Chapter 5

AIR QUALITY IMPACT ASSESSMENT

5 AIR QUALITY IMPACT ASSESSMENT

Introduction

5.1 This Section presents an assessment of the air quality impacts associated with the decommissioning of CLS.

5.2 During building demolition phase where existing superstructures and abandoned installations/ plants/ equipment within CLS will be removed, fugitive dust emissions arising from material handling and truck movements are the major sources of air pollution. The slope improvement works behind CLS will also be dusty. Dust impacts associated with the building demolition and slope improvement works have been assessed and mitigation measures have been recommended, where necessary. Cumulative air quality impacts with other construction activities at Penny's Bay are also presented for this assessment.

5.3 CLS was contaminated by the shipyard activities conducted at the site. Extensive site investigation works have been conducted to identify the exact contamination levels of the soil. It is proposed that the contaminated soils in CLS will be excavated and decontaminated both on-site and off-site. Solidification will be conducted at the CLS to stabilise heavy metals in soil. On the other hand, biopiling, thermal desorption and solidification as parts of the decontamination process will be conducted at the off-site treatment facilities. Air quality impacts associated with the excavation of contaminated soil and treatment of contaminated soil have been assessed. Where necessary, mitigation measures have been recommended to reduce the emissions from the sites.

5.4 Air quality impacts associated with the filling and land formation at CLS have already been presented in the Theme Park EIA Report, and are not assessed in here.

Assessment Criteria

5.5 The criteria and guideline for air quality assessment of EIA process are laid out in Annex 4 and Annex 12 of the *Technical Memorandum on Environmental Impact Assessment Process* (EIAO-TM), respectively.

5.6 The *Air Pollution Control Ordinance* (APCO) provides the statutory authority for controlling air pollutants from a variety of sources. *The Hong Kong Air Quality Objectives* (AQOs) should be satisfied at the Hong Kong Special Administrative Region (HKSAR). The AQOs stipulate the maximum allowable concentrations for typical pollutants, of which total suspended particulates (TSP), respirable suspended particulates (RSP), sulphur dioxide (SO_2) nitrogen dioxide (NO_2), carbon monoxide (CO) and lead (Pb) are relevant to this EIA Study, and are listed in Table 5.1.

Table 5.1 Hong Kong Air Quality Objectives

Pollutant	Maximum Average Concentration (μgm^{-3}) (1)				
	1-Hour (2)	8-Hour (3)	24-Hour (3)	3 months (4)	Annual (4)
TSP	-	-	260	-	80
RSP (5)	-	-	180	-	55
SO_2	800		350	-	80
NO_2	300	-	150	-	80
CO	30000	10000	-	-	-
Pb	-	-	-	1.5	-

1. Measured at 298 K and 101.325 kPa.
2 Not to be exceeded more than three times per year.
3 Not to be exceeded more than once per year.
4. Arithmetic mean.
5 Suspended pariculates in air with a nominal aerodynamic diameter of 10 μm or smaller.

5.7 The EIAO-TM also stipulates that the hourly TSP level should not exceed 500 μgm^{-3} (measured at 25°C and one atmosphere) for construction dust impact assessment. Mitigation measures from construction sites have been specified in the *Air Pollution Control (Construction Dust) Regulation.*

5.8 The EIAO-TM stipulates that the odour level at sensitive receiver should not exceed 5 odour units based on an averaging time of 5 seconds.

5.9 The *Technical Memorandum for Issuing Air Pollution Abatement Notices to Control Air Pollution From Stationary Polluting Process*, under the APCO, stipulates the Health Protection Concentration Level (HPCL) of 38 chemical compounds, and the chemicals relevant to this Project are shown in Table 5.2. The EIAO-TM requires that for air pollutants not established under the APCO, criteria from international organisations should be adopted. The air quality criteria for non-AQO pollutants employed for this Study are also shown in Table 5.2.

Table 5.2 Air Quality Criteria for non-AQO Pollutants

Pollutant	Unit	Criteria	
		1 hour	Annual
Arsenic	$\mu g/m^3$	0.3 (1)	0.03 (2)
Benzo(a)pyrene	$\mu g/m^3$	0.387 (1)	-
Cadmium	$\mu g/m^3$	-	0.005 (3)
Copper	$\mu g/m^3$	100 (2)	2.4(2)
Dioxins (4)	pg I-TEQ/m^3	33.6 (1)	40 (2)
Hexachlorobenzene	$\mu g/m^3$	2.6 (1)	2.8 (2)
Hexavalent Chromium	$\mu g/m^3$	8.5×10^{-3} (1)	0.1(5)
Naphthalene	$\mu g/m^3$	-	3 (5)
Nickel	$\mu g/m^3$	3.87 (1)	0.05 (2)
Polychlorinated biphenyls (PCBs)	$\mu g/m^3$	1.06 (1)	1.2 (2)
Styrene	$\mu g/m^3$	21000 (2)	900 (2)
Zinc	$\mu g/m^3$	-	35 (2)

1. TM for Issuing Air Pollution Abatement Notices to Control Air Pollution From Stationary Polluting Processes
2. California Air Resources Board, 2001
3. WHO Air quality Guideline 2000
4. Expressed as TCDD-equivalent concentration of 2,3,7,8-tetrachlorobenzo dioxin (TCDD)
5. US Environmental Protection Agency – IRIS as at 30 Nov, 2001.

5.10 For non-criteria pollutants, health risk guidelines for the assessment of health risk from exposures to air toxics are given by *California Air Resources Board, California Environmental Protection Agency* (CARB). Guidelines value on acceptability of increased cancer risk from a lifetime exposure to air toxics have been provided and are shown in Table 5.3.

Table 5.3 Health Risk Guidelines for Exposure to Air Toxics (1)

Acceptability of Cancer Risk	Estimated Individual Cancer Risk Level	
	Individual Lifetime Risk (2)	Individual Risk Per Year
Significant	$> 10^{-4}$	$> 1.4 \times 10^{-6}$
Risk should be reduced to As Low As Reasonably Practicable (ALARP)	$> 10^{-6} - 10^{-4}$	$> 1.4 \times 10^{-8} - 1.4 \times 10^{-6}$
Insignificant	10^{-6}	1.4×10^{-8}

1 California Air Resources Board, California Environmental Protection Agency (CARB)
2 Assumed as 70 years recommended by World Health Organization (WHO)

Baseline Conditions and Air Sensitive Receivers

Existing Environment

5.11 The air quality of Penny's Bay is currently dominated by the dusty activities from the infrastructure construction for Penny's Bay Development. Dust measurements are being conducted by the contractor of the Penny's Bay Development to check the dust emissions from the construction site. These dust impact monitoring data include dust from other construction project in Penny's Bay, which depends on the construction activities of these construction projects and could not represent the true background of the site. When the construction works are finished, the dust level will be greatly reduced. On the other hand, the "baseline" data measured prior to the construction projects are conducted within limited time frame and affected by seasonal variation and therefore could not represent the background air quality of the site.

5.12 Other than the heavy construction works, air quality of the CLS is affected by emissions from the North Lantau Highway (NLH) and Penny's Bay Gas Turbine Plant (GTP).

5.13 Off-site decontamination facilities are proposed at To Kau Wan near Ng Kwu Leng. To the south of the To Tau Wan is the toll plaza of North Lantau Expressway. No major pollutant source has been identified in the area and vehicle exhaust emissions of North Lantau Highway are the major pollutant sources of the area.

5.14 Data monitored at the Tung Chung Monitoring Station are employed to represent the background pollutant concentrations of the Study Area. The annual average pollution levels recorded at Tung Chung Monitoring Station in 2000 are summarised in Table 5.4. Levels of Toxic Air Pollutants (TAPs) and heavy metals are not monitored at the monitoring station and the annual average levels of TAPs monitored at the Tsuen Wan station are employed as background for this Study. Background concentrations of other TAPs are not available for this Study, however, it is expected that their levels are negligible in ambient environment.

