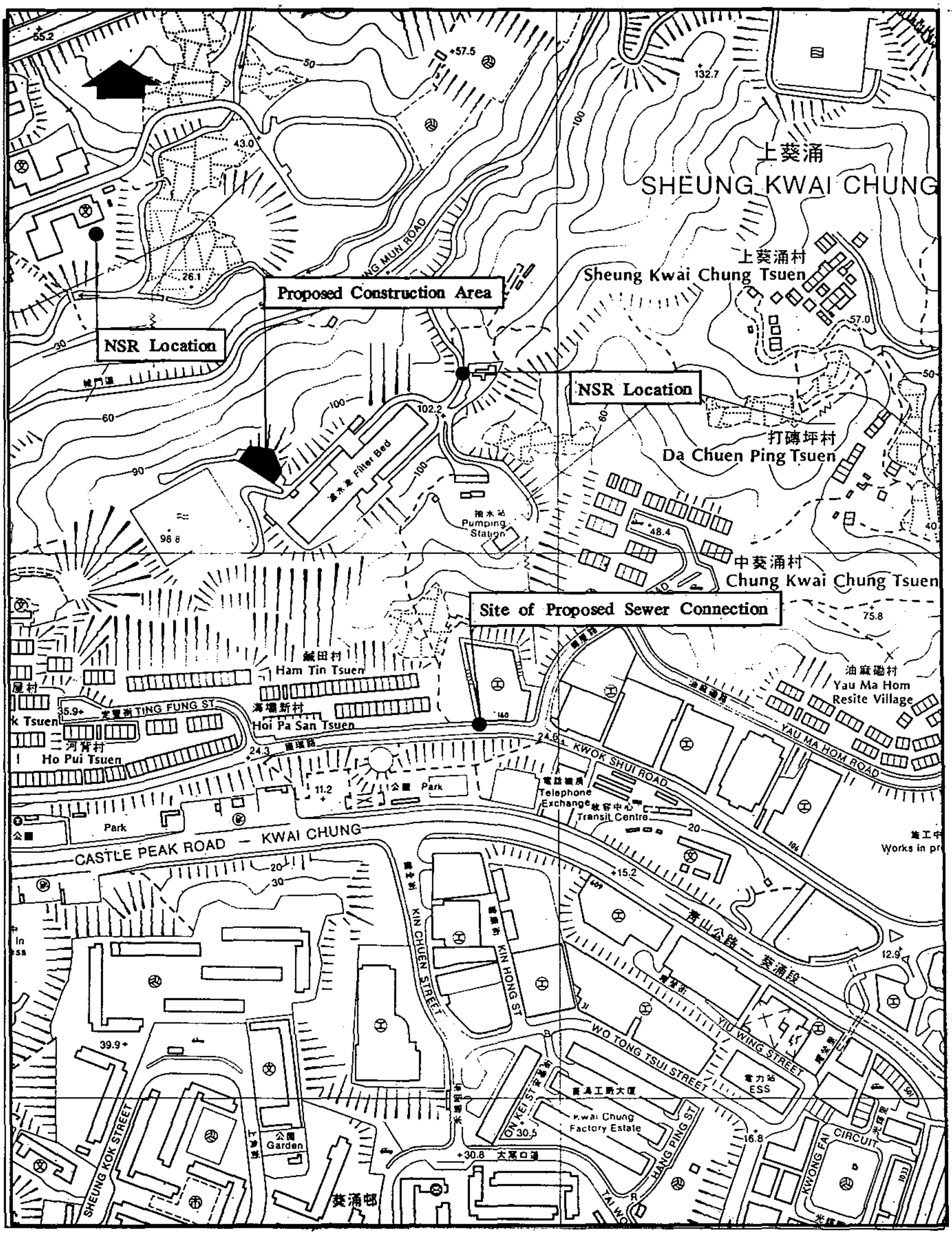

Figure 7.1
Proposed Development and Nearest Sensitive Receiver Location-Tsuen Wan WTW

Discharges from Tsuen Wan WTW flow into the Victoria Harbour Phase 1 (Tsuen Wan and Kwai Chung) Water Control Zone which was declared in 1994.

7.1.3 Geology

The geology of the general area is made up of Mesozoic volcanic and sedimentary rocks with intrusions of granitic igneous rocks. The WTW site is located on an igneous intrusion. This has been weathered and is, therefore, relatively soft down to a depth of up to 12 metres in places. Below this relatively soft surface is considerably harder unweathered bedrock.

7.1.4 Landscape Character and Visual Aspects

Tsuen Wan WTW is located on a ridge which is a major landscape feature for both Kwai Chung and Shing Mun Valley. The ridge forms one of the few areas of land not yet covered by developments. This little developed character extends to the west of the WTW site, giving the appearance of an island of low density/no development, surrounded by high rise residential and industrial developments. Where natural slopes are too great for easy construction they are covered by dense assorted tree and shrub cover.

The existing WTW consists of one major building incorporating offices, process equipment and filter beds. This building is approximately 160 metres long and 30 metres wide. Also on the ridge, to the west of the main building, is a covered service reservoir. Paths follow underground pipe routes down the south east face of the ridge. The narrow access road to the plant winds up the north side of the ridge. Due to the low level of development directly adjoining the WTW the character of the area could be described as rural. However, wherever a view from the WTW is allowed by gaps in surrounding trees it can be seen that the character of the land around the WTW is urban. Noise intrusion is noticeable on the north side of the works from the dual carriageway, Cheung Pei Shan Road. Due to the presence of this road and adjacent factories background noise levels at the works are relatively high.

7.1.5 Ecology

As shown on Plate 7.2, the proposed development site has already been developed and is currently concrete hard standing. No ecologically significant matters are therefore directly relevant for consideration of the site. However, the site is surrounded by a variety of broad leafed trees and the general area may be of significant value to wildlife as, due to the steep slopes, most of the ridge is not easily accessible and has therefore been left relatively undisturbed by man.

7.1.6 Concurrent Developments

The development of a landscaped garden, active sports and recreational facilities, are currently taking place in Shing Mun Valley. The undeveloped area on the ridge to the north east of the WTW has been zoned for the construction of low density village type developments. However, the schedule for construction of these residences has not been identified.

A fire pump house and an associated emergency generator and switchgear room will be built to the north west of the eastern filters. The work which is anticipated to take 14 months will commence in early 1996.

No other developments or significant maintenance tasks are programmed to take place on the WTW site during the development construction period.

Plate 7.1
Tsuen Wan Water Treatment Works Location Plan

Plate 7.2 **Site for Proposed Washwater Recovery Tanks - Tsuen Wan WTW**

Plate 7.3 **Site of Proposed Sewer Connection - Tsuen Wan WTW**

7.1.7 Traffic

From the WTW, the narrow access road joins Shing Mun Road at a T-junction. From this point, access to the major roads system can be gained by turning west; which leads directly to Texaco Road North; or east, which then requires vehicles to pass Cheung Shan Estate before accessing Cheung Pei Shan Road. Shing Mun Road has two narrow lanes and a number of blind bends. Ability to see round a number of corners has been reduced by the hoardings erected to screen the road from construction in Shing Mun Valley. Traffic volumes are light on this road.

7.1.8 Air Quality

Noise

The NSRs to the centre of the proposed development site at Tsuen Wan WTW are:

- Shek Wai Kok Estate (250 metres distant); and
- Auxiliary Nurse Training Quarters (210 metres distant).

Some of the residential buildings to the south-east of the site are closer than those at Shek Wai Kok Estate, however, these are shielded by the existing works building and the ridge upon which the WTW is sited. They are therefore, unlikely to be impacted by the proposed development.

As described in Section 7.1.3, the area surrounding Tsuen Wan WTW is typically urban and this classification can be applied to the NSRs under the Technical Memorandum on Noise from Construction Work other than Percussive Piling.

Shek Wai Kok Estate is directly affected by traffic noise from Cheung Pei Shan Road. However, the southern sides of the buildings, facing the proposed development, are largely angled away from the road and so could only be argued to be indirectly affected by Cheung Pei Shan Road. Cheung Pei Shan Road can be considered as an indirect IF on these NSRs for normal daytime hours, as the road carries a heavy and generally continuous flow of traffic over the daytime and evening periods, (a traffic flow rate in excess of 30,000 vehicles per day).

The Auxiliary Nurse Training Establishment is partially screened from the proposed development site by the existing WTW buildings and the slope of the ridge.

Dust

There is an air pollution monitoring station at 60 Tai Ho Road. The area is classified by the EPD as Urban/Residential. This site is approximately 1 km to the west of the WTW but at only 21 metres above mPD, whereas the proposed site is at 100 metres mPD. However, as the monitoring station is relatively close to the site, its data can be taken to be indicative of the air quality at Tsuen Wan WTW.

Annual means of TSPs have been measured to vary between 87 and 101$\mu g/m^3$ at the Tsuen Wan monitoring station. The Air Quality Objective for the annual mean is 80$\mu g/m^3$. Therefore, any additional dust emitted into the environment can be considered to have a significant impact on the air quality.

7.1.9 Water Quality

Sludge from the western filters is currently discharged into a sewer in Kwok Shui Road. The sewer will lead to Stonecutters Island Sewage Treatment Works. Wastewater from the eastern filters discharges to Shing Mun Road Storm Drain. Both of these discharges currently flow into the Victoria Harbour (Phase 1) Water Control Zone A brief discussion of the likely effects of sludge discharge into the Victoria Harbour is given in Section 5.1.9.

7.1.10 Cultural Heritage and Archaeology

No graves, cemeteries or areas, sites or structures of cultural heritage or archaeological value have been identified as present at Tsuen Wan WTW site.

7.2 Proposed Development

7.2.1 BEECOPS Evaluation for WTW Disposal

The disposal to sewer option for Tsuen Wan was found to be preferable to the dewatering option on all accounts, largely due to the fact that this site currently discharges to sewer with no reported detrimental impacts, the cost of sewer disposal is significantly lower than dewatering, and no significant environmental impacts were identified.

7.2.2 Proposed Development at Tsuen Wan

It is proposed to provide five washwater recovery tanks at Tsuen Wan. In addition, the existing washwater recovery tanks will be converted into sludge storage tanks. Table 7.1 shows details of the proposed equipment to be installed. Figure 7.2 shows the layout for the proposed works.

Table 7.1 Proposed Equipment to be Installed or Constructed at Tsuen Wan WTW

Item Description	Item Size	Material	Unit	Quantity
Washwater recovery tanks	286 m^3	Reinforced Concrete	no.	5
Sludge storage tanks (conversions of existing tanks)	295 m^3	Reinforced Concrete	no.	3

Sludge will be conveyed to sewer via pipeline. The existing sludge pipeline to sewer will be utilised for the majority of the proposed pipeline route. This pipeline is 300 mm diameter. concrete up to a sludge balance tank and then continues as a 200 mm diameter. ductile iron pipe down a steep slope to an existing 225 mm diameter sewer connection beside Kwok Shui Road. It is intended to reconnect the sludge pipeline to an adjacent sewer (see Plate 7.3). Sludge pipeline design details are shown in Table 7.2. Hydraulic control will be required at the bottom of the steep slope and the pipe laying methodology employed will be open trench.

Table 7.2 Sludge Pipeline Design Data

Maximum sludge to sewer	47 l/s	Length of pipe	33 m
Selected pipe size	250 mm	Connection sewer pipe size	300mm
Sludge discharge period	Off-peak only (12.00-8.00 a.m.)	Hydraulic control required	Yes
Pipeline laying method	Open trench		
Selected pipe size	250 mm		

7.2.3 Construction

The construction process is likely to take approximately 12 months. The first month will involve site clearance and preparation. During the following 4-5 months the new washwater recovery tanks will be installed and the existing tanks will be converted to sludge storage tanks. Mechanical and electrical equipment will be installed in the next 4 months followed by conversion works over a period of approximately 3 months. Connection of the pipeline to sewer at Kwok Shui Road is expected to take approximately 1 month. Work is scheduled to commence on site on 29/11/96.

Construction of the proposed washwater recovery tanks will require concrete breaking of the existing surface. Work will also involve realignment of the existing road adjacent to the service reservoir.

Table 7.3 Likely Construction Process, Estimates of Materials and Equipment Required, and Wastes Generated for Proposed Development at Tsuen Wan

General Activity	Specific Activity	Equipment and use	Time period for activity	Time used on site
Site Clearance	Excavation	Breaker (hand held pneumatic) - rock removal	90 days	Working hours
		Generator - power breaker	90 days	Working hours
		Breaker (excavator mounted pneumatic)	90 days	Working hours
		Tracked Excavator - soil and rock moving	90 days	Working hours
		Trucks - concrete removal	90 days	Visits during working hours
Construction	Tank construction and modification	Concrete lorries - delivery of 3600 tonnes of concrete	5 months	Visits during working hours
		Flatbed trucks - delivery of 900 tonnes of re-bar	5 months	Visits during working hours
		Trucks - delivery of approximately 8 loads of formwork and scaffolding	4 months	Visits during working hours
	Pipelaying	Trucks - delivery of 5 loads of piping	2 months	Visits during working hours
		Tracked excavator - excavating pipe run trenches and refilling after pipe laying	2 months	Working hours
		Breaker and compressor (hand held pneumatic) - rock removal	2 months	Working hours
	Mechanical and electrical installation	Trucks - delivery of 20 loads of equipment	2 months	Working hours

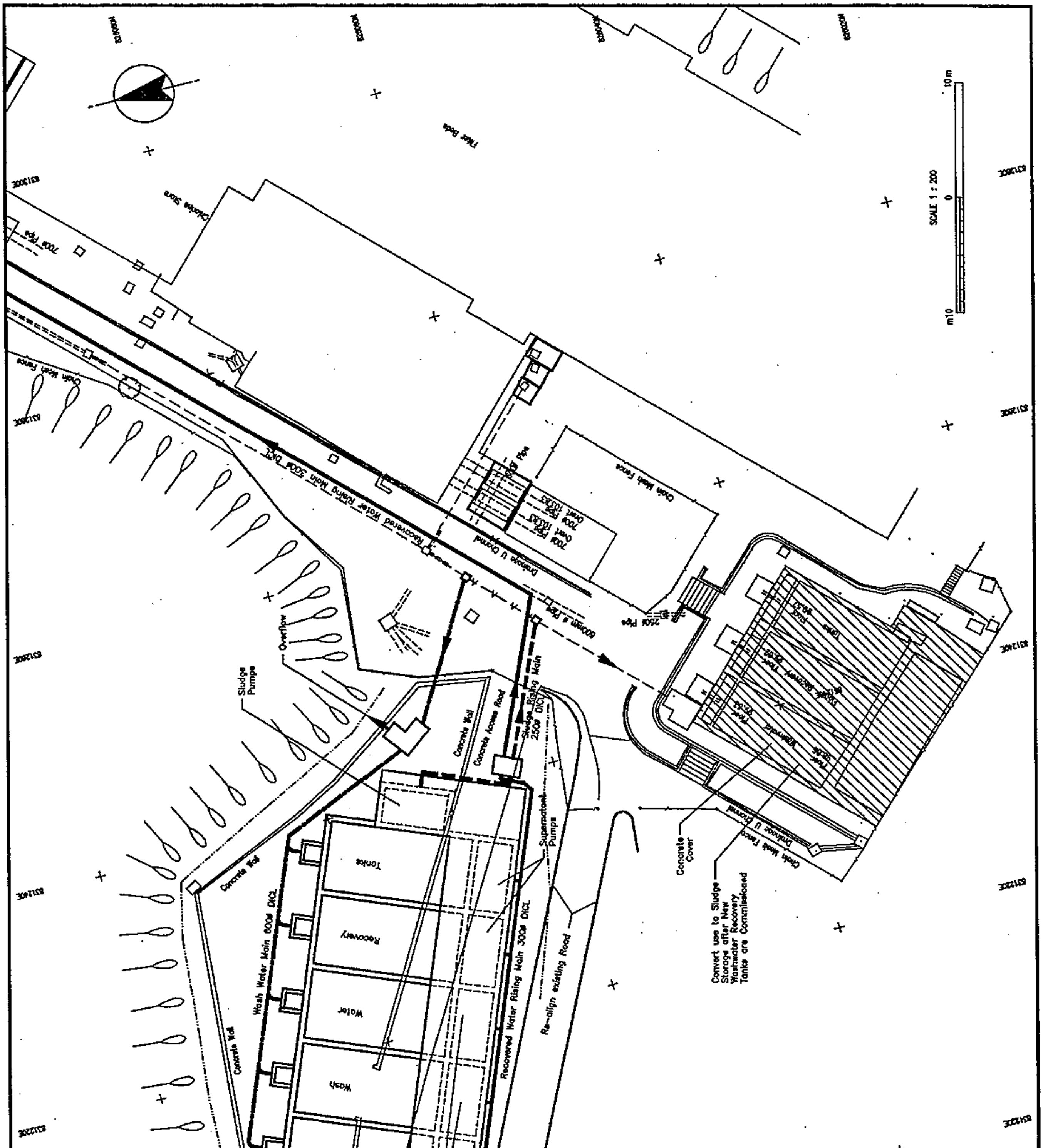

Figure 7.2 : Layout of Proposed Sludge Treatment Facilities at Tsuen Wan WTW

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Table 7.3 shows the likely activities involved in the construction process, estimates of materials and equipment required, and wastes generated.

7.2.4 Operation

Figure 7.3 shows a schematic representation of the water and sludge treatment path, once this development is in service. Discharge of sludge is to sewer leading to Stage I of Stonecutters Island STW. New equipment will be electrically operated.

7.2.5 Key Issues

From the data collected concerning the proposed Development at Tsuen Wan WTW, the key issues were identified as:

- traffic impacts, during sewer connection at Kwok Shui Road ;
- potential visual impacts; and
- potential ecological impacts, due to mature vegetative covering on the borders of the proposed site.

7.3 <u>Construction Phase Impacts and Mitigation Measures</u>

This section examines the potential environmental impacts of the proposed development at Tsuen Wan WTW, along with potential mitigation measures. Special attention is paid to Key Issues.

7.3.1 Visual Impacts

Visual Analysis

Distant views of the site are available from Lo Wai and high rise developments to the north. The existing buildings are apparent on the sky line at the top of the vegetated ridge, however, tree growth obscures much of the site from view. Views of the works from buildings at the foot of the south facing slope are obstructed by the slope. As with views from the north, views from buildings further south are restricted as the existing WTW is largely screened by tree growth. Views are only available from the higher stories of high rise buildings, the nearest of which is approximately 300 metres away. From these vantage points the pleasant appearance of the vegetated slope is marred by the roofs and chimneys of factory units at the base of the slope.

Visual Impact

The existing works has a limited visual impact due to the urban background in which it is placed, and the mitigating influence of vegetation shielding it from view.

The new development site will be visible only from the north as the ridge and existing works will block all views from the south.

Due to the limited extent of works, the existing screen of trees, and the fact that none of the new development will intrude above the existing skyline of the WTW and ridge, the development at Tsuen Wan is not thought to have a significant visual impact.

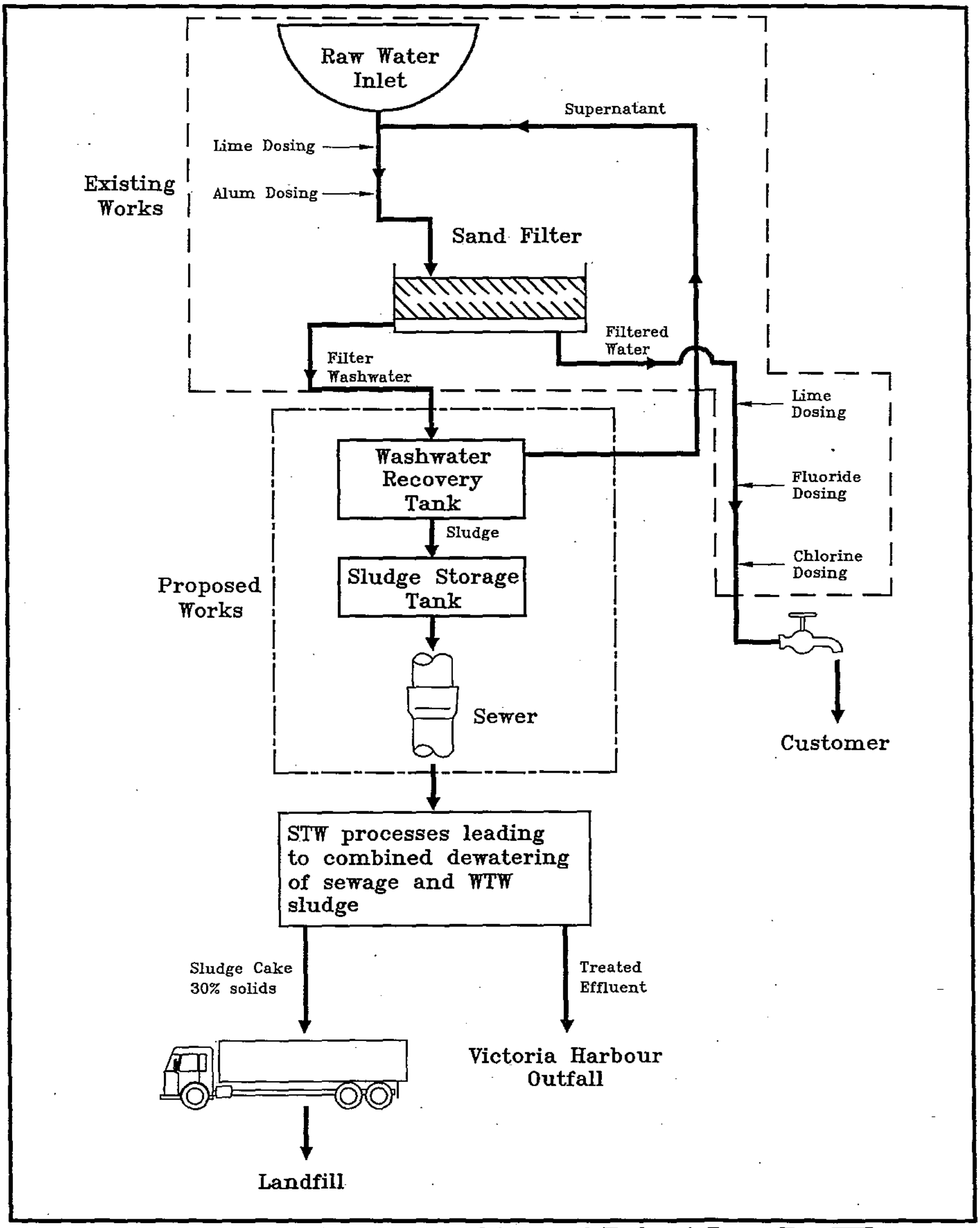

Figure 7.3 : Water Treatment Processes and Proposed Works at Tsuen Wan WTW

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7.3.2 Ecology

No vegetative cover will be lost by the construction of the proposed development, except a strip of rough scrub and grass due to road realignment on the west boundary of the site Ecological impacts are a concern as the area to the north of the proposed site is of ecological value due to its relatively inaccessibility and lush vegetative cover making it a haven for wildlife. Should the construction process affect the trees bordering the site, the value of this area would be significantly impacted.

Birds and other wildlife are likely to be scared away from the area around the development site by the disturbance caused during construction. Due to the limited area of the development numbers of affected wildlife will be small limiting the significance of this impact.

Care should be exercised by the contractors building the development not to allow construction processes to affect the area beyond the edge of the existing concrete wall which marks the northern boundary of the site. This will ensure ecological impacts are kept to a minimum by preventing vegetation beyond the completed works boundary being damaged accidentally. This would also minimise the disturbance to wildlife in the surrounding area by confining the disturbance.

Construction of the proposed development does not require the removal of any established trees.

7.3.3 Traffic

Access to the proposed site is relatively narrow and twisty. This raises the possibility of road traffic accidents involving construction traffic entering or leaving the development. By looking at the estimated volumes of wastes and construction materials required to complete the development it can be estimated that approximately 400 vehicle trips will be required during the 12 month construction period. This means that at peak construction times approximately 50 vehicle movements a day would be made. The addition of this number of vehicles is unlikely to cause significant impacts.

Impacts could be limited by informing construction vehicle drivers of the bad access roads, and informing other regular road users in the area (especially those using the Auxiliary Nurse Training Quarters on the site access road) of the likely presence of construction traffic.

7.3.4 Noise

Noise assessment for the construction of the proposed development has been carried out. Percussive piling will not take place on this site as the geology provides a suitable foundation without piling. The noise assessment was carried out following the methodology described in the EPD Technical Memorandum concerning, "Noise from Construction Work other Than Percussive Piling".

The technical detail of calculation of potential noise levels is shown in Appendix C.

It was found that during construction the CNLs at the Shek Wai Kok Estate and Auxiliary Nurse Training Quarters would be 71.5 dB(A) and 63.5 dB(A) respectively. This means that significant noise impacts at the Auxiliary Nurse Training Quarters are unlikely, but that the calculation shows a possibility of negative effects at the Shek Wai Kok Estate when compared to the ANL of 70 dB(A).

It is likely that the peak noise level of 71.5 dB(A) would only be achieved occasionally and as all construction processes are scheduled to take place during the working day levels are below the ProcPECC recommended daytime level of 75 db(A). The other potential impact at this site is the possible effects on ecology. The erection of acoustic barriers around the site perimeter as a possible mitigation measure could have long term ecological impacts (e.g. tree removal). Use of silenced equipment would be a preferable mitigation measure. Use of a silenced breaker would enable corrected noise levels for the Shek Wai Kok Estate to fall below the ANL.

There is a potential for occasional noise nuisance from the site, but it is not thought to be highly significant

7.3.5 Airborne Emissions

The FDM was applied to the proposed development to calculate the potential total suspended particulates at the two identified NSRs.

The technical details of the way the FDM was applied is described in Appendix D to this document. The model provides a worst case as though dust creating construction activity is taking place on the entire area of the proposed development site for 24 hours and the wind is blowing constantly towards NSRs. The FDM calculated dust concentration value is shown Table 7.4, together with the factors which will, in a real case, make the actual TSPs found at the NSRs lower.

Table 7.4 Modeled Dust Concentrations at NSRs and Correction Factors

NSR	FDM 24 hour average concentration ($\mu g/m^3$)	Actual time wind in quarter towards NSR	Barriers (e.g. topography, vegetation)	Actual Working Hours	% of site likely to be open for dust generation	Realistic 24 hour Concentration at NSR due to Development ($\mu g/m^3$)
Ho Chen Yin Memorial College	36	20	Existing Vegetation	8	70	5
Auxiliary Nurse Training Quarters	48	45	Existing works Existing Vegetation	8	70	5

It should be noted that the model does not allow for the topography of the site (it assumes a flat site with the NSRs at the same level as the site) or for the effects of vegetation around the site. In this case, site topography and the partial screen of trees which will remain around the site will cut dust generation and its movement towards the NSRs significantly.

The results of the modeling exercise show that the fugitive dust emissions from the site are extremely unlikely to cause any noticeable impacts at the NSRs.

Emissions from the development should therefore, be reduced to the lowest possible levels by appropriate mitigation measures. These are shown in Table 7.5.

With these mitigation measures employed during the construction period and the establishment of vegetation as soon as possible over areas of exposed ground, suspended particulates from the construction process should be kept within acceptable limits.

Table 7.5 Fugitive Dust Control Measures

Development Stage and Control Methods	Comments
Land Clearing/Earth Moving	the major source of dust from this development
Watering	Water should be applied over the site prior to conducting any land clearing. This will increase the moisture content of the soil, thereby increasing its stability. Clay soil should be kept above 8% water to prevent dust generation. Water should be re-applied as necessary over the period that bare soil areas are exposed. Water can be applied by sprinklers or hoses.
Minimise Loading Drop Height	Mechanical excavator drivers should ensure that the height spoil is dropped from into haul vehicles is minimised, thus reducing dust generation.
Cover Haul Vehicles	Haul vehicles should be tarpaulined to prevent dust being generated from their loads as they move along the highway.
Paved Road Track Out	Not a major source of dust in this case as haul vehicles will not have access to the site.
Sweep/clean roadways	The access road should be swept or water flushed clean to prevent re-entrainment of deposited dust.
Cover Haul Vehicles	Covered haul vehicles prevent the road from being contaminated with dust.

7.3.6 Water Quality

Due to the small area of the site, volumes of run-off generated will not be large enough to reach local watercourses and produce a potential for raised levels of sediments. Run off will be stopped by surrounding vegetation.

7.3.7 Cultural Heritage and Archaeology

No areas of cultural or archaeological value will be affected by the development at Tsuen Wan WTW.

7.3.8 Safety

Apart from the road safety issues already discussed in Section 7.3.3 construction of the proposed development will not give rise to any other specific safety issues

The existing WTW on this site is also classified as a PHI due to the storage of chlorine on site. The same care should be exercised to prevent increased danger from chlorine deliveries at this site during the construction period as that described in Section 5.3.8

Normal site safety practices should be followed.

The chlorine store on this site is not adjacent to the proposed development area however, contractors should be advised in advance of chlorine deliveries. All construction activities, which could potentially affect a delivery should be suspended until the delivery is complete. Should the construction process have caused any affects which might increase the likelihood of an accident during a chlorine delivery, for example piles of materials stored on roadways or dirt on access roads, these matters should be addressed prior to the delivery. Delivery drivers should be warned of the construction process happening at the WTW to enable them to exercise additional care.

7.3.9 Waste Disposal

Wastes produced by the construction process will be inert. They will be made up of cleared rubble, soil, rock, and unusable or used building materials. Waste disposal is therefore straightforward. As long as these wastes are disposed of at a suitably licensed landfill they should cause no significant environmental impacts.

7.4 Operational Phase Impacts and Mitigation Measures

7.4.1 Visual Impacts

As stated in Section 7.3.1, the proposed development site is largely hidden by the topography, the existing WTW and vegetation. The most important views of the site are middle distance views from the Shek Wai Kok Estate. The tanks and pumping stations proposed are low buildings. This, together with the screening effects of topography and vegetation leads to very low visual impact.

The visual impacts of the proposed development at Tsuen Wan WTW are not thought to be significant.

7.4.2 Ecology

Operation of the proposed development will have very little negative ecological impacts as the site has already been developed. Wildlife displaced by the noise and activity during the construction phase is likely to return to the area once this activity ceases.

Negative ecological impacts of operation are not thought to be significant, so mitigation is not necessary.

The operation of the proposed development will remove an average of 4350 m^3 of water treatment works sludge which would otherwise be released into Shing Mun Road storm drain which would then flow into the Victoria Harbour Water Control Zone. This will help reduce smothering of bottom fauna and the effects on aquatic organisms of reduced light penetration due to high turbidity.

7.4.3 Traffic

The operation of the proposed sludge treatment facilities will not generate additional regular traffic as no sludge tankering is required. Some additional vehicle journeys may be generated by maintenance staff, but the number of these will be insignificant. This additional traffic is insignificant compared with the current traffic levels and traffic carrying capacity of the main roads in the area.

7.4.4 Noise

None of the activities involved in operating the proposed development generate significant noise levels. The current WTW is closer to NSRs and contains similar pumps and tanks to those which are proposed. These currently cause no noticeable noise on site. Therefore, operational noise is not considered significant.

7.4.5 Airborne Emissions

The operational activities of the Proposed development will not generate any significant levels of air emissions.

7.4.6 Water Quality

As mentioned in Section 7.4.2 the operation of the proposed development will remove an average of 4350 m^3 of water treatment works sludge which would otherwise be released into the storm drain system and finally into the Victoria Harbour Water Control Zone. Water quality in these areas will therefore, be improved by a reduction in turbidity and suspended solids.

7.4.7 Cultural Heritage and Archaeology

The operation of the proposed developments would have no effects on Cultural Heritage and Archaeology.

7.4.8 Safety

Operation of the proposed development would have no specific safety implications on site.

7.4.9 Waste Disposal

The existing Tsuen Wan sewer system has surcharge problems which are being tackled by the planned implementation of the Tsuen Wan, Tsing Yi and Kwai Chung Sewerage Master Plan. To avoid compounding these problems DSD advised discharging sludge during off-peak hours from midnight to 8 a.m. This advice should be followed to prevent significant impacts.

The operation of the proposed development will not produce solid wastes requiring disposal. Therefore, solid waste disposal cannot cause significant environmental impacts.

7.5 Summary of Impacts and Mitigation Measures

Tables 7.6 and 7.7 show summaries of the potential construction and operational impacts of the proposed development at Tsuen Wan WTW, and also proposed mitigation measures.

7.6 Conclusions

Environmental impacts resulting from the construction and operation of the proposed development at Tsuen Wan can be reduced to acceptable levels provided that the proposed mitigation measures are fully implemented.

Traffic impacts at Tsuen Wan are considered to be of minor significance, however due to the relatively narrow and twisty access to the WTW road traffic accidents are a potential problem. Construction vehicle drivers and other regular road users should be made aware of the potential dangers in order to minimise potential impacts. Co-ordination between the contractors and the owners of Chung Nam Industrial Building during construction of the sewer connection along Kwok Shui Road, will reduce potential access problems to the factory.

Once operational the proposed development at Tsuen Wan will have no significant impacts.

TABLE 7.6 TSUEN WAN WTW - SUMMARY OF CONSTRUCTION PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual impact of construction site	Adverse	Short term	Local	Minor	-
Ecology	Vegetation loss due to construction	Adverse	Long Term	Local	Minor	-
	Disturbance of natural habitats	Adverse	Short Term	Local	Minor	-
Traffic	Increase in construction traffic on WTW access road	Adverse	Short Term	Local	Minor	Contractors briefed on dangers of narrow access road. Informing of other regular road users, especially the Auxiliary nurse Training Unit.
	Increase in construction traffic on main roads	Adverse	Short Term	Regional	Minor	-
	Lane closure due to sewer connection	Adverse	Short Term	Local	Minor	Co-ordination with factory owner and authorities to time work to minimise impact.
Noise	Construction noise	Adverse	Short Term	Local	Minor	Noise monitoring during construction. Use of silenced PME where possible.
Airborne Emissions	Dust from construction work	Adverse	Short Term	Local	Minor	Fugitive dust control measures.
	Vehicle exhaust emissions	Adverse	Short Term	Local	Minor	-
Water Quality	Site runoff and erosion	Adverse	Short Term	Local	Negligible	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage	No Impact			Nil	N/A
Safety	Potential for accidents on construction site	Adverse	Short Term	Local	Minor	Normal site safety rules to be followed. Contractors briefed on the dangers of chlorine, delivery plan formulated and followed.
	Potential for accidents off site	Adverse	Short Term	Regional	Minor	As road safety above.
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Minor	-

TABLE 7.7 TSUEN WAN WTW - SUMMARY OF OPERATIONAL PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual intrusion	Adverse	Long Term	Local	Negligible	-
Ecology	Removal of natural habitats	Adverse	Long Term	Local	Negligible	-
Noise	Operational noise	Adverse	Long Term	Local	Negligible	-
Airborne Emissions	Dust from operation	Adverse	Long Term	Local	Negligible	-
	Odour from operation	Adverse	Long Term	Local	Negligible	-
Water Quality	Marine water quality	Beneficial	Long Term	Regional	Medium	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage.	No Impact			Nil	N/A
Waste Disposal	Discharge to sewer	Adverse	Long Term	Regional	Minor	-

SECTION 8

ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED SLUDGE TREATMENT DEVELOPMENT AT SHEK LEI PUI WATER TREATMENT WORKS

8.1 Existing Environment

8.1.1 Background

The proposed works for the development of sludge treatment facilities at Shek Lei Pui WTW are limited to a 300mm pipeline from the works, to the nearby Tai Po Road WTW, a distance of 760 metres. Although the development extends outside the existing WTWs boundary most of the route is along the access road owned by WSD. Figure 8.1 and Plate 8.1 show a plan and an aerial photograph of the area, respectively. Shek Lei Pui WTW covers an area of 1.56 hectares and has a designed output of 91 MLD.

Shek Lei Pui WTW is situated to the north of Kowloon, map reference 833 823. The WTW represents the only development in the area and is surrounded by densely vegetated hill slopes. The site is adjacent to the Kam Shan Country Park at the northern end of Butterfly Valley. Access to the works consists of a narrow single track lane over most of the route leading from Tai Po Road at Piper's Hill. The access road is lined with heavy vegetative cover and steep sloping sides. Slope stabilisation has been carried out alongside the road to the north as it passes the service reservoir. An alternative access route runs from the west of the site along Cheung Yuen Road leading to Cheung Hang Road. However, this road is not regularly used for vehicular traffic and portions of this road, close to the WTW, are overgrown. The WSD staff residence 500 metres to the south east is the closest development to the WTW, although a number of squatter residences occur in the area.

The area surrounding the WTW has high amenity value, with several scenic jogging trails, picnic sites and barbecue pits. The area is used heavily at weekends for recreational use. Two jogging tracks into Kam Shan Country Park lead from the WTW access road, however, alternative access to these tracks is available from other areas of the Park. An additional circular walking track running south of the covered service reservoir, outside Kam Shan Country Park leads from the access road close to the site entrance.

8.1.2 Existing Works

Shek Lei Pui WTW is generally served by the Kowloon group of reservoirs, including Jubilee Reservoir and Kowloon Reservoir. Water may also be supplied from Plover Cove. The main facilities currently on the site include:

- the main filter building; and
- a service reservoir.

The main building contains a number of sand media rapid gravity filters with an average filter run time of 18 hours between washes and a washwater consumption of $50m^3$ per wash. No backwash water recovery is practised.

Existing Discharge Practice

Backwash water (2000 m^3/day average) at Shek Lei Pui is discharged to a man-made waterway situated to the west of the covered service reservoir. The waterway follows a densely vegetated gully formed by two above-ground freshwater mains (treated water distribution pipes) from Shek Lei Pui which has since become a natural stream course along part of its length. The sludge stream from Tai Po Road may join the effluent stream from Shek Lei Pui at some point down the hill before entering Victoria Harbour.

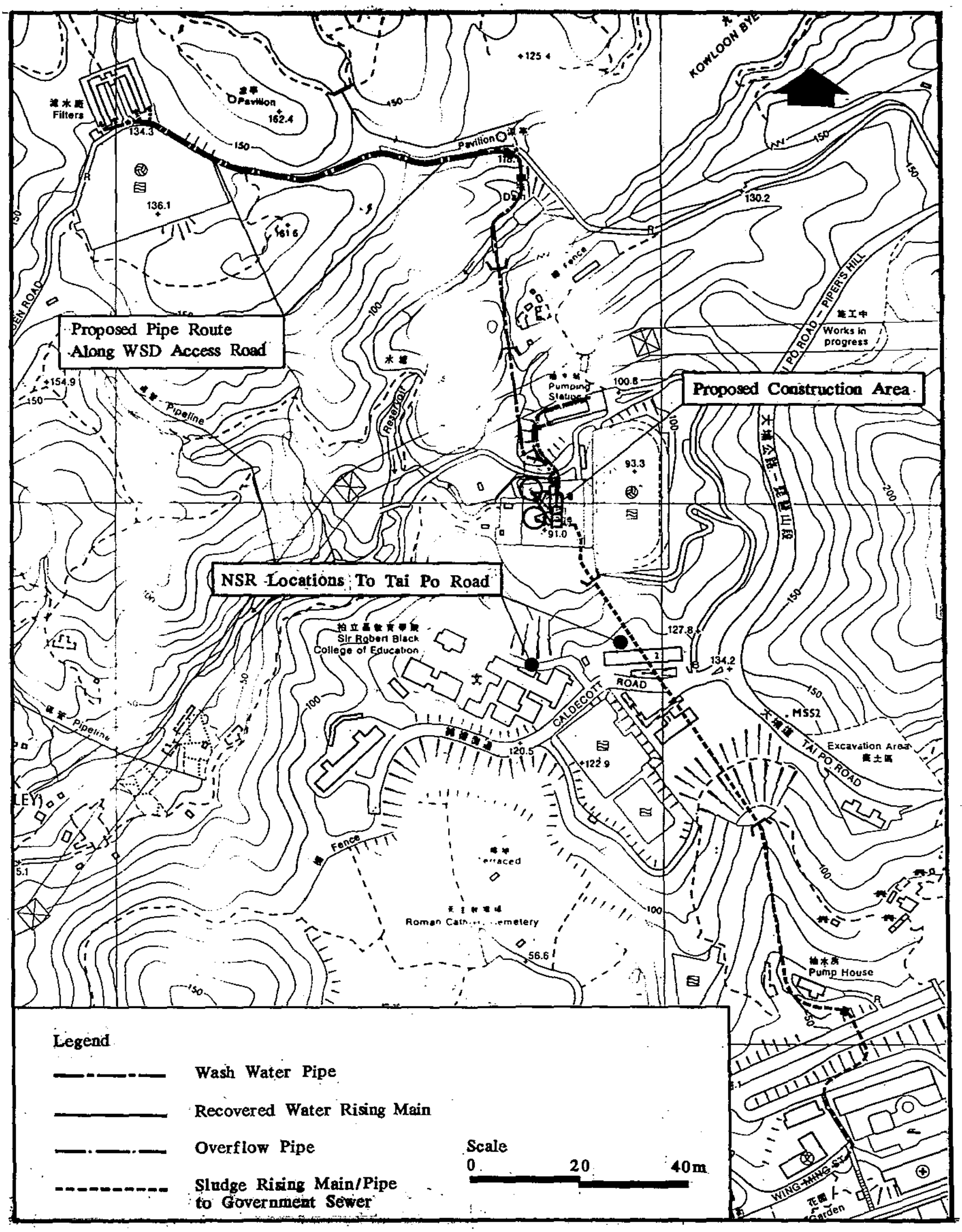
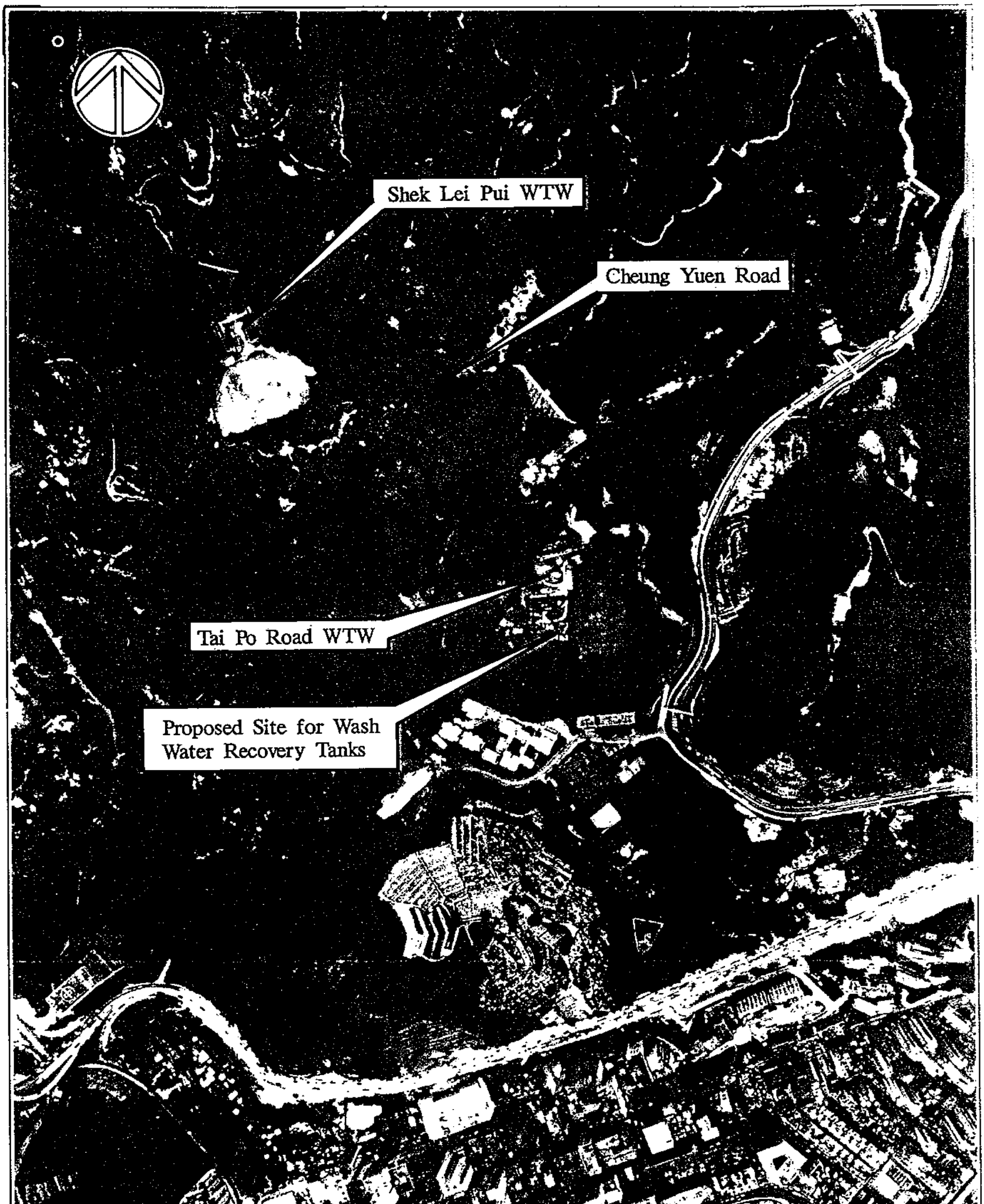


Figure 8.1
Proposed Development and Nearest Sensitive Receiver Location-Shek Lei Pui WTW

Plate 8.1
Shek Lei Pui & Tai Po Road Water Treatment Works Location Plan



Discharges from the treatment works are to the sea within the Victoria Harbour (Phase One) Water Control Zone which was declared in 1994.

8.1.3 Geology

The WTW is situated on fine grained granites formed during the Mesozoic period. The state of decomposition is unknown.

8.1.4 Landscape Character and Visual Aspects

Shek Lei Pui WTW is situated on the southern edge of Kam Shan Country Park. The area is surrounded by gently rolling hills gradually sloping to the south-east. Kowloon Reception Reservoir lies 100 metres to the north, while Kowloon Byewash Reservoir lies 500 metres to the east. The access road to the site runs along side Butterfly Valley from Tai Po Road and crosses Kowloon Byewash Reservoir dam before cutting through the hillside to the WTW.

The existing WTW consists of one main L-shaped building incorporating offices, process equipment and filter beds. The WTW site lies at approximately 134 mPD and is immediately surrounded by vegetated slopes to the north, east and west rising up to 187 mPD. Shek Lei Pui service reservoir, located immediately to the south of the filters, is surrounded by densely vegetated slopes which rise to a small hill before running down to Butterfly Valley in the south. The character of the land surrounding the WTW is therefore rural, dominated by the surrounding densely vegetated hills.

8.1.5 Ecology

The area surrounding the WTW is characterised by a mixture of relatively dense broad-leaved and pine forest with thick undergrowth. Broad-leaved trees such as the native pond spice (*Litsea glutinosa*), fragrant Litsea (*Litsea cubeba*) and red Machilus (*Machilus thunbergii*) are present in this area. The vegetated slopes adjacent to the access road provide a habitat for numerous rhesus and long-tailed macaques. The monkeys can be found in relatively large numbers, particularly around the entrance to the access road off Tai Po Road running along to Kowloon Byewash Reservoir dam. A number of wooden shelters frequented by the monkeys, have been built alongside the road. The monkeys attract many visitors to the area. The area also supports a variety of other wildlife including squirrels and varied bird life.

8.1.6 Concurrent Developments

A trunk main will be laid from Shek Lei Pui WTW to Kau Wah Keng situated to the west, along Cheung Yuen Road. Construction is due to take approximately 1 year commencing towards the end of 1995. No other developments or significant maintenance tasks are programmed to take place on the WTW site during the development construction period.

Shek Lei Pui WTW lies 600 metres outside the Kowloon Outline Zoning Plan. No other development projects were identified in the immediate area.

8.1.7 Traffic Levels

The access road to the plant is restricted to authorised vehicles only, although some visitors feeding monkeys were observed to have driven part way down the road to park in passing places for short periods. The access road to the WTW joins Tai Po Road at a T-junction giving access in both directions. Turning right onto Tai Po Road may be difficult at some times of the day due to the high levels of traffic on the road.

No counts have been obtained for the numbers of light vehicles visiting the works.

8.1.8 Air Quality

Noise

No Noise Sensitive Receivers (NSRs) are located in the vicinity of the Shek Lei Pui WTW. The area is rural in nature and background noise levels are low.

Dust

Air pollution data are available for the monitoring stations located at Sham Shui Po, 37A Yen Chow Street, and Kwai Chung, 1-5 Kwai Hop Street, Kwai Hing. The monitoring station at Sham Shui Po is located approximately 2 km to the south-east of Shek Lei Pui. The location is classified by EPD as Urban/Mixed, Commercial Residential and Industrial. Kwai Chung monitoring station lies approximately 2 km to the west of the site, and is classified as Urban/Mixed and Residential/Industrial. These monitoring stations represent the closest data collection sites to the WTW, however Shek Lei Pui can be considered to be located in a considerably more rural area. Air quality values are therefore likely to be lower than those recorded at the above stations.

Annual means of Total Suspended Particulates (TSPs) for years 1990-1994 have been measured to vary between 99 and 124 micrograms per cubic metre ($\mu g/m^3$) at the Sham Shui Po monitoring station. Values for Kwai Chung vary between 83 and 91 $\mu g/m^3$ for the same period. The Air Quality Objective for the annual mean is $80\mu g/m^3$. Therefore, any additional dust emitted into the environment can be considered to have a significant impact on the air quality.

8.1.9 Water Quality

Sludge from the WTW is currently discharged to a man-made waterway situated to the west of the service reservoir. The waterway joins a stream course which originates from the Kowloon Byewash Reservoir and flows through Butterfly Valley. The stream course joins the storm drainage system in Cheung Sha Wan approximately 1.5 km to the south-east and flows into Victoria Harbour.

The stream water appeared clear, but WTW sludge could be seen to form part of the sediment in the stream bed.

The major perceived impact of discharge of WTW sludge to the marine environment is the introduction of raised levels of suspended solids, and smothering of benthic marine organisms by high sediment settlement adjacent to outfalls. Victoria Harbour's Water Quality Objective for discharges containing suspended solids are that they will not raise the natural ambient suspended solid loading in excess of 30%, nor cause the accumulation of solids leaving suspension which may adversely affect aquatic communities. It is unlikely that under normal circumstances this discharge would exceed these criteria, due to the opportunity sludge solids have for settling out in the streambed.

Heavy metals in WTW sludge and their effects on WQOs are addressed in detail in Appendix C.3 of the "Feasibility Study of the Treatment and Disposal of Waterworks Sludge from Existing Treatment Works". The study concluded that the levels of heavy metals in WTW sludge were, "so low as to not contribute to any significant deterioration of the marine environment..." .

The effects of aluminium in freshwater are discussed in Appendix C" Section 2.3.1 of the Feasibility Report. As the necessary criteria of low pH and high hardness are not present in the waterway the sludge from Shek Lei Pui is discharged to, generation of exotoxic forms of aluminium in the stream course is not possible. Potential impacts would, therefore, be limited to smothering due to sedimentation and other physical effects.

8.1.10 Cultural Heritage and Archaeology

No graves, cemeteries or areas, sites or structures of cultural heritage or archaeological value have been identified as present at the Shek Lei Pui WTW site.

8.2 Proposed Development

8.2.1 BEECOPS Evaluation for WTW Disposal

On-site dewatering at Shek Lei Pui WTW was screened out at an early stage due to site space and access constraints. The next best alternative was identified as transfer of washwater via pipeline to the nearby Tai Po Road WTW where more space for treatment is available.

8.2.2 Proposed Development at Shek Lei Pui

It is proposed to lay a pipeline from Shek Lei Pui WTW to new thickening facilities at Tai Po Road WTW. A new 300 mm diameter. pipe will follow the access road to a new flow regulating control chamber and a medium recovery tank to be constructed next to the road near the Kowloon Byewash Reservoir Dam. Plate 8.2 shows the access road. A deep trench is required for the first 100m to enable the pipe to slope down hill along its length. Trenches for the rest of the pipe will be at minimum depth. From the medium recovery tank the pipe will be surface mounted alongside the western edge of Kowloon Byewash Reservoir Dam following an existing flight of access stairs to the toe of the dam. Plate 8.3 shows the western end of the dam, with the railing of the stairway visible. From the base of the dam the pipe will cross the valley on an existing pipebridge and run through an existing tunnel to Tai Po Road WTW. Pipeline details are shown in Table 8.1.

The proposed layout for the works is shown in Figure 8.2 a and b.

Table 8.1 Sludge Pipeline Design Data

Maximum sludge to sewer rate	22 l/s	Length of pipe	630m
Selected pipe size	300 mm	Connection sewer pipe	N/A
Sludge discharged period	24 hours	Hydraulic control required	Yes
Pipeline laying method	Open Trench		

8.2.3 Construction

The construction process is likely to take approximately 12 months. Deep trenching will be required for approximately 100 metres. To lay the pipe as rapidly as possible work is likely to be carried out by four teams, two working outwards from the centre of the pipeline route and two working at the ends. Work is scheduled to commence on site on 29/11/96.

