Environmental Protection Department

ISLAND WEST TRANSFER STATION

DETAILED ENVIRONMENTAL IMPACT ASSESSMENT (Final)

December 1996

Binnie Consultants Limited
11th Floor, New Town Tower
Pak Hok Ting Street
Shatin, New Territories
Hong Kong

For
Swire BFI Waste Services Ltd
1611 Devon House
979 King's Road
Quarry Bay
Hong Kong

ISLAND WEST TRANSFER STATION
DETAILED ENVIRONMENTAL IMPACT ASSESSMENT

Contents **Page**

Figures

Tables

Appendices

1 INTRODUCTION

1.1 IWTS Project Background

As stated in the *Hong Kong Planning Standards and Guidelines (HKPSG)*[1]:

"The Government's overall objectives for waste management planning are to ensure:

(a) the adequate provision of facilities for cost-effective and environmentally satisfactory disposal of all wastes; and

(b) the availability of and proper enforcement of legislation on storage, collection, transport, treatment and disposal of wastes, to safeguard the health and welfare of the community from any adverse environmental effects."

HKPSG further states that:

"A refuse transfer station (RTS) should be centrally located in the waste catchment it serves, preferably on the water front, with barge access. To minimise incompatibility with adjacent sensitive land uses, a RTS should be sited in an industrial or other non-sensitive area or, if possible, underground.

Sufficient space should be provided for reception and queuing of refuse collection vehicles (RCVs). Short vehicular access from and to major transport routes is preferred, to avoid traffic congestion and delays to RCVs. The adequacy of adjoining road capacities for the RCVs should be determined.

Considerations should be given to the provision of fully enclosed stations and/or suitable barriers for odour and dust control. Adequate control measures should be provided to minimise the impacts and may include provisions for noise control of the machinery and the structure, leachate treatment/disposal systems and installation of air/exhaust cleaning systems."

The Island West Transfer Station (IWTS) project is part of the Hong Kong Government's waste management strategy. Together with the Island East Transfer Station, which was commissioned in 1992, IWTS will handle all the publicly and privately collected waste arisings generated on Hong Kong Island. Wastes brought to IWTS will be compacted, containerised and transported by road or barge to the West New Territories (WENT) landfill.

---

1 *Hong Kong Planning Standards and Guidelines: Chapter 9 Environment* (1993) Planning Department

Previous studies[2,3] commissioned by the Director of Environmental Protection have developed the feasibility of constructing IWTS underground, within a cavern under Mount Davis. This option is intended to maximise the limited land available in Hong Kong by allowing multiple land use occupancy both within and above the cavern space, as well as minimising the environmental impacts of an urban transfer station relative to a ground surface scheme.

In 1994, Swire BFI successfully bid for the contract to design, construct and operate IWTS. The contract was awarded in April 1995.

1.2 DEIA Study Background

An Initial Environmental Impact Assessment[4] (IEIA) was undertaken for IWTS, based on an outline design prepared by consultants engaged by EPD, prior to the Tender being issued. The primary objective of the IEIA was to identify the key environmental issues arising from the project and provide an initial assessment and evaluation of each of the key environmental impacts sufficient to make recommendations that would influence the outline design of the facility. In particular, the IEIA included:

- a description of the environmental setting in which IWTS is to be built;
- a description of the outline design of the facility;
- identification, initial assessment and evaluation of the key environmental impacts associated with the construction and operation of IWTS;
- identification of specific design features and operational controls influencing the outline design of the facility;
- identification and prioritisation of the potential environmental impacts associated with each of the transport options considered for the removal of containerised waste to either West New Territories (WENT) or South East New Territories (SENT) landfills;

---

2 *Refuse Transfer Station Final Report: SPUN A Study of the Potential Use of Underground Space* (December 1989) Ove Arup and Partners for Civil Engineering Services Department, Geotechnical Control Office

3 *Refuse Transfer Station Final Report: CAPRO Cavern Project Studies* (May 1991) Ove Arup and Partners for Civil Engineering Department, Geotechnical Control Office

4 *Consultancy Study for Island West Transfer Station: Initial Environmental Assessment* (July 1992) Scott Wilson Kirkpatrick, Aspinwall & Company, Parsons Brinkerhoff (Asia) and Price Waterhouse for Environmental Protection Department

- recommendations for further environmental studies together with a review and assessment of the need for both short and long term environmental monitoring during construction and operation;

- the terms of reference for the Detailed Environmental Impact Assessment (DEIA) to be undertaken by the successful contractor.

One of the requirements of the Tender Documents was that:

> The Contractor shall submit a Detailed Environmental Impact Assessment (DEIA) for the Facility (including for the avoidance of doubt the WENT Landfill Reception Area). The DEIA shall take account of all aspects of the Design, the Works, and the Operation of the Facility. The DEIA shall, where appropriate, incorporate or refer to, rather than reworking, the IEIA. In particular, the DEIA shall address the key issues identified in the IEIA. (Section 25.1.2)
>
> The DEIA may be completed in phases. The entire DEIA shall be completed within 8 months of the Letter of Acceptance. The Contractor shall update the DEIA as required during the period of the Contract. (Section 10.19.1)

The DEIA was to be prepared in conjunction with the Contractor's design to ensure that mitigating measures were identified to ameliorate impacts of the works, operation and maintenance on the environment.

As part of the tender preparation, a detailed assessment of environmental impacts was undertaken in relation to Swire BFI's design, in order to demonstrate the efficacy of the integral air, water and noise pollution control measures. The DEIA incorporates the findings of the IEIA, the tender stage studies and the results of additional post-tender environmental studies.

1.3 DEIA Study Objectives

The objectives of the DEIA, as set out in the Tender Documents (Section 25.2.1), are:

(i) to describe the Facility and related infrastructure and the requirement for its development and its construction and operation;

(ii) to define the study area which shall include the area occupied by the Facility and other areas in which the construction of the works and of the operation of the Facility may bring environmental impacts and effects;

(iii) to identify and describe the elements of the community and environment likely to be affected by the Facility, and its construction and operation;

(iv) to minimise pollution, environmental disturbance and nuisance arising from the Facility and its construction and operation;

(v) to identify and evaluate the net and cumulative impacts expected to arise during the construction and operation of the Facility in relation to neighbouring land uses and the community;

(vi) to identify methods and measures which have been used to mitigate these impacts and reduce them to acceptable levels;

(vii) to recommend post-implementation environmental monitoring and audit requirements which are necessary to ensure the effectiveness of the environmental protection measures adopted.

1.4 DEIA Study Approach

The approach to completing the DEIA, as specified in the Tender Documents (Section 25.3.1), has been:

(i) to review the data from the IEIA and the Tender EIA;

(ii) to confirm the predictions made in the IEIA of the environmental impacts arising from the construction and operation of the Facility;

(iii) to describe in detail the proposed measures to mitigate effectively any significant environmental impacts in the short and long term;

(iv) to develop an outline programme of construction and operation by which the cumulative environmental impacts of the project with neighbouring land uses can be monitored and assessed;

(v) to develop an operation plan detailing operating guidelines and procedures to ensure that the purpose and objectives are met.

1.5 Structure of Report

The structure and content of the DEIA report is as follows:

Main Report

Section 1:	provides a general introduction to the studies
Section 2:	describes the main features of the project
Section 3:	identifies sensitive receivers and describes the potential air quality, noise, water quality and traffic impacts of the project during the construction phase, together with appropriate impact mitigation measures
Section 4:	describes the potential air quality, noise, water quality, traffic, visual and socio-economic impacts of the project on sensitive receivers during the operational phase, together with appropriate impact mitigation measures
Section 5:	provides a summary of the environmental impacts and associated mitigation measures identified in Sections 3 and 4

Appendices

Appendix 1:	describes the means by which compliance with Environmental Performance Requirements will be achieved
Appendix 2:	outlines proposals for implementation of monitoring and audit programmes
Appendix 3:	details the expected dust, vehicle emission and temperature levels of various areas within IWTS
Appendix 4:	describes the construction and operation phase measures to ensure that air quality and odour control requirements are met
Appendix 5:	details effluent handling and treatment measures at IWTS and WENT landfill reception area
Appendix 6:	details the construction and operation phase measures to ensure that noise control requirements are met

2 PROJECT DESCRIPTION

2.1 Study Area

This section provides a general description of the IWTS facility and study area. The location and layout of IWTS, as designed by Swire BFI, is shown in Figure 2.1. The layout of IWTS has changed substantially from that of the conceptual design studied in the IEIA and as indicated in Figure 2.2. Swire BFI's tender design is significantly more compact than the conceptual design to the extent that the construction areas will be confined to only half of the allotted area; the adjacent location of the tipping hall and compactor hall access eliminates the need for an elevated road along the coastline; and the volume of rock to be excavated is only about 60% of that for the conceptual design.

2.1.1 Current Land Use

As outlined in the Initial Environmental Assessment[1]:

> "The proposed facility for the IWTS is located to the west of Kennedy Town on a narrow strip of land which occupies the northern aspect of Victoria Road, the scenic coastal road which runs along the headland abutting Lau Wong Hoi Hap (Sulphur Channel) and connects Kennedy Town with Wah Fu...
>
> The existing land uses are industrial, residential and recreational and encompass the environs of Kennedy Town (including the incinerator, abattoir and mortuary to the north-east of the proposed development) as well as open space, park and amenity areas surrounding Mount Davis."
>
> "Government establishments located within the area comprise a refuse incinerator, abattoir and mortuary on the waterfront and a wholesale market to the west of Cadogan Street. Future plans for these establishments are targeted at increasing the compatibility of the area with existing residential developments.
>
> Institutional and community facilities in the area include the fire station at New Kennedy Town Plaza, the ambulance depot at Lung Wah Street, the swimming pool complex at Southfield, the urban clinic south of Victoria Road, the community centre at Pokfield Road and the existing schools. There is also a

---

1 *Consultancy Study for Island West Transfer Station: Initial Environmental Assessment* (July 1992) Scott Wilson Kirkpatrick *et al* for Environmental Protection Department

kindergarten and a social centre in the Mount Davis area located further to the west along Victoria Road.

Major roads are concentrated along the flat coastal reclamation strip where the majority of building development already exists. Beginning from Victoria Road in the west, major thoroughfares run in an east-west direction whilst other roads tend to be arranged in a grid pattern."

"The IWTS facility falls within an area zoned Green Belt on the draft Kennedy Town and Mount Davis Zoning Plan No. S/H1/2[2]. In addition, areas required for the access tunnels, portals, and cavern complex are unleased, unallocated Government Land. The Metroplan Landscape Strategy[3] for the Urban Fringe and Coastal Areas Report also identifies areas near to the proposed facility as Landscape Protection Areas and Development Areas with High Landscape Value, and proposes to retain Mount Davis as a landscape protection area with potential for future enhancement as an urban fringe park. The Green Island Feasibility Study[4] has also identified that areas to the west of Mount Davis warrant designation as Areas of High Amenity Value.

The Mount Davis Cottage Area (under the control of Housing Department) at Kung Man Tsuen, which was built more than 30 years ago on terraces formed from cutting steeply into the hillside and by retaining fill behind rubble walls, is a significant residential housing area whose condition and stability will need to be assessed prior to construction. Its location and proximity to the IWTS access and egress tunnels is highly sensitive and the (IEIA stage) design requires each tunnel to pass a minimum of 25 m vertical distance beneath the housing development.

The western extent of Kennedy Town is marked by the boundary between the Kennedy Town Incinerator, which is

---

[2] *Kennedy Town and Mount Davis OZP No. S/H1/2* (August 1988)

[3] *Metroplan: Landscape Strategy for the Urban and Coastal Areas* (March 1989) Strategic Planning Unit, Lands & Works Branch

[4] *Green Island Reclamation Feasibility Study (H197) Technical Paper No. 13, Urban Design and Landscape Guidelines* (1989) Ove Arup & Partners, Peter Y S Pun & Associates for Territory Development Department, Urban Area Development Office

situated at the junction of Sai Ning Street and Victoria Road, and the mixed residential, recreational and industrial marine frontage which extends from the China Merchants Wharf to the Urban Services Department (USD) Depot which is currently used as a depot for Refuse Collection Vehicles (RCVs). A temporary recreation area (football pitches and sitting out area) located in Sai Ning Street is zoned for ultimate use as a Cargo Handling Area. Currently, however, it is heavily used by local schools as well as local residents for sporting activities as well as religious celebrations. Sensitive receptors in this area also include low level housing as well as several multi-storey tower blocks at the western end of Sai Ning Street nearest the USD Depot entrance. The Bus Terminus at the eastern end of Sai Ning Street is to be relocated to the existing abattoir site in Kennedy Town upon its redevelopment for commercial use."

"Proposed developments which will affect the human environment in the area include a comprehensive redevelopment for commercial/residential use with some government/institution and community facilities and a large open space in the zone bounded by Cadogan Street, Kennedy Town New Praya, Davis Street, Catchwide Street and Kui Man Street. Other proposed developments include Route 7 which will link Kennedy Town with Aberdeen."

2.1.2 Topography and Landscape

As stated in the IEIA:

"The topography of the area surrounding Mount Davis (+269 mPD) consists of densely vegetated slopes of tall shrubs, short trees and thick undergrowth falling away steeply towards the sea. The hillside comprises side slopes up to 60°, with a series of small look-out platforms and cleared areas used for growing vegetables. The majority of the hillside is covered with a thick cover of vegetation. Below Victoria Road, an equally dense cover of vegetation has been established.

The IWTS will affect both the rural and urban fringe areas of Green Island, Mount Davis and Kennedy Town. Mount Davis is a prominent hill peak which forms a significant backdrop to development along the edge of Victoria Harbour. The Green Island Feasibility Study has recognised the need to maintain this backdrop and to retain it as a visible feature when approaching Victoria Harbour from the west.

The Green Island Feasibility Study also considered that it was critical for the natural skyline of Mount Davis to be retained. According to the *Hong Kong Planning Standards and Guidelines*[5] *(HKPSG)*, developments on hill tops, scenic ridges and prominent positions should be avoided wherever possible. The guidance document also states that in scenic areas, opportunities should be taken to use the local landform and any excavated material already available to 'fit' the development into the ground form, soften the geometric outline of buildings and screen ancillary features from view. Development should also be sited and planned to minimise long-term visual impact."

2.2 Island West Transfer Station

2.2.1 Description

As designed by Swire BFI and illustrated in Figure 2.3 and the artist's impression in Section 4.5: Visual Impacts, the IWTS facility consists of:

- a partially enclosed spiral ramp to provide access for waste collection vehicles from Victoria Road (+27.8 mPD) down to the tipping hall at (+12 mPD);
- a cavern containing a tipping hall at the upper level and a compactor hall at the lower level;
- access for container vehicles from the compactor hall (+5 mPD) to an interim berthing facility.

The long-term berthing facility for container vessels transferring waste from IWTS to WENT Landfill will be re-provided to the north-west of the Route 7.

2.2.2 Construction Phase

Mobilisation and initial site clearance for construction of IWTS started in May 1995. The facility is due to be fully constructed, commissioned and be ready for operations in April 1997.

The main construction activities will include:

- construction of the spiral ramp;

5 *Hong Kong Planning Standards and Guidelines: Chapter 10 Landscape and Conservation* (1993) Planning Department

- construction of ancillary buildings, eg. weighbridge complex, offices and vehicle maintenance workshop;

- construction of a reinforced earth wall and raised platform to support vehicle reception and weighbridge facilities;

- excavation of the cavern, using blasting techniques, and removal of approximately 42,000 m^3 of rock spoil;

- installation and commissioning of plant inside the cavern, eg. compactor units, ventilation systems, vehicle washing facilities and wastewater treatment plant.

2.2.3 Operation Phase

The facility is due to commence operations in May 1997 and the first operation and maintenance contract will be for a period of 15 years, ie. until the year 2012. The transfer station will provide facilities for the reception and transfer of publicly and privately collected waste from areas of Hong Kong Island. Waste received by road at IWTS will be compacted into containers and transferred by sea to WENT Landfill at Nim Wan.

All refuse handling operations will take place underground within the tipping hall and compactor hall. Within the tipping hall, waste collection vehicles (WCVs) will discharge waste into live-floor hoppers from which the refuse is passed into compactors for compaction into containers.

Entrance to the site for WCVs will be via an acoustically shielded spiral ramp from Victoria Road, the weighbridge complex and the tipping hall access. Traffic light controls in the tipping hall will normally regulate vehicle movements. Under exceptional conditions, between 12-15 vehicles could queue within the access tunnel. Queuing within the access tunnel will be orderly and controlled. After deposition of refuse, vehicles will exit the site via the vehicle washing facilities (located inside the cavern), the access tunnel and the weighbridge.

Tractor-trailer units will shuttle back and forth, via the compactor hall access, between the compactor hall and the berthing facilities. Empty containers will be unloaded from the marine vessel either directly onto the trailers or onto a storage area at the IWTS site. Full containers will be offloaded from the trailers directly onto the marine vessels for transferring to WENT by sea or, under emergency conditions such as typhoons, will be transported from the site via Sai Ning Street and Victoria Road to WENT by road.

IWTS is designed to process a maximum throughput of 1,200 tonnes per day. During the peak 30 minutes of operation, there will be 20 WCVs entering/leaving the transfer station and six tractor-trailer units present in the compactor hall at any one time. There will be one shipping movement to and one shipping movement from the wharf each day.

Waste deliveries will be accepted at IWTS from 07:30-23:30 hours, with routine maintenance carried on during these hours.

2.3 WENT Landfill Reception

At the designated waste reception area at WENT Landfill, containerised waste arriving by sea or road from IWTS will be trans-shipped onto landfill `slave' vehicles for final disposal.

2.4 Adjacent Infrastructure Projects

The long-term access requirement for IWTS has had to take into account additional proposed works in the area as shown in Table 2.1.

Table 2.1 Proposed Infrastructure Projects adjacent to IWTS Site

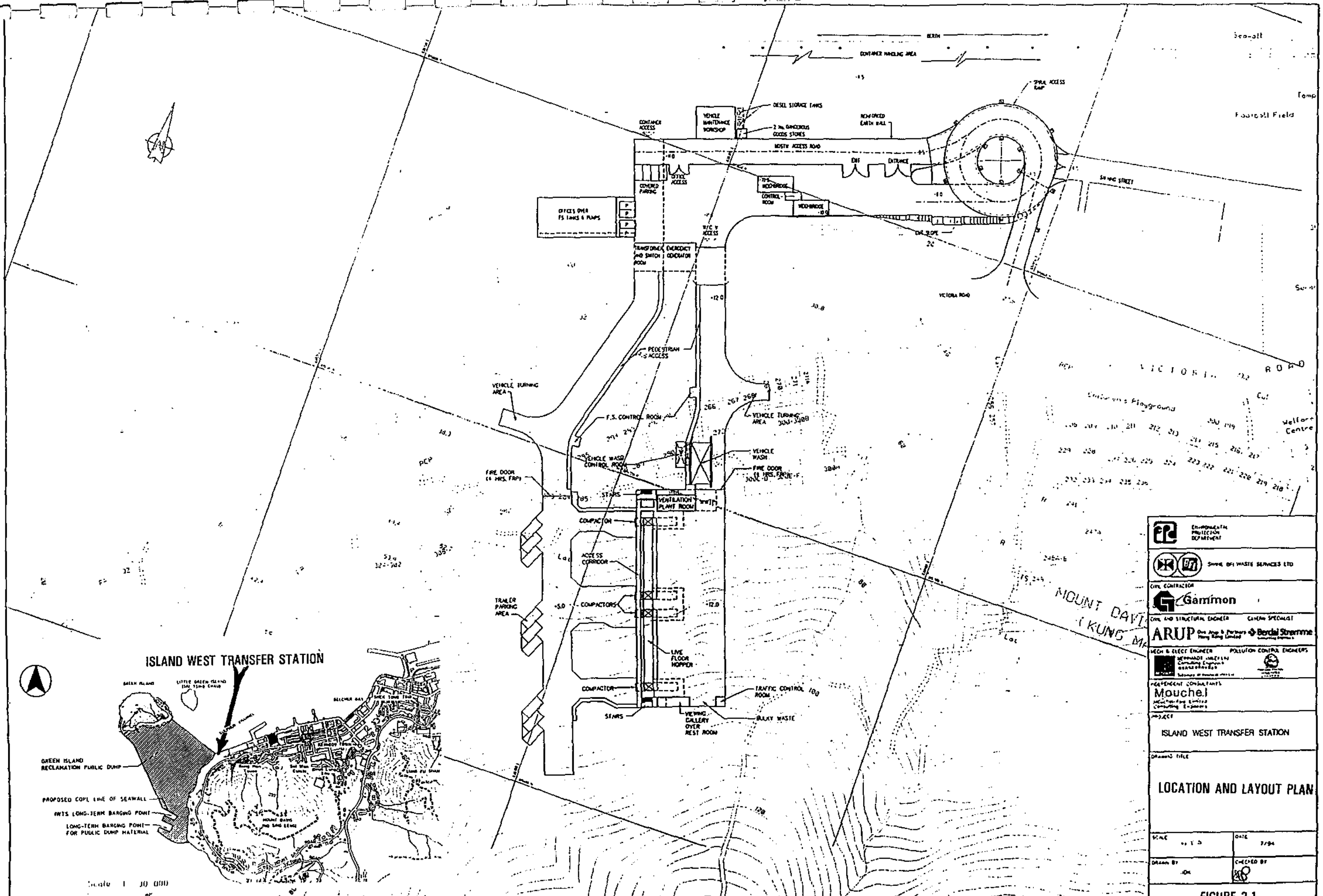
Description	Possible Construction Commencement Date	Proposed Commissioning Date
Green Island Reclamation (Part): Public Dump	1996[6]	2002
Green Island Reclamation (Remainder)	2002	2008
Route 7 (Kennedy Town to Aberdeen)	2008	2011
Mount Davis Sewage Treatment Works	1999	2003
Mount Davis Service Reservoir (fresh water)	1997	1999

[6] *Green Island Reclamation (Part): Public Dump - Environmental & Traffic Impact Assessment - Final Report* (January 1995) Scott Wilson Kirkpatrick *et al* for Civil Engineering Department

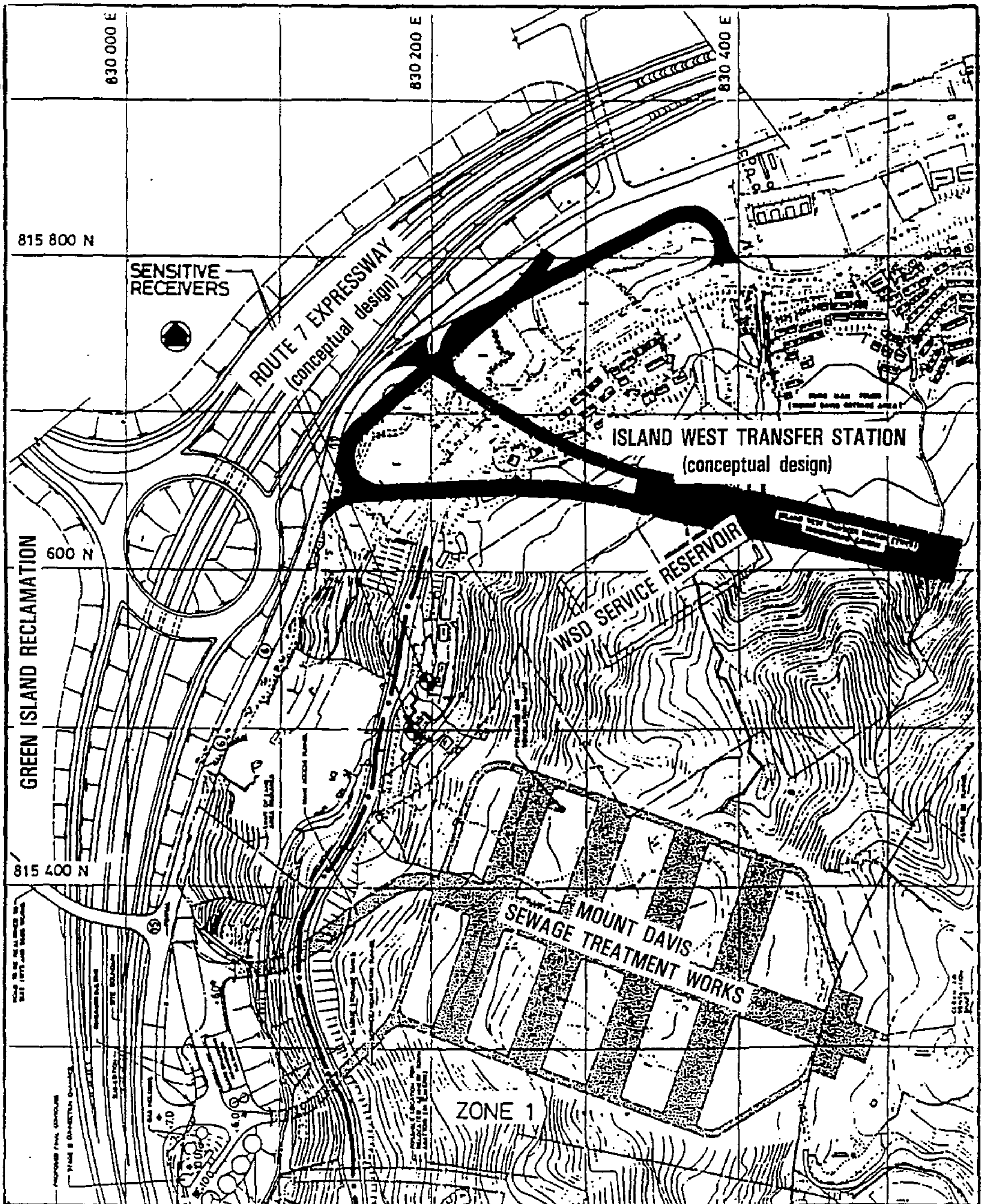
The proposed juxtaposition of the IWTS, Mount Davis Sewage Treatment Works, Mount Davis Service Reservoir, relocated Kennedy Town Abattoir, Route 7 and Green Island Reclamation projects is shown in Figure 2.2, taken from the Strategic Sewage Disposal Scheme Final EIA Report[7]. The disused Kennedy Town Incineration Plant will be redeveloped together with the former wholesale market and abattoir.

It should be noted that, as discussed elsewhere in this report, the layout of IWTS has been improved substantially from that of the conceptual design studied in the IEIA and as indicated in Figure 2.2. Swire BFI's tender design is significantly more compact than the conceptual design to the extent that the construction areas will be confined to only half of the allotted area; the adjacent location of the tipping hall and compactor hall eliminates the need for an elevated road along the coastline; and the volume of rock to be excavated is only about 60% of that for the conceptual design.

[7] *Strategic Sewage Disposal Scheme: Site Investigations & Engineering Studies Stages II, III & IV - Final EIA Report* (January 1993) AB_2H Consultants for Drainage Services Department



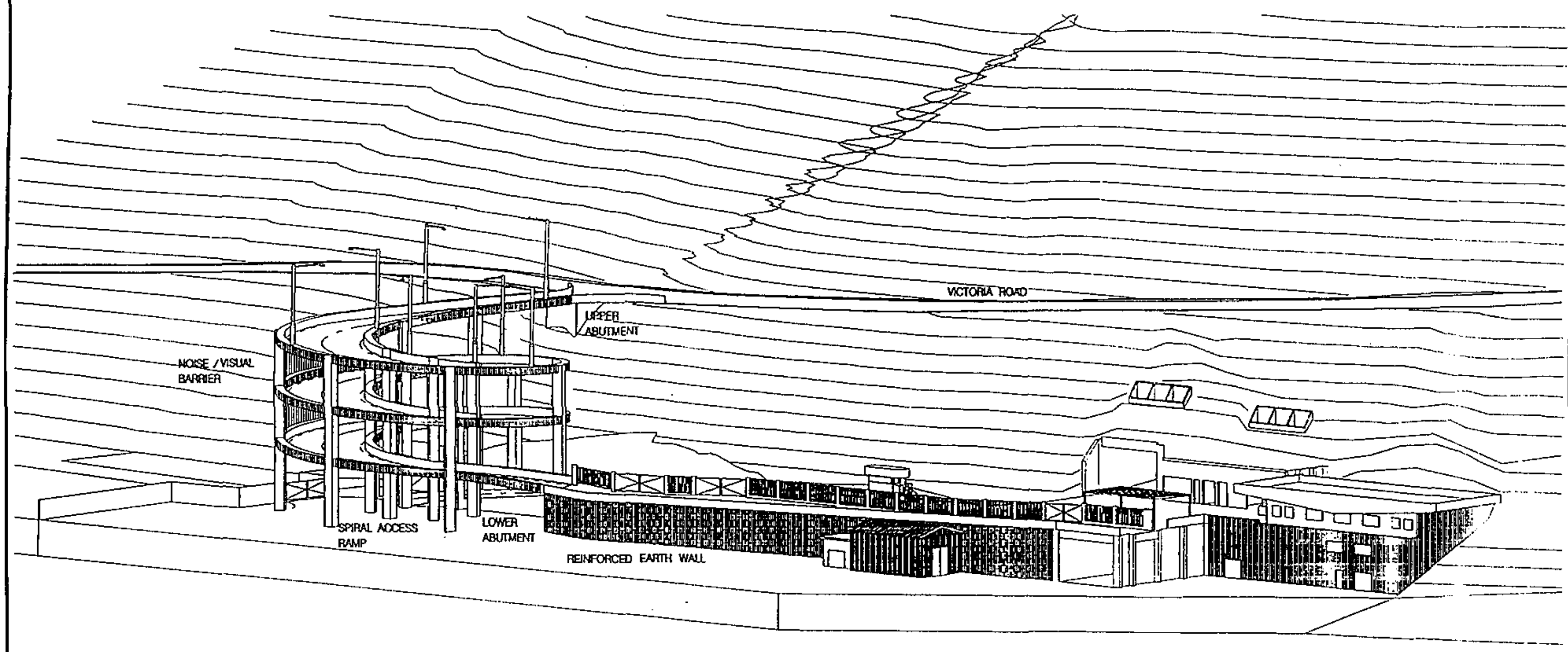
(Adapted from: GIRPD Report, February 1995)



AB$_2$H Consultants

FIGURE 2.2

PROPOSED INFRASTRUCTURE PROJECTS ADJACENT TO IWTS SITE
(Adapted from: SSDS Report, January 1993)



Gammon

SWIRE BFI WASTE SERVICES LTD.

Mouchel

ISLAND WEST TRANSFER STATION

SITE SCHEMATIC

N.T.S

FIGURE 2.3

3 CONSTRUCTION IMPACTS

3.1 General

The construction of the IWTS facility is programmed to commence in May 1995 and to be completed, following commissioning tests, Fire Services Department Inspection and performance trials, in April 1997.

Construction of IWTS will inevitably generate environmental impacts, not least since it involves the excavation of approximately 42,000 m^3 of rock. Nevertheless, the proposed design involves significantly less excavation than the outline design, resulting in a shortening of the construction period and corresponding reduction in construction phase impacts in respect of blasting, dust emissions and noise.

This section identifies and describes the impacts during the construction phase including confirmation of:

- the quantitative determination of impacts;
- the mitigation effects of proposed control measures;
- evaluation of effects on the existing environment;
- assessment in view of current and impending statutory requirements;
- re-evaluation and modification of control procedures for the construction of IWTS and associated infrastructure.

3.2 Noise

In this section, the method of construction has been analysed, the potential major sources of noise identified, and the impact of noise producing processes and construction plant on adjacent noise sensitive uses assessed.

3.2.1 Legislation and Guidelines

Hong Kong Planning Standards & Guidelines (HKPSG) states that:

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

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

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

New environmental legislation on noise control, the *Noise Control (Construction) Regulations* and the associated *TM on Noise from Work within a Designated Area*, is currently being drafted and due to be enacted in mid-1995. This legislation is designed to control noise from the use of specified powered mechanical equipment and the carrying out of prescribed construction work on construction sites within a designated area during restricted hours.

An amendment to the *TM on Noise from Percussive Piling*, phasing out the use of diesel hammers, is also currently being drafted for enactment in mid-1995.

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

- all domestic premises, including temporary housing accommodation;
- hotels and hostels
- offices
- educational institutions, including kindergartens, nurseries and all others where unaided voice communication is required
- places of public worship and courts of law
- hospitals, clinics, convalescences and homes for the aged, diagnostic rooms and wards
- amphitheatres and auditoria, libraries, performing arts centres and Country Parks

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

Table 3.1 Area Sensitivity Ratings

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

Notes:

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

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

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

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

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

Construction Noise

There are no statutory criteria for noise from construction work other than percussive piling generated during the daytime hours of 07:00-19:00, Monday to Saturday, excluding public holidays. However, EPD normally recommends 75 dB(A) as the acceptable noise level during daytime hours.

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

Table 3.2 Basic Noise Levels for General Construction Noise

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

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

Table 3.3 Acceptable Noise Levels for Percussive Piling

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

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

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

Table 3.4 Permitted Hours of Percussive Piling Operation

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

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

- a map (preferably 1:1000 scale) showing precise details of the site location, site limits and nearby noise sensitive receivers, eg. residential buildings, schools, hospitals; and
- location of any stationary powered mechanical equipment on site or, in the case of an application for a percussive piling permit, the piling zone or actual pile locations;

- details of the time period (time of day, duration in days/weeks/months) for which the CNP is required;

- a description, including two photographs and identification codes, and number of units of each item of powered mechanical equipment to be used or, in the case of piling, details of the piling method and pile type including number of units;

- details of any particularly quiet items of equipment or piling methods, special noise control measures to be employed on site, or any other information thought to be relevant.

During daytime works, EPD recommends that the advice in EPD's *Practice Note ProPECC PN2/93* on construction noise abatement practice is followed.

Blasting

The use of blasting is subject to the approval of the Commissioner of Mines. For the IWTS site, the maximum peak particle velocity (PPV) is limited in the Performance Requirements to 13 mm/s and the corresponding vibrational amplitude to 0.2 mm at any inhabited structures (particularly Mount Davis Cottage Area) and Mount Davis service reservoirs, in accordance with the Performance Requirements. At water mains, the maximum vibrational amplitude remains 0.2 mm but the maximum PPV allowed is 25 mm/s. Monitoring and assessment work are subject to the requirements of the Water Supplies Department and the Civil Engineering Department (Mines & Quarries Division).

The Performance Requirements state that restricted working hours (07:00-19:00) are to be used for the blasting of the initial sections of the access, and that noise baffles at the portals shall be used. Thereafter, blasting may be on a continuous all day basis, although no blasting is to be carried out on public holidays. Continuous monitoring is to be undertaken to ensure that the PPV is within 13 mm/s, and all blasting operations are to comply with the requirements of the *Dangerous Goods Ordinance*.

3.2.2 Sensitive Receivers

The noise sensitive receivers (NSRs) selected for the conceptual design in the IEIA were as indicated in Table 3.5:

Table 3.5 IEIA Noise Sensitive Receivers

NSRs	Location
NSR 15	Junction Sai Ning Street/Victoria Street, street level
NSR 16	Flat 24a Regents Height, 80 Victoria Road
NSR 17	Cottage Area 1, Kung Man Tsuen (Community Centre)
NSR 18	Cottage Area 2, Kung Man Tsuen (Unit 213)
NSR 19	Cottage Area 3, Kung Man Tsuen (Unit 283)
NSR 20	Cottage Area 4, Kung Man Tsuen (near Kit Sum Kindergarten)

Note: The NSR numbering is that used for the Green Island Feasibility Study[1,2]

NSRs used for the DEIA are based on those identified in the IEIA for the conceptual design. However, owing to the proposed location and compactness of the tender design which involves only half the gazetted area for the development, the selection of appropriate NSRs has been modified as indicated in Table 3.6. The locations of the NSRs are shown in Figure 3.1.

Table 3.6 DEIA Noise Sensitive Receivers

NSRs	Location
	pre-tender NSR identification
NSR 1	Old People's Home, Sai Ning Street (furthest west facade)
NSR 2	Cottage Area 1, Kung Man Tsuen (Community Centre)
NSR 3	Cottage Area 2, Kung Man Tsuen (Unit 208)
NSR 4	Cottage Area 3, Kung Man Tsuen (Unit 268)
	additional NSR
NSR 5	Serene Court, Victoria Road

Note: NSR 2 is the same as NSR 17; NSR 3 is 5 houses to the west of NSR 18; NSR 4 is 8 houses to the east of NSR 19

1 *Green Island Feasibility Study. Technical Paper 18: Report on Ambient Noise Survey* (1989)

2 EPD letter outlining Protocol for determining Background Noise Levels in the vicinity of the Island West Transfer Station (27 May 1992) Aspinwall & Company Ltd

3.2.3 Existing Environment - Noise

The following Area Sensitivity Ratings have been adopted for the NSRs:

NSR 1	Old People's Home, Sai Ning Street	ASR 'B'
NSR 2-4	Mount Davis Cottage Area	ASR 'A'
NSR 5	Serene Court, Victoria Road	ASR 'C'

The overall acceptable construction noise limit is 75 dB(A) for daytime hours (07:00-19:00 hours) and 60 dB(A) at the Old People's Home.

Daytime noise levels monitored during continuous 24 hour monitoring in 1988 and 1992 for NSRs 17-19 in the Mount Davis Cottage Area, as identified in Table 3.5, are shown in Table 3.7.

Table 3.7 Noise Monitoring Results (1988 and 1992)

Location	1988 results		1992 results	
	LA_{eq}dB(A) (15 min)	LA_{90}dB(A) (15 min)	LA_{eq}dB(A) (15 min)	LA_{90}dB(A) (15 min)
17	67.6	60.8	67.1	56.7
18	67.6	60.8	67.4	57.7
19	64.9	56.8	67.0	63.2

The existing noise environment in the study area is dominated by traffic noise from Victoria Road. During the 1988 survey, other additional sources of significant noise were the abattoir, the wholesale market and the incinerator.

Further daytime noise monitoring results from the Green Island Reclamation Feasibility Study[3] and the Final Environmental Assessment Report of Green Island Reclamation (Part): Public Dump are shown in Table 3.8.

[3] *Green Island Reclamation (Part): Public Dump - Environmental & Traffic Impact Assessment: Supplementary Agreement (II) - Draft Final Report - Recommended Land Access* (February 1995) Scott Wilson Kirkpatrick *et al* for Civil Engineering Department

Table 3.8 Noise Monitoring Results from Green Island Reclamation Studies

Location	Noise Levels		Major Noise Sources
	L_{eq}dB(A)	L_{90}dB(A)	
Serene Court (roof)		54.0-60.5 (1 hour)	Activities at waterfront; Helicopters
Mount Davis Cottage Area	67.0-75.3 (15 min)	57.2-68.7 (15 min)	Road Traffic

During the tender preparation period, spot measurements of daytime background noise levels at the NSRs 1, 3 and 4 were taken during peak hour on a week day using Rion Integrating Sound level Meter NL-11 and Printer CP-01. The results are given in Table 3.9.

Table 3.9 Spot Daytime Noise Measurements (July 1994)

Measurement Points	Date and Time	LA_{eq}dB(A), Peak Hour Measurement	Predominant Noise Sources
NSR1	4 July 1994 09:23-09:40	58.3 - 61.2 (5 min)	Cargo handling noise from China Merchants Godown pier, vehicle movements at USD depot
NSR2	not measured	not measured	Marine traffic, intermittent road traffic noise, occasional helicopter, insect noise and bird song
NSR3	22 June 1994 09:00-10:30	63.3 (5-min) 64.5 (10 min)	As above
NSR4	22 June 1994 09:00-10:30	66.6-68.1 (5-min)	As above

In order to assess the impact to the nearby sensitive receivers, an evening and night-time background noise monitoring was conducted on 12 May 1995 at NSR3 - Mount Davis Cottage Area. The monitoring results in Table 3.10 indicate that the baseline noise levels at the evening and night-time varied from 59.1 dB(A) to 65.0 dB(A) and 49.9 dB(A) to 60.0 dB(A) respectively. In addition, daytime noise monitoring was carried out on 24 May 1995 on the roof of Serene Court (NSR5). The results are shown in Table 3.11: baseline noise measurements are in the range 59.3 dB(A) to 64.4 dB(A).

These background noise levels are of limited significance to daytime activities during the construction phase, but are highly relevant to the IWTS operational phase because they exceed the permitted noise levels for operation of the IWTS. During any noise monitoring of the IWTS operations it may be difficult to distinguish operation noise from background noise. This is an important issue since exceedence of 60 dB(A) L_{eq} (30 min) at any sensitive receiver due to operation of the IWTS will result in the allocation of points for non-compliance.

