3. AIR QUALITY IMPACT

3.1 Introduction

This chapter presents the impact assessment on potential air quality aspects for the construction, operation, restoration and aftercare stages of the Project.

Control measures for construction related activities have been recommended, in accordance with the requirements specified in the Air Pollution Control (Construction Dust) Regulation. Proper emission control limits for stack emissions from ammonia stripping plant, flare and landfill gas (LFG) power generator will be in place for the WENT Landfill Extension, similar to the existing WENT Landfill operation. Together with the implementation of good site practice for the tipping operation, the air quality impact will be controlled to within Hong Kong Air Quality Objectives (HKAQOs).

The assessment has been conducted in accordance with the requirements of Annex 4 and Annex 12 of the TM-EIAO, as well as the requirements set out under Clause 3.4.1 of the EIA Study Brief.

3.2 Environmental Legislation, Standards and Guideline

The relevant legislation and associated guidance notes applicable to the study for the assessment of air quality implications include:

- Environmental Impact Assessment Ordinance (Cap. 499) and Technical Memorandum on Environmental Impact Assessment Process (TM-EIAO);
- Air Pollution Control Ordinance (APCO) (Cap. 311) Air Pollution Control (Construction Dust) Regulation (Cap. 311R);
- Hong Kong Planning Standards and Guidelines (HKPSG);
- World Health Organisation (WHO); and
- United States Environmental Protection Agency (USEPA) references.

3.2.1 Air Quality Objectives

The principal legislation for controlling air pollutants is the Air Pollution Control Ordinance (Cap. 311) and its subsidiary regulations, which define statutory Air Quality Objectives (AQOs) for 7 common air pollutants. The AQOs for these air pollutants are tabulated in **Table 3.1** below.

Table 3.1 Hong Kong Air Quality Objectives

Pollutant	Concentration in micrograms per cubic metre ($\mu g/m^3$) [1] (Parts per million, ppm in brackets)				
	1 Hour [2]	8 Hour [3]	24 Hours [3]	3 Months [4]	1 Year [4]
Total Suspended Particulates (TSP)	500 [7]		260		80
Respirable Suspended Particulates (RSP) [5]			180		55
Carbon Monoxide, CO	30,000 (26.2)	10,000 (8.7)			
Sulphur Dioxide, SO_2	800 (0.3)		350 (0.13)		80 (0.03)
Nitrogen Dioxide, NO_2	300 (0.16)		150 (0.08)		80 (0.04)
Photochemical Oxidants (as Ozone, O_3) [6]	240				

Notes:
[1] Measured at 298K (25°C) and 101.325 kPa (one atmosphere).
[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] Respirable suspended particulates means suspended particulates in air with a nominal aerodynamic diameter of 10 micrometres or smaller.
[6] Photochemical oxidants are determined by measurement of ozone only.
[7] Not an AQO. TM-EIAO suggested short-term averaging level for 1 hour is 500ug/m^3. There is no exceedance allowance for 1-hour TSP guideline level.

3.2.2 Air Pollution Control (Construction Dust) Regulation

The Air Pollution Control (Construction Dust) Regulation identifies those processes that require special dust control. The DBO Contractor of the WENT Landfill Extension is required to inform EPD prior to carrying out such processes and to adopt dust reduction measures while carrying out "Notifiable Works" or “Regulatory Works”, as defined under the regulation. Works relevant to this Project are the site formation activities, for which TSP concentration shall not exceed 500 $\mu g/m^3$.

3.2.3 Odour Criteria

In accordance with Annex 4 of TM-EIAO, the limit of 5 odour units (OU) based on an averaging time of 5 seconds for odour prediction assessment shall not be exceeded at any receivers.

3.2.4 Other Pollutants

Other pollutants that are not covered by the Hong Kong AQOs but may impose a health risk concern have also been considered. The criteria / guideline values related to carcinogenic and non-carcinogenic health risk evaluation are established from the following order of reference:

- World Health Organization (WHO);
- United States Environmental Protection Agency (USEPA); and
- California Environmental Protection Agency (CEPA).

The guidelines for the assessment of carcinogenic health risk from exposure to air toxics are based on the WHO and USEPA Integrated Risk Information System (IRIS)’s acceptable lifetime risk.

Long-term monitoring for 38 species of VOC relating to the landfilling operation is being conducted at the existing WENT Landfill. Nonetheless, emission for 18 species of these VOC is found to be insignificant and below the detection limit. Out of the remaining 20 species of VOC, only 8 species have documentary concern related to carcinogenic and non-carcinogenic health risk. The unit risk factor and reference dosage for the 8 related VOCs are tabulated in **Table 3.2**.

Table 3.2 Unit Risk factors and reference dosage from WHO/IRIS/CEPA database on related VOCs

Substance [1]	Molecular Weight g/mol [4]	Unit Risk Factor per µg/m3 [3]	Reference dosage [2,4,5,6,7]
Benzene (CASRN 71-43-2)	78.11	$6x10^{-6}$	Chronic Inhalation Exposure (RfC): 30 µg/m^3 (9.4ppbv) (IRIS) Acute: 1.3 x 10^3 µg/m^3 (406.9ppbv) (CEPA)
1,4-Dichlorobenzene (CASRN 106-46-7)	147.01	-	Chronic Inhalation Exposure (RfC): 8x10^2 µg/m^3 (133.1ppbv) (IRIS)
Ethyl Benzene (CASRN 100-41-4)	106.16		Chronic: 22,000 µg/m^3 for 1 year averaged All based on WHO (Geneva) Chronic Inhalation Exposure (RfC): 1000 µg/m^3 (230.3ppbv) (IRIS)
Toluene (CASRN 108-88-3)	92.14	-	Acute: 1 x 10^3 µg/m^3 for 30min averaged (odour threshold) (265.4ppbv), based on S5.14 of WHO Chronic: 260 µg/m^3 (69ppbv) of 1 week, based on S5.14 of WHO
Vinyl chloride (CASRN 75-01-4)	62.5	$1.0x10^{-6}$	Chronic Inhalation Exposure (RfC): 100 µg/m^3 (IRIS) Acute: 1.8x10^5 µg/m^3 (70,416ppbv) (CEPA)
Xylenes (CASRN 1330-20-7)	106.16	-	Acute: 4800 µg/m^3 for 24 hour averaged Chronic: 870 µg/m^3 for 1 year averaged All based on WHO (Geneva) Chronic Inhalation Exposure (RfC): 100 µg/m^3 (23.0ppbv) (IRIS)
Tetrachloroethylene (CASRN 127-18-4)	165.8	-	Acute: 8000 µg/m^3 for 30 min averaged; 250 µg/m^3 for 24 hour averaged based on WHO (Geneva)
Methylene Chloride / Dichloromethane (CASRN 75-09-2)	84.93	$4.7x10^{-7}$ [8]	Acute: 3mg/m^3 for 24 hour guideline; Chronic: 0.45mg/m^3 for a weekly guideline All based on S5.7 of WHO

Note: [1]. CASRN – Chemical Abstracts Service Registry Number
[2]. RfC – Reference Concentration
[3]. If WHO standard is available, it will be applied first
[4]. $C_{ppbv} = C_{ug/m3} \times 24.45$ / Molecular Weight
[5]. WHO represents Air Quality Guideline for Europe, WHO
[6]. WHO (Geneva) represents Guidelines for Air Quality, WHO, Geneva, 2000
[7]. CEPA represents California Environmental Protection Agency
[8] As per Integrated Risk Information System (IRIS) (http://www.epa.gov/ncea/iris/subst/0070.htm)

3.2.4.1 Carcinogenic Health Risk Assessment

Emissions pertinent to this Project are benzene and vinyl chloride which are key control parameters from the Ammonia Stripping Plant (ASP), flares and LFG generators. **Tables 3.3** and **3.4** show the unit risk factors for non-criteria key pollutants of benzene and vinyl chloride and the guidelines for assessment of individual risk.

Table 3.3 Unit risk factors guideline for non-criteria pollutants

Pollutant	Unit Risk Factor ($(\mu gm^{-3})^{-1}$)
Benzene	$6x10^{-6}$
Vinyl Chloride	$1.0x10^{-6}$

Table 3.4 Risk guidelines for carcinogenic health risk assessment

Acceptability of Cancer Risk	Estimated Individual Cancer Risk Level ($(\mu gm^{-3})^{-1}$)	
	Individual Lifetime Risk (A)	Individual Risk Per Year (B) = (A)/70
Significant	$>10^{-4}$	$>1.4x10^{-6}$
Risk should be reduced to As Low As Reasonably Practicable (ALARP)	$>10^{-6}$ & $<= 10^{-4}$	$>1.4x10^{-8}$ & $<= 1.4x10^{-6}$
Insignificant	$\leq 10^{-6}$	$\leq 1.4x10^{-8}$

3.2.4.2 Non-Carcinogenic Health Risk Assessment

Non-carcinogenic health risk guidelines apply to the assessment of chronic and acute health risks.

Chronic Health Risks

Using the chronic health risk assessment approach, the chronic reference concentrations for benzene and vinyl chloride are summarized in **Table 3.5** and their acceptability criteria in **Table 3.6**.

Table 3.5 Chronic reference concentrations for benzene and vinyl chloride

Pollutant	Chronic Reference Concentration (AC_A) (Annual Average)
Benzene	30 $\mu g/m^3$ (9.4ppbv) [a]
Vinyl Chloride	100 $\mu g/m^3$ (39.12ppbv) [a]

Note: [a] Yr 2000 updated standard from Integrated Risk Information System (IRIS), USEPA

Table 3.6 Acceptability criteria for chronic non-cancer health risks

Acceptability	Assessment Results [a]
Chronic non-cancer risks are considered "Insignificant"	$AC_A \leq RC_C$
Chronic non-cancer health risks are considered 'Significant". Detailed assessment of the control requirements and further mitigation measures are needed	$AC_A > RC_C$

Note: [a] AC_A and RC_C represent annual average concentration and chronic reference concentration respectively.

Acute Health Risks

Using the acute health risk assessment approach, the acute reference concentrations for benzene and vinyl chloride are summarized in **Table 3.7** and their acceptability criteria in **Table 3.8**.

Table 3.7 Acute reference concentrations

Pollutant	Acute Reference Concentration (AC_{HM}) (1-hour average, µg m^{-3})
Benzene	1.3×10^3 [(a)]
Vinyl Chloride	1.8×10^5 [(a)]

Note : [(a)] California Air Resources Board – Air Toxic Hot Spots Program Risk Assessment Guidelines, Part I – Technical Support Document for the Determination of Acute Reference Exposure Levels for Airborne Toxicants, May 2000.

Table 3.8 Acceptability criteria for acute non-cancer health risks

Acceptability	Assessment Results [(a)]
Acute non-cancer risks are considered "Insignificant".	$AC_{HM} \leq RC_A$
Acute non-caner health risks are considered "Significant". Detailed assessment of the control requirements, and further mitigation measures are needed.	$AC_{HM} > RC_A$

Note: [(a)] AC_{HM} and RC_A represent maximum hourly average concentration and acute reference concentration respectively.

3.3 Description of the Existing WENT Landfill and WENT Landfill Extension

3.3.1 Existing Vehicles Trips Generated from existing WENT Landfill

Based on the latest information from existing WENT Landfill, there is about 400 vehicles/day (or peak hourly flow of 43 vehicle/hour) travelling to and from the existing WENT Landfill site. These vehicles will generate some air pollutants. Most of the waste is however being transported by sea and the same method will be adopted for WENT Landfill Extension.

3.3.2 Existing Barges

Currently, there are 5 barging points at the existing WENT Landfill along the existing coastline to receive waste via barges from different transfer stations. These barges would inevitably generate air quality pollutants during both idling at the barging points and travelling along the marine route. According to the information provided by the operators, the current utilisation schedule of these barges is as follows. Also, according to the EIA Report of STF, the barge for STF is assumed to be berthed at the existing HATS barging point with idling period similar to that of WKTS (see **Figure 3.5a** for the locations of barges).

Table 3.8a Operation schedule for barges

	Barging Points in Existing WENT Landfill					
	IETS	IWTS	OITF	WKTS	NLTS	STF
Round Trips (nos / day)	1	1	1	1	1	1
Idling period (Note)	2130 - 1700	2100 -1800	1100 - 1430	0730 - 1930	0830 – 0920	0600 - 2000
Engine turned on during idling	Aux	Aux	Aux	No	Only Generator	No

Note: Take IETS as an example, 2130 refers to the time when the barge arrives. When it arrives, it would wait until daytime period when the loading / unloading process starts. The process would be completed by 1700 and the barge would leave by 1700. This is the reason why manoeuvring would be before one hour before 2130 and one hour after 1700.

3.3.3 Existing Monitoring Location and Condition

3.3.3.1 Existing plants operation

During operation of existing WENT Landfill, gaseous emission from Ammonia Stripping Plant (ASP), flare system etc. would be generated. The flare system operates only when the ASP is not in use or when excessive LFG is pending for treatment. Yearly monitoring at the inlet and outlet of the flaring system is conducted to verify the destruction efficiency. Past monitoring results conclude that emission from flaring system has complied with the control limits. **Appendix 3.1a** presents the past monitoring results for the removal efficiency of the flaring system.

3.3.3.2 Existing Monitoring and Audit Findings

TSP / RSP

EM&A records for TSP/RSP monitoring over the last 10 years have been reviewed. TSP/RSP monitoring is conducted once every 6 days in two off-site locations (See **Figure 3.1** for existing dust monitoring locations ASR4 & ASR13).

Key observations from the past monitoring records are summarised in **Table 3.9** for TSP/RSP.

Table 3.9 Summary of Dust monitoring record for existing WENT Landfill operation

Monitoring ID	Location	Monitoring Parameters	Frequency	Observations	Mitigation Measures
ASR4	North-west part of Ha Pak Nai	TSP/RSP (24-hour averaged)	Once very 6 days. Increase frequency in case of exceedance event	No exceedance since 2003 (only 2 x 24-hour average abnormalities detected from period 2002 to 2003.)	Increase water spraying frequency in tipping area and haul road by water trucks and sweeper trucks Minimize the exposure duration of cut slopes and temporary capped areas by covering with plastic sheets.
ASR13	South-west part of Ha Pak Nai			No exceedance since 2003 (only 2 x 24-hour average abnormalities detected from period 2002 to 2003.)	

Remark : The established EM&A mechanism and good site practice in existing WENT Landfill effectively contains any dust problem on site in a timely manner.

An Independent Consultant (IC) had also reviewed all these monitoring results and the findings for the site inspection by Environmental Team. A summary of long-term TSP / RSP monitoring results are tabulated in **Table 3.10**.

Table 3.10 10-year averaged TSP/RSP concentration of the nearest ASRs (from Year 1996 to Year 2006)

Pollutants	Parameter	10-year monitoring data at off-site location, ug/m3	
		ASR 4	ASR 13
TSP (24-hr average)	range	25 - 300	15 - 360
	average	87	94

Pollutants	Parameter	10-year monitoring data at off-site location, ug/m3	
		ASR 4	ASR 13
RSP (24-hr average)	range	3 - 290	1 - 300
	average	62	62

Remark: Only 4 x 24-hour average abnormalities detected in 10-year period, and the abnormalities were immediately rectified by standard mitigation measures.

VOC

EM&A records for VOCs monitoring over the last 10 years have been reviewed. VOC monitoring is conducted once every 3 months in four locations around the site boundary (See **Figure 3.2** for existing VOC monitoring locations OM2 to OM5), and one at the gas well.

