5 AIR QUALITY

5.1 INTRODUCTION

This Section assesses the potential air quality impacts associated with the construction and operation of the Sham Tseng Development. The main air quality impact during construction phase will be dust arising from the reclamation and construction activities. Vehicle exhaust emissions and industrial emissions will be the key concerns during the operational phase. Representative Air Sensitive Receivers (ASRs) will be identified and worst case impacts on these receivers will be modelled. Mitigation measures required to protect the ASRs will be recommended, where necessary, to ensure that the legislative air quality criteria and guidelines will be satisfied.

5.2 ENVIRONMENTAL LEGISLATION AND CRITERIA

The criteria for evaluating air quality impacts are laid out in Annex 4 of the *Technical Memorandum on Environmental Impact Assessment Process* (EIAO-TM). The relevant criteria for this study are given below.

The principal legislation for the management of air quality is the *Air Pollution Control Ordinance* (APCO) (Cap 311). The whole of the Hong Kong Special Administrative Region (HKSAR) is covered by the *Hong Kong Air Quality Objectives* (AQOs) which stipulate the limits of some typical air pollutants and the maximum allowable numbers of exceedance over specific periods. The AQOs are shown in *Table 5.2a* below.

Table 5.2a Hong Kong Air Quality Objectives (μg m^{-3})[(i)]

Pollutant	Averaging Time			
	1 Hour [(ii)]	8 Hours [(iii)]	24 Hours [(iii)]	1 Year [(iv)]
Total Suspended Particulates (TSP)	-	-	260	80
Respirable Suspended Particulates (RSP) [(v)]	-	-	180	55
Sulphur Dioxide (SO_2)	800	-	350	80
Nitrogen Dioxide (NO_2)	300	-	150	80
Carbon Monoxide (CO)	30 000	10 000	-	-
Photochemical Oxidants (as Ozone, O_3) [(vi)]	240	-	-	-

Notes:

(i) Measured at 298 K (25 °C) and 101.325 kPa (one atmosphere).

(ii) Not to be exceeded more than three times per year.

(iii) Not to be exceeded more than once per year.

(iv) Arithmetic means.

(v) Respirable suspended particulates are defined as particles suspended in the air with a nominal aerodynamic diameter of 10 μm and smaller.

(vi) Photochemical oxidants are determined by measurement of ozone only.

The EIAO-TM also states that the hourly TSP level should not exceed 500 μg m^{-3} (measured at 298 K and 101.325 kPa) for construction dust impact assessment. An odour criterion of 5 odour units, based on an averaging time of 5 seconds, should also be met.

The *Air Pollution Control (Construction Dust) Regulation* specified the mitigation measures for construction activities. The design and operation of transport terminus should comply with the C*ontrol of Air Pollution in Semi-Confined Public Transport Interchanges* (ProPECC PN 1/98). The air quality inside the semi-confined public transport terminus (PTT) should be maintained in accordance with the *Public Transport Interchange Air Quality Guidelines* (PTIAQG) presented in *Table 5.2b*.

Table 5.2b Public Transport Interchange Air Quality Guidelines (PTIAQG)

Air Pollutants	Averaging Time	Maximum Concentration (μg m^{-3})
Carbon Monoxide	5 minutes	115 000
	1 hour	30 000
Nitrogen Dioxide	5 minutes	1800
	1 hour	300
Sulphur Dioxide	5 minutes	1000
	1 hour	800
Note: All limits are expressed at the reference conditions of 298 K and 101.325 kPa		

The *Tunnel Air Quality Guidelines (TAQG)* specified under the EPD's *Practical Notes on Control of Air Pollution in Vehicle Tunnel, 1995*, should be attained and maintained inside vehicle tunnels. *Table 5.2c* presents these guideline values:

Table 5.2c Tunnel Air Quality Guidelines (TAQG)

Air Pollutants	Averaging Time	Maximum Concentration (μg m^{-3})
Carbon Monoxide	5 minutes	115 000
Nitrogen Dioxide	5 minutes	1800
Sulphur Dioxide	5 minutes	1000
Note: All limits are expressed at the reference conditions of 298 K and 101.325 kPa		

The *Hong Kong Planning Standards and Guidelines* (HKPSG) recommends buffer distances for different type of roads and are illustrated in *Table 5.2d* below.

Table 5.2d HKPSG Air Quality Guidelines on Usage of Open Sites

Type of Road	Buffer Distance	Permitted Use
Trunk Road and Primary Distributor	> 20 m	Active and passive recreational uses
	3 - 20 m	Passive recreational uses
	< 3 m	Amenity areas
District Distributor	> 10 m	Active and passive recreational uses
	< 10 m	Passive recreational uses
Local Distributor	> 5 m	Active and passive recreational uses
	< 5 m	Passive recreational uses
Under Flyover		Passive recreational uses

The HKPSG also recommends a buffer distance of 200 m for industrial sources

with chimneys from ASRs.