Table 5.4 Background Air Quality

Pollutants	Annual Average (μgm^{-3})	Monitoring Station
Total Suspended Particulates	71 μgm^{-3}	Tung Chung
Respirable Suspended Particulates	45 μgm^{-3}	
Sulphur Dioxide	15 μgm^{-3}	
Nitrogen Dioxide	45 μgm^{-3}	
Carbon Monoxide	582 μgm^{-3}	
Cadmium	2.2 ng/m^3	Tsuen Wan
Hexavalent Chromium	0.25 ng/m^3	
Lead	64 ng/m^3	
Nickel	5 ng/m^3	
Indeno(1,2,3-cd)pyrene	0.45 ng/m^3	
Benzo(b)fluoranthene	0.61 ng/m^3	
Benzo(a)pyrene	0.32 ng/m^3	
Dibenzo(a,h)anthracene	0.08 ng/m^3	
Benzo(a)anthracene	0.49 ng/m^3	
Dioxins	0.061 $pgI\text{-}TEQ/m^3$	

Air Sensitive Receivers

5.15 Air Sensitive Receivers (ASRs) have been identified for this assessment, in accordance with the EIAO-TM. Domestic premises, hotel, hostel, hospital, clinic, nursery, temporary housing accommodation, school, educational institution, office, factory, shop, shopping centre, home for the aged and active recreational activity areas are classified as ASRs. The locations of the ASRs for this assessment are listed in Table 5.5 and shown in Figure 5.1. Distance between the ASRs and the site are also shown in Table 5.5.

Table 5.5 Air Sensitive Receiver

ASR	Description	Distance between ASR and site (m)
Penny's Bay		
A1	Penny's Bay GTP	253
A2	Possible Country Park Extension Area	1270
A3	Possible Country Park Extension Area	768
A4	Possible Country Park Extension Area	414
A5	Luk Keng Tsuen	1102
A6	Discovery Bay	2982
A7	Peng Chau	3416
To Kau Wan		
A8	Toll Plaza Administration Building	130
A9	Dockyard Building	90

5.16 Site offices of other construction projects are located at more than 500m from site boundary of CLS, and are not identified as ASR for this assessment.

5.17 The Yam O reclamation is scheduled to be completed by 2008 and will not be affected by the operation of the Project.

Identification of Pollutant Sources

<u>Building Demolition and Slope Improvement</u>

5.18 The building demolition of CLS is scheduled to commence in August 2002, The existing superstructure will be demolished. Demolition of the existing superstructure involves material handling activities and metal cutting works. Shuttle trucks will transport the demolition materials to the temporary barging point at Penny's Bay reclamation where the demolition materials are removed off-site. It is estimated that the demolition of superstructure would last for three months and would generate about 72.5 m^3 of material per day in maximum. Given this estimate, traffic flow of 4 trucks per hour is expected.

5.19 Slope improvement works will be conducted at the hillslopes behind CLS. Dusty activities such as material handling, rock cutting and truck movement over haul road are expected for the works. The slope improvement works will last for 12 months and will generate 300 m^3 soils and 100 m^3 rocks per day in maximum. Traffic flow of 8 trucks per hour is expected for the works.

5.20 Dust control measures specified in the *Air Pollution Control (Construction Dust) Regulation* shall be followed to minimise dust emission from the site.

5.21 SO_2, NO_2 and RSP would be emitted from the diesel-powered construction plants in the site. As the number of plants within the site is small, air pollution impacts from diesel plants are expected to be very minor.

Remediation Phase (CLS)

Excavation

5.22 Site investigation has been conducted for this assessment to check the contamination level of the site. A total of around 2000 soil samples have been collected for the CLS and the SI data indicate that the soils at some areas of CLS have been contaminated attributed to the previous shipyard activities. The detailed site record revealed that odour was not detected during the site investigation, and this observation is consistent with laboratory results of not detecting any odorous materials in the soils. Details of the SI data are shown in Section 4, and relevant data on maximum contamination levels of soils are summarized in Table 5.6 below.

Table 5.6 Maximum Contamination Levels of Soil

Pollutant	Unit	Max Concentration Level
Arsenic	mg/kg	114
Benzo(a)anthracene	mg/kg	1.67
Benzo(a)pyrene	mg/kg	1.9
Benzo(b)fluoranthene	mg/kg	2.38
Cadmium	mg/kg	118
Copper	mg/kg	28100
Dibenz(a,h)anthracene	mg/kg	0.657
Dioxins (1)	ppb I-TEQ	109.383
Hexachlorobenzene	mg/kg	1
Hexavalent Chromium	mg/kg	392
Indeno(1,2,3-cd)pyrene	mg/kg	1.51
Lead	mg/kg	26300
Naphthalene	mg/kg	20.8
Nickel	mg/kg	1790
Polychlorinated biphenyls (PCB)	mg/kg	33.4
Styrene	mg/kg	6.3
Zinc	mg/kg	35700

1. Expressed as TCDD-equivalent concentration of 2,3,7,8-tetrachlorobenzo dioxin (TCDD)

5.23 The SI data indicate that the soils are contaminated with metals, petroleum products including organic semi-volatile organic compounds (SVOC), polycyclic aromatic hydrocarbons (PAH) and dioxins. Level of volatile organic compounds (VOC) were found to be insignificant in the soil, except for some localised areas in trench T11 and at Building D (see Figure 4.1 for their locations), where low levels of styrene and total petroleum hydrocarbon (TPH) were detected.

5.24 The contaminated soils will be excavated and treated either on-site or off-site prior to reuse. It is estimated that a maximum amount of 2000 m^3 contaminated soils will be excavated per day, and the contaminated soils are either treated on-site or off-site at TKW by trucks. The period of excavation of contaminated works will last for six months in maximum.

5.25 Fugitive dusts would be generated during excavation and truck movements on haul road. It is understood that the haul road is paved. Only small volume of excavated materials will be stockpile temporarily. The stockpiling materials are covered and fugitive emission from the stockpile is not expected for this Project.

5.26 The SI investigation programme revealed that the VOC levels are very low and only account for less than 0.7% of the overall excavated soils. When the soil is disturbed during excavation, VOC presented in the gas may be vaporised. As the VOC is localised in the soils of CLS (detected at Building D and Trench 11 only), gaseous VOC emission from the soil is therefore not expected from most of the excavated area. . Both Trench T11 and Building D are located at more than 900 m from the nearest ASR, VOC and odour impact from the excavation works on ASR is therefore not expected. The SVOC and PAH in the soils, being non-volatile under atmosphere conditions, will not be volatilised.

5.27 Elevated levels of pollutants including dioxins and Cr^{6+} have been measured at some hot spots. The pollutants, binding tightly onto the soils, would be dispersed in form of dust, during the excavation process. Other pollutants may also be dispersed in from of dust, however, they are either in low concentrations or toxicity, and their impacts are expected to be minor.

Solidification

5.28 Solidification process is employed to immobilise heavy metals in the soil directly from the CLS. The metal contaminated soils are loaded into the mix bin and solidification agents are added and mix thoroughly. After sufficient residence time, the solidified product is removed from the bin and suitable for reuse. It is expected that TSP would be emitted from the plant during the mixing process. On the other hand, the mixing process facility for storage, handling and mixing of cement will follow the *Air Pollution Control (Construction Dust) Regulation* to limit the cement emission. It is expected that the solidification facilities at CLS will last for about 6 months.

Remediation Phase (TKW)

5.29 At TKW, biopiling, thermal desorption and solidification as parts of the decontamination process will be conducted at the off-site treatment facilities. The dioxins contaminated soils will be tackled by thermal desorption process; whileas the petroleum contaminated soils will be treated by biopiling. The treated soils will be stabilised with solidifying agents by the solidification process prior to reuse. The TKW site is a flat land and only minor site preparation work is required for the proposed treatment facilities. Earth movement and dusty construction works are not expected for the site.

Transportation of Waste from CLS to TKW

5.30 The contaminated soils will be transported by truck from CLS to TKW. The period of transportation of waste is expected to be six months in maximum. It is estimated that about 14 trips per hour will be generated during the peak excavation period. The proposed haul road is shown in Figure 6.3.

5.31 All the dioxins contaminated soils will be transported in the enclosed roll-off truck with sealable top, which will be delivered to the enclosed material handling shed and storage areas. In addition, the material handling processes such as screening and crushing will be conducted in an enclosed environment. Dioxins emission from transportation, loading and unloading process is therefore not expected. Figure 6.5 shows the possible transportation, unloading and handling process at the off-site treatment facilities.

5.32 General contaminated (non-dioxins contaminated) soils will be transported to the storage bin at TKW by truck, and the soils will be covered with impermeable liner to minimise wind erosion. The storage bin is fully enclosed on four sides and on the top to eliminate dust emission. It is expected that fugitive dust may be generated during the unloading of general contaminated soils. Figure 6.4 illustrates the transportation and handling processes for general contaminated soils.

Biopiling

5.33 As a primary purpose to stop percolation of precipitation, biopiles shall be entirely covered by low permeability sheeting, and dust generation due to wind erosions is not envisaged. The biopile will be under negative pressure and fugitive emission of pollutants is therefore not expected.