The sampling methodology was stipulated in Environmental Monitoring Monthly Reports. Equipment specified in Method T015 of USEPA and corresponding HOKLAS methods for the determination of Toxic Organic Compounds in ambient air were adopted for monitoring the existing WENT Landfill. VOC is collected in 6L stainless steel canisters coated internally with silica. Control practices have been exercised including one Field Blank sample with "Zero Air" for checking of potential contamination during the trip. There was another Field Sample which had been spiked with known VOCs and being analysed before and after the trip.

Key observations from the past monitoring records are summarised in **Table 3.11** for VOC. In accordance with the long-term monitoring record, there were only 4 abnormality records on 24-hour averaged data found in a 10-year period (from Year 1996 to 2006).

Table 3.11 Summary of VOC monitoring information for existing WENT Landfill operation

Monitoring ID	Location	Monitoring Parameters	Frequency	Observations	Mitigation Measures
OM2	East of the landfill area	44 VOCs including 8 prominent VOCs: • Benzene; • 1, 4 – Dichlorobenzenes; • Ethylbenzene; • Toluene; • Vinyl chloride; • Xylenes; • Tetrachloroethylene; • Methylene Chloride.	Quarterly basis in March, June, September and December at four boundary locations and one gas well within the landfall. If the monitoring results show abnormality, site inspection and special monitoring will be conducted.	No abnormality observed in the past 10 years	No exceedance was identified in the monitoring. In case of exceedance, site investigation to identify and pipe leakage (compare with gas composition) and to optimize extraction. The objectives are to determine radius of influence of abstraction wells and optimum suction pressure and extraction rates.
OM3	North of the landfill area				
OM4	West of the landfill area				
OM5	South of the landfill area				

Remark: (1) VOC monitoring data and emission trend at source (within gas well) were compared with the results at the site boundary. Independent Consultant (IC) confirmed that the handful number of abnormal readings were not caused by / related to landfill operation.

(2) Trigger limit = OEL (on-site locations OM2, OM4 and OM5) and 1% OEL (off-site location OM3) Trigger limits are available for a limited number of VOCs.

(3) OEL = Occupational Exposure Limit "UK Health and Safety (HSE) EH40/91 or EH40/93" – short term exposure unless otherwise specified.

An IC had also reviewed all these monitoring results and the findings for the site inspection by Environmental Team. It was concluded that no abnormality in the VOC monitoring was observed over the past 10 years. A summary of VOC monitoring results are tabulated in **Table 3.12**.

Table 3.12 10-year averaged VOC concentration at the site boundary of the existing WENT Landfill

Pollutants	Parameter	10-year monitoring data at the site boundary (in μg/m^3 except methane) [1,2 and 3]			
		OM2	OM3	OM4	OM5
1,1,1-Trichloroethane	range	0.78 - 17	0.6 - 24	0.61 - 180	0.8 - 110
(CASRN 71-55-6)	average	1.4	1.7	4.6	3.5
1,2-Dibromoethane	range	1 - 1	1 - 1	1 - 1	1 - 1.5
(CASRN 106-93-4)	average	1.0	1.0	1.0	1.0
1,2-Dichloroethane	range	0.3 - 3.2	0.3 - 3.8	0.3 - 3.8	0.3 - 0.3
	average	0.4	0.4	0.4	0.3
a-Pinene	range	0.8 - 18	0.8 - 16	0.36 - 11	0.6 - 40
	average	1.4	1.3	1.4	2.9
Benzene	range	0.49 - 57	0.5 - 10	0.5 - 18	0.5 - 14
(CASRN 71-43-2)	average	5.9	3.3	3.6	3.0
b-Pinene	range	0 - 0.4	0 - 8.9	0 - 12	0 - 6.8
	average	0.3	0.5	0.7	0.4
Butan-2-ol	range	1.4 - 44	1.4 - 36	1.4 - 62	1.4 - 38
(CASRN 71-36-2)	average	2.3	2.2	2.6	3.5
Butanethiol	range	0 - 1.2	0 - 2	0 - 1.2	0 - 1.2
	average	1.1	1.2	1.1	1.1
Carbon Disulphide	range	0 - 12	0 - 0.9	0 - 7.5	0 - 0.5
(CASRN 75-15-0)	average	0.8	0.5	0.6	0.5
Carbon Tetrachloride	range	0.4 - 1.3	0.6 - 7.7	0.6 - 6.9	0.44 - 12
	average	0.7	0.9	0.8	0.9
Chloroform	range	0.8 - 18	0.8 - 11	0.8 - 11	0.8 - 13
(CASRN 67-66-3)	average	1.4	1.4	1.5	1.2
Dichlorodifluoro-methane	range	0.6 - 583.7	0.6 - 1296	0.6 - 947.6	0.6 - 700.3
(CASRN 75-71-8)	average	32.1	37.3	40.1	37.2

Pollutants	Parameter	10-year monitoring data at the site boundary (in $\mu g/m^3$ except methane) [1,2 and 3]			
		OM2	OM3	OM4	OM5
Dimethyl Sulphide	range	0.2 - 9.2	0.2 - 4	0 - 3	0.2 - 2.8
	average	0.5	0.3	0.3	0.3
Dipropyl Ether	range	0.9 - 0.9	0.9 - 0.9	0.9 - 0.9	0.9 - 1.3
(CASRN 111-43-3)	average	0.9	0.9	0.9	0.9
Limonene	range	0.4 - 150	0.34 - 10	0.4 - 51	0.4 - 380
(CASRN 5989-27-5)	average	9.6	0.9	4.4	28.0
Ethanethiol	range	0.6 - 19	0.6 - 17	0 - 0.6	0.6 - 81
	average	1.0	1.0	0.6	3.2
Ethanol	range	18 - 50	50 - 50	8.2 - 139	50 - 409
	average	49.3	50.0	51.0	66.6
Ethyl Butyrate	range	0.74 - 13	1.2 - 17	0.67 - 4.15	0.2 - 36
	average	1.9	1.8	1.5	2.6
Ethyl Propionate	range	1 - 2.1	1 - 7.3	1 - 1	1 - 1
	average	1.0	1.2	1.0	1.0
Ethyl Benzene	range	0.5 - 480	0.5 - 78	0.5 - 240	0.5 - 87
(CASRN 100-41-4)	average	27.5	6.3	16.9	11.5
m,p-Xylene	range	0.5 - 460	0.5 - 110	0 - 240	0.4 - 130
	average	40.6	13.2	29.3	21.0
m-Dichlorobenzene	range	1 - 48	1 - 17	0 - 58	1 - 23
(CASRN 106-46-7)	average	3.7	2.1	2.7	2.1
Methane (ppm)	range	45 - 100	14 - 100	0 - 100	3.3 - 100
	average	98.8	98.1	96.4	95.8
Methanethiol	range	0 - 0.4	0 - 0.4	0 - 60	0 - 0.4
	average	0.4	0.4	1.6	0.4
Methanol	range	0 - 30	0 - 30	0 - 36	0 - 30
	average	28.3	28.2	28.7	28.1
Methyl Butyrate	range	1 - 1.3	1 - 6.3	1 - 1	0.32 - 1
	average	1.0	1.2	1.0	1.0
Methyl Propionate	range	1.2 - 1.2	1.2 - 6.1	1.2 - 2.2	1.2 - 1.2
	average	1.2	1.3	1.2	1.2
Methylene Chloride	range	0 - 729	0 - 2740	0 - 942	0 - 1588
	average	57.1	122.3	93.7	103.1
n-Butyl Benzene	range	0.74 - 110	1 - 11	1 - 52	1 - 23

Pollutants	Parameter	10-year monitoring data at the site boundary (in $\mu g/m^3$ except methane) [1,2 and 3]			
		OM2	OM3	OM4	OM5
	average	3.5	1.6	2.1	1.9
n-Butyl Acetate	range	0.67 - 140	0.95 - 64	1.2 - 88	1 - 27
	average	4.7	3.0	3.9	3.3
n-Decane	range	0.55 - 47	0.56 - 11	0.7 - 20	0.7 - 11.3
	average	2.3	1.2	1.9	2.1
n-Heptane	range	0.87 - 16	1 - 9.2	0.93 - 12	0.9 - 13.73
	average	2.4	1.8	2.3	2.8
n-Nonane	range	0.42 - 14	0.42 - 5.2	0.68 - 6.2	0.9 - 8.31
	average	1.6	1.2	1.3	1.9
n-Octane	range	1.2 - 6.1	0.34 - 5.5	0.63 - 8	0.85 - 7.3
	average	1.4	1.3	1.5	1.6
n-Propyl Benzene	range	0.48 - 62	0.8 - 27	0.8 - 130	0.34 - 320
	average	8.9	6.3	11.5	15.4
n-Undecane	range	0.39 - 2.6	0.34 - 3.42	0.67 - 5	0.6 - 12
	average	1.2	1.2	1.4	2.1
o-Dichlorobenzene	range	1 - 22	1 - 11	0.9 - 14	0.9 - 4.3
	average	1.9	1.7	1.5	1.1
Xylene	range	0.48 - 150	0.5 - 59	0.41 - 110	0.2 - 67
(CASRN 1330-20-7)	average	12.0	5.1	11.5	8.0
p-Dichlorobenzene	range	1 - 17	0.7 - 12	0 - 220	1 - 220
	average	2.8	2.9	10.1	9.1
Propyl Propionate	range	1 - 44	1 - 41	1 - 26	1 – 74
	average	2.5	3.0	1.7	3.4
Tetrachloroethylene	range	0.5 - 24	0.7 - 45	0.31 - 22	0.7 – 14
(CASRN 127-18-4)	average	1.7	3.1	2.6	2.1
Toluene	range	0.5 - 2200	0.5 - 950	0.5 - 400	0.2 – 1800
(CASRN 108-88-3)	average	120.2	67.6	65.3	110.5
Trichloroethylene	range	0.48 - 25	0.2 - 7.58	0.51 - 16	0.33 - 6.11
(CASRN 79-01-6)	average	2.8	1.7	2.4	1.8
Vinyl Chloride	range	0.3 - 19	0.3 - 9.7	0.3 - 318	0.3 - 0.7
(CASRN 75-01-4)	average	1.4	0.6	6.8	0.3

Remark (1) Assume to take the lowest detection limit as the monitoring result if the equipment record below detection limits

(2) Trigger limit = OEL (on-site locations OM2, OM4 and OM5) and 1% OEL (off-site location OM3) Trigger limits are available for a limited number of VOCs.

(3) OEL = Occupational Exposure Limit "UK Health and Safety (HSE) EH40/91 or EH40/93" – short term exposure unless otherwise specified.

<u>Odour</u>

Odour complaint records from existing WENT Landfill site office and EPD Environmental Compliance Division have been checked. There were about 10 odour complaints in the past 2 years while most of the complaints occurred at Tuen Mun area at a separation distance of more than 2.5km. Detailed investigations were conducted by the Independent Consultant, Environmental Team of the existing WENT Landfill and EPD. According to the record of odour patrol conducted by existing WENT Landfill site staff, occasionally and intermittent slight malodour was only detected in the immediate area of about 50 m from the existing WENT Landfill. No malodour is detected in the area with distance of 1 km from the existing WENT Landfill. Thus, it was concluded that the existing WENT Landfill was not the source of the odour nuisance.

A summary of the odour complaints in the past 10 years (i.e. 1998-2008) is given in **Appendix 3.1b.**

<u>Benzene, Vinly Chloride and NMOCr</u>

Benzene, Vinyl Chloride and Non-methane Organic Carbon (NMOC) have also been monitored at the flare of the existing WENT Landfill, and the monitoring results (from Year 2002 to 2006) are summarised in **Table 3.13**.

Table 3.13 Monitoring data from flare system (from Year 2002 to Year 2006)

Pollutants	**NMOC**		**Vinyl Chloride**		**Benzene**	
5-year Monitoring Results	**Inlet**	**Outlet**	**Inlet**	**Outlet**	**Inlet**	**Outlet**
Max (ppmv)	1400	15	0.28	0.006	0.8	0.012
Min (ppmv)	420	0.7	0.02	<0.002	0.05	<0.002
Average (ppmv)	856	5.18	0.158 or 403.7 μg/m³	0.0032 or 8.2 μg/m³	0.414 or 1322.6 μg/m³	4.4×10^{-3} or 14.1 μg/m³
Removal Efficiency [average value (inlet - outlet) pair_data /inlet]	99.1%		95.4%		98.1%	

Owing to the lack of monitoring data for ASP and power generator, reference has been made using typical control efficiency under Table 2.4-3, AP-42 of USEPA as the best estimate. The typical controlled efficiency of 99.6% and 99.8% are proposed for halogenated species and non-halogenated species for the modern type boiler/stream turbine. As compared to the controlled efficiency of 95.4% and 98.1% for halogenated species and non-halogenated species for flare in existing WENT Landfill, the efficiency in flare would be less effective than the USEPA database using more advance equipment. As a conservative assumption, the controlled efficiency for ASP and power generator is assumed to be the same as that for the flare in the existing WENT Landfill.

3.3.4 Ambient air quality from EPD monitoring station

The WENT Landfill Extension will be located adjacent to the existing WENT Landfill and close to the Black Point Power Station (BPPS). The local air quality is affected by the industrial emissions from the existing WENT Landfill, BPPS, and traffic emissions from existing roads and marine vessels.

There is no fixed air quality monitoring station near the existing WENT Landfill and its extension. The nearest EPD air monitoring station is Yuen Long. In accordance with the Guidelines in Assessing the 'TOTAL' Air Quality Impacts, the recent five years (2003-2007) average monitoring data are adopted as the background concentration. The background air pollutant concentrations adopted in this study are presented in **Table 3.14a** below.

Table 3.14a Background Major Air Pollutant Concentrations (5-year annual averaged)

Pollutant / Year	2003	2004	2005	2006	2007	5-year Averaged Concentration ($\mu g/m^3$)
TSP	98	113	104	101	97	103
RSP	61	71	62	62	64	64
NO_2	60	67	58	58	55	60
SO_2	18	31	28	28	24	26

3.3.5 Contribution of Emission from Black Point Power Station and Castle Peak Power Station

Air quality in the vicinity of the WENT Landfill Extension will also be influenced by the two existing power stations namely Black Point Power Station (BPPS) and Castel Peak Power Station (CPPS). With reference to the approved EIA Study of Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities (EIA-125/2006) and the Sludge Treatment Facilities (EIA-155/2008), the contribution from BPPS and CPPS are adjusted taking into account the updated ozone background concentration, the current generating capacity, and the effect of the low NO_x burners installed in CPA unit and CPB units of CPPS. The same approach was adopted in this assessment.

The adjusted NO_2 ,SO_2 ,and RSP concentrations at different locations are summarized in **Table 3.14b**. Details of the calculations on the adjusted contribution from BPPS and CPPS are shown in **Appendix 3.2**.

Table 3.14b Adjust Maximum Hourly, 2nd Highest Daily and Annual NO_2 ,SO_2 and RSP Concentrations

Location	Adjusted Concentration ($\mu g/m^3$)							
	NO_2 [1]			SO_2			RSP	
	Max. Hourly	Daily	Annual	Max. Hourly	Daily	Annual	Daily	Annual
Ha Pak Nai	94	19.2	0.5	171	60	1.5	3.9	0.1
Lung Kwu Tan	50.5	20.4	0.5	-	39	0.8	4.6	0.1

Note:
[1] Adjustment is based on the latest 5-year average (2003-2007) of the annual average of the daily hourly maximum ozone concentration (78.3 μg/m3) measured at Yuen Long Monitoring Station.