5.3 BASELINE CONDITIONS

5.3.1 Existing Conditions

Existing air quality of the Study Area is mainly affected by the traffic flow along major roads near the reclamation site such as Castle Peak Road and Tuen Mun Road. Construction of sewage pumping station, located to the east of the Study Area, is being carried out and dust levels at the Sham Tseng reclamation site are currently high. No fixed air monitoring station is located near the Study Area. Annual average air quality data monitored at EPD's Tsuen Wan station in 1997 are shown in *Table 5.3a* and will be used as background concentration in this assessment. Odour from the operation of the Garden Bakery can be detected although no complaints have been received by the EPD since 1995.

Table 5.3a Background Air Quality for the Study Area

Pollutants	Annual Average Concentration ($\mu g\ m^{-3}$)
TSP	82
RSP	56
CO	720
SO_2	20
NO_2	68

5.3.2 Air Sensitive Receivers

Representative ASRs have been identified according to the criteria set out in the EIAO-TM by reviewing the landuse plans of the Study Area. Domestic premises, hotel, hostel, hospital, clinic, nursery, temporary housing accommodation, school, educational institution, office, factory, shop, shopping centre, place of public worship, library, court of law, sports stadium or performing arts centre are considered as ASRs. *Table 5.3b* lists the identified existing and future ASRs with their horizontal distances from the site boundary. The locations of the ASRs are shown in *Figures 5.3a* and *5.3b.*

Table 5.3b Locations of Air Sensitive Receivers

ASR	Location	Horizontal Distance from Site Boundary (m)
A1	Rhine Terrace	205
A2	Rhine Garden	325
A3	Lido Garden	30
A4	Sham Tseng Village	110
A5	Sham Tseng Kau Tsuen	245
A6	Sea Crest Villa (Phase I)	100
A7	Sea Crest Villa (Phase II)	70
A8	Sea Crest Villa (Phase III)	125
A9	Sea Crest Villa (Phase IV)	225

ASR	Location	Horizontal Distance from Site Boundary (m)
A10	Proposed Residential Development at San Miguel Brewery	20
A11	Proposed Residential Development at Union Carbide	15
A12	DD 387 Lot 99	20
A13	Sham Tseng Tung Tsuen	120
A14	Golden Villa	130
A15	Dragonville	200
A16	Eastern Winter Swimming Association	300
A17	Dragon Garden	250
A18	Victoria Varie's Court	550
A19	Villa Alfavista	700
P1	Proposed Government Complex on the Reclamation	-
P2	Proposed CDA Site on the Reclamation	-
P3	Proposed School on the Reclamation	-
P4	Proposed Residential Development on the Reclamation	-
P5	Proposed Residential Development on the Reclamation	-
P6	Proposed Western Coastal Park on the Reclamation	-
P7	Promenade above the proposed Sham Tseng Bypass	-

5.4 ASSESSMENT METHODOLOGIES

5.4.1 Construction Phase

Dust Impact

The USEPA approved air dispersion model *Fugitive Dust Model* (FDM) has been used to predict the likely dust impacts at ASRs from the construction of the STD. Both 1-hour and 24-hour TSP concentrations at the worst affected level which is the ground level have been modelled for all the identified ASRs. The particle size distribution and the emission factors used in the *FDM* model has been identified based on the *Compilation of Air Pollutant Emission Factors, 5th Edition, USEPA* (AP-42) and are shown in *Annex H*. Major dust emission rates for the identified construction activities are shown in *Table 5.4a*.

Table 5.4a Emission Rates for Identified Dust Sources

Activity	Emission Rate (1)	Remarks
Truck Haulage	7.54×10^{-3} g m^{-1} s^{-1}	• no. of truck: 30 vehicles per hour • silt content: 8.4% • vehicle weight: 25 Mg • moisture content: 10%
Reclamation and Infrastructure Construction	3.89×10^{-5} g s^{-1} m^{-2}	• assume 30% of the site is active

Notes :

(1) from Updated Compilation of Air Pollutant Emission Factors, USEPA, (AP-42) 5th Edition.

The construction works are expected to be conducted 26 days a month and 10 hours a day. Meteorological data for 1997 (wind speed, wind direction, stability class, temperature and mixing height) from the Hong Kong Observatory Tuen Mun station have been employed for the air quality modelling. Although the meteorological stations on Tsing Yi are located closer to Sham Tseng, the Tuen Mun station was chosen as this station is influenced more by local topography, including the Lantau Island to the south, which should be more representative for Sham Tseng area.

5.4.2 Operational Phase

Vehicular Emissions

The air dispersion model, *CALINE4,* has been used to predict the pollutant levels of NO_2, RSP and CO at the identified ASRs. Vehicle emissions from the major roads near the Study Area such as Castle Peak Road, Tuen Mun Road and the proposed Sham Tseng Bypass on the reclamation area have been included in the model.

Noise mitigation measures such as noise barriers and semi-enclosures proposed as shown in *Figures 4.7a-e* have been incorporated into the model. With the installation of vertical noise barriers, the pollutants generated will be emitted from the top of the noise barriers and the road type was set to 'fill' option. For cantilever barriers and semi-enclosures, it is assumed that the dispersion of the pollutants would be similar to physically shifting the road section by a distance equal to the cover extent and be emitted from the top of the barriers/semi-enclosures, the road type was also set to 'fill' option.

