4 AIR QUALITY IMPACT

4.1 Introduction

This section presents the assessment findings of the potential air quality impacts on air sensitive uses arising from the construction and operation of the proposed CKR. Mitigation measures for construction activities have been recommended and potential environmental impacts associated with construction dust would be controlled to acceptable levels. Assessment results have concluded that the predicted cumulative air quality impacts on all sensitive receivers would comply with the Air Quality Objectives during the operational phase of the Project.

4.2 Legislation and Standards

The air quality impact assessment criteria shall make reference to the Hong Kong Planning Standards and Guidelines (HKPSG), the Air Pollution Control Ordinance (APCO) (Cap.311), and Annex 4 of the Technical Memorandum on Environmental Impact Assessment Process (TM-EIAO).

The APCO (Cap.311) provides the power for controlling air pollutants from a variety of stationary and mobile sources and encompasses a number of Air Quality Objectives (AQOs). In addition to the APCO, the following overall policy objectives are laid down in Chapter 9 of the Hong Kong Planning Standards and Guidelines (HKPSG):

- Limit the contamination of the air in Hong Kong, through land use planning and through the enforcement of the APCO to safeguard the health and well-being of the community; and
- Ensure that the AQO for 7 common air pollutants are met as soon as possible.

Currently, the AQOs stipulate limits on concentrations for 7 pollutants including sulphur dioxide (SO_2), Total Suspended Particulates (TSP), Respirable Suspended Particulates (RSP), Nitrogen Dioxide (NO_2), Carbon Monoxide (CO), photochemical oxidants, and Lead (Pb). The AQOs are listed in the table below.

Table 4.1: Hong Kong Air Quality Objectives (HKAQO)

Pollutant	**Limits on Concentration, µg/m^3 [1] (ppm in brackets)**				
	1-hr [2]	**8-hr [3]**	**24-hr [3]**	**3-Month [4]**	**Annual [4]**
Sulphur Dioxide	800 (0.3)		350 (0.13)		80 (0.03)
Total Suspended Particulates	500 [7]		260		80
Respirable Suspended Particulates [5]			180		55
Carbon Monoxide	30,000 (26.2)	10,000 (8.7)			
Nitrogen Dioxide	300 (0.16)		150 (0.08)		80 (0.04)
Photochemical Oxidants (as ozone) [6]	240				

Pollutant	Limits on Concentration, µg/m³ [1] (ppm in brackets)				
	1-hr [2]	8-hr [3]	24-hr [3]	3-Month [4]	Annual [4]
Lead				1.5	

Notes:
[1] Measured at 298K 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] Respirable suspended particulates means suspended particulates in air with a nominal aerodynamic diameter of 10 micrometres or smaller.
[6] Photochemical oxidants are determined by measurement of ozone only.
[7] Not an AQO but is a criterion for evaluating air quality impacts as stated in Annex 4 of TM-EIAO.

The Air Pollution Control (Construction Dust) Regulation specifies processes that require special dust control. The Contractors are required to inform the EPD and adopt proper dust suppression measures while carrying out "Notifiable Works" (which requires prior notification by the regulation) and "Regulatory Works" to meet the requirements as defined under the regulation.

The Practice Note on Control of Air Pollution in Vehicle Tunnel published by EPD provides guidelines on control of air pollution in vehicle tunnel. Guideline values on tunnel air quality are shown in the following table.

Table 4.2: Tunnel Air Quality Guidelines

Pollutant	Average Time	Maximum Concentration	
		µg/m³ [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

Notes:
[1] Measured at 298K and 101.325 kPa.

4.3 Construction Dust Assessment

4.3.1 Study Area

As discussed in **Section 3**, construction activities associated with the CKR will be mainly undertaken underground. However, at-grade construction works are still required near both tunnel portals (i.e. West and East Portions), and central access/ventilation shaft in Ho Man Tin, and also a barging facility near Tsing Yi. As such, the construction dust assessment for the Project is separated into 4 areas, namely the West Portion, Central Portion, East Portion, and Barging Point. With reference to the EIA Study Brief for this Project (ESB-156/2006), the study area for air quality impact assessment should generally be defined by a distance of 500m from the boundary of the Project. **Figures 4.1.1 – 4.1.4** illustrate the extent of the study area for construction dust assessment in West Portion, Central Portion, East Portion, and Barging Point, respectively.

4.3.2 Ambient Air Quality Condition

Total suspended particulate (TSP) is of key concern during the construction phase. Historical TSP monitoring data from the Air Quality Monitoring Station (AQMS) in Sham Shui Po, Kwun Tong, and Tsuen Wan operated by EPD have been examined. The latest 5 published years of air quality monitoring data, i.e. 2007 to 2011 are tabulated in the table below. The 5-year annual average is adopted as representative background air quality concentration.

Table 4.3: TSP Monitoring Data at Sham Shui Po, Kwun Tong and Tsuen Wan AQMSs (2007-2011)

AQMS	Annual TSP Concentration (μg/m^3)					
	2007	2008	2009	2010	2011	5-year Mean
Sham Shui Po	79	**81**	77	76	79	78.4 (98%)
Kwun Tong	**82**	72	70	67	74	73.0 (91%)
Tsuen Wan	79	67	63	63	69	68.2 (85%)

Notes:
% of AQO is provided in the bracket.
Monitoring results exceeded AQO are shown as bolded characters.

It is observed from the above table that there were no obvious trends of TSP concentrations in Sham Shui Po, Kwun Tong and Tsuen Wan. The lowest annual TSP concentrations in these three AQMSs were recorded in 2010.

In consideration of their individual geographical locations, the 5-year annual TSP averages recorded at Sham Shui Po and Kwun Tong AQMS are adopted as the background TSP concentrations for the West Portion (i.e. 78.4 μg/m^3) and East Portion (i.e. 73.0 μg/m^3) respectively. For the Central Portion, the average from Sham Shui Po and Kwun Tong AQMS is adopted (i.e. 75.7μg/m^3). The 5-year annual TSP concentration recorded in Tsuen Wan (i.e. 68.2 μg/m^3) is adopted as the background concentration for the Barging Point.

4.3.3 Air Sensitive Receivers

In accordance with Annex 12 of the TM-EIAO, Air Sensitive Receivers (ASRs) include domestic premises, hotel, hostel, hospital, clinic, nursery, temporary housing accommodation, school, educational institution, office, factory, shop, shopping centre, place of public worship, library, court of law, sports stadium or performing arts centre. Any other premises or places with which, in terms of duration or number of people affected, has a similar sensitivity to the air pollutants as the aforelisted premises and places are also considered as a sensitive receiver.

Representative ASRs within a distance of 500m from the works limit and temporary at-grade work areas have been identified. These ASRs include both the existing and planned developments. Existing ASRs are identified by means of reviewing topographic maps, aerial photos, land status plans, supplemented by site inspections. They mainly include developed residential buildings with different storey height, educational institution and hotels etc.

Planned/committed ASRs are identified by making reference to relevant Outline Zoning Plans (OZP), Outline Development Plans, Layout Plans and other published plans in the vicinity of the alignment, including:

- South West Kowloon (KPA 20) Outline Zoning Plan (No. S/K20/27);
- Tsim Sha Tsui (KPA 1) Outline Zoning Plan (No. S/K1/26);
- Yau Ma Tei (KPA 2) Outline Zoning Plan (No. S/K2/21);
- Ho Man Tin (KPA 6 & 7) Outline Zoning Plan (No. S/K7/22);
- Hung Hom (KPA 9) Outline Zoning Plan (No. S/K9/24);
- Ma Tau Kok (KPA 10) Outline Zoning Plan (No. S/K10/20);
- Kai Tak (KPA 22) Outline Zoning Plan (No. S/K22/4); and
- Ngau Tau Kok & Kowloon Bay (KPA 13 & 17) Outline Zoning Plan (No. S/K13/27)

For other planned landuses, the relevant stakeholders have been approached to obtain latest planning information such as layout and building height.

The locations of the worst representative ASRs for construction dust assessment are illustrated in **Figures 4.1.1 – 4.1.4**, and are summarised in the table below.

Table 4.4: Representative ASRs for Construction Dust Assessment

ASR ID	Location	Landuse [1]	No. of Storey	Approx. separation distance from works limit (m)
West Portion				
W-A1	Yau Ma Tei Catholic Primary School (Hoi Wang Road)	E	8	80
W-A2	Charming Garden Block 12	R	23	80
W-A3	Yau Ma Tei Catholic Primary School (Tung Kun Street)	E	7	<10
W-A4	Prosperous Garden Block 1	R	28	<10
W-A5	The Coronation	R	30	<10
W-A6	Man Cheong Building	R	18	50
W-A7	Kum Lam Building	R	12	<10
W-A8	Dickson Building	R	18	<10
W-A9	Yau Ma Tei Jockey Club Polyclinic	H	10	<10
W-A10	Alhambra Building	R	15	<10
W-A11	Hong Kong Community College (HKCC) of PolyU	E	19	<10
W-A12	Civil Aid Service Headquarter	GIC	6	20
W-A13	Park Avenue Tower 10	R	35	170
W-A14	Charming Garden Block 1	R	22	70

ASR ID	Location	Landuse [1]	No. of Storey	Approx. separation distance from works limit (m)
W-A15	HKMA David Li Kwok Po College	E	8	120
W-P1	Reprovisioned Yau Ma Tei Police Station (Planned)	GIC	4	<10
W-P5	Hong Kong Red Cross Headquarters (Planned)	GIC	-	<10
W-P6	Refuse Collection Point and street Sleepers' Shelters (Planned)	GIC	4	<10
Central Portion				
M-A1	Kar Man House, Oi Man Estate	R	6	<10
M-A2	Carmel on the Hill	R	25	50
M-A3	SKH Tsoi Kung Po Secondary School	E	8	10
M-A4	Man Fuk House Block A	R	15	110
M-A5	Cascades Block A	R	18	110
M-A6	Ko Fai House, Kwun Fai Court	R	9	20
M-A7	The Open University of Hong Kong	E	12	130
M-A8	Kwun Hei Court	R	41	40
M-A9	Housing Authority Headquarters Block 1	GIC	11	<10
M-A10	Ho Man Tin Government Offices	GIC	14	60
M-A11	Choi Man House, Ho Man Tin Estate	R	42	20
M-A12	King Man House, Ho Man Tin Estate	R	15	210
M-A13	Ho Man Tin Swimming Pool	P	-	10
M-A14	Yee Man house	R	41	<10
M-A15	Ho Min Tin Estate Service Reservoir Playground	P	-	50
M-A16	Ko Shan Road Park	P	-	80
M-A17	Kiu Wai Mansion	R	20	370
M-A18	Sun Man House	R	24	<10
M-A19	Ellery Terrance	R	34	290
M-A20	Dragon View (Block 1)	R	20	250
M-P2	Planned Residential Area B (Planned)	R	-	<10
East Portion				
E-A1	Hong Kong International Trade and Exhibition Centre	GIC	32	40
E-A2	EMSD Headquarters	GIC	22	10
E-A4	Billion Centre	OU	45	80
E-A5	Kai Fuk Industrial Centre	I	9	130

ASR ID	Location	Landuse [1]	No. of Storey	Approx. separation distance from works limit (m)
E-A6	Grand Watefront	R	51	<10
E-A7	Chong Chien Court	R	13	<10
E-A8	Wei Chien Court	R	13	<10
E-A9	Sino Industrial Plaza	I	8	<10
E-A10	HSBC Main Treasury	C	3	30
E-A11	Holy Carpenter Primary School	E	6	<10
E-A12	United Daily News Centre	C	15	<10
E-A13	Merit Industrial Centre	C	11	<10
E-A14	Wyler Gardens	R	13	<10
E-P1 [2]	Site 1B4 – School (Planned)	E	10	240
E-P2 [2]	Site 1I3 – Residential (Planned)	R	32	90
E-P3 [2]	Site 1J1 (Planned)	GIC	16	170
E-P4 [2]	Site 1J3 (Planned)	GIC	8	20
Barging Point				
TY-A1	Grand Horizon Block 6	R	36	390
TY-A2	Tai Sang Container and Godown Centre	I	15	360
TY-A3	Tsing Yi Industrial Centre Phase 1	I	15	380
TY-A4	The Hong Kong Jockey Club International BMX Park	P	1	300

Notes:

[1] R– residential; E – educational; I – Industrial; H – clinic/ home for the aged/hospital; C – commercial; W – worship; GIC – government, institution and community; P – Recreational/Park; OU – Other specified uses (Business)

[2] Based on the best available information including the implementation plan given in the Legco Paper [CB(1)570/08-09(03)], information from CEDD etc., the planned ASRs (E-P1, E-P2, E-P3 and E-P4) within the ex-Kai Tak airport area may be concurrent of CKR although the implementation programme is still yet to be finalised. Hence, these ASRs are included in the construction dust assessment for a conservative assessment.

4.3.4 Identification of Pollution Sources and Representative Pollutants

A review on the construction methodology for various works areas along CKR alignment has been conducted. In general, construction dust as the representative pollutants, will be potentially generated mainly from the land-based at-grade construction works including the following activities. According to HKAQO, the 1-hr, 24-hr and annual concentration would need to be considered. According to Section 13.2.4.3 of USEPA AP-42, most of the particles in fugitive dust have an aerodynamic diameter of <30 μm. Hence, it is appropriate to adopt Total Suspended Particulates (TSP) (with aerodynamic diameter ≦ 30 μm) as the representative pollutant for construction phase. According to EPD's Air Quality Report 2011, the major sources for Respirable Suspended Particulates (RSP) include power generation, road transport, etc. Non-combustion sources only constitute about 14%. Since construction dust is only one of the sources from non-combustion sources. It is unlikely that RSP is a representative pollutant for construction dust.

- Site clearance;
- Soil excavation;
- Backfilling;
- Construction of portals and cut-&-cover tunnel;
- Temporary storage, handling and transportation of material at tunnel exit sites;
- Barging facilities;
- Demolition of existing buildings; and
- Wind erosion of open sites.

Since excavation and backfilling activities near both ends of the CKR tunnel will involve large quantities of earthworks and silty material handling, it is anticipated that there may be dust impact as a result of these activities if mitigation measures are not implemented. For the tunnel construction, since all the construction activities, except the cut-&-cover section, will be undertaken totally underground, dust generated will be confined within the tunnel and no associated dust impact is therefore anticipated.

Construction works in the Central Portion will mainly involve construction of the vertical access shaft for loading of explosives for blasting and the mucking out location for excavated materials. Dust impact is therefore anticipated.

The current construction methodology has proposed the barging facilities near Tsing Yi. Dust emissions due to loading / unloading activities and truck movement are therefore anticipated.

Appendix 4.1 illustrates the at-grade works area for the construction of CKR. Dust emissions from concurrent projects and existing sources would also have potential dust impact on ASRs and the cumulative impacts have been assessed.

4.3.5 Concurrent Projects

The tentative commencement year for the construction of CKR is 2015, and would take approximately 5-6 years for completion. All potential concurrent projects, which may have cumulative environmental impacts during the construction phase of CKR, have been identified and they are summarised in the table below. **Figure 1.4** illustrates the locations of these concurrent projects. The implementation programmes of these concurrent projects are provided by the respective project proponents. Where information is not available, they have been made reference to the best available information such as EIA reports and then confirmed by the respective project proponents for the purpose of this EIA.

Table 4.5: Key Concurrent Projects for Construction Dust Assessment

Key Concurrent Projects	Tentative Construction Programme
Shatin to Central Link – Tai Wai to Hung Hom Section [1]	2012-2018
Kwun Tong Line Extension [2]	2011-2015
Trunk Road T2	2014/2015- end 2020

Key Concurrent Projects	Tentative Construction Programme
Kai Tak Development	2009- beyond 2020
Kai Tak Development – Roads D3A & D4A	2014-2017
Express Rail Link – West Kowloon Terminus [3]	2010-2015
Road Works at West Kowloon	2011-2014
Proposed Road Improvement Works in West Kowloon Reclamation Development Phase I	2014-2015

Notes:
[1] Major civil works will be completed in 2016
[2] Major civil works will be completed in 2014
[3] Construction works in West Kowloon area will be completed in 2014.

Liaisons with each of the project proponents of the above concurrent projects have been made in order to obtain the latest available information and details. All the overlapping construction works within 500m from the project boundary of CKR are included for cumulative dust impact assessment. Where appropriate, references are also made to the approved EIA reports to obtain the details of dust sources. The following briefly describes each concurrent project:

i) Shatin to Central Link – Tai Wai to Hung Hom Section (SCL (TAW-HUH))

SCL (TAW-HUH) is an approximately 11km long extension of the Ma On Shan Line (MOL) from Tai Wai through new stations, including Hin Keng Station (HIK), Diamond Hill Station (DIH), Kai Tak Station (KAT), To Kwa Wan Station (TKW), Ma Tau Wai Station (MTW), Ho Man Tin Station (HOM) and connects the West Rail Line at Hung Hom Station (HUH). Most of the sections would be underground except for a section at Hin Keng, and another section at Hung Hom, where the alignments need to be raised and linked with the Ma On Shan Line and the West Rail Line respectively to form a strategic East-West rail corridor.

SCL (TAW-HUH) has commenced its construction in 2012 and is targeted for completion in 2018, while the major civil construction works will be completed by 2016. It will therefore be constructed concurrently with the proposed CKR from 2015 to 2016. Cumulative dust impact is therefore anticipated. All the construction works within 500m from the CKR project boundary during this period, including site clearance, ground excavation, cut-&-cover tunnel section etc., presented in the EIA report for SCL (TAW-HUH) are included in this assessment.

ii) Kwun Tong Line Extension (KTE) & associated Essential Public Infrastructure Works (EPIW)

The KTE is an approximately 2.6km extension of the existing Kwun Tong Line from Yau Ma Tei Station to a new railway station at Whampoa and an interchange with SCL (TAW-HUH) at Ho Man Tin Station. The KTE includes the construction of the running line, the proposed Ho Man Tin Station, Whampoa Station and their associated structures.