5.34 During the biopiling process, the organic contaminants in soil and off-gas resulted from biodegradation will be extracted to a back-up carbon absorber where any volatile organics are stripped off, and the treated effluent will be discharged via a vent. The raw soils feed into the biopile have very low levels of VOC. The TPH and SVOC will be biodegradable by bacteria into CO_2 and moisture and with traces of intermediate products, which may be volatile. The nature of these secondary VOCs are mainly lower carbon chain constituents of petroleum products. In other biopile project in Hong Kong (Kai Tak Airport), the biopile emissions are found to contain insignificant amount of VOCs. It is therefore expected the VOC emission will satisfy the emission criteria with the biopiling process. This will be confirmed by the emission characterisation during implementation stage. To ensure that the criteria is meet, a back-up carbon absorber is also included in the facility plant prior to discharge to the ambient air. Should excessive toxic or odorous VOC are found in the emission characteristic test, additional measures such as adding new control equipment or reducing flowrate shall be implemented. Removal efficiency of 99% could be achieved by the carbon absorber.

Thermal Desorption

5.35 Thermal desorption process is employed to remove dioxins as well as other organic contaminants of the soil found in CLS. Contaminated soils will be heated up in an indirect heat sink where the organic contaminants including dioxins are vaporised, giving the off-gas. The off-gas will undergo a rapid quenching to bring down the off-gas temperature to $4^{o}C$. After quenching, about 99.99%[1] of dioxins and organic contaminants are condensed while the

[1] Experience from a dioxin remediation project Coleman-Evans site in Florida conducted by RF Weston Inc.

remaining 0.01% is to be treated before discharge by an air treatment unit comprising a spray tower, mist eliminators, a bag house, HEPA filter and carbon absorber. It is expected that the off-gas will comply with the emission standard after passing through the HEPA filter. The carbon absorber is included as a back-up facility to ensure that the emission criteria is satisfied. The air treatment unit would have nominal efficiencies of 99.99% for dioxins and organic compounds. The thermal desorption process together with the air treatment unit, will control the air pollutant emitted from the stack comprising only 0.0001% of dioxin and organic contaminants in soils.

5.36 The thermal desorption is to be designed as enclosed process and fugitive emissions is therefore not expected. Low levels of organic compounds including SVOC and PAHs would be emitted via the stack from this treatment facility. Heavy metals (except mercury, which was not detected in the CLS soil) would not be vaporised by the heat due to their high boiling points. With the treatment process to extract organic compounds in aqueous form and the air treatment unit, organic gas emission from the plant is therefore expected to be minor. Unlike the biopile, the thermal desorption process do not break down complex molecules into shorter chains, the nature of organic gases escaped via the stack is therefore similar in nature of the organic compounds in soil, i.e. no new compound will be generated under the process.

5.37 Appendix 5A shows the performance of a typical thermal desorption plant at Coleman-Evan Wood Preserving Site. It is indicated that for a feeding rate of 17.27 tons/hr, with dioxins level of 5.689 ng/g, air emission of 0.05 ng/m^3 could be achieved with the thermal desorption together with air treatment unit. Both the treatment rate and dioxin contamination soil level is comparable to the proposed treatment units at TKW, the performance is therefore expected to be similar.

Solidification

5.38 Solidification process is employed to immobilise heavy metals in the treated soil after biopiling and thermal desorption process. The soils are loaded into mix bin and solidification agents are added and mix thoroughly. With sufficient residence time, the solidified product is removed from the bin and suitable for reuse. It is expected that the mixing process will be conducted in an enclosed area, and emissions of dust and air pollutants from the facility are not expected. Similar to the solidification plant at CLS, the storage, handling and mixing of cement will follow the *Air Pollution Control (Construction Dust) Regulation* to limit the cement emission.

TKW Decommissioning Phase

5.39 The TKW site will be reinstall to the original state after three years of use. The reinstatement will include dismantling of the treatment facilities and some metal cutting works. Air emission from these activities is expected to be minor. Truck haulage would also be required to remove the dismantled facilities/ equipment. However, the number of truck required is expected to be low.

5.40 A summary of air emission inventory from different activities is shown in Table 5.7.

Table 5.7 Summary of Emission Inventory

Location	Activity	Typical air pollutant
Building Demolition	Material handling	• TSP
	Truck haulage	• TSP
Slope Improvement	Material handling	• TSP
	Wet drilling	• TSP
	Truck haulage	• TSP
Remediation (CLS)	Excavation	• TSP • Chemicals adhered onto dust particulates including dioxins • VOC
	Solidification	• TSP • Chemicals adhered onto dust particulates
Remediation (TKW)	Transportation of waste	• TSP
	Handling of General Contaminated Soil	• TSP • Chemicals adhered onto dust paticulates
	Biopiling	• TOC
	Thermal desorption	• TOC, • Dioxins, • SVOC, • PAH, • Combustion products
	Solidification	-
Decommissioning of TKW site	Dismantling, metal cutting, truck haulage	TSP

Assessment Methodology

Pollutant Emission Rates

CLS Site

5.41 Dust emissions from the construction activities at CLS including building demolition, slope improvement and excavation are the area of concern. Emission rates for dusty activities were estimated based on *USEPA Compilation of Air Pollution Emission Factors (AP-42), 5th Edition*, and are presented in Table 5.8. Mitigation measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* were incorporated in the calculation of emission rate. Detailed calculations of the emission rates are shown in Appendix 5B.

Table 5.8 TSP Emission Rate for Construction Activities at CLS

Activity	Emission Rate	Remarks
• Building demolition and Slope improvement		
Material Handling	• Demolition: .2.194 x 10^{-4} g/s • Slopeworks: 9.078 x 10^{-4} g/s	• Volume of Material: 72.5 m^3 /day for demolition; 300 m^3/day for slopeworks • Moisture content: 24% • Average wind speed: 5.1 m/s • Density of spoil: 2.0 Mg/m^3 • 50% reduction by water suppression. • AP42, Section 13.2.4
Truck Haulage	• Demolition: 7.181 x 10^{-5} g/m/s	• No of truck: 4 trips/hr for demolition and 8 trucks for slopeworks

Activity	Emission Rate	Remarks
	• Slopeworks: 1.436×10^{-4} g/m/s	• Silt content: 10% • Speed: 10 kph • Mean vehicle weight: 12.5 Mg • 85% reduction with paved road • AP42, Section 13.2.2
Wet Drilling	4.667×10^{-7} g/s	• 100 m^3 rock per day • AP42, Section 11.19.2
Wind Erosion	1.35×10^{-6} $g/m^2/s$	• 50% reduction by water suppression • AP42, Section 11.9
• Remediation Phase		
Contaminated Soil Excavation	• 0.054 g/Mg or 6.052×10^{-3} g/s	• Excavation rate: 2000 m^3/day • Moisture content: 24% • Average wind speed: 5.1 m/s • Density of spoil: 2.0 Mg/m^3 • 50% reduction by water suppression. • AP42, Section 13.2.4
Solidification	0.9078×10^{-3} g/s	• Mixing rate: 60 Mg/hr • Moisture content: 24% • Average wind speed: 5.1 m/s • Density of spoil: 2.0 Mg/m^3 • 50% reduction by watering • AP42, Section 13.2.4

5.42 The pollutants in soil including dioxins and Cr^{6+} would be generated and dispersed in form of dust during the excavation. Cr^{6+} would also be emitted in the solidification process. The AP42's dust emission factors for material handling is assumed for the prediction of dioxins and Cr^{6+} emission rates. As discussed in Section 5.22, more than 2000 soil samples have been collected for the SI at CLS, and the maximum pollutant concentrations of the SI data have been employed to calculate the emission factors to produce conservative estimation. Table 5.9 shows the emission rates for dioxins and Cr^{6+} during excavation and solidification. Detailed calculation of emission rates is shown in Appendix 5B.

Table 5.9 Pollutant Emission Rate during Excavation and Solidification

Pollutant	Emission Rate	Remarks
• Excavation		
Dioxins	6.62×10^{-4} µg/s	• Excavation rate: 200 m^3/hr • Density: 2Mg/m^3 • TSP emission factor of 6.052×10^{-3} g/s (contaminated soil excavation of Table 5.8) • Max contaminated level: 109.383 ppb I-TEQ
Cr^{6+}	0.2372 µg/s	• Excavation rate: 20 m^3/hr • Density: 2Mg/m^3 • TSP emission factor of 6.052×10^{-3} g/s (material handling of Table 5.8) • Max contaminated level: 392 mg/kg
Styrene	0.07 g/s	• Excavation rate: 20 m^3/hr • Density: 2Mg/m^3 • all styrene vaporise during excavation • Max contaminated level:6.3 mg/kg
Solidification		
Cr^{6+}	0.1780 µg/s	• Mixing rate: 15 m^3/hr • Moisture content: 24% • Average wind speed: 5.1 m/s • Density of spoil: 2.0 Mg/m^3

Pollutant	Emission Rate	Remarks
		• 50% reduction by watering • TSP emission factor of 0.9078 x 10^{-3} g/s (solidification of Table 5.8) • Max contaminated level: 392 mg/kg

TKW Site

5.43 Contaminated soils will be transported to the TKW site for treatment by truck. TSP would be generated during the truck haulage on haul road. Unloading of general contaminated soils would also be dusty. The TSP emission rates for truck haulage and material handling have been estimated based on emission factors listed in AP42 and are shown in Table 5.10. Dioxins contaminated soils will be transported in roll-off trucks and loaded in an enclosed area. fugitive emission of dioxin contaminated dust is therefore not expected.