Fleet emission factors based on the EuroIII criteria have been used for this assessment. As emission factors beyond year 2011 are not available for the study, year 2011 vehicle emission factors have therefore been assumed for traffic beyond year 2011. It is however believed that, emission rates beyond year 2011 will be lower as fleet mix will continue to improve, more stringent controls will be put into place and vehicles will be fitted with advanced emission control systems. The predicted results will therefore be conservative.

As discussed in Section 4.4.2, two traffic forecast years have been produced according to the two development scenarios in Area 2. The traffic forecast for Year 2019 presents the worst case scenario for all roads except a few sections of Castle Peak Road. The forecasting year for 2016 reviewed that the section of Castle Peak Road between the Western Development Access and the east of the Sham Tseng Bypass, is slightly higher, at approximately 1%, than the forecast for 2019. Since the percentage of heavy vehicle remains unchange for both scenarios and the other road section will have some reduction in the projected traffic flow, it is envisaged that the potential increase in vehicular emissions from this section of Castle Peak Road will be insignificant. Therefore, the peak hour traffic forecast for Year 2019 have been used for the purpose of this assessment as a worst case year in this EIA. Peak hour traffic in the Study Area will occur during daytime and the worst case daytime meteorological conditions have been assumed for the dispersion model which included:

- Wind Speed: 1 m s^{-1}
- Wind Direction: worst angle for each receiver
- Stability Class: D
- Mixing Height: 500 m
- Standard Deviation: 13^{o}
- Temperature: 25 ^{o}C

NO_x is assumed to be inert and levels of NO_2 have been taken as 20% of the total NO_x concentration. The hourly average of pollutants at two affected heights, ground level and 10 m above ground have been modelled in the assessment.

Portal Emissions

Portal emissions from the underpass slip road B have been assessed using the USEPA approved *Industrial Source Complex (ISC3) Dispersion Model*. The portal emission was assessed based on the procedures stated in Section III of PIARC, 1991 and portal air plumes of 100 m has been assumed along the axis of roads and only the well diluted parts would gradually become sheared off. Meteorological data for 1997 from the Tuen Mun weather station, operated by the Hong Kong Observatory, have been employed in the model run. Emission rates for NO_2, CO and RSP have been calculated based on the peak hour traffic flow and is shown in *Table 5.4b* below:

Table 5.4b Portal emission calculation

Portal Emission	Slip Road B
Length of Enclosure (m)	370
Peak Hourly Traffic Flow (veh/hr)	730 (one way traffic)
Fleet Emission of NO_x (g/km/veh)	1.458
Total NO_x Emission Rate (g/s)	0.109
Fleet Emission of CO (g/km/veh)	2.887
CO Emission Rate (g/s)	0.22
Fleet Emission of RSP (g/km/veh)	0.149
RSP Emission Rate (g/s)	0.011

Notes:

(i) Emission rates are calculated from fleet emission factors based on year 2011 of EuroIII.

(ii) NO_2 emission rate is assumed to be 20% of the total NO_x emission.

NO_x is assumed to be inert and levels of NO_2 have been taken as 20% of the total NO_x concentration. The hourly average of pollutants at two affected heights, ground level and 10 m above ground have been modelled in the assessment.

Industrial Emissions

Chimney emission has been modelled by the *ISC3* model. Chimney data of the Study Area have been obtained from the EPD and is shown in *Annex H*. Locations of sources, types of the fuel, its maximum fuel consumption rates, physical dimension for chimney of stacks, exit gas temperature have been included. Meteorological data of 1997 from Tuen Mun weather station, operated by the Hong Kong Observatory, have been employed in the model run. Emission rates of pollutants were calculated based on the USEPA AP-42. General load factors of 41% during day time and 23% during night time are recommended by EPD and were employed for this assessment.

Odour Emissions

Potential odour emission from the Garden Bakery has been modelled using the *ISC3* model. It is stated in the *Guidelines on Choice of Models and Model Parameters* issued by EPD that the *ISC3* model can be used to predict odour impact and it has been applied in a number of odour assessments including the EIAs of Sha Tin Sewage Treatment Work Extension(1) and the International Theme Park(2). The ISCST3 model is considered as the most suitable model for application in this study. Odour strength information used for previous study have been employed in the assessment and are shown in *Annex H*. In the model, stack gas emissions have been assumed as point sources while fugitive emissions from ventilation openings as volume sources. Meteorological data for 1997 from Tuen Mun weather station, operated by the Hong Kong Observatory, have been employed for the model run.

(1) Sha Tin Sewage Treatment Works, Stage III Extension, Environmental Impact Assessment Study, Final Report ERM, 1998.

(2) Construction of an International Theme Park in Penny's Bay of North Lantau and its Essential Associated Infrastructures, Environmental Impact assessment Study, Final Report, ERM, 2000.

The ISC3 model has been used to predict an output which is described by the model as a maximum 1 hour mean concentration. In actual fact, this output corresponds more closely to a maximum 3 minute average. To provide a margin of error, it has been conservatively assumed that concentration calculated by ISC3 can be equated to a 15 minute mean. In order to convert the model outputs to maximum 5 second mean concentrations, a two-step conversion process has been defined. The first step is the conversion of the model output to a maximum three minute mean using the power law formula proposed by Duffee et al(3). The second step is the conversion of 3 minute means to 5 second means using the approach suggested by the Warren Spring Laboratory (WSL)(4). The resulting factors for converting the model outputs to 5 second means, are presented in *Table 5.4c*.

