4 AIR QUALITY

4.1 INTRODUCTION

This section describes the potential air quality impacts arising from the construction and operational activities associated with the implementation of the proposed development in the Study Area. The main air quality impact during construction phase will be those associated with dust emissions from the construction activities. Vehicle emissions and industrial chimney emissions will be the key areas of concern during the operational phase. Details of the proposed developments within the Study Area have been described in *Section* 2.

Air quality impacts affecting the existing and planned Air Sensitive Receivers (ASRs) in the Study Area will be assessed and suitable mitigation measures, where necessary, will be recommended to reduce the air quality impacts to within relevant criteria.

4.2 RELEVANT LEGISLATION AND CRITERIA

The principal legislation for the management of air quality is the *Air Pollution Control Ordinance* (APCO)(Cap 311). The whole of the Hong Kong Special Administrative Region (HKSAR) is covered by the *Hong Kong Air Quality Objectives* (AQOs) which stipulate the statutory limits of some typical air pollutants and the maximum allowable numbers of exceedance over specific periods. The AQOs are shown in *Table 4.2a* below.

Table 4.2a ***Hong Kong Air Quality Objectives ($\mu g\ m^{-3}$)[1]***

Pollutant	Averaging Time			
	1 Hour [2]	8 Hours [3]	24 Hours [3]	1 Year [4]
Total Suspended Particulates (TSP)	-	-	260	80
Respirable Suspended Particulates [5] (RSP)	-	-	180	55
Sulphur Dioxide (SO_2)	800	-	350	80
Nitrogen Dioxide (NO_2)	300	-	150	80
Carbon Monoxide (CO)	30,000	10,000	-	-

Note:
(1) Measured at 298 K (25°C) and 101.325 kPa (one atmosphere).
(2) Not to be exceeded more than three times per year.
(3) Not to be exceeded more than once per year.
(4) Arithmetic means.
(5) Respirable suspended particulates are defined as particles suspended in the air with a nominal aerodynamic diameter of 10 μm and smaller.

In addition, the *Technical Memorandum on Environmental Impact Assessment Process* (EIAO-TM) stipulates that an TSP concentration of 500 μg m^{-3} measured at 298 K and 101.325 kPa (1 atm) should be achieved for construction dust impact assessment. An odour criterion of 5 odour units, based on an averaging time of 5 seconds, should also be met.

The *Air Pollution Control (Construction Dust) Regulation* stipulates the mitigation measures for construction sites. Under the *Air Pollution Control (Specified Processes)*

Regulation, a licence is required for the operation of concreting batching plant.

The design and operation of transport terminus should complied with the *Control of Air Pollution in Semi-Confined Public Transport Interchanges* (ProPECC PN 1/98). The air quality of the transport terminus should be maintained in accordance with the *Transport Terminus Air Quality Guidelines* (TTAQG) presented in *Table 4.2b*.

Table 4.2b ***Transport Terminus Air Quality Guidelines (TTAQG)***

Air Pollutants	Averaging Time	Maximum Concentration ($\mu g\ m^{-3}$)
Carbon Monoxide	5 minutes	115,000
	1 hour	30,000
Nitrogen Dioxide	5 minutes	1,800
	1 hour	300
Sulphur Dioxide	5 minutes	1,000
	1 hour	800

Note: All limits are expressed at the reference conditions of 298 K and 101.325 kPa

Buffer distance requirements for active and passive recreational uses are given in the *Hong Kong Planning Standards and Guidelines* (HKPSG), as shown in *Table 4.2c* below.

Table 4.2c ***HKPSG Air Quality Guidelines on Usage of Open Sites***

Type of Road	Buffer Distance	Permitted Use
Trunk Road and Primary Distributor	> 20 m	Active and passive recreational uses
	3 - 20 m	Passive recreational uses
	< 3 m	Amenity areas
District Distributor	> 10 m	Active and passive recreational uses
	< 10 m	Passive recreational uses
Local Distributor	> 5 m	Active and passive recreational uses
	< 5 m	Passive recreational uses
Under Flyover		Passive recreational uses

Source: *Hong Kong Planning Standards & Guidelines* (1992)

4.3 BASELINE AND FUTURE CONDITIONS

4.3.1 Existing Condition

The existing air quality of Study Area is affected by the chimney emissions from the Castle Peak Hospital and Tuen Mun Hospital located to the south, and the industrial premises located to the north. Vehicular exhaust emissions from traffic on the existing roads including Tsing Lun Road, Tsun Wen Road and Lam Tei Interchange also affect the air quality of the Study Area. Both Tuen Mun Road and Castle Peak Road are located at more than 500 m from the Study Area and therefore their effects on the Study Area should be small.

There is currently no EPD fixed air monitoring station in operation in the Tuen Mun area. The nearest monitoring station that is most representative of the Study Area is in Yuen Long. The air quality data reported for the year 1996 at the Yuen Long EPD station is presented in *Table 4.3a*. The dust levels of the station are high and

exceedances of the annual criteria of TSP and RSP were recorded in 1996.

Table 4.3a ***Background Pollutant Level as in 1996***

Pollutants	Annual Average, μg m^{-3}
TSP	114
RSP	64
SO_2	18
NO_2	52
CO	490[(i)]

Note: The CO concentration was monitored at Kwai Chung Air Monitoring Station.

4.4 *AIR SENSITIVE RECEIVERS*

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 should be considered as ASRs. The identified ASRs for construction and operational phases are listed in *Table 4.4a* respectively and their locations are shown in *Figure 4.4a* respectively.

Table 4.4a ***Location of Air Sensitive Receivers***

ASRs	Location	Construction Phase	Operational Phase
A1	Vertical Interim Housing Development in Area 29	✓	✓
A2	Siu Hang Tsuen West	✓	✓
A3	Siu Hang Tsuen East	✓	✓
A4	Po Tong Ha West	✓	✓
A5	Po Tong Ha East	✓	✓
A6	Scattered Village House	✓	✓
A7	Scattered Village House	✓	✓
A8	Tsz Tin Tsuen West	✓	✓
A9	Tsz Tin Tsuen South	✓	✓
A10	Tsz Tin Tsuen East	✓	✓
A11	San Hing Tsuen	✓	✓
A12	Yau Tze Tin Memorial College	✓	✓
A13	Kei Lun Wai	✓	✓
A14	Siu Hong Court	✓	✓
A15	Tuen Mun Government School	✗	✓
A16	Tuen Mun Hospital	✗	✓
A17	Castle Peak Hospital	✓	✓