The construction works of KTE has commenced in mid-2011 and is scheduled for completion in 2015 according to the approved EIA Study “Kwun Tong Line Extension” (AEIAR-154/2010). In particular, all the major civil works would be completed by 2014 and only some minor reinstatement works would be carried out within the first quarter of 2015. Hence, cumulative construction dust impact from KTE and associated EPIW is not anticipated.

iii) Trunk Road T2

Trunk Road T2 is a dual two-lane trunk road of approximately 3.6 km long connecting the CKR and Tseung Kwan O-Lam Tin Tunnel to form a new strategic highway network in order to relieve the existing heavily trafficked road network in the Central and Eastern Kowloon as well as Tseung Kwan O.

According to the latest implementation programme, the construction of Trunk Road T2 would likely commence in end 2015 and be completed by end 2020, which would interface with the construction of CKR. As such, cumulative dust impact during construction is anticipated.

iv) Kai Tak Development

Redevelopment plan for the former Kai Tak Airport area is proposed to optimise the development potential of the ex-airport site. It covers a land area of about 328 hectares, including the ex-Kai Tak Airport and existing waterfront area at To Kwa Wan, Kowloon Bay etc. According to the current development plan, the infrastructure works are split into 7 sub-packages, such as Cruise Terminal Development, Trunk Road T2 etc. The developments are anticipated to commence in 2009 for completion beyond 2020.

Based on the construction programme presented in LegCo Papers on Kai Tak Development (LC Paper No. CB(1)570/08-09(03)), cumulative dust impact is expected during the interaction with major dusty construction works associated with the proposed CKR, which will be undertaken in Year 2015. For the purpose of cumulative impact assessment, construction works which are located within 500m from the site boundary of CKR with major overlapping construction in Year 2015 are included. Dust emission strengths presented in the approved EIA Study "Kai Tak Development" (KTD) (AEIAR-130/2009) are adopted where appropriate.

v) Kai Tak Development –Roads D3A & D4A

Road D3A and D4A are both dual 2-lane district distributor roads, which are 1.4km and 0.1km long respectively, running on the Runway Precinct of KTD. Road D3A will run along the centre of the Runway Precinct and will replace the original southern section of Road D3 that runs along the waterfront of the Runway Precinct. Road D4A is an extension of Road D4 connecting to the proposed Road D3A. They will serve the Cruise Terminal, the Tourism Node and the development sites in the Runway Precinct.

The construction of these roads will commence in 2014 tentatively and will be completed by 2017. However, the construction site for Road D3A & D4A will be occupied as the barging facilities for the SCL (TAW-HUH). As such, cumulative dust impact due to the concurrent activities from the barging facilities has been addressed.

vi) Express Rail Link (XRL) – West Kowloon Terminus

The Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) will connect West Kowloon Terminus (WKT) to the Mainland section of XRL at Hongmian Dao. The XRL will provide cross-boundary services between stations in Hong Kong, Futian, Longhua, Humen, Shibi, and other major Mainland cities.

The XRL of approximately 26km long will run as an underground railway in dedicated tunnels from WKT to the boundary crossing point at Huanggang. Major construction works in the vicinity of the CKR includes the construction of the proposed WKT and the cut-&-cover tunnel section near Jordan Road. According to the approved EIA Study "Hong Kong Section of Guangzhou - Shenzhen - Hong Kong Express Rail Link" (AEIAR-143/2009), all the construction works in West Kowloon area is scheduled to be completed by end of 2014. In addition, according to the information presented in the latest approved VEP application (VEP-377/2012), the proposed concrete batching plant is located at 500m away from the CKR project boundary and hence any cumulative impacts are not anticipated to be significant. And the northern portion of the works area for XRL described in the VEP would have been completed before the commencement of the CKR construction, which would therefore not interface with CKR.

vii) Road works at West Kowloon

Upon the opening of WKT of the XRL and the future development of the West Kowloon Cultural District (WKCD), additional traffic capacity and network restructuring within the West Kowloon Reclamation Area (WKRA) is required to accommodate the increasing traffic demand. The proposed roads include Road D1A, Road D1, Lin Cheung Road-Austin Road West Underpass and upgrading of Austin Road West.

These road works are currently being under construction and are expected to be completed by 2014, which will therefore not interface with CKR. As such, cumulative dust impact during construction phase is not anticipated.

It is understood that the extent of the barriers and locations of the top openings of underpass have been updated in the latest approved VEP application (VEP-368/2012) since its approved EIA Study (AEIAR-141/2009). However, the effect of the barrier is only localized. The top openings of the underpasses are located about 500m away from the Project and the annual pollutant contributions from these top openings are only insignificant at the nearest identified ASRs under the CKR EIA. It is therefore considered that the abovementioned changes under this VEP would have no significant effect on CKR.

viii) Proposed Road Improvement Works in West Kowloon Reclamation Development Phase I

The project is proposed to improve the existing road infrastructure in the West Kowloon Reclamation Development (WKRD) including the WKCD and WKT etc, and to enhance its accessibility to these developments. It consists of some road widening/improvement works and provision of new link roads. These works are scheduled to commence in early 2014 and complete in 2015.

Construction works within 500m from the CKR project boundary are reviewed. According to the latest information available from its Project Profile (PP-450/2011) and the EIA Study Brief (ESB-236/2011), construction activities would include some modifications of bridge structure and construction of road bridges. Given that the requirements stipulated in the Air Pollution Control (Construction Dust) Regulation and good site practices for dust control will be implemented by the Contractor, dust contribution from this project is considered insignificant. In addition, the nearest ASRs under the CKR Project are W-A12 (Civil Aid Service Headquarters) and W-P5 (Hong Kong Red Cross Headquarters (Planned)), which are located about 150m and 200m away from this road improvement works project. These ASRs are/would be central air-conditioned with fresh air intake at higher level, dust generated from ground level would not have significant impact to these nearest ASRs. For ASRs located further away, potential dust impact would be naturally attenuated to an insignificant level due to distance. Hence, cumulative dust impact during construction phase is not anticipated.

4.3.6 Concurrent Dust Sources

There are 3 existing concrete batching plants (CBPs) within the ex-Kai Tak Airport area, including the Yue Xiu CBP, Glorious CBP, and Yau Lee CBP. Based on the latest information, the Yue Xiu CBP, Glorious CBP and the associated sand depot would cease operation before the commencement of construction of SCL, i.e. 2012. The operation of Yau Lee CBP, on the other hand, would have ceased its operation in 2014 before the occupation of the public rental housing at the same site. Hence, dust emissions from these CBPs are not anticipated.

According to the EIA report for SCL (TAW-HUH), the site next to To Kwa Wan Station under the SCL project (as shown in **Figure 1.3**) would be allocated for new CBP under short-term tenancy. This potential new CBP has been assessed in the EIA report for SCL (TAW-HUH). It is considered that the assumptions made in the SCL (TAW-HUH) EIA are the best available information and are therefore adopted in this assessment.

4.3.7 Emission Inventory

Dust Emission associated with the Project

Fugitive dust impact assessments are carried out based on conservative assumptions of general construction activities which include the following:

- Heavy construction activities including site clearance, ground excavation, construction of the associated facilities, haul road etc;
- Wind erosion of all active open sites;
- Loading/unloading from trucks at barging facilities;
- All construction activities at all work sites to be undertaken concurrently in order to assess the worst-case situation;
- Construction working periods of 26 days a month and 12 hours a day from 7:00am to 7:00pm, except Sundays and public holidays.

The prediction of dust emissions is based on typical values and emission factors from United States Environmental Protection Agency (USEPA) Compilation of Air Pollution Emission Factors (AP-42), 5th Edition. References of the dust emission factors for different dust generating activities are listed below. Calculation of dust emission factors and locations of dust sources are given in **Appendix 4.1**. Detailed descriptions are also discussed in the following sections.

Table 4.6: References of Dust Emission Factors for Different Activities

Operating Sites	Activities	Equations and Assumptions	Reference
All construction and excavation sites	Heavy construction activities including land clearance, ground excavation, cut and fill operations, construction of the facilities, haul road, etc	E = 1.2 tons/acre/month of activity or = 2.69Mg/hectare/month of activity	USEPA AP42, S.13.2.3.3
All construction sites	Wind Erosion	E = 0.85 Mg/hectare/yr (24 hour emission)	USEPA AP42, S.11.9, Table 11.9.4
Barging facilities and/or any stockpiles	Loading/Unloading at barging facilities and any stockpile	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}(kg/megagram)$ k is particle size multiplier U is average wind speed M is material moisture content	USEPA AP42, S13.2.4

Dust emission from construction vehicle movement will generally be limited within the confined worksites and the emission factor given in AP-42 S.13.2.3.3 has taken this factor into account. Watering facilities will be provided at every designated vehicular exit point. Since all vehicles will be washed at exit points and vehicle loaded with the dusty materials will be covered entirely by clean impervious sheeting before leaving the construction site, dust nuisance from construction vehicle movement outside the worksites is unlikely to be significant.

Dust Emission associated with the Concurrent Projects / Dust Sources

For the concurrent projects with overlapping construction works including SCL (TAW-HUH), T2 and KTD, and the concurrent dust sources from the potential new CBP in ex-Kai Tak airport area, the associated dust emission sources and emission strength are referenced to the approved EIA Studies for SCL (TAW-HUH) and KTD.

4.3.8 Assessment Methodology

Dust impact assessment is undertaken using the EPD approved Fugitive Dust Model (FDM). It is a well-known Gaussian Plume model designed for computing air dispersion for fugitive dust sources. Modelling parameters including dust emission factors, particles size distributions, surface roughness, etc are referred to EPD's "Guideline on choice of models and model parameters" and USEPA AP-42. The density of dust is assumed to be 2.5g/m^3. As discussed in **Section 4.3.2**, the 5-year annual averaged TSP concentrations (2007-2011) recorded at Sham Shui Po and Kwun Tong AQMS are adopted as the background TSP concentrations of the West Portion (i.e. 78.4 µg/m^3) and East Portion (i.e. 73.0µg/m^3) respectively. For the Central Portion, the average from Sham Shui Po and Kwun Tong AQMS is adopted (i.e. 75.7µg/m^3). The 5-year annual TSP concentration recorded in Tsuen Wan (i.e. 68.2 µg/m^3) is adopted as the background concentration for the Barging Point. A surface roughness of 100 cm is assumed in the model to represent the urbanised terrain.

During daytime working hours (7am to 7pm), it is assumed that dust emissions would be generated from all dust generating activities and site erosion. During night-time non-working hours (7pm to 7am of the next day), Sunday and public holidays, dust emission source would include site erosion only as construction activities during these hours are ceased.

The 1-hour, 24-hour average and annual TSP concentrations are calculated based on real meteorological data for Year 2010, including wind direction, wind speed, temperature and stability collected from the nearest weather stations, i.e. King's Park (for West Portion and Central Portion), Kai Tak (for East Portion), and Tsing Yi (for Barging Point). The mixing height data from the King's Park station is also adopted.

Fugitive dust impacts are modeled for ASR heights at 1.5m, 5m and 10m above ground. Since all the dust generating sources associated with the Project are at ground level only, these assessment levels would therefore represent the worst-case scenario. Both the unmitigated and mitigated scenarios for the project are presented. A 100x100m grid is used to generate pollution contours in order to investigate the pollutant dispersion.

A summary of modelling parameters adopted in the construction dust assessment are given in the table below:

Table 4.7: Modelling Parameters in FDM

Parameters	Input	Remark
Particle size distribution	1.25um = 7% 3.75um = 20% 7.5um = 20% 12.5um = 18% 22.5um = 35%	Reference from S13.2.4.3 of USEPA AP-42
Background Concentration	78.4µg/m^3 (West Portion) 75.7µg/m^3 (Central Portion) 73.0µg/m^3 (East Portion) 68.2µg/m^3 (Barging Point)	5-year annual averaged value recorded at Sham Shui Po, Kwun Tong, and Tsuen Wan AQMS
Modeling mode	Flatted terrain	-
Meteorological data	Real meteorological data recorded in 2010	West Portion & Central Portion (King's Park meteorological data) East Portion (Kai Tak meteorological data) Barging Point (Tsing Yi meteorological data)

Parameters	Input	Remark
Anemometer Height	King's Park : 25m Kai Tak : 13m Tsing Yi : 10m	Elevation of anemometer : +90mPD (King's Park) +16mPD (Kai Tak) +43mPD (Tsing Yi) Ground level of anemometer : +65mPD (King's Park) +3mPD (Kai Tak) +33mPD (Tsing Yi)
Surface Roughness	100cm	-
Emission period	General construction activities during daytime working hours (7 am to 7 pm) Wind erosion during both day-time (7am to 7pm) and night-time (7pm to 7am of the next day)	-
Assessment height	1.5m, 5m and 10m	-

It is understood that construction activities (except at the Barging Point) will not be taken place on the entire work sites at the same time, but to be undertaken at moving multiple work fronts spread across the work sites. The active areas on each work sites could be best estimated based on the construction method, construction programme and number of operating plants. Based on the engineering information presented in the **Appendix 4.2**, it is estimated that the hourly percentage of active area are in the range of 1.0% to 7.4%, while the annual percentage of active areas are in the range of 0.8% to 5.5%. As a conservative assessment, it is assumed that the hourly and annual percentage active areas are 15% and 6% respectively.

For short-term 1-hour and 24-hour assessment, construction activities and plants would neither be taken place on the entire work site/work area at the same time nor be concentrated in certain areas of the site close to ASRs at any time during construction period. Notwithstanding this, a conservative "Two Tiers" assessment approach has been adopted. An initial screening test, namely "Tier 1 Screening Test" has been undertaken. The Tier 1 screening test is conservative and has represented the worst case situation, whereby all the worksites would be active (i.e. 100%).

The purpose of the Tier 1 screening test is to identify the potentially affected areas where construction dust may accumulate. The hot spot areas identified in the Tier 1 assessment have been subsequently assessed by a more focused Tier 2 test, for which it is assumed that the hourly active works areas (i.e. 15%) for the nearby construction sites are positioned closest to the potentially worst affected ASRs, while the active areas for all other construction sites located relative further away from the ASRs remain at 100% as per Tier 1. Thus, the Tier 2 assessment is also very conservative as it assumes that all works activities with the associated plants in the nearby construction sites would be undertaken in the closest proximity to the potentially affected ASRs at the same time, which as mentioned above would not occur in reality.

For the long-term annual concentration assessment, as mentioned above that all the active construction activities would likely be moving work fronts spreading across the whole works site. On this basis, it is assumed that the dust emissions would be distributed across the whole area of each site to reasonably represent this mode of construction works (i.e. a correction factor of 0.06 is applied to the total dust emission rate for prediction of annual concentration).

4.3.9 Assessment Results (Unmitigated)

The maximum unmitigated Tier 1 1-hour, 24-hour and annual cumulative TSP concentrations at each representative ASR have been assessed and are presented in the tables below. Exceedances of the relevant AQOs are predicted at most of the ASRs. Hence, mitigation measures are therefore required to reduce the dust impact. **Figures 4.2.1 – 4.2.12** illustrate the contours for the cumulative unmitigated 1-hour, 24-hour and annual TSP concentrations in West Portion, Central Portion, East Portion, and Barging Point.

Table 4.8: Predicted Unmitigated Tier 1 Cumulative 1-hour and 24-hour TSP Concentrations at Various Heights above Ground (Including Background Concentration)

ASR ID	Location	1-hour TSP Concentrations at Various Height (µg/m^3)			24-hour TSP Concentrations at Various Height (µg/m^3)		
		1.5m	5m	10m	1.5m	5m	10m
West Portion							
W-A1	Yau Ma Tei Catholic Primary School (Hoi Wang Road)	**2289**	**1972**	**1127**	**440**	**406**	**294**
W-A2	Charming Garden Block 12	**2512**	**2076**	**1083**	**417**	**395**	**308**
W-A3	Yau Ma Tei Catholic Primary School (Tung Kun Street)	**2620**	**2175**	**1405**	**474**	**446**	**364**
W-A4	Prosperous Garden Block 1	**3410**	**2654**	**1506**	**748**	**608**	**437**
W-A5	The Coronation	**4833**	**2094**	**1087**	**903**	**502**	**321**
W-A6	Man Cheong Building	**1818**	**1604**	**972**	**407**	**345**	246
W-A7	Kum Lam Building	**4791**	**3146**	**1768**	**692**	**448**	**320**
W-A8	Dickson Building	**5081**	**3534**	**1816**	**886**	**418**	**296**
W-A9	Yau Ma Tei Jockey Club Polyclinic	**2148**	**2023**	**1464**	**481**	**467**	**383**
W-A10	Alhambra Building	**5102**	**3420**	**1723**	**843**	**625**	**402**
W-A11	Hong Kong Community College (HKCC) of PolyU	**4317**	**2405**	**1231**	**841**	**621**	**364**
W-A12	Civil Aid Service Headquarter	**2785**	**2228**	**1165**	**913**	**706**	**382**
W-A13	Park Avenue Tower 10	**1071**	**1061**	**857**	225	228	205
W-A14	Charming Garden Block 1	**1300**	**1284**	**1010**	**304**	**301**	254
W-A15	HKMA David Li Kwok Po College	**1646**	**1551**	**1083**	**339**	**328**	**264**