Table 5.4c ***Factors for Converting Model Outputs to Maximum 5-second Mean Odour Concentrations***

Pasquill Stability Class	Conversion 15 min to 3 min mean	Conversion 3 min to 5 sec mean	Overall Conversion Factor
A	2.23	10	22.3
B	2.23	10	22.3
C	1.70	5	8.50
D	1.38	5	6.90
E	1.31	5	6.55
F	1.31	5	6.55

5.5 IDENTIFICATION OF IMPACTS

5.5.1 Construction Phase

The likely air quality impact arising from the construction of Sham Tseng Development comprises dust nuisance and gaseous emissions from construction plant and vehicles.

SO_2 and NO_2 will be emitted from the use of diesel-powered mechanical equipment. However, since the gaseous emissions from the equipment will be minor and transient, exceedance of AQO from the use of construction plant on site is not expected.

The construction of the project will commence in 2004 and will be completed by 2012. The likely dust generating activities are:

- reclamation;
- wind erosion over the stockpiles and exposed surfaces of surcharge material;
- traffic movement which is expected to be 30 vehicles per hour on unpaved haul roads; and

(3) RA Duffee, MA O'Brien & N Ostojic, Odour Modelling - Why and How, in recent Developments and Current Practices in Odour, Regulations, Control and Technology, Transaction of the Air & Waste Management Association, ED. DR Derenzon & A Gnyp

(4) A W C Keddie, Dispersion of Odours, in Odour Control - A Concise Guide, Warren Spring Laboratory, 1980

- infrastructure construction for road network and building such as site clearance, ground excavation, cut and fill operations and material transfer.

No batching plant will be present on site. The worst affected construction periods will be the reclamation works for Phases 1 to 4 carried out in parallel between 2005 and 2008, and infrastructure construction for road network and building over the entire reclamation area between 2008 and 2012. Construction works during these periods have been considered as worst case scenario in the assessment. Dust impact from improvement work of Castle Peak Road has also been included.

5.5.2 Operational Phase

Vehicle Emissions

Vehicular emissions such as NO_2, CO, and RSP from open sections of road will be the major air pollutants during the operation of STD. The reclaimed area will be used mainly as residential and commercial developments. Ambient air quality of the Study Area is already being affected by vehicular emissions from users of the existing road network. Additional pollutants from the new roads within STD area, especially the proposed Sham Tseng Bypass, will inevitably affect the air quality of the Study Area.

Internal road network proposed within the STD area are satisfied with the HKPSG recommended buffer distances for local distributors and therefore adverse air quality impact from the internal road network to the nearby sensitive uses is not expected.

Portal Emissions

Pollutants accumulated inside a 370 m underpass slip road B located to the west of Sham Tseng Bypass will be emitted and dispersed via portal. It is expected that the portal air will be emitted horizontally under the action of jet fans. Ventilation systems will be provided for the underpass in order to satisfy the TAQG requirements. The design of the ventilation system, will be refined during the detailed design stage.

Industrial Emissions

An industrial building, Garden Bakery, is located to the eastern part of the proposed STD area. Industrial emissions and fugitive odour emissions from the factory will affect the air quality of the Study Area. NO_2 and SO_2 are the major pollutants from industrial emissions. The former San Miguel and Union Carbide plants located at the existing sea coast are in the process of demolition and redevelopment into private residential developments. A number of small workshops are also located within the Study Area and will also affect the local air quality.

Potential Odour Emissions

Odour may be emitted from the Garden Bakery and the proposed Ting Kau

and Sham Tseng Sewage Treatment Works (TKSTSTW) and Sewage Treatment Facilities for Sham Tseng Development (STFSTD) at Areas 6 and 7. The nullahs on the reclamation and a refuse collection point (RCP) at Area 6 will also be potential odour sources.

Although the bakery odour is not considered hazardous to health, the odour criterion of 5 odour units based on an averaging time of 5 seconds, as stipulated in the Technical Memorandum (TM) of the Environmental Impact Assessment Ordinance (EIAO), is adopted for odour assessment.

For the purpose of this Study, quantitative assessment has been carried out to predict the likely odour levels at the nearest ASRs.

A sewage pumping station (SPS) is proposed at Area 4. As the SPS will be enclosed and underground, with the provision of odour removal facilities such as activated carbon filter at the air vent of the pumping station, as recommended in the *EIA Report of Ting Kau and Sham Tseng Sewerage Scheme, Environmental Impact Assessment Study* [5] for typical pumping station, odour impact to the nearby ASRs is not expected. However, the odour mitigation measures required should be reviewed when the detailed design of the SPS is available.

Public Transport Terminus

A semi-enclosed PTT is proposed below the podium of a CDA at Area 4. The air quality in the PTT should be maintained to satisfy the PTIAQG presented in *Table 5.2b.*

Salt Water Pumping Station

A proposed WSD salt water pumping station is located to the western part of the proposed reclaimed area. The pumping station will adopt on-site generation of sodium hypochlorite solution from sea water for disinfecting seawater for flushing. Diluted hydrogen gas, which is the by-product of the above process, will be released from the pump house. However, as hydrogen gas is not toxic in nature and concentration released will be low (less than 1% in volume of hydrogen gas) to cause any suffocation effect, no adverse air quality impact is expected from the operation of the pumping station.

