3. AIR QUALITY IMPACT

3.1 Introduction

3.1.1 This section presents the potential air quality impacts associated with the construction and operation of the Project. Potential air quality impacts are expected to be dust nuisance during the construction phase and vehicular emissions during the operation phase. Air sensitive receivers (ASRs) have been identified for assessing the potential air quality impacts on these receivers. Appropriate mitigation measures are proposed to alleviate the potential air quality impacts if necessary.

3.2 Environmental Legislation, Standards and Guidelines

3.2.1 Reference was made to the Air Pollution Control Ordinance (Cap.311) (APCO) , and Section 1 of Annex 4 and Annex 12 of the Technical Memorandum on Environmental Impact Assessment Process (EIA-TM) for the criteria for air quality impact assessment in this Project.

Air Quality Objective & EIAO-TM

3.2.2 The APCO provides for the control of air pollutants from a variety of stationary and mobile sources through the establishment of the Air Quality Objectives (AQOs). Currently AQOs stipulate maximum concentrations for a range of pollutants, namely nitrogen dioxide (NO_2), sulphur dioxide (SO_2), total suspended particulates (TSP), respirable suspended particulates (RSP), carbon monoxide (CO), photochemical oxidants (O_3) and lead (Pb). The AQOs are listed in **Table 3.1**.

Table 3.1 Hong Kong Air Quality Objectives

Pollutant (Concentration in micrograms per cubic metre[1])	Averaging Time				
	1 hour[2]	8 hours[3]	24 hours[3]	3 months[4]	1 year[4]
Sulphur Dioxide (SO_2)	800	-	350	-	80
Total Suspended Particulates (TSP)	500[7]	-	260	-	80
Respirable Suspended Particulates (RSP)[5]		-	180	-	55
Nitrogen Dioxide (NO_2)	300	-	150	-	80
Carbon Monoxide (CO)	30000	10000	-	-	-
Photochemical Oxidants (as Ozone (O_3))[6]	240	-	-	-	-
Lead (Pb)	-	-	-	1.5	-

Notes:
1 Measured at 298 K and 101.325 kPa.
2 Not to be exceeded more than three times per year.
3 Not to be exceeded more than once per year.
4 Arithmetic mean.
5 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 criteria for evaluating air quality impacts as stated in Annex 4 of EIA-TM.

3.2.3 For construction dust, Annex 4 of EIA-TM specifies a TSP limit concentration averaged over a 1-hour period to be 500 $\mu g/m^3$ while the maximum acceptable TSP concentration averaged over a 24-hour period to be 260 μg/m^3, as defined in the AQOs. Mitigation measures for construction sites have been specified in the Air Pollution Control (Construction Dust) Regulation. It also requires Contractors and site agents to inform EPD and adopt dust reduction measures while carrying out "Notifiable Works" or "Regulatory Works" as defined under the regulation. Works relevant to this Project include both "Notifiable Works" (road construction) and "Regulatory Works" (dusty materials handling, excavation).

3.3 Description of Environment

3.3.1 The Project area is a well-developed urban area located in West Kowloon. The surrounding land uses comprise a mixture of commercial, residential, and G/IC uses. Dominant air emission sources are identified to be the traffic emissions from West Kowloon Highway, Lin Cheung Road and Nathan Road.

3.3.2 Referring to Section 3.4.1.2. of the EIA Study Brief, the study area for air quality impact assessment shall be defined by a distance of 500 metres from the boundary of the Project site. **Figure 3.1** illustrates the Project works area and study area for the air quality assessment.

3.4 Air Sensitive Receivers

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

3.4.2 Representative assessment points of the identified ASRs are selected for the air quality impact assessment and are tabulated in **Table 3.2**. Locations of the representative ASRs and the assessment points are shown in **Figure 3.2 and Figure 3.3**. The selected assessment points will represent the worst impact points due to the Project having the shortest distances between the project boundaries and the identified ASRs.

Table 3.2 Representative Air Sensitive Receivers

ASR	Description	Land Use	Status	Ground mPD	Height of First ASR Above Ground Level (m)	Shortest Horizontal Distance between ASR and the neared Proposed Road Alignment (m)	No. of Storey	Notes
SH	Skyway House	Office	Existing	3.7	7.5	256	12	(ii)
OC	Olympian City One	Shopping Center	Existing	5.7	12	256	1	(xv)
FR	Florient Rise - Tower 1	Residential	Existing	4.5	28	185	38	(i)
THV	Island Harbourview - Tennis Court	Open Space	Existing	4.9	2	191	1	(iii)
PAV	Park Avenue - Tower 1	Residential	Existing	6.1	25	155	42	(i)
OLP	Olympic Park	Open Space	Existing	6.2	12	135	1	(x)
CG	Charming Garden Phase 2 Block 1	Residential	Existing	5.4	5.5	202	22	(xiii)
LKPC	Li Kwok Po College	Educational	Existing	5.5	1.5	201	7	(v)
IRC	Indoor Recreation Centre	GIC	Planned	5.2	1.5	105	3	(iv)
YCS	Yau Ma Tei Catholic Primary School	Educational	Existing	5.9	1.5	211	7	(v)
WG	West Kowloon Government Office	Office	Planned	5.1	1.5	84	25	(iv)
YMT	Yau Ma Tei PCWA Administrative Building	Office	Existing	5.8	5	40	2	(xiv)
HKCC	PolyU Hong Kong Community College	Educational	Existing	4.9	17	297	19	(viii)
PS	Primary School	Educational	Planned	4.8	1.5	432	8	(iv)
CAS	CAS Headquarter	Office	Existing	5.4	7.5	112	9	(ii)
HT	Hindu Temple	Worship	Planned	5.6	1.5	153	5	(iv)
SRT	Sorrento - Tower 1	Residential	Existing	5.5	39.7	56	65	(i)
YTB	Yue Tak Building	Residential	Existing	4.3	7.5	7	14	(xvi)
CLS	The Cullinan II	Residential	Existing	5.5	62.3	36	56	(i)
ASC	Austin Station Site C	Residential	Planned	5.0	10.0	17	23	(vii)
ICC	International Commerce Centre	Office	Existing	5.6	35	109	118	(xviii)
GB	Garden Building	Residential	Existing	5.5	5.5	43	10	(xvi)
ASD	Austin Station Site D	Residential	Planned	5.5	10.0	7	30	(vii)
VT	The Victoria Towers - Tower 2	Residential	Existing	4.3	43	42	52	(i)
PG	Prosperous Garden Block 1	Residential	Existing	3.5	5.0	454	28	(xi)

WK1	West Kowloon Cultural District - 1	Office	Planned	7.4	4	215	15	(vi)
WK2	West Kowloon Cultural District - 2	GIC	Planned	9.4	4	65	7	(vi)
WK3	Parcel 29 in WKCD	Residential	Planned	9.4	4	289	23	(vi)
WK4	Parcel 5 in WKCD	Residential	Planned	9.4	4	131	15	(vi)
FSDO	Fire Services Department - Kowloon Regional Office	Residential	Existing	4.1	20.2	33	7	(ix)
FSDOG#	Open Space of FSD Office	Open Space	Existing	4.1	1.5	85	1	(xii)
LCMS	Lai Chack Middle School	Educational	Existing	3.9	6.2	45	5	(xvii)
CRGPS	Canton Road Government Primary School	Educational	Existing	3.9	5.5	65	6	(xvii)

