3 AIR QUALITY

3.1 Introduction

3.1.1 This section presents an impact assessment of air quality during the construction and operation phases of the WDII and CWB project. Compared to the previous scheme, the size of reclamation has been decreased in the latest scheme. Potential construction dust impact is expected to be less. However, as the tunnel length of the Central-Wan Chai Bypass has been increased, the operational air quality impact arising from vehicular traffic emissions, tunnel ventilation and portal emissions could be an issue. Odour nuisance associated with the Causeway Bay Typhoon Shelter is an existing environmental problem. This Project will not create any new odour source during the operational phase. However, in order to improve the environment, this Project will take the opportunities to mitigate the potential sources of odour nuisance within the Project area so as to alleviate this existing environmental problem as well as to provide an acceptable environment for the future land uses within the project area (including the proposed open space at the northern breakwater). Appropriate air quality mitigation measures for the proposed development are identified under this Study where necessary.

3.2 Environmental Legislation, Policies, Plans, Standards and Criteria

3.2.1 The criteria for evaluating air quality impacts and the guidelines for air quality assessment are set out in Annex 4 and Annex 12 of the *Technical Memorandum on Environmental Impact Assessment Process* (EIAO-TM).

Air Quality Objective & EIAO-TM

3.2.2 The Air Pollution Control Ordinance (APCO) provides the statutory authority for controlling air pollutants from a variety of sources. The Hong Kong Air Quality Objectives (AQOs), which must be satisfied, stipulate the maximum allowable concentrations of certain pollutants over specific periods. The relevant AQOs are listed in **Table 3.1**.

Table 3.1 Hong Kong Air Quality Objectives

Pollutant	Maximum Concentration (µg m^{-3}) (1)			
	Averaging Time			
	1 hour (2)	8 hour (3)	24 hour (3)	Annual (4)
Total Suspended Particulates (TSP)	-	-	260	80
Respirable Suspended Particulates (RSP) (5)	-	-	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) (6)	240	-	-	-

Notes:
(1) Measured at 298 K and 101.325 kPa.
(2) Not to be exceeded more than three times per year.
(3) Not to be exceeded more than once per year.
(4) Arithmetic mean.
(5) Suspended particulates in air with a nominal aerodynamic diameter of 10 µm or smaller.
(6) Photochemical oxidants are determined by measurement of ozone only.

3.2.3 The EIAO-TM stipulates that the hourly TSP level should not exceed 500 μgm^{-3} (measured at 25°C and one atmosphere) for construction dust impact assessment. Standard mitigation measures for construction sites are specified in the Air Pollution Control (Construction Dust) Regulations.

3.2.4 In accordance with the EIAO-TM, odour level at an air sensitive receiver should meet 5 odour units based on an averaging time of 5 seconds for odour prediction assessment.

Air Pollution Control (Construction Dust) Regulation

3.2.5 Notifiable and regulatory works are under the control of the Air Pollution Control (Construction Dust) Regulation. Notifiable works are site formation, reclamation, demolition, foundation and superstructure construction for buildings and road construction. Regulatory works are building renovation, road opening and resurfacing slope stabilisation, and other activities including stockpiling, dusty material handling, excavation, concrete production etc. This Project is expected to include both notifiable and regulatory works. Contractors and site agents are required to inform the Environmental Protection Department (EPD) on carrying out construction works and to adopt dust reduction measures to reduce dust emission to the acceptable level.

Practice Note on Control of Air Pollution in Vehicle Tunnels

3.2.6 The Practice Note on Control of Air Pollution in Vehicle Tunnels, prepared by the EPD provides guidelines on control of air pollution in vehicle tunnels. Guideline values on tunnel air quality are presented in **Table 3.2**.

Table 3.2 Tunnel Air Quality Guidelines (TAQG)

Air Pollutant	Averaging Time	Maximum Concentration	
		($\mu g/m^3$) (1)	ppm
Carbon Monoxide (CO)	5 minutes	115,000	100
Nitrogen Dioxide (NO_2)	5 minutes	1,800	1
Sulphur Dioxide (SO_2)	5 minutes	1,000	0.4

Note: (1) Expressed at reference conditions of 298K and 101.325kPa.

3.3 Description of the Environment

Baseline Conditions

3.3.1 The study area is in Wan Chai, Causeway Bay and North Point. The nearest EPD air quality monitoring stations are in Central and Central/Western. The annual average concentrations of the pollutants measured at EPD's Central / Western and Central air quality monitoring stations in 2006 adjacent to the WDII development area are summarised in **Table 3.3**.

Table 3.3 Annual Average Concentrations of Pollutants in 2006

Pollutant	Annual Average Concentration in 2006 ($\mu g\ m^{-3}$)	Monitoring Station
CO	862	Central
NO_2	54	Central / Western
RSP	53	Central / Western
TSP	78	Central / Western

3.4 Sensitive Receivers

3.4.1 The study area is within 500m from the project boundary. The study area of air quality assessment is shown in **Figure 3.1**. Existing and planned Air Sensitive Receivers (ASRs) including domestic premises, commercial buildings, educational institutions, and recreational and leisure facilities have been identified for air quality impact assessment.

3.4.2 The identified representative ASRs are listed in **Table 3.4** and the corresponding locations are shown in **Figures 3.2** and **3.3**.

Table 3.4 Details of Air Sensitive Receivers

ASRs	Section	Location	Existing / Planned Land Use	No. of floors	Horizontal Distance (m)	
					Alignment*	Ventilation Building
Existing						
A25	Wanchai	Police Headquarters	G/IC	7	306	357 [1]
A26	Wanchai	HK Academy for Performing Arts (Office/Performance Hall)	G/IC	9	186	254 [1]
A27	Wanchai	Arts Centre	G/IC	10	200	175 [1]
A28	Wanchai	Citic Tower	Commercial	42	160	385 [1]
A29	Wanchai	Servicemen's Guides Association	Commercial	3	116	228 [1]
A30	Wanchai	HK Academy for Performing Arts (Open Space)	G/IC	9	160	144 [1]
A31	Wanchai	Shui On Centre	Commercial	34	190	160 [1]
A32	Wanchai	Hong Kong Convention & Exhibition Centre (HKCEC)	Commercial	46	60	229 [1]
A33	Wanchai	Pedestrian plaza	Recreation	0	95	62 [1]
A34	Wanchai	HKCEC Extension	Commercial	8	100	177 [1]
A35	Wanchai	Great Eagle Centre	Commercial	27	112	372 [1]
A36	Wanchai	Causeway Centre (Block A)	Residential	42	178	531 [1]
A37	Wanchai	Wanchai Swimming Pool	Recreation	3	58	568 [1]
A38	Wanchai	Wanchai Sports Ground	Recreation	0	74	723 [1]
A39	Wanchai	SPCA	G/IC	6	62	787 [1]
A40	Wanchai	Gloucester Road 169-170	Residential	12	306	750 [1]
A41	Wanchai	Gloucester Road 210	Residential	18	276	870 [1]
A42	Wanchai	Gloucester Road 226	Residential	22	264	924 [1]
A43	Causeway Bay	Elizabeth House	Residential	21	231	1023 [1]
A44	Causeway Bay	Sino Plaza	Commercial	33	182	900 [2]
A45	Causeway Bay	World Trade Centre	Commercial	34	151	756 [2]
A46	Causeway Bay	Excelsior Hotel	Commercial	28	147	726 [2]
A47	Causeway Bay	Riviera Mansion	Residential	15	162	705 [2]
A48	Causeway Bay	Marco Polo Mansion (northern façade)	Residential	15	174	633 [2]
A49	Causeway Bay	Marco Polo Mansion (eastern façade)	Residential	15	180	606 [2]
A50	Causeway Bay	Royal Hong Kong Yacht Club	Recreation	3	59	720 [2]
A51	Causeway Bay	Police Officers Club (Tennis Courts)	Recreation	0	70	840 [2]

ASRs	Section	Location	Existing / Planned Land Use	No. of floors	Horizontal Distance (m)	
					Alignment*	Ventilation Building
A52	Causeway Bay	Police Officers Club (Bowling Green)	Recreation	0	116	822 [2]
A53	Causeway Bay	Police Officers Club	Recreation	3	68	774 [2]
A54	Causeway Bay	Bowling Green, Victoria Park	Recreation	0	226	438 [2]
A55	Causeway Bay	Victoria Park Public Swimming Pool	Recreation	0	322	483 [2]
A56	Causeway Bay	Viking Garden	Residential	25	434	591 [2]
A57	Causeway Bay	Victoria court	Residential	18	380	534 [2]
A58	Causeway Bay	Mayson Garden	Residential	24	327	480 [2]
A59	Causeway Bay	Gordon House	Residential	15	293	471 [2]
A60	Causeway Bay	Belle House	Residential	24	214	366 [2]
A61	Causeway Bay	Citicorp Centre	Commercial	36	146	294 [2]
A62	Causeway Bay	Hoi Tao Building	Residential	30	160	300 [2]
A63	Causeway Bay	Victoria Centre	Residential	30	63	249 [2]
A64	Causeway Bay	Seaview Estate	Industrial/ commercial	13	63	282 [2]
A65	Causeway Bay	Harbour Heights	Residential	44	674	312 [2]
A66	Causeway Bay	Whitfield Road Rest Garden	Recreation	0	165	318 [2]
A93	North Point	City Garden (Block 11) (the height of 1st Sensitive Receiver is located at 5m above ground)	Residential	27	16	612 [2]
A94	North Point	City Garden (Block 6) (the height of 1st Sensitive Receiver is located at 5m above ground)	Residential	27	20	744 [2]
A95	North Point	Hong Kong Baptist Church Henrietta Secondary School	Educational	N/a	44	810 [2]
A96	North Point	Provident Centre (Block 1)	Residential	25	46	918 [2]
A97	North Point	Provident Centre (Block 6)	Residential	25	34	984 [2]
A98	North Point	Provident Centre (Block 17)	Residential	25	48	1176 [2]
Future						
A70	Central	Central Government Complex	G/IC	N/a	360	564 [1]
A71	Central	New G/IC site south and east of CITIC Tower	G/IC	20	264	360 [1]
A73	Central	Waterfront related commercial and leisure uses	Recreation	N/a	42	246 [1]
A76	Central	Open space at the west of HKCEC	Recreation	N/a	10	132 [1]
A81	Wanchai	Waterfront related commercial and leisure uses	Commercial	N/a	15	432 [1]

ASRs	Section	Location	Existing / Planned Land Use	No. of floors	Horizontal Distance (m)	
					Alignment*	Ventilation Building
A91	North Point	A land zone as "CDA(1) near Oil Street	CDA(1)	45	40	414 [2]
A92	North Point	A land zoned as CDA near Oil Street	CDA	45	32	513 [2]
A99	Wanchai	OU(Railway Air Intake Location) zone	Other use	3.5m above ground	28	246 [1]
A100	Wanchai	Water Sports Centre	Recreation	N/a	21	894 [2]
A101	Causeway Bay	Open space at CBTS Breakwater	Other use	N/a	150	306 [2]

*Distance from the edge of Trunk Road/ IECL alignment.
[1] Distance from the Central Ventilation Building.
[2] Distance from the exhaust vent shaft of the East Ventilation Building.

3.4.3 For construction dust impact assessment, the proposed ASRs under WDII Project including ASRs A71, A73, A76, A81, A99, A100 and A101 would only be occupied after the completion of construction activities of WDII Project, therefore, the construction dust impact assessment does not cover these ASRs. ASRs A91 and A92 are planned ASRs and there is no construction programme for these two ASRs at the time of this assessment, these two ASRs are therefore also not considered in the construction dust impact assessment. The planned ASR A70 is Central Government Complex which may be occupied during the construction period of WDII Project. As a conservative approach, ASR A70 was considered in the construction dust impact assessment. For operational traffic emission impact, all ASRs listed in **Table 3.4** are considered in the assessment.

3.4.4 During construction phase of the Project, dredging activities would be undertaken at the CBTS, and waterfronts along Wan Chai and North Point. There is potential odour impact associated with the dredging and handling of dredged material from CBTS. During operational phase, this Project will not create any new odour source. However, odour nuisance associated with the Causeway Bay Typhoon Shelter is an existing environmental problem. In order to improve the environment, this Project will take the opportunities to mitigate the potential sources of odour nuisance within the Project area so as to alleviate this existing environmental problem as well as to provide an acceptable environment for the future land uses within the project area (including the proposed open space at the northern breakwater). The odour impact assessment has assessed the existing odour impact in the vicinity of the Causeway Bay Typhoon Shelter and the potential odour impacts on the planned ASRs proposed under WDII Project during the operational phase. Odour mitigation measures have been formulated to alleviate this existing environmental problem. The ASRs considered in the odour impact assessment during operational phase include ASRs A76, A81, A100 and A101.

3.4.5 Regarding the corner of CBTS (i.e. the area in the vicinity of POC), in accordance with the RODP, the pavement at that area would not be changed. The land strip with 1.5m to 4.5m width would not attract pedestrians to stay here. It is expected that this narrow strip of land will continue to serve as pedestrian walkway, not a sensitive land use. The area in the vicinity of drainage culvert outfall Q is also a walkway. No active and passive recreational uses are proposed under the Project along the existing Gloucester Road/Victoria Park Road from the POC to Causeway Bay Flyover. It is not expected that the land uses along CBTS between POC and Causeway Bay Flyover would be changed.

3.5 Identification of Environmental Impacts

Construction Phase

Air Quality Impact from Construction Activities

3.5.1 Construction of seawall and filling works are the major construction works during reclamation. Excavation, materials handling, wind erosion, truck haulage on unpaved roads are other major sources of dust impact. However, no on-site concrete batching activity will take place within the construction site. SO_2, NO_2 and smoke emitted from diesel-powered equipment may also affect the air quality of the study area.

3.5.2 Potential marine traffic emissions from the dredgers would be expected. However, given that only a maximum of 10 dredgers would be concurrently operated at CBTS and Wan Chai waterfront, the associated emissions should be limited. In addition, the nearest distance between the dredgers and ASR (A50) at CBTS is 66m while the nearest distance at Wan Chai waterfront is 27m (ASR A32). Therefore, marine traffic emission impact arising from the Project is anticipated to be insignificant.

3.5.3 For the tunnel works of the Trunk Road, potential dust nuisance is anticipated during excavation and backfilling of the tunnel construction.

3.5.4 The concurrent works for the CRIII project has also been taken into account in assessing the impacts.

Odour Impact from Dredging Activities

3.5.5 The water quality in the typhoon shelter has been polluted by sewage discharges in the past and sediments deposited on the seabed in the vicinity of storm outfalls. These sediments may contain high concentrations of organic matter and heavy metals. The sediments in CBTS would be dredged away when carrying out the temporary reclamation.

3.5.6 For the dredging activities carried out in the vicinity of Police Officers' Club, the dredging operation will be restricted to only 1 small close grab dredger to minimise the odour impact during the dredging activity. The dredging rate should be reduced as much as practicable for the area in close proximity to the Police Officers' Club. As the sediments may contain highly contaminated mud which may be disposed with the use of geosynthetic containers (details shall refer to Section 6), grab dredger has to be used for filling up the geosynthetic containers on barges. As there is no programme constraint for the removal of the sediments at the south-west corner of the typhoon shelter in the vicinity of Police Officers' Club for mitigating the existing odour problem, the dredging rate can be slowed down or restricted to specific non-popular hours in weekdays when it is necessary during construction.

Operational Phase

Traffic Emission Impact

3.5.7 The major sources of traffic emissions include the open road sections and various tunnel portals / ventilation shafts. In accordance with the engineering design for CWB Main Tunnel, there will be zero portal emission at the eastern tunnel portal, Slip Road 1 and Slip Road 3. The exit portals will be provided with an extract system with capacity that exceeds the maximum ventilation rate of the tunnel to achieve zero portal emission. Standby ventilation fans would also be provided to ensure zero portal emission of CWB during all time of the tunnel operation. Therefore, tunnel portal emission impact on the ASRs in the vicinity is not anticipated. Other than emissions from tunnel portal, long sections of landscape deck/deckovers may also result in portal emissions. Within the study area of the Project, there are some existing and planned deckovers which may have portal emissions. The landscape deckovers identified in the study area are summarized as follows:

- Planned deckover along Road P2
- Landscape deck to HKCEC West
- Existing deckover over Expo Drive
- Deckover (New Atrium Link) between Expo Drive Central and Convention Avenue
- Landscaped deck link to waterfront and ferry pier
- Landscaped deck from Victoria Park to CBTS waterfront
- Landscaped deck over Trunk Road Portal

3.5.8 The landscape deck to HKCEC West (with width of about 8.5m), landscaped deck link to waterfront and ferry pier (with width of about 12m), and landscaped deck from Victoria Park to CBTS waterfront (with width of about 16 m) are very short (see **Figure 2.5**), therefore, portal emissions from these three landscape decks are not anticipated. For the landscaped deck over Trunk Road Portal, only one side of the deckover is supported by solid wall (near the Oil Street site), columns would be used as a support on the other side, hence, no portal emission from this landscape deck is expected.