Plate 8.2 Proposed Pipeline Route - Shek Lei Pui

Plate 8.3 West end of Kowloon Byewash Reservoir Dam

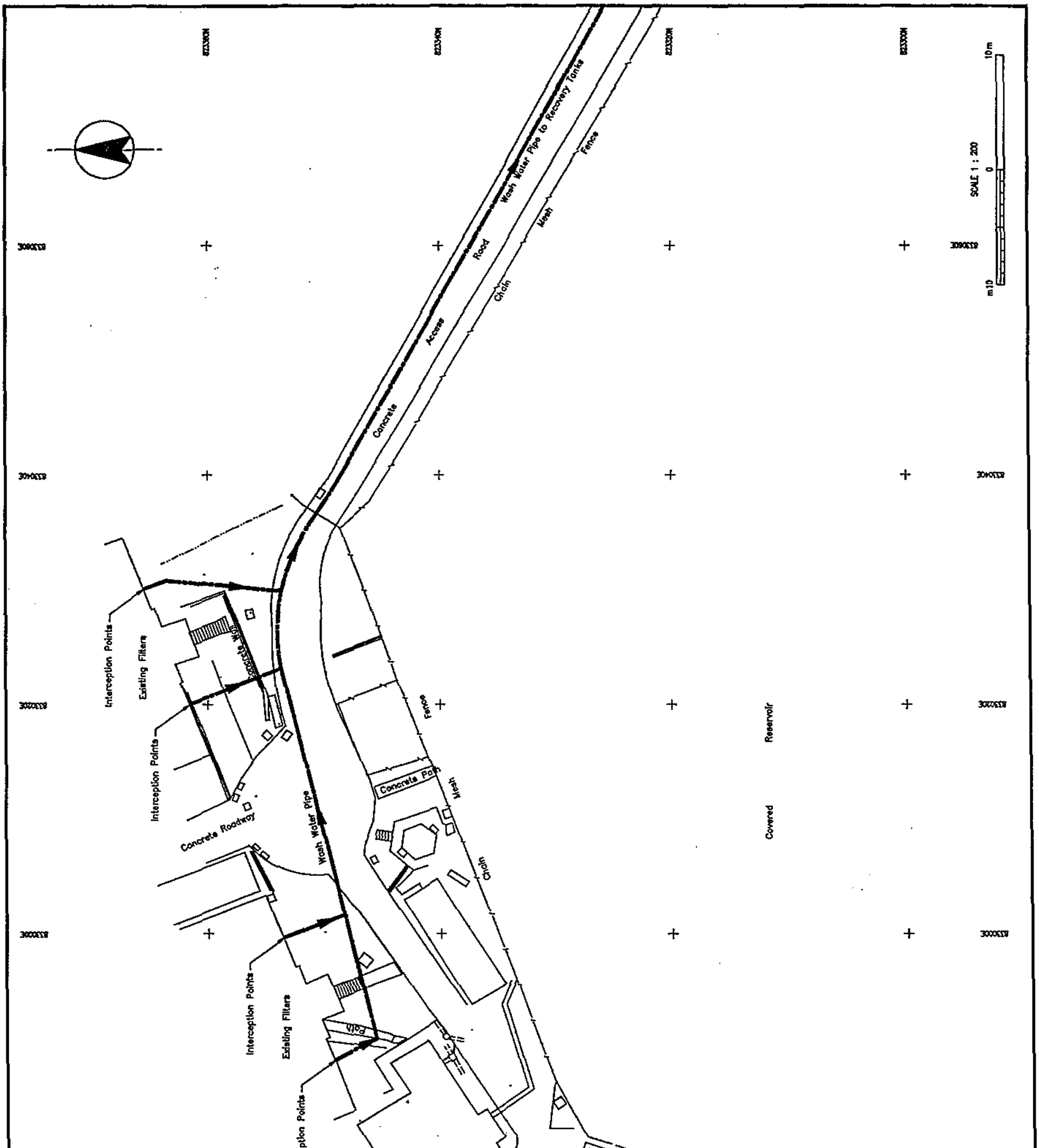


Figure 8.2a : Layout of Proposed Sludge Pipeline at Shek Lei Pui WTW

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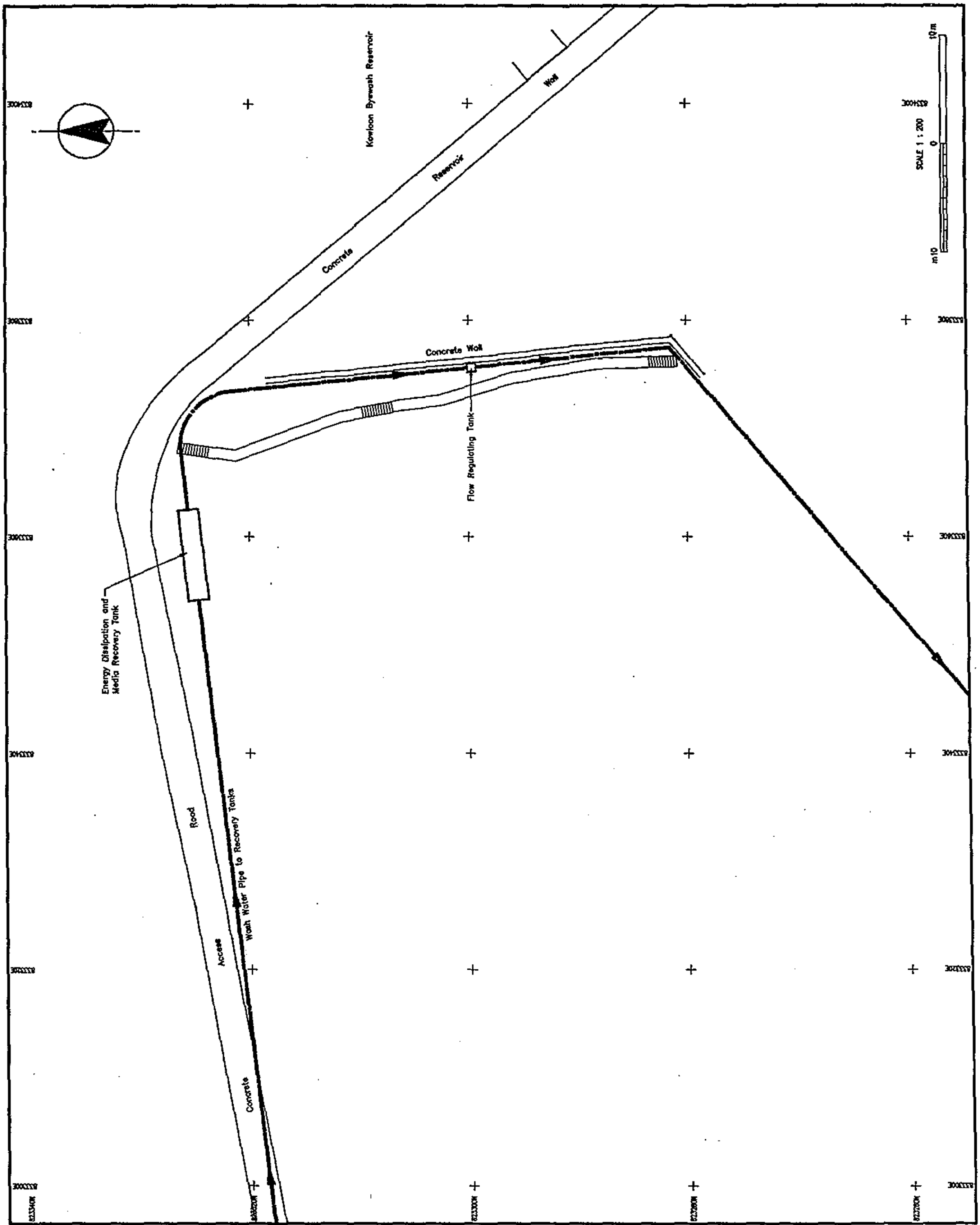

Figure 8.2b : Layout of Proposed Sludge Pipeline - Shek Lei Pui to Tai Po Road

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Construction of the flow regulating chamber and medium recovery tank will require some tree and vegetation clearance adjacent to the access road. Construction of the tanks will take approximately 4 months.

Table 8.2 shows the likely activities involved in the construction process, estimates of materials and equipment required, and wastes generated.

Table 8.2 Likely Construction Process, Estimates of Materials and Equipment Required, and Wastes Generated for Proposed Development at Shek Lei Pui WTW.

General Activity	Specific Activity	Equipment and use	Time period for activity	Time used on site
Site Clearance	Excavation	Breaker and compressor (hand held pneumatic) - rock removal	90 days	Working hours
		Breaker (excavator mounted pneumatic)	90 days	Working hours
		Tracked Excavator - soil and rock moving	90 days	Working hours
		Skip Trucks - soil and rock removal	90 days	Visits during working hours
Construction	Pipelaying	Trucks - delivery of 5 loads of piping	4 months	Visits during working hours
		Tracked excavator - excavating pipe run trenches and refilling after pipe laying	4 months	Working hours
		Breaker and compressor (hand held pneumatic) - rock removal	4 months	Working hours
	Tank construction	Concrete lorries - delivery of 100 tonnes of concrete	2 months	Visits during working hours
		Flatbed trucks - delivery of 3 tonnes of re-bar	2 months	Visits during working hours

8.2.4 Operation

Figure 8.3 shows a schematic representation of the water and sludge treatment path, once this pipeline is in service.

Filter backwash water from Shek Lei Pui will be conveyed along the proposed pipeline to new works at Tai Po Road WTW. Discharge is finally to sewer leading to Stonecutters Island STW.

8.2.5 Key Issues

From the data collected concerning the proposed Development at Shek Lei Pui WTW, the key issues were identified as:

- traffic, due to the necessary closure of the WTW access road;
- ecology, due to the local monkey populations and concerns expressed by the Agricultural and Fisheries Department over the effects of the development on Kam Shan Country Park; and
- archaeology, due to the presence of graded historical structures adjacent to proposed developments.

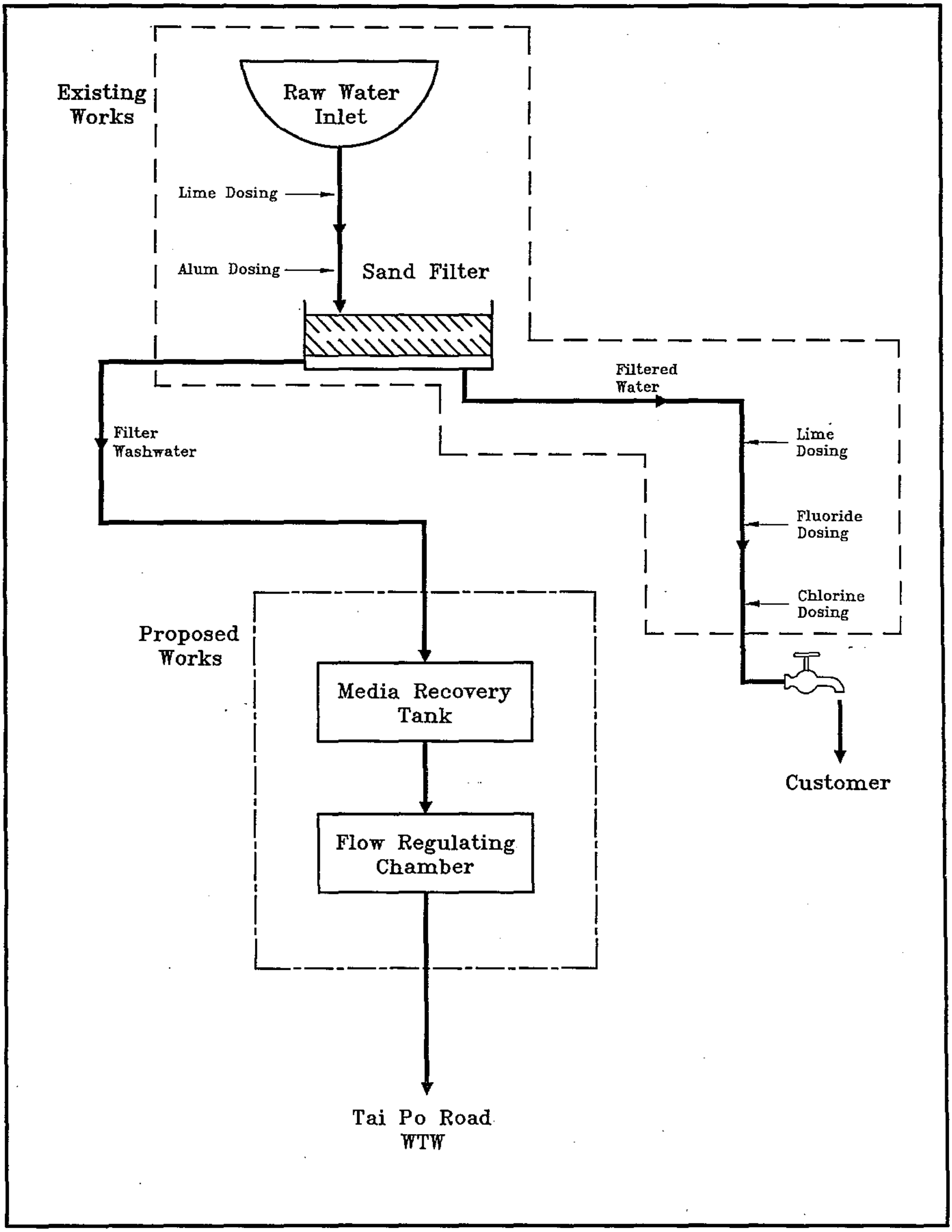

Figure 8.3 : Water Treatment Processes and Proposed Works at Shek Lei Pui WTW

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8.3 Construction Phase Impacts and Mitigation Measures

This section examines the potential environmental impacts of the proposed development at Shek Lei Pui WTW, along with potential mitigation measures. Special attention is paid to Key Issues.

8.3.1 Visual Impacts

The existing WTW have a limited visual impact due to the location of the works in a relatively remote area surrounded by vegetated slopes. There are no adjacent developments overlooking the site and it is largely hidden from view by vegetation and surrounding slopes from vantage points on neighboring walking and jogging trails.

Construction of the proposed pipeline along the access road will not be visible unless the observer walks along the pipe route. This access will be closed during construction.

Visual impacts of the proposed development during construction are therefore, not considered significant.

8.3.2 Ecology

The great majority of the development at Shek Lei Pui will take place along the existing road, and therefore, will have no effect on vegetated areas. The construction of the two tanks proposed to be sited along the pipeline route would require some roadside vegetation, possibly including a small number of trees, to be removed. The area affected would be under 20 m^2.

As with the developments at the other sites, birds and other wildlife are likely to migrate from the area around the development site due to the disturbance caused by construction. This area is particularly rich in wildlife due to its undeveloped nature and connection with extensive areas of country park. Of particular importance are the two species of monkeys who attract, and are attracted by, visitors who come to feed them at the junction of the WTW access road and Tai Po Road. Feeding the monkeys is no longer encouraged due to incidents of people being bitten.

Advice on the potential effects of the construction process on the monkeys was sought from the Agriculture and Fisheries Department. It is thought that the monkeys would simply move away from disruptive noise and activity and therefore, the construction would have little effect on them except to temporarily partially limit their movement in one very small area of their habitat. The main concern of the Agriculture and Fisheries Department was that if monkeys were attracted to the area by construction workers feeding them, or being lax with food materials such as uneaten portions of packed lunches, the monkeys may become a nuisance on the site.

Areas affected by the construction of tanks should be kept to a minimum. The tanks should be constructed alongside the access road, or on the upslope side of the road to minimise visual impact. If the tanks were sited downslope of the road, this would make an obvious impact on the vegetation currently hiding most of route to Shek Lei Pui WTW from view, when seen from the top of Kowloon Reservoir. The tanks themselves would also be visible from this vantage point which would be an unnecessary visual impact.

Signposts describing the proposed works, stating the environmental reasons for the development, apologising for any inconvenience they may cause and the stating the proposed works schedule, should be set up with the cooperation of the Country Parks Service at a number of prominent places along the WSD access road. This exercise will warn regular users of the area who are those who will be most affected by the development.

Barriers set up to keep the public away from the construction process should be of the best quality to dissuade members of the public from entering areas which are unsafe. If possible, access along the WTW road should be kept open for pedestrians during periods when active construction is not taking place, for example, early mornings and weekends.

The contractors building the development should be advised of the potential problem with monkeys and given strict instructions not to feed them deliberately, or accidentally attract the monkeys by leaving food lying around.

Country Parks Ranger Head Office should be kept informed of the progress of works throughout the project.

8.3.3 Traffic

Normal access to Shek Lei Pui WTW along the WSD access road from the east will not be possible during the construction of the pipeline. Part of the road will be closed to public access which may cause inconvenience to those wishing to use the road to access Kam Shan Country Park. Monkeys which are often found in the area are an extra hazard for construction traffic using this route. Restricted vehicular access, for the occasional delivery of chemicals, to the works whilst trenching and pipelaying is in progress will be gained along the normal Works access road. The maximum period that the works can be without chemical delivery is five weeks.

By looking at the estimated volumes of wastes and construction materials required to complete the development it can be estimated that approximately 200 vehicle trips will be required during the 12 month construction period. At peak construction times approximately 20 vehicle movements a day would be made.

Construction traffic drivers, should be made aware of the potential hazards along the access road. These include the restricted width and poor quality of some of the road and the likely presence of pedestrians and of monkeys. Posters to warn of the construction traffic should be erected at the entrance to the road in advance of the construction process starting and visitors to the area requested to use other routes to access the Country Park. The Agriculture and Fisheries Department should be informed prior to the start of construction and the local Country Park Ranger also informed of the development.

As the site has direct access to the main Hong Kong road system, the number of vehicles generated by the construction process is unlikely to cause significant impacts.

There will be some noticeable traffic impacts but these are confined to the road area owned by WSD and are not therefore, considered major.

8.3.4 Noise

As there are no NSRs in proximity of the proposed construction area, no noise assessment for the construction of the proposed development has been carried out. Noise levels are likely to be high during the construction of some areas of the pipeline as deep excavation through rock is expected. However, there are no NSRs nearby and the road is in a deep cutting which will have the effect of directing generated noise upwards. Therefore, it is considered that there will be no significant noise impacts from the proposed development.

8.3.5 Airborne Emissions

The FDM was not applied to this development as the model is not suitable for the assessment of linear trench construction. The development also has no specific NSRs at which to calculate fugitive emission concentrations.

Due to the undeveloped nature of the area the TSP concentrations in the ambient air is likely to be low. However, it is good site practice to carry out dust suppression techniques and those suitable for this development are shown in Table 8.3.

Table 8.3 Fugitive Dust Control Measures

Development Stage and Control Methods	Comments
Land Clearing/Earth Moving	The major source at this development, as the largest potential problem would be from uncovered haul vehicles once on the highway.
Watering	Water should be applied over the site prior to conducting any land clearing. This will increase the moisture content of the soil, thereby increasing its stability. Clay soil should be kept above 8% water to prevent dust generation. Water should be re-applied as necessary over the period that bare soil areas are exposed. Water can be applied by sprinklers or hoses.
Minimise Loading Drop Height	Mechanical excavator drivers should ensure that the height spoil is dropped from into haul vehicles is minimised, thus reducing dust generation.
Cover Haul Vehicles	Haul vehicles should be tarpaulined to prevent dust being generated from their loads as they move along the highway.
Paved Road Track Out	Not a major source of dust in this case as haul vehicles should be using tarmac roads.
Sweep/clean roadways	The access road should be swept or water flushed clean to prevent re-entrainment of deposited dust.
Cover Haul Vehicles	Covered haul vehicles prevent the road from being contaminated with dust.

8.3.6 Water Quality

Due to the nature of the development there should be no run-off. Pumping from excavations may be necessary but this would not be in such large volumes as to cause problems of raised sediment levels in local watercourses.

8.3.7 Cultural Heritage and Archaeology

The Antiquities Advisory Board has listed a number of structures adjacent to the proposed development. The valve house and dam of Kowloon Byewash Reservoir are Grade 2 listed historical structures. The Shek Lei Pui Treatment Works Building is a Grade 3 listed historical structure.

There are no plans which should affect any of these structures. The nearest will be the pipe route at the western end of the Kowloon Byewash Reservoir as this would be within a few metres of the Reservoir. However, the pipe will not affect the structure of the dam. The rest of the proposed developments will not affect any of the other listed structures.

The contractors working on site should be made aware of the listed status of these structures to ensure that they are not accidentally affected during the construction process.

Impacts to Cultural Heritage are therefore, not expected.

It is unlikely that there will be any archaeological impacts as no archaeological sites are known to be affected and the road route has already been excavated to bed road during its construction.

8.3.8 Safety

As the development will involve deep excavations in areas often visited by members of the public, adequate warning signs of deep excavations and barriers to prevent access to construction areas will need to be erected.

The road safety issues discussed in Section 8.3.3, and potential threats from wildlife discussed in Section 8.3.2 should also be acted upon.

The existing WTW on this site is also classified as a PHI due to the storage of chlorine on site. The same care should be exercised to prevent increased danger from chlorine deliveries at this site during the construction period as that described in Section 5.3.8.

As the available access will be restricted during the construction period, stocks of necessary bulk materials should be built up at the WTW site to minimise the need for supplies during the construction period. This is also true of construction supplies.

Normal site safety practices should be followed.

If the WTW is fully stocked with chlorine prior to the commencement of the construction period it is unlikely during this period a chlorine delivery will be necessary. However, if a chlorine delivery is necessary contractors should be advised in advance. All construction activities, which could potentially affect a delivery, should be suspended until the delivery is complete. Should the construction process have caused any affects which might increase the likelihood of an accident during a chlorine delivery, e.g. piles of materials stored on roadways, dirt on access roads, these matters should be addressed prior to the delivery. Delivery drivers should be warned of the construction process happening at the WTW to enable them to exercise additional care.

If these recommendations are followed there should be no safety impacts.

8.3.9 Waste Disposal

Wastes produced by the construction process will be inert. They will be made up of cleared vegetation, soil, rock, and unusable or used building materials. Waste disposal is therefore straightforward. As long as these wastes are disposed of at a suitably licensed landfill they should cause no significant environmental impacts.

8.4 Operational Phase Impacts and Mitigation Measures

8.4.1 Visual Impacts

The only visible parts of the proposed development at Shek Lei Pui, once construction is complete will be a 300mm diameter pipe running down the slope of the valley next to the western end of Kowloon Byewash Dam, and the tops of two covered tanks alongside the WSD access road. These impacts are not thought to be significant.

8.4.2 Ecology

Operation of the proposed development will have no negative ecological impacts further to the permanent loss of the areas of vegetation cleared to locate the two proposed tanks. Wildlife displaced by the noise and activity during the construction phase is likely to return to the area once this activity ceases.

Negative ecological impacts of operation are not thought to be significant, so mitigation is not necessary.

The operation of the proposed development will remove an average of 2000 m^3 of water treatment works sludge which would otherwise be released into local watercourses and finally the Victoria Harbour (Phase 1) Water Control Zone. This will help reduce smothering of bottom fauna and the effects on aquatic organisms of reduced light penetration due to high turbidity.

8.4.3 Traffic

The operation of the proposed sludge treatment facilities will generate no additional traffic except an occasional tanker to remove filter medium caught in the medium recovery tank.

This additional traffic is insignificant.

8.4.4 Noise

None of the activities involved in operating the proposed development generate significant noise levels. Operational noise is not considered significant.

8.4.5 Airborne Emissions

The operational activities of the Proposed development will not generate any significant levels of air emissions.

The sludge will be passing down a closed pipeline and as WTW sludge from Shek Lei Pui WTW is low in algae, it is not odiferous, and has no potential to generate nuisance odours.

8.4.6 Water Quality

As mentioned in Section 8.4.2 the operation of the proposed development will remove at average level of operation 2000 m^3 of water treatment works sludge which would otherwise be released into local watercourses and finally the Victoria Harbour (Phase 1) Water Control Zone. Water quality in these areas will therefore, be improved by a reduction in turbidity and suspended solids.

8.4.7 Cultural Heritage and Archaeology

The operation of the proposed developments would have no effects on Cultural Heritage and Archaeology.

8.4.8 Safety

Operation of the proposed development would have no specific safety implications.

8.4.9 Waste Disposal

Final disposal of the sludge is considered in Section 9.4.9 as the development at Shek Lei Pui Road passes all of the sludge generated for further treatment at Tai Po Road.

8.5 Summary of Impacts and Mitigation Measures

Tables 8.4 and 8.5 show summaries of the potential construction and operational impacts of the proposed development at Shek Lei Pui WTW, and also proposed mitigation measures.

8.6 Conclusions

Environmental impacts resulting from the construction and operation of the proposed development at Shek Lei Pui can be reduced to acceptable levels provided that the proposed mitigation measures are fully implemented.

Increase of construction traffic on the narrow WTW access road is considered to be of medium significance. Potential hazards include the restricted width of the road and the likely presence of pedestrians and monkeys in the area. Construction traffic drivers should be made aware of the potential dangers in order to reduce impacts to a minimum.

Should chlorine delivery be required during the construction period, all activities which could potentially affect the delivery should be suspended until the delivery is complete.

Signposts describing the proposed works should be set up with the cooperation of the Country Parks Service at a number of prominent places along the access road in order to warn regular users of the area.

Loss of vegetation due to tank construction alongside the access road is considered to be of medium significance. Care should be taken by the contractors to ensure impacts are kept to a minimum by preventing damage to vegetation beyond the boundary of the construction area.

The remaining environmental issues are considered to be of minor significance and are not anticipated to exceed relevant environmental standards or guidelines.

Once operational, the proposed development at Shek Lei Pui will have no significant impacts.

TABLE 8.4 SHEK LEI PUI WTW - SUMMARY OF CONSTRUCTION PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual impact of construction site	Adverse	Short term	Local	Negligible	-
Ecology	Vegetation loss due to construction	Adverse	Long Term	Local	Medium	Liaison with Country Parks Service to ensure tank sites minimise vegetation loss.
	Disturbance of natural habitats	Adverse	Short Term	Local	Minor	Contractors briefed on special consideration needed due to monkeys in the area. Public informed of road closure prior to work commencing.
Traffic	Increase in construction traffic on WTW access road	Adverse	Short Term	Local	Medium	Contractors briefed on dangers of narrow road, presence of the public and monkeys.
	Increase in construction traffic on main roads	Adverse	Short Term	Regional	Minor	-
Noise	Construction noise	Adverse	Short Term	Local	Minor	-
Airborne Emissions	Dust from construction work	Adverse	Short Term	Local	Minor	Dust suppression as appropriate.
	Exhaust emissions	Adverse	Short Term	Local	Minor	-
Water Quality	Site runoff and erosion	Adverse	Short Term	Local	Negligible	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage	No Impact			Nil	N/A
Safety	Potential for accidents on construction site	Adverse	Short Term	Local	Minor	Road safety as above. Good housekeeping. Chlorine deliveries should be avoided during the road closure.
	Potential for accidents off site	Adverse	Short Term	Regional	Minor	-
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Minor	-

TABLE 8.5 SHEK LEI PUI WTW - SUMMARY OF OPERATIONAL PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual intrusion	Adverse	Long Term	Local	Minor	-
Ecology	Removal of natural habitats	Adverse	Long Term	Local	Minor	-
Noise	Operational noise	Adverse	Long Term	Local	Negligible	-
Airborne Emissions	Dust from operation	Adverse	Long Term	Local	Negligible	-
	Odour from operation	Adverse	Long Term	Local	Negligible	-
Water Quality	Fresh water quality	Beneficial	Long Term	Local	Medium	-
	Marine water quality	Beneficial	Long Term	Regional	Minor	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage.	No Impact			Nil	N/A
Waste Disposal	Discharge to sewer	Adverse	Long Term	Regional	Minor	-

SECTION 9
ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED SLUDGE TREATMENT DEVELOPMENT AT TAI PO ROAD WATER TREATMENT WORKS

9.1 Existing Environment

9.1.1 Background

The proposed site for development of sludge treatment facilities at Tai Po Road lies within the existing WTW boundary, apart from the proposed pipeline connection to sewer which is on Wing Ming Street, adjacent to Nam Wah Catholic School. Figure 9.1 and Plate 8.1 show a plan and an aerial photograph of the area, respectively. Tai Po Road WTW covers an area of approximately 4.63 hectares and has a designed output of 32 MLD.

Tai Po WTW is situated at the northern end of Butterfly Valley along the valley floor and is surrounded by steep vegetated slopes, map reference 833 823. The site lies adjacent to both Kam Shan and Lion Rock Country Parks about 400 metres to the north. The more industrial area of Cheung Sha Wan lies approximately 400 metres to the south. Access to the works is via narrow lane off Caldecott Road. The access lane runs alongside Tai Po Road for some distance but at an elevation approximately 30 metres lower. Slope stabilisation has been necessary alongside the access road in this area. The slopes surrounding the remainder of the valley are generally densely vegetated. Slopes to the north of the site reach a height of 120 metres close to the WSD Staff Residence which overlooks the WTW.

The Sir Robert Black College of Education, located along Caldecott Road, lies approximately 40 metres above the treatment works on a facing cliff. A number of residential blocks also occur along Caldecott Lane, No. 2 of which overlooks Butterfly Valley. Further south the land slopes down to Ching Cheung Road and Cheung Sha Wan. A large terraced Roman Catholic cemetery is located in this area approximately 400 metres to the south-west of the WTW. A pathway from Caldecott Road leads down to Cheung Sha Wan via a wooded area adjacent to the cemetery. The proposed pipe route follows an existing supply main through this area which is used by the local population for early morning exercise and for sitting outside. The entire slope is crossed by paths and many small shrines and seating areas. Some of the seating areas are substantial and the individuals who made them have obviously invested a great deal of effort and care in their construction. Approximately 50 to 100 metres to the east of the pipe route the Fuk Tak Buddhist Association have sited a number of temples on the adjacent slope. The area south of Ching Cheung Road is dominated by urban/industrial development.

9.1.2 Existing Works

Tai Po Road WTW is generally served by the Kowloon group of reservoirs including Jubilee Reservoir and Kowloon Reservoir. Water may also be supplied from Plover Cove reservoir. The main facilities currently on the site include:

- the main filter building; and
- a service reservoir.

Six sand media rapid gravity filters with an average filter run of 22 hours between washes and a washwater consumption of $150m^3$ per wash are located to the north of the works in the main filter building. No washwater recovery is practised.

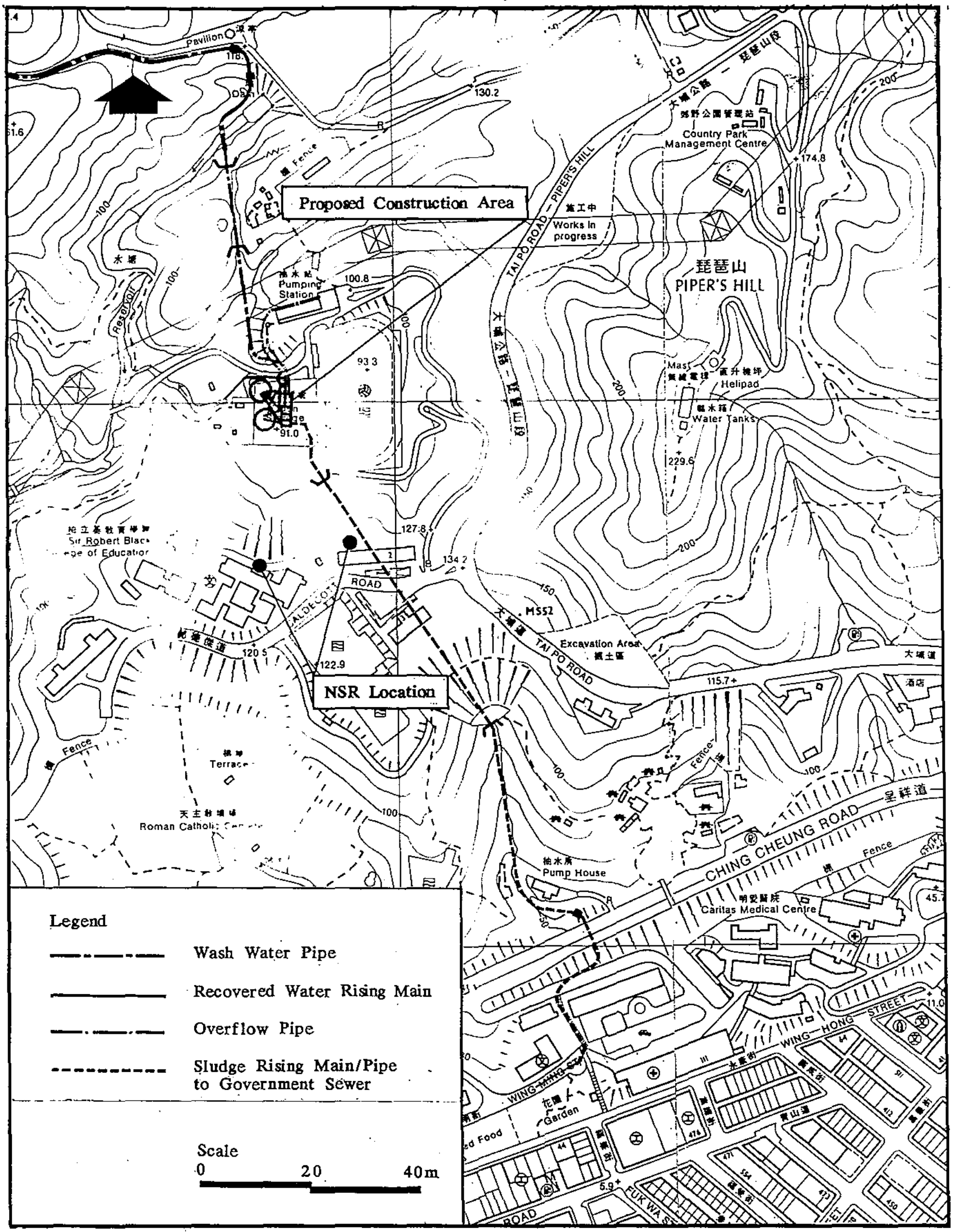

Figure 9.1
Proposed Development and Nearest Sensitive Receiver Location-Tai Po Road WTW

Existing Discharge Practice

Washwater (950 m^3/day average) from Tai Po Road WTW is currently taken through a pipe to a natural stream course which runs by the filter beds. The stream course originates from the Kowloon Byewash reservoir and flows through Butterfly Valley before joining the storm drainage system in Cheung Sha Wan approximately 1 km to the south-west.

Discharges from the treatment works are to the sea within the Victoria Harbour (Phase One) Water Control Zone which was declared in 1994.

9.1.3 Geology

The geology of the general area is made up of Mesozoic volcanic and igneous intrusions with Quaternary Superficial deposits. The WTW site is located on an area of fine grained granites. To the south of the site debris flow deposits are underlain with coarse to fine grained granites.

9.1.4 Landscape Character and Visual Aspects

Tai Po Road WTW is located on the valley floor at the northern end of Butterfly Valley. The existing WTW consists of one major building incorporating offices, process equipment and filter beds. A covered service reservoir, which is used as a playing field, lies to the south of the site. Due to the low level of development directly adjoining the WTW the character of the area could be described as rural. However, traffic noise from Tai Po Road is noticeable at the WTW. The area to the south of the WTW boundary incorporating the developments along Caldecott Road can be characterised as low density residential.

9.1.5 Ecology

The proposed development occurs both within and outside the site boundary. The proposed site for the sludge treatment tanks is within the site boundary. It is currently used as an open storage area and is covered in turf. The wooded area adjacent to the Roman Catholic cemetery, which lies outside the site boundary, consists mainly of broad-leaved trees and stands of bamboo with little undergrowth. The area attracts a variety of wildlife including squirrels and bird life.

9.1.6 Concurrent Developments

Major improvement works to Ching Cheung Road are currently taking place approximately 40 metres north of the Caritas Medical Centre. Tai Po Road WTW lies approximately 100 metres outside the boundary of Cheung Sha Wan Outline Zoning Plan.

No construction is currently occurring in the immediate vicinity to the works. No other developments or significant maintenance tasks are programmed to take place on the WTW site during the development construction period.

9.1.7 Traffic Levels

From the WTW the narrow access road rises from the valley floor and joins the residential two lane Caldecott Road. From this point, access to the major roads system can be gained via Tai Po Road which is a dual carriageway carrying heavy traffic at this point. This junction is marked as being an accident blackspot. The junction is controlled by traffic lights, is on a hill and on a bend with adverse cambers for traffic descending the hill. Tai Po Road is part of the primary distribution network serving North Kowloon.

9.1.8 Air Quality

Noise

The nearest sensitive receivers (NSR) to the centre of the proposed development site at Tai Po Road WTW are:

- Sir Robert Black College of Education, (140 metres distant); and
- Residential development at 2, Caldecott Road, (140 metres distant).

The residential development to the south of the site at 2, Caldecott Road is well screened from the site by the slope of the valley side and the dense vegetation cover. The Sir Robert Black College of Education is only partially screened from the WTW site.

As described in Section 9.1.3, the area surrounding Tai Po Road WTW is typically rural in nature, however, the location of the NSRs can be classified as low density residential. This classification can be applied to the NSRs under the Technical Memorandum on Noise from Construction Work other than Percussive Piling.

The NSRs are affected by Tai Po Road which is a significant noise influencing factor.

Dust

Air pollution data are available for the monitoring stations located at Sham Shui Po, 37A Yen Chow Street, and Kwai Chung, 1-5 Kwai Hop Street, Kwai Hing. The monitoring station area at Sham Shui Po which lies approximately 1.5 km to the south of Tai Po Road is classified by EPD as Urban/Mixed, Commercial Residential and Industrial. Kwai Chung monitoring station lies approximately 2.5 km to the north-west of the site, and is classified as Urban/Mixed and Residential/Industrial. These monitoring stations represent the closest data collection sites to the WTW, however Tai Po Road can be considered to be located in a more rural area. Air pollution values are therefore likely to be lower than those recorded at the above stations.

Annual means of Total Suspended Particulates (TSPs) for years 1990-1994 have been measured to vary between 99 and 124 $\mu g/m^3$ at the Sham Shui Po monitoring station. Values for Kwai Chung vary between 83 and 91 $\mu g/m^3$ for the same period. The Air Quality Objective for the annual mean is $80 \mu g/m^3$. Therefore, any additional dust emitted into the environment can be considered to have a potentially significant impact on air quality.

9.1.9 Water Quality

Sludge from the WTW is currently discharged through a pipe to a natural stream course to the west of the filter beds. The stream course originates from the Kowloon Byewash Reservoir and flows through Butterfly Valley. The stream joins the storm drainage system in Cheung Sha Wan approximately 1.5 km to the south-east and flows into Victoria Harbour.

9.1.10 Cultural Heritage and Archaeology

No graves, cemeteries or areas, sites or structures of cultural heritage or archaeological value have been identified as present at Tai Po Road WTW site.

9.2 Proposed Development

9.2.1 BEECOPS Evaluation for WTW Disposal

Site access constraints dictated that the sewer discharge option was preferred to on-site dewatering at this works. The BEECOPS for this WTW was identified as washwater recovery at this site (including washwater from Shek Lei Pui WTW) and subsequent release of sludge to sewer. The environmental impact of discharging to sewer was assessed as being minimal since all sludge will be collected and dewatered at the future Stonecutters Island STW. No adverse impacts have been identified as a result of treating WTW sludge at Stonecutters Island STW. The proposal represents a deviation from the ISDS recommendation for separate waterworks sludge dewatering for Tai Po Road. However, since the sludge will still be dewatered and ultimately disposed of to landfill, the overall strategy for sludge disposal from Tai Po Road WTW has not changed.

9.2.2 Proposed Development at Tai Po Road

It is proposed to provide two sludge thickeners and balancing tanks at Tai Po Road WTW. Details are shown in Table 9.1 and two views of the proposed site are shown in Plates 9.2 and 9.3. Approximately 860 metres of pipe (not including pipe route from Shek Lei Pui) would be installed together with necessary pumps and mechanisms. Figure 9.2 shows the layout of the proposed development.

Table 9.1 Washwater Recovery Design Data

Item Description	Item Size	Material	Unit	Quantity
Balance tanks	300 m^3	Reinforced concrete	no.	2
Thickener tanks	17.5m dia. internal	Reinforced concrete	item	2

A 150 mm pipeline will convey sludge from the Tai Po Road WTW thickeners to a connection with an existing sewer in Wing Ming Street. The pipeline will be surface laid inside an existing pipe tunnel and down through the wooded embankment alongside an existing freshwater main to Ching Cheung Road. Trenchless pipelaying techniques will be used for laying of the pipeline under Ching Cheung Road. The connection to sewer will occur at Wing Ming Street to the south. Sludge pipeline design data is shown in Table 9.2.

Table 9.2 Sludge Pipeline Design Data

Maximum sludge to sewer rate	18 l/s	Length of pipe	860 m
Selected pipe size	150 mm	Connection sewer pipe size	300 mm
Sludge discharge period	24 hrs	Hydraulic control required	Yes
Pipeline laying method	Open Trench/ Surface		

The proposed site for the sludge pipeline has been relocated from the site proposed in the Feasibility Study for the following reasons:

- reduced environmental impact in terms of tree felling and vegetative cover removal;

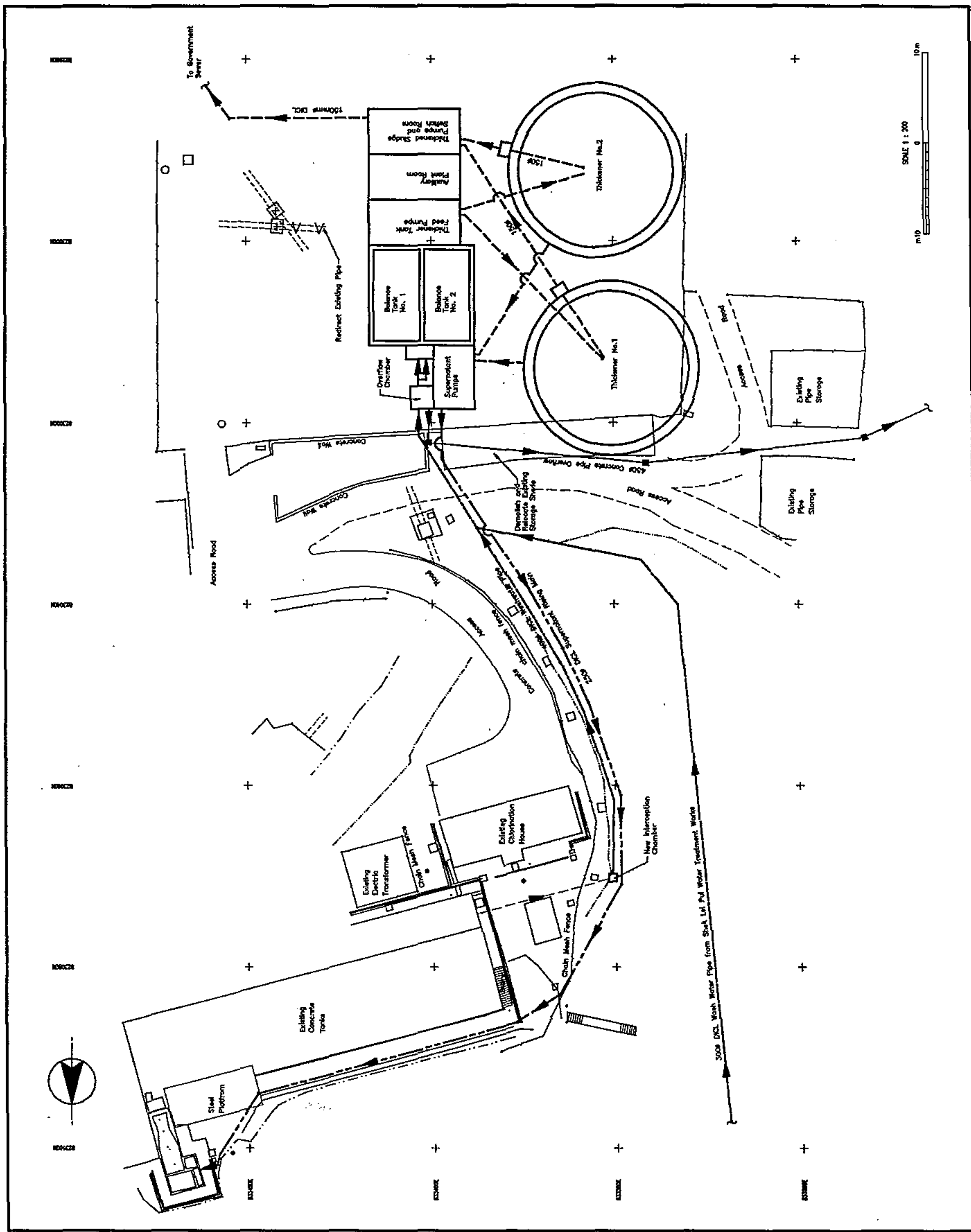

Figure 9.2 : Layout of Proposed Sludge Treatment Facilities at Tai Po Road WTW

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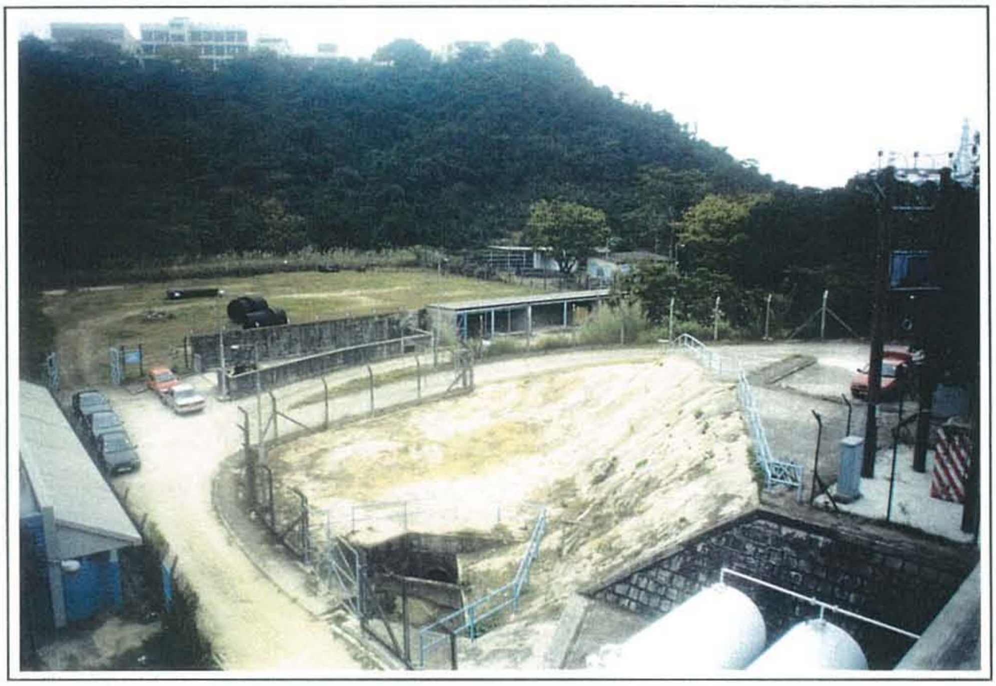

Plate 9.2 Site for Proposed Washwater Recovery Tanks - Tai Po Road WTW

Plate 9.3 Site for Proposed Washwater Recovery Tanks - Tai Po Road WTW

- reduced pipe length;
- make use of existing WSD facilities (freshwater tunnel);
- less traffic disturbance;
- better hydraulics over the whole length of the pipeline; and
- discharges into foul drainage system with a better capacity.

Pipe laying will be surface mounting for the majority of the route. Trenchless techniques will be required to pass the pipe through the Ching Cheung Road embankment without disturbing the road.

9.2.3 Construction

The construction process is likely to take approximately 12 months. The first month of this period will involve site clearance and preparation. During the following 3 to 4 months construction of the balance tanks and thickeners will take place. Pipelaying will also take place concurrently, but will take approximately 5 months. Finally mechanical and electrical equipment will be installed over approximately 3 months followed by a 1 month commissioning period. Work is scheduled to commence on site on 29/11/96.

Site preparation will occur over a relatively short time period due to the small amount of excavation required. Where excavation of pipe routes is necessary digging is likely to be by back-hoe excavator.

Table 9.3 Likely Construction Process, Estimates of Materials and Equipment Required, and Wastes Generated for Proposed Development at Tai Po Road WTW.

General Activity	Specific Activity	Equipment and use	Time period for activity	Time used on site
Site Clearance	Excavation	Breaker and compressor (hand held pneumatic) - rock removal	90 days	Working hours
		Generator - power breaker	90 days	Working hours
		Breaker (excavator mounted pneumatic)	90 days	Working hours
		Tracked Excavator - soil and rock moving	90 days	Working hours
		Skip Trucks - soil and rock removal	90 days	Visits during working hours
Construction	Tank construction	Concrete lorries - delivery of 3600 tonnes of concrete	4 months	Visits during working hours
		Flatbed trucks - delivery of 900 tonnes of re-bar	4 months	Visits during working hours
		Trucks - delivery of approximately 8 loads of formwork and scaffolding	4 months	Visits during working hours
	Pipelaying	Trucks - delivery of 9 loads of piping	4 months	Visits during working hours
		Tracked excavator - excavating pipe run trenches and refilling after pipe laying	4 months	Working hours
		Breaker and compressor (hand held pneumatic) - rock removal	4 months	Working hours
	Mechanical and electrical installation	Trucks - delivery of 15 loads of equipment	2 months	Working hours

Table 9.3 shows the likely activities involved in the construction process, and estimates of materials and equipment required and wastes generated.

9.2.4 Operation

Figure 9.3 shows a schematic representation of the water and sludge treatment path, once this development is in service. The Tai Po Road thickening facility is sized to process a peak of 4550 kg/day of sludge (dry solid weight). Discharge will be to sewer leading to the Stage I works of the Stonecutters Island STW.

9.2.5 Key Issues

From the data collected concerning the proposed Development at Tai Po Road WTW, the key issues were identified as:

- construction noise, due to the nearby Sir Robert Black College of Education and residential development at 2, Caldecott Road; and

- fugitive dust emissions, for the same reason.

9.3 Construction Phase Impacts and Mitigation Measures

This section examines the potential environmental impacts of the proposed development at Tai Po Road WTW, along with potential mitigation measures. Special attention is paid to Key Issues.

9.3.1 Visual Impacts

The site is surrounded by densely vegetated slopes which are unsuitable for development. The WSD Staff Residence overlooks the site from a ridge to the east. Large electric pylons also run along this ridge to the Electric Sub-station at the southern end of Butterfly Valley. The area to be developed within the site boundary is currently open storage covered by turf. The site is visible from the residential development at 2, Caldecott Road and from the Sir Robert Black College of Education. However, views of the WTW are obscured by the slope of the valley side and the vegetation cover, especially from the residential development at 2, Caldecott Road.

The existing works has a limited visual impact due to its location in the valley floor, and the mitigating influence of vegetation shielding it from view.

The new development site will be visible from the south ridge. The residential development at 2, Caldecott Road is well screened from the site by the slope of the valley side and the associated vegetation. Views from Sir Robert Black College of Education are less well screened however, but the limited scale of the development and the sites background of existing works mean development is unlikely to cause a significant visual impact.

9.3.2 Ecology

The ground cover which will have to be removed to carry out the development is poor quality grassland which has been established by the WTW. Some removal of undergrowth may be necessary to clear some of the proposed pipe routes, especially that to the entrance of the pipe tunnel under the ridge to the south of the proposed development. No trees will be lost during the construction process.

Ecological impacts of construction will therefore be of minor significance.

