6.0 AIR QUALITY IMPACT ASSESSMENT

6.1 Air Quality Sensitive Receivers

Representative Air Sensitive Receivers (ASRs) have been identified according to the criteria set out in the Hong Kong Planning Standards and Guidelines and the Air Pollution Control Ordinance (APCO), through site inspections and review of landuse plans of the Study Area. The air impacts on all existing and planned ASRs have been considered. The identification and names of the representative ASRs are shown in Table 6.1 below and shown on Figures 6.1a - 6.1c.

Table 6.1: Air Quality Sensitive Receivers

Air Sensitive Receivers (ASR)	Name	Type / Classification
1-1 to 1-4	Scenery Court	Residential use
2-1 to 2-4	Hilton Plaza	Residential use
3-1 to 3-6	New Town Plaza	Residential use
4-1 to 4-4	Wai Wah Centre	Residential use
5-1 to 5-4	Shatin Plaza	Residential use
6-1 to 6-2	Sha Tin Centre	Residential use
7-1 to 7-3	Lucky Plaza	Residential use
15-1, 15-2, 16-1, 16-2, 17-1, 17-2, 18-1, 18-2, 22	Lek Yuen Estate	Residential Use
19-1 to 19-2	Shatin Tsung Tsin School	School
20-1 to 20-2	Lek Yuen Community Hall	Institutional Use
21-1 to 21-2	Sky Holy Spirit Primary School	School
26	Shatin Fire Stations Quarters (Government Quarters)	Residential Use
27-1, 27-2, 28-1, 29-1, 29-2, 34-1, 34-2, 36-1 to 36-5 39-1 to 39-3	Wo Che Estate	Residential Use
31	Wo Che Lutheran School Ko Fook Iu Memorial School	School
33	Kiangsu-Chekiang College (Shatin)	School
35-1 to 35-2	Pui Ying College (Sha Tin)	School

Air Sensitive Receivers (ASR)	Name	Type / Classification
45-1 to 45-2	Shatin Technical Institute	School
N1, 46-1 to 46-2	Sui Wo Court	Residential use
47-1 to 47-2	Kindergarten	School
50	Po Leung Kuk Siu Hon-sum Primary School	School
51-1, 51-4	Jockey Club Ti - I College	School
52-1 to 52-3	Chun Hang Court Chun Yat Court Chun Hei Court	Residential use
53-1 to 53-7	Ha Wo Che	Residential Villages
54-1 to 54-7	Sheung Wo Che	Residential Villages
55-1 to 55-2	Pai Tau	Residential Villages
56-1 to 56-4	Tin Liu	Residential Villages
57-1 to 57-4	Villa Le Parc	Residential Use
58	Villa Augustana	Residential Use
60	Church	Public Worship
R3 to R5	Proposed Development Area near Lai Chi Yuen	Residential Use
S1	Shatin Clinic	Clinic
S2 to S4	Regional Council Heritage Museum	Institutional
N2 to N3	Isolated House in Fo Tan	Residential
32	HOSDevelopment in Fung Wo Lane	Residential
R1 to R2	Isolated Houses near Sui Wo Court	Residential

6.2 Existing Air Quality Environment

The air quality monitoring data at the nearest EPD monitoring stations to Tai Po Road was used as the background air quality data for the air impact assessment. Air monitoring data for 1997 were requested from the Air Services Group of EPD and are provided in Appendix C-1. A summary of the background air quality data of 1997 at the Shatin EPD monitoring station is shown in Table 6.2.

Table 6.2: **Background Air Quality Data, 1997, at the Shatin EPD Monitoring Station**

Pollutant	Air Monitoring Station	Annual Average Concentration($\mu g/m^3$)
Nitrogen Dioxide (NO_2)	Shatin	49 (1hour)
Carbon Monoxide (CO)	(1)	500 (1hour)
Respirable Suspended Particulates (RSP)	Shatin	47 (24 hour)
Total Suspended Particulates (TSP)	Shatin	67 (24 hour)

(1) CO is not monitored at the Shatin monitoring Station. Therefore, a typical CO value of 500 $\mu g/m^3$ (1 hour) value has been used for the modelling. This value has been used for previous EIA studies.