3.5.9 The overall traffic emission air quality impact for this Project would result from:

- background pollutant levels based on five years averaged monitoring data from EPD monitoring station at Central/Western
- vehicle emissions from open sections of existing and planned road networks in WDII Project and the CWB
- emissions from Central Ventilation Building and East Ventilation Building
- portal emissions from the existing Cross Harbour Tunnel (CHT)
- portal emissions from the planned deckovers along Road P2
- portal emissions from the existing deckover over Expo Drive
- portal emissions from the proposed deckover (New Atrium Link) between Expo Drive Central and Convention Avenue.

3.5.10 Air quality impacts associated with road traffic are caused mostly by NO_2 and RSP. The fleet average emission factors of various classes of vehicles were calculated by the EMFAC Model and are shown in **Appendix 3.8a**. According to the emission rates derived from the EMFAC Model, the ratio of the emission rate for NO_2 (as 20% of NO_X) and CO to the corresponding 1-hour average AQO is 0.0041 and 0.0015, respectively. Detailed calculation of the ratio of the hourly average NO_2 and CO emission rates to the corresponding AQO is presented in **Appendix 3.8b**. The calculation indicates that NO_2 is a more critical criteria air pollutant of concern as compared with CO. In other words, if the predicted NO_2 concentrations comply with the corresponding AQO, CO with lower ratio would also comply with its respective AQO. NO_2 and RSP were selected as the critical traffic air pollutants for the purpose of this assessment.

3.5.11 The tunnel section of the Trunk Road is around 3.5km long. As confirmed with the tunnel ventilation design engineer, a ventilation system would be provided to maintain the air quality inside the tunnel so as to achieve the EPD recommended standard of 1ppm NO_2 concentration within the tunnel in accordance with the "Practice Note on Control of Air Pollution in Vehicle Tunnels". The emission rate of CO is more than 44 times of the NO_2 emission rate with reference to vehicle emission derived from the EMFAC Mode, however, the ratio of guideline standard of CO (5-minutes) concentration to NO_2 (5-minutes) concentration in $\mu g/m^3$ is 64 to 1. Therefore, CO would also comply with the standard. Under the Air Pollution Control (Motor Vehicle Fuel) Regulation, the sulphur content of diesel fuel is required to be less than 0.005%. In view of the low emission rates relative to the statutory limit, SO_2 would also comply with the tunnel air quality limit.

Odour Impact

3.5.12 During operational phase, this Project will not create any new odour source. An extension / modification of Wan Chai East Sewage Screening Plant is not within the scope of the WDII or CWB project, it is only the reprovisioning of the sewage outfall affected by the reclamation work that is within the scope of the WDII Project. However, odour nuisance associated with the Causeway Bay Typhoon Shelter is an existing environmental problem. In order to improve the environment, this Project will take the opportunities to mitigate the potential sources of odour nuisance within the Project area so as to alleviate this existing environmental problem as well as to provide an acceptable environment for the future land uses within the project area.

3.6 Assessment Methodology

Construction Phase

3.6.1 There is potential for SO_2, NO_2 and smoke to be emitted from the diesel-powered equipment and dredgers being used during the construction phase. However, the number of such plant required on-site (land based and water based) will be limited and under normal operation, equipment with proper maintenance is unlikely to cause significant dark smoke emissions and gaseous emissions are expected to be minor. Thus, the AQOs are not expected to be exceeded. Notwithstanding, plant should be regularly maintained to minimise emissions.

3.6.2 The principal source of air pollution during the construction phase will be dust from the dusty activities as mentioned in Section 3.5.1. The impact of fugitive dust sources on air quality depends upon the quantity as well as the drift potential of the dust particles emitted into the atmosphere. Large dust particles (i.e. over 100 µm in diameter) will settle out near the source and particles that are between 30 and 100 µm in diameter are likely to undergo impeded settling. The main dust impacts are likely to arise from particles less than 30 µm in diameter, which have a greater potential to disperse over greater distances.

3.6.3 According to the USEPA AP-42, construction dust particles may be grouped into nine particle size classes. Their size ranges are 0 - 1 µm, 1 - 2 µm, 2 - 2.5 µm, 2.5 - 3 µm, 3 - 4 µm, 4 - 5 µm, 5 - 6 µm, 6 - 10 µm and 10 - 30 µm, and the percentage of particles in each class was estimated to be 4%, 7%, 4%, 3%, 7%, 5%, 4%, 17% and 49%, respectively.

3.6.4 The emission rates adopted in the WDII project assessment for different construction activities were based on the USEPA Compilation of Air Pollutant Emission Factors (AP-42), 5th edition. **Table 3.5** gives the relevant clauses for emission factors used in this assessment in AP-42. Detailed calculation of emission rate is presented in **Appendix 3.1**.

Table 3.5 Emission Factors for Construction Activities and Wind Erosion

Construction Activities	Emission Rate ($g/m^2/s$)	Remark
Road Construction, Building Construction and Material Handling (as Heavy Construction)	E = 3.113426E-05	- 50% work area - 75% reduction by water suppression (watering four times a day) -USEPA AP-42 5th ED., S.13.2.3.3
Wind Erosion	E = 1.347666E-06	- 50% work area - AP-42 5th ED., S.11.9 Table 11.9.4

3.6.5 The Air Pollution Control (Construction Dust) Regulation specifies that dust suppression measures such as watering should be applied for the construction site. Dust emission from the site would be reduced by 75% if watering with complete coverage of active construction area four times a day. This assumption was adopted in the construction dust impact assessment.

3.6.6 As confirmed with the Project Proponent, 10 working hours per day (08:00-18:00) was assumed for the dusty construction works in the assessment. Wind erosion of open work sites would take place over the whole day.

3.6.7 The following summarises the construction activities during the construction stage of the WDII Project. The locations of the different reclamation sites are shown in **Figure 3.4**

Causeway Bay Temporary Reclamation (CBR)

- Temporary Relocation Causeway Bay Typhoon Shelter (CBTS)
- CBTS Temporary Reclamation Stage 1 (TCBR1W & TCBR1E)
- CBTS Temporary Reclamation Stage 2 (TCBR2)
- CBTS Temporary Reclamation Stage 3 (TCBR3)
- CBTS Temporary Reclamation Stage 4 (TCBR4)
- Slip Road 8 & Victoria Park Facilities Reprovisioning

Ex-PCWA Temporary Reclamation

- Temporary Reclamation PCWA Stage 1 (TPCWAE)
- Temporary Reclamation PCWA Stage 2 (TPCWAW)

Wan Chai Reclamation (WCR)

- Wan Chai Reclamation Stage 1 (WCR1)
- Wan Chai Reclamation Stage 2 (WCR2)
- Wan Chai Reclamation Stage 3 (WCR3)
- Wan Chai Reclamation Stage 4 (WCR4)
- New Ferry Pier Reprovisioning & Demolish Existing Pier
- Helipad Reprovisioning at HKCEC
- Roads

HKCEC Reclamation

- HKCEC Reclamation Stage 1 (Water Channel) (HKCEC1)
- HKCEC Reclamation Stage 2 (HKCEC2E & HKCEC2W)
- MTR Tunnel Crossing
- HKCEC Reclamation Stage 3 (HKCEC3E & HKCEC3W)
- Roads

Cross Harbour Watermains

- Submarine Pipeline
- Land Section

North Point Reclamation (NPR)

- North Point Reclamation Stage 1 (NPR1)
- North Point Reclamation Stage 2 (NPR2E & NPR2W)

Construction of IECL

- IECL Connection Work
- East Portal and IEC Connection

Construction of Central Interchange

Tunnel Building and Installation

- East Ventilation Building
- Administration Building
- Central Ventilation Building

3.6.8 Beside the Wan Chai development, some construction activities would be undertaken within 500m from the boundary of WDII development area. The construction period of whole CRIII Project is from February 2003 to September 2012. The interfacing of CRIII dusty construction activities would be from end 2008 to the 1st quarter of 2012. The concurrent dusty construction activities undertaken within 500 m from the boundary of the WDII development area are summarized as follows.

Construction of CWB Tunnel Under CRIII Project

- CWB Tunnel at Initial Reclamation Area East
- CWB Tunnel at Final Reclamation Area East

3.6.9 Based on the construction programme (**Appendix 2.5**) and the number of dusty activities on site, six worst-case scenarios for the development works have been identified throughout the construction period and are shown in **Table 3.6**. Overall, the scenarios presented are considered to be representative of the worst case. The figures showing locations of dusty construction site areas for each scenario are presented in **Figures A3.1** to **A3.6** in **Appendix 3.1**.

Table 3.6 Different Major Dust Generating Activities in the Worst Case Scenarios during Construction Phase

Period	2009 – Early 2010	Mid 2010 – Early 2011	Mid 2011 – Early 2012	Mid 2012 – Early 2013	Mid 2013 – Early 2014	Mid 2014-2016
Worst month	**Jan 2010**	**Aug 2010**	**April 2012**	**Feb 2013**	**Nov 2013**	**Apr 2015**
Activities	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**	**Scenario 6**
1	TCBRIE– Filling	TCBR1E – CWB Tunnel	TCBR1W – CWB Tunnel	TCBR3 – CWB Tunnel	TCBR3 – CWB Tunnel	TCBR4-CWB Tunnel
2	TCBRIW – Filling	TCBR1W – CWB Tunnel	TCBR2 – CWB Tunnel	TCBR4 – Filling	TCBR4 – CWB Tunnel	TPCWAW-CWB Tunnel
3	TCBRIE – CWB Tunnel	TCBR2 – CWB Tunnel	TCBR3 – CWB Tunnel	TPCWAW – CWB Tunnel	Slip Rd 8 & Victoria Park Reprovisioning	Realignment Hung Hing Road
4	TCBR2 – Filling	TPCWAE – CWB Tunnel	TPCWAE – CWB Tunnel	WCR2 – Promenade	TPCWAW – CWB Tunnel	Road P2 from Fleming Road to Marsh Road
5	TPCWAE – CWB Tunnel	WCR1 - Drainage	WCR2 – CWB Tunnel	WCR3 – Filling	WCR3 – CWB Tunnel	Mainline to IEC
6	WCR1 – Filling	WCR1 – Cooling Water	HKCEC2E – Filling	WCR4 – Filling	WCR4 – CWB Tunnel	
7	WCR1 – CWB Tunnel	WCR1 – CWB Tunnel	HKCEC2W – Filling	WCR4 – Drainage	HKCEC2E – Drainage	
8	New Ferry Piers	HKCEC1 – Cooling Water	HKCEC3E – Filling	HKCEC2W – CWB Tunnel	HKCEC2W – Drainage	
9	HKCEC1 – Cooling Water	MTR - Piling	HKCEC3E – Drainage	HKCEC3W – CWB Tunnel	HKCEC2E – CWB Tunnel	
10	HKCEC2E - Filling	NPR1 – CWB Tunnel	HKCEC3W – Drainage	HKCEC3E – CWB Tunnel	HKCEC2W – CWB Tunnel	
11	Cross Harbour Watermains – Land Sections	NPR2E – Filling	HKCEC3E – CWB Tunnel	IEC Connection Work	HKCEC3E – CWB Tunnel	
12	NPR1 – CWB Tunnel	CRIII – CWB Tunnel at Initial Area East	NPR2W – CWB Tunnel	East Ventilation Building	HKCEC3W – CWB Tunnel	
13	NPR2E – Filling	CRIII – CWB Tunnel at Final Area West				
14	NPR2W – CWB Tunnel	CRIII – CWB Tunnel at Final Area East				
15	CRIII – CWB Tunnel at Initial Area East					
16	CRIII-CWB Tunnel at Final East					

3.6.10 Fugitive Dust Model (FDM) (1993 version) was used to assess potential dust impact from the construction works. The worst case meteorological data was used to predict the 1-hour and 24-hour average TSP concentrations at representative discrete ASRs close to the construction works. Since the construction activities would be undertaken at ground level and underground level, the worst dust impact on the ASRs would be at the ground floor of the ASRs. The height of 1.5m above ground, which is the breathing level of human, was adopted for the construction dust impact assessment. As there are some ASRs at the podium level, assessment for ASRs at 5m above ground was also included in the assessment. The meteorological data used in the model were:

- Wind speed: 1 m/s
- Wind direction: 360 wind direction
- Stability class: D (daytime) & F (night time)
- Surface roughness: 1m
- Mixing height: 500 m

3.6.11 Daily TSP concentrations were calculated as follows:

Daily TSP concentration = (number of working hour)/24 × (1-hour average maximum TSP concentration during working hours) + (number of non-working hour)/24 × (1-hour average maximum TSP concentration during non-working hours) + Background

3.6.12 The background TSP concentration of 77 $\mu g/m^3$, based on the latest five years average monitoring data from EPD's Central/Western monitoring station, was adopted as an indication of the future TSP background concentration. As the monitoring data in year 2001 and 2002 were below their respective minimum data requirement of 66% for number of data within the period, therefore, the annual average concentration of TSP was calculated based on the data in Year 2000 and 2003-2006.

Operational Phase

Vehicular Emission Impact (Open Road)

3.6.13 The overall traffic air quality impact for this Project would result from the following sources and the locations of portals and ventilation building emissions are indicated in **Figure 3.5**:

- background pollutant levels based on five years averaged monitoring data from EPD's monitoring stations at Central/Western
- vehicle emissions from open sections of existing and planned road networks (e.g. Trunk Road) in WDII Project and CWB Project
- emissions from Central Ventilation Building and East Ventilation Building
- portal emissions from the existing Cross Harbour Tunnel (CHT)
- portal emissions from the planned deckovers along Road P2
- portal emissions from the existing deckover over Expo Drive
- portal emissions from the proposed deckover (New Atrium Link) between Expo Drive Central and Convention Avenue

3.6.14 The tunnel of Trunk Road Eastbound, CWB Slip Road 3 and Slip Road 1 would be provided with an extraction system with capacity that exceeds the maximum ventilation rate of the tunnel, and the in-tunnel emissions would be exhausted at the vent shaft of East Ventilation Building and Central Ventilation Building. Therefore, the tunnel exit portals of these two slip roads and trunk road eastbound would have zero portal emissions.

Background Concentration

3.6.15 The annual average concentrations of the pollutants measured at EPD's Central / Western air quality monitoring station in the past five years were adopted as the background air quality within and adjacent to the Project area. As the monitoring data in year 2001 and 2002 were below their respective minimum data requirement of 66% for number of data within the period, therefore, the annual average concentration of NO_2, and RSP were calculated based on the data in Year 2000 and 2003 – 2006.

3.6.16 **Table 3.7** summarises the annual average concentrations of the pollutants considered as background concentrations for the cumulative impact assessment.

Table 3.7 Annual Average Concentrations of Pollutants in Past Five Years

Pollutant	Annual Average Concentration in Past Five Years (2000, 2003-2006) at Central/Western Station ($\mu g\ m^{-3}$)
NO_2	55
RSP	54

Vehicle Emissions from Open Sections of Existing and Planned Road Networks

3.6.17 The CALINE4 dispersion model was used for calculation of the 1-hour average NO_2, 24-hour average NO_2 and 24-hour average RSP concentrations. Open sections of existing and planned road networks within 500 m from the boundary of the WDII project area are considered in the model and are listed as follows:

- new roads in the WDII
- new roads in the Central Reclamation Phase III (CRIII)
- the Trunk Road & IECL
- the existing roads (including Island Eastern Corridor, Victoria Park Road, Gloucester Road, Harcourt Road, Causeway Road, Hennessy Road and Queensway)

3.6.18 The predicted morning peak hour traffic flows and vehicle mixes for the road networks in 2031, which is higher than the afternoon peak traffic flow, were used for the assessment of the worst-case air quality scenario. The projected 2031 morning peak hour traffic flows and vehicle compositions are attached in **Appendix 3.2.**

Fleet Average Emission Factors

Vehicle Classes

3.6.19 EMFAC-HK model was adopted to estimate the vehicle emission rates and inventories of exhaust, carbon monoxide, oxides of nitrogen and particulate matter.