* The height of ASR is selected at 1.5m about the floor level
# The open space of FSD Office will be only assessed for construction dust only.
(i) The height of the first ASR is the lowest residential floor. The space below is shopping center which adopts central air conditioning system with fresh air intake at height more than 1.5m above ground level. The assessment contours at 1.5m above ground level can be found in Figures 3.29 to 3.42
(ii) The height of the ASR is determined by the height of the lowest fresh air intake point for central air conditioning system
(iii) Tennis court locates at ground floor about 0.5m above the local ground
(iv) Planned ASRs at 1.5m above ground level are for assessment purpose which may not be the actual fresh air intake or openable window locations
(v) Sport ground of school at ground level
(vi) The height of the first assessment floor is made reference to the latest EIA of WKCD
(vii) The height of the first assessment floor is based on the latest layout from MTRC taken at the lowest residential floor above the drop-off floor at ground
(viii) The height of the ASR is taken at the lowest educational floor with openable windows. The floors below are central ventilated and the respective fresh air intake is higher than 1.5m above ground level. The assessment contours at 1.5m above ground level can be found in Figure 3.29 to 3.42.
(ix) The height of the first ASR is the lowest quarters floor above the office of fire station as the office floors are served by air conditioners and, based on site observation, the windows are also closed.
(x) The height of the ASR is determined based on the active recreational area. The space below is shopping center which adopts central air conditioning system with fresh air intake at height more than 1.5m above ground level. The assessment contours at 1.5m above ground level can be found in Figures 3.29 to 3.42
(xi) The height of the first ASR is the lowest residential floor above utilities rooms at ground floor
(xii) Open space of FSD Office at ground level
(xiii) The first residential floor above its lift lobby
(xiv) Office building above a warehouse at ground floor
(xv) The height of the ASR is determined based on the fresh air intake of the shopping center. The space below is Public Transport Interchange with its fresh air intake at height more than 4m above ground. The assessment contours at 4m above ground can be found in Figure 3.43 to 3.46
(xvi) The height of the ASR is determined based on the lowest residential floor. The space below are shops at ground level and the assessment contour at 1.5m above ground can be found in Figure 3.29 to 3.42
(xvii) The height of the ASR is determined based on the lowest educational floor of the school on top of school entry. The assessment contours at 1.5m above ground level can be found in Figures 3.29 to 3.42
(xviii) The first office floor on top of an entry lobby served by central air conditioning system with fresh air intake at height more than 1.5m above ground level. The assessment contours at 1.5m above ground level can be found in Figures 3.29 to 3.42

3.4.3 The assessment height is 1.5m above the floor level of air sensitive receivers. For air sensitive building with multiple storeys, assessment floors have been selected at the 1st, 3rd, 5th, and 10th sensitive level for TSP assessment. For NO_2 and RSP assessment, the 1st, 5th, and 10th level of the ASR have been selected. For air sensitive buildings with more than 10 storeys, the assessment levels have been taken at every 10 storeys for TSP, NO_2 and RSP assessment in the air quality models.

3.4.4 Only the existing ASRs and the planned ASRs which will exist before 2016 (i.e. the commencement year) were assessed for the construction dust assessment. The completion of the construction for the planned topside residential development at Austin Station Site C has been scheduled in January 2015 based on the latest information from Planning Department and that of Site C is not confirmed. The occupation programme for both Site C and Site D is also not confirmed. Therefore, ASR ASC and ASD have also been assessed as a conservative approach.

3.5 Potential Sources of Impact

Construction Phase

3.5.1 The major construction works of the Project would be site formation, construction of facilities, and construction of the access road. The major potential air quality impact during construction phase of the Project would be dust arising from:

- Excavation for site formation work and column installation
- Materials handling
- Haul roads; and
- Wind erosion of open sites and stockpiling areas.

3.5.2 This Project involves construction/modification of three elevated roads and one at-grade road (total about 1km in length) and junction improvement at Canton Road. The elevated roads are mainly constructed by cast in-situ method, and there will be some site formation works that generate construction dust. However, extensive excavation and transportation of the earth materials would not be required for this Project. In view of site constraint, the elevated road works as well as the junction improvement works would be constructed section by section and the maximum length of the road section to be constructed would be limited to 30m for each work front at a time. One dump truck would be allowable on site for unloading materials due to limited works area. Therefore, extensive excavation and transportation of dusty material are highly unlikely.

Operation Phase

3.5.3 Potential air quality impact on the surrounding ASRs during the operation phase of the Project would arise from the following:

- Background pollution levels for the assessment year;
- Existing road networks within 500m Study Area;
- Existing Portal emissions from Western Harbour Crossing (WHC) and its emission from ventilation building;
- The new elevated roads of this Project;

- Road Works at West Kowloon - Portal emissions from the proposed Lin Cheung Road – Austin Road West Underpasses;
- Road Works at West Kowloon - Portal emissions from the proposed landscape decks on Lin Cheung Road and Austin Road West;
- Road Works at West Kowloon - Emissions from the top openings of the proposed underpasses;
- New roads for CKR Project within 500m of the Study Area with the proposed vertical barrier, cantilevered noise barriers and semi-enclosures which will commence operation in year 2021;
- The proposed enclosures at the portal of CKR tunnel (west end) and the re-provisioned Gascoigne Road under CKR project which will commence operation in year 2021;
- Emissions from CKR ventilation building which will commence operation in year 2021;
- New roads for West Kowloon Cultural District Development Plan which will commence operation in year 2017; and
- Marine emission from Yau Ma Tei Typhoon Shelter, China Ferry Terminal and Ocean Terminal.

3.6 Identification of Representative Air Pollutants

3.6.1 Air Pollutant Control Ordinance (APCO) (Cap311) and EIAO-TM stipulate statutory Air Quality Objective (AQO) for 7 criteria air pollutants including NO_2, SO_2, TSP, RSP, CO, O_3 and lead.

3.6.2 Based on the construction method of the Project, ground excavation, earth material handling and backfilling are the major construction activities of the Project. In general, construction dust (i.e. TSP) will be potentially generated. Therefore, construction dust in term of TSP is considered as the major air pollutant source during the construction phase of the Project.

3.6.3 The air pollutant source during the operational phase of the Project would be the vehicular emissions from both the new and existing roads. Nitrogen Dioxide (NO_2) and Respirable Suspended Particulates (RSP) are considered to be the key criteria pollutants for assessment of the potential air quality impact in this Project.

3.6.4 Carbon Monoxide (CO) is one of the primary pollutants emitted by road transport. Based on the “Air Quality in Hong Kong 2012 Preliminary Report” published by EPD, the highest 1-hour CO concentration and the highest 8-hour CO concentration recorded in Mong Kok monitoring station in year 2012 were 3,590 ug/m^3 and 2,755 ug/m^3 respectively, which are only 12% of 1 hour AQO and 28% of 8-hours criteria level. Therefore, the CO concentration is likely to be non-critical in compliance with the AQO criteria It is considered appropriate to select NO_2 and RSP as the key pollutants for operational phase air quality impact assessment for this Project.

3.6.5 The Air Pollution Control (Fuel Restriction) Regulation was amended and effective October 2008 all liquid fuel must have a sulphur content not exceeding 0.005% by weight. . Given that, SO_2 concentrations from road vehicles are unlikely to be high when compared with the AQO criteria. Hence, SO_2 is also not selected as a key pollutant to be assessed.

3.6.6 Ozone (O_3) is formed from the dissociation of nitrogen dioxide by the action of ultraviolet light and the oxygen atoms subsequently combine with the ambient oxygen molecules. As it is not a primary pollutant emitted from vehicular emission, ozone is not considered as key criteria pollutant for this Project.

3.6.7 Leaded petrol had been banned in Hong Kong since 1999. It is not considered as a pollutant of concern for vehicular emission.

3.6.8 To sum up, Nitrogen Dioxide (NO_2) and Respirable Suspended Particulates (RSP) are chosen to be the criteria pollutants for assessment of the operation phase air quality impact in this Project.

3.7 Assessment Methodology

Construction Phase

3.7.1 Computational model Fugitive Dust Model (FDM) was used to assess the potential dust impact during the construction phase. It is an EPD approved Gaussian Plume model designed for computing air dispersion from fugitive dust sources.

3.7.2 Values for the modelling parameters, including dust emission factors, particles size distributions, surface roughness were obtained from EPD's "Guideline on choice of models and model parameters" and USEPA AP-42. The surface roughness is closely related to the land use characteristics of a study area and associated with the roughness element height. The surface roughness was taken as 100cm as a conservative approach. The density of dust was assumed to be 2.5 g/m^3.

3.7.3 Hourly meteorological data for a full year were extracted from the PATH model in grid (28, 27) and grid (28, 28) and have been adopted for use in FDM. The stability classes were obtained from a separate model, i.e. PCRAMMET. The minimum mixing height was taken from HKO and the value of 121m was adopted.

3.7.4 According to Section 13.2.3.3 of USEPA AP-42, the emission factor for a typical heavy construction activity is 2.69 Mg/hectare/month. The number of working days for a month and number of working hours per day of the project are anticipated to be 26 days and 12 hours respectively. No construction work is anticipated to be carried out on Sundays. From Table 11.9-4 of AP-42, the emission factor of wind erosion is 0.85 Mg/hectare/year.

3.7.5 In view of site constraint, the elevated road works as well as the junction improvement work would be constructed section by section and the maximum length of road section to be constructed would be limited to 30m for each work front at a time. One dump truck would be allowed on site for unloading materials due to limited works area. Therefore, extensive excavation and transportation of dusty material are highly unlikely. It has therefore been assumed that 100% active area of the proposed alignment would be operating for a full year to represent the heavy construction work and haul road as a worst case scenario. Dust emission factors adopted in this assessment are summarized in **Table 3.2** below.