ASR ID	Location	1-hour TSP Concentrations at Various Height (µg/m^3)			24-hour TSP Concentrations at Various Height (µg/m^3)		
		1.5m	5m	10m	1.5m	5m	10m
W-P1	Reprovisioned Yau Ma Tei Police Station (Planned)	Note [1]	**2576**	**1250**	Note [1]	**757**	**450**
W-P5	Hong Kong Red Cross Headquarters (Planned)	**1465**	**1356**	**1017**	**317**	**308**	252
W-P6	Refuse Collection Point and street Sleepers' Shelters (Planned)	**3308**	**2524**	**1361**	**560**	**502**	**366**
Central Portion							
M-A1	Kar Man House, Oi Man Estate	**1584**	**1033**	467	**327**	251	150
M-A2	Carmel on the Hill	**702**	**579**	328	190	176	139
M-A3	SKH Tsoi Kung Po Secondary School	**2441**	**1179**	**568**	**413**	**277**	145
M-A4	Man Fuk House Block A	**925**	**726**	360	**280**	244	163
M-A5	Cascades Block A	**1053**	**874**	457	178	167	133
M-A6	Ko Fai House, Kwun Fai Court	**1888**	**993**	371	**320**	223	146
M-A7	The Open University of Hong Kong	**763**	**686**	444	147	142	122
M-A8	Kwun Hei Court	**708**	**614**	362	147	137	113
M-A9	Housing Authority Headquarters Block 1	**2247**	**1339**	**619**	**351**	251	144
M-A10	Ho Man Tin Government Offices	**1210**	**795**	404	**342**	**276**	164
M-A11	Choi Man House, Ho Man Tin Estate	**540**	**512**	373	132	132	121
M-A12	King Man House, Ho Man Tin Estate	364	361	300	96	96	93
M-A13	Ho Man Tin Swimming Pool	**3421**	**1360**	**566**	**639**	**355**	171
M-A14	Yee Man house	**618**	**565**	375	113	112	106
M-A15	Ho Min Tin Estate Service Reservoir Playground	**1668**	**1014**	**505**	224	194	152
M-A16	Ko Shan Road Park	334	326	261	102	102	97
M-A17	Kiu Wai Mansion	386	374	298	94	94	91
M-A18	Sun Man House	440	413	304	108	106	98
M-A19	Ellery Terrance	447	432	331	109	108	101
M-A20	Dragon View (Block 1)	476	457	345	137	134	118
M-P2	Planned Residential Area B (Planned)	**3433**	**1224**	486	**642**	**315**	173
East Portion							

ASR ID	Location	1-hour TSP Concentrations at Various Height (μg/m^3)			24-hour TSP Concentrations at Various Height (μg/m^3)		
		1.5m	5m	10m	1.5m	5m	10m
E-A1	Hong Kong International Trade and Exhibition Centre	Note [2]	**4311**	**2641**	Note [2]	**601**	**387**
E-A2	EMSD Headquarters	Note [2]	**3820**	**2274**	Note [2]	**543**	**433**
E-A4	Billion Centre	**3058**	**2625**	**1730**	**616**	**581**	**444**
E-A5	Kai Fuk Industrial Centre	**2273**	**2125**	**1575**	**507**	**501**	**411**
E-A6	Grand Watefront	**3064**	**2011**	**1377**	**723**	**482**	**296**
E-A7	Chong Chien Court	**4380**	**3449**	**1779**	**379**	**340**	**273**
E-A8	Wei Chien Court	**6114**	**3832**	**2080**	**890**	**462**	**308**
E-A9	Sino Industrial Plaza	**3274**	**3232**	**2503**	**344**	**349**	**310**
E-A10	HSBC Main Treasury	**3367**	**3246**	**2434**	**411**	**389**	**297**
E-A11	Holy Carpenter Primary School	**2344**	**2279**	**1789**	**354**	**329**	**281**
E-A12	United Daily News Centre	**3382**	**3253**	**2419**	**370**	**352**	**285**
E-A13	Merit Industrial Centre	**2847**	**2490**	**1500**	**300**	**280**	236
E-A14	Wyler Gardens	**4972**	**3765**	**1927**	**497**	**426**	**317**
E-P1	Site 1B4 – School (Planned)	**1547**	**1462**	**1232**	195	192	178
E-P2	Site 1I3 – Residential (Planned)	**2494**	**2270**	**1507**	239	229	202
E-P3	Site 1J1 (Planned)	**1676**	**1615**	**1240**	209	211	194
E-P4	Site 1J3 (Planned)	**3512**	**2729**	**1407**	**317**	**283**	227
Barging Point							
TY-A1	Grand Horizon Block 6	120	118	107	74	74	72
TY-A2	Tai Sang Container and Godown Centre	121	119	105	72	72	71
TY-A3	Tsing Yi Industrial Centre Phase 1	117	114	102	71	71	70
TY-A4	The Hong Kong Jockey Club International BMX Park	128	123	106	71	71	70

Notes:

[1] The planned Yau Ma Tei Police Station would be central air-conditioned and the fresh air intake would be at least 5mAG. Hence there is no air sensitive use at 1.5mAG.

[2] No air sensitive use is observed at 1.5mAG

Table 4.9: Predicted Unmitigated Cumulative Annual TSP Concentrations at Various Heights above Ground (Including Background Concentration)

ASR ID	Location	Annual TSP Concentrations at Various Height (μg/m^3)		
		1.5m	5m	10m
West Portion				
W-A1	Yau Ma Tei Catholic Primary School (Hoi Wang Road)	**80.8**	**80.7**	**80.3**
W-A2	Charming Garden Block 12	**80.3**	**80.2**	79.9
W-A3	Yau Ma Tei Catholic Primary School (Tung Kun Street)	**81.9**	**81.4**	**80.7**
W-A4	Prosperous Garden Block 1	**85.5**	**84.2**	**82.4**
W-A5	The Coronation	**91.2**	**87.8**	**84.3**
W-A6	Man Cheong Building	**80.6**	**80.4**	79.9
W-A7	Kum Lam Building	**83.1**	**81.4**	**80.1**
W-A8	Dickson Building	**85.7**	**82.7**	**80.7**
W-A9	Yau Ma Tei Jockey Club Polyclinic	**83.3**	**82.6**	**81.3**
W-A10	Alhambra Building	**81.4**	**80.8**	**80.0**
W-A11	Hong Kong Community College (HKCC) of PolyU	**84.3**	**83.1**	**81.4**
W-A12	Civil Aid Service Headquarter	**85.4**	**84.5**	**82.5**
W-A13	Park Avenue Tower 10	78.9	79.0	78.9
W-A14	Charming Garden Block 1	79.5	79.5	79.4
W-A15	HKMA David Li Kwok Po College	79.9	79.9	79.7
W-P1	Reprovisioned Yau Ma Tei Police Station (Planned)	Note [1]	**91.9**	**85.9**
W-P5	Hong Kong Red Cross Headquarters (Planned)	79.5	79.5	79.4
W-P6	Refuse Collection Point and street Sleepers' Shelters (Planned)	**83.5**	**83.0**	**81.8**
Central Portion				
M-A1	Kar Man House, Oi Man Estate	77.9	77.6	76.9
M-A2	Carmel on the Hill	77.1	77.0	76.7
M-A3	SKH Tsoi Kung Po Secondary School	77.2	76.8	76.4
M-A4	Man Fuk House Block A	76.6	76.5	76.3
M-A5	Cascades Block A	76.0	76.0	75.9
M-A6	Ko Fai House, Kwun Fai Court	77.5	77.0	76.4

ASR ID	Location	Annual TSP Concentrations at Various Height (µg/m³)		
		1.5m	5m	10m
M-A7	The Open University of Hong Kong	75.8	75.8	75.8
M-A8	Kwun Hei Court	76.1	76.1	76.0
M-A9	Housing Authority Headquarters Block 1	76.4	76.3	76.1
M-A10	Ho Man Tin Government Offices	77.8	77.5	76.9
M-A11	Choi Man House, Ho Man Tin Estate	75.8	75.8	75.8
M-A12	King Man House, Ho Man Tin Estate	75.7	75.8	75.7
M-A13	Ho Man Tin Swimming Pool	78.1	77.2	76.3
M-A14	Yee Man house	75.9	75.9	75.8
M-A15	Ho Min Tin Estate Service Reservoir Playground	76.7	76.6	76.3
M-A16	Ko Shan Road Park	75.8	75.8	75.8
M-A17	Kiu Wai Mansion	75.8	75.8	75.7
M-A18	Sun Man House	75.9	75.9	75.9
M-A19	Ellery Terrance	75.8	75.8	75.8
M-A20	Dragon View (Block 1)	75.9	75.9	75.9
M-P2	Planned Residential Area B (Planned)	80.0	77.9	76.6
East Portion				
E-A1	Hong Kong International Trade and Exhibition Centre	Note [2]	78.5	77.1
E-A2	EMSD Headquarters	Note [2]	76.9	76.0
E-A4	Billion Centre	75.7	75.6	75.2
E-A5	Kai Fuk Industrial Centre	75.5	75.4	75.0
E-A6	Grand Watefront	**81.9**	**80.8**	78.7
E-A7	Chong Chien Court	78.4	78.1	77.1
E-A8	Wei Chien Court	**81.9**	78.9	76.5
E-A9	Sino Industrial Plaza	75.0	75.0	74.8
E-A10	HSBC Main Treasury	75.7	75.7	75.3
E-A11	Holy Carpenter Primary School	74.8	74.5	74.3
E-A12	United Daily News Centre	75.1	74.7	74.4
E-A13	Merit Industrial Centre	77.3	77.3	76.7
E-A14	Wyler Gardens	**80.1**	79.0	77.1

ASR ID	Location	Annual TSP Concentrations at Various Height ($\mu g/m^3$)		
		1.5m	5m	10m
E-P1	Site 1B4 – School (Planned)	74.5	74.4	74.2
E-P2	Site 1I3 – Residential (Planned)	75.8	75.6	75.2
E-P3	Site 1J1 (Planned)	74.8	74.7	74.4
E-P4	Site 1J3 (Planned)	75.8	75.6	75.2
Barging Point				
TY-A1	Grand Horizon Block 6	68.9	68.9	68.9
TY-A2	Tai Sang Container and Godown Centre	68.6	68.6	68.6
TY-A3	Tsing Yi Industrial Centre Phase 1	68.4	68.4	68.4
TY-A4	The Hong Kong Jockey Club International BMX Park	68.4	68.4	68.4

Notes:
[1] The planned Yau Ma Tei Police Station would be central air-conditioned and the fresh air intake would be at least 5mAG. Hence there is no air sensitive use at 1.5mAG.
[2] No air sensitive use is observed at 1.5mAG

4.3.10 Recommended Mitigation Measures for Fugitive Dust

In order to reduce the dust emission from CKR and achieve compliances of TSP criteria at ASRs, the following specific mitigation measures are recommended:

i) Regular watering under a good site practice should be adopted. In accordance with the "Control of Open Fugitive Dust Sources" (USEPA AP-42) as given in **Appendix 4.2**, watering once per hour on exposed worksites and haul road is proposed to achieve dust removal efficiency of 91.7%. These dust suppression efficiencies are derived based on the average haul road traffic of 54 per hour, average evaporation rate and an assumed application intensity of 1.3 L/m^2 for the respective watering frequencies (see **Appendix 4.2**). Any potential dust impact and watering mitigation would be subject to the actual site conditions. For example, for a construction activity that produces inherently wet conditions or in cases under rainy weather, the above water application intensity may not be unreservedly applied. While the above watering frequencies are to be followed, the extent of watering may vary depending on actual site conditions but should be sufficient to maintain an equivalent intensity of not less than 1.3 L/m^2 to achieve the respective dust removal efficiencies. The dust levels would be monitored and managed under an EM&A programme as specified in the EM&A Manual;

ii) For the unloading of spoil from trucks at barging point, installation of 3-sided screen with top cover and the provision of water sprays at the discharge point would be provided. A 50% dust suppression is assumed. This assumption is based upon USEPA AP-42 Control Techniques for Particulate Emissions form Stationary Sources Part 2 which states that watering alone would have

50% dust removal efficiency. This is, however, considered very conservative as the barging point would be provided with a 3-sided enclosure, which would provide additional dust containment and control.

In addition, the Contractor is also obliged to follow the procedures and requirements given in the Air Pollution Control (Construction Dust) Regulation. It stipulates the construction dust control requirements for both Notifiable (e.g. site formation) and Regulatory (e.g. road opening) Works to be carried out by the Contractor. The following dust suppression measures should be incorporated by the Contractor to control the dust nuisance throughout the construction phase:

- Any excavated or stockpile of dusty material should be covered entirely by impervious sheeting or sprayed with water to maintain the entire surface wet and then removed or backfilled or reinstated where practicable within 24 hours of the excavation or unloading;
- Any dusty materials remaining after a stockpile is removed should be wetted with water and cleared from the surface of roads;
- A stockpile of dusty material should not be extended beyond the pedestrian barriers, fencing or traffic cones;
- The load of dusty materials on a vehicle leaving a construction site should be covered entirely by impervious sheeting to ensure that the dusty materials do not leak from the vehicle;
- Where practicable, vehicle washing facilities with high pressure water jet should be provided at every discernible or designated vehicle exit point. The area where vehicle washing takes place and the road section between the washing facilities and the exit point should be paved with concrete, bituminous materials or hardcores;
- When there are open excavation and reinstatement works, hoarding of not less than 2.4m high should be provided as far as practicable along the site boundary with provision for public crossing. Good site practice shall also be adopted by the Contractor to ensure the conditions of the hoardings are properly maintained throughout the construction period;
- The portion of any road leading only to construction site that is within 30m of a vehicle entrance or exit should be kept clear of dusty materials;
- Surfaces where any pneumatic or power-driven drilling, cutting, polishing or other mechanical breaking operation takes place should be sprayed with water or a dust suppression chemical continuously;
- Any area that involves demolition activities should be sprayed with water or a dust suppression chemical immediately prior to, during and immediately after the activities so as to maintain the entire surface wet;
- Where a scaffolding is erected around the perimeter of a building under construction, effective dust screens, sheeting or netting should be provided to enclose the scaffolding from the ground floor level of the building, or a canopy should be provided from the first floor level up to the highest level of the scaffolding;
- Any skip hoist for material transport should be totally enclosed by

impervious sheeting;

- Every stock of more than 20 bags of cement or dry pulverised fuel ash (PFA) should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides;
- Cement or dry PFA delivered in bulk should be stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line and no overfilling is allowed;
- Loading, unloading, transfer, handling or storage of bulk cement or dry PFA should be carried out in a totally enclosed system or facility, and any vent or exhaust should be fitted with an effective fabric filter or equivalent air pollution control system; and
- Exposed earth should be properly treated by compaction, turfing, hydroseeding, vegetation planting or sealing with latex, vinyl, bitumen, shortcrete or other suitable surface stabiliser within six months after the last construction activity on the construction site or part of the construction site where the exposed earth lies.

For the barging facility near Tsing Yi, the following good site practices are required:

- All road surface within the barging facilities will be paved;
- Dust enclosures will be provided for the loading ramp as described in (ii) above;
- Vehicles will be required to pass through designated wheel wash facilities; and
- Continuous water spray at the loading point.

These requirements should be incorporated into the Contract Specification for the civil work. In addition, an audit and monitoring programme during the construction phase should be implemented by the Contractor to ensure that the construction dust impacts are controlled to within the HKAQO. Detailed requirements for the audit and monitoring programme are given separately in the EM&A manual.

4.3.11 Assessment Results (Mitigated)

Short-term Assessment (Tier 1)

The mitigated 1-hour and 24-hour TSP concentrations based on Tier 1 screening test have been predicted. The table below summarizes the cumulative maximum 1-hour and 24-hour TSP impact (Tier 1) at identified ASRs. The results indicate that, for the majority of ASRs, exceedance of 1-hour and 24-hour TSP criteria are not anticipated even assuming the absolute worst case situation, whereby all the worksites would be active (i.e. 100%). However, exceedances of 1-hour TSP concentrations are still predicted at E-A8 (Wei Chien Court). As the Tier 1 assessment is for screening purposes only and would not represent the actual on-site situation, a more focused Tier 2 assessment has been undertaken at E-A8 (Wei Chien Court).

In addition, contours of Tier 1 1-hour and 24-hour TSP concentrations in West Portion, Central Portion, East Portion and Barging Point are shown in the **Figures 4.3.1 – 4.3.10**. Contours indicate that there are no exceedances at other locations, except the 1-hour TSP exceedances near W-A7 (Kum Lam Building), W-A8 (Dickson Building), W-A10 (Alhambra Building) in West Portion and near E-A1 (Hong Kong International Trade and Exhibition Centre), E-A2 (EMSD Headquarters), E-A14 (Wyler Gardens), the WSD Kowloon Bay Pipe Yard and the potential residential developments to the east of the Kai Tak River within ex-Kai Tak airport area in East Portion. For the exceedance at WSD Kowloon Bay Pipe Yard, since no air sensitive use is identified within the premises, no adverse dust impact is therefore anticipated. A more focused Tier 2 assessment is therefore conducted at the area near W-A7 (Kum Lam Building), W-A8 (Dickson Building), W-A10 (Alhambra Building) and E-A14 (Wyler Gardens).

For W-P1 (Reprovisioned Yau Ma Tei Police Station (Planned)), E-A1 (Hong Kong International Trade and Exhibition Centre), E-A2 (EMSD Headquarters), it is observed that all the GIC and commercial uses on ground level are central-air conditioned and the fresh air intakes are located at least 5m above ground. It is also expected that the potential residential developments to the east of the Kai Tak River would generally have a ground lobby on the ground floor and the residential flats (i.e. air sensitive uses) located about 5m above ground. Adverse dust impacts on ground level at these ASRs are therefore not anticipated. However, it is understood that there are elevated dust sources due to the potential new CBP located in the ex-Kai Tak airport area. As such, contours of Tier 1 1-hour and 24-hour TSP concentrations at 5m above ground in the East Portion are also plotted (**Figure 4.3.7-4.3.8**). Results show that exceedance of 1-hour TSP near E-A1 (Hong Kong International Trade and Exhibition Centre) at 5m above ground level is anticipated. A more focused Tier 2 assessment is also conducted at area near E-A1 (Hong Kong International Trade and Exhibition Centre).

