HONG KONG GOVERNMENT
DRAINAGE SERVICES DEPARTMENT

Agreement No. CE/29/93
NORTH AND SOUTH KOWLOON SEWERAGE
STAGE I

HUNG HOM BAY PUMPING STATION ENVIRONMENTAL IMPACT ASSESSMENT

FINAL ASSESSMENT REPORT

May 1995

RUST

EIA/OST·1/P5

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Summary and Recommendations

1. The North and South Kowloon Sewerage Master Plan, which presented its final recommendations in April 1993, identified and prioritised a programme of works which was intended to improve the performance of the sewer network in North and South Kowloon in order to meet the requirements of the Strategic Sewage Disposal Scheme.

2. Stage I of the North and South Kowloon Sewerage project commenced in early 1994. In addition to a number of other priority works, Stage I also included the design and construction of the Hung Hom Bay Pumping Station (Figure 1.1).

3. The Brief required that an environmental impact assessment of the Pumping Station be undertaken prior to the commencement of the detailed design in order to identify and qualify the nature and extent of the environmental impacts associated with the construction and operation of the Pumping Station and to recommend such mitigation measures as were deemed appropriate.

4. The principal conclusions and recommendations contained in the Environmental Assessment are summarised below. It was found that given the generally poor existing environmental quality of the site environs, the nature of sensitive receptors and their distance from the proposed works and the small scale of the development in comparison with other infrastructure projects, the impacts associated with the construction and operation of the Pumping Station are limited. The only potentially significant impact was identified as operational odour impacts. Detailed modelling indicated that odour levels at the nearest Sensitive Receptor would exceed the relevant EPD guideline unless suitable mitigation measures were installed.

5. The Hung Hom Bay Pumping Station will be located adjacent a Regional Magistracy on the Hung Hom Reclamation, at the junction of the Princess Margaret Road Link and the Hung Hom By-pass. Construction of the Pumping Station will proceed in tandem with other infrastructure works on the reclamation.

6. Upon completion of the Pumping Station the proposed landuse surrounding the site will vary from new residential/commercial developments to Government/institutional facilities and District Open Spaces. The general character of the site is likely to be dominated by the Princess Margaret Road Link/Hung Hom By-pass intersection. The intersection is likely to generate significant adverse environmental impacts upon nearby Sensitive Receptors, which will generally overshadow those associated with the Pumping Station.

7. The number of Sensitive Receptors likely to be affected by the proposed works are few. Those likely to be affected by the construction phase are limited to the high density residential development of Whampoa Gardens which overlooks the site from a distance of approximately 300 m. Operational phase Sensitive Receptors include a school, a community centre, a PSPS housing development and a proposed hotel/commercial development - all located more than 120 m from the site - and a Regional Magistracy immediately adjacent the Pumping Station.

8. The principal conclusions and recommendations contained in the Environmental Assessment are summarised below.

Noise

- Given the nature and scale of the construction and the sensitivity and proximity of the nearest Sensitive Receptors, construction noise is unlikely to be a major constraint. Worst case noise levels at the nearest Sensitive Receptor was calculated as 69.2 dB(A) during construction of the basement structure in the first 12 weeks of the programme, well within the 75 dB(A) criterion.

- During the operational phase noise from pumps and ventilation system represent the principle noise sources. Worst case maximum operational noise levels at the nearest Sensitive Receptors readily comply with both the day-time, evening and night-time noise criteria. Since the noise impact is likely to be insignificant no special mitigation measures will be required.

Air Quality

- Due to the scale of the developments, the small area of the work site and the short duration of the works programme, air quality impacts associated with the construction of the Pumping Station is likely to be negligible in comparison with the impacts of other infrastructure projects.

- Operational air quality impacts are the most significant concern arising from the Environmental Assessment. Odour generated by the operation of the Pumping Station was found to exceed the relevant EPD guideline at the nearest Sensitive Receptor in worst case conditions. In order to ameliorate such impacts an activated carbon filter with a minimum odour removal efficiency of 75 % should be installed. This measure combined with regular maintenance and good housekeeping practices is likely to reduce the odour nuisance at the nearest Sensitive Receptor to an acceptable level.

Water Quality

- The impacts upon the marine environment associated with the construction and operation of the Pumping Station will be negligible and will be overshadowed by the effects of existing and future projects in the study area. At present water quality in Hung Hom Bay is affected by ongoing construction and reclamation works however, in the long term the gazetting of Phases II and III of the Victoria Harbour WCZ, the enforcement of the relevant WQOs and the implementation of the SSDS is likely to lead to a significant improvement in the local water quality.

Visual Impacts

- Though the Pumping Station is unlikely to be a positive visual element in its existing setting the visual impacts of the facility will not be significant. Tree and shrub planting along the perimeter and

an architectural finish compatible with and complementary to the proposed Magistracy Building will mitigate the visual intrusion of the Pumping Station structure.

Waste

- The disposal of construction waste and screenings arising during the operation of the Pumping Station is unlikely to be problematic given the nature and small quantities of waste involved.

Cumulative Impacts

- The environmental impacts associated with future projects in the study area, in particular proposed road developments such as the Princess Margaret Road Link and Hung Hom By-pass, are likely to overshadow those impacts associated with the construction and operation of the Pumping Station. Thus it is unlikely that the proposed works will contribute significantly to the cumulative environmental impacts on nearby Sensitive Receptors.

- The Environmental Assessment has been conducted in the context of the net environmental benefits which may be expected as a result of the implementation of the North and South Kowloon Sewerage Master Plan and the Strategic Sewage Disposal Scheme. The anticipated benefits are likely to far outweigh the limited short-term adverse environmental impacts associated with the construction and operation of the Pumping Station.

1. Introduction

1.1 Background

1.1.1 The North and South Kowloon Sewerage Master Plan (SMP)(Watson Hawksley, 1993), which presented its final recommendations in April 1993, identified and prioritised a programme of works which would improve the performance of the sewer network in North and South Kowloon. Amongst its many recommendations the SMP identified the need for the construction of a pumping station in Hung Hom.

1.1.2 Stage I of the North South Kowloon Sewerage project commenced in early 1994. In addition to a number of other priority works, Stage I also included the design and construction of the Hung Hom Bay PS (Figure 1.1). As part of the Brief an environmental assessment is required to identify and assess the potential impacts from such a facility during construction and operation.

1.2 Context and Scope of the Final Assessment Report

1.2.1 The Final Assessment Report (FAR) is the last in a series of documents which identify, qualify and quantify the nature and extent of the environmental impacts associated with the construction and operation of the PS.

1.2.2 In accordance with the requirements of the Brief the FAR is intended to assess the environmental impacts associated with the proposed works and identify suitable mitigation measures to be incorporated in the detailed design. In addition, the FAR outlines briefly the environmental audit requirements for compliance and post-project audit.

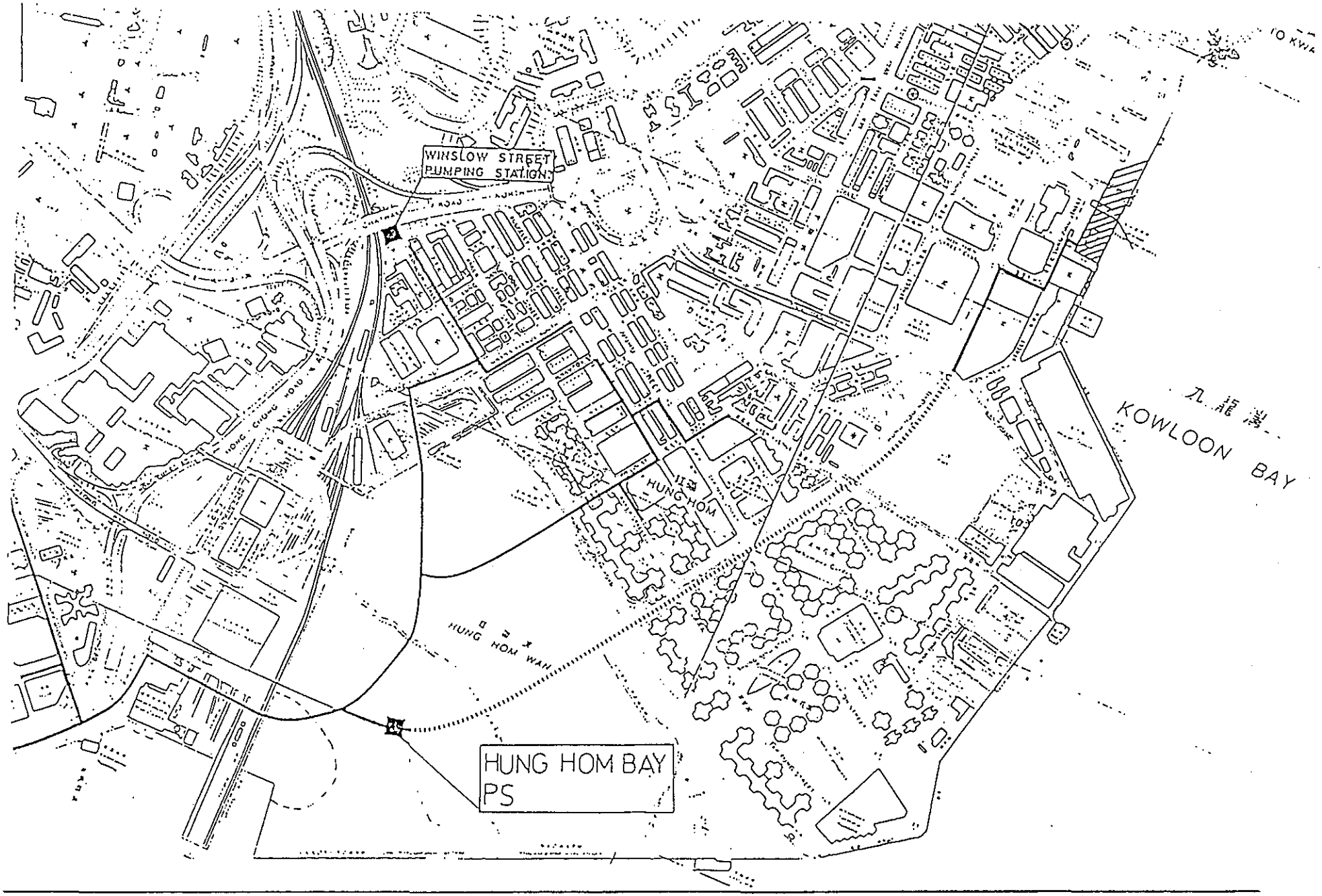

Figure 1.1
Proposed Location of the Hung Hom Bay Pumping Station

2. The Study Area

2.1 Introduction

2.1.1 This section characterises the main landuses within the study area and site environs and identifies those sensitive receptors (SRs) which may be subject to adverse environmental impacts from the construction and operation of the PS.

2.2 Landuse in the Study Area

2.2.1 For practical purposes the study area may be defined as the southern portion of the Revised Draft Hung Hom Outline Zoning Plan (OZP)(Planning Department, 1993). The area covers approximately 100 ha, mainly on reclaimed land, and is bounded to the north by Dyer Avenue and to the west by Chatham Road and the KCRC Hung Hom Station. The eastern boundary of the area coincides with the furthest extent of existing reclamations into Hung Hom Bay.

2.2.2 The existing landuse in the area varies from low quality older housing and obsolete industrial operations to high density public and private housing estates, such as Whampoa Gardens, and thriving commercial and retailing establishments centred upon Hung Hom Road and Wuhu Street. The reclamation area at Hung Hom Bay has been developed for a variety of proposed uses which are identified in the Hung Hom Bay Outline Development Plan (ODP)(Planning Department, 1993). The primary objectives of the ODP are to meet the territorial demand for residential sites, provide for the construction of the Princess Margaret Road Link and Hung Hom By-pass, to provide land for the extension of the existing hotel/office development in Tsim Sha Tsui East and for the provision of G/IC and open space to supplement the currently inadequate provision of such facilities in Hung Hom.

2.3 Site Description

2.3.1 The Hung Hom Bay PS is to be located adjacent a Regional Magistracy at the junction of Princess Margaret Road and the Hung Hom By-pass on the Hung Hom Bay reclamation, as recommended in the Hung Hom Bay ODP (Figure 2.1). Construction of the PS will proceed concurrently with other infrastructure works on the reclamation.

2.3.2 The proposed landuse surrounding the site will vary from commercial uses which may include offices, hotels or serviced apartments, to Government or institutional facilities such as primary schools and a number of open spaces intended for both passive and active recreational uses. A residential development of approximately 2,600 flats has been proposed on a site above the Hung Hom By-pass and overlooking the PS site. Similarly, the more distant residential area of Whampoa Gardens will overlook the site during construction and operation.

2.3.3 The general character of the site, once the PS is operational, is likely to be dominated by the Princess Margaret Road/Hung Hom By-pass intersection. The intersection is likely to generate significant adverse environmental impacts upon nearby SRs which will generally overshadow those associated with the PS.

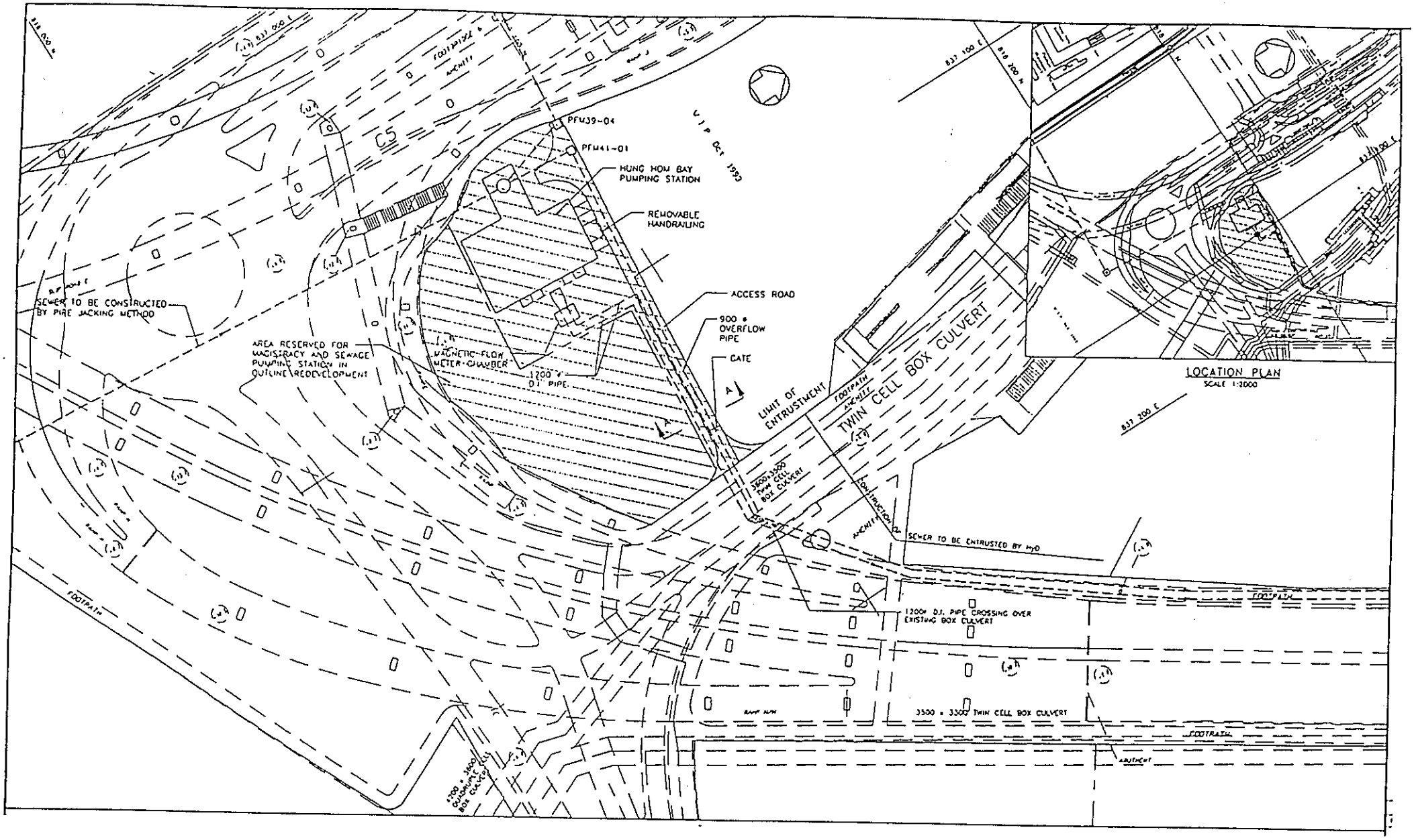

Figure 2.1

Hung Hom Bay Pumping Station Layout Plan

2.4 Existing Environmental Conditions

2.4.1 The existing noise, air and water environment within the study area is characterised below.

Noise

2.4.2 Existing road traffic noise is a significant issue and the potential noise impacts associated with the Princess Margaret Road and Hung Hom By-pass pose a potential environmental concern within the study area. Noise levels by existing roads in the study area were recorded in March 1992 as part of the Hung Hom By-pass/Princess Margaret Road Link Environmental Assessment (Highways Asia, 1992). Results show that the existing L_{10} façade noise level is 78 dB(A) at Willow Mansion, located on the northeast corner of Hung Hom Road and Hung Hom South Road. This noise level exceeds the Hong Kong Planning Standards and Guidelines (HKPSG)(EPD and Planning Department, 1990) recommended maximum of 70 dB(A) for traffic generated noise at the façades of NSRs.

Air Quality

2.4.3 The nearest EPD air quality monitoring stations are located in Tsim Sha Tsui and Mongkok. Annual average and annual maximum daily pollutant concentrations at these monitoring stations are summarised below, in Table 2.1. The results while not typical of the study area are indicative of existing air quality conditions in an area of similar landuses.