Table 3.3 Emission Factors for Dusty Construction Activities

Emission Source	Activity	Emission Rate	Remarks
1. Excavation, Cut & Cover, construction of slip road, new link road, and road/junction improvement for the Project	Heavy Construction Activities	E=2.69 Mg/hectare/month of activity	100% area actively operating 26 days/month, 12 hours/day AP42, Section 13.2.3
	Wind Erosion	E=0.85Mg/hectare/year	100% area actively operating 26 days/month, 12 hours/day AP42, Section 11.9, Table 11.9.4

3.7.6 In the mitigated scenario, the active construction areas would have ground watering applied per hour. The adopted dust suppression of 91.7% is shown in **Appendix 3.8**. The unmitigated scenario does not have any watering for dust suppression.

- Applying 0.13 L/m^2 ground watering per hour on the construction site.

3.7.7 There are two existing construction works in West Kowloon, i.e. Express Rail Link (XRL) and Road Works at West Kowloon (RWWK) and two planned construction works, West Kowloon Cultural District (WKCD) and Central Kowloon Route (CKR) as the concurrent projects. The input parameters of the mitigated scenarios of these two planned projects are given in the EIA for CKR and the latest submitted EIA report for WKCD. The input parameters of TSP assessment can be found in **Appendix 3.8**.

3.7.8 According to the latest EIA for WKCD, the two concrete batching plants are located to southwest of the existing FSD Kowloon Regional Office where are within the WKCD work site. The location of the two concrete batching plants is provided in **Appendix 3.8**. Both the plants shall be operated in Year 2014 and one will be demolished within Year 2014. The construction dust impact for Project have taken into account the two concentre batching plants that both have been included for the assessment in Year 2014, and only one plant has been considered in Year 2015. The silos of the plants are around 20m above ground. To assessment the possible worst impact level, potential dust impact arising from the concrete batching plants on the nearest selected ASRs (i.e. Austin Station Site D (ASD), Garden Building (GB), FSD Kowloon Regional Office (FSDO), Lai Chack Middle School (LCMS), and Canton Road Government Primary School (CRGPS)) have been assessment at the levels close to the height of the silos (i.e. 15mAG, 20mAG, 25mAG). The assessment results indicated that the lowest level is the worst hit level from the plants as shown in **Appendix 3.9**.

3.7.9 The construction programme of this project will be from Year 2014 to end of year 2015 and TSP concentrations have been predicted for these two years. Since the construction of CKR will be started from Year 2015, there is no TSP emission from CKR in Year 2014. Also, the Project shall not be constructed during the restricted hour (ie 1900 to 0700 hours (of the next day) from Monday to Saturday and at any time on Sundays or public holidays) as defined under Noise Control Ordinance.

Background Air Quality

3.7.10 While there is no EPD general air quality monitoring station in West Kowloon area, dust monitoring data is available from two large-scale construction works, XRL and RWWK, located in this area. Dust monitoring in three monitoring stations have been undertaken in the vicinity of the proposed West Kowloon Terminus from March 2010 to July 2013 inclusive, as part of the environmental monitoring and audit (EM&A) works from XRL project. The 41 months average TSP concentration of these three stations is shown in **Table 3.4**.

Table 3.4 Air Quality Monitoring Results for XRL Project

Monitoring Station	Location	Annual Average TSP Concentration (μg/m3)				41 months Average (μg/m3)
		Mar 2010 – Feb 2011	Mar 2011 – Feb 2012	Mar 2012 – Feb 2013	Mar 2013 – Jul 2013	
AM15	Sorrento	81.5	70.3	56.9	36.8	65.6
AM16	Tower 3, Waterfront	75.7	75.0	52.2	31.4	63.3
AM17	The Victoria Towers	78.5	78.5	54.6	38.2	66.6
					Average:	65.2

3.7.11 As these three stations are also close to the Project, it is reasonable to assume that the average TSP concentration of these three stations can represent XRL and RWWK generated dust concentrations plus the prevailing background dust concentrations at West Kowloon. As the programme of XRL and RWWK will overlap with the Project, the averaged recorded TSP concentrations have been taken as background and project-related TSP concentration of these two existing projects.

3.7.12 Audit and monitoring program during the construction phase of this Project has been formulated and is presented in the Environmental Monitoring and Audit Manual prepared under this study.

Operation Phase

3.7.13 All major roads within 500m of the Study Area were included in the model. The hourly, daily and annual average NO_2, and daily and annual average RSP at the selected ASRs have been calculated.

3.7.14 The construction of Project is planned to start by early of Year 2014 for completion by the end of Year 2015. All the new roads proposed under the project "Road Works at West Kowloon" shall also be completed by Year 2015. The CKR project is planned to start by Year 2015 and be completed by Year 2020. The West Kowloon Cultural District Development is planned to start by Year 2013 and be completed by Year 2017 to 2020. A sensitivity test has been conducted to determine the worst-case assessment year and is presented in **Appendix 3.2**. Based on the sensitivity test, Year 2016 was found to be the worst-case assessment year within 15 years (Year 2016 to Year 2030) of the commencement of the Project. The sensitivity test has taken into account the commencement of CKR starting from Year 2021 and the commencement of WKCD starting from Year 2017. The projected hourly traffic flows and vehicle compositions by the Project traffic consultant for the Year 2016, Year 2021, and Year 2030 are provided in **Appendix 3.1**. The traffic flow in Year 2021 and 2030 have included the traffic changes due to the operation of CKR. The forecast traffic flow and speed fraction for Year 2016, Year 2021, and Year 2030 with 16 vehicle classes have been submitted to the Transport Department (TD) for agreement. The agreement letter from TD on the use of the projected traffic data for this Study is also attached in **Appendix 3.1**. The traffic flows for internal roads of WKCD are compatible with year 2020 and year 2030 traffic data in the latest EIA report of WKCD as provided in **Appendix 3.2**.

3.7.15 The assessment of operation phase air quality impact has followed the detailed technical requirements given in Appendix A of the EIA Study Brief. Air dispersion model CALINE4 was employed to predict the concentrations of air pollutants at the identified ASR due to vehicle emissions from the existing and planned open road network within the Study Area; whereas ISCST3 was employed to predict the concentrations due to portal emissions from the existing WHC, and the planned underpasses and landscape decks for Road Works at West Kowloon.

Vehicular Emissions within HKSAR

3.7.16 EMFAC-HK 2.5.1 model was adopted to estimate the vehicle emission rates and inventories of exhaust oxides of nitrogen and particulate matter for worst-case scenario (year 2016). "**Burden**" mode was used for predicting the vehicular emissions of 16 vehicle classes for type 1 road with cool start. "**EmFac**" mode was used for predicting the vehicular emission of 16 vehicle classes for other types of roads with different speed profiles. The 16 vehicle classes are shown in **Table 3.5**. The road types considered in this Project are provided in **Table 3.6**. Traffic data for the road segments within the Study Area with corresponding road type are provided in **Appendix 3.1**.

Table 3.5 16 Vehicle Classes Considered in the EMFAC-HK Model

Vehicle Class No.	Vehicle Class Description	Notation
1	Private Cars (PC)	PC
2	Placeholder (P1)	P1
3	Taxi	Taxi
4	Light Goods Vehicles (<=2.5t)	LGV3
5	Light Goods Vehicles (2.5-3.5t)	LGV4
6	Light Goods Vehicles (3.5-5.5t)	LGV6
7	Medium & Heavy Goods Vehicles (5.5-15t)	HGV7
8	Medium & Heavy Goods Vehicles (>=15t)	HGV8
9	Placeholder (P2)	P2
10	Placeholder (P3)	P3
11	Public Light Buses	PLB
12	Private Light Buses (<=3.5t)	PV4
13	Private Light Buses (>3.5t)	PV5
14	Non-franchised Buses (<6.4t)	NFB6
15	Non-franchised Buses (6.4-15t)	NFB7
16	Non-franchised Buses (>15t)	NFB8
17	Single Deck Franchised Buses	FBSD
18	Double Deck Franchised Buses	FBDD
19	Motor Cycles	MC
20	Placeholder (P4)	P4

Vehicle Class No.	Vehicle Class Description	Notation
21	Placeholder (P5)	P5

Table 3.6 Different Road Types for EMFAC-HK Model

Type No.	Road Type
#Type 1	Local Road 50km/hr with cool start
Type 2	Local Road 50 km/hr
Type 3	District Distributor with 50km/hr
Type 4	Primary Distributor with 50km/hr
*Type 5	Tunnel Related Road with 70km/hr
*Type 6	Tunnel Related Road with 80km/hr
Type 7	Trunk Road with 70km/hr
Type 8	Trunk Road with 80km/hr
Type 9	Trunk Road with 100km/hr

No cold start at the middle of roads other than road type 1

* These road types present in tunnel related road for CKR project only

3.7.17 The vehicle population data (in Year 2010) published by EPD have been used for future assessment years in the EMFAC-HK modelling, while the hourly temperatures and relative humidity profiles required by the modelling were extracted from the meteorological station (at Tsim Sha Tsui) of the Hong Kong Observatory (HKO) for Year 2011. The key assumptions (including vehicle population, technology fractions, hourly temperature and relative humidity) for the EMFAC-HK model are shown in **Appendix 3.3**.