ASRs	Location	Construction Phase	Operational Phase
A18	Quarters of Castle Peak Hospital	✓	✓
A19	Police Station at Leung Shun Street	✓	✓
A20	Goodrich Garden/Blossom Garden	✓	✓
A21	Planned G/IC Use opposite to the Site 3	✗	✓
A22	Proposed Housing Block at Site 1 (South)	✗	✓
A23	Proposed School at Site 1	✗	✓
A24	Proposed Housing Block at Site 1 (North)	✗	✓
A25	Proposed Housing Block at Site 2 (North)	✗	✓
A26	Commercial Centre at the north of Site 2	✗	✓
A27	Proposed School adjacent to Site 2	✗	✓
A28	Proposed School adjacent to Site 4	✗	✓
A29	Proposed Housing Block at Site 4 (North)	✗	✓
A30	Proposed Housing Block at Site 4 (South)	✗	✓
A31	Proposed Housing Block at Site 3 (East)	✗	✓
A32	Commercial Centre at the north of Site 3	✗	✓
A33	Proposed Housing Block at Site 3 (West)	✗	✓

ASRs A15 and 16 are 500 m away from the boundary of the Study Area, and therefore they are not regarded as receivers in the construction stage. In addition, ASRs A21 - 33 are planned receivers and are not regarded as ASRs in the construction phase.

As described in *Section* 2, four housing sites and ten schools are proposed in the Study Area, and their locations are shown in *Figure 2.3a*. A distributor road that passes along the periphery of Po Tong Ha and Tsz Tin Tsuen, connecting Hing Kwai Street and the Lam Tei Interchange, has been proposed. The distributor road will release the traffic loading of Tsun Wen Road and Tsing Lun Road.

The Preferred Development Option has proposed five high-rise residential blocks and two schools in Site 1; seven high-rise residential blocks in Site 2; nine high-rise residential blocks in Site 3; twelve high-rise residential blocks in Site 4; and eight schools in between Site 2 and Site 4. All of these are planned ASRs for the operational phase.

4.5 IDENTIFICATION OF IMPACTS

4.5.1 *Construction Phase*

Dust generating from the road works, development and infrastructure construction will be the major source of pollutants. Construction activities such as material handling, wind erosion of stockpiled materials, concrete batching and truck movement on the unpaved haul roads are the main dust generating sources. Although a concrete batching plant may be located in Site 2, its size is expected to be small as a number of cement works located within the Tuen Mun District could be employed for the supply of pre-mixed concrete. In addition, the housing blocks within the proposed

developments may also be constructed using off-site pre-fabricated components, as the way many public housing developments in Hong Kong are constructed. As such, the requirement for on-site concrete batching will be very much reduced and it is likely that the capacity of the silo will be less than 10,000 tonnes, which will exclude the facility from being classified as a Specific Process or a Designated Project.

The construction of residential developments will be carried out into two phases, Phase 1 (or Development Package 1) and Phase 2 (or Development Package 2). The construction of Phase 1 development will last for 24 months while Phase 2 development will last for 31 months. Phase 1 development is divided into six zones (Zone 1 to 5) which includes the development in Site 1 and Site 5 and a section of the distributor road (between Hing Kwai Street and west of Po Tong Ha). It is assumed that all the six zones will be constructed simultaneously. Spoil is expected from the cut and fill works, and material handling rate and number of truck required for the Phase 1 development are presented in *Table 4.5a* below. All cut and fill works for Phase 1 are assumed to take place in the first 9 months of the Phase 1 construction programme.

Table 4.5a ***Estimate of Construction Traffic Flow and Emission Rate for Phase 1***

Construction Activities	Material Handling Rate (m^3/day)	No. of vehicle required [(i)(ii)] (veh/day)
Cut Work ---		
(i) Zone 1a	253 (zone 1a, 2 and 4 together)	53
(ii) Zone 2		6
(iii) Zone 4		8
Fill Work---		
(i) Zone 1	395 (zone 1,3 and 5 together)	9
(ii) Zone 3		6
(iii) Zone 5		91

Note:
(i) Working hour is assumed as 12 hour a day, 6 days a week and 26 day a month.
(ii) Capacity of a truck is assumed to be 7.5 m^3 and it is assumed that a truck will make 2 trips for each journey.

Phase 2 development is divided into twenty-one zones (Zone 6 to 18a), which includes the developments in Site 2, Site 3 and Site 4 and the remainder of the distributor road (between Po Tong Ha West and Lam Tei Interchange). Road construction and site formation for the residential developments are the major construction works. It is expected that a small concrete batching plant will be located at Site 2. Two temporary works areas of 4,900 m^2 and 5,100 m^2, which could be used for stockpiling, are proposed to the north of Tsz Tin Tsuen. As the construction mitigation measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* will apply for the stockpiles and the ASRs are located at more than 200 m from these temporary works areas, thus satisfying the HKPSG recommended buffer distance for dusty open storage areas, adverse dust impact from stockpiling is considered unlikely.

Dust emission is expected from the cut and fill works, vehicle movement on unpaved haul road and fugitive emissions from concrete batching plant. The material handling rates and number of truck movements for Phase 2 development have been estimated and are presented in *Table 4.5b*.

Table 4.5b *Estimate of Construction Traffic Flow and Emission Rate for Phase 2*

Construction Activities	Material Handling Rate (m^3/day)	No. of vehicle required [(i)(ii)] (veh/day)
Cut Work ---		
(i) Zone 7	163 (zone 7, 7a, 9, 10b, 13 and 18 together)	6
(ii) Zone 7a		2
(iii) Zone 9		1
(iv) Zone 10b		3
(v) Zone 13		7
(vi) Zone 18		21
Fill Work---		
(i) Zone 6	158 (zone 6, 8, 10a, 10c, 11, 11a, 12, 12b, 14, 14a, 15, 15a, 16, 17 adn 18a together)	2
(ii) Zone 8		21
(iii) Zone 10a		1
(iv) Zone 10c		9
(v) Zone 11		5
(vi) Zone 11a		6
(vii) Zone 12		6
(viii) Zone 12a		1
(ix) Zone 14		8
(x) Zone 14a		4
(xi) Zone 15		6
(xii) Zone 15a		9
(xiii) Zone 16		4
(xiv) Zone 17		6
(xv) Zone 18a		5

Note:
(i) Working hour is assumed as 12 hour a day, 6 days a week and 26 day a month.
(ii) Capacity of a truck is assumed to be 7.5 m^3 and it is assumed that a truck will make 2 trips for each journey.