3.4 Air Sensitive Receivers

Air Sensitive Receivers (ASRs) have been identified in accordance with the guidelines in Annex 12 of the TM-EIAO. Existing ASRs were confirmed through site visits and review of survey maps. It is also noted that the latest Outline Zoning Plan does not cover the existing WENT Landfill and its extension, and hence no planned ASRs is identified in the vicinity area. Representative ASRs within a distance of 500m from the Project boundary have been selected for the assessment. Since some of the ASRs are located outside the 500m range, the nearest ASRs are also included in the assessment. Their respective locations are shown in **Figure 3.3** and **Table 3.15** below.

Table 3.15 Summary of representative air sensitive receivers

Assessment Point No.	Assessment Point Description	Use	No. of Storey (max.)	Shortest Horizontal Distance between ASR to boundary of WENT Landfill Extension, m
A1-1	West Ha Pak Nai	Residential	3	1190
A1-2	West Ha Pak Nai	Residential	3	1240
A1-3	West Ha Pak Nai	Residential	3	1065
A1-4	East Ha Pak Nai	Residential	3	1765
A2-1	Black Point Power Station (Office)	Industrial	3	855
A3-1	STF Office	Industrial	3	165
A4-1	Lung Kwu Sheung Tan	Place of Worship	1	900

Note : For IWMF, there is no confirmed site for the development and there is no implementation programme. Hence, IWMF is not considered as a concurrent project and ASR will not be assigned for IWMF.

3.5 Identification of Air Pollution Source and Environmental Impact

3.5.1 Source Identification

On-site and off-site air pollution sources during construction, operation, restoration and aftercare of the Project are summarised in **Tables 3.16** and **3.17** below:

Table 3.16 Sources of air pollution from Construction and Restoration Phases

Sources of air pollution
• Various construction activities during daytime • Wind erosion

Table 3.17 Sources of air pollution from Operation Phase

Sources of air pollution
• Road traffic (There is no increase in total flow between the existing WENT Landfill and its extension). • Potential dust emission arising from daily operations • Gases emission from flare, LFG power generator and ammonia stripping plants. • Odour emission from leachate treatment facilities. • Odour emission and surface gas emission from waste tipping operation. • Emission due to transportation of waste by barges (There is no increase in number of barges and no change under the operation mode). • Dust emission from phases being used due to wind erosion

3.5.2 Construction Phase

Heavy construction activities during daytime include site clearance, ground excavation, cut and fill (i.e. earth moving) operations, construction of the associated facilities and temporary road access within the site. In addition, wind erosion of all open sites including stockpiling will have potential impact.

About 16.6Mm³ of excavated soil will also be generated during the site formation works. Some of which will be reused for on-site infrastructure or stockpiled on site for subsequent use as daily cover, intermediate cover and final capping.

Construction plants will be located across the site, depending on need. The nearest representative ASR, CLP Power Plant, is located at about 850 m away from the nearest construction site boundary (i.e. Phase 4 & 5 Development with a total area of 60ha). The total gaseous emissions generated by the plants over the two construction phases are small (only 10% of the site area, i.e. 6 ha) and it will disperse and be diluted by the ambient air very rapidly. Therefore, the potential air quality impact associated with operation of the construction plants on the identified ASR is envisaged to be limited and minor.

Throughout the construction period, good site practices and dust control measures stipulated in the Air Pollution Control (Construction Dust) Regulation will be implemented to reduce the dust emission as much as possible. The site-specific good site practices and dust control measures are recommended in **Section 3.8**.

According to the approved STF EIA Report, the construction of the proposed STF would commence by Mar 2010 and all the construction activities would be completed by Mar 2011. Since the construction of WENT Landfill Extension would only commence by mid 2010s, there would not be any cumulative construction impacts with STF.

For IWMF, the site selection process is still on-going and there is no implementation plan. Hence, it is not considered as a concurrent project and there would not be cumulative impacts.

A summary of the air pollutant sources for the construction phase of the WENT Landfill Extension is given below:

Project	**Operation**
WENT Landfill Extension	o Excavation and site formation for the phases under construction
	o Waste filling for the phases under operation
	o Slope work and other activities for Nim Wan Road Diversion
Existing WENT Landfill	o Waste filling
	o Restoration
	o Construction of ponds (as part of the ecological mitigation measures for WENT Landfill Extension

Figures 3.4a to 3.4m show the locations of all the construction phase air quality emission sources.

3.5.3 Operation Phase

During the operation phase, the air pollution source considered for cumulative air quality impacts included emissions from:

- Vehicular emissions from traffic associated with the WENT Landfill Extension (including the Nim Wan Road diversion);
- Marine vessels emissions during operation of WENT Landfill Extension;

- Gaseous emissions from operation plants including Ammonia Stripping Plant (ASP) of leachete treatment plant (LTP), LFG power generators and flare system;
- Fugitive emission from the active tipping area, construction plants and Castle Peak Power Plant, emissions of LFG / VOC from landfill surfaces;
- Emissions from other Industrial Plants, including existing WENT Landfill, Black Point Power Plant, Castle Peak Power Plant, the proposed Sludge Treatment Facilities (STF), Green Island Cement Plant, the proposed Eco-Park, and Shiu Wing Steel Mill.
- Odour Emissions from Waste Filling Activities, Operation of LTP and the proposed STF.

Figures 3.5a to 3.5b show the locations of all the operation phase air quality emission sources. The following sections describe the emission inventories identified.

3.5.3.1 Vehicular Emissions from Road Traffic

Current daily vehicular trip generation travelling to and from the existing WENT Landfill site is in the order of 400 vehicles per day (at about 43 veh/hr during peak hour). According to the information from the operator, there would not be any increase in the number of vehicles when the WENT Landfill Extension comes into operation since there would not be any overlap between the operation of the existing WENT Landfill and the WENT Landfill Extension. Traffic access through the existing WENT Landfill used by the villagers of nearby villages at Ha Pak Nai and Lung Kwu Tan (currently around 5 veh/day) would be maintained and not be affected by the Nim Wan Road diversion.

In general, most of the refuse collection vehicles (RCV) for Municipal Solid Waste (MSW) and sludge are of enclosed-type and odorous gases are well contained during transit under normal circumstances. Sludge vehicles / special vehicles that require admission tickets, and special condition can be imposed on the cleanliness of vehicle and disposal period to avoid adverse cumulative impact. With reference to the existing WENT Landfill experience, potential odour impact from RCVs can be adequately controlled and unlikely to be an issue. Quantitative assessment is therefore not required.

In addition, all vehicles will be cleansed by wheel washing facility before leaving landfill, and soil brought away from landfill is thus not anticipated. Vehicle containing dusty material will also be covered by sheet to avoid any potential nuisance. Any dusty discharge on road is a violation of the Public Health & Municipal Ordinance. Therefore adverse off site dust impact is not anticipated.

3.5.3.2 Marine Vessel Emission

Similar to the existing WENT Landfill, marine vessels will be used to transport waste from refuse transfer stations to WENT Landfill Extension, and marine emission would be a concern. These refuse transfer stations include Island East Transfer Station (IETS), Island West Transfer Station (IWTS), Outlying Island Transfer Station (OITS), West Kowloon Transfer Station (WKTS) and North Lantau Transfer Station (NLTS). Emission from a future marine vessel that may be operated to transport the sludge from Stonecutters Island Sewage Treatment Works (SCISTW) to existing WENT Landfill or STF for disposal is also considered in this study.

According to the information from the operation, the existing operation schedule in **Section 3.3.2** would remain unchanged for the WENT Landfill Extension.

3.5.3.3 Gaseous Emissions from Operation Plants

As discussed in **Section 3.3,** there are air quality emission from the ASP and the LFG flaring system. **Figure 5.6** illustrates the schematic arrangement of these plant (for both the WENT Landfill Extension and the existing WENT Landfill).

Emission from Ammonia Stripping Plant

As regards the ammonia stripping plant and leachate treatment plant for the WENT Landfill Extension, new plant will be built to the most updated international standard. For the existing restored WENT Landfill, new plant will also be provided with the most updated international standard. Treatment method such as Sequencing Batch Reactor could be adopted for biological treatment of leachate.

Leachate will be collected from the restored existing WENT Landfill and its extension and pumped to the new leachate treatment plant (LTP) in the new infrastructure area. Each LTP will consist of lecahate storage tanks, ammonia stripping plant, deodoriser, a stripped leachate storage tank, three SBR tanks and an effluent storage. All tanks will be enclosed and the air exhaust from the tanks will be diverted to the deodouriser for odour removal. Alternatively, ventilated cover with low wind speed immediately above the leachate surface will be provided with emissions extracted and diverted to suitable filters for an overall odour removal.

The raw leachate will be stripped in the ammonia stripping plant. The ammonia laden air and the exhaust air of the enclosed tanks will be oxidised and destroyed in the thermal destructor (which will operate at 850°C) prior to discharge to the atmosphere. Under this combustion temperature, the ammonia gas will be completely destroyed. Given particulate matter in the combustion process is negligible, emissions of ASP from the stacks are expected to be insignificant.

In accordance with US Environmental Protection Agency, AP-42 "Compilation of Air Pollutant Emission Factors" data, the thermal destructor is designed to destroy over 99% of VOCs (including methane, vinyl chloride, benzene and other non-methane hydrocarbons) in the landfill gas and exhaust from the ammonia stripping plant. Resulting discharge of benzene and vinyl chloride is reduced to a low limit. Similarly, all gaseous ammonia are completely oxidised to nitrogen and water.

According to USEPA AP 42, Fifth Edition, Volume I Chapter 2: Solid Waste Disposal, Section 2.4.3 "Municipal Solid Waste Landfills", Table 2.4.3 (Nov 1998), the control efficiency of VOC of flaring system could achieve 99% (ref http://www.epa.gov/ttn/chief/ap42/ch02/index.html). This assumption has also been adopted in the approved EIA Reports for NENT Landfill Extension and SENT Landfill Extension.

NO_2, SO_2, Vinyl Chloride and Benzene are the key control parameters which will be quantitatively modelled to assess their potential impact.

The number of leachate storage tanks and sludge tanks are given below.

Type	Number of Tanks	
	WENT Landfill Extension	Existing WENT Landfill
SBR Tank	3	3
Raw Leachate Storage	1	1
Pre-treated Leachate Storage	1	1
Effluent Storage	1	1
Buffer Storage	2	0
Sludge Dewatering & Storage	4	2
Sludge Tanks	0	2

Emission from LFG Power Generators and Flare System

A generator fuelled by LFG will be installed to provide power for on-site plant and equipment. Under normal operations, LFG collected from the WENT Landfill Extension will be primarily used as fuel for the LTP and generators. The remainder will be utilised or flared.

As it is still too early to formulate a LFG export scheme for the WENT Landfill Extension, the following assessment using similar flaring system as the existing landfill will be the worst-case scenario. In fact, the WENT Landfill Extension would generate a significant quantity of LFG over a sufficient long period. The energy associated with the methane in the LFG can be utilized as fuel for engines or, after purification, can be fed into the power supply and natural gas distribution system, where appropriate. The DBO Contractor is required to explore the LFG recovery and utilization system for the WENT Landfill Extension site with the latest technologies in the industry. Emission from LFG would thus be less than the current assessment.

NO_2, SO_2, RSP, Vinyl Chloride and Benzene are the key control parameters which will be quantitatively modelled to assess their potential impact.

3.5.3.4 Emissions from WENT Landfill Extension and existing WENT Landfill

Emissions from Active Tipping Face and Construction Plants

Based on long-term operation practice in existing WENT Landfill, active tipping during daily operation phase for the WENT Landfill Extension is estimated to be two cells with a rough dimension of 60m x 30m for MSW+LCW (Landfilled Construction Waste) + other special wastes. Most of the inactive areas in other phases are covered by impermeable sheets. Hence, for the active phase being implemented, the entire phase would be generating TSP which would be quantitatively included in the model.

Gaseous emissions such as nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) will be generated from the operation of diesel-fuelled construction for the following activities.

- Deposition and compaction of waste – transportation, deposition and compaction of waste;
- Placement and removal of daily covered materials – by excavator, bulldozer, dump truck, vibratory roller and loader; and
- Capping and landscaping (progressive restoration) – by bulldozer, dump truck, vibratory roller, loader and mobile crane.

These plants will be located across the site, depending on need, in active and inactive areas. The nearest representative ASR, CLP Power Plant, is located at about 850 m away from the nearest construction site boundary. The total gaseous emissions generated by the plant over each tipping area are small (only two cells of 60m x 30m) and it will disperse and dilute with the ambient air very rapidly. Therefore, the potential air quality impact associated with operation of the construction plants on the identified ASR is envisaged to be limited and minor.

The management of fugitive dust at the WENT Landfill Extension will be similar to that being implemented at the existing WENT Landfill and will include immediate compaction of the fill area; regular damping down of the surface of the haul road; provision of vehicle washing facility for RCVs at the exit of the WENT Landfill Extension (to ensure no significant dust will be brought onto the public road); and regular cleaning of the main access road and waste reception area by road sweeper. With the implementation of good site practice, adverse dust emission in operating landfill is not anticipated.

Emissions of LFG / VOCs from Landfill Surfaces

Surface emission is controlled by extracting LFG from the waste mass to the flaring system for final destruction. Active extraction system by pumping will be applied and the inactive phase will be sealed and covered by impermeable plastic sheet cover. The edge of plastic sheet cover will be buried and covered underground.

For safety reason, the oxygen content in the LFG needs to be controlled to the minimum so as to reduce the risk of explosion at the flare. Therefore, the chance of oxygen infiltration or

LFG migration at the edge of the covering sheet will be kept to the minimum. Periodic monitoring is being conducted at the site boundary to ensure the ambient VOCs concentration is within the health and safety limit. In accordance with the site investigation records for the past 10 years, there were no exceedance of VOCs limits at the site boundary.

When the existing WENT Landfill is restored, the landfill tipping areas will be capped with plastic sheet together with a thick layer of covering soil similar to other restored landfill sites and hence, the VOC emission will be insignificant.

By the time when the WENT Landfill Extension is in operation, the existing WENT Landfill will be capped with thick soil and equipped with active LFG extraction system. The surface emission from existing WENT Landfill will not be an issue based on the observation from other restored landfills in HK. In order words, the ambient VOC level would be significantly lower than the past monitoring data after restoration of existing WENT Landfill.

For the WENT Landfill Extension, after final levels of waste are reached, a protective soil layer will be placed over the waste before placing the final cap. The final cap comprises geotextile, geomembrane, HDPE liner, geonet, geotextile filer and a soil layer. The impermeable liner and cap will form a containment of void for waste so as to ensure that the waste is completely separated from the surrounding environment. Hence, this containment system will ensure minimal runoff and groundwater entering the waste and prevent off-site migration of leachate, odour and landfill gas. **Figure 7.3** show the typical configuration of the liner system and the cap.

Surface emission from the existing restored WENT Landfill will not be an issue after capping. For WENT Landfill Extension, more strengthen requirements on LFG collection and LFG treatment efficiency will be provided, only a very small portion of VOC would be escaped from the active tipping phase.