5.44 Biopile treatment is effective in removing organic compounds and light petroleum hydrocarbons from contaminated soil. A vacuum is applied, under the action of exhaust air extraction system, is applied on the soils to induce volatilisation of contaminants. The extracted air is treated for organic compounds removal prior to discharge to the ambient air. It is expected that the extracted air will contain negligible level of odour and VOC. A back-up carbon absorber, however, will be installed for the biopile to ensure that both odour and VOC are removed prior to discharge via a vent. It is assumed in this assessment that the vent diameter is 0.3m with discharge height of 8m above ground. The exhaust volume flow rate is about 56 m^3/min. Table 5.10 shows the TOC emission rate for the biopile.

Table 5.10 Pollutant Emission Rate at TKW

Activity	Emission Factor	Remarks
Transportation of Waste	TSP: 2.513 x 10^{-4} g/m/s	• No of truck: 14 trip/hr • Silt content: 10% • Speed: 10 kph • Mean vehicle weight: 12.5 Mg • 85% reduction with paved road • AP42, Section 13.2.2
Handling of general Contaminated soil	TSP: 2.542 mg/s Cr^{6+}: 0.996 μg/s	• Volume of Material: 84 m^3 /hour. • Moisture content: 24% • Average wind speed: 5.1 m/s • Density of spoil: 2.0 Mg/m^3 • 50% reduction by water suppression. • Cr6+ max contaminated level: 392 mg/kg • AP42, Section 13.2.4
Biopiling	TOC: 18.6 mg/s	• TOC emission concentration: 20 mg/m^3 • Exhaust air volume: 56 m^3/min

5.45 Dioxins contaminated soil is treated by thermal desorption. The facility is capable of treating 10m^3/hr of contaminated soil (moisture content of 24% in soil), 24 hours a day, and allow only 0.0001% of dioxins in soil escaped as in gaseous form via the stack. It is assumed that the stack will be 8 m above ground, 0.4m in diameter, exit temperature of 100°C and e-flux velocity of 8 m/s in the assessment. Town gas will be employed for thermal desorption facility, and expected that the consumption rate will be 50 million Btu/hr. The plant will be designed to control dioxins emission concentration of 0.1 ng/m^3. Condensate generated from thermal desorption will be captured in fully enclosed system and air emission from the condensate is therefore not expected.

5.46 Other than dioxins decontamination, the thermal desorption process together with air treatment unit could allow only 0.0001% of SVOC, PAHs in the soil escaped as gaseous pollutants. A maximum emission concentration of 20 mg/m^3 will be incorporated into the design of the plant to limit TOC emission.

5.47 Pollutant emission rates of thermal desorption facility assumed in the model run are summarised in Table 5.11. The SI data indicated that benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene and napthalene were not detected in the dioxins contaminated soils, and these SVOC will not be treated by the thermal desorption process (they will be treated by the biopiling process only).

Table 5.11 Pollutant Emission Rates of Thermal Desorption Facility

Pollutants	Emission Rates	Remarks (1) (2)
Combustion products	SO_2: 0.0037 g/s NO_2: 0.1235 g/s CO: 0.5188 g/s	• Town gas consumption rate: 50 million Btu/hr • NO_2/NO_x conversion rate of 20 % • AP42: Sect 1.4
Dibenz(a,h)anthracene	3.7 ng/s	• Max contaminated level: 657 µg/kg • 0.0001% of pollutant emitted
Dioxins	0.1 ng/s	• Concentration limit of 0.1 ng/m^3 (3)
Hexachlorobenzene	5.6 ng/s	• Max contaminated level: 1000 µg/kg • 0.0001% of pollutant emitted
Polychlorinated biphenyls (PCB)	185.6 ng/s	• Max contaminated level: 33400 µg/kg • 0.0001% of pollutant emitted
Total Organic Compound (TOC)	20 mg/s	• Concentration limit of 20 mg/m^3 (3)

(1) Flow rate of 1 m^3/s
(2) Treatment rate of 20 Mg/hr, for moisture content of 24%.
(3) Expressed as dry, 0°C, 101.325kPa pressure and corrected at 11% oxygen condition.

5.48 Sample calculations of emission rates for the remediation at CLS and TKW are shown in Appendix 5B.

<u>Air Dispersion Model</u>

5.49 Modelling was undertaken to establish the pollutant concentrations at the ASRs of CLS and TKW. The TSP concentrations at the ASRs were predicted by the USEPA approved *Fugitive Dust Model* (FDM). Dust emission rates and associated particle size distributions were determined based on AP42. On the other hand, potential air quality impacts from the exhaust gas of biopile and the thermal desorption process were predicted using the USEPA approved *Industrial Source Complex* (ISC3) model.

5.50 Hourly meteorological data, including wind speed, wind direction, stability class, temperature, mixing height, measured by Hong Kong Observatory at Cheung Chau weather station for the year 2000, were employed for the model run.

5.51 For the soil excavation and solidification at CLS, the following worst case meteorological data were employed to simulate the pollutant levels at different downwind distances from the source.

- Wind direction worst case
- Wind speed: 1 m/s
- Stability class: D class during daytime; F class during night-time

- mixing height 500m
- Surface roughness 1 m

Health Risk Analysis

5.52 Health risk assessment has been calculated based on the risk imposed by TAP. The increase in cancer risk due to inhalation of TAP is determined by multiplying the increase in predicted annual average of the TAP concentration with its unit risk factor. Unit Risk Factors of relevant Toxic Air Pollutants (TAP) have been identified for this assessment and are listed in Table 5.12. The predicted value is compared with the health risk guideline indicated in Table 5.3. The individual lifetime cancer risk per year is obtained by dividing the maximum individual lifetime cancer risk by 70 years.

Table 5.12 Unit Risk Factor of TAPs

Pollutant	Unit Risk Factor $(\mu g/m^3)^{-1}$
Dibenz(a,h)anthracene	43.5×10^{-2} (2)
Dioxins (3)	38 (4)
Hexachlorobenzene	4.6×10^{-4} (1)
PCB	1×10^{-4} (1)

1. US Environmental Protection Agency
2. 2000 WHO Air Quality Guidelines
3. Expressed as TCDD-equivalent concentration of 2,3,7,8-tetrachlorobenzo dioxin (TCDD)
4. California Air Resources Board

Impact Assessment

CLS Site

5.53 TSP concentrations at the ASRs for the building demolition, slope improvement and excavation of contaminated soils of CLS have been assessed. It was assumed that all the dusty activities would be conducted in parallel in the model, as the worst case scenario. Dust suppression measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* have been incorporated in the model. The hourly and daily TSP concentrations at the worst affected elevation (1.5 m above ground level) have been predicted, and their results are summarised in Table 5.13 below.

Table 5.13 Hourly and Daily TSP Concentrations

ASR	TSP Concentration (μgm^{-3}) (1) (2)	
	Hourly average	Daily average
A1	153	86
A2	73	72
A3	73	71
A4	74	71
A5	103	76
A6	82	73
A7	85	72

(1) Background TSP concentration of 71 μgm^{-3} included in the figure.
(2) TSP concentration at elevation of 1.5 m above ground.

5.54 The predicted hourly and daily TSP concentrations at ground level are in the range of 73 – 153 μgm^{-3} and 71 – 86 μgm^{-3}, respectively. It has been predicted that ASR A1 will receive highest hourly and daily TSP levels. Both the hourly and daily dust criteria are satisfied at the ASRs. Figures 5.2 and 5.3 show the hourly and daily TSP contour for the dust impact attributed to this Project.

5.55 High levels of dioxins have been measured at the Area 3 (109.383 ppb TEQ); while Cr^{6+} have been measured at Building B (392 mg/kg). The pollutants are tightly bind with the soil, and might dispersed in form of dust, when disturbed by excavation. In addition, Cr^{6+} would also be emitted during the mixing process of solidification. The potential dioxins and Cr^{6+} during excavation of contaminated soil and Cr^{6+} emission during mixing process of solidification have been assessed, and their maximum hourly concentrations at different distances from the centre of the excavation pit have been predicted and listed in Table 5.14.