6.3 Impacts During Construction

The likely air quality impact arising from the widening and reconstruction of Tai Po Road (Shatin) Section is related to dust nuisance and gaseous emissions from construction plant and vehicles.

SO_2 and NO_2 will be emitted from the diesel-powered equipment used. However, since the numbers of such plant required on-site will be limited, their gaseous emissions will be minor and the Air Quality Objectives (AQOs) for these gases are not expected to be exceeded.

Potential dust nuisance will be the major concern from the widening and reconstruction work of the Project. The major sources of dust on site have been assumed to be from construction, vehicular movement over unpaved haul roads and erosion based on the preliminary implementation programme discussed in Section 2.0 of this Report.

The Fugitive Dust Model (FDM) was used to predict the likely dust impacts at the ASRs from the reconstruction and widening work. Particulate emission rates for the identified potential dust sources were determined based on the USEPA publication *Compilation of Air Pollution Emission Factors (AP42) (USEPA, 4th & 5th edition, 1985 & 1995).* The following model inputs have been included in the assessment of construction dust impacts based on the emission information for different activities listed in AP42:

- 80% of particulates will have a size equal to 30 μm and the remaining 20% are in the respirable fraction with a size of 10 μm or less;
- a silt content of 4.8%;
- a moisture content of 4%;
- an average dust density of 2500 kg/m^3 ; and
- a background TSP(24 hour) concentration used in the impact assessment of 67$\mu g/m^3$.

Meteorological data for 1997 has been obtained from the Hong Kong Observatory for the weather station at Shatin, while mixing height information for 1997 used in the study was obtained from the weather station at King's Park.

Both 1-hour and 24-hour TSP concentrations at the representative ASRs have been determined. A conservative approach has been adopted in the assessment. The construction programme is described in Section 2.0; this is divided into six time periods. The modelling was carried out for the each of the six time periods and the worst case scenario at each sensitive receiver has been determined.

The results of the dust modelling at sensitive receivers are presented in summary in Table 6.3. The full modelling results are provided in Appendix C-2.

Table 6.3: Concentration of Dust Impacts at the Air Sensitive Receivers during Construction Phase Assuming No Mitigation

Air Sensitive Receiver	Concentration of Total Suspended Particulates (including background levels) ($\mu g/m^3$)	
	1 hour	24 hour
1-1	206	137
1-4	251	188
2-3	228	172
3-4	169	133
4-1	187	150
5-2	256	185
5-4	308	214
6-2	225	165
7-2	244	163
7-3	200	137
16-1	609	356
16-2	476	278
17-1	322	183
17-2	229	135
22-1	516	240
26-1	1137	752
27-1	197	126
29-1	234	147
29-2	216	116
36-4	571	332
39-1	428	269
46-1	85	76
52-1	343	164
52-2	296	170
53-5	332	222
53-7	344	226

Air Sensitive Receiver	Concentration of Total Suspended Particulates (including background levels) ($\mu g/m^3$)	
	1 hour	24 hour
54-1	724	514
54-2	797	551
54-3	1045	686
56-1	201	169
56-2	205	205
56-4	141	112
57-1	89	75
58	133	96
59	1000	588
60	176	113
51-1	1010	685
45-1	331	203
45-2	248	167
35-1	776	516
31	497	290
19-1	1273	689
21-1	490	201
40	286	161
47-1	87	79
50	88	76
R1	618	341
R2	391	283
R3	389	271
R4	275	177
R5	92	76
S1	234	132
S2	370	210
S3	439	201
N2 - N3	166	162
32	550	322

As shown in Table 6.3, the construction work may cause dust impacts at some of the air sensitive receivers in excess of the 1 hour 500$\mu g/m^3$ standard unless mitigation is applied. With the implementation of mitigation measures as listed in Section 6.4, which include watering of materials, covering of stockpiled materials and restricting dropping heights, dust impacts can be reduced to a level within the air quality criteria.

Impact modelling has been undertaken to estimate the dust impacts with the mitigation measures in place. The maximum concentrations of dust impacts at the nearest air sensitive receivers during construction with the mitigation measures applied and including background air pollution concentrations are shown in Table 6.4.