Subject to future engineering design, the arrangement of the landfill gas collection system and surface covering material for inactive tipping area could be further improved by modern technology. Regular VOC monitoring will be conducted during the construction, operation, restoration and aftercare stages of the WENT Landfill Extension. Adverse impact on LFG emission is not anticipated.

3.5.3.5 Cumulative Impacts from Other Sources

The cumulative air quality assessment would need to take into account a number of concurrent sources as summarised below.

- WENT Landfill Extension
- Existing WENT Landfill;
- Marine Emission;
- Sludge Treatment Facilities (STF);
- EcoPark;
- Green Island Cement;
- Shiu Wing Steel Mill;
- Castle Peak Power Station; and
- Black Point Power Station.

As it is aware that the approved EIA Study "*Sludge Treatment Facilities*" (EIA-155/2008) has assessed the cumulative impact from these sources, the emission rates presented in the STF EIA were therefore adopted in this assessment.

3.5.3.6 Odour Emission from Waste Filling Activities and Operation of LTP

Odour Emission from Refuse Disposal/Tipping Activities

The WENT Landfill Extension will be designed to receive municipal solid waste (MSW), construction waste and other special wastes. The WENT Landfill Extension is scheduled to start operation in end 2010s. By that time, sludge will be diverted to the proposed Sludge Treatment Facilities for treatment and disposal.

Based on our current assumption, upon the completion of the STF, all the sludge will be incinerated at STF and the ash will be disposed of at the WENT Landfill Extension. Thus, WENT Landfill Extension would not receive sludge during normal design condition. However, under special circumstances, sludge may be disposed of at the WENT Landfill Extension and the sludge will be immediatedly covered, as similar to the case of special waste to minimise the odour impact.

The operation life is expected to be about 10 years. WENT Landfill Extension will be developed in 6 phases (Phases 1 to 6) and open to receive waste from 8am to 8pm every day. The active tipping face is about 60m x 30m (maximum 2 numbers at the later stage of landfill development) and will be covered with 150mm of cover soil at the end of each working day.

Waste Reception Area :

- o All refuse collection vehicles (RCVs) visiting the WENT Landfill Extension are of enclosed-type and expected to comply with the relevant regulations and to be properly maintained; hence the potential odour emission from RCVs is anticipated to be minimal.

Active Tipping Faces :

- o The RCVs delivering MSW and construction waste will be directed to the active tipping faces for unloading. The operation at the active tipping faces will be similar to that of the existing WENT Landfill.

For the worst-case scenario, there will be 2 active tipping faces working simultaneously within the WENT Landfill Extension. The size of each tipping face will be about 60m x 30m. The wastes will be promptly spread by bulldozer and compacted by a landfill compactor to minimize the exposure time of MSW. At the end of the day, the WENT Landfill Extension will be closed and the compacted waste will be covered with 150mm of cover soil immediately. Therefore, odour emissions from the active tipping face are expected during the operating hours; however, the emissions will be much reduced thereafter.

Special waste will be disposed of at the special waste trench which will be immediately covered with soil. The reasons for not including the trench for special waste in the odour assessment are as follows:

- The use of special trench is on an as-needed basis, instead of on a regular basis.
- The size of the special trench is comparatively much small than the tipping face and depends on the quantity of the special waste to be disposed of. According to the current information, the special trench is about 5m x 3m under normal operation.
- The special waste trench will be immediately covered with soil after disposal.

Although the special trench is not expected to occur regularly, however, from the worst-case assessment principle, a special cell for animal carcasses with dimension of 3m x 3m is assumed in the model.

Daily Covered Area :

- o At the end of each working day (i.e. after 8pm), the active tipping faces (a total area of 60m x 30m x 2) will be covered with 150mm of soil and compacted.

Intermediate Cover Area / Inactive tipping Phase:	o	Apart from the active tipping phase, all inactive phases of the WENT Landfill Extension will be covered with 300mm to 600mm of soil / impermeable liner on top in order to enhance landfill gas extraction, and to minimize rainwater infiltration into waste and odour emissions. It is therefore anticipated that no odour will be emitted from this area.
Final Cover Area :	o	After waste filling reaches the final levels, a capping system will be installed. The capping system will comprise (from bottom to top) a soil layer, a non-woven geotextile, an HDPE liner (impermeable layer), a sub-soil drainage layer and a final cover soil layer. Permanent gas extraction system will be installed to extract LFG from the waste mass. Planting will also be provided for the final covered area. It is therefore anticipated that no odour will be emitted from this area.
Main Haul Road to Active Tipping Faces :	o	The MSW will be delivered in RCVs with enclosed compactor body. It is therefore anticipated that the potential odour emission from RCVs will be minimal.
Summary :	o	Only the active tipping faces (daytime) and daily covered area (night-time) will be the major odour sources from the operation phase.

Odour Emission from Operation of Leachate Treatment Plant

To facilitate the development of WENT Landfill Extension, the existing leachate treatment plant of the existing WENT Landfill will be demolished. New on-site leachate treatment plants will be provided for the existing WENT Landfill and its extension. All the storage tanks and SBR tanks will be enclosed with ventilation and emissions will be extracted to suitable odour removal filters for treatment. An overall odour removal efficiency of 99% will be achieved.

According to the latest information, the odour removal efficiency would practically achieved 99%. In the approved EIA Report for NENT Landfill Extension, a 99% of odour removal efficiency was adopted. The locations of the deodouriser units are illustrated in **Figure 3.6.**

3.5.4 Restoration and Aftercare Phase

Fugitive Dust

In view of the nature and scale of the final capping operation, lesser plant will be employed for dusty operations during the restoration phase for final capping. During aftercare period, only a few numbers of plant will be required for regular maintenance.

Gaseous Emission

Nevertheless, emission from the flaring system, LFG power generation, leachate treatment plant and the ASP would still generate some gaseous emission.

In terms of gaseous emission, there will be very light activities within the capped area. Active control system for landfill gas and leachate will be operated without causing adverse environmental impact. In accordance with the observations from some restored landfills, detectable surface gas and odour emission are not anticipated.

As both the emission strength and scale of the operation will be less compared to the construction and operation phases, detailed assessment is not required since the impacts from construction and operation phases at the worse case have been assessed.

LFG

According to the latest design information, the maximum production rate of LFG for WENT Landfill Extension would occur during the operation phase. The LFG generation from the existing WENT Landfill at that time should be very small, probably < 5%. Hence, the assessment of the operation phase would have represented the worst case scenario as far as the LFG impacts are concerned.

Figures 3.5a to 3.5b show the locations of all the air quality emission sources during the restoration and the aftercare phases.

3.6 Assessment Methodology

3.6.1 Construction Phase

3.6.1.1 Dust Emission Sources

The prediction of dust emissions is based on typical values and emission factors from USEPA, AP-42 "Compilation of Air Pollutant Emission Factors". References of the calculations of dust emission factors for different dust generating activities are listed in **Table 3.18a**.

Table 3.18a References of dust emission factors for different activities

Activities	Reference	Operating Sites	Equations & Assumptions
Heavy construction activities including land clearance, ground excavation, cut and fill operations, construction of the facilities, drill & blast, plant movement and hauling over the site areas	S.13.2.3.3	All construction and excavation sites	E = 1.2 tons/acre/month of activity or = 2.69 Mg/hectare/month of activity
Wind Erosion	S.11.9, Table 11.9.4	All construction sites, and stockpile areas, (all open sites)	E = 0.85 Mg/hectare/yr (24 hour emission)

As all the inactive phases within the WENT Landfill Extension will be covered with impermeable sheets, wind erosion and general construction in the active phase are the major sources of dust generation from the site. The construction periods are assumed 26 days a month and 12 hours a day (from 0700 – 1900). Whereas, there will be a 24 hours emission for wind erosion.

Table 3.18b Summary of modeling of construction dust

Operation	Locations of Emission	Activities
WENT Landfill Extension		
Excavation and site formation	Active construction (~10% of the phase under construction for calculating the 1-hr and 24 hr concentration whilst 10% of active construction area is evenly distributed within the entire active construction area for calculating the annual concentration)	Heavy construction
	Other areas of the phase under construction	Wind erosion
Waste filling	Entire area of phase being used	Wind erosion

Operation	**Locations of Emission**	**Activities**
Slope work and other activities for Nim Wan Road Diversion	Slope work	Heavy construction
	Slope work	Wind erosion
Existing WENT Landfill		
Waste filling	Entire area of phase being used	Wind erosion
Restoration	Existing WENT (~10% of entire Existing WENT area)	Heavy construction
	Entire Existing WENT area	Wind erosion
Construction ponds (as part of the ecological mitigation measures for WENT Landfill Extension		Heavy construction & Wind erosion

3.6.1.2 Modelling Scenarios

The preliminary construction programme for the WENT Landfill Extension is given in **Appendix 2.1**. Also shown in the programme is the activities that are anticipated for the existing WENT Landfill.

A review of the preliminary construction programme has been conducted to identify the appropriate modelling scenarios for the purpose of identifying the worst case scenarios. Since the emission factors for heavy construction is much higher than that for the wind erosion, emphasis has been paid to identify any time slots at which different activities for heavy construction would overlap. A summary of the dust modelling scenarios is given below.

Scenarios	**Justifications**
1A & 1B	o Early 2017 – 3rd Quarter of 2017 o Excavation works for Phase 1 o Overlap with the operation phase of the existing WENT Landfill (ie waste filling) o Before 2017, the construction of Phase 2 would not be in place and hence would not be as worse of after early 2017
2A, 2B & 2C	o 4th Quarter of 2018 – Mid 2019 o Excavation works for Phases 2 & 3 overlap o Overlap with the Nim Wan Road diversion o Overlap with the restoration phase of the existing WENT Landfill o Overlap with the operation phase of Phase 1

3A & 3B

- o Early 2022 to mid 2022
- o Excavation works for Phases 4 & 5 overlap
- o Overlap with the ponds construction
- o Overlap with the restoration phase of the existing WENT Landfill
- o Overlap with the operation phase of Phases 1, 2, & 3

In early 2023, the construction of Phases 5 & 6 would also overlap with the pond construction although most of the construction activities of the ponds would have been completed. Besides, the total area of the Phases 5 & 6 would be less than that of Phases 4 & 5. Furthermore, the restoration works for existing WENT Landfill would have been completed. Hence, it is considered that Scenarios 3A and 3B would have represented a more conservative case already.

For each scenario, different sub-scenarios would be conducted to locate the 10% active construction area at closer distance to different ASRs so as to simulate the worst case impacts**.** **Figures 3.4a to 3.4m** show the locations of these dust emission sources for different modelling scenarios.

3.6.1.3 Dispersion Modelling

Dust impact assessment has been undertaken using the FDM model. **Table 3.19** gives the list of modelling parameters. Details of the emission rates are listed in **Appendix 3.3**.

Table 3.19 Modeling parameters

Parameters	Input	Remark
Particle size distribution	1.25um = 3.06% 6.25um = 27.55% 20um = 69.39%	Major dominant dust emission source in landfill is from unpaved road/working area. Owing to the lack of on-site monitoring data for particle distribution, it is the best estimate to assume the particle size distribution is the same as that for unpaved road. Table 13.2.2-2 of Section 13.2, USEPA AP-42, for unpaved road is adopted
Particle density	2.5g/m^3	From Fugitive Dust Model (FDM) Manual
Background Concentration	5-year annual averaged value recorded at EPD's Yuen Long monitoring station (Yuen Long)	'TOTAL' Air Quality Guideline
Modeling mode	Rural with terrain effect Dry deposit mode activated	-
Meteorological data	Lau Fau Shan weather station	Mixing height of 500m adopted in accordance with EPD "Guidelines on Choice of Models and Model Parameters"
Emission period	General construction activities during daytime working hours (8 am to 8 pm) Site erosion over 24-hour period	-

Parameters	Input	Remark
ASR calculating levels	1.5m, 5m and 10m above ASR level	-
Good Site Practice – Standard Precautionary Measures	Assume a 94% efficiency for watering 8 times daily during the day-time period as in general practice based on AP-42 reference.	Periodic watering and covering of inactive construction area with plastic sheet cover. The effectiveness will be monitored in the EM&A.

3.6.1.4 Cumulative Impacts

As can be seen from **Section 3.6.1.2**, the modelling scenarios have included the cumulative impacts from the existing WENT Landfill. For STF, according to their approved STF EIA Report, the construction of the proposed STF would commence by Mar 2010 and all the construction activities would be completed by Mar 2011. Since the construction of WENT Landfill Extension would only commence by mid 2010s, there would not be any cumulative construction impacts with STF.

For IWMF, the site selection process is still on-going and there is no implementation plan. Hence, it is not considered as a concurrent project and there would not be cumulative impacts.

3.6.2 Operation Phase

3.6.2.1 Vehicular Emission

Based on the traffic forecast, there will be insignificant increased in road traffic during the operation of WENT Landfill Extension (the waste catchment will remain the same and there is no overlapping of operation with the existing WENT Landfill).

Vehicular emission from Lung Kwu Tan Road and Nim Wan Road were incorporated into the assessment. The assessment is based on the projected peak hour flows for the worst year of 2028 within 15 years of commencement of operation. With reference to the approved EIA Study "*Sludge Treatment Facilities*" (EIA-155/2008), the same emission factor – Fleet Average Emission Factors for Euro IV Model in Year 2011– had been adopted in this assessment, as shown in the following **Table 3.20a**.

Table 3.20a Fleet Average Emission Factors for Euro IV Model in Year 2011

Vehicle Type	Yr 2011 Emission Factors (g/km-veh)				
	P/C	Taxi	SPB	HGV	PT
NO_x	0.54	0.49	4.96	3.46	6.15

The composite emission factors for the road links were calculated as the weighted average of the emission factors of different types of vehicles. Details of the peak hour traffic flows and the calculation of emission rates are presented in **Appendix 3.4**.

Modelling approach and assumptions for vehicular emission are presented in **Section 3.6.2.8**.

3.6.2.2 Marine Vessel Emission

Similar to the existing WENT Landfill, marine vessels will be used to transport waste from refuse transfer stations to the WENT Landfill Extension, and marine emission would need to be addressed.

The latest information on the operation mode and schedule of marine vessels has been obtained from the operators of these transfer station and is incorporated in the assessment. Detailed calculations of marine emission are given in **Appendix 3.5**. A summary of the emission inventory is summarised in **Appendix 3.6**.

Modelling approach and assumptions for Marine emission are presented in **Section 3.6.2.8**.

For NO_2 concentration, the predicted NO_X from idling barges and travelling barges would be separately converted to NO_2 by adopting the OLM method (with the Yuen Long Ozone concentration).

3.6.2.3 Emission from the Ammonia Stripping Plant and Landfill Engine and Flaring Systems

AQO-Pollutants

The assessment has assumed the maximum LFG generation of 58,000 m^3/hr over the entire life of the WENT Landfill Extension. At that period, the LFG generation from the existing WENT Landfill would have largely diminished from its maximum value of 54,000 m^3/hr during its operation phase to 3,940 m^3/hr.

The emission rates of NO_x, SO_2, and RSP are calculated based on the available landfill gas utilization rates and the emission factors from Table 4-4 of USEPA's "Air Emissions from Municipal Solid Waste Landfills – Background Information for Proposed Standards and Guidelines, March 1991 (EPA-450/3-90-011a)". This approach was also quoted in the EIA report "Sludge Treatment Facilities – Feasibility Study" (EIA-155/2008).