3.7.18 The hourly emissions in Year 2016 (worst-case scenario) were first divided by the number of vehicles and the total distance travelled to obtain the emission factors in gram per mile per vehicle. The calculated vehicle emission factors were then input to the air dispersion model. The calculated vehicle emission factors together with the hourly forecasted traffic flow were used to calculate the emissions of the road links within the study area and the 24 hours emissions for model input in this Project. The calculation of maximum fleet vehicle emission for Year 2016 with 16 vehicle classes is presented in **Appendix 3.4**. The calculated vehicular emissions of NOx and RSP for different vehicle classes for different road types for 24 hours are listed in **Appendix 3.3**. Zero emission factor is displayed if no such vehicle type would run on that road type.

Background Pollutant Concentrations – PATH model

3.7.19 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.

3.7.20 During the 12th Hong Kong-Guangdong Joint Working Group Meeting on Sustainable Development and Environmental Protection in 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 **Table 3.7 to Table 3.9**.

Table 3.7 Summary of 2010 Hong Kong Emission Inventory for the PATH model

Emission Group	**Annual Emission (2010) Tonnes/Yr**			
	SO2	**NOx**	**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 3.8 Summary of 2015 Hong Kong Emission Inventory for the PATH model

Emission Group	**Annual Emission (2015) Tonnes/Yr**			
	SO2	**NOx**	**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 3.9 Summary of 2020 Hong Kong Emission Inventory for the PATH model

Emission Group	**Annual Emission (2020) Tonne/Yr**			
	SO2	**NOx**	**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.

3.7.21 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 2015 were adopted in the calculation of cumulative impact in the Project for assessment year of 2016. Re-simulation of the background (Tier 3) contribution have been conducted by disregarding the road emission sources within the corresponding grid to avoiding double-accounting of local vehicular emissions source from the PATH's concentration outputs since the vehicular emissions within the Study Area have been assessed in the primary (Tier 1) and secondary (Tier 2) contribution. This methodology is made reference to Section 3.3 of "Guidelines on Assessing the TOTAL Air Quality Impacts" issued by EPD.

Model Assumptions for Open Road Vehicle Emission

3.7.22 The air dispersion model CALINE4 was employed to predict the vehicle exhaust pollutants from the Project and surrounding open road network based on the worst hour traffic flow in Year 2016. All major roads within 500m of the Study Area are included in the model. The hourly and daily average NO_2, and daily RSP were calculated by the model.

3.7.23 Air quality impacts arising from the implementation of roadside noise barriers and semi-enclosures/landscape decks for the "Road Works at West Kowloon" project were also incorporated into the air quality model.

Model Assumptions for Emissions from Portals and Top Openings of Underpasses

3.7.24 The portal emissions (NO_2 and RSP) of the WHC, the proposed underpasses and landscape decks, the proposed enclosures at the portal of the CKR tunnel (west end) and the re-provisioned Gascoigne Road under CKR project, as well as the emissions from the top openings of the underpasses were calculated based on the vehicle emissions derived from the adopted fleet average emission factors and peak hour vehicle flows in Year 2016. The roads with opposite traffic directions in the underpasses are separated by the partition walls. The roads with opposite traffic directions under the proposed landscape deck at Lin Cheung Road are fully enclosed but there is no partition wall between the opposite traffic directions. Traffic flow data of Lin Cheung Road have been reviewed and found no significant difference of traffic flow between the Lin Cheung Road Northbound and Southbound. Therefore, it is reasonable to assume that the pollutant concentrations of portal emission for both bounds of Lin Cheung Road are the same and that 1/2 of the total emissions within the landscape deck is emitted through the northbound portal and another half of total emissions is emitted through the southbound portal. This assumption has been adopted in the approved EIA "Road Work at West Kowloon".

3.7.25 Portal emissions from the WHC, the proposed underpasses and landscape decks at Lin Cheung Road and Austin Road West, and the re-provisioned Gascoigne Road were modelled in accordance with the recommendations of the Permanent International Association of Road Congress Report (PIARC, 1991). The pollutants were assumed to eject from the portal as a portal jet such that 2/3 of the total emissions is dispersed within the first 50m of the portal and the other 1/3 of the total emissions within the second 50m.

3.7.26 Reference is also made to the PIARC recommendations for the dispersion of vehicle emissions from the top openings of the underpasses. Based on the new layout in the Environmental Permit (EP-366/2009/A) of "Road Works at West Kowloon", some of the top openings and portal emissions will be different from that of the approved EIA. At Level B1 of the Lin Cheung Road-Austin Road West Underpasses, an opening of substantial size (about 1,600 m^2 in the area and about 40m in diameter) is located above the depressed junction of Austin Road West and Lin Cheung Road. In view of its substantial dimensions and its relatively shallow depth (about 5m), the PIARC recommendations are adopted. Based on this, 2/3 of the total emissions from the enclosed section prior to the opening were assumed to be dispersed within the first 50m of the opening, and the remaining 1/3 of the total emissions were assumed to eject within the remaining open section of the underpass and to the next enclosed sections. For Level B2 of the Lin Cheung Road – Austin Road West Underpasses, the open sections are about 45m, 95m, 32m and 30m in length, respectively. With reference to the PIARC recommendations, the portion of top opening emissions from the enclosed sections of the underpasses prior to the respective open sections dispersed at the openings were assumed to be 10%, 20%, 30% and maximum% (depend on the length) in the approved EIA, and the respective remaining portions were assumed to be ejected into the next enclosed sections due to the piston effect created by moving vehicles. Owing to the depth of the corresponding sections of the underpasses (at Level B2, which is about 10m below the ground level), it was assumed that the portal emissions from the enclosed sections at Level B2 would unlikely disperse completely at the ground-level openings. Four scenarios were considered in the assessment for the top opening emission.

- Scenario 1: 10% Top Opening Emission (Road Work at West Kowloon)
- Scenario 2: 20% Top Opening Emission (Road Work at West Kowloon)
- Scenario 3: 30% Top Opening Emission (Road Work at West Kowloon)
- Scenario 4: Maximum % Top Opening Emission (Road Work at West Kowloon)(66% of the total emission if the length is 50m and 100% for the length 100m)

3.7.27 The locations of the portal emissions considered in the assessment and emission calculations for the portals and the open sections of the underpasses are presented in **Appendix 3.5**.

Model Assumptions for Emissions from Portal and Ventilation Building of WHC

3.7.28 The portal emissions are modelled according to EPD's "Guidelines on Choice of Models and Model Parameters". As there is no information of the emission distribution of the portal and ventilation building of WHC, three scenarios were assumed in the calculation. They are 30%, 50% and 100% from the portal emission. The emission distribution will be followed the PIARC recommendation. The pollutants were assumed to eject from the portal as a portal jet such that 2/3 of the total emissions is dispersed within the first 125m of the portal and the other 1/3 of the total emissions within the second 125m.

- Scenario 1: 30% Portal Emission + 70% Emission from Ventilation Building

- Scenario 2: 50% Portal Emission + 50% Emission from Ventilation Building
- Scenario 3: 100% Portal Emission + 0% Emission from Ventilation Building

Model Assumptions for Emissions from CKR Ventilation Building

3.7.29 Referring to the EIA report of CKR exhibited for Public inspection (EIA-208/2013), the planned commencement of CKR is year 2021. Since the worst assessment year for the Project is year 2016 when the CKR would be under construction, the CKR project was not considered for the operational phase air quality assessment.