Table 4.10: Predicted Mitigated Tier 1 Cumulative 1-hour and 24-hour TSP Concentrations at Various Heights above Ground (Including Background Concentration)

ASR ID	Location	1-hour TSP Concentrations at Various Height (μg/m^3)			24-hour TSP Concentrations at Various Height (μg/m^3)		
		1.5m	5m	10m	1.5m	5m	10m
West Portion							
W-A1	Yau Ma Tei Catholic Primary School (Hoi Wang Road)	262	236	165	109	106	97
W-A2	Charming Garden Block 12	280	244	162	112	109	100
W-A3	Yau Ma Tei Catholic Primary School (Tung Kun Street)	289	252	188	118	113	105
W-A4	Prosperous Garden Block 1	355	292	197	142	128	111
W-A5	The Coronation	473	246	162	158	116	101
W-A6	Man Cheong Building	223	205	153	109	104	94
W-A7	Kum Lam Building	470	333	219	135	113	101

ASR ID	Location	1-hour TSP Concentrations at Various Height (μg/m^3)			24-hour TSP Concentrations at Various Height (μg/m^3)		
		1.5m	5m	10m	1.5m	5m	10m
W-A8	Dickson Building	494	365	223	154	110	99
W-A9	Yau Ma Tei Jockey Club Polyclinic	250	240	193	117	115	106
W-A10	Alhambra Building	495	356	215	151	130	109
W-A11	Hong Kong Community College (HKCC) of PolyU	430	271	174	153	130	105
W-A12	Civil Aid Service Headquarter	303	257	169	156	137	107
W-A13	Park Avenue Tower 10	161	160	143	91	91	89
W-A14	Charming Garden Block 1	180	178	156	97	97	93
W-A15	HKMA David Li Kwok Po College	209	201	162	100	99	94
W-P1	Reprovisioned Yau Ma Tei Police Station (Planned)	Note [1]	286	176	Note [1]	140	112
W-P5	Hong Kong Red Cross Headquarters (Planned)	193	184	156	98	97	93
W-P6	Refuse Collection Point and street Sleepers' Shelters (Planned)	346	281	185	126	119	105
Central Portion							
M-A1	Kar Man House, Oi Man Estate	201	155	108	97	91	82
M-A2	Carmel on the Hill	128	117	97	87	85	82
M-A3	SKH Tsoi Kung Po Secondary School	272	167	117	104	92	82
M-A4	Man Fuk House Block A	146	130	99	94	91	83
M-A5	Cascades Block A	157	142	107	84	83	80
M-A6	Ko Fai House, Kwun Fai Court	226	152	100	99	89	82
M-A7	The Open University of Hong Kong	133	126	106	82	81	80
M-A8	Kwun Hei Court	128	120	99	82	81	79
M-A9	Housing Authority Headquarters Block 1	256	181	121	99	90	82
M-A10	Ho Man Tin Government Offices	170	135	103	101	94	84
M-A11	Choi Man House, Ho Man Tin Estate	114	112	100	81	81	80
M-A12	King Man House, Ho Man Tin Estate	100	99	94	77	77	77
M-A13	Ho Man Tin Swimming Pool	353	182	116	125	101	84
M-A14	Yee Man house	121	116	101	80	80	79

ASR ID	Location	1-hour TSP Concentrations at Various Height (µg/m³)			24-hour TSP Concentrations at Various Height (µg/m³)		
		1.5m	5m	10m	1.5m	5m	10m
M-A15	Ho Min Tin Estate Service Reservoir Playground	208	154	111	89	86	82
M-A16	Ko Shan Road Park	97	96	91	78	78	78
M-A17	Kiu Wai Mansion	101	100	94	77	77	77
M-A18	Sun Man House	106	104	95	79	78	78
M-A19	Ellery Terrance	107	105	97	78	78	78
M-A20	Dragon View (Block 1)	109	107	98	81	81	79
M-P2	Planned Residential Area B (Planned)	354	171	110	130	97	84
East Portion							
E-A1	Hong Kong International Trade and Exhibition Centre	Note [2]	486	334	Note [2]	158	130
E-A2	EMSD Headquarters	Note [2]	438	319	Note [2]	131	117
E-A4	Billion Centre	402	385	301	141	139	126
E-A5	Kai Fuk Industrial Centre	344	339	285	132	133	122
E-A6	Grand Watefront	321	285	250	130	112	105
E-A7	Chong Chien Court	454	378	237	108	104	101
E-A8	Wei Chien Court	**597**	405	259	167	128	109
E-A9	Sino Industrial Plaza	382	379	311	113	115	109
E-A10	HSBC Main Treasury	406	397	319	131	131	120
E-A11	Holy Carpenter Primary School	347	308	251	127	116	107
E-A12	United Daily News Centre	367	358	286	112	111	105
E-A13	Merit Industrial Centre	335	308	223	101	102	99
E-A14	Wyler Gardens	498	399	244	118	112	105
E-P1	Site 1B4 – School (Planned)	343	279	236	130	119	106
E-P2	Site 1I3 – Residential (Planned)	376	299	227	143	131	111
E-P3	Site 1J1 (Planned)	354	285	234	119	114	104
E-P4	Site 1J3 (Planned)	384	320	236	129	125	110
Barging Point							
TY-A1	Grand Horizon Block 6	81	80	77	70	69	69
TY-A2	Tai Sang Container and Godown Centre	80	79	76	69	69	69
TY-A3	Tsing Yi Industrial Centre Phase 1	79	78	75	69	69	69

ASR ID	Location	1-hour TSP Concentrations at Various Height (µg/m³)			24-hour TSP Concentrations at Various Height (µg/m³)		
		1.5m	5m	10m	1.5m	5m	10m
TY-A4	The Hong Kong Jockey Club International BMX Park	80	79	76	69	69	69

Notes:
[1] The planned Yau Ma Tei Police Station would be central air-conditioned and the fresh air intake would be at least 5mAG. Hence there is no air sensitive use at 1.5mAG.
[2] No air sensitive use is observed at 1.5mAG

Short-term Assessment (Tier 2)

A more focused Tier 2 assessment has been conducted on ASR E-A8 (Wei Chien Court), area near the W-A7 (Kum Lam Building), W-A8 (Dickson Building) and W-A10 (Alhambra Building), and area near E-A1 (Hong Kong International Trade and Exhibition Centre) and E-A14 (Wyler Gardens) such that the 15% active works areas (as a conservative assumption) for the adjacent construction site are positioned closest to these ASRs, while the active areas from all the other construction sites located relative further away from the ASRs remain at 100% as per Tier 1. As mentioned in **Section 4.3.8**, the Tier 2 assessment is also very conservative and would over-predict the dust emissions.

The maximum Tier 2 1-hour and 24-hour TSP concentrations have been assessed. The following table summaries the cumulative 1-hour and 24-hour TSP impact (Tier 2) at E-A8. Results show that, both cumulative 1-hour and 24-hour TSP concentrations would comply with the respective criteria and as such, adverse short-term construction dust impact is not anticipated.

Table 4.11: Predicted Mitigated Tier 2 Cumulative 1-hour and 24-hour TSP Concentrations at Various Heights above Ground (Including Background Concentration)

ASR ID	Location	1-hour TSP Concentrations at Various Height (µg/m³)			24-hour TSP Concentrations at Various Height (µg/m³)		
		1.5m	5m	10m	1.5m	5m	10m
East Portion							
E-A8	Wei Chien Court	471	286	222	155	119	104

Contours have been plotted for 1-hour and 24-hour TSP concentrations (Tier 2) at 1.5m above ground for the areas near W-A7 (Kum Lam Building), W-A8 (Dickson Building) and W-A10 (Alhambra Building) in West Portion and E-A8 (Wei Chien Court) and E-A14 (Wyler Gardens) in East Portion, and also at 5m above ground near the E-A1 (Hong Kong International Trade and Exhibition Centre) to illustrate the short-term dust impact on these hot spot areas at the worst affected level and are presented in **Figures 4.4.1 – 4.4.6** respectively. Results indicate that there are no active air sensitive uses located within the area of exceedance, and hence adverse short-term dust impact is not anticipated.

Long-term Assessment

The maximum predicted annual TSP concentrations at identified ASRs in the study area under mitigated case are given in the table below. Contours of annual TSP concentrations at 1.5m above ground have been plotted in **Figures 4.5.1-4.5.3**. Results indicate full compliance of the relevant criterion at all areas adjacent to the work sites, except the eastern boundary of W-A5 (The Coronation). However, based on the current layout plan, there will be no air sensitive use at that area. Hence, adverse annual dust impact is not anticipated.

Table 4.12: Predicted Mitigated Cumulative Annual TSP Concentrations at Various Heights above Ground (Including Background Concentration)

ASR ID	Location	Annual TSP Concentrations at Various Height (μg/m^3)		
		1.5m	5m	10m
West Portion				
W-A1	Yau Ma Tei Catholic Primary School (Hoi Wang Road)	78.7	78.6	78.6
W-A2	Charming Garden Block 12	78.6	78.6	78.6
W-A3	Yau Ma Tei Catholic Primary School (Tung Kun Street)	78.8	78.7	78.6
W-A4	Prosperous Garden Block 1	79.2	79.0	78.8
W-A5	The Coronation	79.8	79.4	79.0
W-A6	Man Cheong Building	78.6	78.6	78.6
W-A7	Kum Lam Building	78.9	78.7	78.6
W-A8	Dickson Building	79.2	78.8	78.6
W-A9	Yau Ma Tei Jockey Club Polyclinic	78.9	78.8	78.7
W-A10	Alhambra Building	78.7	78.7	78.6
W-A11	Hong Kong Community College (HKCC) of PolyU	79.1	78.9	78.7
W-A12	Civil Aid Service Headquarter	79.2	79.1	78.8
W-A13	Park Avenue Tower 10	78.5	78.5	78.5
W-A14	Charming Garden Block 1	78.5	78.5	78.5
W-A15	HKMA David Li Kwok Po College	78.6	78.6	78.5
W-P1	Reprovisioned Yau Ma Tei Police Station (Planned)	Note [1]	79.8	79.1
W-P5	Hong Kong Red Cross Headquarters (Planned)	78.5	78.5	78.5
W-P6	Refuse Collection Point and street Sleepers' Shelters (Planned)	79.0	78.9	78.7

ASR ID	Location	Annual TSP Concentrations at Various Height ($\mu g/m^3$)		
		1.5m	5m	10m
Central Portion				
M-A1	Kar Man House, Oi Man Estate	76.0	75.9	75.8
M-A2	Carmel on the Hill	75.9	75.8	75.8
M-A3	SKH Tsoi Kung Po Secondary School	75.9	75.8	75.8
M-A4	Man Fuk House Block A	75.8	75.8	75.8
M-A5	Cascades Block A	75.7	75.7	75.7
M-A6	Ko Fai House, Kwun Fai Court	75.9	75.8	75.8
M-A7	The Open University of Hong Kong	75.7	75.7	75.7
M-A8	Kwun Hei Court	75.7	75.7	75.7
M-A9	Housing Authority Headquarters Block 1	75.8	75.8	75.7
M-A10	Ho Man Tin Government Offices	75.9	75.9	75.8
M-A11	Choi Man House, Ho Man Tin Estate	75.7	75.7	75.7
M-A12	King Man House, Ho Man Tin Estate	75.7	75.7	75.7
M-A13	Ho Man Tin Swimming Pool	76.0	75.8	75.8
M-A14	Yee Man house	75.7	75.7	75.7
M-A15	Ho Min Tin Estate Service Reservoir Playground	75.8	75.8	75.8
M-A16	Ko Shan Road Park	75.7	75.7	75.7
M-A17	Kiu Wai Mansion	75.7	75.7	75.7
M-A18	Sun Man House	75.7	75.7	75.7
M-A19	Ellery Terrance	75.7	75.7	75.7
M-A20	Dragon View (Block 1)	75.7	75.7	75.7
M-P2	Planned Residential Area B (Planned)	76.2	75.9	75.8
East Portion				
E-A1	Hong Kong International Trade and Exhibition Centre	Note [2]	74.3	74.0
E-A2	EMSD Headquarters	Note [2]	74.0	73.8
E-A4	Billion Centre	73.9	73.9	73.8
E-A5	Kai Fuk Industrial Centre	73.9	73.9	73.7
E-A6	Grand Watefront	74.6	74.5	74.2
E-A7	Chong Chien Court	74.1	74.1	73.9

ASR ID	Location	Annual TSP Concentrations at Various Height (µg/m³)		
		1.5m	5m	10m
E-A8	Wei Chien Court	74.4	74.1	73.8
E-A9	Sino Industrial Plaza	73.6	73.6	73.6
E-A10	HSBC Main Treasury	73.8	73.8	73.7
E-A11	Holy Carpenter Primary School	73.8	73.6	73.5
E-A12	United Daily News Centre	74.1	73.7	73.5
E-A13	Merit Industrial Centre	74.0	74.0	73.9
E-A14	Wyler Gardens	74.3	74.1	73.9
E-P1	Site 1B4 – School (Planned)	73.9	73.8	73.6
E-P2	Site 1I3 – Residential (Planned)	74.5	74.3	74.1
E-P3	Site 1J1 (Planned)	74.1	73.9	73.7
E-P4	Site 1J3 (Planned)	74.2	74.2	73.9
Barging Point				
TY-A1	Grand Horizon Block 6	68.4	68.4	68.4
TY-A2	Tai Sang Container and Godown Centre	68.3	68.3	68.3
TY-A3	Tsing Yi Industrial Centre Phase 1	68.3	68.3	68.2
TY-A4	The Hong Kong Jockey Club International BMX Park	68.3	68.3	68.2

Notes:
[1] The planned Yau Ma Tei Police Station would be central air-conditioned and the fresh air intake would be at least 5mAG. Hence there is no air sensitive use at 1.5mAG.
[2] No air sensitive use is observed at 1.5mAG

4.3.12 Residual Impact for Construction Dust

With the implementation of the mitigation measures as stipulated in the Air Pollution Control (Construction Dust) Regulation, dust control measures, including watering once per hour on exposed worksites and haul road, and good site practices, the predicted 1-hour, 24-hour and annual TSP concentrations on area in the vicinity of the construction sites would comply with the relevant criteria. Hence, no adverse residual dust impact is anticipated.

4.4 Operational Air Quality Assessment

4.4.1 Study Area

The CKR will be mainly underground based on the current design, except for the portals at both ends and the associated connection roads. Vehicular emissions from the open road sections near both tunnel portals and from the three proposed ventilation buildings in Yau Ma Tei, Ho Man Tin and Kai Tak are therefore anticipated.

Operational air quality assessment for CKR will be separated into 3 study areas, namely the *West Portion*, *Central Portion and East Portion*. With reference to the EIA Study Brief for this Project (ESB-156/2006), the study area for air quality impact assessment should generally be defined by a distance of 500m from the boundary of the Project. Emission sources within 500m are included in the near-field models, while emission sources beyond 500m are either included in near-field model or far-field model as appropriate. **Figures 4.6.1 –4.6.3** illustrate the extent of study area for West Portion, Central Portion and East Portion respectively.

4.4.2 Ambient Air Quality Condition

Vehicular emissions, particularly the nitrogen dioxide (NO_2) and respirable suspended particulates (RSP), are the major pollutants during operational phase of the Project. The nearest EPD's Air Quality Monitoring Stations (AQMS) to the study areas are Sham Shui Po AQMS and Kwun Tong AQMS. Historical air quality monitoring data from these two stations have been examined. The latest 5 published years of air quality monitoring data, i.e. 2007 to 2011 are tabulated in the tables below.

Table 4.13: Air Quality Monitoring Data at Kwun Tong AQMS (2007-2011)

Pollutant	Year	Highest 1-hour Average ($\mu g/m^3$)	Highest 24-hour Average ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)
NO_2	2007	**316**	**160**	63
	2008	243	139	59
	2009	249	134	58
	2010	242	123	59
	2011	285	**155**	63
	5-year mean	267 (89%)	142 (95%)	60.4 (76%)
	AQO	300	150	80
RSP	2007	273	134	53
	2008	238	136	47
	2009	226	169	48
	2010	785 #	**681** #	47
	2011	205	117	49
	5-year mean	236	139 (77%)	48.8 (89%)
	AQO	N/A	180	55
SO_2	2007	375	114	19
	2008	258	69	17
	2009	168	57	11
	2010	258	34	10

Pollutant	Year	Highest 1-hour Average (µg/m^3)	Highest 24-hour Average (µg/m^3)	Annual Average (µg/m^3)
	2011	115	42	12
	5-year mean	235 (29%)	63 (18%)	13.8 (17%)
	AQO	800	350	80
CO [1]	2007	N/M	N/M	N/M
	2008	N/M	N/M	N/M
	2009	N/M	N/M	N/M
	2010	N/M	N/M	N/M
	2011	N/M	N/M	N/M
	5-year mean	N/A	N/A	N/A
	AQO	30,000	10,000	N/A
O_3	2007	161	93	31
	2008	185	103	33
	2009	**242**	128	37
	2010	143	110	33
	2011	181	126	37
	5-year mean	182 (76%)	112	34.2
	AQO	240	N/A	N/A

Note:
% of AQO is provided in the bracket.
Monitoring results exceeded AQO are shown as bolded characters
N/M – Not measured
N/A – Not applicable since there is no HKAQO for this parameter
\# The value was recorded during a dust plume originated from northern part of China in March 2010 which was an abnormal event and hence has not been taken to calculate the 5-year mean.
[1] Carbon monoxide is not measured at the Kwun Tong and Sham Shui Po AQMSs

Table 4.14: Air Quality Monitoring Data at Sham Shui Po AQMS (2007-2011)

Pollutant	Year	Highest 1-hour Average (µg/m^3)	Highest 24-hour Average (µg/m^3)	Annual Average (µg/m^3)
NO_2	2007	279	143	69
	2008	266	**169**	69
	2009	250	**158**	65
	2010	300	147	69
	2011	296	**155**	70
	5-year mean	278 (93%)	**154** (103%)	68.4 (86%)
	AQO	300	150	80
RSP	2007	292	164	**57**
	2008	229	141	53
	2009	226	**196**	47

Pollutant	Year	Highest 1-hour Average (µg/m^3)	Highest 24-hour Average (µg/m^3)	Annual Average (µg/m^3)
	2010	630 #	**569** #	48
	2011	213	119	51
	5-year mean	240	155 (86%)	51.2 (93%)
	AQO	N/A	180	55
SO_2	2007	348	109	20
	2008	305	93	20
	2009	226	125	16
	2010	258	78	14
	2011	261	79	17
	5-year mean	280 (35%)	97 (28%)	17.4 (22%)
	AQO	800	350	80
CO [1]	2007	N/M	N/M	N/M
	2008	N/M	N/M	N/M
	2009	N/M	N/M	N/M
	2010	N/M	N/M	N/M
	2011	N/M	N/M	N/M
	5-year mean	N/A	N/A	N/A
	AQO	30,000	10,000	N/A
O_3	2007	237	87	27
	2008	**302**	101	27
	2009	224	99	30
	2010	**252**	89	28
	2011	240	106	31
	5-year mean	**251** (105%)	96	28.6
	AQO	240	N/A	N/A

Note:
% of AQO is provided in the bracket.
Monitoring results exceeded AQO are shown as bolded characters
N/M – Not measured
N/A – Not applicable since there is no HKAQO for this parameter
The value was recorded during a dust plume originated from northern part of China in March 2010 which was an abnormal event and hence has not been taken to calculate the 5-year mean.
[1] Carbon monoxide is not measured at the Kwun Tong and Sham Shui Po AQMSs

It is observed from the above table that, in Kwun Tong area, there were no obvious trends of 1-hour, 24-hour and annual NO_2 concentrations. The highest 1-hour NO_2 concentrations were ranged from 242µg/m^3 in 2010 to 316µg/m^3 in 2007, and the highest 24-hour NO_2 concentrations were ranged from 123µg/m^3 in 2010 to 160 µg/m^3 in 2007. The annual NO_2 concentrations remained relatively steady in the range of 58 – 63µg/m^3, without any exceedance.