The following **Table 3.20b** summaries the emission rates of NO_x, SO_2, and RSP. Detailed calculations are presented in **Appendix 3.5** and a summary of the emission inventory is given in **Appendix 3.6**.

Table 3.20b Emission Rate for AQO Pollutants

Facilities	Emission Rate (g/s)*		
	NO_x	SO_2	RSP
Emissions from WENT Landfill Extension			
Thermal Destructor	0.6786	0.0291	Negligible
LFG Flare System	0.3712	0.2273	Negligible
LFG Power Generator	0.0427	0.0048	0.0598
Emissions from Existing WENT Landfill			
Thermal Destructor	0.3770	0.0162	Negligible
LFG Flare System	0.0049	0.0030	Negligible
LFG Power Generator	0.0427	0.0048	0.0598

Note*:
Emissions from each chimney (2 nos. for Thermal Destructor, 3 nos for LFG Flare System, 2 nos. for LFG Power Generator). There are no standby units.

Non-AQO Pollutants

For the assessment of non-AQO criteria pollutants, an air quality assessment for toxic and flaring emissions will adopt hazard to human life approach to evaluate plant emission from WENT Landfill Extension alone. Based on international references and observations from other landfills in Hong Kong, Vinyl Chloride and Benzene are the key controlling parameters. ISCST3 modelling will be conducted at heights 1.5m above ASR level. Historical meteorological data from Lau Fau Shan weather monitoring station for Year 2006 will be applied.

For the cancer risk assessment, the modelled annual average concentrations will be multiplied by the Unit Risk Factors to obtain the maximum individual lifetime cancer risk. The individual annual risk can be obtained from the individual lifetime risk by dividing by 70 years which is the assumed average lifetime. The calculated individual lifetime risk should be compared with assessment criteria to check the acceptability of the risks at the identified ASRs. The results will be compared with the guideline stipulated under item 2 of Annex 4 of TM-EIAO.

For the non-cancer risk assessment, the modelled annual average and maximum 1-hour average concentrations, together with the background pollutant concentrations, should be directly compared with the chronic reference concentration and the acute reference concentration.

The following **Table 3.21a** summaries the emission rates of Vinyl Chloride and Benzene. Detailed calculations are presented in **Appendix 3.5**, and a summary of the emission inventory is given in **Appendix 3.6**.

Table 3.21a Emission Rate for Non-criteria Pollutants

Facilities	Emission Rate (g/s)*	
	Vinyl Chloride	Benzene
Emissions from WENT Landfill Extension		
Thermal Destructor	2.058×10^{-5}	3.046×10^{-5}
LFG Flare System	1.608×10^{-4}	2.381×10^{-4}
LFG Power Generator	3.430×10^{-6}	5.077×10^{-6}
Emissions from Existing WENT Landfill		
Thermal Destructor	1.143×10^{-5}	1.692×10^{-5}
LFG Flare System	2.013×10^{-6}	3.114×10^{-6}
LFG Power Generator	3.430×10^{-6}	5.077×10^{-6}

Note*:
Emissions from each chimney (2 nos. for Thermal Destructor, 3 nos for LFG Flare System, 2 nos. for LFG Power Generator). There are no standby units

3.6.2.4 Emissions from Active Tipping Area

In view of the small size of the active tipping face, adverse gases emission impact is not anticipated. No detailed modelling is therefore required.

3.6.2.5 Emissions from Other Industrial Plants

Other than the emissions from existing WENT Landfill and WENT Landfill Extension, the assessment has also considered other concurrent emission sources. Since the parameters and assumptions of cumulative impact assessment has already made in the approved EIA Study "*Sludge Treatment Facilities*" (EIA-155/2008), the emission rates and other details of the emissions presented in the STF EIA are therefore adopted directly in this assessment. The emission inventories are presented in **Appendix 3.6**. The corresponding references for the emission factors are listed in **Table 3.21b** below:

Table 3.21b References for various Emission Sources

Source	Reference
Proposed STF	Approved EIA Study "Sludge Treatment Facilities" (EIA-155/2008)
Green Island Cement Plant	Specified Process License
Eco-Park	Approved EIA Study "Development of an EcoPark in Tuen Mun Area 38" (EIA-104/2005)
Shiu Wing Steel Mill	Approved EIA Study "Shiu Wing Steel Mill Tuen Mun Area 38" (EIA-028/BC)

Modelling approach and assumptions for these emissions are presented in **Section 3.6.2.8**. For NO_2 concentration, the predicted NO_X from each of the above sources would be separately converted to NO_2 by adopting the OLM method (with the Lau Fau Shan Ozone concentration).

3.6.2.6 Odour Emissions from Open Tipping Area and Leachate Treatment Facilities

The operation of the WENT Landfill Extension will be divided into 6 phases starting from the east and filling progressively to the west. Five worst-case scenarios have been identified for the odour impact assessment, which have taken into account the worst case odour impact to existing ASRs in Ha Pak Nai, Pak Long and Black Point Power Station. The locations of the active tipping areas for these scenarios are selected in consideration of their shortest distances from the ASRs. These scenarios are summarised in **Table 3.22a** and the worst-affected ASRs are listed in **Table 3.22b**. **Figure 3.7a** illustrates the locations of tipping faces under different modelling scenarios. Modelling approach and assumptions are presented in **Section 3.6.2.8**.

Table 3.22a Identified Worst-case Scenario for Odour Impact Assessment

Worst-case Scenario	Location	Odour Source	Area	Operation Period
Scenario 1	Eastern end of Phase 1	Daytime		
		• Active Tipping Area (2 nos.)	60m x 3m	8am-8pm
		• Maneuvering Area (2 nos.)	60m x 10m	8am-8pm
		• Compacted Area (2 nos.)	60m x 17m	8am-8pm
		• Special Cell for Animal Carcasses	3m x 3m	8am-8pm
		Night-time		
		• Daily cover area (2 nos.)	60m x 30m	8pm-8am on the next day
		24-hour		
		• Deodouriser Unit for WENT Landfill Extension	10m [1]	24-hour
		• Deodouriser Unit for Existing WENT Landfill	10m [1]	24-hour
		• Deodourizing Unit 1 in STF [2]	2m [1]	24-hour
		• Deodourizing Unit 2 in STF [2]	10m [1]	24-hour
Scenario 2	North-east end of Phase 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1
Scenario 3	Northern end of Phase 1	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1
Scenario 4	Southern end of Phase 3	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1
Scenario 5	Western end of Phase 4	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1

Note:
[1] Stack height in meters is presented
[2] Cumulative odour impact from the proposed STF is incorporated in this assessment.

Table 3.22b Worst-affected ASR under Different Odour modelling Scenarios

	Worst-affect ASR	Location
Scenario 1	A1-1, A1-2, A1-4	West & East Ha Pak Nai
Scenario 2	A1-3	West Ha Pak Nai
Scenario 3	A3-1	STF office
Scenario 4	A4-1	Lung Kwu Sheung Tan
Scenario 5	A2-1	Black Point Power Station (Office)

3.6.2.7 Determination of Odour Emission Rates

In-situ odour sampling was adopted to collect odour strength for landfill site in Hong Kong. It is also noted that there is only one accredited laboratory in HK that can conduct such In-situ odour measurement (i.e. Odour Research Laboratory of HKPU).

Odour samples were taken using the flux chamber method which is the method recommended by the USEPA[1] and is also the most commonly used odour sampling method for large surface emission source such as landfill sites. The flux chamber used is a circular chamber with a diameter of 0.41m and an area of 0.13 m^2. It was tightly placed on the surface of the odour source and the air inside the chamber was purged with nitrogen gas at a sweeping rate of 5 litres per minute. The odour sample was collected in a Tedlar bag at a rate of 3 litres per minute. Before taking the next sample, the flux chamber was cleaned with distilled water and then flushed with nitrogen for about 10 minutes to remove residual odour in the chamber.

The odour sampling and subsequent olfactometry tests were conducted by qualified odour panellists from HKPU. The qualified odour panellists had their individual odour threshold of n-butanol in nitrogen gas in the range of 20 to 80 ppb/v as required by the European Standard Method (EN 13725). Odour samples from the active tipping areas, inactive areas and the leachate lagoons of the existing WENT Landfill were collected for the assessment. Measurements were taken between 0900 and 1700 on 27, 28, 30 and 31 August 2007. The ambient surface odour emission fluxes and pollutant concentrations were measured during the reasonable worst-case temperature (mostly above 30^{o}C). Details of the measurement results are listed in **Appendix 3.7**.

Temperature is one of the factors which are thought to affect the strength of the odour emission. By reviewing the meteorological data recorded at the nearest weather station at Lau Fau Shan in 2006, the number of hours having the ambient temperature lower than 30^{o}C was about 95%. However, the odour emission rates were measured at temperatures over 30^{o}C in many instances. As a result, the measured odour emission rates were adopted directly to represent a reasonable worst case scenario. In addition, with reference to the approved EIA "*South East new Territories (SENT) Landfill Extension*" (EIA-143/2007), a reasonable worst case scenario was represented by the average of the measured odour emission rates to avoid overestimating the odour impact. The same approach is adopted in this assessment. The reasonable odour emission rates for area source and point source are presented in **Table 3.23a** and **Table 3.23b** respectively.

Table 3.23a Odour Emission Rates for Area Sources (Temperature under reasonable worst-case condition at 30°C)

Odour Source	Odour Source Emission Rate, OU/m²s
Day time:	
Active Tipping Area – MSW and CW	3.30
Manoeuvring Area	0.5

Odour Source	Odour Source Emission Rate, OU/m²s
Compacted waste Area	0.5
Special Cell for Animal Carcasses	1.48
Night-time:	
Daily cover overlying waste	0.35

Table 3.23b Odour Emission Rates for Point Sources (Temperature under reasonable worst-case condition at 30°C)

Odour Source	Odour Source Emission Rate, OU/s
24-hours:	
Deodourised Unit for WENT Landfill Extension	115.42 [1]
Deodourised Unit for Existing WENT Landfill	90.78 [1]
Deodourising Unit 1 for STF	46.69 [2]
Deodourising Unit 2 for STF	85.61 [2]

Note:
[1] Refer to **Appendix 3.8** for the detailed breakdown
[2] Reference from the approved EIA Study "Sludge Treatment Facilities" (EIA-155/2008)

3.6.2.8 Air Dispersion Model and Modelling Parameters

Vehicular Emission

The USEPA approved line source air dispersion model, CALINE4 developed by the California Department of Transport is used to assess vehicular emissions impact from existing and planned road network. In view of the limitation of the CALINE4 model in modelling elevated roads higher than 10m, the road heights of elevated road sections are set to 10m maximum in the CALINE4 model as the worst-case assumption. Modelling parameters adopted for the worst-case conditions were determined according to EPD's "Guidelines on Choice of Models and Model Parameters " as follows:

- Wind speed : 1 m/s
- Wind direction : worst angle
- Stability : F class
- Surface Roughness : 60cm
- Standard deviation : 5°
- Mixing height : 500m
- Temperature : 25 °C

With reference to the Screening Procedures for Estimating the Air Quality Impact of Stationary Source (EPA-454/R-92-019), a conversion factor of 0.4 is used to convert the 1-hour average concentrations to 24-hour average concentrations. The conversion of the NO_2, and RSP (from vehicular emission using CALINE) from maximum 24-hour concerntration to annual concentration would be based on the contribution of vehicular emission to the cumulative impact at each ASR excluding background concentration and contribution from BPPS/CPPS, as described below:

$$Veh_{Annual} = \frac{x}{(1-x)} \times C_{Annual}$$

where *X* is the contribution of vehicular emission to the cumulative impact excluding background and contributions from BPPS/CPPS:

$$x = \frac{Veh_{24-hour}}{Veh_{24-hour} + C_{24-hour}}$$

$Veh_{24\text{-}hour}$ = Max. 24-hour contribution from vehicular emission

Veh_{Anual} = Annual contribution from vehicular emission

$C_{24\text{-}hour}$ = Max. 24-hour contributions from WENT Extension, Existing WENT Landfill, Marine Emission, STF, Green Island Cement Plant, Eco Park and Shiu Wing Steel Mill

C_{Annual} = Annual contributions from WENT Extension, Existing WENT Landfill, Marine Emission, STF, Green Island Cement Plant, Eco Park and Shiu Wing Steel Mill

Gaseous Emission

Gaseous emissions, including WENT Landfill Extension, existing WENT Landfill, Marine Emission, Proposed STF, Green Island Cement Plant, Eco-Park, and Shui Wing Steel Mill have been assessed by ISCST3 model. The modelling parameters are listed in **Table 3.24**.

Table 3.24 Modeling Parameters

Parameters	Input	Remark
Background Concentration	5-year annual averaged value recorded from existing WENT Landfill monitoring data and Yuen Long Monitoring Station	Follow 'TOTAL' Air Quality Guideline and health risk approach
Modeling mode	Rural with terrain effect	
Meteorological data	Lau Fau Shan weather station in Year 2006; in accordance with EPD Guidelines on Choice of Models and Model Parameters	
Emission period	24-hour operation except Marine Emission	
ASR calculating levels	1.5m, 5m and 10m above ASR level	

Modelling results are compared with the respective criteria. A summary of the relevant criteria is listed in **Table 3.25**.

Table 3.25 Modeling Criteria

Parameters/ Pollutants	Relevant Criteria/Remark
• NO_2 • SO_2 • RSP	• 1-hour averaged criteria (except RSP) • 24-hour averaged criteria • Annual averaged criteria (Remark: Adopt AQOs as criteria.)
• Benzene • Vinyl Chloride	WHO, USEPA, CEPA (Remarks: • Carcinogenic Risk: Annual average concentrations have been multiplied by the Unit Risk Factors to obtain the maximum individual lifetime risk. The individual annual risk could be obtained from the individual lifetime risk divided by 70 years which is the assumed average lifetime. The calculated individual lifetime risk has been compared with assessment criteria to check the acceptability of the risks at the identified ASRs. • Non-carcinogenic risk: Annual average and maximum 1-hour average concentrations together with the background pollutant concentrations should be directly compared with the chronic reference concentration and the acute reference concentration.)

NO_2/NO_x Conversion

The NO_2/NO_x conversion for all emissions was estimated based on the Ozone Limiting Method (OLM). The 5-year average of the annual average of the daily hourly maximum ozone concentration recorded at EPD's Yuen Long Air Quality Monitoring Station of 78.3 $\mu g/m^3$ was adopted for the calculation. The NO_2/NO_x conversion was calculated as follows:

$[NO_2]_{pred}$ = 0.1 x $[NO_x]_{pred}$ + MIN {0.9 x $[NO_x]_{pred}$, or (46/48) x $[O_3]_{bkgd}$}

where

$[NO_2]_{pred}$ = the predicted NO_2 concentration
$[NO_x]_{pred}$ = the predicted NO_x concentration
MIN = the minimum of the two values within the brackets
$[O_3]_{bkgd}$ = the representative O_3 background concentration
(46/48) = the molecular weight of NO_2 divided by the molecular weight of O_3

The OLM were applied to the following sources individually for the estimation of NO_2 concentrations:

- WENT Landfill Extension;
- Existing WENT Landfill;
- Marine Emission (manoeuvring);
- Marine Emission (idling)
- Proposed STF;
- Green Island Cement Plant;
- Eco-Park;
- Shui Wing Steel Mill; and
- Road Traffic Emission.