Model Assumptions for Emissions from Portal of WKCD

3.7.30 Referring to the latest available information from WKCD's EIA report, the first commencement year of WKCD roads and development is Year 2017. Since the worst assessment year for the Project is year 2016 when the WKCD would be under construction, the internal roads as well as portal of WKCD project were not considered for the operational phase air quality assessment.

Model Assumptions for Emissions from Portals of Cherry Street and Chimney

3.7.31 Within the 500m boundary, there is only one existing portal emission from Cherry Street. The pollutants were assumed to eject from the portal as a portal jet such that 2/3 of the total emissions is dispersed within the first 50m of the portal and the other 1/3 of the total emissions within the second 50m.

3.7.32 Within the 1000m boundary, there are total four in-use chimneys. The emission rates of NOx and RSP from these chimneys were calculated based on Table 1.3-1 of Section 1.3 of USEPA AP-42.

3.7.33 To sum up, there are three groups of emissions, including portals, ventilation buildings, and chimneys for assessment using ISCST 3 and based on these a total of 12 scenarios (four in Group 2 and three in Group 3) can be identified as below:

- Group 1: Emission from Chimneys, Portals of Cherry Street (1 Scenario)
- Group 2: Emission from Top Openings and Portals of Road Works at West Kowloon (RWWK) (4 Scenarios)
- Group 3: Emissions from Portal and Ventilation Building of West Harbour Crossing (WHC) (3 Scenarios)

Pollutant Concentration Calculation

3.7.34 The CALINE4 and ISCST3 models calculate hourly concentrations based on one year of Mesoscale Model 5 (MM5) meteorological data in Grid (28,27) and Grid (28,28) extracted from the Pollutants in the Atmosphere and the Transport over Hong Kong (PATH) model. The pollutant concentrations at the ASRs at each hour in the assessment year weare predicted using both CALINE4 and ISCST3 models, where

- The CALINE4 model wais used to predict the open road emissions from the existing and proposed road networks
- The ISCST3 model was used to predict all portal emissions from WHC and proposed underpasses/landscape decks, emissions from the top openings of proposed underpasses in Road Work at West Kowloon project, and chimney emission

3.7.35 The input of the open road emission for CALINE4 was chosen to be the hourly emission of a day to represent the actual scenario. The pollutant concentrations at the ASRs at each hour were calculated by summing up the results obtained from the two models. The highest hourly pollutant concentration predicted at the ASRs amongst the 8760 hours (in a year) was identified as the worst predicted hourly pollutant concentration. The maximum 24-hour average pollutant concentration at the ASRs was the highest daily average concentration amongst the 365 days. The annual average would be the average of the pollutant concentration of 8760 hours.

3.7.36 The future hourly background concentrations for NO_2 and RSP were extracted from Pollutants in the Atmosphere and the Transport model over Hong Kong (PATH). The hourly values of 8760 hours (in a year) for pollutant NO_2 and RSP from the PATH were used for the future background which were added to the CALINE4 and ISCST results respectively to derive the short-term and long-term cumulative impacts.

3.7.37 The Ozone Limiting Method (OLM) has been adopted for the conversion of NO_x to NO_2 based on the predicted O_3 concentrations in Grid (28,28) and Grid (28,27) from the PATH modelling output for all vehicle emissions. The background O_3 was taken to be the hourly values of O_3 concentration from PATH. A tailpipe emission NO_2/NO_x ratio of 7.5% according to the EPD's "Guidelines on Choice of Models and Model Parameters" has also been assumed. The NO_2/NO_x conversion for the land base emission has been calculated as follows:

$$[NO_2]_{pred} = 0.075 \text{ x } [NO_X]_{pred} + \text{MIN } \{0.925 \text{ x } [NO_X]_{pred}, \text{ or } (46/48) \text{ x } [O_3]_{PATH}\}$$

3.7.38 The stability classes were obtained from a separate model, PCRAMMET. The minimum mixing height was taken from HKO and the value was 121m. The surface roughness is closely related to the land use characteristics of a study area and associated with the roughness element height. The surface roughness of the grid (28, 28) was taken as 100 cm and 370 cm for the grid (28, 27) due to the average height of physical structures within the grid area. The wind standard deviation was calculated in accordance with the "Guideline on Air Quality Models (Revised), 1986". The results can be found in the Table 3.10 below.

Table 3.10 Summary of Wind Standard Deviation Adopted in the Model

Stability Class	Wind Standard Deviation	
	Grid (28, 28)	Grid (28, 27)
A	32.9	24
B	32.9	24
C	25.6	24
D	18.3	24
E	11.0	12
F	5.6	7.2

Marine Emission

3.7.39 The 500m Study Area covers part of the Yau Ma Tei Typhoon Shelter on the west, the HK China Ferry Terminal and Ocean Terminal on the south. Emissions from the marine vessels would have potential cumulative air quality impact on nearby ASRs.

3.7.40 There are two parking spaces for cruises in the Ocean Terminal. It was observed from the site survey that one berth was used almost exclusively for the berthing of a 40,000-ton ship. The other berth was periodically used by a 70,000-ton ship. The

40,000-ton ship operates in a day trip mode and moored at the berth from 08:00 to 20:00. The mooring mode of the 70,000-ton ship is irregular and it has been assumed that it moored 24 hours for 7 days per week at the berth as a conservative approach. The USEPA approved model ISCST3 was used to model the gaseous emissions from the two cruises as "Point" sources. Since only the terminal is located within the Study Area, emissions from marine movement for the cruises were not considered in this assessment.

3.7.41 Eight berths are available in the HK China Ferry Terminal for mooring ferries from Macau and Mainland China. There is no chimney emission for this type of ferries since the gas exhaust is from two horizontal pipes at the stern near sea level. Emissions from the eight berths were therefore modelled as "Point" sources by the ISCST3. Effective efflux velocity to account for horizontal plume was assumed to be 0.001 m/s based on "Aermod Implementation Guide" (March 19, 2009) issued by USEPA. Exhaust height was assumed to be 0 for near sea level emissions. However, as the path of the ferry movements is outside the 500m study area from this project, the emissions from ferry movements were excluded in the modeling. The hourly pollutant emission rates weres calculated based on the vessels operational schedule.

3.7.42 The movements of Tugs in Yau Ma Tei Typhoon Shelter within the 500m study area were assessed as area sources. 20 derrick lighter barges were assumed to be operating near the coast from 7am to 9pm for 25% time of operation in an hour. Details assumptions and calculation of marine emissions are presented in **Appendix 3.6**. The marine emission sources locations are provided in **Figure 3.4**.

Prediction of the Cumulative Air Quality Impact

3.7.43 As mentioned in Section 3.7.23, there are 1 scenario for Group 1 emission source, 4 scenarios for Group 2 emission source and 3 scenarios for Group 3. The predicted pollutant concentrations were calculated by summation of the predicted concentration for individual group with the highest pollutant concentration. The cumulative air quality is a combination of the hourly concentrations from portals, ventilation buildings, and chimneys emission (ISCST model), open roads (Caline4 model), marine emission (ISCST model), and background air quality impact from PATH. Ozone Limiting Method was used for conversion of NOx to NO_2 based on the O_3 level from PATH. The NO_2/NO_x conversion for the marine emission has been calculated as follows:

$$[NO_2]_{pred} = 0.1 \times [NO_X]_{pred} + \text{MIN } \{0.9 \times [NO_X]_{pred}, \text{ or } (46/48) \times [O_3]_{PATH}\}$$

3.8 Prediction and Evaluation of Environmental Impacts

Construction Phase

3.8.1 The results for unmitigated scenario of Year 2014 and Year 2015 for each ASRs including background contribution are provided in **Appendix 3.9** and the range of TSP concentration for the same ASRs with different assessment levels are summarized in **Table 3.11** and **Table 3.12**. There are potential exceedances for hourly TSP concentration at ASR YMT in Year 2014 and Year 2015. The unmitigated contours of 1 hour, 24 hour and annual TSP with background contribution of Year 2014 and 2015 at 1.5m above ground (the worst impact level) are shown in **Figure 3.5 to 3.16**.

3.8.2 After applying the mitigation measure of ground watering per hour, the results for mitigated scenario of Year 2014 and 2015 would comply with the AQO's hourly, daily, and annual TSP criteria at all ASRs.