4.5.2 *Operational Phase*

Vehicle Emissions

The Study Area will be affected by the vehicle exhausts from the distributor road and the existing road network including Tsun Wen Road, Tsing Lun Road and Lam Tei Interchange. Vehicular exhaust emissions from these roads including NO_2, CO and RSP are the major areas of concern for low level receivers (1.5 m and 10 m above ground). At higher level (above 30 m), the air quality impact of vehicle exhaust emissions will be reduced. Under the *Air Pollution Control (Motor vehicle Fuel) Regulation*, the sulphur content of diesel fuel is required to be less than 0.05%. With such low levels of sulphur content, adverse SO_2 impact is unlikely.

Industrial Emissions

The Study Area will be affected by emissions from industrial sources in the surrounding area. Chimney data of the relevant area was provided by EPD and are shown in *Annex E*. Chimney emissions from Castle Peak Hospital and Tuen Mun Hospital are the major industrial emission sources. In addition, isolated sources of industrial emissions are also located in Siu Hong Court. The heights of the chimneys in the Study Area are in the range of 30 to 55 m above ground, therefore, the air quality impact of the chimneys on low level receivers is expected to be low. NO_2 and SO_2 are the major pollutants from industrial emissions.

Industrial uses located in San Hing Tsuen are to be phased out as the Town Planning Board has agreed to rezone the area around San Hing Tsuen to the north of the proposed Road D7 from "Industrial (Group D)" to "Residential (Group E) (R(E))" on the draft Lam Tei and Yick Yuen Outline Zoning Plan No. S/TM-LTYY/1. Hence, adverse air quality impacts resulting from the industrial uses in San Hing Tsuen on the planned future residential development can be eliminated.

Odour

A sewage pumping station with a designed flow rate of 1.8 m^3s^{-1} is proposed in Site 2. Odour, originating mainly from hydrogen sulphide in the sewage, could be released from the pumping station and is a potential source of nuisance to the Study Area.

Public Transport Interchange

It is proposed in the Preferred Development Option that Public Transport Interchanges(PTIs) will be located in Site 3 respectively. As these PTIs will be located under a podium structure to reduce their potential noise impact to the surroundings, air quality within these semi-confined PTIs is an environmental concern. Both NO_2 and CO will be the major pollutant sources inside the facilities.

4.6 ASSESSMENT METHODOLOGY

4.6.1 Construction Phase

Dust emission from the construction activities is the main pollutants during construction phase. Potential dust impacts were predicted by the *Fugitive Dust Model* (FDM). Meterological data for 1997 from Tuen Mun weather station, operated by Hong Kong Observatory, was employed for the model run. Dust emission rates and associated particle size distributions for the assessment were determined based on the *Compilation of Air Pollutant Emission Factors, 5th Edition,* USEPA (AP-42) (see *Table 4.6a*). The construction works are expected to be conducted 26 days a month and 12 hours a day. It has been assumed in this assessment that Phase 1 and Phase 2 will be constructed in sequence.

Table 4.6a ***Emission Factors for Construction Activities***

Construction Activities	Emission Factor [(i)]	Remarks
Handling of excavated spoil	$0.14\ u^{1.3}$	• moisture content: 4.8% • u: wind speed
Wind erosion	$2.69 \times 10^{-6}\ g/m^2/s$	
Truck movements on unpaved haul road	2.77 kg/VKT	• silt content of road surface: 10% • vehicle speed: 30 kph • vehicle weight: 25 tonnes • vehicle with 10 wheels

Notes:
(i) From *Compilation of Air Pollutant Emission Factors* (AP-42), 5th Edition, USEPA

4.6.2 Operational Phase

Traffic emissions from the proposed roads and existing road networks will be the major contributing source of air pollution at low elevation receivers (1.5 m and 10 m).

The chimney emissions from Castle Peak Hospital, Tuen Mun Hospital and industrial premises at San Hing Tsuen will be the major sources of air pollution at high elevation (above 30 m).

Vehicle Emissions

The CALINE4 dispersion model was used to predict the hourly concentrations of NO_2, CO and RSP due to the new road and the existing road network. The emission factors used for NO_x, CO and RSP, were calculated based on those derived by the EPD from the EURO II criteria. It is assumed that emission after 2011 will be identical to year 2011, as a worst case assumption.

A comparison of the total emission of the critical pollutant, NO_x, from the distributor road for the years 2011, 2016 and 2021 has been carried out and the results are shown in *Table 4.6b*. A review of the traffic data for the years 2011, 2016 and 2021, has indicated that the year 2021 will be the worst year, assuming that the NO_x emission rate maintains at the 2011 level. Traffic data for 2021 were, therefore, employed to assess the worst case impact for this assessment.

Table 4.6b ***Comparison of NO_x Emission for the New Distributor Road***

	Year 2006	Year 2011	Year 2021
Total Traffic Flow (veh/hr)	389	1,223	1,679
Traffic Breakdown of HGV (%)	37	45	45
Traffic Breakdown of P-c/p (%)	63	55	55
Fleet Emission Rate of NO_x of HGV (g/km)[(i)]	7.31	7.00	7.00[(ii)]
Fleet Emission Rate of NO_x of P-c/p (g/km)[(i)]	0.90	0.90	0.90[(ii)]
Total NO_x Emission Rate (g/km-hr)	1,273	4,458	6,120

Notes:
(i) Fleet emission rate based on EURO II criteria.
(ii) 2011 and 2021 NO_x emission rate are not available and 2011 emission rate is used.

Fleet emission factors based on the EURO II criteria have been used for the model run. As emission factors beyond 2011 are not available for this assessment, the 2011 vehicle emission factors were assumed.

Daytime worst case scenario meterological conditions were assumed in the model run. Typical input parameters for the model are listed below:

- wind speed — 1 m s^{-1};
- wind direction — worst case for each receivers;
- stability class — D;
- mixing height — 500 m;
- standard deviation of wind direction — 18 degrees; and
- temperature — 298 K

Emission factors based on EURO II criteria were used for the assessment. The NO_x gas was assumed to be inert and levels of NO_2 were taken as 20% of total NO_x emissions.

SO_2 emission is the critical pollutant attributed to the industrial emissions, and the SO_2 impacts on higher level receivers were assessed in this EIA. Impacts of industrial emission were modelled with the air dispersion model ISCST3. Meterological data of Tuen Mun Weather Station for the year 1997 were used for the model run. Chimney data of the Study Area are provided by EPD and are shown in *Annex E*. Locations of sources, types of the fuel, its maximum fuel consumption rates, physical dimension for chimney of stacks, exit gas temperature are included. Emission rates of pollutants are calculated based on *Compilation of Air Pollutants Emission Factors, 5th Edition* (AP42) (1995) developed by USEPA. General load factors of 41% during daytime (stability class D-1) and 23% during nighttime are recommended by EPD and employed for this assessment.