3.6.20 The "vehicle fleet" refers to all motor vehicles operating on roads within this Study Area. The modelled fleet was broken down into 16 vehicle classes based on the information as shown in **Table 4.4** (Registration and Licensing of Vehicle by Fuel Type) of the *"Transport Monthly Digest (May 2006)"* and the vehicle group classification was based on the definition in the *"The Annual Traffic Census 2005 – Appendix F Vehicle Classification System"*.

3.6.21 Referring to *"Transport Monthly Digest (May 2006)"*, there were only 0.5% of private car using diesel fuel. It was therefore assumed that all private cars would be grouped as "petrol private car" in the model in view of negligible value. The *"Transport Monthly Digest (May 2006)"* also indicated that there were 3% light good vehicle using petrol fuel. Besides, in accordance with the Up to Date Vehicle Licensed Number by Age and Technology Group Fractions launched on EPD' website, the % of LGV under MC1 is less than 7% of the total vehicle of MC1. Moreover, refer to EPD's Guideline on Modelling Vehicle Emissions Appendix 2 Implementation Schedule of Vehicle Emission Standards in Hong Kong, the implementation schedule of diesel LGV emission standards were later than petrol private car. As a conservative approach, all light good vehicles would be grouped as "diesel light good vehicle". The 16 vehicle classes which were modelled in EMFAC-HK are summarized in **Table 3.8**.

Table 3.8 Vehicle Classes in EMFAC-HK Model

Vehicle Class	Description	Fuel Type	Gross Vehicle Weight
MC1	Petrol Private Cars (PC) & Light Goods Vehicles (LGV)	Petrol	ALL
MC3	Diesel Private Cars & Light Goods Vehicles<2.5t	Diesel	<=2.5t
MC4	Diesel Private Cars & Light Goods Vehicles 2.5-3.5t	Diesel	>2.5-3.5t
MC5	Public Light Buses	LPG, Diesel	ALL
MC6	Light Goods Vehicles >3.5t	Diesel	>3.5-5.5t
MC7	Medium & Heavy Goods Vehicles with GVW 5.5-15t	Diesel	>5.5-15t
MC8	Medium & Heavy Goods Vehicles with GVW >=15t	Diesel	>15t
MC10	Double Deck Franchised Buses	Diesel	ALL
MC11	Motor Cycles	Petrol	ALL
Taxi3	Taxi	LPG	ALL
Taxi4	Private Light Buses <3.5t	LPG, Diesel	<=3.5t
Taxi5	Private Light Buses >3.5t	LPG, Diesel	>3.5t
Taxi6	Non- franchised Buses <6.4t	Diesel	<=6.4t
Taxi7	Non- franchised Buses 6.4-15t	Diesel	>6.4-15t
Taxi8	Non- franchised Buses >15t	Diesel	>15t
Taxi10	Single Deck Franchised Buses	Diesel	ALL

Road Grouping

3.6.22 Based on different road speed limits in local road and trunk road, two sets of emission factors for the two road types were calculated. Gloucester Road, Cross Harbour Road and Central Wan Chai Bypass Trunk Roads (except Tunnel Section), with speed limit of 70kph, were grouped as trunk roads. Other roads within the Study Area, with design speed limit of 50kph, were grouped as local roads. The emission rates of the Trunk Roads Tunnel Section would be calculated by the tunnel engineer. Their calculations would not apply the fleet emission factor generated by EMFAC-HK model. Details of the classification of road type are presented in **Appendix 3.3**.

Input Assumptions in EMFAC-HK

3.6.23 The latest model version EMFAC-HK v1.2 provided by EPD was employed in this Study. The input parameters and model assumptions made in EMFAC-HK model are summarized as follows.

Modelling Modes

3.6.24 As suggested in EPD guideline, "Burden mode" which can provide hourly vehicular emissions according to the diurnal variations of traffic flow, temperature, relative humidity and speed, was selected for this Project. Both CVS and MVE17G CVS output file formats were produced.

Technology Fractions

Exhaust Technology Fractions

3.6.25 Each vehicle class had diverse technological factors in different years. According to the underlying assumption in EMFAC-HK, each vehicle class could be modelled by the individual behaviour of unique technology groups. Each technology group represented the same vehicle class had distinct emission control technologies, similar in-use deterioration rates and responded the same to repair. It means that the vehicles from the same class had the same emission standards or specific equipment installed on them (e.g. multi-port fuel injection, three-way catalyst, adaptive fuel controls, etc) which gave them the same performance.

3.6.26 According to the *"EPD Guideline on Modelling Vehicle Emissions"*, it mentioned that the existing vehicle emission control programmes were included in the EMFAC-HK. No other vehicle emission control measures were assumed in the assessment, thus the default data was adopted in the model.

Evaporative Technology Fractions

3.6.27 Evaporative technology fraction in the model was based on the default value.

Vehicle Population

3.6.28 As recommended in the *"EPD Guideline on Modelling Vehicle Emissions"*, the latest vehicle age distribution data provided in EPD's website, that is, the Vehicle Population in Year 2003, was used except the population of diesel private car, taxi and public light bus.

3.6.29 After the implementation of stringent emission standard in 1998, there was no new certification of diesel private car registration in Hong Kong. Thus, the number of diesel private car was extracted and grouped into the "petrol private car". Since diesel Taxi started to switch to LPG from Year 2001, 100% LPG taxi was therefore assumed for assessment years namely 2016 to 2031.

3.6.30 Environment, Transport and Works Bureau (ETWB) implemented an incentive scheme to encourage the early replacement of diesel light buses with LPG or electric ones since 2002. According to report published by EPD, around 80% of newly registered public light buses are operating on LPG. However, as a conservative approach, the ratio of LPG and diesel public light bus in 2003 was adopted for the vehicle population in future year in the assessment.

3.6.31 According to the above assumptions, vehicle population in Year 2016 is calculated and is presented in **Appendix 3.4**.

Accrual Rate

3.6.32 The default accrual rates in EMFAC-HK were estimated from the local mileage data adjusted to reflect the total vehicle-mile-travelled (VMT) for each vehicle class. The default value was used.

Diurnal Variation of Daily Trips and Daily Vehicle-Mile-Travelled (VMT)

Diurnal Variation of Daily Trips

3.6.33 The diurnal variation of daily trips was used to estimate the start emissions of petrol vehicles, thus the trips of other vehicles would be zero. The number of trips per day of petrol vehicle was equal to the number of cold starts per day. For IEC trunk road, CWB trunk road, some slip roads of CWB and Road P2, there would not be cold start at the middle of the above roads, thus, zero vehicle trip per day was assumed for those roads. For other roads, the diurnal variation of daily trips could be estimated based on the ratio of trip/VMT in the entire territory and the Study Area. For other roads, the number of vehicle trips was calculated by the following equation:

Vehicle Trip of Class 1 in the Study Area at hour 1 = Vehicle trip of Class 1 in the territory* at hour 1 × VMT for vehicle class 1 in the Study Area at hour 1 / VMT for vehicle class 1 in the territory

* where the trip and VMT in the territory could be read from the default data of EMFAC-HK model

Diurnal Variation of Daily Vehicle-Mile-Travelled (VMT)

3.6.34 Vehicle-mile-travelled (VMT) represents the total distance travelled on a weekday. The VMT was calculated by multiplying the number of vehicle which based on the forecasted hourly traffic flow in Year 2031 and the length of road travelled in the Study Area. The input in the model was by vehicle/fuel/hour.

3.6.35 The hourly profile of traffic flow was made reference to the *"Annual Traffic Census 2005"*. The major core station along Gloucester Road (No. 1028) was selected for representing the hourly profile of all roads within the Study Area. However, the same traffic breakdown in % would be applied to all hours.

3.6.36 Those assumptions of producing the hourly traffic flow and the traffic breakdown were approved by the Transport Department. The adopted daily trips and VMT in year 2031 are summarized in **Appendix 3.5**.

Hourly Temperature and Relative Humidity Profile

3.6.37 According to the information provided by the Hong Kong Observatory (HKO), there is no meteorological station at Hong Kong Island, except South Hong Kong Island. Thus, King's Park (anemometer height of 90m) and Hong Kong Observatory (anemometer height of 74m) meteorological stations are the nearest stations to the Project area. The characteristic of HKO meteorological station was considered to be more similar to the Study Area, thus the hourly temperature and relative humidity of HKO meteorological station were adopted for the model input.

Speed Fractions

3.6.38 The speed limits of each road were made reference to the Traffic AIDs from the Transport Department. Referring to the Traffic AIDs, the speed limits of all road links within the Study Area (except Trunk Road Tunnel Section) would not exceed 70kph. In the assessment, as a conservative approach, the speed limit of 70 kph was assumed for Trunk Road. Therefore, all vehicle classes were assumed to have the same speed profile in the model.

3.6.39 To simulate the effect of different road speed during the rush and non-rush hour, sensitivity test had been carried out. The design road speed limits were assumed for representing the situation during non-rush hour; while the vehicle speed of peak hour flow in Year 2031 would be representing the situation during rush-hour.

3.6.40 The flow speeds were calculated based on the peak traffic flow in Year 2031 and volume/capacity ratio of different road types. To obtain the speed fractions of each vehicle type, the vehicle speeds of each road link were first calculated and weighed by VMT. If the road links are in two-way direction, the vehicle speeds were calculated by weighing vehicle speeds of each direction. In addition, the design speed limits of Victoria Park Road (section between Top Glory Tower and Prospect Mansion) eastbound and westbound are different, as a conservative approach, this section would be grouped as local road.

3.6.41 In the model, same road speeds were applied to all hours to demonstrate the effect of using peak flow speed and design speed. Based on the comparison of the total daily emission rate, the worst road speed fraction was applied for predicting the vehicle emissions. Model year of 2031 was adopted in the sensitivity test.

3.6.42 From the results of the sensitivity test, it indicated that higher total daily NO_x and RSP emissions would be obtained at lower road speed, only the total daily NO_x emissions of trunk roads under design speed fractions were slightly greater than that under peak hour flow speed fractions. However, the dominant NO_x emissions were obtained on other roads under all scenarios. Thus, the peak hour flow speed in Year 2031 was applied to all hours for predicting the total daily emissions in this assessment as a conservative approach. The sensitivity test results are presented in **Appendix 3.6**.

Model Year

3.6.43 For the purpose of finding the worst emission year, 15 sets vehicle emissions based on the emission control schemes from Year 2016 to 2031 by using the same VMT in 2031 were produced. The emission standards of each vehicle class were the major factor influencing the vehicle exhaust emission. According to the implementation schedule of emission standards, the latest program was up to Year 2006 or 2009. Vehicles with better emission control (Euro IV and V) would replace the old pre-Euro diesel/petrol vehicles. The vehicle exhaust emissions of Year 2016 to Year 2031 were calculated. Sensitivity tests were undertaken to calculate the vehicle exhaust emissions in different years by using the VMT of each road category and the flow speed fractions in Year 2031. By using the peak hour flow speed in Year 2031 at all hours, the total daily NO_x emissions by 16 vehicle classes in different vehicle exhaust emission years from 2016 to 2031 were summarized in **Appendix 3.7**.

3.6.44 Comparing the total daily NO_x and RSP emissions under different vehicle exhaust emission years from Year 2016 to 2031, the highest vehicle emissions were found in Year 2016 using emission control scenario and were decreased from Year 2016 to 2031. Therefore, as a conservative approach, the emissions using emission control scenario in Year 2016 were adopted for this study.

3.6.45 As a conservative approach, the hourly emissions in Year 2016 were first divided by the number of vehicles and the distance travelled to obtain the emission factors in gram per miles per vehicle. The calculated maximum vehicle emission factors were then selected for incorporation into the air dispersion model. These conservative vehicle emission factors together with the forecasted Year 2031 peak traffic flow were adopted in this air quality impact assessment, which would be the highest emission strength from road vehicles within the next 15 years upon commencement of operation of the proposed road. The calculation of fleet vehicle emission is presented in **Appendix 3.8**.

3.6.46 The calculated vehicular emissions for different vehicle categories were listed in **Table 3.9**.

Table 3.9 Emission Factors for Year 2016 for Different Vehicle Classes (EMFAC-HK)

Vehicle Class	Description	Emission Factors for 2016, g/mile-veh			
		NO_x		RSP	
		Trunk Road	Other Road	Trunk Road	Other Road
MC1	Petrol Private Cars (PC) & Light Goods Vehicles (LGV)	0.1433	0.1545	0.0047	0.0063
MC3	Diesel Private Cars & Light Goods Vehicles<2.5t	0.4012	0.4157	0.1284	0.1516
MC4	Diesel Private Cars & Light Goods Vehicles 2.5-3.5t	0.2642	0.2702	0.0813	0.0896
MC5	Public Light Buses	0.1208	0.1163	0.0887	0.0835
MC6	Light Goods Vehicles >3.5t	2.1532	2.2242	0.1547	0.1836
MC7	Medium & Heavy Goods Vehicles with GVW 5.5-15t	4.4177	4.6047	0.2553	0.3066
MC8	Medium & Heavy Goods Vehicles with GVW >=15t	5.4535	6.0203	0.3635	0.4121
MC10	Double Deck Franchised Buses	2.7890	2.8216	0.0808	0.0902
MC11	Motor Cycles	1.1216	1.0611	0.0487	0.0503
Taxi3	Taxi	0.2376	0.2585	0.0188	0.0252
Taxi4	Private Light Buses <3.5t	0.0000#	0.0000#	0.0000#	0.0000#
Taxi5	Private Light Buses >3.5t	0.3270	0.3390	0.1972	0.2421
Taxi6	Non- franchised Buses <6.4t	0.0000#	0.0000#	0.0000#	0.0000#
Taxi7	Non- franchised Buses 6.4-15t	3.7716	4.7213	0.1433	0.1790
Taxi8	Non- franchised Buses >15t	7.1778	3.6599	0.1433 *	0.1790*
Taxi10	Single Deck Franchised Buses	2.5173	2.4728	0.1631	0.1126

Note:
- Since there is no private light buses <3.5t and non-franchised buses <6.4t travelled within the study area, the calculated emission factors for these two vehicle classes are zero.
* - Since the VMT of non-franchised buses >15t is too small (only 4 vehicles within the study area in Year 2031), the calculated RSP emission factor for this vehicle class is zero in the EMFAC output model file. As a conservative approach, the RSP emission factor of non-franchised buses 6.4-15t would be adopted for non-franchised buses >15t.

Model Assumptions for Open Road Vehicle Emission

3.6.47 In order to calculate the cumulative pollutant concentrations from different sources using different models (CALINE4 and ISCST3) in the later part of the assessment, the dispersion modelling was undertaken assuming 360 predetermined meteorological conditions and the highest predicted pollutant concentration amongst the 360 wind directions were identified. The following summarises the meteorological conditions adopted in the air quality modelling using the CALINE4 model:

- Wind speed : 1 m s^{-1}
- Wind direction : 360 wind directions
- Resolution : 1°
- Wind variability : 24°
- Stability class : D
- Surface roughness : 1 m
- Mixing height : 500 m

3.6.48 The CALINE4 model calculates hourly concentrations only. 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.

3.6.49 Secondary air quality impacts arising from the implementation of roadside noise barriers and enclosures were also incorporated into the air quality model. For the proposed cantilever noise barrier and noise semi-enclosure along the IECL (as shown in **Figures 4.11** and **4.12**), it was assumed that dispersion of the traffic pollutants would have effect similar to assuming that traffic pollutants would be emitted from the top of the canopies and noise semi-enclosures at a point close to the central divider of the road. A figure showing the concerned open road sections considered in the model and the calculation of open road emissions are summarised in **Appendix 3.9**.

Portal and Ventilation Building Emissions

3.6.50 The Industrial Source Complex Short Term 3 (ISCST3) dispersion model was used to predict the portal and ventilation building emissions.

3.6.51 The followings are the portal and ventilation building emissions in and around the study area:

- tunnel portal and ventilation building emissions from the tunnel section of the Trunk Road
- tunnel portal emissions from the existing CHT
- portal emission from deckover over Expo Drive
- portal emission from proposed deckover (New Atrium Link) between Expo Drive Central and Convention Avenue
- portal emissions from the planned deckovers along Road P2.

3.6.52 Three ventilation buildings have been proposed for Trunk Road to discharge the polluted tunnel air:

- West Ventilation Building (WVB): for extracting polluted tunnel air from the Trunk Road Westbound
- Central Ventilation Building (CVB): for extracting polluted tunnel air from the Trunk Road Westbound, Trunk Road Eastbound, Slip Road 1 and Slip Road 3
- East Ventilation Building (EVB): for extracting polluted tunnel air from the Trunk Road Eastbound.