Table 3.10 Evening and Night-time Noise Measurements (May 1995)

Measurement Point	Time	LA_{eq}dB(A), (30 min) Measurement	Predominant Noise Sources
NSR3	19:00-19:30	65.0	Victoria Road traffic, residents' activities incl. TV, insect and bird song
NSR3	19:30-20:00	62.1	As above
NSR3	20:00-20:30	60.0	As above
NSR3	20:30-21:00	60.7	As above
NSR3	21:00-21:30	59.7	As above
NSR3	21:30-22:00	60.2	As above
NSR3	22:00-22:30	59.1	As above
NSR3	22:30-23:00	59.7	As above
NSR3	23:00-23:30	58.9	As above
NSR3	23:30-24:00	58.6	As above
NSR3	00:00-00:30	58.4	As above
NSR3	00:30-01:00	56.1	As above
NSR3	01:00-01:30	55.5	As above
NSR3	01:30-02:00	56.7	As above
NSR3	02:00-02:30	55.0	As above
NSR3	02:30-03:00	53.4	As above
NSR3	03:00-03:30	49.9	As above
NSR3	03:30-04:00	52.7	As above
NSR3	04:00-04:30	53.6	As above
NSR3	04:30-05:00	55.5	As above
NSR3	05:00-05:30	54.8	As above
NSR3	05:30-06:00	57.5	As above
NSR3	06:00-06:30	60.0	As above
NSR3	06:30-07:00	59.7	As above

Table 3.11 Daytime Noise Measurements (May 1995)

Measurement Point	Time	LA_{eq}dB(A), (30 min) Measurement	Predominant Noise Sources
NSR5	07:00-07:30	60.6	Cargo handling noise, marine traffic, intermittent road traffic
NSR5	07:30-08:00	62.1	As above
NSR5	08:00-08:30	59.3	As above
NSR5	08:30-09:00	60.2	As above
NSR5	09:00-09:30	62.4	As above
NSR5	09:30-10:00	61.9	As above
NSR5	10:00-10:30	63.5	As above
NSR5	10:30-11:00	65.1	As above
NSR5	11:00-11:30	64.4	As above
NSR5	11:30-12:00	59.9	As above
NSR5	12:00-12:30	59.8	As above
NSR5	12:30-13:00	62.9	As above
NSR5	13:00-13:30	62.0	As above
NSR5	13:30-14:00	60.6	As above
NSR5	14:00-14:30	62.0	As above
NSR5	14:30-15:00	62.0	As above
NSR5	15:00-15:30	61.0	As above
NSR5	15:30-16:00	60.2	As above
NSR5	16:00-16:30	61.1	As above
NSR5	16:30-17:00	60.2	As above
NSR5	17:00-17:30	60.2	As above
NSR5	17:30-18:00	60.5	As above
NSR5	18:00-18:30	59.5	As above
NSR5	18:30-19:00	59.5	As above

3.2.4 Future Environment - Noise

During the IWTS construction and operational period, the noise generated from other planned construction activities in the area has the potential to seriously affect the background noise levels and sensitive receivers. The other relevant projects in the vicinity are the Green Island Reclamation, Mount Davis Sewage Treatment Works (part of the Strategic Sewage Disposal Scheme), Route 7 (Kennedy Town to Aberdeen) and the Mount Davis Service Reservoir.

Green Island Reclamation (Part): Public Dump project (GIRPD) is to be situated at the northwest of the proposed site. The project was scheduled to start in mid-1995, with the operational phase commencing in early 1996 and ending, at commissioning that part of the Green Island Reclamation, in 2002[4]. However, the operational phase has been delayed pending further environmental studies. The public dump will fill in a portion of Sulphur Channel between Green Island and Kennedy Town, covering an area of some 37 hectares. The dump will form part of larger Green Island Reclamation (due to be formed between 2002 and 2008) which will cover a total area of 185 hectares.

Short term access to GIRPD will be via a barging point on the old Kennedy Town Incineration Plant site. Two long term road access options have been considered: sharing the IWTS access road or utilising a currently disused track down the slope of Mount Davis, which would be upgraded.

The estimation of unmitigated noise levels at the identified NSRs due to the worst-case construction and operation scenario of GIRPD[16] is shown in Table 3.12.

[4] *Green Island Reclamation (part): Public Dump - Environmental & Traffic Impact Assessment* (January 1995) Scott Wilson Kirkpatrick *et al* for Civil Engineering Department

Table 3.12 Predicted Noise Levels from Green Island Reclamation Studies

Location	Predicted Noise Levels L_{eq}dB(A)	
	Construction & Operation Noise from Green Island Reclamation in 1996[1,2]	Construction & Operation Noise from Green Island Reclamation in 2001[1,2]
269-270 Victoria Road (NSR4)	72.7/77.3 dB(A)	71.4/76.9 dB(A)
Serene Court (NSR5)	71.7/80.2 dB(A)	70.5/80.0 dB(A)

Notes: The predicted noise levels shown in the above table include the traffic noise from the access road, construction noise and operational noise.

1 Traffic using disused track option
2 Traffic using shared IWTS road option

According to the GIRPD study[5], the shared IWTS access road would require construction of extensive noise barriers. The shared road option has been recently been abandoned.

The SSDS Mount Davis Sewage Treatment Works (STW) project is to be located at the western end of the IWTS. According to the SSDS Final EIA Report[6], the project is programmed to start in 1998. However, the IWTS tender documents give a tentative construction commencement date of 1999. The construction works include the cavern excavation, reclamation for marine frontage, working areas and the access road.

The predicted total Sound Power Level of all the powered equipment used during SSDS Mount Davis Sewage Treatment Works construction period will be 127 dB(A). The unmitigated noise levels at the identified NSRs without taking account of the topography effect are shown in Table 3.13.

---

5 *Green Island Reclamation (Part): Public Dump - Environmental & Traffic Impact Assessment: Supplementary Agreement (II) - Draft Final Report - Recommended Land Access* (February 1995) Scott Wilson Kirkpatrick *et al* for Civil Engineering Department

6 *Strategic Sewage Disposal Scheme: Site Investigations & Engineering Studies Stages II, III & IV - Final EIA Report* (January 1993) AB_2H Consultants for Drainage Services Department

Table 3.13 Predicted Noise Levels from SSDS Mount Davis Sewage Treatment Works construction period

NSRs	Distance between Notional Noise Source and NSRs (m)	Predicted Noise Level dB(A)
NSR1	540 m	67.4 dB(A)
NSR2	570 m	66.9 dB(A)
NSR3	520 m	67.7 dB(A)
NSR4	440 m	69.1 dB(A)

Development of Route 7 (Kennedy Town to Aberdeen) highway is scheduled to commence in 2008 and last until 2011. At the time of preparation of this report, the detailed feasibility study of Route 7 had not commenced and consequently information on its alignment and future noise levels was not available.

Construction of WSD Mount Davis Service Reservoir, due to be located near the IWTS site, is due start in 1997. The proposed commissioning date is 1999.

The commencement dates indicate that the only construction activity likely to overlap with construction of IWTS is the development of the Green Island Public Dump: these simultaneous works potentially offer limited mutual benefits, as discussed elsewhere in this report.

3.2.5 Construction Noise

Swire BFI's design is considerably more compact than the outline design resulting in a smaller area being affected by construction and thus an overall reduction in the area subject to noise impacts. The topography of the surrounding area results in a high degree of screening of the construction area from the surrounding NSRs particularly NSRs 2, 3, and 4. This assessment will demonstrate the acceptability of the works in terms of compliance with agreed and statutory noise criteria including a description of the necessary mitigative measures required to achieve compliance.

Construction noise impact due to the operation of powered mechanical equipment was predicted based on the proposed work programme under two scenarios. Scenario 1 is the time when construction of the spiral ramp, reinforced earth wall and initial excavating will be taking place. Scenario 2 involves the time when the above ground facilities are being constructed including offices, weighbridge and cargo handling facilities. Locations of the notional noise sources associated with these activities are shown in Figure 3.1.

Noise Prediction

(i) Use of Powered Mechanical Equipment (PME)

A list of powered mechanical equipment used as the basis of the construction noise modelling is presented in Appendix 6. The Appendix also includes the noise level predicted due to each of the construction activities identified. The sound power levels for each activity are first summed up logarithmically to give a total level.

The reduction of sound over the intervening distance when the PME is on the ground surface is given by the following expression:

$$SPL = (SWL - 20 \log r - 11 + DI) \text{ dB(A)}$$

where SPL is the sound pressure level expected at the NSRs and

SWL is the logarithmic sum of sound power levels of the PME for each activity (eg. ramp construction);

r is the horizontal intervening distance between the NSR and the noise source;

DI is the directivity factor. In this case where there is unidirectional sound propagation with the ground being one reflective surface DI is 3 dB(A).

At all the NSRs, topography offers partial or substantial barrier effects from the portals. In each case, barrier correction is calculated using the method on Figure 4 and Chart 9 of the *Calculation of Road Traffic Noise*, issued by the UK Department of Transport, 1988. The barrier effect is a negative corrective correction added to the predicted noise levels. The noise barrier corrections for NSRs 1 to 5 are -15.2 dB(A), -20.8 dB(A), -19.7 dB(A), -17 dB(A) and -15.2 dB(A) respectively. Prediction results are summarized in Table 3.14.

(ii) Loading/Unloading of Spoil onto Barge

The noise resulting from the loading and unloading operation of spoil onto barges at the NSRs is predicted using the same model as above. Prediction results are summarized in Table 3.14.

(iii) Haul Road Traffic

The noise from dump trucks moving along the haul road has been calculated using the method stated in the section A.3.4.2 of BS 5228: Part 1: 1984. The haulage traffic is estimated at 200 vehicles per 24 hours, or 8 vehicles per hour. The expression is as follows:

$$L_{Aeq\,(1\,hr)} = L_{WA} - 33 + 10 \log Q - 10 \log V - 10 \log 10\,d$$

where

L_{WA}	is the sound power level of the plant (dB(A)), 117 dB(A) for dump trucks
Q	is the number of vehicle per hour, 8 in this case
V	is the average traffic speed (km/h), assumed 20 km/h
d	is the distance of receiving position from the centre of haul road

A 3 dB(A) correction will be added for the facade correction.

The haulage traffic noise L_{Aeq} (1 hour) at NSRs 1-5 are 54.9 dB(A), 51.6 dB(A), 53.6 dB(A), 56.0 dB(A) and 52.2 dB(A) respectively. The results are summarised in Table 3.14.

Table 3.14 Summary of Predicted Construction Noise Impacts

	Predicted Noise Levels dB(A)				
Scenario I	NSR1	NSR2	NSR3	NSR4	NSR5
Noise from ramp building (piling)	84.0	67.0	69.0	57.0	70.0
Noise from ramp building (07:00 - 19:00)	65.4	50.7	51.9	40.9	52.7
Noise from site formation and reinforced earth wall construction (07:00 - 19:00)	67.1	60.6	53.8	65.4	61.7
Noise from open portal cut for the first 20 m of tunnels (07:00 -19:00)	68.7	65.5	68.4	77.0	66.2
Noise from ventilation fans, generators, etc. for excavation (07:00 - 07:00)	44.2	35.1	39.4	50.5	41.5
Noise from barges loading spoil (07:00 - 19:00)	49.4	43.7	45.9	46.8	46.1
Construction traffic on site transferring spoil to barge/ stockpile	54.9	51.6	53.6	56.0	52.2
Overall (07:00 - 19:00)					
- without mitigation	72.2	67.0	68.8	77.3	67.8
- with mitigation	64.2	59.0	60.8	69.3	59.8
Overall (19:00 - 23:00)					
- without mitigation	55.3	51.7	53.8	57.1	52.6
- with mitigation	47.3	42.7	45.8	49.1	44.6
Overall (23:00 - 07:00)					
- without mitigation	55.3	51.7	53.8	57.1	52.6
- with mitigation	47.3	42.7	45.8	49.1	44.6

Scenario II	NSR1	NSR2	NSR3	NSR4	NSR5
Noise from offices, weighbridge, etc. construction (07:00 - 19:00)	82.7	71.2	75.2	78.1	77.6
Noise from ventilation fans, generators, etc. for excavation (07:00 - 07:00)	44.2	35.1	39.4	50.5	41.5
Noise from barges loading spoil (07:00 - 19:00)	49.4	43.7	45.9	46.8	46.1
Construction traffic on site transferring spoil to barge/ stockpile area (07:00 - 07:00)	54.9	51.6	53.6	56.0	52.2
Overall (07:00 - 19:00)					
- without mitigation	82.7	71.3	75.2	78.1	77.6
- with mitigation	74.7	63.3	67.2	70.1	69.6
Overall (19:00 - 23:00)					
- without mitigation	55.3	51.7	53.8	57.1	52.6
- with mitigation	47.3	42.7	45.8	49.1	44.6
Overall (23:00 - 07:00)					
- without mitigation	55.3	51.7	53.8	57.1	52.6
- with mitigation	47.3	42.7	45.8	49.1	44.6

Notes:

Appendix 6 lists the powered mechanical equipment used as the basis of the construction noise calculations.

3.2.6 Night-time Construction Activities

Once the initial 20 m of the cavern access been excavated, excavation will be undertaken on a 24 hour per day basis.

Having established suitable noise levels at sensitive receivers for day and night working, the noise levels for various night time activities can be assessed. Static plant will be located and silenced to minimise its impact. Other essential night time operations will include loading out rock spoil from the portals. This will be loaded to a stockpile area and not directly into a barge, thus reducing the generation of noise. Barge loading will be undertaken only during the day (07:00-19:00 hours) and in such a manner as not to exceed any noise limits.

At the commencement of the contract, the noise survey was used to establish background noise levels prior to construction. The results of this baseline monitoring are shown in Tables 3.10 and 3.11. As work is commenced at night, regular monitoring will be carried out to establish actual levels of noise from individual operations. All necessary steps will be taken to reduce noise levels wherever practicable. Monitoring will continue on a regular basis until clear patterns and noise levels have been established. If any changes in work patterns are initiated that may affect noise levels, further monitoring will be carried out during introduction to ensure compliance with the permitted noise levels.

3.2.7 Construction Noise - Mitigation Measures

The results above assume noise attenuation from site hoarding and the screening effect of the north facing slope into which the tunnels are cut. During the initial period of construction (Scenario I) additional mitigation measures are required to reduce noise levels to within acceptable limits at NSR1 during daytime hours and at all of the NSRs between 23:00 and 7:00. During the day, the main noise nuisance will arise from construction of the portals adjacent to NSR4. At night, the greatest nuisance will arise from dump trucks operating between the barging point and the portals.

During the latter stages of construction (Scenario II) mitigation measures will be required to reduce daytime and night time noise levels at all NSRs.

Swire BFI will ensure that statutory noise criteria will not be exceeded at NSRs during construction. This can be achieved by implementation of the following mitigation measures:

- use of silenced generators and compressors where possible (potential overall reduction 3 dB(A));

- use of temporary noise barriers angled inward towards the site or plant at the top where necessary;

- good management of site activities;

- minimising the transportation of spoil material between the cavern and barging point during the night time (23:00 - 07:00 hours).

Additional measures to reduce daytime noise levels will include:

- use of acoustic enclosures for crane motor and drill rig;
- siting of plant as far as possible away from NSRs;
- reduction in the number of idling lorries and powered mechanical equipment as much as possible;
- ensuring plant and vehicles are well maintained particularly in regard to exhaust systems.

Throughout the construction period, weekly monitoring of noise levels as LA_{eq} (30 min) will be carried out at NSR 1 to 4 to ensure that the statutory levels are complied with. Any measured exceedence will result in implementation of additional noise reduction measures.

3.2.8 Blasting - Noise and Vibration

Blasting will be undertaken throughout the period of excavation of the access and cavern over a period of approximately 8 months. Excavation work beyond 20 m of the portals will be on a 24 hour per day basis, 6 days per week. Blasting operations will comply with the requirements of the *Dangerous Goods Ordinance* together with any additional requirements of the Commissioner of Mines. Nevertheless, vibration could be experienced at the nearby Mt Davis Cottage area.

To achieve the blast vibration levels, it will be necessary to limit the explosive charge weight per delay. This can be achieved with either electric or non-electric detonations by sequenced blasting to give up to 140 delay spacings. The non-electric system, which is the only one permitted in Hong Kong, will be used.

Blast patterns will be designed to give one delay number per cut hole which are effectively treated as confined despite the presence of large diameter open holes at the centre of the cut. Unconfined holes will be blasted with two or more holes charge weight per delay.

To establish site parameters, blast size will be reduced by opening into the access with short rounds of restricted weight. The specified monitoring stations will be set up and from recordings, the blast round can gradually be increased to the optimum level. Blasting will initially be undertaken during the day only.

As the access passes under the road and cottage area, the depth increases rapidly and it is expected that vibration levels will fall enabling full face blasting to be carried out on an unrestricted basis.

The slopes adjacent to the portals will have been cleared and stabilised with rock pinning. As blasting could disturb the surface, survey monitor lines will be set up across the slope and checked after every blast. Crack detection monitors will also be placed on joint structures above the portals. These will be visually examined after each blast. Should any specific rock feature exposed during slope stability work require additional monitoring the necessary monitoring system will be installed. In addition to the measurement surveys, visual examination will be carried out along the slope on a daily basis.

Apart from slope stability work it is not considered that buildings or road structures will require any additional treatment. However, it will be necessary to establish the condition of all structures and services likely to be affected and limit the blast size accordingly.

3.2.9 Blasting - Mitigation Measures

To minimise any noise nuisance, it is essential that all practicable noise reduction measures are taken. Initially, trial blasting will be carried out and this will produce a limited level of noise which will be monitored to establish the actual noise level achieved at the NSRs and the levels that are acceptable.

Blasting will be required first at the portals, when blast noise levels will potentially be at their greatest. Reduced charges can be employed at these locations. As the excavations advance underground, the noise emissions will be greatly reduced. To achieve acceptable levels, the blast pattern will be designed not only to give high efficiency but to reduce the total quantity of explosive being used in any blast. Initial trial blasts will, therefore, take place with a small number of shotholes and light explosive charge, while remaining compatible with achieving an acceptable level of blast efficiency.

In addition to careful blast design, the portal blast areas will be covered by noise muffling safety baffles which not only minimise the fly dirt but also reduce noise transmission to the atmosphere. These noise and fly rock baffles will consist of heavy chain screens with heavy sheeting (strips or conveyor belting). If the NSRs are in direct line-of-sight such that sound deflection or attenuation can be achieved by specific hoardings, additional such precautions will be deployed.

All initial trial blasts will be undertaken during the day when sensitivity levels are higher. Following monitoring of trial blast noise levels achieved and reaction (if any) to them, the blast patterns may be adjusted to provide the most efficient blasting system possible within the accepted noise limit.

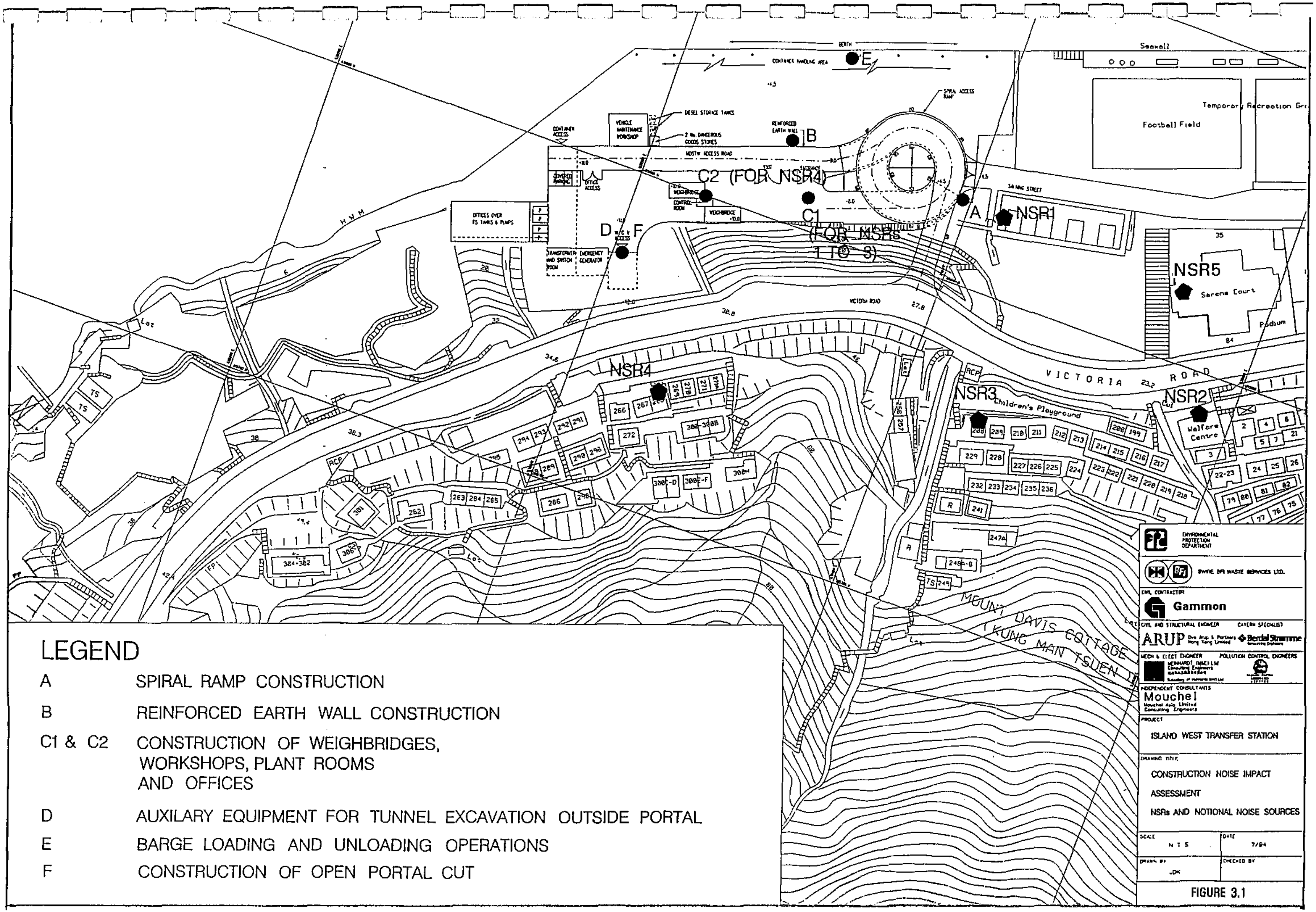
It should be stressed that while relatively low levels of noise emission can be achieved by low efficiency blasting, this can have a bigger overall nuisance effect due to the much increased frequency of blasting. The use of inefficient blast patterns will only serve to increase the amount of explosive consumed and result in more noise in total during the project period.

In addition to adopting all practical measures to minimise noise emissions, the local residents will be advised of the date, timing and duration of blasting activities, and Swire BFI's contact personnel will be available on a 24 hour basis to deal with any queries from the public.

3.2.10 Summary

Construction of the IWTS facility will be undertaken in such a way as to minimise the impacts of noise from powered mechanical equipment, blasting and construction-related traffic on nearby sensitive receivers.

Regular monitoring of noise levels and implementation of appropriate mitigation measures will ensure that noise levels are kept within the required limits at all times during construction of the transfer station.



BERTH
CONTAINER HANDLING AREA
Seawall
Temporary Recreation Gr
Football Field
SPIRAL ACCESS RAMP
DIESEL STORAGE TANKS
VEHICLE MAINTENANCE WORKSHOP
2 No. DANGEROUS GOODS STORES
REINFORCED EARTH WALL
CONTAINER ACCESS
OFFICES OVER FS TANKS & PUMPS
WEIGHBRIDGE
CONTROL ROOM
TRANSFORMER AND SWITCH ROOM
EMERGENCY GENERATOR
VICTORIA ROAD
Serene Court
Podium
Children's Playground
Welfare Centre
MOUNT DAVIS COTTAGE
(KUNG MAN TSUEN)
E
B
A
C1 (FOR NSRs 1 TO 3)
C2 (FOR NSR4)
D
F
NSR1
NSR2
NSR3
NSR4
NSR5
LEGEND
A SPIRAL RAMP CONSTRUCTION
B REINFORCED EARTH WALL CONSTRUCTION
C1 & C2 CONSTRUCTION OF WEIGHBRIDGES, WORKSHOPS, PLANT ROOMS AND OFFICES
D AUXILARY EQUIPMENT FOR TUNNEL EXCAVATION OUTSIDE PORTAL
E BARGE LOADING AND UNLOADING OPERATIONS
F CONSTRUCTION OF OPEN PORTAL CUT
ENVIRONMENTAL PROTECTION DEPARTMENT
SWIRE BFI WASTE SERVICES LTD.
CIVIL CONTRACTOR
Gammon
CIVIL AND STRUCTURAL ENGINEER
CAVERN SPECIALIST
ARUP
Berdal Strømme
MECH & ELECT ENGINEER
POLLUTION CONTROL ENGINEERS
INDEPENDENT CONSULTANTS
Mouchel
Mouchel Asia Limited Consulting Engineers
PROJECT
ISLAND WEST TRANSFER STATION
DRAWING TITLE
CONSTRUCTION NOISE IMPACT ASSESSMENT
NSRs AND NOTIONAL NOISE SOURCES
SCALE
N T S
DATE
7/94
DRAWN BY
JDK
CHECKED BY
FIGURE 3.1

3.3 Air Quality

Previous Environmental Assessments for other waste transfer stations in Hong Kong and Island East[6,7,8] as well as the IWTS IEIA have identified the following sources of air quality to be of concern:

- dust from on-site construction;
- emissions from construction traffic.

In this section, the method of construction is analysed and potential major sources of dust identified, and the impact of dust producing processes and construction plant on adjacent air sensitive uses fully assessed with the knowledge of final construction methods and plant.

3.3.1 Legislation and Guidelines

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

New environmental legislation entitled *Air Pollution Control (Construction Dust) Regulations* is currently under consultation. These regulations are to control the dust emission from construction sites by a notification and permit procedure.

The IWTS study area is located within the Harbour Air Control Zone declared in December 1986. The Air Quality Objectives for this zone were established in January 1987 and were aimed at the protection of public health. The health related air quality objectives for seven air pollutants are shown in Table 3.15.

---

6 *Island East Transfer Station: Final Environmental Review Report* (November 1989) Environmental Protection Department

7 *Island East Transfer Station: Final Report* (September 1990) Environmental Protection Department

8 *Kowloon Bay Refuse Transfer Station: Environmental Impact Assessment: Final Key Issues Report No.1* (March 1991) Environmental Protection Department

Table 3.15 Hong Kong Air Quality Objectives (AQOs)

Pollutant	Concentration $(\mu g)m^3$					Health effects of pollutant at elevated ambient levels
	Average Time					
	1hr	8hrs	24hrs	3mths	1yr	
Sulphur Dioxide	800[2]		350[3]		80	Respiratory illness; reduced lung function; morbidity and mortality rates increase at higher levels.
Total Suspended Particulate			260[3]		80	Respirable fraction has effects on health.
Respirable Suspended Particulates			180[3]		55	Respiratory illness; reduced lung function; cancer risk for certain particles; morbidity and mortality rates increase at higher levels.
Nitrogen Dioxide	300[2]		150[3]		80	Respiratory irritation; increased susceptibility to respiratory infection; lung development impairment.
Carbon Monoxide	30000[2]	10000[3]				Impairment of co-ordination; deleterious to pregnant women and those with heart and circulatory conditions.
Photochemical Oxidants as ozone	240[2]					Eye irritation; cough; reduced athletic performance; possible chromosome damage.
Lead				1.5		Affects cell and body processes; likely neuro-psychological effects, particularly in children; likely effects on rates of incidence of heart attacks, strokes and hypertension.

Notes: Concentrations measured at 298°K (25°C) and 101.325 kPA

1 Suspended particles in air with a nominal aerodynamic diameter of 10 μm or smaller
2 Criteria not to be exceeded more than 3 times per year
3 Criteria not to be exceeded more than once per year

Construction Dust

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

Cement and Concrete

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

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

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

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

3.3.2 Sensitive Receivers

The air (dust and odour) sensitive receivers (ASRs) in the area are the residential developments in the vicinity of Sai Ning Street and the Mount Davis Cottage Area. As noted in the IEIA, the prevailing winds are predominantly north-east to easterly away from the Old People's Home, Serene Court and other ASRs on Sai Ning Street. The Mount Davis Cottage Area, although overlooking the construction site, is also partially screened by the steep embankment, the coastal site of Victoria Road and by vegetation.

3.3.3 Existing Environment - Air Quality

Air quality management and monitoring in Hong Kong are the responsibility of the Environmental Protection Department (EPD); the overall air quality of the area can be seen from the results of the routine air quality monitoring carried out by them. An annual summary of air quality data for 1994[9] for all the monitoring stations is shown in Figures 3.2 to 3.4.

The nearest EPD continuous air monitoring station to Kennedy Town is Central and Western at Upper Level Police Station between High Street and Hospital Road. Air pollution levels are measured 18 m above ground level. Pollutants monitored at the station are sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), total and respirable suspended particulates (TSP & RSP) and lead (Pb).

A comparison of the maximum 1-hour and maximum 24-hour figures given in EPD's 1995 report with those in EPD's 1994 report indicate that air pollutant concentrations measured at the Central and Western station have decreased. The annual average concentrations for TSP recorded during 1994 by EPD exceeded the air quality objective.

Air Quality in Kennedy Town

Baseline dust level monitoring results taken in the area in May 1995 are shown in Table 3.16. The monitoring locations are shown in Figure 3.5. TSP levels of between 50 and 180 $\mu g/m^3$ and RSP levels or between 30 and 110 $\mu g/m^3$ were recorded. These baseline TSP levels recorded are well within the hourly average 500 $\mu g/m^3$ limit set for construction dust.

9 *Environment Hong Kong 1995 (A Review of 1994): Chapter 10.11.c* (1995) Environmental Protection Department

Table 3.16 Baseline Air Quality Monitoring Results (May 1995)

Date/Time	D1		D2	
	TSP ($\mu g/m^3$)	RSP ($\mu g/m^3$)	TSP ($\mu g/m^3$)	RSP ($\mu g/m^3$)
6 May 1995 (16:30) to 7 May 1995 (17:30)	-	-	130	100
8 May 1995 (14:45) to 9 May 1995 (15:30)	90	60	110	70
9 May 1995 (15:35) to 10 May 1995 (15:45)	100	50	80	60
10 May 1995 (15:30) to 11 May 1995 (16:00)	-	-	100	60
11 May 1995 (16:00) to 12 May 1995 (16:30)	-	-	100	70
12 May 1995 (17:30) to 13 May 1995 (17:00)	50	40	70	40
13 May 1995 (17:00) to 14 May 1995 (18:00)	70	40	50	40
15 May 1995 (11:30) to 16 May 1995 (11:45)	-	-	180	110
16 May 1995 (12:00) to 17 May 1995 (11:30)	-	-	110	50
17 May 1995 (12:00) to 18 May 1995 (12:45)	-	-	80	60
18 May 1995 (13:30) to 19 May 1995 (14:00)	80	50	-	-
19 May 1995 (15:00) to 20 May 1995 (16:00)	60	30	-	-
20 May 1995 (17:00) to 21 May 1995 (17:45)	60	30	-	-
22 May 1995 (15:00) to 23 May 1995 (14:45)	70	50	-	-
23 May 1995 (15:00) to 24 May 1995 (16:00)	90	60	-	-
24 May 1995 (17:00) to 25 May 1995 (18:00)	140	70	-	-

Elevated levels of particulates and nitrogen dioxide from combustion sources, vehicles and construction activity is a common problem observed at other air pollution monitoring sites in Hong Kong.

There are several sources of air pollution in the vicinity of the proposed IWTS facility. The principal concerns are related to odour nuisance and motor vehicle emissions.

Odour emissions from the Kennedy Town Abattoir have been a source of complaint. Emissions are generated by the animal lairages and slaughtering activities, together with odorous emissions from the by-product plant and the crematory facilities operating within the abattoir compound[10].

EPD has carried out a review of odour nuisance problems created by the abattoir, the by-products plant and the crematory. The review indicated that odour problems were likely to occur within a 300 m radius of the existing facilities. For the existing abattoir alone the distance for which odour nuisances would be likely is 200 m.

Both the emissions from the (now disused) incinerator and the abattoir suffer from poor air dispersion conditions due to the relative heights of the emissions and the close proximity of the surrounding buildings. The diverse topography of the locality also contributes to air dispersion problems.

The Hong Kong Government is presently considering the feasibility of relocating the abattoir to a cavern facility approximately 400 m west of the proposed IWTS site.

Motor Vehicle Emissions

Motor vehicle exhausts emit a wide range of compounds. Those which are of general concern include carbon monoxide (CO), oxides of nitrogen (NO_x) (nitric oxide (NO) and nitrogen dioxide (NO_2)), hydrocarbons (HC), particulates and lead (Pb). Particular concern in Hong Kong has been raised about emissions of Pb and NO_2. Pollutant emission levels are principally dependent on traffic volume and speed, age of vehicle, type of combustion engine (petrol or diesel), driving mode, etc. The pollutant concentration at the sensitive receptor will be determined by distance of the receptor location from the highway, topography and prevailing meteorological conditions. The concentration of the emitted pollutant falls off rapidly with distance from the roadside kerb and concentrations are highest when the wind is blowing obliquely to the road at low windspeeds.

In Hong Kong, there has been a phased reduction in the maximum permitted Pb content of petrol to a current level of 0.15 g/1 maximum. Table 3.14 shows that a long-term AQO of 1.5 $\mu g/m^3$ (3-months) has been set. NOx are emitted from motor vehicles mainly in the form of NO which is oxidised to NO_2.

---

10 *Green Island Reclamation Feasibility Study: Technical Paper 21 - Air Quality - Existing Conditions* (1989) Ove Arup & Partners, Peter Y S Pun & Associates for Urban Area Development Office

In peak traffic hours, the centre of Kennedy Town exhibits traffic congestion and low vehicle speeds, although the traffic volume is not high. There is, however, a large amount of pedestrian, hand-trolley and roadside activity in the area, associated with nearby markets.

Other smaller pollution sources in the locality include restaurants, pig roasting and lard-boiling factories. The air pollution problems from these are principally odour nuisance.

Radon

As outlined in the IEIA, radon is a colourless, odourless and radioactive gas formed from the radioactive decay of radium. Long term exposure to high concentrations of radon or its decay products may increase the risk of contracting lung cancer.

The risk from radon would increase in an enclosed environment, such as a cavern, if it were not provided with adequate ventilation. Recent studies in Hong Kong[11] found that results from 45% of locations monitored exceeded the US Environmental Protection Agency action guideline of 150 Bq/m^3 (becquerels per cubic metre). Radon levels were strongly affected by ventilation rates.

The IWTS will be built in a complex sequence of undifferentiated volcanic rocks intermixed with sequences of lavas, coarse tuffs and agglomerates which have been metamorphosed suggesting localised contact with granite and its association with radon gas emissions.

Although radon is not emitted from volcanic tuff (the formation in which the cavern will be built), monitoring for radon gas will be undertaken to ensure compliance with the above standard and to check for any lateral migration. If at the time of construction, and shortly thereafter, radon screening monitors show unduly high levels of radon gas then adequate ventilation will be adopted during construction. It is not considered necessary to maintain monitoring for radon during the operational phase, as by this stage the ventilation systems will have been installed.

3.3.4 Future Environment - Air Quality

As discussed elsewhere in this report, the only other major infrastructure development to be constructed/operated concurrently with the construction of IWTS is the Green Island Reclamation Public Dump.

---

11 *Environment 1991, Chapter 5* (1992) Environmental Protection Department

Dispersion modelling studies carried out during the Environmental and Traffic Impact Assessment for this project indicated that sensitive receivers are unlikely to be adversely affected by particulate levels from construction activities, which include the operation of concrete batching and rock crushing plant. The studies also show that if adequate mitigation measures are practised, such as regular watering of haul roads, dust concentrations will be kept well below the recommended air quality guidelines.

3.3.5 Air Quality Outside Cavern - Impacts

Dust and fume generation outside the cavern will arise principally from initial blasting, materials handling and transfer as well as vehicular as well as vehicular and plant engine emissions. Dust emissions, and hence their degree of impact, will be determined by the degree of effort placed upon dust control. The construction contractor will be required to ensure that the Hong Kong Government Air Quality Objectives (AQO) for 24 hour average TSP and RSP of 260 $\mu g/m^3$ and 180 $\mu g/m^3$ respectively are complied with. In addition, the Performance Requirements state that the airborne dust level shall not exceed 500 $\mu g/m^3$ at any location within the site.

The main dust producing activities will occur during the first eight months of construction phase during which time the following activities will take place:

- excavation of the open cut
- reinforced earth wall and haul road construction to +11 mPD
- excavation of access and caverns
- construction of the spiral ramp

Plant operating outside the cavern includes excavators, dump trucks, generators, barges and cranes.

Dust emissions will arise from the following sources:

- initial blasting
- vehicle movements on the unpaved haul road
- stockpiling at the barging point
- loading and unloading at the barging point
- earth moving for the reinforced earth wall
- operation of a dry shotcrete batching plant

3.3.6 Air Quality Outside Cavern - Mitigation Measures

With the significant reduction in the amount of excavation required by the Swire BFI design compared with that of the conceptual design, coupled with the implementation and maintenance of rigorous dust suppression measures listed below, no construction operations will result in exceedences of the AQOs.

The following dust suppression measures will be incorporated into the site management practices to ensure compliance with the AQO:

- daily watering of unpaved areas, access roads, construction areas and dusty storage piles by fixed and/or mobile spray systems during dry weather conditions;
- imposing a vehicle speed limit of 8 km/hr on site to minimise dust entrainment on unpaved areas;
- dusty stockpiles will be enclosed on three sides;
- where possible storage and handling areas will be hardstanding;
- covering of vehicle loads leaving the site via Sai Ning Street;
- use of wheel and vehicle wash facilities at the site exit;
- drilling equipment will be properly maintained and fitted with dust extraction or water flush systems;
- routing of construction plant travelling to and from the site to, as far as possible, avoid sensitive receivers in the area;
- dry mix batching will be carried out in a totally enclosed area with exhaust to suitable fabric filters;
- regular inspection of all plant and vehicles will be carried out by the site contractor to ensure that they are operating efficiently and that exhaust emissions are not causing a nuisance.

As part of the Environmental Monitoring & Audit of the IWTS project, dust levels will be monitored at two locations at the site boundary throughout the construction phase. In this way, any significant deterioration in air quality as a result of construction activities will be detected at an early stage and additional mitigation measures will be implemented to reduce dust emissions to acceptable levels.

On-site dust levels will also be measured regularly at a third dust monitoring station throughout the construction period to ensure that airborne dust levels on site do not exceed 5 mg/m^3.

3.3.7 Air Quality Inside Cavern - Impacts

Noxious and dusty fumes will be generated in the confined area of the underground works during the construction phase from activities such as the operation of plant and blasting. In addition, radon emissions have been identified as a hazard. Adequate ventilation will be essential to ensure that air quality does not deteriorate beyond acceptable limits.

3.3.8 Air Quality Inside Cavern - Mitigation Measures

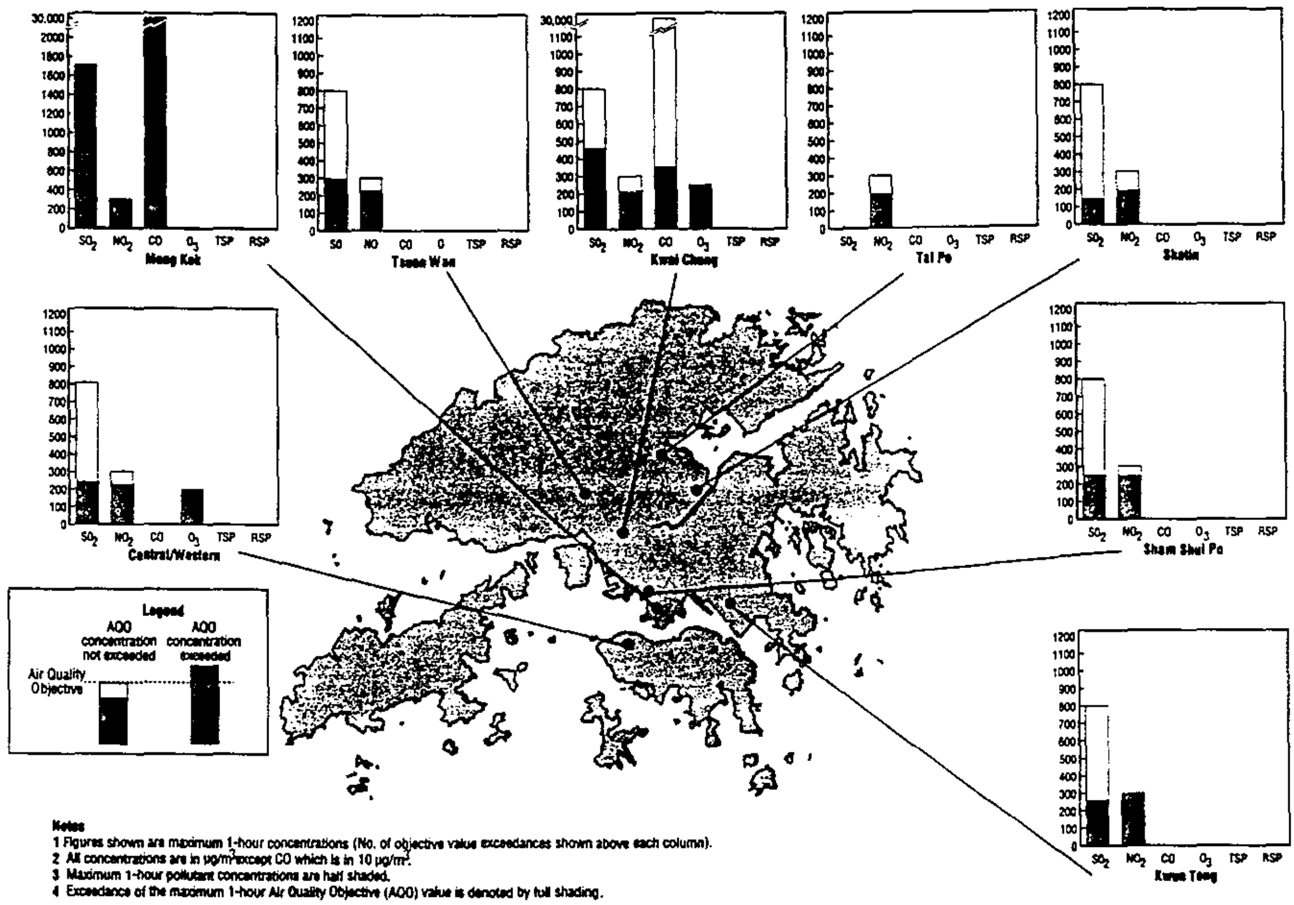
During the construction phase, the cavern ventilation system will be such that fumes are diluted to a level, within the works, which meets the appropriate health and safety standards. At the point of discharge, the air will not present a hazard to those working in the cavern or indeed to the surrounding areas.

