3. AIR QUALITY

3.1 Introduction

This section addresses the air quality impacts associated with the construction and operation of the MOS Extension. Potential air quality impacts are identified, particularly during the construction phase of the railway extension, the stations and the depot.

During the construction phase, there will be dust impacts from site preparation activities, earthworks and construction of the super-structure. Exhaust emissions from trucks and powered mechanical equipment may affect sensitive receivers in the surrounding study area. The extent of impact depends on the distances between the work sites and the sensitive receivers, the construction methodology and the number of mechanical plant and vehicles employed on site.

Since electrically powered trains will be used, there will be no adverse operational air quality impacts, although there might be some dust generation from abrasion, and gaseous and/or particulate emissions from maintenance operations. There is also the potential for ozone generation due to arcing between the power rail and train pick-ups. However, these pollutant sources are expected to have little or no impact on surrounding sensitive uses and are not considered further.

3.2 Government Legislation and Standards

The principal legislation relating to air quality is the *Air Pollution Control Ordinance (APCO) (Cap 311)*. The entire Hong Kong Special Administration Region (HKSAR) is covered by *Air Quality Objectives* (AQOs) which stipulate the statutory limits of seven air pollutants and the maximum allowable numbers of exceedances over specific periods. The AQOs are shown in *Table 3.2a.*

Table 3.2a Hong Kong Air Quality Objectives (μg m^{-3})[i]

Pollutant	Averaging Time				
	1 Hour[ii]	8 Hours[iii]	24 Hours[iii]	3 Months[iv]	1 Year[iv]
Total Suspended Particulates (TSP)	-	-	260	-	80
Respirable Suspended Particulates[v] (RSP)	-	-	180	-	55
Sulphur Dioxide (SO_2)	800	-	350	-	80
Nitrogen Dioxide (NO_2)	300	-	150	-	80
Ozone (O_3)	240	-	-	-	-
Lead (Pb)	-	-	-	1.5	-

Pollutant	Averaging Time				
	1 Hour[ii]	8 Hours[iii]	24 Hours[iii]	3 Months[iv]	1 Year[iv]
Carbon Monoxide (CO)	30,000	10,000	-	-	-

Note:

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

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

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

(iv) Arithmetic means.

(v) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometres and smaller.

The *Air Pollution Control (Construction Dust) Regulation* specifies control requirements for construction activities. In addition, the *Technical Memorandum on Environmental Impact Assessment Process* (TMEIA) stipulates an hourly TSP limit of 500 $\mu g\ m^{-3}$ for construction dust at the affected sensitive receivers.

For public transport interchanges, the ProPECC Note (PN 1/98), *Control of Air Pollution in Semi-Confined Public Transport Interchanges* issued by the EPD, specifies air quality standards inside semi-confined bus termini; the standards are presented in *Table 3.2b*.

Table 3.2b Recommended Air Quality inside Public Transport Interchange

Pollutant	Maximum Concentration not to be Exceeded* ($\mu g\ m^{-3}$)	
	Averaging Time	
	5-minutes	1-hour
NO_2	1,800	300
SO_2	1,000	800
CO	115,00	30,000

* expressed at reference condition of 25 C and 101.325 kPa

3.3 Sensitive Receivers and Baseline Conditions

According to the EIAO TM, 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). Identified air sensitive receivers (ASRs) within the study area of 500m either side and along the full stretch of the proposed MOS alignment are summarised in *Table 3.3a of Annex A1 in Volume 2 - Technical Annexes* together with their horizontal distances from the nearest work site boundary. *Figures 3.3a-r of Annex A2* in *Volume 2 - Technical Annexes* show the locations of the ASRs.

The study area is classified as urban and the majority of land uses in the vicinity of the work sites are residential, recreational and institutional. The existing EPD air quality monitoring station in Sha Tin has been used to provide the baseline air quality of the area. The concentrations of pollutants based on the 1997 annual average are used as the background concentration and are summarised in *Table 3.3a* below. The main sources of pollutants are the traffic on existing roads and highways. Industrial uses are only found within Shek Mun Industrial Area.