3.6.53 The location of the WVB is outside the study area of this EIA, therefore, only emissions from the CVB and EVB were considered in this assessment. The portal emissions from Trunk Road Eastbound and CWB slip roads, and ventilation building emissions provided by the ventilation design engineers are summarised in **Table 3.10**. Portal emissions from other existing / planned deckovers predicted by EMFAC model are also presented in **Table 3.10.**

Table 3.10 Portal and Ventilation Building Emissions

Type	NO_X (g/s)	RSP (g/s)
Portal Emission		
Trunk Road Eastbound	0	0
Slip Road 1	0	0
Slip Road 2 under HKCEC Atrium Link Deckover	1.455E-02	7.956E-04
Slip Road 3	0	0
Cross Harbour Tunnel	1.110E+00	6.828E-02
Expo Drive Central	1.024E-02	5.787E-04
P2 Road (Eastbound) Under HKCEC Atrium Link Deckover	9.892E-03	6.026E-04
P2 Road (Westbound) Under HKCEC Atrium Link Deckover	1.319E-02	8.972E-04
Central Wan Chai Bypass (Westbound) Under HKCEC Atrium Link Deckover	8.654E-03	6.781E-04
Convention Avenue Under HKCEC Atrium Link Deckover	1.527E-02	9.951E-04
Expo Drive	6.476E-02	4.335E-03
P2 Road between Tim Wa Ave, and Tim Mei Ave	2.060E-02	1.482E-03
Ventilation Building		
East Ventilation Building (Trunk Road Eastbound)	2	2.258E-02#
Central Ventilation Building	3.966	3.003E-01

Note: # Electrostatic precipitator will be installed, dust removal efficiency of 80% has been considered in the calculation.

3.6.54 The preliminary design of the ventilation buildings (including minimum mid-discharge heights, exhaust directions, exhaust area of ventilation buildings and exit velocity) is summarised in **Table 3.11**. The tunnel ventilation schematic diagram is indicated in **Appendix 3.15**. The approximate dimensions of the exhaust vent shaft, the discharge height and stack area are shown in the illustrations annexed in **Appendix 10.1**. For a worst case scenario in the air quality assessment, the minimum height of stack was used in modelling.

Table 3.11 Design of Ventilation Buildings

	Cross-sectional area of stack (m^2)	Exit velocity ($m\ s^{-1}$)	Minimum mid-discharge height (meter above ground)	Exhaust direction
East Ventilation Building (EVB) - Vent shaft at the breakwater	94	8	16.25	Inclined 45 degree upward (discharge towards sea direction)
Central Ventilation Building (CVB)	219	8	17.5	Vertical

3.6.55 The emission from EVB is discharged from the louvre on the side of the vent shaft over 250 degree laterally with exit velocity of 8m/s at inclined 45 degree upward direction. Since the ISCST3 dispersion model employed in this assessment cannot simulate the dispersion from an inclined discharge, the EVB discharge at the vent shaft is therefore simulated as four numbers of discrete point sources with vertical discharge. The four point sources are evenly located around the 250 degree discharge louver. The discharge heights of the point sources are set at the middle height of the discharge louvre and the total discharge area of the four point sources is equivalent to the area of the discharge louver. The exit velocities of the point sources are set as the vertical component of the inclined discharge velocity of 8/ms, i.e. 5.66m/s vertically upward. The horizontal component of the inclined discharge velocity was not simulated in the ISCST3 mode. This may result in some deviations in the initial dispersion pattern of the discharged plume, yet the final form of the discharged plume and hence the level of impact associated with the final plume predicted by the ISCST3 model on far field air sensitive receivers should be very much the same as that of the inclined discharge. For those near field air sensitive receivers that are on the opposite side of the inclined discharge, the ISCST3 model prediction based on the source simulation described above should be on the conservative side, and vice versa for those near field air sensitive receivers facing the inclined discharge. In this assessment, all the air sensitive receivers facing the inclined discharge are located at far field (say at more than 300m from the discharge) except some air sensitive receivers located at the eastern end of the breakwater. Yet the height of the air sensitive receiver on the breakwater is only 1.5m above ground which is much lower than the discharge height of the vent shaft at 16.25m and these air sensitive receivers should not be subject to the direct impingement of the plume discharged from the vent shaft of EVB. For all the other near field air sensitive receivers (say air sensitive receivers within 300m from the discharge), they are located on the opposite side on the inclined discharge and the ISCST3 model prediction should produce results on the conservative side with regards to the impacts of the EVB discharge. To summarise, the simulation approach described above should produce representative impact prediction at the identified air sensitive receivers with regards to the EVB discharge at the vent shaft.

3.6.56 The portal emissions (NO_2, and RSP) of the existing CHT, the existing underpasses and the planned deck-over were calculated based on the vehicle emission derived from the EMFAC model and vehicle flows in 2031. A figure showing the locations of the tunnel/enclosures portal emissions and ventilation buildings, and the calculations of portal emissions is attached in **Appendix 3.10**.

3.6.57 Portal emissions were modelled in accordance with the *Permanent International Association of Road Congress Report* (PIARC, 1991). Pollutants were assumed to eject from the portal as a portal jet such that 2/3 of the total emissions was dispersed within the first 50 m of the portal and 1/3 of the total emissions within the second 50 m.

3.6.58 As mentioned in Section 3.6.47, 360 predetermined meteorological conditions were used. The following summarises the meteorological conditions adopted in the air quality modelling using the ISCST3 model:

- Wind speed : 1 m s^{-1}
- Wind direction : 360 wind directions
- Resolution : 1°
- Stability class : D
- Mixing height : 500 m
- Emission temperature : 7° above ambient

3.6.59 For the calculation of the NO_2 concentrations, the vehicular emission factor for NO_x was used and the conversion factor from NO_x to NO_2 for all roads and portal emissions of tunnels and ventilation building was based on the Ambient Ratio Method (assuming 20% of NO_x to be NO_2) which is one acceptable approach as stipulated in EPD's "Guidelines on Choice of Models and Model Parameters". The locations of open road emission sources, portal and ventilation buildings are shown in **Appendix 3.11**.

Cumulative Impact

3.6.60 As mentioned in Section 3.6.15, background pollutant levels within and adjacent to the WDII, vehicle emissions from open sections of the existing and planned road networks, tunnel portal and ventilation building emissions from the Trunk Road, and portal emissions from the existing CHT, the existing and planned deckovers will contribute to the cumulative impact.

3.6.61 The pollutant concentrations at the ASRs at different wind directions (1 degree resolution) were predicted by both CALINE4 and ISCST3 models, where

- the CALINE4 model was used to predict the open road emissions from the existing and planned road networks

- the ISCST3 model was used to predict all the portal emissions (Trunk Road, CHT, existing and planned deckover) and ventilation shaft emissions.

3.6.62 The cumulative pollutant concentrations at the ASRs at each specific wind direction were calculated by summing the results from the two models. The highest pollutant concentrations at the ASRs amongst the 360 wind directions were identified as the worst predicted cumulative pollutant concentrations.

Vehicular Emission Impact (Inside the CWB Tunnel/ deckover)

3.6.63 In accordance with the *"Practice Note on Control of Air Pollution in Vehicle Tunnels",* the air quality inside the tunnel should achieve the EPD recommended standard of 1ppm NO_2 concentration. As advised by the ventilation engineer, the air quality inside the CWB Tunnel would comply with the above standard, which is the design requirement for the tunnel ventilation system.

3.6.64 Under the proposed deckover for planned HKCEC Atrium Link, the road considered in the assessment including (i) Expo Drive Central; (ii) CWB Slip Road 2; (iii) Road P2 eastbound; (iv) Road P2 westbound; (v) CWB Slip Road 3 including tunnel section; and (vi) Convention Avenue.

3.6.65 As Convention Avenue and Expo Drive Central are located far away from the other four road sections (Road P2 Eastbound & Westbound and CWB Slip Road 2 & Slip Road 3), good mixing of air pollutants from Road P2 and CWB under the deckover would be anticipated. However, mixing of vehicular emissions from Convention Avenue and Expo Drive Central would not be expected, so these two road sections were considered as separate tunnel sections in the assessment. In total, three separated tunnel sections under the deckover were assumed for the in-tunnel air quality model run:

(i) Deckover along Expo Drive Central – emissions contributed from Expo Drive Central
(ii) Deckover along Road P2 Eastbound & Westbound and CWB Slip Road 2 & Slip Road 3 - emissions contributed from Road P2 Eastbound & Westbound, CWB Slip Road 2 & Slip Road 3 (open road section under the deckover)
(iii) Deckover along Convention Avenue – emissions contributed from Convention Avenue

3.6.66 As the representative ASRs are located along the Convention Avenue, except tunnel portal emission from CWB westbound was included in the emission of its “tunnel” tube, the tunnel portal emission was also included in the emissions from “tunnel” tube of Convention Avenue, so as to provide highly conservative results. No ventilation system was assumed.

3.6.67 The air quality under the planned deckover on HKCEC Atrium Link was calculated based on the empirical formulas of fluid dynamics. A conversion factor of 12.5% including tailpipe NO_2 emission (taken as 7.5% of NO_x) plus 5% of NO_2/NOx for tunnel air recommended in PIARC for air expelled from the tunnel was taken in this assessment as the inside tunnel conversion factor. Two scenarios were considered in the assessment, i.e. normal traffic flow condition and congested traffic flow condition. It was assumed that under normal traffic flow condition, the vehicles are at a speed of 50 kph, whereas under congested mode, the vehicles are at a speed of 10 kph, the separation between vehicles is assumed to be 1 m. Different emission factors for normal condition (which presented in **Table 3.9**) and congestion condition (emission factor with traffic speed at 10kph) are used to calculate the air quality under the deckover. The calculation of in-tunnel air quality for section of deckover on planned HKCEC Atrium Link and emission factor of 10 kph are presented in **Appendix 3.12**. As per the discussion in Section 3.5.11, only NO_2 was assessed for the existing/planned deckover.

Odour Impact

Odour Emission Source

3.6.68 During operational phase, this Project will not create any new odour source. However, odour nuisance associated with the Causeway Bay Typhoon Shelter is an existing environmental problem. In order to improve the environment, this Project will take the opportunities to mitigate the potential sources of odour nuisance within the Project area so as to alleviate this existing environmental problem as well as to provide an acceptable environment for the future land uses within the project area. Therefore, the assessment was focused on the existing odour emission sources within the study area and formulated practicable odour mitigation measures to alleviate this existing odour problem. In order to identify the existing odour emission sources and determine the extent and level of existing odour impacts, odour surveys including odour patrols and air sampling on existing odour source area for olfactometry analysis were carried out by the Hong Kong Polytechnic University (HKPU) in September 2006 and July 2007.

Odour Patrol

3.6.69 Odour patrols were carried out in September 2006 and July 2007 by two qualified odour panel members from the Odour Laboratory of HKPU. They used their olfactory senses to detect/identify any odour problems and the locations of odour sources along/at the ex-PCWA and CBTS (including the areas in the vicinity of storm outfall P, Q, R and S), Northern Breakwater and Eastern Breakwater. The patrol members were free from any respiratory illnesses and do not normally work at or live in the area in the vicinity of CBTS and any typhoon shelter.

3.6.70 Each patrol day consisted of two patrol exercises in two different time periods (morning and afternoon/evening) and at least one patrol exercise of each patrol day was conducted during the low tide period of the day.

3.6.71 During the odour patrol, the patrol members recorded the weather condition including wind direction and temperature, location where odour was detected, possible source of odour, perceived intensity of the odour, duration of odour and characteristics of the odour detected.

3.6.72 The perceived intensity detected by odour patrol members was divided into 5 levels which are ranked in order as follows. The staying time at each patrol location was at least 2 -3 minutes to detect the odour intensity and the patrol location was at downwind direction of potential odour source area. The highest perceived intensity at each location during patrol was recorded.

0	Not detected	No odour perceived or an odour so weak that it cannot be easily characterised or described
1	Slight	Identifiable odour, slight
2	Moderate	Identifiable odour, moderate
3	Strong	Identifiable odour, strong
4	Extreme	Severe odour

3.6.73 In conjunction with the odour patrol, on-site H_2S measurement was conducted at the locations where odour was detected during the odour patrol. The purpose of the measurement was to provide initial idea about the strength of odour emission in terms of H_2S concentration. The H_2S concentration was measured by a portable H_2S analyzer (Jerome 631-X H_2S analyzer) at the odorous locations identified by the odour patrol members.

3.6.74 There were a few clusters of yachts/vessels at moorings. The patrol routes covered the whole water surface at CBTS as far as possible. The odour patrol areas are indicated in **Figure 1** and **1a** of **Appendix 3.13**. The odour patrol at Northern Breakwater and Eastern Breakwater were conducted at the downwind direction of CBTS. The detailed odour patrol procedures and results are presented in **Appendix 3.13**. The mean odour intensity levels and the odour characteristics recorded at the patrol locations in the 2006 survey and 2007 survey are summarized in **Table 3.12** and **3.13** respectively.

Table 3.12 Summary of Odour Patrol Results in Year 2006 Survey

Site ID	Location	Mean Odour Intensity	Odour Character	Duration	On-site H_2S Conc. (ppb)	Possible Sources
1	CBTS near Victoria Park	0	n.d.	n.d.	3-5	n.d.
1a	CBTS near Fire Station	0.5	Rotten organics + sea wind blow	Intermittent	5	Sea water and refuse near the bank
2	CBTS near Victoria Park Road	0.06	Rotten organics + sea wind blow*	Intermittent	3-10	Sea water and refuse near the bank
2a	CBTS near Noonday Gun	0.25	Rotten organics + sea wind blow*	Intermittent	7-10	Sea water and refuse near the bank
3	CBTS near Police Officers' Club	1.44	Rotten organics/ decayed sediment + diesel smell	Persistent	7-15	Sea water and boats at CBTS
4	CBTS near carpark of Police Officers Club	0.75	Rotten organics/ decayed sediment + diesel smell	Persistent/ intermittent	4-7	Sea water and boats at CBTS
5	Ex-PCWA , GFS Temporary Helipad	0	n.d.	n.d.	3-6	n.d.

Note: n.d. – Not detected; * only detected on 11 September 2006.

Table 3.13 Summary of Odour Patrol Results in Year 2007 Survey

Location	Odour Intensity Level #	Odour Nature #	Duration #	On-site H_2S Conc. (ppb) #	Possible Sources #
P1	2 / 2	Oily & decayed waste	Persistent	5 – 9 / 3 – 4	Floating debris, sediment
P2	2 / 2	Oily & decayed waste	Persistent	5 – 11 / 4 – 6	Floating debris, sediment
P3	1 / 1	Oily & decayed waste	Persistent	4 – 6 / 2 – 3	Floating debris, sediment
P4	1 / 1	Oily & decayed waste	Intermittent	2 – 4 / 2 – 3	Floating debris, sediment
P5	0 / 0	- / -	n.d.	0 – 1 / 2 – 3	- / -
P6	0 / 0	- / -	n.d.	1 / 2	- / -
P7	0 / 0	- / -	n.d.	1 / 2	- / -
P8	0 / 0	- / -	n.d.	1 – 2 / 2	- / -
P9	0 / 0	- / -	n.d.	1 / 2	- / -
P10	0 / 1	- / Rotten-egg	n.d. / Intermittent	1 / 0 – 1	- / Air bubbles from sediment were noted at nearby area
P11	0 / 2.5	- / Rotten-egg	n.d. / Intermittent	0 – 2 / 7 – 11	- / Floating debris
P12	1 / 3	Sewage + rotten-egg	Persistent	2 – 27 / 11 - 44	Outfall + air bubbles from sediment
P13	2.5 / 2	Sewage + rotten-egg	Persistent	14 – 37 / 42 - 70	Outfall + air bubbles from sediment
P14	3 / 2	Rotten-egg	Persistent	10 – 57 / 41 - 81	Air bubbles from sediment
P15	1 / 0	Oily and decayed wastes	Intermittent / n.d.	4 – 12 / 2 - 3	Floating debris / -
P16	0 / 0	- / -	n.d.	2 – 3 / 2	- / -
P17	0 / 0	- / -	n.d.	2 – 3 / 1 - 2	- / -
P18	0 / 0	- / -	n.d.	1 – 2 / 0 – 1	- / -
P19	0 / 0	- / -	n.d.	0 – 1 / 0 - 1	- / -
P20	0 / 0	- / -	n.d.	0 – 1 / 1 – 2	- / -
P21	0 / 0	- / -	n.d.	1 – 2 / 1 - 2	- / -
P22	0 / 0	- / -	n.d.	1 – 3 / 1 – 3	- / -
P23	0 / 1	- / Oily and wastes	n.d. / Intermittent	2 – 7 / 2 -4	- / Floating debris
P24	0 / 0	- / -	n.d.	2 – 5 / 1 – 2	- / -
P25	1.5 / 0	Rotten-egg / -	Intermittent / n.d.	5 – 27 / 2 - 5	Air bubbles from sediment at nearby area / -
P26	0 / 0	- / -	n.d.	0 – 2 / 1 – 2	- / -
P27	0 / 0	- / -	n.d.	1 / 2 - 5	- / -
P28	0 / 0	- / -	n.d.	1 – 2 / 2 – 4	- / -
P29	0 / 0	- / -	n.d.	0 – 1 / 1	- / -
P30	1 / 0	Rotten-egg / -	Intermittent / n.d.	0 – 1 / 0 - 1	Air bubbles from sediment at nearby area / -
P31	2 / 1	Sewage + rotten-egg	Persistent /Intermittent	2 – 13 / 5 – 13	Outfall + air bubbles from sediment
P32	0 / 0	- / -	n.d.	1 – 2 / 3 – 4	- / -
P33	0 / 0	- / -	n.d.	2 – 3 / 2 – 4	- / -
P34	0 / 0	- / -	n.d.	1 – 6 / 1 – 4	- / -
P35	1 / 0	Decayed wastes	Intermittent / n.d.	9 – 10 / 1 - 2	Floating debris / -
P36	0 / 0	- / -	n.d.	2 / 2 - 6	- / -

Note: # - morning result / afternoon result; n.d. – Not detected.