There will be continuous monitoring of carbon dioxide, nitrogen oxides and radon levels within the IWTS cavern throughout the construction period. Should any additional air treatment be required, such as dust extractors in conjunction with shotcreting work or underground fabrications, then filter/precipitator units will be used. At no time will emissions of fumes or dust from the site exceed any statutory or specified limits.

3.3.9 Summary

Construction activities at the IWTS facility will follow good site practice. Air quality both within and outside the excavated cavern will be monitored, and appropriate mitigation measures for cavern ventilation and dust suppression will maintain air quality levels within acceptable limits.

Maximum 1-hour Air Pollutant Concentrations and Objectives

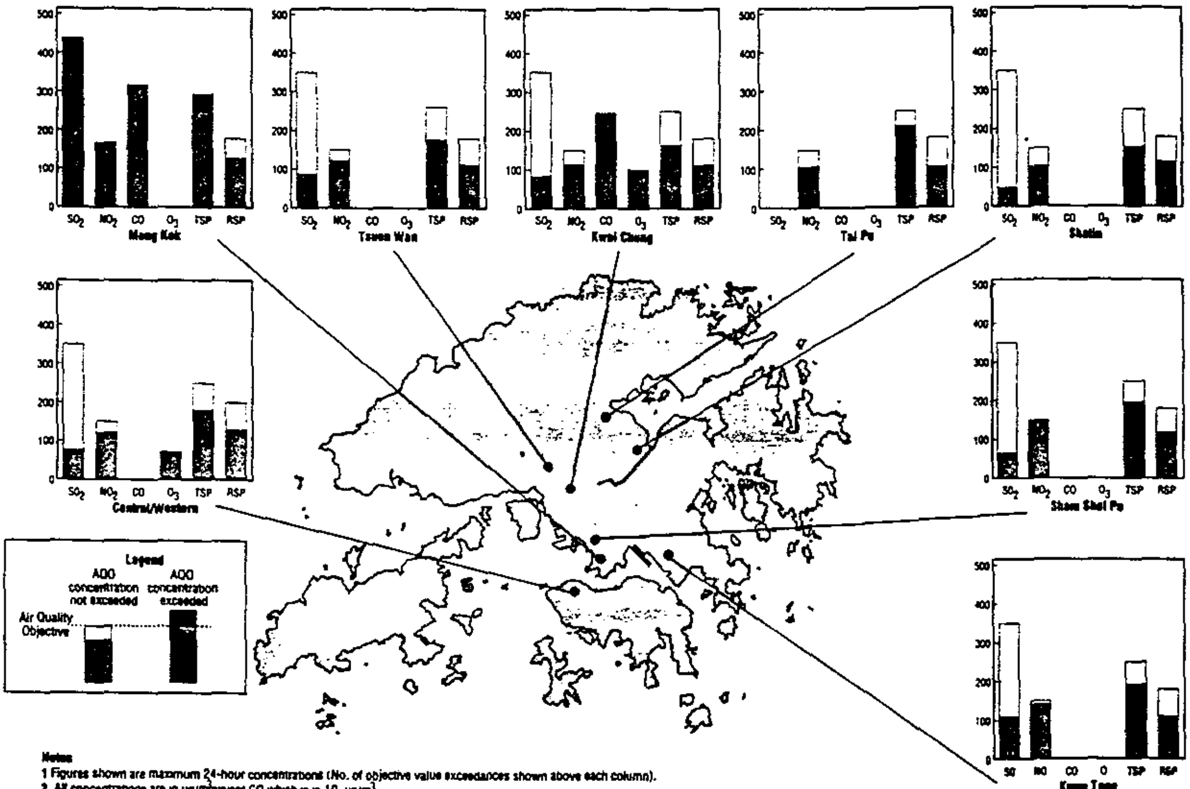


Notes
1 Figures shown are maximum 1-hour concentrations (No. of objective value exceedances shown above each column).
2 All concentrations are in µg/m³ except CO which is in 10 µg/m³.
3 Maximum 1-hour pollutant concentrations are half shaded.
4 Exceedance of the maximum 1-hour Air Quality Objective (AQO) value is denoted by full shading.

FIGURE 3.2

Source:
ENVIRONMENT HONG KONG 1995

Maximum 24-hour Air Pollutant Concentrations and Objectives

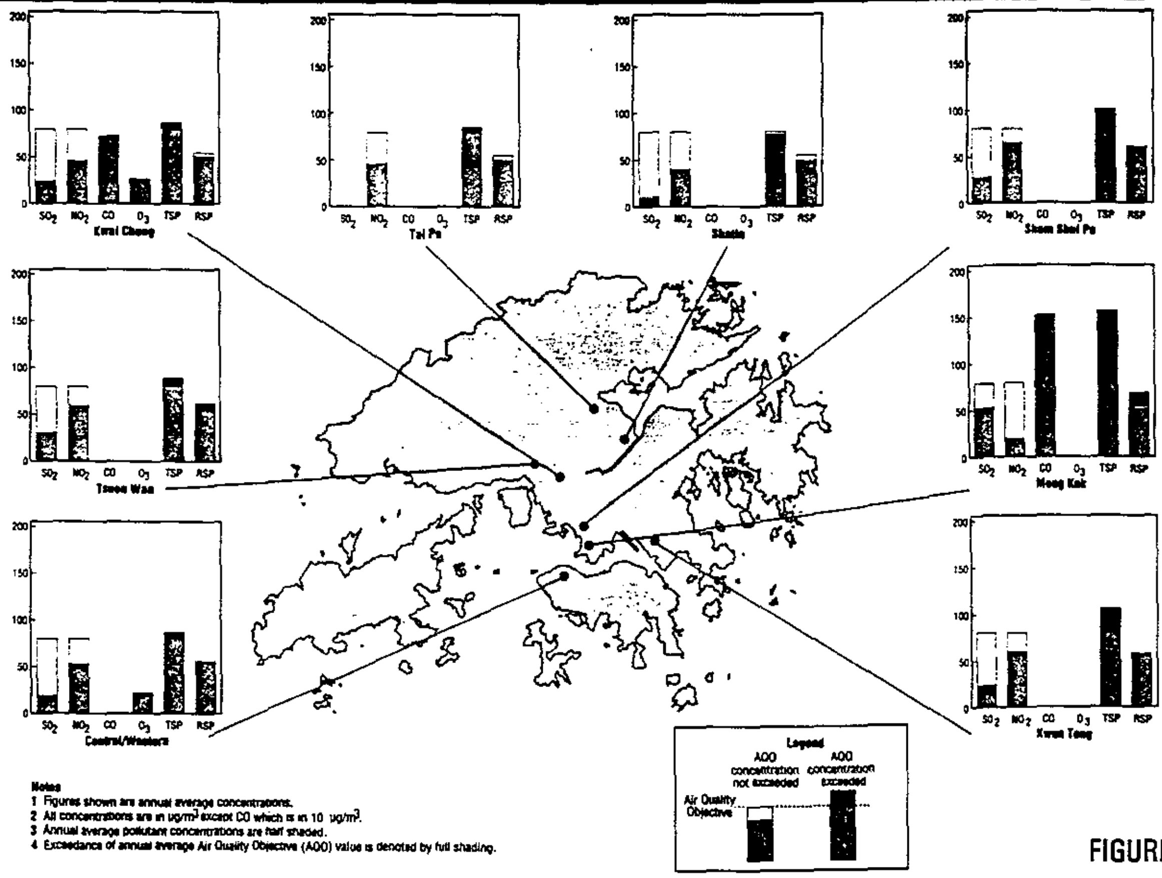


Notes

1 Figures shown are maximum 24-hour concentrations (No. of objective value exceedances shown above each column).
2 All concentrations are in μg/m³ except CO which is in 10 μg/m³.
3 Maximum 24-hour pollutant concentrations are half shaded.
4 Exceedance of the maximum 24-hour Air Quality Objective (AQO) value is denoted by full shading.

FIGURE 3.3

Annual Average Air Pollutant Concentrations and Objectives



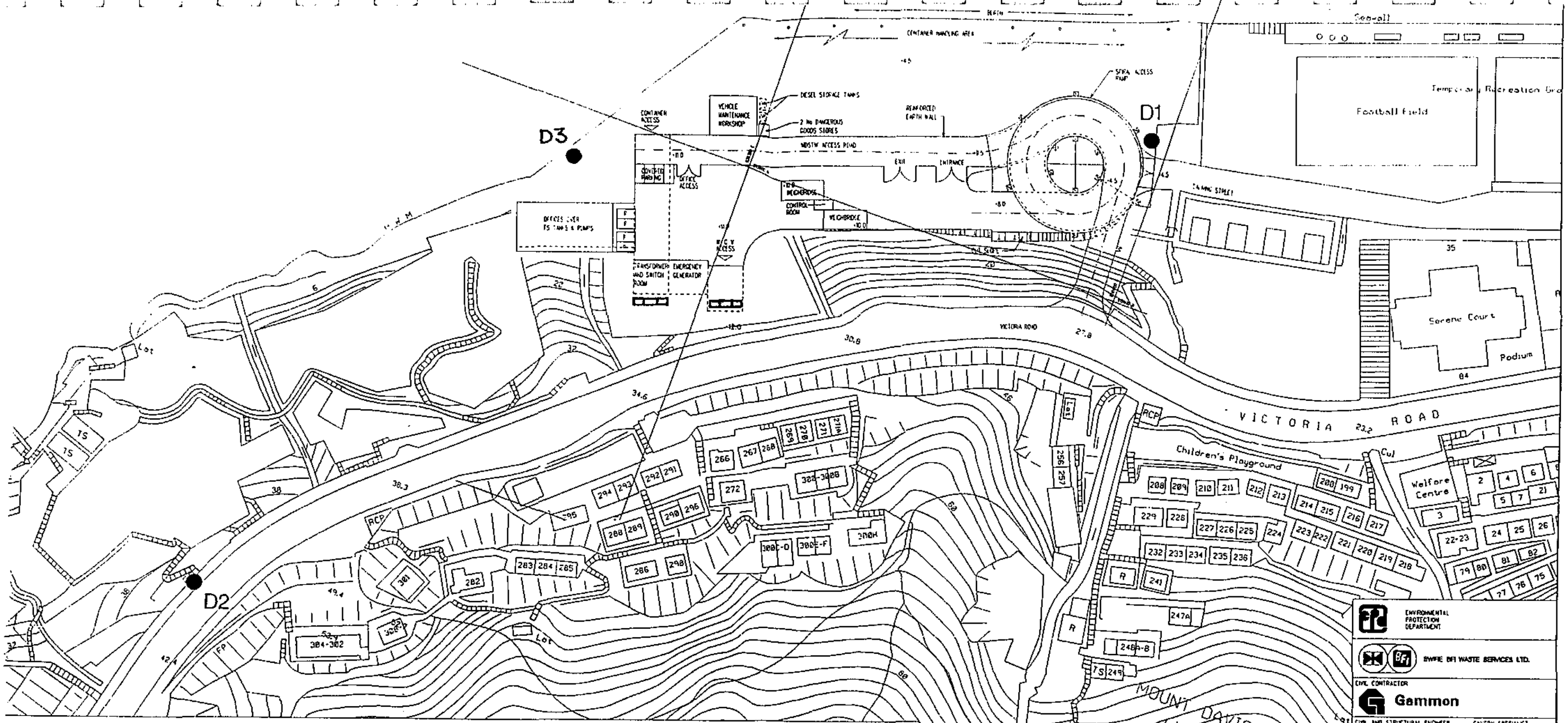
Notes

1 Figures shown are annual average concentrations.
2 All concentrations are in μg/m³ except CO which is in 10 μg/m³.
3 Annual average pollutant concentrations are half shaded.
4 Exceedance of annual average Air Quality Objective (AQO) value is denoted by full shading.

FIGURE 3.4

Source:

ENVIRONMENT HONG KONG 1995



LEGEND

- D1 DUST MONITORING LOCATION
- D2 DUST MONITORING LOCATION
- D3 DUST MONITORING LOCATION
- ▥ VENTILATION SHAFT

ENVIRONMENTAL PROTECTION DEPARTMENT

SWIRE BFI WASTE SERVICES LTD.

CIVIL CONTRACTOR: Gammon

CIVIL AND STRUCTURAL ENGINEER: ARUP Ove Arup & Partners Hong Kong Limited

CAVERN SPECIALIST: Berdal Strømme

MECH & ELECT ENGINEER: BERNHARDT (HK) Ltd

POLLUTION CONTROL ENGINEERS

INDEPENDENT CONSULTANTS: Mouchel — Mouchel Asia Limited, Consulting Engineers

PROJECT: ISLAND WEST TRANSFER STATION

DRAWING TITLE: DUST MONITORING LOCATIONS

SCALE	DATE
N T S	7/94
DRAWN BY: JOK	CHECKED BY:

DRAWING NO: FIGURE 3.5

3.4 Water

This section describes the potential impact of the construction of the IWTS facility on water quality in the study area.

3.4.1 Legislation and Guidelines

The principal legislation for controlling water pollution in Hong Kong is the *Water Pollution Control Ordinance (WPCO) [Cap 358]* of 1981 which allows for gazettal of Water Control Zones (WCZ) within which the discharge of liquid effluents and the deposit of matter into any water bodies, public sewers and drains are controlled. Parts of the Victoria Harbour WCZ have recently (1995) been gazetted; Victoria Harbour WCZ is the last area of Hong Kong waters to be addressed in this way. The WPCO is applicable for construction site discharges as well as for discharges during the operational phase.

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

Tables 3.17-20 list the required standards for IWTS effluents discharged to inshore waters and sewers, and for discharges from WENT Landfill.

Table 3.17 Performance Requirements: IWTS Effluents Discharged into Inshore Waters of Victoria Harbour Water Control Zone

Determinand / Flow rate (m^3/day)	≤10	>10 to ≤200
pH (pH units)	6-9	6-9
Temperature (^{0}C)	40	40
Colour (lovibond units)(25 mm cell length)	1	1
Suspended solids	50	30
BOD	50	20
COD	100	80
Oil & Grease	30	20
Iron	15	10
Boron	5	4
Barium	5	4
Mercury	0.1	0.001
Cadmium	0.1	0.001
Other toxic metals individually	1	1
Total toxic metals	2	2
Cyanide	0.2	0.1
Phenols	0.5	0.5
Sulphide	5	5
Total residual chlorine	1	1
Total nitrogen	100	100
Total phosphorus	12	10
Surfactants	20	15
E Coli (count/100 ml)	5000	5000

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

Table 3.18 Performance Requirements: IWTS Effluents Discharged into Foul Sewer

Flow rate (m³/day) / Determinand	≤10	>10 and ≤200	>100 and ≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	>800 and ≤1000	>1000 and ≤1500	>1500 and ≤2000	>2000 and ≤3000	>3000 and ≤4000	>4000 and ≤5000	>5000 and ≤6000
pH (pH units)	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10
Temperature (°C)	43	43	43	43	43	43	43	43	43	43	43	43	43
Suspended solids	1200	1000	900	800	800	800	800	800	800	800	800	800	800
Settleable solids	100	100	100	100	100	100	100	100	100	100	100	100	100
BOD	1200	1000	900	800	800	800	800	800	800	800	800	800	800
COD	3000	2500	2200	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Oil & Grease	100	100	50	50	50	40	30	20	20	20	20	20	20
Iron	30	25	25	25	15	12.5	10	7.5	5	3.5	2.5	2.8	1.5
Boron	8	7	6	5	4	3	2.4	1.6	1.2	0.8	0.6	0.5	0.4
Barium	8	7	6	5	4	3	2.4	1.6	1.2	0.8	0.6	0.5	0.4
Mercury	0.2	0.15	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.2	0.15	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	4	4	4	3	1.5	1.5	1	1	1	1	1	1	1
Nickel	4	3	3	2	1.5	1	1	0.8	0.7	0.7	0.6	0.6	0.6
Chromium	2	2	2	2	1	0.7	0.6	0.4	0.3	0.2	0.1	0.1	0.1
Zinc	5	5	4	3	1.5	1.5	1	0.8	0.7	0.7	0.6	0.6	0.6
Silver	4	3	3	2	1.5	1.5	1	0.8	0.7	0.7	0.6	0.6	0.6
Other toxic metals individually	2.5	2.2	2	1.5	1	0.7	0.6	0.4	0.3	0.2	0.15	0.12	0.1
Total toxic metals	10	10	8	7	3	2	2	1.6	1.4	1.2	1.2	1.2	1
Cyanide	2	2	2	1	0.7	0.5	0.4	0.27	0.2	0.13	0.1	0.08	0.08
Phenols	1	1	1	1	0.7	0.5	0.4	0.27	0.2	0.13	0.1	0.1	0.1
Sulphide	10	10	10	10	5	5	4	2	2	2	1	1	1
Sulphate	1000	1000	1000	1000	1000	1000	1000	900	800	600	600	600	600
Total nitrogen	200	200	200	200	200	200	200	100	100	100	100	100	100
Total phosphorus	50	50	50	50	50	50	50	25	25	25	25	25	25
Surfactants (total)	200	150	50	40	30	25	25	25	25	25	25	25	25

Notes: All units in mg/l unless otherwise stated; all figures are upper limits unless otherwise indicated

1 Discharge of the following substances into foul sewers is prohibited: polychlorinated biphenyls (PCB); polyaromatic hydrocarbon (PAH); fumigant or pesticide; radioactive substances; chlorinated hydrocarbons; flammable or toxic solvents; petroleum oil or tar; calcium carbide; wastes liable to form scum or deposits in any part of the sewer; any substance of a nature or quantity likely to damage the sewer or to interfere with any of the treatment processes

Table 3.19 Performance Requirements: WENT Landfill Reception Area Surface Water Discharge

Determinand	Concentration
Ammoniacal Nitrogen	5 mg/l
BOD	20 mg/l
COD	80 mg/l
Suspended solids	30 mg/l
Oil and grease	10 mg/l

The Performance Requirements state that the concentrations of the determinants given in Table 3.19, as detected through routine monitoring at discharge points, shall not exceed the stated trigger levels.

Table 3.20 Performance Requirements: WENT Landfill Reception Area Foul Water Discharge

Determinand	Concentration
pH (pH units)	6-10
Temperature (°C)	43
Suspended solids	800
Settleable solids	100
BOD	800
COD	2000
Oil and grease	40
Iron	12.5
Boron	3
Barium	3
Mercury	0.001
Cadmium	0.001
Copper	1.5
Nickel	1
Chromium	0.7
Zinc	1.5
Silver	1.5
Other toxic metals individually	0.7
Total toxic metals	2
Cyanide	0.5
Phenols	0.5
Sulphide	5
Sulphate	1000
Total nitrogen	200
Total phosphorous	50
Surfactants (total)	25

Construction Site Discharges

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

Dredging

Guidance on the dredging, classification and disposal of marine mud is given in Works Branch Technical Circulars Nos. 6/92 *Fill Management* and 22/92 *Marine Disposal of Dredged Mud*, and in EPD's Technical Circular No. 1/1/92 *Classification of Dredged Sediments for Marine Disposal.*

Sediments are classified according to their level of contamination by toxic metals. The classification criteria for contamination levels are laid down in Table 3.21. It should be noted that it is necessary for the concentration of only one metallic element to be exceeded for sediments to be identified as falling within a particular class.

Table 3.21 Classification of Sediments by Metal Content (mg/kg dry weight)

	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
Class A	0.0-0.9	0-49	0-54	0.0-0.7	0-34	0-64	0-140
Class B	1.0-1.4	50-79	54-64	0.8-0.9	35-39	65-74	150-190
Class C	1.5 or more	80 or more	65 or more	1.0 or more	40 or more	75 or more	200 or more

Sediments classified according to the metal contents as outlined in Table 3.21 must be handled and disposed of in accordance with the methods shown in Table 3.22.

Table 3.22 Sediment Handling and Disposal by Class

Sediment Class	Definition
Class A	Uncontaminated material, for which no special dredging, transport or disposal methods are required beyond those which would normally be applied for the purpose of ensuring compliance with EPD's Water Quality Objectives, or for protection of sensitive receptors near the dredging and disposal areas
Class B	Moderately contaminated material, which requires special care during dredging and transport, and which must be disposed of in a manner which minimises the loss of pollutants either into solution or by resuspension
Class C	Seriously contaminated material, which must be dredged and transported with great care, which cannot be dumped in the gazetted marine disposal grounds and which must be effectively isolated from the environment upon final disposal

Note: Tests results should be rounded off to two significant figures before comparing with the table, eg. Cd to the nearest 0.1 mg/kg, Cr to the nearest 1 mg/kg, Zn to the nearest 10 mg/kg.

Under the terms of WBTC 6/92, the dredging and disposal of any volume of contaminated mud must be agreed with the Fill Management Committee. The rationale for contaminated mud removal must be provided and directed to the Principal Government Geotechnical Engineer who acts as advisor to the Fill Management Committee on this matter. The sediment sampling and testing programme must be agreed with the Principal Environmental Protection Officer of the Solid Waste Control Group of EPD.

3.4.2 Sensitive Receivers

The main water quality sensitive receiver for the IWTS site is the inshore waters of the Victoria Harbour Water Control Zone. For WENT Landfill Reception Area, the main sensitive receiver is Deep Bay. Standards for effluents being discharged into these waters are outlined above.

3.4.3 Existing Environment - Water Quality

As outlined in the IEIA:

> "The Sewage Strategy Study[12] for Hong Kong states that the current state of water pollution in Hong Kong is poor and is deteriorating. A clear link has been established between sewage based pollution and illness afflicting beach users, so much so that beaches are being closed progressively each year. Excess nutrients in the water have caused, and are continuing to cause, eutrophication of the seawater in certain areas: these effects manifest themselves in algal blooms and occur in places where they had never previously been experienced.
>
> Pollution close to the shore is noticeable. Victoria Harbour is described as housing some of the worst polluted stretches of water in the world. The pollution is derived from both domestic and industrial sources.
>
> The Green Island Feasibility Report[13] refers to the 'beneficial uses of the water in the Kennedy Town area of Victoria Harbour'. It states that the harbour water in this area falls into the category of being able to maintain its beneficial uses most of the time. This is probably due to the open aspect of the water in this location, and the degree of dilution and dispersion which the water body receives.
>
> The beneficial uses for the marine waterfront in the vicinity of Mount Davis and the Kennedy Town area have been described as providing:
>
> (i) maintenance and preservation of natural aquatic ecosystems and wildlife;
> (ii) aesthetic enjoyment;
> (iii) boating and secondary contact recreation;
> (iv) navigation and shipping;
> (v) industrial and domestic (flushing) supply."

---

12 *Sewage Strategy Study - Main Report* (November 1989) Watson Hawksley, Mott Hay & Anderson, ERL (Asia) Ltd and Shankland Cox for Environmental Protection Department

13 *Green Island Reclamation Feasibility Study (H197) Technical Paper No. 24: Water Quality Existing Situation* (1989) Ove Arup & Partners and Peter P S Yun & Associates for Territory Development Department, Urban Area Development Office

Water quality monitoring data from two stations, WM7 (at Kennedy Town) and WM8 (at Sai Ying Pun) for 1992[14] is summarised in Table 3.23.

The 1991 results of EPD's 1992 sediment sampling programme for Kennedy Town are shown in Table 3.24. These sediments are classified as Class C because of their metal content, and would require special dredging, handling and disposal. These results are of particular relevance in relation to Swire BFI's planned clearance of 200-300 m^3 of silt and boulders to facilitate marine access to the barging point.

---

14 *Marine Water Quality in Hong Kong - Report EP/TR9/93* (January 1994) Environmental Protection Department

Table 3.23 Summary Statistics of 1992 Water Quality of Victoria Harbour

Determinand		Victoria Harbour West	
		VM7	VM8
Temperature (°C)	Surface	22.2 (11.3 - 28.3)	22.3 (11.4 - 28.3)
	Bottom	22.1 (11.5 - 28.0)	22.0 (11.4 - 28.1)
Salinity (ppt)	Surface	30.7 (25.0 - 32.6)	31.2 (24.2 - 32.6)
	Bottom	31.0 (25.9 - 32.6)	31.2 (23.7 - 32.8)
Dissolved Oxygen (% saturation)	Surface	70 (40 - 103)	81 (62 - 114)
	Bottom	66 (37 - 99)	87 (45 - 172)
pH value		7.9 (7.7 - 8.1)	8.0 (7.9 - 8.2)
Secchi Disc (m)		1.7 (1.0 - 2.8)	1.7 (0.8 - 3.0)
Turbidity (NTU)		6.3 (3.1 - 12.3)	5.4 (1.7 - 10.5)
Suspended Solids (mg/L)		9.6 (2.0 - 18.3)	7.9 (2.3 - 16.3)
Biological Oxygen Demand BOD_5 (mg/L)		1.3 (0.6 - 2.0)	1.2 (0.5 - 1.9)
Inorganic Nitrogen (mg/L)		0.46 (0.13 - 0.95)	0.31 (0.08 - 0.80)
Total Nitrogen (mg/L)		0.80 (0.33 - 1.64)	0.62 (0.28 - 1.54)
PO_4 - P (mg/L)		0.05 (0.02 - 0.08)	0.04 (0.01 - 0.07)
Total Phosphorus (mg/L)		0.13 (0.08 - 0.20)	0.11 (0.06 - 0.19)
Chlorophyll - a (μg/L)		1.12 (0.23 - 7.47)	1.29 (0.20 - 9.53)
E. coli (no./100mL)		1957 (133 - 14667)	442 (28 - 3733)

Note:

1. Except as specified, data presented are depth-averaged data.
2. Data presented are annual arithmetic means except for *E. coli* data which are geometric means.
3. Data enclosed in brackets indicate the ranges.

Table 3.24 Typical Marine Sediment Composition adjacent to Kennedy Town

Parameter	Unit	Value
Particle size distribution	% below 63 μm	>80
Conductivity electrochemical potential[1]	-mV	>250
Total organic carbon[2]	mg/kg dry solids	0.5 - 0.7
Total nitrogen[3]	mg/kg dry solids	300 - 500
Total phosphorus[3]	mg/kg dry solids	250 - 300
Chromium[4]	mg/kg dry solids	50 - 55
Copper[4]	mg/kg dry solids	100 - 200
Zinc[4]	mg/kg dry solids	120 - 140
Nickel[4]	mg/kg dry solids	20 - 25
Lead[4]	mg/kg dry solids	50 - 70
Mercury[4]	mg/kg dry solids	0.11 - 0.14

Notes:

1 Negative values indicate an anaerobic environment which is associated with organic pollution. The more negative the Eh values, the more inorganic the substrate.

2 Total organic carbon represents the amount of organic matter in bottom sediments.

3 The concentrations of macronutrients, nitrogen and phosphorus, in bottom sediments indicate the degree of organic pollution and microbial activity in the decomposing organic matter. The higher the nutrient concentration, the higher the eutrophic potential of sediments.

4 High concentrations of heavy metals in bottom sediments adjacent to urban area are due to discharges of industrial effluents. High concentrations of chromium, zinc and copper are particularly associated with textile, printed circuit board and electroplating industries.

The water quality and sediment sampling data above result from the cumulative effects of long term pollution from industrial and residential activities in the area.

As outlined in the IEIA:

> "There are (also) direct discharges into Victoria Harbour in this area; the most notable of these being from Kennedy Town Abattoir. Other direct discharges include vegetable oil distribution processes, petrol stations, printers, metal forming,

photographic processing, etc. These all contribute to the overall pollution of the marine water although there are current proposals to relocate the abattoir and pre-treat its effluent, thus improving the marine water quality in the area.

It is also known that there are 16 separate outfalls from stormwater systems in the vicinity. The quantity and quality of these discharges have not been identified but it is known that the range of variance is significant. These stormwater systems have been observed to act as collectors and disposal outlets for foul water from local domestic residences."

On 8 June 1995, water quality monitoring was undertaken at three locations near the existing seawall. The monitoring locations are indicated in Figure 3.6 and the results are shown in Table 3.25.

3.4.4 Future Environment - Water Quality

Development of the Green Island Reclamation Public Dump has the potential to impact on water quality in the vicinity of Kennedy Town/Green Island due to the embayment of sewage laden stagnant water during parts of the tidal cycle. However, sediment plume and water quality modelling undertaken during the GIRPD studies have indicated that the impacts on water quality will be minimal and acceptable.

The Strategic Sewage Disposal Scheme (SSDS) studies have identified that in the future all wastewaters from the northern population centres on Hong Kong Island will be treated at a sewage treatment works (Mount Davis STW) ... and that the effluent from these works will be discharged either through a deep tunnel into the ocean or locally, to the south of Hong Kong Island.

The future development of the SSDS works and its associated interception of drainage water should help to improve the water quality conditions off Kennedy Town.

Table 3.25 Baseline Water Quality Monitoring Results (June 1995)

Tide	Parameter	Location 1			Location 2			Location 3		
		1 Metre Below Surface	Middle Depth	1 Metre Above Bottom	1 Metre Below Surface	Middle Depth	1 Metre Above Bottom	1 Metre Below Surface	Middle Depth	1 Metre Above Bottom
Mid-Ebb 10:00-10:30	Dissolved Oxygen (%)	82.4	83.4	85.4	81.0	82.4	84.8	84.4	85.0	84.3
	Turbidity (NTU)	7.8	4.8	12.0	5.4	6.1	31.0	4.8	7.2	17.0
	Temperature (°C)	25.0	24.9	24.9	25.0	24.9	24.9	25.0	25.0	24.9
	Suspended Solids (mg/L)	10.0	9.8	16.0	13.0	13.0	41.0	5.6	11.0	24.0
	Nitrate Content (mg/L)	0.33	0.34	0.4	0.35	0.42	0.75	0.39	0.82	0.84
	Total Phosphorus (mg/L)	nd	nd	nd	nd	nd	nd	nd	nd	nd
	Zinc Content (mg/L)	nd	0.05	nd	nd	nd	nd	0.16	nd	0.03
Mid-Flood 15:35-16:30	Dissolved Oxygen (%)	92.5	81.3	81.2	90.8	80.3	77.0	80.5	82.5	80.5
	Turbidity (NTU)	2.6	5.2	9.9	2.8	4.0	14.0	3.5	4.9	18.0
	Temperature (°C)	25.6	26.4	24.9	25.9	25.4	24.9	25.7	25.4	24.9
	Suspended Solids (mg/L)	5.0	7.4	13.0	5.0	6.6	20.0	5.4	6.2	24.0
	Nitrate Content (mg/L)	0.84	0.48	0.49	0.81	0.55	0.84	0.77	0.89	0.81
	Total Phosphorus (mg/L)	nd	nd	nd	nd	nd	nd	nd	nd	nd
	Zinc Content (mg/L)	nd	nd	nd	nd	0.07	0.07	nd	0.12	0.05

Note: mg/l=milligrammes per litre nd=none detected Detection Limit of Analysis: Total Phosphorus: 0.2 mg/l
NTU=Nephelometric Turbidity Unit Zinc Content: 0.05 mg/l

3.4.5 Construction Activities - Impacts

The IEIA concluded that:

> "Construction of the waste transfer station should not involve any significant aqueous pollution. However, water used in tunnelling operations is likely to be laden with silt and other readily settleable materials. Prior to the discharge of this water to the stormwater system, it will be necessary to remove the suspended matter. A silt trap, suitably located, will provide the necessary means for such removal. Regular removal of accumulated solids will be required to ensure efficient functioning of the silt trap. The disposal of solids will be via a similar route to that used for the disposal of the remainder of the spoil material excavated from the cavern.
>
> Oil spillages from plant used during construction are unlikely to represent significant pollution incidents. There will be some absorption of the oil onto the solid materials and some mixing with water used in construction. By combining the operation of the silt trap with an oil and grease trap, the water arisings when discharged will be free from floating oils. Under construction conditions, it is unlikely that any dispersed oils will be present."

3.4.6 Construction Activities - Mitigation Measures

For disposal of site runoff, the site will be divided into east and west portions along the future entrance gate area. The eastern portion will be collected into a silt/grease trap near Sai Ning Street before discharging into the existing 600 mm stormwater drain. The western portion will be collected into another silt/grease trap near the end of the existing seawall before discharging into the existing 900 mm diameter stormwater drain. All existing stream courses adjacent to the site will be kept free from any debris and any excavated material arising from the works.

Compounds in the works areas will be designed to take account of contaminated surface water. Oil and fuel bunkers will be bunded to prevent discharges due to accidental spillages or breaching of tanks. Layers of sawdust, sand or equivalent material will be laid underneath or around any construction plant or equipment that leaks oil. The polluted clean up materials will be replaced with clean materials on a regular basis. Any polluted materials will be disposed of in an acceptable and regular manner.

Foul water will be collected in a sump pit which will be regularly taken away by pump trucks.

Groundwater from the excavation and process water used during excavation will be pumped out of the cavern to the silt/grease trap near the end of the existing seawall before being discharging into the stormwater system. The silt/grease traps will be designed with a volume capacity capable of handling a once in five years rainfall event. Swire BFI will ensure that water discharging into the stormwater system from the silt/grease traps complies with the requirements of a Group 3 effluent under Section 24.3.2 of the Performance Requirements.

Swire BFI will undertake periodic inspections to ensure that good working practice is being observed and that the silt traps are managed to ensure optimum performance.

The key to effective control of site runoff is to limit the potential for erosion and sedimentation by the following measures:

- scheduling of excavation work during the dry season as much as possible;
- limiting areas of excavation as much as possible;
- stabilising exposed surfaces as soon as possible after excavation in a manner appropriate to the geotechnical characteristics of the substratum (this could involve hydroseeding with selected plant species, chunaming, etc.);
- accommodating permanent works within the temporary works where possible.

3.4.7 Dredging Activities - Impacts

Dredging has the potential to impact adversely on the marine environment. Disturbance of contaminated sediments can release pollutants into the waters. Resuspension of sediments can adversely affect turbidity and affect any existing benthic community.

The results of a marine survey carried out by Swire BFI during preparation of their tender indicated that the water depths at the temporary berthing area are generally sufficient. However, the underwater inspection report (appended to Section 22.3) notes the presence of mud and boulders on the seawall berm stones. Clearance of these obstructions will be necessary to permit safe berthing. It is likely that a barge and grab will be used to remove the small quantities of debris (200-300 m^3 of silt and boulders). Since the clearance activities will take place only within 5 metres of the seawall alignment, disturbance to the sea bed is not anticipated. Marine impacts from construction are thus expected to be minimal.

Swire BFI has, therefore, concluded that no gazetting under the *Foreshore and Seabed (Reclamations) Ordinance [Cap 127]* will be required.

The quality of site runoff will be strictly controlled through the use of silt traps and other appropriate means to ensure that the only discharges to the Victoria Harbour Water Control Zone conform with the contractual requirements outlined in Section 3.3.

3.4.8 Dredging Activities - Mitigation Measures

As outlined above, the dredging activities are not expected to disturb the sea bed or impact on the marine environment. Dredging off the berthing site is unlikely to have any benthic significance. However, contaminated muds may be encountered. Any contaminated materials will be disposed of appropriately at the contaminated mud pits off East Sha Chau.

As outlined in Appendix 2: Environmental Monitoring and Audit, a limited water quality monitoring programme will be carried out prior to, during and immediately after dredging activities in order to ensure compliance with the water quality standards that apply.

3.4.9 Summary

Dredging and construction activities related to the construction of the IWTS facility will be undertaken in a manner which minimises adverse impacts on water quality. Regular monitoring and implementation of mitigation measures will ensure that performance limits for water quality will not be exceeded.

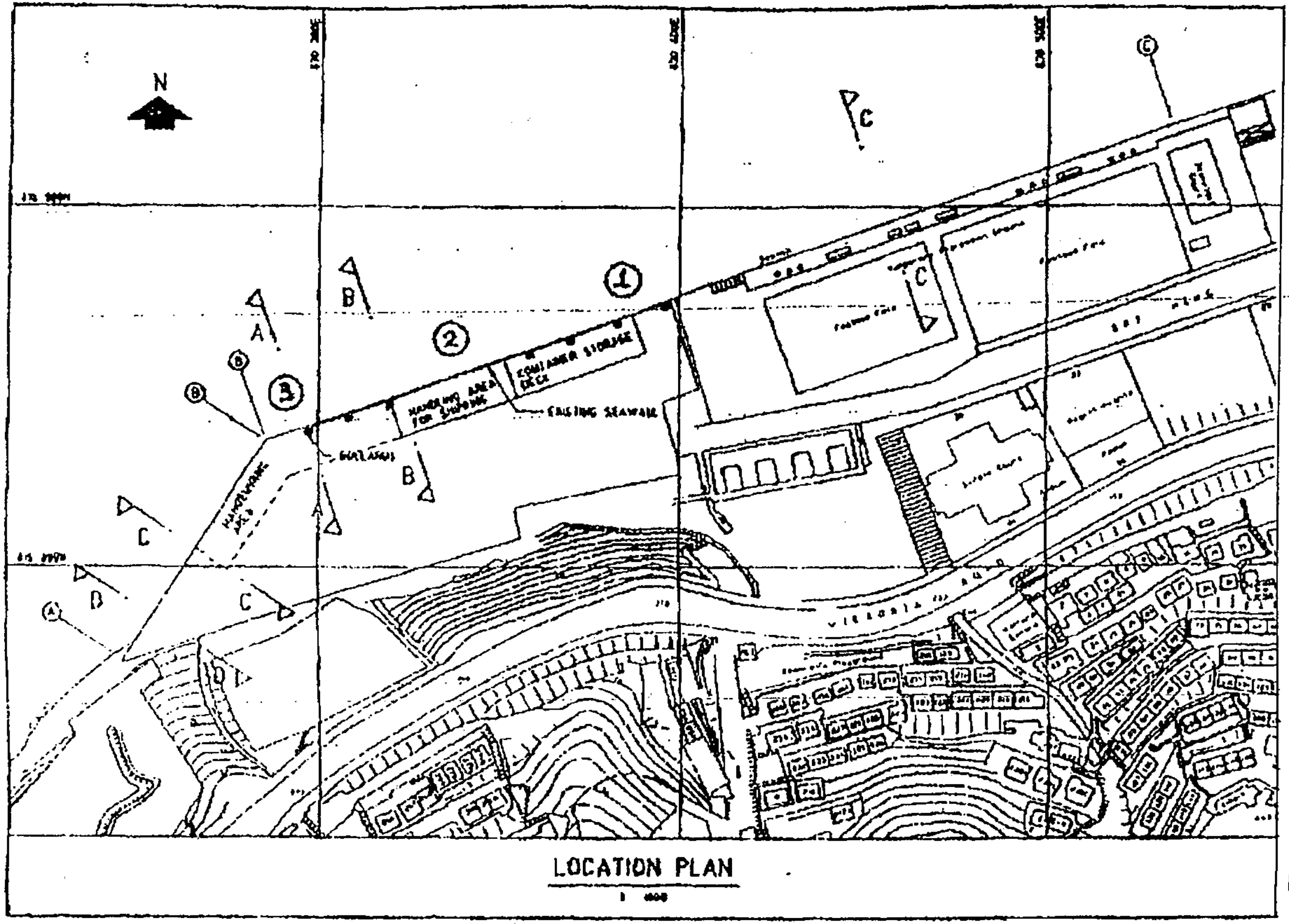


FIGURE 3.6

WATER QUALITY MONITORING LOCATIONS

3.5 Transportation Impacts

This section outlines the impacts of construction-related road and marine transport on the study area.

3.5.1 Construction Traffic - Road

Construction traffic entering and leaving the site will do so via Sai Ning Street and the USD Depot, as discussed in IWTS Working Paper No. 4[15]. However, the only vehicles entering the site will be those delivering materials. All excavated spoil will be transported from the site by barge, not by road. The volume of road traffic will be much less than the RCV traffic currently accessing the USD depot, hence there should be no adverse impact on noise, air quality or traffic congestion in the area.

3.5.2 Construction Traffic - Marine

One of the Hong Kong Government's key policy objectives for waste management is to ensure that proper facilities are available to dispose of all wastes in a cost-effective and environmentally acceptable manner. One of the preferred means of disposal of suitable surplus materials such as excavated rock is by the infilling of areas for reclamation. This means of spoil disposal reduces the need to dredge or quarry materials for fill, and at the same time reduces the need to dispose of spoil materials to landfill sites.

In early 1992, the Fill Management Committee formulated a Public Dumping Strategy which identified short and long term reclamation sites required to meet the demand for the disposal of surplus materials suitable for public dumping. One of the key components of the strategy is the Green Island Public Dump[16], which will provide the only facility for the dumping of materials suitable for public dumping on Hong Kong Island in the period between 1996 and 2002. As described earlier, the dump will comprise a portion of Sulphur Channel between Green Island and Kennedy Town, covering an area of some 37 hectares.

The marine barging point for the Green Island Public Dump will be located on the former Kennedy Town Incineration Plant site, and will provide a temporary facility for the transfer of materials to the dump from the beginning of 1996 to approximately mid-1997. After this date, transfer of material to

---

15 *Consultancy Study for Island West Transfer Station: Working Paper No. 4: Land Use and Planning* (April 1992) Environmental Protection Department

16 *Green Island Reclamation (Part): Public Dump - Environmental & Traffic Impact Assessment - Final Report* (January 1995) Scott Wilson Kirkpatrick *et al* for Civil Engineering Department

the dump would take place by access road, the location of which has been the subject of recent study[17].

At first glance, it would appear that the juxtaposition of the IWTS and Green Island Public Dump facilities would offer an ideal route for the disposal of all suitable spoil from excavation of the caverns. However, the construction schedule for IWTS indicates that blasting and excavation of the caverns is due to commence in mid-June 1995 and to be completed by mid-March 1996, indicating only a partial overlap of operations. Only part of the tipping hall excavation and the compactor hall excavation is scheduled to take place in 1996. Slippage of this programme would mean that more excavated rock could be dumped at the Green Island site.

3.5.3 Summary

Construction-related traffic from the IWTS facility will have a minimal impact on sensitive receivers in the study area.

