3 AIR QUALITY

3.1 INTRODUCTION

3.1.1 This Section presents an evaluation of the potential air quality impacts from the construction and operation of the Project, and the results were assessed with reference to the relevant environmental legislation, standards and criteria.

3.2 LEGISLATIVE REQUIREMENTS AND EVALUATION CRITERIA

3.2.1 The principal legislation for the management of air quality in Hong Kong is the *Air Pollution Control Ordinance (APCO) (Cap. 311)*. The AQOs implemented on 1 January 2022 have been adopted as the assessment criteria as shown in **Table 3.1**.

Table 3.1 Hong Kong Air Quality Objectives

Air Pollutant	Averaging Time	Concentration ($\mu g/m^3$)	No. of Exceedances Allowed per Year
Respirable Suspended Particulates (RSP) [(b)]	24-hour	100	9
	Annual	50	-
Fine Suspended Particulates (FSP) [(c)]	24-hour	50	18[(d)]
	Annual	25	-
Nitrogen Dioxide (NO_2)	1-hour	200	18
	Annual	40	-
Sulphur Dioxide (SO_2)	10-minute	500	3
	24-hour	50	3
Carbon Monoxide (CO)	1-hour	30,000	0
	8-hour	10,000	0
Ozone (O_3)	8-hour	160	9
Lead	Annual	0.5	-

Notes:

(a) Concentrations of gaseous air pollutants (i.e. NO_2, SO_2, CO and O_3) are measured at 293K and 101.325kPa.
(b) Suspended particles in the air with a nominal aerodynamic diameter of 10µm or less.
(c) Suspended particles in the air with a nominal aerodynamic diameter of 2.5µm or less.
(d) On a best endeavours basis, a reduced number of allowable exceedances of 18 days per year for 24-hour FSP (in lieu of 35 days per year as set out in the *Air Pollution Control (Amendment) Bill 2021*) should be adopted for air quality impact assessments for new government projects.

3.2.2 The Technical Memorandum issued under the EIAO states that the hourly concentration of Total Suspended Particulates (TSP) should not exceed 500µg/m³ (measured at 25°C and 1 Atmosphere) at Air Sensitive Receivers (ASRs) for dust impact assessment.

3.2.3 The measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* will be followed to ensure that potential dust impacts are properly controlled. Requirements stipulated in the *Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation* and *Air Pollution Control (Fuel Restriction) Regulation* will also be followed to control potential emissions from non-road mobile machinery during the construction phase of the Project.

3.3 ASSESSMENT AREA AND AIR SENSITIVE RECEIVERS

3.3.1 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 ASRs. Any other premises or place 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 is also considered to be a sensitive receiver.

3.3.2 In accordance with Clause 3.4.4.2 of the EIA Study Brief, the Assessment Area is defined as an area within 500m from the boundaries of the Project site and the work areas of the Project. The Project site boundary including all works areas of the Project during the construction phase is shown in **Figure 3.1**. The Project site boundary including the proposed new roads and existing roads with modifications and junction improvement during the operation phase is shown in **Figure 3.2**. The Project site and the 500m Assessment Area are shown in **Figure 3.3**. A number of representative ASRs within the 500m Assessment Area have been identified. Relevant Outline Zoning Plans (OZPs) and other published plans in the vicinity of the Project site have been reviewed in the identification of planned representative ASRs. The identified representative ASRs are presented in **Table 3.2** and their locations are shown in **Figure 3.3**. Full details of these representative ASRs are provided in **Appendix 3.1**.

Table 3.2 Identified Representative ASRs within 500m Assessment Area

ASR ID	Description	Type of Use	Status	Max. Height of Building (mAG)	Approx. Separation Distance from Construction Project Site Boundary (m)	Approx. Separation Distance from Operation Project Site Boundary (m)
A01	Luen Cheong Can Centre	Industrial	Existing	75	15	25
A02	Nan Fung Industrial City – Block 1	Industrial	Existing	60	15	15
A03	Nan Fung Industrial City – Block 2	Industrial	Existing	60	15	30
A04	Nan Fung Industrial City – Block 5	Industrial	Existing	60	30	35
A05	The Esplanade	Residential	Existing	70	160	220
A06	Lung Yat Estate – Kin Lung House	Residential	Existing	95	20	80
A07	Church of Christ in China Hoh Fuk Tong Primary School	Educational	Existing	25	50	50
A08	Lung Mun Oasis – Block 5	Residential	Existing	75	35	40
A09	Lung Mun Oasis – Block 3	Residential	Existing	75	40	50
A10	Glorious Garden – Block 1	Residential	Existing	75	25	145
A11	Hong Chi Morninglight School Tuen Mun	Educational	Existing	15	65	80
A12	Independent Commission Against Corruption Training Camp	G/IC[(c)]	Existing	10	25	30
A13	Ju Ching Chu Secondary School (Tuen Mun)	Educational	Existing	25	20	30

ASR ID	Description	Type of Use	Status	Max. Height of Building (mAG)	Approx. Separation Distance from Construction Project Site Boundary (m)	Approx. Separation Distance from Operation Project Site Boundary (m)
A14	Yan Chai Hospital No. 2 Secondary School	Educational	Existing	25	25	40
A15	Tsing Shan Tsuen 107A	Village	Existing	5	30	40
A16	Tsing Shan Tsuen 83	Village	Existing	5	25	30
A17	Hong King Garden – Block A	Residential	Existing	60	180	195
A18	Kam Fai Garden – Block 1	Residential	Existing	60	20	70
A19	Dragon Inn Court – Block 2	Residential	Existing	40	70	95
A20	Palm Cove – Tower 5	Residential	Existing	60	100	135
A21	Sam Shing Temple	Worship	Existing	10	45	45
A22	Hanford Garden – Block 1	Residential	Existing	70	20	35
A23	Siu Lun Court – Sui Lun House	Residential	Existing	100	30	35
A24	Chung Sing Benevolent Society Mrs. Aw Boon Haw Secondary School	Educational	Existing	25	15	45
A25	Tuen Mun Siu Lun Complex	G/IC(c)	Existing	45	60	110
P01	Yip Wong Road PRH Phase 1	Residential	Planned	140	35	50
P02	Yip Wong Road PRH Phase 2	Residential	Planned	140	125	140
P03 (b)	Proposed G/IC	G/IC (c)	Planned	30	95	150

Notes:

(a) The air quality impacts on all identified representative ASRs were considered in the assessment of both construction and operation phases.

(b) P03 is currently under private treaty grant application and is proposed to be a church and ancillary facilities with social welfare services. Detailed design and layout are not available at the moment. A maximum building height of 8 storeys is stipulated in the P03 area on the draft Tuen Mun Outline Zoning plan No. S/TM/36. A general assumption of 30m (3.75m per storey) building height was assumed.

(c) G/IC means Government, Institution or Community.

3.4 BASELINE CONDITIONS

3.4.1 The Project is located in Tuen Mun and the local air quality is primarily influenced by emissions from existing road traffic, industrial premises and marine traffic in Castle Peak Bay and Tuen Mun Typhoon Shelter.

Measured Background Air Quality

3.4.2 The nearest EPD's air quality monitoring station (AQMS) is the Tuen Mun AQMS, about 800m to the north of the HWRSR Project site. **Table 3.3** presents the relevant time averaged concentrations of air pollutants measured at the Tuen Mun AQMS in the most recent five years (i.e. 2017 to 2021).

Table 3.3 Concentrations of Air Pollutants Measured at EPD's Tuen Mun AQMS in the Recent Five Years (2017 to 2021)

Year	Concentration of Pollutants ($\mu g/m^3$)										
	19th Highest 1-hr NO_2	Annual NO_2	4th Highest 24-hr SO_2	4th Highest 10-min SO_2	10th Highest 24-hr RSP	Annual RSP	10th Highest 24-hr FSP	Annual FSP	10th Highest Daily Max 8-hr O_3	Daily Max 1-hr CO	Daily Max 8-hr CO
2017	188	46	26	88	99	43	65	27	176	1,740	1,630
2018	177	47	20	94	87	42	53	26	173	1,900	1,666
2019	166	47	12	45	89	41	53	24	203	2,050	1,758
2020	166	40	10	98	84	34	47	20	166	1,650	1,513
2021	172	44	9	22	87	36	46	19	161	1,720	1,450
AQOs	**200**	**40**	**125**	**500**	**100**	**50**	**75**	**35**	**160**	**30,000**	**10,000**

Note:
(a) Underlined values mean exceedance of the AQOs (effective from 2014 to 2021) at the time of air quality monitoring.

3.4.3 No exceedance of 19th highest 1-hour NO_2 criterion was recorded at Tuen Mun AQMS for the past five years (2017 to 2021). Exceedances of annual NO_2 criterion were recorded in all recent five years except 2020 at Tuen Mun AQMS.

3.4.4 No exceedances of 4th highest 24-hour SO_2 and 4th highest 10-min SO_2 criteria were recorded at Tuen Mun AQMS for the past five years (2017-2021).

3.4.5 No exceedances of 10th highest 24-hour RSP and annual RSP criteria were recorded at Tuen Mun AQMS for the past five years (2017-2021).

3.4.6 No exceedances of 10th highest 24-hour FSP and annual FSP criteria were recorded at Tuen Mun AQMS for the past five years (2017-2021).

3.4.7 No exceedances of maximum 1-hour CO and 8-hour CO criteria were recorded at Tuen Mun AQMS for the past five years (2017-2021).

3.4.8 Exceedances of 10th highest daily 8-hour O_3 criterion were recorded at Tuen Mun AQMS over the past five years (2017-2021).

Predicted Future Background Air Quality

3.4.9 The background air pollutant concentrations predicted by the PATH v2.1 model (i.e. Pollutants in the Atmosphere and their Transport over Hong Kong) in different PATH grids within the Assessment Area in Year 2024 (i.e. the year of tentative commencement of construction of Project) and Year 2030 (i.e. the year available from PATH closest to the year of tentative commencement of operation of Project) are presented in **Table 3.4**.