Table 6.4: Concentrations of Dust Impacts during the Construction Phase with General Control Requirements

Air Sensitive Receiver	Concentration of Total Suspended Particulates (including background levels) ($\mu g/m^3$)	
	1 hour	24 hour
1-1	105	89
1-4	104	85
2-3	107	90
3-4	96	82
4-1	103	92
5-2	124	103
5-4	140	112
6-2	115	97
7-2	121	96
7-3	107	-88
16-1	232	155
16-2	192	131
17-1	144	102
17-2	116	88
22-1	204	120
26-1	276	201
27-1	107	81
29-1	111	87
29-2	104	82
36-4	177	125
39-1	146	112
46-1	71	70
52-1	124	87
52-2	114	88
53-5	148	114
53-7	123	116
54-1	268	203
54-2	290	215
54-3	365	256
56-1	108	98
56-2	109	109
56-4	90	81
57-1	74	70
58	84	75
60	92	79
51-1	356	257
45-1	128	109
45-2	106	88
35-1	285	205

Air Sensitive Receiver	Concentration of Total Suspended Particulates (including background levels) ($\mu g/m^3$)	
	1 hour	24 hour
31	151	120
19-1	435	257
21-1	196	108
40	115	87
47-1	72	70
R1	203	138
R2	186	133
R3	131	97
R4	113	86
R5	75	69
S1	106	82
S2	111	82
S3	105	82
N2-N3	91	80
32	169	145

The results show that with the mitigation measures detailed above, the dust impacts at the ASRs will be within the Air Quality Objectives.

6.4 Mitigation Measures During Construction

The dust control measures detailed below should be incorporated in the Contract Specification as an integral part of good construction practice and implemented to minimise dust nuisance to within acceptable levels arising from the works.

(1) Watering of unpaved roads, which results in road dust suppression by forming moist cohesive films among the discrete grains of road surface material. An effective watering programme, i.e. twice daily watering with complete coverage, is estimated to reduce erosion of unpaved roads by 50%;

(2) Watering at every 1.5 hours at the construction area during construction is estimated to reduce dust emissions by 70%;

(3) Where breaking of oversize rock/concrete is required, watering should be implemented to control dust. Water spray should be used during the handling of fill material at the site and at active cuts, excavation and fill sites where dust is likely to be created;

(4) Dropping heights for excavated materials should be controlled to a practical height to minimize the fugitive dust arising from unloading;

(5) 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;

(6) All stockpiles of aggregate or spoil should be enclosed or covered and water applied in dry or windy condition; and

(7) Effective water sprays should be used on the site at potential dust emission sources.

6.5 Impacts During Operation

6.5.1 Assessment Methodology

Impacts on air quality during operation of the Tai Po Road (Shatin Section) will be due to vehicular emissions. The worst case traffic flows over a 15 year time period will be during the year 2021 based upon the traffic calculations as detailed in Section 4.0 of this Report.

Because EPD emission factors for vehicles only provide projections up to the year 2011, the emission rates for 2011 have been used for the 2021 traffic flows. This provides the worst case of emission factors and traffic volumes. The vehicular emission factors of nitrogen oxides (NO_x), respirable suspended particulates (RSP) and carbon monoxide (CO) for each vehicle type in the year 2011 have been obtained from data supplied by the EPD and are provided in Appendix C-3.

The nitrogen dioxide (NO_2) has been assumed to be 7.5% of total NO_x emissions, based upon the ozone limiting method.

The background concentrations assumed for use in the impact assessment as detailed in Table 6.2 are:

NO_2 (1 hour) :	49 $\mu g/m^3$
CO (1 hour) :	500 $\mu g/m^3$
RSP (24 hour):	47 $\mu g/m^3$

In addition, a background ozone concentration of 64.78 $\mu g/m^3$, derived from the annual average of the daily maximum from EPD's Kwai Chung monitoring station, was agreed with EPD's Air Services Group for use in the assessment.