(5) Ting Kau and Sham Tseng Sewerage Scheme, Environmental Impact Assessment Study, Agreement No. CE 35/94, Final Report, Mott Connell Ltd, 1995. Registered under the EIAO, EIA-077/BC.

Nullahs

As sewage discharge will be collected by sewage master scheme and treated at the sewage treatment works, adverse odour from nullahs is not expected; additionally the nullahs will be decked-over.

Refuse Collection Point

Odour nuisance from the proposed RCP at Area 6 will be avoided by proper waste management. Adverse odour impact to the ASRs is not anticipated.

5.6 EVALUATION OF IMPACTS

5.6.1 Construction Phase

The dust impact during construction phase of STD has been modelled using FDM. The predicted hourly and daily TSP levels at ground level at the identified ASRs are shown in *Table 5.6a*.

Table 5.6a Predicted Hourly and Daily TSP Level for STD ($\mu g\ m^{-3}$)[(i)]

ASRs	Location	Average Hourly TSP Level	Average Daily TSP Level
A1	Rhine Terrace	189	104
A2	Rhine Garden	203	108
A3	Lido Garden	363	138
A4	Sham Tseng Village	292	130
A5	Sham Tseng Kau Tsuen	244	119
A6	Sea Crest Villa (Phase I)	220	118
A7	Sea Crest Villa (Phase II)	242	115
A8	Sea Crest Villa (Phase III)	219	93
A9	Sea Crest Villa (Phase IV)	147	89
A10	Proposed Residential Development at San Miguel Brewery	**665**	180
A11	Proposed Residential Development at Union Carbide	**726**	190
A12	DD 387 Lot 99	247	95
A13	Sham Tseng Tung Tsuen	168	96
A14	Golden Villa	254	94
A15	Dragonville	312	124
A16	Eastern Winter Swimming Association	338	123
A17	Dragon Garden	235	100
A18	Victoria Varie's Court	140	87
A19	Villa Alfavista	140	85

Notes: (i) Background TSP level included in the results
(ii) Bold figure exceeds dust criteria

The predicted hourly and daily TSP levels are in the range of 140 - 726 μg m^{-3} and 85 - 190 μg m^{-3}, respectively. Highest hourly and daily TSP levels are predicted at the Proposed Residential Building at Union Carbide (A11). It is expected that dust levels would be exceeded at some receivers. Dust suppression measures are therefore required to reduce emissions from the site.

5.6.2 Operational Phase

Vehicular Exhaust Emissions

NO_2, CO and RSP are the major pollutants in vehicular exhaust emissions. ASRs at lower levels (ground level and 10 m above ground) will be most affected. The cumulative air pollutant levels at low level receivers, taking into account contributions from vehicular and portal emissions from underpass, and effects of the proposed noise mitigation measures, are shown in *Table 5.6b*.

Table 5.6b Cumulative Air Pollutant Levels at Low Level Receivers (μg m^{-3})[(i)]

ASRs	Hourly Cumulative Air Pollutant Levels at Low Level Receivers					
	Ground Level			10 m Above Ground		
	NO_2	CO	RSP [(ii)]	NO_2	CO	RSP [(ii)]
A1	164	1543	77	156	1541	75
A2	133	1356	69	130	1347	68
A3	134	1423	68	119	1166	65
A4	137	1311	71	133	1308	70
A5	181	1734	79	173	1715	77
A6	128	1279	68	128	1253	67
A7	117	1178	66	117	1143	65
A8	130	1634	67	126	1271	65
A9	152	1907	80	152	1534	72
A10	102	1045	62	102	1028	62
A11	105	1100	63	101	1094	62
A12	137	1679	70	212	2147	73
A13	160	1541	76	152	1539	74
A14	127	1319	68	123	1201	67
A15	160	2057	74	144	1496	68
A16	150	2825	78	150	1547	69
A17	137	1786	70	133	1346	67
A18	132	1614	68	132	1298	67
A19	156	1711	73	156	1617	72
P1	99	961	62	99	960	62
P2	98	1000	61	98	992	61
P3	104	1090	63	100	1085	62
P4	98	1050	61	98	1027	61
P5	119	1257	65	115	1122	64
P6	136	1417	68	129	1338	66
P7	117	1232	65	110	1106	64
AQO Criteria	**300**	**30 000**	**180** [(iii)]	**300**	**30 000**	**180** [(iii)]

Notes:
(i) Vehicular exhaust, portal emission and background pollutant concentrations are included in the predicted results.
(ii) Daily concentration
(iii) 24-hour criterion of AQOs.

It can be seen that the predicted cumulative hourly NO_2 and CO, and daily RSP concentrations at ground level and 10 m above ground at all the ASRs, including the waterfront promenade above the Sham Tseng Bypass, are within the AQO criteria so that adverse air quality impact is not expected.