Table 3.4 Background Air Pollutant Concentrations Predicted by the PATH v2.1 Model in 2024 and 2030

PATH Grid	Concentration of Pollutants ($\mu g/m^3$)										
	19th High-est 1-hr NO_2	Annual NO_2	4th High-est 24-hr SO_2	4th High-est 10-min SO_2	10th High-est 24-hr RSP	Annual RSP	19th High-est 24-hr FSP	Annual FSP	10th Highest Daily Max 8-hr O_3	Daily Max 1-hr CO	Daily Max 8-hr CO
Year 2024											
18,40	108.6	26.7	63.7	13.0	69.3	27.7	38.5	26.1	225.8	910.5	833.5
19,40	119.2	29.9	60.6	13.0	70.6	28.1	39.2	25.8	219.8	924.7	845.4
19,41	113.6	26.4	60.2	12.8	70.9	27.8	38.6	26.2	230.3	925.6	849.1
19,42	109.4	24.8	61.7	13.3	71.2	27.9	38.0	26.3	232.5	925.3	849.2
20,39	117.0	34.3	89.5	12.9	67.2	28.6	39.1	25.4	207.8	927.8	847.2
20,40	115.4	29.1	58.0	12.5	69.6	27.9	39.1	25.7	217.5	930.5	851.3
20,41	112.6	26.8	55.3	12.3	71.1	28.3	39.2	26.4	228.6	936.1	859.5
21,39	112.9	32.4	101.8	12.3	67.9	28.3	38.8	25.5	206.1	930.9	847.5

PATH Grid	19th Highest 1-hr NO_2	Annual NO_2	4th Highest 24-hr SO_2	4th Highest 10-min SO_2	10th Highest 24-hr RSP	Annual RSP	19th Highest 24-hr FSP	Annual FSP	10th Highest Daily Max 8-hr O_3	Daily Max 1-hr CO	Daily Max 8-hr CO
Concentration of Pollutants (μg/m^3)											
21,40	104.2	25.4	68.4	12.0	68.6	27.4	38.8	24.4	216.7	930.2	847.6
21,41	99.7	20.8	60.1	11.6	67.8	27.5	37.2	25.6	224.7	929.8	851.4
Year 2030											
18,40	93.3	22.7	40.6	10.8	69.3	27.1	38.2	26.0	212.4	908.6	843.9
19,40	99.8	24.6	40.2	11.2	70.3	27.5	38.9	25.5	211.3	924.3	854.0
19,41	95.0	21.9	43.3	11.3	70.6	27.1	38.2	26.0	210.0	925.3	857.8
19,42	96.9	20.6	44.7	11.4	71.0	27.3	37.8	26.5	207.4	927.0	858.2
20,39	105.5	28.6	56.1	11.3	67.2	28.0	38.7	25.4	205.3	928.0	856.1
20,40	99.3	23.8	39.5	10.9	69.4	27.3	38.7	25.2	208.3	929.6	858.5
20,41	94.0	21.7	41.5	11.0	70.9	27.7	38.9	25.7	208.6	933.6	866.0
21,39	103.2	27.0	62.5	10.9	67.9	27.7	38.9	24.7	205.5	932.1	855.7
21,40	89.2	20.8	40.5	10.9	68.6	26.8	38.4	24.9	208.1	931.8	855.9
21,41	87.7	17.3	41.3	10.7	68.0	26.9	36.9	25.3	207.4	932.4	860.5
AQOs (e)	**200**	**40**	**50**	**500**	**100**	**50**	**50**	**25**	**160**	**30,000**	**10,000**

Notes:

(a) The multiplicative factor for the stability class calculated for each hour was applied to the 1-hour SO_2 concentrations to estimate the 10-minute SO_2 concentrations.

(b) Underlined values mean AQO exceedance.

(c) An adjustment of 11.0ug/m^3 and 10.3ug/m^3 were added to the RSP background for calculation of 24-hour RSP and annual RSP, respectively.

(d) An adjustment of 3.5ug/m^3 was added to the FSP background for calculation of annual FSP.

(e) Prevailing AQOs implemented on 1 January 2022.

3.4.10 As shown in **Table 3.4**, the predicted background concentrations of NO_2, SO_2, RSP, FSP and CO in all PATH grids within the Assessment Area in 2024 and 2030 are below the relevant AQO criteria. The predicted background concentrations of O_3 in 2024 and 2030 show exceedances of the relevant AQO criterion in all relevant PATH grids.

3.5 IDENTIFICATION OF AIR EMISSION SOURCES

Construction Phase

3.5.1 The construction of the Project primarily involves the construction of elevated carriageway and slip road, modification and realignment of existing roads, as well as associated junction modification works. The key construction activities associated with the construction of the Project include site clearance, slope works, piling works and superstructure works. Slope works and piling works may involve soil excavation. Soil excavation involves handling of excavated materials, wind erosion from temporary stockpiling and exposed works areas which are considered dust-generating sources and may have the potential to generate fugitive dust emissions if not properly managed. Superstructure works, typically involving cast-in-situ or installation of prefabricated bridge deck and segments, are not major dust-generating activities and are expected to generate minimal fugitive dust emissions.

3.5.2 Gaseous emissions (i.e. NO_2 and SO_2) will be emitted from construction equipment and dump trucks to be used on-site during the construction of the Project. However, considering that the Project works sites are relatively small (i.e. minor slope works and piling works only with works divided into various sub-areas, see **Sections 3.8.1 to 3.8.6**) with limited number of construction equipment operating concurrently (i.e. a few numbers of plant only, see **Section 3.8.7**) and limited number of dump trucks per day (a few truck trips per day, see **Section 3.8.7**), NO_2 and SO_2 emissions from construction equipment and dump trucks during the construction of the Project are expected to be minimal and not considered key air pollutants of concern, considering that these emissions will be regulated under the *Air Pollution Control (Non-road*

Mobile Machinery)(Emission) Regulation and *Air Pollution Control (Fuel Restriction) Regulation*.

3.5.3 The key air pollutants of concern arising from the construction of the Project include TSP, RSP, FSP.

Operation Phase

3.5.4 Vehicular emissions arising from the proposed new roads of the Project and the modified existing roads are the key air emission sources associated with the operation of the Project. The proposed new roads of the Project include at-grade roads and flyovers. The key air pollutants of concern arising from the operation of the Project are NO_2, RSP and FSP. SO_2 and CO are not considered key air pollutants of concern as discussed in the following paragraphs.

3.5.5 Given that ultra-low sulphur fuel is used for all types of vehicles in Hong Kong and the fact that SO_2 from vehicular emissions contribute less than 1% of the total emissions (2020 Hong Kong Emission Inventory Report by EPD), SO_2 is not a key air pollutant of concern arising from vehicular emissions. Therefore, SO_2 is not a key air pollutant of concern arising from the operation of the Project and thus was not considered in the assessment.

3.5.6 Although CO is an air pollutant emitted from road traffic, the measured CO concentrations at all AQMSs in Hong Kong are consistently well below the relevant AQO criteria. With reference to EPD's *Air Quality in Hong Kong 2021*, the highest measured 1-hour average CO and 8-hour average CO concentrations among all AQMSs were 2,150µg/m^3 and 1,774µg/m^3, respectively, which were well below the respective AQO criteria of 30,000 µg/m^3 and 10,000µg/m^3. CO is thus not a key air pollutant of concern arising from vehicular emissions. Therefore, CO is not a key air pollutant of concern arising from the operation of the Project and thus was not considered in the assessment.

3.5.7 Apart from vehicular emissions from the proposed new roads of the Project and the modified existing roads associated with the Project, vehicular emissions from existing open road traffic, portal emissions from existing full enclosures, bus and minibus termini, and heavy goods vehicle and bus/ coach parking sites within the 500m Assessment Area may contribute to the cumulative air quality impact on the identified ASRs.

3.5.8 There is a possibility that the middle ventilation building of the proposed Tuen Mun Bypass would be located within the 500m Assessment Area and thus its emissions during operation have the potential to contribute to the cumulative air quality impact on the identified ASRs during operation phase. However, as the proposed Tuen Mun Bypass is still at preliminary design stage, the location of the middle ventilation building or its stack/ emission parameters are not yet available during the EIA stage of this Project. The potential emissions from the middle ventilation building and the associated impacts on surrounding ASRs will be assessed in the EIA study of Tuen Mun Bypass (ESB-348/2021).

3.5.9 Besides, emissions from marine vessels (NO_x, RSP and FSP) at Castle Peak Bay and Tuen Mun Typhoon Shelter within the 500m Assessment Area may also contribute to the cumulative air quality impact on the identified ASRs during operation phase. Key air pollutants from marine emissions include NO_2, SO_2, RSP and FSP. However, as stated in **Section 3.5.5**, SO_2 is not a key air pollutant of concern arising from the operation of the Project, thus SO_2 emissions from marine vessels were not considered in this assessment.

3.5.10 Emissions from chimneys and other industrial emission sources within the 500m Assessment Area may contribute to the cumulative air quality impact on the identified ASRs. Major point sources within 4km from the identified ASRs (i.e. asphalt plant at Lam Tei Quarry) may also have the potential to contribute to the overall air quality impact on the identified ASRs. As stated in **Section 3.5.5**, SO_2 is not a key air pollutant of concern arising from the operation of the Project, thus SO_2 emissions from chimneys and other industrial emission sources were not considered in this assessment.

3.6 CONSTRUCTION PHASE ASSESSMENT METHODOLOGY

Overview of Fugitive Dust Impact from Project

3.6.1 As mentioned in **Section 3.5**, slope works and piling works would involve excavation and handling of excavated materials, and thus have the potential to generate fugitive dust. The potential fugitive dust impacts arising from each of the work sites under this Project are discussed in the sections below.