For the Sham Shui Po area, there was also no obvious trend observed. The highest 1-hour NO_2 concentrations were ranged from 250µg/m^3 in 2009 to 300µg/m^3 in 2010, and the highest 24-hour NO_2 concentrations were ranged from 143µg/m^3 in 2007 to 169 µg/m^3 in 2008. In particular, the 5-year mean of highest 24-hour NO_2 concentration in Sham Shui Po has exceeded the criterion of 150µg/m^3. The annual NO_2 concentrations were in the range of 65 – 70µg/m^3.

For RSP concentrations in both Kwun Tong and Sham Shui Po areas, the highest 24-hour concentrations of 681µg/m^3 and 569µg/m^3 were recorded in 2010. Nevertheless, these exceedances were due to the dust plume originated from the northern part of Chine in March 2010, which is an abnormal event. Excluding this year, there was a general decreasing trend of 1-hour and 24-hour RSP concentrations in both Kwun Tong and Sham Shui Po AQMS. The annual RSP concentrations had dropped in 2008 and remained rather steady from 2008 to 2011, ranging from 47 – 49µg/m^3 and 47 – 53µg/m^3 in Kwun Tong and Sham Shui Po AQMS respectively.

The 1-hour, 24-hour and annual SO_2 concentrations in both areas were relatively low and well within the AQO.

Highest 1-hour O_3 concentrations from 2007 to 2011 were relatively high in both areas, in the range of 143 – 242µg/m^3 in Kwun Tong, and 224 – 302µg/m^3 in Sham Shui Po. In particular, the 5-year mean of highest 1-hour O_3 concentration in Sham Shui Po has exceeded the criterion of 240µg/m^3.

4.4.3 Air Sensitive Receivers

Similar to construction phase, representative ASRs within a distance of 500m from the proposed open road sections covered by this Project and within a distance of 500m from the proposed ventilation buildings have been identified in accordance with Annex 12 of the TM-EIAO. These ASRs include both the existing and planned developments. The locations of the representative ASRs for operational air quality assessment during the operation of the Project are illustrated in **Figures 4.6.1 – 4.6.3**, and are summarised in the table below.

Table 4.15: Representative ASRs for Operational Air Quality Assessment

ASR ID	Location	Landuse [1]	No. of Storey	Approx. separation distance from works limit (m)
West Portion				
W-A1	Yau Ma Tei Catholic Primary School (Hoi Wang Road)	E	8	80
W-A2	Charming Garden Block 12	R	23	80
W-A3	Yau Ma Tei Catholic Primary School (Tung Kun Street)	E	7	<10
W-A4	Prosperous Garden Block 1	R	28	<10
W-A5	The Coronation	R	30	<10
W-A6	Man Cheong Building	R	18	50
W-A7	Kum Lam Building	R	12	<10
W-A8	Dickson Building	R	18	<10
W-A9	Yau Ma Tei Jockey Club Polyclinic	H	10	<10

ASR ID	Location	Landuse [1]	No. of Storey	Approx. separation distance from works limit (m)
W-A10	Alhambra Building	R	15	<10
W-A11	Hong Kong Community College (HKCC) of PolyU	E	19	<10
W-A12	Civil Aid Service Headquarter	GIC	9	20
W-A13	Park Avenue Tower 10	R	35	170
W-A14	Charming Garden Block 1	R	22	70
W-A15	HKMA David Li Kwok Po College	E	8	120
W-P1	Reprovisioned Yau Ma Tei Police Station (Planned)	GIC	4	<10
W-P3	West Kowloon Government Offices (Planned)	GIC	25	<10
W-P4	Indoor Recreation Centre (Planned)	GIC	-	<10
W-P5	Hong Kong Red Cross Headquarters (Planned)	GIC	-	<10
W-P6	Refuse Collection Point and street Sleepers' Shelters (Planned)	GIC	4	<10
W-P7	Primary School (Planned)	E	8	<10
W-P8	Hindu Temple (Planned)	W	10	70
Central Portion				
M-A1	Kar Man House, Oi Man Estate	R	6	<10
M-A2	Carmel on the Hill	R	25	50
M-A3	SKH Tsoi Kung Po Secondary School	E	8	10
M-A4	Man Fuk House Block A	R	15	110
M-A5	Cascades Block A	R	18	110
M-A6	Ko Fai House, Kwun Fai Court	R	9	20
M-A7	The Open University of Hong Kong	E	12	130
M-A8	Kwun Hei Court	R	41	40
M-A9	Housing Authority Headquarters Block 1	GIC	11	<10
M-A10	Ho Man Tin Government Offices	GIC	14	60
M-A11	Choi Man House, Ho Man Tin Estate	R	42	20
M-A12	King Man House, Ho Man Tin Estate	R	15	210
M-A13	Ho Man Tin Swimming Pool	P	-	10
M-A14	Yee Man house	R	41	<10
M-A15	Ho Man Tin Estate Service Reservoir Playground	P	-	50
M-A16	Ko Shan Road Park	P	-	80
M-A17	Kiu Wai Mansion	R	20	370
M-A18	Sun Man House	R	24	<10
M-A19	Ellery Terrance	R	34	290

ASR ID	Location	Landuse [1]	No. of Storey	Approx. separation distance from works limit (m)
M-A20	Dragon View (Block 1)	R	20	250
M-P1	Valley Road Estate Redevelopment (Planned)	R	48	160
M-P2	Planned Residential Area B (Planned)	R	-	<10
M-P3	Ho Man Tin South Phase 2 (Planned)	R	150mPD [2]	<10
M-P4	Ho Man Tin Redevelopment (Outline Zoning Plan No. S/K7/21) (Planned)	R	120mPD [2]	80
M-P5	Ho Man Tin Redevelopment (KIL 11128) (Planned)	R	-	100
M-P6	Hong Kong Polytechnic University Student Hostel Phase 3 (Planned)	R	120mPD [2]	320
East Portion				
E-A1	Hong Kong International Trade and Exhibition Centre	GIC	32	40
E-A2	EMSD Headquarters	GIC	22	10
E-A4	Billion Centre	OU	45	80
E-A5	Kai Fuk Industrial Centre	I	9	130
E-A6	Grand Watefront	R	51	<10
E-A7	Chong Chien Court	R	13	<10
E-A8	Wei Chien Court	R	13	<10
E-A9	Sino Industrial Plaza	I	8	<10
E-A10	HSBC Main Treasury	C	3	30
E-A11	Holy Carpenter Primary School	E	6	<10
E-A12	United Daily News Centre	C	15	<10
E-A13	Merit Industrial Centre	C	11	<10
E-A14	Wyler Gardens	R	13	<10
E-P1	Site 1B4 – School (Planned)	E	10	240
E-P2	Site 1I3 – Residential (Planned)	R	32	90
E-P3	Site 1J1 (Planned)	GIC	16	170
E-P4	Site 1J3 (Planned)	GIC	8	20
E-P5	Site 1L3 - Residential (Planned)	R	15	130
E-P6	Site 1L2 - Residential (Planned)	R	32	100
E-P7	Site 2D2 – Stadium (Planned)	GIC	17	15
E-P8	Site 2D1 – Stadium (Planned)	GIC	17	260
E-P9	Site 1P – Administration Building (Planned)	GIC	8	<10
E-P10	Site 3C1 – Hospital (Planned)	H	14	110
E-P11	Site 3C1 – Hospital (Planned)	H	14	60
E-P12	Site 3D2 – Commercial (Planned)	C	30	440

ASR ID	Location	Landuse [1]	No. of Storey	Approx. separation distance from works limit (m)
E-P13	Site 4Ab – Metro Park (Planned)	P	-	310
E-P14	Site 4Aa – Metro Park (Planned)	P	-	<10
E-P15	Site 5A4a (Planned)	CDA	20	40
E-P16	Site 5A4b (Planned)	CDA	32	50
E-P17	Site 3B1- Secondary School (Planned)	E	10	30
E-P18	Site 3B1 (Planned)	NA[3]	-	15

Notes:
[1] R– residential; E – educational; I – Industrial; H – clinic/ home for the aged/hospital; C – Commercial; W – worship; GIC – government, institution and community; P – Recreational/Park; OU – Other specified uses (Business); CDA – Comprehensive Development Area
[2] Outline Zoning Plan No. S/K7/22
[3] No information available. Landuse zoned as “undefined”.

4.4.4 Identification of Representative Air Pollutants

As discussed in **Section 4.2**, the Air Pollution Control Ordinance (APCO) (Cap 311) and its subsidiary regulations define statutory AQOs for 7 common air pollutants including NO_2, SO_2, TSP, RSP, CO, O_3 and lead. According to Clause 3.4.6.3(vi)(b) of the EIA Study Brief, the key / representative air pollutant parameters for CKR shall be identified, including the types of pollutants and the averaging time concentration.

The air quality pollutant source during the operational phase of CKR would be the emission from the vehicles travelling on the new and existing roads. The tailpipe emission would comprise a number of pollutants, including Nitrogen Oxides (NO_x), Respirable Suspended Particulates (RSP), Sulphur Dioxides (SO_2), Toxic Air Pollutants (TAP), Lead (Pb) etc. As discussed in the following sections, only the NO_2 and RSP are considered the key air quality pollutant for this highway infrastructure project and the concentrations of the other pollutants are very low and hence are not considered as the key pollutants for the purposes of this air quality assessment. The issue on Ozone (O_3) which is highly influenced by the regional situation would also be discussed.

i) Nitrogen Dioxide (NO_2)

Nitrogen oxides (NO_x) is known to be one of the pollutants emitted by vehicles. According to the 2010 Hong Kong Emission Inventory Report published by EPD (http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/2010HKEIReportEng.pdf) which is the latest available information by the time of preparing this report, the dominant source of NO_x generated in HK is the navigation which constitutes about 32% of the total in 2010. Road transport is the second largest NO_x emission group, accounting for about 30% of the total (see table below).

Table 4.16: The emission percentage and the amount of NOx in Hong Kong (2010)

Pollutant Source Categories	NO_x Emission %[1]	NO_x Emission (tons) [1]
Public Electricity Generation	25%	27,000
Road Transport	30%	32,700
Navigation	32%	35,000
Civil Aviation	4%	4,350

Pollutant Source Categories	NO_x Emission %[1]	NO_x Emission (tons) [1]
Other Fuel Combustion	9%	9,520
Non-combustion	N/A	N/A
Total	100%	109,000

Note:
[1] Figures extracted from 2010 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/2010HKEIReportEng.pdf)

Together with VOC and in the presence of O_3 under sunlight, NO_x would be transformed to NO_2. As discussed in **Section 4.4.2**, the latest 5-year average of annual NO_2 concentrations in Kwun Tong and Sham Shui Po are about 76% and 86% of the AQOs respectively.

The operation of CKR would inevitably increase the traffic flow and hence the NO_x emission and subsequently the NO_2 concentrations near to the roadside. Hence, NO_2 is one of the key / representative pollutants for the operational air quality assessment of the Project. 1-hour, 24-hour and annual averaged concentrations at each identified ASRs would be assessed and compared with the relevant AQO to determine the compliance.

ii) Respirable Suspended Particulates (RSP or PM10)

Respirable Suspended Particulates (RSP or PM10) refers to suspended particulates with a nominal aerodynamic diameter of 10µm or less. According to the EPD's data, (http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/2010HKEIReportEng.pdf), and other research studies (Tian et al., 2011 & Wie-Zhen et al., 2008), road vehicles, particularly diesel vehicles, are one of the sources of RSP in Hong Kong.

According to the latest statistics of 2010 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/2010HKEIReportEng.pdf), road transport is the second largest source of RSP accounting for 21% of the total emissions. As discussed in **Section 4.4.2**, the latest 5-year average of the annual RSP concentration in Kwun Tong and Sham Shui Po are about 89% and 93% of the AQO respectively.

Table 4.17: The emission percentage and the amount of RSP in Hong Kong (2010)

Pollutant Source Categories	RSP Emission % [1]	RSP Emission (tons) [1]
Public Electricity Generation	16%	1,010
Road Transport	21%	1,340
Navigation	36%	2,260
Civil Aviation	<1%	54
Other Fuel Combustion	12%	778
Non-combustion	14%	898
Total	100%	6340

Note:
[1] Figures extracted from 2010 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/2010HKEIReportEng.pdf)

The operation of CKR would inevitably increase the traffic flow and hence the RSP concentrations near to the roadside. Hence, RSP is also one of the key representative pollutants for the operational air quality assessment of the Project. The 24-hour and annual averaged concentrations at each identified ASRs would be assessed and compared with the relevant AQOs to determine the compliance.

iii) Sulphur Dioxide (SO_2)

According to the latest statistics of 2010 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/2010HKEIReportEng.pdf), the dominant sources of Sulphur Dioxide (SO_2) in Hong Kong are electricity generation and navigation which constitute the majority of the emissions (about 98%). Although SO_2 is also one of the pollutants emitted by vehicles, road transport is the smallest emission source of SO_2 and only constitutes less than 1% of the total SO_2 (see the following table). The introduction of ultra low sulphur diesel for vehicle fleet in Year 2000 has also helped reducing the SO_2 emission in Hong Kong.

Table 4.18: The emission percentage and the amount of SO_2 in Hong Kong (2010)

Pollutant Source Categories	SO_2 Emission %[1]	SO_2 Emission (tons) [1]
Public Electricity Generation	50%	17,800
Road Transport	<1%	286
Navigation	48%	16,900
Civil Aviation	<1%	299
Other Fuel Combustion	<1%	268
Non-combustion	N/A	N/A
Total	100%	35,500

Note:
[1] Figures extracted from 2010 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/2010HKEIReportEng.pdf)

As discussed in **Section 4.4.2**, the latest 5-year average of annual SO_2 concentrations in Kwun Tong and Sham Shui Po are only 17% and 22% of the AQO respectively. This clearly indicates that the AQOs for SO_2 could be well achieved with great margin in the study area. Given that road transport only contributes a very small amount of SO_2 and there is still a large margin to the AQO compared to the other pollutants such as RSP and $NO_{2,}$ it is considered appropriate to select RSP and $NO_{2,}$ but not SO_2 as the key pollutants for quantitative assessment for the operational phase of a road project.

iv) Ozone (O3)

According to the EPD's "Air Quality in Hong Kong 2011", O_3 is a regional air pollution problem which affects the entire PRDEZ, including Hong Kong. The following table summarises the Year 2011 O_3 monitoring data in Hong Kong extracted from the EPD's report titled "Air Quality in Hong Kong 2011". It can be seen that the highest 1-hour O_3 concentration in various regions of Hong Kong would exceed the existing AQO. The O_3 concentration at Tap Mun which is away from any highway infrastructures and industrial sources is also very high. This implies that O_3 is highly influenced by regional sources instead of local emission sources. This is also in line with other studies such as Y. Sun study in 2011 – "In situ measurements of SO_2, NO_x, NO_y, and O_3 in Beijing, China during August 2008"[4-1] and "In situ measurements of NO, NO_2, NO_y, and O_3 in Dinghushan (112°E, 23°N), China during autumn 2008"[4-2] .

Table 4.19: 2011 Ozone monitoring data extracted from "Air Quality in Hong Kong 2011"

Station	Highest 1-Hour Conc (μg/m^3) [1] (AQO=240)	Highest Daily Conc (μg/m^3) [2]	Annual Avg. Conc (μg/m^3) [2]
Central/Western	**278**	128	36
Eastern	**257**	126	46
Kwai Chung	213	102	28

Station	Highest 1-Hour Conc (µg/m^3) [1] (AQO=240)	Highest Daily Conc (µg/m^3) [2]	Annual Avg. Conc (µg/m^3) [2]
Kwun Tong	181	126	37
Sham Shui Po	240	106	31
Tsuen Wan	223	112	31
Sha Tin	**241**	157	43
Tai Po	**260**	153	48
Tung Chung	**312**	144	44
Yuen Long	**310**	131	39
Tap Mun	**316**	167	71

Note:
[1] Bolded values mean exceedance of the AQO.
[2] Ozone does not have a 24-hour and annual AQOs.