6.5.2 Model Input Parameters

Traffic emissions have been modelled using the traffic pollution model CALINE4. Because the peak hour traffic occurs during daytime, neutral meteorological conditions were assumed. Typical input parameters that were used for the CALINE4 model are listed below:

Wind Speed:	1 metre per second
Wind Direction:	worst case for each receiver
Wind Direction Standard Deviation	18.3 Degrees
Stability Class	D
Mixing Height	1000 metres
Temperature	25 Deg. C
Surface Roughness	100 cm

Height of discrete receptors 1.5 metres above ground level
Height of grid receptors 1.5 metres above ground level

CALINE4 is only a screening model and so it is not possible to obtain results over an averaged 24-hour period. However, maximum concentrations for a 24-hour period can be calculated by multiplying the maximum 1-hour concentrations obtained from the model with the multiplication factor of 0.4 (+/-0.2). This factor is generally used to convert short term concentrations estimated by screening models to long term concentrations and is accepted by regulatory agencies in the U.S.A [1].

The NO_x results obtained from the CALINE4 model have been subject to the Tier 2 screening level analysis of the Ozone Limiting Method [2]. This utilised the background ozone concentration of 64.78 $\mu g/m^3$ and a NO_x to NO_2 conversion of 7.5%.

6.5.3 *Model Results*

The model results are provided in Appendix C-4 and are summarised in Table 6.5. The air pollution contours at 1m above ground level are depicted in Figures 6.2,6.3 and 6.4.

Table 6.5: Air Quality Modelling Results

ASR *	CO (1 hour, μg/m^3)	NO_2 (1 hour, μg/m^3)	RSP (24 hour, μg/m^3)
01	3465	265	124
02	3787	281	132
03	2922	237	108
04	3940	290	136
05	2792	228	104
06	2619	219	98
07	2334	203	92
15, 16, 22	2975	238	111
19	3305	254	121
21	2084	192	86
26	2943	236	112
27, 29, 36, 39	2586	215	99
31	2004	187	85
35	3050	240	114
40	2388	200	92
45	2814	215	102
46	1273	150	64
47	1274	150	64
50	1348	153	65
51	4603	282	137
52	2317	192	85
53	2953	236	110
54	2964	237	112
56	2723	226	103
57	1856	181	79
58	2400	209	95
60	2833	231	108
R3	3352	258	121
R4	3016	241	112
R5	2899	235	110
S1	2845	231	106
S2	2875	233	107
S3	2629	221	101
S4	1956	184	81
N1	1230	147	62
N2	2280	197	88
32	3260	252	121

* The ASR numbers is based on the prefix on ASR numbers in Table 6.1. For example, 1 in this table includes 1-1, 1-2, 1-3 and 1-4 in Table 6.1.

The model results show that air quality during operations of the roadway will not result in an exceedance of the Air Quality Objectives and will be below the criteria for 24 hour RSP of 180μg/m^3, 1 hour NO_2 of 300μg/m^3 and 1 hour CO of 30,000μg/m^3.

6.6 Operational Mitigation Measures

Because the Project will not exceed the Air Quality Objectives, no operational mitigation measures are required.

6.7 Residual Impacts

With the incorporation of recommended mitigation measures, air pollution emissions during construction will be reduced to an acceptable level without residual impacts. The results from operational modelling show that air pollution impacts from operation of the roadway will be within the Air Quality Objectives and therefore no residual impacts will occur.

Excessive watering of the site may result in secondary impacts from run off of solid materials into drainage areas. Measures have been incorporated in Section 7.0 of the Report to reduce potential impacts to water quality.

a) "Practical Guide to Atmospheric Dispersion Modeling", Trinity Consultants, Inc., U.S.A. Table 10-5, p.10-16.

b) Brode, R.W., 1988: Screening Procedures for Estimating the Air Quality Impact of Stationary Sources. EPA-450/4-88-010, U.S.A Environmental Protection Agency, Research Triangle Park, N.C, U.S.A, p.4-17.

Use of Ozone Limiting Method for Estimating Nitrogen Dioxide Concentrations, Draft for Comment, OLM/ARM Work Group, U.S.A Environmental Protection Agency, November 1997.