Construction of slip road connecting Lung Fu Road to Tsing Wun Road northbound (LFRSR NB)

3.6.2 The works primarily include minor slope works along Tsing Wun Road northbound, piling and superstructure works along the elevated carriageway from Lung Fu Road northbound to Tsing Wun Road northbound, as well as some associated minor road realignment works. The extent of areas requiring slope works is limited (up to 1,720m^2 per worksite at a time) and thus the potential fugitive dust emissions arising from such minor slope works are expected to be limited and localised (see **Section 3.8** and **Appendix 3.11**). Piling works will take place within a small confined area (maximum of about 100m^2 per location, total of 12 locations) and any associated fugitive dust emissions are also expected to be limited and localised. Minimal fugitive dust emissions are expected to be generated from superstructure works.

Construction of slip road connecting Tsing Wun Road to Lung Fu Road southbound (LFRSR SB)

3.6.3 The works primarily include piling and superstructure works along the elevated carriageway from Tsing Wun Road southbound to Lung Fu Road southbound, as well as some associated minor road realignment works. Piling works will take place within a small confined area (maximum of about 100m^2 per location, total of 17 locations) and any associated fugitive dust emissions are also expected to be limited and localised. Minimal fugitive dust emissions are expected to be generated from superstructure works.

3.6.4 With the construction of LFRSR SB, modification/ realignment of existing at-grade slip road connecting Tsing Wun Road southbound and Wong Chu Road eastbound will be carried out, where minor slope works along Tsing Wun Road southbound will be required as a result. The extent of areas requiring slope works is limited (up to 970m^2 per worksite at a time), and that the slope works will be divided into various sub-areas where the associated minor earthworks will take place over a relatively small area only at any one time (see **Section 3.8** and **Appendix 3.11**). Potential fugitive dust emissions arising from such minor slope works are expected to be limited and localised.

Construction of slip road linking Tuen Mun Road northbound and Hoi Wing Road westbound (HWRSR)

3.6.5 The works primarily include slope works along Tuen Mun Road northbound, piling and superstructure works, as well as junction improvement works at Castle Peak Road – Castle Peak Bay and Hoi Wing Road (CPR/HWR). The slope works along Tuen Mun Road will not be carried out for the entire section (up to 2,690m^2 per worksite at a time) at the same time. Instead, it will be divided into various sub-sections where the earthworks will be confined to within relatively small works area at any one time (see **Section 3.8** and **Appendix 3.11**). Potential fugitive dust emissions due to slope works along Tuen Mun Road are expected to limited and localised. Minimal fugitive dust emissions are expected to be generated from superstructure works and junction improvement works.

Summary

3.6.6 In view of the above discussions, fugitive dust emissions associated with the construction of the Project are considered minor and adverse fugitive dust impact to the identified ASRs is not anticipated with the incorporation of proper dust control measures. A quantitative assessment of the construction dust impact arising from the Project is considered not necessary. The potential air quality impacts due to construction of the Project are addressed qualitatively in **Section 3.8**.

3.7 OPERATION PHASE ASSESSMENT METHODOLOGY

Overview of Assessment Approach

3.7.1 A quantitative assessment has been carried out to evaluate the operational air quality impact at the identified ASRs per Clause 4(i), Appendix B of the EIA Study Brief. NO_2, RSP and FSP impacts have been quantitatively assessed as these were identified as the key air pollutants of concern during the operation phase.

3.7.2 Cumulative AQIA has been undertaken with reference to EPD's *Guidelines on Assessing the 'Total' Air Quality Impacts*, taking into account Tier 1, Tier 2 and Tier 3 emission source contributions:

(a) Tier 1 contributions – vehicular emissions from the proposed new roads and modified roads of the Project;

(b) Tier 2 contributions – other key emission sources within the 500m Assessment Area that may have the potential to contribute to the cumulative air quality impact, including vehicular, portal, industrial and marine emissions.

(c) Tier 3 contributions – represents background contributions which include other potential emission sources not captured by Tier 1 and Tier 2 contributions. The Project is expected to commence operation in 2031, and the predicted hourly background concentrations of NO_2, RSP and FSP in 2030 [(1)], which is the nearest available year, in the relevant PATH grids obtained from the PATH model v2.1 were adopted as the background contributions. The use of 2030 background pollutant concentrations is considered conservative as background air quality in 2030 is expected to be similar to or worse than that in 2031.

3.7.3 The cumulative concentrations at the ASRs were estimated by adding together the hour-by-hour contributions from modelled results for Tier 1, Tier 2 and the predicted PATH hourly background concentrations in 2030 (Tier 3). Relevant time-period averages of the 8,760 hourly results for the air pollutants assessed were calculated and compared with the respective AQO criteria to evaluate the cumulative air quality impact at the ASRs.

(1) PATH v2.1 data (Level 1, 0 to 17m above model ground), PATH v2.1 Data Dissemination System, July 2021

Vehicular Emissions from Proposed New Roads and Existing Roads (Tier 1 and Tier 2)

3.7.4 Vehicular emissions (NO_2, RSP and FSP) from all proposed new roads and existing roads within the 500m Assessment Area as shown in **Figure 3.4** have been quantitatively assessed as Tier 1 and Tier 2 contributions. Traffic forecast for the identified roads for 4 design years, including 2031 (i.e. commencement of operation of the Project), 2033 [(2)], 2036, and 2046 (15 years after the commencement of operation of the Project) were provided by the Traffic Consultant and are presented in **Appendix 3.2**. The traffic forecast data for each design year provided include a breakdown of hourly traffic flows for 18 vehicle types (as per EMFAC-HK model (latest version, v4.3)) and the hourly traffic speed for 24 hours for each of the identified roads. The methodology for the traffic forecast projection has been endorsed by Transport Department and the endorsement letter is also provided in **Appendix 3.2**.

3.7.5 Total vehicular emissions within the 500m Assessment Area in each of these 4 design years have been evaluated and 2031 was predicted to have the highest total vehicular emissions as presented in **Table 3.5**. Therefore, 2031 is considered the worst year and has been adopted for the assessment of vehicular emission impact during operation phase as a conservative assessment. Traffic data and detailed calculations of total vehicular emissions within the 500m Assessment Area for 2031, 2033, 2036 and 2046 are provided in **Appendix 3.2**.

Table 3.5 Total Vehicular Emissions within the 500m Assessment Area in 2031, 2033, 2036 and 2046

Year	NO (g/day)	NO_2 (g/day)	RSP (g/day)	FSP (g/day)
2031	196287.4	31082.3	9455.1	8693.9
2033	148287.8	27197.1	7026.9	6470.7
2036	109090.5	27953.7	4713.8	4344.6
2046	93175.4	25575.8	4074.4	3753.2

3.7.6 Apart from running vehicular emissions, start emissions may also occur along Local Distributors (LDs) and Rural Roads (RRs) which may have no stopping or parking restrictions according to the Annual Traffic Census published by TD. Start emissions from different vehicle types (except Double-Decker Franchised Buses (FBDD), Single-Decker Franchised Buses (FBSD), Public Light Buses (PLB), Heavy Goods Vehicles (HGV, including HGV7, HGV8 and HGV9) and Non-

(2) The highest traffic flows for the identified roads within the 500m Assessment Area are expected to occur in the year right before the commissioning of the proposed TMB. Given the original target commissioning year of TMB was in 2036 (adopted in the traffic model), 2036 (before the commissioning of TMB) was selected as one of the years for determining the worst year for the assessment. Subsequently, the Government stated that they would strive to commission TMB earlier than 2036, possibly as early as 2033. Therefore, 2033 was also selected as one of the years for determining the worst year for the assessment. Traffic flows in 2033 and 2036 before the commissioning of TMB are estimated by using the growth rate method approved by the Transport Department. Regardless of whether TMB will be commissioned in 2036 or in any earlier years (as early as 2033), the highest possible traffic flows for the concerned roads within 15 years after the commencement of operation of the Project would be captured in the 2036 traffic forecast (before the commissioning of TMB). The worst year for assessment would be determined among the selected years (i.e. 2031, 2033, 2036, 2046) with no underestimation of vehicular emissions.

franchised Buses (NFB, including NFB8 and NFB9 [(3)(4)])) along these identified LDs and RRs within the 500m Assessment Area have been considered using a 'broad-brush' approach based on the default trip-to-vehicle kilometres travelled (VKT) ratio for each vehicle type obtained from the EMFAC-HK model (latest version, v4.3) in 2031, where the VKT adopted was reduced to 13.73% of the default VKT to reflect the VKT from LDs and RRs (i.e. minor roads) only [(5)].

3.7.7 Summary of the composite vehicular NO, NO_2, RSP and FSP emission factors in 2031 for each road link within the 500m Assessment Area for the assessment is provided in **Appendix 3.3**.

Vehicular Emissions associated with Bus and Minibus Termini, Heavy Goods Vehicle and Bus/ Coach Parking Sites (Tier 2)

3.7.8 A number of bus and minibus termini have been identified within the 500m Assessment Area. The locations of these bus and minibus termini are shown in **Figure 3.5**. The emissions associated with these bus and minibus termini will contribute to the cumulative air quality impacts to the identified ASRs. NO_2, RSP and FSP impacts due to vehicular emissions from the identified bus and minibus termini (including starting, idling and running emissions from FBDD and PLB) have been included as Tier 2 contributions. No FBSD was identified at the identified bus and minibus termini during the site survey. Emission from FBSD at identified bus and minibus termini is thus not considered.

3.7.9 Besides, several major heavy goods vehicle and bus/ coach parking sites have been identified within the 500m Assessment Area. The locations of these parking sites are indicated in **Figure 3.5**. The emissions associated with these heavy goods vehicle and bus/ coach parking sites will contribute to the cumulative air quality impacts to the identified ASRs. NO_2, RSP and FSP impacts due to vehicular emissions from the identified heavy goods vehicle and bus/ coach parking sites (including starting and running emissions from HGV and NFB) have been included as Tier 2 contributions.