The predicted cumulative hourly NO_2, CO and daily RSP concentrations at ground level are in the range of 98 - 181 μg m^{-3}, 961 - 2825 μg m^{-3} and 61 - 80 μg m^{-3}, respectively. The predicted cumulative hourly NO_2, CO and daily RSP concentrations at 10 m above ground are in the range of 98 - 212 μg m^{-3}, 960 - 2147 μg m^{-3} and 61 - 73 μg m^{-3}, respectively. Results in *Table 5.6b* indicate that NO_2 is the critical pollutant and the highest predicted cumulative hourly NO_2 concentration at ground level is predicted at the Sham Tseng Kau Tsuen (A5) and DD387 Lot 99 (A12) at 10 m above ground.

Isopleths of the critical pollutant, NO_2, at ground level and 10 m above ground are shown in *Figure 5.6a, 5.6b, 5.6i and 5.6j*.

Industrial Emissions

High level receivers are mainly affected by existing industrial emissions in the area. The predicted hourly SO_2 and NO_2 concentrations at the planned development of the reclamation at a high of 30 m, 70 m, 100 m and 150 m above ground are shown in *Table 5.6c* below.

Table 5.6c Predicted Hourly SO_2 and NO_2 Concentrations at Different Elevations (μgm^{-3})

ASRs	Predicted Hourly Concentration (I)							
	30 m Above Ground		70 m Above Ground		100 m Above Ground		150 m Above Ground	
	SO_2	NO_2	SO_2	NO_2	SO_2	NO_2	SO_2	NO_2
A1	318	107	246	131	43	72	25	68
A2	57	75	118	85	64	76	28	69
A3	73	73	121	92	41	75	57	71
A4	47	71	172	82	118	102	35	70
A5	51	71	62	75	56	76	35	69
A6	38	71	38	74	30	70	31	69
A7	40	72	31	70	29	70	34	69
A8	41	71	32	72	25	69	31	69
A9	25	69	25	69	36	69	27	69
A10	38	71	155	90	98	93	35	69
A11	27	69	321	107	293	184	45	70
A12	28	70	27	70	27	70	63	72
A13	371	129	94	80	31	70	23	68
A14	120	86	93	96	48	73	24	69
A15	26	69	26	69	29	69	55	71
A16	25	69	27	69	27	70	86	74
A17	28	69	30	70	25	69	41	70
A18	25	69	27	70	30	69	31	69
A19	24	69	45	72	41	73	62	72
P1	33	70	529	150	324	168	27	69
P2	37	71	164	80	79	120	29	70
P3	53	71	44	72	40	74	60	71
P4	45	71	50	72	49	80	38	70
P5	37	70	35	71	32	71	64	72
P6	27	69	53	72	38	74	66	72
P7	39	72	78	80	81	85	33	69
AQO	**800**	**300**	**800**	**300**	**800**	**300**	**800**	**300**

Notes:
(i) Background levels of NO_2 and SO_2 are included in the predicted concentration.

The above table indicates that the AQO criteria for NO_2 and SO_2 will be

satisfied at all elevations. Isopleths of NO_2 and SO_2 at 30 m, 70 m and 100 m above ground are shown in *Figures 5.6c* to *5.6h*.

Odour from Sewage Treatment Facilities, Sewage Pumping Station and Refuse Collection Point

Hydrogen sulphide is the major source of odour from the planned TKSTSTW. According to the *EIA Report of Ting Kau and Sham Tseng Sewerage Scheme, Environmental Impact Assessment Study* [6], odour removal and treatment facilities will be installed at the planned TKSTSTW to achieve 99.9% odour removal efficiency. The highest odour level predicted was 1.3 OU at Golden Villa. For STFSTD at Area 6 to cater for the increased population generated by Sham Tseng Development, the additional flow generated will be about 4,510 m^3/day, which is about 28% of the capacity of the planned TKSTSTW (16 500 m^3 per day). It is assumed that similar design and mitigation measures will be adopted at the STFSTD[7]. With about 28% increase in odour level, EPD's odour criterion is expected to be complied at the nearby ASRs.

Odour from wet well of the pumping station is not expected provided that odour removal facilities, such as activated carbon filter, are installed at the air vent of the station.

Garden Bakery

The bakery process of Garden Bakery would inevitably generate some odour in the immediate vicinity of the site. Odour levels predicted at the nearby planned ASRs at different elevations on an averaging time of 5 seconds are shown in *Table 5.6d* below.

Table 5.6d Predicted Odour Levels at Different Elevations (Odour Unit)

ASRs	Predicted Odour Level (Odour Unit)							
	Ground Level	**10 m**	**20 m**	**30 m**	**40 m**	**50 m**	**60 m**	**70 m**
P1	21	23	28	- (i)	-	-	-	-
P2	19	19	19	18	22	18	17	15
P3	11	11	11	- (I)	-	-	-	-
P4	11	11	11	11	11	10	9	9
P5	10	10	10	10	9	9	8	7
P6	6	- (I)	-	-	-	-	-	-
P7	14	14	- (i)	-	-	-	-	-

Notes: (i) Receiver height lower than the specified elevation

(6) Ting Kau and Sham Tseng Sewerage Scheme, Environmental Impact Assessment Study, Agreement No. CE 35/94, Final Report, Mott Connell Ltd, 1995. Registered under the EIAO, EIA-077/BC.