Table 3.3a Background Air Quality (μgm^{-3})(i)

Pollutant	Annual Average
NO_2	49
SO_2	11
CO(ii)	720
RSP	47
TSP	66

Note:

(i)Background air quality is based on the Air Quality in Hong Kong 1997.

(ii)Monitored at Kwai Chung Monitoring Station

Hin Keng to Tai Wai

The alignment between Hin Keng and Tai Wai will be at grade and construction dust impacts are likely in the area around Hin Keng Estate and the sports facilities to the south of the existing KCR alignment. Most of the land uses within this area are residential and recreational. A total of 12 ASRs (A1 - A12) have been identified within this area. Most of the ASRs (A1, A2, A3, A4, A6, A10, A11 and A12) are located less than 100 m from the work site boundary. The nearest ASR to the work site is A6 (Hin Tin Playground) which is 10 m from the work site.

The existing air quality is mainly affected by vehicular exhaust emissions. Che Kung Miu Road and Mei Tin Road are the major roads of the area. The average daily traffic flows along these two roads during 1997 were 17,240 and 35,550 vehicles respectively (*Annual Traffic Census 1997, Traffic and Transport Survey Division).*

Tai Wai to Sha Tin Tau

Twenty-nine ASRs (A13 - A40a) have been identified within the study area from the Tai Wai to Sha Tin Tau. The region surrounding the work sites consists mainly of residential, recreational, industrial and educational uses. 18 ASRs (A17, A18, A19, A20, A21, A22, A24-A31, A34, A37, A39 and A40a) are located less than 100 m from the work site boundary. The nearest ASR to the site boundary is A29 (Tai On Building) which is located at 26 m away.

Vehicle emissions from Che Kung Miu Road, Hung Mui Kuk Road and Lion Rock Tunnel Road are the dominant pollutant sources of the existing air quality. The annual average daily traffic flows on these roads were 17,240 , 26,820 and 14,260 vehicles respectively. Industrial emissions from the area near Man Lai Court is another pollutant source that may have a small influence on the existing local air quality environment.

Sha Tin Tau to Sha Kok Street

Between Sha Tin Tau and Sha Kok Street stations the sensitive receivers identified within the study area include residential buildings, schools, churches and recreational areas. A total of 39 ASRs (A41 - A79) were identified for this section. 25 ASRs including Koo Arm Temple, Lei Uk Tsuen, Immaculate Heart of Mary School, Lutheran Salvation Church, Chun Shek Estate, Tsang Tai Uk, Pok Hong Estate, and Sha Kok Estate are located within 100 m from the work site boundary. A56 (Tsang Tai Uk, New Development), A61 (C C Sha Tin Church), A62 (Pok Man House) and A64 (Tin Ka Ping Kindergarten) are the nearest ASRs which are located at 5 m from the work site boundary.

The ambient air quality in this area is mainly affected by the traffic on Lion Rock Tunnel Road, Sha Kok Street and the local access roads. The annual averaged daily traffic flows on Lion Rock Tunnel Road and Sha Kok Street were 23,460 and 15,590 vehicles respectively in 1997.

Sha Kok Street to City One, Sha Tin

The area surrounding the section from Sha Kok Street to City One Stations consists of residential buildings, schools, a recreational ground, a clinic and a hospital. 16 ASRs (A80 - A94) are identified for this area and all the identified receivers are located less than 100 m from the work site boundary. Sha Tin Wai, Wong Uk Tsuen No. 3-4 and the Wong Clan Ancestral Hall are the nearest affected receivers which are both located 5 m from the work site boundary.

Background air quality in this area is dominated by the traffic emissions from Sha Tin Wai Road, Tai Chung Kiu Road and other local access roads. Of these roads, Sha Tin Wai Road and Tai Chung Kiu Road were recorded as having annual average daily traffic flows of 34,810 and 25,490 vehicles respectively in 1997.