3.7.10 Vehicle activity data for each relevant vehicle type (i.e. FBDD, PLB) associated with the identified bus and minibus termini were obtained based on desktop information (e.g. bus schedule, bus route, etc.) and/ or by site surveys conducted by the Traffic Consultant, including:

- Number of starts and corresponding soak times for terminating vehicles for 24 hours within the terminus;
- Number of non-terminating vehicles for 24 hours within the terminus;

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(3) The air quality impact arising from NFB termini within the Assessment Area is expected to be minimal as the daily trips associated with the NFB termini are very limited. Start emissions from NFB6 and NFB7 have been conservatively considered in the 'broad-brush' approach along all LDs and RRs to take into account start emissions from these NFB termini (i.e. coaches providing residents' services) within the Assessment Area. In addition, start emissions from NFB (i.e. NFB8 and NFB9) due to on-street NFB parking spaces along Hoi Wah Road, as well as those from HGVs due to on-street parking spaces at San Lik Street and Hung Cheung Road, and possible parking sites within industrial buildings in the Tuen Mun Kau Hui Industrial Area have also been considered using the 'broad-brush' approach (for all road links within 700m spread distance from these NFB and HGV parking spaces). On-street parking spaces are difficult to conduct traffic surveys as there is an inaccuracy of vehicle flows due to illegal and over-time parking. In order not to underestimate the emission due to these on-street parking spaces, a 'broad-brush' approach (start emissions spread over the 700m spread distance from these NFB and HGV on-street parking spaces) is adopted as a conservative approach. For the possible parking sites within industrial buildings in the Tuen Mun Kau Hui Industrial Area, some sites are inaccessible to conduct surveys due to security reasons from the site's management offices. In order not to underestimate the emission due to these possible parking sites, the same 'broad-brush' approach as aforementioned is also adopted. Start emissions from these NFB and HGV are considered for all road links within 700m spread distance from the NFB and HGV parking spaces and are shown in Figure 3.4c.

(4) Start emissions from NFB8 and NFB9, and HGV7, HGV8, and HGV9 from the identified NFB and HGV parking sites (other than those mentioned in footnote [3]) have already been considered using the precise approach and thus start emissions from these vehicle types from the identified NFB and HGV parking sites were excluded on local roads in the broad-brush approach.

(5) The average daily VKT from minor roads (i.e. all trafficable roads that are outside the major road network, all types of restricted roads and local access roads) accounts for 13.73% of the average daily VKT from all roads in Hong Kong with reference to the latest Annual Traffic Census (2021) by Transport Department.

- Average travelling distance from ingress to stopping place within the terminus;
- Average travelling distance from stopping place to egress within the terminus;
- Average travelling speed within the terminus; and
- Idling time for terminating and non-terminating vehicles.

No FBSD was identified at the identified bus and minibus termini during the site survey. Emission from FBSD at identified bus and minibus termini is thus not considered.

3.7.11 Vehicle activity data for each relevant vehicle type (i.e. HGV, NFB) associated with the identified heavy goods vehicle and bus/ coach parking sites were obtained by site surveys conducted by the Traffic Consultant, including:

- Number of starts and corresponding soak times for terminating vehicles for 24 hours within the parking site;
- Average travelling distance from ingress to stopping place within parking site;
- Average travelling distance from stopping place to egress within the parking site; and
- Average travelling speed within the parking site.

3.7.12 In order to appreciate the existing traffic conditions of the aforementioned traffic facilities, comprehensive traffic counts have been conducted to collect necessary existing traffic data for the emission assessment.

3.7.13 To collect the existing traffic data under the normal traffic pattern, the survey was conducted for 24 hours at the normal weekdays in mid of May 2022 after the relaxation of social distancing measures effective on 21 April 2022 announced by the Government.

3.7.14 The methodology of the surveys for the aforementioned traffic facilities is described below:

<u>Bus and Minibus Termini</u>

3.7.15 For bus and minibus termini, surveyors were arranged at two main locations:

Ingress and Egress Points

3.7.16 Surveyors arranged at the ingress and egress points of the sites recorded the vehicle type, vehicle registration number, bus route number, travelling speed, arrival time and departure time.

Bus Ranks

3.7.17 Surveyors arranged in each bus rank recorded vehicle type, vehicle registration number, bus route number, travelling speed and engine stop/start time.

3.7.18 Three vehicle types were recorded for the bus and minibus termini, namely FBDD, FBSD and PLB. Soaking time of each vehicle was determined based on the vehicle engine stop/ start time. Idling time for terminating and non-terminating vehicles was determined based on the vehicle engine start/ departure time and the vehicle arrival/ departure time, respectively.

<u>Heavy Goods Vehicle and Bus/ Coach Parking Sites</u>

3.7.19 For heavy goods vehicle and bus/ coach parking sites, surveyors were arranged at the ingress and egress points of the sites. They recorded the vehicle type, vehicle registration number, travelling speed, arrival time and departure time. Seven vehicle types were recorded for the parking sites, namely medium goods vehicles (>5.5-15t) (HGV7), medium goods vehicles (>15-24t) (HGV8), heavy goods vehicles (>24t) (HGV9), non-franchised buses (<=6.4t) (NFB6), non-franchised buses (>6.4-15t) (NFB7), non-franchised buses (>15-24t) (NFB8), and non-franchised buses (>24t) (NFB9). Soaking time of each vehicle was determined based on the vehicle arrival/ departure time.

3.7.20 For both termini and parking sites surveys, the average travelling distances between ingress/egress points and stopping places were determined according to the survey map or on-site measurement.

3.7.21 The abovementioned vehicle activity information associated with bus and minibus termini, heavy goods vehicle and bus/ coach parking sites obtained from site surveys and desktop review is provided in **Appendix 3.4**. These information have been used as the basis for calculating the starting, idling and running emissions (including NO, NO_2, RSP and FSP vehicular emissions) associated with the identified bus and minibus termini, as well as starting and running emissions (including NO, NO_2, RSP and FSP vehicular emissions) associated with the identified heavy goods vehicle and bus/ coach parking sites. Reference was made to the *Calculation of Start Emissions in Air Quality Impact Assessment* published by EPD for the calculations of the starting, idling and running emissions. Starting and running emissions were based on emission factors predicted by the EMFAC-HK model (latest version, v4.3). Cold idling emissions were based on emission factors from Annex A of the *Calculation of Start Emissions in Air Quality Impact Assessment*, while warm idling emissions were based on emission factors from *Road Tunnels: Vehicle Emissions and Air Demand for Ventilation* (*PIARC-VEADV*) published by World Road Association.

3.7.22 The starting emissions for diesel vehicles fitted with selective catalytic reduction (SCR) devices (i.e. FBDD, diesel PLB, HGV and NFB) would be released over a total spread distance of 700m from where the vehicle start takes place, while the starting emissions for liquefied petroleum gas (LPG) vehicles (i.e. LPG PLB) would be released over a total spread distance of 150m from where the vehicle start takes place. All running and idling emissions have been assumed to be released on the spot.

3.7.23 For emissions within the identified bus and minibus termini, starting emissions from terminating vehicles as well as idling and running emissions from terminating and non-terminating vehicles have been considered and modelled. For emissions outside the identified bus and minibus termini, starting emissions from terminating vehicles associated with the remaining spread distance outside of the identified bus and minibus termini have been considered and modelled. All the calculated starting emissions from terminating vehicles were adjusted based on their respective idling emissions within that particular terminus, with reference to the *Calculation of Start Emissions in Air Quality Impact Assessment*.

3.7.24 For emissions within the identified heavy goods vehicle and bus/ coach parking sites, starting and running emissions from terminating/ parking vehicles have been considered and modelled. For emissions outside the identified heavy goods vehicle and bus/ coach parking sites, starting emissions from terminating/ parking vehicles associated with the remaining spread distance outside of the parking sites have been considered and modelled.

3.7.25 Sam Shing Public Transport Interchange and Lung Mun Oasis Bus Terminus are semi-confined, while other identified bus termini are open areas. The identified heavy goods vehicle and bus/ coach parking sites are open areas except for Nan Fung Industrial City Car Park which is semi-confined.

3.7.26 The locations of the emission sources, detailed emission calculations and emission inventory associated with bus and minibus termini, heavy goods vehicle and bus/ coach parking sites are provided in **Appendix 3.4**.

<u>Portal Emissions in the Vicinity of the Project (Tier 2)</u>

3.7.27 A number of existing full enclosures along Tuen Mun Road and Wong Chu Road have been identified within the 500m Assessment Area and their locations are shown in **Figure 3.6.**

3.7.28 The portal emissions were calculated based on the traffic forecast data and EMFAC emission factors in 2031. NO_2, RSP and FSP impacts due to portal emissions from these identified existing full enclosures have been included as Tier 2 contributions.

3.7.29 The locations of the portal emission sources are illustrated in **Figure 3.6**. Detailed calculations and emission inventory of these portal emissions are provided in **Appendix 3.5**.

Marine Emissions in the Vicinity of the Project (Tier 2)

3.7.30 Tuen Mun Typhoon Shelter and Castle Peak Bay are located within the 500m Assessment Area. The marine emissions from Tuen Mun Typhoon Shelter and Castle Peak Bay have been identified and calculated based on publicly available information and site survey. A realistic worst-case assumption considering possible growth of vessel movement during the assessment period (i.e. up to 2046) within the Tuen Mun Typhoon Shelter have been adopted in order to provide a conservative assessment. NO_2, RSP and FSP impacts due to marine emissions have been included as Tier 2 contributions.

3.7.31 The locations of the marine emission sources are shown in **Figure 3.7**. Detailed calculations and emission inventory of these marine emissions are provided in **Appendix 3.6**.

Industrial Emissions in the Vicinity of the Project (Tier 2)

3.7.32 Chimney emissions from industrial premises have been identified within the 500m Assessment Area and these chimney emissions (NO_2, RSP and FSP) have been included as Tier 2 contribution as they may contribute to the overall air quality impact at the identified ASRs. The locations of these industrial emission sources are shown in **Figure 3.8**. Emission inventory for industrial emissions is provided in **Appendix 3.7**.