(7) Further assessment would be required only if the detailed design of the proposed TKSTSTW Expansion deviates substantially from the assumption that the design will be similar to the planned TKSTSTW

The results show that the predicted odour levels at all the planned ASRs would exceed the odour criterion of 5 odour units (based on an averaging time of 5 seconds) as stipulated in the TM of the EIAO. The most affected ASRs are P1 and P2 (Proposed Government Complex at Area 6 and CDA site) and the highest odour level of **28 OU** is predicted at P1 at **20 m** above ground.

Although exceedances of odour criterion were predicted under the worst case meteorological condition, the magnitude and extent of the actual impact at the future ASRs are likely to be lower as a result of shielding from high-rise buildings located right next to the bakery. It should also be pointed out that, odour from bakery operations are not considered to have the potential to cause any adverse health effect.

Public Transport Terminus

The vehicle exhaust inside the proposed PTT should satisfy the PTIAQG. Mechanical ventilation may be required and its design and operation should meet the requirements specified in the ProPECC PN 1/98. Adverse air quality impact due to operation of PTT is therefore not expected.

5.7 MITIGATION MEASURES

5.7.1 Construction Phase

It is predicted that dust levels at some of the identified receivers would exceed the dust criteria and dust suppression measures in accordance to the *Air Pollution Control (Construction Dust) Regulation* are recommended during construction phase to avoid adverse dust impact to the ASRs:

- excavated dusty material should be covered by impervious sheeting and sprayed with water to keep the entire surface wet;
- haul roads should be located away from sensitive receivers and sprayed with water to keep the entire road surface wet;
- every vehicle should be washed to remove dusty materials from its body and wheels before leaving a construction site;
- the load carried by vehicle should be covered by impervious sheeting to ensure no leakage of dusty materials from the vehicle; and
- the heights from which fill materials are dropped should be controlled to a practical level to minimise the fugitive dust arising from unloading.

Through the implementation of the above mitigation measures, dust levels will be reduced. It is estimated that a 50% reduction in dust levels could be achieved for truck haulage, reclamation and infrastructure construction. The mitigated hourly and daily TSP levels are shown in *Table 5.7a*.

Table 5.7a Mitigated Hourly and Daily TSP Levels (μg m^{-3})[(i)]

ASRs	Location	Average Hourly TSP Level	Average Daily TSP Level
A1	Rhine Terrace	136	93
A2	Rhine Garden	142	95
A3	Lido Garden	223	110
A4	Sham Tseng Village	187	106
A5	Sham Tseng Kau Tsuen	163	100
A6	Sea Crest Villa (Phase I)	151	100
A7	Sea Crest Villa (Phase II)	162	99
A8	Sea Crest Villa (Phase III)	150	88
A9	Sea Crest Villa (Phase IV)	115	85
A10	Proposed Residential Development at San Miguel Brewery	373	131
A11	Proposed Residential Development at Union Carbide	404	136
A12	DD 387 Lot 99	165	88
A13	Sham Tseng Tung Tsuen	125	89
A14	Golden Villa	168	88
A15	Dragonville	197	103
A16	Eastern Winter Swimming Association	210	103
A17	Dragon Garden	159	91
A18	Victoria Varie's Court	111	84
A19	Villa Alfavista	111	84

Notes: (i) Background TSP level included in the results.

5.7.2 Operational Phase

Odour

The predicted odour levels at all the planned ASRs would exceed the odour criterion of 5 units (based on an averaging time of 5 seconds) as stipulated in the TM of the EIAO. Therefore, re-planning of the development has been considered to reduce the extent of the odour impacts. However, the constraints and associated environmental problem arising from the roads in the immediate vicinity would preclude any further re-arrangement of the recommended layout to remove such exceedances. This was strengthened by the fact that the predicted odour level at P6 located at the western end of the reclamation farthest from the bakery still exceeds the criterion.

Indirect mitigation measures that could be applied are the installation of central air conditioning and deodourisation facilities for the fresh air intake at the nearby buildings. This may be applicable for some uses which rely on central air conditioning system for ventilation but cannot be applied to open areas and residential buildings which rely on openable windows for ventilation according to the Building Regulations. Therefore, indirect mitigation measures are not considered feasible.

Direct mitigation measures that could be applied to minimise the impact include reducing emissions by enclosure and installation of odour removal systems at the exhausts. Nevertheless, it should be noted that the site where Garden Bakery is presently located has been zoned to CDA for commercial/residential purposes. Thus, relocation of Garden Bakery before the first population intake in 2012 would be the long term solution to mitigate the odour problem. Whilst residual odour will occur before any relocation of the Garden Bakery, the odour impact will not cause any adverse public health effect or risk to life. The magnitude and extent of the odour impact are also considered not major and this is illustrated by a few complaints received (2 only) since 1995. Hence it is considered that the residual bakery odour is not a serious long term issue to the proposed Project.

Odour from the planned TKSTSTW at Area 7 and the STFSTD at Area 6 could be mitigated by the installation of odour removal and treatment facilities. Potential odour nuisance from the proposed RCP at Area 6 could be avoided by proper waste management. Adverse odour impact to the ASRs is not anticipated.

To minimize odour impacts, the wet well of the proposed pumping station will be located underground and enclosed by air-tight covers. A reinforced concrete superstructure will be provided to enclose the underground substructures including the wet well, inlet chamber, screening chamber, etc. In addition, a de-odourizer and a forced ventilation system will be installed to remove odour before discharging air from the pumping station to open air. With these measures incorporated into the design of the pumping station, no adverse odour impacts are anticipated.