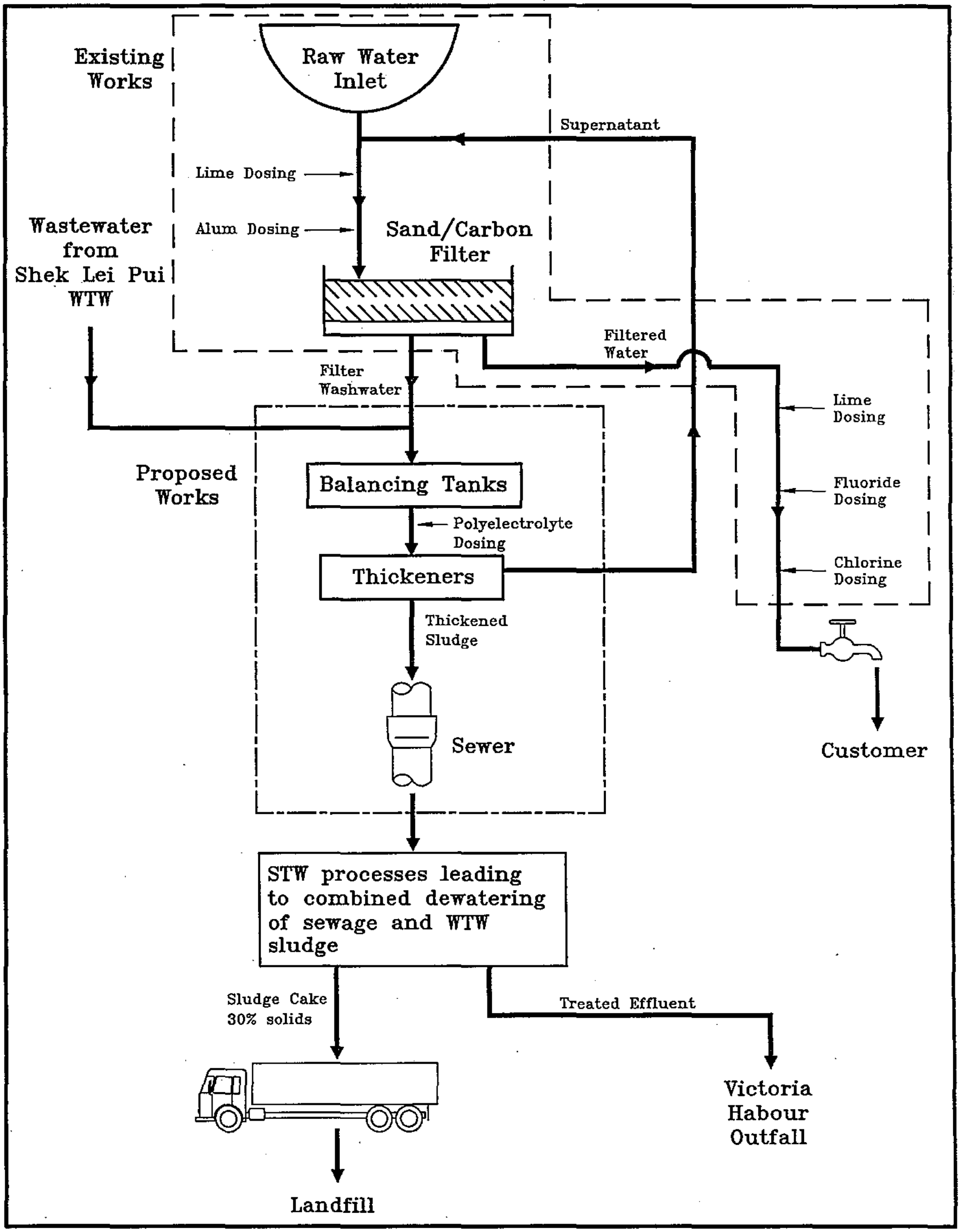

Figure 9.3 : Water Treatment Processes and Proposed Works at Tai Po Road WTW

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The proposed site for the main development is an open field area and therefore, of limited value to birds and other wildlife. Those that are present may be scared away from the area around the development site by the disturbance caused during construction. However, due to the limited area of the development and the low value of the immediate surrounding area of the works to wildlife, numbers affected will be small, limiting the significance of this impact.

The pipeline to Ching Cheung Road will be surface mounted, adjacent to an existing, much larger, pipe and the activity necessary to carry this work out will be little more disturbing to wildlife than the activities of people taking walks and exercising in this area. No vegetation would be affected by this part of the development.

There would be scope at the Tai Po Road site to establish an improved vegetative cover around the edges of the proposed development and establishment of bushes or trees around the proposed development could be considered.

9.3.3 Traffic

By looking at the estimated volumes of wastes and construction materials required to complete the development it can be estimated that approximately 350 vehicle trips will be required during the 12 month construction period. At peak construction times approximately 30 vehicle movements a day would be made.

The site has access to the main Hong Kong road system, via Caldecott Road and Tai Po Road. This junction is traffic-light controlled and therefore, construction traffic should not have difficulty using it, or cause problems for other traffic. Drivers should be made aware that the junction is dangerous if approaching from the north, as the junction is obscured by a bend.

9.3.4 Noise

A noise assessment for the construction of the major part of the proposed development (adjacent to the existing works) has been carried out. The remaining works involve the surface laying of a pipeline to Ching Cheung Road and a sewer connection to the south of the road. These developments are not major enough to be subjected to a noise assessment. Percussive piling will not take place on this site as the geology provides a suitable foundation without piling. The noise assessment was carried out following the methodology described in the EPD Technical Memorandum concerning, "Noise from Construction Work Other Than Percussive Piling".

The technical detail of calculation of potential noise levels is shown in Appendix C.

It was found that during construction the CNLs at the Sir Robert Black College of Education and residential development at 2, Caldecott Road would be 76.5 dB(A) and 66.5 dB(A) respectively. The potential for disturbance by construction noise at 2, Caldecott Road is prevented by the shielding effect of topography. The CNL at the Sir Robert Black College is above the recommended daytime level for schools (70 dB(A)) (ProPECC Practice Notes PN 2/93). Without some mitigation measures such as use of silenced equipment, it is likely that noise nuisance would be generated at the Sir Robert Black College of Education. Construction noise is therefore, considered to have the potential for significant environmental impacts.

Use of silenced PME would enable the corrected noise level at the Sir Robert Black College of Education to fall below 70 dB(A).

9.3.5 Airborne Emissions

The FDM was applied to the proposed development to calculate the potential total suspended particulates at the two identified NSRs. The technical details of the way the FDM was applied is described in Appendix D to this document. The model provides a worst case as though dust creating construction activity is taking place on the entire area of the proposed development site for 24 hours and the wind is blowing constantly towards NSRs. The FDM calculated dust concentration value is shown Table 9.4, together with the factors which will, in a real case, make the actual TSPs found at the NSRs lower.

Table 9.4 Modeled Dust Concentrations at NSRs and Correction Factors

NSR	FDM 24 hour average concentration (μg/m³)	Actual time wind in quarter towards NSR	Barriers (e.g. topography, vegetation)	Actual Working Hours	% of site likely to be open for dust generation	Realistic 24 hour Concentration at NSR due to Development (μg/m³)
2, Caldecott Road	450	15	Slope of hillside (up to NSR) Existing Vegetation	8	40	50
Sir Robert Black College of Education	424	15	Slope of hillside (up to NSR) Existing Vegetation	8	40	50

It should be noted that the model does not allow for the topography of the site (it assumes a flat site with the NSRs at the same level as the site) or for the effects of vegetation around the site. In this case, the calculated value for maximum concentration may be well above the real case as the screening vegetation on the slopes around the valley sides above the site are likely to reduce actual dust transport significantly.

The results of the modeling exercise show that the fugitive dust emissions from the site would fail the AQO TSP of 260 μg/m³ average over 24 hours, if construction activity was to continue for 24 hours a day, the local topography was completely flat, and the local weather conditions blew dust from the site to the NSRs constantly over the 24 hour period. The results of the modeling exercise, when considered with the "real world" site specific factors, such as existing topography, the smaller area of the site likely to be exposed at one time and especially prevailing winds, which blow mostly away from the site, means that the site is actually unlikely to cause the 24 hour AQO for TSPs to be exceeded at the NSRs.

However, as reliable background TSP counts are not available for the immediate area, it is preferable that fugitive emissions from the development should be reduced to the lowest possible levels by appropriate mitigation measures. These are shown in Table 9.5.

Table 9.5 Fugitive Dust Control Measures

Development Stage and Control Methods	Comments
Land Clearing/Earth Moving	the major source of dust from this development
Watering	Water should be applied over the site prior to conducting any land clearing. This will increase the moisture content of the soil, thereby increasing its stability. Clay soil should be kept above 8% water to prevent dust generation. Water should be re-applied as necessary over the period that bare soil areas are exposed. Water can be applied by sprinklers or hoses.
Minimise Loading Drop Height	Mechanical excavator drivers should ensure that the height spoil is dropped from into haul vehicles is minimised, thus reducing dust generation.
Cover Haul Vehicles	Haul vehicles should be tarpaulined to prevent dust being generated from their loads as they move along the highway.
Paved Road Track Out	Not a major source of dust in this case as haul vehicles will not have access to the site.
Sweep/clean roadways	The access road should be swept or water flushed clean to prevent re-entertainment of deposited dust.
Cover Haul Vehicles	Covered haul vehicles prevent the road from being contaminated with dust.

With these mitigation measures employed during the construction period and the establishment of vegetation as soon as possible over areas of exposed ground once construction is complete, suspended particulates from the construction process should be kept within acceptable limits.

9.3.6 Water Quality

Due to the small area of the site volumes of run-off generated will not be large enough to reach local watercourses and produce a potential for raised levels of sediments. Run off will be stopped by surrounding vegetation.

9.3.7 Cultural Heritage and Archaeology

The sitting out areas described in Section 9.1.1 which are found on the slope from the southern end of the pipe tunnel, leading from the main site, down to Ching Cheung Road is the only area of cultural value which will be affected by the development at Tai Po Road WTW. No actual damage will be done to the area as the new 150mm pipe will be surface mounted alongside the existing 500mm supply main. No heavy equipment will be needed and therefore, construction will require minimal disruption of others enjoyment of the area.

9.3.8 Safety

Apart from the road safety issues already discussed in Section 9.3.3 construction of the proposed development will not give rise to any other specific major safety issues.

The existing WTW is classified as a PHI due to the storage of chlorine on site. The same care should be exercised to prevent increased danger from chlorine deliveries at this site during the construction period as that described in Section 5.3.8.

Normal site safety practices should be followed.

Contractors should be advised in advance of chlorine deliveries. All construction activities, which could potentially affect a delivery, should be suspended until the delivery is complete. Should the construction process have caused any affects which might increase the likelihood of an accident during a chlorine delivery, e.g. piles of materials stored on roadways, dirt on access roads, these matters should be addressed prior to the delivery. Delivery drivers should be warned of the construction process happening at the WTW to enable them to exercise additional care.

9.3.9 Waste Disposal

Wastes produced by the construction process will be inert. They will be made up of cleared vegetation, soil, rock, and unusable or used building materials. Waste disposal is therefore straightforward. As long as these wastes are disposed of at a suitably licensed landfill they should cause no significant environmental impacts.

9.4 <u>Operational Phase Impacts and Mitigation Measures</u>

9.4.1 Visual Impacts

As stated in Section 9.1.4, the proposed development site is largely hidden by its position in a valley. The development site will be overlooked only by the Sir Robert Black College of Education and this is not considered an important view. Future landscaping may reduce this view.

The visual impacts of the proposed development at Tai Po Road WTW are not thought to be significant.

9.4.2 Ecology

Operation of the proposed development will have no negative ecological impacts further to the permanent loss of the area of grassland used for construction of the facilities. Wildlife displaced by the noise and activity during the construction phase is likely to return to the area once this activity ceases.

Negative ecological impacts of operation are not thought to be significant, so mitigation is not necessary.

The operation of the proposed development will remove a maximum of 4550 kg/day (dry solid weight) of water treatment works sludge which would otherwise be released into local waterways leading to the storm drainage system in Cheung Sha Wan and eventually the Victoria Harbour Water Control Zone. This will help reduce smothering of bottom fauna and the effects on aquatic organisms of reduced light penetration due to high turbidity.

9.4.3 Traffic

The operation of the proposed sludge treatment facilities will generate no extra traffic as sludge is transferred by sewer.

9.4.4 Noise

None of the activities involved in operating the proposed development generate significant noise levels. The current WTW contains similar pumps and tanks to those which are proposed. These currently cause no noticeable noise on site. Therefore, operational noise is not considered significant.

9.4.5 Airborne Emissions

The operational activities of the proposed development will not generate any significant levels of air emissions.

As WTW sludge from Tai Po Road WTW will be contained within a pipeline, is low in algae, it is not odiferous, and has no potential to generate nuisance odours.

9.4.6 Water Quality

As mentioned in Section 9.4.2 the operation of the proposed development will remove a maximum of 4550 kg (dry solid weight) of water treatment works sludge which would otherwise eventually be released into the Victoria Harbour Water Control Zone. Water quality in this area will therefore, be improved by a reduction in turbidity and suspended solids.

9.4.7 Cultural Heritage and Archaeology

The operation of the proposed developments would have no effects on Cultural Heritage and Archaeology.

9.4.8 Safety

Operation of the proposed development would have no specific safety implications on site.

9.4.9 Waste Disposal

The operation of the proposed development will pass thickened sludge to Stonecutters Island STW where the volume will be greatly reduced by the removal of water. The remaining sludge cake will be disposed of to a licensed landfill site. Following this disposal route waste disposal is not thought to present significant environmental impacts.

9.5 Summary of Impacts and Mitigation Measures

Tables 9.6 and 9.7 show summaries of the potential construction and operational impacts of the proposed development at Tai Po Road WTW, and also proposed mitigation measures.

9.6 Conclusions

Environmental impacts resulting from the construction and operation of the proposed development at Tai Po Road can be reduced to acceptable levels provided that the proposed mitigation measures are fully implemented.

Noise from construction noise is considered to be of medium significance due to the close proximity of residential development at 2, Caldecott Road (140 metres distance) and the Sir Robert Black College of Education (140 m distance) to the site, however noise control measures including the use of silenced PME at all times will enable noise impacts to fall below ProPECC recommended daytime levels. With regard to the College of Education, scheduling of work to avoid sensitive periods such as examinations should be carried out in order to meet ProPECC recommended noise levels during examinations (65 dB(A)).

The remaining environmental issues are considered to be of minor significance and are not anticipated to exceed relevant environmental standards or guidelines.

Once operational, the proposed development at Tai Po Road will have no significant impacts.

TABLE 9.6 TAI PO ROAD WTW - SUMMARY OF CONSTRUCTION PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual impact of construction site	Adverse	Short term	Local	Minor	-
Recreation	Disturbance of local sitting-out area	Adverse	Short Term	Local	Minor	Careful installation of pipe works by contractors. Posters placed in the area prior to development informing the public of the work.
Ecology	Vegetation loss due to construction	Adverse	Long Term	Local	Minor	-
	Disturbance of natural habitats	Adverse	Short Term	Local	Minor	-
Traffic	Increase in construction traffic on WTW access road	Adverse	Short Term	Local	Minor	-
	Increase in construction traffic on main roads	Adverse	Short Term	Regional	Minor	Contractors briefed on the dangers of the access junction.
Noise	Construction noise	Adverse	Short Term	Local	Medium	Noise monitoring during construction. Use of silenced equipment.
Airborne Emissions	Dust from construction work	Adverse	Short Term	Local	Minor	Fugitive dust control measures.
	Exhaust emissions	Adverse	Short Term	Local	Minor	-
Water Quality	Site runoff and erosion	Adverse	Short Term	Local	Negligible	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage	No Impact			Nil	N/A
Safety	Potential for accidents on construction site	Adverse	Short Term	Local	Minor	Normal site safety procedures. Contractors briefed on the dangers of chlorine, delivery plan formulated and followed.
	Potential for accidents off site	Adverse	Short Term	Regional	Minor	As road safety above.
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Minor	-

TABLE 9.7 TAI PO ROAD WTW - SUMMARY OF OPERATIONAL PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual intrusion	Adverse	Long Term	Local	Minor	Some landscaping as appropriate.
Ecology	Removal of natural habitats	Adverse	Long Term	Local	Minor	-
Noise	Operational noise	Adverse	Long Term	Local	Negligible	-
Airborne Emissions	Dust from operation	Adverse	Long Term	Local	Negligible	-
	Odour from operation	Adverse	Long Term	Local	Negligible	-
Water Quality	Fresh water quality	Beneficial	Long Term	Local	Medium	-
	Marine water quality	Beneficial	Long Term	Regional	Minor	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage.	No Impact			Nil	N/A
Waste Disposal	Discharge to sewer	Adverse	Long Term	Regional	Minor	-

SECTION 10
ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED SLUDGE TREATMENT DEVELOPMENT AT TUEN MUN WATER TREATMENT WORKS

10.1 Existing Environment

10.1.1 Background

The proposed site for development of sludge treatment facilities at Tuen Mun lies within the existing WTW boundary. Figure 10.1 and Plate 10.1 show a plan and an aerial photograph of the area, respectively. Tuen Mun WTW covers an area of 5.35 hectares and provides a treated water output of 330 MLD.

Tuen Mun WTW is situated to the north east of Tuen Mun New Town, in Shin Mun River Valley on the western side of the New Territories, map reference 816 829. The site is "L" shaped, with the base of the L to the north. A small but steep hill borders the site to the west in the cleft of the " L", and the much larger Shui Ngau Shan (Buffalo Hill) slopes away from the site up to the east. A spur road from Tuen Mun Road, giving access to Yuen Long Highway, passes along the northern edge of the site. King Fung Path (a minor road) gives access to the southern end of the WTW and the high rise residential estate, Grandeur Garden, which is located there. Development of the new Lingnam Collage is currently taking place adjacent to the north eastern corner of the site, and a road is being extended from this construction site south, along the edge of the hillside.

10.1.2 Existing Works

The main raw water supply for Tuen Mun WTW is Tai Lam Chung reservoir approximately 5 km to the east, with additional supplies piped from China. The main facilities currently on the site include:

- the main filter building;
- five clarifiers;
- six washwater recovery tanks; and
- six additional filters.

Four clarifiers (Stage I-IV) are located in the centre of the works adjacent to the chemical house and administration block. Thirty-two sand media rapid gravity filters are situated adjacent to the clarifiers. The filters have an average filter run time of 35 hours between washes and a washwater consumption of $136m^3$ per wash. Water from these filters discharges to four washwater recovery tanks to the west. An additional larger clarifier (Stage V) lies further south, close to the eastern edge of the site boundary. Six sand media rapid gravity filters are also located in this area. These filters have an average filter run time of 30 hours between washes and a washwater consumption of $350m^3$ per wash. The filters discharge to two washwater recovery tanks adjacent to the filter beds.

Existing Discharge Practice

Sludge from the treatment process at Tuen Mun WTW is discharged to the Tuen Mun Nullah via storm drain. Sludge from the Stage I-IV clarifiers ($230m^3$/day average) and bottom sludge from the associated washwater recovery tanks ($42m^3$/day average) feeds directly to a concrete channel which enters the Nullah. Sludge from the Stage V clarifier (450-$620m^3$/day average) and from the associated washwater recovery tanks ($70m^3$/day average) is also discharged to the channel. The Nullah eventually discharges to Castle

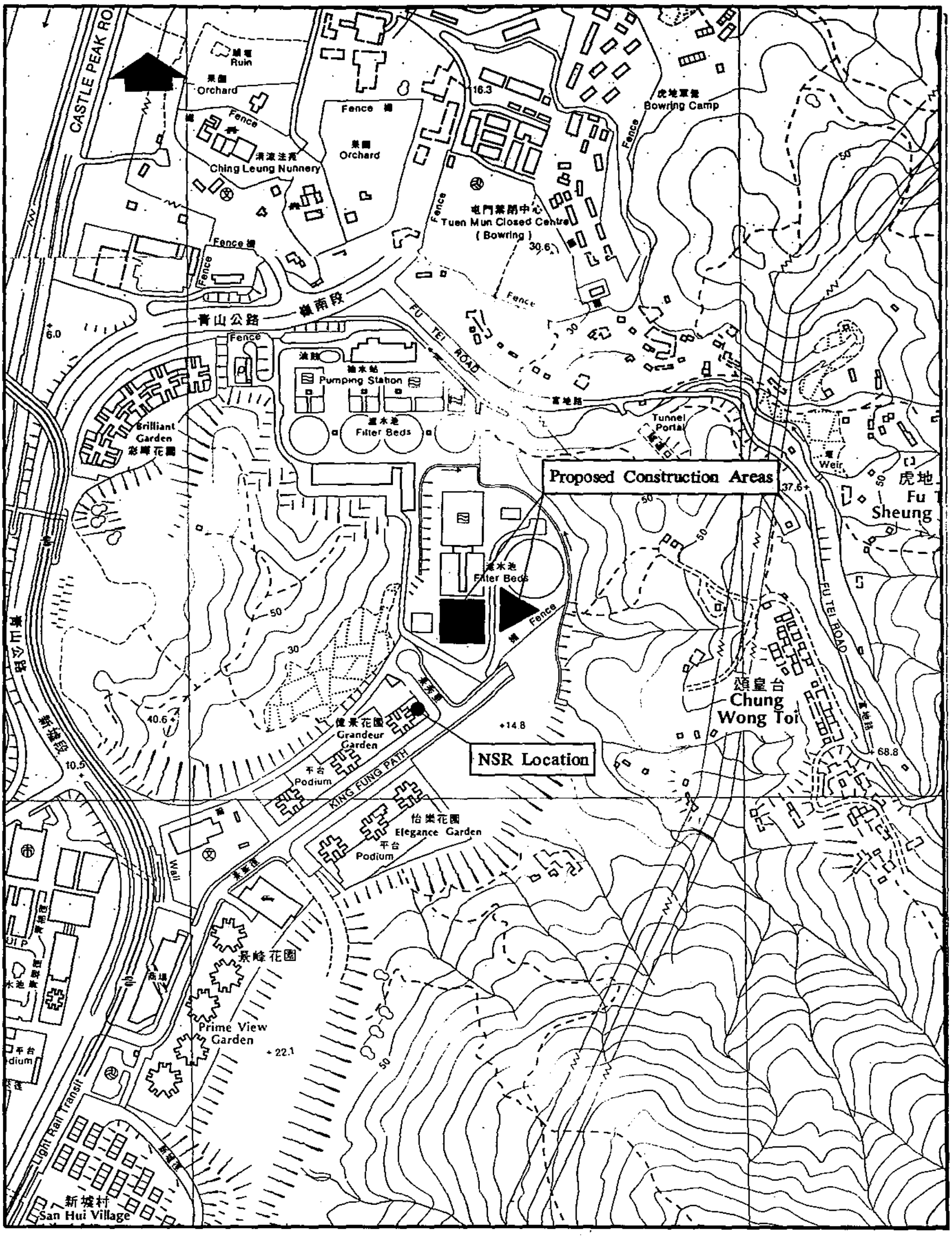
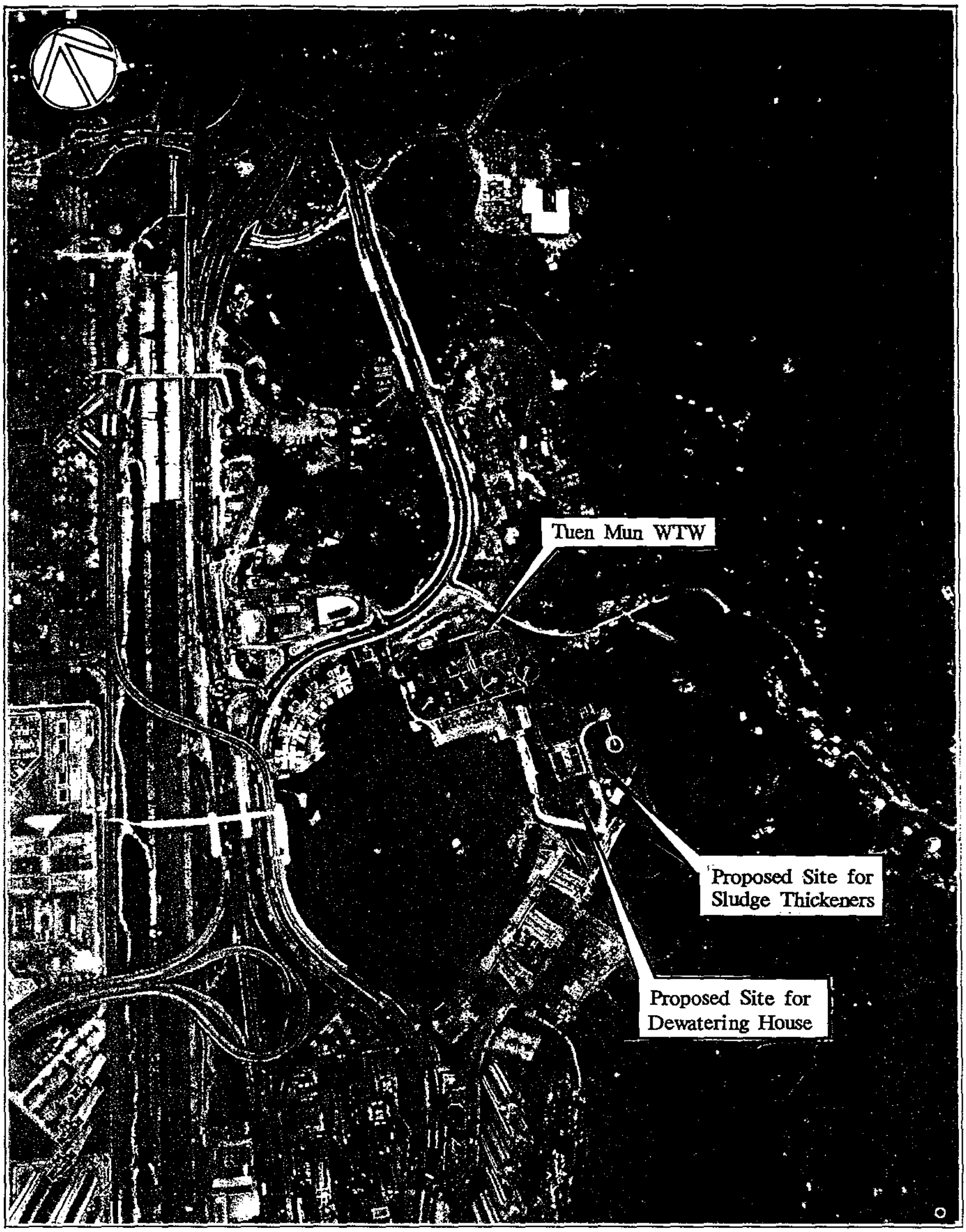


Figure 10.1
Proposed Development and Nearest Sensitive Receiver Location-Tuen Mun WTW

Plate 10.1
Tuen Mun Water Treatment Works Location Plan



Peak Bay (the shores of which include four gazetted beaches) and eventually into the Urmston Road tidal channel.

Tuen Mun WTW is situated within the North Western Water Control Zone (NWWCZ) which was initially declared on 1 April 1992.

10.1.3 Geology

The geology of the area is dominated by Mesozoic volcanic and intrusive igneous rocks, underlain with Palaeozoic sedimentary rocks and overlain by extensive areas of Quaternary superficial deposits. Bedrock below the WTW consists of decomposed volcanics at a depth of 3 to 7 metres.

10.1.4 Landscape Character and Visual Aspects

Tuen Mun WTW is located on the eastern side of the Tuen Mun River Valley, placed between a small hill rising at least 30 metres above the site to the west and the major east facing hillside of Buffalo Hill to the west. Development on these areas is currently limited to scattered illegal squatter dwellings. The extreme north west corner of the site wraps around the side of the small hill and butts against the west side of the easternmost high rise residential block of Brilliant Garden. The effect of the spur road off Tuen Mun Road running past the front of the works at a slightly higher level than the site, and the residential developments to the west and south of the WTW, together with the natural topography of a small valley, give the site an enclosed aspect. The height of the residential developments, especially those at Grandeur Garden, dominate the area. The vegetated slopes to the east have been damaged by squatters and previous clearance which gives the area an uncared for appearance. The small hill to the west was cut back during the original construction of the WTW, and concrete retaining structures and chainlink fencing make it less attractive than it could be.

Normally background noise levels for the WTW would be low. However, due to the construction of Lingnam Collage, construction noise was evident during a site visit. Of special note was the high level of sound produced by a hydraulic hammer mounted on an excavator building the road along the eastern edge of the site. The noise echoed around the valley.

The site is in the transition zone between the town and the rural area but considering the number of developments around the site it can be considered to exhibit more of an urban than rural character.

Visual Analysis

The site was visited and possible viewpoints and their importance assessed. Priority viewpoints are those deemed to be those with the most direct views overlooking the site from active areas, for example those where there is a transport, housing or recreational view of the site.

10.1.5 Ecology

The proposed development site has already been greatly influenced by the construction of the existing WTW. Half of the area is composed of fill material built up to give a level surface approximately a metre above the original road level. The current vegetation is close cut grass sward of little ecological value. The other half of the site supports patchy grass growth but the original ground surface level has been largely retained. This part of the site is of no significant ecological value.

10.1.6 Concurrent Developments

As already discussed above, a number of construction tasks are taking place around the WTW. The largest of these is the construction of Lingnam College to the north-east of the site. The other is the construction of an access road along the eastern boundary of the WTW. Further developments are unlikely as areas to the north and south of the site are already developed, and areas to the east and west are designated as Green Belt where there would be a presumption against development proposals.

No other developments or significant maintenance tasks are programmed to take place on the WTW site during the development construction period.

10.1.7 Traffic Levels

The WTW access is onto Fu Tei Road a few metres from where Fu Tei road joins a spur road off Tuen Mun Road. The spur road is a dual carriageway with a relatively light traffic load. Tuen Mun Road is part of the New Territories main road network and is high standard dual carriageway.

10.1.8 Air Quality

Noise

The NSR to the centre of the proposed development site at Tuen Mun WTW is:

- Grandeur Garden Estate, (100 metres distant).

Some construction will take place at the north of the site (mostly pipelaying), but this is not considered of great enough magnitude to require modelling. If acceptable noise levels can be achieved at the nearest housing block of Grandeur Garden Estate, then levels are expected to be acceptable for other residential developments in the area, such as Chung Wong Toi and Brilliant Garden, as these are further away and screened by topographical features.

As described in Section 10.1.3, the area surrounding Tuen Mun WTW can be assessed as urban. This classification can be applied to the NSRs under the Technical Memorandum on Noise from Construction Work other than Percussive Piling.

The development site is far enough from the main road for the road not to be considered as an influencing factor on noise levels, even though some noise from the road is likely.

The northernmost block of flats at Grandeur Gardens directly overlooks the proposed site and is not influenced by any significant noise sources or screened by topological features.

Dust

The nearest air pollution monitoring station to Tuen Mun is the site at 60 Tai Ho Road, Tsuen Wan. The area is classified by the EPD as Urban/Residential. This site is approximately 20 km to the west of the WTW at a similar height above mPD. The monitoring station is a considerable distance from the proposed site and in a more densely populated area. Its data are likely therefore, to give a higher particulate background than is actually the case at Tuen Mun WTW.

Annual means of TSPs have been measured to vary between 87 and 101$\mu g/m^3$ at the Tsuen Wan monitoring station. The Air Quality Objective for the annual mean is 80$\mu g/m^3$.

Therefore, any additional dust emitted into the environment can be considered to have a significant impact on the air quality.

10.1.9 Water Quality

Sludge from the WTW is currently discharged to the Tuen Mun Nullah via a storm drain. The Nullah runs through the centre of the New Town and is currently heavily polluted. Discharge from Tuen Mun Nullah is to Castle Peak Bay. Reduction of pollution to the Tuen Mun Nullah and beaches affected by its discharge into Castle Peak Bay is desirable.

10.1.10 Cultural Heritage and Archaeology

No graves, cemeteries or areas, sites or structures of cultural heritage or archaeological value have been identified as present at Tuen Mun WTW site.

10.2 Proposed Development

10.2.1 BEECOPS Evaluation for WTW Disposal

Transferring WTW sludge from Tuen Mun is not feasible due to the large volume of sludge generated. Direct discharge to the sea, specifically the North Lantau tidal stream, was also ruled out. This part of the coastal waters has experienced a dramatic increase in pollution loading over the last 2-3 years and is currently the subject of an on-going EPD monitoring programme as land is available on site on which to locate additional facilities. On-site dewatering was, therefore, selected as the BEECOPS for this WTW.

10.2.2 Proposed Development at Tuen Mun

It is proposed to provide sludge thickening and sludge dewatering facilities at Tuen Mun WTW. The development will consist of the installation of:

- a pair of gravity thickeners;
- Stage I-IV sludge collection pipeline, pumping station and pressure main;
- Stage V clarifier sludge pumps;
- sludge transfer pumping main;
- dewatering house buffer tanks;
- conversion of all existing washwater recovery tanks to balancing tanks; and
- the construction of a dewatering house.

The details of these are shown in Table 10.1. Plate 10.2 shows the site area, looking north-west from the nearest tower block in Grandeur Gardens. Approximately 1150 metres of pipes, ranging in diameter from 100 mm to 750 mm, would also be installed together with necessary pumps and mechanisms.

The development is limited to the southern end of the existing site. The proposed layout is shown on Figure 10.2

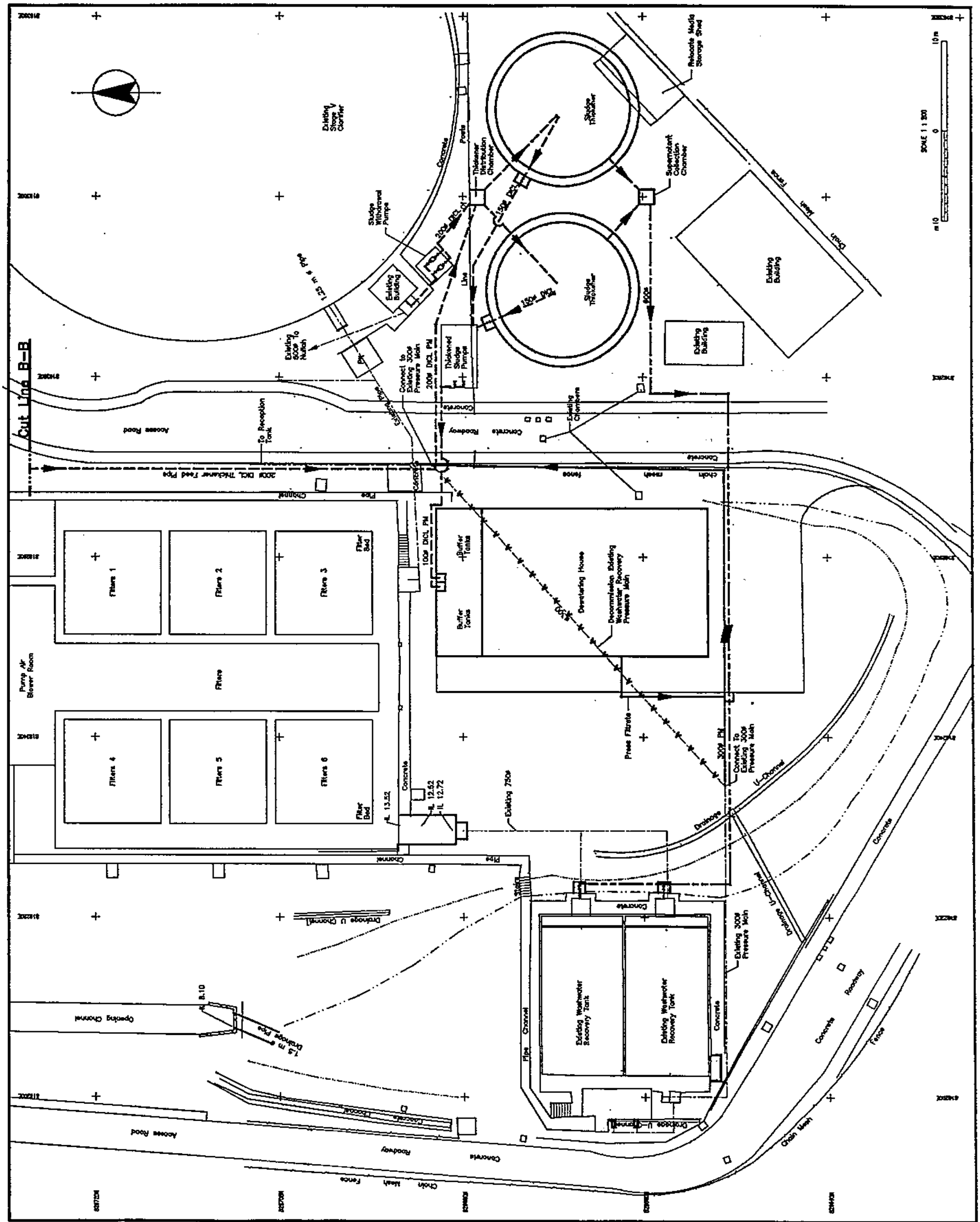


Figure 10.2 : Layout of Proposed Sludge Treatment Facilities at Tuen Mun WTW

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Table 10.1 Proposed Equipment to be Installed or Constructed at Tuen Mun WTW

Item Description	Item Size	Material	Unit	Quantity
Dewatering House	13.5 m high x 26m long x 15m wide	Reinforced concrete	no.	1
Thickener tanks	15m dia. internal	Reinforced concrete	no.	2
Thickener mechanisms	15 m dia.	Steel	no.	2
Buffer Tanks	369 m^3 (total)	Reinforced concrete	no.	2
Sludge draw-off pumps	9 l/s		no.	2

10.2.3 Construction

The construction process is likely to take approximately 24 months. The first month of this period will involve site clearance and preparation. During the following 13 months the necessary structures will be built on site. The installation of pumps, mechanisms and electrical equipment will take approximately 6 months. Testing and commissioning the new works will take a further 2 months. Work is scheduled to commence on site on 20/11/96.

Materials and equipment would be brought to the site by road. The main access to the site is from Fu Tei Road, with a disused back entrance from King Fung Path. Some storage space is available on site which may lead to concentration of deliveries early on in the project. It would be preferable for vehicles transporting materials to or from the site to avoid using Castle Peak Road which passes through the more residential parts of Tuen Mun town centre and use Tuen Mun Road instead. However, traffic leaving the works is forced to follow Castle Peak Road until Pui To Road, which gives access to Tuen Mun Road heading north, or to Tuen Hing Road, which gives access to Tuen Mun Road heading south.

A large flat area of grass land is available for the proposed development south of the existing WTW. This area is approximately 50 metres by 40 metres. There are no special on site access problems. Only turf and limited amounts of topsoil will have to be removed prior to commencement of construction.

Following site preparation, foundations for the structures would be laid. Piling is not thought to be necessary. The dewatering house and concrete tanks would be formed from concrete produced at an existing concrete batching plant, and steel re-bar.

Pipe routes are likely to be excavated using hand operated pneumatic drills and a back-hoe excavator mounted pneumatic breaker.

Table 10.2 shows the likely activities involved in the construction process, estimates of materials and equipment required, and wastes generated.

Table 10.2 Likely Construction Process, Estimates of Materials and Equipment Required, and Wastes Generated for Proposed Development at Tuen Mun WTW.

General Activity	Specific Activity	Equipment and use	Time period for activity	Time used on site
Site Clearance	Topsoil Removal	Trucks - removal of turf and topsoil	10 days	Visits during working hours
		Tracked Excavator - top soil removal	10 day	Working hours
	Excavation	Breaker and compressor (hand held pneumatic) - rock removal	90 days	Working hours
		Breaker (excavator mounted pneumatic)	90 days	Working hours
		Tracked Excavator - soil and rock moving	90 days	Working hours
		Skip Trucks - soil and rock removal	90 days	Visits during working hours
Construction	Tank construction	Concrete lorries - delivery of 3200 tonnes of concrete	20 months	Visits during working hours
		Flatbed trucks - delivery of 800 tonnes of re-bar	20 months	Visits during working hours
		Trucks - delivery of approximately 12 loads of form work and scaffolding	20 months	Visits during working hours
	Dewatering House	Concrete lorries - delivery of 5000 tonnes of concrete	20 months	Visits during working hours
		Flatbed trucks - delivery of re-bar	20 months	Visits during working hours
		Trucks - delivery of approximately 15 loads of form work and scaffolding	20 months	Visits during working hours
	Pipelaying	Trucks - delivery of 15 loads of piping	6 months	Visits during working hours
		Tracked excavator - excavating pipe run trenches and refilling after pipe laying	6 months	Working hours
		Breaker (hand held pneumatic) - rock removal	6 months	Working hours
	Mechanical and electrical installation	Trucks - delivery of 30 loads of equipment	4 months	Working hours

10.2.4 Operation

Figure 10.3 shows a schematic representation of the water and sludge treatment path, once this development is in service. New equipment will be electrically operated.

The Tuen Mun WTW dewatering facility is sized to process a peak of 11095 kg/day of sludge (dry solid weight). Dewatered sludge will be transported by road for disposal at WENT landfill.

10.2.5 Key Issues

From the data collected concerning the proposed Development at Tuen Mun WTW, the key issues were identified as:

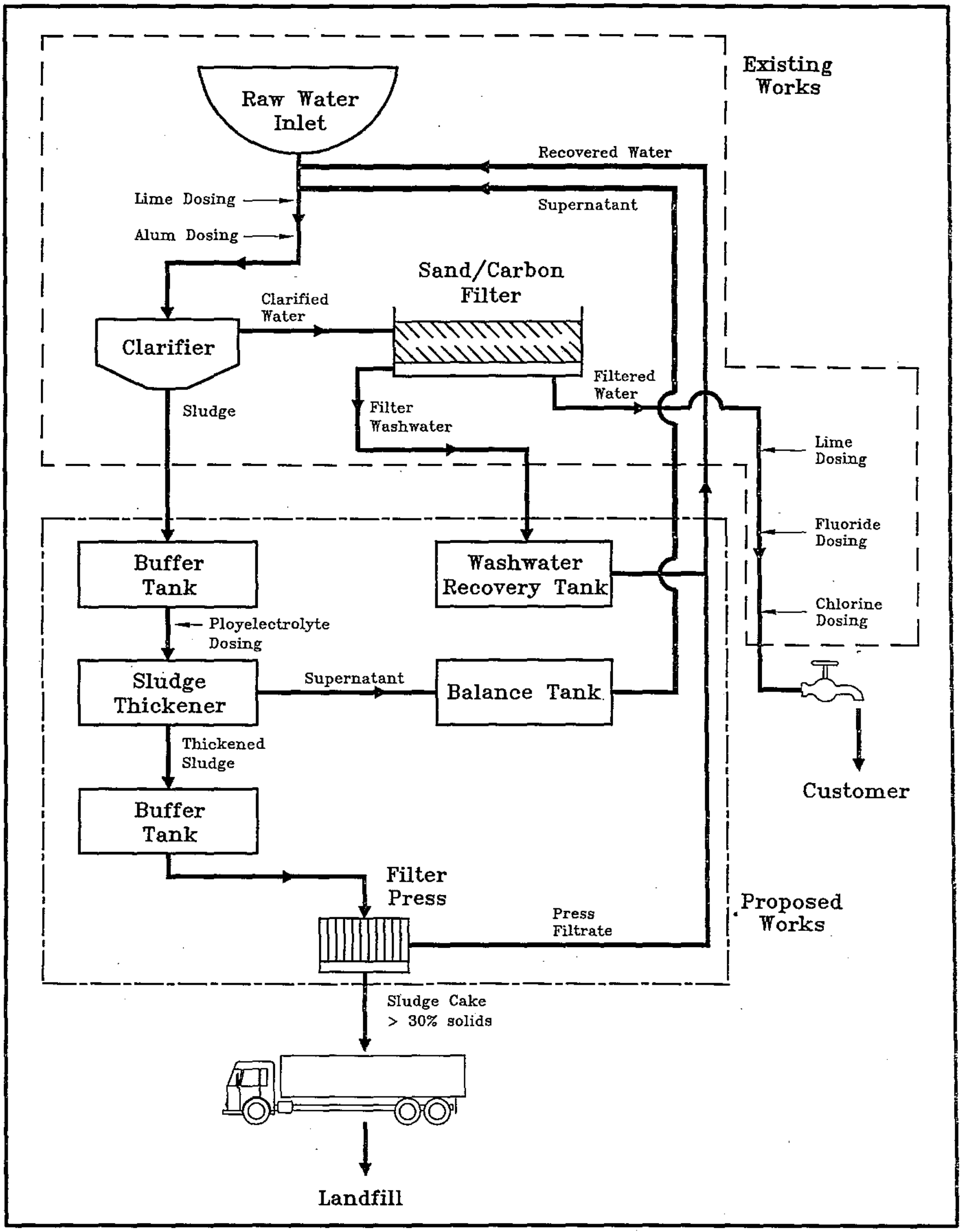

Figure 10.3 : Water Treatment Processes and Proposed Works at Tuen Mun WTW

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- construction and operational noise, due to the nearby high rise residential development NSR;
- fugitive dust emissions, for the same reason; and
- visual impacts, for the same reason.

10.3 Construction Phase Impacts and Mitigation Measures

This section examines the potential environmental impacts of the proposed development at Tuen Mun WTW, along with potential mitigation measures. Special attention is paid to Key Issues.

10.3.1 Visual Impacts

The present WTW is comprised of mainly low (two-three stories) and partly buried structures in the form of open circular and rectangular tanks. There are various ancillary buildings in the southeastern corner of the site.

Views are available from the Tuen Mun spur road from which the works form a lower than usual continuation of the urban area of Tuen Mun New Town.

One housing block, at the eastern end of Brilliant Garden, directly overlooks the WTW but will not overlook any part of the development site. From the upper stories of this building the washwater recovery tanks can be seen directly below, but a pump house and row of trees screen views of most of the rest of the site.

The northernmost residential block of Grandeur Gardens has a commanding view of the southern end of the site. This area is largely level with a number of single storey storage sheds and a large flat area currently covered in turf. Further north the two storey filter block largely obscures any view of the clarifiers. In the middle distance the construction of Lingnam Collage intrudes onto the skyline. These views of development generally detract from the natural appearance of the vegetated valley sides and distant views of hills on the horizon to the north.

The visual impact of construction will be generally to lower to value of the views from Grandeur Gardens. However, as the visual impact of construction is transitory in nature it is not thought to be of major importance. Operation phase impacts are long term and are considered in Section 10.4.1 below.

10.3.2 Ecology

The ground cover which will have to be removed to carry out the development is poor quality grassland which has been established by the WTW. No vegetative cover of ecological value will be affected. There is relatively little bush and tree cover adjacent to the proposed site, except on the small hill to the west. This limits the number of birds and other wildlife around the site. Those that are present may be scared away from the immediate area of the development site by the disturbance caused during construction. However, due to the limited area of the development and the low value of the surrounding area of the works to wildlife, numbers affected will be small, limiting the significance of this impact.

There is some scope at the Tuen Mun site establish an improved vegetative cover around the edges of the proposed development, especially to the south which could assist in screening the new development.

Ecological impacts are not thought to be significant.

10.3.3 Traffic

By looking at the estimated volumes of wastes and construction materials required to complete the development, it can be estimated that approximately 900 vehicle trips will be required during the 24 month construction period. It is likely that at peak construction times approximately 50 vehicle movements a day would be made.

The site has good access to the New Territories main road network but drivers should be prevented from following Tuen Mun Road through the centre of Tuen Mun. Castle Peak Road should be used as a preferred route as this has been designed to take heavy traffic through the town.

Drivers should be forbidden from using King Fung Path as an access route to the development site, as this road runs through the middle of high density housing areas.

The increase in heavy traffic due to the construction process should have no major impacts on the local road network.

10.3.4 Noise

A noise assessment for the construction of the proposed development has been carried out. Percussive piling will not take place on this site as the geology provides a suitable foundation without piling. The noise assessment was carried out following the methodology described in the EPD Technical Memorandum concerning, "Noise from Construction Work Other Than Percussive Piling".

The technical detail of calculation of potential noise levels is shown in Appendix C.

It was found that during construction, the CNL at Grandeur Garden Estate would be 83.5 dB(A). This substantially exceeds both EPD's recommended daytime noise levels stated in Practice Notes (ProPECC PN 2/93) and the ANL, partially due to the naturally reverberant nature of the valley the site is located in, but also due to the scale of development and the proximity of the NSR. Acoustic barriers and use of silenced equipment will definitely be required to enable some construction processes to take place at the site. However, it will be difficult to screen activities due to the large size of the proposed construction and the height of Grandeur Gardens. Noise calculations (see Appendix C) show that calculated noise levels can be reduced to 76 dB(A) at Grandeur Gardens when all equipment on site is silenced. In order to acheive levels below 75 dB(A) use of equipment should be controlled. During the use of a silenced breaker, for example, no other construction operations generating sound levels in excess of 107 dB(A) should be carried out. This would enable calculated noise levels at Grandeur Gardens of 72 dB(A). During other times the use of the listed silenced equipment (without silenced breaker) would acheive a CNL of 73 dB(A). Use of temporary enclosures and/or acoustic barriers placed close to the noise source would reduce noise levels further.

Construction noise is therefore, considered to have the potential for significant environmental impacts.

10.3.5 Airborne Emissions

The FDM was applied to the proposed development to calculate the potential total suspended particulates at the NSR. The technical details of the way the FDM was applied is described in Appendix D to this document. The model provides a worst case, as though dust creating construction activity is taking place on the entire area of the proposed development site for 24 hours and the wind is blowing constantly towards NSRs. The FDM calculated dust concentration value is shown Table 10.3, together with the factors which will, in a real case, make the actual TSPs found at the NSRs lower. It should be noted that the model assumes a flat site, which in this case is applicable. The model does not allow for the effects of vegetation around the site, which is important in this case as there is screening vegetation at the south between the site and the NSR. This would have some arresting effect on suspended particulate movement towards the NSRs.

Table 10.3 Modeled Dust Concentrations at NSRs and Correction Factors

NSR	FDM 24 hour average concentration ($\mu g/m^3$)	Actual time wind in quarter towards NSR	Barriers (e.g. topography, vegetation)	Actual Working Hours	% of site likely to be open for dust generation	Realistic 24 hour Concentration at NSR due to Development ($\mu g/m^3$)
Grandeur Garden Estate	335	30	Surrounding vegetation	8	70	100

The results of the modeling exercise show that the fugitive dust emissions from the site might exceed the AQO TSP of 260 $\mu g/m^3$ average over 24 hours, but only if construction activity was to continue for 24 hours a day, the local topography was completely flat, and the local weather conditions blew dust from the site to the NSR constantly over the 24 hour period. The results of the modeling exercise, when considered with the "real world" site specific factors, such as shielding vegetation and prevailing winds, has shown that the site is unlikely to cause the 24 hour AQO for TSPs to be exceeded at the NSR but there is a real likelihood that significant increases in ambient dust will be caused by construction of the development.

As potential impacts could be significant, and as reliable background TSP counts are not available for the immediate area, it is preferable that fugitive emissions from the development should be reduced to the lowest possible levels by appropriate mitigation measures. These are shown in Table 10.4.

With these mitigation measures employed during the construction period and the establishment of vegetation as soon as possible over areas of exposed ground, once construction is complete, suspended particulates from the construction process should be kept within acceptable limits.

Table 10.4 Fugitive Dust Control Measures

Development Stage and Control Methods	Comments
Land Clearing/Earth Moving	the major source of dust from this development
Watering	Water should be applied over the site prior to conducting any land clearing. This will increase the moisture content of the soil, thereby increasing its stability. Clay soil should be kept above 8% water to prevent dust generation. Water should be re-applied as necessary over the period that bare soil areas are exposed. Water can be applied by sprinklers or hoses.
Minimise Loading Drop Height	Mechanical excavator drivers should ensure that the height spoil is dropped from into haul vehicles is minimised, thus reducing dust generation.
Cover Haul Vehicles	Haul vehicles should be tarpaulined to prevent dust being generated from their loads as they move along the highway.
Vehicle movement on Unpaved Areas	Possible as in this case the site area is large enough for vehicles to move at appreciable speed.
Watering	Water should be re-applied as necessary over the period that bare soil areas are exposed. Water can be applied by sprinklers or hoses.
Reduce Speed Limits	15 mph maximum to prevent excessive vehicle speed lifting dust.
Paved Road Track Out	Potential source of dust in this case as haul vehicles will have access to the site.
Sweep/clean roadways	The access road should be swept or water flushed clean to prevent re-entrainment of deposited dust.
Cover Haul Vehicles	Covered haul vehicles prevent the road from being contaminated with dust.

10.3.6 Water Quality

Due to the relatively large area of the site, it is possible that volumes of run-off generated will be large enough to reach local storm drains which would produce raised levels of sediments in Tuen Mun Nullah. Run off should be directed from the storm drains where practicable, possibly into the existing washwater recovery system.

Construction impacts on water quality are not thought to be significant.

10.3.7 Cultural Heritage and Archaeology

No areas of cultural or archaeological value will be affected by the development at Tuen Mun WTW.

10.3.8 Safety

Apart from the road safety issues already discussed in Section 10.3.3 construction of the proposed development will not give rise to any other specific safety issues.

The existing WTW is classified as a PHI due to the storage of chlorine on site. The main access route to the site is past the chlorine storage area. The same care should be exercised to prevent increased danger from chlorine deliveries at this site during the construction period as that described in Section 5.3.8.

Normal site safety practices should be followed.

Contractors should be advised in advance of chlorine deliveries. All construction activities, which could potentially affect a delivery, should be suspended until the delivery is complete. Should the construction process have caused any effects which might increase the likelihood of an accident during a chlorine delivery, for example piles of materials stored on roadways, dirt on access roads, these matters should be addressed prior to the delivery. Delivery drivers should be warned of the construction process happening at the WTW to enable them to exercise additional care.

10.3.9 Waste Disposal

Wastes produced by the construction process will be inert. They will be made up of cleared vegetation, soil, rock, and unusable or used building materials. Waste disposal is therefore straightforward. As long as these wastes are disposed of at a suitably licensed landfill they should cause no significant environmental impacts.

10.4 Operational Phase Impacts and Mitigation Measures

10.4.1 Visual Impacts

As stated in Section 10.3.1, the only view of the development site is a major one from Grandeur Gardens Estate. To properly assess the potential visual impact of the sludge treatment developments and in particular the sludge dewatering house, a computer generated impression of the completed development was produced. Plate 10.2 shows the existing view from the garden area on the third floor of the nearest housing block of Grandeur Gardens. Plate 10.3 shows the computer generated photoimage of the completed proposed development. It can be seen from these images that the development will be a significant feature in the views from the lower stories of Grandeur Gardens, and significantly cut down on the area of grass previously looked over. It also brings the developed part of the site closer to the residential area.

It is proposed that in order to minimise the intrusion of the development, the sludge dewatering house should be finished using the same matt green the other buildings on site are already painted. The material used for the roof should also have a matt finish to prevent reflection of sunlight off its surface to the upper stories of the Grandeur Gardens Estate.

The visual impacts of the proposed development at Tuen Mun WTW are not thought to be major.