4.7 EVALUATION OF IMPACTS

4.7.1 *Construction Phase*

The likely daily and hourly dust impacts for the Study on the ASRs at ground level and 10 m above ground for the construction of Phase 1 and Phase 2 developments were modelled and the results are presented in *Table 4.7a* and *Table 4.7b*.

Table 4.7a *Predicted Hourly and Daily TSP Level for Phase 1 Development (μgm^{-3})[(i)]*

ASRs	Hourly TSP Level		Daily TSP Level	
	Ground Level	10 m Above Ground	Ground Level	10 m Above Ground
A1	455	321	140	135
A2	**721**	266	166	138
A3	274	212	122	120
A4	**583**	314	153	135
A5	286	233	123	121
A6	298	244	127	124
A7	181	170	117	117
A8	214	191	122	120
A9	224	199	119	118
A10	199	186	121	120
A11	178	172	119	119
A12	171	164	117	116
A13	208	190	118	117
A14	175	169	117	116
A17	196	181	120	120
A18	279	237	122	121
A19	242	218	121	121
A20	294	251	128	126
AQO	**500**	**500**	**260**	**260**

Notes:
(i) Background TSP level included in the results.
(ii) Figures in bold indicate exceedance of the AQO criteria.

The above results show that the predicted TSP levels at all ASRs, except ASRs A2 (Siu Hang Tsuen West) and A4 (Po Tong Ha West), are within the hourly and daily criteria. The predicted hourly TSP levels at ground level and 10 m above ground are in the range of 153 - 721 $\mu g\ m^{-3}$ and 149 - 321 $\mu g\ m^{-3}$ respectively. Highest hourly TSP levels are predicted at A2 (Sui Hang Tsuen West) and A1 (Vertical Interim Housing Development in Area 29) for ground level and 10 m above ground respectively. The predicted daily TSP levels at ground level and 10 m above ground are in the range of 117 - 166 $\mu g\ m^{-3}$ and 116 - 138 $\mu g\ m^{-3}$ respectively. Highest daily TSP levels at ground level and 10 m above ground are predicted at A2 (Siu Hang Tsuen West).

Table 4.7b *Predicted Hourly and Daily TSP Level at Phase 2 Development (μgm^{-3})[(i)]*

ASRs	Hourly TSP Level		Daily TSP Level	
	Ground Level	10 m Above Ground	Ground Level	10 m Above Ground
A1	256	203	126	122
A2	191	158	122	121
A3	303	199	130	123
A4	237	156	133	125
A5	195	163	123	120
A6	335	165	155	125
A7	269	172	133	120
A8	210	161	125	123
A9	482	185	166	129
A10	237	187	128	123
A11	265	200	126	122
A12	253	192	127	125
A13	242	176	131	127
A14	184	162	120	119
A17	190	175	125	124
A18	194	168	127	126
A19	181	169	126	125
A20	199	184	125	124
AQO	**500**	**500**	**260**	**260**

Notes:
(i) Background TSP level included in the results.

For Phase 2, the dust levels at all ASRs are within the hourly and daily criteria. The predicted hourly TSP levels at ground level and 10 m above ground are in the range of 149 - 482 $\mu g\ m^{-3}$ and 145 - 203 $\mu g\ m^{-3}$ respectively while the predicted daily TSP levels at ground level and 10 m above ground are in the range of 118 - 166 $\mu g\ m^{-3}$ and 117 - 129 $\mu g\ m^{-3}$. Highest ground level and 10 m above ground hourly TSP levels are predicted at A9 (Tsz Tin Tsuen South) and A1 (Vertical Interim Housing Development in Area 29) respectively. The highest daily TSP levels at ground level and high level are predicted at A9 (Tsz Tin Tsuen South). All the predicted TSP levels during Phase 2 construction are expected to comply with the criteria.

At this preliminary stage, the size of the concrete batching plant should be small and less than 10,000 tonnes as discussed in *Section 4.5.1*, and therefore its impact could not be quantified in this assessment. However, . The HKPSG recommends the location of concrete batching plant at more than 100 m from air sensitive uses. Adherence to the *Best Practical Means for Cement Works (Concrete Batching Plant)* issued by the EPD should also reduce the emissions from such facilities. With the above considerations and measures in place, adverse dust impact from the small concrete batching plant, if used, is considered unlikely.

4.7.2 *Operational Phase*

Low Level Receivers

NO_2, CO and RSP are the major pollutants in vehicle exhaust emissions. ASRs at lower level will receive higher impacts. The cumulative air pollutant levels at low level receivers, taking into account contributions from traffic on road network and industrial premises, are shown in *Table 4.7c*.

Table 4.7c ***Cumulative Air Pollutant Levels at Low Level Receivers ($\mu g\ m^{-3}$)[(i)]***

ASRs	Hourly Cumulative Air Pollutant Levels at Low Level Receivers					
	Ground Level			10 m Above Ground		
	NO_2	CO	RSP	NO_2	CO	RSP
A1	202	1,527	144	198	1,527	143
A2	216	952	110	112	952	108
A3	101	838	104	97	838	102
A4	99	837	103	99	837	103
A5	81	722	96	81	722	96
A6	107	837	107	118	952	111
A7	100	837	104	100	837	104
A8	77	607	95	77	607	95
A9	116	953	110	93	723	101
A10	78	607	95	74	607	93
A11	100	837	104	100	837	104
A12	108	838	107	105	838	105
A13	79	608	95	79	608	95
A14	101	838	104	94	723	101
A15	97	723	102	94	723	101
A16	103	836	105	99	837	103
A17	82	723	96	79	608	95
A18	94	723	101	94	723	101
A19	120	953	111	116	953	110
A20	127	953	114	124	953	113
A21	164	1,297	129	157	1,182	126
A22	149	1,182	123	141	1,182	120
A23	104	837	105	100	837	104
A24	145	1,182	122	160	1,182	128
A25	100	837	104	96	838	102
A26	124	953	113	101	838	104

ASRs	Hourly Cumulative Air Pollutant Levels at Low Level Receivers					
	Ground Level			10 m Above Ground		
	NO_2	CO	RSP	NO_2	CO	RSP
A27	82	723	96	82	723	96
A28	105	838	106	101	838	104
A29	154	1,183	125	135	1,068	118
A30	79	608	95	79	608	95
A31	90	723	99	90	723	99
A32	169	1,298	131	135	1,068	118
A33	150	1,183	123	146	1,183	122
AQO Criteria	**300**	**30,000**	**180**	**300**	**30,000**	**180**

Notes:
(i) Vehicle exhaust, industrial emission and background are included in the predicted concentration.