City One, Sha Tin to Shek Mun

For this section of the alignment, the area surrounding the construction sites consists of residential and industrial buildings, hospitals and schools. In total, 16 ASRs (A95 - A110) have been identified within the study area, and all of them except A96 (Prince of Wales Hospital Accommodation), A99 (St Rosa of Lima's School) and A105 (Koon Wah Mirror Gp. Building) are located less than 100 m from the work site boundary.

Ambient air quality in this area is affected by traffic emissions from Chap Wai Kon Street and Tai Chung Kiu Road which had annual average daily traffic flows of 5,470 and

25,490 vehicles respectively in 1997. Air emissions from industrial premises in Shek Mun and near Ngau Pei Sha may also have a minor influence on local air quality.

Shek Mun to Chevalier Garden

Between Shek Mun and Chevalier Garden Stations, the surrounding areas comprises mainly residential and industrial uses, and an Hospital. Industrial buildings are mainly located around Shek Mun. Pictorial Garden is located along the Shing Mun River and a number of small scattered villages and Sha Tin Hospital are located along the Tate's Cairn Highway. A total of 35 ASRs (A111 - A135) have been identified along this section of the alignment. Apart from A118, A120-A122, A127, A131 and A132, all the other ASRs are located within 100 m from the work site boundary. The nearest ASRs to the boundary are A116 (Metropole Square), A117(China Light & Power Office), A119 (Topsail Plaza) and A135 (Kam Tai Court Block J) which are each located 5 m from the boundary.

Ambient air quality is affected by the traffic on Tate's Cairn Highway, Ma On Shan Road and Tolo Highway, and to a lesser extent from air emissions from industrial premises in Shek Mun. The daily traffic flows levels on the above Highways ranged from 7,630 to 82,300 vehicles in 1997.

Chevalier Garden to Heng On

Sensitive uses within this section of the alignment include residential developments and schools. A total of 10 ASRs (A136 - A145) have been identified within this area. All ASRs except A138 (Proposed Residential Development at the east of Area 86B), A143 (Residential Development to the Southwest of Vista paradise) and A145 (PLK Wu Chung College) are located within 100 m from the work site boundary. The nearest ASRs to the construction site are A139 (Proposed Health and Welfare Building) and A142 (Chinese YMCA College) which are both 10 m from the site boundary.

Traffic on Ma On Shan Road, Sai Sha Road and the interchange has a major influence on the ambient air quality in the area. In 1997, the annual average daily traffic flows on these roads were 33,350 and 13,010 vehicles, respectively. Vehicular exhaust from the traffic on these roads is the main source of air pollutants.

Heng On to Ma On Shan

A total of 13 ASRs (A146 - A158) have been identified in the study area between Heng On and Ma On Shan Stations. The identified sensitive receivers comprise residential buildings, schools, a sports stadium and a church. All of them except A148 (Chung Dak House), A150 (St Josephs Secondary School) and A151 (Fung Yiu King Memorial Secondary School) are located within 100 m from the work site boundary. Toi Shan Association Wong Tat To Memorial School (A146) is the nearest ASR which is 5 m from the work site boundary.

Background air quality in this area is dominated by the traffic exhaust from Sai Sha Road and Ma On Shan Road. In 1997, the annual average daily traffic flows on Sai Sha Road and Ma On Shan Road were 16,650 and 45,730 vehicles respectively.

Ma On Shan to Lee On

Along the most easterly section of the railway alignment, most of the land uses close to the work sites are residential and educational uses, although they also include a church. A total of 23 ASRs (A159 - A180) have been identified and all of them except A172 (Wu Kai Sha Youth Centre) and A180 (Li Po Chun United World College) are located 100 m away from the site boundary. The nearest ASRs to the boundary are A159 (Sunshine City Block M), A160 (Tolo Place Block 4), A163 (Ma On Shan Centre Block 1), A164 (Fu Fai Garden Block 1) and A179 (Residential Development to the east of Lee On Estate) all of which are located 5 m from the boundary.

Ambient air quality is affected by the traffic on Sai Sha Road and other local access roads. A159, A160, A163, A164 and A179 are likely to experience high dust impacts due to their close proximity to the site boundary.