---

17 *Green Island Reclamation (Part): Public Dump - Environmental & Traffic Impact Assessment: Supplementary Agreement (II) - Draft Final Report - Recommended Land Access* (February 1994) Scott Wilson Kirkpatrick, Aspinwall & Company, British Maritime Technology, Hydraulics and Water Research Asia Ltd, MVA Asia Ltd for Civil Engineering Department

3.6 Construction Impacts - Summary

The main construction related impacts are expected to be noise and vibrations related to excavation, blasting, haul road traffic and access ramp construction and dust arising from the same activities. Site runoff will be controlled through implementation of erosion control measures and installation of effective silt/grease traps to ensure water discharge to the stormwater drainage system complies with statutory requirements.

During construction, there will be minimal impact on the local road network since all spoil will be disposed of by barge directly from the site. Marine impacts will be minimal because of the small amount of dredging required for marine access to the temporary berthing area.

With the implementation of the proposed control measures outlined and detailed further in Appendices 1-6, environmental impacts in terms of dust, noise, water quality, road and marine traffic will be kept to within statutory or acceptable limits.

4 OPERATIONAL IMPACTS

4.1 General

This section considers the environmental impacts likely to be generated during operation of the IWTS under normal and emergency conditions.

4.2 Noise

This section discusses the cumulative impact of plant (internal and external) as well as waste collection vehicles (WCV) traffic on noise sensitive receivers (NSRs) or operation personnel, including the cumulative impact of the likely increase of WCV traffic on NSRs along the existing and proposed access roads leading to the Facility. Where unacceptable impacts are identified, appropriate mitigation measures are proposed.

The overall noise climate of the study area will be re-evaluated using the relevant background and projected noise data when the final design of the Route 7 Expressway, as well as the other developments proposed in the vicinity of Mount Davis, has been conducted. The proposed Route 7 scheme will result in significant increases in background noise levels across a wide area. As the programme for other projects has not been confirmed, the noise impact analysis has been carried out on the limited relevant information available at the time of the DEIA.

4.2.1 Legislation and Guidelines

Noise Levels outside the Transfer Station

For the purposes of the DEIA, the following Area Sensitivity Ratings (ASRs) have been selected for the nearby Noise Sensitive Receivers (NSRs):

NSR 1	Old People's Home, Sai Ning Street	ASR 'B'
NSR 2-4	Mount Davis Cottage Area	ASR 'A'
NSR 5	Serene Court, Victoria Road	ASR 'C'

The relevant Acceptable Noise Level (ANL) in dB(A) presented in the *TM on The Assessment of Noise from Places other than Construction Sites, Domestic Premises or Public Places* corresponding to ASRs 'A', 'B' and 'C' are given in Table 4.1.

Table 4.1 Acceptable Noise Levels during Operation

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

(Source: *TM on The Assessment of Noise from Places other than Construction Sites, Domestic Premises or Public Places*)

Hong Kong Planning Standards & Guidelines (HKPSG) states that noise levels from a new fixed source should be 5 dB(A) below the relevant ANL presented in the *TM on The Assessment of Noise from Places other than Construction Sites, Domestic Premises or Public Places* or the prevailing background noise level, whichever is lower. The revised ANLs in dB(A) corresponding to ASRs 'A', 'B' and 'C' are given in Table 4.2.

Table 4.2 HKPSG Recommended Operational Noise Levels

Time Period / ASR	A	B	C
Day (07:00-19:00) and Evening (19:00-23:00)	55	60	65
Night (23:00-07:00)	45	50	55

(Source: *Hong Kong Planning Standards & Guidelines*)

Noise Levels within the Transfer Station

The following conditions will apply to fixed noise sources during the operation of IWTS:

- At 1 metre distance from any source the measured L_{eq} (5 min) noise level shall not exceed 90 dB(A) when all plant is in operation
- At 1 metre distance from any source the measured L_{eq} (5 min) noise level shall not exceed 85 dB(A) when the noise is from the source alone

- At 6 metre distance from any source the measured L_{eq} (5 min) noise level shall not exceed 65 dB(A) when noise is from the source alone

- Any equipment with a sound power level rating at peak loading of more than 90 dB(A) must be acoustically shielded

Ventilation and air-conditioning system noise levels are not to exceed NC 65 and noise levels from the ventilation system at 1 m from the fan room are not to exceed 75 dB(A).

Noise levels within the transfer station cavern are to comply with the occupational health and safety dose for an 8 hour working day of 85 dB(A) and equivalent daily noise dose for an 8 hour working day of 85 dB(A). The legal requirement is defined in the *Code of Practice for the Protection of Hearing in Industrial Undertakings issued by the Labour Department and the Factories and Industrial Undertakings (Noise at Work) Regulations 1992.*

4.2.2 Existing Environment - Noise

Baseline daytime background noise levels (L_{eq} (30 min)) recorded in the study area in May 1995 vary from 59.3 dB(A) to 64.4 dB(A). Evening noise measurements vary from 59.1 to 65 dB(A) and night time noise measurements from 49.9 to 60 dB(A). The background noise levels are dominated by intermittent road traffic noise, mainly from Victoria Road.

Further details of noise monitoring in the area are given in Section 3.2.

4.2.3 Future Environment - Noise

As outlined in Section 3.2.4, the noise generated from other planned construction activities in the area has the potential to seriously affect the background noise levels and sensitive receivers during the IWTS construction and operational period. The other relevant projects in the vicinity are the Green Island Reclamation, Mount Davis Sewage Treatment Works (part of the Strategic Sewage Disposal Scheme), Route 7 (Kennedy Town to Aberdeen) and the Mount Davis Service Reservoir.

4.2.4 Operational Noise - Noise Sources

Operational noise sources are shown in Figure 4.1. The main noise source is the movement of waste collection vehicles (WCVs) on the spiral access ramp which connects IWTS to Victoria Road and within the site, to and from the tunnel portal. Other noise sources will be the ventilation shaft and the loading and unloading of containers. The other potential noise source is the emergency generator/switchgear room.

4.2.5 Operational Noise - WCV movements within the Transfer Station

During peak hour operation during the design year (2012), the traffic flow within IWTS is expected to be 68 vehicles per hour.

Calculation of the noise levels generated from WCVs travelling along the spiral ramp to and from the tunnel portal has been based on the basic acoustic calculation method. First, the spiral ramp to the tunnel portal is divided into small segments. Second, based on the sound power level (SWL) and the timing of the WCVs driving along that segment, the equivalent sound power level in 30 minutes is derived. The correction for the distance between the segment and the NSRs is based on the methodology described in British Standard 5228 (1984). The final calculation procedure to calculate the predicted noise level at NSRs is to combine all the noise from all the segments.

The relevant equations of the major calculation are described as follows :

Single Event Sound Power Level (SWL)

The single event sound power level of the WCVs driving in each segments is defined as the constant level which would deliver the same A weighted noise energy to the receiver as that event itself. The relevant equation for each segment is:

$$SWL = 10 Log_{10} \frac{1}{t_o} \int \left(\frac{W_A(t)}{W_o} \right)^2 dt$$

where W_A is the instantaneous A-weighted sound power level
W_o is the reference sound power level (10^{-12} watt)
t_o is the reference time, ie. 1 second
t is the time interval long enough to encompass all sound of the event

Equivalent WCV Sound Power Level in 30 minutes

The equivalent sound power level of the WCVs in 30 minutes is determined as the total energy in each segment converted into the sound power level over 30 minutes. The relevant formula for each segment is:

LAeq = 10 * Log (1/T * N * 10^SWL/10)

where LAeq is equivalent continuous noise level
T is the period of interest, in seconds
N is the number of the WCVs in the period of interest
SWL is the single event sound power level

Screening Effect

The screening effect of the hillside is calculated using the equation listed in the *A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level L_{eq}* for the calculation of the barrier correction. The equation is based on the path difference and the noise frequency of the source. It has been assumed that the noisiest frequency from a WCV is 500 Hz; this frequency has been adopted as the worst scenario for assessment purposes.

The detailed calculation of the screening effect is illustrated below:

Correction =10 Log (3 + 20N)

Where N=2 δ/ λ
δ is the path difference in metres
λ is the acoustic wavelength in metres

Distance Attenuation

The correction of distance attenuation has been based on the following formula:

SPL = SWL + 20LogD + 8

where SPL is the sound pressure level at the receiver
SWL is the sound power level of the equipment (WCV)
D is the distance between the noise source and receiver in metres

A 3 dB(A) correction is added for the facade correction.

Using the above equations and taking account of screening effect, the noise level at NSRs are given in Table 4.3. Detailed calculations are presented in Appendix 6.

Table 4.3 Predicted Noise Levels from WCVs driving along Access Ramp (at the most affected floor of each NSR)

NSR	Predicted Noise Levels in $L_{Aeq(30\ min)}$ dB(A)
NSR1	54.6 dB(A)
NSR2	53.6 dB(A)
NSR3	53.6 dB(A)
NSR4	53.6 dB(A)
NSR5*	65.4 dB(A)

* The most affected floor at NSR5 Serene Court is 12/F

The results in Table 4.3 indicate that the noise levels generated from WCV movements within the Transfer Station will be within *HKPSG*'s recommended operational noise levels at all NSRs except for NSR5, where there is a predicted exceedance of 0.4 dB(A). However, as the screening correction adopted for this assessment is for a thin, rigid barrier rather than the substantial barrier incorporated into design of the spiral ramp, the actual noise levels experienced at the NSRs are likely to be much lower than predicted. No additional mitigation measures are required.

4.2.6 Operational Noise - Noise from Ventilation Shaft

Noise at the ventilation shaft will result from operation of the two main exhaust fans and an additional fan from the wastewater treatment plant. The fans will be installed in an isolated concrete room upstream of the venturi scrubbers. Noise from the fans will be considerably attenuated within the scrubbers, where the ventilation air is forced through liquid. After scrubbing, the air will be vented along a 67 m long concrete lined duct, one surface of which has a rough-textured surface of shotcreted, blasted rock. The ventilation duct includes several changes of direction. The ventilation shaft, located above the portal, faces out of the cliff face towards the sea and away from the sensitive receivers.

Considerable attenuation of ventilation fan noise will be achieved within the ventilation system: it is assumed that the attenuation of the scrubbers is 13 dB(A) and the attenuation of the ventilation shaft is 0.11 dB(A) per linear metre.

Sound power levels (SWL) of the radial fans are shown in Table 4.4.

Table 4.4 Sound Power Levels of Radial Fan

Spectrum / Source	63 Hz (dB)	125 Hz (dB)	250 Hz (dB)	500 Hz (dB)	1K Hz (dB)	2K Hz (dB)	4K Hz (dB)	8K Hz (dB)	Total SWL dB(A)
Main Exhaust Fans	111	114	117	113	111	106	103	98	115
WWTP Fan	110	113	113	110	104	98	91	85	111

Calculation of the noise levels arising at the ventilation shaft based on the SWL given in Table 4.4 is shown in Table 4.5.

Table 4.5 Calculation of Noise Levels from Ventilation Shaft

Spectrum / Source	63 Hz (dB)	125 Hz (dB)	250 Hz (dB)	500 Hz (dB)	1K Hz (dB)	2K Hz (dB)	4K Hz (dB)	8K Hz (dB)	Total SWL
1 Main Exhaust Fan	111	114	117	113	111	106	103	98	
1 Main Exhaust Fan	111	114	117	113	111	106	103	98	
1 WWTP Fan	110	113	113	110	104	98	91	85	
Combined SWL	115.5	118.5	120.8	117.0	114.4	109.3	106.1	101.1	
Less attenuation of scrubber and ventilation shaft	-20	-20	-20	-20	-20	-20	-20	-20	
Overall SWL	95.5	98.5	100.8	97.0	94.4	89.3	86.1	81.1	105
Conversion to A weighting [dB(A)]	69.3	82.4	92.2	93.8	94.4	90.5	87.1	80.0	99.4 dB(A)

The predicted noise levels at NSRs from the ventilation shaft have been calculated using the following equation:

$$SWL = SPL + 20\log R + 8$$

where SWL is the combined sound power level of the noise source calculated using the expression :

$$SWL = 10 \text{ Log}_{10} [\Sigma^{n}{}_{1}\text{Antilog}_{10}(SWLn/10)] \text{ dB(A)}$$

n = component noise levels

SPL is the sound pressure level at the receiver

R is the distance between noise source and receiver in metres

A 3 dB(A) correction is added for the facade correction.

The screening effect of the hillside is calculated using the equation listed in *A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level L_{eq}* for the calculation of the barrier correction, as detailed earlier in this section.

NSR1 and the lower floors of NSR5 are screened by the IWTS spiral ramp. NSR2, NSR3 and NSR4 are screened by the slope. It is assumed the correction of the screening effect for NSR1, NSR2 and NSR3 is 5 dB(A). With a path difference of 1.0 m, the screening effect correction factor for NSR4 is 18.2 dB(A).

The predicted noise levels at NSRs from the ventilation shaft, with and without inclusion of the factor for the screening effect afforded by the topography and structures, are shown in Table 4.6.

Table 4.6 Predicted Noise Levels from Ventilation Shaft

NSR	Distance in metres	Predicted Noise Levels in $L_{Aeq(30\ mins)}$ dB(A) (without screening effect)	Predicted Noise Levels in $L_{Aeq(30\ mins)}$ dB(A) (with screening effect)
NSR1	120 m	52.8 dB(A)	47.8 dB(A)
NSR2	180 m	49.3 dB(A)	44.3 dB(A)
NSR3	125 m	52.5 dB(A)	47.5 dB(A)
NSR4	40 m	62.4 dB(A)	44.2 dB(A)
NSR5	173 m	49.6 dB(A)	49.6 dB(A)

In addition to the screening effect of topography and the access ramp, the ventilation shaft exit is located at the mid-level of the slope below Victoria Road and it faces towards the waterfront, away from all NSRs. This will further attenuate the noise emitted from the ventilation shaft as experienced at the NSRs. Thus the actual noise levels arising from the ventilation shaft during the operational phase of IWTS are predicted to be well below the statutory requirement.

4.2.7 Operational Noise - Container Loading and Unloading

During the day-time, containers will be loaded and unloaded onto a vessel at the loading area. The noise generated from the loading and unloading activities has been monitored at Island East Transfer Station (IETS). Table 4.7 shows the predicted noise levels at NSRs from container loading and unloading at IWTS. The calculations are based on the IETS monitoring results and the methodology described in British Standard 5228 (1984), treating the container handling noise as a simple point source.

Table 4.7 Predicted Noise Levels from Loading and Unloading Containers

NSR	Predicted Noise Levels in $L_{Aeq(30\ mins)}$ dB(A)
NSR1	46.4 dB(A)
NSR2	40.7 dB(A)
NSR3	42.9 dB(A)
NSR4	43.8 dB(A)
NSR5	46.1 dB(A)

4.2.8 Operational Noise - Emergency Generator/Switchgear Room

The emergency generator is located in a concrete structure and will be operated when the electricity supply to IWTS is interrupted, to provide electricity for Fire Services equipment, smoke ventilation, emergency lighting and associated systems. During an emergency situation, all normal operations within IWTS will be stopped.

The emergency generator will be test run for approximately 30 minutes every month as part of the operation and maintenance routine.

As detailed above, the Performance Requirements specify that at one metre and 6 metres distance from any source, the measured L_{eq} (5 min) noise level shall not exceed 85 dB(A) and 65 dB(A) respectively when the noise is from the source alone. On this basis, it is assumed that the sound pressure level at one metre from the IWTS emergency generator is 85 dB(A) or less and that the attenuation of the two metre long silencer is 12 dB(A).

The switchgear is installed in a separate confined room. Noise generated from switchgear operation is negligible. The only equipment producting sound in this room are two ventilation fans. The sound power level of each ventilation fan is assumed to be 70 dB(A).

The predicted noise levels at NSRs from the emergency generator/switchgear room have been calculated using the following equation:

$$SWL = SPL + 20\log R + 8$$

where SWL is the combined sound power level of the noise source calculated using the expression :

$$SWL = 10 \, Log_{10} \, [\Sigma^{n}_{1} \, Antilog_{10}(SWLn/10)] \, dB(A)$$

n = component noise levels

SPL is the sound pressure level at the receiver
R is the distance between noise source and receiver

A 3 dB(A) correction is added for the facade correction.

NSR1 and the lower floors of NSR5 are screened by the IWTS spiral ramp. NSR2, NSR3 and NSR4 are screened by the hillside. It is assumed that the correction for the screening effect for NSR1 and NSR5 is 5 dB(A) and that the screening effect for NSR2, NSR3 and NSR4 is 10 dB(A).

Based on the above assumptions, the predicted noise levels at NSRs from operation of the emergency generator/switchgear room alone are given in Table 4.8.

Table 4.8 Predicted Noise Levels from Emergency Generator/Switchgear Room

NSR	Distance in metres	Predicted Noise Levels in $L_{Aeq(30\ mins)}$ dB(A)
NSR1	124 m	29.7 dB(A)
NSR2	186 m	21.2 dB(A)
NSR3	126 m	24.6 dB(A)
NSR4	45 m	33.5 dB(A)
NSR5	178 m	26.6 dB(A)

The predicted noise levels in Table 4.8 indicate that when the emergency generator and switchgear are operated, the noise levels at nearby NSRs will be well below the statutory standard. In addition, the air outlet of the emergency generator/switchgear room faces towards the waterfront, away from the NSRs. Consequently, the noise levels at the NSRs from this source are likely to be even lower than predicted.

Operation of the emergency generator/switchgear room will not generate adverse noise impacts on nearby NSRs.

4.2.8 Operational Noise - Cumulative Impacts

The noise impacts from WCV movements, the ventilation shaft and container loading and unloading have been combined in Table 4.9. Noise emissions from the emergency generator have been excluded in this table as use of the generator is does not form part of normal operations.

Noise impacts under the 'worst case' scenario, with the emergency generator undergoing its monthly 30 minute test run, are shown in Table 4.10.

Table 4.9 Cumulative Noise Levels at NSRs during Operational Period (without Emergency Generator)

NSR	Noise from WCVs along Spiral Ramp & Tunnel Portal	Noise from Ventilation Shaft	Noise from Container Loading & Unloading	Total Noise Levels in $L_{Aeq(30\ mins)}$ dB(A)
NSR1	54.6 dB(A)	47.8 dB(A)	46.4 dB(A)	55.9 dB(A)
NSR2	53.6 dB(A)	44.3 dB(A)	40.7 dB(A)	54.3 dB(A)
NSR3	53.6 dB(A)	47.5 dB(A)	42.9 dB(A)	54.8 dB(A)
NSR4	53.6 dB(A)	44.2 dB(A)	43.8 dB(A)	54.5 dB(A)
NSR5	65.4 dB(A)	44.6 dB(A)	46.1 dB(A)	65.6 dB(A)

Table 4.10 Cumulative Noise Levels at NSRs during Operational Period
(during 30 minute test run of Emergency Generator)

NSR	Noise from WCVs along Spiral Ramp & Tunnel Portal	Noise from Ventilation Shaft	Noise from Container Loading & Unloading	Noise from Emergency Generator/ Switchgear Room	Total Noise Levels in $L_{Aeq(30\ mins)}$ dB(A)
NSR1	54.6 dB(A)	47.8 dB(A)	46.4 dB(A)	29.7 dB(A)	55.9 dB(A)
NSR2	53.6 dB(A)	44.3 dB(A)	40.7 dB(A)	21.2 dB(A)	54.3 dB(A)
NSR3	53.6 dB(A)	47.5 dB(A)	42.9 dB(A)	24.6 dB(A)	54.8 dB(A)
NSR4	53.6 dB(A)	44.2 dB(A)	43.8 dB(A)	33.5 dB(A)	54.5 dB(A)
NSR5	65.4 dB(A)	44.6 dB(A)	46.1 dB(A)	26.6 dB(A)	65.6 dB(A)

In view of the low noise level contribution from the emergency generator/ switchgear room, the total noise levels in L_{Aeq} db(A) under both scenarios are identical.

The results in Tables 4.9 and 4.10 indicate that noise levels from operational activities at IWTS during the design year (2012) will generally be within the statutory limits and Performance Requirements. The predicted total noise level at NSR5 will be 65.6 dB(A), which slightly exceeds the *HKPSG* limit but will satisfy the limit of the *Noise Control Ordinance*.

However, it should be noted that the peak arrival rate in the year 2012 on which these operational noise calculations are based may only occasionally be experienced - indeed, it may never occur.

In addition, the predicted noise emissions from the ventilation shaft and from container loading/unloading operations are likely to have been over-estimated during the calculation process. The ventilation shaft faces out towards the sea, away from the sensitive receivers. This will further reduce the noise levels experienced at the NSRs. The type of vessel-mounted crane used in the container handling operations at IWTS is likely to be significantly quieter than that monitored at IETS.

It is, therefore, considered highly likely that the noise levels experienced at all nearby NSRs as a result of the waste handling operations at IWTS will be within the *HKPSG* limit in the design year.

Swire BFI has already undertaken all reasonable measures to minimise operational noise impacts at nearby sensitive receivers. These measures include the installation of a partial acoustic barrier on the spiral ramp which consists of double-skinned, lined steel cladding with 50 mm gap between the sheets extending between the parapets. This will help ameliorate the noise generated by vehicles traversing the spiral ramp. No further mitigation measures are required.

4.2.9 WENT Landfill Reception Area

Noise impacts from the operation of waste reception facilities at WENT have been calculated by Swire BFI for the operation of WENT Landfill; the results are shown in Table 4.11. The assessment took into consideration the simultaneous operation of the six waste container berthing facilities at WENT, only one of which will be used by the IWTS operation.

The nearest NSRs to the site are residences at Ha Pak Nai village, 500 m to the west of the designated IWTS container berthing facility. The ASR has been assumed to be 'A'.

The Performance Requirements state that noise levels at WENT must not exceed a combined sound power level of 103 dB(A).

Table 4.11 Predicted Noise Levels from WENT Landfill Reception Area (simultaneous operations at all six berthing facilities)

NSR (as referenced in WENT Report)	Predicted Noise Level dB(A)	Noise Criteria (ANL-5 dB(A)) 07:00 - 23:00 55 dB(A) $L_{Aeq(30\ min)}$
E8	46.5	Acceptable
F8	49.7	Acceptable
G8	51.7	Acceptable
*	49.1	Acceptable
F9	45.7	Acceptable
G9	46.2	Acceptable
H11	40.6	Acceptable

The results show that during operational hours at the WENT Landfill Reception Area (08:00-20:00 hours) and for any extension of these hours up to 23:00 hours, noise levels from the container berthing facility will be well within the specified criteria. No additional mitigation measures will be required.

4.2.10 Traffic Noise from Victoria Road

Noise calculations undertaken as part of the IEIA demonstrated that the expected increase in traffic noise due to movements of WCVs accessing the site along Victoria Road through Kennedy Town would be insignificant. Design year operation of IWTS will add onto Victoria Road traffic flows a daily flow of approximately 200 two way movements of WCVs, and a peak hour flow of only 34 two way vehicle movements. Victoria Road already has substantial volumes of traffic including a number of Heavy Goods Vehicles.

The following calculation demonstrates the increase in traffic noise due to additional movements of WCVs driving along Victoria Road.

Using the methodology for the calculation of traffic noise contained in *Calculation of Road Traffic Noise* and the calculation assumptions listed below, the expected noise levels at 2/F and 14/F of NSR5 are listed in Table 4.12.

Peak hour existing traffic flow[1]:	710
Peak hour additional traffic flow:	68 WCVs
Average speed:	50 km/hour
Percentage of heavy vehicles:	45%

Note 1: Based on the 1994 Annual Traffic Census at Core Station 1012

Table 4.12 Predicted Noise Levels from WCV Traffic on Victoria Road

NSR facing Victoria Road	Predicted Noise Levels: Existing Traffic L_{10}(1 hour) dB(A)	Predicted Noise Levels: Existing Traffic + IWTS Peak Hour Traffic L_{10}(1 hour) dB(A)
Southern facade of 2/F, Serene Court	76.0	76.8
Southern facade of 14/F, Serene Court	72.5	73.2

The resultant increase in the traffic noise would be less than 1 dB(A), which is below the accepted threshold of significance.

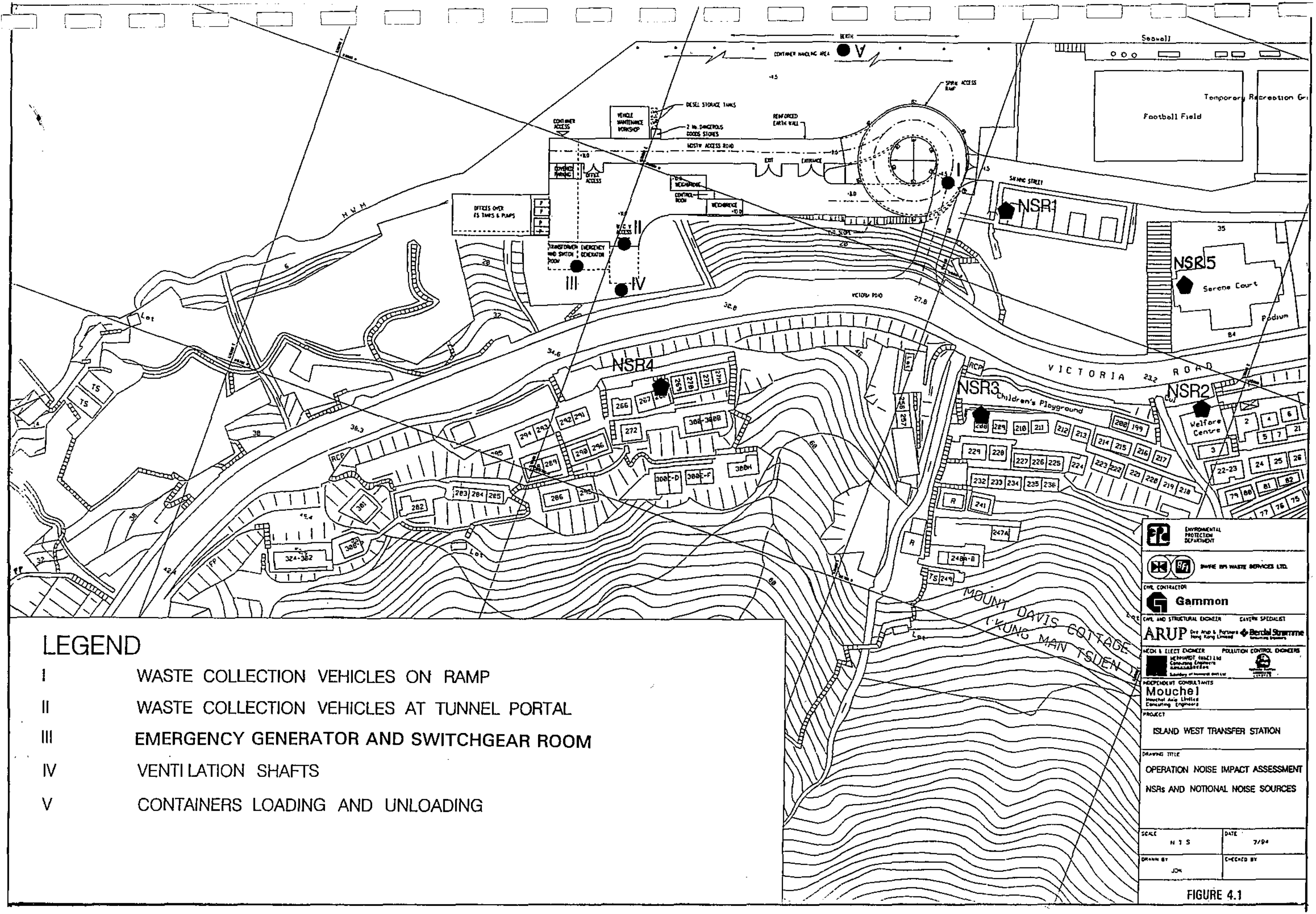
4.2.11 Summary

The operational noise impact assessment predicts that noise levels from operational activities at IWTS during the design year (2012) will generally be within the statutory limits and Performance Requirements.

Noise impact studies for WENT Landfill show that between the hours of 08:00-23:00 hours, noise levels from simultaneous operation of all container berthing facilities will be well within the specified criteria.

Operational phase noise monitoring will be undertaken to ensure that noise levels are kept within the required limits.

The noise impact from increased traffic flows on Victoria Road is less than 1 dB(A), which is insignificant.



LEGEND

I	WASTE COLLECTION VEHICLES ON RAMP
II	WASTE COLLECTION VEHICLES AT TUNNEL PORTAL
III	EMERGENCY GENERATOR AND SWITCHGEAR ROOM
IV	VENTILATION SHAFTS
V	CONTAINERS LOADING AND UNLOADING

ENVIRONMENTAL PROTECTION DEPARTMENT

SWIRE BFI WASTE SERVICES LTD.

CIVIL CONTRACTOR: Gammon

CIVIL AND STRUCTURAL ENGINEER: ARUP Ove Arup & Partners Hong Kong Limited

CAVERN SPECIALIST: Berdal Strømme

MECH & ELECT ENGINEER: HENNARDT

POLLUTION CONTROL ENGINEERS

INDEPENDENT CONSULTANTS: Mouchel Mouchel Asia Limited Consulting Engineers

PROJECT: ISLAND WEST TRANSFER STATION

DRAWING TITLE: OPERATION NOISE IMPACT ASSESSMENT NSRs AND NOTIONAL NOISE SOURCES

SCALE	DATE
N T S	7/94
DRAWN BY: JDM	CHECKED BY

FIGURE 4.1

4.3 Air Quality

Previous Environmental Assessments for other waste transfer stations in Hong Kong and Island East[1,2,3] as well as the IWTS IEIA have identified the following sources of air quality to be of concern:

- dust from transfer station operations;
- odour from transfer operations;
- litter from on-site operations;
- emissions from transfer station traffic.

Following completion of construction activities, the air pollution problems arising from the operation of a waste transfer station will be principally those of odours associated with the refuse and the waste collection vehicles (WCVs) and, to a lesser extent, exhaust emissions from the WCVs serving the facility. Although a waste transfer station is not a 'specified process' under the *Air Pollution Control Ordinance*, the handling of waste is generally perceived as an activity not wholly compatible with other land uses and is therefore a 'bad neighbour' activity. Measures to minimise the impact of the development are therefore important.

In this section, the cumulative impacts from aerial emissions including dust and odour from the Facility on air sensitive receivers (ASRs) shall be assessed and operation standards confirmed.

4.3.1 Legislation and Guidelines

The Hong Kong Air Quality Objectives (AQOs) state the maximum acceptable concentration of air pollutants. The AQOs for one and 24 hour concentrations of five major pollutants are shown in Table 4.13. The Government aims to achieve the AQOs throughout the Territory as soon as 'reasonably practicable'. Efforts are being made to control and reduce air pollution emitters in areas where the AQOs are already exceeded, eg. by controlling new developments. The AQOs will apply to the operational phases of the project.

---

1 *Island East Transfer Station: Final Environmental Review Report* (November 1989) Environmental Protection Department

2 *Island East Transfer Station: Final Report* (September 1990) Environmental Protection Department

3 *Kowloon Bay Refuse Transfer Station: Environmental Impact Assessment: Final Key Issues Report No.1* (March 1991) Environmental Protection Department

Table 4.13 Air Quality Objectives

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

Notes: Concentrations measured at 298°K (25°C) and 101.325 kPA

1 One hour criteria not to be exceeded more than 3 times per year
2 24 hour criteria not to be exceeded more than once per year
3 Suspended particles in air with a nominal aerodynamic diameter of 10 μm or smaller

There is no current legislation for odour. As stated in the IEIA, the evaluation and measurement of odour is both subjective and fraught with technical difficulties. The composition of refuse odours is complex and primarily a function of the type of waste constituent and the biological decomposition process. The types of odorous components emitted may include indoles, skatoles, methylamines, mercaptans, organic acids, alkyl sulphides and hydrogen sulphide. However, the limits set out in the Performance Requirements are a maximum of '2 odour units at the site boundary at all times.' An Odour Level of 2 is assumed to equate to a Dilution Factor of 2, which means that the odour must not exceed a level twice that of its detection threshold.

Odour intensities for other Hong Kong transfer stations[4] have been categorised into the classes shown in Table 4.14.

4 *West Kowloon Transfer Station Tender Documents* (December 1994) ERM Hong Kong *et al* for Environmental Protection Department

Table 4.14 Odour Intensity Categorisation

Odour Units	Category	Description
0	Not detected	No odour perceived or an odour so weak that it can not be readily characterised or described
1	Slight	Slightly identifiable odour
2	Moderate	Moderately identifiable odour
3	Strong	Strongly identifiable odour
4	Extreme	Extremely identifiable odour

4.3.2 Emission Levels

Emission Levels within IWTS

Potential dust emissions within the transfer station would arise principally from above the waste receiving hoppers and from vehicles travelling to and from the tipping hall. Dust levels, however, will be kept low due to the rigorous dust control measures applied within the transfer station. The fundamental means of dust control will be provided by the ventilation system.

The principal pollutants of vehicle emissions comprise Carbon Monoxide (CO) and Oxides of Nitrogen (NO_x). The Performance Requirements set out the maximum levels of CO and NO in the WCV tunnel and tipping hall at 35 ppm and 15 ppm respectively. The UK Health and Safety Executive in their publication *EH40/93* specify the long term exposure limits (for an 8 hour TWA reference period) at 50 ppm for CO and 25 ppm for NO. Hence the limits set out in the Performance Requirements represent an additional safety margin.

The expected peak emission levels of CO and NO within the transfer station have been calculated to provide the data necessary to design the ventilation system which will ensure that no exceedance of the maximum allowable levels will occur. The calculations used and assumptions made to design the required ventilation system are as follows.

Emission Levels outside IWTS

Dust emissions outside IWTS and at the berthing area will arise from resuspension of any dust from vehicles on access and egress roads and from particulate emissions from WCVs. These emissions will be minimised by regular stringent cleansing as part of the overall site maintenance, cleansing and good housekeeping operations.

During the IEIA, with EPD's approval, a screening air dispersion modelling study was undertaken using the Gaussian TRRL 1052 Model (PREDCO) developed by Transport Road Research Laboratory, UK[5]. The purpose of the exercise was to evaluate the likely impact of WCV emissions on air quality.

The access road and the adjoining Victoria Road was regarded as a linear set of point sources and not as a line. The road was subdivided into sections according to its type and position so that characteristics of traffic were specified separately for each section. This allowed for a more detailed consideration of exhaust emission rates which are significantly related to the vehicle operating conditions. Varying windspeeds and wind conditions were also considered in the modelling study.

The modelling was developed to predict carbon monoxide values, although the CO value may be used to estimate concentrations of hydrocarbons, nitrogen oxides (NO_x) with NO_2 assumed to be 20% and lead (Pb). The model is based on the assumption that the dispersal of material from a point source is such that the vertical and horizontal concentration distributions produced are Gaussian or normal in form. Most traffic generated pollution is emitted at ground level, and the most important impact is near to ground level, where people are likely to be exposed. The model therefore assumes no difference in height between source and receptor. As a consequence, any predictions made assume that all sources and receptors to be at the same height and will be over-estimated where this is not so. For the purposes of the screening study, these conservative over-estimates will compensate for the possible accumulative effects of the embankment topography.

The emission rates depend on the volume of traffic using the road, its composition and the operating model of the vehicles. Two assumptions are made in the model to simplify the calculation and the data input requirements. Firstly, it has been assumed that petrol and diesel engine vehicles emit equal amounts of CO. This is justified in that the lower concentration of CO in diesel exhaust is offset by the larger volume of exhaust produced by large

5 *The Estimation of Air Pollution Concentrations from Road Traffic: TRRL Supplementary Report 1052* (1982) Hickman AJ and Bolwill DM, Transport Road Research Laboratory

diesel engines. By making this assumption, the dependency of emission rates on traffic composition is eliminated and total traffic flows only need to be known. Secondly, a single factor, speed, was chosen to represent the engine operating model. The expression for determining emission rates in the model was determined from the analysis of in-service emissions of UK vehicles and USA data on the relationship between CO and mean vehicle speed.

For the purposes of the study, the access ramp to the cavern was separated into five sections (based on the outline design which had a long elevated access ramp from Victoria Road to the proposed site): the 'T' junction with Victoria Road, the road bend leading to the ramp, the long ramp middle section, the road bend at the top of the ramp and the section entering the cavern portal. Turning speeds on to and off the ramp of 7 kph were applied and speeds of 10-20 kph were applied to the ramp. The portion of Victoria Road leading to the ramp junction was similarly divided into sections. Assumed road traffic speeds were 20 and 40 kph.

Peak hourly flows will give rise to the highest emission rates. Elevated emissions are likely to occur when WCVs are turning from Victoria Road onto the access road and queuing on the cavern access ramp. The peak hourly traffic flows used as the basis of modelling calculations are as follows. WCV flows were 34-42 with a daily level of 200-250 vehicles entering the facility. The acceptance of privately collected waste would increase the daily flow levels to 300-350. It was, however, considered unlikely that the peak hourly rate overall would exceed 43 vehicles. The maximum number of container vehicles leaving the station per day would be between 72 and 86.

Predictions indicate that the air quality impact from peak hourly flows of WCVs is likely to be insignificant. Predicted levels were based on an assumed windspeed of 2 m/s. Maximum levels occurred for the wind directions 210°-360°. These windspeeds and directions for Green Island occur infrequently. Predicted maximum hour CO levels are based on peak hourly traffic flow for the nearest residences of Sai Ning Street, Mount Davis Cottages and the playground and residences at the junction of the access road and Victoria Road were 0.64 (0.7), 0.24 (0.3), 0.7 (0.8) and 0.52 ppm (0.6 mg/m^3) respectively. The corresponding maximum increase in NO_2 levels above background levels would be less than 4 ppb (7.5 μg/m^3). The average maximum 1 hour predicted CO and NO_2 levels for the daily operating period are 0.3 ppm (0.3 mg/m^3) and 2 ppb (3.8 μg/m^3) respectively for the playground area close to the junction of Victoria Road with the ramp.

The relatively low predicted values given are for maximum likely peak hour traffic flow assuming the worst case, infrequent, meteorological conditions outlined above. It is likely that predicted ground level concentrations are an over estimate.

The impact of containerised vehicles travelling from the cavern to the marine berthing facility is likely to be insignificant. Vehicle flows are considerably less than those for WCVs and the road alignment for the tender design is both shorter and further from sensitive areas.

4.3.3 Ventilation System

The prime means of maintaining air quality within the cavern is through the design of an efficient ventilation system. In principle, the ventilation system will extract air from working areas in the transfer station at a sufficient rate to control the internal air quality of the station, while at the same time creating a pressure gradient such that make up air is always flowing inwards. All air extracted from the operational areas will be treated prior to discharge to atmosphere.

Transfer Station Main Extraction System

The transfer station main extraction system is designed to handle the ventilation requirements for the tipping hall, WCV Access, compactor hall and container access, via a common ventilation system.

The central exhaust station consists of two main industrial type extraction fans sized to satisfy both the air changes requirement of the tipping hall (8 air changes), compactor hall (5 air changes) and at the same time satisfy the pollutant dilution requirement for peak operations.

In addition, the air flow split provided by two main fans and odour/dust scrubbers permits close control of the environmental parameters whilst maintaining energy efficiency. During low throughput periods, it is expected that only one unit will be required to operate in order to meet the environmental parameters, providing significant energy savings.

Exhaust air from the station will be treated by a biological and chemical scrubber system for odour and dust removal prior to discharging the air to atmosphere.

Exhaust Ventilation for Tipping Hall

Vehicle emissions resulting from WCVs manoeuvring and discharging in the tipping hall will rise to the roof space. The roof space will have exhaust air ducts extracting air from high level and are located directly above the WCV discharge positions.

The positioning of the duct will ensure that the exhaust emissions produced as the vehicles discharge will be collected without significant mixing with the air in the operator occupancy level. This system follows the philosophy of locating the extraction points close to the sources of likely emissions, which has proved to be very successful at Island East Transfer Station.

In addition, within the tipping hall, air will be extracted through points located at the rear of the live floor hoppers. In this way, lower level air from the tipping hall will be drawn across the top of the live hoppers so that any odours or dust generated during waste discharge will be drawn directly into the air exhaust system.

At Kowloon Bay, Island East and Sha Tin Transfer Stations, the ventilation system provides a cross flow of air across the tipping hall to the live floor hopper ducts. This system ensures that the air quality at operator level is maintained at a reasonable standard, and that emissions of dust and odour are retained in the hopper area. Unlike the other transfer stations, which can draw external air through grilles in the wall of the tipping hall, IWTS requires a separate boosted ducted arrangement. This arrangement extracts air from the tipping hall entrance area and supplies it at low level to vents in the distal half of the hall.

The boosted duct system will prevent short circuiting of air from the WCV access directly into the live hopper area, and minimise the possibility of having stagnant areas at the far end of the tipping hall.

Any dust created during the tipping operation will be minimised by spraying water mist over the live hopper floor. The cross ventilation across the tipping hall into the live hopper area creates a face velocity to contain the dust cloud locally.

Exhaust Ventilation for Compactor Hall

The generation of dust in the compactor hall is not seen as a major problem. The heaviest source is likely to be particulates from the exhaust systems of vehicles operating in the area. The regular sweeping and washing down of the surfaces in this area should ensure that dust generation is kept to a minimum. The sources of any fumes or odour are likely to be the vehicle exhaust systems and any liquor which is expressed from the refuse. This liquor will be drained immediately to the wastewater sump.

The compactor hall will have air ducts extracting air from high level and the rear of the compactor rooms, and at high level in the vehicle manoeuvring area, thus capturing vehicle fumes and potential dust emissions from the compactor/container interface.

Exhaust air ducts will be connected to the inlet air plenum of the main exhaust fans, and the exhaust air will be treated via the wet scrubber system in the same manner as that for the tipping hall exhaust.