It can be seen that all the predicted cumulative hourly NO_2, CO and RSP concentrations at ground level and 10 m above ground level ASRs are within the AQO criteria and therefore would not cause any adverse air quality impact.

The predicted cumulative hourly NO_2, CO and RSP concentrations at ground level are in the range of 77 - 216 $\mu g\ m^{-3}$, 607 - 1527 $\mu g\ m^{-3}$ and 95 - 144 $\mu g\ m^{-3}$ respectively. The predicted cumulative hourly NO_2, CO and RSP concentrations at 10 m above ground are in the range of 74 - 198 $\mu g\ m^{-3}$, 607 - 1527 $\mu g\ m^{-3}$ and 93 - 143 $\mu g\ m^{-3}$ respectively. Results in *Table 4.7c* indicate that NO_2 is the critical pollutant and the highest predicted cumulative hourly NO_2 concentration at ground level is predicted at A2 (Siu Hang Tsuen West) while that at 10 m above ground is predicted at A1 (Vertical Interim Housing Development in Area 29).

Isopleths of the critical pollutant, NO_2, at ground level and 10 m above ground are shown in *Figure 4.7a* and *Figure 4.7b* respectively. The figures show that the NO_2 levels within the Study Area at both ground level and at 10 m above ground will satisfy the AQO criteria.

High Level Receivers

The predicted hourly SO_2 and NO_2 concentrations at 30 m, 60 m and 90 m above ground are listed in *Table 4.7 d* below.

Table 4.7d *Predicted Hourly SO_2 and NO_2 Concentrations at Different Elevations ($\mu g\ m^{-3}$)*

ASRs	Predicted Hourly SO_2 Concentration[(i)]					
	30 m Above Ground		60 m Above Ground		90 m Above Ground	
	SO_2	NO_2	SO_2	NO_2	SO_2	NO_2
A1	84	58	200	67	106	62
A2	86	58	237	71	536	109
A3	76	57	166	65	488	104
A4	39	54	67	57	116	63
A5	48	55	134	65	406	95
A6	82	57	209	68	321	85
A7	77	57	319	77	156	67
A8	95	59	251	72	224	75
A9	84	58	196	67	301	83
A10	102	59	140	62	329	86
A11	132	62	**885**[(iii)]	125	379	92
A12	119	61	709	111	681	125
A13	57	56	104	62	201	72
A14	61	57	311	77	699	127
A15	82	57	501	93	**1,351**[(iii)]	199
A16[(ii)]	N/A	N/A	N/A	N/A	N/A	N/A
A17	84	58	238	71	596	116
A18	57	56	130	64	398	94
A19	54	56	82	59	157	67
A20	83	57	187	66	531	109
A21	49	55	138	65	503	106
A22	71	57	157	64	90	60
A23	50	55	168	69	533	109
A24	78	57	225	70	417	96
A25	77	57	219	69	189	67
A26	84	58	561	98	704	128
A27	80	57	200	67	144	66
A28	56	56	119	63	440	99
A29	55	56	158	65	659	123
A30	61	57	150	67	596	116
A31	86	58	230	70	303	84
A32	55	59	166	68	502	142

ASRs	Predicted Hourly SO_2 Concentration[(i)]					
	30 m Above Ground		60 m Above Ground		90 m Above Ground	
	SO_2	NO_2	SO_2	NO_2	SO_2	NO_2
A33	70	56	186	66	467	102
AQO	**800**	**300**	**800**	**300**	**800**	**300**

Note:
(i) Vehicle exhaust, industrial emission and background are included in the predicted concentration.
(ii) Tuen Mun Hospital are the pollutant sources and the impacts on the sources themselves have not been assessed.
(iii) **Bold** figure indicates exceedance of the AQO criteria.

The above table indicates that the NO_2 criteria will be satisfied at all elevations. For SO_2, it will be satisified at all elevations except A11 (San Hing Tsuen) and A15 (Tuen Mun Government School). However, no air sensitive uses in San Hing Tsuen is anticipated at levels higher than 60 m. Therefore, the air quality in the existing low rise village development will satisify the AQO criteria. For Tuen Mun Government School, the height of the school is lower than 90 m. Therefore, the air quality at the elevation of the school will also satisfy the AQO criteria.

Isopleths of the critical pollutant, SO_2, at 30 m, 60 m and 90 m above ground are presented in *Figures 4.7c* to *e*. From the isopleths, it is indicated that an exceedance of the SO_2 AQO at Siu Hong Court above 90 m will occur (see *Figure 4.7e*). This is primarily due to an existing emission source located at Siu Hong Court, and the cumulative impact of the existing industrial emissions at San Hing Tsuen and from the stack of the Tuen Mun Hospital. The exceedance at this elevation is not considered to be sourced from the proposed Tuen Mun Area 54 development.

Odour

Hydrogen sulphide is the major source of odour from the proposed sewage pumping station in Site 2. As the flow of sewage is small and it is anticipated that odour suppression measures such as enclosing and scrubbing would be incorporated in the design of the facility, odour nuisance from sewage would be sufficiently mitigated and the odour criteria would likely be satisfied. It should be noted that the details of the sewage pumping station is not available at this stage. Therefore, detailed mitigation measures for the sewage pumping station cannot be prescribed. However, as the proposed sewage pumping station is a Schedule 2 designated project under the EIA Ordinance, details of the mitigation measures for the sewage pumping station would be proposed in the future EIA under separate cover to meet the requirements of the EIA Ordinance.

Public Transport Interchange

The designs of the PTIs are not available at this stage. Should a semi-confined design be adopted for the PTIs, the air quality requirements stipulated in TTAQG and ProPECC PN 1/98 should be followed and no adverse air quality impact within the PTIs is expected.

4.8 MITIGATION MEASURES

4.8.1 Construction Phase

The predicted hourly and daily TSP levels at all ASRs except ASRs A2 (Siu Hang Tsuen West) and A4 (Po Tong Ha West) are within the AQO criteria. According to the *Air Pollution Control (Construction Dust) Regulation*, control measures should be implemented during construction to maintain good air quality.

The following control measures are recommended to minimise dust emissions from the implementation of the Preferred Development Option:

- excavated dusty material should be covered by impervious sheeting and sprayed with water to keep the entire surface wet;
- the haul roads should be sprayed with water to keep the entire road surface wet;
- every vehicle should be washed to remove dusty materials from its body and wheels before leaving a construction site;
- the load carried by vehicle should be covered by impervious sheeting to ensure no leakage of dusty materials from the vehicle;
- the heights from which fill materials are dropped should be controlled to a practical level to minimise the fugitive dust arising from unloading; and
- the haul roads should be located away from ASRs.