3.7.33 In addition, the asphalt plant at Lam Tei Quarry has been identified as a major point source located about 3.2km north of the nearest identified ASR (A36). However, emissions from the asphalt plant at Lam Tei Quarry would not have direct impact to the identified ASRs of this Project due to screening by natural terrain as well as other buildings and structures. Potential impact from emissions of this asphalt plant is considered sufficiently represented by the PATH v2.1 model (Tier 3 contribution) and thus not separately modelled by local dispersion model.

Implication of Direct Noise Remedies (DNR)

3.7.34 As described in **Section 4**, the proposed Direct Noise Remedies (DNR) for the Project involve implementation of low noise road surfacing (LNRS) along LFRSR NB only, while installation of new noise barriers or noise enclosure is not required. Thus, there would be no air quality implication as a result of the implementation of the proposed DNR for the Project. Comparison between with and without DNR scenarios in terms of air quality impact as mentioned in 5(ix) of Appendix B of the EIA Study Brief is considered not necessary.

Air Dispersion Model, Meteorological Data and Modelling Assumptions

3.7.35 An EPD recommended air dispersion model, AERMOD, was used to model the potential air quality impact at the ASRs due to emissions from operation activities of the Project, portal, bus and minibus termini and carparks, marine and industrial emissions. The quantitative assessment was conducted following the latest EPD's *Guidelines for Local-scale Air Quality Assessment Using Model*.

3.7.36 The Project site and the 500m Assessment Area fall within the PATH grids (18,40), (19,40), (19,41), (19,42), (20,39), (20,40), (20,41), (21,39), (21,40) and (21,41). The relevant PATH grids in which the representative ASRs are located have been identified and shown in **Appendix 3.1**. The predicted meteorological data for the relevant PATH grids from the PATH v2.1 model obtained from EPD's website were used for model input.

3.7.37 AERMET, the meteorological pre-processor of AERMOD, was run to generate AERMOD-ready meteorological data for AERMOD model input. The land use parameters, including Albedo, Bowen ratio and surface roughness are required inputs for AERMET. The land use of 1km from the identified ASRs within each PATH grid has been evaluated to determine the PATH-grid specific surface roughness values. The land uses of the 10km x 10km region from the Project site have been evaluated to determine the values of the Albedo and Bowen ratio for the PATH grids. Detailed calculations of albedo, Bowen ratio and surface roughness are presented in **Appendix 3.8**. Land use maps illustrating the determination of the land use parameters are also shown in **Appendix 3.8**.

3.7.38 The AERMET/AERMOD model input parameters and assumptions for operation phase AQIA are summarised in **Table 3.6**.

Table 3.6 AERMET / AERMOD Model Input Parameters and Assumptions for Operation Phase AQIA

Input Parameters & Assumptions	Descriptions
Air dispersion model	AERMOD
Type of Sources	• Industrial emissions: point sources • Portal emissions: volume sources • Bus and minibus termini, carparks: area and volume sources • Marine emissions: point sources
Assessment Parameter	• 1-hour and annual NO_2 • 24-hour RSP and annual RSP • 24-hour FSP and annual FSP
Assessment Heights	• 1.5m, 5m, 10m, 15m, 20m, 25m, 30m above ground • 40m to 140m (at interval of 10m) above ground
Meteorological data	• Weather Research and Forecasting Model (WRF) data in 2015 from the PATH v2.1 were used to input into AERMET to produce AERMOD-ready meteorological data • PATH grids: (18,40), (19,40), (19,41), (19,42), (20,39), (20,40), (20,41), (21,39), (21,40) and (21,41). • Actual mixing heights recorded by the HKO in 2015 were in the range of 131m to 1,941m. Mixing heights from WRF data which are lower than 131m or higher than 1,941m were adjusted to 131m and 1,941m, respectively • Wind direction of 0º adjusted to 360º • Wind speed smaller than 1m/s adjusted to 1m/s • Anemometer height of WRF data = 9m

3.7.39 Portal emissions were modelled with reference to *Section III of the Permanent International Association of Road Congress Report (PIARC), 1991*. The portal emissions were modelled as multiple volume sources using AERMOD. The locations of the portal emission sources associated with these existing full enclosures are shown in **Figure 3.6**.

3.7.40 An EPD's recommended model, EMFAC-HK model (latest version, v4.3), was used to predict the vehicular emission factors of NO, NO_2, RSP and FSP for the 18 vehicle types in 2031 (i.e. the year with the predicted highest vehicular emissions within 15 years of commencement of operation). "EMFAC" mode was used for the model run. The latest *Use of Temperature and Relative Humidity Data for Vehicular Emission Factor Prediction* issued by EPD was followed for the treatment of ambient temperature and relative humidity in generating vehicular emission factors for this assessment. For assessment of short-term impact from vehicular emissions (i.e. 24-hour averaging or less), the daily profile of minimum temperature and relative humidity in each hour for each month recorded at the nearest weather station (i.e. Tuen Mun Children and Juvenile Home) in 2021 was adopted in the EMFAC-HK to generate vehicular emission factors of NO, NO_2, RSP and FSP. For assessment of long-term impact from vehicular emissions (i.e. annual averaging), the daily profile of average temperature and relative humidity in each hour for each month recorded at the Tuen Mun Children and Juvenile Home in 2021 was adopted in the EMFAC-HK to generate vehicular emission factors of NO, NO_2, RSP and FSP. Summary of the composite vehicular NO, NO_2, RSP and FSP emission factors in 2031 for each road link within the 500m Assessment Area for CALINE4 input are provided in **Appendix 3.3**.

3.7.41 An EPD's recommended air dispersion model, CALINE4, was used for predicting the NO_2, RSP and FSP impacts due to vehicular emissions from the identified roads (proposed new and existing roads) within the 500m Assessment Area. Details of the road configurations are provided in **Appendix 3.3**.

3.7.42 As the road elevation of CALINE4 model is limited to 10m, three separate model runs (M1, M2 and M3) were conducted to avoid any underestimation of pollutant concentrations at ASRs located 10mAG or above. **Table 3.7** shows the properties of the model groups.

Table 3.7 Properties of CALINE4 Model Groups

CALINE4 Model Group	Road Link Height (mAG)	ASR Height (mAG)
M1	0-10	All ASRs
M2	10-20 (All road links in this group will be deducted by 10mAG in model)	ASRs with height >10mAG (All ASRs in this group will be deducted by 10mAG in model)
M3	10-20 (All road links in this group will be set to 10mAG)	ASRs with height ≤10mAG

3.7.43 For road sections with vertical noise barriers, the mixing width adopted is the road width plus 3m on the side without the barrier and the height of emissions is at the top of barriers. For those with cantilever noise barriers, the mixing width adopted is the road width plus 3m on the side without the barrier and the modelled roads were shifted by the horizontal extent of the cantilever to the uncovered side with the height of emissions at the top of cantilevered barriers. For those with semi-enclosures, the mixing width adopted will be the road width plus 3m on the side without the semi-enclosure and the modelled roads were shifted by the horizontal extent of the semi-enclosure to the uncovered side with the height of emissions at the top of semi-enclosures.

3.7.44 The surface roughness height is a required parameter for CALINE4 and it is closely related to the land use characteristics within a study area. The land use types (i.e. urban, new development, rural and water areas) within each of the concerned PATH grids have been examined. Typical values of surface roughness height used for urban, new development, rural and water areas are 370cm, 100cm, 50cm and 0.1cm, respectively. The area-weighted surface roughness height for each of the concerned PATH grids as presented in **Table 3.8** have been calculated based on the percentage coverage of the aforementioned land use types within the PATH grid and were adopted for the CALINE4 model run. Detailed calculations of the area-weighted surface roughness heights for the identified PATH grids are provided in **Appendix 3.9**. Land use maps illustrating the determination of surface roughness heights are also shown in **Appendix 3.9**.

Table 3.8 Area-weighted Surface Roughness Heights for CALINE4 Input

PATH Grid	Area-weighted Surface Roughness Height (cm)
18,40	58
19,40	237
19,41	208
19,42	210
20,39	18
20,40	249
20,41	289
21,39	123
21,40	135

PATH Grid	Area-weighted Surface Roughness Height (cm)
21,41	86

3.7.45 Wind directional variability was calculated based on the following formula according to the stability class with reference to Irwin, J.S., 1980 (6).

$S_o = S \times (Z_o/15cm)^{0.2}$
Where Zo = is the surface roughness length (in cm) of the PATH grid; So = is the standard deviation of the horizontal wind direction Fluctuations (in degrees) S = is the standard deviation of the horizontal wind direction fluctuations (in degrees) for an aerodynamic surface roughness length of 15cm with reference to Irwin, J.S., 1980. S is a function of Pasquill stability class.

3.7.46 The standard deviations of the horizontal wind direction fluctuations under different Pasquill Stability categories for each of the concerned PATH grids are presented in **Appendix 3.9**.

3.7.47 The CALINE4 model input parameters and assumptions for operation phase AQIA are summarised in **Table 3.9**.

Table 3.9 CALINE4 Model Input Parameters and Assumptions for Operation Phase AQIA

Input Parameters & Assumptions	Descriptions
Air dispersion model	CALINE4
Year of traffic flow	• 2031 (Year of predicted highest vehicular emissions within 15 years of commencement of operation)
Vehicular Emission Factors	• EMFAC-HK (latest version, v4.3) emission factors in 2031
Assessment Parameter	• 1-hour NO_2 and annual NO_2 • 24-hour RSP and annual RSP • 24-hour FSP and annual FSP
Assessment Heights	• 1.5m, 5m, 10m, 15m, 20m, 25m, 30m above ground • 40m to 140m (at interval of 10m) above ground
Meteorological data	• Weather Research and Forecasting Model (WRF) data in 2015 from the PATH v2.1 • PATH grids: (18,40), (19,40), (19,41), (19,42), (20,39), (20,40), (20,41), (21,39), (21,40) and (21,41). • Actual mixing heights recorded by the HKO in 2015 were in the range of 131m to 1,941m. Mixing heights from WRF data which are lower than 131m or higher than 1,941m were adjusted to 131m and 1,941m, respectively • Wind speed smaller than 1m/s adjusted to 1m/s • Stability class extracted from each concerned PATH grid in PATH v2.1 • Calculation of wind directional variability based on stability class and surface roughness length for each concerned PATH grid

Post-processing of Modelling Results

1-hour NO_2 assessment

3.7.48 Ozone Limiting Method (OLM) was adopted for the conversion of NO_x to NO_2. For stack emissions, the hourly concentrations of NO_x were predicted at the relevant assessment heights

(6) Dispersion Estimate Suggestion #8: Estimation of Pasquill Stability Categories. U.S. Environmental Protection Agency, Research Triangle Park, NC. (Docket Reference No.II-B-10), Irwin, J.S., 1980.

of the identified ASRs. The initial NO_2/NO_x ratio for stack emissions was assumed to be 0.1[7], with NO and NO_2 comprising 90% and 10% of NO_x, respectively.