10.4.2 Ecology

Operation of the proposed development will have no negative ecological impacts further to the permanent loss of grassland under buildings as described in Section 10.3.2. Wildlife displaced by the noise and activity during the construction phase is likely to return to the area once this activity ceases.

Negative ecological impacts of operation are not thought to be significant, so mitigation is not necessary.

The operation of the proposed development will remove a peak of 11095 kg per day (dry solid weight) of water treatment works sludge which would otherwise be released into Tuen Mun Nullah. This will help reduce smothering of bottom fauna and the effects on aquatic organisms of reduced light penetration due to high turbidity.

10.4.3 Traffic

The operation of the proposed sludge treatment facilities will on average generate approximately 2-3 lorry loads of sludge to be disposed of at WENT landfill.

This additional traffic is insignificant compared with the current traffic levels and traffic carrying capacity of the main roads from Tuen Mun WTW to WENT landfill.

10.4.4 Noise

Filling lorries with sludge by dropping it through bars into the trucks below, while the lorries stand in open bays may generate some noise. With the proposed orientation of the sludge dewatering facility the lorry bays would face Grandeur Gardens. Plate 10.3 shows the proposed road access and the doors to the sludge bays which are yellow. This orientation, together with the naturally reverberant nature of the area may lead to noise nuisance. Using the currently proposed orientation for the sludge dewatering house, sludge lorries are also brought along the plant perimeter road, as near to Grandeur Gardens as it is possible to get.

It is therefore proposed to re-orientate the sludge dewatering house by a 90 degree clockwise rotation of the design shown in Figure 10.2. This gives the following benefits:

- the loading bays are no longer pointed towards Grandeur Gardens, therefore noise from loading operations would be significantly reduced;

- the loading operation would be further from Grandeur Gardens, thus further reducing the possibility for noise impacts;

- the new access point on the northern side of the existing washwater reclaim tanks would keep sludge lorries significantly further from Grandeur Gardens, avoiding their traveling along the site perimeter road: and

- tall buildings would be kept more in the centre of the site, reducing visual impact.

If these measures are taken operational noise should not be significant.

10.4.5 Airborne Emissions

The operational activities of the proposed development will not generate any significant levels of air emissions. The most important source of air contamination connected with the new plant will be from the exhausts of lorries removing sludge, and these are in low enough numbers not to be considered significant.

Plate 10.2
Tuen Mun WTW before proposed development

Plate 10.3
Computer-generated view of Tuen Mun WTW after development

As WTW sludge from Tuen Mun WTW is low in algae, it is not odiferous, and has no potential to generate nuisance odours.

10.4.6 Water Quality

As mentioned in Section 10.4.2 the operation of the proposed development will remove a peak load of 11095 kg per day of water treatment works sludge which would otherwise be released into Tuen Mun Nullah. Water quality in this area will therefore, be improved by a reduction in turbidity and suspended solids.

10.4.7 Cultural Heritage and Archaeology

The operation of the proposed developments would have no effects on Cultural Heritage and Archaeology.

10.4.8 Safety

Operation of the proposed development would have no specific safety implications on site.

Lorry transportation of 30% solids WTW sludge has no specific safety implications. The material is similar to clay and should a vehicle carrying this material be involved in a road traffic accident similar clean up procedures to those employed if clay was the load involved would be adequate. No special protective equipment would be necessary for emergency services attending.

10.4.9 Waste Disposal

The sludge cake will be disposed of to a licensed landfill site. Following this disposal route waste disposal is not thought to present significant environmental impacts.

10.5 Summary of Impacts and Mitigation Measures

Tables 10.5 and 10.6 show summaries of the potential construction and operational impacts of the proposed development at Tuen Mun WTW, and also proposed mitigation measures.

10.6 Conclusions

Environmental impacts resulting from the construction and operation of the proposed development at Tuen Mun can be reduced to acceptable levels provided that the proposed mitigation measures are fully implemented.

Noise from construction is considered to be of medium significance due to the close proximity of Grandeur Garden Estate to the site (100 metres distance). Without the incorporation of mitigation measures, construction noise is anticipated to exceedance ProPECC recommended daytime levels. Noise control measures including the use of silenced PME at all times, scheduling of activities and the erection of acoustic barriers will enable construction noise impacts to fall within acceptable levels.

A number of mitigation measures have also been proposed in order to reduce potential noise impacts during the operational phase. These include reorientation of the dewatering house to reduce noise levels at the nearby residences.

Air quality impacts resulting from construction activites at Tuen Mun are considered to be of medium significance, however incorporation of dust control measures (see Table 10.4) will reduce potential impacts to a minimum.

The visual impact of the proposed development from Grandeur Gardens Estate is considered to be of medium significance. Impacts during construction are transitory in nature, however operational impacts are long term and will generally lower the value of the views from the housing estate. Mitigation measures will be incorporated in order to reduce impacts to a minimum.

The remaining environmental issues are considered to be of minor significance and are not anticipated to exceed relevant environmental standards or guidelines.

TABLE 10.5 TUEN MUN WTW - SUMMARY OF CONSTRUCTION PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual impact of construction site	Adverse	Short term	Local	Medium	-
Ecology	Vegetation loss due to construction	Adverse	Long Term	Local	Negligible	-
	Disturbance of natural habitats	Adverse	Short Term	Local	Negligible	-
Traffic	Increase in construction traffic on WTW access road	Adverse	Short Term	Local	Minor	-
	Increase in construction traffic on main roads	Adverse	Short Term	Regional	Minor	-
Noise	Construction noise	Adverse	Short Term	Local	Medium	Noise monitoring during construction. Use of silenced PME. Noise barriers as required around noisy activities.
Airborne Emissions	Dust from construction work	Adverse	Short Term	Local	Medium	Fugitive dust control measures.
	Exhaust emissions	Adverse	Short Term	Local	Minor	-
Water Quality	Site runoff and erosion	Adverse	Short Term	Local	Negligible	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage	No Impact			Nil	N/A
Safety	Potential for accidents on construction site	Adverse	Short Term	Local	Minor	Normal site safety practices. Contractors briefedbreifed on dangers of chlorine, delivery plan formulated and followed.
	Potential for accidents off site	Adverse	Short Term	Regional	Minor	-
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Minor	-

TABLE 10.6 TUEN MUN WTW - SUMMARY OF OPERATIONAL PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual intrusion	Adverse	Long Term	Local	Medium	Finish of buildings to blend with existing structures.
Ecology	Removal of natural habitats	Adverse	Long Term	Local	Negligible	-
Traffic	Increase in operational traffic on WTW access road	Adverse	Long Term	Local	Minor	-
	Increase in operational traffic on main roads	Adverse	Long Term	Regional	Minor	-
Noise	Operational noise	Adverse	Long Term	Local	Negligible	Re-orientation of building to point pickup bays away from residences. Use of silenced equipment.
Airborne Emissions	Dust from operation	Adverse	Long Term	Local	Negligible	-
	Odour from operation	Adverse	Long Term	Local	Negligible	-
Water Quality	Fresh water quality	Beneficial	Long Term	Local	Minor	-
	Marine water quality	Beneficial	Long Term	Regional	Minor	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage.	No Impact			Nil	N/A
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Minor	-

SECTION 11
ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED SLUDGE TREATMENT DEVELOPMENT AT SILVERMINE BAY WATER TREATMENT WORKS

11.1 Existing Environment

11.1.1 Background

The proposed site for development of sludge treatment facilities at Silvermine Bay lies within the existing WTW boundary. Figure 11.1 and Plate 11.1 show a plan and an aerial photograph of the area respectively. Silvermine Bay WTW covers an area of 4.76 hectares and provides a treated water output of 159 MLD.

Silvermine Bay WTW is situated on Lantau Island, approximately 20 km west of Hong Kong Island, at map reference 817 813. The WTW is located on the southern side of Silvermine Bay on a ridge 80 metres above Mui Wo, the administrative centre for Lantau Island. The main ferry terminal for Lantau Island is overlooked by the WTW.

Access to the WTW is via a narrow road leading from South Lantau Road. The Mui Wo Agricultural Extension Office (Agricultural & Fisheries Department) and the Lantau Vehicle Servicing Depot (Government E & M Servicing Department) are located along the WTW access road, approximately 150 metres to the north. Round Table Village is the nearest settlement to the WTW, 200 metres to the north-east. The nearest part of Mui Wo to the proposed development is Nagan Wan Estate, 300 metres to the north. This estate, along with most of Mui Wo, is screened from the site by the ridge. The New Territories Heung Yee Kuk Southern District Secondary School on Mui Wo Ferry Pier Road is approximately 350 metres north-east of the site. The small settlement of Lai Chi Yuen Tsuen lies 250 metres to the south, at the foot of the slope.

East of the WTW the hillside is terraced and a variety of horticultural activities take place. All the area around the site is heavily vegetated with well developed tree and shrub growth.

11.1.2 Existing works

The main raw water supply for Silvermine Bay WTW is Shek Pik reservoir. The main facilities currently on the site include:

- the main filter building;
- three clarifiers; and
- two washwater recovery tanks.

Silvermine Bay WTW is a two stage treatment process comprising of clarification prior to filtration. Three clarifiers are located to the east of the main filter beds. Ten sand media rapid gravity filters, with an average filter run time of 32 hours between washes and washwater consumption of $264m^3$ per wash, are located within the main building. Washwater is taken from the filters and stored in two washwater recovery tanks to the south of the site. Overflow from the tanks is pumped to the inlet works for re-treatment. Most of the solids from the washwater storage tanks is recycled to the clarifiers.

Existing Discharge Practice

Sludge from the clarifiers enters a stream course at two locations and flows into Silvermine Bay near the turn off to Mui Wo Ferry Pier Road. Discharge is below low water level on a beach within an enclosed embayment. A visible brown plume can be seen after discharge.

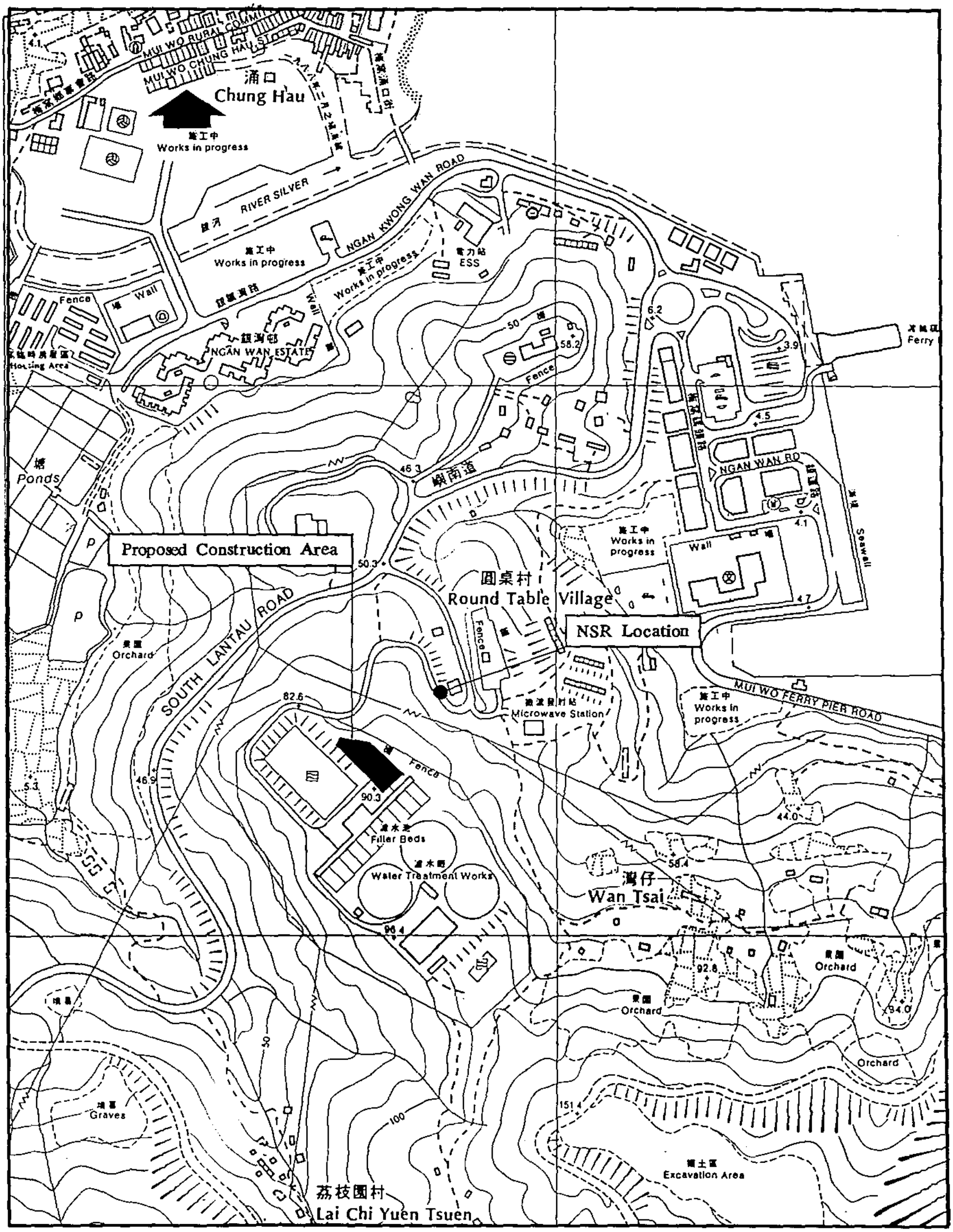

Figure 11.1
Proposed Development and Nearest Sensitive Receiver Location-Silvermine Bay WTW

The treatment works are located within the Southern Waters Water Control Zone which was fully declared in August 1989.

11.1.3 Geology

The area consists of a ridge of major intrusive igneous rock, surrounded by bands of minor intrusions. The geology underlying the WTW site is made up of fine grained Jurassic, or Cretaceous, quartz.

11.1.4 Landscape Character and Visual Aspects

Silvermine Bay WTW is located on a ridge which is part of the ring of hills surrounding the Bay. The area around the site is designated as Green Belt but does not form part of either of the two Lantau Country Parks. The hard underlying geology of the area and the influence of weathering has lead to a landscape of ridges and ravines. The island is almost completely rural with only limited development. However, the WTW is adjacent to Mui Wo, one of the major areas of development on the island. This is largely low density residential development.

11.1.5 Ecology

The proposed development site is within the boundary of the existing WTW. Part of the area is paved with concrete, where delivery vehicles bring supplies to the WTW. This area has no ecological value. Adjacent to this is an area of land currently used as a pipe store. Two small trees have become established on this area and weeds around the pipes have been allowed to grow (see Plate 11.2). This area is not of significant ecological value. A slope joining this area is also to be used as part of the development site. This has a more varied cover of grasses and sedges, and also is the site for three mature She Oak trees (see Plate 11.3). The land area is of limited ecological value.

11.1.6 Concurrent Developments

Residential developments are taking place in Mui Wo below the WTW plant.

No other developments or significant maintenance tasks are programmed to take place on the WTW site during the development construction period.

11.1.7 Traffic

Access to the plant is from South Lantau Road. Only permitted vehicles are allowed to use South Lantau Road which keeps traffic levels relatively light and limited to taxis, buses and other essential users. Although this is the main road on the island, it is narrow and is forced to wind between the hills. A 1 in 8 slope occurs along South Lantau Road between the roundabout close to Mui Wo Ferry Pier and the turn-off to the WTW access road.

11.1.8 Air Quality

Noise

The NSR to the centre of the proposed development site at Silvermine Bay WTW is:

- Round Table Village, (200 metres distant).

If noise levels are predicted to be acceptable at Round Table Village, they should be acceptable at Lai Chi Yuen Tsuen which is sheltered by the existing WTW and the crest of the ridge.

Plate 11.1
Silvermine Bay Water Treatment Works Location Plan

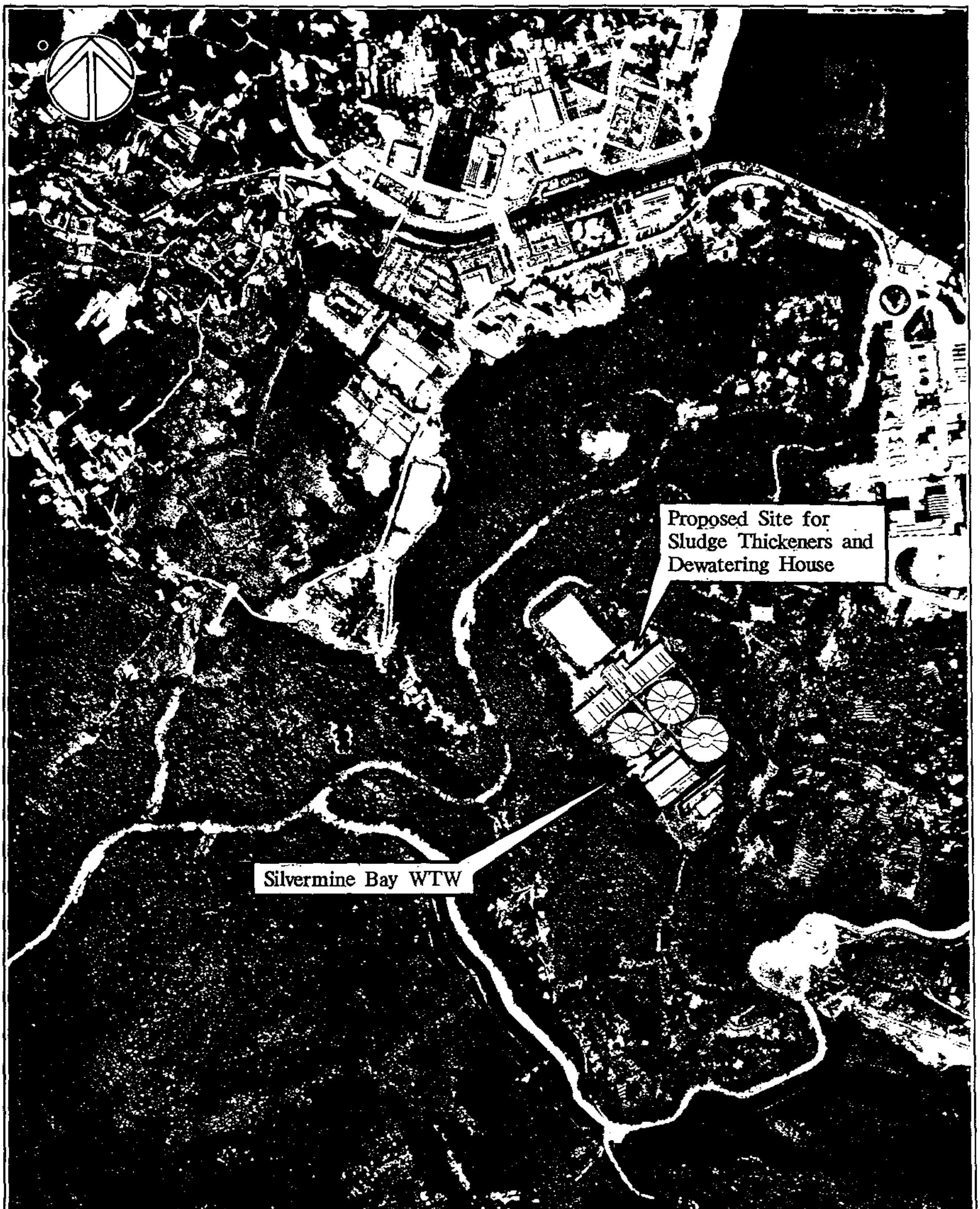

Plate 11.2 **Site for Proposed Dewatering House - Silvermine Bay WTW**

Plate 11.3 **Site of Proposed Sludge Thickeners - Silvermine Bay WTW**

As described in Section 11.1.4, some the area surrounding Silvermine Bay WTW is typically rural but developed areas are within a few hundred metres to the north to north-west. Therefore the classification of low density residential area can be applied to the NSR under the Technical Memorandum on Noise from Construction Work other than Percussive Piling.

The NSR is not affected by any significant noise influencing factors.

Dust

There is no air pollution monitoring station on Lantau Island, probably due to its rural nature. The nearest monitoring station is at Hong Kong South, 789 Pokfulum Rd.

The site is in a residential area at a height of 150 above mPD. As the proposed site is in a less heavily populated area and at a height of 100m the data from the station can be used as indicative of the air quality at Silvermine Bay WTW.

In 1991 the monthly means of TSPs were measured to vary between 34 and 92$\mu g/m^3$ at the monitoring station. The Air Quality Objective for the annual mean is 80$\mu g/m^3$. Therefore, any additional dust emitted into the environment could be considered to have a significant impact on the air quality, depending on the time of year.

11.1.9 Water Quality

Sludge from the WTW is currently discharged into a pipeline leading to the small bay directly below the WTW where the discharge can be seen to cause a plume of suspended sediments. As the area is used by tourists and visitors, this is inappropriate.

11.1.10 Cultural Heritage and Archaeology

Lantau Island is known for ancient settlements and archaeological sites, and the WTW lies within the Silvermine Bay Archaeological Site. All the proposed site area appears to have been affected by the construction of the original works and no graves, cemeteries or areas, sites or structures of cultural heritage or archaeological value have been identified as present at Silvermine Bay WTW site. The Antiquities and Monuments Office have expressed the wish to be notified in advance of ground breaking, in order to ensure a member of their staff can oversee excavations.

11.2 Proposed Development

11.2.1 BEECOPS Evaluation for WTW Disposal

Silvermine Bay is a large works which services most of Lantau in addition to Southern Hong Kong Island. The local sewerage network and treatment works at Mui Wo is comparatively small and therefore, it is of insufficient capacity to accept sludge discharged from the WTW. Two options were considered for discharge of sludge from the waterworks:

- dewatering at an expanded facility at the Mui Wo STW (which is also an ISDS option); or
- dewatering at Silvermine Bay WTW.

The availability of a site at Mui Wo STW could not be guaranteed, and as the STW is proposed to be expanded, there may not be sufficient space on site to accommodate a combined dewatering plant. The BEECOPS solution was therefore identified as a sludge dewatering facility be located at the water treatment works site where space is available.

11.2.2 Proposed Development at Silvermine Bay

It is proposed to provide sludge clarifying, thickening and dewatering facilities at Silvermine Bay WTW. The development will consist of the installation of:

- sludge collection pipeline;
- clarifier sludge buffer tank and pumping station;
- two gravity thickeners;
- supernatant return pumping station;
- thickened sludge pumping station;
- dewatering house buffer tanks; and
- the construction of a dewatering house.

The details of these are shown in Table 11.1. Approximately 620 metres of pipes, ranging in diameter from 80 mm to 750 mm, would also be installed together with necessary pumps and mechanisms.

The development is limited to the southern end of the existing site, apart from some of the pipe runs which cross the existing site. The proposed layout is shown on Figure 11.2.

Table 11.1 Proposed Equipment to be Installed or Constructed at Silvermine Bay WTW

Item Description	Item Size	Material	Unit	Quantity
Dewatering House	15m high x 26m long x 13.5m wide	Reinforced concrete	no.	1
Dewatering House Buffer Tanks	268 m^3	Reinforced concrete	no.	1
Clarifier sludge buffer tank	270 m^3	Reinforced concrete	no.	1
Thickener tanks	11m dia. internal	Reinforced concrete	item	2
Thickener mechanisms	11 m dia.	Steel	item	2
Supernatant pumps	20 l/s		item	2
Thickener feed pumps	20 l/s			2
Thickened sludge draw-off pumps	3 l/s		item	2

11.2.3 Construction

The construction process is likely to take approximately 24 months. The first month of this period will involve site clearance and preparation. During the following 12 months the necessary structures will be built on site. The installation of pumps, mechanisms and electrical equipment will take approximately 6 months. Testing and commissioning the new works will take approximately 2 months. Work is scheduled to commence on site on 20/11/96.

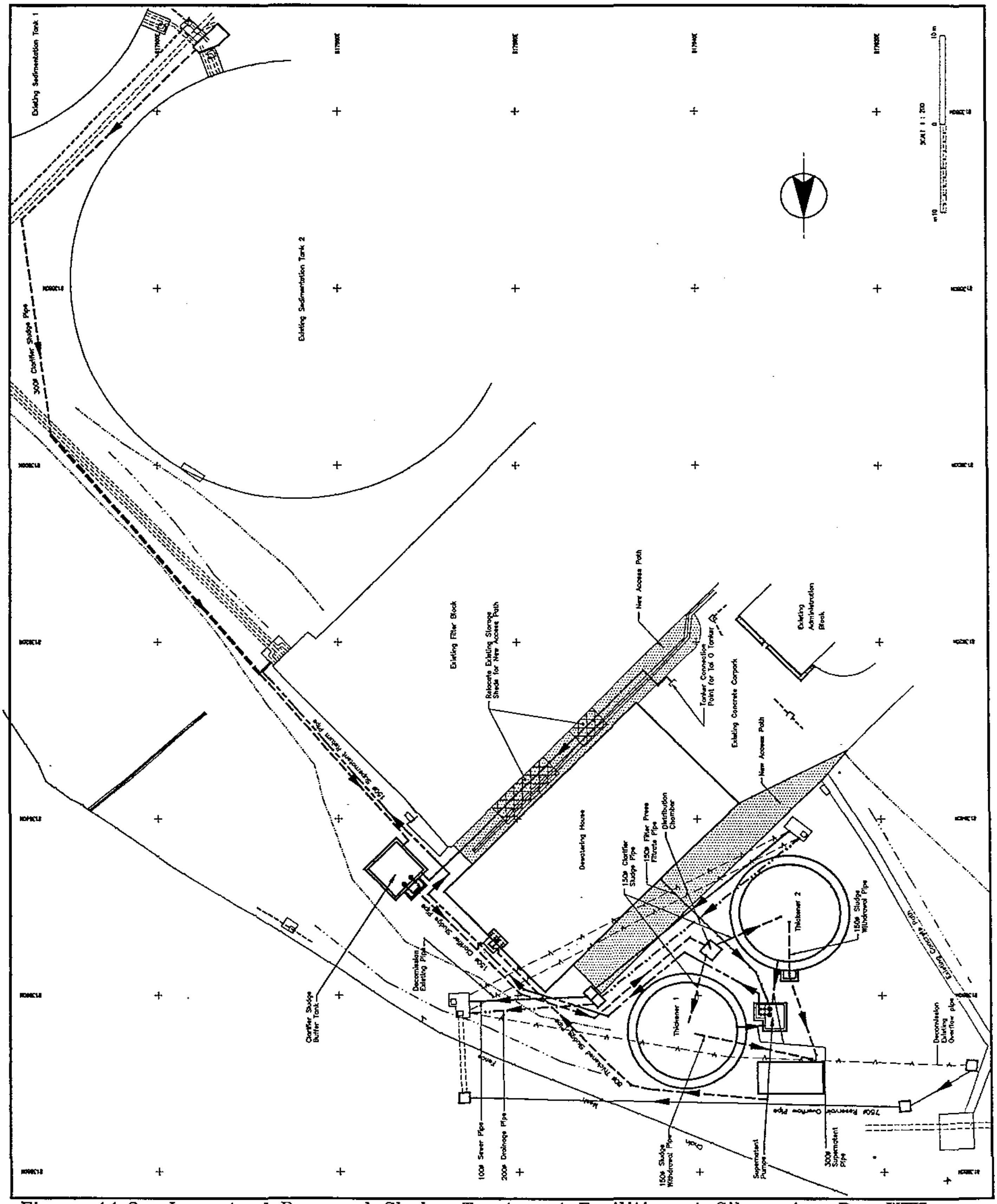

Figure 11.2 : Layout of Proposed Sludge Treatment Facilities at Silvermine Bay WTW

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All construction materials will have to be brought by sea to Mui Wo harbour; materials and equipment would be brought to the site by road along South Lantau Road. All construction traffic will have to be permitted.

The land available for the proposed dewatering house development is a level partially paved area at the northern end of the existing WTW. The area is approximately 30m by 20m. The site for the thickeners is just to the north of this area and slopes from west down to the east. This area is also approximately 30 metres by 20 metres. There are no special on site access problems. Turf and topsoil will have to be removed prior to commencement of construction. A level area will then be excavated for the clarifiers. A low retaining wall will be necessary to support the slope. Piling is unlikely as firm bedrock is expected to form the foundations. Piling should be avoided due to the close proximity of the existing supply reservoir in case of vibration damaging the structure.

The dewatering house and concrete tanks would be formed from concrete produced at an existing concrete batching plant, and steel re-bar.

Pipe routes are likely to be excavated using hand operated pneumatic drills and back-hoe excavators.

Table 11.2 Likely Construction Process, Estimates of Materials and Equipment Required, and Wastes Generated for Proposed Development at Silvermine Bay WTW.

General Activity	Specific Activity	Equipment and use	Time period for activity	Time used on site
Site Clearance	Topsoil Removal	Trucks - removal of turf and topsoil	10 days	Visits during working hours
		Tracked Excavator - top soil removal	10 day	Working hours
	Excavation	2 Breaker and compressor (hand held pneumatic) - rock removal	90 days	Working hours
		Generator - power breaker	90 days	Working hours
		Breaker (excavator mounted pneumatic)	90 days	Working hours
		Tracked Excavator - under soil and rock moving	90 days	Working hours
		Trucks - soil and rock removal	90 days	Visits during working hours
Construction	Dewatering House/Tank construction	Concrete lorries - delivery of 3200 tonnes of concrete	20 months	Visits during working hours
		Flatbed trucks - delivery of 800 tonnes of re-bar	20 months	Visits during working hours
		Trucks - delivery of approximately 12 loads of form work and scaffolding	20 months	Visits during working hours
	Dewatering House	Materials to site	20 months	Visits during working hours
	Pipelaying	Trucks - delivery of 7 loads of piping	4 months	Visits during working hours
		Tracked excavator - excavating pipe run trenches and refilling after pipe laying	6 months	Working hours
		Breaker and compressor (hand held pneumatic) - rock removal	6 months	Working hours
	Mechanical and electrical installation	Trucks - delivery of 30 loads of equipment	4 months	Working hours

Table 11.2 shows the likely activities involved in the construction process, and estimates of materials and equipment required and wastes generated.

11.2.4 Operation

Figure 11.3 shows a schematic representation of the water and sludge treatment path, once this development is in service. New equipment will be electrically operated.

The Silvermine Bay WTW dewatering facility is sized to process a peak of 7890 kg/day of sludge (dry solid weight). Dewatered sludge will be transported by barge for disposal at WENT landfill.

11.2.5 Key Issues

From the data collected concerning the proposed Development at Silvermine Bay WTW, the key issues were identified as:

- traffic impacts, as the main access road to the proposed site is restricted; and
- visual impacts, as the proposed development will be visible on the skyline of Silvermine Bay.

11.3 Construction Phase Impacts and Mitigation Measures

This section examines the potential construction phase environmental impacts of the proposed development at Silvermine Bay WTW, along with potential mitigation measures. Special attention is paid to Key Issues.

11.3.1 Visual Impacts

The existing WTW consists of three large clarifiers, a large block of rapid sand filters, a service reservoir and the chemical dosing block. These large constructions are not visible, except from the north-east, due to the well developed screen of vegetation around the works. The only available view point from which the site has an impact is from the north-east, looking south-west. With the ferry terminal almost directly below the WTW this is the view that visitors looking from the ferry have as their first close up view of Lantau Island. The sides of two of the clarifiers can be seen, as well as the north eastern end of the filter block, which has been decorated by a large mosaic. Once on the island, the existing town buildings largely block this view. These buildings are the only structures breaking the skyline of Silvermine Bay, however, some obviously planted regular stands of trees are visible on the northern side of the Bay. Three large She Oak (*Casuarina equisetifolia*), which are within the WTW boundary are visible on the skyline.

The existing works has a relatively large visual impact due to the rural nature of the rest of the hill crest around the Bay.

Items of equipment such as cranes used in the construction of the new development will be visible on the skyline. However, due to the transitory nature of the construction process this is not thought to be a major impact.

Operation phase impacts are long term and are considered in Section 11.4.1 below.

11.3.2 Ecology

The ground cover which will have to be removed to carry out the development is poor quality grassland which has been established by the WTW since the construction of the storage reservoir. No vegetative cover of ecological value will be affected.

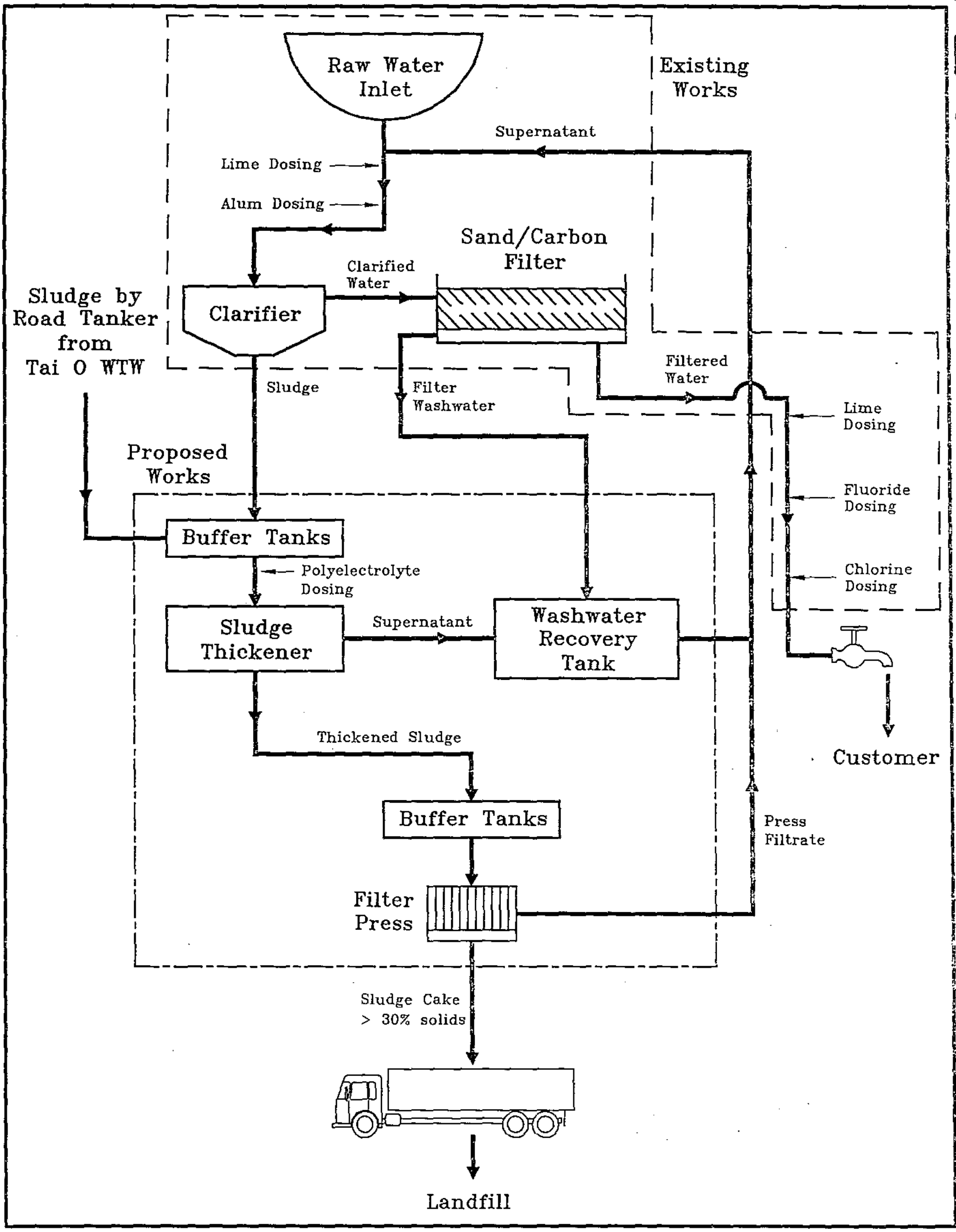

Figure 11.3 : Water Treatment Processes and Proposed Works at Silvermine Bay WTW

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Careful positioning of the thickener sites has enabled them to be placed so that the three She Oak trees present will not be affected by the construction process..

The two small trees which have been allowed to grow on the pipe storage area will have to be removed. No other trees will be affected.

The slope to the north-east of the site is well developed with trees and other vegetative cover. However, the access road to the WTW runs through this area. Birds and other wildlife using this area may migrate from the immediate area of the development site due to the disturbance caused during construction. However, due to the limited area of the development and the other large areas of similar or greater ecological value in the near vicinity, wildlife will move away from the disturbance with little difficulty. Therefore, the significance of this impact is not thought to be high.

Contractors should be made aware in strong terms of the value of the She Oak trees, especially the largest, nearest to the WTW and contractually bound to leave them undisturbed.

Ecological impacts are not thought to be significant.

11.3.3 Traffic

South Lantau Road is the main access road to the WTW site. Vehicles using this road have to be licensed as access is restricted by the Transport Department. The road is steep and twisty and special care must therefore be exercised by construction traffic using it. However, due to its restricted nature, although the road is well used, it still has plenty of extra carrying capacity.

By looking at the estimated volumes of wastes and construction materials required to complete the development it can be estimated that approximately 850 vehicle trips will be required during the 24 month construction period. It is likely that at peak construction times approximately 50 vehicle movements a day would be made.

This may produce significant impacts as the vehicles will have to travel from the pier to the start of South Lantau Road. This is a busy area where residents and visitors arrive on the ferry and leave for the mainland.

Contractors should be made aware of the potential dangers of construction traffic moving around the ferry terminal area and on the Island's narrow roads.

11.3.4 Noise

A noise assessment for the construction of the proposed development has been carried out. Percussive piling will not take place on this site as the geology provides a suitable foundation without piling. The noise assessment was carried out following the methodology described in the EPD Technical Memorandum concerning, "Noise from Construction Work Other Than Percussive Piling".

The technical detail of calculation of potential noise levels is shown in Appendix C.

It was found that, during construction, the CNL at Round Table Village would be 65 dB(A). This falls below the recommended daytime levels (ProPECC PN 2/93) therefore, noise nuisance should not be a significant problem.

Construction noise is not considered to produce significant environmental impacts.

11.3.5 Airborne Emissions

The FDM was applied to the proposed development to calculate the potential total suspended particulates at the identified NSR. The technical details of the way the FDM was applied is described in Appendix D to this document. The model provides a worst case as though dust creating construction activity is taking place on the entire area of the proposed development site for 24 hours and the wind is blowing constantly towards the NSR. The FDM calculated dust concentration value is shown Table 11.3, together with the factors which will, in a real case, make the actual TSP found at the NSR lower. It should be noted that the model does not allow for the topography of the site (it assumes a flat site with the NSRs at the same level as the site) or for the effects of vegetation around the site. There is screening vegetation around all of the site and topography also would have some arresting effect on suspended particulate movement towards the NSR in this case.

Table 11.3 Modeled Dust Concentrations at NSRs and Correction Factors

NSR	FDM 24 hour average concentration ($\mu g/m^3$)	Actual time wind in quarter towards NSR	Barriers (e.g. topography, vegetation)	Actual Working Hours	% of site likely to be open for dust generation	Realistic 24 hour Concentration at NSR due to Development ($\mu g/m^3$)
Round Table Village	248	50	Topography Existing Vegetation	8	70	70

The results of the modeling exercise show that the fugitive dust emissions from the site might approach the AQO TSP of 260 $\mu g/m^3$ average over 24 hours, only if construction activity was to continue for 24 hours a day, the local topography was completely flat, and the local weather conditions blew dust from the site to the NSRs constantly over the 24 hour period. The results of the modeling exercise, when considered with the "real world" site specific factors, such as shielding vegetation and prevailing winds, has shown that the site is unlikely to cause the 24 hour AQO for TSPs to be exceeded at the NSRs.

However, as reliable background TSP counts are not available for the immediate area, it is preferable that fugitive emissions from the development should be reduced to the lowest possible levels by appropriate mitigation measures. These are shown in Table 11.4.

Plate 11.4
Silvermine Bay WTW before proposed development

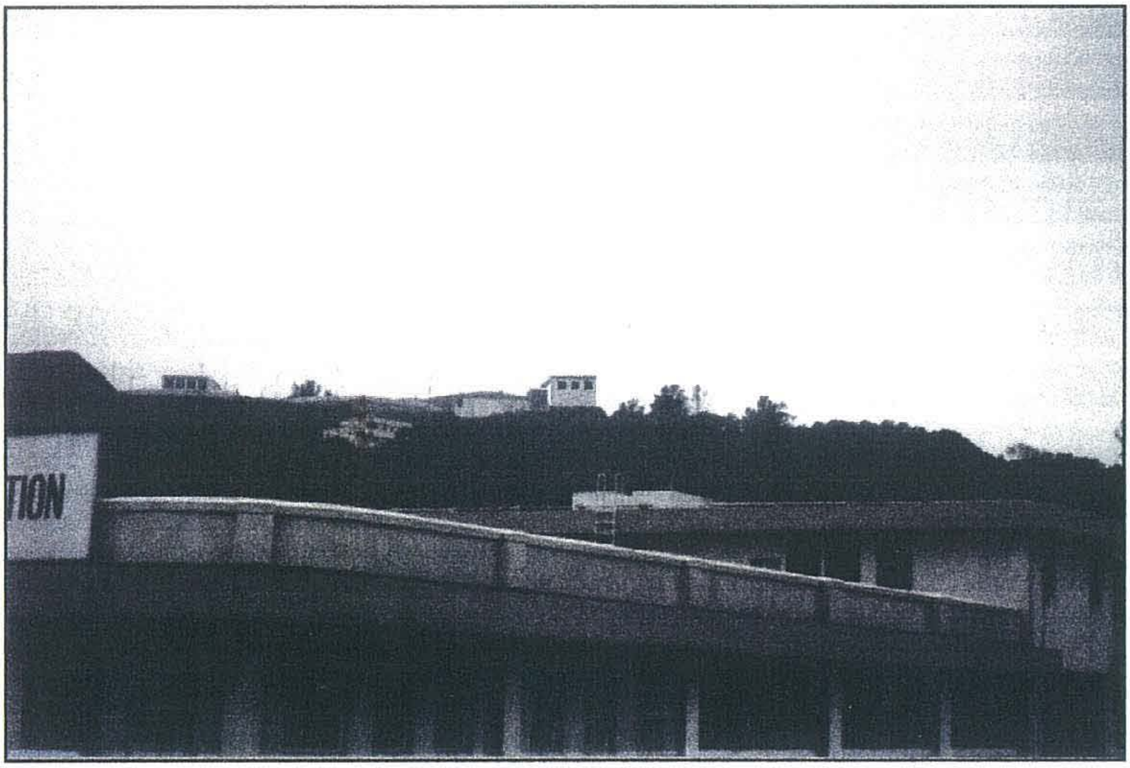

Plate 11.5
Computer-generated view of Silvermine Bay WTW after development

Table 11.4 Fugitive Dust Control Measures

Development Stage and Control Methods	Comments
Land Clearing/Earth Moving	the major source of dust from this development
Watering	Water should be applied over the site prior to conducting any land clearing. This will increase the moisture content of the soil, thereby increasing its stability. Clay soil should be kept above 8% water to prevent dust generation. Water should be re-applied as necessary over the period that bare soil areas are exposed. Water can be applied by sprinklers or hoses.
Minimise Loading Drop Height	Mechanical excavator drivers should ensure that the height spoil is dropped from into haul vehicles is minimised, thus reducing dust generation.
Cover Haul Vehicles	Haul vehicles should be tarpaulined to prevent dust being generated from their loads as they move along the highway.
Paved Road Track Out	Not a major source of dust in this case as haul vehicles will not have access to the site.
Sweep/clean roadways	The access road should be swept or water flushed clean to prevent re-entrainment of deposited dust.
Cover Haul Vehicles	Covered haul vehicles prevent the road from being contaminated with dust.

With these mitigation measures employed during the construction period and the establishment of vegetation as soon as possible over areas of exposed ground once construction is complete, suspended particulates from the construction process should be kept within acceptable limits.

11.3.6 Water Quality

The construction site is partially on a slope, and therefore, erosion may be a problem should there be heavy rain while the ground surface is exposed. This is unlikely to cause problems of raised sediment loads in local stream courses as the vegetated slope below the site would absorb the flow. However, steps to prevent soil loss from the site should be used as a matter of good site practice. Boards placed across the slope may be sufficient if carefully placed.

Construction impacts on water quality are not thought to be significant.

11.3.7 Cultural Heritage and Archaeology

It is noted in Section 3.1.10 that the Antiquities and Monuments Office have expressed the wish to be notified in advance of ground breaking, in order to ensure a member of their staff can oversee excavations as the WTW lies within the Silvermine Bay Archaeological Site. This should be done to enable expert supervision and assistance should anything of value be discovered. However, it is likely that all the proposed site area has been affected by the construction of the original works and therefore such discoveries are unlikely.

The presence of a member of the Antiquities and Monuments Office will ensure that there are no significant impacts to archaeological or cultural matters of value.

11.3.8 Safety

Apart from the road safety issues already discussed in Section 11.3.3, construction of the proposed development will not give rise to any other specific safety issues.

The existing WTW is classified as a PHI due to the storage of chlorine on site. The area on which the sludge press house will be constructed is adjacent to the delivery door to the chlorine storage area. The same care should be exercised to prevent increased danger from chlorine deliveries at this site during the construction period as that described in Section 5.3.8

Normal site safety practices should be followed.

Contractors should be advised in advance of chlorine deliveries. All construction activities, which could potentially affect a delivery, should be suspended until the delivery is complete. Should the construction process have caused any effects which might increase the likelihood of an accident during a chlorine delivery, for example piles of materials stored on roadways or dirt on access roads, these matters should be addressed prior to the delivery. Delivery drivers should be warned of the construction process taking place at the WTW to enable them to exercise additional care.

11.3.9 Waste Disposal

Wastes produced by the construction process will be inert. They will be made up of cleared vegetation, soil, rock, and unusable or used building materials. Waste disposal is therefore straightforward. As long as these wastes are disposed of at a suitably licensed landfill they should cause no significant environmental impacts.

11.4 Operational Phase Impacts and Mitigation Measures

11.4.1 Visual Impacts

As stated in Section 11.3.1, the new development will be visible from the ferry on approach to the island. To properly assess the potential visual impact of the sludge treatment developments and in particular the sludge dewatering house, a computer generated impression of the completed development was produced. Plate 11.2 shows the existing view from the ferry on approach to Lantau. Plate 11.3 shows the computer generated photoimage of the completed proposed development. It can be seen from these images that the development will be a significant feature in the view from the ferry. However, as long as the sludge dewatering house is finished using a matt finish of neutral colour it will not create a major change on the skyline.

The negative visual impacts of the proposed development at Silvermine Bay WTW are not thought to be major.

The development will remove the regular brown plume in the sea near the ferry terminal caused by the release of sludge from the WTW. This will be a significant aesthetic improvement.

11.4.2 Ecology

Operation of the proposed development will have no negative ecological impacts further to the permanent loss of grassland under buildings as described in Section 11.3.2. Wildlife displaced by the noise and activity during the construction phase is likely to return to the area once this activity ceases.

Negative ecological impacts of operation are not thought to be significant, so mitigation is not necessary.

The operation of the proposed development will remove a peak of 7890 kg/day of sludge (dry solid weight) which would otherwise be released into Silvermine Bay. This will help reduce smothering of bottom fauna and the effects on aquatic organisms of reduced light penetration due to high turbidity.

This is a significant positive ecological impact.

11.4.3 Traffic

The operation of the proposed sludge treatment facilities will generate on average approximately 2 lorry loads of sludge per day to be disposed of by lorry and barge to WENT landfill.

This additional road and water traffic is insignificant compared with the current traffic levels and traffic carrying capacity of the main roads and waste barges from Silvermine Bay WTW to WENT landfill.

11.4.4 Noise

Filling lorries with sludge by dropping it through bars into the trucks below while the lorries stand in open bays may generate appreciable noise. However, the proposed orientation of the sludge press facility has the lorry bays facing the existing WTW building so no significant noise impacts are expected.

11.4.5 Airborne Emissions

The operational activities of the proposed development will not generate any significant levels of air emissions. The most important source of air contamination connected with the new plant will be from the exhausts of lorries removing sludge, and these are in low enough numbers not to be considered significant.

As WTW sludge from Silvermine Bay WTW is low in algae, it is not odiferous, and has no potential to generate nuisance odours.

11.4.6 Water Quality

As mentioned in Section 11.4.2 the operation of the proposed development will remove a peak load of 7890 kg per day of water treatment works sludge which would otherwise be released into the sea in a small bay below the WTW. Water quality in this area will therefore, be improved by a reduction in turbidity and suspended solids.

11.4.7 Cultural Heritage and Archaeology

The operation of the proposed developments would have no effects on Cultural Heritage and Archaeology.

11.4.8 Safety

Operation of the proposed development would have no specific safety implications on site.

Lorry transportation of 30% solids WTW sludge has no specific safety implications. The material is similar to clay and should a vehicle carrying this material be involved in a road traffic accident similar clean up procedures to those employed if clay was the load involved would be adequate. No special protective equipment would be necessary for emergency services attending.

The barge carrying the sludge would also have no problems specific to carrying WTW sludge.

11.4.9 Waste Disposal

The sludge cake will be disposed of to a licensed landfill site. Following this disposal route waste disposal is not thought to present significant environmental impacts.

11.5 Summary of Impacts and Mitigation Measures

Tables 11.5 and 11.6 show summaries of the potential construction and operational impacts of the proposed development at Silvermine Bay WTW, and also proposed mitigation measures.

11.6 Conclusions

Environmental impacts resulting from the construction phase of the works at Silvermine Bay are not considered to be of major importance. Predicted noise and dust levels during construction are not anticipated to exceed relevant environmental standards or guidelines. However, mitigation measures should be implemented in order to reduce potential impacts to a minimum.

In view of the location of Silvermine Bay WTW in an Archaeological Site, a member of the Antiquities and Monuments Office will be present during excavation work in order to provide assistance and supervision should anything of value be discovered.

Once operational, the visual impact of the proposed development from the north-east, looking south-west is considered to be of medium significance. The proposed dewatering house will generally lower the value of the views from the approach route to Silvermine Bay via ferry. Mitigation measures will be incorporated in order to reduce impacts to a minimum.

Construction of the proposed works will have a positive impact on water quality. The regular coloured plume, discharging into the sea adjacent to the ferry peir will be removed providing a significant asthetic improvement in the area.

TABLE 11.5 SILVERMINE BAY WTW - SUMMARY OF CONSTRUCTION PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual impact of construction site	Adverse	Short term	Local	Minor	-
Ecology	Vegetation loss due to construction	Adverse	Long Term	Local	Minor	Preserve major trees on the site.
	Disturbance of natural habitats	Adverse	Short Term	Local	Minor	-
Traffic	Increase in construction traffic on WTW access road	Adverse	Short Term	Local	Minor	Contractors briefed on dangers of narrow roads.
	Increase in construction traffic on main roads	Adverse	Short Term	Regional	Minor	Contractors briefed on dangers of narrow roads and presence of tourists and the public
Noise	Construction noise	Adverse	Short Term	Local	Minor	Noisy operations carried out separately if possible.
Airborne Emissions	Dust from construction work	Adverse	Short Term	Local	Minor	Fugitive dust control measures.
	Exhaust emissions	Adverse	Short Term	Local	Minor	-
Water Quality	Site runoff and erosion	Adverse	Short Term	Local	Negligible	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage	Not Known	Long Term	Regional	Not Known	Liaison with the Antiquities and Monuments Office.
Safety	Potential for accidents on construction site	Adverse	Short Term	Local	Minor	Normal site safety procedures. Contractors briefed on the dangers of chlorine, delivery plan formulated and followed.
	Potential for accidents off site	Adverse	Short Term	Regional	Minor	As road safety above
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Minor	-

TABLE 11.6 SILVERMINE BAY WTW - SUMMARY OF OPERATIONAL PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES						
Environmental Issue	**Impact Description**	**Impact Type**	**Nature**	**Effects**	**Significance**	**Proposed Mitigation Measures**
Visual Impact	Visual intrusion	Adverse	Long Term	Local	Medium	Design of visible parts of development to blend in with existing structures.
Ecology	Removal of natural habitats	Adverse	Long Term	Local	Negligible	-
Traffic	Increase in operational traffic on WTW access road	Adverse	Long Term	Local	Minor	-
	Increase in operational traffic on main roads	Adverse	Long Term	Regional	Minor	-
Noise	Operational noise	Adverse	Long Term	Local	Negligible	-
Airborne Emissions	Dust from operation	Adverse	Long Term	Local	Negligible	-
	Odour from operation	Adverse	Long Term	Local	Negligible	-
Water Quality	Marine water quality	Beneficial	Long Term	Regional	Medium	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage.	Not Known	Long Term	Regional	Not Known	-
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Minor	-

SECTION 12

ENVIRONMENTAL IMPACT ASSESSMENT OF PROPOSED SLUDGE TREATMENT DEVELOPMENT AT TAI O WATER TREATMENT WORKS

12.0 Introduction

The BEECOPS selection process, carried out during the Feasibility Study of the Treatment and Disposal of Waterworks Sludge from Existing Works identified transfer of unthickened sludge to Silvermine Bay for dewatering, as the preferred disposal option for Tai O. This recommendation was made given the information thought correct at the time. Tai O WTW washwater was thought to discharge into a stream running alongside Tai O Road which flows through ponds and finally to the sea.