Odour Emission

The 5-second Odour Unit (OU) at the ASRs was assessed by AUSPLUME model. The use of AUSPLUME model has been approved by the EPD. It is based on the Gaussian dispersion equation and is similar to ISCST3. Other modelling parameters were determined according to EPD's "Guidelines on Choice of Models and Model Parameters".

Hourly meteorological data as recorded at the Lau Fau Shan Weather Station in 2006 was obtained from the Hong Kong Observatory for modelling the 1-hour average odour concentrations at the representative sensitive receivers.

Owing to the remote nature within 3km study radius, rural mode will be adopted in accordance with the USEPA Guideline for Air Quality Model. The modelling parameters will be determined in accordance with relevant international papers, such as "Workbook of Atmospheric Dispersion Estimates: An Introduction to Dispersion Modelling, Second Edition, D. Bruce Turner". In accordance with the research, the Pasquill-Gifford parameters, and for rural mode dispersion can be estimated for a short averaging time period (3-minutes), which is equivalent to computer dispersion models set up to estimate conservative 1-hour average concentration. In other words, the predicted 1-hour average concentrations from AUSPLUME model will be equivalent to 3-minute average concentrations in rural condition.

To further convert these 3-minute average concentrations to 5-second averages, a Stability Class Conversion Factor of 10 will be employed for those hours with very unstable atmospheric Stability Classes A-B, and a factor of 5 will be used for those hours with Stability Classes C-F, in accordance with the "Odour Control – A concise Guide, Warren Spring Laboratory". By taking both factors into account, the following Stability Class conversion factors would be applied. **Table 3.26** shows the conversion factors applied to determine the 5-second value under different stability classes.

Table 3.26 Multiplying factors for averaging time correction for odour assessment (taking account of EPD's Guideline on Choice of Models and Model Parameters)

Atmospheric Stability Class	Conversion Factor from 1 hour to 15 min	Conversion Factor from 15 min to 3 min	Conversion Factor from 3 min to 5s	Resultant Conversion Factor from 1 hour to 5s
A	1	1	10	10
B	1	1	10	10
C	1	1	5	5
D	1	1	5	5
E	1	1	5	5
F	1	1	5	5

These conversion factors were applied to the emission rates input in the model run. The modelled results will therefore be the 5-second odour concentrations. **Table 3.27** presents the corrected odour emission rates for the modelling run.

Table 3.27 Corrected Odour Emission Rates

Modeling Period	Odour Source	Odour Emission Rate, OU/m²s	Corrected Odour Emission Rates, OU/m²s	
			Stability Class A & B [3]	Stability Class C – F [4]
Day-time (8am-8pm)	Active Tipping Area	3.30	33.0	16.5
	Maneuvering Area	0.50	5.0	2.5
	Compacted Area	0.50	5.0	2.5
	Special Cell for Animal Carcasses	1.48	14.8	7.4
Night-time (8pm-8am on the next day)	Daily cover area	0.35	3.5	1.75
24-hours	Deodourised Unit for WENT Landfill Extension	115.42 OU/s [1]	1154.2	577.1
	Deodourised Unit for Existing WENT Landfill	90.78 OU/s [1]	907.8	453.9
	Deodourising Unit 1 for STF	46.69 OU/s [2]	466.9	233.45
	Deodourising Unit 2 for STF	85.61 OU/s [2]	856.1	428.05

Notes:
[1] refer to **Appendix 3.8** for the detailed breakdown
[2] Reference from the approved EIA Study "Sludge Treatment Facilities" (EIA-155/2008)
[3] A conversion factor of 10 is applied to convert the results from 3 minutes to 5 seconds.
[4] A conversion factor of 5 is applied to convert the results from 3 minutes to 5 seconds.

The overall modelling parameters are summarised in **Table 3.28** for ease reference.

Table 3.28 Modeling parameters

Parameters	Input	Remark
Background Concentration	No (major source from landfill)	In accordance with the preliminary design information, 5 scenarios have been assessed.
Modeling mode	Rural model with flatted terrain	
Meteorological data	Lau Fau Shan weather station in Year 2006	

Parameters	Input	Remark
Emission period	• Daytime emission (8am-8pm) from tipping at active cell • Night time emission (8pm-8am) from daily cover overlying tipped waste • Whole day for emission from leachate treatment facilities • Effective temporary covers with impermeable plastic sheets will be applied at the inactive tipping areas, and no emission is anticipated. • Active LFG extraction system with an engineering cap will be applied at the restored WENT Landfill and no emission is anticipated.	In accordance with the preliminary design information, 5 scenarios have been assessed.
ASR calculating levels	1.5m, 5m and 10m above local ground	

Notes: LFG extraction system would be provided for inactive tipping areas.

The locations of odour emission sources from existing WENT Landfill and its extension are shown in **Figure 3.6** and **Figure 3.7a**.

3.7 Prediction and Evaluation of Air Quality Impact

3.7.1 Construction Phase

With the provision of 8 times / day of watering, the predicted maximum 1-hour and 24-hour average TSP concentration at the ASRs will be within the 500µg/m^3 and 260 µg/m^3 criterion, respectively. No adverse construction dust impact is anticipated. When the actual construction programme and methodology is finalised by the DBO Contractor, this measures can be further reviewed and verified by the EM&A monitoring.

Tables 3.29 and **3.30** show the 1-hour and 24-hour averaged TSP levels at the identified ASRs. Details of the assessment results are given in **Appendix 3.9**.

Table 3.29 Predicted highest 1-hr TSP Concentrations

ASR	Max 1- hr TSP Concentration, ug/m^3 [1]		
	Scenario 1 (1A and 1B)	Scenario 2 (2A, 2B and 2C)	Scenario 3 (3A and 3B)
Ha Pak Nai	127 – 188	138 - 243	140 - 243
Black Point Power Station	117 – 119	129 - 143	137 - 143
STF Office	139 – 192	146 - 203	149 - 174
Lung Kwu Sheung Tan	118 – 119	134 - 137	134 - 138
Criterion	500	500	500

Notes:
[1] A background concentration of 103ug/m^3 has been included and 8 times of watering per day (during daytime only) has been adopted.

Table 3.30 Predicted highest 24-hr TSP Concentrations

ASR	Max 24- hr TSP Concentration, ug/m^3 [1]		
	Scenario 1 (1A and 1B)	Scenario 2 (2A , 2B and 2C)	Scenario 3 (3A and 3B)
Ha Pak Nai	108 - 123	111 - 139	112 - 140

ASR	Max 24- hr TSP Concentration, ug/m3 [1]		
	Scenario 1 (1A and 1B)	Scenario 2 (2A , 2B and 2C)	Scenario 3 (3A and 3B)
Black Point Power Station	107	114 - 118	114 - 115
STF Office	119 - 128	120 - 133	123 - 128
Lung Kwu Sheung Tan	106 - 107	110 - 112	110 - 111
Criterion	260	260	260

Notes:
[1] A background concentration of 103ug/m3 has been included and 8 times of watering per day (during daytime only) has been adopted.

It can be seen from the above table that, after implementing 8 times of watering / day (during daytime only), both the 1-hr TSP and 24-hr TSP would be comply with the respective criterion at all the ASRs and there are no residual dust impacts for these parameters. The annual TSP concentrations have also been assessed for Scenario 1, Scenario 2 and Scenario 3 and the cumulative (i.e. WENT Landfill Extension and existing WENT Landfill) annual TSP concentrations are summarized in **Table 3.30a**. The project contributions to the annual TSP concentrations are summarized in **Table 3.30b**. Details of the assessment results are given in **Appendix 3.9**.

Table 3.30a Predicted Annual TSP Concentrations

ASR	Annual TSP Concentration - Cumulative [1]		
	Scenario 1	Scenario 2	Scenario 3
Ha Pak Nai	103-105	104-106	104-106
Black Point Power Station	104	107	107
STF Office	111-113	113-115	114-116
Lung Kwu Sheung Tan	103	104	104
Criterion	80	80	80

Notes:
[1] A background concentration of 103ug/m3 has been included and 8 times of watering per day (during daytime only) has been adopted.

Table 3.30b Predicted Annual TSP Concentrations – Contribution from WENT Landfill Extension

ASR	Annual TSP Concentration – Project Contribution [1]		
	Scenario 1	Scenario 2	Scenario 3
Ha Pak Nai	0.1-0.2	0.2-0.4	0.3-0.5
Black Point Power Station	0.4-0.5	3.0-3.2	2.9-3.1
STF Office	2.4-3.3	2.8-3.6	4.0-4.9
Lung Kwu Sheung Tan	0.1-0.2	0.8-0.9	0.8-0.9

Notes:
[1] 8 times of watering per day (during daytime only) has been adopted.

It can be seen from the above table that the cumulative (i.e. WENT Landfill Extension and existing WENT Landfill) annual TSP concentrations are in the range 103 – 116ug/m^3 which have exceeded the criterion of 80ug/m^3. This is obviously due to the high background concentration of 103ug/m^3. However, it can also be seen from the above that the contribution from the WENT Landfill Extension is less than 1 ug/m^3 for all the residential developments and place of worship (Ha Pak Nai and Lung Kwu Sheung Tan) in the vicinity. This is less than 1% of the annual AQO (0.8 ug/m^3). For the receivers in Black Point Power Station and STF, however, the contributions would be higher, in the range of 0.4 – 3.2 ug/m^3 and 2.4 – 4.9 ug/m^3 respectively, which would constitute about 0.5 - 4% and 3 - 6.1%of the annual AQO and 0.4 – 3.1% and 2.3 – 4.8% of the background concentration. However, it should be noted that the office areas of STF and the Black Point Power Station are central air-conditioned and hence any typical dust filters associated with the air-conditioning system would reduce at least 50% of the TSP level and hence would enable achieving the criterion. Hence, the cumulative annual TSP concentrations at Black Point Power Station and STF would be 52 - 54 and 56 - 58 ug/m^3 respectively, which are within the annual AQO. The pollutant contours are given in **Figures 3.8a to 3.8n**.

3.7.1.1 "What if IWMF not proceed"

The feasibility of IWMF is still being conducted and there is no decision on the implementation programme and site selection. In case the IWMF is not located at the middle ash lagoon, the boundary of the WENT Landfill Extension would be further expanded to include the middle lagoon. The assessment so far has assumed that the pollutant sources are close to the waste boundary which is much closer to the sensitive receivers. Hence, even the middle ash lagoon is employed for the IWMF, the worst case environmental impacts have already been addressed in the current assessment and no additional impact on the sensitive receivers would be generated.

3.7.2 Operation Phase

3.7.2.1 AQO Criteria Pollutant

The maximum predicted 1-hour, 24-hour and annual NO_2 ,SO_2 and RSP concentrations at the identified ASRs were presented in **Table 3.31, Table 3.32a** and **Table 3.32b** respectively. Detailed assessment results are presented in **Appendix 3.10**.

Table 3.31 Predicted Cumulative 1-hr, 24-hr, and Annual Average NO_2 Concentration at Various Heights

ASR ID	Assessment Height (mAG)	Predicted Cumulative NO_2 Concentration in ug/m^3		
		1-hour	24-hour	Annual
A1-1	1.5	285	105	64
	5	285	105	64
	10	284	105	64
A1-2	1.5	258	102	64
	5	257	102	64
	10	254	102	64
A1-3	1.5	240	96	63
	5	240	96	63
	10	239	96	63
A1-4	1.5	263	98	63
	5	263	98	63
	10	264	99	63
A2-1	1.5	163	98	63
	5	163	98	63
	10	163	98	63
A3-1	1.5	275	106	65
	5	275	106	65
	10	275	105	66
A4-1	1.5	290	132	69
	5	290	132	69
	10	290	132	69

ASR ID	Assessment Height (mAG)	Predicted Cumulative NO_2 Concentration in ug/m³		
		1-hour	24-hour	Annual
	AQO Criteria	**300**	**150**	**80**

Table 3.32a Predicted Cumulative 1-hr, 24-hr, and Annual Average SO_2 Concentration at Various Heights

ASR ID	Assessment Height (mAG)	Predicted Cumulative SO_2 Concentration in ug/m³		
		1-hour	24-hour	Annual
A1-1	1.5	239	92	28
	5	239	92	28
	10	239	92	28
A1-2	1.5	232	91	28
	5	232	91	28
	10	232	91	28
A1-3	1.5	223	90	28
	5	223	90	28
	10	223	90	28
A1-4	1.5	232	91	28
	5	232	91	28
	10	232	91	28
A2-1	1.5	54	69	27
	5	54	69	27
	10	54	69	27
A3-1	1.5	220	90	28
	5	220	90	28
	10	220	90	28
A4-1	1.5	59	71	28
	5	59	71	28
	10	59	71	28
	AQO Criteria	**800**	**350**	**80**

Table 3.32b Predicted Cumulative 24-hr and Annual Average RSP Concentration at Various Heights

ASR ID	Assessment Height (mAG)	Predicted Cumulative RSP Concentration in ug/m³	
		24-hour	Annual
A1-1	1.5	73	65
	5	73	65
	10	73	65

ASR ID	Assessment Height (mAG)	Predicted Cumulative RSP Concentration in ug/m^3	
		24-hour	Annual
A1-2	1.5	72	64
	5	72	64
	10	72	64
A1-3	1.5	73	64
	5	73	64
	10	73	64
A1-4	1.5	79	65
	5	79	65
	10	78	65
A2-1	1.5	92	66
	5	92	66
	10	92	66
A3-1	1.5	76	65
	5	76	65
	10	76	65
A4-1	1.5	84	65
	5	83	65
	10	83	65
	AQO Criteria	**180**	**55**

All the results are within the relevant AQO criteria, except the annual RSP concentrations at all the identified ASRs. According to the detailed assessment results presented in **Appendix 3.10**, it is found that the contribution from the Project (WENT Landfill Extension), Existing WENT Landfill and marine emissions, is less than 1% of the AQO. Moreover, the background RSP concentration of 64 μg/m^3 adopted from Air Monitoring Station at Yuen Long has already exceeded the AQO criteria of 55 μg/m^3, adverse air quality impact arisen from the Project is relatively insignificant, and therefore, mitigation measures are not required.

Apart from the identified ASRs, the hourly and/or daily contours plots for NO_2, SO_2 and RSP at 1.5m above ground are also produced to illustrate if there would be any area(s) within predicted exceedance of the AQO. Contours are plotted for the overall area (with a coarser grid size of 500m) and four focused area, including Ha Pak Nai Area, STF office, Black Point Power Station and Lung Kwu Tan Area (with a finer grid size of 100-200m). **Figures 3.9a to 3.9h** illustrate the hourly/daily/annual contour plots for NO_2, SO_2 and RSP. It is observed that there are no air sensitive uses within the exceedance area(s).

3.7.2.2 Non-criteria Pollutants

The maximum hourly and annual averaged concentrations of non-criteria pollutants (vinyl chloride and benzene) were predicted. The cumulative cancer risk for benzene and vinyl chloride (i.e. cancer risk of vinyl chloride plus that of benzene) is also within the cancer risk criteria. The contribution from the ASP, flare and generator plants are insignificant. **Tables**

3.33a and 3.33b show the non-criteria pollutant levels at the identified ASRs. Detailed results for non-criteria pollutants are given in **Appendix 3.11**. The emission impacts at the ASR are within the acute and chronic health risk criteria.