3.7.49 For vehicular emissions (including emissions from open roads, portals, bus and minibus termini and carparks), NO_x and NO_2 emission factors for each vehicle type are provided in EMFAC-HK model (latest version, v4.3). NO emission factor for each vehicle type was determined by subtracting the NO_2 emission factor from the NO_x emission factor. The hourly concentrations of NO and NO_2 were separately predicted at the relevant assessment heights of the identified ASRs.

3.7.50 The predicted NO concentrations from all modelled sources were converted to NO_2 based on OLM and were then added with the predicted NO_2 concentrations from all modelled sources to determine the total predicted NO_2 concentrations at the ASRs. The total NO_2 concentrations were calculated as follows:

$[NO_2]_{pred\ total}$ = $[NO_2]_{pred}$ + MIN {$[NO]_{pred}$, or (46/48)x$[O_3]_{bkgd}$}

$[NO_2]$ pred total	=	the total predicted NO_2 concentration
$[NO_2]$ pred	=	sum of the predicted NO_2 concentration due to direct emissions from all sources
[NO] pred	=	sum of the predicted NO concentration from all sources
MIN		means the minimum of the two values within the brackets
$[O_3]$bkgd	=	the representative O_3 background concentration; (46/48) is the molecular weight of NO_2 divided by the molecular weight of O_3

3.7.51 The predicted O_3 concentrations in 2030 in the relevant PATH grids obtained from the PATH v2.1 model were used for the conversion of NO_x to NO_2 in OLM.

Annual NO_2 assessment

3.7.52 Jenkin Method was adopted for the conversion of cumulative NO_x to NO_2 by using the functional form of annual mean of NO_2-to-NO_x with reference to *Review of Methods for NO to NO_2 Conversion in Plumes at Short Ranges (Jenkin, 2004a)* by UK Environmental Agency. The calculation is presented as follows:

$$[NO2] = \frac{\left([NOx] + [OX] + \frac{J}{K}\right) - \sqrt{([NOx] + [OX] + \frac{J}{K})^2 - 4[NOx][OX]}}{2}$$

$[NO_2]$	=	sum of the predicted NO_2 concentration from all sources
$[NO_x]$	=	sum of the predicted NO_x concentration from all sources
[OX]	=	sum of the NO_2 concentration and O_3 concentration (i.e. [OX] = $[NO_2]$ + $[O_3]$)
J	=	photolysis rate of NO_2
K	=	the rate coefficient for reaction between NO and O_3

3.7.53 The above functional form was used to analyse the recent five years of annual mean data obtained from relevant EPD's air quality monitoring stations (AQMS). The selected AQMS for the analysis are Tuen Mun General Station, Tap Mun General Station and Mong Kok Roadside Station. Tuen Mun General Station is the nearest station from the Project and therefore chosen as the representative station. Tap Mun General Station and Mong Kok Roadside Station were also included in order to cover a wider range of NO_x concentration in Hong Kong. The data analysis and derivations of conversion equation for cumulative annual NO_x to NO_2 are provided in **Appendix 3.10**.

(7) Air Quality Studies for Heathrow: Base Case, Segregated Mode, Mixed Mode and Third Runway Scenarios modelled using ADMS-Airport, 2007.

Background Concentrations (Tier 3)

3.7.54 The hourly background NO_2, RSP and FSP concentrations in 2030 predicted by the PATH v2.1 were used to establish the background contributions (Tier 3) for the cumulative AQIA. The predicted PATH background concentrations specific to the PATH grids within which the ASRs are located were adopted. The predicted PATH background concentrations adopted are conservative estimates with double counting of vehicular emissions.

3.7.55 As per *Guidelines on Choices of Models and Model Parameters* published by EPD, the RSP and FSP concentrations from PATH v2.1 were adjusted as below:

- 10^{th} highest daily RSP concentration: add 11.0µg/m^3;
- Annual RSP concentration: add 10.3µg/m^3;
- 19^{th} highest daily FSP concentration: Nil; and
- Annual FSP concentration: add 3.5µg/m^3.

Cumulative Pollutant Concentrations at ASRs

3.7.56 The predicted NO_2, RSP, FSP results from AERMOD and CALINE4 (Tier 1 and Tier 2 contributions) at the relevant assessment heights of each ASR were added up with the PATH background concentrations (Tier 3) on an hour-by-hour basis. Relevant time-period averages of the 8,760 hourly results for NO_2, RSP and FSP at the ASRs were calculated for comparison with the respective assessment criteria to evaluate compliance.

3.8 EVALUATION OF IMPACTS

Construction Phase

Fugitive dust from construction of LFRSR NB and LFRSR SB

3.8.1 As discussed in **Section 3.6**, the construction works primarily involve piling and superstructure works along the elevated carriageways, with road realignment works which involve some minor slope works. Fugitive dust emissions from superstructure works are expected to be minimal. External lateral support (ELS) for piling works will take place within a small confined area and any associated fugitive dust emissions are expected to be limited and localised. The slope works would require minor earthworks, but the works would be divided into various sub-areas such that the associated earthworks would only take place over a small area at any one time. Any potential fugitive dust emissions due to such minor slope works are thus also considered limited and localised.

3.8.2 Figures illustrating the indicative extent of the earthworks in sequence for the construction of LFRSR NB and LFRSR SB are provided in **Appendix 3.11**. Description of the works with potential earthworks, locations and timing are summarised in **Table 3.10**.

Table 3.10 Description of Works with Potential Earthworks, Locations and Timing for Construction of LFRSR NB and LFRSR SB

Month of Construction	Location	Description of Works with Potential Earthworks	Approx. Maximum Extent of Earthworks Area
16-20	LFRSR SB: Slip road between Tsing Wun Road and Wong Chu Road	• Road resurfacing and realignment for temporary road diversion, substructures and permanent road; • Slope strengthening work for the affected slope	890m^2

Month of Construction	Location	Description of Works with Potential Earthworks	Approx. Maximum Extent of Earthworks Area
21-24	LFRSR SB: Slip road between Tsing Wun Road and Wong Chu Road	• Road resurfacing and realignment for proposed retaining wall and new road; • Slope strengthening for the affected slope	970m^2
36-39	LFRSR NB (north): Tsing Wun Road northbound	• Road resurfacing and realignment for substructure and superstructure of retaining wall and portal structure; • Slope strengthening for the affected slope	1,720m^2
	LFRSR NB (south): near Lung Mun Road	• Road resurfacing and realignment for proposed retaining wall and new road;	1,600m^2
		• ELS for pier columns	385m^2
40-41	LFRSR NB	• ELS for pier columns	640m^2
43-44	LFRSR SB/ NB (south)		670m^2
45-46	LFRSR SB (south)		420m^2
47-48	LFRSR SB (north)		360m^2

3.8.3 It can be seen that the earthworks associated with the construction of LFRSR NB and LFRSR SB are minor with limited active earthworks areas at any one time. No extensive or lasting excavation works is required. Potential fugitive dust emissions due to the ELS and slope works for the construction of LFRSR NB and LFRSR SB would be limited, localised and transient. Therefore, adverse fugitive dust impact arising from the construction of LFRSR NB and LFRSR SB is not anticipated with implementation of good construction site practices and proper dust mitigation measures recommended in the *Air Pollution Control (Construction Dust) Regulation*.

Fugitive dust from construction of HWRSR

3.8.4 As discussed in **Section 3.6**, the construction works primarily involve slope works along Tuen Mun Road northbound, ELS works for piling and superstructure works, as well as junction improvement works. The slope and ELS works will be divided into various sub-sections where the earthworks will be confined to within relatively small works area at any one time.

3.8.5 Figures illustrating the indicative extent of the earthworks in sequence for the construction of HWRSR are provided in **Appendix 3.11**. Description of the works with potential earthworks, locations and timing are summarised in **Table 3.11**.

Table 3.11 Description of Works with Potential Earthworks, Locations and Timing for Construction of HWRSR

Month of Construction	Location	Description of Works with Potential Earthworks	Approx. Maximum Extent of Earthworks Area
47	Tuen Mun Road northbound (Section 1)	• Slope strengthening for the affected slope • ELS and excavation for U-trough structure	750m^2
48-49	Tuen Mun Road northbound (Sections 1 and 2)		1,700m^2
50	Tuen Mun Road northbound (Sections 2 and 3)		1,725m^2
51-52	Tuen Mun Road northbound (Sections 3 and 4)		1,575m^2

Month of Construction	Location	Description of Works with Potential Earthworks	Approx. Maximum Extent of Earthworks Area
53	Tuen Mun Road northbound (Sections 3, 4 and 5)		2,690m^2
54	Tuen Mun Road northbound (Sections 4, 5 and 6)		2,660m^2
55-56	Tuen Mun Road northbound (Sections 5 and 6)		1,865m^2
57	Tuen Mun Road northbound (Sections 6)		750m^2

3.8.6 With the slope and ELS works divided into various sub-sections, the extent of the earthworks along Tuen Mun Road northbound during with the construction of HWRSR is limited at any one time. No extensive or lasting excavation works is required. Potential fugitive dust emissions due to the ELS and slope works for the construction of HWRSR would be limited, localised and transient. Therefore, adverse fugitive dust impact arising from the construction of HWRSR is not anticipated with implementation of good construction site practices and proper dust mitigation measures recommended in the *Air Pollution Control (Construction Dust) Regulation*.