During the preliminary design stage of this project it was found that Tai O washwater did in fact discharge on to a piece of land on the hillside some 73 m above sea level. In addition, although the rated output of Tai O WTW is 2 MLD it generally operates at 1 MLD, reducing the amount of estimated waste by half. In view of these facts an alternative 'do-nothing option' has also been considered in the Environmental Impact Assessment process for Tai O.

12.1 Existing Environment

12.1.1 Background

The proposed site for development of sludge treatment facilities at Tai O lies within the existing WTW boundary, except for a sludge holding tank and the pipeline running from the WTW to this tank. Figure 12.1 and Plate 12.1 show a plan and an aerial photograph of the area, respectively. Tai O WTW is a very small plant covering an area of 0.52 hectare and with a maximum treated water output of 2 MLD, but mainly operated at 1 MLD.

Tai O WTW is situated on Lantau Island approximately 20 km west of Hong Kong Island at map reference 803 812. The WTW is located on the ridge of a hill to the south of Tai O at a height of 70 metres. There is no other development on the ridge. Around the base of the ridge are a number of scattered individual houses, the nearest being 200 metres due west of the site.

The town of Tai O lies approximately 2 km to the north-west. Its nearest major buildings to the proposed site are the Buddhist Fat Ho Memorial College and a fire station 450 metres from the main site. These buildings are adjacent to the proposed sludge storage tank site. The area around the main site is heavily vegetated with well developed tree and shrub growth.

12.1.2 Existing Works

Tai O WTW takes water from Shek Pik and Yi O reservoirs. The main facilities currently on the site include:

- the main filter building; and
- a service reservoir.

The WTW incorporates three sand pressure filters with a maximum washwater consumption of $14m^3$ per wash and an average filter run time of 24 hours between washes.

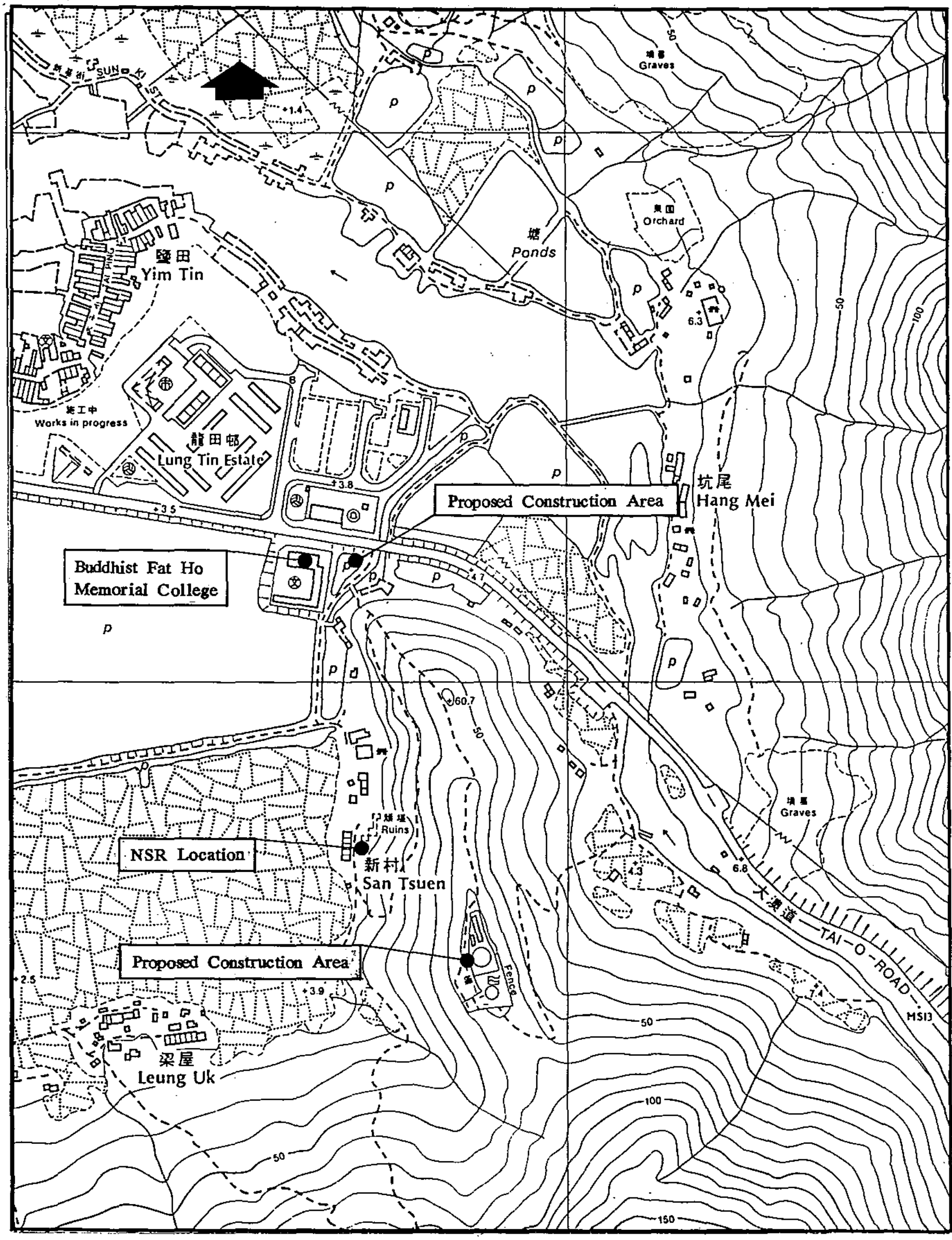

Figure 12.1
Proposed Development and Nearest Sensitive Receiver Location-Tai O WTW

Existing Discharge Practice

Current discharge of washwater is via 150 mm pipe which discharges onto the hillside to the west of the works 73 metres above sea level. The maximum washwater quantity is 14 m^3/day. If the filter is not particularly dirty the quantity used during washing is reduced. The majority of the washwater volume is therefore treated water. A review of the water quality for the for the last 18 months reveals that the average amount of solids generated during treatment is only 3 kg per day.

No stream-course was observed to have been formed beyond the point of discharge, probably due to the small amount of washwater discharged and the presence of the surrounding vegetation.

The coastal waters around Tai O form part of the North Western Water Control Zone which was declared in 1992.

12.1.3 Geology

The geology of the area is predominantly volcanic rocks formed during the Repulse Bay formation in the Mesozoic period. The WTW is located on top of a ridge of Pyroclastic rock comprising of Fine Ash Vitric Tuff. The underlying geology comprises alluvial deposits laid down in the Pleistocene Period.

12.1.4 Landscape Character and Visual Aspects

Tai O WTW is located on a ridge which is part of the major range of hills stretching to the south of Tai O. The area around the site is of high scenic value with dramatic sweeping vegetated hillsides and deep valleys. The area immediately around the site does not form part of the Lantau Country Parks.

Visual Analysis

The existing WTW is a small collection of single storey buildings and two covered reservoirs which have been sunk into the ridge to ground level. Due to the surrounding growths of pine trees, the site is not visible from any vantage point. The only sign of the WTW from publicly accessible areas, are the unobtrusive starts of the two access paths which lead up to the works. No road serves the works.

Visual Impact

The existing works has no visual impact due to its small size and the complete screen of surrounding vegetation.

12.1.5 Ecology

As there is no space within the site fence for the proposed development, the site for the washwater recovery tanks is outside the boundary of the existing works. The area around the existing site is mostly steeply sloping and covered in pine trees and undergrowth. The designated area for the washwater recovery tanks has been chosen due to the relative flatness of the ground and the near absence of large trees (Plate 12.2). In addition to the pine trees present the area is covered by a turf of assorted grasses and sedges. A short turf cover predominates along the majority of the route of the pipeline from the washwater recovery tanks to the proposed sludge storage tank. The vegetation at the proposed site of the washwater recovery tank is a long grass sward (Plate 12.3).

Plate 12.1
Tai O Water Treatment Works Location Plan

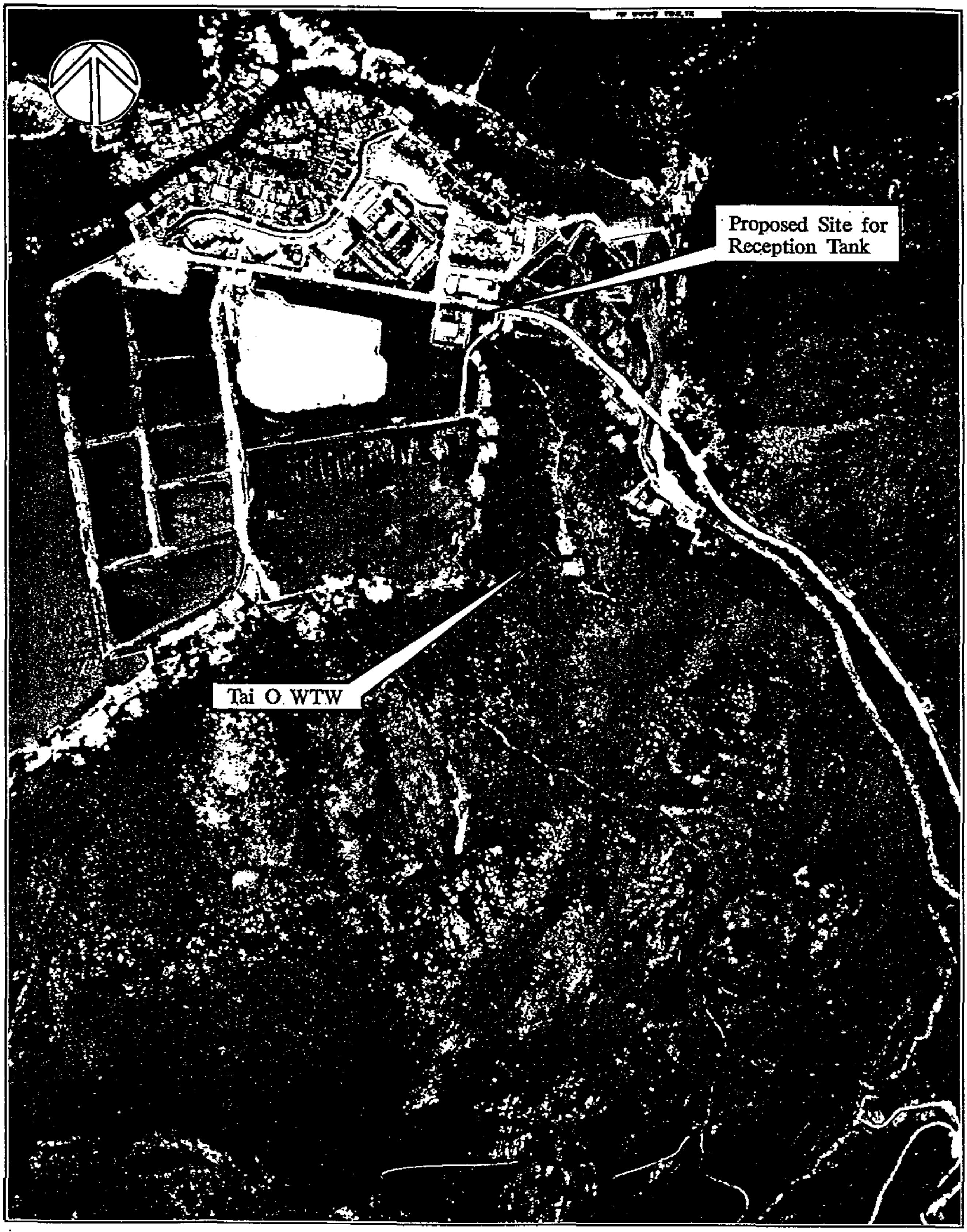

Plate 12.2 Site of Proposed Washwater Recovery Tanks - Tai O WTW

Plate 12.3 Site of Proposed Sludge Holding Tank - Tai O WTW

12.1.6 Concurrent Developments

A major construction project is currently underway approximately 500 metres to the north-west of the site, where land is being reclaimed from derelict fish ponds for business development.

No other developments or significant maintenance tasks are programmed to take place on the WTW site during the development construction period.

12.1.7 Traffic

Access to the plant is from Tai O Road. This is an extension of South Lantau Road which runs the length of the island. In places the road is narrow, and along most of its length it is forced to twist among the hills of the island. Only permitted vehicles are allowed to use South Lantau Road, which keeps traffic levels relatively light and limited to taxis, buses and other essential users. The final 300 metres to the WTW is limited to a choice between a footpath leading from the east, which is unsuitable for even 4x4 vehicles, or a narrow concrete stairway along the ridge of the hill from the north.

12.1.8 Air Quality

Noise

The NSR to the centre of the proposed development site at Tai O WTW is:

- the houses at San Tsuen, (150 metres distant).

As described in Section 12.1.4, the area surrounding Tai O WTW is typically rural and this classification can be applied to the NSR under the Technical Memorandum on Noise from Construction Work other than Percussive Piling.

The NSR is not affected by any significant noise influencing factors.

Dust

There is no air pollution monitoring station on Lantau Island, probably due to its rural nature. The nearest monitoring station is at Hong Kong South, 789 Pokfulum Rd.

The monitoring site is in a residential area at a height of 150 above mPD. As the proposed site is in a less heavily populated area and at a height of 100m, the data from the station can only be used as indicative of the air quality at Tai O WTW.

In 1991 the monthly mean of TSPs were measured to vary between 34 and 92$\mu g/m^3$ at the monitoring station. The Air Quality Objective for the annual mean is 80$\mu g/m^3$. Therefore, any additional dust emitted into the environment could be considered to have a significant impact on the air quality, depending on the time of year.

12.1.9 Water Quality

Sludge from the WTW is currently discharged into a pipeline following the stairway access path to the west of the site. The pipe discharges onto the hillside 60 metres from the works. (Plate 12.4 and 12.5). The nearest water course to the discharge point is approximately 75 metres away. The absence of any stream-course continuing down the hillside can be accounted for by the low volumes of washwater discharged and the presence of the surrounding vegetation, preventing erosion. The soil is a loose soft clay which is highly vegetated. Any solids in the washwater would be filtered in the soil and or bound up by the vegetation. Given the small volume and relatively large distance from the discharge point it is improbable that any washwater is reaching this water course. It is known from tests carried out on other washwaters that metals of major concern are mostly of an insoluble nature. In the unlikely event that any water reaches the ground water it is unpolluted.

12.1.10 Cultural Heritage and Archaeology

Lantau Island is known for ancient settlements, and archaeological sites and ruins are found at the foot of the western slope of the ridge on which the WTW is sited. However, no graves, cemeteries or areas, sites or structures of cultural heritage or archaeological value have been identified as present on, or adjacent to, the areas proposed for development.

12.2 Do-Nothing Option

Following a review of the BEECOPS evaluation process for Tai O WTW it was concluded that an alternative 'do-nothing' option should be considered. The current discharge to the hillside is very low volume, and unlikely to have toxic chemicals. In addition, the discharge is not causing any significant visual, physical or any other identified negative impacts.

In order to assess the possible impacts that the release of sludge might be having on the vegetation on the hillside, which was not obvious to a visual inspection, the scientific literature was searched for examples of studies into the application of WTW sludge to land.

Lucas *et al.* (1994) carried out a literature review and series of experiments to identify the effects of alum sludge application to land. The main problem found on land to which WTW sludge has been applied is a lowering in the available phosphorous. This is because, during the coagulation process alum is converted to aluminum hydroxides which are similar to the aluminum hydroxides naturally present in soils. These hydroxides can increase a soils buffering capacity and increase adsorption and precipitation of specific anions. One of these anions is organophosphorous. Lucas *et al.* found that application of 2% sludge gave yield reductions of less than 15% in fescue growth and that additional application of phosphorous fertilizers would restore the yield.

Geertsema *et al.* (1994) carried out 30 month tests on application of alum sludge to 33 test plots on which 3-4 year old pine trees were being grown. They found that:

- no significant differences could be detected in the chemical content of the pine tissue of trees grown on control plots versus sludge - amended soils;

- alum sludge land application did not cause metals migration;

- no effects were observed with respect to pine tree growth;

- nitrate levels in ground and soil water did not increase due to sludge application; and

- phosphorous did not seem to be limiting as enough was available to buffer the sludge and provide the necessary amount for proper tree growth.

S. D. Lin (1991) carried out a two year study on alum sludge application to corn and soybean farmland. Lin found that no nutrients or heavy metals were present in grains, and that concentrations in whole plants and leaves were generally not significantly increased by the sludge applications. He concluded that on the basis of his study, 'Land application of alum sludge appears to be a viable method (of disposal) with no apparent environmental degradation'.

Plate 12.4 Mouth of Sludge Disposal Pipe - Tai O

Plate 12.5 Slope Below Mouth of Sludge Disposal Pipe - Tai O

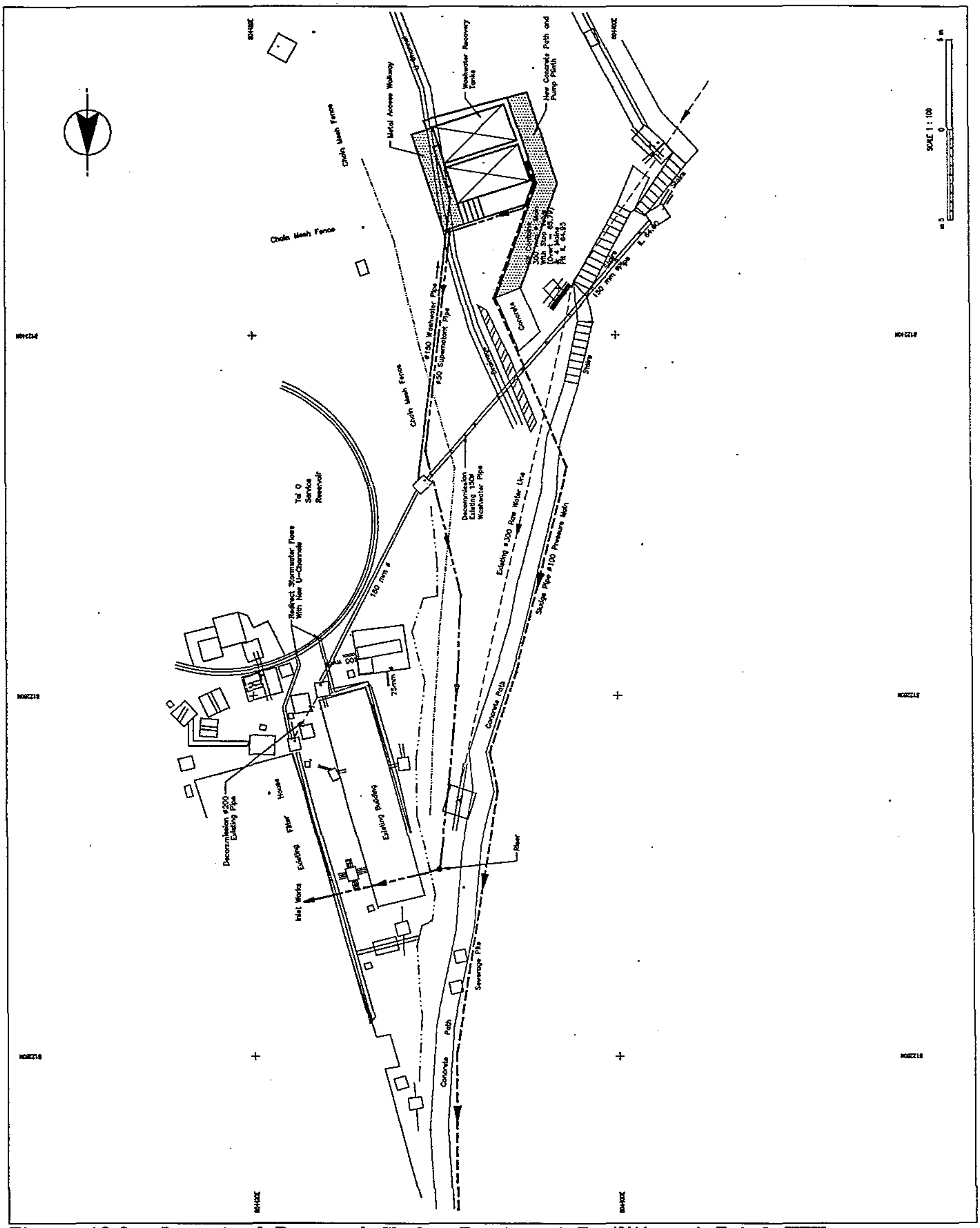

Figure 12.2 : Layout of Proposed Sludge Treatment Facilities at Tai O WTW

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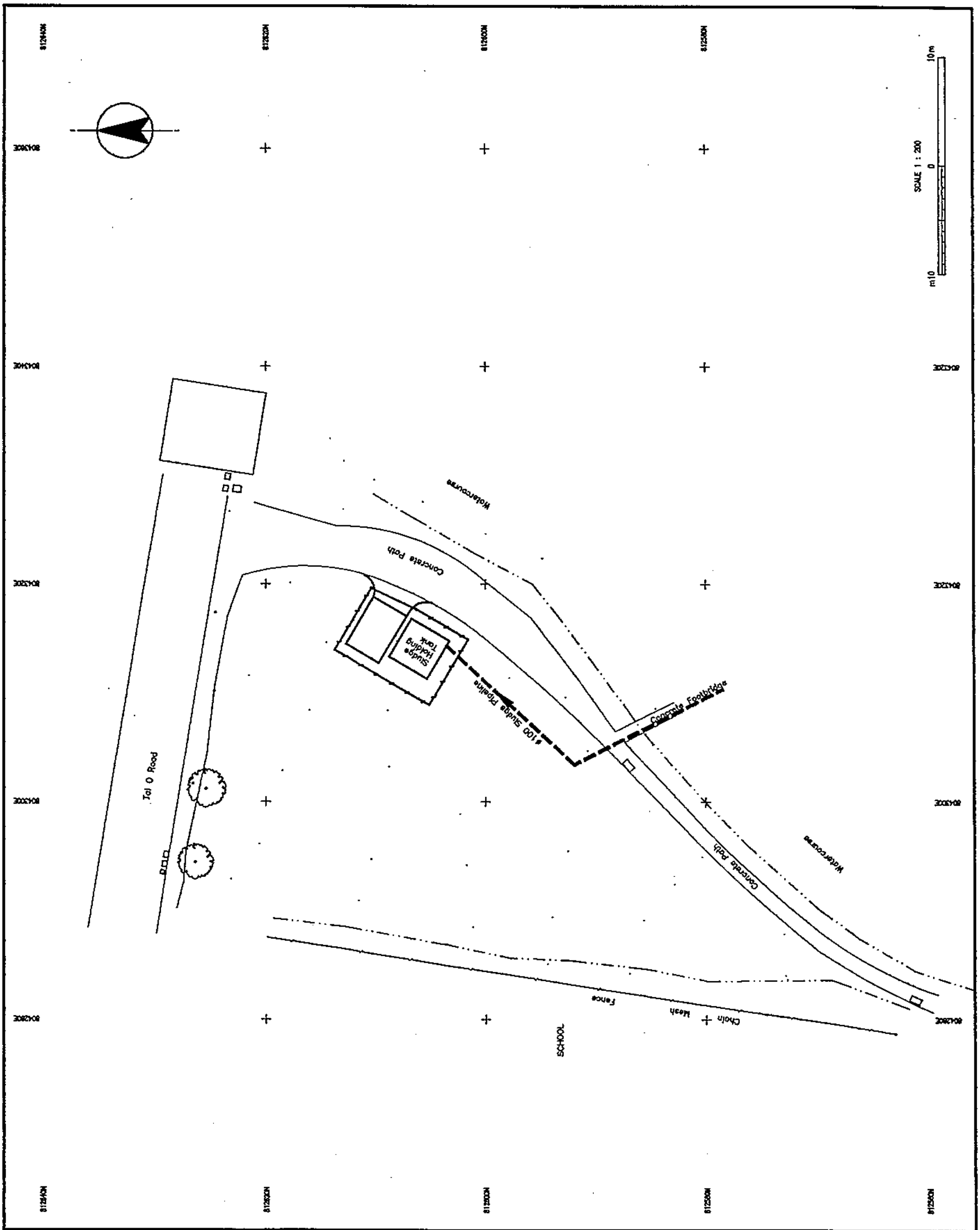

Figure 12.3 : Layout of Proposed Sludge Storage Tank at Tai O

The study has indicated that the existing sludge disposal facilities at Tai O are not causing significant ecological damage.

Potential environmental impacts of a 'do-nothing' option would be confined to possible effects on the existing vegetation and the presence of any ground water/land contamination. In order to establish whether the current disposal practice is causing any detrimental impacts it is recommended that further research be conducted.

12.3 Proposed Development (should the 'Do-Nothing' Option be shown to be inappropiate)

12.3.1 BEECOPS Evaluation for WTW Disposal

The small size and lack of road access to the Tai O WTW precluded on-site dewatering and so the preferred BEECOPS option was to transfer unthickened sludge to Silvermine Bay for dewatering. This was also the preferred option under the ISDS study. Use of the sewage treatment system at Tai O was considered impractical as it was thought likely that the Imhoff Tank system used for sewage treatment would fail if waterworks sludge were discharged over an extended period. Therefore, the transfer option was identified as the preferred BEECOPS option for Tai O.

12.3.2 Proposed Development at Tai O

Should the BEECOPS option be adopted, it is proposed to provide washwater recovery facilities at Tai O WTW. The development is therefore, limited to the addition of two washwater recovery tanks, a sludge storage tank and associated pipes and pumps. The details of these are shown in Table 12.1. Approximately 470 metres of pipes, ranging in diameter from 50 mm to 150 mm, would also be installed.

The development is limited to a small area east of the existing site, with a pipeline run along the existing access path to the sludge storage tank on an area of disused land adjacent to the Buddhist Fat Ho College. The proposed layout is shown on Figures 12.2 and 12.3.

Table 12.1 Proposed Equipment to be Installed or Constructed at Tai O WTW

Item Description	Item Size	Material	Unit	Quantity
Washwater recovery tanks	18 m^3	Reinforced concrete	no.	2
Sludge storage tank	30 m^3	Reinforced concrete	no.	1

12.3.3 Construction

Construction at this site is only likely to take 4 to 5 months. The first month of this period will involve site clearance and preparation. During the following 4 months the necessary structures will be built on site. Finally, the installation of pumps, mechanisms and electrical equipment, and testing of the new works will take approximately 6 weeks. Work is scheduled to commence on 20/11/97.

Materials and equipment would be brought to the site along Tai O Road. This road is restricted and permits will be required for all construction vehicles. Materials may be delivered by boat from either Mui Wo or Tai O docks. Access to the site is only possible up a flight of steps or along a steep path which may be suitable for motorised wheelbarrows, but certainly no larger vehicles.

Delivery of materials to the site must therefore, be either hand carried, loaded on a motorised wheelbarrow, or flown in by helicopter.

The gently sloping area of land shown in Plate 12.2 is available for the proposed development, east of the existing WTW. Two or three pine trees will have to be removed to clear the site. A number of other trees may have to be removed to provide space for an access path and pipe route. A platform would have to be cut on the site to accommodate the washwater recovery tanks. Turf, topsoil and rock will have to be removed prior to commencement of construction.

The sludge holding tank would be built on the currently disused land shown in Plate 12.3.

Following site preparation, foundations for the structures would be laid. Piling is not thought to be necessary. The concrete tanks would be formed from concrete produced at an existing concrete batching plant, and steel re-bar.

Pipes will be surface run, mounted on concrete plinths.

Table 12.2 shows the likely activities involved in the construction process, and estimates of materials and equipment required and wastes generated.

Table 12.2 Likely Construction Process, Estimates of Materials and Equipment Required, and Wastes Generated for Proposed Development at Tai O WTW.

General Activity	Specific Activity	Equipment and use	Time period for activity	Time used on site
Site Clearance	Topsoil removal	Hand tools / Small tracked excavator	7 days	Working hours
	Excavation	Breaker and compressor (hand held pneumatic) - rock removal	30 days	Working hours
		Generator - power breaker	30 days	Working hours
		Small Tracked Excavator/Hand digging - under soil and rock moving	30 days	Working hours
		Trucks - soil and rock removal	30 days	Visits during working hours
Construction	Tank construction	Concrete lorries - delivery of 120 tonnes of concrete	1 month	Visits during working hours
		Flatbed trucks - delivery of 30 tonnes of re-bar	1 month	Visits during working hours
		Trucks - delivery of approximately 2 loads of form work and scaffolding	1 month	Visits during working hours
	Pipelaying	Trucks - delivery of 2 loads of piping	1 months	Visits during working hours
		Trucks - delivery of 360 loads of concrete	2 months	Working hours
	Mechanical and electrical installation	Trucks - delivery of 4 loads of equipment	1 months	Working hours

12.3.4 Operation

Figure 12.4 shows a schematic representation of the water and sludge treatment path, once this development is in service. New equipment will be electrically operated. Transfer of sludge to Silvermine Bay will require approximately 1 tanker trip every 2 days.

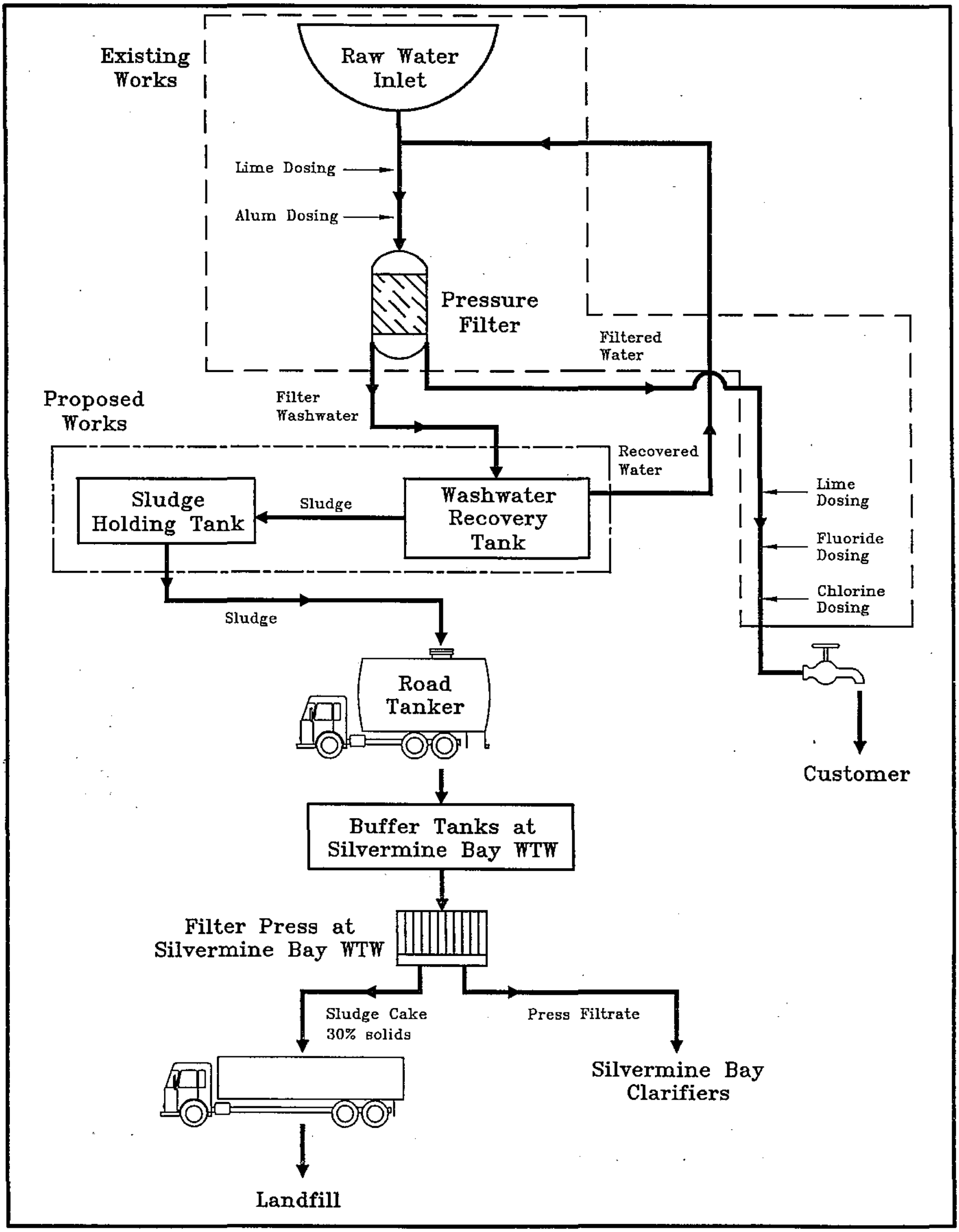

Figure 12.4 : Water Treatment Processes and Proposed Works at Tai O WTW

12.3.5 Key Issues

From the data collected concerning the proposed Development at Tai O WTW, the key issues were identified as:

- ecological damage, as some trees will have to be removed to provide a site for the new development;
- construction noise, due to the proximity of some of the development to the Buddhist Fat Ho Memorial College; and
- traffic issues, due to the likelihood of construction materials being brought along South Lantau Road and there being no road access to the site.

12.4 Construction Phase Impacts and Mitigation Measures

This section examines the potential environmental impacts of the proposed BEECOPS development at Tai O WTW, along with potential mitigation measures. Special attention is paid to Key Issues.

12.4.1 Visual Impacts

The existing WTW is not visible due to the compact nature of the works, its location on a hill-top and the screen of pine trees which cover the hill. Visual impact is not considered to be a significant issue at this site.

12.4.2 Ecology

The proposed development will have a minor ecological impact, as a very limited area is intended to be affected by the works. A small number of pine trees will be lost during the construction process to provide a site for the proposed washwater recovery tanks. Ecological impacts of construction will therefore be of minor significance.

The WTW is surrounded by heavily vegetated, inaccessible slopes, although the dogs kept at the WTW may keep the number of birds and other wildlife, near the works, lower than if the dogs were not present. The wildlife that is present may move from the area around the development site, due to disturbance caused during construction. However, due to the limited area of the development, the numbers affected will be small, limiting the significance of this impact.

Ecological impacts could be greatly increased if the contractors building the development decide that the construction of a road to the site or a winch haul-way is necessary to transport materials to the top of the hill. Both of these methods of transporting materials would require the clearing of a much larger linear area of land than that required for the construction increasing a number of impacts many times. In order to keep ecological impacts to a minimum this should not be permitted. Materials should be carried to the site by hand, on motorised wheel barrow or by helicopter.

12.4.3 Traffic

South Lantau Road is the main access road to the WTW site. Vehicles using this road have to be licensed as access is restricted by the Transport Department. The road is steep and twisty so special care must be exercised by construction traffic using it. If materials are landed at Mui Wo they will have to be brought along this road the entire length of the island, giving more opportunities for potential road traffic accidents. If materials were landed at Tai O town the transportation distance would be much shorter, although the materials would have to be moved through the town.

By looking at the estimated volumes of wastes and construction materials required to complete the development, it can be estimated that approximately 100 vehicle trips will be required during the 12 month construction period. This means that at peak construction times approximately 10 vehicle movements a day would be made.

This is unlikely to produce significant impacts on traffic densities as the number of vehicle movements is so low.

12.4.4 Noise

A noise assessment for the construction of the portion of the proposed development which would take place adjacent to the WTW has been carried out. The tank construction adjacent to the Buddhist Fat Ho Memorial College is so small and of such short duration that an assessment is not thought necessary. Work would require only a few days and it is recommended that this should take place during the school holidays to prevent disturbance of teaching activities.

Percussive piling will not take place on this site as the geology provides a suitable foundation without piling. The noise assessment for the main construction was carried out following the methodology described in the EPD Technical Memorandum concerning, "Noise from Construction Work Other Than Percussive Piling".

The technical detail of calculation of potential noise levels is shown in Appendix C.

It was found that during construction the CNLs at the residential developments at San Tsuen would be 59 dB(A). The residences are screened from the work site by the hill slope and the development is so limited in scale, construction noise is not thought likely to be significant.

Should helicopters be employed to transport materials to the site, this would have to be re-assessed, although the novelty of a limited number of helicopters in the area might help prevent the noise generated from being perceived as such a nuisance as general construction noise.

12.4.5 Airborne Emissions

The site is too limited in size to require fugitive emission modelling. The vegetation around the site will reduce the distance any generated dust travels. However, the site should be kept damp to limit dust emissions and haul vehicles should be covered to prevent dust generation along South Lantau Road.

12.4.6 Water Quality

Due to the small area of the site, volumes of run-off generated will not be large enough to reach local watercourses and produce a potential for raised levels of sediments. Run off will be stopped by surrounding vegetation.

12.4.7 Cultural Heritage and Archaeology

No areas of cultural or archaeological value will be affected by the development at Tai O WTW.

12.4.8 Safety

Apart from the road safety issues already discussed in Section 12.4.3 construction of the proposed development will not give rise to any other specific safety issues.

Normal site safety practices should be followed.

12.4.9 Waste Disposal

Wastes produced by the construction process will be inert. They will be made up of cleared vegetation, soil, rock, and unusable or used building materials. Waste disposal is therefore, straightforward. Some of these materials would be suitable to restore parts of one of the paths leading up to the WTW which has been subject to erosion. Should the path be used by powered wheel barrows or dumper trucks to access the site, repair to the track may be necessary due to damage caused by these activities.

12.5 Operational Phase Impacts and Mitigation Measures

12.5.1 Visual Impacts

The proposed development adjacent to the WTW, will not be visible from any publicly accessible area. The sludge storage tank adjacent to the Buddhist Fat Ho Memorial College will not be of sufficient size to create significant visual intrusion.

The visual impacts of the proposed development at Tai O WTW are not thought to be significant.

12.5.2 Ecology

Operation of the proposed development will have no negative ecological impacts, further to the permanent loss of two small areas of land used for the development, unless measures to create improved construction access routes, as described in Section 12.3.2, are taken. In this case a larger area of land will be lost. Wildlife displaced by the noise and activity during the construction phase is likely to return to the area once this activity ceases.

Negative ecological impacts of operation are not thought to be significant, so mitigation is not necessary.

The operation of the proposed development will remove 14 m^3/day (maximum) of washwater which would otherwise be released onto the side of the hill below the WTW. This flow is currently dispersed and absorbed by the vegetation on the hillside below the pipe mouth. It is unlikely that any of the sludge reaches any waterways or the sea. The vegetation on the hillside does not seem to be adversely affected by the presence of the sludge.

12.5.3 Traffic

The operation of the proposed sludge treatment facilities will generate:

- 1 sludge tanker journey to Silvermine Bay WTW every two days.

This additional traffic is insignificant compared with the current traffic levels and traffic carrying capacity of South Lantau Road.

12.5.4 Noise

None of the activities involved in operating the proposed development generate significant noise levels. The existing WTW contains similar pumps and tanks to those which are proposed. These currently cause no noticeable noise on site. Therefore, operational noise is not considered significant.

12.5.5 Airborne Emissions

The operational activities of the proposed development will not generate any significant levels of air emissions. The most important source of air contamination connected with the new plant will be from the exhausts of tankers removing sludge, and this is not considered significant.

As WTW sludge from Tai O WTW is low in algae, it is not odiferous, and has no potential to generate nuisance odours.

12.5.6 Water Quality

As mentioned in Section 12.4.2 the operation of the proposed development will have no effect on local water quality as the sludge does not reach any local watercourses.

12.5.7 Cultural Heritage and Archaeology

The operation of the proposed developments would have no effects on Cultural Heritage and Archaeology.

12.5.8 Safety

Operation of the proposed development would have no specific safety implications on site.

Tanker transportation of WTW sludge is discussed in Section 5.4.8. This will cause no significant impacts.

12.5.9 Waste Disposal

The sludge from Tai O will be transported for further treatment to Silvermine Bay WTW. The sludge cake from Silvermine Bay will be disposed of to a licensed landfill site. Following this disposal route, waste disposal is not thought to present significant environmental impacts.

12.6 Summary of Impacts and Mitigation Measures

Tables 12.3 and 12.4 show summaries of the potential construction and operational impacts of the proposed development at Tai O WTW and also proposed mitigation measures, should the BEECOPS option be accepted.

12.7 Conclusions

Environmental impacts resulting from the construction and operation of the proposed BEECOPS development at Tai O are not considered to be of major importance. Predicted noise and dust levels during construction are not anticipated to exceed relevant environmental standards or guidelines. However, potential loss of vegetation to allow access to the site may be a problem. This would be particularly significant should the construction of a new road or a winch haul-way be required to transport materials to the top of the hill. Both of these methods of transporting materials would require the clearing of a much larger linear area of land. Increase in traffic during both the construction and operation phase may be considered to be potentially dangerous due to the local road conditions. South Lantau Road, which is the main access road to Tai O is both steep and windy.

Although the EIA process indicated that the existing sludge disposal facilities at Tai O are not causing significant environmental damage, further research is required to support a 'do-nothing' option at Tai O. The potential impacts of the BEECOPS option must be considered in relation to those from a 'do-nothing' option. In order to assess the environmental impacts of a 'do-nothing' option it is recommended that a scientific monitoring programme be conducted. Assessment of the monitoring results will allow the two options; continuation of the existing disposal practice or commencement of the BEECOPS development to be evaluated.

TABLE 12.3 TAI O WTW - SUMMARY OF CONSTRUCTION PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual impact of construction site	Adverse	Short term	Local	Minor	-
Ecology	Vegetation loss due to construction	Adverse	Long Term	Local	Minor	-
	Disturbance of natural habitats	Adverse	Short Term	Local	Minor	-
Traffic	Increase in construction traffic on main roads	Adverse	Short Term	Local	Minor	Contractors briefed on the dangers of the narrow roads and presence of tourists.
Noise	Construction noise	Adverse	Short Term	Local	Minor	-
Airborne Emissions	Dust from construction work	Adverse	Short Term	Local	Minor	-
	Exhaust emissions	Adverse	Short Term	Local	Negligible	-
Water Quality	Site Runoff and erosion	Adverse	Short Term	Local	Negligible	-
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage	No Impact			Nil	N/A
Safety	Potential for accidents on construction site	Adverse	Short Term	Local	Minor	-
	Potential for accidents off site	Adverse	Short Term	Regional	Minor	As road safety above.
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Negligible	-

TABLE 12.4 TAI O WTW - SUMMARY OF OPERATIONAL PHASE POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Environmental Issue	Impact Description	Impact Type	Nature	Effects	Significance	Proposed Mitigation Measures
Visual Impact	Visual intrusion	Adverse	Long Term	Local	Negligible	-
Ecology	Removal of natural habitats	Adverse	Long Term	Local	Minor	Scientific Monitoring Programme to establish whether continuation of current disposal method is less environmentally damaging than the proposed development.
Traffic	Increase in operational traffic on main roads	Adverse	Long Term	Local	Minor	-
Noise	Operational noise	Adverse	Long Term	Local	Negligible	-
Airborne Emissions	Dust from operation	Adverse	Long Term	Local	Negligible	-
	Odour from operation	Adverse	Long Term	Local	Negligible	-
Water Quality	Fresh water quality	No Impact			Nil	N/A
	Marine water quality	No Impact			Nil	N/A
Cultural Heritage & Archaeology	Effects on sites of archaeological or cultural heritage.	No Impact			Nil	N/A
Waste Disposal	Utilisation of landfill space	Adverse	Long Term	Regional	Minor	-

SECTION 13
ENVIRONMENTAL MITIGATION, MONITORING AND AUDIT REQUIREMENTS

13.1 Introduction

Environmental monitoring will provide an assessment of the effectiveness of the mitigation measures employed during the construction phase at the various WTW. This section sets out the mitigation measures, proposed monitoring and audit requirements for the proposed works all of which shall be carried out by the project proponent.

13.2 Mitigation Measures

13.2.1 Airborne Pollution Mitigation Measures

Modelling has shown that the construction work at Silvermine Bay, Tuen Mun and Eastern may have the potential to create fugitive dust emissions which may have a subsequent impact upon the surrounding area.

Fugitive dust emissions from the developments should, therefore, be reduced to the lowest possible levels. The following mitigation measures should be applied at Silvermine Bay and Eastern.

Development Stage and Control Methods	Comments
Land Clearing/Earth Moving	The major source of dust from the developments
Watering	Water should be applied over the sites prior to conducting any land clearing. This will increase the moisture content of the soil, thereby, increasing its stability. Clay soil should be kept above 8% water content to prevent dust generation. Water should be re-applied as necessary over the period that bare soil areas are exposed. Water can be applied by sprinklers or hoses.
Minimise Loading Drop Height	Mechanical excavator drivers should ensure that the height spoil is dropped from into haul vehicles is minimised, thus reducing dust generation.
Cover Haul Vehicles	Haul vehicles should be tarpaulined to prevent dust being generated from their loads as they move along the highway.
Paved Road Track Out	Not a major source of dust in these cases as haul vehicles will not have access to the sites.
Sweep/clean roadways	The access road should be swept or water flushed clean to prevent re-entrainment of deposited dust.
Cover Haul Vehicles	Covered haul vehicles prevent the road from being contaminated with dust.

The Tuen Mun development site requires the following additional measures:

Development Stage and Control Methods	Comments
Vehicle Movement on Unpaved Areas	Possible as the site area is large enough for vehicles to move at appreciable speed.
Watering	Water should be re-applied as necessary over the period that bare soil areas are exposed. Water can be applied by sprinklers or hoses.
Reduce Speed Limits	15 mph maximum to prevent excessive vehicle speed lifting dust.

It should also be noted that paved road track out is more important at this site as haul vehicles will have access to the site. With these mitigation measures employed during the construction period and the establishment of vegetation as soon as possible over areas of exposed ground once construction is complete, suspended particulates from the construction process will be kept within acceptable limits.

13.2.2 Noise

The following measures are general and should be applied at all construction sites. Noisy equipment should always be sited as far away as possible from any NSRs. Noise generating equipment should be switched off when not in use and should not be used for periods longer than necessary. Advantage should be taken of the screening effects of any nearby objects such as temporary site offices. Whenever possible, the removal of a stockpile of earth or a topographical noise barrier should commence at the far side of any noise-sensitive receiver that may exist. The earth itself acts as a natural sound barrier reducing noise levels and minimising the length of disturbance to the receiver.

The life of equipment can be prolonged and noise emissions reduced through regular and effective maintenance by trained personnel.

Sound reducing equipment should also be checked regularly. It should be noted that increases in plant noise levels are often indicative of imminent failure or breakdown.

It is the responsibility of the site supervisor to ensure that the operations of all plant and work do not annoy any nearby NSR. Unnecessary noises such as shouting should be avoided by all site personnel.

Use of equipment which has been effectively silenced minimises the noise generated on construction sites and at the same time reduces the level of exposure of workers to noise. Wherever possible the quietest option should be chosen, i.e. electric equipment should be preferred over diesel-powered equipment and hand-held hydraulic breakers over pneumatic breakers. However, it is important that the equipment in use is the most suitable for the job. Equipment which is greatly over-powered or, conversely, greatly under powered should not be used.

Dump trucks and excavators are powered by internal combustion engines. The reduction of engine noise at source generally requires modification of the existing components. However, the transmission of engine noise can also be reduced by vibration isolation of individual components of the main engine structure or (more usually) by providing specially designed partial or full acoustic enclosures for individual noise generating components and by applying damping material to vibrating panels. Partial or full enclosures can result in a reduction in the overall noise level of 10 and 25 dB(A).

For general construction noise, no noise restrictions are imposed during the day-time period (0700-1900) of the normal working day under the Technical Memorandum. However, the Environmental

Protection Department have issued "Professional Persons Environmental Consultative Committee (ProPECC) Practice Notes' which give non-statutory recommended day-time noise levels for construction activities. Noise at the facade of the receiver during 0700-1900 hours should not exceed 75 dB(A) at a dwelling and 70 dB(A) at a school (65 dB(A) during examinations).

Acceptable Noise Levels calculated for all days during the evening (1900-2300 hours), and general holidays (including Sundays) during the daytime and evening (0700-2300 hours) were also used to assess the impact of construction noise at the various sites.

When compared to the ProPECC recommended day-time noise levels, the projected noise levels from the construction works at Eastern, Red Hill, Tai Po Road and Tuen Mun may have the potential to create noise impact. In the event that construction work would occur outside unrestricted hours, comparison with ANLs is necessary. When compared to ANLs, the construction work at Eastern, Red Hill, Tsuen Wan Silvermine Bay and Tuen Mun may have the potential to create an impact upon the surrounding area with regards to noise. Noise emissions from the developments must, therefore, be reduced to the lowest possible levels by applying appropriate mitigation measures as described below.

Eastern WTW

At the Eastern development the noise impacts from the piling operations are considered not to be significant because the CNL was below ANL. During the noisiest period of construction, the CNL exceeds the recommended daytime level of 75 dB(A) at the Senior Staff Housing by 1 dB(A).

The loudest piece of equipment proposed for use at this site is a back-hoe mounted hydraulic breaker. This will be used for breaking rock underlying the site during site clearance, and prior to foundation laying. Use of a hydraulic concrete crusher, often used as a quieter substitute for some tasks for which back-hoe mounted hydraulic breakers are used, is therefore, inappropriate in this case.

To ensure compliance with recommended daytime noise levels a silenced mounted breaker should be used. This would limit construction noise levels at the Senior Staff Housing to 73 dB(A).

Red Hill WTW

At the Red Hill development the construction operations may cause an impact upon the Hong Kong International School. In order to meet recommended daytime noise levels for schools construction noise needs to be reduced at source. There are a number of ways of doing this, either by partially enclosing the engine on the dump truck or on the excavator, or by using a hydraulic hand held breaker. Use of a silenced mounted breaker would reduce the CNL at the School to > 68 dB(A). Close liaison with the School in order to identify sensitive periods such as school examinations will be necessary. Work should be scheduled in order to avoid sensitive periods.

Tsuen Wan WTW

At Tsuen Wan WTW CNLs for Shek Wai Kok Estate and the Auxiliary Nurse Training Quarters are 71.5 dB(A) and 63.5 dB(A) respectively. Noise levels at both sites are below recommended daytime noise levels, therefore reducing noise at source is not necessary. Work should be confined to unrestricted hours (0700 - 1900).

Tai Po Road WTW

At the Tai Po Road development the construction operations may cause an impact upon the Sir Robert Black College of Education but not the residential housing. To alleviate this impact items of PME should be silenced where possible. Use of silenced PME would reduce the CNL at the College to 68 dB(A). Close liaison with the College in order to identify sensitive periods such as school examinations will be necessary. Work should be scheduled in order to avoid sensitive periods.

Tuen Mun WTW

As stated in section 10.3.4, the construction at the Tuen Mun will cause a noise impact problem, due to the reverberate nature of the valley, the scale of the development and the proximity of the NSR. The CNL using the list of equipment stated in Table C5a (Appendix C) at Grandeur Garden Estate will be 83.5 dB(A). Using silenced equipment the CNL could be reduced to 76 dB(A). However, careful scheduling of noisy work would enable the CNL to fall below the recommended daytime levels.

During the use of a silenced breaker no other construction operations generating sound levels in excess of 107 dB(A) should be carried out. This would allow a CNL of 72 dB(A) at Grandeur Gardens. Use of all other items of silenced PME (without breaker) would allow a CNL level of 73 dB(A) to be achieved. To ensure compliance with the recommended daytime noise levels at Grandeur Gardens, a clause will be entered into the contract with the contractor. This is shown as Clause 9 within the tender specifications.

This states that;

- Un-silenced excavator mounted breakers must not be operated on this site.
- Only one silenced excavator mounted breaker can be operated on the site at any one time.
- During periods of operation of a silenced excavator mounted breaker, no other construction operations generating sound levels in excess of 107 dB(A) shall be carried out within the site boundary.

To reduce the overall predicted noise level at Tuen Mun WTW a silenced compressor would be required. A reduction in noise emission level is normally reduced by the application of sound absorbing linings to the casing, the use of mufflers and isolation of the engine and the compressor unit from the chassis by anti-vibration mounts. It should be noted that the panels or flaps of the machine enclosure should not be opened for ventilation purpose. This is not necessary (and may result in overheating) and will significantly increase the level of noise being emitted.

13.3 Environmental Quality Performance Limits

In order to ensure compliance with relevant environmental quality objectives for environmental quality performance limits are typically used to give an indication of a deteriorating environmental quality. The commonly used approach is the application of environmental limits termed Trigger, Target and Action (TAT) levels. These levels are defined as follows:

Trigger Level - provides an indication of any deterioration in a particular environmental parameter.

Action Levels - indicate the need for appropriate remedial action to be taken in order to prevent a breach of the Target level:

Target Level - the maximum level of a particular environmental parameter at which the works should proceed. Target levels are stipulated in relevant pollution control ordinances, HKPSG for various environmental parameters or established by EPD for a particular project.

The TATs for each of the environmental parameters which may be exceeded due to a development are incorporated into action plans, whose contents are aimed at ensuring compliance with environmental criteria.

Air TATs

Air quality levels found during preconstruction background monitoring (see Section 13.4.1) will enable TAT levels to be set. The Trigger level would be set at 30% above baseline. The Action level would be the average of the Trigger level and Target level. For suspended particulate monitoring Target levels would be 500 $\mu g/m^3$ for one hour or 260 $\mu g/m^3$ averaged over 24 hours. These values are based on EPD Air Quality Objectives.

Noise TATs

Trigger and Action levels for construction noise monitoring are also based on the number of complaints received from local NSRs. One complaint involving construction noise would represent the trigger level, whereas more than one complaint within a two week period would represent the action level.