As exceedance of the TSP criteria is predicted at some ASRs (namely Siu Hang Tsuen West and Po Tong Ha West), it is recommended that the maximum vehicle speed within construction sites should be maintained at 20 km hr^{-1} or below in addition to the above recommended mitigation measures. The mitigated hourly and daily TSP levels are shown in *Table 4.8a*.

Table 4.8a ***Mitigated Predicted Hourly and Daily TSP Level for Phase 1 Development (μgm^{-3})[(i)]***

ASRs	Hourly TSP Level		Daily TSP Level	
	Ground Level	10 m Above Ground	Ground Level	10 m Above Ground
A1	316	239	130	128
A2	464	205	144	129
A3	208	173	119	118
A4	389	234	137	127
A5	217	186	119	118
A6	223	192	122	120
A7	154	148	116	116
A8	174	161	119	118
A9	180	165	117	117
A10	165	158	118	118

ASRs	Hourly TSP Level		Daily TSP Level	
	Ground Level	10 m Above Ground	Ground Level	10 m Above Ground
A11	153	149	117	117
A12	148	145	116	115
A13	170	160	116	116
A14	151	147	116	115
A17	163	154	118	117
A18	207	188	119	118
A19	191	177	119	118
A20	220	198	123	121
AQO	**500**	**500**	**260**	**260**

Notes:
(i) Background TSP level included in the results.

The results presented in *Table 4.8a* indicate that the air quality impacts associated with the construction activities of Phase 1 can be mitigated to comply with the AQO criteria. With the implementation of the recommended mitigation measures, no residual impact is anticipated.

In addition, good housekeeping practice and the following control measures recommended under the *Best Practicable Means Requirements for Cement Work (Concrete Batching Plant)* should be adopted to prevent fugitive dust emissions:

- loading, unloading, handling, transfer or storage of any dusty materials should be carried out in a totally enclosed system;
- all dust-laden air or waste gas generated by the process operations should be properly extracted and vented to fabric filtering system to meet the emission limits for TSP;
- vents of all silos and cement/pulverised fuel ash (PFA) weighing scale should be fitted with fabric filtering system;
- the materials which may generate airborne dust emissions should be wetted by water spray system;
- all receiving hoppers should be enclosed on tree sides up to 3 m above unloading point;
- all conveyor transfer points should be totally enclosed;
- all access and route roads within the premises should be paved and wetted; and
- vehicle cleaning facilities should be provided and used by all concrete trucks before leaving the premises to wash off any dust on the wheels and/or body.

4.8.2 *Operational Phase*

The AQO will be satisfied at all ASRs at both low levels (ground level and 10 m above ground) and high levels (30 - 90 m above ground) except A11 (San Hing Tsuen) and A15 (Tuen Mun Government School) with the existing layout. Exceedance of AQO was predicted at A11 (San Hing Tsuen) (60 m above ground) and at A15 (Tuen Mun Government School) (90 m above ground). However, no air sensitive uses are present at level of 30 m above ground of these ASRs, therefore, the AQO criteria will be satisfied. Hence, no further mitigation is required for the receivers.

To ensure that odorous gas will not be emitted from the sewage pumping station to the surroundings, odour control system such as activated carbon filter or scrubber system is recommended at the exhausts of the pumping station. Any odour generated by the plant will be controlled by good engineering design and measures and therefore odour nuisance is not expected. As the proposed sewage pumping station is a Schedule 2 designated project under EIAO, details of the mitigation measures for the sewage pumping station would be proposed in the future EIA under separate cover to meet the requirements of the EIA Ordinance.

As the PTIs to be included in the Preferred Development would likely be of a semi-confined design, mechanical ventilation would be required. The ventilation systems of these PTIs should be designed to meet the requirements and criteria specified in ProPECC PN 1/98 and TTAQG. In addition, it is suggested that the ventilation shafts should be located away from the ASRs by a distance of at least 10 m to avoid any potential air quality impacts from the exhaust.

4.9 *Environmental Monitoring and Audit Requirements*

4.9.1 *Construction Phase*

The construction work will inevitably lead to dust emissions, mainly from material handlings, truck haulage, concrete batching and stockpiling. It is predicted that the dust generated will exceed the hourly criteria of 500 $\mu g\ m^{-3}$ at ASRs A2 and A4 (See *Figure 4.4a*) during Phase 1 construction.

Mitigation measures are recommended in *Section 4.8.1* to limit the dust emission and dispersion. With the implementation of the recommended dust control measures, the TSP levels at the affected ASRs will comply with the dust criteria.

Dust monitoring requirements will be recommended in the EM&A Manual to ensure the efficacy of the control measures. Monitoring stations should be set up at A2 and A4.

4.9.2 *Operational Phase*

Since the predicted results show no exceedance of the AQO criteria due to the present housing development, EM&A with respect to air quality is not required during the operational phase.

4.10 CONCLUSIONS

4.10.1 *Construction Phase*

Road works, development and infrastructure construction will be major sources of air pollutants. Construction activities such as material handling, wind erosion and truck movement on the unpaved haul roads will be the main dust generating activities.

Exceedance of the hourly and daily criteria for TSP levels at A2 (Siu Hang Tsuen West) and A4 (Po Tong Ha West) during Phase 1 cut and fill works was predicted. However, implementation of appropriate mitigation measures, as recommended in the *Air Pollution Control (Construction Dust) Regulation*, and a reduction of vehicle speed to 20 km hr^{-1} should be sufficient to ensure compliance of the established air quality criteria. For the construction activities during Phase 2, no exceedance of hourly and daily TSP level was predicted at all identified ASRs. To ensure the efficacy of the recommended air quality control measures, environmental monitoring and audit is recommended.

The proposed concrete batching plant at Site 2, if used, would most likely be small in size. However, it is still recommended that the facility should be located at more than 100 m from ASRs, as recommended in the HKPSG, and the *Best Practical Means for Cement Works (Concrete Batching Plant)* should be followed to ensure that there will be no air quality impact from concrete batching.

4.10.2 *Operational Phase*

The AQO will be satisfied at all ASRs at both low levels (ground level and 10 m above ground) and high levels (30 m - 90 m above ground) except A11 (San Hing Tsuen) and A15 (Tuen Mun Government School) with the existing layout. Exceedance of AQO was predicted at A11 (San Hing Tsuen) (60 m above ground) and at A15 (Tuen Mun Government School) (90 m above ground). However, no air sensitive uses are present at level of 30 m above ground of these ASRs, therefore, the AQO criteria will be satisfied. Hence, no further mitigation measures are required for receivers.