3.8.3 The contours of 1 hour, 24 hour and annual TSP with background contribution of Year 2014 and 2015 at 1.5m above ground (the worst impact level) are shown in **Figure 3.17 to 3.28**. Exceedance zones can be found in hourly, daily and annual TSP contours in both Year 2014 and Year 2015. Exceedance zones cover areas including CKR construction site near Lai Cheung Road, the WKCD project site and the workshop of existing fire services department's Kowloon regional office. For WKCD, no development would be in operation in year 2014 and year 2015, thus the WKCD area was not considered as an air sensitive receiver during the construction period of the Project. For the fire services department's Kowloon regional office, the exceedance zone covered the northwest corner of the workshop in Year 2014 which is not classified as air sensitive receiver. The discrete ASR FSDOG at 1.5m above ground of the open space of FSD Office has been assessed, no exceedance was found. The construction site of CKR near Lai Cheung Road/Lin Cheung Road is not considered as ASR. Since no air sensitive receiver is identified within the exceedance zone during the construction period of the Project, no adverse construction dust impact is anticipated. The summary of the TSP concentration is shown in **Table 3.11** and **Table 3.12** below.

Table 3.11 Predicted Cumulative Maximum Hourly, Daily and Annual Construction Dust Concentrations at Various Heights above ASRs for Year 2014

ASR	Range of TSP Concentration (µg/ m^3)					
	Unmitigated Scenario			Mitigated Scenario		
	1hr TSP	24hr TSP	Annual TSP	1hr TSP	24hr TSP	Annual TSP
SH	115.2 - 216.3	77.4 - 86.9	66 - 66.4	77.1 - 88	67.6 - 68.7	65.4 - 65.4
OC	163.9	82.9	66.3	81.1	68.2	65.4
FR	86.6 - 127	68.8 - 81.5	65.5 - 66.7	72 - 80.8	66.4 - 68.5	65.3 - 65.4
THV	179.7	84.5	68.8	82.8	68.6	65.7
PAV	85.3 - 135.9	68 - 82.9	65.4 - 67.6	71.5 - 83	66.3 - 68.9	65.3 - 65.5
OLP	177	90.2	69.5	90.3	70.2	65.8
CG	89.9 - 225.5	72.5 - 92.3	66.1 - 69	73.8 - 96.3	67.7 - 70.7	65.4 - 65.8
LKPC	165.5 - 211.4	84.6 - 87.6	68.3 - 68.6	90.7 - 94.6	70.2 - 70.6	65.7 - 65.7
YCS	153.4 - 176	86.3 - 91	68.2 - 68.5	90.2 - 92.2	70.5 - 70.9	65.7 - 65.7
YMT	304	141.2	**93.4**	100.9	74.9	68.2
HKCC	96.8 - 130.4	73.8 - 80.9	66.5 - 67.3	77.7 - 88	68.8 - 70.2	65.5 - 65.6
PG	88.2 - 125	70.1 - 76.8	66 - 66.5	76.4 - 93	67.5 - 70.2	65.5 - 65.6
CAS	164 - 250.3	82.4 - 90.9	67.6 - 68.2	92.4 - 107.3	70.7 - 72	65.8 - 65.9
SRT	78.9 - 107.9	67.5 - 75.9	65.4 - 67.2	71.3 - 82	66.1 - 69.9	65.3 - 65.9
YTB	108.3 - 275.5	74.8 - 106.9	66.6 - 73.5	88.3 - 156.4	71 - 77.7	66 - 66.9
CLS	80.9 - 98.3	67.5 - 71.2	65.5 - 66.3	72.5 - 80.2	66.3 - 68.1	65.3 - 65.7
ASC	88.7 - 236.9	70 - 106.4	65.9 - 73.4	77.9 - 149.7	68 - 78	65.6 - 67.1
ICC	82.5 - 136.3	67.7 - 83.3	65.5 - 68	72.9 - 91.6	66.4 - 72.4	65.3 - 66.7

ASR	Range of TSP Concentration (µg/ m^3)					
	Unmitigated Scenario			Mitigated Scenario		
	1hr TSP	24hr TSP	Annual TSP	1hr TSP	24hr TSP	Annual TSP
GB	129.6 - 462.9	77.9 - 134.1	67 - 75.8	104.4 - 192.4	74.1 - 86.9	66.5 - 68.2
ASD	87.2 - 325.2	67.8 - 117.7	65.5 - 72.3	76.8 - 175.7	66.7 - 86.9	65.4 - 68.3
VT	83.6 - 121	67.4 - 75.7	65.4 - 66.5	73.6 - 103.3	66.4 - 73.3	65.3 - 66.3
FSDO	167.5 - 275.9	87.3 - 110.5	67.5 - 69.5	141.8 - 215.9	80.7 - 95.5	67 - 68.4
LCMS	273.2 - 476.6	100 - 125.1	68.2 - 70.4	194.2 - 269.2	89.2 - 99.9	67.5 - 68.8
CRGPS	270.6 - 454.8	99.3 - 122.7	67.9 - 69.8	189.1 - 253.2	87.8 - 98.4	67.2 - 68.6
FSDOG	496.4	137.7	79.1	487.3	137.4	74.6

Table 3.12 Predicted Cumulative Maximum Hourly, Daily and Annual Construction Dust Concentrations at Various Heights above ASRs for Year 2015

ASR	Range of TSP Concentration (µg/ m^3)					
	Unmitigated Scenario			Mitigated Scenario		
	1hr TSP	24hr TSP	Annual TSP	1hr TSP	24hr TSP	Annual TSP
SH	122.4 - 231.7	80 - 90.5	66 - 66.3	84.4 - 103.4	70.2 - 72.3	65.3 - 65.4
OC	181.6	86.1	66.2	98.9	71.4	65.4
FR	90.7 - 135.8	69.5 - 85.1	65.5 - 66.6	76.1 - 92.3	67 - 72.1	65.3 - 65.4
THV	211.7	87.8	68.9	114.8	71.5	65.7
PAV	90.7 - 151.8	69 - 88.1	65.4 - 67.4	76.9 - 98.9	67.1 - 74.1	65.3 - 65.5
OLP	215	101.2	69.4	128.4	81.2	65.7
CG	98.4 - 279.9	74.1 - 107.2	66 - 69	82.3 - 150.7	69.5 - 85.6	65.3 - 65.8
LKPC	207.7 - 279.6	98.5 - 104.6	68.2 - 68.6	132.9 - 162.8	84.1 - 87.6	65.7 - 65.8
YCS	201.7 - 254.9	102.2 - 112.1	68.2 - 68.6	138.5 - 168.5	86.3 - 92	65.7 - 65.8
YMT	407.9	161.1	**94**	191.3	93.4	68.4
HKCC	110.1 - 184.3	77.7 - 100.6	66.4 - 67.4	91 - 140.6	72.7 - 89.9	65.4 - 65.7
PG	93.6 - 253.8	71.2 - 105.6	65.8 - 66.9	82.7 - 214	68.7 - 99	65.4 - 66
CAS	204.2 - 325.2	101.5 - 122	67.5 - 68.4	132.6 - 197.7	91.2 - 108.8	65.9 - 66.3
SRT	84.2 - 119.9	67.4 - 79.3	65.4 - 66.9	76.6 - 93.9	66.7 - 73.8	65.3 - 65.6
YTB	113 - 262.7	74.7 - 110.9	66.3 - 72.8	94.3 - 143.6	71 - 79.6	65.6 - 66.4
CLS	85 - 105.2	68 - 72.9	65.4 - 66	76.7 - 87.1	67.1 - 70.1	65.3 - 65.5
ASC	92.4 - 223.3	69.7 - 107.4	65.6 - 72.7	81.5 - 136	67.9 - 79	65.4 - 66.5
ICC	86 - 139.1	68.1 - 82.6	65.4 - 67.2	77.2 - 95	67.2 - 72.9	65.3 - 66
GB	123.2 - 425.9	75.2 - 128.5	66.3 - 74.5	98.1 - 155.5	71.3 - 81.3	65.8 - 67.1
ASD	88.3 - 289.8	67.8 - 109.9	65.4 - 70.8	78 - 140.2	66.7 - 80.6	65.3 - 66.9
VT	86.6 - 110.6	67.3 - 72.3	65.3 - 65.8	76.6 - 92.9	66.3 - 69.9	65.2 - 65.7
FSDO	129.8 - 191.5	76.7 - 89.7	66.3 - 67.5	104.1 - 131.5	72.4 - 78.1	65.9 - 66.5
LCMS	204.3 - 351.5	86.5 - 108.3	66.8 - 68.6	125.3 - 160.3	77.6 - 85.7	66.2 - 67.2
CRGPS	208.4 - 321.5	85.5 - 101.8	66.6 - 68.2	126.9 - 164.6	76.3 - 84.1	66.1 - 67.2
FSDOG	495.6	120.0	75.8	262.4	107.6	71.4