Table 5.14 Maximum Hourly Pollutant Concentrations from Excavation and Solidification Facility

Distance from Centre of Excavation Pit/ Solidification Facility (m)	Excavation (1)			Solidification (4)
	Cr^{6+} Concentration ($\mu g/m^3$) (5) (6)	Dioxins Concentration ($pgI\text{-}TEQm^{-3}$) (2) (6)	Styrene Concentration ($\mu g/m^3$) (3)	Cr^{6+} Concentration ($\mu g/m^3$) (5) (6)
20	0.0058	16.0	1636	0.0068
30	0.0049	13.0	1378	0.0044
40	0.0038	10.0	1048	0.0030
50	0.0029	7.5	789	0.0022
100	0.0011	2.6	264	0.0008
150	0.0007	1.3	129	0.0005
Criteria (1-hr)	0.0085	33.6	21000	0.0085

(1) Max excavation rate of 200 m^3/hr for dioxins; 20 m^3/hr for Cr^{6+} and styrene
(2) Max dioxins concentration: 109.383 ppb I-TEQ
(3) Max styrene concentration 6.3 mg/kg
(4) Max mixing rate of 15 m^3/hr
(5) Max Cr^{6+} concentration: 392 mg/kg
(6) Background concentration included in the predicted figure.

5.56 Table 5.14 above revealed that, with the proposed excavation rate (200 m^3/hr for dioxins and 20 m^3 for Cr^{6+}), both the hourly Cr^{6+} criteria of 0.0085 $\mu g/m^3$ and the hourly dioxins criteria of 33.6 pg/m^3 would be satisfied for receivers located at more than 20 m. Also, the Cr^{6+} concentration will be low and satisfy the hourly criteria at 20m from the solidification facility. As the closest ASR A1 (Penny's Bay GTP), is located at more than 20 m from dioxins contaminated pit, adverse Cr^{6+} and dioxins and impacts on ASR are therefore not expected.

5.57 Styrene in soil, being volatile in nature, would be escaped as gaseous form when the soil is disturbed. Assuming that all the styrene is vaporised during excavation, the emission rate of styrene level is estimated to be 252 g/hr (assumed excavation rate of 20 m^3/hr). Concentration of styrene is calculated to be 1767 $\mu g/m^3$ and satisfy the hourly criteria of 21000 $\mu g/m^3$.

5.58 Other pollutants such as SVOC, PAH and heavy metal might also be generated and dispersed in form of dust during excavation and mixing process of solidification. However, in view of the low contamination levels in soil and low toxicity of these pollutants, it is expected that air quality impacts of these pollutants will comply with the criteria, if the hourly dust criteria of 500 $\mu g/m^3$ is satisfied. Maximum hourly concentration of pollutants in 500 $\mu g/m^3$ dust have been calculated and are shown in Table 5.15. It is predicted that the respective pollutant criteria will be satisfied should the hourly TSP criteria be met.

Table 5.15 Maximum Hourly Pollutant Concentrations for Excavation

Pollutant	Max contaminated level in soil (mg/kg)	Max Concentration in air (μg/m^3) (1)	Hourly Criteria (μg/m^3)
Arsenic	114	0.057	0.3
Benzo(a)anthracene	1.67	0.0009 (2)	- (3)
Benzo(b)fluoranthene	2.38	0.0018 (2)	- (3)
Benzo(a)pyrene	1.9	0.0013 (2)	0.387
Cadmium	118	0.0612 (2)	- (3)
Copper	28100	14	100
Dibenz(a,h)anthracene	0.657	0.0003	- (3)
Hexachlorobenzene	1	0.0005	2.6
Indeno(1,2,3-cd)pyrene	1.51	0.00121 (2)	- (3)
Lead	26300	13.2 (2)	- (3)
Naphthalene	20.8	0.0104	- (3)
Nickel	1790	0.9 (2)	3.87
Polychlorinated biphenyls (PCB)	33.4	0.0167	1.06
Zinc	35700	17.85	- (3)

(1) Concentration of pollutant in 500 μg/m^3 dust.
(2) Background concentration included in the figure.
(3) Hourly criteria not available.

5.59 The air quality assessment above has confirmed that air quality is within the criteria for receivers locating within 500m from the site. Site offices for other Penny's Bay construction projects are located at more than 500m from site boundary of CLS, health risk from the construction works for workers on other site is therefore not expected. The duration of excavation of contaminated soils will be around less than half year, and annual average pollutant concentrations are therefore not predicted for the excavation works.

TKW Site

5.60 The general contaminated soils are covered with impermeable sheeting during transportation, and water spray will be applied to the potential emission points to minimise dust emission. In addition, the mixing process of solidification, are conducted in enclosed environment and fugitive emission from these process is not expected. Cumulative dust emissions from the handling of general contaminated soil process and truck haulage have been calculated and the results are shown in Table 5.16.

Table 5.16 Hourly and Daily TSP Concentration

ASR	TSP Concentration (μgm^{-3}) (1) (2)	
	Hourly average	Daily average
A8	77	73
A9	192	94

(3) Background TSP concentration of 71 μgm^{-3} included in the figure.
(4) TSP concentration at elevation of 1.5 m above ground.

5.61 It has been predicted that ASR A9 will receive highest hourly and daily TSP level. Maximum hourly and daily TSP concentrations of 192 μgm^{-3} and 94 μgm^{-3}, respectively have been predicted. The TSP impacts at the ASRs are low and well within the criteria. The site boundary will also receive dust impact less than 500 μg/m^3 (hourly average) and 260 μg/m^3 (daily average). Contours of the 1-hr and 24-hr averaged TSP at the worst affected heights (1.5m above ground) have been plotted and are shown in Figures 5.2 and 5.3. Background concentrations have been included in the TSP contour plots.

5.62 Some chemicals adhere onto the dust particulates including Cr^{6+} may be emitted during the unloading of general contaminated soil. With the low emission rate of dust and Cr^{6+}, the predicted concentration at ASR will be low and satisfy the criteria. Table 5.17 shows the predicted Cr^{6+} concentration at the ASRs. As discussed in Section 5.58 above, due to the low contamination level of the general contaminated soil, the air quality criteria of chemical including SVOC, PAH and heavy metal will be satisfied should the dust criteria of 500 μg/m^3 is satisfied.

Table 5.17 Predicted Cr^{6+} Concentration for Unloading of General contaminated Soil

ASR	Cr^{6+} Concentration (μgm^{-3}) (1) (2)	
	Hourly average	Daily average
A8	0.00028	0.00025
A9	0.00135	0.00036

(5) Background concentration included in the figure.
(6) Predicted concentration at elevation of 1.5 m above ground.

5.63 All the dioxins contaminated soils will be transported, delivered, and handled in enclosed environment and fugitive emissions of the pollutants are therefore not expected.

5.64 Air pollutants from combustion products of gaseous fuel (SO_2, NO_2 and CO) will be emitted via the chimney of thermal desorption plant. Air quality impacts of combustion products at the ASRs have been predicted and are shown in Table 5.18 below.

Table 5.18 Air Quality Impact of Gaseous Fuel Combustion at ASR

ASR	Height above ground (m)	SO_2 (μgm^{-3})			NO_2 (μgm^{-3})			CO (μgm^{-3})	
		1-hr	24-hr	1-yr	1-hr	24-hr	1-yr	1-hr	1-yr
A8	1.5	17.1	16.1	15.1	116.0	83.0	47.1	880.3	590.8
	10	17.3	16.3	15.1	123.3	87.1	47.1	911.0	590.9
	20	16.4	15.9	15.0	91.2	74.6	46.1	775.9	586.8
	30	15.4	15.2	15.0	59.5	53.3	45.2	642.7	583.0
	40	15.2	15.0	15.0	52.8	45.9	45.0	614.8	582.2
A9	1.5	15.9	15.1	15.0	75.6	48.9	45.5	710.3	584.1
	10	16.4	15.2	15.0	92.5	50.2	45.6	781.6	584.7
	20	18.4	15.3	15.0	156.8	53.6	45.8	1051.7	585.4
	30	22.5	15.4	15.0	296.5	57.2	45.9	1638.4	585.6
	40	18.3	15.2	15.0	154.2	51.1	45.4	1040.7	583.8
Criteria		800	350	80	300	300	80	30000	-

(1) Background included in the above figure.