Unlike other pollutants such as NO_x, O_3 is not a primary pollutant emitted from man-made sources but is formed by a set of complex chain reactions between various chemical species, including NO_x and VOC, in the presence of sunlight. According to Sun et al. and Dahlmann et al. the rate of formation of O_3, also known as Ozone Production Efficiency, depends not only on NO_x and VOC levels, but atmospheric oxidation, temperature, radiation, and other meteorological factors in the atmosphere of different regions. The formation of O_3 generally takes several hours to proceed (EPD, 2009)[4-3] and therefore O_3 recorded locally could be attributed to emissions generated from places afar.

According to "A Study Review Hong Kong's Air Quality Objectives" (http://www.epd.gov.hk/epd/english/environmentinhk/air/studyrpts/aqor_report.html), due to the abundance of its precursors (VOC and NO_x) from a great variety of sources such as motor vehicles, industries, power plants and consumer products, etc., ozone can be widely formed in the region and can be transported over long distance. The general rising trend of ozone levels in Hong Kong over the past years reflects an aggravation in the photochemical smog problem on a regional scale. All these indicate that local traffic emission is not a dominant controlling factor in O_3 formation.

According to the EPD's "Air Quality in Hong Kong 2011" report, NO_x emissions from motor vehicles have the potential to react with and remove O_3 in the air, and regions with heavy traffic normally have lower ozone levels than areas with light traffic. It is therefore possible that the Project may contribute to a decrease in O_3 in the immediate area along main roads. O_3 is therefore not considered as a key air pollutant for the operational air quality assessment of the Project.

v) Carbon Monoxide (CO)

Carbon Monoxide (CO) is one of the primary pollutants emitted by road transport. According to the latest statistics of 2010 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/2010HKEIReportEng.pdf), CO emissions from road transport contributed about 68% of total CO emission in 2010 (see the table below).

Table 4.20: The emission percentage and the amount of CO in Hong Kong (2010)

Pollutant Source Categories	CO Emission %	CO Emission (tons)
Public Electricity Generation	5%	3,310
Road Transport	68%	47,600

Pollutant Source Categories	CO Emission %	CO Emission (tons)
Navigation	16%	11,400
Civil Aviation	4%	2,530
Other Fuel Combustion	7%	5,100
Non-combustion	N/A	N/A
Total	100%	70,000

It is understood that road transportation is the dominant source of CO emission; nevertheless, the air quality impact due to CO is still relatively minor considering its existing concentrations. The highest 1-hour, 8-hour and annual CO concentrations in Hong Kong for Year 2011 are summarised in the following table.

Table 4.21: 2011 CO monitoring data extracted from "Air Quality in Hong Kong 2011"

Station	Highest 1-Hour Conc (µg/m^3) [1] (AQO=30000)	Highest 8-hour Conc (µg/m^3) (AQO=10000)	Annual Avg. Conc (µg/m^3) [2]
Tsuen Wan	2730	2158	585
Tung Chung	2290	2188	660
Yuen Long	3210	2610	677
Tap Mun	1490	1459	752
Causeway Bay	4030	3309	1010
Central	3790	2516	820
Mong Kok	3110	2400	1034

Note:
[1] Bolded values mean exceedance of the AQO.
[2] CO does not have annual AQO.

It is clearly indicated that the AQOs for CO could be well achieved with great margin in the study area. The highest 1-hour CO concentration and highest daily CO concentration in Mong Kok are only 10% and 24% of their respective AQOs, which are both far below the criteria. Given that there is still a large margin to the AQO compared to the other pollutants such as RSP and NO_2, it is considered appropriate to select RSP and NO_2, but not CO as the key pollutants for quantitative assessment for the operational phase of a road project.

vi) Toxic Air Pollutants (TAPs)

There are six kinds of Toxic Air Pollutants (TAPs) routinely monitored in HK, including polychlorinated biphenyls (PCBs), dioxins, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), carbonyls, and toxic elemental species.

Dioxins, carbonyls, PCBs and most toxic elemental species are not considered primary sources of vehicular emissions (http://www.epd.gov.hk/epd/english/environmentinhk/air/studyrpts/assessment_of_tap_measurements.html & http://www.eea.europa.eu/publications/EMEPCORINAIR5/Sources_of_PCB_emissions.pdf/view), and hence, these three TAPs are not considered as key / representative air pollutants for the operational air quality assessment.

Vehicular emissions may be a source of diesel particulate matters, PAHs and VOCs. Elemental carbon, which constitutes a large portion of diesel particulate matters mass, is commonly used as a surrogate for diesel particulate matter. According to the data from EPD, the elemental carbon showed a significant decrease in concentration in Mong Kong by 47.5% from 2001 to 2009, and Tsuen Wan by 51.3% from 1999 to 2009. This is because the implementation of EURO

III vehicle emission standard to goods vehicle and bus in 2001 and EURO IV standard to all types of vehicle in 2006-2007 (http://www.epd.gov.hk/epd/english/environmentinhk/air/data/emission_inve.html). It is not considered as a key air pollutant for the operational air quality assessment.

Currently, no ambient air quality standards have been set for PAHs. However, with reference to US and European Community air quality guidelines, the European commission has a very stringent guideline concentration for PAHs. According to the latest EPD study report in 2011 - "Annual Air Quality Monitoring Results - Air Quality in Hong Kong 2011" (http://www.epd-asg.gov.hk/english/report/files/AQR2011e_final.pdf), the concentration of PAHs level (Benzo[a]pyrene, BaP) in Hong Kong was 0.22 ng/m^3 monitored at both the Tsuen Wan and Central/Western stations respectively in 2011 which was still much lower than the guidelines of European Communities of 1ng/m^3.

Table 4.22: Comparison of TAPs concentration in Hong Kong (2011) and the EU Air Quality Standards

Air Pollutants	Guidelines / Standards (ng/m^3)	Highest Avg Conc at Tsuen Wan station (ng/m^3)	Highest Avg Conc at Central/Western station (ng/m^3)	Compliance
	EU			EU
PAHs (BaP)	1 (Annual Average)[1]	0.22 (Annual Average)[2]	0.22 (Annual Average)[2]	Well Achieved

Note:
[1] Referenced from http://ec.europa.eu/environment/air/quality/standards.htm
[2] Referenced from http://www.epd-asg.gov.hk/english/report/files/AQR2011e_final.pdf

There are different standards for different VOC compounds. According to the latest EPD study report in 2011 – "Annual Air Quality Monitoring Results - Air Quality in Hong Kong 2011" (http://www.epd-asg.gov.hk/english/report/files/AQR2011e_final.pdf), benzene, 1-3 butadiene, formaldehyde and perchloroethylene are the VOCs that may have more health concern, and the USEPA also identified benzene and 1-3 butadiene are carcinogenic.

Table 4.23: Comparison of VOCs concentration in Hong Kong (2011) and the EU Air Quality Standards

TAP	Guidelines / Standards (µg/m^3)	Highest Avg Conc at Tsuen Wan station (µg/m^3)	Highest Avg Conc at Central/Western station (µg/m^3)	Compliance
Benzene	5 (Annual Average) [1]	1.62	1.53	Well Achieved
1-3 butadiene	2.25 (Running Annual Average) [1]	0.13	0.13	Well Achieved
Formaldehyde [2]	9 (Annual Average) [3]	-	3.61	Well Achieved
Perchloroethylene	40 (Annual Average) [4]	0.47	0.51	Well Achieved

Note:
[1] Referenced from the UK National Air Quality Strategy (NAQS) (http://www.medway.gov.uk/environmentandplanning/environmentalhealth/airquality/airqualityfordevelopers.aspx)
[2] The measurement of formaldehyde was affected by influence from renovation works at Princess Alexandra Community Centre as well as nearby buildings of Tsuen Wan Station. Hence, only formaldehyde concentration at the Central/Western station is reported.

[3] Referenced from the Office of Environmental Health Hazard Assessment (OEHHA) Toxicity Criteria Database, California, USA (http://www.oehha.ca.gov/tcdb/index.asp)
[4] Referenced from the Integrated Risk Information System (IRIS), USEPA (http://www.epa.gov/iris/subst/0106.htm)

As shown in the above table, the measured VOCs concentration in Hong Kong urban area is far below the UK and US standards. Also, according to Hong Kong Air Pollutants Emission Inventory (http://www.epd.gov.hk/epd/english/ environmentinhk/air/data/emission_inve.html), the VOCs level has dropped by approximately 50% in 2007 since 1990 due to the EPD progressive improvement of EURO standard vehicles over the past two decades. With reference to the EPD's 2010 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/2010HKEIReportEng.pdf), vehicular emission is also not the primary source of VOCs, accounting for about 23% of the total in Hong Kong. Besides, according to another study - "Seasonal and diurnal variations of volatile organic compounds (VOCs) in the atmosphere of Hong Kong" [4-4], benzene, and 1-3 butadiene only contributed about 6-13% of overall vehicular emission VOCs. In other words, only 1.6-3.5% of the overall VOC emissions in Hong Kong are benzene and 1-3 butadiene contributed by vehicular emission.

The historical monitoring data showed that the concentrations of PAHs and VOCs were only in small amount. It is also reasonably believed that the emission of PAHs and VOCs should be significantly decreased after the implementation of EURO V standard vehicles in 2013; and the elimination of most of the pre-EURO standard and EURO I vehicles. The TAPs is also not specified under the current AQO. Based on above reasons, TAPs is not considered as a key air pollutant for the operational air quality assessment.

vii) Lead (Pb)

As leaded petrol had been banned in Hong Kong in 1999, it is no longer considered as a primary source in Hong Kong. According to the "Annual Air Quality Monitoring Results - Air Quality in Hong Kong 2011" from EPD (http://www.epd-asg.gov.hk/english/report/files/AQR2011e_final.pdf), the measured 3-month averaged lead level was ranging from 0.020 $\mu g/m^3$ (Kwun Tong and Central/ Western) to 0.104 $\mu g/m^3$ (Yuen Long). The measured concentration is much lower than the 3-month AQO of 1.5 $\mu g/m^3$. Therefore, lead is not considered as a key / representative air pollutant for the operational air quality assessment.

As discussed in above, NO_2 and RSP have been concluded to be the representative air pollutants. These two pollutants are stipulated in the HKAQO. Hence, it is considered appropriate to adopt the time averaging as stipulated in the HKAQO.

4.4.5 Pollution Sources and Concurrent Projects

4.4.5.1 Vehicular Emission from Open Road

As discussed in **Section 4.4.4**, the NO_2 and RSP are the two key air pollutants generated from road traffic emissions during operational phase of the Project. Other than vehicular emissions from project related roads, those from the concurrent projects, such as the Road works at West Kowloon, planned road networks associated with Kai Tak Development, T2, etc. would also have cumulative air quality impact on nearby ASRs. The table below shows a summary of concurrent projects that would generate cumulative impact from open road and induced traffic. **Figures 4.7.1 – 4.7.3** illustrate the road networks within 500m of each study area (i.e. West Portion, East Portion and Central Portion).

Table 4.24: Concurrent Projects included in the Operational Air Quality Assessment

Concurrent Projects	Tentative Commissiong Year
Trunk Road T2	End 2020 [3]
Planned road networks associated with Kai Tak Development	Road D2 – End 2017 Road D3 (part) – 2020 Road D4 & Road D3 (part) – End 2017
Kai Tak Development (KTD) – Roads D3A & D4A	2017
Road works at West Kowloon	2014
Proposed Road Improvement Works in West Kowloon Reclamation Development Phase I	2015
Tseung Kwan O - Lam Tin Tunnel and Associated Works (TKO-LTT) [1]	End 2020
Cross Bay Link (CBL) [1]	End 2020
West Kowloon Cultural District (WKCD) [1]	Starting from 2013 (in stages)
Express Rail Link – West Kowloon Terminus [2]	2015

Notes:

[1] The TKO-LTT and WKCD are located outside 500m of the study areas and hence the road networks are excluded in the model. However, the traffic forecast has also been taken into account the induced traffic from these concurrent projects.

[2] Induced traffic has been taken into account.

[3] A number of traffic model scenarios have been investigated in the TIA studies. It was agreed with TD that, with Road T2 and CBL in place, traffic would be diverted outside the 500m of study area, resulting in less traffic volume. It was concluded in the TIA that the scenario with CKR and TKO-LTT (but without T2 and CBL) is the critical and worst assessment scenario for CKR EIA Study. The TD's endorsement letter is given in Appendix 4.3A.

Liaisons with the respective project proponents of the above concurrent projects have been made to obtain the latest available project information and details. Where information is not available, references have been made to the approved EIA reports which are regarded as the best available information at the time of preparing this EIA.

4.4.5.2 Vehicular Emission from Tunnel Portal and Ventilation Building

Based on current tunnel ventilation design of the CKR, vehicular emission inside the tunnel will be discharged to atmosphere via the three proposed ventilation buildings, i.e. West Ventilation Building (WVB) located in Yau Ma Tei (West Portion), Central Ventilation Building (CVB) in Ho Man Tin (Central Portion) and East Ventilation Building (EVB) in Kai Tak (East Portion). Limited emission from the CKR tunnel portals would be achieved in order to reduce potential air quality impact in this area. The tunnel ventilation system is designed with the objective to remove/dilute vehicle emissions to achieve the air quality standards specified in EPD's "Practice Note on Control of Air Pollution in Vehicle Tunnels", and to maintain limited discharge of emission from the portals. In addition, to further reduce the air quality impact, an air purification system (APS) will be adopted which will remove the pollutant concentrations before releasing to atmosphere via the three ventilation buildings. As described in **Section 3.2.9**, the proposed APS will comprise two main processes: the use of Electro-static Precipitators (ESP) to remove the particulates and the NO_2 removal system, either using specially prepared activated carbon filter media or decomposing modules which are periodically regenerated on site by "washing" with chemical solutions such as ammonia, potassium hydroxide or sodium sulphite etc. The current APS design aims to achieve a removal efficiency of 80% for particulate and 80% for NO_2. **Figures 4.7.1 – 4.7.3** illustrate the locations of the proposed tunnel portals, the associated landscape deck and ventilation buildings associated with CKR in each study area.

Other than those tunnel portals and ventilation buildings of the CKR mainline, there are also proposed full enclosures on other roads associated with CKR including those on Hoi Wang Road, reprovision section of GRF and near Prosperous Garden and tunnels for Ring Road and Slip Road S3. Besides, the existing and planned tunnel/enclosure portals and ventilation buildings within the study areas that would also have cumulative air quality impact on nearby ASRs. **Figures 4.7.1 – 4.7.3** illustrate the locations of these existing/planned tunnel portals and ventilation buildings in each study area and a summary is given in the table below.

Table 4.25: Existing and Planned Tunnel/Enclosure Portals and Ventilation Buildings included in the Operational Air Quality Assessment

Existing and Planned Tunnel/Enclosure Portals and Ventilation Buildings	Tentative Commissiong Year
CKR Associated	
Proposed full enclosure on Hoi Wang Road	End 2020
Proposed full enclosure over the reprovision section of Gascoigne Road Flyover	End 2020
Proposed full enclosure near Prosperous Garden	End 2020
CKR- Tunnel for Ring Road and Slip Road S3	End 2020
Existing and Planned	
Trunk Road T2 - Tunnel for Ring road near Kai Tak Runway	End 2020
KTD - Proposed landscape deck for Road D2	End 2017
Road works at West Kowloon - Proposed underpass and tunnel portals for Austin Road/ Lin Cheung Road, and the proposed landscape decks at Lin Cheung Road	2014
Kai Tak Tunnel and ventilation building	Existing
Western Harbour Crossing (WHC) – Tunnel portal and ventilation building in West Kowloon area	Existing
Cherry Street Tunnel	Existing

4.4.5.3 Industrial Emission

Chimney survey and desktop study have been conducted to identify existing and planned chimneys within 500m study area. The chimney information, including fuel consumption rate, stack height, gas exhaust velocity, exhaust temperature and the internal diameter of the stack etc have been collected from the respective operators where available. References have also been made to the approved EIA studies (e.g. the approved KTD EIA report for the planned hospital in Kai Tak) and specified process licence (e.g. SP licence for the Towngas plant in Ma Tau Kok). Summary of all identified existing/planned chimneys in each study area and their locations are given in **Figures 4.7.4 – 4.7.6**. As confirmed by the operators, some of them have no longer been used and some are being used for emergency only. The table below lists the chimneys that are included in the operational air quality assessment.

Table 4.26: Existing and Planned Chimneys included in the Operational Air Quality Assessment

Source ID	Description	Operation Mode
West Portion		
W1	Boiler at Tak Yue Restaurant	Continuously in-use
W2	Boiler at Tak Yue Restaurant	Continuously in-use
W3	Boiler at Tak Yue Restaurant	Continuously in-use
W4	Boiler at Mei Du Restaurant	Continuously in-use
East Portion		
HOS	Planned Hospital in KTD	Planned Hospital
TG_1	Specified Process Licence for HKCG	Continuously in-use
TG_2	Specified Process Licence for HKCG	Continuously in-use
TG_3	Specified Process Licence for HKCG	Continuously in-use
TG_4	Specified Process Licence for HKCG	Continuously in-use
TG_16	Specified Process Licence for HKCG	Continuously in-use

Notes:
[1] No chimneys being operated in Middle Portion.

4.4.5.4 Marine Emission

The existing To Kwa Wan Typhoon Shelter (TKWTS) is partially within 500m of the Project boundary and the cumulative air quality impact due to the gaseous emission from marine vessels berthing at TKWTS has also been assessed. Reference has been made to the approved EIA report "*Kai Tak Development*" (KTD) (AEIAR-130/2009) and the "*Study on Marine Vessels Emission Inventory, Final Report (February 2012)*" published by EPD for the emission details. It is observed from the site survey that there are only about 20 barges/vessels within the TKWTS and all of them have no activities. This observation is in line with that from the approved KTD EIA Study. It has therefore assumed 20 barges with auxiliary engine operating within the TKWTS in this assessment. Unlike the Public Cargo Working Areas (PCWAs), there are no loading/unloading activities at typhoon shelter. The typhoon shelter only provides a sheltered space to protect the vessels during typhoons and inclement weather conditions. Its occupancy shall reach its maximum only during typhoon period and all vessels shall not be operated. Thus, assuming 20 barges with auxiliary engine operating within the TKWTS is very conservative in this assessment.