Table 2.1 Annual Average and Annual Maximum Daily Pollutant Concentrations at the Tsim Sha Tsui and Mongkok Monitoring Stations in 1992.

Parameters		Pollutant Concentrations ($\mu g/m^3$)			
Location		SO_2	NO_2	TSP	RSP
Tsim Sha Tsui Monitoring Station	Arithmetic Mean	22	X	88	60
	Maximum Daily Concentration	150	X	300	250
Mongkok Monitoring Station	Arithmetic Mean	50	76	160	76
	Maximum Daily Concentration	150	150	425	225
Air Quality Objectives		80	88	80	55

Notes:
- TSP - Total Suspended Particulates
- RSP - Respirable Suspended Particulates
- X - No results

(Source: EPD, 1993)

2.4.5 Levels of sulphur dioxide, nitrogen oxide and particulates are high and frequently exceed the relevant AQOs at the two nearest monitoring stations. These pollutants are associated primarily with road traffic and the numerous demolition and construction works underlay

within the study area. The study area is not located within a topographically confined airshed.

Water Quality

2.4.6 Results of routine EPD water quality monitoring at station VM4 are summarised in Table 2.2 (EPD, 1994). The results indicate high levels of nitrogenous compounds and bacterial loading in these coastal waters. Marine sediment and muds are likewise contaminated with high concentrations of heavy metals (EPD, 1994).

2.4.7 Reclamation in Hung Hom Bay and seawall construction along the Hung Hom waterfront further exacerbate the existing poor water quality. These developments which require the dredging and removal of contaminated sediments invariably disturb and release toxic material into the water column to a greater or lesser degree dependent upon the prevailing water conditions. At present these activities, coupled with the low assimilative qualities of the waters, their poor water exchange capacities and the effects of storm water discharges contribute to the existing poor water quality in the area.

2.5 Sensitive Receptors

2.5.1 The location of SRs and the nature of the impacts at each are shown in Figures 2.2 and 2.3 for the construction and operational phases of the works. The SRs have been identified in accordance with the HKPSG.

2.5.2 *Construction*

CSR1 Whampoa Gardens - High density residential development of 17 storeys which overlooks the proposed PS site and the Hung Hom Bay reclamation. It is separated from the reclamation by the Hung Hom South Road.

CSR2 Hung Hom Bay - Grossly polluted water body which fronts the Hung Hom Bay reclamation. Existing water quality is further reduced as a result of the reclamation works.

2.5.3 *Operation*

The locations of SR have been established from the Revised Draft Hung Hom OZP (planning Department, 1993) and are therefore provisional. The ultimate landuse in the area may be subject to change.

OSR1 Location of the Regional Magistracy and a proposed commercial office development to the north of and adjoining the site.

OSR2 A proposed Public Sector Participation Scheme (PSPS) housing area development northeast of the site. The development is intended to serve a population of approximately 8000. The structure is to be located on a podium straddling the Hung Hom By-pass and will be separated from the site by the Hung Hom By-pass/Princess Margaret Road intersection.

Table 2.2 **Annual Average and Annual Maximum Daily Pollutant Concentrations at Monitoring Stations in Victoria Harbour between 1991 and 1993**

Parameters		Pollutant Concentrations					
Sampling Point	Year	NH_4-N (mg/l)	Total N (mg/l)	BOD_5 (mg/l)	DO (mg/l)	SS (mg/l)	*E.Coli* (No./100ml)
VM4	1991	0.319 (0.677)	0.961 (2.584)	0.968 (2.063)	6.055 (3.073)	8.840 (20.000)	5,520 (13,067)
	1992	0.310 (0.461)	0.815 (1.262)	1.321 (2.103)	4.697 (2.863)	18.334 (73.333)	8,014 (19,667)
	1993	0.174 (0.355)	0.841 (1.172)	1.655 (8.093)	4.704 (5.959)	7.122 (14.333)	5,927 (16,000)

Notes:
- Average annual pollutant concentrations are calculated as arithmetic means.
- Values in parentheses represent annual maximum daily pollutant concentrations.

(Source: EPD, 1994, Correspondence, 15/05/94)

OSR3 A proposed primary school north of the site, adjacent to the proposed PSPS development. The receptor is separated from the site by a road and will likely have its line of sight to the PS either partially or completely obscured.

OSR4 A proposed hotel/serviced apartment development to the south of the site. The receptor is separated from the site by the Hung Hom By-pass/Princess Margaret Road intersection.

OSR5 A proposed clinic, indoor game centre and community centre to the east of the PS site. This development is separated from the site by an area designated as District Open Space and the Hung Hom By-pass/Princess Margaret Road intersection. A substantial portion of this development is likely to be shielded from line of sight by the proposed PSPS development.

2.6 Other Projects

2.6.1 The following development projects will proceed within, or impinge upon, the study area concurrent with and subsequent to the construction of the PS. These projects have been taken into account in the assessment of cumulative impacts during the construction and operational phases of the project.

2.6.2 *Hung Hom By-pass/Princess Margaret Road Link* - This development will link Salisbury Road to Hung Hom Road, across the Hung Hom reclamation. Work will commence in October 1995 at the earliest and is scheduled for completion by 1998. This major development is likely to create the most significant environmental impacts of any projects in the study area.

2.6.3 *Hung Hom Bay Reclamation Infrastructure Projects* - The reclamation is scheduled for completion in 1994 and infrastructure construction in 1997. The engineering infrastructure on the reclamation will be entrusted to Highways Department and will include the construction of sewer mains and water supply pipes.

2.6.4 *Strategic Sewage Disposal Scheme* - The SSDS is designed to assist in the achievement of Water Quality Objectives (WQO), as defined under the Water Pollution Control Ordinance, 1980 (WPCO), by intercepting and diverting sewage flows from present and future collection nodes and transferring these flows to a deep ocean outfall in the Lema Channel. Implementation of this scheme will ensure a greater degree of treatment than achieved at present. Stage I of the SSDS involves the provision of deep tunnel sewers to collect sewage from Kowloon and transfer it to Stonecutters Island for chemically assisted primary treatment before discharge via an interim outfall located in Victoria Harbour. The overall effect of this project will be to significantly improve the existing water quality in Hung Hom Bay and Kowloon Bay.

2.6.5 *Hung Hom Road Widening* - Hung Hom Road is scheduled to be widened from dual 2-lane to dual 3-lane highway, for completion after 1998.

2.6.6 *KCRC Freight Station* - The development of the KCRC freight station on the western boundary of the Hung Hom reclamation was scheduled to begin in late 1993.

2.6.7 *Public Housing Schemes* - Comprise the re-development of existing sites within Hung Hom Estate in order to reduce residential density in these areas in accordance with the recommendations of the Kowloon Density Study. The re-development is programmed in two phases for completion in 1998 and 2002 respectively.

2.6.8 *Hung Hom Bay Reclamation Development Projects* - Development of a number of DLO sites for recreational use will follow upon completion of the infrastructure works in 1997. Other developments, such as the PSPS and CDA will not be programmed until the land disposal strategy has been formulated.

2.6.9 Of those developments highlighted above only the Infrastructure Projects, Princess Margaret Road Link/Hung Hom By-pass and Sewage Disposal Strategy Works are likely to contribute significantly to any cumulative impacts as a result of either their timing, scale or location.

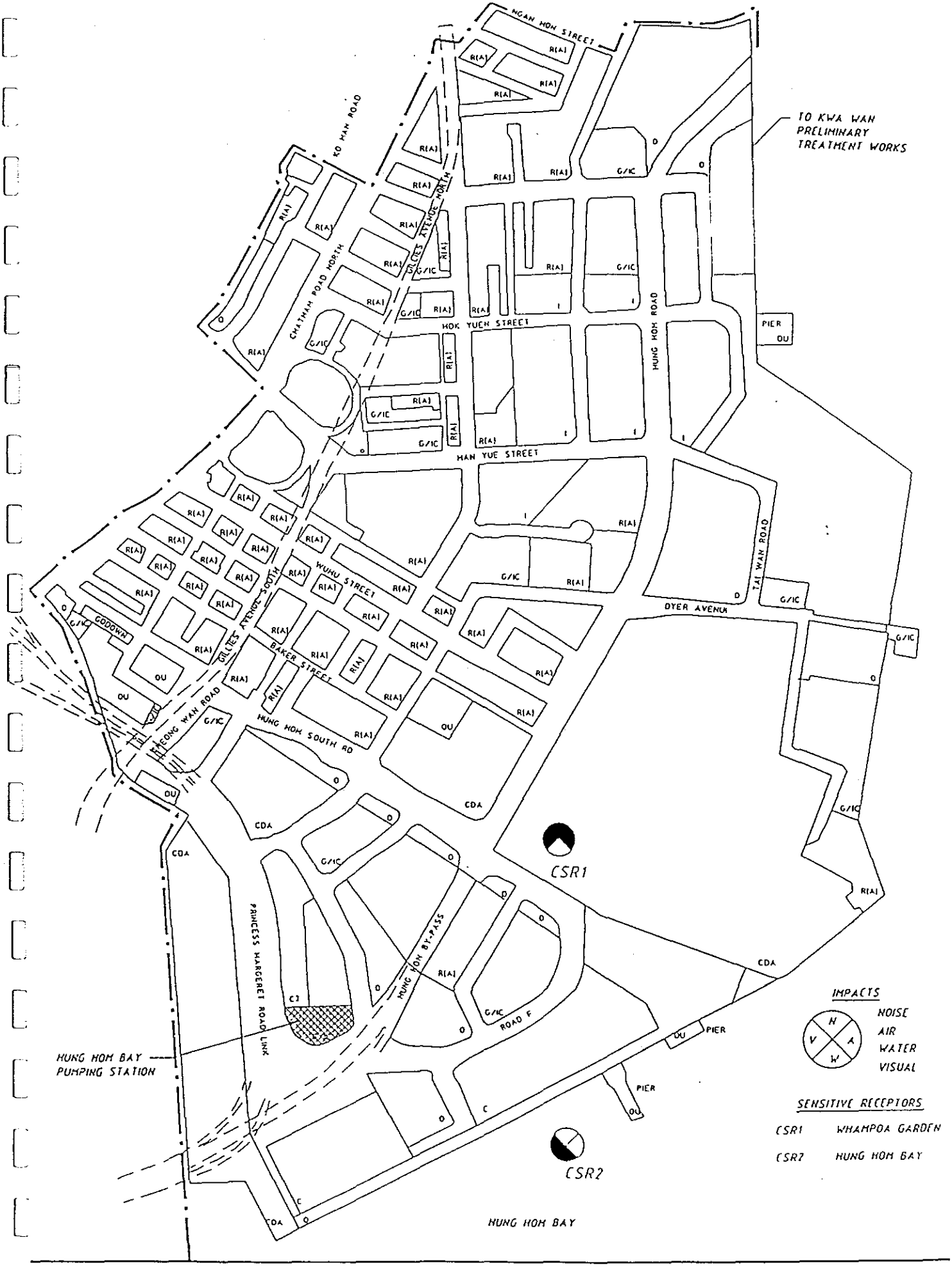

Figure 2.2

Construction Phase Impacts and Sensitive Receptors

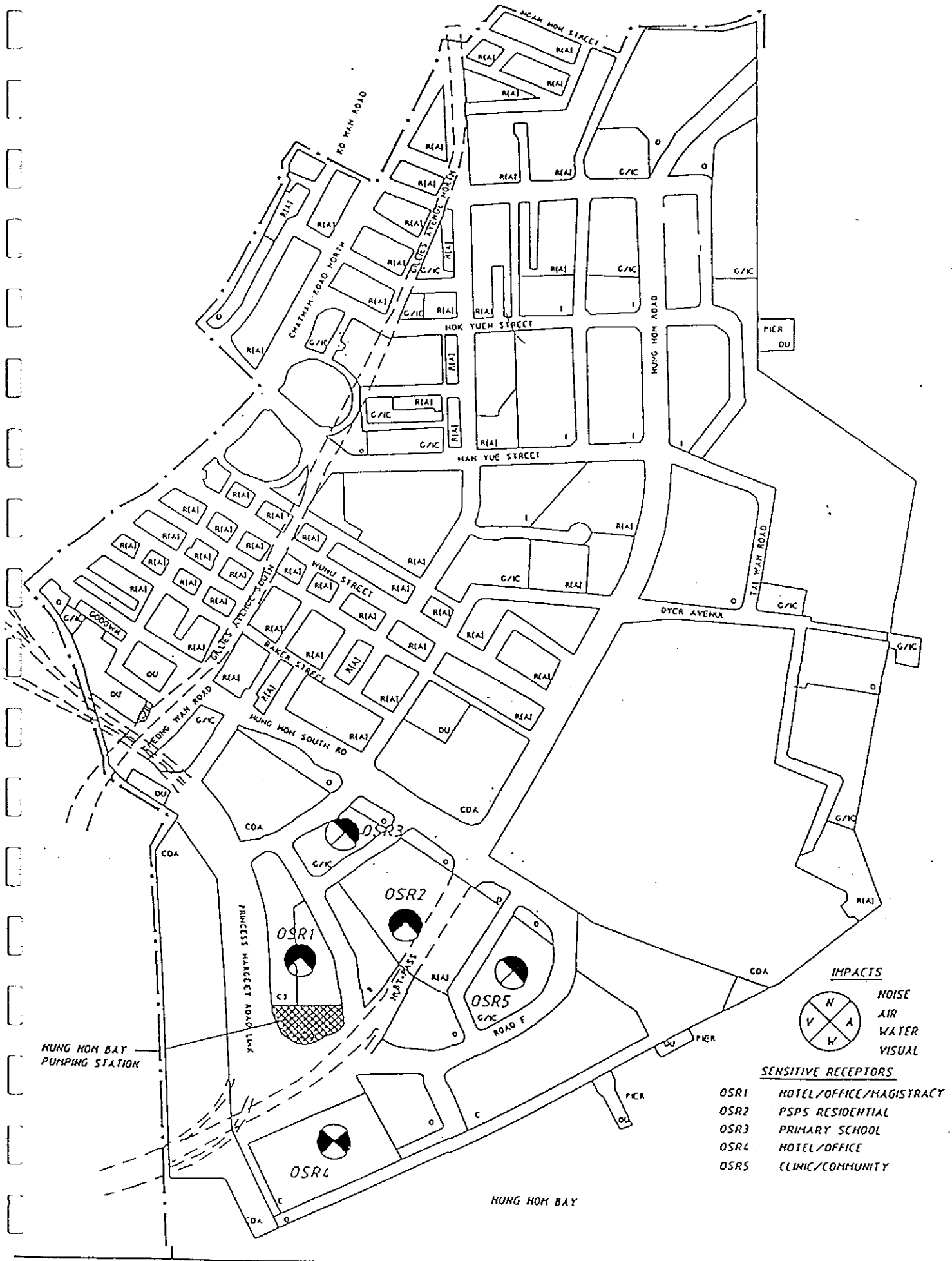

Figure 2.3

Operational Phase Impacts and Sensitive Receptors

3. Hung Hom Bay Pumping Station

3.1 Introduction

3.1.1 This section describes the construction and operational requirements of the Hung Hom Bay PS. The design of the PS is in its preliminary stage and a number of variables have yet to be resolved.

3.2 Construction Activities and Programme

3.2.1 The Hung Hom Bay PS is designed as a conventional wet well/dry well pumping station to pump sewage flows from the incoming South Kowloon Trunk Sewer and the Hung Hom Branch Sewers to the existing To Kwa Wan Preliminary Treatment Works via the Hung Hom Bay Trunk Sewer on Hung Hom Road.

3.2.2 The PS will be located on the Hung Hom Bay reclamation on a site reserved for the PS and a future magistracy in accordance with the Hung Hom Bay ODP. The pumping station will be located on the west side of the G reserve as indicated in Figure 2.1. The access road, rising mains and overflow pipe have been routed along the boundary between the G reserve and OSR1. At present the detailed design, location and layout of the Magistracy is undetermined.

3.2.3 Construction of the Hung Hom Bay PS will be co-ordinated with the construction of the South Kowloon Trunk Sewer, and is scheduled for completion in 1997. The pumphouse will comprise a below ground structure with overall dimensions of 26 m length, 13.5 m width and approximately 15 m depth. The above ground pumphouse will have a similar plan dimension and will be approximately 7.4 m high. The programme will involve the construction of the station housing and transport and installation of a total of 6 centrifugal pumps in tandem with the construction of the rising mains, pump chamber access channels and screens. A provisional Construction Programme is shown in Table 3.1 and summarised in stages below.

Sub-structure

3.2.4 The construction of the sub-structure will proceed within previously constructed diaphragm, walls and will comprise the following activities:

(i) excavation and construction of temporary/permanent lateral support down to -11.5 mPD;

(ii) construction of 12 No. 1 m diameter bored piles founded at -40 mPD;

(iii) construction of base slab at level -12.0 mPD;

(iv) placement of internal wall and top slab;

(v) excavation of perimeter trench with concrete lining and apron;

(vi) excavation for 1.2 m thick, 5 m long diaphragm wall panels;

(vii) placement of reinforcement cages;

(viii) placement of diaphragm wall panels; and,

(ix) finishes.

Superstructure

3.2.5 The superstructure will be a steel framed construction with geometry and cladding to conform as far as practicable with the adjacent Magistracy. After the completion of the ground slab the station walls will be constructed by traditional timber formwork.

Overflow

3.2.6 A high level emergency overflow will be provided at the inlet to the pumping station to discharge to the box culvert on the east boundary of the site, under Road D. The box culvert will discharge into Hung Hom Bay at the seawall.