3.6.75 Odour patrol results indicated that no odour nuisance was detected at ex-PCWA, the areas in the vicinity of Northern Breakwater and Eastern Breakwater, the areas in the vicinity of storm drain outfall R and S. High odour intensity levels were recorded at the corner of CBTS (near Police Officer's Club) and the area in the vicinity of Outfall Q. Based on the findings of the odour surveys, the following four existing odour sources found at CBTS are identified and the possible causes of odour are summarized below.

(a) Sediment at the corner of CBTS and areas in the vicinity of Storm Drain Outfall Q

3.6.76 CBTS receives discharges from several drainage systems from Causeway Bay and Happy Valley. There are four outfalls including outfall P, Q, R and S discharging into CBTS as shown in **Figure 5.3B**. Currently these systems primarily receive stormwater and street runoffs. Odour patrol results indicated that odour nuisance was detected at the corner of CBTS (near Police Officers' Club) and areas in the vicinity of storm drain outfall Q. It is likely that polluted sewage/wastewater has been discharged to this storm drain through some expedient connections made in the past. The sewage/wastewater discharged from these expedient connections contained high levels of pollutants, which together with the stagnant water system at the corner of CBTS, resulted in the deposition of a contaminated sediment layer today.

3.6.77 Under normal conditions, the organic matter is decomposed by micro-organisms aerobically using the oxygen in the water and also diffused to the sediment. The resultant products are carbon dioxide and water:

Organic matter + oxygen → energy + carbon dioxide + water

3.6.78 When the organic load exceeds the carrying capacity, oxygen is not available for aerobic respiration and sulphate in seawater is used as the agent for anaerobic respiration by micro-organisms.

3.6.79 Hydrogen sulphide is formed when the organic rich sediments act as a substrate for the action of sulphate-reducing bacteria (SRBs) which reduce the sulphate in the absence of oxygen. Organic sulphur compounds, such as mercaptans, also contribute partly to the odour with process similar to hydrogen sulphide:

Organic matter + sulphate → energy + hydrogen sulphide + water

Organic matter with sulphide → energy + mercaptans + water (minor pathway)

3.6.80 This is also reflected by the observations made during the odour patrols that high concentration of hydrogen sulphide was detected in the air samples collected above the water surface at the corner of CBTS and the area in the vicinity of Outfall Q by the handheld H_2S detector.

(b) Polluted discharges from Outfall P and Q

3.6.81 In accordance with the site observation during odour patrol, polluted discharge from storm drain outfall P and sewage-like discharge from storm drain outfall Q into CBTS were noted in the odour patrols and causing odour nuisance. During odour sampling exercise in the 2007 odour survey, very high odour concentration and hydrogen sulphide concentrations were detected at the area in the vicinity of Outfall Q and its headspace. This supports the observation that the polluted discharge from outfall Q consisted of sewage which likely came from expedient connections.

(c) Slime attached on the shoreline seawall

3.6.82 Oil and greases discharged from the storm drain outfall P and Q were accumulated at the south-western corner of CBTS due to stagnant water flow and poor water circulation and some of the oil and greases were attached on the shoreline seawall. As there was no cleaning of the shoreline seawall before, the slime attached on the seawall caused odour nuisance in particular during low tide periods.

(d) Floating Debris

3.6.83 Floating debris at CBTS was observed during odour survey. The debris might be disposed from the boats at CBTS or in the discharges from outfalls. The quantity of floating refuse collected was higher in the summer months (See **Table 6.5**) which may be attributed to the heavy rains and typhoons bringing more refuse into the harbour. In the summer, the wind direction is from the south-west which also brings more refuse into the harbour.

Air Sampling and Olfactometry Analysis

3.6.84 Based on the findings of the odour patrols, the odour intensity level recorded at some locations within CBTS was equal to or higher than 1, which is classified as identifiable odour. However, the site observation indicated that the odour detected at these locations was intermittent with duration less than 1 minute. These locations are unlikely to be odour sources as the duration of odour detected at source location should be persistent (at least 2 – 3 minutes). The intermittent odour was most likely due to wind dispersion from nearby odour source areas. Hence, the potential odour sources locations should fulfil the following two criteria:

(i) Mean odour intensity level equal to or higher than 1 during patrol exercise; and
(ii) The duration of odour detected was persistent during patrol.

3.6.85 Based on the above two criteria, Site ID 3 (corner of CBTS) in Year 2006 odour patrol and Locations P1 (corner of CBTS, similar location of Site ID3 in Year 2006 odour patrol), P2, P3, P12, P13, P14 and P31 in Year 2007 odour patrol were considered as existing odour source locations. In order to determine the level of odour impact under the existing situation, source air samples were collected from these existing odour source locations and ambient air samples were collected along the CBTS waterfront for olfactometry analysis. The air sampling exercises were conducted on 15 September 2006 and 28 July 2007 during noon/afternoon and at low tide condition. The sampling periods are considered to represent the reasonable worst case condition as more hydrogen sulphide would be released from sediment under high temperature (hot season) and low water depth (low tide condition). In the 2007 odour survey, air sample inside headspaces of storm outfall P and Q were also collected to demonstrate whether the discharge from these two outfalls is a potential source contributing to the existing odour nuisance.

3.6.86 The air sampling and subsequent olfactometry tests were conducted by Odour Research Laboratory of HKPU which is an accredited laboratory in Hong Kong to conduct such odour sampling and olfactometry test.

3.6.87 Source air sampling above potential odorous water surface were based on "hood" methods[1], whereby a flux hood type apparatus was placed on the odour emitting surface of potential source locations, and air was blown through it. A dynamic flux hood was employed in the sampling work to collect odour samples from water surfaces, in which an odour-free gas from a nitrogen gas cylinder was supplied to generate an air flow at 20L/min inside the flux hood. The emission rate was then given by airflow through the hood and the odour concentration of the exit air. The ambient air samples were collected via a sampling tube connecting to an odour sampling system (i.e. air pumps and Tedlar bags). The empty sample bag was placed in a rigid plastic container and the container was then evacuated at a controlled rate and the bag was filled. The air sampling locations of the Year 2006 and 2007 odour surveys are indicated in **Figure 1** and **2** of **Appendix 3.13**. The collected samples were sent to the Odour Research Laboratory of the Hong Kong Polytechnic University for olfactometry analysis within 24 hours.

3.6.88 The odour concentration of the air samples were determined by a forced-choice dynamic olfactometer with a panel of human assessors being the sensor in accordance with the European Standard Method (EN13725). Each odour testing session comprised at least six qualified panellists. All the panellists were screened beforehand by using a 50 ppm solution/mixture of certified n-butanol standard gas. Their individual odour thresholds of n-butanol in nitrogen gas were in the range of 20 to 80 ppb/v as required by EN13725. The odour panellists were all free from any respiratory illnesses and were not normally working at or living in the area in the vicinity of CBTS and typhoon shelters.

Existing Odour Emission Inventory

3.6.89 Based on the findings of the odour surveys in September 2006 and July 2007, existing odour nuisance was identified at the corner of the CBTS near the Police Officers' Club and the water surface area in the vicinity of Outfall P and Q. No existing odour nuisance was detected at the east and centre of CBTS, ex-PCWA, Northern Breakwater, Eastern Breakwater and nearby areas and the areas in the vicinity of Outfall R and S.

3.6.90 The odour concentration (in terms of ou/m^3) of the collected air samples were determined by olfactometry analysis. The specific odour emission rate (SOER) of each existing area source was calculated by the following equation:

$$\text{SOER (ou/m}^2\text{.s)} = \frac{\text{Odour concentration(ou/m}^3\text{) x Air flow rate inside hood (m}^3\text{/s)}}{\text{Covered water surface area (m}^2\text{)}}$$

$$= \text{OC x (0.02/60) / (0.2 x 0.2 x 3.14) = OC x 0.00265}$$

3.6.91 The odour concentrations and odour emission rates of the existing source areas estimated from the 2006 and 2007 survey results are summarised in **Table 3.14** and **3.15** respectively.

[1] Sampling for Measurement of Odours, P.Gostelow, P. Longhurst, S.A. Parsons and R.Mstuetz, 2003.

Table 3.14 Results of Olfactometry Analysis (Year 2006)

Sample ID	Ambient Air or Source Sample	Odour Concentration (ou/m^3)	Odour Emission Rate (ou/m^2/s)
1-A	Ambient air sample	19	-
1-E	Source sample above water surface	61	0.16
2-A	Ambient air sample	32	-
2-E	Source sample above water surface	82	0.22
3-A	Ambient air sample	42	-
3-E	Source sample above water surface	143	0.38
4-A	Ambient air sample	37	-
4-E	Source sample above water surface	134	0.36
5-A	Ambient air sample	20	-
5-E	Source sample above water surface	75	0.20

Table 3.15 Results of Olfactometry Analysis (Year 2007)

Sample ID	Odour Nature	Possible Source	In-situ H_2S (ppb)	Odour Concentrations (ou/m^3)	Odour Emission Rate (ou/m^2/s)
1	Oily & decayed wastes + rotten-egg	Floating debris + sediment + sewage	120 – 130	5792	15.32
2	Oily & decayed wastes + rotten-egg	Floating debris + sediment + sewage	5 – 6	164	0.43
3	Oily & decayed wastes + rotten-egg	Floating debris + sediment + sewage	11 – 12	889	2.35
4	Oily & decayed wastes + rotten-egg	Floating debris + sediment + sewage	3 – 4	484	1.28
5	Oily & decayed wastes + rotten-egg	Floating debris + sediment + sewage	3 – 4	469	1.24
8	Septic sewage + rotten-egg	Outfall + sediment with gas bubbling	2400	30,530	80.77
9	Septic sewage + rotten-egg	Outfall + sediment with gas bubbling	15	670	1.77
10	Septic sewage + rotten-egg	Outfall + sediment with gas bubbling	370 – 380	6208	16.42
11	Septic sewage + rotten-egg	Outfall + sediment with gas bubbling	12 - 13	433	1.15

3.6.92 Comparing the results of the two odour surveys, higher odour emission rates were obtained in the 2007 odour survey. This might be due to the fact that the sampling day in 2007 was very hot and the sampling exercise was conducted at the lowest tide (below 0.5mPD) and during period with very high temperature (31 – 33 degrees Celsius). Discharges from Outfall Q with sewage-like smell were noted during the entire odour sampling period. The odour emission rates derived from the 2007 odour survey were considered as reasonable worst case emission rates and were therefore adopted in the assessment for the prediction of the worst odour concentrations at the representative ASRs. However, the odour emission rate derived from Sample ID 8 (Year 2007) was unreasonably high (80.77 ou/m^2/s). The emission rates derived from other air samples collected in the vicinity of outfall Q such as Sample ID 9 (the closest point to the outfall Q) and Sample ID10 were significantly lower. These two air sample locations were also close to Sample ID8. In accordance with the past experience in other odour projects, the odour emission rates for sewage and sludge related sources were not higher than 40 ou/m^2/s. It was therefore suspected that the air sample of Sample ID8 might be contaminated in the laboratory analysis. The result for this sample was therefore discarded and the emission rate used in the modelling was based on the second highest odour emission rate (i.e. 16.42 ou/m^2/s) derived from Sample ID10 which was also close to Sample ID8.

3.6.93 The odour concentrations of air samples collected inside the headspaces of outfall P and Q were 884 ou/m^3 and 71320 ou/m^3, respectively. The results indicated that high odour concentrations were detected in the headspace of outfall Q. Under the worst case condition as identified by the odour surveys during low tide, the rate of change in tide level is very slow and hence the rate of displacement of the headspace air volume from the outfalls to the atmosphere, if any, would also be very low. Therefore, no air displacement from the headspace of the outfalls was considered in the odour modelling. During other tidal conditions, the rate of displacement of the headspace air volume from the outfalls to the atmosphere might be higher, yet the odour emissions from other potential odour source locations would be significantly less and are therefore not considered as worst case conditions.

3.6.94 Based on the findings of the odour surveys, the locations of potential odour source areas considered in the odour modelling for the worst case scenario are shown in **Appendix 3.14**. Besides, with reference to the results of the odour surveys carried out in 2006 and 2007, it is noted that the odour emission rates of the identified odour source areas would be lower under lower ambient temperature. The recorded ambient temperature during the sampling period in 2006 and 2007 was in the range of 25-29 ^{o}C and 31-34 ^{o}C respectively. The estimated odour emission rates based on the 2006 odour survey results are significantly lower than those derived based on the 2007 odour survey results. The highest odour emission rate derived from the 2006 odour survey results is 0.38 ou/m^2/s whereas the highest odour emission rate derived from the 2007 odour survey results is 16.42 ou/m^2/s. For the purpose of this assessment to produce reasonable prediction under different ambient temperature, the odour emission rates during periods with ambient temperature equal to or greater than 30 ^{o}C were derived from the 2007 odour survey results, whereas the odour emission rates during periods with ambient temperature less than 30 ^{o}C were taken as the highest odour emission rate derived from the 2006 odour survey results, i.e. 0.38 ou/m^2/s. The emission factors of the existing source areas under different temperature ranges are summarized in **Table 3.16**.

Table 3.16 Existing Odour Emission Inventory for the Worst Case Scenario

Sample ID	Odour Emission Rate ($ou/m^2/s$)	
	(for ambient temperature <30 ^oC)	(for ambient temperature >= 30 ^oC)
1	0.38	15.32
2	0.38	0.43
3	0.38	2.35
4	0.38	1.28
5	0.38	1.24
8	0.38	16.42
9	0.38	1.77
10	0.38	16.42
11	0.38	1.15

Air Dispersion Model

3.6.95 Odour impacts were assessed using air dispersion model, ISCST3. Hourly meteorological data for the year 2005 (including wind speed, wind direction, air temperature, Pasquill stability class and mixing height) of the Hong Kong Observatory Weather Station were employed for the model run. The study area is in an urban area, "Urban" model was adopted in the model.

3.6.96 The modelled hourly odour concentrations at the ASRs were converted into the 5-second odour concentration so as to compare with the EIAO-TM odour criteria. In accordance with EPD's "Guidelines on Choice of Models and Model Parameters", it is recommended to follow the methodologies proposed by Duffee et al.[2] and Keddie[3] in performing the conversion from hourly and 5-second average concentration. However, it is noted that these methodologies are based on findings of earlier researches on dispersion of odour emissions from point sources. More recent researches indicated that the peak-to-mean ratio of odour dispersion would depend upon the type of source, atmospheric stability and distance downwind. Depending on the physical source configuration, the peak-to-mean ratio of odour dispersion from area source could be far smaller than that from point source. In this assessment, the potential odour sources to be studied are in the form of area sources in CBTS. Therefore, for the purpose of this assessment to produce more reasonable predictions for odour dispersion from area sources, reference was made to the peak-to-mean ratio for area source stipulated in "Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales" published by the Department of Environment and Conservation, New South Wales, Australia (NSW Approved Method).

[2] Richard A. Duffee, Martha A. O"Brien and Ned Ostojic (1991). Odour Modelling – Why and How, Recent Developments and Current Practices in Odour Regulation, Controls and Technology, Air & Waste Management Association.