5.65 It has been predicted that the NO_2, SO_2, CO impacts at all ASRs are low and within the AQO criteria. Worst Contours of the critical pollutants for gaseous combustion products, 1-hr averaged NO_2, at the worst affected heights (30m above ground of A9 for NO_2) have been plotted and are shown in Figure 5.4. Background concentrations have been included in the contour plot.

5.66 TOC would be emitted from the operation of biopile and thermal desorption facility at TKW. On the other hand, low level of dioxins would be escaped from the thermal desorption plant. The TOC and dioxins impacts on the ASRs have been predicted for this assessment and the results are shown in Table 5.19. Highest concentrations of 57.7 ug/m^3 TOC and 0.26 pg/m^3 I-TEQ/m3 have been predicted at A9. It is revealed that the TOC and dioxins will be low and satisfied their respective criteria at the ASRs. Contours of the 1-hr averaged TOC and dioxins at the worst affected heights, (20m above ground of A9 for TOC and 30m above ground of A9 for dioxins) have been plotted and are shown in Figures 5.5 to 5.6. Background concentrations have been included for dioxins contour plot.

Table 5.19 TOC and Dioxins Impacts at ASR

ASR	Height above ground (m)	TOC (μgm^{-3})		Dioxins (pgI-TEQ m^{-3}) (1)	
		1-hr	Annual	1-hr	Annual
A8	1.5	19.2	0.7	0.12	0.063
	10	27.4	0.8	0.12	0.063
	20	12.5	0.4	0.10	0.062
	30	4.1	0.1	0.07	0.061
	40	2.3	0.0	0.07	0.061
A9	1.5	10.0	0.2	0.09	0.062
	10	30.6	0.2	0.10	0.062
	20	57.7	0.3	0.15	0.062
	30	43.7	0.2	0.26	0.062
	40	18.2	0.1	0.15	0.061
Criteria		-	-	33.6	40

(1) Background concentration included in the figure for dioxins.

5.67 TAPs, other than dioxins, have been detected in the soils. Most of the TAPs would be treated by the biopile, however, soils contaminated with TAPs and dioxins would be treated by the thermal desorption facilities. Trace levels of TAPs would be escaped from the plant and their impacts on the ASRs have been predicted and are shown in Table 5.20. It is indicated that the TAP levels at the ASRs are well within the respective criteria, during the operation of the facility.

Table 5.20 TAPs Impacts at ASR

ASR	Height above ground (m)	Dibenz(a,h)anthracene (1) (pg/m^3)		Hexachlorobenzene (pg/m^3)		PCB (pg/m^3)	
		1-hr	Annual	1-hr	Annual	1-hr	Annual
A8	1.5	82.1	80.1	3.2	0.1	106.7	3.1
	10	82.3	80.1	3.5	0.1	117.7	3.2
	20	81.3	80.0	2.1	0.1	69.4	1.7
	30	80.4	80.0	0.6	0.0	21.7	0.4
	40	80.2	80.0	0.4	0.0	11.7	0.1
A9	1.5	80.9	80.0	1.3	0.0	45.9	0.7
	10	81.4	80.0	1.9	0.0	71.4	1.0
	20	83.3	80.0	3.1	0.0	168.0	1.2
	30	87.4	80.0	6.9	0.0	377.8	1.3
	40	83.2	80.0	3.5	0.0	164.1	0.6
Criteria (pg/m^3)		-	-	2.6×10^6	2.8×10^6	1.06×10^6	1.2×10^6

1 Background concentration included in the figure.

5.68 It has been assessed that the air quality impacts at the ASRs are low and the criteria are satisfied. Adverse air quality impacts on sensitive receivers at both ground level and higher levels are not expected from the off-site treatment facilities, under worst case scenario. Sample output files for the air dispersion model is shown in Appendix 5C.

TKW Decommissioning Phase

5.69 The TKW site will be reinstall to the original state after three years of use. The air quality impacts of the reinstatement will be minor. Only small amount of dismantling of the treatment facilities and metal cutting works are expected. It is predicted that the impacts will compile with the air quality criteria.

Health Risk Analysis

5.70 This section assesses the increase in health risk from exposure of TAPs. The increase cancer risk due to inhalation of TAP is determined by multiplying the increase in predicted annual average of the TAP concentration with its unit risk factor. The individual lifetime cancer risk per year is obtained by dividing the maximum individual lifetime cancer risk by 70 years. As discussed in Section 5.47, only trace amounts of PAHs, namely dibenz(a,h)anthracene, hexachlorobenzene and PCBs, are found in dioxins contaminated soil and would be treated by thermal desorption facilities. These PAHs would be released into atmosphere together with dioxins, after treatment, and would increase the health risk at ASRs. On the other hand, gaseous carcinogenic materials are not expected from the biopile and solidification facility at TKW. As discussed in Sections 5.58 and 5.62, low levels of pollutants would be escaped during the contaminated soil handling. Their levels are very low and of short duration (a few hours per day for less than 6 months), the health risk levels associated with unloading are therefore expected to be very low and are neglected in the calculation of health risk. The increase in annual concentrations of TAPs (i.e. excluding background levels) at the worst affected receiver (ASR A9, 30m above ground) and their individual health risk per year (i.e. lifetime risk / 70 years) have been calculated and shown in Table 5.21.

Table 5.21 Individual Health Risk at the Worst Affected Receiver

Pollutant	Maximum annual concentration (pg/m^3)	Unit Risk Factor $(\mu g/m^3)^{-1}$	Individual Risk Per Year
Dibenz(a,h)anthracene	0.0657	43.5×10^{-2} (2)	4.08×10^{-10}
Dioxins (3)	0.00172	38 (4)	9.34×10^{-10}
Hexachlorobenzene	0.0954	4.6×10^{-4} (1)	6.27×10^{-13}
PCBs	3.185	1×10^{-4} (1)	4.55×10^{-12}
Total Risk from facility			$\mathbf{0.135 \times 10^{-8}}$

(1) US Environmental Protection Agency
(2) 2000 WHO Air Quality Guidelines
(3) Expressed as TCDD-equivalent concentration of 2,3,7,8-tetrachlorobenzo dioxin (TCDD).
(4) California Air Resources Board

5.71 The health risk from the operation of the off-site facilities has been calculated. It has been assessed that that dioxins will pose the highest risk to the receivers, and the total health risk from the off-site treatment facilities have been calculated to be 0.135×10^{-8} per year, which is much lower than the guideline value of 1.4×10^{-8}. The risk level associated with the operation of the off-site treatment facilities is therefore assessed to be insignificant, and satisfy international criteria.

5.72 At the worst hit elevation above ground of the boundary of TKW site, the health risk per year is assessed to be less than 0.24×10^{-8}, which satisfy the guideline value. The health risk criteria will therefore be satisfied outside the off-treatment plant. Constraints further development for the TKW site is therefore not expected.

5.73 As discussed in the respective chapters of this EIA Report, dioxins contaminated run-off and soil will be controlled and properly stored in TKW. Also, livestock and vegetables are not expected around TKW, and exposure pathway through ingestion of livestock and vegetables are therefore not expected. The closest designated Fish Culture Zone is located at Ma Wan, which is located at more the1500 m the north-east of TKW. It is therefore expected that the risk level associated with exposure through intake of fish will not be an issue.

Cumulative Impacts

5.74 Air quality impacts during reclamation of Penny's Bay and the construction of the theme park have been predicted in the approved EIA Report *Construction of an International Theme Park in Penny's Bay at North Lantau and its Essential Associated Infrastructures.* Cumulative air quality impact from the dusty activities for the decommissioning of CLS together with other activities from the construction of theme park are also presented in this EIA Report. It is understood that blasting activities for the Chok Ko Wan Link Road (CKWLR) and the Penny's Bay Rail Link (PBRL) will not be conducted before 2003, and cumulative impact of blasting during the building demolition, slope improvement and excavation of contaminated soils is therefore not included. Cumulative air quality impacts for ASRs at Penny's Bay are shown in Table 5.22.

Table 5.22 Cumulative Hourly and Daily TSP Concentration

ASR	CLS (μgm^{-3}) (1)		Theme Park (μgm^{-3}) (2)		Cumulative (μgm^{-3}) (1)	
	Hourly	Daily	Hourly	Daily	Hourly	Daily
A1	153	86	113	39	266	125
A2	73	72	68	28	141	100
A3	73	71	84	31	157	102
A4	74	71	80	18	154	89
A5	103	76	115	22	218	98
A6	82	73	67	15	149	88
A7	85	72	86	14	171	86

(1) Background TSP concentration of 71 μgm^{-3} included in the figure.
(2) EIA, Theme Park and Associated Developments, without background TSP concentration.

5.75 Air quality impacts from the treatment facilities including biopile, thermal desorption and solidification processes have already been presented in Tables 5.17- 5.19. As there is no other industrial activity at the TKW, cumulative air quality impacts are therefore not expected.