3.4 Construction Impacts

3.4.1 Potential Sources of Impact

The principal source of potential air quality impacts during the construction of the MOS Extension will be dust. Exhaust emissions from site vehicles and powered mechanical equipment (PME) will have minimal impacts on the surrounding area owing to the limited number of potential sources. All the access roads to the work sites will be paved. Temporary stockpiling of spoil on site is also expected.

The main construction activities likely to generate dust impacts would include demolition and site clearance, materials handling and transfer off-site, and vehicle movements within work sites. Batching plants located at the Shek Mun and Lee On Station worksites are likely to be used for viaduct box girder section production. The production rate of the batching plants is expected to be 200 m^3/day. Viaduct construction along the alignment would impose limited dust impacts on the surrounding areas due to the pre-casted construction method. However, construction of the stations along the alignment has the potential to cause air quality impacts on the surrounding environment.

Construction dust would be generated mainly from exposed materials during handling of spoil and from vehicular movements within the construction sites during the site clearance and site formation stages. *Table 3.4a* shows the estimated amount of spoil to be handled within each construction site. There are likely to be extensive earthworks at Tai Wai Station and the Depot site, and along the sections of the alignment between Tai Wai and Sha Tin Tau, Heng On and Ma On Shan, and Ma On Shan and Lee On. The main types of the spoil will be rock fill material, decomposed granite and marine deposits.

Table 3.4a Estimated Volume of Spoil to be handled in Construction Phase

Construction Site	Estimated Spoil Volume (m^3)	Construction Period (month)
Hin Keng to Tai Wai	12000	8
Tai Wai Station and Depot	171000	22
Tai Wai to Sha Tin Tau	33000	6
Sha Tin Tau Station	19000	7
Sha Tin Tau to Sha Kok Street	18100	6
Sha Kok Station	18100	7
Sha Kok Street to City One, Sha Tin	19400	6
City One Station	18100	7
City One Sha Tin to Shek Mun	27200	6
Shek Mun Station	18100	7
Shek Mun to Chevalier Garden	15500	6
Chevalier Garden Station	15100	7
Chevalier Garden to Heng On	30600	6
Heng On Station	12700	7
Heng On to Ma On Shan	34400	6
Ma On Shan Station	18100	7
Ma On Shan to Lee On	43800	17
Lee On Station	4400	7

In addition to the temporary works areas identified along the alignment, seven potential 'off-site' work areas, namely Sites A to G, have been proposed for the storage, set-up, preparation and installation of track and systems related equipment along the alignment of the MOS Extension. The locations of these worksites are shown on *Figures 2.1a-c.* However, as the storage of track and systems related materials and equipment would not generate dust, no dust impacts are expected in relation to the proposed use of Sites D and E, which are predominantly proposed as storage areas. Similarly, the track and systems related installation works proposed at worksites A, B, C, F and G are also considered to present a minimal potential for the generation of dust. As such, since the Contractors will be legally bound to comply with the requirements of the *Air Pollution Control (Construction Dust) Regulations* in relation to any track and systems related works

undertaken at these locations, no dust impacts are predicted in relation to the use of these worksites.

3.5 Evaluation of Impacts

According to the *Hong Kong Planning & Standards Guidelines* (HKPSG), a buffer distance of at least 100 m between the construction site and the receivers should be maintained to minimize dust nuisance. The haul routes should be also located away from the receivers.

Hin Keng to Tai Wai

It can be seen from *Table 3.3a* in *Annex A1 of Volume 2 - Technical Annexes*, that ASRs A1-A4, A6, A10-A12 are located within 100 m from the construction site, consequently, the separation distance does not satisfy the HKPSG requirement. Dust level at these ASRs may be high.

Tai Wai to Sha Tin Tau

In total, 18 ASRs within this section of the alignment are, as indicated in *Table 3.3a* of *Annex A1* in *Volume 2 - Technical Annexes*, located within 100 m from the work site boundary and are therefore likely to experience high dust impact. In particular, A29 (located 26 m from the boundary) is likely to be adversely affected.