Table 3.33a Predicted health risk level for benzene and vinyl chloride at various heights (background included)

ASR ID	Height (mAG)	Predicted max vinyl chloride concentrations (µg/m³)			Predicted max benzene concentrations (µg/m³)		
		max 1-hr and annual averaged vinyl chloride (1)	Predicted Individual Risk Level per Year for Chronic Effect	Within Acute and Chronic Reference Conc and Individual Risk Level	max 1-hr and annual averaged benzene level (2)	Predicted Individual Risk Level per Year Chronic Effect	Within Acute and Chronic Reference Conc and Individual Risk Level
A1-1	1.5	~2.275	2.857E-13	within	~3.95	1.714E-12	within
	5	~2.275	2.857E-13	within	~3.95	1.714E-12	within
	10	~2.275	2.857E-13	within	~3.95	1.714E-12	within
A1-2	1.5	~2.275	2.857E-13	within	~3.95	2.571E-12	within
	5	~2.275	2.857E-13	within	~3.95	2.571E-12	within
	10	~2.275	2.857E-13	within	~3.95	2.571E-12	within
A1-3	1.5	~2.275	1.429E-13	within	~3.95	1.714E-12	within
	5	~2.275	1.429E-13	within	~3.95	1.714E-12	within
	10	~2.275	1.429E-13	within	~3.95	1.714E-12	within
A1-4	1.5	~2.275	2.857E-13	within	~3.95	2.571E-12	within
	5	~2.275	2.857E-13	within	~3.95	2.571E-12	within
	10	~2.275	2.857E-13	within	~3.95	2.571E-12	within
A2-1	1.5	~2.275	2.857E-13	within	~3.95	2.571E-12	within
	5	~2.275	2.857E-13	within	~3.95	2.571E-12	within
	10	~2.275	2.857E-13	within	~3.95	2.571E-12	within
A3-1	1.5	~2.275	5.714E-13	within	~3.95	5.143E-12	within
	5	~2.275	7.143E-13	within	~3.95	6.857E-12	within
	10	~2.275	1.143E-12	within	~3.95	1.114E-11	within
A4-1	1.5	~2.275	1.429E-13	within	~3.95	1.714E-12	within
	5	~2.275	1.429E-13	within	~3.95	1.714E-12	within
	10	~2.275	1.429E-13	within	~3.95	1.714E-12	within

Remarks:
(1) Vinyl chloride background of 2.275µg/m³ has been incorporated; and
(2) Benzene background of 3.95µg/m³ has been incorporated

Table 3.33b Predicted cumulative health risk level from benzene and vinyl chloride at various heights (background included)

ASR ID	Height (mAG)	Predicted Individual Lifetime Risk Level per year (Benezene + Vinyl Chloride)	Within Individual Risk Level
A1-1	1.5	2.000E-12	within
	5	2.000E-12	within
	10	2.000E-12	within
A1-2	1.5	2.857E-12	within
	5	2.857E-12	within
	10	2.857E-12	within
A1-3	1.5	1.857E-12	within
	5	1.857E-12	within
	10	1.857E-12	within
A1-4	1.5	2.857E-12	within
	5	2.857E-12	within
	10	2.857E-12	within
A2-1	1.5	2.857E-12	within
	5	2.857E-12	within
	10	2.857E-12	within
A3-1	1.5	5.714E-12	within
	5	7.571E-12	within
	10	1.229E-11	within
A4-1	1.5	1.857E-12	within
	5	1.857E-12	within
	10	1.857E-12	within

3.7.2.3 Odour Emission

The maximum 5-second averaged odour concentrations at the ASRs were predicted for 5 representative operating scenarios; namely Scenario 1 to Scenario 5, and the results are listed in **Table 3.34**. Exceedances of the odour criterion of 5 OU are expected at A1-3 (West Ha Pak Nai), A2-1 (Black Point Power Station), A3-1 (STF office) and A4-1 (Lung Kwu Sheung Tan). Mitigation measures are therefore required.

Table 3.34 Predicted Odour Concentration (OU, 5s averaging) under reasonably worst-case condition

ASR ID	Height (m)	Maximum Odour Concentration (OU)				
		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
At 1.5m above Ground						
A1-1	1.5	3.1	3.9	4.3	1.5	1.6
A1-2	1.5	3.4	2.3	2.3	0.9	0.8
A1-3	1.5	3.8	**5.2**	2.9	1.4	0.9
A1-4	1.5	1.7	2.7	1.5	1.4	0.6
A2-1	1.5	1.7	1.4	2.4	4.8	**5.6**
A3-1	1.5	**28.4**	**7.9**	**32.5**	3.7	2.9
A4-1	1.5	2.0	2.1	1.0	**6.3**	1.1

ASR ID	Height (m)	Maximum Odour Concentration (OU)				
		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
At 5m above Ground						
A1-1	5	3.1	3.8	4.3	1.5	1.6
A1-2	5	3.4	2.2	2.3	0.9	0.7
A1-3	5	3.7	**5.1**	2.9	1.3	0.9
A1-4	5	1.7	2.6	1.5	1.4	0.6
A2-1	5	1.6	1.4	2.4	4.7	**5.4**
A3-1	5	**25.0**	**7.6**	**26.3**	3.6	2.9
A4-1	5	2.0	2.1	1.0	**6.2**	1.1
At 10m above Ground						
A1-1	10	2.9	3.6	4.1	1.5	1.5
A1-2	10	3.2	2.1	2.2	0.9	0.7
A1-3	10	3.5	4.7	2.7	1.3	0.9
A1-4	10	1.6	2.5	1.5	1.3	0.6
A2-1	10	1.6	1.3	2.3	4.4	5.0
A3-1	10	**15.9**	**12.1**	**12.5**	**12.1**	**12.1**
A4-1	10	2.0	2.0	1.0	**5.7**	1.0

Note: Bold value means exceedance of 5 OU odour limit

3.7.2.4 "What if IWMF not proceed"

Similar to the construction phase, the assessment so far has assumed that the pollutant sources are close to the waste boundary which is much closer to the sensitive receivers. Hence, even the middle ash lagoon is employed for the IWMF, the worst case environmental impacts have already been addressed in the current assessment and no additional impact on the sensitive receivers would be generated.

3.7.3 Restoration and Aftercare Phase

No potential odour impact is anticipated during the restoration and aftercare phases.

3.8 Mitigation Measures

3.8.1 Construction Phase

Dust emission from construction vehicle movement is confined within the worksites area. Watering facilities will be provided at every designated vehicular exit point.

Watering should be implemented 8 times per day to suppress the dust generation. Periodic dust monitoring at the nearby ASRs should also be conducted and detailed in the EM&A manual.

In case of non-compliance, additional mitigation measures in accordance with the EM&A requirements will be implemented.

3.8.2 Operation Phase

3.8.2.1 Stack Discharge from ASP, Flare and LFG Power Generator

The emission factors assumed in this EIA would be included in the specification. Subject to the subsequent EPD's requirement on chimney installation, regular stack monitoring of air pollutants, including NO_x, SO_2, RSP, NMOCs, vinyl chloride, and benzene shall be carried out at a quarterly interval (i.e. once every 3 months), and the operating conditions, including exhaust gas temperature and velocity shall be monitored continuously in order to demonstrate compliance during the operations.

3.8.2.2 Odour from Leachate Treatment Facilities

As mentioned in **Section 3.5.3.6**, it is noted that a new on-site leachate treatment plant has been planned. For the proposed leachate treatment plant in WENT Landfill Extension, the overall leachate treatment facilities include:

- Adopted updated treatment method such as Sequencing Batch Reactor for future leachate treatment. Provision of ventilated cover for the leachate storage lagoons / tanks and emissions extracted to suitable odour removal filters for odour removal.
- Ferric nitrate or sodium hypochlorite can be added to oxidise the odourous chemical in the leachate. The pH value of leachate can be controlled to a suitable value from future on-site experiment such that the generation of any odourous H_2S and ammonia can be optimised.
- For the gaseous extraction system, the wind speed immediately above the leachate surface should be kept to minimal (in the order of 0.001m/s) such that the odour emission strength from lagoon can be minimised. Suitable treatment system should be provided for odour removal. The ventilated gaseous emission from lagoons should be provided with 5-10 air change per hour for further dilution before discharge. Together with all the above measures, an overall odour removal efficiency of 99% can be achieved.
- The locations of discharge points and discharge heights should be in accordance with the assumptions adopted in the EIA Report. If the future locations / heights of the stacks deviate from the assumptions adopted in the EIA Study, reassessment of the air quality impact should be conducted.
- The overall arrangement should be investigated in details by the DBO Contractor and agreed with IEC and EPD. As such, the odour emission from the future leachate treatment facilities will be insignificant.

3.8.2.3 Odour from Waste Transfer and Tipping Activities

Exceedances of the odour criterion of 5 OU are expected at A1-3 (West Ha Pak Nai), A2-1 (Black Point Power Station), A3-1 (STF office) and A4-1 (Lung Kwu Sheung Tan). In order to mitigate the adverse odour impact, the following mitigation measures are recommended:

(1) Setback of the Tipping Faces

In general operation, there are 2 numbers of 60m x 30m tipping faces. It is recommended that one of the tipping faces should only be located within 1100m from ASR A1-3, 1200m from ASR A2-1 and 1200m from ASR A4-1. The following **Table 3.35a** summarises the minimum setback distance required.

Table 3.35a Minimum Setback Distance Required

Phase	Modelling Scenario (Affected ASRs)	Setback Distance (m)
Phase 1	Scenario 2 (A1-3)	1100
Phase 3	Scenario 4 (A4-1)	1200
Phase 4	Scenario 5 (A2-1)	1200

In order to assess the worst-case for this mitigation option, the relocated tipping faces are assumed to site at the same wind direction to the worst-affected ASRs. **Figure 3.7b** illustrates the locations of tipping faces at various setback distances.

(2) On-site Odour Removal System

Adverse odour impact is expected at the planned ASR at the proposed STF office. As it is located adjacent to the odour sources, any setback of tipping face would not be capable of reducing the odour nuisance. As such, on-site odour removal system, such as activated carbon filter, is recommended. As a general practice, the odour removal system should achieve an odour removal efficiency of at least 90%. Therefore, 90% odour removal is assumed at the ASR A3-1.

The mitigated odour concentrations are therefore assessed and the results are summarised in the following **Table 3.35b**. Assessment results show that, with the implementation of the abovementioned mitigation measures, the odour concentration at all the ASRs would comply with the odour limit of 5 OU.

Table 3.35b Predicted Odour Concentration with Mitigated Measures

ASR ID	Height (m)	Maximum Odour Concentration (OU)				
		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
At 1.5m above Ground						
A1-1	1.5	3.1	4.4	4.3	1.0	1.6
A1-2	1.5	3.4	3.1	2.3	1.6	1.2
A1-3	1.5	3.8	4.3	2.9	1.5	1.4
A1-4	1.5	1.7	2.5	1.5	1.3	0.9
A2-1	1.5	1.7	1.6	2.4	2.4	2.5
A3-1*	1.5	2.8	0.7	3.2	0.4	0.3
A4-1	1.5	2.0	1.9	1.0	3.3	1.9
At 5m above Ground						
A1-1	5	3.1	4.3	4.3	1.0	1.5
A1-2	5	3.4	3.0	2.3	1.5	1.2
A1-3	5	3.7	4.2	2.9	1.4	1.4
A1-4	5	1.7	2.4	1.5	1.3	0.8
A2-1	5	1.6	1.6	2.4	2.4	2.4
A3-1*	5	2.5	0.7	2.6	0.4	0.3
A4-1	5	2.0	1.9	1.0	3.2	1.9
At 10m above Ground						
A1-1	10	2.9	4.1	4.1	0.9	1.5
A1-2	10	3.2	2.9	2.2	1.5	1.2
A1-3	10	3.5	3.9	2.7	1.4	1.4
A1-4	10	1.6	2.3	1.5	1.2	0.8
A2-1	10	1.6	1.5	2.3	2.3	2.2
A3-1*	10	1.6	1.2	1.2	1.2	1.2
A4-1	10	2.0	1.8	1.0	3.0	1.8

Note * On-site odour removal efficiency of 90% is adopted.

Contours for odour concentrations at 1.5m above ground under various modelling scenario with mitigation measures (setback only) implemented are illustrated in **Figures 3.10a to 3.10e**.

The followings are some odour precautionary measures that shall be considered by EPD and FEHD as environmental initiatives:

<u>During Operation / Restoration Phases</u>

- Planting rows of trees along the northern side of WENT Landfill Extension (ie slope toe) and along realigned Nim Wan Road.
- Providing a vehicle washing facility before the exit of the landfill and providing sufficient signage to remind RCV drivers to pass through the facility before leaving the landfill.
- Reminding the RCV drivers to empty the liquor collection sump and close the valve before leaving the tipping face.
- Washing down the area where spillage of RCV liquor is discovered promptly.

- Reminding operators to maintain their RCVs properly and that liquor does not leak from the vehicles.
- Installation of vertical and/or horizontal LFG extraction system to enhance extraction of LFG from the waste mass and hence minimise odour associated with fugitive LFG emissions.
- Progressive / temporary restoration of the areas which reach the finished profile (a final capping system including an impermeable liner will be put in place) and installation of a permanent LFG extraction system.
- Maintaining the size of the active tipping face not greater than 2 x 60 m x 30 m. Active tipping face means the area where tipping activities are being carried out. Only one tipping face within 1100m from ASR A1-3, 1200m from ASR A2-1 & 1200m from ASR A4-1 is allowed.
- Daily cover the compacted waste with 150mm of soil.
- Covering the non-active tipping phase (ie the whole phase where no tipping activities are being carried out) with 300mm to 600mm of soil / an impermeable liner (on top of the intermediate cover), which will not only prevent odour emissions from landfilled waste but also enhance LFG extraction by the LFG extraction system.
- Providing deodoriser for the Leachate Treatment Plant (LTP).
- Enclosing all the leachate storage and treatment tanks and diverting the exhaust air from these tanks to a deodoriser to avoid potential odour emissions from the LTP.
- As an improvement measure to enhance to environmental standard for waste transfer, EPD could take the initiative to recommend others to use enclosed type RCVs (dominantly government vehicles and sludge vehicles).
- The trench for special waste shall be covered with soil immediately upon the disposal of special waste to reduce the odour emission.
- Cleaning / watering of the surface and clearing of the waste water receptor of government RCV is recommended before leaving refuse transfer station or government Refuse Collection Point (FEHD).
- The use of alternative daily cover (less permeable layer) instead of inert material should be considered under worst-case weather condition, subject to EM&A Programme.
- The use of immediate daily cover for odorous waste such as animal waste etc. under critical condition should also be considered, subject to EM&A Programme.
- In accordance with some reference from New Zealand, odour from active tipping area can be much reduced if the waste is covered by sandwich covering material such that it is confined in a solid/semi solid condition. Such covering material will be acted as sandwich protective layers to block the interaction of waste. Only diffusion mode (small scale) will be present. These would be applied during very hot and stable weather condition. Twice daily covering (mid day and close of business) can be arranged in case odour patrol identify potential odour nuisance, subject to EM&A Programme.
- During stable and calm weather condition and subject to EM&A programme, tipping could be arranged to further increase the setback distance.

<u>During Aftercare Phase</u>

- Continue to maintain the integrity of the capping system.
- Provision of vertical and/or horizontal LFG extraction system to enhance extraction of LFG from the waste mass and hence minimise odour associated with fugitive LFG emissions.
- Enclosing all the leachate storage and treatment tanks and diverting the exhaust air from these tanks to a deodoriser to avoid potential odour emissions from the LTP.