To minimise odour nuisance on the surrounding area, it is recommended that control measures such as activated carbon filter or scrubber system be incorporated in the design for the sewage pumping station. However, as the proposed sewage pumping station is a Schedule 2 designated project under EIAO, details of the mitigation measures for the sewage pumping station would be proposed in the future EIA under separate cover to meet the requirements of the EIA Ordinance.

As the design of the PTIs within the Preferred Development Option would likely be of a semi-confined nature, the requirements specified in TTAQG and ProPECC PN 1/98 should be followed for the design of the ventilation systems of the PTIs. In addition, it is suggested that the ventilation shafts should be located away from the ASRs by a distance of at least 10 m to avoid any potential air quality impacts from the exhaust.

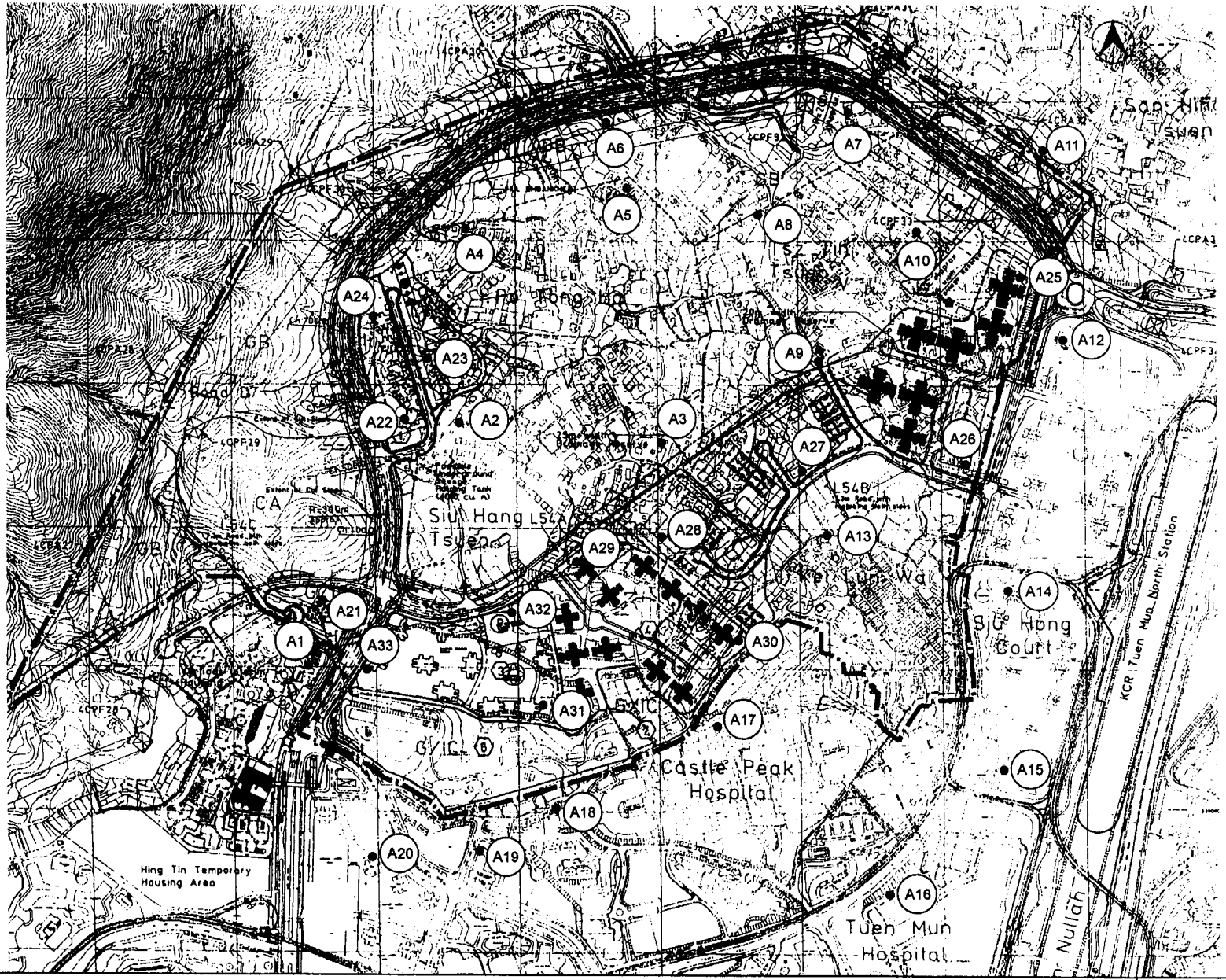

FIGURE 4.4a

LOCATION OF AIR SENSITIVE RECEIVERS (ASRs)