Public Transport Terminus

The air quality inside the proposed PTT should satisfy the PTIAQG. Mechanical ventilation may be required and its design and operation should meet the requirements specified in the ProPECC PN 1/98. In addition, it is suggested that the ventilation shafts should be located away from the ASRs to avoid potential air quality impact from the PTT exhaust.

5.8 ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENTS

5.8.1 Construction Phase

Air quality impact during construction phase has been assessed and dust level at all ASRs will comply with the dust criteria with the implementation of dust suppression measures in accordance with the *Air Pollution Control (Construction Dust) Regulation.*. Dust monitoring has been recommended to ensure the efficacy of the control measures and to ensure that the dust criteria will not be exceeded at any ASRs during STD construction. EM&A locations and requirements are discussed in *Section 13.4* and the EM&A Manual.

5.8.2 Operational Phase

No exceedance of AQO criteria due to the proposed development on the STD have been predicted, air quality monitoring for the operational phase is therefore not required.

5.9 CONCLUSIONS

5.9.1 Construction Phase

Reclamation and Construction Works

Dust will be the principal pollutant during the construction phase of Sham Tseng Development. Reclamation, wind erosion over surcharge material, vehicle movements on haul roads and infrastructure construction are expected to be the principal dust sources. Air quality impact during construction phase has been assessed and dust level at all ASRs will comply with the dust criteria with the implementation of dust suppression measures in accordance with the *Air Pollution Control (Construction Dust) Regulation.* Dust monitoring has been recommended to ensure the efficacy of the control measures and to ensure that the dust criteria will not be exceeded at any ASRs during STD construction.

5.9.2 Operational Phase

Traffic and Industrial Impacts

Vehicle exhaust from existing and future roads and industrial emissions will be the major pollutant sources during the operation of the STD. The ASRs will be affected by road traffic emissions at low level (less than 30 m above ground) and by industrial emissions at high level (greater than 30 m above ground). The predicted results show that the AQO criteria will be satisfied at all ASRs at both low and high levels due to vehicular exhaust (taken into account of the effects of the proposed noise mitigation measures) and industrial emissions.

Ting Kau and Sham Tseng Sewage Treatment Work and Sewage Treatment Facilities for Sham Tseng Development

To minimise odour nuisance from the operation of the proposed Ting Kau and Sham Tseng Sewage Treatment Works at Area 7 and the Sewage Treatment Facilities for Sham Tseng Development at Area 6, odour removal and treatment facilities will be installed and EPD's odour criterion will thus be complied with.

Developments above Reclamation

Odour impact from the nullahs on the reclamation is not expected as sewage discharged will be collected by the Sewage Master Scheme and treated at the sewage treatment works; additionally the nullahs will be both extended and decked-over through the STD. Odour nuisance from the proposed Refuse Collection Point at Area 6 will be avoided by proper waste management.

With regard to the odour from the Garden Bakery, the predicted odour levels at all the planned ASRs would exceed the odour criterion of 5 units (based on an averaging time of 5 seconds) as stipulated in the TM of the EIAO. Therefore, re-planning of the development has been considered to reduce the extent of the odour impacts. However, the constraints and associated environmental problem arising from the roads in the immediate vicinity would preclude any further re-arrangement of the recommended layout to remove such exceedances. This was strengthened by the fact that the predicted odour level at P6 located at the western end of the reclamation farthest from the bakery still exceeds the criterion.

Indirect mitigation measures that could be applied are the installation of central air conditioning and deodourisation facilities for the fresh air intake at the nearby buildings. This may be applicable for some uses which rely on central air conditioning system for ventilation but cannot be applied to open areas and residential buildings which rely on openable windows for ventilation according to the Building Regulations. Therefore, indirect mitigation measures are not considered feasible.

Direct mitigation measures that could be applied to minimise the impact include reducing emissions by enclosure and installation of odour removal systems at the exhausts. Nevertheless, it should be noted that the site where Garden Bakery is presently located has been zoned to CDA for commercial/residential purposes. Thus, relocation of Garden Bakery before the first population intake in 2012 would be the long term solution to mitigate the odour problem. Whilst residual odour will occur before any relocation of the Garden Bakery, the odour impact will not cause any adverse public health effect or risk to life. The magnitude and extent of the odour impact are also considered not major and this is illustrated by the lack of complaints received. Hence it is considered that the residual bakery odour is not a serious long term issue to the proposed Project.

It is concluded that residual impact will occur before any relocation of the Garden Bakery. However, the odour impact will not cause any adverse public health effect or risk to life. The magnitude and extent of the odour impact are also considered not major and this is illustrated by a few complaints received (2 only) since 1995. Hence it is considered that the residual bakery odour is not a serious long term issue to the proposed Project. Thus, it can be considered that the criteria set out in the TM Section 4.5.1d can be met.

Air quality inside the proposed Public Transport Terminus should satisfy the Public Transport Interchange Air Quality Guidelines. Mechanical ventilation may be required and its design and operation should meet the requirements specified in the ProPECC PN 1/98.