3.2.7 The overflow will be fitted with a coarse screen chamber and a flap valve at its downstream end where it discharges to the box culvert. Additional measures will also be incorporated into the design to reduce the impacts of such emergency discharges. These measures are detailed in Section 7.

E & M Provisioning

3.2.8 Appendix A provides a summary of the E&M equipment to be installed in the PS. The building services to be installed include the placement of the 6 centrifugal pumps, electrical installation and main switchboard, the ventilation system and the building lighting.

Finishing

3.2.9 Finishings will include internal works such as plastering, plumbing and metal work and external works such as connection of utilities, provision of access roads and landscaping.

Road Access Arrangements

3.2.10 To accommodate construction at the pumping station site, temporary road access will be required on the reclamation area. These roads will also provide access for the necessary vehicles and construction equipment required by the other infrastructure projects in the area. As such, the traffic volume associated with the comparatively minor PS project will be negligible compared with the larger projects on the reclamation.

Table 3.1 Construction Sequence for the Hung Hom Bay Pumping Station

Trade/ Work		Activity Description		Duration
1.	Diaphragm Wall & Micro-piles	1.1	Construct the guide walls on ground.	1 week
		1.2	Excavation to founding level, to form trenches in earth for diaphragm wall body.	3 weeks
		1.3	Drill hole through diaphragm wall to design penetration depth for micro-pile.	5 weeks
		1.4	Fix the reinforcement and grout the micro-piles.	2 weeks
		1.5	Deliver fixed reinforcement of wall into trench and cast the wall with tremie-concrete.	
2.	Basement Structure	2.1	Excavation of core space to design depth and installation of temporary props and de-watering, if required. Pouring of concrete once design beam soffit level is reached.	3 weeks
		2.2	Expose the couplers, fix the reinforcement and cast the cross beams.	9 weeks
		2.3	Repeat step 2.1 and 2.2 until completion of the base slab.	
		2.4	Deliver the facilities with large volumes and heavy weights, such as pumps, fittings etc.	5 weeks
		2.5	Construct the internal structures such as walls, columns, staircases etc.	
		2.6	Repeat step 2.4 and 2.5 until completion of the sub-structure.	
3.	Superstructure	3.1	After completion of the ground slab, construct the walls (columns) of superstructure by traditional timber formwork.	2 weeks
		3.2	Install the crane beams.	1 week
		3.3	Construct the roof.	1 week

4.	Finishing Works	4.1	Steel and metal works, ironmongery etc.	7 weeks
		4.2	Plastering.	
		4.3	Plumbing and drainage.	
5.	Installation of building services and other works	5.1	Install pumps, electrical installation, air circulation systems etc.	5 weeks
6.	External works and Pavements	6.1	Excavation.	1 week
		6.2	Connect the pipes and other services.	2 weeks
		6.3	Backfill and lay pavement block.	2 weeks
		6.4	Landscaping.	
			TOTAL	**48 weeks**

Notes:
(a) The micro-pile may not be required if the diaphragm wall sits upon bed rock.
(b) Grouting at the foot of the wall may be required in the event the bleeding of water is severe.
(c) Part of the building services works may proceed in parallel with the finishing works.

3.3 Operational Requirements and Layout

3.3.1 The PS has a design flow capacity of 3600 l/s and will receive sewage flows from the South Kowloon and Hung Hom Bay areas. Incoming sewage will enter the PS through a mechanical raking device which will remove any large debris from the sewage flow. The sewage then passes into a number of wet wells in which the centrifugal pump units are located, to be pumped out to a rising main connected to the To Kwa Wan Preliminary Treatment Works.

3.3.2 An emergency by-pass will be provided to divert flows to the seawall for discharge to Hung Hom Bay in case of the failure of the pumping station. The detailed design will investigate and incorporate all practical precautions to minimise the likelihood of such an event such as the provision of stand-by pumps, telemetric warning devices, emergency storage to accommodate 2DWF, fine screen, and outlet located below the Low Water Mark and access to a portable mobile generator.

3.3.3 The main items requiring periodic maintenance and inspection in the PS will be the bar screens and wet wells. Regular cleaning of the screens will be necessary to prevent blockage of the screens by debris. When the sewage collects in the wet wells, the entrained grit tends to settle out thereby reducing the well capacity and restricting inflow to the pumps. The accumulated grit will be removed periodically along with any greasy deposits and multiple compartments will be provided so that the station can stay in operation while one or more wells are cleaned. Facilities will be provided on site for temporary storage of screenings in sealed drums or skips prior to removal for disposal at landfill.

3.3.4 The ventilation system is required to change air in the lower 3 m of both wet and dry wells 25 times/hour, which corresponds to a ventilation capacity of 223 m^3/min for each well. The vent will discharge outside the building. Odour arising from the septicity of the sewage is to be expected although odorous emissions will be minimized by careful design and operation of the pumping station. It is important, for example, to achieve a good match between incoming flows and the pumping rate. This will avoid surcharging of the incoming sewers and also minimise wear and tear to the pumps caused by excessive starting and stopping. A deodorisation system will be installed in order to reduce odour to an acceptable level. The deodorisation system is discussed further in Section 5.

4. Noise Impacts

4.1 Introduction

4.1.1 This section deals with the noise impacts associated with the construction and operation of the PS. The relevant assessment criteria, input assumptions and assessment methodology are described below.

4.2 Environmental Standards and Guidelines

Construction Noise

4.2.1 Noise impacts arising from the construction activities at the PS are assessed in accordance with the Noise Control Ordinance, 1988 (NCO) and the Technical Memorandum on Noise from Construction Works other than Percussive Piling (EPD, 1991).

4.2.2 Construction activity during restricted evening and night-time hours (19:00 - 07:00 hours) and on general holidays and Sundays is not expected and piling plant will not be used. Thus, an assessment criterion of L_{eq}(30 min) 75 dB(A) (façade noise level) for this urban area has been adopted.

Operational Noise

4.2.3 Operational noise is assessed on the basis of the Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites (EPD, 1989).

4.2.4 The Technical Memorandum requires that the neighbourhood of the PS be characterized to determine the Area Sensitivity Rating (ASR). The Noise Sensitive Receivers (NSRs) are located on the Hung Hom Reclamation, adjacent or close to the Hung Hom Bypass and Princess Margaret Road Link. The NSRs may thus be assumed to have an ASR of "C", appropriate for an urban area directly or indirectly affected by a major road. The operational phase NSRs are shown in Figure 2.3.

4.2.5 On the basis of this ASR, the appropriate Acceptable Noise Levels (ANLs) for NSRs in the study area are shown in Table 4.1. Since sensitive receivers OSR1 (magistracy), OSR3 (primary school) and OSR5 (clinic/community) will not normally be in use at night, the night-time assessment criterion is not applicable.

4.2.6 In addition to the above criteria the Hong Kong Planning Standards and Guidelines (HKPSG) require that fixed noise sources should be designed so that, when assessed in accordance with the Technical Memorandum, the level of the intruding noise at the façade of the nearest SR should be either 5 dB(A) below the appropriate ANL or below the prevailing background noise level, whichever is lower. Since it is not possible to establish a representative background noise level (due to the presence of plant and equipment associated with the reclamation works) the criterion of ANL-5 dB(A) has been adopted for this assessment.

Table 4.1 Acceptable Noise Levels for Operational Noise

NSR	Acceptable Noise Level, dB(A)	
	Day/Evening (07:00-23:00)	Night (23:00-07:00)
OSR1, OSR3, OSR5	70	not applicable
OSR2	70	60

4.3 Impact of Construction Phase

4.3.1 The reclamation is currently vacant, and construction of the pumping station is expected to proceed concurrently with other developments on the reclamation.

4.3.2 The construction of the PS will be carried out in sequential steps. Major construction works will involve diaphragm wall and micro-piles, basement structures, super-structure, finishing works, building services installation and other works. Table 4.2 details the plant and equipment required for each construction task.

4.3.3 The equipment schedule shown in Table 4.2 is a tentative one indicating the types of plant and equipment that will be on site at a given stage. It is unlikely that all the equipment will be used simultaneously during a particular construction stage. However, for the purpose of this assessment, total sound power levels (SWL) during various construction stages have been calculated based on the assumption that all plant and equipment will be operated at the same time. As indicated in the table, construction of basement structures will be the noisiest work (estimated total SWL = 126.1 dB(A)), representing the worst case scenario for the construction noise assessment.

4.3.4 Calculations for the Corrected Noise Level (CNL) at the most affected NSR, Whampoa Garden (i.e. CSR1), are given in Table 4.3. The CNL at CSR1 is predicted to be 69.2 dB(A); well within the EPD recommended noise level of 75 dB(A).

Table 4.3 Construction Noise Calculations

NSR	Source-Receiver Distance m	SWL dB(A)	Distance Attenuation dB(A)	Façade Effect dB(A)	CNL dB(A)
CSR1	395	126.1	-59.9	+3	69.2

Table 4.2 Typical Plant and Equipment Requirements for Construction of the Pumping Station

Task	Equipment	No. of Pieces	SWL, dB(A)	
			Per Piece	Total
Diaphragm Wall and Micro-piles	Air compressor	1	109	124.2
	Backhoe	1	112	
	Bar bender	1	90	
	Bentonite filtering plant	1	105	
	Boring machine	2	115	
	Concrete pump	1	109	
	Concrete truck with mixer	1	109	
	Dump truck	2	117	
	Electric saw	3	108	
	Generator	1	108	
	Mobile crane (with grab)	2	112	

Table 4.2 (Cont'd)

Task	Equipment	No. of Pieces	SWL, dB(A)	
			Per Piece	Total
Basement Structures	Air compressor	1	109	126.1
	Backhoe	1	112	
	Bar bender	1	90	
	Concrete pump	1	109	
	Concrete truck with mixer	1	109	
	Dump truck	2	117	
	Electric saw	3	108	
	Generator	1	108	
	Mobile crane (with grab)	2	112	
	Concrete compactor	4	105	
	Convey belt	1	90	
	Dewatering pump	4 - 6	85	
	Pneumatic breaker (hand held)	4	117	

Table 4.2 (Cont'd)

Task	Equipment	No. of Pieces	SWL, dB(A)	
			Per Piece	Total
Super-structure	Bar bender	1	90	117.3
	Concrete compactor	4	105	
	Electric saw	3	108	
	Generator	1	108	
	Mobile crane	1	112	
Finishing Works	Electric saw	3	108	116.2
	Generator	1	108	
	Mobile crane	1	112	
Building Services Installation & Other Works	Generator	1	108	108
External Works & Pavement	Backhoe	1	112	115.4
	Generator	1	108	
	soil compactor	2	108	

4.4 Impact of Operational Phase

4.4.1 The plant and equipment likely to contribute to noise arising from the PS are indicated in Table 4.4 together with their respective number, location, capacity, type of containment, operation mode and sound power level.

4.4.2 The general arrangement of the PS and layout of the major noise generating plant and equipment are indicated in Drawing Nos. RH/2401/P172, P173 and P174 in Appendix C.

4.4.3 The noise levels arising from the plants and equipment have been predicted using the following equations:

$$CNL = PNL + C(e) + C(i) + C(r) + C(f) \quad .....(1)$$

where, CNL = corrected noise level, dB(A)
PNL = uncorrected noise level, dB(A)
C(e) = end correction for fan, dB(A)
C(i) = insertion loss of enclosure, dB(A)
C(r) = reverberation correction, dB(A)
C(f) = façade correction, dB(A)

The uncorrected noise level is calculated using the following equation:

$$PNL = SWL - 20 \log R - 8 \quad .....(2)$$

where, SWL = sound power level, dB(A)
R = source-receiver distance, m

4.4.4 The worst case scenario - all duty sewage pumps, sump pumps and ventilation fans operating simultaneously - has been adopted for the operational noise prediction.

4.4.5 The corrected noise levels at the nearest façade of the SRs has been calculated according to Equations (1) and (2). Apart from distance attenuation and façade correction, a correction of +3 dB(A) has been applied to the predicted noise levels to account for the exit effects of the fans or reverberation effects of the sewage pump motors. In addition, the screening effects due to building/room enclosures have also been taken into account. The noise assessment, however, has assumed that all entrances and doors are normally closed.

4.4.6 Tables 4.5 to 4.8 show the predicted corrected noise levels at the respective SRs. According to the noise calculations, the predicted operational noise levels at OSR1, OSR2, OSR3 and OSR5 are 48.7, 31.0, 32.1 and 31.9 dB(A) respectively. These noise levels comply with the HKPSG stipulated daytime/evening and night-time noise criteria of 65 and 55 dB(A) respectively. As such, the operation of the PS is unlikely to cause significant impact to nearby SRs.

Table 4.4 Plant and Equipment Schedule for Installation in the Pumping Station

Plant/Equipment	No.	Location	Capacity	Type of Containment	Operation Mode	SWL per Item dB(A)
Sewage Pump No. 1 to 6	6	Mechanical Building	900 l/s @ 21 m (250 KW)	Enclosed	(see note)[a]	88
Sump Pump	2	Sump pits in dry well	21 l/s @ 5 m	Enclosed	Intermittent	85
Belt driven fan (for dry well)	2	Mechanical Building[b]	1.86 m^3/s @ 350 Pa	Semi-enclosed	Continuous	76.5
Axial fan (for wet well)	2	Mechanical Building[b]	1.86 m^3/s @ 350 Pa	Semi-enclosed	Continuous	76.5
Axial fan (for screen chamber)	1	Mechanical Building[b]	1.25 m^3/s @ 300 Pa	Semi-enclosed	Continuous	74

Notes: a There are two sets of sewage pumps, each comprising 2 duty and 1 standby pumps (one set consists of pump nos. 1 to 3 and the other set consists of pump nos. 4 to 6). All 4 duty pumps will be on under the worst situation.

b It is assumed that all fans will be mounted at southern end (at ceiling level) of the Mechanical Building and exhausted through the southern wall of the building.

Table 4.5 Predicted Operational Noise Levels at OSR1

Plant/Equipment		SWL dB(A)	R m	PNL dB(A)	C(e) dB(A)	C(l) dB(A)	C(r) dB(A)	C(f) dB(A)	CNL dB(A)
Sewage Pump[a]	No. 1	88	30	-	-	-20	+3	+3	-
	No. 2	88	27	51.4	-	-20	+3	+3	37.4
	No. 3	88	24	52.4	-	-20	+3	+3	38.4
	No. 4	88	18	-	-	-20	+3	+3	-
	No. 5	88	15	56.5	-	-20	+3	+3	42.5
	No. 6	88	12	58.4	-	-20	+3	+3	44.4
Sump Pump (near sewage pump no. 1)		85	30	47.5	-	-20	-	+3	30.5
Sump Pump (near sewage pump no. 6)		85	14	54.1	-	-20	-	+3	37.1
Fans (2 nos. for dry well)		79.5[b]	35	40.6	+3	-10	-	+3	36.6
Fans (2 nos. for wet well)		79.5[b]	35	40.6	+3	-10	-	+3	36.6
Fan (for screen chamber)		74	35	35.1	+3	-10	-	+3	31.1
Total Noise Level at Receiver		-	-	-	-	-	-	-	48.7

Notes: a The 2 pumps of each pump set closest to the sensitive receiver (i.e. total 4 pumps) have been allowed for noise calculation.
b Total sound power level for 2 fans.

Table 4.6 Predicted Operational Noise Levels at OSR2

Plant/Equipment		SWL dB(A)	R m	PNL dB(A)	C(e) dB(A)	C(l) dB(A)	C(r) dB(A)	C(f) dB(A)	CNL dB(A)
Sewage Pump[a]	No. 1	88	162	-	-	-20	+3	+3	-
	No. 2	88	160	35.9	-	-20	+3	+3	21.9
	No. 3	88	158	36.0	-	-20	+3	+3	22.0
	No. 4	88	156	-	-	-20	+3	+3	-
	No. 5	88	154	36.2	-	-20	+3	+3	22.2
	No. 6	88	152	36.4	-	-20	+3	+3	22.4
Sump Pump (near sewage pump no. 1)		85	161	32.9	-	-20	-	+3	15.9
Sump Pump (near sewage pump no. 6)		85	155	33.2	-	-20	-	+3	16.2
Fans (2 nos. for dry well)		79.5[b]	157	27.6	+3	-10	-	+3	23.6
Fans (2 nos. for wet well)		79.5[b]	159	27.5	+3	-10	-	+3	23.5
Fan (for screen chamber)		74	161	21.9	+3	-10	-	+3	17.9
Total Noise Level at Receiver		-	-	-	-	-	-	-	31.0

Notes: a The 2 pumps of each pump set closest to the sensitive receiver (i.e. total 4 pumps) have been allowed for noise calculation.
b Total sound power level for 2 fans.

Table 4.7 Predicted Operational Noise Levels at OSR3

Plant/Equipment		SWL dB(A)	R m	PNL dB(A)	C(e) dB(A)	C(i) dB(A)	C(r) dB(A)	C(f) dB(A)	CNL dB(A)
Sewage Pump[a]	No. 1	88	213	-	-	-20	+3	+3	-
	No. 2	88	210	33.6	-	-20	+3	+3	19.6
	No. 3	88	207	33.7	-	-20	+3	+3	19.7
	No. 4	88	204	-	-	-20	+3	+3	-
	No. 5	88	201	33.9	-	-20	+3	+3	19.9
	No. 6	88	198	34.1	-	-20	+3	+3	20.1
Sump Pump (near sewage pump no. 1)		85	211	30.5	-	-20	-	+3	26.5
Sump Pump (near sewage pump no. 6)		85	202	30.9	-	-20	-	+3	26.9
Fans (2 nos. for dry well)		79.5[b]	213	24.9	+3	-10	-	+3	20.9
Fans (2 nos. for wet well)		79.5[b]	215	24.9	+3	-10	-	+3	20.9
Fan (for screen chamber)		74	217	19.3	+3	-10	-	+3	15.3
Total Noise Level at Receiver		-	-	-	-	-	-	-	32.1

Notes: a The 2 pumps of each pump set closest to the sensitive receiver (i.e. total 4 pumps) have been allowed for noise calculation.
b Total sound power level for 2 fans.