Air quality impact from emissions from construction plant

3.8.7 Construction equipment and dump trucks would be used during the construction of the Project. Given the Project site areas and the associated construction works are relatively small scale, the number of construction plants and dump trucks deployed on site will be limited [(8)] and the associated emissions from the operation of these construction plants are expected to be minimal. Requirements in the *Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation* and *Air Pollution Control (Fuel Restriction) Regulation* will be followed to control the emissions from the construction plants. Adverse air quality impact associated with the operation of the construction plants is not anticipated.

Operation Phase

Cumulative Air Quality Impact at the identified ASRs (during Project Operation)

3.8.8 The cumulative NO_2, RSP and FSP impacts, taking into account vehicular emissions from open roads, portals, bus and minibus termini, heavy goods vehicles and coach parking sites, industrial emissions and marine emissions within the 500m Assessment Area, as well as background air quality in 2030 from PATH v2.1, have been evaluated at the identified representative ASRs during the operation phase of the Project. The predicted cumulative NO_2, RSP and FSP concentrations at the worst affected height of the identified representative ASRs during operation of the Project are presented in **Table 3.12**. Detailed assessment results of all relevant assessment heights of the identified representative ASRs are provided in **Appendix 3.12**.

Table 3.12 Predicted Cumulative Pollutant Concentrations at the Worst Affected Height of the Identified Representative ASRs during Project Operation

ASR ID	Predicted Cumulative Concentrations (μg/m^3)					
	19th Highest 1-hr NO_2	Annual NO_2	10th Highest 24-hr RSP	Annual RSP	19th Highest 24-hr FSP	Annual FSP
A01	115.4	25.8	71.0	27.6	38.6	15.8
A02	122.9	27.5	71.1	27.7	38.7	15.9
A03	126.2	27.8	71.2	27.7	38.9	15.9
A04	126.7	28.4	71.3	27.8	38.9	16.0

(8) About 7 and 6 numbers of construction plant at LFRSR works site and HWRSR works site, respectively, will be operating at any one time based on estimation by Engineer. About 4 dump trucks per day among all works sites.

ASR ID	Predicted Cumulative Concentrations (µg/m³)					
	19th Highest 1-hr NO_2	Annual NO_2	10th Highest 24-hr RSP	Annual RSP	19th Highest 24-hr FSP	Annual FSP
A05	126.6	24.9	71.3	27.6	38.7	15.8
A06	126.0	26.6	71.4	27.7	38.6	15.9
A07	122.4	25.8	71.2	27.6	38.6	15.8
A08	128.0	28.5	70.9	28.0	39.4	15.8
A09	126.8	27.4	70.8	27.9	39.3	15.8
A10	130.0	26.5	70.7	27.9	39.3	15.7
A11	122.8	25.8	71.2	27.6	38.7	15.8
A12	125.1	26.6	71.3	27.6	38.8	15.9
A13	128.4	27.2	71.3	27.7	38.9	15.9
A14	118.5	26.8	71.3	27.7	38.9	15.9
A15	119.3	26.8	71.3	27.7	38.9	15.9
A16	118.5	27.4	71.2	27.7	38.8	15.9
A17	128.3	29.0	70.0	28.0	39.1	15.9
A18	115.1	22.8	68.9	27.2	38.6	15.4
A19	102.9	21.2	68.9	27.1	38.7	15.3
A20	115.6	25.0	69.8	27.7	39.1	15.6
A21	112.1	24.8	69.8	27.6	39.1	15.6
A22	138.7	31.1	70.3	28.1	39.5	16.0
A23	128.8	30.7	70.4	28.1	39.7	16.0
A24	136.8	33.6	70.6	28.3	39.9	16.2
A25	136.9	32.1	70.4	28.3	39.8	16.2
P01	133.8	29.9	71.4	27.9	39.1	16.1
P02	133.6	29.1	71.4	27.9	39.1	16.1
P03	131.7	31.4	70.3	28.2	39.6	16.1
AQOs	**200**	**40**	**100**	**50**	**50**	**25**

Notes:
(a) The 1-hour NO_2 AQO allows 18 exceedances over a year and the results presented are in the 19th highest.
(b) The 24-hour RSP AQO allows 9 exceedances over a year and the results presented are in the 10th highest.
(c) The 24-hour FSP AQO allows 18 exceedances over a year and the results presented are in the 19th highest.

3.8.9 As presented in **Table 3.12** and **Appendix 3.12**, it can be seen that the predicted cumulative NO_2, RSP and FSP impacts at all relevant assessment heights of all identified representative ASRs during operation of the Project comply with the respective AQO criteria.

3.8.10 Contour plots showing the cumulative NO_2, RSP and FSP impacts with operation of the Project at the worst-hit level are provided in **Figures 3.10** to **3.15**. For annual NO_2 impact, it can be seen that 2 small exceedance zones are predicted, but there are no air sensitive uses identified within these exceedance zones as they are all located on or right next to the road. No exceedance zones are predicted within the Assessment Area for 1-hour NO_2, 24-hour and annual RSP, and 24-hour and annual FSP impact during the operation of the Project. Therefore, it can be concluded that adverse air quality impact associated with the operation of the Project is not anticipated.

Incremental Air Quality Impact arising from the Project

3.8.11 In order to evaluate the air quality impact arising from the Project, the cumulative air quality impact without the operation of the Project has also been predicted. The detailed predicted cumulative NO_2, RSP and FSP concentrations at all relevant assessment heights of the identified representative ASRs without the operation of the Project are presented in **Appendix 3.13**. The difference in predicted cumulative pollutant concentrations at the ASRs between with and without the Project operation is summarised in **Table 3.13**.

Table 3.13 Difference in Predicted Cumulative Pollutant Concentrations at the Identified Representative ASRs between with and without Project operation

ASR ID	Range of Predicted Cumulative Concentrations (µg/m³)					
	19th Highest 1-hr NO_2	Annual NO_2	10th Highest 24-hr RSP	Annual RSP	19th Highest 24-hr FSP	Annual FSP
A01	-0.93 to 0.06	-0.02 to -0.01	0	0	0	0
A02	-0.45 to 1.73	-0.02 to 0.12	0	0 to 0.01	-0.01 to 0	0 to 0.01
A03	-0.33 to 2.36	-0.05 to 0.04	0	0	-0.01 to 0	0
A04	0.01 to 2.20	-0.09 to 0	-0.01 to 0	0	-0.02 to 0	0
A05	-0.63 to 1.98	-0.16 to 0	-0.01 to 0	-0.01 to 0	-0.01 to 0	-0.01 to 0
A06	-1.67 to 1.63	-0.08 to 0	0	0	-0.01 to 0	0
A07	0.77 to 4.11	-0.01 to 0.03	0	0	0	0
A08	-0.19 to 2.10	-0.02 to 0.07	-0.01 to 0	0	0	0
A09	-0.59 to 2.84	-0.01 to 0.08	0	0 to 0.01	0	0
A10	0.02 to 2.48	-0.11 to 0.03	0	-0.01 to 0	0 to 0.01	-0.01 to 0
A11	-0.25 to 1.25	0.01 to 0.16	0.01 to 0.01	0 to 0.01	0 to 0.01	0 to 0.01
A12	-0.31 to 3.36	0 to 0.34	0 to 0.02	0 to 0.02	0 to 0.03	0 to 0.02
A13	-0.34 to 4.70	0.11 to 0.57	0.01 to 0.04	0.01 to 0.04	0.01 to 0.05	0.01 to 0.03
A14	0 to 2.88	0.03 to 0.31	0 to 0.02	0 to 0.02	0 to 0.02	0 to 0.02
A15	1.28 to 2.86	0.01 to 0.10	0	0 to 0.01	0	0 to 0.01
A16	-0.26 to 0.10	0.04 to 0.05	0.01 to 0.01	0.01 to 0.01	0 to 0.01	0.01 to 0.01
A17	-2.56 to 0	-0.08 to 0	0	-0.01 to 0	0	-0.01 to 0
A18	-1.61 to 0.07	0 to 0.02	0	0	0	0
A19	-0.11 to 0.40	0 to 0.02	0	0	0	0
A20	-0.60 to 0.45	-0.01 to 0.04	0	0	0	0
A21	-0.72 to 0.01	0.01 to 0.03	0 to 0.01	0	0 to 0.01	0
A22	-0.88 to 0.09	-0.02 to 0.19	0 to 0.01	0 to 0.01	0 to 0.01	0 to 0.01
A23	-0.89 to 0.30	-0.01 to 0.23	0 to 0.02	0 to 0.01	0 to 0.03	0 to 0.01
A24	-1.33 to 0.58	0.02 to 0.12	0 to 0.01	0 to 0.01	0.01 to 0.02	0 to 0.01
A25	-0.91 to 0.41	-0.17 to 0.01	-0.02 to 0	-0.02 to 0	-0.03 to 0	-0.02 to 0
P01	-0.11 to 2.23	-0.16 to 0	-0.01 to 0	-0.01 to 0	-0.02 to 0	-0.01 to 0
P02	-1.15 to 0.49	-0.23 to 0	-0.02 to 0	-0.02 to 0	-0.02 to 0	-0.01 to 0
P03	-1.60 to 0	-0.22 to 0	-0.02 to 0	-0.02 to 0	-0.02 to 0	-0.01 to 0

Notes:
(a) Figures shown are the range of difference in predicted pollutant concentrations among all relevant assessment heights of each ASR (With Project – Without Project).
(b) Negative values represent a reduction of predicted pollutant concentrations due to the operation of the Project.

3.8.12 With the presence of the Project, the increment in cumulative air quality impact at the identified representative ASRs is minor, with a maximum increase of annual NO_2, RSP and FSP concentrations of about 0.57µg/m³, 0.04µg/m³ and 0.03µg/m³, respectively.