[3] Keddie, A. W, C(1980). Dispersion of Odours, Odour Control – A concise Guide, Warren Spring Laboratory.

3.6.97 The dispersion modelling techniques employed for this assessment followed those described in EPD's "Guidelines on Choice of Models and Model Parameters" using ISCST3 model except the use of alternative peak-to-mean ratios discussed above. However, it should be noted that the peak-to-mean ratios stated in the NSW Approved Method are derived based on experimental and theoretical analyses and assuming a 0.1% exceedance level (Ref.: Statistical Elements of Predicting the Impact of a Variety of Odour Sources, Peter R. Best, Karen E. Lunney and Christine A. Killip, Water Science and Technology, Australia, 44: 9 pp 157-164 2001). In other words, there would be a 0.1% probability that the actual peak concentration would be higher than those derived with the peak-to-mean ratios stated in the NSW Approved Method. The residual odour impact associated with this 0.1% probability is addressed in Sections 3.8 and 3.9 below.

3.6.98 In accordance with the NSW Approved Method, the conversion factors are used for converting the 1-hour average concentrations to 1-second average concentrations. As a conservative approach, these conversion factors were directly adopted for converting the 1-hour average concentrations predicted by the ISCST3 model to 5-second average concentrations for compliance checking with the odour criteria. Besides, in this case, the potential odour sources are located in the vicinity of the ASRs, therefore, the ASRs are considered to be located in the near field region with regards to the odour sources as per the NSW Approved Method. The conversion factors adopted in this assessment for different stability classes are shown in **Table 3.17**.

Table 3.17 Conversion Factors to 5-second Mean Concentration

Pasquill Stability Class	Conversion Factor (1 hour to 5 seconds)
A	2.5
B	2.5
C	2.5
D	2.5
E	2.3
F	2.3

Presentation of Assessment Results

3.6.99 The predicted odour concentrations within the study area under the existing scenario were presented in the form of contour plots and are attached in **Appendix 3.14**.

Level of Uncertainty in the Assessment

Construction Dust and Road Traffic Emission Impact Assessments

3.6.100 The emission rates adopted in the construction dust impact assessment are in accordance with the USEPA Compilation of Air Pollutant Emission Factors (AP-42), which had previously been applied in similar situations in other EIA studies.

3.6.101 The Fugitive Dust Model (FDM) for construction dust impact assessment, Caline4 model for open road traffic emission impact assessment, and Industrial Source Complex Short Term 3 (ISCST3) dispersion model for portal/vent shaft emission impact assessment are generally accepted models for use in assessing construction dust impacts and road traffic emission impacts.

3.6.102 There would be some limitations such as the accuracy of the predictive base data for future conditions e.g. traffic flow forecasts, plant inventory for the proposed construction works and sequences of construction activities. Uncertainties in the assessment of impacts have been considered when drawing conclusions from the assessment.

Odour Impact Assessment

3.6.103 The degree of uncertainty of the predicted odour impacts depends on the accuracy of the estimated odour emission rates and the air dispersion modelling. The number of air samples collected as well as the intrinsic limitations of the air sampling technique and the olfactometry analysis would also affect the accuracy of odour emission rate estimation.

3.6.104 The odour patrol was conducted over a limited number of days to identify the potential odour source locations, however, the patrol days were all sunny days in very hot season and the patrol period covered the low tide condition. It is believed that the potential odour source locations at CBTS have been identified. Besides, given that the odour surveys were carried out in a limited number of days at worst-case weather and tidal conditions, the measured odour concentrations are basically worst-case snapshot values. Given the above, the estimated odour emission rates are considered to represent reasonable worst case conditions.

3.6.105 Air sampling is an important step in the process of measuring the odour concentrations of the sources, as is the quality and reliability of the results. All the odour sampling was carried out by the odour sampling team of HKPU which has the most extensive local experience in odour sampling. The potential error associated with odour sampling process is considered to be on the low side.

3.6.106 It should be noted that all the odour concentrations (in ou/m^3) and hence area source emission rates (in ou/m^2/s) were measured by olfactometry analysis carried out at the Odour Research Laboratory of HKPU in accordance with the European Standard Method (EN13725). This European Standard Method specifies a method for the objective determination of the odour concentration of a gaseous sample using dynamic olfactometry with human assessors. The detection limit for this European Standard Method is 10 ou/m^3. Yet the detection limit of this European Standard Method could vary between laboratories. Therefore, in reviewing the odour concentration results (in ou/m^3), it should be noted that a measured low odour concentration value would normally has a higher degree of error due to the inherent properties of the olfactometry analysis method.

3.7 Prediction and Evaluation of Environmental Impacts

Construction Phase

3.7.1 Construction activities for WDII, Trunk Road and CRIII Project will cause cumulative dust impact on the nearby sensitive receivers.

3.7.2 Since most of the construction activities are at ground level, the likely cumulative dust impacts of the WDII on the ASRs at 1.5 m and 5 m above ground were modelled.

3.7.3 The predicted cumulative maximum 1-hour average TSP and 24-hour average TSP during construction are shown in **Tables 3.18 - 3.21**.

Table 3.18 Predicted Cumulative Maximum 1-hour Average TSP Concentrations at 1.5m above ground

ASR	Predicted Concentration (μg m^{-3}) *						
	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5	Scen. 6	Max.
A25	123	107	172	162	172	92	172
A26	151	130	252	247	252	94	252
A27	195	135	199	196	199	101	199
A28	132	120	222	204	226	91	226
A29	170	154	409	402	408	94	409
A30	216	175	277	276	277	99	277
A31	208	138	193	192	193	106	208
A32	221	186	394	434	421	155	434
A33	378	232	367	269	366	107	378
A34	246	173	328	224	328	103	328
A35	141	126	240	278	278	149	278
A36	124	121	175	205	200	117	205
A37	214	213	329	414	358	256	414
A38	241	228	235	292	214	173	292
A39	225	206	199	238	190	184	238
A40	113	112	131	152	148	105	152
A41	120	118	129	150	142	113	150
A42	121	120	129	147	138	120	147
A43	127	125	125	138	134	132	138
A44	150	149	149	163	151	139	163
A45	189	189	189	218	209	192	218
A46	193	193	193	230	223	206	230
A47	180	180	180	226	222	208	226
A48	158	158	158	224	224	218	224
A49	151	150	151	219	219	215	219
A50	306	306	306	193	192	174	306
A51	212	212	212	210	204	180	212
A52	201	199	200	191	179	163	201
A53	280	277	277	216	204	184	280
A54	147	145	156	185	320	164	320
A55	125	123	129	153	237	127	237
A56	111	108	113	133	148	115	148
A57	116	114	119	141	194	117	194
A58	123	121	128	148	277	120	277
A59	129	128	137	154	183	122	183
A60	148	147	160	166	167	126	167
A61	183	182	193	181	181	132	193
A62	166	162	162	155	153	118	166
A63	221	212	174	195	152	119	221
A64	194	175	165	223	140	113	223
A65	185	172	166	254	132	109	254
A66	170	170	184	184	184	135	184
A70	217	210	168	162	174	88	217
A95	225	220	102	238	99	159	238
A96	167	162	99	185	98	139	185
A97	149	145	98	167	97	125	167
A98	121	117	95	132	95	95	132

Note: * Background concentration is included.
Hourly TSP criteria (EIAO-TM): 500 μg m^{-3}

Table 3.19 Predicted Cumulative Maximum 24-hour Average TSP Concentrations for at 1.5m above ground

ASR	Predicted Concentration (μg m^{-3}) *						
	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5	Scen. 6	Max.
A25	98	91	122	117	121	84	122
A26	111	102	158	156	158	84	158
A27	131	105	134	133	134	88	134
A28	102	98	145	136	147	83	147
A29	119	113	229	226	229	85	229
A30	141	124	169	169	169	87	169
A31	137	106	131	130	131	90	137
A32	143	129	221	241	235	111	241
A33	213	149	210	168	210	90	213
A34	154	122	193	145	193	88	193
A35	106	101	152	169	168	109	169
A36	99	98	122	136	134	95	136
A37	140	140	192	231	207	156	231
A38	152	146	151	178	143	119	178
A39	145	137	136	154	132	124	154
A40	94	94	103	112	110	89	112
A41	97	97	102	111	108	93	111
A42	97	98	102	110	106	96	110
A43	100	100	100	107	104	101	107
A44	111	111	111	119	113	104	119
A45	129	129	129	143	139	128	143
A46	130	130	130	148	145	134	148
A47	124	124	124	146	144	135	146
A48	114	115	115	144	144	139	144
A49	111	111	112	142	142	138	142
A50	180	183	183	132	132	120	183
A51	139	141	141	139	136	122	141
A52	134	134	135	132	126	115	135
A53	171	170	170	144	138	124	171
A54	109	108	113	127	187	116	187
A55	99	99	101	113	151	99	151
A56	92	92	94	103	110	94	110
A57	95	94	97	107	132	95	132
A58	98	97	101	111	170	96	170
A59	101	100	105	114	126	97	126
A60	109	109	116	120	120	99	120
A61	125	125	132	127	127	101	132
A62	118	117	118	115	114	95	118
A63	142	142	124	132	113	95	142
A64	130	124	119	145	107	93	145
A65	126	122	118	159	104	91	159
A66	120	120	127	129	128	102	129
A70	141	139	121	118	124	82	141
A95	144	145	89	153	88	113	153
A96	117	118	88	128	87	104	128
A97	109	110	87	119	86	98	119
A98	97	97	86	103	86	85	103

Note: * Background concentration is included.
Daily TSP (AQO): 260 μg m^{-3}

Table 3.20 Predicted Cumulative Maximum 1-hour Average TSP Concentrations at 5m above ground

ASR	Predicted Concentration (μg m^{-3}) *						
	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5	Scen. 6	Max.
A25	125	104	175	163	174	93	175
A26	153	122	248	242	248	95	248
A27	194	125	199	196	199	102	199
A28	135	115	226	207	230	92	230
A29	173	142	364	354	364	95	364
A30	213	155	266	266	266	100	266
A31	206	127	192	195	192	107	206
A32	219	167	318	390	367	154	390
A33	323	187	312	270	311	109	323
A34	229	151	308	224	308	104	308
A35	143	120	234	259	257	148	259
A36	125	114	178	203	199	118	203
A37	203	182	258	371	344	208	371
A38	222	186	234	291	219	166	291
A39	214	176	202	241	190	183	241
A40	115	108	134	155	151	106	155
A41	122	114	132	153	145	113	153
A42	124	115	132	150	141	120	150
A43	130	120	128	141	134	132	141
A44	152	138	151	167	155	141	167
A45	185	167	185	221	211	193	221
A46	188	170	188	231	224	206	231
A47	176	160	176	226	223	207	226
A48	158	145	157	221	221	215	221
A49	152	139	152	216	216	211	216
A50	259	230	259	195	195	176	259
A51	202	179	200	208	202	176	208
A52	199	178	197	196	182	165	199
A53	265	233	263	220	206	186	265
A54	148	134	156	188	209	167	209
A55	127	117	130	157	216	130	216
A56	113	105	115	136	151	117	151
A57	118	109	121	144	191	119	191
A58	124	115	131	152	223	122	223
A59	130	121	140	159	179	124	179
A60	148	136	163	171	171	129	171
A61	180	163	196	186	185	135	196
A62	168	150	166	158	157	120	168
A63	219	190	177	196	155	121	219
A64	194	161	167	222	143	115	222
A65	186	157	167	248	135	111	248
A66	169	154	186	189	188	137	189
A70	201	174	173	167	180	88	201
A93	410	354	115	432	107	167	432
A94	301	258	106	299	102	169	301
A95	228	199	104	239	101	147	239
A96	171	152	101	189	99	132	189
A97	152	137	99	171	98	123	171
A98	124	113	96	135	96	96	135

Note: * Background concentration is included.
Hourly TSP criteria (EIAO-TM): 500 μg m^{-3}

Table 3.21 Predicted Cumulative Maximum 24-hour Average TSP Concentrations at 5m above ground

ASR	Predicted Concentration (μg m^{-3}) *						
	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5	Scen. 6	Max.
A25	100	90	122	117	122	84	122
A26	112	98	154	152	154	85	154
A27	131	100	133	132	133	88	133
A28	105	95	146	137	147	83	147
A29	122	108	205	200	204	85	205
A30	140	114	162	162	162	87	162
A31	136	100	129	132	129	90	136
A32	142	119	185	219	206	111	219
A33	186	126	182	167	183	91	186
A34	145	111	181	144	181	89	181
A35	108	98	148	158	158	108	158
A36	99	95	123	134	132	95	134
A37	134	125	160	209	199	135	209
A38	142	126	149	176	144	116	176
A39	139	123	136	155	131	124	155
A40	95	92	104	113	111	90	113
A41	99	95	103	112	109	93	112
A42	100	96	103	111	107	96	111
A43	103	98	101	108	104	101	108
A44	112	106	111	120	114	105	120
A45	126	119	126	144	139	128	144
A46	127	119	127	148	145	134	148
A47	122	115	122	145	144	134	145
A48	114	109	114	142	142	138	142
A49	112	106	112	140	140	136	140
A50	158	145	157	132	132	121	158
A51	136	126	135	138	135	120	138
A52	133	124	132	134	127	116	134
A53	163	149	161	145	138	125	163
A54	110	104	113	128	137	117	137
A55	100	96	102	115	140	100	140
A56	94	90	95	104	111	95	111
A57	96	92	98	109	129	96	129
A58	99	95	102	113	144	97	144
A59	101	97	106	116	125	98	125
A60	110	104	117	122	122	100	122
A61	124	117	132	129	129	102	132
A62	119	111	119	116	115	96	119
A63	143	131	125	132	115	96	143
A64	132	118	119	143	109	94	143
A65	128	115	119	155	105	92	155
A66	118	112	128	131	130	104	131
A70	134	122	123	120	126	82	134
A93	224	200	95	235	91	117	235
A94	181	162	91	179	89	118	181
A95	148	135	90	152	89	108	152
A96	122	114	89	129	88	101	129
A97	113	106	88	121	87	97	121
A98	99	95	86	105	86	85	105

Note: * Background concentration is included.
Daily TSP(AQO): 260 μg m^{-3}

3.7.4 Based on results indicated in **Tables 3.18** to **3.21**, no exceedance of 1-hour average and 24-hour average TSP guideline and AQO is predicted at the ASRs 1.5m and 5m above ground. The predicted cumulative maximum 1-hour average and 24-hour average TSP concentration contours at 1.5m and 5m above local ground are shown in **Figures 3.6** to **3.17**. Exceedances of the 1-hour average TSP guideline of 500 μg/m^3 and the 24-hour average TSP AQO of 260 μg/m^3 are noted in some areas at 1.5m above ground including:

Exceedance of the 1-hour average TSP guideline of 500 μg/m^3

Scenario 1 – sea area, area next to Cross Harbour Tunnel and area next to HKCEC, IEC
Scenario 2 – sea area and IEC
Scenario 3 – sea area, area next to Cross Harbour Tunnel, area next to HKCEC, area underneath New Atrium Link (Extension of HKCEC)
Scenario 4 - sea area, IEC, part of waterfront in the vicinity of Causeway Bay Flyover, area underneath New Atrium Link (Extension of HKCEC), area in the vicinity of existing Wan Chai Pier and nearby PTI, area next to Servicemen's Guides Association
Scenario 5 – sea area, area underneath New Atrium Link (Extension of HKCEC), area in the vicinity of existing Wan Chai Pier and nearby PTI, area next to Servicemen's Guides Association
Scenario 6 – sea area and part of waterfront in the vicinity of Causeway Bay Flyover

Exceedance of the 24-hour average TSP AQO of 260 μg/m^3

Scenario 1 – sea area, area next to Cross Harbour Tunnel and area next to HKCEC, IEC
Scenario 2 – sea area, IEC and area next to Cross Harbour Tunnel
Scenario 3 – sea area, area next to Cross Harbour Tunnel, areas next to Servicemen's Guides Association and HKCEC, area underneath New Atrium Link (Extension of HKCEC)
Scenario 4 - sea area, IEC, part of waterfront in the vicinity of Causeway Bay Flyover, GFS Helipad, area underneath New Atrium Link (Extension of HKCEC), area in the vicinity of existing Wan Chai Pier and nearby PTI, area next to Servicemen's Guides Association
Scenario 5 – sea area, part of waterfront near Causeway Bay Flyover, area underneath New Atrium Link (Extension of HKCEC), area in the vicinity of existing Wan Chai Pier and nearby PTI, area next to Servicemen's Guides Association
Scenario 6 – sea area and part of waterfront in the vicinity of Causeway Bay Flyover

3.7.5 Exceedances were noted at the above identified areas but they are not ASRs and no air sensitive areas are located within these exceedance areas.