Table 4.8 Predicted Operational Noise Levels at OSR5

Plant/Equipment		SWL dB(A)	R m	PNL dB(A)	C(e) dB(A)	C(i) dB(A)	C(r) dB(A)	C(f) dB(A)	CNL dB(A)
Sewage Pump[a]	No. 1	88	210	-	-	-20	+3	+3	-
	No. 2	88	209	33.6	-	-20	+3	+3	19.6
	No. 3	88	207	33.7	-	-20	+3	+3	19.7
	No. 4	88	207	33.7	-	-20	+3	+3	19.7
	No. 5	88	209	33.6	-	-20	+3	+3	19.6
	No. 6	88	210	-	-	-20	+3	+3	-
Sump Pump (near sewage pump no. 1)		85	211	30.5	-	-20	-	+3	26.5
Sump Pump (near sewage pump no. 6)		85	211	30.5	-	-20	-	+3	26.5
Fans (2 nos. for dry well)		79.5[b]	208	25.1	+3	-10	-	+3	21.1
Fans (2 nos. for wet well)		79.5[b]	210	25.0	+3	-10	-	+3	21.0
Fan (for screen chamber)		74	212	19.5	+3	-10	-	+3	15.5
Total Noise Level at Receiver		-	-	-	-	-	-	-	31.9

Notes: a The 2 pumps of each pump set closest to the sensitive receiver (i.e. total 4 pumps) have been allowed for noise calculation.
b Total sound power level for 2 fans.

4.5 Mitigation Measures

4.5.1 As demonstrated in Sections 4.3 and 4.4 above, both construction and operational noise levels predicted at the SRs will be well within the prescribed assessment criteria. As the noise impacts will be insignificant, the implementation of specific mitigation measures is not anticipated. However, the Contractor should observe the following site management and general noise control measures as good practice.

- Good housekeeping: Noisy equipment and activities should be sited by the contractor as far from SRs as is practical. Idle equipment should be turned off or throttled down.
- Proper plant and equipment maintenance: Construction plant and equipment should be properly maintained, operated and used no more often than is necessary.
- Use of quietened plant and equipment: Noisy plant or equipment should be replaced by quieter alternatives where possible (e.g. plant with vibration isolation devices, partial or full acoustic enclosures).
- Manual operation: If site conditions permit, manual operations would generally be the quietest process.
- Careful scheduling of works: Noisy activities can be scheduled to minimise exposure of the SRs to high levels of construction noise. Construction activities should be planned so that the parallel operation of several sets of noisy equipment is avoided.
- Limited hours of use for PME: Noisy PME should be operated only during normal daytime. Prolonged operation of noisy equipment should be avoided.
- Use of temporary noise barriers: Enclosures or partial enclosures for noisy activities should be applied where the noise impact is potentially severe.

4.5.3 Likewise, no specific mitigatory measures will be required for operational noise impacts, however the proper placement of plant and equipment is encouraged. Given that the PS will be situated immediately adjacent to the Regional Magistracy (OSR1), it is recommended that noisy equipment be installed along the southern site boundary if practical. The exhaust louvres of the ventilation system, therefore, should be located on the southern wall of the Mechanical Building (location of exhaust louvres is also determined by considerations on odour impact, see Section 5.5 for details).

4.6 Cumulative Impacts

4.6.1 Two public works projects in the Hung Hom Bay reclamation area are to be implemented concurrently with the PS works and could result in cumulative impacts. These projects are: (1) the Princess Margaret Road Link/Hung Hom Bypass; and, (2) the engineering infrastructure works including sewer and water mains.

4.6.2 At the time of construction of the pumping station, construction of the Princess Margaret

Road Link/Hung Hom Bypass may be taken place close to the PS site. The construction noise level during the daytime at Whampoa Garden Phase 4 (i.e. CSR1) was estimated to be 78 dB(A), as reported in the "Hung Hom Bypass and Princess Margaret Road Link Preliminary Report Part 1 Volume 1 - Report (Final)". The cumulative construction noise impact contributed by the PS (69.2 dB(A) at receiver CSR1) would be 0.5 dB(A). The cumulative effect would therefore be negligible as noise generated by the construction of the Princess Margaret Road Link/Hung Hom Bypass will be the dominant source.

4.6.3 In the absence of information relating to the engineering infrastructure works, the precise nature and extent of the overall cumulative impacts cannot be determined at this stage. However, given the small scale of the construction work associated with the PS, and the ample buffer distance between the site and the sensitive receiver, it is unlikely that the PS will contribute significantly to the cumulative impacts on any nearby sensitive receivers.

4.7 Conclusions

4.7.1 Construction of the PS will generate noise from the use of powered mechanical equipment. Given the nature and scale of the construction activities, and the sensitivity and proximity of the nearest SRs, construction noise is unlikely to be a major constraint. The maximum noise level at the receiver has been predicted to be 69.2 dB(A) when construction of basement structures is under way. As a preventive measure, the contractor should observe good housekeeping practices and general noise control provisions.

4.7.2 During the operational phase, pumps and fans represent the principal noise sources in the PS. The noise assessment indicates that noise level at the most affected receiver, OSR1, will be 48.7 dB(A). This demonstrates that the noise impact due to the operation of the PS will comply with both the daytime, evening and night-time noise criteria. Since the impact is unlikely to be significant, no special mitigation measures are required. Nevertheless, it is recommended that the exhausts of the ventilation system be located on the farthest wall from OSR1 in order to minimize the noise impact.

5. Air Quality Impacts

5.1 Introduction

5.1.1 This section examines the potential air quality impacts associated with the construction and operation of the PS, focusing in particular upon the practical application of suitable odour mitigation measures. The relevant assessment criteria, input assumptions and modelling methodologies are described below.

5.2 Environmental Standards and Guidelines

Construction Dust

5.2.1 Construction dust impacts have been assessed in accordance with the Air Pollution Control Ordinance, 1983, which established a set of health-related Air Quality Objectives (AQOs) for seven pollutants, including TSP and RSP. Compliance with the AQOs shown in Table 5.1, as well as the 500 $\mu g/m^3$ 1-hour TSP guideline recommended by EPD, is required.

Table 5.1 Hong Kong Air Quality Objectives

Parameters	Average Concentration ($\mu g/m^3$)	
	24-hour[a]	Annual[b]
TSP	260	80
RSP	180	55

Notes: a Not to be exceeded more than once per year.
b Arithmetic means.

Odour

5.2.2 Odour is a subjective parameter and there is no statutory criteria for maximum levels of odours in Hong Kong. For the purpose of odour monitoring, the EPD's recommended odour nuisance criteria is 2 odour units (OUs) at the site boundary. For the purpose of odour modelling, a level of 5 OUs averaged over 5 seconds at the sensitive receiver will be used.

5.3 Impact of Construction Phase

5.3.1 The magnitude of construction dust impacts depends largely on the interaction between the dust sources (e.g. earth moving activities, building construction, material handling and construction-related traffic movements), sensitive receivers and the dust generation/dispersion process.

5.3.2 The construction works involved in this case are not extensive and will be no more dusty than other building construction projects of a comparable size in Hong Kong. The anticipated construction programme is short - the PS is scheduled to be completed within 48 weeks - and the nearest SR (CSR1), is located 330 m from the site boundary. Provided that good housekeeping practices are adhered to and dust control measures are implemented at site, no major dust impact is envisaged during the construction phase.

5.4 Impact of Operational Phase

5.4.1 The only significant operational air quality impact likely to arise from the handling of sewage in the PS will be odorous emissions.

5.4.2 Odour-producing substances found in sewage generally consist of complex mixtures of small, relatively volatile compounds which are odorous both individually and collectively. Most of the odorous emissions result from the anaerobic decomposition of organic matter containing sulphur and nitrogen.

5.4.3 Among the many potential odour sources within any sewerage system, hydrogen sulphide (H_2S) is the most commonly known and prevalent odorous gas (USEPA, 1985). In this regard the concentration of H_2S has been employed as a representative odour level for the odour assessment.

Odour Unit and Odour Concentration

5.4.4 The definition of odour unit adopted by EPD is based on that used by the Environmental Protection Authority (Victoria), Australia. According to this definition, an odour unit is defined as the ratio of: the volume which the sample occupies when diluted to the odour threshold, to the total volume of the sample.

5.4.5 Analogously, the odour unit can be determined in terms of odour concentration (in parts per million by volume, ppm_v):

OU = actual odour concentration / odour concentration at threshold level

5.4.6 Since the threshold concentration of H_2S, the carrier gas of the odorous emissions, is 0.00047 ppm_v, the odour unit at a particular sensitive receiver can be represented by the following mathematical relationship:

OU = concentration of H_2S at receiver / threshold concentration of H_2S

= concentration of H_2S at receiver / 0.00047 ppm_v

Alternatively, using $\mu g/m^3$ as the concentration unit:

OU = concentration of H_2S at receiver / 0.6535 $\mu g/m^3$

5.4.7 Therefore, EPD's recommended odour limits at the sensitive receiver and the site boundary are 3.27 $\mu g/m^3$ (or 0.00235 ppm_v) and 1.31 $\mu g/m^3$ (or 0.00094 ppm_v) respectively.

Emission Rate of H_2S

5.4.8 Emission of H_2S from the PS has been calculated based on two considerations: (1) rate of H_2S generated from the wet well; and (2) ventilation of the wet well.

5.4.9 Emission of H_2S from the wet well under typical sewage conditions has been estimated according to the equations developed by Pomeroy (USEPA, 1985):

$$R_{sf} = \emptyset_{st} / d_m$$

$$\emptyset_{st} = 0.69 \times (su)^{3/8} \times j \times DS$$

where, R_{sf} = emission of H_2S, mg/l-hr
$\emptyset_{st}$ = flux of H_2S, g/m^2-hr
d_m = mean hydraulic depth, m
s = slope of energy grade line, m/m
u = stream velocity, m/s
j = proportion of dissolved sulfide present as H_2S
DS = dissolved sulfide concentration, mg/l

The following sewage characteristics have been adopted:

Temperature of sewage = 20°C
pH of sewage = 7
DS = 4 mg/l

5.4.10 The rate of H_2S emitted from the PS through the ventilation system has been calculated using the following equation:

Rate of H_2S vented outside the PS = (R_{sf} x ventilation rate) / ventilated volume

Ventilation will be provided to change air in the lower 3 m of the wet well 25 times per hour, which corresponds to a ventilation rate of 223 m^3/minute.

5.4.11 Based upon the H_2S emission rate and ventilation rate calculation using the equations above, the predicted rate of H_2S released from the PS will be 3.2×10^{-5} g/s, which exceeds the design criterion of 5×10^{-7} g/s as determined in the Key Issues Report (KIR). Therefore, detailed odour assessment and appropriate deodorization of ventilation emissions are required.

Odour Modelling

5.4.12 The concentration of H_2S at SRs has been calculated using the ISCST model (urban mode for point source and 1-hour concentration), based on the recommended odour level of 5 OUs at

the sensitive receptor and adjusted to a 5-second averaging time. One year's sequential meteorological data from the Royal Observatory's King's Park Station for the year 1993 has been used.

5.4.13 The following input parameters have been used for the odour modelling:

- According to the latest pumping station layout available at this stage, the odour source height (i.e. location of the wet well ventilation exhaust) would be at 3 m above ground.
- Since the mechanical ventilation system has not been finalised yet, the exit velocity and exit diameter have been assumed to be 7 m/s and 800 mm respectively, which are typical for extraction fans suitable for this type of application.
- The wet well ventilation exhaust louvre shall be installed on the southern wall of the Mechanical Building furthest from the nearest SR (OSR1).

5.4.14 The adjustment of concentration averaging time has been based on R.A. Duffee, *et al* (1991):

$$C_{1\ hr} = C_{3\ min} \times (t_{3\ min} / t_{1\ hr})^{p}$$

$$C_{5\ sec} = C_{3\ min} \times cf$$

where, C = odour concentration
t = averaging time
p = power-law exponent
cf = correction factor

Odour Modelling Results

5.4.15 The results of the unmitigated odour modelling are presented in Figure 5.1 and are summarized in Table 5.2. The odour modelling indicates that the concentration levels at OSR2, OSR3, OSR4 and OSR5 are less that 1 OU, and therefore comply with EPD's odour criterion. However, the odour concentrations at OSR1 at levels 10 m and 20 m are 5.2 OUs and 6.5 OUs respectively. It is clear that the air quality impacts on OSR1 are significant and mitigation measures will be required.

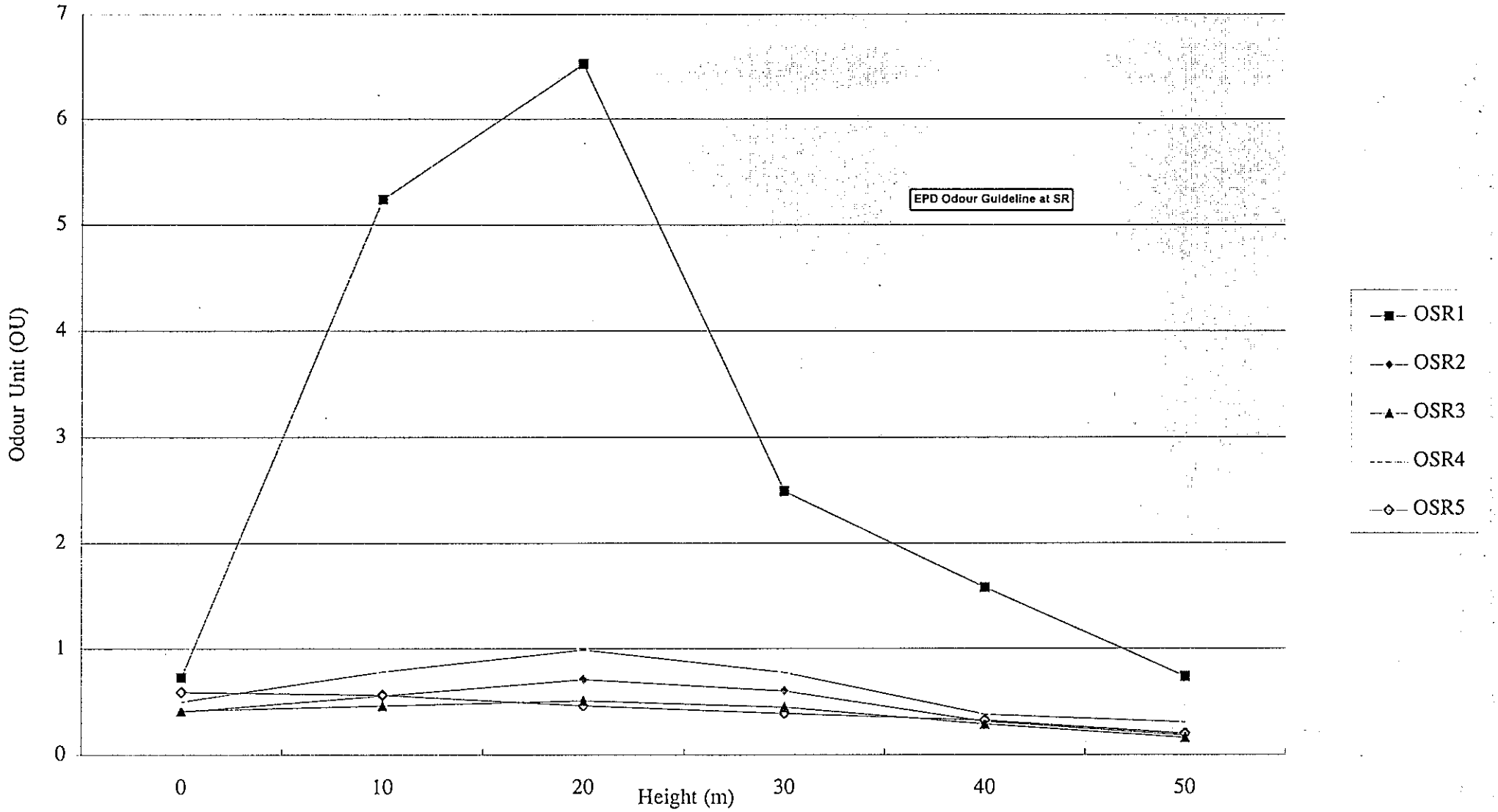

Figure 5.1. Odour Modelling Results

Table 5.2 Predicted Odour Concentration Levels at Sensitive Receptors (Unmitigated)

Sensitive Receiver	Source-Receiver Distance	Maximum Odour Level	
		OU	Level Above Ground (m)
OSR1	30	6.5	20
OSR2	150	0.7	20
OSR3	200	0.5	20
OSR4	120	1.0	20
OSR5	230	0.6	0

5.5 Mitigation Measures

Construction Phase

5.5.1 Although construction activities are unlikely to cause a significant impact, it is recommended that the contractor should observe the following site management and general dust control provisions as good practice:

- Stockpiles of sand and aggregate greater than 20 m^3 for use in concrete manufacturing should be enclosed on 3 sides with walls extending above the top of the pile and 2 m beyond the front of the pile.
- Effective water sprays should be employed during the delivery and handling of all raw and aggregate and other similar material when dust is likely to be created and to dampen all stored materials during periods of persistent dry and windy weather.
- Contractor should restrict all motorised vehicles to a maximum speed of 8 kph.
- Areas within the site where there is regular movement of vehicles should have an approved hard surface and be kept clear of loose surface material.
- Wheel washing facilities should be installed and used by all vehicles leaving the site.
- Any conveyor belts should be fitted with wind boards and conveyor transfer points and hopper discharge areas should be enclosed in order to minimise dust emissions.
- Cement and other fine grained materials delivered in bulk should be stored in closed silos fitted with high level alarm indicators.
- Weight hoppers should be vented to a suitable filter.
- Details of adequate dust suppression plant, including water bowsers with spray bars

or means of applying surface chemical treatment, should be submitted to and approved by the RSS.