Sha Tin Tau to Sha Kok Street

It can be seen from *Table* 3.3a in *Annex A1 of Volume 2 - Technical Annexes*, that A41-A43, A49-A52, A54-A57, A60-A70 and A73-A77 are the nearest ASRs. The buffer distances for these receivers do not satisfy the HKPSG requirements. In particular, receivers A56 (Tsang Tai Uk, New Development), A61 (C C Sha Tin Church), A62 (Pok Man House) and A64 (Tin Ka Ping Kindergarten), may experience high dust impacts from the construction works.

Sha Kok Street to City One Sha Tin

Receivers A80-A94 (total 15 ASRs) are located less than 100 m from the work site. The buffer distances do not therefore satisfy the HKPSG requirements. The nearest ASRs, A81 (Sha Tin Wai Playground), A92 (Wong Uk Tsuen No. 3-4) and A92a (the Wong Clan Ancestral Hall) which are located 5 m from the boundary and are therefore likely to experience high dust impacts.

City One Sha Tin to Shek Mun

Receivers A95, A97, A98, A100-A104, and A106-A110 are located less than 100 m from the site boundary, as indicated in *Table 3.3a* in *Annex A1 of Volume 2 - Technical Annexes*. They may experience a high dust impact especially A97(the Pamela Youde

Child Assessment Centre/School Dental Clinic) and A102 (Yau Kam Yuen Pre-vocational School) which are both located 5 m from the boundary.

Shek Mun to Chevalier Garden

Receivers A111-A117, A119, A123-A126, A128-A130 and A133-A135 are located within 100 m from the work site boundary as indicated in *Table 3.3a* in *Annex A1 of Volume 2 - Technical Annexes.* In particular, A116 (Metropole Square), A117 (China Light & Power Office), A119 (Topsail Plaza) and A135 (Kam Tai Court Block J) which are located 5 m from the site, may experience high dust impacts.

Chevalier Garden to Heng On

Receivers A136, A137, A139-A142 and A144 are located less than 100 m from the site and the buffer distances do not therefore satisfy the HKPSG requirements. In particular, A139 (Proposed Health and Welfare Building) and A142 (the Chinese YMCA College) which are both located 10 m from the site boundary may experience high dust impacts.

Heng On to Ma On Shan

As is indicated in *Table 3.3a* in *Annex A1 of Volume 2 - Technical Annexes,* receivers A146, A147, A149, and A152-A158 are located less than 100 m from the site boundary and consequently, the buffer distance does not satisfy the HKPSG requirements. The nearest ASR, A146 (Toi Shan Association Wong Tat To Memorial School) is likely to experience a high dust impact.

Ma On Shan to Lee On

Receivers A159-A171a and A173-A179 are located less than 100 m from the work site boundary as is indicated in *Table 3.3a* in *Annex A1 of Volume 2 - Technical Annexes.* According to the HKPSG, their buffer distances do not satisfy the requirement and it is expected that they may experience a high dust impact especially at A159, A160, A163, A164 and A179 (which are each located 5 m from the boundary).

Environmental control and mitigation measures stipulated in Air Pollution Control (Construction Dust) Regulation are required to limit the dust emission from the site and protect the ASRs from high dust impacts. The mitigation measures are described in *Section 3.6* below.

3.6 Mitigation Measures

Standard dust suppression measures specified in the *Air Pollution Control (Construction Dust) Regulations* should be incorporated into contract documents and adopted as part of good site practices to minimise potential dust impacts on the ASRs. The following measures should be implemented in order to reduce dust generation:

- the areas at which demolition work are to take place should be sprayed with water or dust suppressing chemicals immediately upon commencing the works and at regular intervals throughout the duration of the demolition works in order to ensure that the entire surface of the works is maintained in a damp condition;
- all demolished items that have the potential to emit dust particles should be covered entirely with impervious sheeting or placed in an area sheltered on the top and the 3 sides within a day of demolition;
- any excavated material which may potentially emit dust should be covered entirely by impervious sheeting or sprayed with water so as to maintain it in a damp condition;
- vehicle washing facilities should be provided at every exit point, and mechanisms put in place to ensure that they are used effectively;
- where a site boundary adjoins a road, street, service lane or other area accessible to the public, hoarding of not less than 2.4 m above ground level should be provided along the entire length of that portion of the site boundary except for any site entrances or exits;
- every main haul road should be sprayed with water or a dust suppressing chemical so as to maintain the entire road surface in a damp condition; and
- all dusty materials should be sprayed with water or a dust suppression chemical immediately prior to any loading, unloading or transfer operation so as to maintain the dust materials in a damp condition.