Air for the compactor hall is induced through the container accessway by the central ventilation system. In order to provide an effective distribution of this air, a duct with a booster fan will collect air at the entrance to the compactor hall and distribute it evenly along its length in much the same way as the tipping hall system. The resultant crossflow air will ensure that 'dead air' areas are eliminated, and prevent excessive build up of either heat or pollutants at the distal end of the hall.

Pollutant detectors (CO, NO_x, visibility) are provided in the tipping hall and the compactor hall and will be strategically located at the operator level to ensure maintenance of air quality within the cavern complex.

The control system for the central ventilation system will be linked to the air monitoring system, so that the air flow rate is controlled to minimise pollutant loadings.

Exhaust Ventilation for Tipping Hall Access and Compactor Hall Access

The length of the WCV access and container access is approximately 67 metres and 90 metres respectively, and are ventilated in a similar manner to an access into a basement or low rise industrial building.

The ventilation of these accessways is longitudinal. Air is induced by the central ventilation system into the cavern complex, flowing from the portals through accessways into the compactor and tipping halls.

This system has the merit of always maintaining a negative pressure gradient in the transfer station at less than atmospheric pressure, thereby containing dust and odour.

Ventilation Rate Calculation

(i) Vehicle Exhaust Emission

The extraction rate is calculated to satisfy air change criteria and the pollution control criteria.

The vehicle pollution loading is calculated based on PIARC 1991 recommendations which provide vehicle emission data based on vehicle weight, speed and gradient of road.

Using the USD collection fleet data provided in Appendix G2 of the Instructions to Tenderers, the average gross weight of a WCV is around 17 tonnes. The container vehicle and tractor combination weighs approximately 26 tonnes when fully loaded.

The minimum speed quoted in PIARC is 20 km/h, which provides a pessimistic emission level for IWTS, where the average speed is much less. Since the incoming WCV has to leave the weighbridge and perform a left turn into the access, it is expected that the average speed will be less than 20 km/h. Although the Swire BFI queuing model demonstrates that queuing will not occur, a worst case scenario has been modelled where at peak time each WCV spends 3 minutes in the accessway and a further 6 minutes in the tipping hall. Of this total 9 minutes, typically 3 minutes will be spent travelling and manoeuvring, 3 discharging and the remainder idling. Hence, the actual likely emissions will be in the order of two-thirds those predicted.

The same average speed is also used as the guideline for the container tractor.

The emission rates have been selected in accordance with the EPD *Practice Notes on Control of Air Pollution in Vehicle Tunnels*, using EEC R24 (no control) data fro the WCV traffic and EURO1/US Transient 1990/91 for the container tractors. The lower emissions of the US Transient 1990/91 are considered appropriate for the container tractors, since Swire BFI will maintain them to a high standard and they will be fitted with engines to US EPA certification.

Appendix 3 provides the detailed calculation of emission and dilution rates and also provides calculations of air requirements to provide dilution of the predicted pollutants. From these calculations it can be seen that:

For WCVs, the NO dilution requirement will be most critical,

thus Q(NO) = 5.27 m^3/s per vehicle

For container tractors, the haze dilution requirement will be most critical,

thus Q(haze) = 4.10 m^3/s per vehicle

(ii) Tipping Hall and Tipping Hall Access

The volume of the Tipping Hall is approximately 15,000 m^3 including the 2,000 m^3 enclosed area above the live floor hopper.

- Based on air change requirement:

  Eight air changes per hour have been allowed for in the area so that the total extraction rate from the tipping hall is 120,000 m^3/h (or 33.3 m^3/s). This will include the 20 air changes exhausted through the live floor hopper which is 11.1 m^3/s. The rest (22.2 m^3/s) will be exhausted via high level exhaust air ducts.

- Based on pollutant level:

  The vehicle arrival pattern model produced by Swire BFI indicates that during the peak 30 minutes of operation, there will be 20 WCVs entering/leaving IWTS. Each WCV spends about 6 minutes in the tipping hall to complete the tipping cycle and spends about 3 minutes in the vehicle wash and WCV access.

  As a result, the worst scenario is equivalent to 6 WCVs simultaneously discharging during the peak 30 minutes period which requires a fresh air quantity of:

$$Q = 6 \times 5.27 \text{ m}^3/\text{s} = 31.6 \text{ m}^3/\text{s}$$

Thus, the 8 air changes per hour (or 33.3 m^3/s) provided in the tipping hall will be adequate to cover the pollution requirements.

(iii) Compactor Hall and Compactor Access

- Based on air change requirement:

  The volume of the compactor hall including vehicle manoeuvring area is about 11,000 m^3. Five air changes have been allowed for in this area so that the total extraction rate is 55,000 m^3/h (or 15.3 m^3/s).

- Based on pollutant level:

  The majority of activity in this area is container loading and changing containers.

  During the peak 30 minutes period, there will be 6 container vehicles present in the compactor hall and each spends 6 minutes changing containers.

  This is equivalent to the productivity of the compactors of 12 containers per hour or 6 per half hour.

It has been assumed that the average speed of a container vehicle is 20 km/h. With this speed, the time taken to enter or leave the compactor hall via the container access (90 m length) will be less than 0.5 minutes.

The equivalent number of vehicles simultaneously operating in the area will be 1.4. Thus, the fresh air quantity required is as follows:

$$Q = 1.4 \times 4.1 = 5.74 \text{ m}^3/\text{s}$$

The calculations show that 5 air changes per hour (or 15.3 m^3/s) can comfortably cover the pollution ventilation requirement for both the compactor hall and the container access.

Isolation dampers have been designed in the ductwork system to isolate some zones of ductwork when that zone is not in use, to improve energy efficiency in off-peak periods.

(iv) Temperature Control

The total air flow described above and the design of the ventilation system will be adequate to ensure that the tipping hall temperature does not exceed 6°C above outside ambient temperature.

Unlike the existing transfer stations, the wall surface inside the cavern will have surface temperature lower than ambient, even in extreme summer conditions, and no solar load. Heat in the cavern complex will be gained from incoming vehicles, electric motors and hydraulic power packs.

Strategic positioning of extraction grilles and boosted air supply vents will ensure that the warm and polluted air rises to extraction points, and minimal mixing occurs with the cooler and cleaner air at operator level.

Heat will be readily dissipated through the ventilation system and lost by conduction and convection through wall surfaces. The temperature variation of the cavern wall surfaces will be minimal, since the cavern itself behaves as a large heat sink.

(v) Wastewater Treatment Plant Area

Twenty air changes will be provided for this area, which is equivalent to 3 m^3/s.

The plant area will be mechanically exhausted 24 hours per day, independent of the main exhaust fans.

Two explosion rated exhaust fans (one duty and one standby) will be provided to maintain adequate ventilation and maintain the area at negative pressure at all times.

Exhaust fans will be backed up by the generator to continue operation during fire or power failure.

Make-up air for the plant room will be through adjacent areas in the compactor hall.

4.3.4 Dust and Odour Control Measures

Design Outline

In practical terms, the dust and odour control systems form one continuous process. The extraction system by which air is collected and delivered to the treatment process is described above.

The air flows necessary for adequate dust and fume control will be more than sufficient to prevent odours from escaping from the cavern and accessways, and also to prevent odours from reaching objectionable levels within the enclosed areas.

Measures for dust and odour removal from extracted air at IWTS are based on the system developed by Swire BFI for Sha Tin Transfer Station. The system comprises a wet dust collection system with an odour scrubbing system using biologically active water from the wastewater treatment plant, plus additional chemical scrubbing using hypochlorite for a final 'polishing' of the emissions. Full details of the system are presented in the relevant IWTS Design Reports.

Wet scrubber systems are efficient dust removers with removal efficiencies of 98-99% being quoted for 5 μm diameter and larger particles, and about 80% for 2 μm diameter particles.

Swire BFI's operation at Sha Tin has shown that the wet scrubber system can easily achieve the required air quality emission standards, ie. 2 Odour Units at the site boundary.

Odour Removal Efficiencies

The design basis requirements for the IWTS odour control system is for there to be a maximum of 2 odour units in the exhaust gases leaving the system during operation, and that the odour at the physical site boundary should not exceed 2 odour units. This means that the benefits of dilution during dispersion from the exhaust stack cannot be included within the design.

During the assessment of the proposals for the Sha Tin Transfer Station odour control system, the assessment that was put forward was purposely conservative, particularly as regards to the levels of odour which have been encountered to date within the Kowloon Bay and Island East Transfer Station tipping floors and compaction areas. Indeed, such is the experience as regards odours in these areas, it is frequently found that where outside doors are left open for considerable periods, there are no deleterious offsite odours.

The Sha Tin design was based on 2,000 odour units at the live floor hopper where odour generation is the highest within the station. Operation of the Sha Tin Transfer Station has demonstrated that with modest dispersion dilution from the exhaust stack and the 2 scrubbers both performing at the low end of their expected rate of efficiency, even a worst case of 10,000 odour units within all of the extracted air would not cause a site boundary odour above 2 units.

With a worst case odour for the IWTS facility of 2,000 odour units in the input to the scrubbers and using the odour removal efficiencies at the low end of each scrubber's expected range of efficiency, the calculation of the final odour would be as follows:

> Design maximum input odour of 2,000 odour units.
>
> Scrubbers would have a minimum removal efficiency of 90%, thus the odour leaving the scrubber would be less than 2000 x 10/100 = 200 odour units.
>
> Hypochlorite scrubbers would have a minimum removal efficiency of 99 % thus the odour leaving the scrubber would be less than 200 x 1/100 = 2 odour units.
>
> Thus the design of the system would meet the design requirements and ensure efficient dispersion above the building, and compliance with the odour limit of 2 Odour Units at the site boundary.

Handling and Disposal of Scrubber Liquors

The scrubbing liquors will consist of dilute solutions of Sodium Hypochlorite (NaOCl) and Sodium Hydroxide (NaOH). Both are widely used chemicals.

Sodium hypochlorite is the active reagent. Being an oxidiser, will oxidise odorous pollutants to make them suitably safe and odour free. A product of the reaction is Hydrogen Chloride (HCl) which dissolves in water to form Hydrochloric acid. This is neutralised by the caustic soda to form common salt (NaCl) and water (H_2O).

Caustic soda is also included to keep the pH high so as to keep a buffer Sodium Bicarbonate in solution (resulting from the absorption of Carbon Dioxide (CO_2) from the atmosphere) so as to prevent a sudden odour release causing the pH to fall and for unreacted chlorine to be released from the hypochlorite.

The liquors will be delivered in small plastic drums (either 10 or 25 litres) and be transferred by manually tipping into the respective reagent storage tank.

Contaminated scrubbing solution will require appropriate disposal, but dilute sodium hypochlorite can be used with washwater to provide an effective washing liquid for surface cleaning, or any remaining free chlorine can be simply neutralised with a sodium bisulphite solution with treated liquor added to the wastewater treatment input. A hazard assessment for sodium hypochlorite is not considered necessary.

Odour Control for Wastewater Facility

The ventilation and environmental control system is designed to enable the air flows from the wastewater treatment plant to be treated independently of the main air system. Such an arrangement permits 24 hour running, regardless of the status of the main fans.

In normal circumstances, wastewater treatment plant air will continue through the same dust and odour scrubbing process as the rest of the air in the transfer station. Under circumstances where the main fans are not operating, the wastewater treatment plant air will still be treated through the secondary hypochlorite scrubber, which will effectively deal with odours.

Discharge of Exhaust Gases

The exhaust from the dust and odour control system will be routed down a roof duct above the WCV accessway and will be discharged via a small stack which will project clear of the largest adjacent structure. The exhaust gases will leave this stack at a minimum rate of 15 m/s (at full operating capacity) from the slope of the adjacent hillside. This will ensure that the exhaust gases will effectively clear any immediately adjacent building wake influences.

4.3.5 WENT Landfill Reception Area

Dust and vehicle emissions arising from the operation of the WENT Landfill Reception Area are considered to have little impact. Daily operations will include 72 movements from the WENT Reception Area to the landfill. The entire area will be hardstanding and regularly swept and wetted to ensure dust entrainment is minimised. All vehicles entering the site will have passed through the WENT vehicle wash facility.

4.3.6 Summary

The design and operational measures to be used at IWTS to achieve the required air quality are as follows:

- the transfer station cavern will be extract ventilated, with all extracted air from potentially dusty or odorous areas passing through dust and odour control scrubbing systems prior to being vented to the atmosphere;
- the tipping hall will be totally enclosed;
- all surfaces and drainage arrangements have been designed with easy-to-clean surfaces and without difficult-to-clean corners, crevices and enclosed areas;
- all roads, accessways, floor and vehicle manoeuvring areas will be regularly washed and swept with equipment suitable for the duty;
- waste will be stored only in closed containers;
- provision has been made for washing container exteriors every trip;
- vehicle and wheel washing facilities have been provided.

The air quality assessment has demonstrated that the design of IWTS ventilation system and associated air treatment systems result in air quality, both within and outside the cavern, that conform with the strict environmental performance criteria required by EPD. In addition, regular monitoring of air quality parameters within the cavern and at the site boundary will be undertaken to ensure that these standards are maintained.

Dust and vehicle emissions arising from the operation of the WENT Landfill Reception Area will have minimal impact.

Effluent Drainage and Disposal

In this section, aqueous emissions including surface drainage are identified and quantified with due consideration for adequate interception, handling, treatment and disposal guidelines. Emphasis is placed on achieving effective interception of uncontaminated ground and surface waters and preventing contamination by wastewaters arising at the Facility.

4.4.1 Legislation and Guidelines

The relevant legislation and guidelines relating to water quality and discharge of wastewaters to inshore waters of Victoria Harbour Water Control Zone and to sewers are outlined in Section 3.4.

4.4.2 Water Source Separation

Swire BFI will ensure the separation of contaminated and uncontaminated effluent drainage streams arising from IWTS as defined in the Performance Requirements. They will also ensure that accidental spillages will not result in unacceptable discharges of contaminated effluents to storm and surface water drainage systems. The provisions for the disposal of all effluent, rainfall runoff, and contaminated and uncontaminated water flowing, generated by or arising from the facility are described below.

Drainage of Stormwater (IWTS)

Stormwater drainage at the transfer station is collected from 5 separate areas:

- Runoff from the slopes above the site and the flow in the existing stream course will be intercepted in channels and catchpits at the perimeter of the site and conveyed in underground stormwater drains direct to the existing stormwater drain outfall.

- Runoff collected in gullies along the entrance road leading from Victoria Road at high level will be conveyed in downpipes and underground drains direct to the existing storm drain in Sai Ning Street.

- Runoff collected in gullies along the road leading to the future Mount Davis Sewage Treatment Works Road beyond the site exit will be conveyed in underground drains direct to the existing storm drain in Sai Ning Street.

- Site runoff from open paved areas will be collected in gullies along the seaward site boundary for treatment before discharge to the stormwater drainage system. Roof runoff from site buildings will be conveyed in underground drains to the same treatment point. Treatment will consist of screening, sedimentation and oil interception. All stormwater collected by this system (Group 2 effluent) will be screened in a chamber upstream of the 3-cell oil interceptor to be provided. Because of the high risk of oil, grease and silt being washed through the interceptor during heavy rainfall, a bypass will be provided in the screen chamber so that only the first flush and low flows during light rainfall will be intercepted for treatment. This approach to the treatment of potentially contaminated stormwater is considered reliable and consistent with current Government practice relating to similar areas such as open bus termini and cargo handling areas[6].

Drainage of Foul Water (IWTS)

Contaminated water, soil and wastewater collected from the vehicle maintenance workshop, offices and marine container vessels (Groups 1 and 4 effluent) will be conveyed in underground pipes to the wastewater treatment plant within the cavern. Contaminated water generated at level +5 mPD will be pumped from a pump sump located adjacent to the access road retaining wall.

Treated effluent from the wastewater treatment plant in the cavern will be pumped out along a pressure sewer rising up to a terminal manhole in the footpath of Victoria Road. A connection will be provided from this manhole to an existing manhole in the road.

Drainage of Surface Water in the Cavern Accessways

Surface water collected in channels along the tipping hall accessway will be conveyed in the channel to the vehicle washing recirculation sump.

Since the waste containers will be sealed and washed prior to leaving the compactor hall, surface water collected in channels along the compactor accessway will be conveyed by underground storm drains via an interceptor to the existing stormwater drain outfall.

---

6 *ProPECC 5/93: Drainage Plans subject to comment by the Environmental Protection Department: Building (Standards of Sanitary Fitments, Plumbing, Drainage Works and Latrines) Regulations 40(1), 40(2), 41 (1) and 90* (1993) Environmental Protection Department

Drainage of Surface Water in Tipping Hall and Compactor Hall

Swire BFI experience at Kowloon Bay and Island East Transfer Stations has proved that drainage channels laid into the tipping floor are subject to blockage and concrete attack by liquors, at the change in section of the floor. As at Sha Tin, Island West has been designed to prevent such problems by laying the floor to adequate falls.

Surface water in the tipping hall will be collected in the live floor hoppers by casting the floor slab to 1:70 falls. This water (Group 1 effluent) will include the leachate from the WCVs and will be conveyed in the drainage channel in the live floor corridor, below the live floor hopper, to the wastewater collection sump (WWCS). The contaminated water in the WWCS will be pumped to the wastewater treatment plant. Treated effluent from the wastewater treatment plant will be pumped out along a pressure sewer rising up to a terminal manhole in the footpath of Victoria Road.

Drainage of Seepage Water

Seepage water from the cavern walls will be collected in channels running along the top of edge walls around the cavern perimeter. This water will then be discharged into the below-slab seepage drains by means of down pipes.

Seepage water from below the concrete slab in the cavern and access is to be collected in slotted pipe drains and discharged into the treated effluent tank.

4.4.3 Effluent Generation

Sources and Volume (IWTS)

The sources and effluents for IWTS are generally as identified and grouped in the Performance Requirements. In addition to the effluent sources listed, there will be an extra Group 1 flow resulting from the recycle flow to the wet scrubber used in de-dusting and preliminary odour control of the air extracted from the transfer station. As this flow is a recycle, it will have a zero net volume but its solids content will contribute to the COD loading on the effluent plant. Group 1 liquors will also include bilge waters from the marine container vessels which are likely to include seawater and contaminated waters.

Group 1

These sources are identified as:

- liquor derived during the compression of waste in WCVs and held in tanks fitted to the WCVs;
- liquor held within the collection vehicle body derived from the collection of waste;
- liquor from the compactor derived from the compaction of waste;
- water from the washing down of the tipping hall, live floor hoppers, compactors, containers, compactor hall floor, tipping floor and WCV access;
- vehicle washing water emanating from within the transfer station;
- discharges from any workshop/maintenance area;
- recycle flow to the scrubber on the air extraction system;
- bilge waters from the marine container vessels.

Based on the experience gained from operating the Kowloon Bay, Island East and Sha Tin Transfer Stations and on a comparison between the amount of refuse handled at these transfer stations, the estimated volume of Group 1 wastewater that will require treatment at IWTS will not exceed 40 m^3/day.

Water from the vehicle washing unit will be recycled within the unit. As this process is a net user of water, it is anticipated that there will be only small and intermittent flows of water in the form of blowdown. This discharge of recirculated liquor to the wastewater treatment plant will take place occasionally so as to minimise the build up of solids within the vehicle washing system. During maintenance or emptying for cleaning purposes the effluent will be pumped to the wastewater collection sump tank. The maximum volume of this source is approximately 5 m^3/day on an intermittent basis.

Group 2

These sources are identified as surface drainage from areas where there is potential risk of contamination from accidental spillage, etc. Again, the experience gained from operating the Kowloon Bay, Island East and Sha Tin

Transfer Stations indicates the volume of this wastewater will not be substantial and has been calculated to be less than 20 m^3/day.

The area considered to be at potential risk of contamination is the WCV accessway, where during peak waste flows vehicles may queue whilst awaiting access to the tipping hall. Harsh braking or acceleration could cause spillage from the vehicles (either solids or liquids), and despite the regular cleaning that will take place this material could be washed into the local road drains. For this reason, separate road drainage, connected directly to the wastewater collection sump, is being provided to collect all spillages and washdowns from the whole length of the WCV accessway. In addition, groundwater seepage over potentially contaminated surfaces has been estimated at a maximum of 10 m^3/day.

Group 3

These sources are identified as surface drainage from all site areas where there is little or no risk of contamination by the transfer station operation. These will be discharged to the public surface water system via grease and oil interceptors provided within the site boundary.

In accordance with the Civil Engineering Manual, the system will be designed for a storm return period of 50 years and the design flow is calculated from the 'Rational Method'.

The oil and grease interceptor for drainage of the site has been designed to retain the 'first flush' and a by-pass is provided in the event of a substantial storm.

Group 4

These sources are identified as the wastewater and sewage from the toilets and other utilities which will be discharged from facilities inside the cavern and pumped from facilities outside the cavern, directly to the rundown screen in the wastewater collection sump.

The volume has been calculated in accordance with the *Civil Engineering Manual: Volume 5* giving, for a total site personnel of about 65 persons, an approximate volume of 4.6 m^3/day, say 5 m^3/day.

Summary of Volume to be Treated

From the identified effluent sources, the total volume of wastewater requiring treatment is expected to be as follows :

Group 1 -	45 m^3/day
Group 2 -	30 m^3/day
Group 4 -	5 m^3/day
Total	80 m^3/day

4.4.4 Effluent Quality

Groups 1 and 2

It is recognised that the influent to the IWTS wastewater treatment system could vary significantly on a day to day basis. However, for the purposes of the proposed design, a worst-case set of characteristics is listed below:

Parameter	Result	Unit
pH	4.6	std units
Total dissolved solids	6,480	mg/l
Total suspended solids	88	mg/l*
Total acidity (as CaCO3)	2,784	mg/l
BOD5	12,000	mg/l
Chemical Oxygen Demand	21,600	mg/l
Ammonia nitrogen (as N)	96	mg/l
Kjeldahl nitrogen (as N)	320	mg/l
Total phosphorous (as P)	0.05	mg/l
Oil and Grease	1,200	mg/l

* After 30 minutes settlement

The BOD figure has been increased from that used for Kowloon Bay and Island East Transfer Stations. This is to reflect the contribution from the recycle stream to the wet scrubber, plus some increase in strength from the additional water expelled from the refuse during compaction due to the improved compaction system relative to these two transfer stations. However, this increase is less than that estimated for Sha Tin Transfer Station, as the degree of pre-compaction to be used at IWTS is less than that installed at Sha Tin.

This data was used along with the projected maximum daily volume of 40 m^3/day of influent to size the reaction vessels for the wastewater treatment system. The maximum of 30 m^3 of possibly contaminated washdown water from the access routes and groundwater seepage is considered unlikely to contribute significantly to this biological loading. In effect, it will simply provide dilution.

Group 3

Group 3 effluent is identified as surface drainage from all site areas where there is little or no risk of contamination and will be discharged to the public surface water system after treatment.

Oil/grease separators are provided on-site prior to discharge to the surface water system and a bypass is also provided to cater for extreme events. The bypass nevertheless ensures that the first flush is retained within the interceptor.

Group 4

The quality of this effluent has been taken as the average for domestic sewage in Hong Kong.

4.4.5 Effluent Treatment and Disposal

Design Outline

The design of the effluent treatment plant is generally as outlined in the Performance Requirements.

The sizing of the wastewater treatment system is based on information acquired through operating the Kowloon Bay and Island East Transfer Stations, and from the initial experience gained at the Sha Tin Transfer Station. Additionally, the influent to the Kowloon Bay, Island East and Sha Tin Transfer Stations' wastewater treatment systems were analyzed in order to have a better understanding of the strength of the wastewater to be treated at IWTS.

For the effluent treatment system, a modification of the activated sludge system known as Sequencing Batch Reactor (SBR) has been chosen. It has been shown at the Sha Tin Transfer Station that this system offers many advantages and will produce an effluent that is in accordance with the requirements set forth in Table 1 of the *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage System, Inland & Coastal Waters*.

As at Sha Tin, the wastewater treatment plant is integrated with the air scrubbing system which utilises active liquors from the treatment process in the first stage scrubbing for dust and odour. The final layout brings both systems together at the northern end of the cavern complex, providing treatment for collected air and water before being exhausted along ducts and pipes in the accessways.

The wastewater treatment method for Groups 1 and 2 will use the following unit process operations:

- wastewater collection sump with coarse filter and pump;
- sump/rundown screen for gross solids removal at the entry of the wastewater buffer/equalisation tank. This tank will also enable the removal of oil and grease using an oil mop device;
- two Sequencing Batch Reactors (SBR) positioned one above the other, operating in series which will have the facility for trace element and nutrient addition and for minor pH correction;
- an outlet buffer and monitoring tank for the treated effluent. Treated effluent will be held in this tank while specific testing is carried out to confirm it is suitable for discharge to foul sewer. If the quality is found to be unsatisfactory, the effluent will be pumped back to the lower SBR for re-treatment;
- a filter press for the dewatering of the sludge that will be produced in the SBRs. The positioning of the filter press above the level of the lower SBR allows the filter press contents to be reprocessed if the resulting sludge is found to be not sufficiently dewatered;
- dewatered filter cake will be returned to the hopper area for inclusion and compaction with the other waste;
- filtrate from the filter press will be returned to the wastewater collection sump.

Additional information on this system is included in the relevant Design Report.

4.4.6 Sludge Disposal

The SBR will generate a quantity of activated sludge microorganisms that will have to be wasted from the system on a regular basis. Therefore, an additional component of the wastewater treatment system for IWTS will be the sludge transfer, sludge thickening system and the filter press dewatering for the wasted microorganisms. The dewatered filter cake will be transported manually in plastic trays (similar to those in use at Island East and Sha Tin Transfer Stations) and included with the refuse within a waste container for transfer to a landfill. The expected normal daily sludge production is likely to be in the order of 3.5 m^3/day of filter cake. This will not cause any adverse impact when mixed with domestic waste.

4.4.7 Discharges to Foul Water

The maximum daily volume of wastewater from all potential sources requiring treatment at the wastewater treatment plant is 80 m^3/day. Only half of this volume is likely to contain significant solids content. Maximum daily filter cake production has been calculated to be 16.6 m^3/day with an expected norm of around 3.5 m^3/day. Hence the maximum discharge from the wastewater treatment plant to the foul sewer will be about 63 m^3/day. This is well below the allowable limit for discharges from IWTS to the foul sewer (500 m^3/day) as stated in the Performance Requirements.

The proposed drainage and effluent system has been designed to separate the water arisings so as to enable them to be directed to the most appropriate drainage stream, thus assuring that unacceptable volumes or quality are avoided.

4.4.8 WENT Landfill Reception Area

Drainage of Stormwater (WENT)

The reception area platform is designed with a fall toward the seawall. Surface water will be collected in channels along the site boundary and pass through an oil separator prior to discharge via the 600 mm outfall in the seawall.

Drainage of Foul Water (WENT)

Foul water will be collected at the container wash area, the vehicle workshop and from around the fuel tanks, and conveyed in underground pipes connected to the existing foul water system at WENT prior to being pumped to the WENT wastewater treatment plant.

Effluent Quality (WENT)

Effluent volumes arising at the WENT Landfill Reception Area will be less than 5 m^3/day, comprising container wash water. Container wash water is likely to have similar characteristics to household wastewater.

Sources and Volumes (WENT)

Foul water generated at the WENT Landfill Reception Area will comprise mainly container wash water.

4.4.9 Summary

The water quality impact assessment has demonstrated that all sources of contaminated and potentially contaminated effluent generated at IWTS will be effectively separated from runoff. The effluents will be adequately treated on site to conform at all times to the appropriate standards outlined in the *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters*, prior to discharge to the foul sewer or stormwater drainage system.

Regular monitoring of treated effluent from the wastewater treatment plant, and stormwater drainage from site runoff, will ensure that all discharges are maintained within the specified performance limits.

4.5 Transportation Impacts

This section outlines the potential impacts from marine and road transportation of waste to and from the IWTS and WENT Landfill. Municipal wastes will be delivered to IWTS in refuse collection vehicles via Victoria Road. Containerised wastes will be transferred either by sea or road to the WENT Landfill.

4.5.1 Transportation Options

All refuse arriving at IWTS will be transported by road. However there are two options for the removal of containerised waste to WENT Landfill as considered in the IEIA: road and marine transport. Table 4.15 from the IEIA shows a comparison between the severity of environmental impacts of marine and road transport options to WENT Landfill.

Table 4.15 Comparison of Marine and Road Transport Option Impacts

Impact		Marine Transport	Road Transport
Air	Odour	0	*
	Dust	0	*
	Gaseous Emission	*	*
Marine Water Quality		*	0
Noise		*	* *
Vibration		*	* *
Visual Amenity		*	* *
Transport (Congestion)		*	* *
Storage of Containers		* *	*
Access		*	* *

Key: 0 no significant impact
* moderately significant impact
* * significant impact

Road transportation to WENT will be necessary under emergency conditions, eg. typhoons. Under normal conditions, marine transportation of waste is the preferred option.

4.5.2 Marine Transport

Transfer of waste containers by a marine container vessel to the WENT Landfill site will take place using a specified route via Victoria Harbour and Deep Bay. In view of the fact that only one sailing per day of a container vessel is expected between IWTS and WENT Landfill, the impact on marine traffic in the area will be insignificant.

Similarly, the impacts of marine transportation of containerised waste are expected to be insignificant. Container doors and seals will be sufficiently robust to cope with on- and off-loading without spillage of refuse or leakage of refuse leachate. Wastewaters from marine vessels including sewage and bilge water, which may be contaminated with diesel and oil spillages, will not be allowed to discharge into the seawater but will be discharged directly from the marine vessels to the IWTS wastewater treatment plant. Noise and vibration impacts of container vessel movements will be insignificant.

4.5.3 Land Transport

The IWTS facility is designed so that there will be no queuing of WCVs onto Victoria Road, even under emergency conditions.

Land transportation of containers from IWTS to WENT Landfill may be required during typhoon or other emergency conditions. Table 4.4 identifies noise, vibration, visual amenity and traffic as significant impacts from road movement of containers. The impact on sensitive receivers of noise and vibration (from empty containers) from container vehicles will be reduced in the immediate vicinity of the transfer station by the acoustically enclosed spiral access ramp. The visual impact of container transport is of limited significance in an area already frequently traversed by lorries and WCVs.

Road haulage of containers may temporarily lead to an increase in traffic congestion and possibly impact on road safety: however, the improvements in Victoria Road and the proposed Route 7 developments should lead to an amelioration of traffic congestion which will offset any impacts from IWTS operations.

4.5.4 Container Storage on Green Island Reclamation

The only marine transport impact considered significant in the IEIA study is the visual impact of stored containers. This is highlighted as an issue in relation to the Performance Requirements:

> "..the requirement for long-term container storage on Green Island Reclamation is undesirable because of the proposed

residential and recreational uses of land adjacent to the location of the marine berthing facility."

At any one time, up to 20 empty containers will be stored immediately outside the IWTS cavern. This is not likely to be of visual nuisance to nearby sensitive receivers (the residents of the Old People's Home, Serene Court and Mount Davis Cottage Area) due to the site being screened either by the spiral ramp or by Victoria Road and the steep slope.

Neither empty nor full containers will be stored at either of the proposed barging points: the temporary barging area at Sai Ning Street or the long term barging area on Green Island Reclamation. This is because containers are systematically and directly on- or off-loaded between the container handling unit and the marine container vessel at the barging point without the need for intermediate storage on land in the vicinity of the vessel.

Under emergency conditions, the container handling units will transport the containers directly to and from WENT Landfill by road, again without the need for storage outside the IWTS site.

Consequently, there will be no adverse visual or other impacts from container storage at the barging point. The use of subdued colours for the exteriors of the containers could further diminish any perceived visual impacts from containers on the marine vessel.

4.5.5 Summary

Environmental impacts from the transportation of containerised waste from IWTS to WENT Landfill will be minimal. Road transportation, which will be used under emergency conditions, will have little impact on traffic congestion, particularly in view of the road improvements associated with the proposed Route 7 development.

4.6 Visual Impacts

The location of IWTS in an underground cavern is in itself a significant factor in mitigating the impact of such a development. Visual impacts during construction will be transitory and most directly affect the residential developments at the end of Sai Ning Street and those around the Mount Davis Cottage Area (Kung Man Tsuen), who will have clear close range views of the ramp construction and vegetation clearance. During operation, the ramp and vehicular movements will be the main cause of visual impact from residential and recreational areas off Sai Ning Street and the Mount Davis Cottage Area.

This section describes the visual and landscape mitigation measures including architectural finishes, colour schemes, landscape, screening and planting works which Swire BFI intends to adopt for the facility.

4.6.1 Visible Components

The potentially visible components of the development will be:

- operational vehicles; waste collection vehicles and the container vessels
- portals, vent shafts, ancillary buildings and reinforced earth wall
- cut slopes
- spiral ramp and access road
- planting

Figure 4.2 is an artist's impression of the proposed IWTS scheme.

4.6.2 Visual Impacts

The most significant effects on the existing landscape are likely to arise from the following:

- loss of mature trees and understorey vegetation from the slope below Victoria Road;

- minor re-profiling of the slope in the vicinity of the cavern portals;

- extension of the built environment along the coastline from Kennedy Town, against the existing semi-natural backdrop of the Mount Davis area;

The most significant visual intrusion on the existing views of visually sensitive receivers is likely to arise from construction of the access ramp.

Visually sensitive receivers include residents of:

- the Old People's Home adjacent to the site at the end of Sai Ning Street;
- the police residential quarters immediately to the east off Kai Wai Man Road;
- Serene Court, Sai Ning Street.

Users of:

- the temporary recreational facilities at the end of Sai Ning Street containing a football pitch, a basketball court, ball courts and a sitting area;

- the Mount Davis Urban Fringe Park, currently comprising a limited network of footpaths and lookout points.

Passengers:

- in the ferries and boats in the area of the Western Harbour including the Discovery Bay, Outlying Islands and Macau ferries.

When considered in the context of the overall development and comparing alternative access arrangements, the impact on both landscape and visual receptors is minimal.

4.6.3 Mitigation Measures

In order to minimise the visual impact of the development, a series of measures is incorporated which help blend it into the surrounding environment, as follows:

<u>Architectural Treatment</u>

- above ground structures are set back into, or against existing slopes to create a visual backdrop. This is a particular consideration in the design of the portal area;

- the visible structure of the access ramp is kept to a minimum to reduce its mass and optimise visual permeability;

- buildings and structures are designed to present a uniform and co-ordinated image with aesthetically pleasing elevations. During the detailed design stage, further assessments of the visual aspects of the project have been undertaken, resulting in the repositioning of the external buildings, ie. maintenance workshop, fuel tanks and Dangerous Goods store, to further improve the visual impact;

- architectural finishes and colour schemes are selected to minimize glare and to reflect the colour spectrum of the surrounding landscape;
- the visual massing of any facade is kept to a minimum by avoiding large flat surfaces. Where unavoidable, large surfaces are broken by using differing cladding materials and/or colours;
- shadow lines have been developed using roof overhangs and recessed windows, etc. to create a three dimensional aspect to otherwise flat facades;
- extensive roof areas, particularly flat roofed areas are kept to a minimum;
- visually transparent forms of fencing and railings have been used wherever possible to minimise visual impacts within the site and along the site perimeter. Solid masonry walling has been avoided.

Landscape

- where natural slope profiles are disturbed by cut or fill, the finished formation has aimed to follow existing contours and reduce the contrast between the man-made slope and the natural landform;
- in disturbed areas, particularly where existing vegetation has been removed and earthworks are visible, replanting will be undertaken at the earliest practicable stage;
- new planting will be undertaken to replace that lost during construction, to reinforce the existing planting structure, and to form additional screening elements in the landscape from significant viewing points;
- buffer planting along the eastern perimeter of the site will be undertaken to reduce the visual impacts caused by the ramp structure on residential development to the west;
- where possible, planting species have been selected with the intention of reinstating vegetation cover similar to that existing. A mix of native trees and shrubs is proposed, with climbers and groundcovers planted as an edge mix along retaining walls and buildings to soften built form where appropriate;

- planting is to be undertaken where possible within the site in order to soften views of the development. This will be important around the administration buildings and tunnel portal area.

4.6.4 Summary

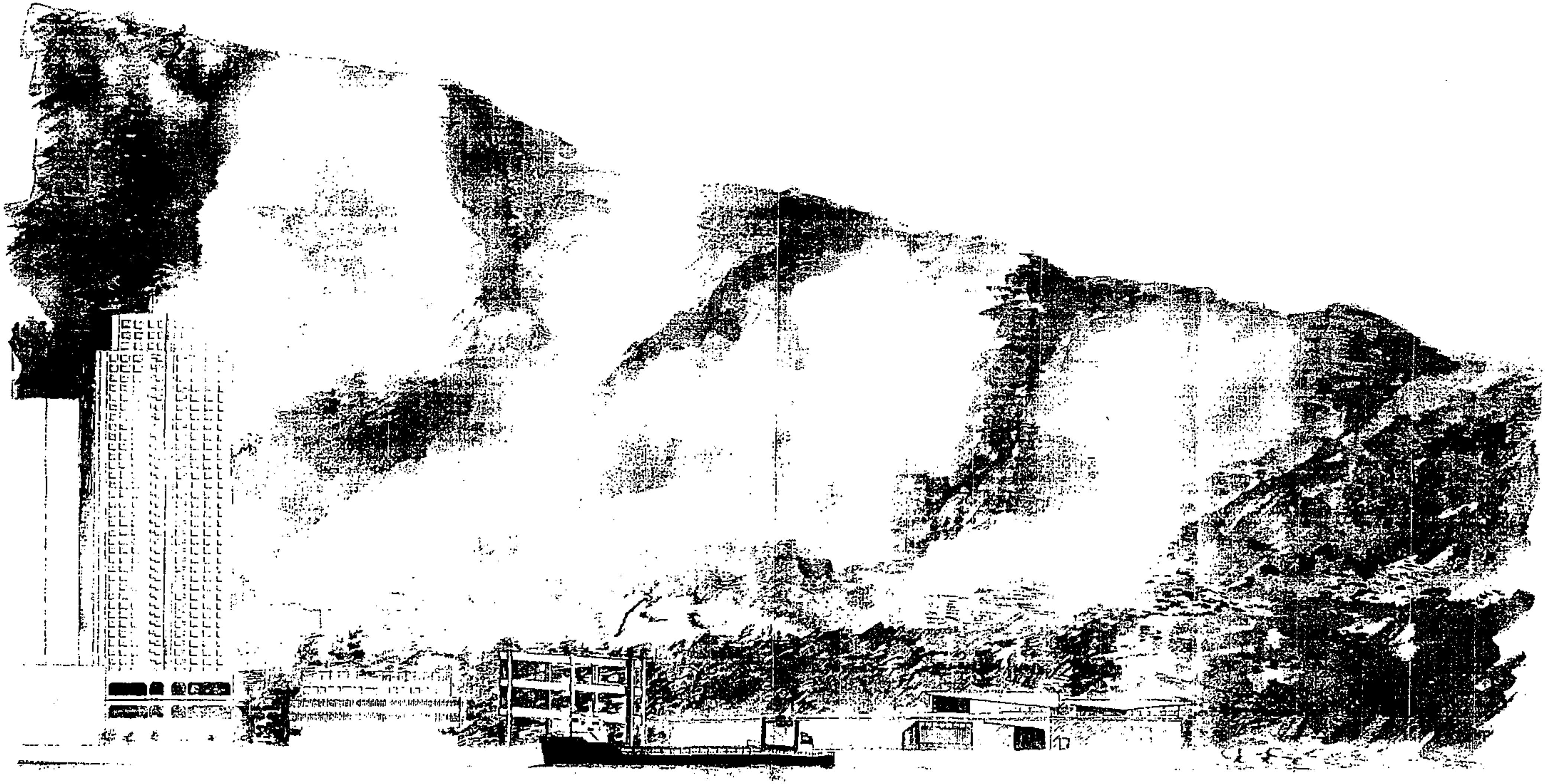
The IWTS development will be visible from within a clearly defined and self contained visual envelope on the landward side delimited by the surrounding mountains and development blocks. It will also be visible from the western harbour waters.

The potential receptors within this visual envelope are adjacent dwellings, users of the recreational facility and harbour traffic including ferry passengers.

The visual impact experienced by these receptors shall be greatest during the construction phase when a high visual impact will be experienced from loss of existing vegetation cover, construction of the spiral ramp and construction activity. Harbour traffic and ferry passengers will experience a low visual impact from views of earthworks and general construction activity.

Mitigation measures including planting, reinstatement of slope profiles, and sensitive architectural treatment of buildings will significantly reduce these impacts.

The landscape and visual impacts must be viewed in context with the overall long term development strategy for the area. As part of the Green Island Reclamation proposals, the Route 7 Expressway may be built immediately north of the site with this substantial road located on elevated structures (+13 m) in this section. It would thus provide a visual barrier between the site and proposed high rise residential development who will look down into and across the site. However, in the context of the view this impact is not considered significant.



Island West Transfer Station
SWIRE BFI WASTE SERVICES LIMITED

FIGURE 4.2

ARTIST'S IMPRESSION OF ISLAND WEST TRANSFER STATION

4.7 Socio-economic Impacts

In this section, the negative effects perceived by people likely to be affected by the project are determined and Swire BFI's public relations and consultation programme is outlined.

4.7.1 Public Perception

The handling of waste is generally perceived as an activity not wholly compatible with other land uses, particularly residential land use, and is therefore considered a 'bad neighbour' activity. There are a number of existing 'bad neighbour' activities in Kennedy Town, including an abattoir and a mortuary/crematory. The site for IWTS is currently used as a parking/storage area for Urban Services Department's refuse collection vehicles.

It should be noted that the Instructions to Tenderers states that the local District Board has already endorsed the construction of the transfer station in a cavern.