- Any vehicle with an open load carrying area used for moving potentially dust producing material should have properly fitting side and tail boards and a tarpaulin cover.

Operational Phase

5.5.2 The odour assessment has concluded that odour control and prevention measures are needed as a safeguard against the possibility of odour nuisance. Mitigation can be achieved through the design of the PS, installation of suitable deodorisation units and good housekeeping practice, either by preventing H_2S emissions, or by treating H_2S-contaminated air.

Pumping Station Design

5.5.3 Careful design of the pumping station and associated mechanical systems can help to prevent odour release. Self-cleaning velocities should be maintained at all sewers and channels to prevent solids deposition. From the odour prevention point of view, a minimum self-cleaning velocity of 0.45 m/s at minimum flow is advised. A velocity of less than 0.2 m/s may cause deposition of organic solids and grit, with resulting generation of objectionable odours.

5.5.4 Ventilation outlets should be directed away from the adjoining SR (OSR1) to help ameliorate the odour impact. In particular, the exhaust louvre for the wet well should be installed on the southern wall of the Mechanical Building.

5.5.5 The release of H_2S gas can also be minimised by matching the pumping rates, which are determined by pump duties and operational sequences, as closely as possible to the inflow rates. In this way, surcharging of the influent sewers, with its consequent odour production, may be avoided.

Deodorisation System

5.5.6 A review of possible odour control and prevention technologies suited to the present application was undertaken in the Key Issues Report. Those deodorisation techniques which were evaluated included:

- air injection;
- oxygen injection;
- addition of hydrogen peroxide;
- addition of chlorine;
- use of wet scrubbers; and,
- use of carbon filters.

5.5.7 Table 5.3 summarises the major advantages and disadvantages of the principal deodorisation techniques.

5.5.8 Given that the sewage will be relatively fresh, oxygenation of the wet well will not be required and the use of air injection or oxygen injection is likely to be ineffective.

5.5.9 Hydrogen peroxide and chlorine are strong oxidants. Their transportation, storage and handling imply risks that must be managed with extreme care. The use of hydrogen peroxide and chlorine in a densely populated area such as Hung Hom is particularly risky. Based on these safety considerations, it is recommended that these two treatment techniques should not be employed in the PS.

5.5.10 While wet scrubbers are well suited to ventilation of the PS, their application in the PS are discouraged because the common reactive compounds added to scrubbing liquid (e.g. chlorine, potassium permanganate, hydrogen peroxide or ozone) may cause potential hazards or high operating costs.

5.5.11 Another standard odour control technique is thermal incineration. Since thermal incineration is generally only used for very high volumes of odorous industrial emissions, it would not be suitable for the PS due to high capital and running costs.

5.5.12 Biological treatment in the form of biofilters can also be used in sewerage applications. Odour removal is achieved by the use of micro-organisms grown on an inert packing media. Biofilters may be started up with a mixture of activated sludge and nutrient solution. As an alternative treatment process, odorous air may be passed through a soil, peat or composite bed, where odour is removed under the influence of enzymes produced by micro-organisms in the soil. Although the installation and running costs of this type of deodorisation system are relatively low, odour breakthrough is more likely and the biofilters are in general less effective than other odour control systems such as activated carbon.

5.5.13 Activated carbon filters are considered the most suitable deodorisation measure for the PS. This odour removal technique has many benefits over other methods discussed above. The major advantages of an activated carbon system are:

- Activated carbon filters are very efficient in reducing odour. Typical activated carbon filter products may offer odour removal efficiencies ranging from 75% to over 99.5%.
- This deodorisation method does not involve the use of hazardous chemicals and thus it can be used safely in urban areas.
- Proper regeneration of carbon could reduce the operating cost and increase the useful life of carbon for odour removal.
- The activated carbon odour control system is easy to install and maintain as it could be isolated from the ventilation system without affecting the normal operation of the exhaust fans.
- Considerable local experience exists in the design, installation and operation of this type of system.

5.5.14 A number of options are available for the regeneration of spent activated carbon, for example, in-situ regeneration and off-site regeneration. Since the design of the ventilation system (e.g. system layout, equipment selection, pressure and flow calculations) has not been finalised at this stage, it is recommended that the detailed design of the deodorisation system should include performance and cost comparisons for various activated carbon options.

Table 5.3 Advantages and Disadvantages of Principal Deodorisation Systems

System	Cost		Equipment and Space Requirements	Operational Needs and Restrictions	Major Disadvantages/Advantages
	Capital	Running			
Biofilter	Low/Moderate	Low	Moderate	Relatively simple	• Desorption if concentration varies significantly • Odour breakthrough possible • System inflexible • Limited local experience • Low capital & operational costs
Wet Scrubber	Moderate	High	Moderate / High	Frequent maintenance	• Potential for desorption • Complex system • Scrubbing compounds e.g. Cl_2 & H_2O_2 are potentially hazardous • System highly flexible
Ozone	Moderate / High	High	Moderate / High	Frequent maintenance & close monitoring	• Potential hazard • Limited local application • Very effective odour removal agent
Activated Carbon	Low	Low / Moderate	Low	Relatively simple	• Regeneration or replacement of carbon required • Simple but efficient system • Cost effective • Widely installed in local sewerage pumping stations

Odour Prevention

5.5.15 The implementation of good housekeeping practices at the PS will also contribute to the prevention of odorous emissions. The following practices should be incorporated into maintenance procedures at the plant:

- Wet wells should be inspected weekly to ensure that odour-generating grease, oil and scum do not accumulate. If build-up of these substances is a problem, the frequency of inspection and removal will have to be increased.
- Regular cleaning and flushing of screens and other sewage handling equipment should be enforced, to prevent the accumulation of odour-producing organic debris.
- Grit stored on the site should be kept in closed containers. Grit should not be stored for long periods of time before disposal.
- Sludge deposits in wet wells and channels should be regularly removed, and the walls flushed. Sludge left in the pump and pipes can produce odorous gas. When shutting down a pump for a prolonged period of time, it should be completely drained and sludge removed from the pump and connecting pipes.
- Regular inspections and services on deodorisation and ventilation systems should be provided to ensure the proper operation of these systems.

Mitigated Odour Modelling Results

5.5.16 An activated carbon deodorization system offering a minimum removal efficiency of 75% is recommended as this is appropriate for a system capable of polishing air flows to the required extent. Results of the mitigated odour modelling for receiver OSR1 at levels 10 m and 20 m are presented in Table 5.3. The worst case maximum predicted odour level at OSR1 is 1.625 OUs, and thus EPD's odour modelling criterion can be complied with when mitigation is implemented.

Table 5.4 Predicted Odour Concentration Levels at OSR1 (Mitigated)

Level Above Ground (m)	Odour Level (OUs)	
	Unmitigated	Mitigated
10	5.2	1.3
20	6.5	1.625

5.6 Cumulative Impacts

5.6.1 Given the small scale of the PS, the air quality impacts associated with other more extensive infrastructure projects within the study area are likely to overshadow those impacts associated with the proposed works. Therefore it is unlikely that the PS will contribute significantly to the cumulative impacts on any nearby sensitive receivers.

5.7 Conclusions

5.7.1 Given the nature and scale of the construction activities, and the sensitivity and proximity of the nearest SRs, dust generated during the construction phase is unlikely to be a major constraint. However, the contractor should observe the recommended housekeeping and general dust control measures as a preventive measure.

5.7.2 During the operation of the PS, odour will cause significant impact to the sensitive receivers in the vicinity. The principal odour source is H_2S emitted from sewage in the wet well. To ameliorate this adverse impact, activated carbon filter with a minimum 75% odour removal efficiency is recommended. Performance and cost effectiveness of various system options should be evaluated when conducting the detail design of the deodorisation system.

6. Water Quality Impacts

6.1 Introduction

6.1.1 This section examines the water quality impacts arising from the operation and construction of the PS.

6.2 Environmental Standards and Guidelines

6.2.1 The principal legislation relating to marine water quality in Hong Kong is the Water Pollution Control Ordinance, 1980/1990 (WPCO). The WPCO makes provision for the gazetting of Water Control Zones (WCZ) within which specific Water Quality Objectives (WQO) are declared. The WQOs form the basis of limits applied to the quality of any discharges entering the water body via sewers, storm drains or surface runoff. These limits are embodied in the relevant Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (EPD, 1991).

6.2.2 The implementation of the WPCO in the study area, in the form of the Victoria Harbour WCZ, will be in 3 phases. Phase I was gazetted on 1 November, 1994 and covers inland and coastal areas to the east and west of the Harbour and includes an area between Yau Long and Jordan Valley in the vicinity of Kai Tak Airport. The Victoria Harbour WCZ is scheduled to be extended to Hung Hom Bay by 1997.

6.2.3 At present no WQOs have been set for the study area which includes Hung Hom Bay. Hence there is no statutory control on the quality of liquids discharged to these waters. However, the design of the respective facilities should take into consideration the requirements of the Pase I WQOs which will come into effect in Hung Hom Bay as a result of the gazetting of Phases II and III of the Victoria Harbour WCZ. The Phase I WQOs are shown in Table 6.1.

6.3 Existing Water Quality

6.3.1 The ability of Victoria Harbour to assimilate pollutants is governed by its estuarine flows and tidal flushing. The residual flows through Victoria Harbour vary seasonally, with minimum flows of the order of 15 million m^3/day. Currents in Hung Hom Bay's eastern fairway (indicative of currents in the study area as a whole) do not generally exceed 1 m/s.

6.3.2 EPD have established a marine water quality monitoring station (VM4) which is indicative of water quality in Hung Hom Bay. The results from water quality monitoring station VM4 (see section 2, Table 2.2) indicate a high level of nitrogenous compounds and bacterial loading. *E. Coli* and Ammoniacal-nitrogen concentrations regularly exceed the respective WQOs and Dissolved oxygen concentrations occasionally fall below the relevant WQO (> 4mg/l for 90% of samples).

Table 6.1 Water Quality Objectives for Victoria Harbour (Phase One) Water Control Zone

Water quality parameter	Objective	Part(s) of Zone
Aesthetic Appearance	No objectionable odour or discolouration; Absence of tarry residues, flotsam etc.; Mineral oil should not be visible on the surface; No recognisable sewage derived debris; Absence of substances which might settle to cause objectionable deposits.	Whole Zone
Escherichia Coli	not to exceed 1000/100ml calculated as the geometric mean of 5 consecutive samples taken at intervals of 7 to 21 days	Inland Waters
Colour	not to exceed 50 Hazen Units	Inland Waters
Dissolved Oxygen	not less than 4 mg/l for 90% of samples and not less than 2 mg/l for 90% of samples within 2 m of the seabed; not less than 4 mg/l	Marine Waters Inland Waters
pH	between 6.5 and 8.5, change due to waste discharge not to exceed 0.2; not to exceed the range of 6.0 - 9.0	Marine Waters Inland Waters
Temperature	change due to waste discharge not to exceed 2°C	Whole Zone
Salinity	change due to waste discharge not to exceed 10% of natural ambient concentration	Whole Zone
Suspended Solids	waste discharge not to raise natural ambient concentration more than 30% nor cause the accumulation of solids which may adversely affect aquatic communities; not to exceed annual median of 25 mg/l	Marine Waters Inland Waters
Ammoniacal-Nitrogen	annual arithmetic mean not to exceed 0.021 mg/l	Whole Zone
Nutrients	should not be present in quantities that cause excessive algal growth; annual mean depth average of inorganic nitrogen not to exceed 0.4 mg/l	Marine Waters
5-Day Biochemical Oxygen Demand	not to exceed 5 mg/l	Inland Waters
Chemical Oxygen Demand	not to exceed 30 mg/l	Inland Waters
Toxic Substances	not present at concentrations sufficient to cause danger to aquatic organisms	Inland Waters

6.3.5 Until the WPCO is extended to Hung Hom Bay in the form of the Victoria Harbour WCZ Phases II and III, and suitable WQOs are set, the assessment of potential impacts associated with the PS must be evaluated against the Phase I WQOs, bearing in mind the existing poor water quality of Hung Hom Bay.

6.3.6 There are no beneficial users as defined in the HKPSG located within the study area.

6.4 Impact of Construction Phase

6.4.1 Runoff from the 36ha Hung Hom Bay reclamation contains high levels of suspended solids which impinge upon the water quality of Hung Hom Bay. Construction sites, in general, also affect local water quality as a result of the potentially high levels of suspended solids that may be entrained in overland flows during rain storms, as well as posing a minor risk to water quality as a result of fuel oil spillages and machine washings.

6.4.2 However, the impacts specifically associated with the construction of the PS are limited. This is due to the small scale of the development, the minimal amount of excavation and material handling that will be required and the distance of the site from the waterfront. Typical construction methods employed during site formation and the construction of the works are unlikely to cause a significant impact upon water quality in Hung Hom Bay. In comparison with the other infrastructure projects on the reclamation, proceeding in tandem with the construction of the PS, the impacts are likely to be negligible.

6.5 Impact of Operational Phase

6.5.1 Under normal circumstances there will be no water quality impacts associated with the operation of the PS. In the rare event that the pumps fail or that flows exceed the maximum capacity of the works during storm events, sewage will by-pass the PS and discharge into Hung Hom Bay. The PS however, is designed in such a way as to minimise the risk of such events and the likelihood of emergency discharges to Hung Hom Bay is very low. It should also be noted that because of the circumstances under which an emergency release is likely to take place (that is prolonged and heavy rainfall) dilution of the sewage is likely to limit the impact of the emergency discharge upon the receiving water body.

6.5.2 Given the existing poor water quality in the Bay and the rare circumstances which lead to such events - either an emergency scenario or heavy and prolonged rainfall which will effectively dilute the discharged sewage - the water quality impacts associated with such events are not considered significant, and do not warrant further assessment. Ultimately the water quality in the study area will be significantly improved as a result of these and other sewage improvement works.

6.6 Mitigation Measures

6.6.1 The following measures should be investigated and reviewed for incorporation into the final design of the PS in order to reduce the likelihood of an emergency discharge and to avoid or minimise the impacts of such an event should it occur.

- provision of stand-by pumps;
- provision of emergency power supply;
- emergency storage with capacity to accommodate 2DWF;
- installation of fine screen on overflow;
- provision of telemetric signalling device;
- emergency discharge should be located below the Low Water Mark; and,
- implementation of an Action Plan to reduce response time to such emergencies.

6.7 Cumulative Impacts

6.7.1 The water quality implications of existing and future projects in the study area are likely to overshadow those associated with the construction and operation of the PS. At present water quality in Hung Hom Bay is characterised by the impacts of ongoing construction and reclamation works. In the long term the gazetting of Phases II and III of the Victoria Harbour WCZ, the enforcement of the relevant WQOs and the implementation of the SSDS is likely to significantly improve local water quality.

6.8 Conclusions

6.8.1 The impacts upon the marine environment associated with the construction and operation of the PS will be minor. Given the existing poor water quality in the study area, the implementation of the SSDS in 1997 and the planned reclamation works in Kowloon Bay associated with South East Kowloon Development, the water quality impacts associated with the proposed works are not considered significant.

7. Visual Impacts

7.1 Introduction

7.1.1 This section of the report identifies :

- Potential visual impacts which will be experienced during the construction and operational phases of the proposed development.
- Landscape mitigation measures.
- Residual visual impacts after implementation of the mitigation measures.

7.2 Assessment Methodology

7.2.1 The visual impact of the proposed developments is assessed by :

a. Investigation of the landscape context of the development site in terms of the surrounding topography, vegetation, landuse and landscape character.

b. Identification of the major zones of visual influence of the site.

c. Identification of the potential visual receptors which will be affected by the development.

d. Synthesis of the above information leading to a comparative evaluation of the visual impacts.

Zone of Visual Influence

7.2.2 The zone of visual influence has been identified through site investigation and desktop analysis. The area of visibility is restricted by existing landforms, vegetation and buildings which surround the proposed sites. Having identified the zone of visual influence, it is possible to identify the potential visual receptors or groups of visual receptors within this zone.

Sensitive Visual Receptors

7.2.3 For the purpose of this study, the potential visual receptors may be grouped into four main categories which are listed below. The relative sensitivity of these receptors and the context of potential visual intrusion associated with the proposed works is assessed below.

i. Those who view the development from their homes;

This category of visual receptors is considered to be the most affected by any visual intrusion associated with the developments. This is because the attractiveness, or otherwise, of the outlook from the home will have a very significant affect on the home dwellers' perception of the quality and acceptability of their home environment

and their general quality of life.

ii. Those who view the development from their workplace;

This category of visual receptor is considered to be comparatively less affected by potential visual intrusion than those in the first category. This is because they are employed in activities where visual outlook plays a less important, although still significant, role in the perception of the quality of the working environment.

iii. Those who view the development whilst taking part in an outdoor leisure activity;

This category of visual receptors is considered more or less sensitive according to the type and nature of activity being enjoyed.

iv. Those who view the development whilst travelling along a public thoroughfare.

The degree of sensitivity of these receptors depends to a large extent on the speed of travel and whether the view is continuous or occasionally glimpsed. Generally, the slower the speed of travel and the more continuous the viewing experience becomes, the greater the degree of sensitivity.