Operational Phase

Traffic Emission Impact (Open Road)

3.7.6 Taking into account vehicle emissions from open road networks, portal and ventilation building emissions from the Trunk road, portal emissions from the CHT, existing underpasses and planned deckovers, and the background pollutant concentrations, the cumulative 1-hour average NO_2, 24-hour average NO_2 and 24-hour average RSP concentrations were predicted and the highest pollutant concentrations at each ASR under the worst wind directions were calculated.

3.7.7 In order to determine the potential impacts on the upper level receivers, pollutant concentrations at various levels (1.5 m, 5m, 10 m, 20m, 30m and 40m above ground) were calculated. **Tables 3.22**, **3.23** and **3.24** summarise the predicted cumulative maximum 1-hour average NO_2, 24-hour average NO_2 and 24-hour average RSP concentrations at different elevations respectively.

Table 3.22 Predicted Cumulative Maximum 1-hour Average NO_2 Concentrations at the Representative ASRs at Different Elevations

ASRs	Predicted 1-hour averaged Concentration ($\mu g\ m^{-3}$) *					
	1.5m AGL	5m AGL	10m AGL	20m AGL	30m AGL	40m AGL
A25	100	95	87	87	87	87
A26	79	78	77	77	77	77
A27	81	78	77	77	77	77
A28	81	80	78	78	78	78
A29	77	76	75	75	75	75
A30	81	79	77	77	77	77
A31	85	82	79	79	79	79
A32	83	82	80	79	79	79
A33	77	75	75	74	74	74
A34	74	74	74	74	73	73
A35	79	79	78	78	78	78
A36	96	93	88	88	88	88
A37	94	87	83	83	82	82
A38	98	94	89	88	88	87
A39	95	94	93	93	91	90
A40	130	124	113	113	113	112
A41	126	123	116	115	114	113
A42	132	128	119	118	117	115
A43	131	127	118	116	113	110
A44	170	152	129	120	108	99
A45	175	154	125	114	106	106
A46	167	149	122	114	106	106
A47	143	135	119	114	106	102
A48	118	114	107	105	102	99
A49	110	107	102	101	99	97
A50	194	189	174	135	101	83
A51	255	245	218	163	118	100
A52	178	175	164	132	101	101
A53	250	239	208	136	94	94
A54	97	93	89	89	89	89
A55	84	83	82	82	82	82
A56	90	79	75	75	75	74
A57	94	85	79	79	79	79
A58	96	86	82	82	82	82
A59	96	87	83	83	83	83
A60	91	83	81	81	80	80
A61	91	84	81	81	81	80
A62	88	83	79	79	79	79
A63	78	78	77	77	77	77
A64	77	77	76	76	76	75
A65	76	76	75	75	75	75

ASRs	Predicted 1-hour averaged Concentration ($\mu g\ m^{-3}$) *					
	1.5m AGL	**5m AGL**	**10m AGL**	**20m AGL**	**30m AGL**	**40m AGL**
A66	83	83	82	82	82	82
A70	75	74	73	73	73	73
A71	79	78	77	77	77	77
A73	104	89	81	81	81	81
A76	90	86	81	81	81	81
A81	89	86	82	82	82	82
A91	78	80	84	84	84	85
A92	77	77	76	76	76	77
A93	84	84	82	82	82	82
A94	82	82	81	81	81	81
A95	78	78	78	78	78	78
A96	75	75	75	75	75	75
A97	76	75	74	74	74	74
A98	76	76	74	74	74	74
A99	86	84	80	80	80	80

Note: * Background concentrations are included.
1-hr NO_2 criteria (AQO): 300 $\mu g\ m^{-3}$

Table 3.23 Predicted Cumulative Maximum 24-hour Average NO_2 Concentrations at the Representative ASRs at Different Elevations

ASRs	Predicted 24-hour averaged Concentration ($\mu g\ m^{-3}$) *					
	1.5m AGL	5m AGL	10m AGL	20m AGL	30m AGL	40m AGL
A25	73	71	68	68	68	68
A26	65	64	64	64	64	64
A27	65	64	64	64	64	64
A28	66	65	64	64	64	64
A29	64	64	63	63	63	63
A30	66	65	64	64	64	64
A31	67	66	65	65	65	65
A32	66	66	65	65	65	65
A33	64	63	63	63	63	63
A34	63	63	62	62	62	62
A35	65	64	64	64	64	64
A36	71	70	68	68	68	68
A37	71	68	66	66	66	66
A38	72	70	68	68	68	68
A39	71	71	70	70	70	69
A40	85	83	78	78	78	78
A41	84	82	79	79	79	78
A42	86	84	81	80	80	79
A43	85	84	80	80	78	77
A44	101	94	85	81	76	73
A45	103	94	83	79	76	76
A46	100	93	82	78	76	76
A47	90	87	81	78	75	74
A48	80	79	76	75	74	72
A49	77	76	74	73	72	72
A50	111	109	103	87	73	66
A51	135	131	120	98	80	73
A52	104	103	98	86	74	73
A53	133	128	116	87	70	70
A54	72	70	69	69	69	68
A55	67	66	66	66	66	66
A56	69	64	63	63	63	63
A57	71	67	65	65	65	65
A58	71	67	66	66	66	66
A59	71	68	66	66	66	66
A60	69	66	65	65	65	65
A61	69	66	65	65	65	65
A62	68	66	65	65	65	65
A63	64	64	64	64	64	64
A64	64	64	63	63	63	63
A65	63	63	63	63	63	63
A66	66	66	66	66	66	66
A70	63	63	62	62	62	62
A71	65	64	64	64	64	64
A73	75	69	66	66	66	66
A76	69	67	65	65	65	65

ASRs	Predicted 24-hour averaged Concentration ($\mu g\ m^{-3}$) *					
	1.5m AGL	**5m AGL**	**10m AGL**	**20m AGL**	**30m AGL**	**40m AGL**
A81	69	67	66	66	66	66
A91	64	65	67	67	67	67
A92	64	64	63	63	64	64
A93	67	66	66	66	66	66
A94	66	66	65	65	65	65
A95	64	64	64	64	64	64
A96	63	63	63	63	63	63
A97	63	63	63	63	63	63
A98	64	63	63	63	63	63
A99	67	67	65	65	65	65

Note: * Background concentrations are included.
24-hr NO_2 criteria (AQO): 150 $\mu g\ m^{-3}$

Table 3.24 Predicted Cumulative Maximum 24-hour Average RSP Concentrations at the Representative ASRs at Different Elevations

ASRs	Predicted 24-hour averaged Concentration (μg m^{-3}) *					
	1.5m AGL	5m AGL	10m AGL	20m AGL	30m AGL	40m AGL
A25	59	58	58	58	58	58
A26	57	57	57	57	57	57
A27	57	57	56	56	56	56
A28	57	57	57	57	57	57
A29	57	56	56	56	56	56
A30	57	57	57	57	57	57
A31	57	57	57	57	57	57
A32	57	57	57	57	57	57
A33	57	56	56	56	56	56
A34	56	56	56	56	56	56
A35	57	57	57	57	57	57
A36	59	58	58	58	58	58
A37	59	58	57	57	57	57
A38	59	59	58	58	58	58
A39	59	59	59	59	58	58
A40	62	62	61	61	61	60
A41	62	62	61	61	61	61
A42	63	63	61	61	61	61
A43	63	63	62	61	61	60
A44	69	66	63	62	61	59
A45	69	66	63	61	60	60
A46	68	66	62	61	60	60
A47	65	64	62	61	60	60
A48	62	61	60	60	60	59
A49	61	60	60	60	59	59
A50	71	70	69	64	60	57
A51	78	77	74	67	61	59
A52	69	69	67	63	60	59
A53	78	76	73	64	59	59
A54	59	59	58	58	58	58
A55	58	57	57	57	57	57
A56	58	57	56	56	56	56
A57	59	58	57	57	57	57
A58	59	58	57	57	57	57
A59	59	58	57	57	57	57

ASRs	Predicted 24-hour averaged Concentration (µg m^{-3}) *					
	1.5m AGL	5m AGL	10m AGL	20m AGL	30m AGL	40m AGL
A60	58	57	57	57	57	57
A61	58	58	57	57	57	57
A62	58	57	57	57	57	57
A63	57	57	57	57	57	57
A64	57	57	57	57	57	56
A65	57	57	57	56	56	56
A66	57	57	57	57	57	57
A70	56	56	56	56	56	56
A71	57	57	56	56	56	56
A73	60	58	57	57	57	57
A76	58	58	57	57	57	57
A81	58	58	57	57	57	57
A91	57	57	58	58	58	58
A92	56	56	56	56	56	56
A93	57	57	57	57	57	57
A94	57	57	57	57	57	57
A95	56	56	56	56	56	56
A96	56	56	56	56	56	56
A97	57	57	56	56	56	56
A98	57	57	56	56	56	56
A99	58	57	57	57	57	57

Note: * Background concentrations are included.
24-hr RSP criteria (AQO): 180 µg m^{-3}

3.7.8 Based on the above prediction, no exceedance of the 1-hour average NO_2, 24-hour average NO_2 and 24-hour average RSP AQOs would occur at any representative ASR in the Study Area. From the results, it is found that the maximum pollutant concentrations would occur at 1.5m above ground (the lowest assessment height). The predicted cumulative maximum hourly average NO_2, 24-hour average NO_2 and RSP concentration contours at 1.5m above local ground are shown in **Figures 3.18** to **3.20**. Exceedances of 1-hour average and 24-hour average NO_2 concentrations are noted at part of the building of the POC in the contour plots, however, the building of the POC is provided with central air conditioning and there is no fresh air intake at these areas, i.e. no air sensitive areas are located within the exceedance areas.

Vehicular Emission Impact (Inside the Tunnel/deckover)

3.7.9 For the air quality assessment inside the planned deckover on future HKCEC Atrium Link, the predicted maximum NO_2 concentrations under normal traffic flow and congested traffic flow would be 114 $\mu g/m^3$ and 130 $\mu g/m^3$ respectively, and would comply with the Tunnel Air Quality Objective (1800 $\mu g/m^3$). Detailed calculations and results are presented in **Appendix 3.12**. The in-tunnel air quality inside the proposed trunk road should be complied with the Tunnel Air Quality Objective with proper engineering design (as mentioned in section 3.6.62).

Odour Impact

3.7.10 Odour nuisance associated with the Causeway Bay Typhoon Shelter is an existing environmental problem. This Project will not create any new odour source during the operational phase. However, in order to improve the environment, this Project will take the opportunities to mitigate the potential sources of odour nuisance within the Project area so as to alleviate this existing environmental problem as well as to provide an acceptable environment for the future land uses within the project area.

3.7.11 In order to identify the existing odour emission sources and determine the extent and level of existing odour impacts, odour surveys including odour patrols and air sampling on existing odour source area were undertaken. The odour patrol was conducted in a limited number of days to identify the existing odour source locations. The patrol days were all sunny days in very hot season and the patrol period covered the low tide condition. It is believed that the existing odour source locations at CBTS have been identified. Besides, given that the odour surveys were carried out in a limited number of days, the measured odour concentrations are basically snapshot values. Yet, given that all the odour surveys were carried out during hot season and low tide conditions, the estimated odour emission rates are considered representing reasonable worst case conditions.

3.7.12 The odour contour plot for the study area under the existing scenario with worst case odour emission rates is presented in **Appendix 3.14**. The odour modelling results indicate that the existing odour levels in the vicinity of CBTS are far higher than the odour criterion of 5 ou/m^3 averaged over 5 seconds. This concurs with the findings of the 2006 and 2007 odour surveys that moderate to high odour intensity levels were sometimes observed at some locations in the vicinity of CBTS.

3.7.13 The odour concentrations predicted at the planned ASRs under WDII Project based on the worst case existing odour emission rates are summarized in **Table 3.25**. It is noted that the proposed planned air sensitive uses in Central, Wan Chai and Causeway Bay area would also exceed the odour criterion of 5 ou/m^3 averaged over 5 seconds under the worst case condition.

Table 3.25 Predicted Odour Concentrations at the Representative ASRs (Based on the Existing Odour Emission Rates) Under the Worst Case Condition

ASRs	Section	Location	Odour Concentration (ou/m^3 averaged over 5 seconds)
A76	Central	Open space at the west of HKCEC	4.9
A81	Wanchai	Waterfront related commercial and leisure uses	12.1
A100	Wanchai	Water Sports Centre	44.0
A101	Causeway Bay	Open space at Northern Breakwater	96.7

Note: There is 0.1% probability of exceeding the predicted odour concentration inherent in the calculation method.

3.7.14 It should be noted that the predicted odour impacts presented for the existing scenario are worst case predictions based on worst case odour emissions estimated from survey data recorded under very hot season and low tide conditions as well as worst case atmospheric dispersion conditions assumed in the odour model. The worst case predictions are not representing the general situation under the existing scenario. The chance for all these worst case conditions to occur concurrently is considered to be remote. The model predictions only represent the worst case condition at a limited period of time. Whereas the odour surveys were carried out at particular days with very hot season and low tide conditions, the findings of the odour survey are also specific to the conditions on those odour survey days. With reference to the observations of the odour surveys and above odour assessment results, practicable odour mitigation measures are formulated with an objective to alleviate the existing odour problem in the vicinity of CBTS. Details of the proposed odour mitigation measures are described in the next section.

3.8 Mitigation of Adverse Environmental Impacts

Construction Phase

3.8.1 As shown in **Tables 3.18** to **3.21** and explanation given in Section 3.7.4, the cumulative maximum 1-hour average and 24-hour average TSP concentrations are predicted to comply with the TSP criteria at all representative ASRs with watering on the active works area four times a day. The area within study area of WDII Project would also meet the TSP criteria. In order to further ensure compliance with the AQOs at the ASRs at all time, requirements of the Air Pollution Control (Construction Dust) Regulation shall be adhered to during the construction period. In addition, the following mitigation measures, good site practices and a comprehensive dust monitoring and audit programme are recommended to minimise cumulative dust impacts.

- Strictly limit the truck speed on site to below 10 km per hour and water spraying to keep the haul roads in wet condition;
- Watering during excavation and material handling;
- Provision of vehicle wheel and body washing facilities at the exit points of the site, combined with cleaning of public roads where necessary; and
- Tarpaulin covering of all dusty vehicle loads transported to, from and between site locations.

Operation Phase

Traffic Emission Impact

3.8.2 The predicted air quality impacts on the ASRs are within the Air Quality Objectives. Exceedances of AQO criteria were predicted at some areas in the vicinity of Cross Harbour Tunnel, however, there would be no air sensitive uses in these areas. No mitigation measures will be required during the operation phase.

Odour Impact

3.8.3 The Project itself would not introduce any additional odour emission sources within the study area. However, as indicated in the odour assessment presented in Section 3.7 above, odour nuisance associated with the Causeway Bay Typhoon Shelter is an existing environmental problem and adverse odour impacts in the vicinity of CBTS would be expected during worst case conditions. Without any further measures, the possible future status of the existing odour pollution sources are described as follows:

Polluted sewage from drainage outfall

3.8.4 The Drainage Services Department (DSD) has conducted the Causeway Bay Typhoon Shelter Expedient Connection Surveys during August 1997 and January 1999. According to the "Final Report of the Causeway Bay Typhoon Shelter Expedient Connection Surveys" under Agreement No. CE 78/94 Wan Chai East and North Point Sewerage issued in October 2000, DSD was responsible to rectify 6 number of expedient connection in Causeway Bay area. Five of the 6 expedient connections had been blocked / rectified. The remaining one is scheduled to be completed in early 2008. Except these 6 expedient connections, the report also identified a list of buildings where polluted flows into stormwater system which would require the Building Department to follow up or improper discharges causing pollution to stormwater system which would involve EPD's pollution control. It is expected that most of the expedient connections to storm water outfall would be rectified in future, the odour generated from sewage discharged from outfall would be reduced comparing with the existing scenario.

Floating debris discharged from the boats

3.8.5 As advised by the Marine Department, it is a routine exercise that they collect the floating refuse at CBTS every day. In view of no significant increase in the number of boats mooring at CBTS during operation year of the Project, it is expected that any odour impact that may be generated from floating refuse in future would be similar to the existing condition.