4.7.2 Public Relations and Consultation

In addition to press releases, Swire BFI's public relations programme involves the distribution of individual written communication to all inhabitants living in the area around the site in the Old People's Home, Serene Court and Mount Davis Cottage Area. The communication will contain the following information:

- description of the IWTS contract, relevant background information and names of the principal organisations involved;
- construction programme detailing all possible activities which could be considered to cause a nuisance, including the proposed mitigation measures;
- assurances that there will be no negative effects from the construction activities on the general public, and particularly the inhabitants of neighbouring properties;
- the name and telephone number of Chinese- and English-speaking contact personnel who will be contactable 24 hours per day.

The bulletins will be updated at regular intervals and distributed to all concerned parties.

In addition, during periods of blasting:

- an announcement of the date and time of blasting will be displayed on notice boards erected at the entrance of the Mount Davis Cottage Area and the main site entrance in Sai Ning Street, together with the anticipated completion date of cavern construction (ie. when blasting will be completed);

- a representative of Swire BFI will be available to attend meetings called by residents' associations to respond to queries about construction of IWTS.

4.7.3 Summary

Swire BFI will ensure that construction and operation of IWTS is undertaken in such a way as to minimise nuisance as much as possible. Individual queries from the public will be answered by Swire BFI's contact personnel, who will be contactable on a 24 hour basis.

4.8 Operational Impacts - Summary

The main operational impact is expected to be vehicle noise from WCVs serving the site. This will be ameliorated by partially enclosing the spiral access ramp with an acoustic barrier.

Environmental impacts of noise, dust, odour and effluent emissions from the IWTS facility itself will be minimal, due to the construction of the facility within a cavern and the innovative design of the ventilation/scrubbing and wastewater control systems.

Impacts on marine and road traffic will be limited. Marine transportation of the containerised waste between IWTS and WENT will involve only one sailing per day. Impacts of road transportation of containerised waste during emergency conditions will not be considerable, particularly in view of the proposed road improvements (construction of Route 7 Expressway).

Visual impacts of the facility will be minimal, due to construction of the facility within a cavern and the compactness of the site. Containers will not be stored on land at the proposed permanent berthing facility on Green Island Reclamation.

With the implementation of the proposed control measures outlined and detailed further in Appendices 1-6, environmental impacts in terms of noise, air quality, water quality, road and marine traffic will be kept to within statutory or acceptable limits.

5 CONCLUSIONS

The Island West Transfer Station has been planned and designed to be constructed and operated in a way which minimises the impacts on the noise, air and water quality of the surrounding environment and sensitive receivers.

Appendices

1 GENERAL

2 ENVIRONMENTAL MONITORING & AUDIT

3 DUST, VEHICLE EMISSION AND TEMPERATURE CONTROL

4 AIR QUALITY/ODOUR CONTROL

5 EFFLUENT HANDLING AND TREATMENT

6 NOISE CONTROL

APPENDIX 1 GENERAL

The Contractor shall describe the means by which compliance with Environmental Performance Requirements are to be achieved. The general approach to implementation and practical enforcement of controls shall be described. In particular, this Appendix shall include, but not be restricted to, for example:

(a) Proposals for any noise controls necessary during construction together with a completed application for a Construction Noise Permit (CNP) under the provisions of the Noise Control Ordinance if works are to be continued during restricted hours;

(b) Description of provisions for controlling contamination of runoff during construction, including design criteria and maintenance of silt traps.

A1.1 Achievement of Environmental Performance Requirements

Swire BFI's approach to the achievement of Environmental Performance Limits at Island West Transfer Station has been, based on its experience of the design, construction and operation of other transfer stations in Hong Kong, to design the transfer station and manage operations in such a way that Performance Requirements will be met.

In addition, the programme of Environmental Management and Audit outlined in Appendix 2 will ensure that critical environmental parameters (noise, air quality, water quality) will be regularly and systematically monitored during the construction and operation periods. Swire BFI's Project Manager will be responsible for the review and audit of all monitoring data. Should deteriorating trends and exceedances with respect to the statutory or agreed environmental parameters be noted by the Project Manager, he will implement appropriate action to reduce the levels to acceptable limits.

A1.2 Construction Noise

Swire BFI will ensure that statutory noise criteria will not be exceeded at NSRs during construction. This can be achieved by implementation of the following mitigation measures:

- use of silenced generators and compressors where possible (potential overall reduction 3 dB(A));
- use of temporary noise barriers angled inward towards the site or plant at the top where necessary;
- good management of site activities;

- minimising the transportation of spoil material between the cavern and barging point during the night time (23:00 - 07:00 hours);

- using of noise-reducing mats during blasting.

Additional measures to reduce daytime noise levels will include:

- use of acoustic enclosures for crane motor and drill rig;

- siting of plant as far as possible away from NSRs;

- reduction in the number of idling lorries and powered mechanical equipment as much as possible;

- ensuring plant and vehicles are well maintained particularly in regard to exhaust systems.

All construction noise permit applications for IWTS will be prepared and submitted by Swire BFI's civil contractor, Gammon Construction.

A1.3 Construction Runoff Control

Swire BFI will limit the potential for erosion and sedimentation due to site runoff by the following measures:

- scheduling of excavation work during the dry season as much as possible;

- limiting areas of excavation as much as possible;

- stabilising exposed surfaces as soon as possible after excavation in a manner appropriate to the geotechnical characteristics of the substratum;

- accommodating permanent works within the temporary works where possible

Further details are presented in Section 3.4.6 Construction Activities - Mitigation Measures.

APPENDIX 2 ENVIRONMENTAL MONITORING & AUDIT

The Contractor shall include proposals for the implementation of monitoring and audit programmes. The minimum required environmental monitoring schedule during the operation is given in Section 25.5 of the PR. Additional requirements shall be identified in the DEIA. The Contractor shall indicate the means of management and supervision of: monitoring and audit; storage, retrieval and reporting of data; and responsibilities and lines of communication, necessary to detect and act upon any detected non-compliance.

A2.1 Introduction

The process of monitoring a key number of environmental media in the vicinity of the Island West Transfer Station will provide a database for assessing the short and long-term environmental effects of its waste transfer operations. An environmental monitoring programme will also play a vital part in the effective management of site operations enabling compliance with all relevant regulations and ordinances and other environmental guidelines set by Government to be determined and verified.

Environmental monitoring is also necessary to confirm assumptions made in the initial design criteria for the Transfer Station, and to provide data at an early stage which provides information on a reduction in the integrity of any of the environmental control systems. Operational protocols can also be monitored and working practices within (and outside) the Transfer Station changed or improved following systematic review or audit of the monitoring data.

Swire BFI will appoint ACTS Testing Laboratories Inc. as environmental consultant. ACTS will be responsible for:

- monitoring of all environmental parameters as specified in the Performance Requirements and the DEIA;
- ensuring access at all times to monitoring equipment, maintenance of the equipment and its accurate and continued operation;
- processing, storage, retrieval and reporting of environmental data and for reporting of instances of non-compliance of the Environmental Performance Requirements.

The monitoring and audit programme implemented by Swire BFI will:

- ensure continuity and consistency with monitoring surveys undertaken during the preparatory stages of the project;

- allow data and information to be retrieved and interpreted throughout the construction of the Transfer Station in order to ensure compliance with appropriate environmental standards and pollution control objectives;

- allow data and information to be retrieved and interpreted throughout the construction of the facility in order to ensure that no long term deterioration in environmental quality occurs adjacent to the Transfer Station site and/or facility;

- undergo a periodic and systematic audit in order to establish the standard of environmental performance in relation to the Transfer Station management objectives and standards of operational practice;

- provide data for the design of remedial measures in the event of deleterious environmental impact;

- determine the effectiveness of any remedial measures undertaken.

The following subsections describe the arrangements for monitoring, auditing, reporting and actioning matters arising from the detailed environmental assessment in respect of the operation activities associated with the Swire BFI design.

A2.2 Environmental Monitoring - Construction

A2.2.1 Noise

Noise monitoring will be undertaken at NSRs 1 to 4, identified in Figure 3.1.

Daytime, evening and night time noise levels will be established prior to commencement of construction by undertaking successive LA_{eq} (30 min) readings in the study area. Daytime measurements will be taken at the roof of Serene Court (NSR5) and evening and night time measurements will be taken at NSR3, Mount Davis Cottage Area.

During construction, Swire BFI proposes to undertake weekly noise measurements (LA_{eq} (30 min)) at the four NSRs. The purpose of the monitoring is to determine statutory compliance and to determine that good practice and all reasonable controls are in place and being used.

A2.2.2 Air Quality

Site Boundary

Baseline levels of Total Suspended Particles (TSP) and Respirable Suspended Particles (RSP) at the site boundary will be established prior to construction by taking ten 24 hour readings over a three week period. The methodology and equipment used is described below. The proposed monitoring location is shown on Figure 3.5.

Owing to the compactness and location of the Swire BFI design relative to the conceptual design, Swire BFI considers that monitoring of dust levels at two locations at the site boundary will be sufficient to establish compliance with the Air Quality Objectives during the construction period. The two monitoring stations chosen are shown in Figure 3.5 and include D1 at the eastern boundary adjacent to Sai Ning Street and D2 adjacent to the site boundary along Victoria Road. Continuous 24-hour duration samples will be taken at a frequency of once per week throughout the construction phase.

TSP and RSP will be collected using a high volume sampler whose performance specification complies with that required by *USA Standard Title 40, Code of Federal Regulations Chapter 1 (Part 50)*. The RSP fraction (less than 10 μg) shall be collected by the use of an appropriate assembly attached to the sampler. Station D1 will be equipped with a wind logging device. Monitoring at the two stations with simultaneous wind recording will ensure that the dust levels monitored clearly and unequivocally indicate the contribution of the Transfer Station construction activities to ambient TSP and RSP levels. One of the monitoring stations (depending on the wind direction at the time) will act as a control station throughout the construction phase.

During such periods as blasting is undertaken at the surface and up to 20 m underground, TSP (1 hour average) levels will be monitored. In accordance with the Performance Requirements, monitoring will be undertaken on an hourly basis for a 2 hour period after blasting and hourly if dust levels are still unacceptable.

On-site TSP levels (24 hour average) will be measured at a third monitoring station D3 located between the cavern portals and the barging point. Samples will be collected once per week throughout the construction period.

Within Cavern

Monitoring of CO, NO_x, TSP, RSP and Radon will be carried out on a weekly basis during cavern excavation to ensure that limits recommended by the Labour Department are not exceeded. CO and NO_x will be monitored using USEPA approved equipment and portable high volume samplers will be used to monitor for TSP, RSP and Radon. Monitoring locations will be agreed with the Labour Department during the detailed design stage.

A2.2.3 Blasting Vibrations

Blast monitoring stations will be established at specified locations at the commencement of tunnelling and will provide continuous data on blast vibration throughout the construction period. Where blast vibrations exceed acceptable limits, the size and frequency of blasts will be revised.

A2.2.4 Surface Water Quality

The IEIA and DEIA have both concluded that construction of the waste transfer station should not involve any significant water pollution, provided provisions are made for the removal of suspended matter prior to discharge of the water to the stormwater drainage system. Swire BFI will ensure the efficient operation of silt/grease traps through regular maintenance and removal of accumulated solids.

A2.2.5 Marine Water Quality

The only potential marine water quality impact that could arise as a result of the Swire BFI design would be from clearance of the marine access to the barging point. No other marine construction activities are required. The clearance would involve removal of approximately 200 to 300 m^3 of predominantly silt and boulders immediately adjacent to the sea wall. This would be completed within two days.

Swire BFI consider that monitoring of water quality parameters throughout the construction phases in the light of such limited marine construction activities is not necessary.

A2.3 Environmental Monitoring - Operation

A2.3.1 Noise

During operation, Swire BFI proposes to undertake noise monitoring will be undertaken at NSRs 2, 3, 4 and 5, identified in Figure 4.1.

Daily noise measurements (LA_{eq} (30 min)) at the four NSRs will be made between 0700 and 2300 hours at a frequency of once per week for the first month of operation, and thereafter once every three months.

Night time noise measurements (LA_{eq} (30 min)) at the four NSRs will be made between 2300 and 0700 hours once per week for the first month of operation, and thereafter once every six months.

A2.3.2 Air Quality

Site Boundary

Air quality measurements (24 hour TSP and RSP; CO and NO_x) will be made at the ventilation shaft and cavern portal. The measurements will initially be made once every 6 days on a continuous basis: the monitoring frequency may be revised subject to recommendations arising from environmental auditing, and subject to the Employer's agreement.

Within Cavern

Monitoring of particulates (haze) will be carried out on a weekly basis during for the first year of operation, thereafter monthly. Continuous monitoring and recording of CO, NO_x, SO_x, CH_4, NH_3 and H_2S will be undertaken throughout the operational phase using USEPA approved equipment. Monitoring locations will be agreed with the Labour Department during the detailed design stage.

Ventilation Shaft

Verification of the air exchange rates will be undertaken every 6 months.

A2.3.3 Odour

Odour will be assessed at the site boundary (ie. along the access route, at the ventilation shaft, cavern portal, Victoria Road and Sai Ning Street) during a daily walk over survey by the Employer's Representative. Additional monitoring will be undertaken at times of received complaints.

Any exceedance of the 2 Odour Unit limit detected in the walk over survey will be reported to the Project Manager, who will make appropriate operational adjustments to:

(i) the air flow rate through the venturi odour control scrubbers;

(ii) the concentration of hypochlorite in the scrubbers.

A2.3.4 Wastewater Treated Effluent

The flow, pH and temperature of the treated effluent will be continuously monitored and recorded. COD and suspended solids levels will be monitored daily. BOD_5 and ammoniacal nitrogen levels will be monitored daily until the treatment process has been established (a minimum period of 6 weeks) and thereafter at a weekly interval. Grease, oil and detergent levels will be monitored weekly for the first year, thereafter monthly.

A2.3.5 Stormwater Discharge

Levels of BOD_5, COD, grease and oil in stormwater discharge will be monitored monthly.

A2.3.6 Vermin

In addition to weekly inspections of the site, staff will be required to report any sightings of birds and other pests, or any evidence of their activity.

A2.4 Assessment Techniques

A description of the standard equipment Swire BFI intends to use and a method statement of the analytical techniques employed to monitor the various parameters noted above is given below.

(A) 24 hour and 1 hour Total Suspended Particulate (TSP)

Reference Method :
40 Code of Federal Registration, Chapter 1, Part 50, Appendix B (7-1-90 Edition).

> "*Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method)*".

Test Equipment :
GMW Model No. 2310105X High Volume Sampler equipped with GMW 5 Calibration Kit, 7-Day Timer, G130 Controller, G901 Elapsed Time indicator, GBM 2000H Blower Motor and 105 Continuous Flow Recorder.

(B) 24 hour Respirable Suspended Particulate (RSP)

Reference Method :
40 Code of Federal Registration, Chapter 1, Part 50, Appendix J (7-1-90 Edition).

> "*Reference Method for the Determination of Particulate Matter as PM10 in the Atmosphere*".

Test Equipment :
GMW PM10 Sampler with Model G70 Regulator, 7-Day Timer, G901 Elapsed Time Indicator, G105 Continuous Flow Recorder and G360 Volumetric Flow Controller.

(C) Noise: LeqA Measurement

Reference Method :
"*Technical Memorandum for the Assessment of Noise from places other than Domestic Premises, Public or Construction Sites*" - Environmental Protection Department, Hong Kong.

Test Equipment :
Rion NL-14, IEC 651, 804 Type I Sound Level meter equipped with NC-73 Acoustic Calibrator (½" adaptor) and EC-04A Microphone Extension.

(D) Carbon Monoxide (CO)

Reference Method :
CO in monitoring air diffuses through a plastic membrane into the liquid electrolyte of the sensor. CO is then converted electro-chemically at the sensor electrode causing a current to flow. This current is proportional to the CO partial pressure.

Test Equipment :
Drager Pao II Carbon Monoxide Monitor.

(E) Nitrogen Oxides (NO_x)

Reference Method :
ASTM D1608, "*Standard Test Method for Oxides of Nitrogen in Gaseous Combustion Products (Phenol - Disulphomic Acid Procedure*".

Test Equipment :
(i) Gilian 17G9 Air Sampler equipped with Gil Special Midget Fitted Impinger and Low Flow Module.

(ii) Perkin-Elmer Lambda 2 UV-Visible Spectrophotometer.

(F) Radon

Reference Method:
Airborne radio-nuclides are sampled on a filter. The alpha-particles collected are then counted using a semi-conductor detection system and the count is displayed immediately on a digital readout.

Test Equipment:
Davis Honeywell Professional Radon Monitor NA 091713 equipped with data output port for printer attachment.

(G) Effluent Quality

Reference Method : "Standard Method for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 18th Edition, 1992".

(i) Chemical Oxygen Demand, COD

- Open reflux with Potassium Dichromate solution followed by back filtration with Ferrous Ammonium Sulphate.

(ii) Suspended Solids

- Filtration with 1.5 μm Glass fibre filter paper. Gravimetric determination of residue at 103-105°C.

(iii) Biochemical Oxygen Demand, BOD

- Measurement of dissolved oxygen depletion after a 5-days incubation period at 20°C.

(iv) Ammoniacal Nitrogen

- Distil the ammonia into a borate buffer followed by titration with standardised Sulphuric Acid

(v) Grease and Oil

- Extraction of the sample with Chloroform/Freon followed by gravimetric determination.

(vi) Total Detergents

- Non-ionic surfactants - Dragendorff Reagent
- Anionic surfactants - Methylene Blue Solution

A2.5 Testing Organisations

Swire BFI intends to employ ACTS Testing Labs to undertake all the monitoring and testing of environmental parameters both during construction and operation of the

Transfer Station. ACTS is currently employed by Swire BFI to carry out all routine operational monitoring at the Island East and Sha Tin Transfer Stations.

ACTS Testing Labs Inc, formed in 1973, is one of the leading consumer products testing and inspection organisations in the United States, performing evaluations and inspections for manufacturers, retailers and waste services organisations. ACTS achieved HOKLAS accreditation in June 1995.

A2.6 Data Storage and Retrieval

Data from monitoring will be stored by the Project Manager.

A2.7 Auditing, Reporting and Action

Swire BFI's Project Manager will be responsible for the review and audit of all monitoring data. Should deteriorating trends and exceedances with respect to the statutory or agreed environmental parameters be noted by the Project Manager, he will implement appropriate action to reduce the levels to acceptable limits.

The Project Manager's Monthly Report to EPD will include details of:

- the results of any monitoring undertaken;
- actions and mitigation measures adopted or to be adopted to redress unacceptable, consequential or unanticipated environmental impacts, together with an assessment of their likely effectiveness;
- comparison with both statutory and contractual compliance limits;
- details of response in the event of any omissions or failures.

APPENDIX 3 DUST, VEHICLE EMISSION AND TEMPERATURE CONTROL

The Contractor shall state the expected dust levels, vehicle emission levels and temperature for various areas within the Facility, and details the specific procedures and equipment to be provided.

A3.1 Dust and Vehicle Emissions

The expected dust levels and vehicle emission levels for various areas within IWTS will be within the limits stipulated by the Performance Requirements.

A3.2 Temperature Levels

The total air flows and the design of the ventilation system will be adequate to ensure that the tipping hall temperature does not exceed 6°C above outside ambient temperature.

Unlike the existing transfer stations, the wall surface inside the cavern will have surface temperature lower than ambient, even in extreme summer conditions, and no solar load. Heat in the cavern complex will be gained from incoming vehicles, electric motors and hydraulic power packs.

Strategic positioning of extraction grilles and boosted air supply vents will ensure that the warm and polluted air rises to extraction points, and minimal mixing occurs with the cooler and cleaner air at operator level.

Heat will be readily dissipated through the ventilation system and lost by conduction and convection through wall surfaces. The temperature variation of the cavern wall surfaces will be minimal, since the cavern itself behaves as a large heat sink.

A3.3 Air Quality Control Procedures and Equipment

The dust level, vehicle emission and temperature levels within IWTS will be achieved by the measures outlined in Appendix 4, which summarises relevant material as presented in Sections 3.3 and 4.3 of this DEIA report, together with the associated calculations and diagrams.

APPENDIX 4 AIR QUALITY/ODOUR CONTROL

The Contractor shall describe the measures to be incorporated in the works and the operations to ensure that the requirements for air quality and avoidance of odour are met.

A4.1 Construction Air Quality

A4.1.1 Air Quality Outside Cavern - Impacts

Dust and fume generation outside the cavern will arise principally from initial blasting, materials handling and transfer as well as vehicular as well as vehicular and plant engine emissions. Dust emissions, and hence their degree of impact, will be determined by the degree of effort placed upon dust control. The construction contractor will be required to ensure that the Hong Kong Government Air Quality Objectives (AQO) for 24 hour average TSP and RSP of 260 $\mu g/m^3$ and 180 $\mu g/m^3$ respectively are complied with. In addition, the Performance Requirements state that the airborne dust level shall not exceed 5 mg/m^3 at any location within the site.

The main dust producing activities will occur during the first eight months of construction phase during which time the following activities will take place:

- excavation of the open cut
- reinforced earth wall and haul road construction to +11 mPD
- excavation of accessways and caverns
- construction of the spiral ramp

Plant operating outside the cavern includes excavators, dump trucks, generators, barges and cranes.

Dust emissions will arise from the following sources:

- initial blasting
- vehicle movements on the unpaved haul road
- stockpiling at the barging point
- loading and unloading at the barging point
- earth moving for the reinforced earth wall
- operation of a dry shotcrete batching plant

A4.1.2 Air Quality Outside Cavern - Mitigation Measures

The following dust suppression measures will be incorporated into the site management practices to ensure compliance with the AQO:

- daily watering of unpaved areas, access roads, construction areas and dusty storage piles by fixed and/or mobile spray systems during dry weather conditions;
- imposing a vehicle speed limit of 8 km/hr on site to minimise dust entrainment on unpaved areas;
- dusty stockpiles will be enclosed on three sides;
- where possible storage and handling areas will be hardstanding;
- covering of vehicle loads leaving the site via Sai Ning Street;
- use of wheel and vehicle wash facilities at the site exit;
- drilling equipment will be properly maintained and fitted with dust extraction or water flush systems;
- routing of construction plant travelling to and from the site to, as far as possible, avoid sensitive receivers in the area;
- dry mix batching will be carried out in a totally enclosed area;
- regular inspection of all plant and vehicles will be carried out by the site contractor to ensure that they are operating efficiently and that exhaust emissions are not causing a nuisance.

As part of the Environmental Monitoring & Audit of the IWTS project, dust levels will be monitored at two locations at the site boundary throughout the construction phase. In this way, any significant deterioration in air quality as a result of construction activities will be detected at an early stage and additional mitigation measures will be implemented to reduce dust emissions to acceptable levels. On-site dust levels will also be measured regularly throughout the construction period to ensure that airborne dust levels on site do not exceed 5 mg/m^3.

A4.1.3 Air Quality Inside Cavern - Impacts

Noxious and dusty fumes will be generated in the confined area of the underground works during the construction phase from activities such as the operation of plant and blasting. In addition, radon emissions have been identified as a hazard. Adequate ventilation will be essential to ensure that air quality does not deteriorate beyond acceptable limits.

A4.1.4 Air Quality Inside Cavern - Mitigation Measures

During the construction phase, the cavern ventilation system will be such that fumes are diluted to a level, within the works, which meets the appropriate health and safety standards. At the point of discharge, the air will not present a hazard to those working in the cavern or indeed to the surrounding areas.

There will be continuous monitoring of carbon dioxide, nitrogen oxides and radon levels within the IWTS cavern throughout the construction period. Should any additional air treatment be required, such as dust extractors in conjunction with shotcreting work or underground fabrications, then filter/precipitator units will be used. At no time will emissions of fumes or dust from the site exceed any statutory or specified limits.

A4.2 Operational Air Quality

A4.2.1 Air Quality Outside Cavern - Impacts

Dust emissions outside IWTS and at the berthing area will arise from resuspension of any dust from vehicles on access and egress roads and from particulate emissions from WCVs. Odour from the refuse could also be a problem.

A4.2.2 Air Quality Outside Cavern - Mitigation Measures

Dust emissions will be minimised by regular stringent cleansing as part of the overall site maintenance, cleansing and good housekeeping operations. Dust emissions are not a problem at other existing transfer stations in Hong Kong. Refuse will be containerised, and all WCVs and containers will be washed before leaving the site. The air exhausted from the transfer station ventilation system will be scrubbed prior to venting to atmosphere.

A4.2.3 Air Quality Inside Cavern - Impacts

Potential dust emissions within the transfer station would arise principally from above the waste receiving hoppers and from vehicles travelling to and from the tipping hall. Noxious gases and odours would arise from vehicle emissions and from the refuse handled.

A4.2.4 Air Quality Inside Cavern - Mitigation Measures

Dust levels will be kept low due to the rigorous dust control measures applied within the transfer station. The prime means of maintaining air quality within the cavern - whether particulates, noxious gases or odour - is through the design of an efficient ventilation system, as described in Section 4.3.

In principle, the ventilation system will extract air from working areas in the transfer station at a sufficient rate to control the internal air quality of the station, while at the same time creating a pressure gradient such that make up air is always flowing inwards. All air extracted from the operational areas will be treated prior to discharge to atmosphere.

Calculations for vehicle pollutant emissions and associated fresh air requirements referred to in Section 4.3 are presented here, together with a process flow diagram of air routes.

Appendix 1

Pollutant Calculation per Vehicle (based on PIARC-1991)

WCV: 17 tonnes, O gradient, average speed 20 km/h, EEC R24 (no control) standard.

1. For CO, qo = 0.37 m^3/h (Fig 1, page 63)

   fv = 0.8 (Fig 2, page 66)

   $Q(CO) = \frac{0.37 \times 0.8}{3600} \times \frac{106}{35} = 2.35\ m^3/s$

2. For NOx qo = 1,220 g/h (Table 5, page 69, EEC R24 standard)
   Assume NO represents 70% by weight of NOx,
   NO qo = 1,220 x 0.7 = 845 g/h

   fv = 0.4 (Fig 1, page 63), Air density = 1.2 kg/m^3

   $Q(NO) = \frac{0.854 \times 0.4}{3600 \times 1.2} \times \frac{106}{15} = 5.27\ m^3/s$

3. For Haze, qo = 216 m^2/h (Table 5, page 69, EEC R24 standard)

   fv = 0.6 (Fig 5, page 67)

   $Q(Haze) = \frac{216 \times 0.6}{3600} \times \frac{1}{0.007} = 5.14\ m^3/s$

Container Tractor: 26 tonnes, O gradient, average speed 20 km/h, US Transient 91 standard.

1. For CO, qo = 0.37 m^3/h (Fig 1, Page 63)

   fv = 0.8 (Fig 2, page 66)

   $Q(CO) = \frac{0.37 \times 0.8}{3600} \times \frac{106}{35} = 2.35\ m^3/s$

2. For NOx qo = 825 g/h (Table 5, page 69, US Transient 91 standard)
   Assume NO represents 70% by weight of NOx,
   NO qo = 825 x 0.7 = 578 g/h

   fv = 0.4 (Fig 1, page 63), Air density = 1.2 kg/m^3

   $Q(NO) = \frac{0.578 \times 0.4}{3600 \times 1.2} \times \frac{106}{15} = 2.85\ m^3/s$

3. For Haze, qo = 112 m^2/h (Table 5, page 69, US Transient 91 standard)

   fv = 0.6 (Fig 5, page 67)

   $Q(Haze) = \frac{172 \times 0.8}{3600} \times \frac{1}{0.007} = 4.10\ m^3/s$

Appendix 2

Fresh Air Requirements for Pollutant Dilution

Environmental Criteria : CO Lim = 35 ppm
NO Lim = 15 ppm
Haze = 0.007/m

WCV : 17 tonnes

QF(CO)	=	2.35 m^3/s	)
QF(NO)	=	5.27 m^3/s	) use 5.27 m^3/s
QF(Haze)	=	5.14 m^3/s	)

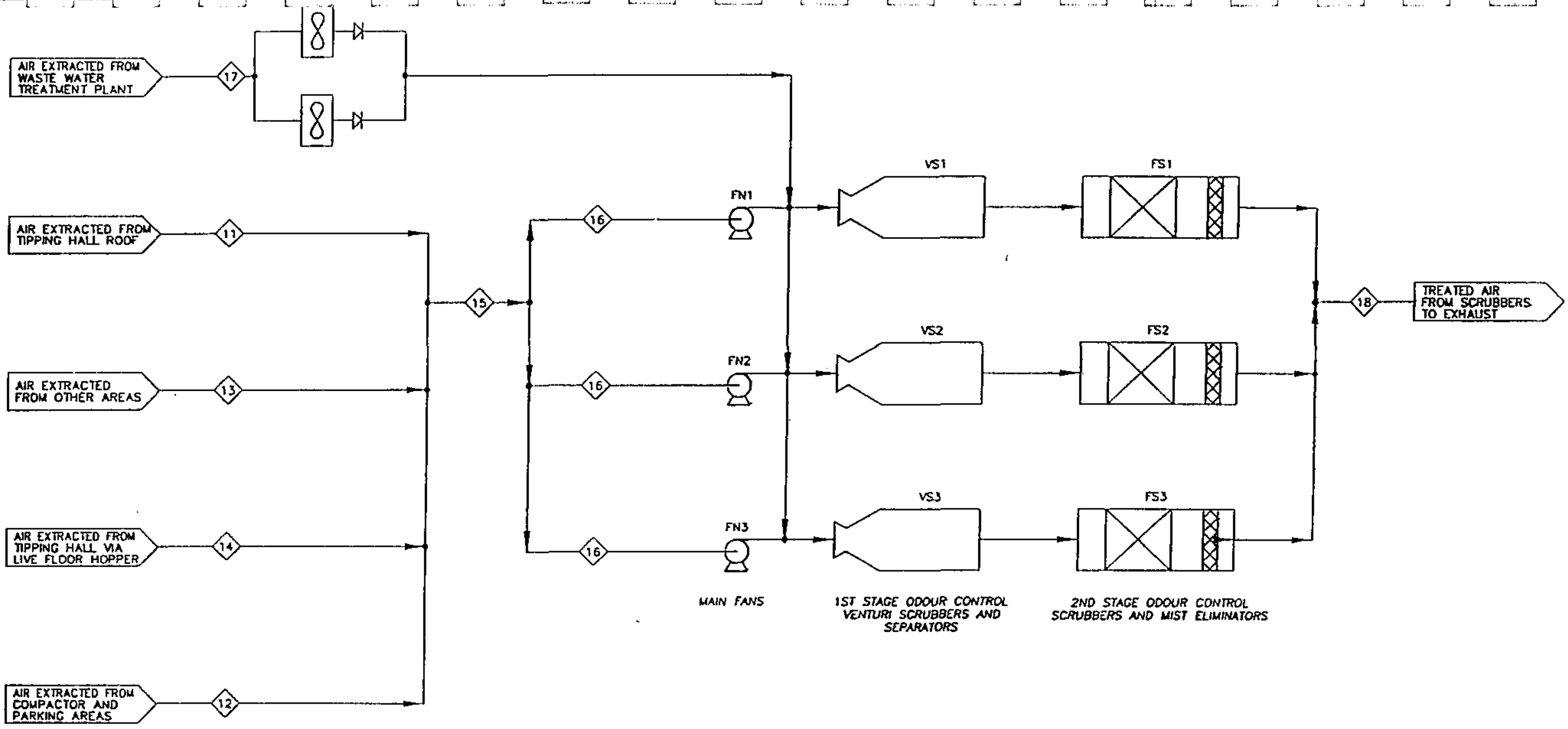
Container Tractor: 26 tonnes

QF(CO)	=	2.35 m^3/s	)
QF(NO)	=	2.85 m^3/s	) use 4.10 m^3/s
QF(Haze)	=	4.10 m^3/s	)

30 minutes Peak Traffic Flow Data

Designation	No. of vehicle	Period spent with engines on (min.)	Engine minutes (min.)	Equivalent car emitting pollutants for 30 minutes	Required fresh air for dilution
WCV Access Road	20	3	60	2	10.5 m^3/s
Tipping Hall	20	6	120	4	21.1 m^3/S
Compactor Hall	6	6	36	1.2	4.9 m^3/s
Container Access	12	0.5	6	0.2	0.8 m^3s
					37.3 m^3/s

Total Fresh Air Required



STREAM No.		11	12	13	14	15	16	17	18
STREAM DESCRIPTION		AIR EXTRACTED FROM TIPPING HALL ROOF	AIR EXTRACTED FROM COMPACTOR & PARKING AREAS	AIR EXTRACTED FROM OTHER AREAS	AIR EXTRACTED FROM TIPPING HALL VIA LIVE FLOOR HOPPERS	TOTAL AIR TO ODOUR CONTROL SYSTEM	AIR TO INDIVIDUAL FANS	AIR EXTRACTED FROM WWTP	TREATED AIR FROM SCRUBBERS EXHAUST
DESIGN SG (AIR)	MIN NORM MAX	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.0
DESIGN FLOWRATE	M^3/SEC					53	18	6	53
DESIGN PRESSURE mmWG	MIN NORM MAX	-400 -50 ATMOS	-400 -50 ATMOS	-400 -50 ATMOS	-400 -50 ATMOS	-400 -50 ATMOS	-400 -50 ATMOS	-400 -70 40	ATMOS 50 400
OPERATING TEMPERATURE °C	MIN NORM MAX	10 AMB 40	10 AMB 40	10 AMB 40	10 AMB 40	10 AMB 40	10 AMB 40	10 AMB 40	10 AMB 40
NOMINAL DUCT SIZE (I/D)	mm								

Rev	By	Description	Date
A	JWB	REVISED FOLLOWING INPUT FROM SWIRE BFI	11.07.94

Checked | Date
Drawn JWB. | Date 23/05/94
Scale NTS (A3)

RICHARD PAXTON ASSOCIATES Ltd.
Cathedral House, Beacon Street, Lichfield, WS13 7AA, England
Tel: 0543 250939 Fax: 0543 250940

Title: PROCESS FLOW DIAGRAM OF AIR ROUTES

Project: ISLAND WEST TRANSFER STN.

Client: SWIRE BFI

Drawing No. 9404/443/8110 A

APPENDIX 5 EFFLUENT HANDLING AND TREATMENT

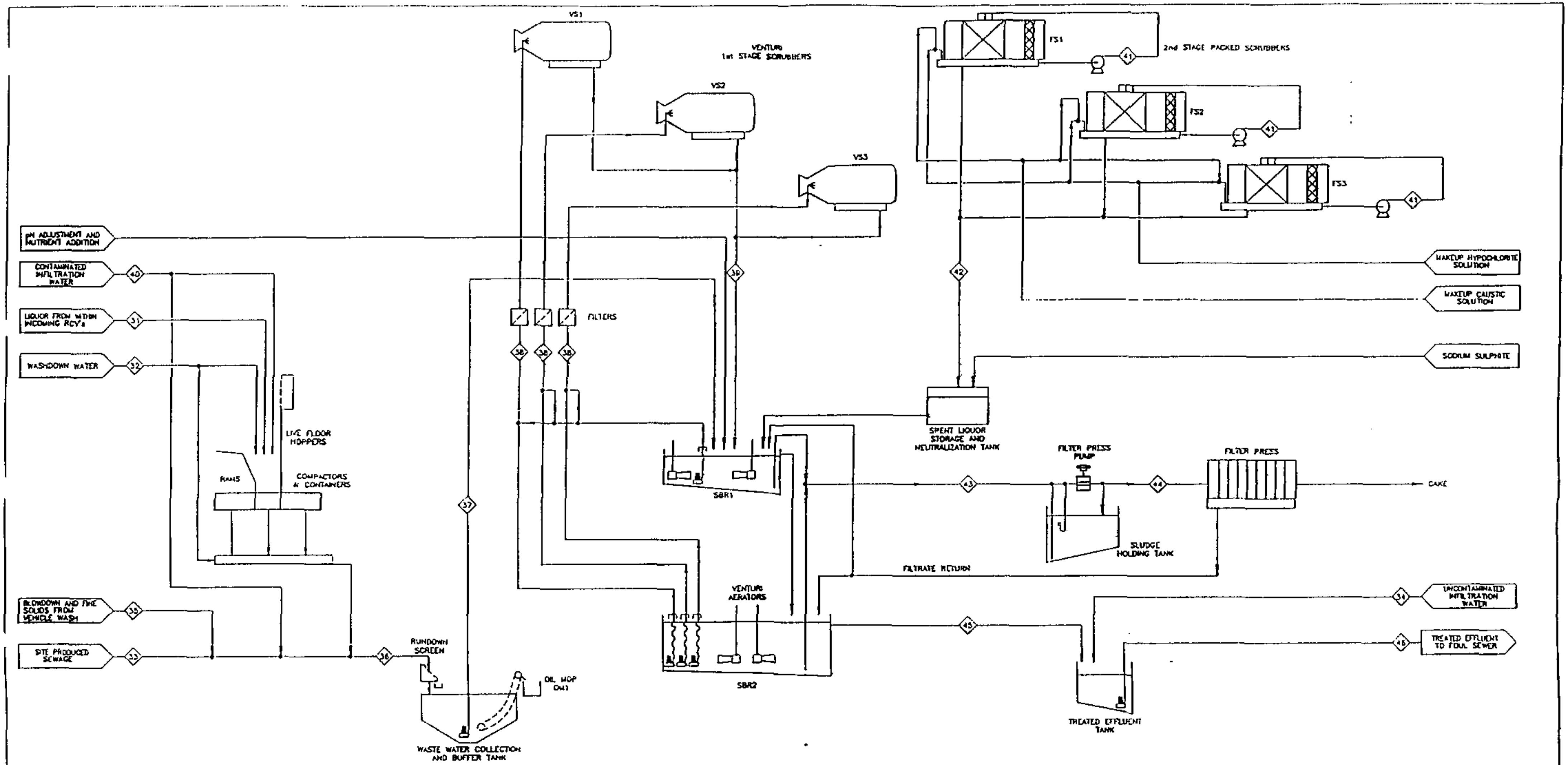
The Contractor shall provide his best estimates of the volumes and composition of drainage/effluent arising from individual sources on the Facility and when combined according to the groups specified. The wastewater treatment plant shall be described in detail, including the resulting anticipated improvement in the effluent, and the quality and discharge rate of the effluent to be disposed of. Estimates shall be provided for storm and wastewater arising from the reception areas and other facilities at the landfill sites.

A5.1 Effluent Volumes and Composition

The volumes and composition from IWTS site and WENT Reception Area are detailed in Section 4.4.

A5.2 Effluent Treatment and Disposal

The proposed methods of effluent treatment and disposal are outlined in Section 4.4. Supporting information referred to in that section is presented here.



STREAM No.		31	32	33	34	35	36	37	38
STREAM DESCRIPTION		LIQUOR FROM WITHIN INCOMING RCV's	WASHDOWN WATER	SITE PRODUCED SEWAGE	UNCONTAMINATED INFILTRATION WATER	BLOWDOWN AND FINE SOLIDS FROM VEHICLE WASH	INFLUENT TO WWCS	FEED TO SBR's	FEED TO INDIVIDUAL VENTURI SCRUBBERS
DESIGN SG (WATER)	MIN NORM MAX	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.0 1.2	1.0 1.0 1.1	1.0 1.0 1.1
pH	MIN NORM MAX	3 4-9 10	3 4-9 10	4 4-9 10	6 7 9	4 4-9 10	3 4-9 10	3 4-9 10	5 6-8 9
VISCOSITY (cP)	MIN NORM MAX	1 1-5 5	1-5 5	1 1-5 5	1 1-5 5	1 1-5 5	1 1-5 50	1 1-5 50	1 1-5 50
FLOWRATE m³/hr	MIN NORM MAX	0 5 10	0 5 10	0 2 5	0.4 0.8 1.6	0 5 5	0 5 15	0 15 15	0 100 100
PRESSURE Bar.g	MIN NORM MAX	ATMOS BY GRAVITY	ATMOS BY GRAVITY	PUMPED DISCHARGE	ATMOS BY GRAVITY	ATMOS BY GRAVITY	ATMOS BY GRAVITY	0 3 6	0 3 6
OPERATING TEMPERATURE °C	MIN NORM MAX	10 30 40	10 20 30	10 30 40	10 20 30	10 AMB 40	10 AMB 40	10 AMB 35	10 AMB 35
NOMINAL PIPE SIZE (I/D)	mm			100	100	80		80	100

STREAM No.		39	40	41	42	43	44	45	46	
STREAM DESCRIPTION		RETURN FROM VENTURI SCRUBBERS	CONTAMINATED INFILTRATION WATER	RECIRCULATED HYPOCHLORITE SOLUTION	SPENT LIQUOR	SLUDGE TO HOLDING TANK	SLUDGE TO FILTER PRESS	DECANTED LIQUOR	TREATED EFFLUENT TO FOUL SEWER	
DESIGN SG (WATER)	MIN NORM MAX	1.0 1.0 1.1	1.0 1.0 1.1	1.0 1.1 1.2	1.0 1.1 1.2	1.0 1.0 1.2	1.0 1.0 1.2	1.0 1.0 1.1	1.0 1.0 1.1	
pH	MIN NORM MAX	5 6-8 9	3 4-9 10	9 10 14	3 9 14	5 6-8 9	5 6-8 9	5 6-8 9	6 7 8	
VISCOSITY (cP)	MIN NORM MAX	1 1-5 50	1 1-5 5	1 1 5	1 1 5	0 20 250	0 20 250	1 1 5	1 1 1	
FLOWRATE m³/hr	MIN NORM MAX	0 300 300	0.1 0.2 0.4	0 140 140	0 10 30	0 10 10	0 10 10	0 80 80	0 40 40	
PRESSURE Bar.g	MIN NORM MAX	0 0 1	ATMOS BY GRAVITY	0 1 6	0 0 6	0 1 10	0 0-6 10	0 0 2	0 1 6	
OPERATING TEMPERATURE °C	MIN NORM MAX	10 AMB 35	10 AMB 35	10 AMB 35	10 AMB 35	10 AMB 40	10 AMB 40	10 AMB 40	10 AMB 40	
NOMINAL PIPE SIZE (I/D)	mm	300		150	80	80	80	150	80	

Rev	By	Description	Date

Checked	Date
Drawn JWB.	Date 24/05/94
Scale NTS	(A2)

RICHARD PAXTON ASSOCIATES Ltd.
Cathedral House, Beacon Street,
Lichfield, WS13 7AA, England
Tel: 0543 250939 Fax: 0543 250940

Title: PROCESS FLOW DIAGRAM OF LIQUID ROUTES

Project: ISLAND WEST TRANSFER STN.