7.2.4 The significance of the visual impact of the sites on the visual receptors varies greatly and is ultimately dependent on the complex inter-relationship of a number of factors including;

- Nature of the development and its compatibility with the surrounding landscape.
- Number and nature of visual receptors.
- Distance of the visual receptor from the development site.
- Length of time the development is in view.
- Landscape context of the development.
- Visual backdrop to the development site from important view points.
- Whether the development blocks attractive views or screens unattractive ones.

7.3 Site Context

Topography

7.3.1 The PS is to be sited on the Hung Hom reclamation area which is essentially flat and only several metres above sea level. To the south and east, the reclamation area fronts onto Kowloon Bay and to the north, west and north-east, it is bounded by existing urban development on the flat land of the Kowloon peninsula.

Vegetation

7.3.2 The site is still in the process of reclamation and there is no existing vegetation.

Landuse

7.3.3 The reclamation site is currently bordered to the west by the International Mail Centre, Hong Kong Coliseum and the KCRC depot and freight yards. Hung Hom South Road lies to the north with multi-storey residential estates beyond.

7.3.4 Located to the west of the site will be elevated roadways associated with a major interchange, and a commercial complex over the KCRC freight yards and elevated roadways to the south will separate the site from a hotel/service apartment complex. Commercial uses are proposed to the north and residential developments to the east.

Landscape Character

7.3.5 The current landscape is a relatively featureless active reclamation site dominated by current works machinery and KCRC freight handling and docking facilities. Site formations and excavations highlight the transient nature of the existing setting. Well established land-uses bordering the reclamation site provide the visual backdrop to views from within the site. The Hong Kong Coliseum is the most distinctive landmark to the west.

7.3.6 The proposed pumping station will ultimately lie within a dense urban environment of mixed land uses, including a major bypass, residential and commercial developments.

Zone of Visual Influence

7.3.7 The current zone of visual influence of the proposed development site extends to the edges of the reclamation area and to the neighbouring land-uses outlined above and is illustrated by Figure 7.1. Proposed land-uses must also be considered in assessing the likely visual impact of the PS and these are illustrated by Figure 7.2. The principal potential vantage points within the primary zone of visual influence can be summarised as follows:

a. Current Zone of Visual Influence

i. Views experienced from the north-east

- From the residential blocks at Hung Hom Bay Centre, Willow Mansions, Palm Mansions and Lily Mansions.

ii. Views experienced from the east

- From Kowloon Bay.

iii. Views experienced from the south

- From Kowloon Bay.

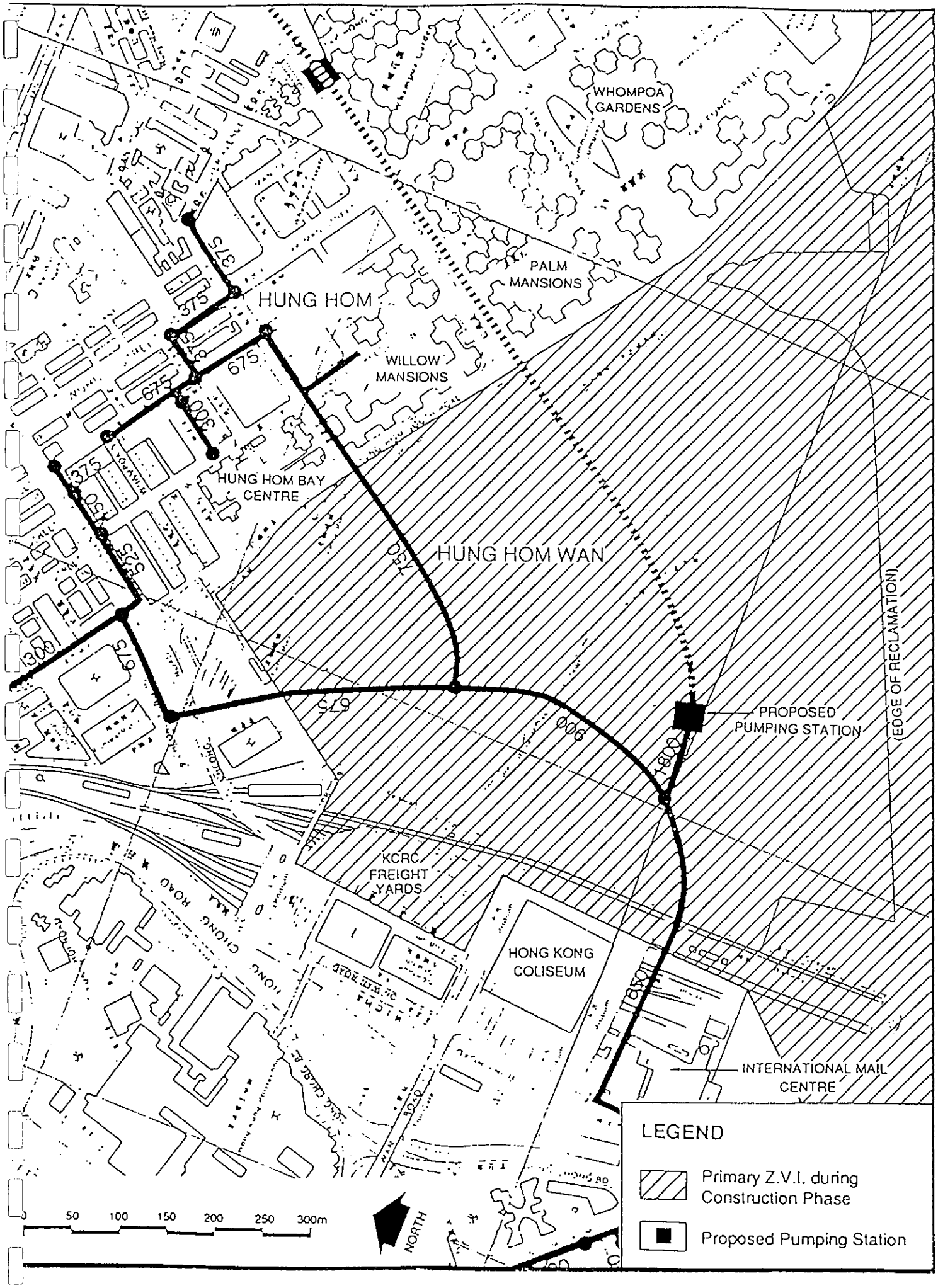

Figure 7.1
Zone of Visual Influence - Hung Hom Bay PS (Construction)

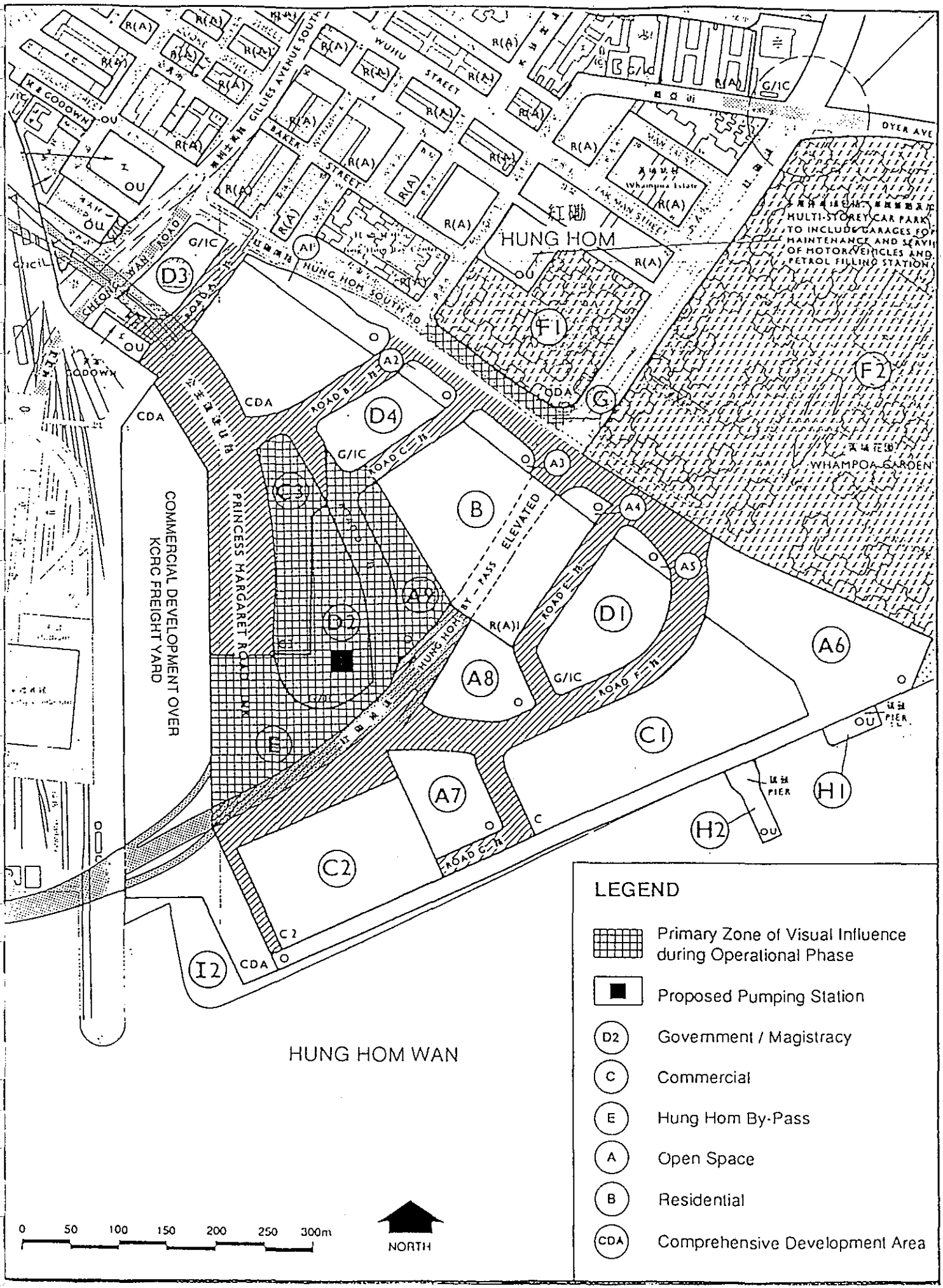

Figure 7.2
Zone of Visual Influence - Hung Hom Bay PS (Operation)

iv. Views from the west

- From the Hong Kong Coliseum.
- From the KCRC freight yards.
- From the International Mail Centre.

b. Zone of Influence in Context of Proposed Pumping Station

i. Views experienced from the north

- From proposed commercial uses.

ii. Views experienced from the east

- From proposed elevated roadways and residential development.
- From proposed open space.

iii. Views experienced from the south

- From proposed elevated roadways and hotel/service apartment complex.

iv. Views experienced from the west

- From proposed elevated roadways.
- From proposed commercial development over KCRC freight yards.

v. Views experienced from the Magistracy

The location and timing of construction of the Magistracy are not known in detail but it will lie adjacent to the pumping station and thus potentially constitute the most sensitive visual receptor.

7.4 Impact of Construction Phase

7.4.1 Potential visual impacts during the construction phase are associated with construction vehicles, machinery and temporary site buildings.

7.4.2 The PS is likely to be constructed earlier than most other proposed developments in the reclamation area and therefore, there are unlikely to be any sensitive receivers in the immediate vicinity.

7.4.3 Negative visual impacts during the construction phase will be experienced from a distance by;

i. Users of Hong Kong Coliseum podium.

ii. Users of footbridge from KCRC station.

iii. Residents at Hung Hom Bay Centre, Willow Mansions, Palm Mansions and Lily Mansions.

iv. Workers in the KCRC freight yards and docking facility.

7.4.4 The PS will constitute a minor visual impact in the development of the Hung Hom Bay reclamation area. Other large scale developments, particularly the proposed highway network, is likely to proceed at the same time and the impact on the visual receptors must be considered in this context. Those visual receptors that exist during the construction phase of the pumping station namely those associated with land-uses fringing the reclamation area, will suffer only minor impact due to their distance and the general background levels of construction activity.

7.4.5 Due to the site context during the construction phase, lying within a wider zone of construction activity, and the distance of most visual receptors, no special landscape mitigation measures are recommended beyond standard construction procedures such as control of dust levels (which have been discussed in a previous Section) and erection of site hoardings. The Magistracy, however, does require a long term visual buffer to the pumping station and it is recommended that this is established at the time of construction so that the visual impact on the adjacent development may be reduced. The form of this buffer depends on more detailed information concerning design, layout and finish of the Magistracy but might incorporate planting and solid screening structures.

7.5 Impact of Operational Phase

7.5.1 The visible components of the site during the operational phase include the pumping station building and structures, service vehicle movements and temporary container storage.

7.5.2 Negative visual impacts during the operational phases will be experienced by:

i. Users of Hong Kong Coliseum.

ii. Workers in proposed commercial uses to the north.

iii. Workers and residents in proposed hotel/service apartment complex to the south.

iv. Workers in proposed commercial development over KCRC freightyard to the west.

v. Drivers and passengers on the proposed elevated roadways associated with the Hung Hom Bypass.

vi. Workers in the Magistracy.

vii. Users of the open space to the east.

7.5.3 Due to the dense urban context of the environs and the difficulties of quantifying impacts on general land use proposals, the visual impacts on most of the above recipients are considered to be minor. The major elevated road system is likely to present a more significant visual

impact than the pumping station and may in fact screen it to a certain extent from potentially sensitive adjacent land uses. Users of the highway will only experience brief views of the pumping station. The eastern edge of the site facing an open space across the road is likely to cause a significant visual impact and the creation of a visual buffer to the works is recommended. As the pumping station is unlikely to be a positive visual element within the urban scene, it is recommended that tree planting be carried out on the site perimeter should space allow. This will generally soften the visual impact within a dense urban environment in which neighbouring landuses have not yet been determined in detail.

7.5.4 The other sensitive visual receptor during the operational phase will be the Magistracy whose impact should be reduced by the visual buffer established during construction. This should be maintained, particularly if vegetation forms a component, to preserve it's screening function. Suitable storage facilities for screenings and grit should be provided and excessive service vehicle movement reduced. If these measures are implemented the likely visual impacts will be limited.

7.6 Residual Impacts

7.6.1 The residual impacts of the scheme are those which cannot be mitigated by landscape measures. The PS will continue to create a minor visual impact to adjacent land uses throughout its operation however, these are not considered significant. It is assumed that the works will be adequately maintained and thus their visual appearance will not significantly deteriorate.

7.7 Conclusions

7.7.1 Construction of the proposed PS is not expected to generate significant visual impacts due to its position within a large zone of active reclamation construction. Existing visual receptors are situated at some distance from the PS site and are not considered sensitive.

7.7.2 During its operational phase, the PS will not constitute a significant visual impact in relation to the proposed adjacent land uses. However, it is unlikely to provide a positive visual element in a dense urban scene. It is therefore recommended that tree planting be carried out on the site perimeter to generally soften the boundary between proposed land uses. The potential impact on the open space to the east can be mitigated by providing such a visual buffer on the eastern site margin adjacent to the road. The only sensitive visual receptor of the pumping station will be the Magistracy and this impact can be mitigated by maintenance of a visual buffer. Suitable storage facilities for screenings and grit should be provided and excessive service vehicle movement avoided. The construction of the highway system is likely to generate greater visual impact and may provide a certain amount of screening to the PS.

8. Waste Issues

8.1 Introduction

8.1.1 This Section examines the sources of waste arising from the construction and operation of the PS and their likely impacts.

8.2 Environmental Standards and Guidelines

8.2.1 The Waste Disposal Ordinance, 1980 (WDO) and subsequent Waste Disposal Plan (WDP)(EPD, 1989), governs the disposal of wastes in Hong Kong. The WDP identifies "screenings and grit" from sewage screening and treatment works as a "Difficult and Special" waste, which requires special handling, treatment and disposal arrangements. It is recommended that such wastes be transported by a private contractor engaged by the operator and delivered to landfill for disposal.

8.3 Impacts of Construction Phase

8.3.1 Excavation material from the construction of the foundations of the PS and other general construction wastes such as building debris and timber will be produced during the construction of the PS. The spoil will require removal from site and subsequent disposal. Options for disposal include use as reclamation fill, re-cycling or disposal via marine dumping (provided spoil is not contaminated) or to landfill (provided the material has an inert matter content $< 30\%$). Due to the nature of the material and the small quantity involved (approximately 6300 m^3) disposal is unlikely to be problematic.

8.4 Impacts of Operational Phase

8.4.1 The operation of the PS gives rise to grit and screenings. Screenings vary from large debris > 100mm in diameter collected at the Coarse Screen to fine screenings removed from the emergency overflow. Existing practice is to collect the screenings in 50 gallon drums where they are stored until disposal to landfill.

8.4.2 Due to the quantity of flow and the nature of the screens the waste collected at the PS is negligible in comparison with that collected at the other wastewater treatment facilities - for example the existing Preliminary Treatment Works at To Kwa Wan - or with the 4520 tonnes of domestic waste disposed of to landfill daily in 1992 (EPD, 1993).

8.4.3 Waste collected during the operation of the PS should be stored temporarily in drums or skips and disposed at landfill provided the water content of the waste is less than 80%. In order to reduce nuisance odours from the storage of screenings the drums or skips should be sealed and stored in a bunded and covered area set aside specifically for that purpose.

8.5 Conclusions

8.5.1 The disposal of construction waste and screenings from the operation of the PS is unlikely to be problematic. The quantity of construction waste associated with such a small project is negligible in comparison with other infrastructure projects which will proceed in tandem with these works. Likewise, screenings arising from the operation of the PS are unlikely to cause a nuisance given the quantity and the nature of the waste produced.