Operation Phase

3.8.4 Taking into account vehicle emissions from open road networks, portal emissions from the WHC, the proposed underpasses and landscape decks, and emissions from the top openings of proposed underpasses for Road Work at West Kowloon project, and the future background pollutant concentrations based on PATH model, the cumulative maximum 1-hour average NO_2, 24-hour average NO_2, annual average NO_2, 24-hour average RSP and annual average RSP concentrations for the worst year 2016 were predicted and the highest pollutant concentrations at each ASR were calculated and are presented in **Table 3.13** and **Appendix 3.7.**

3.8.5 Based on the modelling results, all the ASRs would comply with the AQOs for annual NO_2, daily and annual RSP. However, the predicted maximum hourly NO_2 concentrations at some of ASRs are expected to exceed the AQO once per year. As this level of exceedance is still within the allowable numbers of exceedance for hourly NO_2 (3 times per year), the AQO is complied with. Moreover, the majority of hourly NO_2 exceedance would be due to the background concentration. The contribution from the new roads of the Project is less than 0.4%. Detailed breakdown of hourly and daily NO_2 exceedances with contributions from different emission sources are provided in **Table 3.14**. The predicted maximum NO_2 and RSP concentration contours at 1.5mAG (The level that highest predicted pollutants concentrations would occur) are shown in **Figure 3.29 to Figure 3.38**. The predicted 4^{th} maximum hourly NO_2 and 2^{nd} maximum daily NO_2 concentration contours at 1.5mAG are also shown in **Figure 3.39** to **Figure 3.42**. Although a few exceedance zones are predicted at 1.5mAG in the contour plots (opening and related roads of West Harbour Tunnel and West Kowloon Highway for 24-hour NO_2, and part of the Public Transport Interchange (PTI) under the shopping centre of Olympian City One, opening and related roads of West Harbour Tunnel, West Kowloon Highway, the New Yau Me Tei Typhoon Shelter and Canton Road for Annual NO_2), no existing or planned ASR is present in these zones at the worst affected level. Contours plot for 2^{nd} maximum daily and annual NO_2 concentration at 4.0mAG (top level of the PTI under the shopping centre of Olympian City One) are provided in **Figure 3.43-3.46**. No exceedance zone is found except in the West Kowloon Highway. Therefore, no adverse operational phase air quality impact is anticipated.

Table 3.13 Predicted Cumulative Maximum Hourly, Daily and Annual Average Air Pollutants Concentrations at Representative ASRs for Worst-case Scenario (Year 2016)

ASRs	Floor	Height above ground (m)	Results with background (μg/m^3)				
			1hr NO2	24hr NO2	Annual NO2	24hr RSP	Annual RSP
SH-1	1	7.5	282.5	126.9	65.7	116.6	44.7
SH-5	5	19.5	257.6	121.1	59.7	114.9	43.8
SH-10	10	34.5	245.3	113.7	53.2	114.1	43.3
OC-1	1	12	255.2	132.7	68.4	114.5	44.9
FR-1	1	28	256.7	121.1	56.9	114.8	43.6
FR-5	5	40	246.3	116.1	52.0	114.3	43.2

ASRs	Floor	Height above ground (m)	Results with background (μg/m^3)				
			1hr NO2	24hr NO2	Annual NO2	24hr RSP	Annual RSP
FR-10	10	55	244.4	112.6	48.6	114.0	43.0
FR-20	20	85	243.6	110.0	46.0	113.9	42.9
FR-30	30	115	243.5	109.4	45.1	113.9	42.8
THV-1	1	2	262.4	135.2	75.4	115.6	45.6
PAV-1	1	25	258.2	126.4	56.4	114.8	43.6
PAV-5	5	37	247.6	119.9	52.3	114.3	43.3
PAV-10	10	52	245.4	115.2	49.2	114.0	43.1
PAV-20	20	82	243.9	111.5	46.5	114.0	42.9
PAV-30	30	112	243.6	110.4	45.4	113.9	42.8
PAV-40	40	142	243.8	109.1	44.3	113.9	42.6
OLP-1	1	12	**301.9**	133.7	60.2	116.1	44.1
CG-1	1	5.5	294.7	128.4	59.4	115.7	44.1
CG-5	5	17.5	266.9	125.4	57.5	115.2	43.8
CG-10	10	32.5	248.4	121.0	54.2	114.5	43.5
CG-20	20	62.5	244.7	115.4	49.1	114.1	43.1
LKPC-1	1	1.5	280.6	125.8	59.8	115.5	44.1
LKPC-5	5	13.5	266.2	124.3	58.3	115.2	43.9
IRC-1	1	1.5	**301.6**	133.9	63.2	116.1	44.4
YCS-1	1	1.5	288.1	124.4	61.5	115.4	44.3
YCS-5	5	13.5	274.2	122.9	59.5	115.1	44.1
WG-1	1	1.5	**304.9**	139.1	70.4	116.9	45.5
WG-5	5	13.5	274.0	129.5	63.4	115.4	44.3
WG-10	10	28.5	258.6	123.0	57.8	114.5	43.8
WG-20	20	58.5	252.4	116.9	50.6	114.1	43.3
YMT-1	1	5	257.4	138.2	73.3	115.4	45.2
HKCC-1	1	17	277.3	122.3	64.4	115.1	44.7
HKCC-5	5	29	252.7	118.8	57.6	114.7	43.8
HKCC-10	10	44	246.2	116.6	52.6	114.4	43.4
PS-1	1	1.5	279.5	134.3	61.7	115.6	44.3
PS-5	5	13.5	271.3	132.3	60.3	115.3	44.1
PG-1	1	5	**309.1**	124.3	64.3	115.9	44.7
PG-5	5	17	**305.0**	122.9	61.0	115.2	44.2
PG-10	10	32	277.4	119.6	56.7	114.8	43.8
PG-20	20	62	251.7	116.5	50.2	114.4	43.4
CAS-1	1	7.5	**308.3**	145.2	66.3	116.3	45.0
CAS-5	5	19.5	284.5	138.5	61.3	115.5	44.5
HT-1	1	1.5	**313.6**	148.8	67.1	116.5	45.0

ASRs	Floor	Height above ground (m)	Results with background (µg/m^3)				
			1hr NO2	24hr NO2	Annual NO2	24hr RSP	Annual RSP
HT-5	5	13.5	**309.9**	142.9	64.0	115.8	44.7
HT-10	10	28.5	278.6	135.1	57.8	115.3	44.2
SRT-1	1	39.7	273.1	133.1	55.0	115.0	44.1
SRT-5	5	51.7	272.9	130.5	51.8	114.8	43.9
SRT-10	10	66.7	272.8	128.4	48.9	114.7	43.7
SRT-20	20	96.7	272.5	126.0	45.4	114.6	43.5
SRT-30	30	126.7	272.5	123.4	42.9	114.5	43.1
SRT-40	40	156.7	272.5	122.6	42.6	114.5	43.0
SRT-50	50	186.7	272.8	123.2	43.5	114.6	43.0
SRT-60	60	216.7	273.2	126.5	46.5	114.7	43.2
YTB-1	1	7.5	277.7	146.0	69.9	116.4	45.1
YTB-5	5	19.5	274.7	141.8	62.7	115.6	44.5
YTB-10	10	34.5	274.1	136.7	56.0	115.2	44.2
CLS-1	1	62.3	273.1	129.1	50.1	114.7	43.9
CLS-5	5	74.3	272.9	127.6	48.4	114.6	43.8
CLS-10	10	89.3	272.7	126.2	46.7	114.6	43.7
CLS-20	20	119.3	272.5	123.9	43.7	114.5	43.2
CLS-30	30	149.3	272.5	123.0	42.9	114.5	43.1
CLS-40	40	179.3	272.9	123.4	43.6	114.6	43.0
CLS-50	50	209.3	273.4	126.3	46.1	114.7	43.1
ASC-1	1	10	275.1	143.8	69.6	115.9	45.1
ASC-5	5	22	274.3	139.0	61.6	115.4	44.5
ASC-10	10	37	273.7	134.8	54.8	115.1	44.2
ASC-20	20	67	273.2	129.7	47.6	114.8	43.8
ICC-1	1	35	275.7	136.2	55.7	115.2	44.6
ICC-5	5	47	274.1	132.5	53.2	114.9	44.4
ICC-10	10	62	273.2	129.6	50.6	114.7	44.1
ICC-20	20	92	272.9	126.5	47.1	114.6	43.8
ICC-30	30	122	272.5	123.8	44.0	114.5	43.3
ICC-40	40	152	272.5	123.1	43.3	114.5	43.1
ICC-50	50	182	272.9	123.7	44.1	114.6	43.1
ICC-60	60	212	273.7	127.1	46.4	114.7	43.1
ICC-70	70	242	274.7	130.0	48.1	114.9	43.2
ICC-80	80	272	273.4	125.7	46.9	114.7	43.1
ICC-90	90	302	272.9	122.2	44.8	114.6	42.9
ICC-100	00	332	272.5	120.9	43.5	114.5	42.9
ICC-110	10	362	272.5	120.5	42.9	114.5	42.8