5.76 Worst case emission combined with worst meteorological conditions have been employed to predict the air quality impacts at the ASRs. The prediction results were compared with both Hong Kong and international criteria. Modelling results indicted that the air quality criteria at ASRs will be satisfied under worst case scenario. It is therefore expected that the assessment criteria could be satisfied at all time.

Mitigation Measures

<u>Building Demolition and Slope Improvement</u>

5.77 Dust mitigation measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* shall be incorporated to control dust emission from the site. Under the regulation, demolition works is a notifiable work, and the contractor is responsible for carrying out the work and give notice to the authority prior to commencing the work. Major control measures relevant to this Project are listed below:

- skip hoist for material transport shall be totally enclosed by impermeable sheeting;
- vehicle washing facilities shall be provided at every vehicle exit point;

- the area where vehicle washing takes place and the section of the road between the washing facilities and the exit point shall be paved with concrete, bituminous materials or hardcores;

- where a site boundary adjoins a road, streets or other accessible to the public, hoarding of not less than 2.4 m high from ground level shall be provided along the entire length except for a site entrance or exit;

- every main haul road shall be scaled with concrete and kept clear of dusty materials or sprayed with water so as to maintain the entire road surface wet;

- the portion of road leading only to a construction site that is within 30m of a designated vehicle entrance or exit shall be kept clear of dusty materials;

- every stock of more than 20 bags of cement shall be covered entirely by impermeable sheeting placed in an area sheltered on the top and the 3 sides;

- all dusty materials shall be sprayed with water prior to any loading, unloading or transfer operation so as to maintain the dusty materials wet;

- vehicle speed shall be limited to 10 kph except on completed access roads;

- every vehicle shall be washed to remove any dusty materials from its body and wheels before leaving the construction sites; and

- dusty materials carried by vehicle leaving a construction site shall be covered entirely by clean impermeable sheeting to ensure dust materials do not leak from the vehicle.

Remediation Phase

5.78 In addition to the above mitigation measures, the following measures shall be incorporated at the work sites of contaminated pits during excavation. Occupational safety measures for the contaminated soil excavation have been described in Section 4.

- Excavation of dioxins contaminated soils shall be limited to 200 m^3/hr; whereas excavation of chromium VI and styrene contaminated soils shall be limited to 20 m^3/hr.

- The top layer soils shall be sprayed with fine misting of water immediately before the excavation;

- Inactive excavated area shall be covered by impermeable sheeting to minimise dust emissions.

- Dioxins contaminated soils shall be transported in roll-off truck with sealable top, and general contaminated soils shall be covered with impermeable sheeting during transportation.

Treatment Facilities

5.79 The design of the treatment facility shall satisfy the following criteria to limit the emission of air pollutants:

- Loading and handling of dioxins contaminated soil shall be conducted in an enclosed environment.

- Barrier shall be erected on four sides of the storage bin of general contaminated soils.

- Gaseous fuel shall be used for the thermal desorption facility.

- For the thermal desorption process, the dioxin emissions shall be 0.1 ng/m^3 and TOC emission 20 mg/m^3, with exhaust gas flow rate less than 60 m^3/min.

- The design of thermal desorption plant and associated air treatment unit shall allow only 0.0001% of dioxins, SVOC and PAHs from the soils, escaped as gaseous pollutants.

- TOC emission from the biopile shall be limited to 20 mg/m^3, with maximum flow rate of 56 m^3/min. Carbon absorber with 99 % control efficiency shall be installed to treat the off-gas prior to discharge.

- Characteristic study shall be conducted for the biopile to identify the concentration of individual species of VOC. Should excessive toxic or odorous VOC are found, additional measures such as adding new control equipment or reducing flowrate shall be implemented.

5.80 While the standard control measures shall be implemented in the treatment sites, specific mitigation measures in relation to the treatment process are summarised as follows.

- Biopiles shall be entirely covered with impermeable sheeting to minimize wind erosion.

- Spent activated carbon of the carbon absorber shall be replaced regularly.

- Temporary stockpiles for solidification shall be covered with impermeable sheeting to minimize wind erosion.

- Mixing process of solidification at TKW will be conducted in enclosed area.

- Minimum material handling shall be employed and carried out in an enclosed manner wherever possible.

- The thermal desorption shall be of enclosed process.

5.81 The handling and mixing of cement will follow the *Air Pollution Control (Construction Dust) Regulation* to limit cement emission.

- Cement shall be covered entirely by impermeable sheeting or placed in an area sheltered on the top and the 3 sides.
- Cement shall be stored in a closed silo fitted with audible high level of alarms to warn of over-filling.

Conclusions

5.82 Dust emission from the site is an area of the concern for the building demolition, slope improvement and remediation of CLS. TSP would be generated from materials handling and truck movement over haul roads. With the incorporation of dust control measures stipulated in the *Air Pollution Control (Construction Dust) Regulation,* the TSP level at the ASR will be low and within the acceptable criteria.

5.83 Dioxins would be dispersed in form of dust during the excavation of contaminated soils. Modelling results indicated that the impacts at the ASRs satisfy the hourly criteria with the proposed excavation rates.

5.84 The contaminated soils are treated by means of biopiles, solidification and thermal desorption plant, at CLS and TKW. The thermal desorption process and mixing activity of solidification at TKW shall be conducted in enclosed process and biopiles entirely covered with impermeable sheeting.

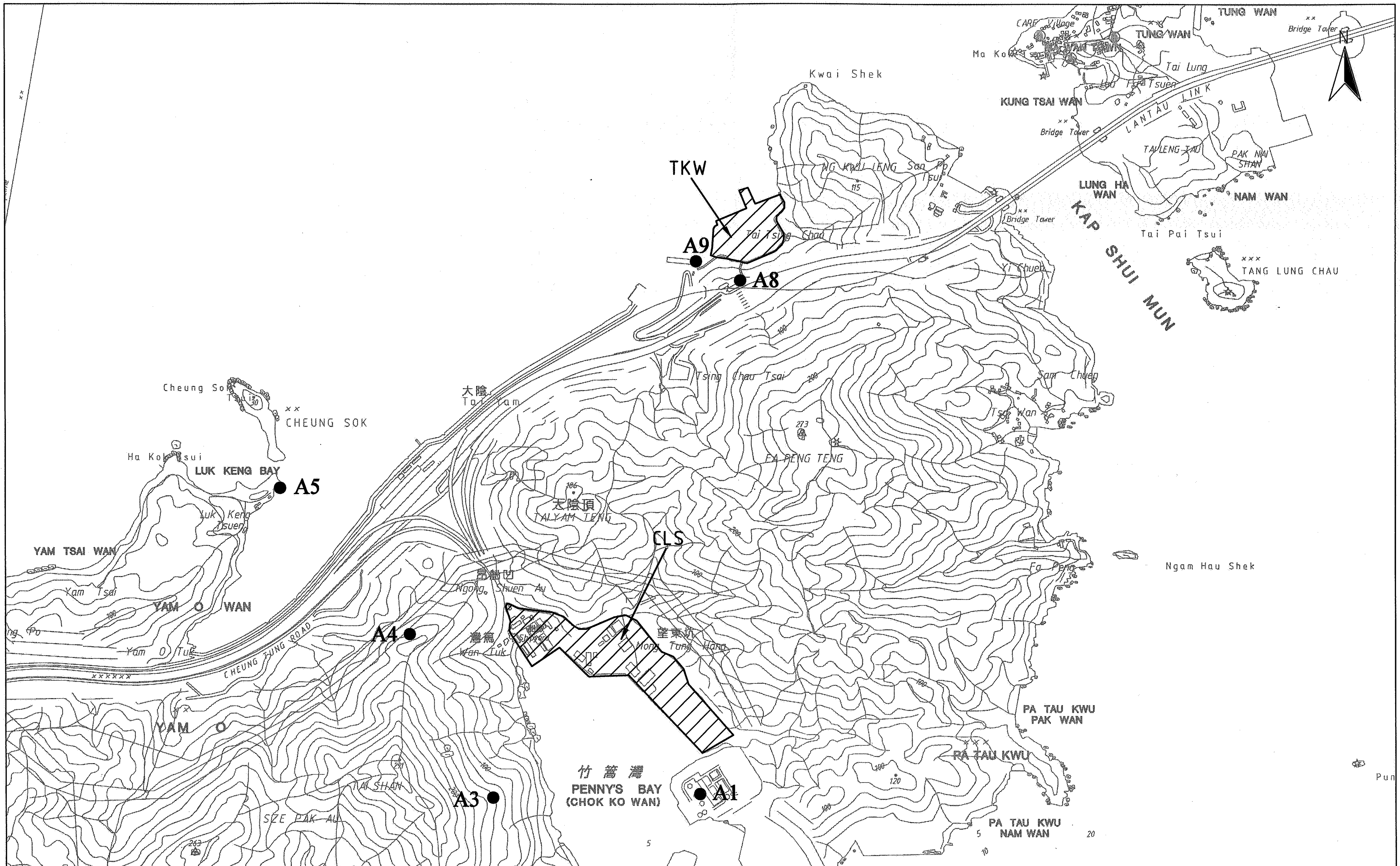
5.85 The designs of thermal desorption process and the associated air treatment unit is able to remove dioxins as well as other organic contaminants of the soil. Contaminated soils will be heated up in an indirect heat giving the off-gas, and off-gas will undergo a rapid quenching. Air pollutants, escaped from quenching process will be discharge after passing through air treatment unit comprising a spray tower, mist eliminators, baghouse, HEPA filter and backup carbon absorber. Discharge concentration of dioxins will be controlled to within 0.1 ng/m^3, while the organic gas will be limited to 20 mg/m^3. The design of thermal desorption plant and associated air treatment unit shall allow only 0.0001% of dioxins, organic gases and PAHs from the soils, escaped as gaseous pollutants.