Apart from the TKWTS, there is no other marine emission within 500m of the Project. However, for conservative assessment, it has also considered to include the major emission source immediately outside 500m in the near-field dispersion model for assessing the cumulative air quality impacts (i.e. the committed cruise terminal at Kai Tak). Reference has also been made to the KTD EIA report and the "*Study on Marine Vessels Emission Inventory, Final Report (February 2012)*" published by EPD for the emission details of the cruise terminal.

According to the Port Control (Public Cargo Working Areas) Order 2011 gazetted in December 2011, the Kwun Tong Public Cargo Working Areas (PCWAs) which is outside 500m of the Project will be decommissioned to make way for the development of the Kwun Tong Promenade Stage 2. All the operations at the PCWA had already moved out (i.e. no operation within the KTTS). As such, there is no marine emission anticipated from the Kwun Tong PCWAs, and hence are not included in the cumulative impact assessment.

Figure 4.7.6 illustrates the locations of the cruise terminal and the existing TKWTS in the East Portion study area.

4.4.5.5 Helicopter Emission

A heliport is proposed at the end of the Kai Tak Runway under the KTD. Although it is outside 500m of the Project, it is considered as a potential major emission and hence its cumulative air quality impact on nearby ASRs has been assessed in the near-field dispersion model. Reference has been made to the approved EIA Study "*Kai Tak Development*" (KTD) (AEIAR-130/2009) for the emission details of the proposed heliport. **Figure 4.7.6** illustrates the locations of the proposed heliport in the East Portion study area.

4.4.5.6 Summary of Projects and Sources Included in Operational Air Quality Assessment

A summary of emissions from projects and sources included in Operational Air Quality Assessment is tabulated below:

Table 4.27: Projects/Sources for Operational Air Quality Assessment

Projects / Sources	Associated air quality impact
West Portion	
CKR and associated connection roads [1]	Vehicular emission from portal of the CKR tunnel and its associated landscape deck, ventilation building, as well as the connection roads
Express Rail Link – West Kowloon Terminus	Vehicular emission from its induced traffic
Road Works at West Kowloon [1]	Vehicular emission from its road network, induced traffic, proposed underpass and tunnel portals for Austin Road/ Lin Cheung Road, and the proposed landscape decks at Lin Cheung Road, as well as its induced traffic
Proposed Road Improvement Works in West Kowloon Reclamation Development Phase I	Vehicular emission from its road network and induced traffic
West Kowloon Cultural District	Vehicular emission from its induced traffic only
Proposed full enclosure on Hoi Wang Road [1]	Vehicular emission from portal
Proposed full enclosure over the reprovision section of Gascoigne Road Flyover [1]	Vehicular emission from portal
Proposed full enclosure near Properous Garden [1]	Vehicular emission from portal
Western Harbour Crossing (WHC) [1]	Vehicular emission from tunnel portal and

Projects / Sources	**Associated air quality impact**
	ventilation building
Cherry Street Tunnel [1]	Vehicular emission from tunnel portal
Other existing road networks within 500m	Vehicular emission from all open roads
Boiler at Tak Yue Restaurant	Chimney emission
Boiler at Mei Du Restaurant	Chimney emission
Middle Portion	
CKR central ventilation building [1]	Vehicular emission from ventilation building
Other existing road networks within 500m	Vehicular emission from all open roads
East Portion	
CKR and associated connection roads [1]	Vehicular emission from portal of the CKR tunnel, landscape deck, CKR-Ring Road, and Slip Road S3, ventilation building, as well as the connection roads
Kai Tak Tunnel [1]	Vehicular emission from tunnel portal and ventilation building
Trunk Road T2 [1]	Vehicular emission from its road network, induced traffic, and tunnel portals from Ring road near Kai Tak Runway
Kai Tak Development [1]	Vehicular emission from its road network, induced traffic, and portals from the proposed landscape deck for Road D2
KTD – Roads D3A & D4A	Vehicular emission from its road network and induced traffic
Tseung Kwan O - Lam Tin Tunnel and Associated Works (TKO-LTT)	Vehicular emission from its induced traffic only
Cross Bay Link (CBL)	Vehicular emission from its induced traffic only
Other existing road networks within 500m	Vehicular emission from all open roads
Planned Hospital in KTD	Chimney emission
Specified Process Licence for HKCG	Chimney emission
Kai Tak Development – Cruise Terminal	Marine emission
To Kwa Wan Typhoon Shelter	Marine emission
Kai Tak Development – Heliport	Gaseous emission from the helicopter

Notes:
[1] The locations of tunnel portals and ventilation buildings are illustrated in Appendix 4.8.

Other than the emission sources described in the above table, the background concentration have also included the influence of other emission such as marine emission, power plant, airports, etc (see **Section 4.4.6.3**). Hence, together with the above emission sources, the cumulative impact would have included all the major air pollutant sources.

4.4.6 Assessment Methodology

4.4.6.1 In-tunnel Air Quality

It is the responsibility of the Applicant to ensure that the air quality inside comply with EPD's "Practice Note on Control of Air Pollution in Vehicle Tunnels". The air quality inside the tunnel should meet the EPD recommended standard of 1ppm NO_2 concentration. Air quality within the tunnel is to be monitored and the tunnel ventilation system is designed with the objective to remove/ dilute vehicle emissions so that air quality inside will comply with stated air quality standards. **Appendix 4.3** describes how the air pollutant within the proposed CKR tunnel is derived and addressed in this EIA study.

4.4.6.2 Determination of Assessment Year

According to Clause 3.4.6.3 (v) (b) of the EIA Study Brief for the Project, the air pollution impacts of future road traffic shall be calculated based on the highest emission strength from road within the next 15 years upon commencement of operation of the Project. The selected assessment year should represent the highest emission scenario, given the combination of emission factors and traffic flow for the selected year.

Vehicular tailpipe emissions from open roads are calculated based on the EPD EMFAC-HK model v2.1 at the time of assessment (end 2012). However, the latest model version EMFAC-HK v2.5 is just released by EPD in early January 2013. As concluded in the “Outline of Changes in January 2013 Release of EMFAC-HK” in EPD website, the overall effects on emission estimates are insignificant. There are only some changes in the output file formats due to items removal as comparing with v2.1. Besides, one output file name is also changed and the format for input files is changed from VKT to VMT to ensure the consistency in units used in input files (US units). The above format changes would not impose any change in the emission rate. Therefore, the vehicular tailpipe emission rates generated from v2.1 are still adopted in this assessment. The emission refers to the combination of the following:

- Vehicular emission from CKR and its associated road networks;
- Vehicular emission from road networks within 500m of the West Portion study area (i.e. road networks within 500m of the open section of CKR, widening of Gascoigne Road Flyover (GRF), portal and ventilation building of CKR);
- Vehicular emission from road networks within 500m of the Middle Portion study area (i.e. road networks within 500m of the ventilation building since the CKR is in tunnel form in the middle section);
- Vehicular emission from road networks within 500m of the East Portion study area (i.e. road networks within 500m of the open section of CKR, portal and ventilation building of CKR).

Based on the current programme, the CKR is planned for comissioning by the end of 2020. Therefore, EmFAC-HK models have been carried out for Year 2021, 2026 and 2036 (15 years after commissioning) to determine the highest emission and hence the worst assessment year. The traffic forecast data is given **Appendix**

4.4. The methodology, key model assumptions and results (including emission factors) are presented in **Appendix 4.5**.

The total vehicular emissions within the study areas are summarized in the table below. Results indicate that the highest NO_x and RSP emission scenario occurs at Year 2021 and hence is the worst assessment year for operational air quality assessment.

Table 4.28: Summary of Total Daily Pollutant Emissions

Year	Total NO_x Emission (gram/day)	Total RSP Emission (gram/day)
2021	1240802	59302
2026	843940	46803
2036	514304	32588

4.4.6.3 Prediction of the Future Background Air Quality

PATH (Pollutants in the Atmosphere and their Transport over Hongkong) is a regional air quality model developed by EPD to simulate air quality over Hong Kong against the Pearl River Delta (PRD) as background. For EIA applications, it simulates wind field, pollutant emissions, transportation and chemical transformation and outputs pollutant concentrations over Hong Kong and the PRD region at a fine grid size of 1.5km.

During the 12th Hong Kong-Guangdong Joint Working Group Meeting on Sustainable Development and Environmental Protection (Nov 2012), the Hong Kong and Guangdong Governments jointly endorsed a Major Air Pollutant Emission Reduction Plan for the Pearl River Delta Region up to year 2020. A comprehensive emission inventory for Hong Kong and PRD was compiled for year 2010 based on current best estimates and projected to 2015 and 2020 in accordance with the emission reduction measures proposed in the plan. The emission inventory for year 2010 was used in PATH and produced reasonable agreement with air quality measurements. The emission inventories for years 2015 and 2020 were also used in PATH to predict air qualities for future years. The Hong Kong emission inventories are summarized in **Tables 29a-29c**.

Table 29a: Summary of 2010 Hong Kong Emission Inventory for the PATH model

Emission Group	Annual Emission (2010) Tonnes/Yr			
	SO_2	NO_x	RSP	VOC
Public Electricity Generation	17800	27000	1010	413
Road Transport	286	32700	1340	7900
Navigation	16900	35000	2260	3660
Civil Aviation	299	4350	54	396
Other Fuel Combustion	268	9520	778	849
Non-combustion	N/A	N/A	898	20500
Total	**35500**	**109000**	**6340**	**33700**

Table 29b: Summary of 2015 Hong Kong Emission Inventory for the PATH model

Emission Group	**Annual Emission (2015) Tonnes/Yr**			
	SO_2	**NO_x**	**RSP**	**VOC**
Public Electricity Generation	12500	27600	830	390
Road Transport (1)	305	20070	809	5122
Navigation	13102	35760	2359	3830
Civil Aviation (2)	493	6670	89	433
Other Fuel Combustion(3)	225	8000	654	713
Non-combustion	N/A	N/A	965	21527
Total	**26625**	**98100**	**5706**	**32015**

Table 29c: Summary of 2020 Hong Kong Emission Inventory for the PATH model

Emission Group	**Annual Emission (2020) Tonne/Yr**			
	SO_2	**NO_x**	**RSP**	**VOC**
Public Electricity Generation	6180	20900	560	360
Road Transport (1)	322	11000	540	1640
Navigation	15695	37010	2440	3867
Civil Aviation (2)	650	8770	120	570
Other Fuel Combustion(3)	228	8100	697	720
Non-combustion	N/A	N/A	1032	21488
Total	**23075**	**87200**	**5389**	**28645**

Notes:

1. Emissions from Road Transport for years 2015 and 2020 are estimated based on VKTs forecast provided by the Transport Department and EMFAC-HK Model version 2.1.
2. Emissions from Civil Aviation for years 2015 and 2020 are estimated based on ATM of 362,000 and 476,000 respectively.
3. Emissions from the following major facilities are considered in the inventory: HK & China Gas, Green Island Cement and Integrated Waste Management Facilities.

PATH model was used to quantify the background air quality during the operational phase of the Project. Emission sources including roads, marine, airports, power plants and industries within the Pearl River Delta Economic Zone and Hong Kong were considered in the PATH model. Details of the PATH Model and related emission inventory can be found in EPD's web site. The hourly pollutant concentration data predicted by PATH for year 2020 are provided by EPD and adopted in the calculation of cumulative impact in the Project. However, since the vehicular emission at local scale (i.e. the road networks within the study areas mentioned in **Section 4.4.6.2**) is modeled by near-field dispersion model CALINE, the respective emission has been removed from the concerned grids to avoid overestimation and the PATH model has been re-run. The updated PATH background concentrations for the concerned grids which cover the study areas of this Project for Year 2020 are extracted in **Appendix 4.6**.

4.4.6.4 Prediction of the Vehicular Emission from Open Road

The EMFAC-HK estimates the hourly vehicular emission (in tonne) for each road category. The USEPA approved near field air dispersion model, CALINE4 developed by the California Department of Transport has been used to assess vehicular emissions impact from all existing and planned open road network. The CALINE4 requires input of the emission rates (in gram per mile per vehicle). The hourly emission rates for each vehicle class (in gram per mile per vehicle) are obtained by dividing the hourly emissions calculated in the EMFAC-HK by the Vehicle Kilometres Travelled (VKT) for the respective hour. The calculation of the NO_x and RSP emission factors are given in **Appendix 4.5**. The composite vehicle emission factors for each road link for the assessment year 2021 is given in **Appendix 4.7**.

Grid-specific composite real meteorological data extracted from EPD's PATH model are adopted in CALINE4 model, including relevant temperature, wind speed, direction and mixing height. The stability classes are obtained from a separate PCRAMMET model. The mixing height is capped to 121m as per the real meteorological data. For the treatment of calm hours, the approach recommended in the "Guideline on Air Quality on Air Quality Models Version 05" has been adopted.

The surface roughness height is closely related to the land use characteristics, and the surface roughness is estimated as 10 percent of the average height of physical structures within 1km study area. Surface roughness of 100cm is assumed to represent the urbanized terrain. The wind standard deviation is estimated in accordance with the "Guideline on Air Quality Models (Revised), 1986", as summarized in the table below.

Table 4.30: Summary of Wind Standard Deviation for Surface Roughness of 100cm

Stability Class	Wind Standard Deviation
A	32.9
B	32.9
C	25.6
D	18.3
E	11.0
F	5.6

Ozone Limiting Method (OLM) was adopted for conversion of NO_x to NO_2, using the predicted O_3 and NO_2 levels from PATH model. According to EPD's Guidelines on Choice of Models and Model Parameters, the vehicular tailpipe NO_2 emission is assumed to be 7.5% of NO_x.

Owing to the constraint of the CALINE4 model in modelling elevated roads higher than 10m, the road heights of elevated road sections in excess of 10m high above local ground or water surface are set to 10m in the model as the worst-case assumption. For barriers along roads or any proposed noise barriers as a noise mitigation measures, the line source has been modelled at the tip of the barrier and the mixing width is limited to the actual uncovered road width in order to address the associated secondary environmental impact. The road type of the concerned section is set to the "fill" option in CALINE4.

4.4.6.5 Prediction of the Vehicular Emission from Tunnel Portals and Ventilation Buildings

The USEPA approved model, ISCST3, is adopted to model the vehicular emission from tunnel portals, portals of landscape deck/full enclosure and ventilation buildings. Portal emissions are modeled in accordance with the Permanent International Association of Road Congress Report (PIARC, 1991), where it is assumed that the pollutant will be ejected from the portal as a portal jet such that 2/3 of the total emission will be dispersed within first 50m from the portal, and 1/3 of the total emission within the second 50m. To take into account the horizontal jet effect, portal emission is modeled as "Volume" source. On the other hand, emissions from the ventilation buildings are modeled as "Point" source in ISCST3. The pollution sources that are covered in the near field dispersion ISCST3 model include the following:

(A) Portal emission from CKR tunnel and associated landscape deck

The total length of the CKR tunnel is approximately 3.75km and the CVB is at some 1.75km from the eastern portal (i.e. 2km from western portal). The current tunnel ventilation system is designed to extract a portion of emission (e.g. p%) from the first 1.75km of the west bound tunnel (WBT) to the CVB. The p% depends on the design of the air flow rates of the ventilation fans which would vary for different hours. The remaining portion of emission (e.g. 100-p%) will be mixed with that from the second 2km of WBT and 90% of these emission will then be ventilated to WVB. The remaining 10% from the western tunnel portal will be mixed with the vehicular emission inside the connecting landscape deck and the total emission will be emitted via 3 openings (i.e. CKR and landscape deck portal, portal of the CKR emergency road and CKR east bound tunnel). The emissions from each portal are estimated based on the traffic split.

Similar tunnel ventilation system is applied to the CKR east bound tunnel (EBT). However, since it is considered possible that all emissions inside the western landscape deck will be drawn into the EBT, it has therefore assumed all emissions from the CKR landscape deck to be drawn into the EBT for conservative assessment. The tunnel ventilation system will extract a portion of emission (e.g. p%) from the first 2.0km of the EBT and from the landscape deck to the CVB. The p% depends on the design of the air flow rates of the ventilation fans which would vary for different hours. The remaining portion of emission (e.g. 100-p%) will be mixed with that from the second 1.75km of EBT and 90% of these emission will then be ventilated to EVB. The remaining 10% will be emitted via the CKR eastern tunnel portal. Calculation of the CKR portal emissions is provided in **Appendix 4.8**.

(B) Emission from CKR ventilation buildings

An APS will be adopted which will remove the pollutant concentrations before discharging to atmosphere via the three ventilation buildings. The current APS design aims to achieve a removal efficiency of 80% for particulate and 80% for NO_2 (i.e. assuming tailpipe NO_2 emission to be 7.5% of NO_x). Two modules will be operated at the CVB for all hours. For WVB and EVB, two modules will be operated from 00:00 to 07:00 and three modules will be operated from 07:00 to 24:00. In addition, the APS will be switched off from 01:00 to 06:00 for regular daily maintenance. The current design of the ventilation buildings including air flow rate, exit velocity, exit temperature, discharge heights, exhaust directions, exhaust area is provided by the engineer and summarised in **Appendix 4.8**. The emission calculation is also presented in the appendix.

Based on the current design, the emission from CVB and EVB will be discharged in an upward direction; while that from WVB will be discharged at an inclined 45 degree upward direction towards the sea. Since the ISCST3 model cannot simulate the dispersion from an inclined discharge, the exit velocity of the discharge has been set as the vertical component of the inclined discharge velocity. The horizontal component of the inclined discharge velocity was not simulated in the model. As the emission is discharged towards the sea and the ASRs are located at least 150m away on the opposite direction of the discharge, the effect of the discharge plume on these ASRs should be very insignificant.