3.9 MITIGATION MEASURES

Construction Phase

3.9.1 The following dust control measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* and good site practices will be incorporated into the Contract Specifications and implemented throughout the construction phase:

- Impervious sheet shall be provided for skip hoist for material transport;
- The area where demolition work or any dusty work take place should be sprayed with water or a dust suppression chemical immediately prior to, during and immediately after such work as far as practicable;

- Establishment and use of vehicle wheel and body washing facilities at the exit points of the site;
- Provision of not less than 2.4m high hoarding from ground level along site boundary where adjoins a road, streets or other accessible to the public except for a site entrance or exit;
- All dusty materials should be sprayed with water or a dust suppression chemical immediately prior to any loading, unloading or transfer operation;
- Dropping heights for excavated materials should be controlled to a practical height to minimise the fugitive dust arising from unloading;
- During transportation by truck, materials should not be loaded to a level higher than the side and tail boards, and should be dampened or covered before transport;
- Temporary stockpiles of dusty materials shall be either covered entirely by impervious sheets or sprayed with water to maintain the entire surface wet all the time;
- Stockpiles of more than 20 bags of cement, dry pulverised fuel ash and dusty construction materials shall be covered entirely by impervious sheeting sheltered on top and 3-sides;
- All exposed areas shall be kept wet or covered by impervious sheets to minimise dust emission;
- ULSD will be used for all construction plant on-site, as defined as diesel fuel containing not more than 0.005% sulphur by weight) as stipulated in *Environment, Transport and Works Bureau Technical Circular (ETWB-TC(W)) No 19/2005* on Environmental Management on Construction Sites;
- The engine of the construction equipment during idling shall be switched off;
- Regular maintenance of construction equipment deployed on-site shall be conducted to prevent black smoke emission;
- NRMMs, e.g. mobile generator and air compressor, shall comply with the prescribed emission standards with a proper label approved by EPD in accordance with the *Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation*; and
- Electric power supply for on-site machinery shall be provided as far as practicable for construction activities.

<u>Operation Phase</u>

3.9.2 No adverse air quality impact during the operation of the Project is anticipated. Mitigation measures are thus considered not necessary during the operation phase.

3.10 CUMULATIVE IMPACT

<u>Construction Phase</u>

3.10.1 The construction period of the Project is tentatively from mid-2024 to 2031. Concurrent projects in the vicinity of the Project site have been identified and presented in **Table 2.8** and **Figure 2.9**. Concurrent projects that may have the potential to interact with the construction of the Project are summarised in **Table 3.14** and their locations are shown in **Figure 3.9**.

Table 3.14 Summary of the Concurrent Projects in the Vicinity of the Project Site during Construction Phase

Project	Project Proponent	Construction Period
Construction of Public Housing Development at Wu Shan Road Public Housing Site	HD	2022 to 2026/2027
Construction of Public Housing Development at Tuen Hing Road, Tuen Mun Area 23 Public Housing Site	HD	2026 to 2030/2031
Construction of Public Housing Development at Yip Wong Road Phase 1 and Phase 2	HD	2020 to 2024/2025
Cycle Track Between Tsuen Wan and Tuen Mun (Tuen Mun to So Kwun Wat Section)	CEDD	2023 to 2026
Tuen Mun Bypass	HyD	2026 to 2033
Tuen Mun South Extension	MTRCL	2023 to 2030
Reprovision of Tuen Mun Swimming Pool and Tuen Mun Golf Centre Practice Green, Pet Garden and Community Green Station	MTRCL	2023 to 2030
Sports Ground and Open Space in Area 16, Tuen Mun	ArchSD	2023/2024 to 2027/2028

Note:
(a) The implementation of these projects would be subject to further development and subsequent actions of the respective project proponents.

3.10.2 The currently ongoing construction of the public housing site development at Yip Wong Road is considered relatively small scale and mainly involve piling and superstructure works, and thus the associated fugitive dust emissions are expected to be limited with proper implementation of good site practices. The construction of the Cycle Track Between Tsuen Wan and Tuen Mun would also mainly involve minor piling and superstructure works with limited fugitive dust emissions expected. Cumulative dust impact from the abovementioned construction works at the Yip Wong Road public housing site and cycle track with the Project is expected to be minimal.

3.10.3 The public housing site developments at Wu Shan Road and Tuen Hing Road are currently undergoing site formation works which are expected to complete by 2024. With earthworks of the Project expected to commence starting 2025, cumulative dust impact from site formation works of the public housing site developments at Wu Shan Road and Tuen Hing Road are not expected. After completion of the site formation works, the construction works at the public housing site developments at Wu Shan Road and Tuen Hing Road would mainly involve piling and superstructure works where the associated fugitive dust emissions are expected to be limited with proper implementation of good site practices. Cumulative dust impact from the abovementioned construction works at the Wu Shan Road and Tuen Hing Road public housing sites with the Project is expected to be minimal.

3.10.4 A part of Tuen Mun Bypass (near Sam Shing Hui) falls within the Assessment Area. This part of the Tuen Mun Bypass will be built underground except for possible aboveground works for the construction of the middle ventilation building near the Sam Shing Hui area. The construction of the middle ventilation building would primarily involve superstructure works only within a confined footprint and thus fugitive dust emissions are expected to be limited. Cumulative dust impact from the abovementioned construction works of the potential ventilation building with the Project is expected to be minimal. The construction dust impact of the ventilation building and aboveground works of Tuen Mun Bypass at the Sam Shing Hui area shall be assessed in the EIA Study of the Tuen Mun Bypass (ESB-348/2021).

3.10.5 The construction works of the proposed Tuen Mun South Extension would involve demolition of the existing Tuen Mun Swimming Pool, excavation, piling and superstructure works for the proposed Tuen Mun Area 16 Station and Tuen Mun South Station. The existing Tuen Mun Swimming Pool, the proposed Tuen Mun Area 16 Station and Tuen Mun South Station are located about 320m east, 310m east and 970m south of the LFRSR Project site, respectively.

The closest ASRs (in all directions) to these construction works are at least 150m from this proposed Project. The demolition of the existing Tuen Mun Swimming Pool and excavation works of the Tuen Mun Area 16 Station would be more than 100m away from the nearest identified ASRs of this proposed Project, while the excavation works of the Tuen Mun South Station would be more than 900m away from the nearest identified ASRs of this proposed Project. Given the separation distance (see **Figure 3.9** for illustration of the separation distances between the concurrent projects and the proposed works boundary), cumulative dust impact from the abovementioned demolition and excavation works with the Project is expected to be minimal.

3.10.6 The proposed reprovision of Tuen Mun Swimming Pool, Tuen Mun Golf Centre Practice Green and Pet Garden and Community Green Station will involve piling and superstructure works with limited dust emissions expected. Cumulative dust impact from the proposed reprovision works with the Project is expected to be minimal.

3.10.7 The proposed Sports Ground and Open Space in Area 16 may involve site clearance, piling works and superstructure works. The location of the proposed Sports Ground and Open Space in Area 16 is more than 300m away from the LFRSR Project site. The closest ASRs (in all directions) to these construction works are at least 250m from this proposed Project. The potential construction works associated with the proposed Sports Ground and Open Space in Area 16 would be at least 300m away from the nearest identified ASRs of this proposed Project. Given the separation distance, cumulative dust impact from the abovementioned construction works with the Project is expected to be minimal.

3.10.8 In view of the above discussions, adverse cumulative air quality impact from the identified concurrent projects during construction phase is not expected.

Operation Phase

3.10.9 Cumulative air quality impact during operation of the Project has been evaluated as discussed in **Section 3.8**. No adverse air quality impact from all emission sources within 500m from the proposed Project site boundary is anticipated.

3.11 RESIDUAL IMPACT

Construction Phase

3.11.1 Adverse residual air quality impact during the construction phase of the Project is not expected with the implementation of the mitigation measures as described in **Section 3.9** and those stipulated in the *Air Pollution Control (Construction Dust) Regulation*.

Operation Phase

3.11.2 Cumulative air quality impact during operation of the Project is predicted to comply with the relevant AQO criteria as discussed in **Section 3.8**. Adverse residual air quality impact during the operation phase of the Project is not anticipated.

3.12 ENVIRONMENTAL MONITORING AND AUDIT

Construction Phase

3.12.1 Adverse air quality impact during the construction phase is not anticipated with the implementation of proper mitigation measures and good construction site practices. However, regular dust monitoring and environmental site inspections are recommended to be carried out during the construction phase to ensure the proper implementation of the recommended mitigation measures and that the mitigation measures are effective and to ensure that no nearby ASRs will be subject to adverse air quality impact. Representative and closest ASRs in all directions shall be selected for on-site dust monitoring to ensure that there is no adverse dust impact on the nearby ASRs. Details of the EM&A programme for air quality during construction phase are provided in a standalone EM&A Manual.

Operation Phase

3.12.2 Adverse air quality impact arising from the operation of the Project is not anticipated. EM&A programme for air quality during operation phase is considered not necessary.

3.13 CONCLUSION

Construction Phase

3.13.1 The construction of the Project primarily involves the construction of elevated carriageways and slip roads, modification and realignment of existing roads, as well as associated junction modification works. The key construction activities associated with the construction of the Project include site clearance, slope works, piling works and superstructure works. Slope works and piling works are considered potential dust-generating activities and may generate fugitive dust emissions. With the implementation of relevant air quality mitigation measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* and good construction site practices, adverse air quality impact due to construction works of the Project is not anticipated.

Operation Phase

3.13.2 The cumulative air quality impacts, taking into account emissions from the Project, emissions from adjacent emission sources (i.e. vehicular emissions from open roads, portals, bus and minibus termini, heavy goods vehicles and coach parking sites, industrial emissions and marine emissions within the 500m Assessment Area), as well as general background air quality in 2030, have been evaluated during the operation phase of the Project. The results conclude that the predicted cumulative NO_2, RSP and FSP impacts would comply with the relevant AQO criteria. Hence, adverse air quality impact due to operation of the Project is not anticipated.