ASRs	Floor	Height above ground (m)	Results with background (µg/m^3)				
			1hr NO2	**24hr NO2**	**Annual NO2**	**24hr RSP**	**Annual RSP**
GB-1	1	5.5	294.1	148.3	69.8	118.1	45.4
GB-5	5	17.5	275.5	141.4	63.1	116.9	44.8
GB-10	10	32.5	274.5	136.2	56.1	116.5	44.5
ASD-1	1	10	288.1	145.2	68.6	117.3	45.3
ASD-5	5	22	274.7	139.6	60.0	116.7	44.7
ASD-10	10	37	274.2	134.9	54.1	116.3	44.5
ASD-20	20	67	273.4	129.2	47.4	115.8	44.2
ASD-30	30	97	273.1	126.3	44.7	115.5	44.0
VT-1	1	43	275.1	132.7	51.8	119.6	44.7
VT-5	5	55	274.5	130.8	49.1	118.9	44.6
VT-10	10	70	273.9	129.0	46.9	118.1	44.5
VT-20	20	100	273.2	126.3	44.6	117.1	44.2
VT-30	30	130	272.5	123.2	42.0	115.0	43.4
VT-40	40	160	272.5	123.0	41.9	114.9	43.2
VT-50	50	190	272.5	124.1	43.1	114.9	43.1
WK1-1	1	4	275.7	147.8	61.8	115.8	45.8
WK1-5	5	16	275.2	144.8	59.0	115.6	45.5
WK1-10	10	31	274.3	139.6	55.9	115.2	45.1
WK2-1	1	4	274.9	143.8	69.5	118.2	45.8
WK2-5	5	16	274.7	139.7	63.7	117.7	45.2
WK3-1	1	4	273.5	141.0	59.8	115.4	45.9
WK3-5	5	16	273.4	138.9	57.9	115.2	45.6
WK3-10	10	31	273.3	135.6	55.4	115.1	45.2
WK3-20	20	61	273.0	130.3	50.7	114.8	44.5
WK4-1	1	4	274.5	141.5	66.5	117.2	45.6
WK4-5	5	16	274.3	138.1	62.7	116.9	45.2
WK4-10	10	31	274.0	134.1	56.8	116.6	44.9
FSDO-1	1	20.2	277.1	137.2	59.0	124.5	45.4
FSDO-5	5	32.2	276.2	134.2	54.9	123.1	45.2
LCMS-1	1	6.2	**313.3**	148.2	64.5	127.0	45.7
LCMS-5	5	18.2	277.3	137.9	58.8	125.6	45.3
CRGPS-1	1	5.5	**305.6**	148.2	64.6	128.2	45.8
CRGPS-5	5	17.5	280.1	138.3	58.9	126.8	45.4
AQO			**300**	**150**	**80**	**180**	**55**

Table 3.14 Summary Breakdown of Predicted Cumulative NO_2 Concentrations for ASRs with Potential Exceedance

ASR	Floor	Maximum of Cumulative Hourly NO_2 Concentration (µg/ m^3)							
		*No. of Exceedance	Cumnulative Impact	Other Sources Contribution		The Project Contribution		Background Contribution	
OLP-1	1	1	**301.9**	98.0	32.4%	0.05	0.01%	203.9	67.5%
IRC-1	1	1	**301.6**	97.7	32.4%	0.06	0.02%	203.9	67.6%
WG-1	1	1	**304.9**	100.9	33.1%	0.11	0.04%	203.9	66.9%
PG-1	1	1	**309.1**	104.0	33.6%	1.20	0.39%	203.9	66.0%
PG-5	5	1	**305.0**	100.0	32.8%	1.11	0.36%	203.9	66.8%
CAS-1	1	1	**308.3**	77.8	25.2%	0.00	0.00%	230.5	74.8%
HT-1	1	1	**313.6**	82.9	26.4%	0.26	0.08%	230.5	73.5%
HT-5	5	1	**309.9**	79.2	25.6%	0.18	0.06%	230.5	74.4%
LCMS-1	1	1	**313.3**	82.8	26.4%	0.00	0.00%	230.5	73.6%
CRGPS-1	1	1	**305.6**	75.1	24.6%	0.00	0.00%	230.5	75.4%

* Number of exceedance per year

3.9 Mitigation of Adverse Environmental Impacts

Construction Phase

3.9.1 Construction air quality impact is expected to be acceptable if mitigation measures are properly implemented. Dust control measures stipulated in the Air Pollution Control (Construction Dust) Regulation and good site practice shall be adopted as follows:

(a) Good housekeeping to minimize dust generation, e.g. by properly handling and storing dusty materials

(b) Adopt dust control measures, such as dust suppression using water spray on exposed soil (at least 8 times per day), in areas with dusty construction activities and during material handling.

(c) Store cement bags in shelter with 3 sides and the top covered by impervious materials if the stack exceeds 20 bags

(d) Maintain a reasonable height when dropping excavated materials to limit dust generation

(e) Limit vehicle speed within site to 10km/hr and confine vehicle movement in haul road

(f) Minimize exposed earth after completion of work in a certain area by hydroseeding, vegetating, soil compacting or covering with bitumen

(g) Provide wheel washing at site exit. The body and wheel of the vehicles should be thoroughly cleaned with water to prevent carrying dust outside of the site

(h) Hard pave the area at site exit with concrete, bitumen or hardcores

(i) Cover materials on trucks before leaving the site to prevent dropping or being blown away by wind

(j) Regular maintenance of plant equipment to prevent black smoke emission

(k) Throttle down or switch off unused machines or machine in intermittent use

(l) Carry out regular site inspection to audit the implementation of mitigation measures

(m) Carry out air quality monitoring throughout the construction period

(n) Watering once per hour on exposed worksites and haul road is proposed to achieve dust removal efficiency of 91.7% for the permitted maximum traffic of 4 vehicles per hour. The application intensity of 0.13 L/m^2 for the respective watering frequencies should be applied and can be found in **Appendix 3.8**.

Operation Phase

3.9.2 During operation phase of the Project, the predicted maximum 1-hour and 24-hour average NO_2, and maximum 24-hour average RSP concentrations at the representative ASRs would comply with the AQO. No adverse air quality impact in future is expected. Therefore, no mitigation measure is proposed.

3.10 Environmental Monitoring and Audit Requirements

Construction Phase

3.10.1 With implementation of dust suppression measures, no unacceptable construction air quality impact is anticipated. Regular air quality monitoring will be proposed at representative ASRs and to ensure that relevant air quality standard can be met. The EM&A requirement is detailed in a standalone EM&A Manual.

Operation Phase

3.10.2 Based on the modeling results, the vehicular emission will not exceed the air quality objectives at ASRs for all modeled parameters in the operational phase. No monitoring or audit is proposed.

3.11 Conclusion

Construction Phase

3.11.1 Air quality impacts from the construction works for the Project would mainly be related to construction dust from excavation and materials handling. With the implementation of mitigation measures specified in the Air Pollution Control (Construction Dust) Regulation, dust impact on air sensitive receivers would comply with the AQO.

Operation Phase

3.11.2 The construction of Project is planned to start by early of Year 2014 for completion by the end of Year 2015. Sensitivity tests indicated that the year 2016 was the worst-case assessment year within 15 years of the commencement of the Project.

3.11.3 The potential impacts arising from the background pollutant levels within and adjacent to the Project site, together with vehicle emissions from open road networks, portal emissions from the WHC, and the proposed underpasses/landscape decks of Road Work at West Kowloon have been assessed. Results show that no adverse air quality would be expected at the ASRs in the vicinity of the Project site in the design year. No mitigation measures are required.