(C) Portal emission from full enclosure on Hoi Wang Road, full enclosure at the Prosperous Garden, full enclosure over re-provisioned Gascoigne Road Flyover, proposed landscape deck on CKR at East Portion, Cherry Street tunnel, Trunk Road T2 - Ring road, CKR - Ring Road, Slip Road S3, proposed landscape deck for Road D2 in KTD

The portal emissions from the proposed full enclosure on Hoi Wang Road, full enclosure at the Prosperous Garden, full enclosure over re-provisioned Gascoigne Road Flyover, proposed landscape deck on CKR at East Portion, as well as T2 – Ring road, CKR – Ring Road and Slip Road S3 road are calculated based on the Year 2021's projected traffic flow and vehicular emission factors as given in **Appendix 4.5**. **Appendix 4.8** shows the calculation of these portal emissions.

(D) Emission from Kai Tak tunnel portals and associated ventilation building

Assumption on the emission split between ventilation building and Kai Tak Tunnel (i.e. 50/50%) has been made with reference to the approved EIA Study "Kai Tak Development" (AEIAR-130/2009) (KTD EIA) and the emissions are calculated based on the Year 2021's projected traffic flow and vehicular emission factors. **Appendix 4.8** presents the calculations for the emission from Kai Tak tunnel portal and its associated ventilation building. Details on the release height, exit temperature, exit velocity and equivalent stack diameter for the ventilation building assumed in the model are also given in the appendix.

(E) Emission from the proposed underpass and tunnel portals for Austin Road/ Lin Cheung Road, and the proposed landscape decks at Lin Cheung Road

For all tunnel/underpass/landscape deck associated with the Road Works at West Kowloon, the same modeling approach and assumptions presented in the approved EIA Study "Road Works at West Kowloon" (AEIAR-141/2009) (WKRW EIA) have been adopted. Four scenarios are considered in the model run i.e. assuming 10%, 20%, 30% and maximum % (depending on the length of the opening concerned) of the portal emissions to be dispersed at the ground-level openings and the worst worst impact results amongst the 4 scenarios have been taken for conservative assessment. The emission calculations for the portals and the open sections of the underpasses based on the Year 2021's projected traffic flow and vehicular emission factors are presented in **Appendix 4.8**.

(F) Emission from portals of Western Harbour Crossing (WHC) and its associated ventilation building

Since there is no information available for the percentage split of emission between the tunnel portals and ventilation buildings, the following modelling scenarios on three typical cases have been carried out

- Scenario 1: Assume 30% of emissions inside tunnel are emitted from portal and 70% from ventilation building
- Scenario 2: Assume 50% of emissions inside tunnel are emitted from portal and 50% from ventilation building
- Scenario 3: Assume 100% of emissions are emitted from portal (as per the approved WKRW EIA)

The emission calculations for the WHC portals and its ventilation building based on the Year 2021's projected traffic flow and vehicular emission factors are presented in **Appendix 4.8**. The worst impact results amongst these three scenarios have been taken for conservative air quality assessment.

Similar to CALINE4, grid-specific composite real meteorological data extracted from EPD's PATH model have been adopted in ISCST3 model. "Urban" mode is applied. OLM is adopted for conversion of NO_x to NO_2, using the predicted O_3 and NO_2 levels from PATH model. According to EPD's Guidelines on Choice of Models and Model Parameters, the vehicular tailpipe NO_2 emission is assumed to be 7.5% of NOx.

4.4.6.6 Prediction of the Emission from Industrial Chimneys

All chimneys being continuously in use or being planned within 500m of each study area as identified in **Section 4.4.5.3** have been included in the near-field dispersion model. For the chimneys for the restaurant identified in West Portion, the latest information on the fuel consumption rate, stack height, diameter, exit velocity and temperature was provided by the chimney operator. Where there is no available information, assumptions have been made with reference to EPD's Guidelines on Choice of Models and Model Parameters. The NO_x and RSP emissions (in g/s) are calculated based on the respective emission factors for boilers in accordance with the USEPA AP-42 Section 1.3. The assumptions on the emission rate, stack height, diameter, exit velocity and temperature for the chimney in the planned hospital in KTD are based on the approved KTD EIA report and for the Towngas plant in Ma Tau Kok are based on the SP licence. A summary of all these emission calculations for the identified chimneys are given in **Appendix 4.9**.

The potential air quality impact associated with the industrial emissions has been assessed by the EPD approved dispersion model, ISCST3. All these emissions have been modeled as "Point" source in the model. For conservative assessment, it is assumed that they will be operated continuously over 24 hours. OLM is adopted for conversion of NO_x to NO_2, using the predicted O_3 and NO_2 levels from PATH model. The in-stack NO_2:NO_x ratio for the industrial chimneys is assumed to be 10%.

4.4.6.7 Prediction of the Emission from Marine Vessels

As mentioned in **Section 4.4.5.4**, all the operations within the KTTS had already moved out and there is no marine emission anticipated. For emissions associated with the committed cruise terminal near the end of Kai Tak Runway and the existing TKWTS, they have been estimated in accordance with the latest information extracted from the approved KTD EIA report and the "*Study on Marine Vessels Emission Inventory, Final Report (February 2012)*" published by EPD. Detailed calculations are presented in **Appendix 4.9**.

The USEPA approved model, ISCST3, is used to model the gaseous emission from marine vessels. The marine emission from the planned cruise terminal has been modeled as "Point" source while that from the typhoon shelters has been modeled as "Area" source. OLM is adopted for conversion of NO_x to NO_2, using the predicted O_3 and NO_2 levels from PATH model. The in-stack NO_2:NO_x ratio for the marine vessels is assumed to be 10%.

4.4.6.8 Prediction of the Emission from Helicopter

There is also no updated information on the planned heliport in KTD and hence the approved KTD EIA report is considered as the best available information. The USEPA approved model, ISCST3, is used to model the gaseous emission from the heliport based on the emission rate extracted from the KTD EIA report (as presented in **Appendix 4.9**). "Volume" source has been adopted. For conservative assessment, it is assumed that they will be operated continuously over 24 hours. The in-stack NO_2:NO_x ratio for the helicopters is assumed to be 10%.

4.4.6.9 Prediction of the Cumulative Air Quality Impact

The cumulative operational air quality is a combination of the emission impact at local scale (i.e. open road from CALINE4, tunnel portals, ventilation buildings, chimneys, marine vessels and helicopters from ISCST3) and background air quality impact from other concurrent and regional sources (i.e. from PATH) on an hourly basis. OLM is used for conversion of NO_x to NO_2 based on the O_3 level from PATH directly as described in the above sections. As a conservative approach, the OLM is applied separately to the following groups of emission sources:

West Portion

- Group A – All open roads + All tunnel/landscape deck portals + All underpass
- Group B – CKR ventilation building
- Group C – WHC ventilation building
- Group D – Industrial chimney (low rise)
- Group E – Industrial chimney (high rise)

Middle Portion

- Group A – All open roads
- Group B – CKR ventilation building

East Portion

- Group A – All open roads + All tunnel/landscape deck portals
- Group B – CKR ventilation building
- Group C – Kai Tak Tunnel ventilation building
- Group D – Towngas plant in Ma Tau Kok
- Group E – Planned hospital in KTD
- Group F – Planned cruise terminal and To Kwa Wan Typhoon Shelter
- Group G – Helicopter

The maximum 1-hour, 24-hour and annual NO_2 and RSP concentrations are then determined at each ASR at 10 levels (including 1.5m 5m, 10m, 20m, 30m, 40m, 50m, 60m, 70m and 80m) and compared with the respective AQOs.

4.4.7 Assessment Results

The maximum 1-hour, 24-hour and annual NO_2 and RSP concentrations at each ASR have been assessed the results are presented in the table below. Detailed results are presented in **Appendix 4.10**. It can be seen from the table below that all the predicted maximum NO_2 and RSP concentrations are all within the respective criteria. Contours of maximum 1-hour NO_2 concentrations and maximum 24-hour and annual NO_2 and RSP concentrations at the worst affected level (i.e. 1.5m above ground) in West, Central and East Portions are plotted in **Figures 4.8.1 – 4.8.15**. It is also observed that there are no areas of exceedances. Hence adverse cumulative air quality impact during the operational phase is not anticipated.

Table 4.31: Predicted Maximum Cumulative 1-hour, 24-hour and Annual Averaged Concentrations of NO_2 and RSP at representative ASRs (Including Background Concentrations)

ASR ID	Location	Max. NO_2 Concentration ($\mu g/m^3$)			Max. RSP Concentration ($\mu g/m^3$)	
		1-hour	24-hour	Annual	24-hour	Annual
West Portion						
W-A1	Yau Ma Tei Catholic Primary School (Hoi Wang Road)	251	104	57.3	112	43.1
W-A2	Charming Garden Block 12	264	107	59.2	113	43.2
W-A3	Yau Ma Tei Catholic Primary School (Tung Kun Street)	273	125	56.6	113	43.0
W-A4	Prosperous Garden Block 1	283	122	58.3	113	43.2
W-A5	The Coronation	268	119	56.1	112	43.1
W-A6	Man Cheong Building	280	122	58.0	113	43.2
W-A7	Kum Lam Building	284	132	64.4	113	43.6
W-A8	Dickson Building	284	131	61.9	113	43.5
W-A9	Yau Ma Tei Jockey Club Polyclinic	282	125	61.1	113	43.3
W-A10	Alhambra Building	286	125	65.2	111	43.2
W-A11	Hong Kong Community College (HKCC) of PolyU	278	114	62.6	113	43.6
W-A12	Civil Aid Service Headquarter	262	125	62.7	112	43.8
W-A13	Park Avenue Tower 10	245	99	49.8	112	42.4
W-A14	Charming Garden Block 1	251	103	52.4	112	42.8

ASR ID	Location	Max. NO_2 Concentration ($\mu g/m^3$)			Max. RSP Concentration ($\mu g/m^3$)	
		1-hour	24-hour	Annual	24-hour	Annual
W-A15	HKMA David Li Kwok Po College	251	100	52.8	112	42.7
W-P1	Reprovisioned Yau Ma Tei Police Station (Planned)	263	118	56.3	112	43.1
W-P3	West Kowloon Government Offices (Planned)	277	114	61.0	113	43.8
W-P4	Indoor Recreation Centre (Planned)	277	114	56.4	114	43.5
W-P5	Hong Kong Red Cross Headquarters (Planned)	276	110	54.0	113	43.2
W-P6	Refuse Collection Point and street Sleepers' Shelters (Planned)	247	116	62.5	112	43.3
W-P7	Primary School (Planned)	263	120	58.9	112	43.3
W-P8	Hindu Temple (Planned)	262	122	61.5	112	43.6
Central Portion						
M-A1	Kar Man House, Oi Man Estate	260	99	44.8	112	42.5
M-A2	Carmel on the Hill	273	96	42.3	112	42.4
M-A3	SKH Tsoi Kung Po Secondary School	275	97	46.0	112	42.6
M-A4	Man Fuk House Block A	264	97	45.1	112	42.5
M-A5	Cascades Block A	269	96	42.7	112	42.4
M-A6	Ko Fai House, Kwun Fai Court	281	97	41.0	112	42.4
M-A7	The Open University of Hong Kong	273	98	44.2	112	42.5
M-A8	Kwun Hei Court	276	92	37.8	112	42.1
M-A9	Housing Authority Headquarters Block 1	268	98	45.1	112	42.5
M-A10	Ho Man Tin Government Offices	263	96	42.7	112	42.4
M-A11	Choi Man House, Ho Man Tin Estate	275	92	38.0	112	42.1
M-A12	King Man House, Ho Man Tin Estate	280	94	39.7	112	42.2
M-A13	Ho Man Tin Swimming Pool	262	95	40.3	112	42.2
M-A14	Yee Man house	266	92	37.8	112	42.1
M-A15	Ho Man Tin Estate Service Reservoir Playground	272	94	39.2	112	42.2
M-A16	Ko Shan Road Park	267	89	32.8	110	41.0

ASR ID	Location	Max. NO_2 Concentration ($\mu g/m^3$)			Max. RSP Concentration ($\mu g/m^3$)	
		1-hour	24-hour	Annual	24-hour	Annual
M-A17	Kiu Wai Mansion	277	97	35.5	111	41.2
M-A18	Sun Man House	277	98	43.1	112	42.4
M-A19	Ellery Terrance	280	100	44.4	112	42.5
M-A20	Dragon View (Block 1)	278	99	45.1	112	42.5
M-P1	Valley Road Estate Redevelopment (Planned)	270	101	50.1	112	42.8
M-P2	Planned Residential Area B (Planned)	259	101	47.2	112	42.6
M-P3	Ho Man Tin South Phase 2 (Planned)	281	92	37.6	112	42.1
M-P4	Ho Man Tin Redevelopment (Outline Zoning Plan No. S/K7/21) (Planned)	279	92	38.8	112	42.2
M-P5	Ho Man Tin Redevelopment (KIL 11128) (Planned)	279	94	41.7	112	42.4
M-P6	Hong Kong Polytechnic University Student Hostel Phase 3 (Planned)	261	106	44.6	110	42.3
East Portion						
E-A1	Hong Kong International Trade and Exhibition Centre	270	96	44.0	109	40.6
E-A2	EMSD Headquarters	278	93	45.3	109	40.8
E-A4	Billion Centre	262	94	49.2	107	41.1
E-A5	Kai Fuk Industrial Centre	270	101	50.3	109	41.5
E-A6	Grand Watefront	261	99	41.0	110	41.6
E-A7	Chong Chien Court	258	97	40.9	110	41.6
E-A8	Wei Chien Court	258	98	39.3	110	41.5
E-A9	Sino Industrial Plaza	277	102	45.8	110	41.0
E-A10	HSBC Main Treasury	269	96	44.4	109	40.6
E-A11	Holy Carpenter Primary School	258	96	38.3	110	41.5
E-A12	United Daily News Centre	258	96	38.3	110	41.5
E-A13	Merit Industrial Centre	258	95	53.8	110	42.4
E-A14	Wyler Gardens	258	99	39.6	110	41.5
E-P1	Site 1B4 – School (Planned)	268	84	38.8	108	40.3

ASR ID	Location	Max. NO_2 Concentration ($\mu g/m^3$)			Max. RSP Concentration ($\mu g/m^3$)	
		1-hour	24-hour	Annual	24-hour	Annual
E-P2	Site 1I3 – Residential (Planned)	265	81	35.1	108	40.0
E-P3	Site 1J1 (Planned)	267	87	40.1	108	40.4
E-P4	Site 1J3 (Planned)	276	83	39.4	108	40.3
E-P5	Site 1L3 - Residential (Planned)	278	87	40.6	108	40.4
E-P6	Site 1L2 - Residential (Planned)	280	94	43.5	109	40.6
E-P7	Site 2D2 – Stadium (Planned)	286	96	49.7	110	42.2
E-P8	Site 2D1 – Stadium (Planned)	261	85	35.7	107	39.9
E-P9	Site 1P – Administration Building (Planned)	266	98	53.7	107	41.2
E-P10	Site 3C1 – Hospital (Planned)	252	93	43.8	106	40.7
E-P11	Site 3C1 – Hospital (Planned)	246	97	52.2	106	41.2
E-P12	Site 3D2 – Commercial (Planned)	252	96	45.1	106	40.8
E-P13	Site 4Ab – Metro Park (Planned)	247	93	42.5	106	40.4
E-P14	Site 4Aa – Metro Park (Planned)	254	95	44.9	106	40.6
E-P15	Site 5A4a (Planned)	271	96	41.9	110	41.7
E-P16	Site 5A4b (Planned)	261	97	41.2	110	41.6
E-P17	Site 3B1- Secondary School (Planned)	255	93	43.2	106	40.5
E-P18	Site 3B1 (Planned)	252	94	44.4	106	40.6

4.4.8 Operational Requirement for the APS

In order to maintain the performance of the APS, air pollutant sensors would be adopted in the TVS/APS to monitor the pollutant concentration levels continuously at the inlet and outlet of the system. The sensor type would be selected by the Contractor based on a performance specification. In case that the pollutant removal efficiencies were detected below the committed 80% for both particulate and NO_2, as a contingency plan, immediate measures would be implemented to increase the overall contact time between the air pollutant and the APS to secure the pollutant removal rate. Simultaneously, the NO_2 removal system or the ESP module will be refreshed by means of removal/replacement of the media (such as activated carbon) or washing the modules with appropriate chemical solutions, depending on the detailed design in the future. Detailed contingency plan shall be formulated by the Contractor and submitted to the Transport Department for agreement before the commencement of the proposed APS.

In addition, a commissioning test shall also be conducted by the Contractor to demonstrate the performance of the proposed APS. Details of the commissioning test shall also be submitted for agreement with the Transport Department before the commencement of the Project.

4.5 Conclusion

Air quality impact assessment has been conducted for both construction and operational phases of CKR. Potential dust impact would be generated from the site clearance, ground excavation, construction of the associated facilities and transportation of soil during the construction phase. Quantitative fugitive dust assessments have been conducted. Results have concluded that there will not be any adverse residual air quality impacts during construction phase given frequent watering in all works area once per hour during working hours (7:00am – 7:00pm) and provision of a dust enclosure at barging point.

Operational phase air quality assessments have concluded that the predicted air quality impacts on all sensitive receivers would comply with AQO. The tunnel ventilation system of CKR is designed to maintain limited discharge of emission from the portals. An air purification system (APS) will be adopted to remove the pollutant concentrations before releasing to atmosphere via the three ventilation buildings. The current design aims to achieve a removal efficiency of 80% for particulate and 80% for NO_2. It is recommended that a commissioning test shall be conducted by the Contractor to confirm the APS performance before the commencement and continuous monitoring during daily operation thereafter. In case that the performance of APS during operation could not achieve the committed removal efficiency, the procedures to be formulated by the Contractor in the contingency plan shall be followed.

4.6 References

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