13.2.1 Action Plans

Action Plans provide for appropriate corrective action to minimise environmental impacts. A suitable Action Plan is shown below.

Event	Notify	Identify	Remediate	Report
Trigger	Notify Resident Site Engineer.	Identify source, review working methods.	Increase monitoring frequency to daily.	Notify Resident Site Engineer following termination of breach.
Action	Notify Resident Site Engineer	Identify source, commence additional monitoring.	Implement simple mitigation measures identified.	Notify Resident Site Engineer following termination of breach.
Target	Notify EPD / Resident Site Engineer.	Continue additional monitoring. Carry out detailed checks on working methods and practices to identify possible causes of exceedance.	Implement all additional mitigation measures that have been identified. Continue additional monitoring.	Notify EPD / Resident Site Engineer following termination of breach.

13.4 Environmental Monitoring

To ensure environmental impacts are kept to minimum levels monitoring procedures are necessary. The recommended monitoring programme is described below.

The findings of the EIA have indicated that it will not be necessary to carry out environmental monitoring during the operational phase due to the environmentally benign nature of the facilities operations. Monitoring will be carried out by suitably qualified non-contractoral staff, the Monitoring Team.

13.4.1 Airborne Emissions

Air quality monitoring should be carried out during the construction phases of the developments at:

- Silvermine Bay;
- Tuen Mun; and
- Eastern.

Measurement of airborne emissions are required at the following sites:

Location	Sensitive Receiver	NSR Measurement Point
Silvermine Bay	Round Table Village	see Figure D11
Tuen Mun	Grandeur Garden	see Figure D10
Eastern	Senior Staff Housing	see Figure D6
Eastern	Hong Kong Adventist Hospital	see Figure D6
Eastern	Royal Hong Kong Jockey Club	see Figure D6

Monitoring Programme

Baseline monitoring of TSP levels should be carried out for a continuous period of two weeks before each project starts in order to obtain baseline conditions of the area. The proposed monitoring programme is shown in Table 13.1.

The air quality monitoring data shall be checked against the Trigger, Target and Action levels by the Monitoring Team. The Action Plan shall be implemented should exceedances of TAT levels occur.

Table 13.1 Airborne Particulate Monitoring Programme

Parameter	Location	Duration	Frequency	Target Level
TSP	Site Specific. Agree with EPD	Early stage of construction during site clearance and excavations	24 hour sampling every six days	Daily TSP AQO:260 ug/m^{-3}
			Hourly sampling three times per week during construction	Rec. TSP: 500ug/m^{-3}/hr

The remaining sites will not require monitoring. However, an inspection programme should be carried out by the Monitoring Team, to ensure exposed soil areas are adequately damped. Inspection should take place three times per week during construction. Oservations should be recorded using an air quality monitoring checklist (see Appendix F). If the surface of the site is found not be have been damped to a suitable level, this should take place immediately. If the site has not been damped twice within a one month period a dust monitoring scheme will be required to be implemented on a similar basis to that to be carried out at the larger sites.

Monitoring for airborne emissions should be carried out with the following equipment: a high volume TSP sampler as referred to in the USEPA Standard Method 40, CFR Part 50, Appendix B.

13.4.2 Noise

Noise monitoring will be carried out to ensure that the construction methods undertaken do not generate noise levels which exceed target levels. Noise monitoring should be carried out during the construction period at the following sites: Eastern, Red Hill, Tsuen Wan, Tai Po Road, Tuen Mun and Silvermine Bay.

The sensitive receivers can be seen on the following Figures: Eastern D6; Red Hill D7; Tsuen Wan D8; Tai Po Road D9; Tuen Mun D10; and Silvermine Bay D11.

Baseline monitoring of noise levels should be carried out for a continuous period of two weeks before the project starts to obtain baseline conditions of the area.

Table 13.2 Noise Monitoring Programme

Parameter	Location	Duration	Frequency
dB(A)	Site Specific. Agree with EPD	During periods of greatest construction activity	3 times per day, once a week

Noise levels should be determined at a position 1m from the most affected external facade of the nearest sensitive receivers. However, at this distance facade reflection effects will be experienced and an allowance of -3 dB(A) should be made to recorded levels to account for this factor.

In the event of a breach of TAT levels the monitoring frequency shall be increased to daily monitoring until the breach is resolved.

The sound level meter used to measure noise levels should comply with International Electrotechnical Commission 651:1979 (Type 1) and 804:1985 (Type 1). The meter should be calibrated with the manufacturer's recommended sound level calibrator before each period of use. The sound level meter including the sound level calibrator shall be verified by the manufacturers every two years.

13.5 Environmental Audit Requirements

Detailed Design and Audit Stage

To ensure the implementation of environmental mitigation measures recommended by the EIA, audit of the implementation is required. This will be carried out by appropriate members of the consultant's environmental team under instruction of the overall Project Manager. This will include regular cross checking of the engineering team's progress in incorporating the proposed mitigation measures during the detailed design stage and drafting of the contract documents up to the stage of production of the Draft Tender Document. As each of the three Draft Tender Documents are completed they would be audited by the environmental team and any deviation from the recommendations within the EIA would be highlighted to the engineering team for alteration prior to submission of the final Tender Documents.

Construction Stage

The Resident Site Engineer will be the consultants main point of contact for each site during construction. He will be responsible for ensuring the mitigation measures detailed in the contract documents are carried out by the contractor.

Project auditing is required to ensure that all stages of the monitoring programme comply with relevant environmental standards, policies and guidelines. To ensure that the monitoring program is conducted effectively, the Monitoring Team should submit a Monitoring and Audit (M&A) report to the Resident Site Engineer. This should show all monitoring results in relation to TAT levels. It should also include details of any TAT exceedances and Action Plan deployment.

13.6 Environmental Complaints Procedures

Complaints about environmental issues from the public are likely be made to EPD's well publicised hotline number. EPD should then inform the Resident Site Engineer. Complaints by other routes should all be handed to the Resident Site Engineer. All environmental complaints should be recorded and the validity of the complaint investigated at the time when the site is notified about the complaint. If appropriate, monitoring should be undertaken or increased with reference to Trigger, Action and Target levels. An example of a complaints proforma can be seen in Figure F1.

13.7 Contractual Documents

The inclusion of construction noise and air emissions control specifications into tender and contract conditions will:

- allow all tenders to take the cost of noise and air emissions control into account;
- minimise contractual disputes on the responsibility to provide noise and air emission abatement measures;
- encourage thoughtful and economical planning of works, and will avoid expensive retrofitting and delay;
- result in better image; and
- as a result of quieter operations, place the contractors in a better position with respect to the application for a Construction Noise Permit.

Contractual and Tender conditions for environmental impact control are shown in Appendix E.

SECTION 14
GENERAL CONCLUSIONS AND RECOMMENDATIONS

14.1 Introduction

This section briefly discusses the general findings of the EIA, and highlights the major conclusions and recommendations for the progression of the developments in the most environmentally sound way.

14.2 Conclusions

The EIA has found very few significant adverse impacts and most of these are transitory as they are connected with the construction process, i.e. noise and dust. This can be attributed to the limited extent of developments and the siting of nearly all work within existing WTW boundaries. The developments at all of the WTW are small in terms of infrastructure development projects. Only the developments at Silvermine Bay and Tuen Mun, where sludge dewatering houses are proposed, are of a relatively large scale. Provided the mitigation measures described in the report are adopted, the impacts of these developments will largely be confined to impacts on the landscape.

Without the incorporation of mitigation measures, construction noise is anticipated to exceed ProPECC recommended daytime levels at Tuen Mun WTW. Noise control measures including the use of silenced PME at all times, scheduling of activities and the erection of acoustic barriers will enable construction noise impacts to fall within acceptable levels.

The construction at Eastern is of increased significance due to the proposed cutting to provide a level site, requiring the removal of a considerable volume of spoil and loss of trees. A tree survey will be carried out in order to fully assess the impact of the development on the existing trees. Without the incorporation of mitigation measures, construction noise is anticipated to exceed ProPECC recommended daytime noise levels at the Senior Staff Housing. Mitigation measures for both fugitive dust and noise control should enable this development to proceed with minimum impact and, once operational, the development will have no significant impacts.

The development at Shek Lei Pui will have the largest impact on the general public as the pipe route along the WTW access road, while being the most environmentally acceptable route, will reduce access to a public park. Informing the public of this in advance and co-ordinating with the Country Parks Rangers will help to mitigate this transitory impact.

Construction noise at both Red Hill and Tai Po Road is anticipated to exceed ProPECC recommended daytime noise levels at the nearby schools. However, recommended mitigation measures to reduce noise impacts to acceptable measures have been identified in Chapter 6 and 9 respectively.

14.3 Recommendations

The site specific recommendations and mitigation measures proposed in Sections 5.3 - 5.4 through 12.4 - 12.5, and summarised in tabular form at the end of each of these chapters together with those listed in Chapter 13, should be adopted and incorporated into the tender requirements for the construction of the WTWs. This includes environmental monitoring, audit and performance requirements for air quality (fugitive dust) and construction noise.

The most important mitigation measures identified, to prevent avoidable permanent environmental damage, are related to good construction practices to prevent unnecessary ecological damage beyond the site areas at Eastern and Tsuen Wan WTW.

14.4 Tai O WTW

The study findings suggest that the existing sludge disposal facilities at Tai O are not causing significant environmental damage, and are unlikely to be causing any measurable impact on WQO's. Construction and operation of sludge handling facilities at Tai O is likely to result in greater environmental damage than a 'do-nothing' option allowing the existing sludge disposal practice to be continued. Potential environmental impacts of a 'do-nothing' option would be confined to possible effects on the existing vegetation. In order to establish whether the current disposal practice is causing any detrimental impact on the surrounding vegetation it is recommended that a scientific monitoring programme be undertaken at the site. Identification of the preferred option for Tai O will only be concluded following assessment of the monitoring results.

It is suggested that prior to the comprehensive monitoring programme being implemented that an initial investigation covering ground and plant condition be instigated to establish whether the discharge has caused any detrimental effects to the vegetation or any ground water/land contamination to date.

The proposed monitoring programme shall take place over 18 months, incorporating both dry and wet seasons. Assessment of the monitoring results will provide recommendations with respect to the preferred method of sludge disposal. Should the BEECOPS proposal be identified as the preferred option, construction of the proposed works will be initiated to allow completion of the works in line with those at Silvermine Bay WTW.

APPENDIX A
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APPENDIX B
WATER QUALITY OBJECTIVES

Table B1
Selection of water quality objectives for marine waters of Southern WCZ

Water Quality parameters	Objective	Part(s) of Zone
E. coli	annual geometric mean not to exceed 610/100mL	secondary contact recreation subzone fish culture subzone
D.O. within 2m of bottom	not less than 2 mg/L for 90% samples	marine waters
Depth averaged D.O.	not less than 4 mg/L for 90% samples	marine waters except fish culture subzones
	not less than 5 mg/L for 90% samples	fish culture Subzones
pH value	to be in the range 6.5-8.5; change due to waste discharge not to exceed 0.2	marine waters except bathing beaches
Salinity	change due to waste discharge not to exceed 10% of natural ambient level	whole zone
Temperature change	change due to waste discharge not to exceed 2°C	whole zone
Suspended solids	waste discharge not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect the aquatic communities	marine waters
Toxicants	not to be present at levels producing significant toxic effects	whole zone
Un-ionised ammonia	annual mean not to exceed 0.021 mg/L	whole zone
Nutrients	not to be present in quantities that cause excessive algal growth	marine waters
	annual mean depth average inorganic nitrogen not be exceed 0.1 mg/L	

Table B2
Selection of water quality objectives for marine waters of North-western WCZ

Water Quality Parameters	Objective	Part(s) of Zone
E. coli	annual geometric mean not to exceed 610/100mL	secondary contact recreation subzone
D.O. within 2m of bottom	not less than 2 mg/L for 90% samples	marine waters
Depth averaged D.O.	not less than 4 mg/L for 90% samples	marine waters
pH value	to be in the range 6.5-8.5, change due to waste discharge not to exceed 0.2	marine waters except bathing beach subzones
Salinity	change due to waste discharge not to exceed 10% of natural ambient level	whole zone
Temperature change	change due to waste discharge not to exceed 2°C	whole zone
Suspended solids	waste discharge not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect aquatic communities	marine waters
Toxicants	not to be present at levels producing significant toxic effect	whole zone
Un-ionised ammonia	annual mean not to exceed 0.021 mg/L	whole zone
Nutrients	not to be present in quantities that cause excessive algal growth	marine waters
	annual mean depth average inorganic nitrogen not be exceed 0.5 mg/L	marine waters except Castle Peak subzone

Table B3
Selection of water quality objectives for marine waters of Western Buffer WCZ

Water Quality Parameters	Objective	Part(s) of Zone
E. coli	annual geometric mean not to exceed 610/100mL	secondary contact recreation subzone fish culture subzone
D.O. within 2m of bottom	not less than 2 mg/L for 90% samples	marine waters
Depth averaged D.O.	not less than 4 mg/L for 90% samples	marine waters except fish culture subzones
	not less than 5 mg/L for 90% samples	fish culture subzones
pH value	to be in the range 6.5-8.5, change due to waste discharge not to exceed 0.2	marine waters except bathing beach subzones
Salin	change due to waste discharge not to exceed 10% of natural ambient level	whole zone
Temperature change	change due to waste discharge not to exceed 2°C	whole zone
Suspended solids	waste discharge not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect aquatic communities	marine waters
Toxicants	not to be present at levels producing significant toxic effect	whole zone
Un-ionised ammonia	annual mean not to exceed 0.021 mg/L	whole zone
Nutrients	not to be present in quantities that cause excessive algal growth	marine waters
	annual mean depth average inorganic nitrogen not be exceed 0.4 mg/L	marine waters

Table B4
Selection of water quality objectives for marine waters of Victoria Harbour (Phase 1) WCZ

Water Quality Parameters	Objective	Part(s) of Zone
E. coli	annual geometric mean not to exceed 610/100mL	secondary contact recreation subzone fish culture subzone
D.O. within 2m of bottom	not less than 2 mg/L for 90% samples	marine waters
Depth averaged D.O.	not less than 4 mg/L for 90% samples	marine waters except fish culture subzones
	not less than 5 mg/L for 90% samples	fish culture subzones
pH value	to be in the range 6.5-8.5; change due to waste discharge not to exceed 0.2	marine waters except bathing beach subzones
Salinity	change due to waste discharge not to exceed 10% of natural ambient level	whole zone
Temperature change	change due to waste discharge not to exceed 2°C	whole zone
Suspended solids	waste discharge not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect aquatic communities	marine waters
Toxicants	not to be present at levels producing significant toxic effect	whole zone
Un-ionised ammonia	annual mean not to exceed 0.021 mg/L	whole zone
Nutrients	not to be present in quantities that cause excessive algal growth	marine waters
	annual mean depth average inorganic nitrogen not be exceed 0.4 mg/L	marine waters

APPENDIX C
NOISE ASSESSMENT

Construction Noise Assessments were carried out for sites where construction noise may cause significant impacts. The detailed noise assessment methodology given in the EPD Technical Memoranda concerning, "Noise from Percussive Piling" and "Noise from Construction Work other Than Percussive Piling" were followed as appropriate. The following tables give the results for each proposed site using these methodologies. For general construction work, no noise restrictions are imposed during the daytime period (07.00-19.00, Monday to Saturday), however recommended daytime noise levels as set out in the 'ProPECC Practice Notes PN2/93' have been adopted.

Table C1a **Eastern** **All Unsilenced P.M.E.**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Breaker (unsilenced)	122												
Dump Truck	117	122,117	5	1	123								
Breaker, Hand Held	117					123,119	4	1.5					
Saw, chain, hand	114	117,114	3	2	119								
Lorry	112								124.5				
Tracked	112	112,112	0	3	115								
Excavator/loader													
Air Compressor	109					115,111.	3.5	1.5		124.5,116.	8	0.5	125
Generator	108	109,108	1	2.5	111.5								
Crane, Tower	95								116.5				
		95,	95	0	95								
						95,	95	0					
									95				
										95,	95	0	95

Table C1b **Eastern** **Silenced Breaker**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Dump Truck	117												
Breaker (silenced)	112	117,112	5	1	118								
Breaker, Hand Held	117					118,119	1	2.5					
Saw, chain, hand	114	117,114	3	2	119								
Lorry	112								120.5				
Tracked	112	112,112	0	3	115								
Excavator/loader													
Air Compressor	109					115,111.	3.5	1.5		120.5,116.	4	1.5	122
Generator	108	109,108	1	2.5	111.5								
Crane, Tower	95								116.5				
		95,	95	0	95								
						95,	95	0					
									95				
										95,	95	0	95

Table C2a **Red Hill** **All Unsilenced P.M.E.**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Breaker (unsilenced)	122												
Dump Truck	117	122,117	5	1	123								
Breaker, Hand Held	117					123,118	5	1					
Lorry	112	117,112	5	1	118								
Tracked	112								124				
Excavator/loader													
Air Compressor	109	112,109	3	2	114								
Generator	108					114,108	6	1		124,115	9	0.5	124.5
		108,	108	0	108								
						108,			115				

Table C2b **Red Hill** **Silenced Breaker**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Dump Truck	117												
Breaker (silenced)	112	117,112	5	1	118								
Breaker, Hand Held	117					118,118	0	3					
Lorry	112	117,112	5	1	118								
Tracked	112								121				
Excavator/loader													
Air Compressor	109	112,109	3	2	114								
Generator	108					114,108	6	1		121,115	6	1	122
		108,	108	0	108								
									115				
			0		0								

Table C3a **Tsuen Wan** **All Unsilenced P.M.E.**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Breaker (unsilenced)	122												
Dump Truck	117	122,117	5	1	123								
Breaker, Hand Held	117					123,118	5	1					
Lorry	112	117,112	5	1	118								
Tracked	112								124				
Excavator/loader Air Compressor	109	112,109	3	2	114								
Generator	108					114,108	6	1		124,115	9	0.5	124.5
		108,	108	0	108								
									115				

Table C3b **Tsuen Wan** **Silenced Breaker**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Dump Truck	117												
Breaker (silenced)	112	117,112	5	1	118								
Breaker, Hand Held	117					118,118	0	3					
Lorry	112	117,112	5	1	118								
Tracked	112								121				
Excavator/loader Air Compressor	109	112,109	3	2	114								
Generator	108					114,108	6	1		121,115	6	1	122
		108,	108	0	108								
									115				

Table C4a **Tai Po Road** **All Unsilenced P.M.E.**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Breaker (unsilenced)	122												
Dump Truck	117	122,117	5	1	123								
Breaker, Hand Held	117					123,118	5	1					
Lorry	112	117,112	5	1	118								
Tracked Excavator/loader	112								124				
Air Compressor	109	112,109	3	2	114								
Generator	108					114,108	6	1		124,115	9	0.5	124.5
		108,	108	0	108								
									115				

Table C4b **Tai Po Road** **Silenced Breaker**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Dump Truck	117												
Breaker (silenced)	112	117,112	5	1	118								
Breaker, Hand Held	117					118,118	0	3					
Lorry	112	117,112	5	1	118								
Tracked Excavator/loader	112								121				
Air Compressor	109	112,109	3	2	114								
Generator	108					114,108	6	1		121,115	6	1	122
		108,	108	0	108								
									115				

Table C4c **Tai Po Road** **All Silenced P.M.E.**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Breaker (silenced)	112												
Dump Truck (partially enclosed)	107	112,107	5	1	113								
Lorry	112					113,114	1	2.5					
Breaker, Hand Held (hydraulic)	110	112,110	2	2	114								
Tracked Excavator/loader (partially enclosed)	102								115.5				
Air Compressor (silenced)	100	102,100	2	2	104								
Generator (silenced)	100					104,100	4	1.5		115.5,105.	10	0.5	116
		100,	100	0	100								
									105.5				

Table C5a **Tuen Mun** **All Unsilenced P.M.E.**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Breaker (unsilenced)	122												
Dump Truck	117	122,117	5	1	123								
Breaker, Hand Held	117					123,120	3	2					
Breaker, Hand Held	117	117,117	0	3	120								
Lorry	112								125				
Tracked Excavator	112	112,112	0	3	115								
Tracked Excavator	112					115,114	1	2.5		125,117.5	7.5	0.5	125.5
Air Compressor	109	112,109	3	2	114								
Generator	108								117.5				
		108,	108	0	108								
						108,	108	0					
									108				
										108,	108	0	108

Table C5b **Tuen Mun** **Silenced Breaker**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Dump Truck	117												
Breaker (silenced)	112	117,112	5	1	118								
Breaker, Hand Held	117					118,120	-2	3					
Breaker, Hand Held	117	117,117	0	3	120								
Lorry	112								121				
Tracked Excavator	112	112,112	0	3	115								
Tracked Excavator	112					115,114	1	2.5		121,117.5	3.5	1.5	122.5
Air Compressor	109	112,109	3	2	114								
Generator	108								117.5				
		108,	108	0	108								
						108,	108	0					
									108				
										108,	108	0	108

Table C5c **Tuen Mun** **All Silenced P.M.E.**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Breaker (silenced)	112												
Dump Truck (partially enclosed)	107	112,107	5	1	113								
Breaker, Hand Held (hydraulic)	110					113,113	0	3					
Breaker, Hand Held (hydraulic)	110	110,110	0	3	113								
Lorry	112								116				
Tracked Excavator (partially enclosed)	102	112,102	10	0.5	112.5								
Tracked Excavator (partially enclosed)	102					112.5,10	8.5	0.5		116,113	3	2	118
Air Compressor (silenced)	100	102,100	2	2	104								
Generator (silenced)	100								113				
		100,	100	0	100								
						100,	100	0					
									100				
										100,	100	0	100

Table C5d **Tuen Mun** **All Silenced P.M.E. without Breaker**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Breaker, Hand Held (hydraulic)	110												
Dump Truck	107	110,107	3	2	112								
(partially enclosed) Lorry	112					114,112	2	2					
Breaker, Hand Held	110	112,110	2	2	114								
(hydraulic) Tracked Excavator	102								114				
(partially enclosed) Tracked Excavator	102	102,102	0	3	105								
(partially enclosed) Air Compressor	100					105,103	2	2		114,107	7	1	115
(silenced) Generator (silenced)	100	100,100	0	3	103								
									107				
			0										
							0						

Table C5e Tuen Mun Silenced Breaker with PME below 107 dB(A)

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Breaker (silenced)	112												
Dump Truck (partially enclosed)	107	112,107	5	1	113								
Tracked Excavator (partially enclosed)	102					113,105	8	0.5					
Tracked Excavator (partially enclosed)	102	102,102	0	3	105								
Air Compressor (silenced)	100												
									113.5				
Generator (silenced)	100	100,100	0	3	103								
						103,3	100	0		113.5,103	10.5	0.5	114
			0	3	3								
									103				
			0		0								
						0,	0						
									0				
										0,	0		0

Table C6a **Silvermine Bay** **All Unsilenced P.M.E.**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Breaker (unsilenced)	122															
Dump Truck	117	122,117	5	1	123											
Breaker, Hand Held	117					123,120	3	2								
Breaker, Hand Held	117	117,117	0	3	120											
Lorry	112								125							
Lorry	112	112,112	0	3	115											
Tracked Excavator	112					115,115	0	3		125,118	7	1	126			
Tracked Excavator	112	112,112	0	3	115											
Compressor	109								118							
Generator	108	109,108	1	2.5	111.5											
						111.5,	111.5	0						14.5	0	126
									111.5							
										111.5,	111.5	0	111.5			

Table C6b **Silvermine Bay** **Silenced Breaker**

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Dump Truck	117															
Breaker (silenced)	112	117,112	5	1	118											
Breaker, Hand Held	117					118,120	2	2								
Breaker, Hand Held	117	117,117	0	3	120											
Lorry	112								120							
Lorry	112	112,112	0	3	115											
Tracked Excavator	112					115,115	0	3		120,118	2	2	122			
Tracked Excavator	112	112,112	0	3	115											
Compressor	109								118							
Generator	108	109,108	1	2.5	111.5											
						111.5,	111.5	0						10.5	0.5	122.5
									111.5							
										111.5,	111.5	0	111.5			

Table C7a Tai O All Unsilenced P.M.E.

Powered Mechanical Equipment	Sound Power Level dB(A)	Two SP	Difference in dB(A)	Amount to Add to high SPL	Running SP dB(A)	Two SP	Difference in dB(A)	Amount to Ad to high SPL	Running SPL dB(A)	Two SPL	Difference in dB(A)	Amount to Add to high SPL	Running SPL dB(A)
Breaker, hand held	117												
Tracked Excavator	112	117,112	5	1	118								
Air Compressor	109					118,111.	6.5	1					
Generator	108	109,108	1	2.5	111.5								
Dumper	106								119				
	0	106,0	106	0	106								
	0					106,0	106	0		119,106	13	0	119
	0	0,0	0		0								
	0								106				
	0	0,0	0		0								
							0						
											0		

Table C8 Calculation of Corrected Noise Levels from Proposed Construction Operations at Eastern WTW using Unsilenced PME

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recom-mended Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL)
Senoir Staff Housing	C	Stubbs Road Direct IF	75	N/A	70	125	3	(50m) -42	-10	76
Hong Kong Adventist Hospital	C	Stubbs Road Direct IF	75	N/A	70	125	3	(180m) -53	-10	65
Royal Hong Kong Jockey Club	B	N/A	75	N/A	65	125	3	(120) -50	-10	68

Table C9 Calculation of Corrected Noise Levels from Proposed Construction Operations at Eastern WTW using Silenced Breaker

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recom-mended Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL)
Senoir Staff Housing	C	Stubbs Road Direct IF	75	N/A	70	122	3	(50m) -42	-10	73
Hong Kong Adventist Hospital	C	Stubbs Road Direct IF	75	N/A	70	122	3	(180m) -53	-10	62
Royal Hong Kong Jockey Club	B	N/A	75	N/A	65	122	3	(120) -50	-10	65

Table C10 Calculation of Corrected Noise Levels from Proposed Construction Operations at Red Hill WTW using Unsilenced PME

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommend -ed Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Residential Housing	A	N/A	75	N/A	60	124.5	3	(200m) -54	-10	63.5
Hong Kong International School	A	N/A	75	N/A	60	124.5	3	(400m) < 57	0	< 70.5

Table C11 Calculation of Corrected Noise Levels from Proposed Construction Operations at Red Hill WTW using Silenced Breaker

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommend -ed Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Residential Housing	A	N/A	75	N/A	60	122	3	(200m) -54	-10	61
Hong Kong International School	A	N/A	75	N/A	60	122	3	(400m) < 57	0	< 68

Table C12 Calculation of Corrected Noise Levels from Proposed Construction Operations at Tsuen Wan WTW using Unsilenced PME

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommed-ed Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Shek Wai Kok Estate	C	Cheung Pei Shan Road, Indirect	75	N/A	70	124.5	3	(250m) -56	0	71.5
Auxiliary Nurse Training Quarters	B	N/A	75	N/A	65	124.5	3	(210m) -54	-10	63.5

Table C13 Calculation of Corrected Noise Levels from Proposed Construction Operations at Tsuen Wan WTW using Silenced Breaker

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommed-ed Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Shek Wai Kok Estate	C	Cheung Pei Shan Road, Indirect	75	N/A	70	122	3	(250m) -56	0	69
Auxiliary Nurse Training Quarters	B	N/A	75	N/A	65	122	3	(210m) -54	-10	61

Table C14 Calculation of Corrected Noise Levels from Proposed Construction Operations at Tai Po Road WTW using Unsilenced PME

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommed -ed Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Sir Robert Black College of Education	C	Tai Po Road	75	N/A	70	124.5	3	(140m) 51	0	76.5
Residential Development 2, Caldecott Road	C	Tai Po Road	75	N/A	70	124.5	3	(140m) 51	-10	66.5

Table C15 Calculation of Corrected Noise Levels from Proposed Construction Operations at Tai Po Road WTW using Silenced Breaker

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommed -ed Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Sir Robert Black College of Education	C	Tai Po Road	75	N/A	70	122	3	(140m) 51	0	74
Residential Development 2, Caldecott Road	C	Tai Po Road	75	N/A	70	122	3	(140m) 51	-10	64

Table C16 Calculation of Corrected Noise Levels from Proposed Construction Operations at Tai Po Road WTW using Silenced PME

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommed-ed Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Sir Robert Black College of Education	C	Tai Po Road	75	N/A	70	116	3	(140m) 51	0	68
Residential Development 2, Caldecott Road	C	Tai Po Road	75	N/A	70	116	3	(140m) 51	-10	58

Table C17 Calculation of Corrected Noise Levels from Proposed Construction Operations at Tuen Mun WTW using Unsilenced PME

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommended Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Grandeur Garden Estate	C	N/A	75	N/A	70	125.5	3 + 3 (for reverberant nature of locality)	(100m) -48	0	83.5

Table C18 Calculation of Corrected Noise Levels from Proposed Construction Operations at Tuen Mun WTW using Silenced Breaker

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommended Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Grandeur Garden Estate	C	N/A	75	N/A	70	122.5	3 + 3 (for reverberant nature of locality)	(100m) -48	0	80.5

Table C19 Calculation of Corrected Noise Levels from Proposed Construction Operations at Tuen Mun WTW using Silenced PME

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommended Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Grandeur Garden Estate	C	N/A	75	N/A	70	118	3 + 3 (for reverberant nature of locality)	(100m) -48	0	76

Table C20 Calculation of Corrected Noise Levels from Proposed Construction Operations at Tuen Mun WTW using Silenced PME without Breaker

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommed-ed Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Grandeur Garden Estate	C	N/A	75	N/A	70	115	3 + 3 (for reverberant nature of locality)	(100m) -48	0	73

Table C21 Calculation of Corrected Noise Levels from Proposed Construction Operations at Tuen Mun WTW using Silenced Breaker / Silenced PME (sound levels below 107 dB(A)

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommed-ed Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Grandeur Garden Estate	C	N/A	75	N/A	70	114	3 + 3 (for reverberant nature of locality)	(100m) -48	0	72

Table C22 Calculation of Corrected Noise Levels from Proposed Construction Operations at Silvermine Bay WTW using Unsilenced PME

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommended Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Round Table Village	A	N/A	75	N/A	60	126	3	(200m) -54	-10	65

Table C23 Calculation of Corrected Noise Levels from Proposed Construction Operations at Silvermine Bay WTW using Silenced Breaker

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommended Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Round Table Village	A	N/A	75	N/A	60	122.5	3	(200m) -54	-10	61.5

Table C24 Calculation of Corrected Noise Levels from Proposed Construction Operations at Tai O WTW using Unsilenced PME

Nearest Sensitive Receiver	Area Sensitivity Rating (ASR)	Influencing Factors (IF)	Recommended Daytime Noise Level dB(A)	Correction For Duration	Acceptable Noise Level (ANL) dB(A)	Predicted Noise Level (PNL) dB(A)	Acoustic Reflection Correction dB(A)	Distance Attenuation dB(A)	Correction For Barrier Effect dB(A)	Corrected Noise Level (CNL) dB(A)
Residential Development at San Tsuen	A	N/A	75	N/A	60	119	3	(180m) -53	-10	59

APPENDIX D
FUGITIVE DUST MODELLING

Introduction

Fugitive Dust Emisions from construction sites are largely caused by construction activities such as the loading of spoil and vehicles moving at speed across open ground. The FDM model was applied to the sites which are of adequate size to potentially produce significant volumes of fugitive dust.

Setup Criteria

Details of the parameters and how they should be fed into the model can be found in the instruction manual for the model. In this case the following setup parameters were used to give a worst case model result.

The FDM model was used with one input file for each run containing information on the receptors, sources and model switches and options. The file also contained meteorological information for a 24 hour period.

In each case the emission was modeled as an area source with an area equal to that of the entire proposed development site. Therefore, the model is likely to overestimate dust production as some portions of some of the sites will not be disturbed and therefore, will not give rise to fugitive dust emissions.

The following model setup descriptions follow the format in which the various options are output from the model.

Convergence Option

Default five line integration was used as none of the sites are large enough to justify a larger number of integrations.

Meteorological Option

Meteorological data was generated for a standardised day. The standard day used was designed to give the best case potential conditions for dust generation at the site and best case conditions to transport the dust to the NSR.

For the standardised day the following options were used:

- Wind speed was set at a constant 2ms^{-1}, this rate will minimise turbulent mixing.
- Wind direction was set to blow constantly from the proposed development site to the NSR, thus conveying the maximum potential volume of dust to the NSR.

  Mixing height 10,000 (default)
- Temperature was set at 303 degrees Kelvin (30 degrees Celsius) which represents the approximate temperature of a warm summer day which is the period during which fugitive dust emissions are likely to be greatest.
- Air stability class was set at Turner class 4 to reflect stable conditions under which dust concentrations will be maximised.

Plot file

A plot file was not produced as plot modeling was not necessary.

Post Processing

No post processing of the output file was required

Deposition Velocity and gravitational settling velocity

Deposition velocity and gravitational settling velocity were calculated by the model as no special conditions were required to be modeled in this case.

Average Concentrations

24 hour average concentrations were calculated

Long Term Average

The average for the 24 hour period was calculated. This would not vary over a longer period as a steady state is reached early in the modeling period.

Calms Recognition

Calms recognition was not required as all wind-speeds are over $1ms^{-1}$

Hourly Emission Rates

Hourly emission rates were not used as the emission was taken as being constant.

Number of Sources Processed

In each case one source (the whole development site) was processed.

Number of Receptors Processed

One model run was carried out for each receptor so in each case the number of receptors is one.

Particle Size Classes

One particle size of 15micro metres was used. This particle size is above the 10 micrometres threshold for respirable particles but well below the size at which fugitive emissions are large enough to settle rapidly due to their own size (30 micro metres).

Hours of Meteorological Data Processed

Meteorological data for one day was used.

Length of One Hour.

Length of one hour was set as 60 minutes

Roughness Length

Roughness length was set to 5 cm. This is a reasonable assumption for the amount of roughness on the site surface during construction work.

Scaling Factor

All measurements are in metres. Therefore, scaling was set to 1.0.

Particle Density

A particle density of 1.8g/cm^3 was used as this is a good approximation of the density of clay soil.

Anemometer Height

A default anemometer height of 10m was used.

Methodology Followed To Acquire Other Information Required By The Model.

A 1:5000 plan of the area containing the proposed development site and the NSRs was enlarged photographically to 200% of its size to give a large scale plan on which to work. Scales were taken from the photographically enlarged plan.

Using the engineering site layout plans as a guide, the best fit rectangle was drawn around the area in which the development is proposed. The centre of the area was found by drawing two lines from opposite apexes of the rectangle. The dimensions of this rectangle were measured from the plan using the appropriate scale.

A model X and Y axis were added to the diagram, using the existing map coordinate lines where possible.

One side of the site rectangle was extended on the plan to allow the source rotation angle (in respect to the X-axis) to be read from the plan using a protractor.

Using a set square, lines were drawn from the centre of the site to the X and Y axes. This enabled the coordinates of the site centre to be read from the axes using the appropriate scale. The NSRs were drawn onto the plan and in a similar manner to that used for finding the coordinates of the site, the X and Y coordinates of the NSRs was read from the plan.

Lines were drawn joining the NSRs to the centre of the proposed development site. The wind direction which would blow directly from the proposed development site to each NSR could therefore be read from the plan, again with a protractor.

Modeling Data

Copies of the plans used, showing the sites, NSRs and co-ordinate systems origins, are shown for each site overleaf, followed by the output files generated by the model. Input data read from the plans is included as Table D.1 at the end of this appendix.

```
FUGITIVE DUST MODEL (FDM)
          VERSION 93070
          MAR, 1993
     DATE AT START OF RUN: 25/03/95   TIME AT START OF RUN: 14:12:05.47

     RUN TITLE: EASTERN - ADVENTIST HOSPITAL NSR

     INPUT FILE NAME  : easthos.in
     OUTPUT FILE NAME : easthos.out

     CONVERGENCE OPTION 1=OFF, 2=ON                  1
     MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED      1
     PLOT FILE OUTPUT, 1=NO, 2=YES                   1
     MET DATA PRINT SWITCH, 1=NO, 2=YES              2
     POST-PROCESSOR OUTPUT, 1=NO, 2=YES              1
     DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER   1
     PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES        1
     PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES        1
     PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES        1
     PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES       2
     PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES     2
     BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES    0
     READ HOURLY EMISSION RATES, 1=NO, 2=YES         0
     NUMBER OF SOURCES PROCESSED                     1
     NUMBER OF RECEPTORS PROCESSED                   1
     NUMBER OF PARTICLE SIZE CLASSES                 1
     NUMBER OF HOURS OF MET DATA PROCESSED          24
     LENGTH IN MINUTES OF 1-HOUR OF MET DATA        60.
     ROUGHNESS LENGTH IN CM                        5.00
     SCALING FACTOR FOR SOURCE AND RECPTORS      1.0000
     PARTICLE DENSITY IN G/CM**3                   1.80
     ANEMOMETER HEIGHT IN M                       10.00

     GENERAL PARTICLE SIZE CLASS INFORMATION

                      GRAV.          FRACTION
      PARTICLE     CHAR.  SETTLING  DEPOSITION  IN EACH
        SIZE      DIA.  VELOCITY  VELOCITY     SIZE
       CLASS      (UM)  (M/SEC)   (M/SEC)     CLASS
       -----  ----------  -------  ---------  --------
         1   15.0000000     **         **    1.0000

     ** COMPUTED BY FDM

     RECEPTOR COORDINATES (X,Y,Z)

     (   54.,   104.,  0.)

     SOURCE INFORMATION

        ENTERED EMIS.   TOTAL
         RATE (G/SEC,  EMISSION   WIND
          G/SEC/M OR     RATE  SPEED   X1     Y1     X2     Y2  HEIGHT  WIDTH/ANGLE
     TYPE    G/SEC/M**2)  (G/SEC)  FAC.   (M)    (M)    (M)    (M)    (M)    (M)
     ---- -------------- --------- ------ ------- ------- ------ ------- ------- -------
       3    0.000160000   0.15392  0.000   156.   190.    37.    26.   3.00   7.00
                        ==========
     TOTAL EMISSIONS    0.15392E+00 GRAMS/SEC
```

SHORT DISTANCE (5,000 M) MASS CONSERVATION CORRECTION FACTORS USED

24 HOUR AVERAGE FOR HOUR ENDING 24
CONCENTRATIONS IN MICROGRAMS/M**3
AVERAGE EMISSIONS FOR THIS PERIOD = 0.15392E+00 GRAMS/SEC
(54., 104., 155.984)

24 HOUR AVERAGE FOR HOUR ENDING 24
DEPOSITION RATE IN MICROGRAMS/M**2/SEC
(54., 104., 2.576)

METEOROLOGICAL DATA FOR DAY 1. (HOURS 1 TO 24)

WIND SPEED (M/SEC)	WIND DIRECTION (DEGREES)	STABILITY CLASS (TURNER)	MIXING HEIGHT (M)	AMBIENT TEMP. (DEG. K)
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0
2.00	49.	4	10000.	303.0

DATE AT END OF RUN: 25/03/95 TIME AT END OF RUN: 14:12:14.70
ELAPSED TIME FOR THIS RUN: 0.92300E+01 SECONDS
OR 0 HOURS 0 MINUTES 9.23 SECONDS

```
        FUGITIVE DUST MODEL (FDM)
        VERSION 93070
        MAR, 1993
DATE AT START OF RUN: 25/03/95   TIME AT START OF RUN: 15:43:49.22

RUN TITLE: EASTERN - HONG KONG JOCKEY CLUB NSR

INPUT FILE NAME  : EASTJC.IN
OUTPUT FILE NAME : EASTJC.OUT

CONVERGENCE OPTION 1=OFF, 2=ON                    1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED        1
PLOT FILE OUTPUT, 1=NO, 2=YES                     1
MET DATA PRINT SWITCH, 1=NO, 2=YES                2
POST-PROCESSOR OUTPUT, 1=NO, 2=YES                1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER     1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES         2
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES       2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES      0
READ HOURLY EMISSION RATES, 1=NO, 2=YES           0
NUMBER OF SOURCES PROCESSED                       1
NUMBER OF RECEPTORS PROCESSED                     1
NUMBER OF PARTICLE SIZE CLASSES                   1
NUMBER OF HOURS OF MET DATA PROCESSED            24
LENGTH IN MINUTES OF 1-HOUR OF MET DATA          60.
ROUGHNESS LENGTH IN CM                         5.00
SCALING FACTOR FOR SOURCE AND RECPTORS       1.0000
PARTICLE DENSITY IN G/CM**3                    1.80
ANEMOMETER HEIGHT IN M                        10.00

GENERAL PARTICLE SIZE CLASS INFORMATION

                        GRAV.            FRACTION
 PARTICLE       CHAR.  SETTLING DEPOSITION  IN EACH
   SIZE         DIA.  VELOCITY  VELOCITY    SIZE
   CLASS        (UM)  (M/SEC)   (M/SEC)    CLASS
   -----  ----------- --------  ---------- --------
     1   15.0000000      **        **    1.0000

** COMPUTED BY FDM

RECEPTOR COORDINATES (X,Y,Z)

(  238.,    237.,  0.)

SOURCE INFORMATION

     ENTERED EMIS.    TOTAL
      RATE (G/SEC,  EMISSION   WIND
       G/SEC/M OR      RATE  SPEED     X1      Y1      X2      Y2  HEIGHT  WIDTH/ANGLE
TYPE   G/SEC/M**2)   (G/SEC)  FAC.    (M)     (M)     (M)     (M)    (M)     (M)
---- -------------- --------- ------ ------- ------- ------- ------- ------- -------
  3    0.000160000   0.15392 0.000    156.    190.     37.     26.   3.00    7.00
                  ==========
```

TOTAL EMISSIONS 0.15392E+00 GRAMS/SEC

SHORT DISTANCE (5,000 M) MASS CONSERVATION CORRECTION FACTORS USED

24 HOUR AVERAGE FOR HOUR ENDING 24
CONCENTRATIONS IN MICROGRAMS/M**3
AVERAGE EMISSIONS FOR THIS PERIOD = 0.15392E+00 GRAMS/SEC
(238., 237., 263.755)

24 HOUR AVERAGE FOR HOUR ENDING 24
DEPOSITION RATE IN MICROGRAMS/M**2/SEC
(238., 237., 4.356)

METEOROLOGICAL DATA FOR DAY 1. (HOURS 1 TO 24)

WIND SPEED (M/SEC)	WIND DIRECTION (DEGREES)	STABILITY CLASS (TURNER)	MIXING HEIGHT (M)	AMBIENT TEMP. (DEG. K)
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0
2.00	240.	4	10000.	303.0

DATE AT END OF RUN: 25/03/95 TIME AT END OF RUN: 15:43:57.41
ELAPSED TIME FOR THIS RUN: 0.81900E+01 SECONDS
OR 0 HOURS 0 MINUTES 8.19 SECONDS

```
        FUGITIVE DUST MODEL (FDM)
        VERSION 93070
        MAR, 1993
DATE AT START OF RUN: 25/03/95   TIME AT START OF RUN: 15:44:00.59

RUN TITLE: EASTERN - STAFF RESIDENCES NSR

INPUT FILE NAME  : EASTSTF.IN
OUTPUT FILE NAME : EASTSTF.OUT

CONVERGENCE OPTION 1=OFF, 2=ON                     1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED         1
PLOT FILE OUTPUT, 1=NO, 2=YES                      1
MET DATA PRINT SWITCH, 1=NO, 2=YES                 2
POST-PROCESSOR OUTPUT, 1=NO, 2=YES                 1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER      1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES           1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES           1
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES           1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES          2
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES        2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES       0
READ HOURLY EMISSION RATES, 1=NO, 2=YES            0
NUMBER OF SOURCES PROCESSED                        1
NUMBER OF RECEPTORS PROCESSED                      1
NUMBER OF PARTICLE SIZE CLASSES                    1
NUMBER OF HOURS OF MET DATA PROCESSED             24
LENGTH IN MINUTES OF 1-HOUR OF MET DATA           60.
ROUGHNESS LENGTH IN CM                          5.00
SCALING FACTOR FOR SOURCE AND RECPTORS        1.0000
PARTICLE DENSITY IN G/CM**3                     1.80
ANEMOMETER HEIGHT IN M                         10.00

GENERAL PARTICLE SIZE CLASS INFORMATION

                      GRAV.            FRACTION
 PARTICLE      CHAR.  SETTLING  DEPOSITION  IN EACH
   SIZE       DIA.  VELOCITY   VELOCITY    SIZE
  CLASS       (UM)  (M/SEC)    (M/SEC)    CLASS
  -----  -----------  --------  ----------  --------
    1   15.0000000       **        **   1.0000

** COMPUTED BY FDM

RECEPTOR COORDINATES (X,Y,Z)

(  128.,    190.,  0.)

SOURCE INFORMATION

    ENTERED EMIS.    TOTAL
     RATE (G/SEC,  EMISSION    WIND
      G/SEC/M OR    RATE   SPEED    X1      Y1      X2      Y2  HEIGHT  WIDTH/ANGLE
TYPE   G/SEC/M**2)  (G/SEC)   FAC.   (M)     (M)     (M)     (M)    (M)     (M)
---- --------------- ---------- ------ -------- -------- -------- -------- ------- --------
  3    0.000160000   0.15392  0.000   156.    190.     37.     26.   3.00    7.00
                   ===========
```

TOTAL EMISSIONS 0.15392E+00 GRAMS/SEC

SHORT DISTANCE (5,000 M) MASS CONSERVATION CORRECTION FACTORS USED

24 HOUR AVERAGE FOR HOUR ENDING 24
CONCENTRATIONS IN MICROGRAMS/M**3
AVERAGE EMISSIONS FOR THIS PERIOD = 0.15392E+00 GRAMS/SEC
(128., 190., 275.702)

24 HOUR AVERAGE FOR HOUR ENDING 24
DEPOSITION RATE IN MICROGRAMS/M**2/SEC
(128., 190., 4.553)

METEOROLOGICAL DATA FOR DAY 1. (HOURS 1 TO 24)

WIND SPEED (M/SEC)	WIND DIRECTION (DEGREES)	STABILITY CLASS (TURNER)	MIXING HEIGHT (M)	AMBIENT TEMP. (DEG. K)
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0
2.00	97.	4	10000.	303.0

DATE AT END OF RUN: 25/03/95 TIME AT END OF RUN: 15:44:09.87
ELAPSED TIME FOR THIS RUN: 0.92800E+01 SECONDS
OR 0 HOURS 0 MINUTES 9.28 SECONDS

FUGITIVE DUST MODEL (FDM)
VERSION 93070
MAR, 1993
DATE AT START OF RUN: 25/03/95 TIME AT START OF RUN: 16:03:52.09

RUN TITLE: RED HILL - HOUSING DEVELOPMENT

INPUT FILE NAME : RHRES.IN
OUTPUT FILE NAME : RHRES.OUT

```
CONVERGENCE OPTION 1=OFF, 2=ON                1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED       1
PLOT FILE OUTPUT, 1=NO, 2=YES               1
MET DATA PRINT SWITCH, 1=NO, 2=YES            2
POST-PROCESSOR OUTPUT, 1=NO, 2=YES            1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER   1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES        1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES        1
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES        1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES      2
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES     2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES    0
READ HOURLY EMISSION RATES, 1=NO, 2=YES        0
NUMBER OF SOURCES PROCESSED                 1
NUMBER OF RECEPTORS PROCESSED                1
NUMBER OF PARTICLE SIZE CLASSES             1
NUMBER OF HOURS OF MET DATA PROCESSED         24
LENGTH IN MINUTES OF 1-HOUR OF MET DATA       60.
ROUGHNESS LENGTH IN CM                 5.00
SCALING FACTOR FOR SOURCE AND RECPTORS       1.0000
PARTICLE DENSITY IN G/CM**3             1.80
ANEMOMETER HEIGHT IN M                 10.00

GENERAL PARTICLE SIZE CLASS INFORMATION

                    GRAV.            FRACTION
 PARTICLE      CHAR.  SETTLING  DEPOSITION   IN EACH
   SIZE      DIA.  VELOCITY   VELOCITY     SIZE
   CLASS      (UM)   (M/SEC)    (M/SEC)    CLASS
 -----  -----------  --------  ----------  --------
   1   15.0000000      **        **    1.0000

** COMPUTED BY FDM

RECEPTOR COORDINATES (X,Y,Z)

( 427.,   270.,  0.)

SOURCE INFORMATION

    ENTERED EMIS.    TOTAL
     RATE (G/SEC,  EMISSION   WIND
      G/SEC/M OR     RATE   SPEED    X1      Y1      X2      Y2  HEIGHT  WIDTH/ANGLE
TYPE    G/SEC/M**2)  (G/SEC)   FAC.    (M)     (M)     (M)     (M)     (M)     (M)
---- --------------- ---------- ------ ------- -------- ------- -------- ------- -------
  3    0.000160000   0.19360  0.000   293.    248.     55.     22.   3.00  -10.00
                 ==========
TOTAL EMISSIONS    0.19360E+00 GRAMS/SEC

SHORT DISTANCE (5,000 M) MASS CONSERVATION CORRECTION FACTORS USED

24 HOUR AVERAGE FOR HOUR ENDING   24
CONCENTRATIONS IN MICROGRAMS/M**3
AVERAGE EMISSIONS FOR THIS PERIOD =     0.19360E+00 GRAMS/SEC
( 427.,   270.,  192.733)
```

24 HOUR AVERAGE FOR HOUR ENDING 24
DEPOSITION RATE IN MICROGRAMS/M**2/SEC
(427., 270., 3.183)

METEOROLOGICAL DATA FOR DAY 1. (HOURS 1 TO 24)

WIND SPEED (M/SEC)	WIND DIRECTION (DEGREES)	STABILITY CLASS (TURNER)	MIXING HEIGHT (M)	AMBIENT TEMP. (DEG. K)
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0
2.00	258.	4	10000.	303.0

DATE AT END OF RUN: 25/03/95 TIME AT END OF RUN: 16:04:05.38
ELAPSED TIME FOR THIS RUN: 0.13290E+02 SECONDS
OR 0 HOURS 0 MINUTES 13.29 SECONDS

FUGITIVE DUST MODEL (FDM)
VERSION 93070
MAR, 1993
DATE AT START OF RUN: 25/03/95 TIME AT START OF RUN: 15:45:53.24

RUN TITLE: RED HILL - HONG KONG INTERNATIONAL SCHOOL

INPUT FILE NAME : RHSCH.IN
OUTPUT FILE NAME : RHSCH.OUT

CONVERGENCE OPTION 1=OFF, 2=ON 1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED 1
PLOT FILE OUTPUT, 1=NO, 2=YES 1
MET DATA PRINT SWITCH, 1=NO, 2=YES 2
POST-PROCESSOR OUTPUT, 1=NO, 2=YES 1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER 1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES 1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES 1

```
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES         2
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES        2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES       0
READ HOURLY EMISSION RATES, 1=NO, 2=YES          0
NUMBER OF SOURCES PROCESSED                 1
NUMBER OF RECEPTORS PROCESSED                1
NUMBER OF PARTICLE SIZE CLASSES               1
NUMBER OF HOURS OF MET DATA PROCESSED            24
LENGTH IN MINUTES OF 1-HOUR OF MET DATA         60.
ROUGHNESS LENGTH IN CM                  5.00
SCALING FACTOR FOR SOURCE AND RECPTORS        1.0000
PARTICLE DENSITY IN G/CM**3               1.80
ANEMOMETER HEIGHT IN M                  10.00

GENERAL PARTICLE SIZE CLASS INFORMATION

                GRAV.          FRACTION
 PARTICLE     CHAR.  SETTLING DEPOSITION  IN EACH
   SIZE     DIA.  VELOCITY  VELOCITY    SIZE
  CLASS     (UM)  (M/SEC)   (M/SEC)   CLASS
  -----  ----------- -------- ---------- --------
    1  15.0000000     **       **   1.0000

** COMPUTED BY FDM

RECEPTOR COORDINATES (X,Y,Z)

(  67.,   387.,  0.)

SOURCE INFORMATION

    ENTERED EMIS.    TOTAL
     RATE (G/SEC,  EMISSION   WIND
      G/SEC/M OR     RATE   SPEED    X1     Y1     X2     Y2  HEIGHT  WIDTH/ANGLE
TYPE   G/SEC/M**2)  (G/SEC)   FAC.   (M)    (M)    (M)    (M)    (M)    (M)
---- --------------- ---------- ------ ------- -------- ------- -------- ------- -------
  3    0.000160000  0.19360 0.000   293.    248.    55.    22.   3.00  -10.00
                   ===========
TOTAL EMISSIONS    0.19360E+00 GRAMS/SEC

SHORT DISTANCE (5,000 M) MASS CONSERVATION CORRECTION FACTORS USED

24 HOUR AVERAGE FOR HOUR ENDING  24
CONCENTRATIONS IN MICROGRAMS/M**3
AVERAGE EMISSIONS FOR THIS PERIOD =    0.19360E+00 GRAMS/SEC
(  67.,   387.,   63.168)

24 HOUR AVERAGE FOR HOUR ENDING  24
DEPOSITION RATE IN MICROGRAMS/M**2/SEC
(  67.,   387.,   1.043)
```

METEOROLOGICAL DATA FOR DAY 1. (HOURS 1 TO 24)

WIND SPEED (M/SEC)	WIND DIRECTION (DEGREES)	STABILITY CLASS (TURNER)	MIXING HEIGHT (M)	AMBIENT TEMP. (DEG. K)
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0
2.00	122.	4	10000.	303.0

DATE AT END OF RUN: 25/03/95 TIME AT END OF RUN: 15:46:06.65
ELAPSED TIME FOR THIS RUN: 0.13410E+02 SECONDS
OR 0 HOURS 0 MINUTES 13.41 SECONDS

FUGITIVE DUST MODEL (FDM)
VERSION 93070
MAR, 1993
DATE AT START OF RUN: 25/03/95 TIME AT START OF RUN: 15:44:17.18

RUN TITLE: TSUEN WAN - HO CHEN YIN MEMORIAL COLLEGE NSR

INPUT FILE NAME : TWANCOL.IN
OUTPUT FILE NAME : TWANCOL.OUT

CONVERGENCE OPTION 1=OFF, 2=ON 1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED 1
PLOT FILE OUTPUT, 1=NO, 2=YES 1
MET DATA PRINT SWITCH, 1=NO, 2=YES 2
POST-PROCESSOR OUTPUT, 1=NO, 2=YES 1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER 1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES 1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES 1
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES 1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES 2
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES 2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES 0
READ HOURLY EMISSION RATES, 1=NO, 2=YES 0
NUMBER OF SOURCES PROCESSED 1
NUMBER OF RECEPTORS PROCESSED 1
NUMBER OF PARTICLE SIZE CLASSES 1
NUMBER OF HOURS OF MET DATA PROCESSED 24
LENGTH IN MINUTES OF 1-HOUR OF MET DATA 60.
ROUGHNESS LENGTH IN CM 5.00
SCALING FACTOR FOR SOURCE AND RECPTORS 1.0000
PARTICLE DENSITY IN G/CM**3 1.80
ANEMOMETER HEIGHT IN M 10.00

GENERAL PARTICLE SIZE CLASS INFORMATION

PARTICLE SIZE CLASS	CHAR. DIA. (UM)	GRAV. SETTLING VELOCITY (M/SEC)	DEPOSITION VELOCITY (M/SEC)	FRACTION IN EACH SIZE CLASS
1	15.0000000	**	**	1.0000

** COMPUTED BY FDM

RECEPTOR COORDINATES (X,Y,Z)

(81., 289., 0.)