In addition to the above, the following control measures, recommended under the *Best Practicable Means Requirements for Cement Work (Concrete Batching Plant)* should also be incorporated into the contract documents to prevent fugitive dust emission:

- every stockpile of cement or dry pulverised fuel ash shall be covered entirely by impervious sheeting;
- all receiving hoppers for unloading materials shall be enclosed on 3 sides up to 3 m above the unloading point;
- cement or dry pulverised fuel ash delivered in bulk shall be stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line to warn of over-filling;
- silo used for the storage of cement or dry pulverised fuel ash shall not be overfilled;
- the loading, unloading, handling, transfer or storage of dusty materials should be carried out in such a manner to minimise dust emissions and in an enclosed system or facility;
- any vent or exhaust shall be fitted with an effective fabric filter;

- the belt conveyor should be enclosed on the top and on 2 sides with a metal board at the bottom to eliminate any dust emission due to wind-whipping effects;
- all conveyor transfer points should be totally enclosed;
- the filter bags in the cement silo dust collector must be thoroughly shaken after cement is blown into the silo to ensure adequate dust collection for subsequent loads;
- for dry mix batching, the truck batching aperture shall be shrouded and fitted with water suppression sprays; and
- vents of all silos and weighing scale shall be fitted with a fabric filtering system.

Should any dredged or excavated materials be odorous, the following mitigation measures are recommended to minimise odour nuisance at nearby ASRs:

- the odorous material should be removed within one day to reduce the amount of time available for decomposition; and
- the odorous materials should be covered with plastic tarpaulin sheets in the stockpile area.

The outline EM&A proposals for the control of construction dust are defined *in Section 12.3*.

3.7 Operational Phase

As the rolling stock to be utilised will be electrically powered, no potential air quality impacts have been identified during the normal operation of the MOS Extension. However, low levels of dust may be created by the abrasion and wear of track, electrical pick-up gear and rolling stock and from maintenance activities. These emission sources are anticipated to be limited and no adverse air quality impacts from these sources are expected. Railway impacts will be limited to the station ventilation systems and the air quality inside the bus termini within related development structures.

Station Ventilation System

Ventilation fans and louvres, or air ventilation systems should be provided to ensure sufficient local air movement within the station concourse. Smoke extraction vents should also be provided in the event of fire. The vents for all ventilation systems should be directed away from nearby sensitive receivers.

Bus Terminus

The bus termini would be located at Tai Wai Station and at Lee On Station. The design of the ventilation systems should achieve the 1-hour and the 5-minute criteria as stated in ProPECC Note (PN 1/98) as shown in *Table 3.2b*. In addition, the air inlet and exhaust of

the ventilation system should be directed away from the nearby sensitive uses to avoid nuisance.

3.8 Conclusions

Construction dust has been identified as the main air quality impact arising from the MOS Extension during the construction phase. Handling of excavated materials, concrete batching and vehicle movements within the construction site are the main potential sources of dust. The construction works will be undertaken within a predominantly urban area and the majority of land uses close to the potential sites are identified as ASRs. Some of the ASRs will not satisfy the buffer distance requirement stipulated in the HKPSG. Mitigation measures stated in the Air Pollution (Construction Dust) Regulation should be followed to limit the dust emission from the site.

Environmental Monitoring & Audit is recommended for ensuring the compliance of the dust criteria.

Air quality impacts during the operational phase of the MOS Extension are not considered to be of concern as limited potential sources have been identified. The design of the ventilation systems for the stations and the bus termini should be carefully considered to ensure that the established criteria are met.