9. Environmental Monitoring and Audit Manual

9.1 Introduction

9.1.1 This section includes extracts from the Environmental Monitoring & Audit (EM&A) Manual, the scope and contents of which have been agreed with EPD. Reference should be made to the actual EM&A Manual for further details on the monitoring and audit requirements.

Purpose of the Manual

9.1.2 The Environmental Monitoring and Audit (EM&A) Manual is intended to ensure that potential adverse impacts arising from the construction and operation of the pumping station are monitored and kept to a minimum and to recommend appropriate preventive measures to control potential problems.

9.1.3 The EM&A Manual provides;

- general guidance to the Engineer with regard to preventive environmental monitoring and auditing of air, noise and odour parameters affected by the construction and operation of the pumping station;
- guidance to the Engineer and the Contractor on the implementation of suitable prevention and mitigation measures;
- recommended Action Plans to be implemented in the event of a breach of prescribed levels;
- specific guidance on monitoring methodologies, procedures and frequencies for air, noise and odour parameters, as required; and,
- information on the location and nature of sensitive receptors.

Approach

9.1.4 A pragmatic and preventive approach has been adopted in the EM&A Manual, balancing the need for both a comprehensive and cost-effective monitoring programme. It is recommended that the Engineer adopt a similarly flexible approach in the application and interpretation of the Manual.

9.1.5 As part of the monitoring schedule three levels have been set in order to maintain compliance with environmental objectives and to provide advance warning of potential problem areas, thereby stimulating the implementation of an Action Plan before the regulatory standards are reached.

9.1.6 The three levels are referred to as:

Trigger Level a reference value to be used as an "early warning" of a deterioration in environmental quality.

Action Level indicates that deterioration is significant and that investigative and corrective action is required.

Target Level the maximum permissible level which will achieve compliance with the appropriate regulatory standard or guideline and is therefore the uppermost limit which is acceptable in terms of environmental quality. The monitoring schedule is therefore devised to prevent this level being attained.

9.1.7 Trigger, Action and Target Levels have been set according to the appropriate regulatory standard or guideline or as recommended by EPD. Specific action will be required in the event of a substantiated complaint and procedures for handling such complaints are detailed in the EM&A Manual.

9.2 Construction Phase

9.2.1 The environmental assessment indicates that, due to the nature and proximity of the SRs and the small scale of the proposed works relative to other infrastructure projects on the reclamation, the adverse environmental impacts associated with the construction of the pumping station are limited.

Air Quality Monitoring and Audit Requirements

9.2.2 The air quality impacts associated with the construction of the pumping station are unlikely to generate adverse impacts at nearby SRs. Nevertheless, the following monitoring and audit requirements shall be adhered to during construction in order to prevent the generation of adverse air quality impacts.

(i) Baseline Monitoring

9.2.3 The Contractor will be required to conduct baseline air quality monitoring at CSR1 (Figure 2.2) for at least two consecutive weeks prior to commencement of construction and according to the following frequency:

- daily for 24 hours
- 3 times per day for 1 hour

The baseline monitoring will comprise measurements for Total Suspended Particulates (TSP) (particles with diameter 0 - 30 μm) in accordance with the standard high volume sampling method specified in Title 40, Code of Federal Regulations, Chapter 1 (Part 50), Appendix B.

(ii) Regular Air Quality Monitoring

9.2.4 During the construction phase 24 hour TSP measurements will be conducted once every 6 day period and 1 hour TSP measurements will be conducted 3 times in the same 6 day period. All potential dust generating equipment operating during the sampling period should be identified either by observation or liaison with Resident Engineers overseeing other developments on the reclamation.

(iii) Audit

9.2.5 The audit comprises a review of the available monitoring data and comparison with the relevant statutory requirements and guidelines and any environmental performance standards specified in the Contract to ensure compliance with the relevant legislative requirements and guidelines.

9.2.6 Three levels have been devised to monitor compliance with environmental objectives and to provide advance warning of potential air quality problems (Table 9.1).

Table 9.1 Trigger, Action and Target Levels for TSP

TSP Parameter	Trigger Level	Action Level	Target Level
1 hour	1 hour TSP concentration 30 % above baseline	Median concentration between Trigger and Target Levels	500 $\mu g/m^3$
24 hour	24 hour TSP concentration 30 % above baseline	Median concentration between Trigger and Target Levels	260 $\mu g/m^3$

9.2.7 In the unlikely event that the monitoring results exceed the above Trigger, Action or Target levels, the Engineer and the Contractor will be required to take immediate action in accordance with the Air Quality Action Plan detailed in Table 9.2.

(iv) Dust Suppression Measures

9.2.8 Those dust suppression measures detailed in section 5.5.1 should be implemented by the Contractor in accordance with Good Working Practice.

Noise Monitoring and Audit Requirements

9.2.9 Construction noise levels are unlikely to cause significant adverse impacts at nearby SRs and therefore only limited spot check monitoring will be required.

(i) Baseline Monitoring

9.2.10 The Contractor will be required to conduct baseline noise monitoring prior to the commencement of any construction works in order to determine the ambient noise levels at CSR1 (Figure 2.2). The baseline noise monitoring will be conducted at 4 hour intervals over a one week period in terms of A-weighted equivalent continuous sound pressure levels over any 5 and 30 minute period ($L_{eq(5\ min)}$ and $L_{eq(30\ min)}$).

Table 9.2 Air Quality Action Plan

Event	Action by Engineer	Action by Contractor
Trigger Level exceeded for one sample.	Repeat measurement as soon as possible. Notify Contractor.	Identify source.
Trigger Level exceeded for more than one consecutive sample.	Repeat measurement as soon as possible. Notify Contractor and EPD immediately.	Identify source and implement necessary mitigation measures.
Action Level exceeded for one sample.	Repeat measurement as soon as possible. Notify Contractor and EPD immediately.	Identify source and implement necessary mitigation measures.
Action Level exceeded for more than one consecutive sample.	Daily monitoring to be conducted. Notify Contractor and EPD immediately. Require Contractor to make additional proposals for dust suppression.	Identify source. Review plant and equipment and working procedures. Submit proposals for reducing dust to the Engineer. Implement remedial action to reduce the dust emission immediately. Notify the Engineer of action taken.
Target Level Exceeded for one sample.	Daily monitoring to be conducted. Notify Contractor and EPD immediately. Require Contractor to make additional proposals for dust suppression. Submit investigation report to EPD as soon as possible.	Identify source. Review plant and equipment and working procedures. Submit proposals for reducing dust to the Engineer. Implement remedial action to reduce the dust emission immediately. Notify the Engineer of action taken. Provide investigation report.
Target Level exceeded for more than one consecutive sample.	Daily monitoring is to be imposed immediately. Notify Contractor and EPD immediately. Require Contractor to make additional proposals and to take immediate steps to reduce dust and to provide report of such to EPD as soon as possible.	Identify source. Review plant and equipment and working procedures. Submit proposals for reducing dust to the Engineer. Implement dust suppression measures immediately. Notify Engineer of action taken and submit an investigation report which should include proposals to prevent such exceedance occurring again. Stop the relevant portion of work as necessary or as determined by the Engineer.

(ii) Predicted Noise Level

9.2.11 The Engineer will calculate daily $L_{eq(30\ min)}$ noise levels at CSR1 based upon an inventory of operating mechanical equipment compiled by the Contractor at the beginning of each week. All the equipment specified in the inventory will be assumed to operate simultaneously. In the event that the calculated predicted noise level at CSR1 is greater than 75 dB(A) spot check monitoring will be required.

(iii) Spot Check Monitoring at the Site Boundary

9.2.12 Noise levels will be measured in accordance with the Technical Memorandum on Noise from Construction Works Other than Percussive Piling, issued under Section 9 of the NCO. Leq(30 min) noise levels will be measured at the site boundary in the event that the daily predicted noise level, calculated by the Engineer, exceeds 75 dB(A) at CSR1 or immediately following receipt of any complaint.

(iv) Spot Check Monitoring at the Sensitive Receptor

9.2.13 Noise levels recorded by monitoring at the site boundary shall be extrapolated to indicate noise levels at CSR1. Monitoring at the SR will only be required if the site boundary monitoring results indicate that the Target Level is being exceeded at the SR or in the event that the pumping station is identified as the source of a complaint from the general public. All other operational noise sources within the reclamation works area at the time of sampling should be identified either by observation or liaison with Resident Engineer(s) over-seeing other developments on the reclamation.

(v) Audit

9.2.14 Three levels have been formulated to monitor compliance with environmental objectives and to provide early warning of potential noise nuisance (Table 9.3).

Table 9.3 Trigger, Action and Target Levels for Construction Noise

Time Period	Trigger Level	Action Level	Target Level (dB(A))
Unrestricted Period 0700 -1900 hours all normal weekdays	Receipt of one complaint	Receipt of more than one complaint in any week	75 (over 30 min period)
Note: (1) Target Noise Levels for the Unrestricted Period are recommendations only and are not mandatory. (2) Construction work is not anticipated during restricted hours. In the very unlikely event that construction activity does occur during restricted hours the NCO noise criteria shall be adopted as the Target level.			

9.2.15 In the event that the Trigger, Action or Target levels are exceeded the Engineer and the Contractor will be required to take immediate action in accordance with the Noise Action Plan detailed in Table 9.4 below.

Table 9.4 Noise Action Plan

Event	Action by Engineer	Action by Contractor
Predicted noise level at SR exceeds 75 dB(A)	Conduct noise monitoring at site boundary	Arrange work so that simultaneous operation of most noisy equipment is avoided
Noise monitoring at site boundary exceeds equivalent of 75 dB(A) at SR	Conduct noise monitoring at the SR	Arrange work so that simultaneous operation of most noisy equipment is avoided
Receipt of one complaint	Substantiate complaint and conduct noise monitoring at the site boundary and extrapolate to SR	Review daily use of equipment
Receipt of more than one complaint in any week	Notify Contractor and require them to propose noise reduction measures. Increase frequency of noise monitoring at SR	Submit noise reduction measures to Engineer and implement approved measures
75 dB(A) exceeded between 0700 - 1900 hours on normal weekdays as measured at SR	Notify Contractor and EPD. Require Contractor to implement mitigation measures and check efficacy of those measures	Implement approved mitigation measures and demonstrate effectiveness of said measures.

9.3 Operation Phase

9.3.1 The environmental impacts associated with the operation of the pumping station are limited to odour impacts arising from the normal operation of the wet well and the routine cleaning of screens and storage of screen debris.

Odour Monitoring and Audit Requirements

9.3.2 Odour impacts arising from the operation of the pumping station were identified as potentially the most significant environmental impact associated with the project. Therefore, formal odour monitoring will be required following commissioning of the pumping station in order to avoid generating adverse odour impacts.

(i) Routine Odour Monitoring

9.3.3 Routine odour monitoring will comprise an informal inspection of the site boundary, conducted three times daily, by an observers who do not normally work on site. The

observers will characterise the detected odour as either "Extreme", "Strong", "Moderate" or "Slight" and will log the timing, location and perceived intensity of the detected odour. The odour observers should be screened for their suitability in accordance with the Australian EPA (Victoria) Method - Standard Analytical Procedure B1.

(ii) Formal Odour Monitoring

9.3.4 The purpose of the formal odour monitoring is to provide regular quantative measurements of the odour impact to ensure compliance with EPD's odour standard of 2 OU at the site boundary. Formal monitoring will be conducted at two locations on the site boundary, one up-wind and one downwind of the odour source once per month until the results of any three consecutive samples indicate compliance with the 2 OU standard. Three gas samples will be collected from each location and assessed for odour by an odour panel.

(iii) Audit

9.3.5 Three levels have been formulated to monitor compliance with environmental objectives and to provide early warning of potential odour problems (Table 9.5).

Table 9.5 Trigger, Action and Target Levels for Odour

Parameter	Trigger	Action	Target
Odour	Either the perceived level of "Slight" indicated by the observer in an odour patrol or a documented complaint from the public.	Either detection of perceived level of "Moderate" or above as indicated by the observer in two consecutive odour patrols, or two documented odour complaints from the public within any two weeks.	Either exceedance of 2 OU as measured by dynamic olfactometric method at site boundary or exceedance of the perceived level of "Strong" by the observer on two consecutive odour patrols or two or more documented odour complaints from the general public.

9.3.6 In the event that the monitoring results exceed the above Trigger, Action and Target levels, the Engineer and the Contractor will be required to take immediate action in accordance with the Odour Action Plan detailed in Table 9.6.

(iv) Good House-keeping Measures

9.3.7 The implementation of a number of good house-keeping measures will ensure that odour nuisance is minimised. Measures should include:

- inspect wet-wells frequently to prevent the accumulation of oil and scum;
- frequent and regular cleaning of screens and other sewage handling equipment;
- collection and storage of screenings in sealed drums, prior to disposal;

- regular wash out of pump chambers; and,
- regular maintenance checks on mitigation measures and ventilation systems.

(v) Operating Checks

9.3.8 In the month immediately preceding the commissioning of the pumping station, the Contractor will be required to demonstrate the adequacy of the odour control unit. Spot check monitoring following commission will ensure the effective operation of the unit under a variety of operating conditions.

Table 9.6 Odour Action Plan

Event	Action
Odour detected at site boundary.	Identify the odour source and repeat patrolling to confirm findings. Take any necessary mitigation measures.
Action Level exceeded.	Identify the source and cause of the odour. Repeat patrolling to confirm the findings and notify the relevant DSD personnel. Discuss with Senior Engineer suitable remedial action to be undertaken. Implement the agreed remedial measures.
Target Level exceeded.	Identify the source and cause of the odour. Repeat patrolling to confirm the findings and notify the relevant DSD personnel and EPD. Discuss with Senior Engineer suitable remedial action to be undertaken. Implement the agreed remedial measures. Review operational procedures to prevent future recurrence. Conduct odour measurements by dynamic olfactometric method to confirm the odour level at the site boundary complies with the 2 OU standard following implementation of the remedial measures.

9.4 Post Project Environmental Audit

9.4.1 A comprehensive environmental audit will be conducted following the commissioning of the pumping station. The principal purpose of which will be to:

- establish the pumping station's degree of compliance with statutory limits and planning guidelines;
- review changes in environmental legislation and policy following commissioning and to ensure future compliance;
- examine the effectiveness of management practice and mitigation measures with respect to achieving environmental quality objectives; and,

- recommend improvements to the system and its operation.

9.4.2 The audit should commence in the 13th month following the commissioning of the pumping station and should be conducted by an independent agent approved by DSD and EPD. Management, operations and maintenance staff will be required to provide inputs to the audit and this requirement should be incorporated into the job description.

9.4.3 The content of the audit should include, but not be limited to, those activities described in Table 9.7. The Environmental Audit Report should identify the nature and extent of operational noise and odour impacts, review the efficacy of mitigation measures and recommend modifications if required and summarise and interpret the results of the monitoring data previously collected and any other monitoring undertaken by the audit team.

Table 9.7 Proposed Framework for Post Project Environmental Audit

Activity	Format	Basis of Assessment	Reporting
Odour Assessment	Review of monitoring data and complaints statistics, if any.	Odour levels are acceptable if the measurements do not exceed the Target Levels of 2 OU at site boundary and 5 OU at nearest sensitive receiver and if complaints statistics do not indicate odour levels are perceived to be a nuisance. Effectiveness of mitigation measures should be addressed.	Indication of compliance and recommendations for improvements to mitigation measures if required.
Noise Assessment	Measurement of noise levels in the immediate vicinity of the site.	Noise levels are acceptable if facility does not cause a breach of the NCO, planning guidelines or baseline as appropriate.	Indication of compliance with statutory and planning guidelines and indication of consistency with results of the Environmental Assessment Reports.
Regulatory Review	Review of new legislation, technical memoranda, planning guidelines and codes of practice and their impacts on future operations.	Establishment of relevance to facility and assessment of need/method of compliance and necessary upgrading of facilities.	Interpretive report.