SOURCE INFORMATION

TYPE	ENTERED EMIS. RATE (G/SEC, G/SEC/M OR G/SEC/M**2)	TOTAL EMISSION RATE (G/SEC)	WIND SPEED FAC.	X1 (M)	Y1 (M)	X2 (M)	Y2 (M)	HEIGHT (M)	WIDTH/ANGLE (M)
3	0.000160000	0.10080	0.000	227.	79.	35.	18.	3.00	-32.00

TOTAL EMISSIONS 0.10080E+00 GRAMS/SEC

SHORT DISTANCE (5,000 M) MASS CONSERVATION CORRECTION FACTORS USED

24 HOUR AVERAGE FOR HOUR ENDING 24
CONCENTRATIONS IN MICROGRAMS/M**3
AVERAGE EMISSIONS FOR THIS PERIOD = 0.10080E+00 GRAMS/SEC
(81., 289., 35.247)

24 HOUR AVERAGE FOR HOUR ENDING 24
DEPOSITION RATE IN MICROGRAMS/M**2/SEC
(81., 289., 0.582)

METEOROLOGICAL DATA FOR DAY 1. (HOURS 1 TO 24)

WIND SPEED (M/SEC)	WIND DIRECTION (DEGREES)	STABILITY CLASS (TURNER)	MIXING HEIGHT (M)	AMBIENT TEMP. (DEG. K)
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0
2.00	146.	4	10000.	303.0

DATE AT END OF RUN: 25/03/95 TIME AT END OF RUN: 15:44:25.03
ELAPSED TIME FOR THIS RUN: 0.78500E+01 SECONDS
OR 0 HOURS 0 MINUTES 7.85 SECONDS

```
        FUGITIVE DUST MODEL (FDM)
        VERSION 93070
        MAR, 1993
DATE AT START OF RUN: 25/03/95  TIME AT START OF RUN: 15:44:31.19

RUN TITLE: TUSEN WAN - AUXILLIARY NURSE TRAINING QUARTERS

INPUT FILE NAME  : TWANNQ.IN
OUTPUT FILE NAME : TWANNQ.OUT

CONVERGENCE OPTION 1=OFF, 2=ON                    1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED        1
PLOT FILE OUTPUT, 1=NO, 2=YES                     1
MET DATA PRINT SWITCH, 1=NO, 2=YES                2
POST-PROCESSOR OUTPUT, 1=NO, 2=YES                1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER     1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES         2
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES       2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES      0
READ HOURLY EMISSION RATES, 1=NO, 2=YES           0
NUMBER OF SOURCES PROCESSED                       1
NUMBER OF RECEPTORS PROCESSED                     1
NUMBER OF PARTICLE SIZE CLASSES                   1
NUMBER OF HOURS OF MET DATA PROCESSED            24
LENGTH IN MINUTES OF 1-HOUR OF MET DATA          60.
ROUGHNESS LENGTH IN CM                         5.00
SCALING FACTOR FOR SOURCE AND RECPTORS       1.0000
PARTICLE DENSITY IN G/CM**3                    1.80
ANEMOMETER HEIGHT IN M                        10.00

GENERAL PARTICLE SIZE CLASS INFORMATION

                  GRAV.           FRACTION
 PARTICLE    CHAR. SETTLING DEPOSITION  IN EACH
   SIZE     DIA.  VELOCITY   VELOCITY    SIZE
  CLASS     (UM)  (M/SEC)    (M/SEC)    CLASS
  -----  ---------- -------- -------- -------
    1   15.0000000      **        **   1.0000

** COMPUTED BY FDM

RECEPTOR COORDINATES (X,Y,Z)

(  420.,    166.,  0.)

SOURCE INFORMATION

     ENTERED EMIS.    TOTAL
     RATE (G/SEC,  EMISSION   WIND
      G/SEC/M OR     RATE   SPEED   X1     Y1     X2     Y2 HEIGHT  WIDTH/ANGLE
TYPE   G/SEC/M**2)  (G/SEC)   FAC.   (M)    (M)    (M)    (M)    (M)     (M)
---- ------------- --------- ----- ------ ------ ------ ------ ------ -------
  3    0.000160000   0.10080 0.000  227.    79.    35.    18.   3.00  -32.00
                   ==========
```

TOTAL EMISSIONS 0.10080E+00 GRAMS/SEC

SHORT DISTANCE (5,000 M) MASS CONSERVATION CORRECTION FACTORS USED

24 HOUR AVERAGE FOR HOUR ENDING 24
CONCENTRATIONS IN MICROGRAMS/M**3
AVERAGE EMISSIONS FOR THIS PERIOD = 0.10080E+00 GRAMS/SEC
(420., 166., 47.831)

24 HOUR AVERAGE FOR HOUR ENDING 24
DEPOSITION RATE IN MICROGRAMS/M**2/SEC
(420., 166., 0.790)

METEOROLOGICAL DATA FOR DAY 1. (HOURS 1 TO 24)

WIND SPEED (M/SEC)	WIND DIRECTION (DEGREES)	STABILITY CLASS (TURNER)	MIXING HEIGHT (M)	AMBIENT TEMP. (DEG. K)
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0
2.00	245.	4	10000.	303.0

DATE AT END OF RUN: 25/03/95 TIME AT END OF RUN: 15:44:43.71
ELAPSED TIME FOR THIS RUN: 0.12520E+02 SECONDS
OR 0 HOURS 0 MINUTES 12.52 SECONDS

FUGITIVE DUST MODEL (FDM)
VERSION 93070
MAR, 1993
DATE AT START OF RUN: 25/03/95 TIME AT START OF RUN: 15:45:38.69

RUN TITLE: TAI PO ROAD - 2, CALDECOTT ROAD

INPUT FILE NAME : TPR2.IN
OUTPUT FILE NAME : TPR2.OUT

CONVERGENCE OPTION 1=OFF, 2=ON 1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED 1
PLOT FILE OUTPUT, 1=NO, 2=YES 1
MET DATA PRINT SWITCH, 1=NO, 2=YES 2
POST-PROCESSOR OUTPUT, 1=NO, 2=YES 1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER 1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES 1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES 1
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES 1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES 2
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES 2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES 0
READ HOURLY EMISSION RATES, 1=NO, 2=YES 0
NUMBER OF SOURCES PROCESSED 1
NUMBER OF RECEPTORS PROCESSED 1
NUMBER OF PARTICLE SIZE CLASSES 1
NUMBER OF HOURS OF MET DATA PROCESSED 24
LENGTH IN MINUTES OF 1-HOUR OF MET DATA 60.
ROUGHNESS LENGTH IN CM 5.00
SCALING FACTOR FOR SOURCE AND RECPTORS 1.0000
PARTICLE DENSITY IN G/CM**3 1.80
ANEMOMETER HEIGHT IN M 10.00

GENERAL PARTICLE SIZE CLASS INFORMATION

PARTICLE SIZE CLASS	CHAR. DIA. (UM)	GRAV. SETTLING VELOCITY (M/SEC)	DEPOSITION VELOCITY (M/SEC)	FRACTION IN EACH SIZE CLASS
1	15.0000000	**	**	1.0000

** COMPUTED BY FDM

RECEPTOR COORDINATES (X,Y,Z)

(456., 370., 0.)

SOURCE INFORMATION

TYPE	ENTERED EMIS. RATE (G/SEC, G/SEC/M OR G/SEC/M**2)	TOTAL EMISSION RATE (G/SEC)	WIND SPEED FAC.	X1 (M)	Y1 (M)	X2 (M)	Y2 (M)	HEIGHT (M)	WIDTH/ANGLE (M)
3	0.000160000	0.65280	0.000	400.	496.	68.	60.	3.00	0.00

==========

TOTAL EMISSIONS 0.65280E+00 GRAMS/SEC

SHORT DISTANCE (5,000 M) MASS CONSERVATION CORRECTION FACTORS USED

24 HOUR AVERAGE FOR HOUR ENDING 24
CONCENTRATIONS IN MICROGRAMS/M**3
AVERAGE EMISSIONS FOR THIS PERIOD = 0.65280E+00 GRAMS/SEC
(456., 370., 449.538)

24 HOUR AVERAGE FOR HOUR ENDING 24
DEPOSITION RATE IN MICROGRAMS/M**2/SEC
(456., 370., 7.424)

METEOROLOGICAL DATA FOR DAY 1. (HOURS 1 TO 24)

WIND SPEED (M/SEC)	WIND DIRECTION (DEGREES)	STABILITY CLASS (TURNER)	MIXING HEIGHT (M)	AMBIENT TEMP. (DEG. K)
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0
2.00	337.	4	10000.	303.0

DATE AT END OF RUN: 25/03/95 TIME AT END OF RUN: 15:45:47.37
ELAPSED TIME FOR THIS RUN: 0.86800E+01 SECONDS
OR 0 HOURS 0 MINUTES 8.68 SECONDS

```
      FUGITIVE DUST MODEL (FDM)
      VERSION 93070
      MAR, 1993
DATE AT START OF RUN: 25/03/95  TIME AT START OF RUN: 15:45:24.30

RUN TITLE: TAI PO ROAD - SIR ROBERT BLACK COLLEGE

INPUT FILE NAME  : TPROOL.IN
OUTPUT FILE NAME : TPROOL.OUT

CONVERGENCE OPTION 1=OFF, 2=ON              1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED        1
PLOT FILE OUTPUT, 1=NO, 2=YES             1
MET DATA PRINT SWITCH, 1=NO, 2=YES            2
POST-PROCESSOR OUTPUT, 1=NO, 2=YES            1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER    1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES        1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES        1
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES        1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES       2
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES      2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES     0
READ HOURLY EMISSION RATES, 1=NO, 2=YES         0
NUMBER OF SOURCES PROCESSED                 1
NUMBER OF RECEPTORS PROCESSED                1
NUMBER OF PARTICLE SIZE CLASSES              1
NUMBER OF HOURS OF MET DATA PROCESSED          24
LENGTH IN MINUTES OF 1-HOUR OF MET DATA        60.
ROUGHNESS LENGTH IN CM                  5.00
SCALING FACTOR FOR SOURCE AND RECPTORS       1.0000
PARTICLE DENSITY IN G/CM**3                1.80
ANEMOMETER HEIGHT IN M                   10.00

GENERAL PARTICLE SIZE CLASS INFORMATION

                  GRAV.           FRACTION
 PARTICLE      CHAR.  SETTLING DEPOSITION  IN EACH
   SIZE       DIA.  VELOCITY   VELOCITY    SIZE
  CLASS       (UM)  (M/SEC)    (M/SEC)    CLASS
  -----  ----------  --------  ---------- --------
    1   15.0000000     **         **    1.0000

** COMPUTED BY FDM

RECEPTOR COORDINATES (X,Y,Z)

(  350.,   365.,  0.)

SOURCE INFORMATION

     ENTERED EMIS.    TOTAL
      RATE (G/SEC,  EMISSION   WIND
       G/SEC/M OR     RATE  SPEED    X1     Y1    X2     Y2  HEIGHT  WIDTH/ANGLE
TYPE   G/SEC/M**2)  (G/SEC)  FAC.   (M)    (M)   (M)    (M)    (M)    (M)
---- -------------- ---------- ------ ------- -------- ------- -------- ------- -------
  3   0.000160000   0.65280 0.000  400.   496.   68.    60.   3.00   0.00
              ===========
```

TOTAL EMISSIONS 0.65280E+00 GRAMS/SEC

SHORT DISTANCE (5,000 M) MASS CONSERVATION CORRECTION FACTORS USED

24 HOUR AVERAGE FOR HOUR ENDING 24
CONCENTRATIONS IN MICROGRAMS/M**3
AVERAGE EMISSIONS FOR THIS PERIOD = 0.65280E+00 GRAMS/SEC
(350., 365., 424.434)

24 HOUR AVERAGE FOR HOUR ENDING 24
DEPOSITION RATE IN MICROGRAMS/M**2/SEC
(350., 365., 7.009)

METEOROLOGICAL DATA FOR DAY 1. (HOURS 1 TO 24)

WIND SPEED (M/SEC)	WIND DIRECTION (DEGREES)	STABILITY CLASS (TURNER)	MIXING HEIGHT (M)	AMBIENT TEMP. (DEG. K)
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0
2.00	22.	4	10000.	303.0

DATE AT END OF RUN: 25/03/95 TIME AT END OF RUN: 15:45:33.53
ELAPSED TIME FOR THIS RUN: 0.92300E+01 SECONDS
OR 0 HOURS 0 MINUTES 9.23 SECONDS

```
          FUGITIVE DUST MODEL (FDM)
          VERSION 93070
          MAR, 1993
     DATE AT START OF RUN: 25/03/95   TIME AT START OF RUN: 15:44:48.43

     RUN TITLE: TUEN MUN - GRANDEUR GARDEN ESTATE

     INPUT FILE NAME  : TMUGG.IN
     OUTPUT FILE NAME : TMUGG.OUT

     CONVERGENCE OPTION 1=OFF, 2=ON                       1
     MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED               1
     PLOT FILE OUTPUT, 1=NO, 2=YES                    1
     MET DATA PRINT SWITCH, 1=NO, 2=YES                   2
     POST-PROCESSOR OUTPUT, 1=NO, 2=YES                   1
     DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER          1
     PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES               1
     PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES               1
     PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES               1
     PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES              2
     PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES              2
     BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES               0
     READ HOURLY EMISSION RATES, 1=NO, 2=YES              0
     NUMBER OF SOURCES PROCESSED                      1
     NUMBER OF RECEPTORS PROCESSED                      1
     NUMBER OF PARTICLE SIZE CLASSES                    1
     NUMBER OF HOURS OF MET DATA PROCESSED                24
     LENGTH IN MINUTES OF 1-HOUR OF MET DATA            60.
     ROUGHNESS LENGTH IN CM                      5.00
     SCALING FACTOR FOR SOURCE AND RECPTORS          1.0000
     PARTICLE DENSITY IN G/CM**3                 1.80
     ANEMOMETER HEIGHT IN M                     10.00

     GENERAL PARTICLE SIZE CLASS INFORMATION

                    GRAV.          FRACTION
      PARTICLE    CHAR. SETTLING DEPOSITION  IN EACH
        SIZE     DIA.  VELOCITY   VELOCITY    SIZE
       CLASS     (UM)  (M/SEC)    (M/SEC)    CLASS
       -----  ----------- -------- ---------- --------
         1   15.0000000     **         **    1.0000

     ** COMPUTED BY FDM

     RECEPTOR COORDINATES (X,Y,Z)

     (  210.,     87.,  0.)

     SOURCE INFORMATION

        ENTERED EMIS.    TOTAL
         RATE (G/SEC,  EMISSION   WIND
          G/SEC/M OR     RATE  SPEED    X1      Y1     X2      Y2  HEIGHT  WIDTH/ANGLE
     TYPE   G/SEC/M**2)  (G/SEC)  FAC.   (M)     (M)    (M)     (M)    (M)    (M)
     ---- -------------- ---------- ------ ------- -------- ------- -------- ------- -------
       3    0.000160000   0.44800 0.000   280.    166.   100.     28.   3.00   0.00
                    ==========
```

TOTAL EMISSIONS 0.44800E+00 GRAMS/SEC

SHORT DISTANCE (5,000 M) MASS CONSERVATION CORRECTION FACTORS USED

24 HOUR AVERAGE FOR HOUR ENDING 24
CONCENTRATIONS IN MICROGRAMS/M**3
AVERAGE EMISSIONS FOR THIS PERIOD = 0.44800E+00 GRAMS/SEC
(210., 87., 335.758)

24 HOUR AVERAGE FOR HOUR ENDING 24
DEPOSITION RATE IN MICROGRAMS/M**2/SEC
(210., 87., 5.545)

METEOROLOGICAL DATA FOR DAY 1. (HOURS 1 TO 24)

WIND SPEED (M/SEC)	WIND DIRECTION (DEGREES)	STABILITY CLASS (TURNER)	MIXING HEIGHT (M)	AMBIENT TEMP. (DEG. K)
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0
2.00	41.	4	10000.	303.0

DATE AT END OF RUN: 25/03/95 TIME AT END OF RUN: 15:45:03.32
ELAPSED TIME FOR THIS RUN: 0.14890E+02 SECONDS
OR 0 HOURS 0 MINUTES 14.89 SECONDS

```
       FUGITIVE DUST MODEL (FDM)
       VERSION 93070
       MAR, 1993
DATE AT START OF RUN: 25/03/95   TIME AT START OF RUN: 15:45:08.10

RUN TITLE: SILVERMINE BAY - ROUND TABLE VILLAGE

INPUT FILE NAME  : SBVILL.IN
OUTPUT FILE NAME : SBVILL.OUT

CONVERGENCE OPTION 1=OFF, 2=ON                    1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED        1
PLOT FILE OUTPUT, 1=NO, 2=YES                     1
MET DATA PRINT SWITCH, 1=NO, 2=YES                2
POST-PROCESSOR OUTPUT, 1=NO, 2=YES                1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER     1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES         2
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES       2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES      0
READ HOURLY EMISSION RATES, 1=NO, 2=YES           0
NUMBER OF SOURCES PROCESSED                       1
NUMBER OF RECEPTORS PROCESSED                     1
NUMBER OF PARTICLE SIZE CLASSES                   1
NUMBER OF HOURS OF MET DATA PROCESSED            24
LENGTH IN MINUTES OF 1-HOUR OF MET DATA          60.
ROUGHNESS LENGTH IN CM                          5.00
SCALING FACTOR FOR SOURCE AND RECPTORS        1.0000
PARTICLE DENSITY IN G/CM**3                     1.80
ANEMOMETER HEIGHT IN M                         10.00

GENERAL PARTICLE SIZE CLASS INFORMATION

                     GRAV.        FRACTION
 PARTICLE    CHAR.  SETTLING  DEPOSITION  IN EACH
   SIZE      DIA.  VELOCITY   VELOCITY    SIZE
  CLASS      (UM)  (M/SEC)    (M/SEC)     CLASS
  -----  ----------- -------- ---------- --------
    1   15.0000000      **        **    1.0000

** COMPUTED BY FDM

RECEPTOR COORDINATES (X,Y,Z)

( 500.,   230.,  0.)

SOURCE INFORMATION

     ENTERED EMIS.    TOTAL
      RATE (G/SEC,  EMISSION   WIND
       G/SEC/M OR     RATE   SPEED    X1     Y1     X2     Y2  HEIGHT  WIDTH/ANGLE
TYPE   G/SEC/M**2)  (G/SEC)   FAC.   (M)    (M)    (M)    (M)    (M)    (M)
---- -------------- --------- ----- ------- ------- ------ ------- ------ ------
  3    0.000160000   0.64000 0.000   322.   176.   100.    40.   3.00  -46.00
              ==========
```

TOTAL EMISSIONS 0.64000E+00 GRAMS/SEC

SHORT DISTANCE (5,000 M) MASS CONSERVATION CORRECTION FACTORS USED

24 HOUR AVERAGE FOR HOUR ENDING 24
CONCENTRATIONS IN MICROGRAMS/M**3
AVERAGE EMISSIONS FOR THIS PERIOD = 0.64000E+00 GRAMS/SEC
(500., 230., 247.702)

24 HOUR AVERAGE FOR HOUR ENDING 24
DEPOSITION RATE IN MICROGRAMS/M**2/SEC
(500., 230., 4.091)

METEOROLOGICAL DATA FOR DAY 1. (HOURS 1 TO 24)

WIND SPEED (M/SEC)	WIND DIRECTION (DEGREES)	STABILITY CLASS (TURNER)	MIXING HEIGHT (M)	AMBIENT TEMP. (DEG. K)
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0
2.00	253.	4	10000.	303.0

DATE AT END OF RUN: 25/03/95 TIME AT END OF RUN: 15:45:17.71
ELAPSED TIME FOR THIS RUN: 0.96100E+01 SECONDS
OR 0 HOURS 0 MINUTES 9.61 SECONDS

Table D.1 FDM Model Input Parameters

SITE	X of NSR	Y of NSR	X of Area Source Centre	Y of Area Source Centre	X Length of Source	Y Length of Source	Wind Direction	Site Rotation Angle	Input File Name
Adventist Hospital (EASTERN)	54	104	156	190	37	26	49	7	EASTHOS.IN
Royal Hong Kong Jockey Club (EASTERN)	238	237	156	190	37	26	240	7	EASTJC.IN
Eastern WTW Staff Residences	128	190	156	190	37	26	97	7	EASTSTF.IN
Ho Chen Yiu Memorial College (TSUEN WAN)	81	289	227	79	35	18	146	-32	TWANCOL.IN
Auxilliary Nurse Training Quarters (TSUEN WAN)	420	166	227	79	35	18	245	-32	TWANNQ.IN
Grandeur Garden Estate (TUEN MUN)	210	87	280	166	100	28	41	0	TMUGG.IN
Round Table Village (SILVERMINE BAY)	500	230	322	176	100	40	253	-46	SBVILL.IN
Sir Robert Black College of Education (TAI PO ROAD)	350	365	400	496	68	60	22	0	TPROOL.IN
2 Caldecott Road (TAI PO ROAD)	456	370	400	496	68	60	337	0	TPR2.IN
Hong Kong International School (RED HILL)	67	387	293	248	55	22	122	-10	RHSCH.IN
Housing Development (RED HILL)	427	270	293	248	55	22	258	-10	RHRES.IN

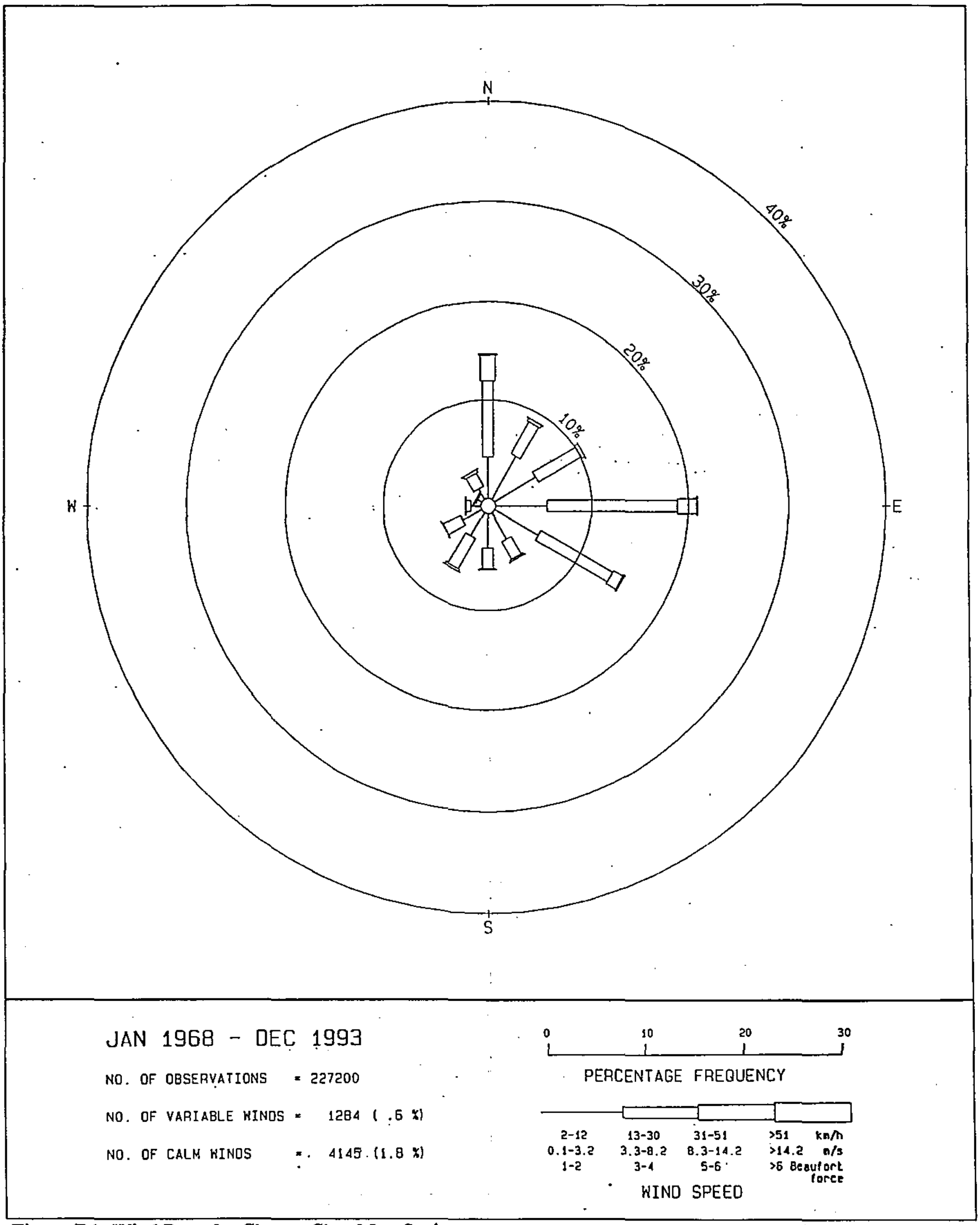


Figure D1 Wind Rose for Cheung Chau Met. Station

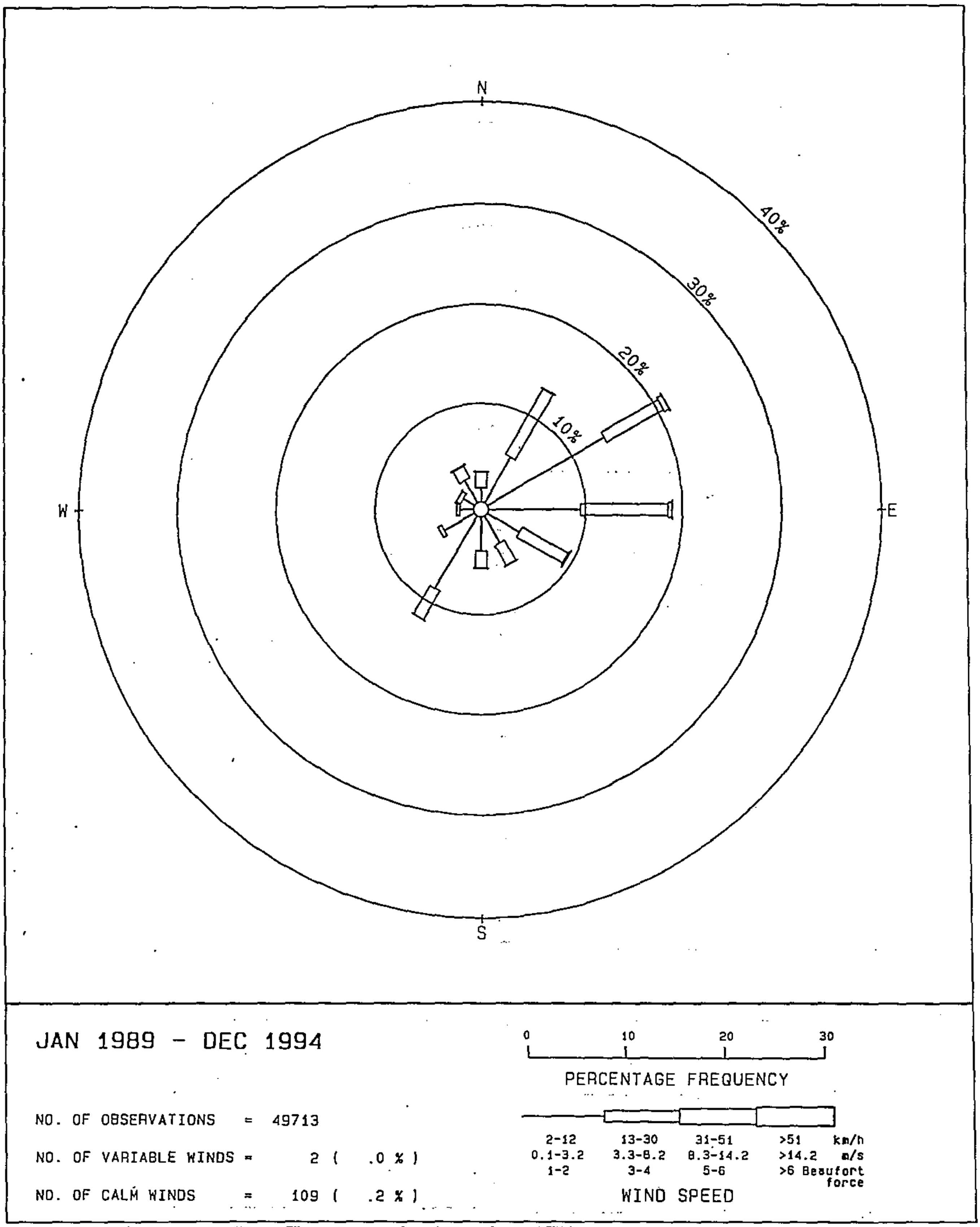


Figure D2 Wind Rose for Hong Kong International Terminals AWS

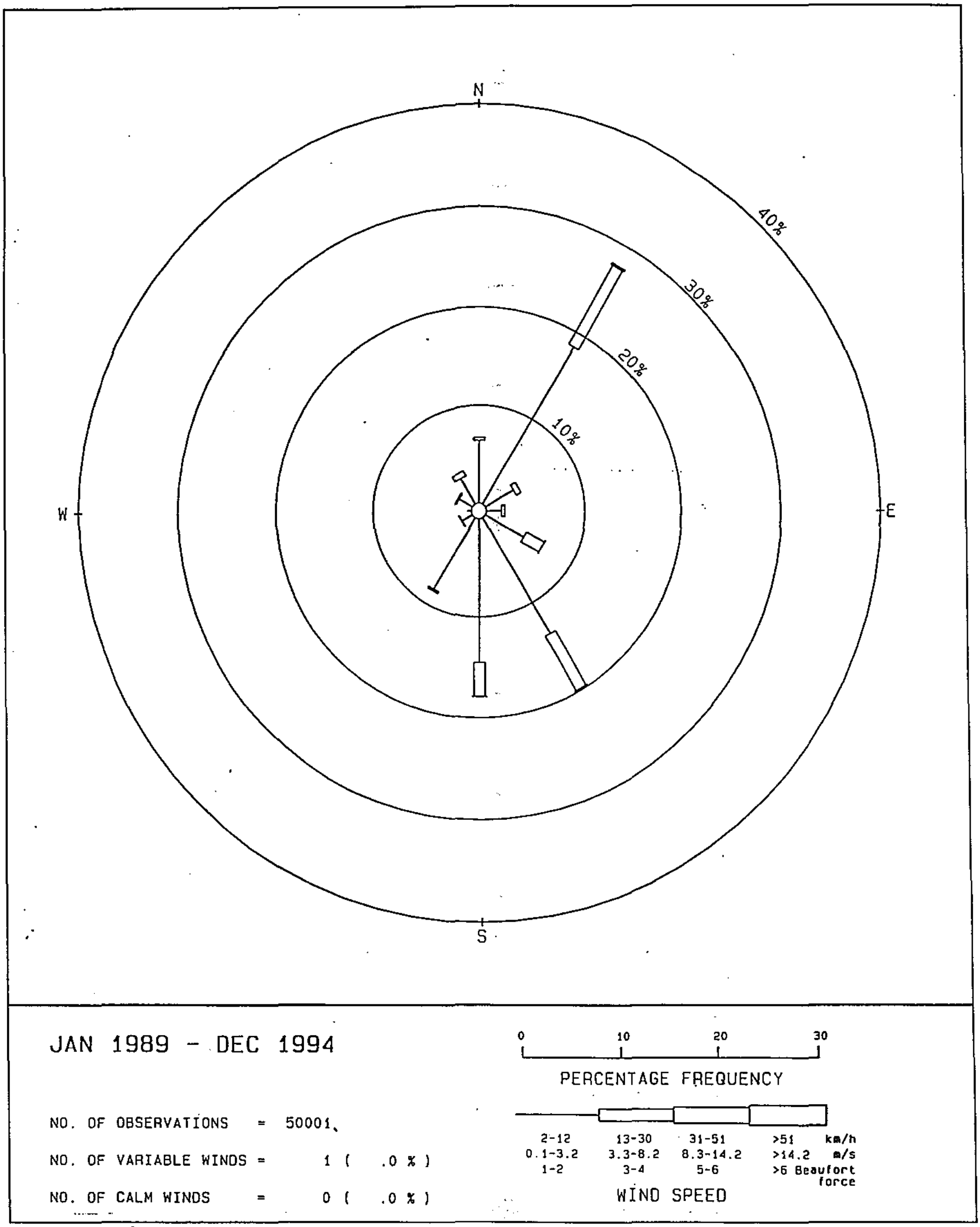


Figure D3 Wind Rose for Tuen Mun

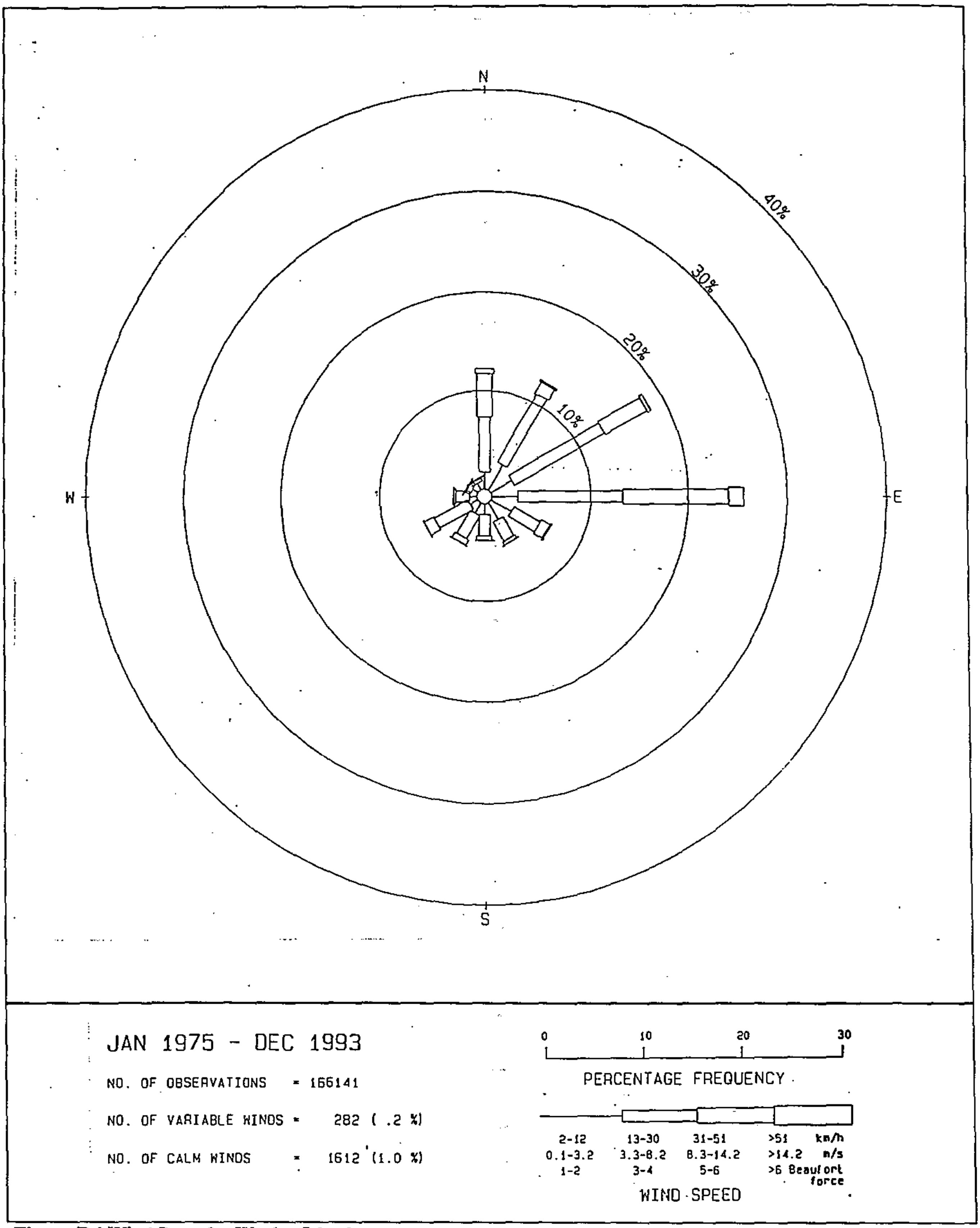


Figure D4 Wind Rose for Waglan Island

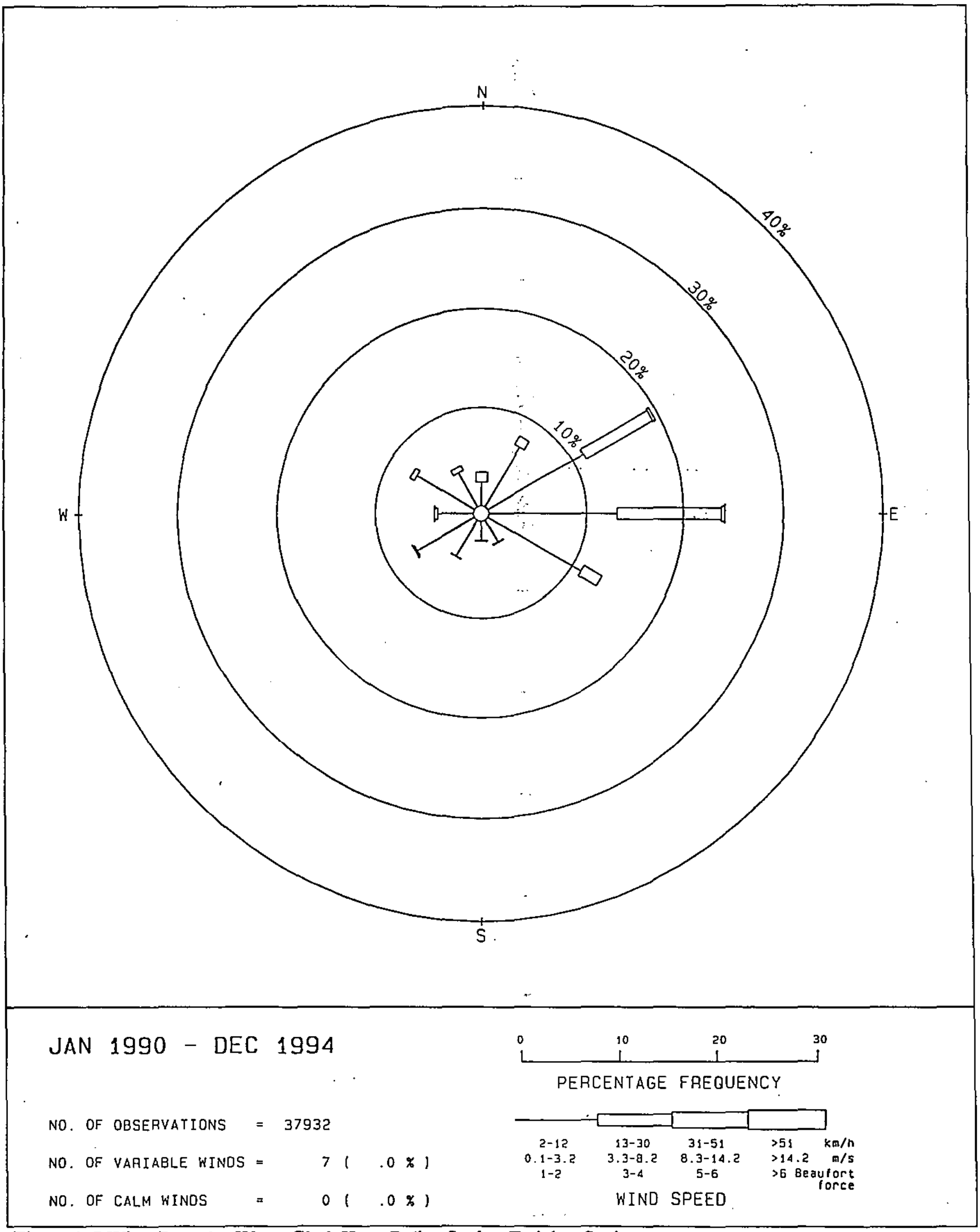
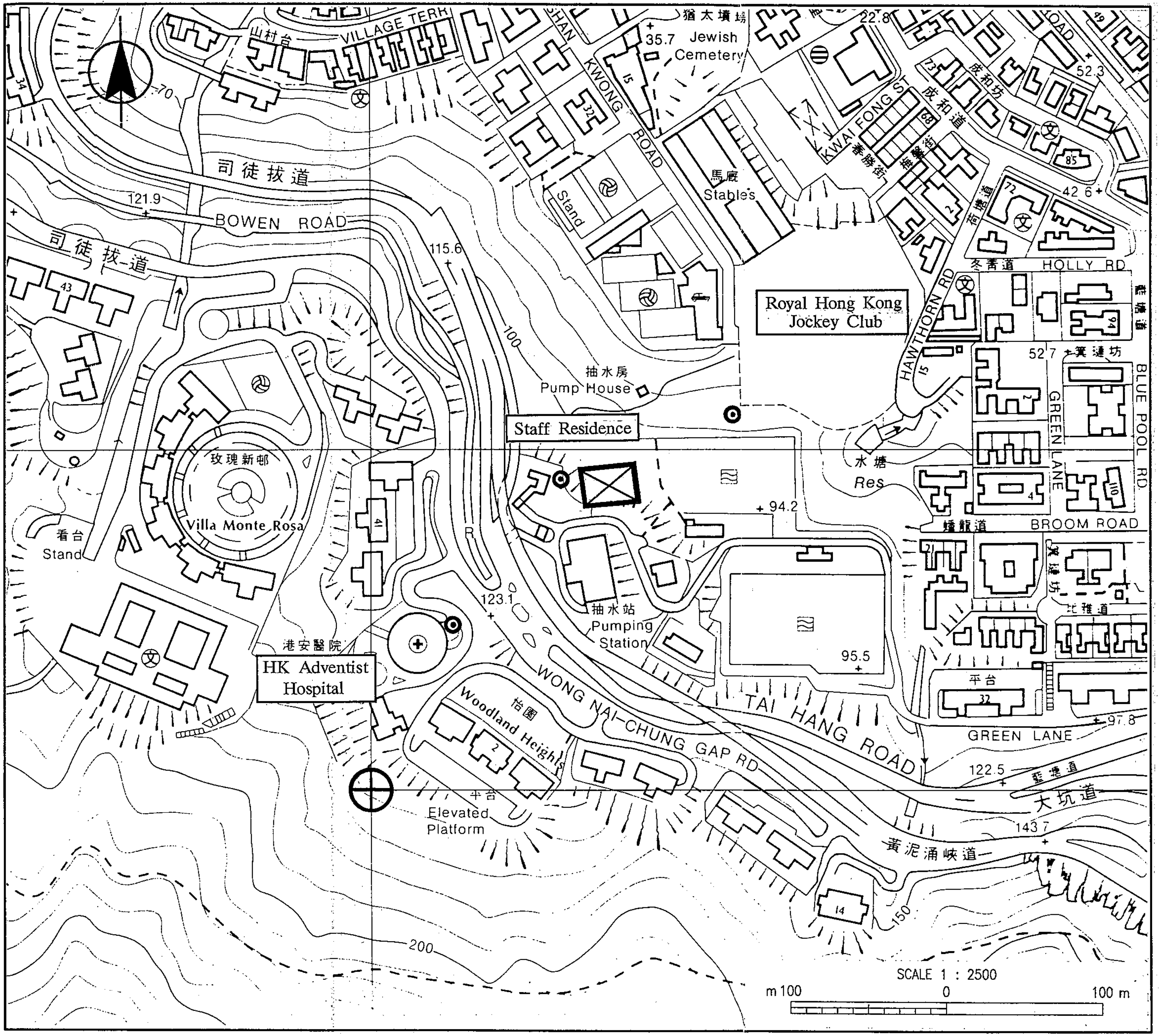