5.86 The organic contaminants in soil and off-gas in the biopile will be degraded and extracted through back-up carbon absorber where the volatile organics are stripped off. Design of biopile will control the TOC emission to 20 mg/m^3 in maximum. Off-gas from biopiles shall be treated by back-up carbon absorber to ensure 99 % pollutant is removed prior to discharge. Solidification process could immobilise the pollutants and the mixing process at TKW will be enclosed.

5.87 Trace amount of toxic air pollutants including dioxins would be escaped from the treatment facilities after passing through air treatment unit. Air quality impacts of the pollutants have been modelled under the worst case scenario. Modelling results indicated that the air pollutants emitted from the facilities including dioxins and TAPs are very low and air quality impacts at the ASRs will comply with the respective criteria.

5.88 Air quality impact associated with the decommissioning of TKW site will be low and complied with the criteria.

5.89 The risk level associated with the operation of the off-site treatment facilities has been assessed to be insignificant, and comply with international criteria.



Title			
Agreement No. CE 68/99 Infrastructure for Penny's Bay Development - Engineering Design and Construction Decommissioning of Cheoy Lee Shipyard	Scale 1 : 15000	Project No. R06100	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
Locations of Representative Air Sensitive Receivers (Sheet 1 of 2)	Date Feb 2002	Figure No. 5.1	

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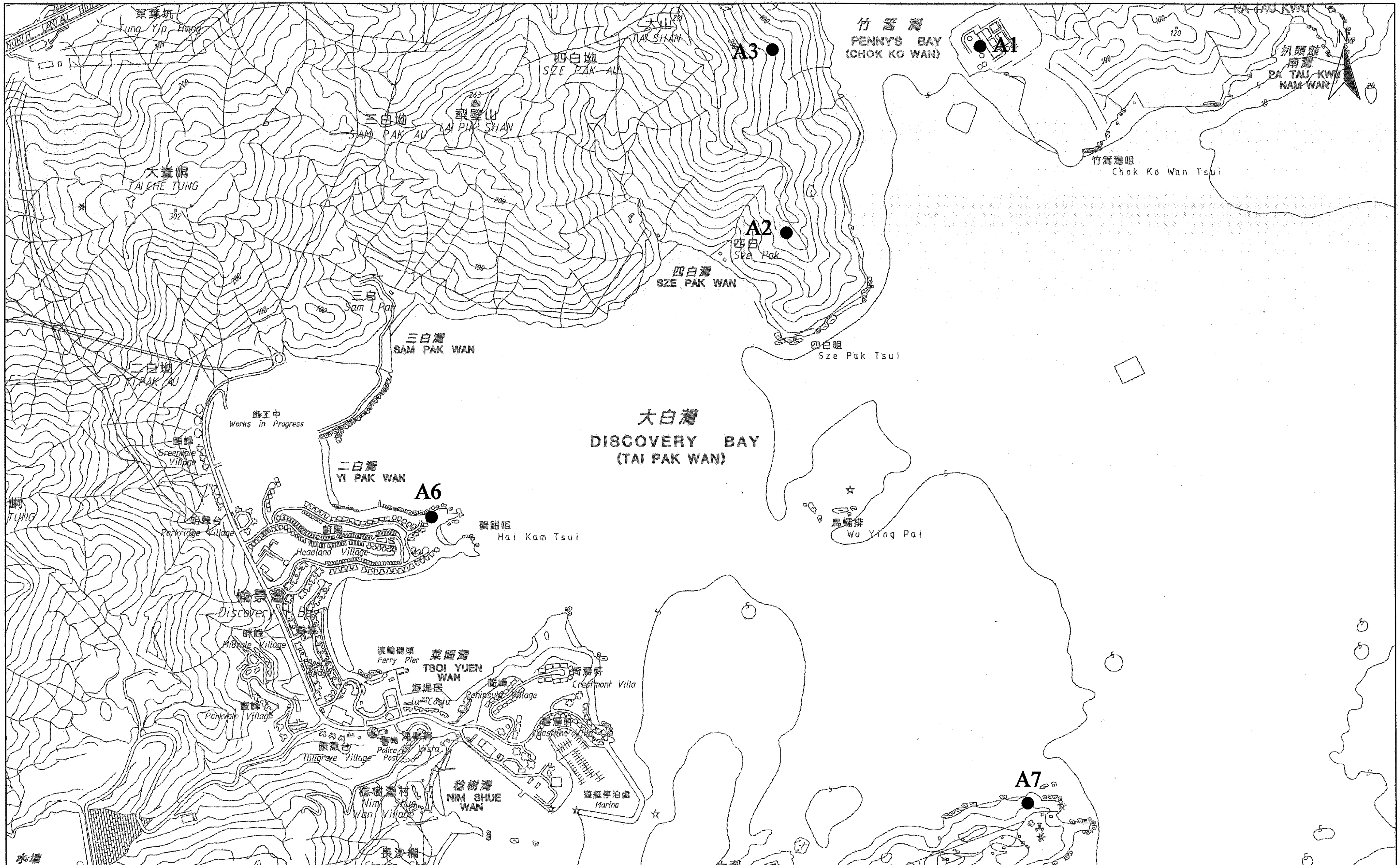

Title			
Agreement No. CE 68/99 Infrastruture for Penny's Bay Development - Engineering Design and Construction Decommissioning of Cheoy Lee Shipyard **Locations of Representative Air Sensitive Receivers (Sheet 2 of 2)**	Scale 1 : 15000	Project No. R06100	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
	Date Feb 2002	Figure No. 5.1	

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Title			
Agreement No. CE 68/99 Infrastructure for Penny's Bay Development - Engineering Design and Construction Decommissioning of Cheoy Lee Shipyard Contours of Hourly TSP Concentrations ($\mu g/m^3$) at 1.5m Above Ground Level	Scale: As Shown	Project No. R06100	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
	Date: Feb 2002	Figure No. 5.2	

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Title			
Agreement No. CE 68/99 Infrastructure for Penny's Bay Development - Engineering Design and Construction Decommissioning of Cheoy Lee Shipyard	Scale As Shown	Project No. R06100	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
Contours of Daily TSP Concentrations ($\mu g/m^3$) at 1.5m Above Ground Level	Date Feb 2002	Figure No. 5.3	

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Title			
Agreement No. CE 68/99 Infrastructure for Penn's Bay Development - Engineering Design and Construction Decommissioning of Cheoy Lee Shipyard Contours of Hourly NO_2 Concentrations ($\mu g/m^3$) at 30m Above Ground Level - To Kau Wan	Scale: As Shown	Project No. R06100	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
	Date: Feb 2002	Figure No. 5.4	

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Title			
Agreement No. CE 68/99 Infrastructure for Penn's Bay Development - Engineering Design and Construction Decommissioning of Cheoy Lee Shipyard	Scale As Shown	Project No. R06100	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
Contours of Hourly TOC Concentrations ($\mu g/m^3$) at 20m Above Ground Level - To Kau Wan	Date Feb 2002	Figure No. 5.5	

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Title	Scale	Project No.
Agreement No. CE 68/99 Infrastructure for Penn's Bay Development - Engineering Design and Construction Decommissioning of Cheoy Lee Shipyard	As Shown	R06100
Contours of Hourly Dioxin Concentrations (pg/m^3) at 30m Above Ground Level - To Kau Wan	Date: Feb 2002	Figure No. 5.6

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