Slime attached on the shoreline seawall and sediment at CBTS

3.8.6 The shoreline of CBTS would not be changed under the Project, therefore, dredging activities would be focused on the proposed Trunk Road area. As most of the expedient connections within the study area are expected to be rectified in future with follow up action by DSD, EPD, FEHD and BD as proposed in the "Final Report of the Causeway Bay Typhoon Shelter Expedient Connection Surveys", the flow of raw sewage discharged from the outfall would be significantly decreased. Less odour emission generated from the sediment and the slime in future would be expected.

3.8.7 In addition to the rectification works on expedient connections and the regular floating refuse collection described above, the Project Proponent would like to take the opportunity to mitigate the existing sources of odour nuisance within the Project area by implementing an enhancement proposal. The objective of the enhancement proposal is to alleviate the existing odour problem as well as to provide an acceptable environment for the future land uses within the project area.

3.8.8 Details of the enhancement proposal shall refer to the separate paper on "Enhancement Package for Existing Odour Sources Identified at Causeway Bay Typhoon Shelter" (see **Appendix 15.1**). Dredging would be conducted at the corner of CBTS to remove the sediment (see **Figure 3.21**) and the slime attached on the shoreline seawall would be cleaned during implementation of harbour-front enhancement. Dredging inside the CBTS for the construction of the Trunk Road as shown in **Figure 3.21** will also improve the existing odour conditions at CBTS.

3.8.9 With the concerted efforts from various government departments, including DSD, EPD, FEHD, BD, MD, HyD and CEDD, on the implementation of the above enhancement package, the existing accumulated sediments and slimes on the seawall would be removed, the expedient connections would be rectified, the floating refuse would be removed by the regular harbour cleansing service, illegal discharge and dumping into the CBTS and misconnection of drainage system would be controlled by enforcement of relevant ordinance with patrol, the potential odour sources would be substantially reduced and the future situation would be improved as compared to the existing condition. Taking into account the potential effect of the above measures in reducing odour nuisance, including complete removal of the major generator of odour namely the sediment at the corner of CBTS by dredging and the dredging inside the CBTS for the construction of the Trunk Road, the future mitigated odour emission strength of the identified odour sources is estimated to be reduced by 70%. This odour reduction efficiency is considered to be reasonable and conservative.

3.8.10 The odour contour plot for the study area under the future scenario with 70% reduction in odour emissions is presented in **Appendix 3.14**. The odour modelling results indicate that with the implementation of the proposed enhancement package, the predicted odour levels in the vicinity of CBTS would be reduced significantly by about 70% in general. In other words, this Project will alleviate the existing odour problems in the vicinity of CBTS to a large extent by implementing the proposed enhancement measures.

3.8.11 With regards to the planned ASRs under WDII Project, the modelling results also showed marked reduction in the predicted odour levels after the implementation of the proposed enhancement measures. The modelling results under the future mitigated scenario are shown in **Table 3.26**.

Table 3.26 Predicted Odour Concentrations at the Representative ASRs (Mitigated Scenario) under the Worst Case Condition

ASRs	Section	Location	Odour Concentration (ou/m^3 over 5 second average)
A76	Central	Open space at the west of HKCEC	1.5
A81	Wanchai	Waterfront related commercial and leisure uses	3.6
A100	Wanchai	Water Sports Centre	13.2
A101	Causeway Bay	Open space at Northern Breakwater	29.0

Note: There is 0.1% probability of exceeding the predicted odour concentration inherent in the calculation method.

3.8.12 As shown in **Table 3.26** with the implementation of the proposed enhancement measures, exceedances of the odour criterion are still predicted at two planned ASRs A100 and A101 under the worst case condition. It is noted that odour exceedance predicted at the waterfront in CBTS, however, the residual odour impact is considered as of transient nature for the visitors along the waterfront in CBTS.

3.8.13 In order to investigate the frequency of exceedance of the odour criterion at the two planned ASRs, odour modelling was conducted for every hour of a year based on year 2005 meteorological data. The modelling results indicated that out of 8760 hours in a year, only 1 hour (or 0.01% of time) and 9 hours (or 0.1% of time) with exceedances of the odour criterion are predicted at ASR A100 and A101 respectively. However, as discussed above in Section 3.6.96, the peak-to-mean ratios stated in the NSW Approved Method employed in this odour assessment has assumed a 0.1% exceedance level. Therefore, there is a 0.1% probability that the actual peak concentration would be higher than those derived with the peak-to-mean ratios stated in the NSW Approved Method. Conservatively, if we assume all of this 0.1% actual peak concentration (which are higher than the predicted peak concentration) exceeded the odour criterion, then there would be 0.1% more of time exceedance in year at the two planned ASRs. For the other ASRs, there is also a 0.1% probability that the actual odour levels as perceived at the ASRs would exceed the predicted odour concentration. A summary of the predicted frequency of exceedance, including the additional 0.1% due to intrinsic uncertainty of the modelling approach, at the two planned ASRs are shown in **Table 3.27**.

Table 3.27 Number of Hour Exceeding the Odour Criterion at the Representative ASRs (Mitigated Scenario) in a Year

ASRs ID	A100	A101
% of time exceedance in a year	0.11%	0.2%

3.9 Evaluation of Residual Impacts

Construction Phase

3.9.1 With the implementation of the proposed mitigation measures and the dust suppression measures stipulated in *Air Pollution Control (Construction Dust) Regulation* during the construction phase, no adverse residual air quality impact would be expected.

Operational Phase

3.9.2 No adverse residual traffic emission impact was predicted.

3.9.3 The odour modelling results indicate that with the implementation of the proposed enhancement package, the predicted odour levels in the vicinity of CBTS would be reduced significantly by about 70% in general. In other words, this Project will alleviate the existing odour problems in the vicinity of CBTS to a large extent by implementing the proposed enhancement measures. However, exceedances of the odour criterion are still predicted at two planned ASRs A100 and A101 under the worst case condition. The following points should be noted with reference to EIAO-TM Clause 4.4.3 with regards to the residual odour impacts at these planned ASRs:

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

In this assessment, the odour emission rates obtained from the survey in Year 2007 were under worst case conditions with the sampling exercise carried out at noon with very low tide (below 0.5mPD) and extremely high ambient temperature (around 33 degrees Celsius). The predicted maximum odour concentrations at the planned ASR (CBTS breakwater), which is the nearest to the existing odour sources, would be about 29 ou/m^3 over 5 second average. If we assume the dominant odorant is H_2S, 29 ou/m^3 is equivalent to H_2S concentration of about 0.0145 ppm. In terms of human health effects of hydrogen sulphide[4] exposure of 0 – 10 ppm would cause irritation of the eyes and nose; while exposure of 10 – 50 ppm would cause headache. Therefore, it is expected that no adverse health impact to human for exposure under such a low concentration of H_2S.

(ii) *The magnitude of adverse environmental impacts*

Based on the modelling results, the predicted worst odour concentration at representative planned ASRs are:

Representative ASRs ID	A76	A81	A100	A101
Worst Odour Conc. (ou/m^3 over 5-second averaged)	1.5	3.6	13.2	29.0

Note: There is 0.1% probability of exceeding the predicted odour concentration inherent in the calculation method.

(iii) *The geographic extent of the adverse environmental impacts*

The extent of exceedance of odour criterion indicated in **Figure A3.14-3** of Appendix 3.14.

(iv) *The duration and frequency of the adverse environmental impacts*

The exceedance of odour criterion would occur:

ASRs ID	A100	A101
Total no. of hour exceeding the criterion in a year	1	9
% of time exceedance in a year	0.01%	0.1%
% of time exceedance in a year (taking into account of 0.1% probability of exceeding the predicted odour concentration inherent in the calculation method)	0.11%	0.2%

(v) *The likely size of community or the environment that may be affected by the adverse impacts*

As indicated in **Figure A3.14-2** and **A3.14-3** of Appendix 3.14, with the implementation of proposed enhancement package, the odour concentrations in Central, Wan Chai and Causeway Bay area would be reduced substantially as compared with the existing scenario, however, exceedance of the odour criterion of 5 ou/m^3 over 5 second average would still be predicted in part area of Wan Chai and Causeway Bay (about 60,000 residents) under the worst case condition. Adverse odour impact (i.e. exceeding the EIAO-TM odour criterion) at the planned ASRs would only occur for less than 0.2% of time in a year (taking into account of 0.1% probability of exceeding the predicted odour concentration inherent in the calculation method).

[4] Hydrogen Sulfide Safety Factsheet, August 2004 (www.safetydirectory.com/hazardous_substances/hydrogen_sulfide/fact_sheet.htm)

(vi) The degree to which adverse environmental impacts are reversible or irreversible.

Under the future scenario, odour nuisance would be a very short-tem impact for two planned ASRs (ASR A100 and A101) based on the assumption of 70% odour reduction efficiency for the proposed enhancement measures. It is very likely that the proposed enhancement measures would result in higher odour reduction efficiency and the odour impact at the two planned ASRs would be further minimized.

(vii) The ecological context

The exceedance would not involve any ecological context.

(viii) The degree of disruption to sites of cultural heritage

The exceedance would not involve any cultural heritage context.

(ix) International and regional importance

The exceedance would not involve any international and regional importance.

(x) Both the likelihood and degree of uncertainty of adverse environmental impacts

The modelling results indicated that out of 8760 hours in a year, only 1 hour (or 0.01% of time) and 9 hours (or 0.1% of time) with exceedances of the odour criterion are predicted at ASR A100 and A101 respectively. However, as discussed above in Section 3.6.96, the peak-to-mean ratios stated in the NSW Approved Method employed in this odour assessment has assumed a 0.1% exceedance level. Therefore, there is a 0.1% probability that the actual peak concentration would be higher than those derived with the peak-to-mean ratios stated in the NSW Approved Method. Conservatively, if we assume all of this 0.1% actual peak concentration (which are higher than the predicted peak concentration) exceeded the odour criterion, then there would be 0.1% more of time exceedance in year at the two planned ASRs. For the other ASRs, there is also a 0.1% probability that the actual odour levels as perceived at the ASRs would exceed the predicted odour concentration.

The degree of uncertainty of the predicted odour impacts depends on the accuracy of the estimated odour emission rates and the air dispersion modelling. The number of air samples collected as well as the intrinsic limitations of the air sampling technique and the olfactometry analysis would also affect the accuracy of odour emission rate estimation.

The odour patrol was conducted over a limited number of days to identify the potential odour source locations, however, the patrol days were all sunny days in very hot season and the patrol period covered the low tide condition. It is believed that the potential odour source locations at CBTS have been identified. Besides, given that the odour surveys were carried out in a limited number of days at worst-case weather and tidal conditions, the measured odour concentrations are basically worst-case snapshot values. Given the above, the estimated odour emission rates are considered to represent reasonable worst case conditions.

Air sampling is an important step in the process of measuring the odour concentrations of the sources, as is the quality and reliability of the results. All the odour sampling was carried out by the odour sampling team of HKPU which has the most extensive local experience in odour sampling. The potential error associated with odour sampling process is considered to be on the low side.

It should be noted that all the odour concentrations (in ou/m^3) and hence area source emission rates (in $ou/m^2/s$) were measured by olfactometry analysis carried out at the Odour Research Laboratory of HKPU in accordance with the European Standard Method (EN13725). This European Standard Method specifies a method for the objective determination of the odour concentration of a gaseous sample using dynamic olfactometry with human assessors. The detection limit for this European Standard Method is 10 ou/m^3. Yet the detection limit of this European Standard Method could vary between laboratories. Therefore, in reviewing the odour concentration results (in ou/m^3), it should be noted that a measured low odour concentration value would normally has a higher degree of error due to the inherent properties of the olfactometry analysis method.

3.9.4 Referring to the points discussed in Section 3.9.3 above, no adverse health or risk impact is expected at the planned ASRs under WDII Project (i.e. proposed open space at Northern Breakwater and proposed Wan Chai Water Sport Centre) though its odour levels exceed the EIAO-TM criteria in accordance with the air modelling results (13 - 29 ou/m^3 over 5 second average) under the worst case condition. The time of exceedance of the odour criterion at these two planned ASRs is expected to be less than 0.2% of time in a year. Therefore, the residual odour impact at the planned ASRs is not persistent. It is supported by the odour patrol results that no odour nuisance detected at the ex-PCWA and Northern Breakwater (i.e. the locations of proposed open space at Northern Breakwater and proposed land uses at Wan Chai North new waterfront) during odour patrols conducted in Year 2006 and Year 2007 Odour Survey. Hence, no unacceptable odour impact is expected at the future WDII ASRs.

3.10 Environmental Monitoring and Audit

Construction Phase

3.10.1 With the implementation of the proposed dust suppression measures, good site practices and dust monitoring and audit programme, acceptable dust impact would be expected at the ASRs. Details of the monitoring requirements such as monitoring locations, frequency of baseline and impact monitoring are presented in the stand-alone EM&A Manual.

Operational Phase

3.10.2 Since the predicted air quality due to traffic emission in the study area complies with the AQO, no environmental monitoring and audit is proposed. Nevertheless, the operator for the proposed CWB tunnel, HyD, will conduct air quality monitoring for the operation performance of the EVB and associated East Vent Shaft. Regarding the odour issue, monthly (from July to September) monitoring of odour impacts, for a period of 5 years, is proposed during the operational phase of the Project to ascertain the effectiveness of the Enhancement Package over time, and to monitor any on-going odour impacts at the ASRs. If residual odour impact is still found at the end of the odour monitoring programme, further investigation would be carried out to review the odour problem and to identify the parties responsible for further remedial action.

3.11 Conclusion

Construction Phase

3.11.1 During construction, reclamation, filling and surcharging were identified as the major dust sources. Trunk Road tunnel works would also generate dust. Due to the complex sequencing of the construction activities, six worst case scenarios of the construction schedules have been identified and assessed. The findings of the construction phase air quality assessment indicate that no exceedance of the 1-hour and 24-hour total TSP criteria are predicted at ASRs in the vicinity of the construction sites. In order to ensure compliance with the TSP criteria at the ASRs at all times, the dust suppression measures and requirements of the *Air Pollution Control (Construction Dust) Regulation* should be adhered to during the construction period. In addition, a comprehensive dust monitoring and audit programme are recommended to ensure the effective implementation of dust suppression measures.

Operational Phase

3.11.2 The cumulative effect arising from the background pollutant levels within and adjacent to the WDII, vehicle emissions from open road networks, tunnel portal and ventilation building emissions from the Trunk Road, tunnel portal emissions from the CHT and portal emissions from existing underpasses and planned deckovers have been assessed. Results show that the predicted air quality at the ASRs would comply with the AQO criteria. No mitigation measures are required. The air quality inside the tunnel section of Trunk Road and planned deckovers at the HKCEC Atrium Link, Road P2 and Expo Drive would also comply with EPD in-tunnel air quality standards.

3.11.3 With the Trunk Road tunnel ventilation system designed for zero portal emission at the eastern portal, at North Point, potential air quality impacts from the tunnel portal emission would be avoided. In addition, the air quality at the eastern portal area would be enhanced by locating the vent shaft at the end of the eastern breakwater of the CBTS and by the introduction of an electrostatic precipitator system at the East Ventilation Building to screen RSPs from the tunnel emissions.

3.11.4 During operational phase, this Project will not create any new odour source. However, odour nuisance associated with the CBTS is an existing environmental problem. In order to improve the environment, this Project will take the opportunity to mitigate the potential sources of odour nuisance within the Project area so as to alleviate this existing environmental problem, as well as to provide an acceptable environment for the future land uses within the project area. Enhancement measures have been formulated to alleviate this existing odour problem. These include rectification of expedient connections, regular collection of floating debris, dredging to remove the polluted and odorous sediments at the corner of CBTS and clean up the slime attached on CBTS seawall. With the implementation of these enhancement measures, the predicted odour levels in the vicinity of CBTS would be reduced significantly. In other words, this Project will alleviate the existing odour problems in the vicinity of CBTS to a large extent by implementing the proposed enhancement measures. However, some exceedances of the odour criterion are still predicted at two planned ASRs A100 and A101 under the worst case condition. Nevertheless, the residual odour impact at these planned ASRs is not persistent, with a time of exceedance of the odour criterion expected to be less than 0.2% of time in a year. In view of this infrequent likelihood of occurrence, no unacceptable adverse odour impact would be expected at the planned ASRs within the study area.

3.11.5 Monthly monitoring (from July to September) of odour impacts, for a period of 5 years, is proposed during the operational phase of the Project to ascertain the effectiveness of the Enhancement Package over time, and to monitor any on-going odour impacts at the ASRs. If residual odour impact is still found at the end of the odour monitoring programme, further investigation would be carried out to review the odour problem and to identify the parties responsible for further remedial action.