Figure D5 Wind Rose for Wong Chuk Hang Police Station Training Station

Figure D6
Eastern Area
Source Treatment
for FDM

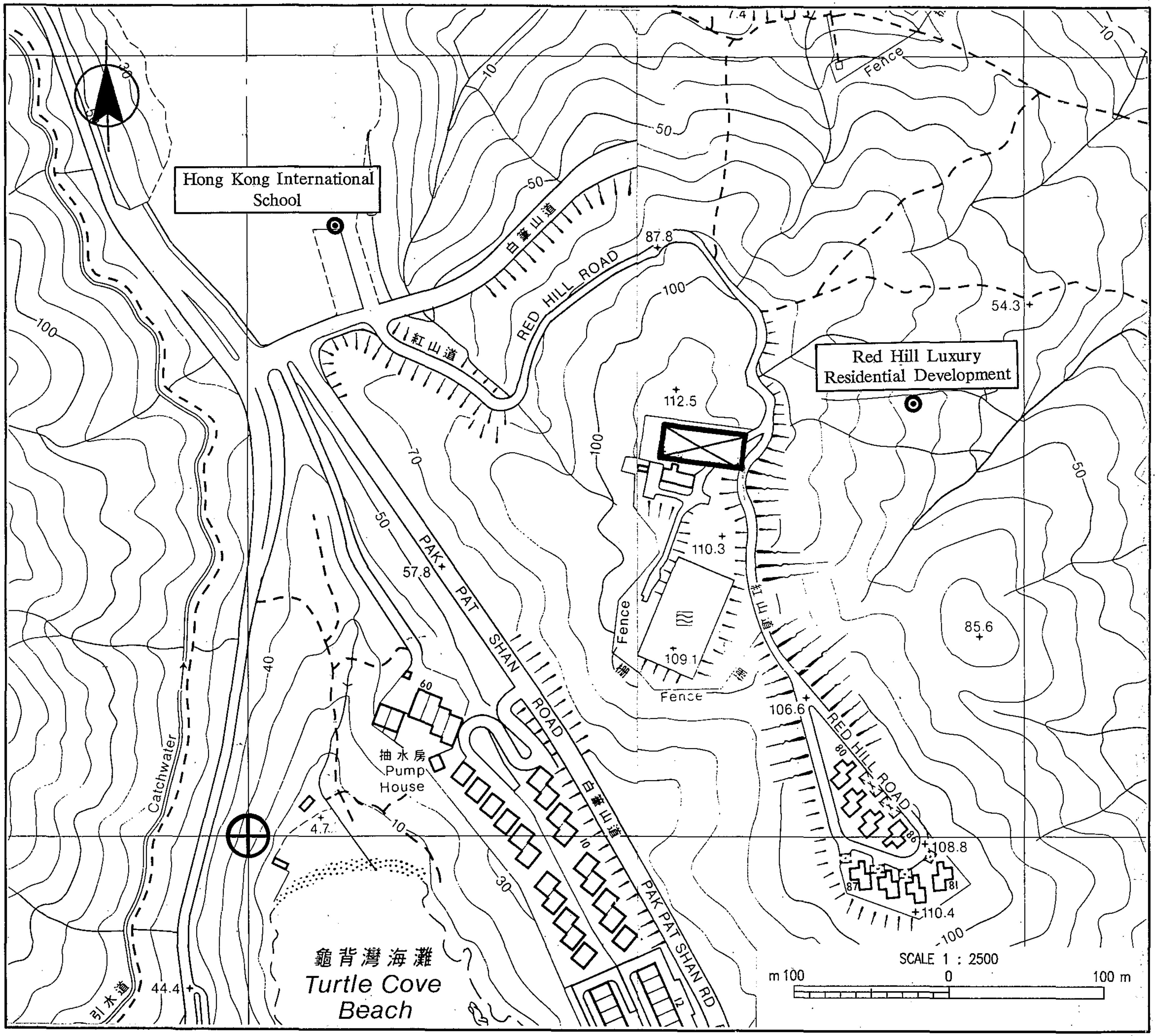


Legend

- NSR Measurement Point
- Modelling Origin
- Proposed Development Site

MONTGOMERY WATSON
環協顧問工程師

Figure D7
Red Hill Area Source Treatment for FDM

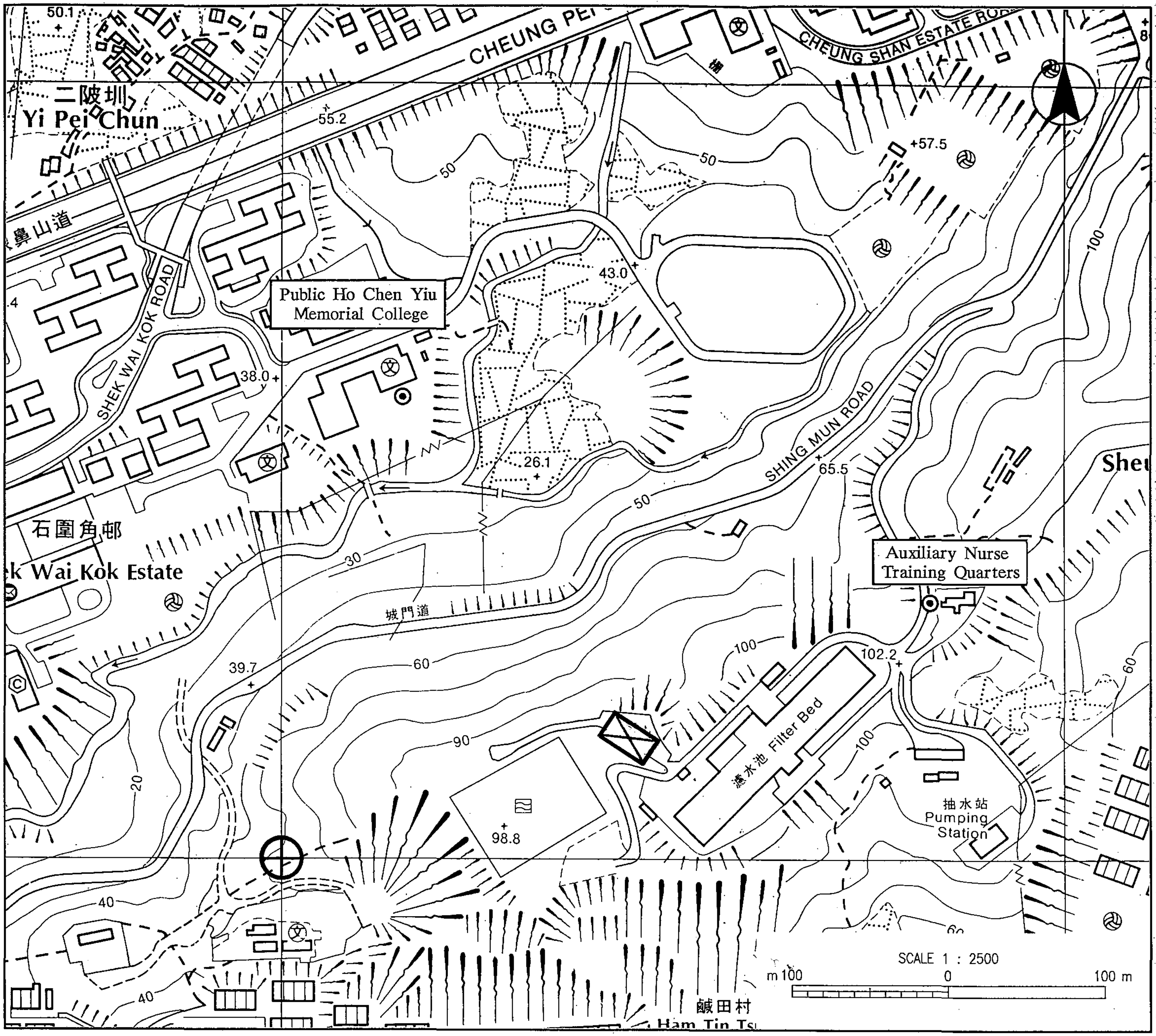


Legend

- NSR Measurement Point
- Modelling Origin
- Proposed Development Site

MONTGOMERY WATSON
環協顧問工程師
環協

Figure D8
Tsuen Wan Area Source Treatment for FDM

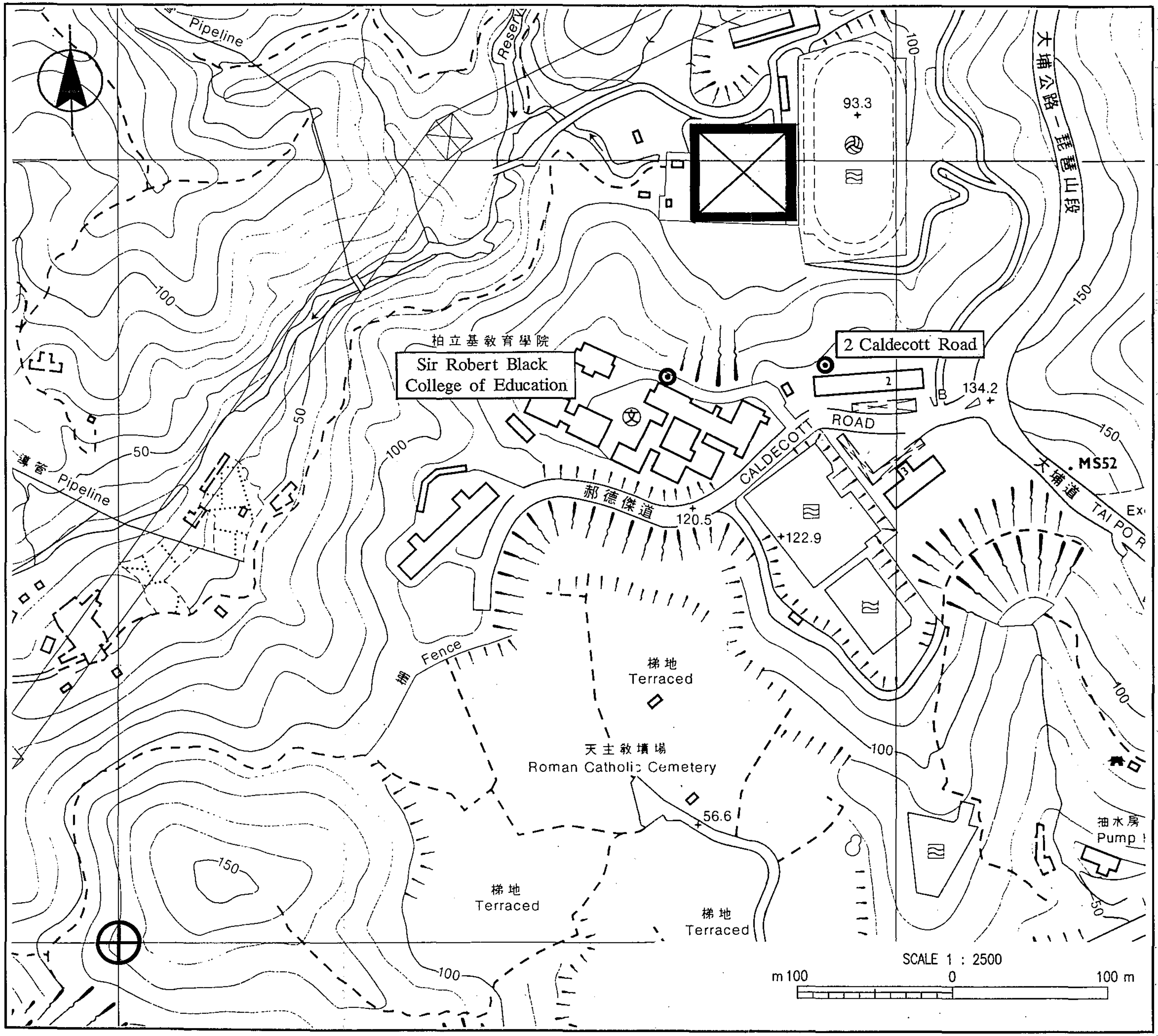


Legend

⊙	NSR Measurement Point
⊕	Modelling Origin
⊠	Proposed Development Site

MONTGOMERY WATSON
環協顧問工程師

Figure D9
Tai Po Road Area Source Treatment for FDM

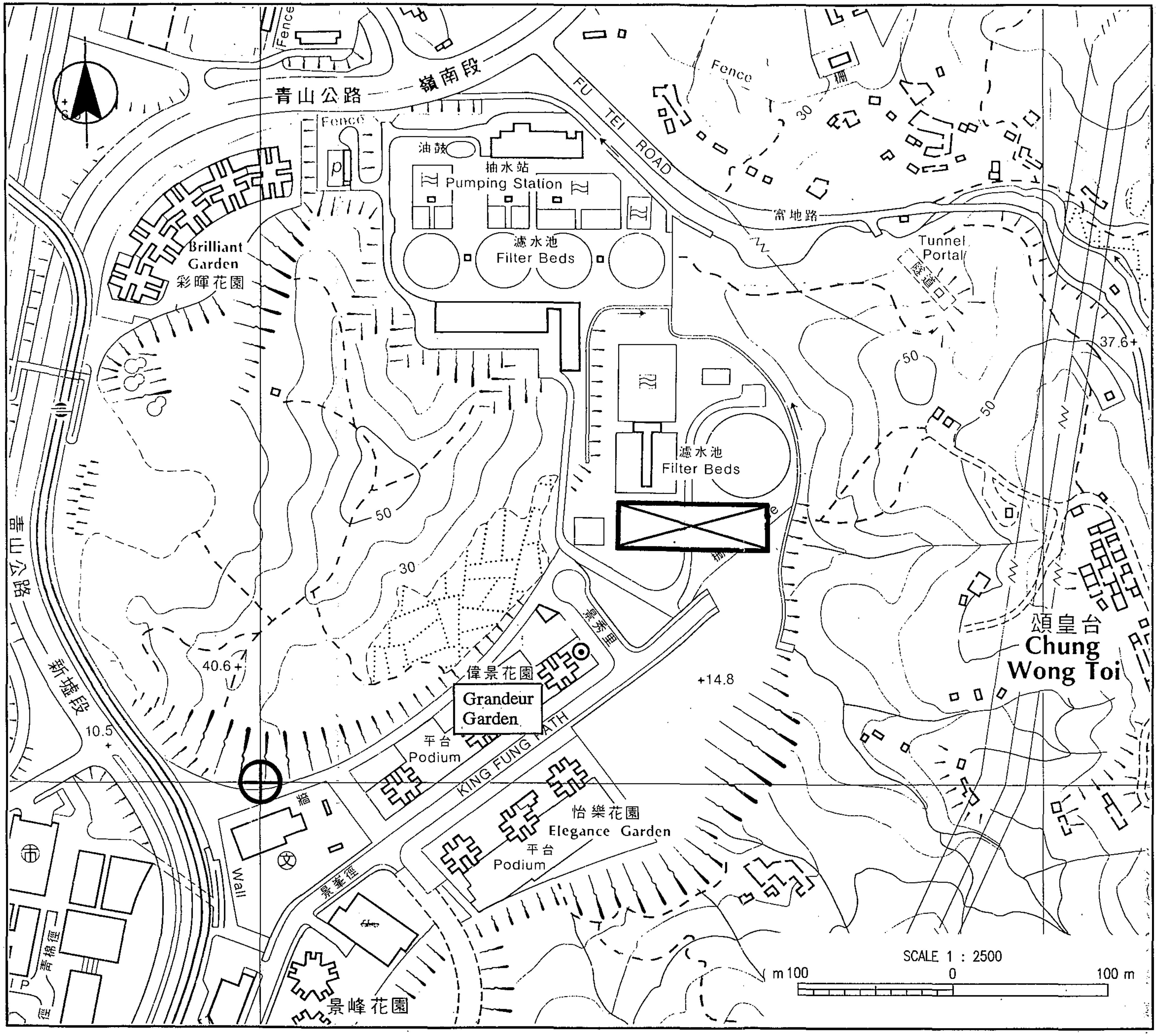


Legend

- NSR Measurement Point
- Modelling Origin
- Proposed Development Site

MONTGOMERY WATSON
環協顧問工程師
環協

Figure D10
Tuen Mun Area
Source Treatment
for FDM



Legend

NSR Measurement Point

Modelling Origin

Proposed Development Site

MONTGOMERY WATSON
環協顧問工程師
環協

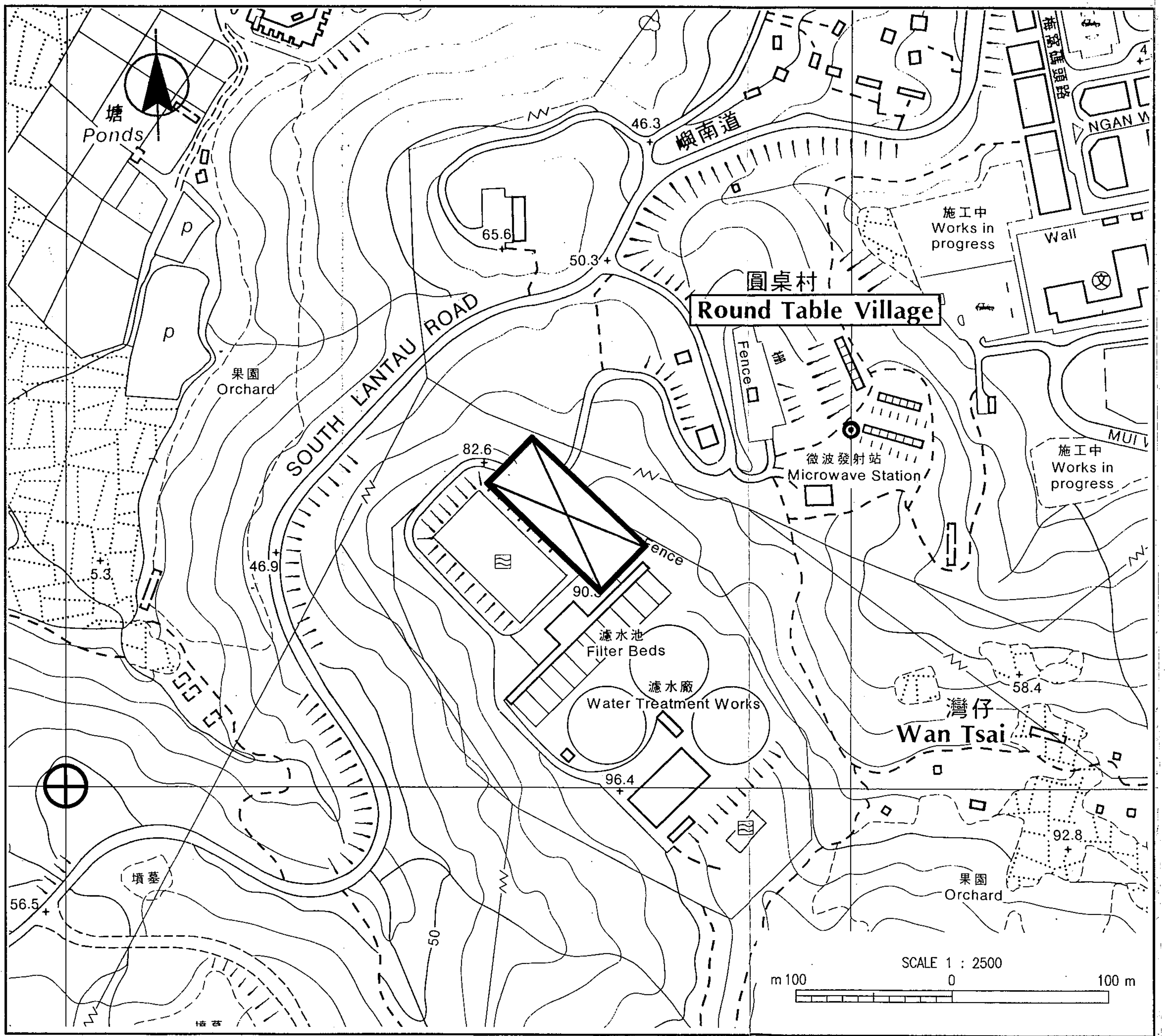


Figure D11
Silvermine Bay Area Source Treatment for FDM

Legend

NSR Measurement Point

Modelling Origin

Proposed Development Site

MONTGOMERY WATSON
環協顧問工程師

APPENDIX E
CONTRACTORAL CLAUSES

Recommended Air Pollution Control Clauses for Construction Work

Clause 1.

The Contractor shall comply with and observe all ordinances, bye-laws, regulations and rules for the time being in force in Hong Kong governing the control of any form of pollution, whether aerial or otherwise, and the protection of the environment.

Clause 2.

The Contractor shall provide a high volume TSP sampler as referred to in the USEPA Standard Method 40, CFR Part 50 Appendix B. The Contractor shall maintain the equipment in proper working order and provide a substitute when the equipment is out or otherwise not available.

Clause 3.

The Contractor shall ensure that fugitive emissions shall be reduced to the lowest possible levels at Silvermine Bay, Tsuen Mun and Eastern by applying the appropriate mitigation measures with respect to the development stage. The Contractor shall:

(i) Apply water over the sites by means of sprinklers or hoses prior to any land clearing activities, and keep re-applying water as necessary over the period during which bare soil is exposed;

(ii) Minimise the height from which spoil is dropped into haul vehicles;

(iii) Ensure that all haul vehicles are covered i.e. tarpaulined;

(iv) Sweep clean or water flush access roads;

(v) With regard to the Tseun Mun development site the Contractor shall be responsible for imposing a 15mph maximum speed limit on all site vehicles.

Clause 4.

The Contractor should take all such necessary measures as may be 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 any unnecessary and/or excessive airborne emissions.

Clause 5.

Before the commencement of any work, the Engineer may require the methods of working, equipment and emission-reducing measures intended to be used on the site to be made available for inspection and approval to ensure that they are suitable for the project. In particular, the tenderer shall submit information on the types and models of emissions -reducing equipment and treatments he intends to use as described in the Tender document. Failure to provide such information may lead to disqualification of his tender submission.

Clause 6.

The Contractor shall devise, arrange methods of working and carry out the Works in such a manner so as to minimise airborne emission impacts on the surrounding environment, and shall provide experienced personnel with suitable training to ensure that these methods are implemented.

Clause 7.

The Contractor shall ensure that all plants and equipment to be used on site are properly maintained in good operating condition. The cost of maintaining all plant shall be deemed to be included in the relevant contract rates.

Clause 8.

Subject to compliance with clauses 6 and 7 above, the Engineer may upon application in writing by the Contractor, allow the use of any equipment and the carrying out of any construction activities for any durations provided that he is satisfied with the application which, in his opinion, to be of absolute necessity and adequate emission control has been provided

Clause 9.

The contractor shall stop the construction process or operation of equipment in the event of non-compliance of the clauses in this contract. Any stoppage of work which may be ordered by the site Engineer on account of failure to comply with these clauses will not entitle the Contractor to any extension of time for completion or any compensation whatsoever.

Recommended Noise Pollution Control Clauses for Construction Work

Clause 1.

The Contractor shall comply with and observe all ordinances, bye-laws, regulations and rules for the time being in force in Hong Kong governing the control of any form of pollution, whether aerial or otherwise, and the protection of the environment. In particular, the Contractor will comply with and observe the Noise Control Ordinance and its subsidiary regulations.

Clause 2.

The Contractor shall provide an approved integrating sound level meter to IEC 651 : 1979 (Type 1) and 804 : 1985 (Type 1) and the manufacturer's recommended sound level calibrator for the exclusive use of the Engineer at all times. The Contractor shall maintain the equipment in proper working order and provide a substitute when the equipment is out of order or otherwise not available.

Clause 3.

The sound level meter including the sound level calibrator shall be verified by the manufacturers every two years to ensure they perform to the same levels of accuracies as stated in the manufacturer's specifications. That is to say at the time of measurements, the equipment shall have been verified within the last two years and be in full working order.

Clause 4.

The Contractor should take all such necessary measures as may be 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 any unnecessary and excessive noise which disturbs or annoys any nearby noise sensitive receptors.

Clause 5.

Before the commencement of any work, the Engineer may require the methods of working, equipment and sound-reducing measures intended to be used on the site to be made available for inspection and approval to ensure that they are suitable for the project. In particular, the tenderer shall submit information on the types and models of silenced equipment and acoustic treatments for unscilenced equipment he intends to use as described in the Tender document. Failure to provide such information may lead to disqualification of his tender submission.

Clause 6.

The Contractor shall devise, arrange methods of working and carry out the Works in such a manner so as to minimise noise impacts on the surrounding environment, and shall provide experienced personnel with suitable training to ensure that these methods are implemented.

Clause 7.

The Contractor shall ensure that all plants and equipment to be used on site are properly maintained in good operating condition and noisy construction activities shall be effectively sound-reduced by means of silencer, mufflers, acoustic linings or shields, acoustic sheds or screens or other means to avoid disturbance to any nearby noise sensitive receivers. The cost of maintaining all plant shall be deemed to be included in the relevant contract rates.

Clause 8.

Subject to compliance with clauses 6 and 7 above, the Engineer may upon application in writing by the Contractor, allow the use of any equipment and the carrying out of any construction activities for any durations provided that he is satisfied with the application which, in his opinion, to be of absolute necessity and adequate noise insulation has been provided to the educational institutions to be affected, or of emergency nature, and not in contravention with the Noise Control Ordinance in any respect.

Clause 9.

(i) Un-silenced excavator mounted breakers must not be operated at the following sites: Eastern; Red Hill; Tai Po Road and Tuen Mun.

(ii) Only one silenced excavator mounted breaker shall be operated at any one time.

(iii) At Tuen Mun WTW: during periods of operation of a silenced excavator mounted breaker, no other construction operations generating sound levels in excess of 107 dB(A) shall be carried out within the site boundary.

Clause 10.

At Eastern, the following equipment should not be used during the time period from 1900 to 2300, dump truck, hand-held pneumatic breaker, tracked excavator/loader and air compressor. These should be replaced by a partially enclosed dump truck and tracked excavator/loader, hand-held hydraulic breaker and silenced air compressor.

At Red Hill WTW the breaker should be replaced with a silenced version between the time period 0700 and 1900. In addition, noise reduction at source can be achieved in a number of ways,

- by partially enclosing the dump truck,
- using a hand held hydraulic breaker instead of a pneumatic beaker, or
- by partially enclosing the excavator/loader and using a silenced air compressor.

At Tuen Mun, the following equipment should not be used during the time period from 0700 to 1900, dump truck, hand-held pneumatic breaker, tracked excavator/loader, air compressor; and generator. These should be replaced by a partially enclosed dump truck, partially enclosed tracked excavator/loader, hand-held hydraulic breaker; silenced air compressor and a silenced generator.

Clause 11.

For the purposes of the above clauses, any domestic premises, hotels, hostel, temporary housing accommodation, hospital, medical clinic, educational institution, place of public worship, library, court of law, performing arts centre or office building shall be considered a noise sensitive receiver.

Clause 12.

The Contractor shall, when necessary, apply as soon as possible for a construction noise permit in accordance with the Noise Control (General) Regulations, display the permit as required and copy to the Engineer. The Contractor is to note that neither the Authority nor its employees can influence the issue or terms of a construction noise permit.

Clause 13.

The contractor shall stop the construction process or operation of equipment in the event of non-compliance of the clauses in this contract. Any stoppage of work which may be ordered by the site Engineer on account of failure to comply with these clauses will not entitle the Contractor to any extension of time for completion or any compensation whatsoever.

APPENDIX F

AIR QUALITY MONITORING CHECKLIST AND COMPLAINTS PROFORMA

Air Quality Monitoring Checklist for Site Audit

This checklist is for use in auditing fugitive dust control and mitigation measures on construction sites. Auditor complete all sections of the form, sign and have the RE or senior staff member on site counter-sign before leaving the site.

A. Weather Conditions (at time of audit)

1. Approximate Windspeed = [ms^{-1}]

2. Approximate cloud cover = [%]

3. **Rainfall**

	Recent	Current	Forecast (for today)
Light			
Heavy			
Very Heavy			

B. Fugitive Dust Sources

1. Approximate area of soil exposed = [m^3]

(Record in m^3 the area of ground present on the site the soil or subsoil surface of which is exposed, i.e. not covered by vegetation, concrete, buildings thereby allowing the potential for easy erosion. Hard rock faces should not be included in this assessment.)

2. Approximate area of stockpiles of loose materials = [m^3]

(Record in m^3 the area of stockpiles of loose materials with a grain size smaller than coarse sand. Include stockpiles of excavated soil and subsoil in this assessment.)

3. Are the stockpiles adequately covered and/or damped to prevent adding significantly to airborne particulates? [YES NO]

4. What PME operations are taking place on site at this time?

(Record PME operations currently taking place and those planned or that have taken place during the day.)

C. Fugitive Dust Suppression/ Monitoring Measures

1. Are records of air quality monitoring available and in good order? [YES NO]

2. Is air quality monitoring equipment available and in good order? [YES NO]

3. Are records of site damping operations available and in good order? [YES NO]

4. Are the facilities to damp the entire exposed soil area easily available and in good working order?

[YES NO]

e.g.Taps or standpipes present, connected to water supply of sufficient pressure, hoses long enough, spray heads fitted. Other damping equipment as necessary present and in working order.)

5. Are any other fugitive dust mitigation measures being operated?

(record any other dust suppression measures e.g. site speed limits, physical baffles in loading areas, wheel washes)

D. General

1. Is the road into the site clean of significant deposits of construction generated particulate matter? YES NO

2. Are haul vehicles loads adequately coverd by tarpaulines? YES NO

3. Are excavator drivers aware of requirements for minimising drop heights? YES NO

4. Indicate the general quality of Site Housekeeping: Satisfactory ☐ Unsatisfactory ☐

E. Remedial Action

1. Is remedial action necessary to enforce dust suppression measures or ensure they are employed in a more rigorous manner? YES NO

2. What remedial actions (if any)were taken at the time of this audit.

F. Any Other Comments

The above is an accurate record of conditions found on site:

Auditor
Signed : ____________________ Date: / / ____________________

Site Representative (RE/Site Supervisor)

Signed: ____________________ Name (Print) ____________________

Name: ....
(complainer)

Address: ....
(complainer)

....

....

Date: ....

Nature of Complaint: ....
....
....
....
....
....

Complaint received by: ....

Investigators Comments: ....
....
....
....
....
....

Conclusion/Recommendations for Action: ....
....
....
....
....
....

Implementation of Action: ....
....
....
....
....
....

Signed: .... Date: ....
(Supervising Officer/Engineer)

Figure F1: Complaints Proforma

APPENDIX G
COMMENTS AND RESPONSES

From: WSD
Ref: (52) in WWO 4722/R/0.3
Date: 3 July 1995

	Comments	Responses
	DSD No comments	
	CHE/HK, HyD No comments	
	CHE/NT, HyD In general, the CHE of appropriate Regions and CHE/Str should be consulted for any pipework laid at highways and associated structures, when more details are available. Regarding the proposed developments described in the report, I have the following observations from a highway point of view:	
	Eastern and Red Hill	
(a)	As these proposals fall in HK Region, CHE/HK would give his comments.	
	Tsuen Wan	
(b)	As the proposed development limits to works within the existing WTW boundary and there would be minor pipework at Kwok Shui Road only, I have no comment.	
	Shek Lei Pui	
(c)	The proposed development limits to a 300 mm pipeline running from the works, to the Tai Po Road WTW. As the pipeline has not been clearly annotated in Figure 8.1, I presume that it is the one shown lying along Cheung Yuen Road, which is being maintained by this office.	The pipe connections at Shek Lei Pui are shown in Figure 8.2. The route is described in detail in Section 8.2.2., and part of it shown in Plate 8.2. It is thought that a further figure would add little to the report.
	Tai Po Road	
(d)	The proposed development limits to works within the existing WTW boundary and a 300 mm pipeline connecting to Wing Ming Street. As the pipeline has not been clearly annotate in Figure 9.1, I presume that it is the one shown in Figure 8.1 running across Caldecott Road, Ching Cheung Road and Wing Ming Street. The busy traffic on Ching Cheung Road would be a major constraint to the laying of the pipeline and para 9.2.3 may thus need to address related problems. In connection with the pipework at the said roads, which fall in Kowloon Region, CHE/K should be consulted.	The pipe route will be added to Figure 9.1. The report will address the issues following the resolution that the pipeline will not now be entrusted to others. Trenchless pipelaying techniques will be used. CHE/K will be consulted in connection with work on Wing Ming Street
	Tuen Mun and Silvermine Bay	
(d)	As the proposed development lies within the existing WTW boundary only, I have no comment.	

Comment	Response
Tai O	
(e) The proposed works include a pipeline linking the WTW and a sludge holding tank. As the pipeline has not been shown in Figure 12.1, I cannot offer any comment.	The pipeline is shown in Figure 12.2 and Figure 12.3, and described in Section 12.2.2.
I understand from Mr K H To of DEP that a copy of the draft Final Report has also been sent to CHE/HK. However, please include in the distribution list for future circulations CHE(D&M)/NT and CHE/HK in place of D of Hy.	Noted.
AFD My specific comments are as follows:	
(i) Tree Felling:	
(a) Eastern WTW: The proposed works will cut into an area of 600 m, the ecological impacts resulted from the removal of trees should not be considered as insignificant. A detailed tree survey of the affected area and suitable mitigation measures are required.	The area is 600m², i.e. approximately 20 metres by 30 metres. The loss of approximately 20 trees is described as "of medium significance" in Section 5.3.2. The ecological impact of the loss is further described in the same Section as "minor". A detailed tree survey will be performed of the area with a view to avoiding removing trees of high value, if there are any present environmental scientists visiting the site (though not arboriculturalists) did not identify any trees of particular significance. Section 5.3.2 also indicates that there is no scope for replacement trees at Eastern WTW.
(b) In general: Tree felling proposal together with compensatory planting scheme should be incorporated wherever appropriate.	Agreed.
(ii) Visual Impact: Planting of trees is favoured to offset the visual impact. Please seek ASD's comment on this aspect.	It is not thought that this will be necessary as existing trees should still shield the site from view, as stated in Section 5.3.1. Re-enforcement of screening vegetation is also noted as being likely in section 5.4.1.
TD I note from the DFR that of the eight sites under study only five sites will generate sludge truck traffic and the highest generation is that for the Island Eastern Water Treatment Works with only four trips per day. As such, I consider that the permanent traffic impact due to the works is not significant. However, you should consult and obtain agreement on mitigation measures from our relevant Regional Office if there is any anticipated disruption to the traffic flow during the design and construction stages.	Noted.

	<u>HAD</u> The EIA report had been brought to the attention of respective DOs. They had no adverse comments except the following:	
	<u>District Office DO (Islands)</u>	
Section12	DO(Is) has reservations as to whether the proposed development at Tai O is worth pursuing given the seemingly thin grounds for the project. (Paras 12.4.2 and 12.4.6 refer)	We concur with this view.
	<u>District Office DO (Southern)</u>	
Section 6	Members of the Water Projects Committee of SDB requested the possible impacts of the projects caused to the environment, in particular, in terms of noise and air, during construction be closely monitored.	Noted.
	<u>CE/MNW, WSD</u> I would suggest that the diagram for water treatment process should be amended to our comments which are marked up in the attached sheet to reflect the actual situation.	
	<u>CEME/P, WSD</u>	
1.	Typographic Errors:	
(a)	The number of supernatant pumps and sludge draw-off pumps as given in Table 5.1 on P 26 should be 2 instead of 21.	Agreed.
(b)	The title of Table 6.2 on P 43 was for "Eastern WTW" which should be for "Red Hill WTW".	Agreed.
(c)	"Shung Kwai Chung" on the first line of the second paragraph of Section 7.1.1 on P 52 should read "Sheung Kwai Chung".	Agreed.
(d)	The title of Table 10.2 on P 96 was for "Eastern WTW" which should be for "Tuen Mun WTW".	Agreed.
(e)	The extra words "should be" on line 2 of the first paragraph of Section 13.3 on P 132 should be deleted.	Agreed.
(f)	The description "Wastewater from Tai Po Road WTW" on the left hand side of Figure 9.3 should read "Wastewater from Shek Lei Pui WTW".	Agreed.
2.	Section 6 - Red Hill WTW As pointed out in the last paragraph of Section 6.1.2 on P 38, the treatment works has two distinct sludge sources, viz from washwater recovery tanks and flocculation tanks. However, the proposed sludge treatment facilities as shown in Figures 6.2 and 6.3 have only catered for the sludge from washwater recovery tanks and not for those from flocculation tanks. The Consultant has to include both sludge sources in their proposal.	The volume of sludge from the flocculation tanks has been advised as being 1.2 m^3 every 5 days and as previously responded to in comments to the PSR the quantity of solids has been accounted for. The necessary hydraulic connections will be made. The connecting pipe from the flocculation tank has already been installed by WSD.

	Comment	Response
3.	Section 7 - Tsuen Wan WTW	
(a)	As mentioned in Table 7.2 and P 55, the sludge discharge period will be limited to off-peak hours only, ie from midnight to 8.00 am. Therefore the sludge in the sludge storage tank will be settled before being discharged. Would the Consultant please advise what mitigation measures they would provide in order to avoid the exceedance of EPD's Discharge Standards during the initial discharge.	The sludge storage tanks are mixed.
(b)	Only part of the washwater recovery tanks which will be converted into sludge storage tanks after the new washwater recovery tanks are commissioned were shown in Figure 7.2. The Consultant should provide a full drawing of the proposal.	Agreed.
4.	Section 8 - Shek Lei Pui WTW	
(a)	The Consultant should provide a full drawing of Figure 8.2 covering all the details of the proposal up to the thickening facilities at Tai Po Road WTW including the media recovery tank and the flow regulating control chamber near the Kowloon Byewash Reservoir Dam. The supernatant return pipe/flow from Tai Po Road WTW should also be shown in this Figure and Figure 8.3 if the return is agreed.	Figure 8.2 will be extended (or further Figures inserted) to show the entire route to Tai Po Road WTW, including the media recovery tank and flow regulating chamber. We have not been instructed to install a return supernatant pipe.
(b)	In Section 8.3.8 on P 73, the Consultant must ensure that the access road shall be wide enough to enable the chlorine delivery lorry/fire engines to pass through during the laying of the pipes along the access road.	Restricted vehicular access, for the occasional delivery of chemicals, to the works whilst trenching and pipelaying is in progress will be gained along the normal Works access road.
5.	Section II - Silvermine Bay WTW In line with the proposed development as given in Section 11.2.2 on P 109, the description "clarifier sludge buffer tank" in Figure 11.2 should read "clarifier sludge buffer tank and pumping station". Moreover the supernatant return pumping station, thickened sludge pumping station and the thickened sludge draw-off pumps should also be shown in this Figure.	Agreed
6.	General Comments	
(a)	The Consultant has specifically mentioned in Section 5.2.4, 7.2.4 and 10.2.4 that additional staff may be required for operation and maintenance of the new equipment. Whilst in Section 6.2.4, it is mentioned that new equipment will be electrically operated and is unlikely to require any additional staff to operate and maintain it. Also, the staff requirement for other locations was not mentioned. Would the Consultant please substantiate the staff requirements for these three locations.	The levels of staff increase are so insignificant they will not affect the outcome of the EIA they become irrelevant. Reference to this item will be removed from the report.
(b)	Subject to the settlement of the comments on the draft Preliminary Stage Report, some of the data, Tables or Figures given in the EIA report may need to be updated.	Agreed.

	<u>CE/CM, WSD</u>	
	A Chinese version of the Executive Summary should also be prepared.	Agreed.
Table 5.1	There is a typographical error in the quantities and item sizes of the proposed list of equipment. Please check.	Agreed.

From: CE/MSW
Ref: (21) in WWO/M/ 11/2/502/90 V
Date: 3 July 1995

	Comments	Responses
	Executive Summary	
Page iv	Shek Lei Pui, 2nd Para, Bullet 1. The road affected should be an unnamed WSD access road rather than Cheung Yuen Road	Agreed.
	Main Report	
7.1.1	1st para, last sentence. Suggested to read "has a designed output of 317 MLD"	Agreed.
	2nd para, line 2, should read "The ridge runs south-west to north-east..."	Agreed.
	2nd para, 2nd last line. Should read "....Kwok Shui Road and ..."	Agreed.
7.1.2	3rd para. 2nd last sentence. Should read "....to a surface channel leading to Ham Tin Tsuen situated to the south of the works"	Agreed.
7.1.6	A fire pump house and an associated emergency generator and switchgear room will be built at the north-west area to the eastern filters. The work is being designed by Design Division. Construction is anticipated to take 14 months commencing in early 1996.	Agreed.
7.1.9	1st para. 1st sentence. Should read "...from the western filters...".	Agreed.
	1st para. Line 4. Suggested to read "....Victoria Harbour (Phase 1) Water Control Zone".	Agreed.
7.2.2	The latest scheme is to provide five washwater recovery tanks. Relevant text and diagram should be amended.	Agreed.
Fig 7.3	The dosing of lime, fluoride and chlorine should be shown as part of the existing works. "Raw Water Reservoir" is suggested to read "Raw Water Inlet".	Agreed.
8.1.1	1st para. Last sentence. Suggested to read "has a designed output of 91 MLD."	Agreed.
Fig 8.1	The proposed pipe route should be along an un-named WSD access road rather than Cheung Yuen Road.	Agreed.
8.1.6	A trunk main will be laid from Shek Lei Pui T/W to Kau Wah Keng No.1 and No.2 S/Rs along Cheung Yuen Road. Construction will take approximately 1 year commencing later this year.	Agreed.
Fig 7.3	Same comment as on Figure 7.3	Agreed.

	Comments	Responses
8.3.2	Reference to Cheung Yuen Road should be amended to WSD access road.	Agreed.
8.3.3	Same comment as on Section 8.3.2	Agreed.
9.1.1	1st para. Last sentence. Suggested to read "has a designed output of 32 MLD."	Agreed.
Fig 9.3	Same comment as on Figure 7.3.	Agreed.
9.5	"Shek Lei Pui WTW" should read "Tai Po Road WTW". Tables 9.6 and 9.7 are missing.	Noted.

From: **Director of Home Affairs (Tuen Mun District Office)**
Ref: **(23) in HAD/D/28/28/IV**
Date: **6 July 1995**

	Comments	Responses
Section 10	(a) Re. para. 10.3.4 of report, the construction process would likely generate noise level at 84 dB(A) to Grandeur Garden Estate. In spite of noise mitigation measures proposed, objections and complaints from residences nearby are still anticipated. D of EP is requested to further consider other viable noise mitigation measures to minimize the nuisances to nearby residents.	Noted
	(b) The dewatering facilities may present potential noise impact to residents nearby. D of WS has been advised to consult the Environmental Improvement and District Development Committee (EIDDC) on the proposed project at the latter's meeting on 20.7.95; and	Noted
	(c) Mechanisms should be in place to address public's enquiries and concern for monitoring the noise level and receiving complaints.	Agreed - suitable recommendations for addressing the public's enquiries and receiving complaints (if any) will be included in the report

From: **EPD**
Ref: **(9) in EP1/G/79 III**
Date: **4 July 1995**

Comments	Responses
(i) Lack of detail of mitigation measures	
It is identified in the report that construction and operation activities proposed at some WTW will have the potential to cause noise and air pollution and mitigation measures will be required. However, details of the proposed mitigation measures are not given in the report. It is important for an EIA study to identify suitable mitigation measures which can effectively alleviate the impacts to acceptable levels so that the mitigation requirements can be incorporated into the contract document.	1a) Noise pollution See Response to (iii) below. 1b) Air pollution Methodologies for minimising air pollution are given as appropriate for each site within the report. Ref e.g. Sections 5.3.5, Table 5.4. At this stage in design these methodologies are the greatest level of detail which can be given for control of emissions from activities which will take place on site. Contract documents will be produced which place the responsibility on the contractor to carry out the dust control measures suggested in the report so mitigating potential impacts and achieving acceptably low emissions. This will be included in the final report. Further consideration of this issue is given below in answer to comment (ii)
(ii) Lack of Environmental Monitoring and Audit information	
The information given in para. in 13.4 to 13.4.2 failed to address the requirements for environmental monitoring and audit set out in para. 4.8 of Appendix II of the Study Brief. According to the Study Brief, a proposed Environmental Schedule (Manual) should be included in the report.	Additional information, fulfilling this part of the brief for air and noise monitoring/audit will be appended into the Final Report.
(iii) Noise Assessment	
a) The value of the "daytime basic noise limits" quoted in Appendix C as criteria for construction noise assessment is incorrect. Reference should be made to noise assessment criteria set out in "ProPECC Practice Notes PN2/93". Further, it is noted that the predicted construction noise levels exceed the daytime limit at some sensitive receivers. The consultants should recommend mitigation measures for sites where exceedance of noise limits is likely to occur. Recommendations for detailed design of mitigation measures should also be provided. Please note that the general statement "provide noise barrier if necessary" is not acceptable.	The consultant will amend the Final Report to include the values stated in "ProPECC Practice Notes PN2/93". As the Pro PECC Practice notes allow higher noise levels at sensitive receivers (in most cases) any change in conclusions will show a lessening of environmental effect. Recommendations for mitigation measures where significant effects may occur are already present in the report. It is not possible to give detailed noise reduction plans at this stage in the design process as types, durations and locations of

Comments	Responses
	noisy activities are not known. However, further detail of methodologies will be added to the final report.
b) It is the responsibility of the project proponent and his contractors to comply with statutory requirements set out in relevant Technical Memorandum of the Noise Control Ordinance and non-statutory requirements set out in the "ProPECC Practice Notes PN2/93" and Chapter 9 of the Hong Kong Planning Standards and Guidelines. Percussive piling and general construction work using powered mechanical equipment during restricted hours will require construction noise permits.	Noted.
c) To achieve the requirements describe in b), suitable clause should be provided in the contract to reduce noise. A copy of "Recommended Noise Pollution Control Clauses for Construction Works" is attached for your information.	Agreed. A statement to this effect will be included in the Final Report.
(iv) Improvement works at Tai O WTW	
With regard to Tai O WTW, we indicated in our memo to you dated 25 May (reference EP50/S5/2 IX) that we do not support the proposed option of continuing the current sludge disposal practice at Tai O WTW. Discharging the sludge to the nearby hill side is not acceptable unless a comprehensive assessment of the proposed. In this connection, would the consultants please re-asses the acceptability of construction noise and option is made providing scientific justifications. A site visit and a small scale literature review relating to land application are insufficient justification for the conclusions presented in para 12.4.2 of the report.	Noted. The consultants agree that further evidence is required to support the opinion that the level of environmental damage and economic effort required to provide and operate treatment facilities for the sludge generated at Tai O, far outweigh any environmental gains. A study is to be commissioned to provide further data, which will clarify the position at this site.
(v) Appendix C Table C2 which is duplicated from Table C1 should be deleted.	Tables C1 and C2 have been amended.
. Regarding comments from other members of the EAWG, I would draw your attention to the memo from DAF dated 21 June reference AF DVL 01/50 Annex 1, in which he sets out concerns with respect to tree felling and compensatory planting schemes and details the need fro a tree survey and mitigation recommendations.	Noted.
3. Apologies about the slow reply. I would suggest that the consultants contact the relevant sections of EPD (or other EAWG members) to discuss these outstanding concerns. Please contact either the undersigned or our Mr. B.I. Dubin on 2835 1129 if you have any questions.	Noted.

From: **EPD**
Ref: **(12) in EP1/G/79 III**
Date: **12 July 1995**

	Comments	Responses
	General Comments	
(i)	In the dust impact assessment, the "daily" construction dust impacts were compared with the "annual means" instead of the "daily" dust concentrations of EPD stations. Would the consultants please provide an explanation.	Recent (1991-1994) daily dust values for the EPD stations were not available. However, annual means for the period 1990-1994 were made available by EPD Air Services Group. These recent air quality values are thought to be more indicative of the current situation.
(ii)	Majority of the work sites are located at relatively remote areas. Would the consultants please clarify whether it is applicable to use EPD's monitoring data as to present the background profile.	The draft report provides commentary of the applicability of the EPD monitoring data on each site. As noted, the sites are usually in more remote (less dusty) areas than the nearest EPD monitoring station and therefore, use of this data will give a worst case scenario.
(iii)	Would the consultants please clarify for each work site whether the cumulative dust impacts (including the background levels) would exceed the statutory Air Quality Objectives.	This information is contained within the report in Sections 5.3.5 through 12.3.5. In all cases mitigation measures are recommended to lower emissions to the lowest level possible as "good practice". The construction activities are unlikely to cause suspended particulate levels to exceed the AQOs and, with the recommended mitigation measures in place, fugitive emissions from the sites should be negligible.
Para. 13.4.1	Specific Comments	
(iv)	The 24 hours TSP sampling frequency should be once every 6 days.	Agreed.
(v)	The hourly sampling should be undertaken 3 times per week during construction.	Agreed.
(vi)	A check list for inspection undertaken by the consultants (not the contractor) should be prepared.	Agreed - an example check sheet will be produced for inclusion in the Final Report.
(vii)	For sites where routine air quality monitoring is not required, trigger level/baseline monitoring should be determined prior to construction.	On sites where routine monitoring is not recommended there is no significant chance of the limited development causing unacceptable air emissions, especially with the proposed mitigation measures. Therefore baseline monitoring is not considered necessary.
(viii)	A dust monitoring schedule including details of monitoring frequency and location should be prepared by the consultants (not by the Contractor due to conflict of interests) for EPD endorsement prior to commencement of works.	Agreed.
App D (ix)	Would the consultants please provide justification for the "emission factor" used in the air quality modelling.	The emission factor was used to represent the likely dust generated from each square metre of exposed ground during active construction i.e dust raised by PME operations. The

Comments	Responses
	factor is based on previous experience and similar studies.
(x) The "roughness length" used in the modelling exercise is 5cm instead of 30cm as stated in Appendix D. Furthermore, the wind speed (i.e. 2m/s) used in the exercise is different to that (3m/s) stated in Appendix D. Would the consultants please provide an explanation on the discrepancies and clarify whether a re-run on the model is required.	The stated roughness on page two of Appendix D should read 5cm. The stated speed on page one of Appendix D should read $2ms^{-1}$ Both of these values give conservative, i.e. high dust generation, results for the model. Another model run is not thought necessary.
(xi) The proposed adjustment on 24 hours dust concentration by using the proportion of time during which the wind blows towards the receptor is inappropriate. The proportion of time is based on annual wind statistics while there are observations that wind can consistently blow from one particular direction for a long period of time. Unless justification is provided, the aforesaid adjustment factor should be dropped.	Noted - this factor will have a bearing on the level of dust deposited but not on airborne concentrations.

From: EPD
Ref: ( ) in EP1/G/79 III
Date: 22 Septembr 1995

	Comments	Responses
	Executive Summary (ES)	
i)	Page i As mentioned during our meeting yesterday, the ES and the revised EIA report are inconsistent when they refer to the Feasibility Study of the Treatment and Disposal of Waterworks Sludge (eg whether 12 or 14 sites were studied in 1993 or 1994), MW should amend the relevant text. In addition, the ES should follow your approach in your Draft PWSC paper (ie giving a brief account of those sites planned to be decommissioned or scoped out during the ER). Please note that a simple statement will be sufficient.	Agreed - the relevant text shall be amended.
ii)	Figure 1.1 We support the addition of Figure 1.1 to illustrate the locations of the sites. However, different notations shall be used for proposed development sites and the solution site at Pak Kong. The inclusion of Aberdeen on the plan needs to be documented in the text, otherwise, we don't see the point of marking Aberdeen on the figure. (For WSD's internal consideration: We prefer to take it out).	Agreed - Notations on Figure 1.1 shall be amended and notation for Aberdeen shall be removed from the Figure.
iii)	Page ii For those "Proposed Developments" (especially for Tai O), somehow the text should state the items listed are original proposals that will subject to detail checking during the EIA/BEECOPS test (otherwise members might have difficulties in understanding the recommendation for further studies in Tai O).	Agreed.
	The section on Environmental Legislation and Guidelines looks unfinished. (For example, the HKPSG 70 dB(A) noise limit for operational phase traffic noise impact was not included). Furthermore, does it include legislations and guidelines for construction and operation impacts?	Additional information will be incorporated into Section 4.
iv)	EIA Findings and Recommendations The text should highlight any anticipated exceedance(s) of the relevant environmental standards/guideline (with values of modelling results where appropriate), the mitigation needed and the level/acceptability of any residual impacts.	Agreed.
v)	Page vi As regards the "conclusion" for Tai O (3rd last	

	Comments	Responses
	para. on the left) please amend 'One conclusion reached was ..." to 'The study findings suggested ....'. For the 2nd last para. on the left, please replace `shown' by `indicated'.	Agreed.
vi)	Environmental Monitoring and Auditing The ES should state the project proponent will implement the mitigation measures required and conduct EM & A to ensure compliance.	Agreed. A statement to this effect will be included in the Final Report.
	Revised Draft EIA Report	
	Please note that the above comments also apply generally to the revised EIA DFR Report. In addition, the following should be noted:	Noted.
i)	Page 6-8 Footnote should be added to indicate the sources of ISDS/ISDS options.	Agreed. The footnote shall reference: Watson Hawskley, Integrated Sludge Disposal Strategy Study, Final Report 1993, Environmental Protection Department.
ii)	Page 9 & 11 Table 2.2 and Table 2.3, the consultant should state the proposals for Tai O are initial options subject to detailed checking in the EIA, otherwise, members might have difficulties in understanding the reasons for recommending further studies at the Conclusion section.	Agreed.
iii)	Page 10 Para. 2.4.2 - Environmental. In fact, the EIA also assessed the construction phase impacts.	Agreed.
iv)	Section 12 & 14. As agreed during our Steering Group meeting the Sections shall include a statement on the way forward for Tai O. The last sentence of 14.2 & 14.3 should be rewritten in line with our comments to the ES.	Agreed. Section 14 shall be amended in line with comment above.

From: **EPD**
Ref: **( ) in EP 30/S5/2 XIII**
Date: **21 September 1995**

Comments	Responses
Section 12.1.9 Water Quality, second last sentence	
As trace heavy metals are still found in soluble form of washwater, please replace ".... all the metals, if any, are of an insoluble nature ...." with ".... metal of major concern are mostly of an insoluble nature ...". In addition, we suggest the conclusive statement. "In the unlikely event that any water reaches the groundwater it is unpolluted". be deleted.	The trace metals detected are within the standards for potable water. We agree to your first suggestion, however, our comment "In the unlikely event that any water reaches the ground water it is unpolluted" is entirely correct.
Section 12.4.2 Ecology, 3rd paragraph second last sentence	
We suggest to delete the sentence "None of the sludge reaches any waterways or the sea." as this statement is to be confirmed in the proposed monitoring programme.	We will use the term "It is unlikely that any sludge reaches.....".
Section 12.4.2 Ecology, last paragraph	
As discussed in the Second Steering Group meeting, this paragraph is too conclusive and inconsistent with the executive summary. The consultant would need to revise it accordingly.	Agreed. The paragraph shall be amended to read 'The study has indicated that the existing sludge disposal facilities at Tai O are not causing significant ecological damage'.
Section 14.3 Recommendation, 3rd paragraph, line 2	
To delete "and are specifically not causing any impact on WQOs" because whether the existing disposal practice for Tai O WTW discharge is having an impact on WQOs will be investigated in the proposed monitoring programme.	Although we have firm opinions on this issue we agree to amend the text to read "and are unlikely to be causing any measurable impact on WQO's"
Section 14.4 Further Study, last sentence	
Please add ", and the presence of any ground water/land contamination" after the word "vegetation".	Agreed.

From: **District Officer (Tuen Mun)**
Ref: **(36) in TM 153/1/57**
Date: **28 September 1995**

Comments	Responses
I refer to your aforementioned to HAD among others. We are requested to forward our comments to you direct regarding the captioned work.	
a) para. 10.3.3 : I have reservation on the conclusion that "the increase in heavy traffic due to construction process should have no major impacts on the local road network". First, the generation of 50 vehicle movements a day is a considerable increase. Second, Castle Peak Road is already a congested road and the increase in traffic may further aggravate its condition, and	50 vehicles per day at peak construction time translates to between 6 and 7 per hour which is extremely small compared to the daily hourly traffic flow along these roads. During non peak construction times the traffic movements would be reduced. Highways department have not made any protests to these small numbers of traffic movements.
b) para. 10.3.4 : it has been mentioned that acoustic barriers and restricted use of silenced equipment will be required to enable construction processes to take place at the site. However, it is not known what types of acoustic barriers are deemed necessary and where should they be erected. Also, it seems that the restricted use of silenced equipment would only help reducing the noise level to a marginally acceptable level. In view of the noise nuisance likely to be generated from the construction work, complaints from residents of Grandeur Garden will be anticipated.	The type of acoustic enclosure would be subject to agreement with EPD. Specific clauses would be inserted into the Contract Documents requiring the Contractor to agree the type of enclosure with EPD. This would form part of the Construction Permit thus ensuring compliance.
You will recall that when the Environmental Improvement and District Development Committee (EIDDC) of Tuen Mun District Board was consulted on the project on 20 July 1995, Members of EIDDC had requested and you had undertaken that the EIA Report would be presented for their comments once available. I would therefore be grateful if you could follow up on EIDDC's request in due course.	We assume WSD/EPD will respond to this item.

From: **DSD - CE/E&M Projects**
Ref: **(26) in DSD EM/7/4/36**
Date: **28 September 1995**

Comments	Responses
I note that the consultants for the captioned study have recommended that WTW sludges from Shek Lei Pui, Tai Po Road and Tsuen Wan Water Treatment Plants be transported via sewers to Stonecutters Island STW.	
Please ask Montgomery Watson to advise what impact it will have on SCISTW, if any, and to confirm that the STW will be able to handle this additional load.	This has been dealt with under previous documentation, however, we can confirm that SCISTW has been designed to handle the additional load.
Sludges from Eastern, Redhill, Silvermine Bay, Tai O and Tuen Mun Water Treatment Plants are to dewatered on site and disposed of at landfills. Some of these recommendations seem to be at variance with BEECOPS.	The schemes are in accordance with the BEECOPS. It is suggested that reference is made to the Final Report of the Feasibility Study.
	Please note that both of these are historical issues that have been covered through extensive consultation and documentation.

From: **CE/HK**
Ref: **(41) in WWO (HK) 1/15/1452/94 II**
Date: **26 September 1995**

Comments	Responses
I refer to your above memo and would comment as follows :	
a) Location of construction site as shown in Figure 5.1 and 5.2 are different. Please request the consultant to clarify.	The drawings will be aligned.
b) Page 39, section 6.1.4, 2nd para, 1st line, "mPD" should be "PD".	The text will be modified and the term mPD will be used.
c) Figure 6.2, opposite page 42, should clearly show how the sludge from the flocculation tank would be conveyed to the sludge balancing tank after the existing 300 mm diameter pipe is decommissioned to give space for construction of the proposed facilities.	The term "decommission" will be removed as the pipe is not to be decommissioned.

From: **EPD**
Ref: **( ) in EP 50/SS/2**
Date: **14 October 1995**

Comments	Responses
Section 12.2. para. 1, line 2 As there is no scientific data on the quality of effluent from Tai O WTW, we suggest to replace the sentence "The current discharge to the hillside is very low volume, and contains no toxic chemicals (only containing potable water lightly contaminated with clay solids and aluminium sulphate)" by "The current discharge to the hillside is very low volume, and unlikely to have toxic chemicals".	Noted, the relevant text shall be amended.
Section 12.7 para 2 As mentioned in to section 12.2 para 1, last sentence, the discharge is not causing any significant visual, physical or any other identified negative impacts. It would be too soon to jump to a conclusion as stated in this paragraph. We suggest to amend the conclusive statement "Although the EIA process concluded that..." to "Although the EIA process indicated that...".	Agreed, the relevant text shall be amended.

From: EPD
Ref: ( ) in EP 1/G/79
Date: 16 October 1995

Comments	Responses
i) Executive Summary Page vii, second para of EM&A, should it be "The Action Plan is based on Trigger,..."?	Agreed, the text will amended.
ii) EIA Report For the BEECOPS option, the revised draft final EIA report indicates that in order to minimise the impacts due to the minor construction works adjacent to Buddhist Fat Ho Memorial College, the construction works should be carried out during the school holidays to avoid the construction impacts. Though I understand that this arrangement might become irrelevant if the do-nothing option is justified and adopted, in view of the fact that the BEECOPS option is still viable alternative, should these potential environmental impacts and proposed mitigation be mentioned in the Executive Summary similar to other sites.	Agreed, the text will be modified to include reference to the proposed mitigation measures for the construction works associated with the BEECOPS option at Tai O.