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Appendices

Appendix A

Electrical and Mechanical Equipment Schedule

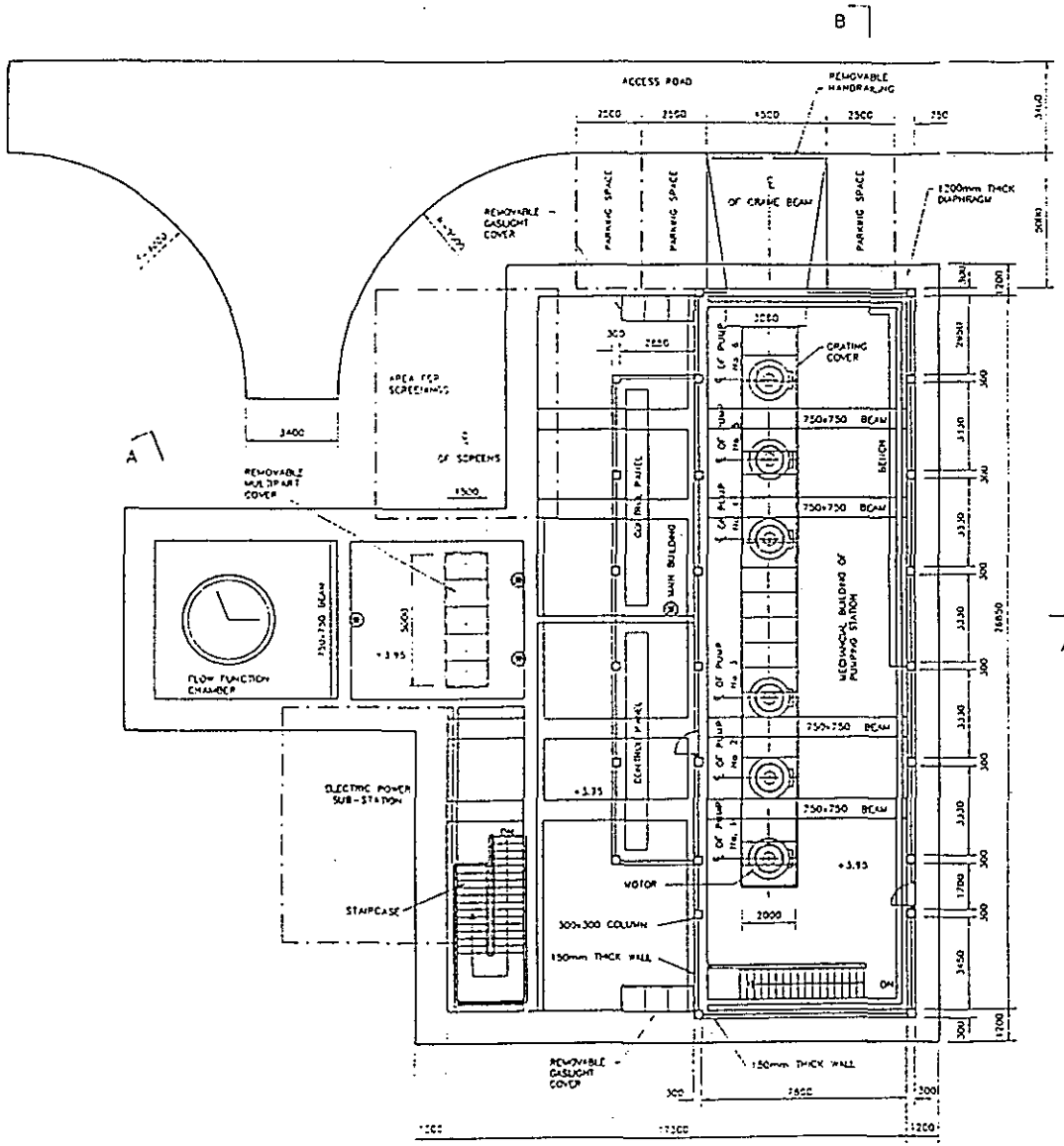
Equipment	Qty	Capacity	Remarks
Sewage pump	6	3600 l/s 21 m head	Driven by vertical spindle, squirrel cage induction motor of 250 KW rating.
Bar screen	2	6 m x 6 m	Auto-rake, 20 mm dia. bar with approximate 100 mm spacing.
Penstock	2	1800 mm x 1800 mm opening 200 mm dia opening 1500 mm x 1500 mm opening	Driven by electrical actuator.
Magnetic Flow Meter	2	1200 mm dia. at 1800 l/s	With detector head, converter unit, indicator, chart recorder totalizer.
Sump pumps	2	2 l/s 5 m head	Submersible type controlled by level sensors.
Ventilation fans	2	1.86 m^3/s at 350 Pa	Dry well, belt driven.
	2	1.86 m^3/s at 350 Pa	Wet well axial flow with coated impeller.
	1	1.25 m^3/s at 300 Pa	Screen chamber, axial flow with coated impeller.
Valves	6	600 mm dia.	Gate valve: electric operation, cast iron body s.s. spindle.
	6	600 mm dia.	Gate valve with actuator: electric operated.
	3	1200 mm dia.	Gate valve: valves and pipes outside pump room.
	6	600 mm dia.	Check valve: quick closing recoil type.

Lighting	12	single, wall mounted 1200mm fluorescent fitting.	General lighting in main building.
	10	twin, wall mounted 1200mm fluorescent fitting.	General lighting in main building.
	20	single, wall mounted 1200mm fluorescent fitting.	Weather proof in dry chamber and screen chamber.
	2	twin, wall mounted 1200mm fluorescent fitting.	Weather proof in dry chamber and screen chamber.
	8	bulk head lighting.	Weather proof in wet chamber.

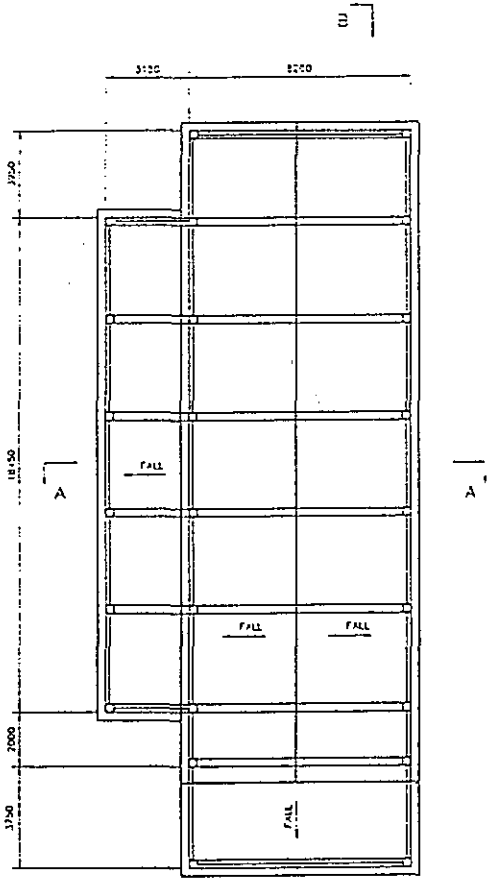
Appendix B

Hung Hom Bay Pumping Station - General Layout Drawings

NORTH



PLAN ON GROUND LEVEL (+3.95)



PLAN ON ROOF LEVEL

NOTES:

REV.	DATE	DESCRIPTION	CHKD

PROJECT
AGREEMENT No. CE 29/93
NORTH AND SOUTH KOWLOON SEWERAGE STAGE I

CLIENT
DRAINAGE SERVICES DEPARTMENT

CONSULTANT
MAUNSELL AECOM LIMITED
in association with
Halcrow CHARLES HASWELL & PARTNERS (FAR EAST) LIMITED
MVA(Asia) URBIS TRAVERS MORGAN LTD.
HYDRAULICS & WATER RESEARCH (ASIA) LTD.

JOB TITLE
HUNG HOM BAY PUMPING STATION

DRAWING TITLE
GENERAL ARRANGEMENT
SHEET 1 OF 3

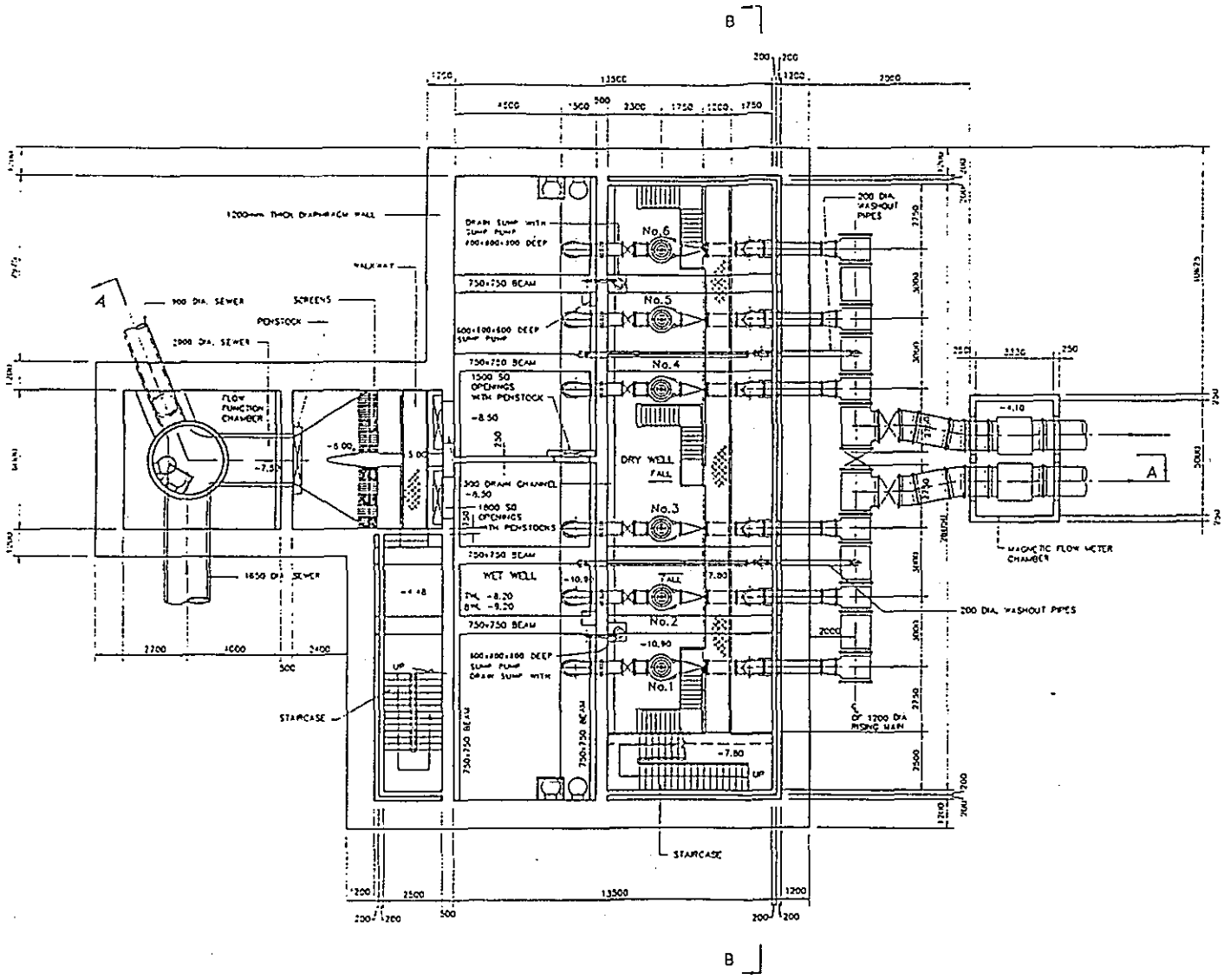
DRAWING NUMBER
RH/2401/P/172

REV.

DESIGNED BY	DATE NOVEMBER 1994
DRAWN BY F.K. YUEN	SCALE 1 : 200
CHECKED BY	APPROVED BY

NOTES:

NORTH



SECTIONAL PLAN

MK	DATE	DESCRIPTION	CHECK

PROJECT
AGREEMENT No. CE 29/93
NORTH AND SOUTH KOWLOON SEWERAGE STAGE 1

CLIENT
DRAINAGE SERVICES DEPARTMENT
STRATEGIC SEWERAGE DISPOSAL SCHEME NUMBER

CONSULTANTS
Rust Jacobs LIMITED
Haswell DAVIES HASWELL & PARTNERS (FAR EAST) LIMITED
MVA(Asia) URBIS TRAVERS MORGAN LTD.
HYDRAULICS & WATER RESEARCH (ASIA) LTD.

JOB TITLE
HUNG HOM BAY PUMPING STATION

DRAWING TITLE
GENERAL ARRANGEMENT
SHEET 2 OF 3

DRAWING NUMBER
RH/2401/P/173

DESIGNED BY	DATE
	NOVEMBER 1994
DRAWN BY Y.K. TUCH	SCALE 1 : 200
CHECKED BY	APPROVED BY

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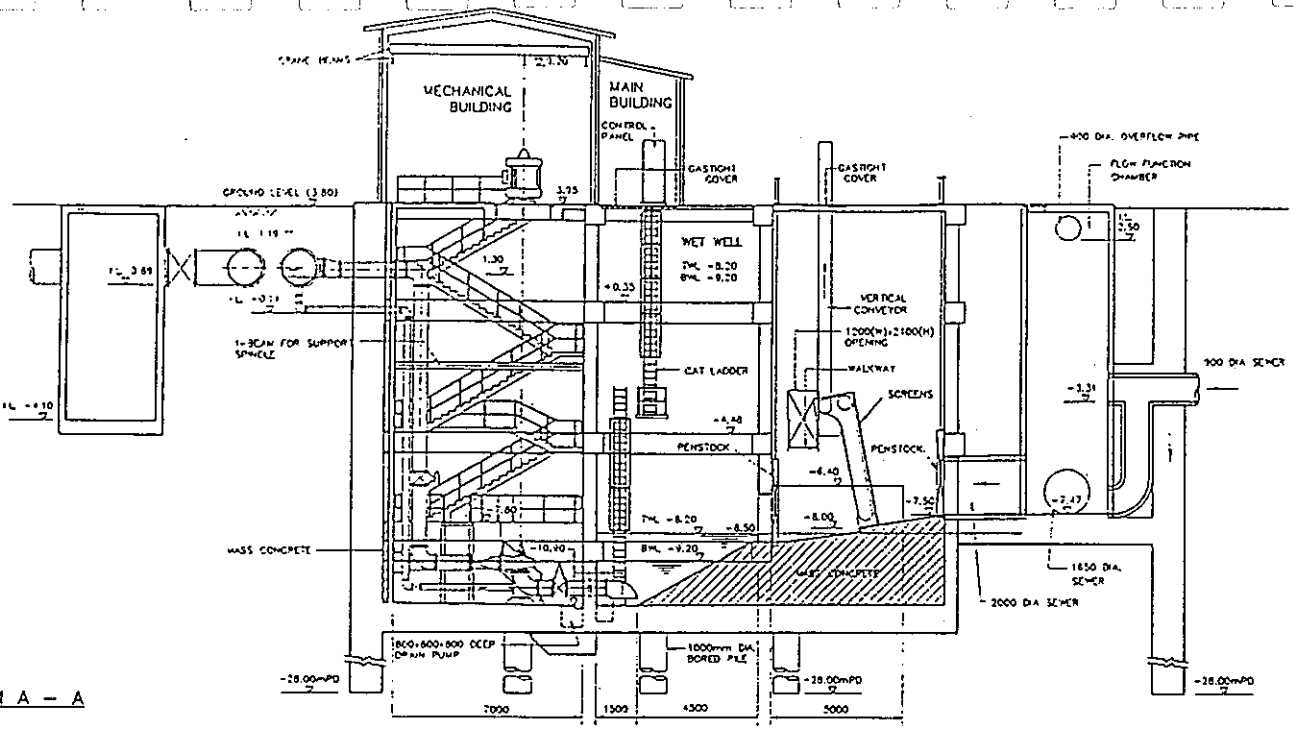
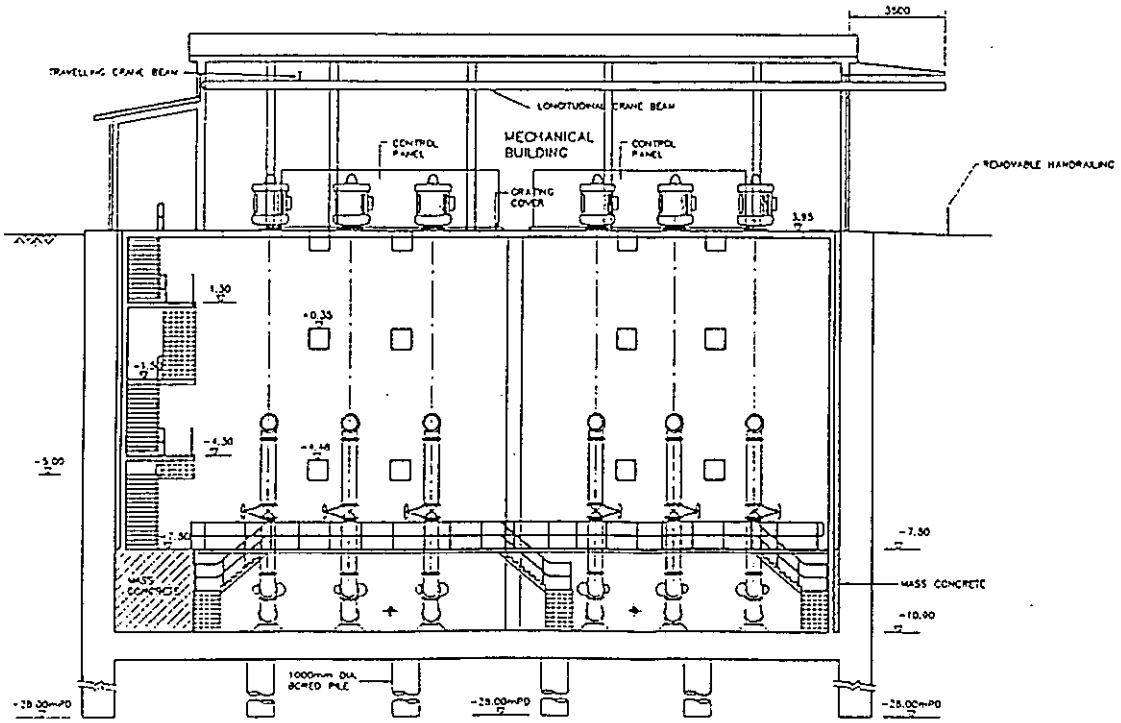
WEST



SECTION A – A

SOUTH

NORTH



SECTION B – B

NOTES

REV.	DATE	DESCRIPTION	CHKD

PROJECT
AGREEMENT No. CE 29/93
NORTH AND SOUTH KOWLOON SEWERAGE STAGE 1

CLIENT
DRAINAGE SERVICES DEPARTMENT

CONSULTANT
MVA(Asia) URBIS TRAVERS MORGAN LTD.
HYDRAULICS & WATER RESEARCH (ASIA) LTD.

JOB TITLE
HUNG HOM BAY PUMPING STATION

DRAWING TITLE
GENERAL ARRANGEMENT
SHEET 3 OF 3

DRAWING NUMBER RH/2401/P/174	REV.
DESIGNED BY	DATE NOVEMBER 1994
DRAWN BY Y.K.YUEN	SCALE 1 : 200
CHECKED BY	APPROVED BY