Client: SWIRE BFI

Drawing No. 9404/443/B111 -

APPENDIX A TO SECTION 2/24.3

Waste Water Treatment Plant Design Memorandum

1. Raw Waste Water Characteristics:

	Worst	Typical	Units
pH	4-8	4-8	
BOD-5	12000	4800	mg/litre
COD	21600	8000	mg/litre
Suspended Solids	88	88	mg/litre
Kjeldahl nitrogen (as N)	320	160	mg/litre
Oil and Grease	1200	560	mg/litre
Flow - Effluent (as above)	40	20-40	m^3/day
- Contaminated washdown	20	0-20	m^3/day

2. Treated Product Requirements:

pH	6-10	
BOD-5 (maximum)	1000	mg/litre
COD (maximum)	2500	mg/litre
Suspended solids (maximum)	1000	mg/litre
Settleable solids (maximum)	100	mg/litre
Dissolved oxygen (minimum)	2	mg/litre
Total Nitrogen	200	mg/litre
Oil and Grease	100	mg/litre
Temperature	43	°C

3. Waste Water Collection System:

Inflow	Gravity drainage channels
Screening	Manual run down screen
opening	1 mm
screenings hopper volume	0.1 m^3
Collection sump volume	155 m^3
type	Concrete sump with sloped base
Odour control	Enclosed tank with air extraction
Transfer pumps	Duty and standby
type	Submersible centrifugal
capacity	15 m^3/hr each

4. Biological Treatment:

	SBR1	SBR2	
Type			Sequential batch reactor (SBR)
No. of units			2
Length	12m	16.5m	
Width	4.4m	5.9m	
Typ. Liquid Depth			
- high			2.5m (av.)
- maximum			3.0m (av.)
Aeration			Submerged eductor with natural air aspiration
number			2 per SBR (4 total)
Oxygen requirement:			
BOD input (maximum)			480 kg/day
aerator oxygen input (design)			30 kg/hr (total)
operating hours			16-22 hrs/day
Level control			High alarm
Treated liquor output			Timer controlled gravity flow to fixed level in reactor, into holding tank for checking before pumping to sewer
Sludge output			Batch - as required Settled solids pumped to 30m^3 holding tank Solids dewatered using filter press Filtrate returned to SBRs
Solids production			0.5-1.0 kg/kg BOD removed

APPENDIX B TO SECTION 2/24.3

B.1 Process Operation

The basic operational steps of the sequence batch reactor process are shown in Figure 1. All process steps (Fill, React, Settle and Decant) are completed in a single tank. Waste streams in a batch reactor are treated with the same unit process steps found in a conventional plant. In a conventional plant, influent feeds continuously, proceeds through a sequence of separate dedicated process tanks, and discharges continuously. In the slightly modified Sequential Batch Reactor (SBR) concept used here, the influent feeds uniformly and is treated continuously throughout the working day and then proceeds through a similar sequence of dedicated process periods (instead of tanks), and discharges periodically.

The batch process works as follows :

At the beginning of the working day, the process cycle commences. The reactor is at a fixed minimum liquid level set by the treated effluent off-take arrangement. At this level, the upper reactor is about $10m^3$ below the overflow and is being aerated as well as feeding the venturi scrubbers. It will also be receiving the return flow from the venturi scrubbers. The other is about $80m^3$ below it's normal maximum level and contains approximately $190m^3$ of settled biomass. Aeration then commences in this settled reactor, followed by the scrubber liquor being fed to the venturi scrubbers from this reactor. Influent is then added to the upper SBR in a steady sequence of small volume inputs controlled uniformly throughout the working day.

At the end of the working day (after all the cleaning down activities have been completed) the venturi scrubber liquor recirculation is re-arranged to feed from and return to the upper reactor. The venturi aerators in the lower reactor are allowed to run on using a preset time switch. Two principal modes of operation in this second reactor are available at this stage:

a) simple aeration for BOD/COD reduction
b) anoxic mixing for denitrification followed by aeration to complete BOD/COD reduction and to re-oxygenate the effluent.

Other operating modes could also be selected, but for this duty these alternatives are unlikely to be required.

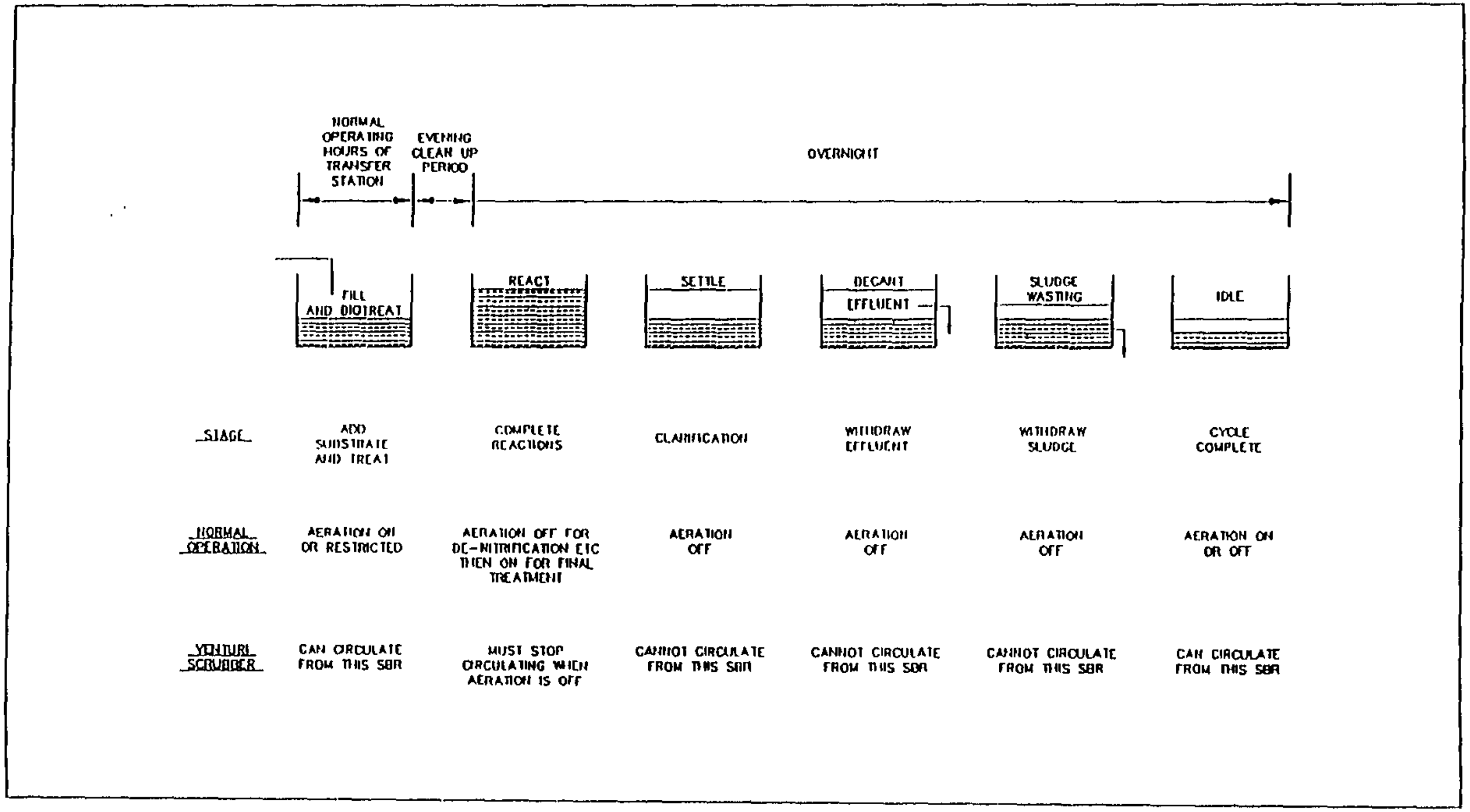


Figure 1. SBR Operating Sequence

It is expected that option (b) will rarely be required, but should experience from previous days' production indicate high nitrogen levels in the effluent then this alternative mode can be utilized. It is achieved by simply closing the valves on the air inlets to the submerged venturi aerators, which then perform as submerged jet mixers, enabling the biomass to exploit the oxygen content of the nitrate and nitrite ions for further BOD removal whilst liberating the majority of the nitrogen content as nitrogen gas.

Once adequate time has elapsed for the oxidized nitrogen content to have been reduced sufficiently, a preset timer would re-open the valves on the air inlets to the venturi aerators to allow re-aeration and final BOD reduction.

In reality, the controller sequencing system will be arranged to always operate in operating mode (b), with operating mode (a) being selected by setting the timer for the anoxic period to near zero.

After sufficient re-aeration time has elapsed a second preset timer would then shut down the aerators and a solids settlement stage would commence. During this stage, the SBR functions as a quiescent clarifier with no internal movement or fluid flow.

Approximately one hour before the next working day is due to commence, a time switch will open the decant pipe rinse-out valve followed by the arrangement for starting the decanting by gravity on the settled SBR, allowing settled supernatant to flow by gravity to the outlet buffer storage tank. At the same time, the sludge transfer pump will start (if it has been preset to do so - depending on current solids loadings) and will pump for a preset period from the lowest point in this SBR to the sludge holding tank.

The gravity flow of supernatant will flow only until the liquid level in that SBR has reached the outlet pipe level on the gravity flow pipe, or the decanting timer times out and closes the valve on the decant line, whichever is the sooner.

Thus, in summary, the SBRs will normally operate on 24 hour cycles. This cycle time is dictated by the requirements of the venturi scrubbers for scrubber fluid recirculation during all working hours of the transfer station.

The venturi scrubber water recirculation system has been designed to be able to operate satisfactorily (e.g. by re-arranging the hose outputs from the submersible pumps and relocating two of the pumps to the other SBR) even in the event of one of the SBRs being completely out of action for repair or because of biological problems. This enables many alternative modes of operation to be arranged as best suits the treatment and odour control requirements. For example:

i) 48 hour cycles so as to allow longer denitrification periods or other specialist treatment sequences.

ii) 48 hour cycles so as to enable significant periods of extended aeration to reduce biological solids production or filamentous microorganism problems without affecting the odour control capability of the venturi scrubbers. (Experience would indicate that highly active biomass is more effective in odour control than biomass undergoing extended aeration).

iii) 48 or 24 hour cycles so as to enable the different seasonal variations in the effluent quality and strength to be treated most effectively. The capability of operating with 48 hour cycles is particularly important when COD and BOD ratios are high.

To understand the full potential of the flexibility of the proposed process and its inherent robustness to varying inputs (in terms of both quality and volume) it would be useful if the following items were discussed in more detail.

B.2 Process Control

For most sewage or other biodegradable type wastes the SBR process can operate successfully within a single reactor and consistently produce a 30/30 effluent or better.

The desired operating schedule of the process equipment will be determined according to current performance, expected influent conditions and the effluent requirements. This schedule will then be programmed into the system controller which will use a simple sequencing logic using relays, timers and time clocks. In addition, several remote sensors (eg. level and flow switches) will be used to monitor and control essential safety requirements and other issues in the process.

B.3 Flow Transients

With the utilization of submerged jet aeration and fixed liquor level after decanting, the variable liquid input volumes will be easily accommodated. The reactors are designed with enough tank depth and operational flexibility to produce a satisfactory effluent. By allowing liquid level sensors to override the timed input system from the waste water collection sump, overfilling of the SBRs can be avoided. Similarly, level sensors in the waste water collection sump will be used to adjust the timed input system to the SBRs so as to ensure that under normal circumstances the sump will be empty at the end of the working day.

B.4 Shock Loads and Process Adaptability

Due to the variable nature of the acclimated biomass, the system is highly resistant to shock organic loads.

The MLSS population which develops will be inherently acclimatized and adapted to alternating anoxic and aerobic conditions, so shock organic loading should have little effect on the process. Sudden drops in dissolved oxygen or extended periods of anoxic conditions caused by shock loads are simply analogous to conditions to which the biomass should already be acclimated.

Loading variations will be handled easily by simply changing the cycle process time allotments as and when the variation is detected.

This flexibility of operation demonstrates one of the most important and fundamental advantages of the system. By basing primary unit process operation on the variable parameter of time rather than the fixed constraint of space as in conventional continuous flow activated sludge tanks, the entire SBR activated sludge process is readily variable. In minutes, an operator will be able to lengthen or shorten the aeration, settlement, or decant cycle to achieve a desired process modification. This same ability in a continuous flow system would exist only if the operator could easily vary the volume, geometry, number, or location of the aeration basins and clarifiers. This places and preserves ultimate control in the hands of the engineer and operator.

B.5 Specific Control Functions

In addition to varying cycle duration, effective process control can be exercised by varying the degree of aeration during the cycle. This will be achieved by turning off one of the two aerators in each SBR or by restricting the air flow to one or both aerators in each SBR. In addition, this action can be carried out for all or only part of the cycle, eg. restricting air input while the venturi scrubbers are working, followed by zero air for denitrification and then full aeration for rapid final treatment prior to the settle and decant stages.

By controlling the availability of dissolved oxygen and/or BOD substrate, the system can selectively discourage the growth of many filamentous organisms, achieve nitrogen and/or phosphorous removal, and maximise aeration efficiency. Submerged jet aeration provides mixing independent of aeration and thus integrates well with the entire batch concept.

Following withdrawal of effluent in the decant step, influent will be introduced and the jet mixers will initiate mixing and aeration. In situations where filamentous organisms tend to proliferate, or the benefits of nitrogen or phosphorous removal are desired, proven control strategies are available to effect the necessary remedial conditions.

Many filamentous organisms are typically "obligate aerobes" and must have oxygen to function most efficiently. In addition, their high surface area to mass ratio is highly advantageous in substrate-limited conditions. Comparative studies with conventional continuous activated sludge systems have demonstrated that filamentous organisms lose their competitive edge in the SBR while the rapid-settling facultative organisms are favoured. The historic problem of filamentous-based sludge bulking can often be eliminated or controlled in most cases by varying cycle strategies or by specific addition of essential trace elements. This is especially relevant where high-strength wastes are treated. Once again, the operating flexibility is very wide as process changes are accomplished by simple timer changes.

Under high biological loading conditions, the oxygen uptake rate is very high and the dissolved oxygen concentration can be near zero for most of the working day. This is because the waste water will be added in relatively frequent small but uniform amounts throughout the day. Under these process conditions, the aeration system has a greater oxygen driving force and is likely to operate with up to 20% more efficiency.

The normal anoxic mix following the shut down of the venturi scrubber recirculation from a SBR can accomplish any necessary biological nitrogen and phosphorous removal. In addition to nitrogen removal, this accomplishes recovery of oxygen for energy savings, and of alkalinity for maintenance of pH. The resultant reduction in aeration power requirements that should be achievable could be significant, ranging possibly up to 10 percent for the higher nitrogen content samples.

B.6 Reactor Geometry

Continuous loop reactor (CLR) flow patterns will be utilized in the proposed design for the SBR. The CLR configuration is the most energy efficient design available due to conservation of fluid mixing momentum. In addition, a synergistic effect on jet aeration efficiency occurs in the CLR because bubble rise rates are reduced. The circulating mixed liquor flow is characteristic of the CLR. The immediate dilution of influent which results is immense compared to conventional systems. The CLR hydraulic flow regime substantially augments the stability, effluent consistency and energy efficiency of the process.

B.7 Liquid/Solids Separation

Immediately following the substrate removal cycle, liquid/solids separation (clarification) will be accomplished utilizing the entire reactor for quiescent settling. After the jet mixers are shut off there will be a smooth decrease in bulk liquid velocity within the reactor. This will enhance biomass flocculation, thereby improving settlement and effluent quality.

During the settling period, no influent will enter the reactor, no effluent will be discharged and, at least for most of the period, no sludge will be wasted. Because settling occurs under these ideal quiescent conditions, the induced velocity currents which plague conventional clarifiers will be absent. In addition, the potential for short-circuiting of influent will be eliminated.

Isolation of the clarification process from influent flow rate is an essential factor in the success of batch reactor performance.

B.8 Effluent Withdrawal

Following the Settle cycle the effluent withdrawal, or Decant cycle, will begin. Control of the Decant process will be provided by the cycle times and the adjustable height arrangements on the output pipes to the buffer holding tank. Clarified supernatant will be collected through a submerged decant pipe in each SBR so as to avoid surface scum. The device will be designed to affect uniform draw-off without disturbing the settled sludge interface. When the liquid level has reached the minimum level (or if the decanting control timer times out, closing the decanting valve), the Decant cycle will end.

The minimum liquid level is based on the requirement to ensure there is sufficient space in the SBRs to allow the full receipt of a maximum days waste water production, wash down and other inputs of 80 m^3. The large volume of sludge that can also be pumped to the sludge holding tank allows for the possibility that the MLSS is in a bulked condition or that sludge wasting has been inadequate for a period of time. This "worst-case" approach provides a conservative and reliable design at a nominal additional cost for the extra tank volumes.

B.9 Solids Inventory Maintenance

Close control of biological solids inventory and sludge recycle is an essential and difficult demand on conventional continuous flow plant operators. Clarifier sludge blanket levels, underflow solids concentrations, recycle ratios, sludge wasting rates, sludge recycle and return pump operation schedules, etc., must all be monitored and evaluated continuously in a conventional continuous flow plant. In the proposed batch reactor, relatively infrequent adjustment to the rate of sludge wasting is all that will be required except under extended periods of high or very variable biological loading. All the operator must do is sample and check the MLSS and check the settled sludge interface level in the SBR prior to the next mixing and aeration sequence. Sludge wasting will then be automated quite easily as described below. There will be no underflow solids, no recycle ratios, and no return sludge pumps to consider.

Sludge wasting will normally take the form of a timed pumping phase from the settled SBR to the sludge holding tank. The tank volume is about $30m^3$ before reaching the overflow. The sludge pump is also able to pump the supernatant and any settled solids from the whole tank, or from above a selected level, back to the SBR tanks. Alternatively the supernatant, followed by the solids (or the remaining solids) can be pumped to the filter press for dewatering.

Once a decanting cycle has been completed and aeration restarted, the filter press start up, or the return of liquor to the SBR's (if solids are not to be wasted) will be an automatic timer- and logic-initiated function which would have been set up by the operator on the previous evening. In this way a relatively predictable and easily adjusted amount of solids can be wasted during each SBR sequence using a manually selected timer setting and an entirely timer- and logic-controlled mechanism and without the need for any process sensors.

Normally, sludge wasting will be completed at the end of the decant period when sludge compaction is greatest, but can be initiated at any time if it is found to be necessary. Routine rinse down of the thickening tank to prevent odorous sludges being discharged will be easily achieved from the side of the tank using the adjacent walkway.

APPENDIX C TO SECTION 2/24.3

Plant Sizing

C.1 Flow

The incoming flow rate is estimated as a maximum of 40m^3/day of all refuse derived liquids, plus washdown water etc. Normal flows of these liquors are more likely to be about 30m^3/day.

In addition to this concentrated effluent, there will be up to 10m^3 per day of slightly contaminated water resulting from cavern water infiltration, up to 20 m^3 per day from the wash down of the accessway to the tipping hall, up to about 5m^3 per day of sewage and washrooms water and up to about 5 m^3 per day of fine silts and blow down from the vehicle washing facility water recovery system.

In effect, because of its much weaker biological content, this latter group of waters will act as a dilutent.

C.2 Quality of the Concentrated Influent

Values assumed for Design :

pH	4.6
Total dissolved solids	6480 mg/l
Total suspended solids	88 mg/l
Total acidity as $CaCO_3$	2,784 mg/l
BOD5	12,000 mg/l
COD	21,600 mg/l Values
Ammonia N	96 mg/l
Kjeldahl nitrogen	320 mg/l
Total phosphorous	0.05 mg/l
Oil and Grease	1200 mg/l

These values are based on worst case input liquor analyses experience at KBTS and IETS. They represent slightly reduced strength values from those which have been accepted in the submission for STTS plus an allowance for dust.

It should be noted that on the basis of routine operating experience at KBTS and IETS, normal BODs are likely to be in the region of 2,400-6,400 mg/l. It is expected that sulphide and thus organically produced sulphate levels will be low, frequently at or below detection limits.

C.3 Oxygen Requirement

The oxygen requirement for BOD removal from the worst case effluent quality and volume

$= \frac{40 \times 12{,}000}{1000}$ $\qquad \frac{\text{volume } (m^3/d) \times \text{strength } (mg/l)}{1000 \text{ (to convert to kg/d)}}$

$= \underline{480 \text{ kg/d}}$

If aeration occurs over a minimum period of 16 hours per day, then the required oxygen transfer rate will be

$\frac{480}{16} = 30$ kg/hr $\qquad \frac{480 \text{ kg/d}}{16 \text{ hrs/d}}$

C.4 Tank Volume

BOD removal = 480 kg/d (from 24.3.5.3 above)

Typical high rate treatment volumetric loading rates range between 1.5-3.5 kg BOD/m^3 day for the biological treatment of these sorts of effluents.

For design purposes a conservative average estimate of 2.5kg BOD/m^3 day will be used. Thus the volume of aeration tanks required for the more normal 16 hours per day aeration is

$\frac{480}{2.5} \times \frac{24}{16} = 288m^3 \qquad \frac{480 \text{ kg/d}}{2.5 \text{ kg/m}^3}$ x ratio of full to only part day operation

If 2 tanks are used, one of approximately 4.4m x 12m x 2.5m average working depth and the other of approximately 5.9m x 16.5m x 2.5m average working depth, then the volume is:

132m^3 & 243m^3 per respective tank
or 375m^3 total

This represents more than the average volume necessary during the 16 hours (288 m^3) plus half of the maximum daily input (40 m^3) plus over half a day's recycle in case of out of specification quality. In practice, as noted earlier, the assumed daily input is likely to be lower, providing greater over capacity.

It is difficult to visualize a circumstance in which an SBR would be entirely out of action for more than a day or almost two. Even if one of the four aerators goes down and is not replaced immediately, hydraulic residence time is achieved using both SBR tanks and by circulating the tanks one to another using the venturi scrubber recirculation pumps fed from the lower SBR returning to the upper SBR, and overflowing back to the lower tank. In addition, the aeration capability of the venturi scrubbers as aerators has been ignored from the design calculations in order to make the design more conservative.

C.5 Sludge Production

On the basis of widely reported experience elsewhere, sludge production rates are expected to be around 0.5 - 1 kg of dry solids/kg BOD removed. Thus between:

0.5 x 480 kg BOD per day

= 240 kg per day of solids

and

1.0 x 480 kg BOD per day

= 480 kg per day of solids

of dry solids is likely to be produced per day when handling maximum design strength and volume of waste water input.

Under the normally expected conditions of about 4800mg/litre of BOD and $30m^3$ per day, it is not expected that solids production will exceed

$$0.5 \text{ kg/kg BOD} \times \frac{4800 \text{ mg/l BOD} \times 30\text{m}^3\text{/day}}{1000 \text{ (to convert to kg)}}$$

$$= 0.5 \times \frac{4800 \times 30}{1000}$$

= 72 kg per day

Dust removed from the air passing through the scrubber may add up to a further 100 kg per day (equivalent to the removal of a time weighted average of over $20mg/m^3$ of dust throughout the whole 24 hours). However, based on the experience at KBTS and IETS, it is not expected that total dust removal will exceed 50 kg per day.

In a reasonably well settled form, it is anticipated that the expected average mix of solids will achieve a 3 to 4% by weight dry solids content. Thus for normal operation of 72kg of biological solids and 50kg of dust solids, the volume of sludge to be disposed of per day will be about:

$$\frac{(72+50)}{0.035} \times \frac{1}{1000} \text{ m}^3 \text{ per day}$$

$= 3.5$ m^3 per day

C.6 Nutrient Balances

General experience with activated sludge systems shows that the required nutrient balance for conventional operation is 0.03 to 0.06 mg nitrogen and 0.007 to 0.01 mg phosphorous per mg BOD to be removed. Thus nitrogen needed for BOD reduction of the maximum strength influent is:

12,000 mg/litre of BOD x (0.03 to 0.06) mg N per mg BOD

= 360 to 720 mg/l of influent

It would therefore appear that with influent nitrogen levels of about 320 mg/litre, there may be insufficient nitrogen for good operation at high input BOD levels and nitrogen may need to be added. However, under normal circumstances nitrogen addition should not be necessary.

The phosphorous needed for BOD reduction is:

12,000 mg/litre of BOD x (0.007 to 0.01) mg P per mg BOD

= 84 to 120 mg/l of influent

Obviously the influent phosphorous levels (about 0.05 mg/l) are low and phosphorous will have to be added on a routine basis.

These calculations confirm the experience already obtained at KBTS and IETS.

C.7 Requirements for pH Adjustment

The pH of the incoming wastes is low and as a result, pH adjustment could be expected to be a general requirement. The addition of lime as $CaCO_3$ is proposed for reasons of simplicity, safety and operational reliability. The chosen design basis (¶ 24.3.5.2 above) shows an acidity of 2784 mg/litre, or 2.78 kg/cu m. Thus for full pH correction, the theoretical maximum lime usage is:

40 cu m/day x 2.78 kg/cu m = 111 kg/day

However, under normal circumstances natural biological buffering will cope with most if not all of the acidity, and inputs of less than 15 kg per day are anticipated. Again, this is confirmed by experience at KBTS and IETS. In fact, at IETS, lime input has not been necessary.

APPENDIX 6 NOISE CONTROL

The Contractor shall describe the measures to be incorporated in the works and the operation to ensure that the requirements for noise control are met.

A6.1 Construction Noise

The mitigation measures for construction noise are fully described in Section 3.2 and summarised in Appendix 1. The list of powered mechanical equipment and construction noise calculations referred to in Section 3.2 are presented in this Appendix.

A6.2 Operational Noise

During the operational period only the noise generated from the access ramp is likely to generate adverse impacts to the nearby NSRs. However, Swire BFI will install an acoustic barrier of double-skinned, lined steel cladding with 50 mm gap between the sheets which extend between the parapets. This will help ameliorate the noise generated by vehicles traversing the spiral ramp.

The construction of the cavern will itself reduce operational noise levels experienced outside IWTS. Noise escaping from the cavern via the ventilation shaft will not adversely impact on nearby NSRs.

Operatives working within the cavern will be protected from experiencing excessive noise levels by the location of noisy plant in isolated rooms.

Details of the calculation of noise from WCVs travelling on the spiral ramp during the operational phase and example of the noise calculation of containers loading/unloading and noise from the ventilation shaft are presented in this Appendix.

APPENDIX 1. Noise Levels due to Stationary Equipment

Assumptions

1 Barrier correction is added as necessary.
Partial screening = - 5 dB(A)
Total screening = - 10 dB(A)

2 Not all activities can be viewed at any NSRs

3 No ground absorption or air absorption.

4 All equipment is assumed to work simultaneously

5 Equipment will be working at six different locations

	Notional noise sources	Distance (m) NSR1	NSR2	NSR3	NSR4	NSR5
A	Ramp construction closest to the NSRs.	17	92.5	45	90	73
B	Reinforced earth wall construction	70	147.5	102.5	85	130
C	Buildings, internal roads, landscaping etc.					
	C1 for NSRs 1 to 3, C2 for NSR4	65	137.5	87.5	62.5	118
D	Ventilation fans, FS, pumps, tanks.	120	180.0	125	47.5	164
E	Barges Loading Spoil from tunnelling activity	85	165.0	127.5	115	125
F	Open Portal Cut	130	187.5	135.0	50	174
G	Haulage traffic	65	137.5	87.5	50	120

The following is the list of equipment and CNP no.
and the corresponding sound power level data.

Code	CNP No.	Equipment Name.	SWL	No. of Units	Overall SWL
1	1	Air Compressor Atlas Copco 350 cf, 250 cfm	109	3	113.8
2	101	Generator 150 kVA	108	2	111.0
3	81	Excavator Cat 325 KATO 880G	112	3	116.8
4		Dry Spraying Machine ALIVA-MEDIQ Type 246 (or equal)	109	1	109.0
5	49	Tower Crane (with 70 m boom)	95	1	95.0
6	61	Derrick Barge (2000 tonne capacity)	104	1	104.0
7		Hopper Barge (1600 tonne capacity)	104	2	107.0
8	81	Wheel Loader Cat 980F Cat 950E	112	2	115.0
9	141	Lorry	112	4	118.0
10	186	Roller (4 tonne capacity)	108	1	108.0
11	50	Compactor	105	1	105.0
12	48	Crane Lorry (17 tonne capacity)	112	1	112.0
13	48	Crawler Crane P&H BM1200 (100 tonne capacity)	112	1	112.0
14	164	Piling Equipment (assumed GRAB & CHISEL)	115	2	118.0
15		Drilling Rig (assumed like compressor)	109	1	109.0
16	81	5/8 m3 Front End Loaders	112	1	112.0
17	241	Main Ventilation Fans	108	2	111.0
18	1	750 cfm Compressor	109	1	109.0
19	101	Generator Set 500 kVA	108	1	108.0
20	81	JCB Excavator	81	1	81.0
21		Water Dowser (assumed not noisy)			
22		Barges Loading / Unloading Operation *			93.0
23	182	Crawler Drill	123	1	123.0
24	81	Front End Shovel	112	1	112.0
25	67	Dump Trucks	117	2	120.0
26	47	Shotcrete	109	1	109.0

Estimates based on measurement of loading unloading containers at the
Island East Transfer Station, August 1993.

Scenario I Notional Source	Equipment associated with Noise source	Overall SWL
A	5,	95
B	6,7	109
D	16,17,18,19,20,21	116
E	22	93
F	23,24,25,26	126
Piling	14	118

Scenario II Notional Source		
C1, C2	1,2,3,4,8,9,10,11,12,13,15	124
D	16,17,18,19,20,21	116
E	22	93

Example **Sheet**

NSRx

Scenario I Location	SPL / Distanc	Noise Levels After Distance Correction dB(A)	Noise Levels After Barrier Correcti	PNL
A	a / x	a-20*@LOG(x)-8	D5	10*@LOG(10^(E5/10)+10^(E6/10)+10^(E7/10))
B	b / y	b-20*@LOG(y)-8	D6	
D	c / z	d-20*@LOG(z)-8	D7-10	
Scenario II				
C1	d / w	c-20*@LOG(w)-8	D10	10*@LOG(10^(E10/10)+10^(E11/10))
D	e / z	d-20*@LOG(z)-8	D11-10	

Partial screening, post b. correction = post d. correction - 5 dB(A)
Total screening, post b. correction = post d. correction - 10 dB(A)

APPENDIX 2. Noise Levels due to Piling

Piling Equipment-assume GRAB & CHISEL

NSR	Overall SWL	Distance	Post D Correction	Post B Correction
NSR1	118.0	17	84.00	84.00
NSR2	118.0	92.5	67.00	67.00
NSR3	118.0	45	74.00	69.00
NSR4	118.0	90	67.00	57.00
NSR5	118.0	70	70.00	70.00

APPENDIX 3. Noise Levels due to Mobile Sources

Mobile noise sources

G Haulage traffic

	SWL	Traffic flow / hr	Flow corr.	Speed (km/hr)	Speed corr.	Distance	Distance corr.	Barrier effect due to topography	Predicted LAeq at SR
NSR1	117	8	9.03	20	-13.01	65	-18.13	-10	51.89
NSR2	117	8	9.03	20	-13.01	137.5	-21.38	-10	48.64
NSR3	117	8	9.03	20	-13.01	87.5	-19.42	-10	50.60
NSR4	117	8	9.03	20	-13.01	50	-16.99	-10	53.03
NSR5	117	8	9.03	20	-13.01	120	-20.79	-10	49.23

NSR1									
Scenario I Location		Overall SWL	Distance	D Correction	B Correction	Path difference due to topography	Predicted noise level	PNL (A+B+D+E+F+G) (07:00 - 19:00)	PNL (D+G) (19:00 - 07:00)
A (07:00 - 19:00)	Ramp construction closest to the NSRs.	95	17	-32.61	0.00	0.00	65.39	72.12	52.58
B (07:00 - 19:00)	Reinforced earth wall construction	109	70	-44.90	0.00	0.00	67.10		
D (07:00 - 07::00)	Ventilation fans, FS, pumps, tanks.	116	120	-49.58	-10.00	-15.20	44.22		
E (07:00 - 19:00)	Barges Loading Spoil from tunnelling activity	93.0	85	-46.59	0.00	0.00	49.41		
F (07:00 - 19:00)	Open Portal Cut	126	130	-50.28	-10.00	0.00	68.72		
G (07:00 - 07::00)	Haulage traffic						51.90		
								PNL (C+D+G) (07:00 - 19:00)	PNL (D+G) (19:00 - 07:00)
Scenario II									
C (07:00 - 19::00)	Buildings, internal roads, landscaping etc. C1 for NSRs 1 to 3, C2 for NSR4	124	65	-44.26	0.00	0.00	82.74	82.75	52.58
D (07:00 - 07::00)	Ventilation fans, FS, pumps, tanks.	116	120	-49.58	-10.00	-15.20	44.22		
G (07:00 - 07::00)	Haulage traffic						51.90		
E (07:00 - 19:00)	Barges Loading Spoil from tunnelling activity	93.0	85	-46.59	0.00	0.00	49.41		

NSR2										
Scenario I Location		Overall SWL	Distance	D Correction	Correction	Path difference due to topography	Predicted noise level	PNL (A+B+D+E+F+G) (07:00 - 19:00)	PNL (D+G) (19:00 - 07:00)
A (07:00 - 19:00)	Ramp construction closest to the NSRs.	95	92.5	-47.32	0.00	0.00	50.68	66.95	48.79
B (07:00 - 19:00)	Reinforced earth wall construction	109	147.5	-51.38	0.00	0.00	60.62		
D (07:00 - 07::00)	Ventilation fans, FS, pumps, tanks.	116.0	180	-53.11	-10.00	-20.80	35.09		
E (07:00 - 19:00)	Barges Loading Spoil from tunnelling activity	93.0	165.0	-52.35	0.00	0.00	43.65		
F (07:00 - 19:00)	Open Portal Cut	126	187.5	-53.46	-10.00	0.00	65.54		
G (07:00 - 07::00)	Haulage traffic						48.60		
								PNL (C+D+G) (07:00 - 19:00)	PNL (D+G) (19:00 - 07:00)
Scenario II									
C (07:00 - 19::00)	Buildings, internal roads, landscaping etc. C1 for NSRs 1 to 3, C2 for NSR4	124	137.5	-50.77	-5.00	0.00	71.23	71.27	48.79
D (07:00 - 07::00)	Ventilation fans, FS, pumps, tanks.	116.0	180	-53.11	-10.00	-20.80	35.09		
E (07:00 - 19:00)	Barges Loading Spoil from tunnelling activity	93.0	165.0	-52.35	0.00	0.00	43.65		
G (07:00 - 07::00)	Haulage traffic						48.60		

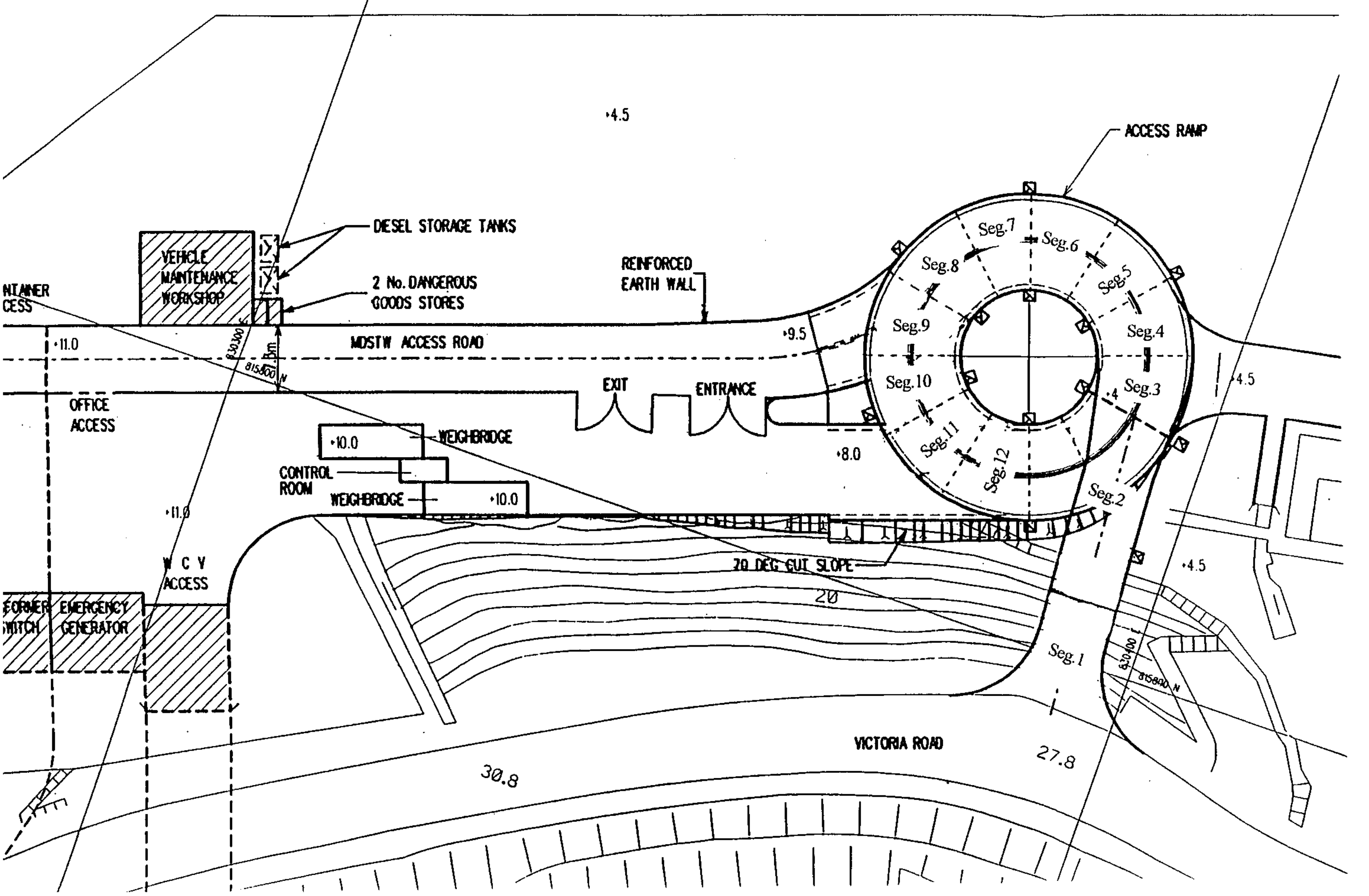
NSR3									
Scenario I Location		Overall SWL	Distance	D Correction	B Correction	Path difference due to topography	Predicted noise level	PNL (A+B+D+E+F+G) (07:00 - 19:00)	PNL (D+G) (19:00 - 07:00)
A (07:00 - 19:00)	Ramp construction closest to the NSRs.	95	45	-41.06	-5.00	0.00	51.94	68.73	50.91
B (07:00 - 19:00)	Reinforced earth wall construction	109	102.5	-48.21	-10.00	0.00	53.79		
D (07:00 - 07::00)	Ventilation fans, FS, pumps, tanks.	116	125	-49.94	-10.00	-19.70	39.36		
E (07:00 - 19:00)	Barges Loading Spoil from tunnelling activity	93.0	127.5	-50.11	0.00	0.00	45.89		
F (07:00 - 19:00)	Open Portal Cut	126	135	-50.61	-10.00	0.00	68.39		
G (07:00 - 07::00)	Haulage traffic						50.60		
Scenario II								PNL (C+D+G) (07:00 - 19:00)	PNL (D+G) (19:00 - 07:00)
C (07:00 - 19::00)	Buildings, internal roads, landscaping etc. C1 for NSRs 1 to 3, C2 for NSR4	124	87.5	-46.84	-5.00	0.00	75.16	75.18	50.91
D (07:00 - 07::00)	Ventilation fans, FS, pumps, tanks.	116.0	125	-49.94	-10.00	-19.70	39.36		
E (07:00 - 19:00)	Barges Loading Spoil from tunnelling activity	93.0	127.5	-50.11	0.00	0.00	45.89		
G (07:00 - 07::00)	Haulage traffic						50.60		

NSR4

Scenario I Location		Overall SWL	Distance	D Correction	B Correction	Path difference due to topography	Predicted noise level	PNL (A+B+D+E+F+G) (07:00 - 19:00)	PNL (D+G) (19:00 - 07:00)
A (07:00 - 19:00)	Ramp construction closest to the NSRs.	95	90	-47.08	-10.00	0.00	40.92	77.34	54.93
B (07:00 - 19:00)	Reinforced earth wall construction	109	85	-46.59	0.00	0.00	65.41		
D (07:00 - 07::00)	Ventilation fans, FS, pumps, tanks.	116	47.5	-41.53	-10.00	-17.00	50.47		
E (07:00 - 19:00)	Barges Loading Spoil from tunnelling activity	93.0	115	-49.21	0.00	0.00	46.79		
F (07:00 - 19:00)	Open Portal Cut	126	50	-41.98	-10.00	0.00	77.02		
G (07:00 - 07::00)	Haulage traffic						53.00		
Scenario II								PNL (C+D+G) (07:00 - 19:00)	PNL (D+G) (19:00 - 07:00)
C (07:00 - 19::00)	Buildings, internal roads, landscaping etc. C1 for NSRs 1 to 3, C2 for NSR4	124	62.5	-43.92	-5.00	0.00	78.08	78.11	54.93
D (07:00 - 07::00)	Ventilation fans, FS, pumps, tanks.	116	47.5	-41.53	-10.00	-17.00	50.47		
E (07:00 - 19:00)	Barges Loading Spoil from tunnelling activity	93.0	115	-49.21	0.00	0.00	46.79		
G (07:00 - 07::00)	Haulage traffic						53.00		