3.8.2.4 VOC Surface Emission and Future Ambient Level

Similar to other restored landfill, the existing WENT Landfill will be capped by plastic covering sheet and a thick layer of soil during restoration period. Surface gas emission from existing restored landfill is insignificant. With the installation of permanent capping, together with the LFG management system, there are double preventive measures against surface emission. Odour and VOC emission from the restored WENT Landfill is not anticipated.

For the WENT Landfill Extension, with an effective temporary covers, together with LFG management system (active extraction to collect LFG within the landfill cells), natural escape of odourous VOC to the nearby ASRs is negligible.

EM&A will be conducted to review the future VOC ambient concentration and effectiveness of the extraction system. VOC monitoring at ASRs to be conducted once every 3 months is recommended before the commissioning of WENT Landfill Extension (as base-line) and in every year of tipping operation, during the period when the ASP and flare are not in operation. By comparing the monitoring data at the boundary and at ASR, the cause of VOC and the general downwind dispersion effect from the boundary to the ASR can be established.

Development of LFG Export Scheme / energy recovery scheme will be encouraged for the WENT Landfill Extension.

3.8.3 Restoration and Aftercare Phase

Similar measures as in construction and operation phases will be applied.

3.9 Residual Environmental Impact

3.9.1 Residual Impact: Annual TSP and Annual RSP

As presented in the preceding sections, all the air quality criterion as stipulated in the Air Quality Objectives and in the EIAO-TM are met, with the exception of Annual TSP and Annual RSP.

Such exceedances constitute residual environmental impact, the significance of which needs to be addressed. In this regard, the following points are of vital relevance:

(a) As shown in **Sections 3.7.1 and 3.7.2** the background Annual TSP & RSP concentrations already exceed their respective criteria. Hence, though this Project emits only a small amount of TSP & RSP, the Annual criteria are still exceeded after adding background concentrations. For ease of reference the relevant results are shown again in the summary below:

Data (μg/m³)	Criterion	Background	Due to this Project	Due to Existing WENT Landfill	Other Sources	Total
Annual TSP (Village Houses/Place of Worship)	80 (AQO)	103	*< 1*	*< 2*	-	103 to 106
Annual TSP (CLP Office)	80 (AQO)	103	*0.4-3.2*	*<1*	-	104-107
Annual TSP (STF Office)	80 (AQO)	103	*2.4-4.9*	*< 8*	-	111-116
Annual RSP	55 (AQO)	64	0.0 to 0.3 *(Results are so small that these two need to be added to show a reportable figure)*		*< 66*	64 to 66

These data summarise the range of results at the 7 no. ASRs, i.e. showing the highest and lowest data.

(b) The Background figures (103/64 for Annual TSP/RSP respectively) are the average results of actual monitoring data obtained at EPD's Air Monitoring Station at Yuen Long for the Years 2003 to 2007. These data have been confirmed by EPD as final. A summary is tabulated below:

Year	2003	2004	2005	2006	2007	2008
Annual Average TSP (μg/m³)	98	113	104	101	97	87
Annual Average RSP (μg/m³)	61	71	62	62	64	60
Remarks	• Average of 2003 - 2007 Annual TSP/RSP = 103/64 respectively; • Data of 2003 - 2007 already confirmed by EPD as final.					Provisional

It can be seen that though the background TSP/RSP monitoring data at Yuen Long have exceeded the Annual criteria (80/55 for Annual TSP/RSP respectively), they are on a downward trend. And although the 2008 data are currently classified as provisional (pending EPD's final confirmation), they do express the downward trend clearly. This downward trend is conceivably due to general reduction in emissions in the Pearl River Delta (PRD) area. In view of the Guangdong Province Government's commitment on reduction of PRD emissions, the aforesaid downward trend will obviously continue in the years ahead. The assumption in this EIA that Background concentrations are equal to the average of 2003 - 2007 data at EPD's Yuen Long Air Quality Monitoring Station is obviously conservative.

(c) RSP

The RSP generated by this Project is minor in comparison with the AQO Criteria and the background figures. In fact, the annual average RSP figures generated solely by this Project at the 7 no. ASRs are less than 0.3 μg/m³. As a comparison, the reporting tolerance of suspended particulates is generally of the order of 1 μg/m³. Thus, the effect due to the Annual RSP on the ASRs is unlikely to be significant.

TSP

The TSP generated by this Project is minor in comparison with the AQO Criteria and the background figures. Though the Project figures are not as minute as that of RSP, it should be noted that TSP is relatively less significant than RSP in terms of health consideration, because the particle size of RSP is much smaller than TSP and hence would have higher health implications especially in relation to respiratory system. In any case, the TSP figures generated by this Project are much less than both AQO criterion and the background figure anyway.

Details of the findings are presented below:

- For the calculation of the annual TSP concentration due to the construction of Nim Wan Road realignment, 10% of the works area (assume evenly distributed over the entire works area of Nim Wan Road realignment) has been adopted for the location of the emission over the whole 2-year construction period, which is on the conservative side as the construction works would not affect 10% of the area over the entire 2-year construction period.
- The TSP/RSP figures for each ASR are the figure at an outdoor point outside its premises. In the case of ASR A2-1 Black Point Power Station office and A3-1 STF office, the TSP inside the offices will be much lower, as an air-conditioner filter is generally capable of removing 50% dust. Hence, the mitigated cumulative

annual TSP concentrations at ASR A2-1 and A3-1 would be within the annual AQO.

- Also worth noting is that ASR A4-1 is a place-of-worship. The actual receivers at this ASR are therefore generally the worshippers/descendants whose visits to the place are transient in nature. From the points of view of Annual TSP/RSP, their effect on the worshippers/visitors are unlikely to be significant, provided that the Hourly and Daily TSP/RSP figures do not exceed the AQO criteria (which is indeed the case here).
- As regards the other 4 ASRs A1-1 to A1-4, they are village houses at Ha Pak Nai, the contribution due to the construction of the WENT Landfill Extension is less than 1 μg/m³ out of the cumulative impact of up to 106 μg/m³. Hence, it can be concluded that the residual impact due to the Project itself (ie WENT Landfill Extension) is insignificant.

Notwithstanding the fact that the exceedances of Annual TSP & RSP criteria are by far predominantly due to existing high Background concentrations rather than this Project itself, the exceedances should still be considered as residual environmental impact. In this regard, the significance of this residual impact will be discussed below in the light of aspects stipulated in EIAO-TM Clause 4.4.3 and its Annex 20 Clause 7.

3.9.2 Factors in EIAO-TM Clause 4.4.3:

(i) effects on public health and health of biota or risk to life

TSP

As pointed out in Section 3.9.1(a) above, this Project itself generates only up to 4.9 μg/m³ for Annual TSP. These are already the highest figures amongst the various ASRs. As mentioned in 3.9.1(c) above, since the ASR A2-1 and A3-1 are central air-conditioned, any typical dust filters associated with the air-conditioning system would reduce at least 50% of the TSP level and hence the annual TSP level would be within the annual AQO. For the other ASRs, the impact due to this Project is insignigicant. Moreover, as TSP is relatively less of a concern from health/life point of view as explained in 3.9.1(c), it is considered that the effects on public/biota health or risk-to-life should not be significant. Also relevant is that the TSP figures are likely to have been overestimated too, in view of conservatism factor discussed in 3.9.1(c).

RSP

As pointed out in Section 3.9.1(a) above, this Project itself generates only less than 0.3 μg/m³ for Annual RSP. These are already the highest figures amongst the various ASRs. As the Project figures for RSP are all-the-more minute, it is considered that the effects on public/biota health or risk-to-life should not be significant.

(ii) the magnitude of the adverse environment impacts – As discussed above, even with conservatism factor, the assessed TSP/RSP figures due to this Project are still minute (especially for RSP). And although the Background figures are high, they are on a downward trend. Hence, the magnitude by which they exceed the Annual TSP/RSP criteria will diminish in the years ahead.

(iii) the geographic extent of the adverse environmental impacts – The residual impact is by far predominantly caused by the high Background Annual TSP/RSP figures. In terms of geographic extent, this is of course an area-wide issue. Nevertheless, the impact caused by this Project itself is minute, and the geographic extent of its own impact should be local, in a remote area between Lung Kwu Sheung Tan and Ha Pak Nai.

(iv) the duration and frequency of the adverse environmental impacts – The construction works near CLP office are the realignment works of Nim Wan Road and the works would last for about 2 years. As stated above, the residual impact is mainly due to the high Background Annual TSP/RSP figures and the contribution due to this Project itself is minute.

(v) the likely size of the community or the environment that may be affected by the adverse impacts – As discussed in 3.9.1 (c), the offices of ASRs A2-1 & A3-1 are unlikely to be affected, whereas the visits by worshippers/visitors to ASR A4-1 are transient in nature and therefore unlikely to be affected from the points of view of Annual TSP/RSP. As regards ASRs A1-1 to A1-4, 3.9.1(c) above has pointed out that the residual impact due to this Project itself is insignificant.

(vi) the degree to which the adverse environmental impacts are reversible or irreversible – As explained above, the impact due to this Project itself is minute. Upon completion of the WENT Landfill Extension, the project site will be restored to an area of substantial plantation, and will cease to emit TSP/RSP.

(vii) the ecological context – The exceedance does not involve ecological context.

(viii) the degree of disruption to sites of cultural heritage – The exceedance does not involve cultural heritage context.

(ix) international and regional importance – The exceedance does not involve international and regional importance.

(x) both the likelihood and degree of uncertainty of adverse environmental impacts – As explained in 3.9.1, the assessed TSP/RSP figures are likely to be on the conservative side i.e. high side.

3.9.3 Questions in Annex 20 Clause 7:

Have the available standards, assumptions and criteria which can be used to evaluate the impacts been discussed?	Yes
Have the predicted impacts been compared to the available standards and criteria?	Yes
Have the residual impacts, which are the net impacts with the mitigation measures in place, been described and evaluated against the available Government policies, standards and criteria?	Yes
Have the residual impacts been discussed and evaluated in terms of the impact on the health and welfare of the local community and on the protection of environmental resources?	Yes
Have the magnitude, location and duration of the residual impacts been discussed in conjunction with the value, sensitivity and rarity of the resource?	Yes
Where there are no generally accepted standards or criteria for the evaluation of residual impacts, have alternative approaches been discussed and, if so, is a clear distinction made between fact, assumption and professional judgment?	Not applicable
Have the residual impacts, if any, arising from the implementation of the proposed mitigation measures, been considered?	Yes

Clearly the residual impacts as regards Annual TSP & RSP are by far predominantly caused by existing Background concentrations unrelated to this Project, and that the impacts due to this Project itself are minute. The Annual TSP figures due to this Project itself are minor in magnitude, whereas the Annual RSP figures are even (much) smaller; yet both TSP and RSP figures are likely to have been overestimated, due to conservatism in the assessment. In view of the above, the residual impacts as regards Annual TSP & RSP ought not be considered as an issue of environmental concern in the context of this Project.

Nevertheless, the following measures would be taken to control the TSP figures due to this Project. These include:

(a) Shift some of the dust-generating tasks (e.g. excavation and site formation) further away from the affected ASR(s) in case weather condition such as wind direction is particularly adverse towards that ASR(s).

(b) Further increase the frequency of daily watering – In Section 3.7.1 above it has been put forward that watering will be carried out 8 times a day. This could be increased further if necessary.

The necessity for further measures as outlined above should be subjected to actual EM&A results, which will also determine the extent/details of the measures.

3.10 Conclusion

The potential air quality impacts during construction, operation, restoration and aftercare phases of the WENT Landfill Extension Project have been assessed.

3.10.1 Construction Phase

Construction dust modelling results show that the 1-hr and 24-hr average TSP concentrations at all the receivers would comply with the legislative requirements. The cumulative annual TSP concentration would however, due to the high background level, exceeds the respective criterion. Further analysis suggests that the contribution from the WENT Extension Project would nevertheless be insignificant, especially for the neighbouring village houses. For other areas that are provided with air-conditioning, it is anticipated typical dust filters would be able to reduce the dust level by 50% and hence would be sufficient to ensure acceptable air quality. Good site practice such as 8 times / day of watering should be carried out to control the dust problems. Requirements for regular monitoring of dust concentration are detailed in the EM&A Manual.

3.10.2 Operation Phase

3.10.2.1 Stack Gas and Surface Gas Emission

Dispersion modelling results show that gaseous emissions from ammonia stripping plant, LFG power generator and flaring system of the WENT Landfill Extension will have no adverse impact on the ASRs throughout the operation period of the WENT Landfill Extension, except the annual RSP concentration. However, further analysis revealed that the annual RSP contribution from the Project (WENT Landfill Extension), Existing WENT Landfill and marine emissions is less than 1% of the annual AQO. In addition, the background RSP concentration of 64 $\mu g/m^3$ adopted from Air Monitoring Station at Yuen Long has already exceeded the AQO criteria of 55 $\mu g/m^3$. Air quality impact arisen from the Project is therefore insignificant.

Subject to the subsequent EPD's requirement on chimney installation, regular stack monitoring of air pollutants, including NO_x, SO_2, RSP, NMOCs, vinyl chloride, and benzene shall be carried out at a quarterly interval (i.e. once every 3 months), and the operating conditions, including exhaust gas temperature and velocity shall be monitored continuously in order to demonstrate compliance during the operations.

By adopting the best practice using effective active extraction system, plastic sheet cover at inactive tipping phase plus periodic EM&A monitoring, the surface gas emission can be significant reduced. With the provision of these measures, no adverse health risk impact is anticipated.

Regular emission monitoring of these facilities is recommended to ensure their proper functioning.

3.10.2.2 Odour

Odour assessment results show that some operational constraints on the locations of tipping faces (ie only one tipping face within certain distance from some sensitive receivers (1100m from West Ha Pak Nai, 1200m from office of Black Point Power Station & 1200m from Lung Kwu Sheung Tan)) are required to ensure compliance of the odour limits for the receivers. For the office at the STF office, some odour removal facilities would be installed to reduce the odour level accordingly. Other odour control measures (eg application of daily cover) would be implemented to minimise the odour impact.

Ventilated cover with emissions extracted to suitable odour removal filters for odour removal has been proposed for planned lagoons. Updated treatment method such as Sequencing Batch Reactor has been proposed for future lagoon. Ferric nitrate or sodium hypochlorite shall be added to oxidise the odourous chemical in the leachate. The pH value of leachate can be controlled to a suitable value from future on-site experiment such that the generation of any odourous H_2S and ammonia can be optimised.

Suitable treatment system with overall odour removal efficiency of 99% should be provided for the leachate treatment plant for odour removal.

The locations of discharge points and discharge heights should be in accordance with the assumptions adopted in the EIA Report. If the future locations / heights of the stacks deviate from the assumptions adopted in the EIA Study, reassessment of the air quality impact should be conducted.

3.10.3 Restoration and Aftercare Phases

The scale of construction activities during the restoration and aftercare phases of the WENT Landfill Extension will be small when compared with the construction phase. Construction dust is therefore not anticipated to be an issue.

The impact of stack gas emissions from treatment facilities will be much reduced during these phases given the gradual reduction in leachate and LFG generation rates over time.

Odour in restored landfill will not be a concern.

Air quality conditions will not be worse than during the operation phase and hence no adverse impact is anticipated.