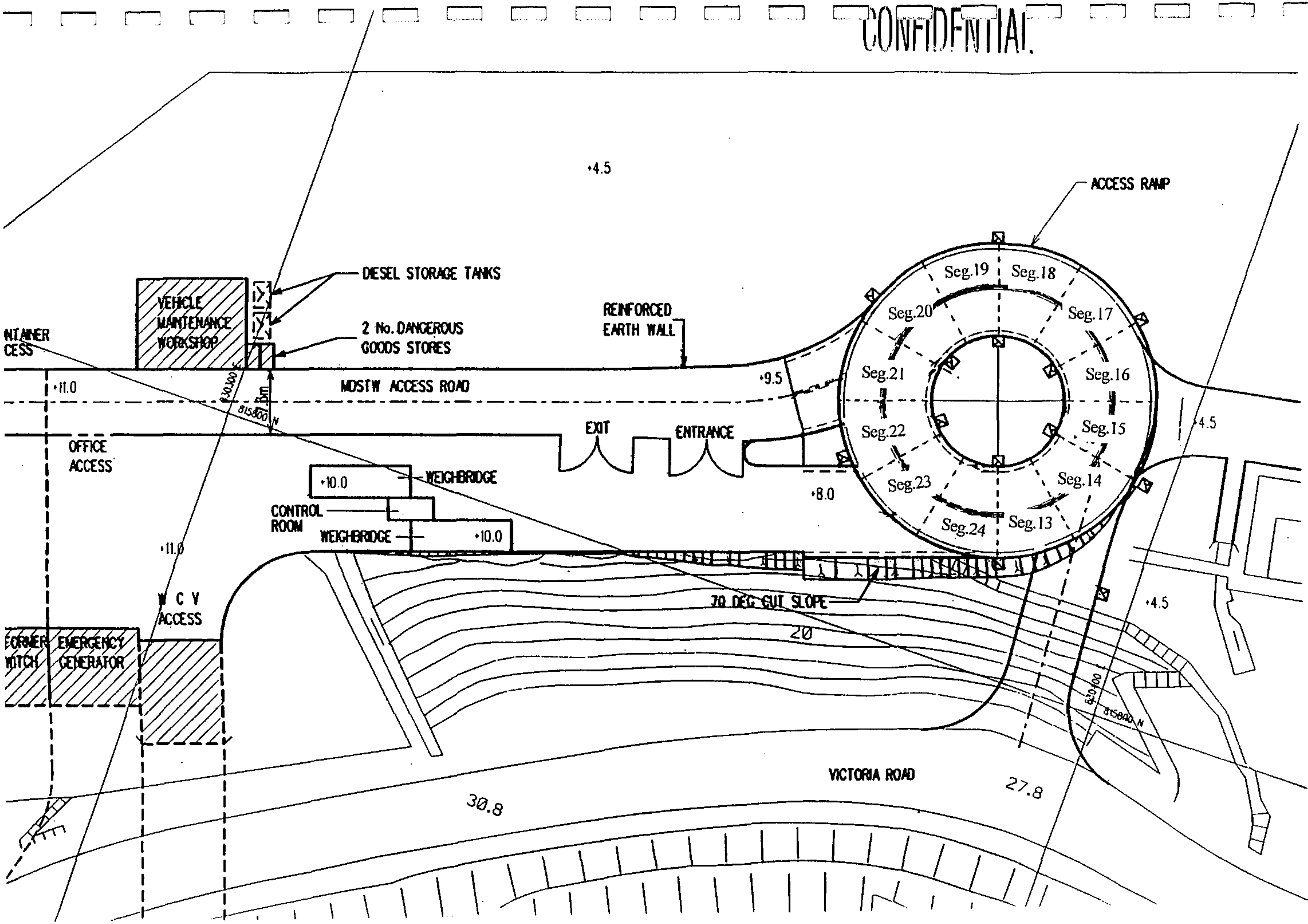
NSR5

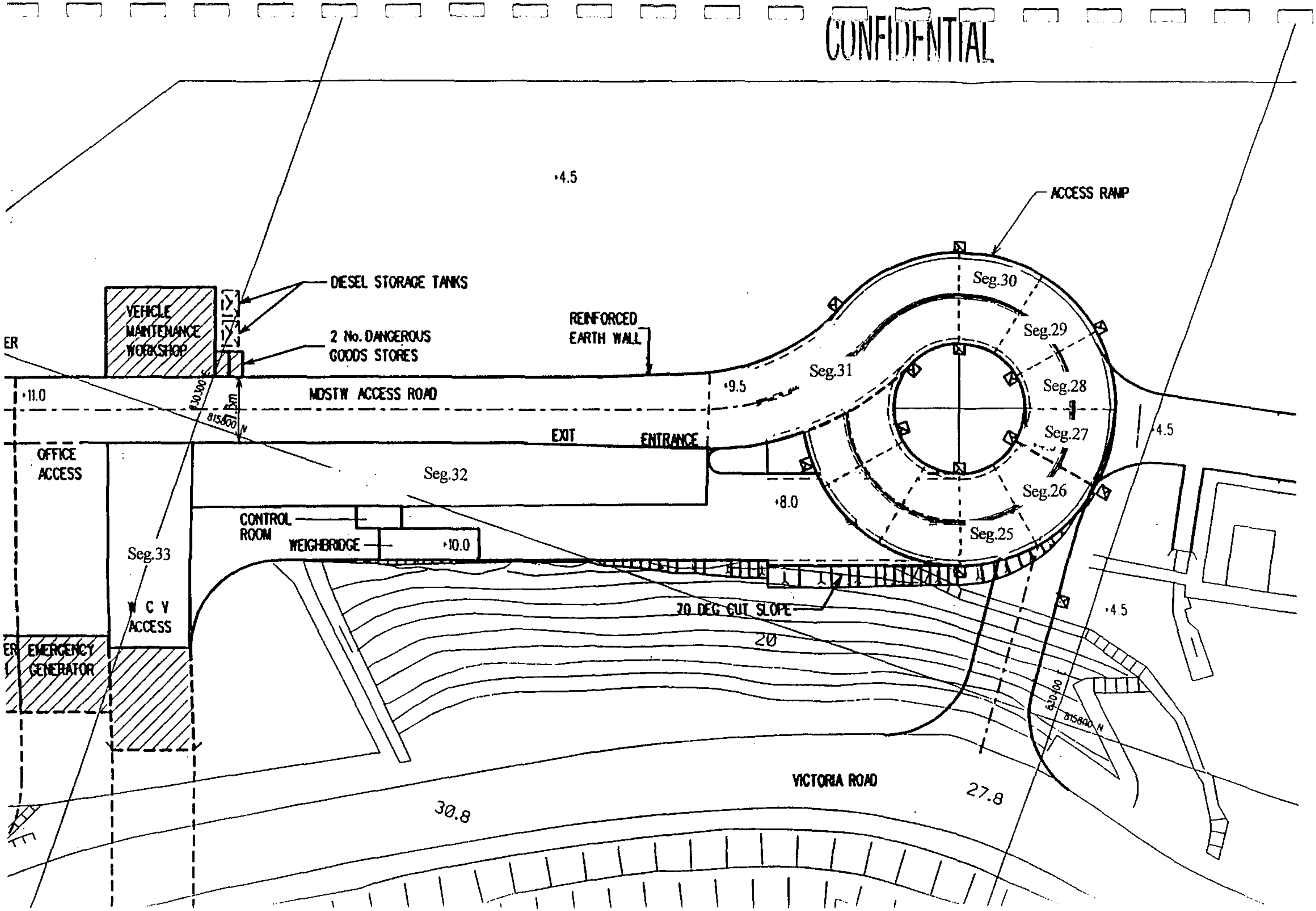
Scenario I Location		Overall SWL	Distance	D Correction	B Correction	Path difference due to topography	Predicted noise level	PNL (A+B+D+E+F+G) (07:00 - 19:00)	PNL (D+G) (19:00 - 07:00)
A (07:00 - 19:00)	Ramp construction closest to the NSRs.	95	73	-45.27	0.00	0.00	52.73	67.76	49.88
B (07:00 - 19:00)	Reinforced earth wall construction	109	130	-50.28	0.00	0.00	61.72		
D (07:00 - 07::00)	Ventilation fans, FS, pumps, tanks.	116	164	-52.30	-10.00	-15.20	41.50		
E (07:00 - 19:00)	Barges Loading Spoil from tunnelling activity	93.0	125	-49.94	0.00	0.00	46.06		
F (07:00 - 19:00)	Open Portal Cut	126	174	-52.81	-10.00	0.00	66.19		
G (07:00 - 07::00)	Haulage traffic						49.20		
								PNL (C+D+G) (07:00 - 19:00)	PNL (D+G) (19:00 - 07:00)
Scenario II									
C (07:00 - 19::00)	Buildings, internal roads, landscaping etc. C1 for NSRs 1 to 3, C2 for NSR4	124	118	-49.44	0.00	0.00	77.56	77.57	49.88
D (07:00 - 07::00)	Ventilation fans, FS, pumps, tanks.	116	164	-52.30	-10.00	-15.20	41.50		
E (07:00 - 19:00)	Barges Loading Spoil from tunnelling activity	93.0	125	-49.94	0.00	0.00	46.06		
G (07:00 - 07::00)	Haulage traffic						49.20		



+4.5
ACCESS RAMP
DIESEL STORAGE TANKS
VEHICLE MAINTENANCE WORKSHOP
2 No. DANGEROUS GOODS STORES
REINFORCED EARTH WALL
NTAINER CESS
+11.0
MDSTW ACCESS ROAD
+9.5
830300 E
815600 N
8m
OFFICE ACCESS
EXIT
ENTRANCE
+10.0
WEIGHBRIDGE
CONTROL ROOM
WEIGHBRIDGE
+10.0
+8.0
+11.0
Seg.1
Seg.2
Seg.3
Seg.4
Seg.5
Seg.6
Seg.7
Seg.8
Seg.9
Seg.10
Seg.11
Seg.12
+4.5
+4.5
70 DEG CUT SLOPE
20
W C Y ACCESS
FORMER SWITCH
EMERGENCY GENERATOR
830400 E
815800 N
VICTORIA ROAD
30.8
27.8

CONFIDENTIAL





CONFIDENTIAL
+4.5
ACCESS RAMP
DIESEL STORAGE TANKS
VEHICLE MAINTENANCE WORKSHOP
2 No. DANGEROUS GOODS STORES
REINFORCED EARTH WALL
Seg.30
Seg.29
Seg.31
Seg.28
Seg.27
Seg.26
Seg.25
Seg.32
Seg.33
ER
+11.0
830300 E
815800 N
MOSTW ACCESS ROAD
+9.5
4.5
EXIT
ENTRANCE
OFFICE ACCESS
+8.0
CONTROL ROOM
WEIGHBRIDGE
+10.0
W C V ACCESS
70 DEG CUT SLOPE
+4.5
20
EMERGENCY GENERATOR
830300
815800 N
VICTORIA ROAD
27.8
30.8

NSR1 2/F

02-Oct-96

Segment	Segment Length	Travelling Time sec.	Source SWL	Total No. of RCV	Leq(30 min) SWL	Distance to NSR	Vert. Dist. to NSR	Slant dist. to NSR	Estimated Path Difference	Para./barr. Correction	Predicted SPL dB(A)	TOTAL SPL dB(A)
1	12.0	2.9	112.0	34.0	99.4	30.0	15.7	33.9	1.89	-20.5	43.2	
2	20.0	4.8	112.0	34.0	101.6	18.0	15.0	23.4	1.81	-20.3	48.8	49.9
3	6.8	1.6	112.0	34.0	96.9	17.0	14.1	22.1	1.71	-20.1	44.9	51.1
4	6.8	1.6	112.0	34.0	96.9	22.0	13.7	25.9	3.18	-22.7	40.9	51.5
5	6.8	1.6	112.0	34.0	96.9	29.0	13.2	31.9	4.08	-23.8	38.0	51.7
6	6.8	1.6	112.0	34.0	96.9	37.0	12.8	39.1	5.07	-24.7	35.3	51.8
7	6.8	1.6	112.0	34.0	96.9	39.0	12.3	40.9	6.04	-25.0	34.7	51.8
12	6.8	1.6	112.0	34.0	96.9	32.0	9.6	33.4	4.28	-24.0	37.4	52.0
13	6.8	1.6	112.0	34.0	96.9	25.0	9.2	26.7	4.72	-24.4	38.9	52.2
14	6.8	1.6	112.0	34.0	96.9	18.0	8.7	20.0	5.62	-25.0	40.9	52.5
15	6.8	1.6	112.0	34.0	96.9	17.0	8.2	18.9	5.35	-25.0	41.4	52.8
16	6.8	1.6	112.0	34.0	96.9	22.0	7.6	23.3	7.24	-25.0	39.5	53.0
17	6.8	1.6	112.0	34.0	96.9	29.0	7.1	29.9	7.72	-25.0	37.4	53.2
18	6.8	1.6	112.0	34.0	96.9	37.0	6.1	37.5	8.08	-25.0	35.4	53.2
19	6.8	1.6	112.0	34.0	96.9	39.0	5.5	39.4	8.37	-25.0	35.0	53.3
24	6.8	1.6	112.0	34.0	96.9	32.0	3.4	32.2	13.11	-25.0	36.7	53.4
25	6.8	1.6	112.0	34.0	96.9	25.0	2.8	25.2	16.48	-25.0	38.9	53.5
26	6.8	1.6	112.0	34.0	96.9	18.0	2.3	18.1	17.36	-25.0	41.7	53.8
27	6.8	1.6	112.0	34.0	96.9	17.0	1.8	17.1	16.35	-25.0	42.2	54.1
28	6.8	1.6	112.0	34.0	96.9	22.0	1.2	22.0	19.56	-25.0	40.0	54.3
29	6.8	1.6	112.0	34.0	96.9	29.0	0.7	29.0	18.57	-25.0	37.6	54.4
30	6.8	1.6	112.0	34.0	96.9	37.0	-0.3	37.0	17.18	-25.0	35.5	54.4
31	6.8	1.6	112.0	34.0	96.9	39.0	-0.9	39.0	10.40	-25.0	35.1	54.5
32	73.0	17.5	112.0	34.0	107.2	80.0	-2.0	80.0	5.82	-25.0	39.1	54.6
33	10.0	2.4	112.0	34.0	98.6	117.0	-1.0	117.0	4.68	-24.4	27.8	54.6

NSR2 G/F

02-Oct-96

Segment	Segment Length	Travelling Time sec.	Source SWL	Total No. of RCV	Leq(30 min) SWL	Distance to NSR	Vert. Dist. to NSR	Slant dist. to NSR	Estimated Path Difference	Para./barr. Correction	Predicted SPL dB(A)	TOTAL SPL dB(A)
1	12.0	2.9	112.0	34.0	99.4	93.0	2.3	93.0	0.06	-8.1	46.9	
2	20.0	4.8	112.0	34.0	101.6	101.0	3.0	101.0	0.05	-7.8	48.7	50.9
3	6.8	1.6	112.0	34.0	96.9	103.0	3.9	103.1	0.05	-7.5	44.1	51.7
4	6.8	1.6	112.0	34.0	96.9	108.0	4.3	108.1	0.08	-8.8	42.4	52.2
5	6.8	1.6	112.0	34.0	96.9	114.0	4.8	114.1	0.06	-8.3	42.5	52.6
6	6.8	1.6	112.0	34.0	96.9	120.0	5.2	120.1	0.06	-8.2	42.1	53.0
7	6.8	1.6	112.0	34.0	96.9	124.0	5.8	124.1	0.16	-11.0	39.0	53.2
8	6.8	1.6	112.0	34.0	96.9	125.0	6.3	125.2	0.25	-12.5	37.4	53.3
9	6.8	1.6	112.0	34.0	96.9	123.0	6.8	123.2	0.60	-15.8	34.3	53.3
10	6.8	1.6	112.0	34.0	96.9	120.0	7.4	120.2	0.84	-17.2	33.1	53.4
11	6.8	1.6	112.0	34.0	96.9	116.0	7.9	116.3	1.27	-18.9	31.7	53.4
12	6.8	1.6	112.0	34.0	96.9	110.0	8.4	110.3	2.54	-21.8	29.3	53.4
13	6.8	1.6	112.0	34.0	96.9	102.0	8.8	102.4	0.63	-15.9	35.7	53.5
31	6.8	1.6	112.0	34.0	96.9	128.0	17.5	129.2	2.89	-22.3	27.3	53.5
32	73.0	17.5	112.0	34.0	107.2	153.0	19.5	154.2	2.20	-21.2	37.3	53.6
33	10.0	2.4	112.0	34.0	98.6	185.0	18.5	185.9	1.44	-19.4	28.8	53.6

NSR3 G/F

02-Oct-96

Segment	Segment Length	Travelling Time sec.	Source SWL	Total No. of RCV	Leq(30 min) SWL	Distance to NSR	Vert. Dist. to NSR	Slant dist. to NSR	Estimated Path Difference	Para./barr. Correction	Predicted SPL dB(A)	TOTAL SPL dB(A)
1	12.0	2.9	112.0	34.0	99.4	50.0	5.3	50.3	0.27	-12.8	47.5	
2	20.0	4.8	112.0	34.0	101.6	63.0	6.0	63.3	0.28	-12.8	47.7	50.6
3	6.8	1.6	112.0	34.0	96.9	76.0	6.9	76.3	0.28	-12.9	41.3	51.1
4	6.8	1.6	112.0	34.0	96.9	82.0	7.3	82.3	0.29	-12.9	40.6	51.5
5	6.8	1.6	112.0	34.0	96.9	87.0	7.8	87.3	0.28	-12.9	40.2	51.8
6	6.8	1.6	112.0	34.0	96.9	90.0	8.2	90.4	0.28	-12.9	39.9	52.1
7	6.8	1.6	112.0	34.0	96.9	92.0	8.8	92.4	0.28	-12.8	39.7	52.3
8	6.8	1.6	112.0	34.0	96.9	90.0	9.3	90.5	0.32	-13.4	39.4	52.5
9	6.8	1.6	112.0	34.0	96.9	87.0	9.8	87.6	0.48	-14.9	38.1	52.7
10	6.8	1.6	112.0	34.0	96.9	83.0	10.4	83.6	0.52	-15.2	38.2	52.8
11	6.8	1.6	112.0	34.0	96.9	77.0	10.9	77.8	0.65	-16.1	38.0	53.0
12	6.8	1.6	112.0	34.0	96.9	70.0	11.4	70.9	1.28	-18.9	36.0	53.1
13	6.8	1.6	112.0	34.0	96.9	70.0	11.8	71.0	0.27	-12.7	42.2	53.4
31	6.8	1.6	112.0	34.0	96.9	87.0	22.0	89.7	1.57	-19.7	33.1	53.4
32	73.0	17.5	112.0	34.0	107.2	101.0	23.0	103.6	3.35	-23.0	38.9	53.6
33	10.0	2.4	112.0	34.0	98.6	127.0	22.0	128.9	4.34	-24.1	27.3	53.6

NSR4 G/F

02-Oct-96

Segment	Segment Length	Travelling Time sec.	Source SWL	Total No. of RCV	Leq(30 min) SWL	Distance to NSR	Vert. Dist. to NSR	Slant dist. to NSR	Estimated Path Difference	Para./barr. Correction	Predicted SPL dB(A)	TOTAL SPL dB(A)
1	12.0	2.9	112.0	34.0	99.4	42.0	13.8	44.2	0.63	-16.0	45.4	
2	20.0	4.8	112.0	34.0	101.6	58.0	14.5	59.8	0.62	-15.9	45.1	48.3
3	6.8	1.6	112.0	34.0	96.9	70.0	15.4	71.7	0.62	-15.9	38.8	48.7
4	6.8	1.6	112.0	34.0	96.9	75.0	15.8	76.7	0.63	-16.0	38.2	49.1
5	6.8	1.6	112.0	34.0	96.9	80.0	16.3	81.6	0.64	-16.0	37.6	49.4
6	6.8	1.6	112.0	34.0	96.9	82.0	16.7	83.7	0.67	-16.2	37.2	49.7
7	6.8	1.6	112.0	34.0	96.9	82.0	17.3	83.8	0.70	-16.4	37.0	49.9
8	6.8	1.6	112.0	34.0	96.9	79.0	17.8	81.0	0.75	-16.7	37.0	50.1
9	6.8	1.6	112.0	34.0	96.9	75.0	18.3	77.2	0.79	-16.9	37.3	50.3
10	6.8	1.6	112.0	34.0	96.9	69.0	18.9	71.5	0.81	-17.0	37.8	50.6
11	6.8	1.6	112.0	34.0	96.9	62.0	19.4	65.0	0.82	-17.0	38.6	50.8
12	6.8	1.6	112.0	34.0	96.9	58.0	19.9	61.3	0.79	-16.9	39.2	51.1
13	6.8	1.6	112.0	34.0	96.9	58.0	20.3	61.4	0.79	-16.9	39.2	51.4
31	6.8	1.6	112.0	34.0	96.9	72.0	30.0	78.0	1.10	-18.2	35.8	51.5
32	73.0	17.5	112.0	34.0	107.2	63.0	31.0	70.2	0.76	-16.8	48.5	53.3
33	10.0	2.4	112.0	34.0	98.6	57.0	30.0	64.4	0.49	-15.0	42.4	53.6

Segment	Segment Length	Travelling Time sec.	Source SWL	Total No. of RCV	Leq(30 min) SWL	Distance to NSR	Vert. Dist. to NSR	Slant dist. to NSR	Estimated Path Difference	Para./barr. Correction	Predicted SPL dB(A)	TOTAL SPL dB(A)
1	12.0	2.9	112.0	34.0	99.4	75.0	1.3	75.0	0.07	-8.5	48.4	
2	20.0	4.8	112.0	34.0	101.6	75.0	2.0	75.0	0.07	-8.5	50.6	52.6
3	6.8	1.6	112.0	34.0	96.9	75.0	2.9	75.1	0.07	-8.5	45.9	53.4
4	6.8	1.6	112.0	34.0	96.9	79.0	3.3	79.1	0.07	-8.5	45.4	54.1
5	6.8	1.6	112.0	34.0	96.9	85.0	3.8	85.1	0.06	-8.1	45.2	54.6
6	6.8	1.6	112.0	34.0	96.9	93.0	4.2	93.1	0.05	-7.7	44.8	55.0
7	6.8	1.6	112.0	34.0	96.9	97.0	4.7	97.1	0.05	-7.7	44.4	55.4
12	6.8	1.6	112.0	34.0	96.9	90.0	7.2	90.3	0.05	-7.7	45.1	55.8
13	6.8	1.6	112.0	34.0	96.9	82.0	7.8	82.4	0.05	-7.7	45.9	56.2
14	6.8	1.6	112.0	34.0	96.9	76.0	8.3	76.5	1.85	-20.4	33.8	56.2
15	6.8	1.6	112.0	34.0	96.9	75.0	8.8	75.5	1.85	-20.4	33.9	56.3
16	6.8	1.6	112.0	34.0	96.9	79.0	9.4	79.6	1.85	-20.4	33.4	56.3
17	6.8	1.6	112.0	34.0	96.9	85.0	9.9	85.6	0.06	-8.1	45.1	56.6
18	6.8	1.6	112.0	34.0	96.9	93.0	10.9	93.6	0.05	-7.7	44.7	56.9
19	6.8	1.6	112.0	34.0	96.9	97.0	11.5	97.7	0.05	-7.7	44.4	57.1
24	6.8	1.6	112.0	34.0	96.9	90.0	13.6	91.0	0.05	-7.7	45.0	57.4
25	6.8	1.6	112.0	34.0	96.9	82.0	14.2	83.2	0.05	-7.7	45.8	57.7
26	6.8	1.6	112.0	34.0	96.9	76.0	14.7	77.4	1.85	-20.4	33.7	57.7
27	6.8	1.6	112.0	34.0	96.9	75.0	15.2	76.5	1.85	-20.4	33.8	57.7
28	6.8	1.6	112.0	34.0	96.9	79.0	15.8	80.6	1.85	-20.4	33.3	57.7
29	6.8	1.6	112.0	34.0	96.9	85.0	16.3	86.5	0.06	-8.1	45.0	57.9
30	6.8	1.6	112.0	34.0	96.9	93.0	17.3	94.6	0.05	-7.7	44.7	58.1
31	6.8	1.6	112.0	34.0	96.9	97.0	17.9	98.6	0.07	-8.5	43.5	58.3
32	73.0	17.5	112.0	34.0	107.2	137.0	18.7	138.3	1.16	-18.5	40.9	58.4
33	10.0	2.4	112.0	34.0	98.6	172.0	18.0	172.9	0.38	-14.0	34.8	58.4

SERENE COURT 12/F

02-Oct-96

Segment	Segment Length	Travelling Time sec.	Source SWL	Total No. of RCV	Leq(30 min) SWL	Distance to NSR	Vert. Dist. to NSR	Slant dist. to NSR	Estimated Path Difference	Para./barr. Correction	Predicted SPL dB(A)	TOTAL SPL dB(A)
1	12.0	2.9	112.0	34.0	99.4	75.0	29.3	80.5	0.13	0.0	56.2	
2	20.0	4.8	112.0	34.0	101.6	75.0	30.0	80.8	0.13	0.0	58.4	60.5
3	6.8	1.6	112.0	34.0	96.9	75.0	30.9	81.1	0.13	0.0	53.7	61.3
4	6.8	1.6	112.0	34.0	96.9	79.0	31.3	85.0	0.13	0.0	53.3	61.9
5	6.8	1.6	112.0	34.0	96.9	85.0	31.8	90.7	0.13	0.0	52.7	62.4
6	6.8	1.6	112.0	34.0	96.9	93.0	32.2	98.4	0.13	0.0	52.0	62.8
7	6.8	1.6	112.0	34.0	96.9	97.0	32.7	102.4	0.13	0.0	51.7	63.1
12	6.8	1.6	112.0	34.0	96.9	90.0	35.2	96.7	0.00	-4.8	47.4	63.2
13	6.8	1.6	112.0	34.0	96.9	82.0	35.8	89.5	0.00	-4.8	48.1	63.4
14	6.8	1.6	112.0	34.0	96.9	76.0	36.3	84.2	1.85	-20.4	32.9	63.4
15	6.8	1.6	112.0	34.0	96.9	75.0	36.8	83.6	1.85	-20.4	33.0	63.4
16	6.8	1.6	112.0	34.0	96.9	79.0	37.4	87.4	1.85	-20.4	32.6	63.4
17	6.8	1.6	112.0	34.0	96.9	85.0	37.9	93.1	0.00	-4.8	47.7	63.5
18	6.8	1.6	112.0	34.0	96.9	93.0	38.9	100.8	0.00	-4.8	47.0	63.6
19	6.8	1.6	112.0	34.0	96.9	97.0	39.5	104.7	0.00	-4.8	46.7	63.7
24	6.8	1.6	112.0	34.0	96.9	90.0	41.6	99.2	0.00	-4.8	47.2	63.8
25	6.8	1.6	112.0	34.0	96.9	82.0	42.2	92.2	0.00	-4.8	47.8	63.9
26	6.8	1.6	112.0	34.0	96.9	76.0	42.7	87.2	1.85	-20.4	32.6	63.9
27	6.8	1.6	112.0	34.0	96.9	75.0	43.2	86.6	1.85	-20.4	32.7	63.9
28	6.8	1.6	112.0	34.0	96.9	79.0	43.8	90.3	1.85	-20.4	32.3	63.9
29	6.8	1.6	112.0	34.0	96.9	85.0	44.3	95.8	0.00	-4.8	47.5	64.0
30	6.8	1.6	112.0	34.0	96.9	93.0	45.3	103.5	0.00	-4.8	46.8	64.1
31	6.8	1.6	112.0	34.0	96.9	97.0	45.9	107.3	0.00	-4.8	46.5	64.2
32	73.0	17.5	112.0	34.0	107.2	137.0	46.7	144.7	0.03	0.0	59.0	65.3
33	10.0	2.4	112.0	34.0	98.6	172.0	46.0	178.0	N/A	0.0	48.6	65.4

Segment	Segment Length	Travelling Time sec.	Source SWL	Total No. of RCV	Leq(30 min) SWL	Distance to NSR	Vert. Dist. to NSR	Slant dist. to NSR	Estimated Path Difference	Para./barr. Correction	Predicted SPL dB(A)	TOTAL SPL dB(A)
1	12.0	2.9	112.0	34.0	99.4	75.0	34.9	82.7	N/A	0.0	56.0	
2	20.0	4.8	112.0	34.0	101.6	75.0	35.6	83.0	N/A	0.0	58.2	60.2
3	6.8	1.6	112.0	34.0	96.9	75.0	36.5	83.4	N/A	0.0	53.4	61.1
4	6.8	1.6	112.0	34.0	96.9	79.0	36.9	87.2	N/A	0.0	53.0	61.7
5	6.8	1.6	112.0	34.0	96.9	85.0	37.4	92.9	N/A	0.0	52.5	62.2
6	6.8	1.6	112.0	34.0	96.9	93.0	37.8	100.4	N/A	0.0	51.9	62.6
7	6.8	1.6	112.0	34.0	96.9	97.0	38.3	104.3	N/A	0.0	51.5	62.9
12	6.8	1.6	112.0	34.0	96.9	90.0	40.8	98.8	0.00	-4.8	47.2	63.0
13	6.8	1.6	112.0	34.0	96.9	82.0	41.4	91.8	0.00	-4.8	47.9	63.2
14	6.8	1.6	112.0	34.0	96.9	76.0	41.9	86.8	1.85	-20.4	32.7	63.2
15	6.8	1.6	112.0	34.0	96.9	75.0	42.4	86.2	1.85	-20.4	32.7	63.2
16	6.8	1.6	112.0	34.0	96.9	79.0	43.0	89.9	1.85	-20.4	32.4	63.2
17	6.8	1.6	112.0	34.0	96.9	85.0	43.5	95.5	0.00	-4.8	47.5	63.3
18	6.8	1.6	112.0	34.0	96.9	93.0	44.5	103.1	0.00	-4.8	46.9	63.4
19	6.8	1.6	112.0	34.0	96.9	97.0	45.1	107.0	0.00	-4.8	46.5	63.5
24	6.8	1.6	112.0	34.0	96.9	90.0	47.2	101.6	0.00	-4.8	47.0	63.6
25	6.8	1.6	112.0	34.0	96.9	82.0	47.8	94.9	0.00	-4.8	47.6	63.7
26	6.8	1.6	112.0	34.0	96.9	76.0	48.3	90.0	1.85	-20.4	32.4	63.7
27	6.8	1.6	112.0	34.0	96.9	75.0	48.8	89.5	1.85	-20.4	32.4	63.7
28	6.8	1.6	112.0	34.0	96.9	79.0	49.4	93.2	1.85	-20.4	32.1	63.7
29	6.8	1.6	112.0	34.0	96.9	85.0	49.9	98.6	0.00	-4.8	47.2	63.8
30	6.8	1.6	112.0	34.0	96.9	93.0	50.9	106.0	0.00	-4.8	46.6	63.9
31	6.8	1.6	112.0	34.0	96.9	97.0	51.5	109.8	0.00	-4.8	46.3	63.9
32	73.0	17.5	112.0	34.0	107.2	137.0	52.3	146.6	N/A	0.0	58.9	65.1
33	10.0	2.4	112.0	34.0	98.6	172.0	51.6	179.6	N/A	0.0	48.5	65.2

SERENE COURT 15/F

02-Oct-96

Segment	Segment Length	Travelling Time sec.	Source SWL	Total No. of RCV	Leq(30 min) SWL	Distance to NSR	Vert. Dist. to NSR	Slant dist. to NSR	Estimated Path Difference	Para./barr. Correction	Predicted SPL dB(A)	TOTAL SPL dB(A)
1	12.0	2.9	112.0	34.0	99.4	75.0	37.7	83.9	N/A	0.0	55.9	
2	20.0	4.8	112.0	34.0	101.6	75.0	38.4	84.2	N/A	0.0	58.1	60.1
3	6.8	1.6	112.0	34.0	96.9	75.0	39.3	84.7	N/A	0.0	53.3	60.9
4	6.8	1.6	112.0	34.0	96.9	79.0	39.7	88.4	N/A	0.0	52.9	61.6
5	6.8	1.6	112.0	34.0	96.9	85.0	40.2	94.0	N/A	0.0	52.4	62.1
6	6.8	1.6	112.0	34.0	96.9	93.0	40.6	101.5	N/A	0.0	51.8	62.5
7	6.8	1.6	112.0	34.0	96.9	97.0	41.1	105.3	N/A	0.0	51.4	62.8
12	6.8	1.6	112.0	34.0	96.9	90.0	43.6	100.0	0.00	-4.8	47.1	62.9
13	6.8	1.6	112.0	34.0	96.9	82.0	44.2	93.1	0.00	-4.8	47.7	63.0
14	6.8	1.6	112.0	34.0	96.9	76.0	44.7	88.2	1.85	-20.4	32.5	63.0
15	6.8	1.6	112.0	34.0	96.9	75.0	45.2	87.6	1.85	-20.4	32.6	63.0
16	6.8	1.6	112.0	34.0	96.9	79.0	45.8	91.3	1.85	-20.4	32.2	63.0
17	6.8	1.6	112.0	34.0	96.9	85.0	46.3	96.8	0.00	-4.8	47.4	63.2
18	6.8	1.6	112.0	34.0	96.9	93.0	47.3	104.4	0.00	-4.8	46.7	63.3
19	6.8	1.6	112.0	34.0	96.9	97.0	47.9	108.2	0.00	-4.8	46.4	63.4
24	6.8	1.6	112.0	34.0	96.9	90.0	50.0	103.0	0.00	-4.8	46.9	63.4
25	6.8	1.6	112.0	34.0	96.9	82.0	50.6	96.3	0.00	-4.8	47.4	63.6
26	6.8	1.6	112.0	34.0	96.9	76.0	51.1	91.6	1.85	-20.4	32.2	63.6
27	6.8	1.6	112.0	34.0	96.9	75.0	51.6	91.1	1.85	-20.4	32.3	63.6
28	6.8	1.6	112.0	34.0	96.9	79.0	52.2	94.7	1.85	-20.4	31.9	63.6
29	6.8	1.6	112.0	34.0	96.9	85.0	52.7	100.0	0.00	-4.8	47.1	63.7
30	6.8	1.6	112.0	34.0	96.9	93.0	53.7	107.4	0.00	-4.8	46.5	63.7
31	6.8	1.6	112.0	34.0	96.9	97.0	54.3	111.2	0.00	-4.8	46.2	63.8
32	73.0	17.5	112.0	34.0	107.2	137.0	55.1	147.7	N/A	0.0	58.8	65.0
33	10.0	2.4	112.0	34.0	98.6	172.0	54.4	180.4	N/A	0.0	48.4	65.1

SERENE COURT Top Floor

02-Oct-96

Segment	Segment Length	Travelling Time sec.	Source SWL	Total No. of RCV	Leq(30 min) SWL	Distance to NSR	Vert. Dist. to NSR	Slant dist. to NSR	Estimated Path Difference	Para./barr. Correction	Predicted SPL dB(A)	TOTAL SPL dB(A)
1	12.0	2.9	112.0	34.0	99.4	75.0	68.5	101.6	N/A	0.0	54.2	
2	20.0	4.8	112.0	34.0	101.6	75.0	69.2	102.0	N/A	0.0	56.4	58.5
3	6.8	1.6	112.0	34.0	96.9	75.0	70.1	102.6	N/A	0.0	51.6	59.3
4	6.8	1.6	112.0	34.0	96.9	79.0	70.5	105.9	N/A	0.0	51.4	59.9
5	6.8	1.6	112.0	34.0	96.9	85.0	71.0	110.7	N/A	0.0	51.0	60.4
6	6.8	1.6	112.0	34.0	96.9	93.0	71.4	117.3	N/A	0.0	50.5	60.9
7	6.8	1.6	112.0	34.0	96.9	97.0	71.9	120.7	N/A	0.0	50.3	61.2
12	6.8	1.6	112.0	34.0	96.9	90.0	74.4	116.8	0.00	-4.8	45.8	61.4
13	6.8	1.6	112.0	34.0	96.9	82.0	75.0	111.1	0.00	-4.8	46.2	61.5
14	6.8	1.6	112.0	34.0	96.9	76.0	75.5	107.1	1.85	-20.4	30.9	61.5
15	6.8	1.6	112.0	34.0	96.9	75.0	76.0	106.8	1.85	-20.4	30.9	61.5
16	6.8	1.6	112.0	34.0	96.9	79.0	76.6	110.0	1.85	-20.4	30.6	61.5
17	6.8	1.6	112.0	34.0	96.9	85.0	77.1	114.7	0.00	-4.8	45.9	61.6
18	6.8	1.6	112.0	34.0	96.9	93.0	78.1	121.5	0.00	-4.8	45.4	61.7
19	6.8	1.6	112.0	34.0	96.9	97.0	78.7	124.9	0.00	-4.8	45.2	61.8
24	6.8	1.6	112.0	34.0	96.9	90.0	80.8	121.0	0.00	-4.8	45.5	61.9
25	6.8	1.6	112.0	34.0	96.9	82.0	81.4	115.5	0.00	-4.8	45.9	62.0
26	6.8	1.6	112.0	34.0	96.9	76.0	81.9	111.7	1.85	-20.4	30.5	62.0
27	6.8	1.6	112.0	34.0	96.9	75.0	82.4	111.4	1.85	-20.4	30.5	62.0
28	6.8	1.6	112.0	34.0	96.9	79.0	83.0	114.6	1.85	-20.4	30.3	62.0
29	6.8	1.6	112.0	34.0	96.9	85.0	83.5	119.1	0.00	-4.8	45.6	62.1
30	6.8	1.6	112.0	34.0	96.9	93.0	84.5	125.7	0.00	-4.8	45.1	62.2
31	6.8	1.6	112.0	34.0	96.9	97.0	85.1	129.0	0.00	-4.8	44.9	62.3
32	73.0	17.5	112.0	34.0	107.2	137.0	85.9	161.7	N/A	0.0	58.0	63.7
33	10.0	2.4	112.0	34.0	98.6	172.0	85.2	191.9	N/A	0.0	47.9	63.8

Appendix 5 Calculation of noise levels from containers loading and unloading

Assumptions

1. The sound power level of the crane on the vessel is 90 dB(A)

2. The noise generating part of the crane is located at 10 mPD

Sample calculation

NSR	Horizontal Distance	Vertical Distance	Slant Distance	Distance + Facade Correction dB(A)	Predicted Noise Level dB(A)
NSR4	110 m	31.7 m	114.5 m	46.2 dB(A)	43.8 dB(A)

Operation Noise Calculation - Screening effect at NSR4 from Ventilation Shaft

Noise from the Ventilation Shaft

Equipment	No. of Equi	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	Total SWL
Main fan	1	111.0	114.0	117.0	113.0	111.0	106.0	103.0	98	
Main fan	1	111.0	114.0	117.0	113.0	111.0	106.0	103.0	98	
WWTP fan	1	110.0	113.0	113.0	110.0	104.0	98.0	91.0	85	
Combined SWL		115.5	118.5	120.8	117.0	114.4	109.3	106.1	101.1	
Less Scrubber & shaft correction		-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	
Overall SWL		95.5	98.5	100.8	97.0	94.4	89.3	86.1	81.1	**105.0**
Convert to A weighted factor		-26.2	-16.1	-8.6	-3.2		1.2	1.0	-1.1	
Leq dB(A)		69.3	82.4	92.2	93.8	94.4	90.5	87.1	80.0	**99.4**

Noise from the Ventilation Shaft with Hillside Screening Effect

The path difference between the hillside and NSR4 is 1.0 m and the maximum correction is 25 dB(A)

Equipment	No. of Equi	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8K Hz	Total SWL
Main fan	1	111.0	114.0	117.0	113.0	111.0	106.0	103.0	98	
Main fan	1	111.0	114.0	117.0	113.0	111.0	106.0	103.0	98	
WWTP fan	1	110.0	113.0	113.0	110.0	104.0	98.0	91.0	85	
Combined SWL		115.5	118.5	120.8	117.0	114.4	109.3	106.1	101.1	
Less Scrubber & shaft correction		-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	
Overall SWL		95.5	98.5	100.8	97.0	94.4	89.3	86.1	81.1	**105.0**
Wave length m		5.46	2.75	1.38	0.69	0.34	0.17	0.09	0.04	
N factor for screening		0.37	0.73	1.45	2.91	5.81	11.63	23.26	46.51	
Screening Correction		-10.14	-12.44	-15.06	-17.86	-20.77	-23.72	-25.00	-25.00	
Overall SWL after hillside Screening		85.32	86.02	85.74	79.12	73.66	65.62	61.15	56.12	
Convert to A weighted factor		-26.2	-16.1	-8.6	-3.2		1.2	1.0	-1.1	
Leq dB(A)		59.1	69.9	77.1	75.9	73.7	66.8	62.1	55.0	**81.2**

The Total screening effect of the hillside for NSR4 is :

99.4 dB(A) - 81.2 dB(A) = 18.2 dB(A)

Operational Noise

02-Oct-96

NSR	Noise from ventilation Shaft	Noise from Loading & Unloading	Noise from Spiral ramp & Tunnel portal	Total Noise Level dB(A)
NSR1	47.8	46.4	54.6	55.9
NSR2	44.3	40.7	53.6	54.3
NSR3	47.5	42.9	53.6	54.8
NSR4	44.2	43.8	53.6	54.5
NSR5	49.6	46.1	65.4	65.6