FILE: C1707/C1707w7
DATE: 20/10/98

Environmental Resources Management

ERM

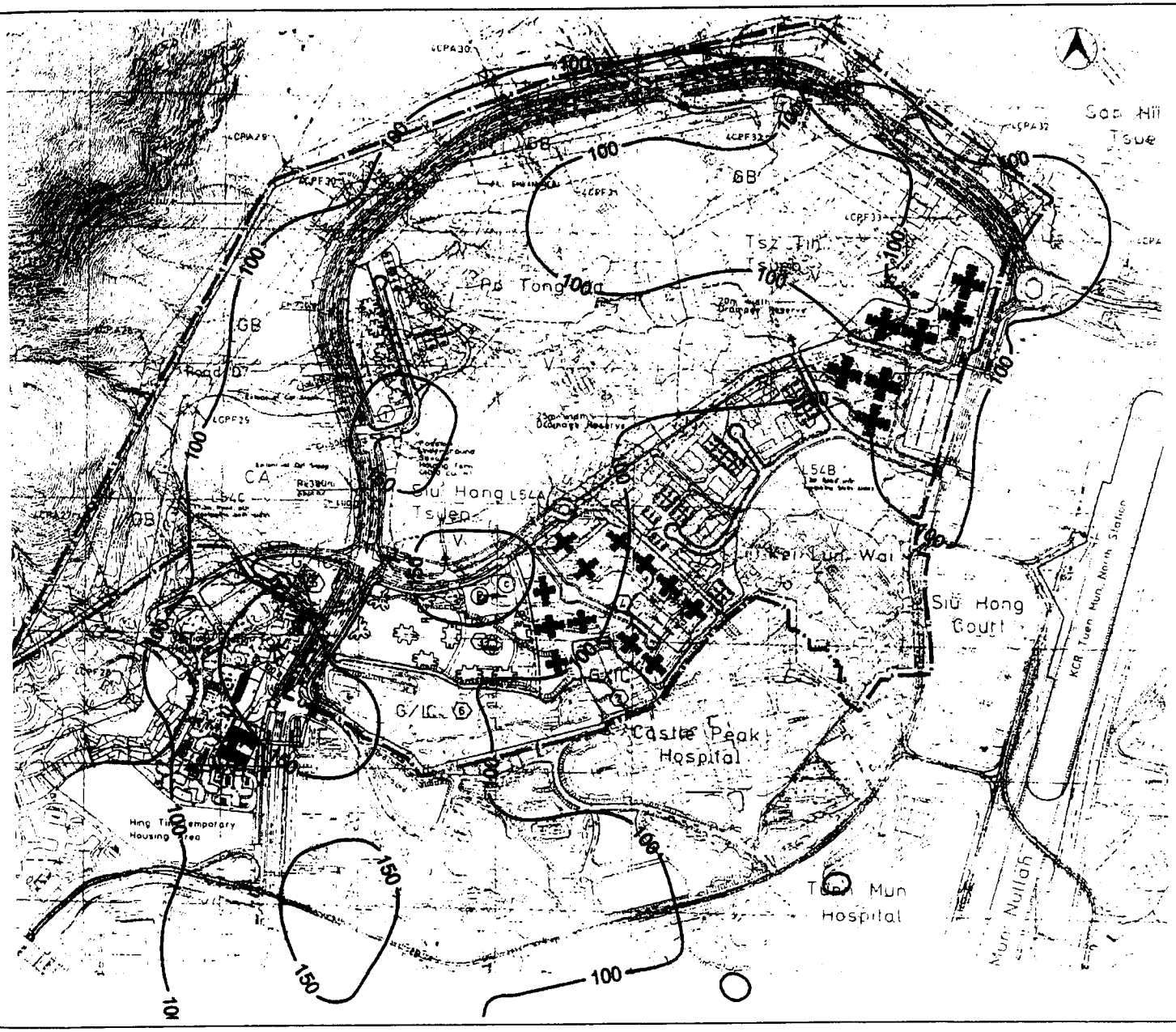

FIGURE 4.7a

ISOPLETHS OF NITROGEN DIOXIDE AT ABOVE GROUND

Environmental Resources Management

ERM

FILE: C1707/C1707V4
DATE: 20/10/98

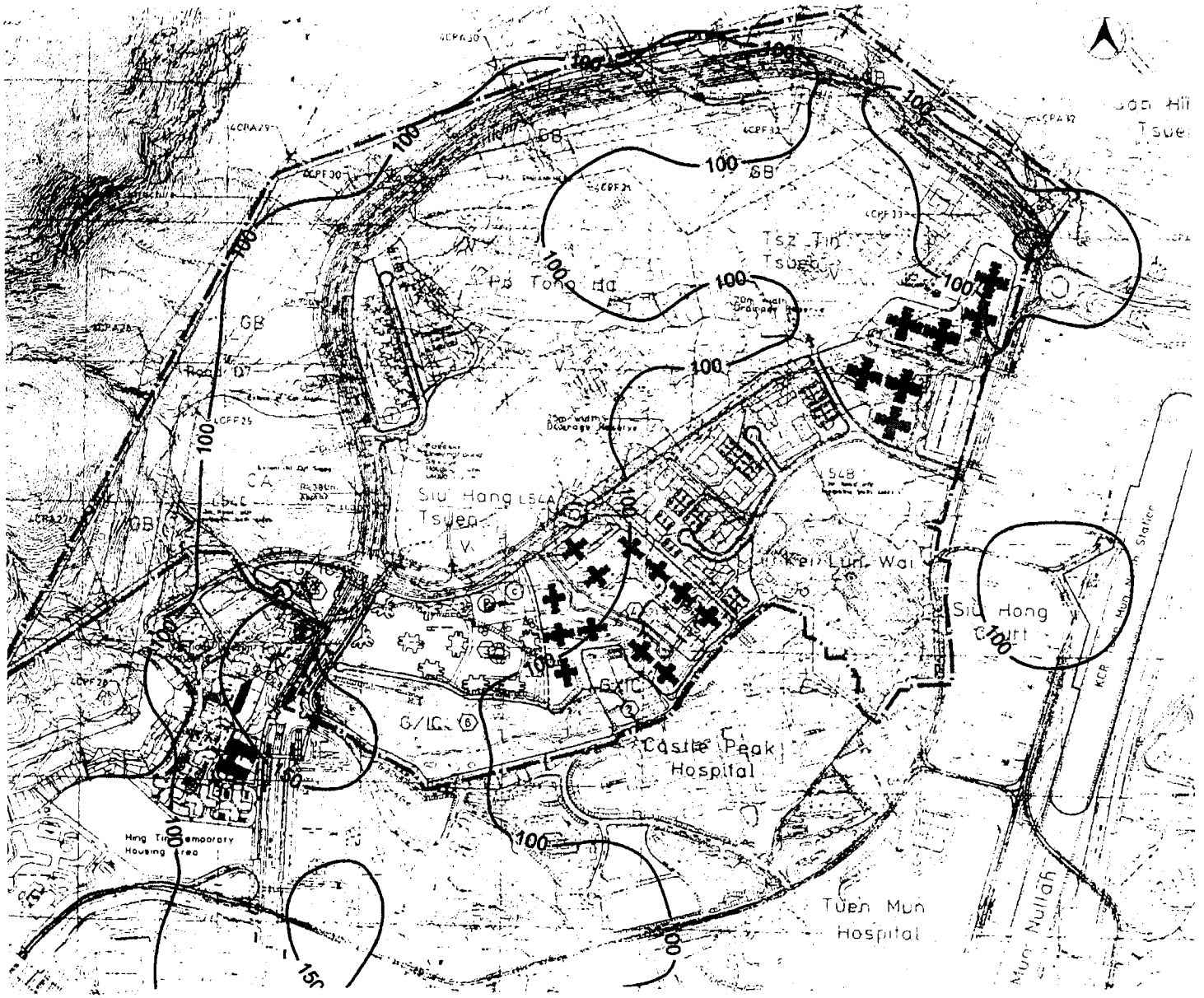

FIGURE 4.7b

ISOPLETHS OF NITROGEN DIOXIDE AT 10 m ABOVE GROUND

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FILE: C1707/C1707V5
DATE: 20/10/98

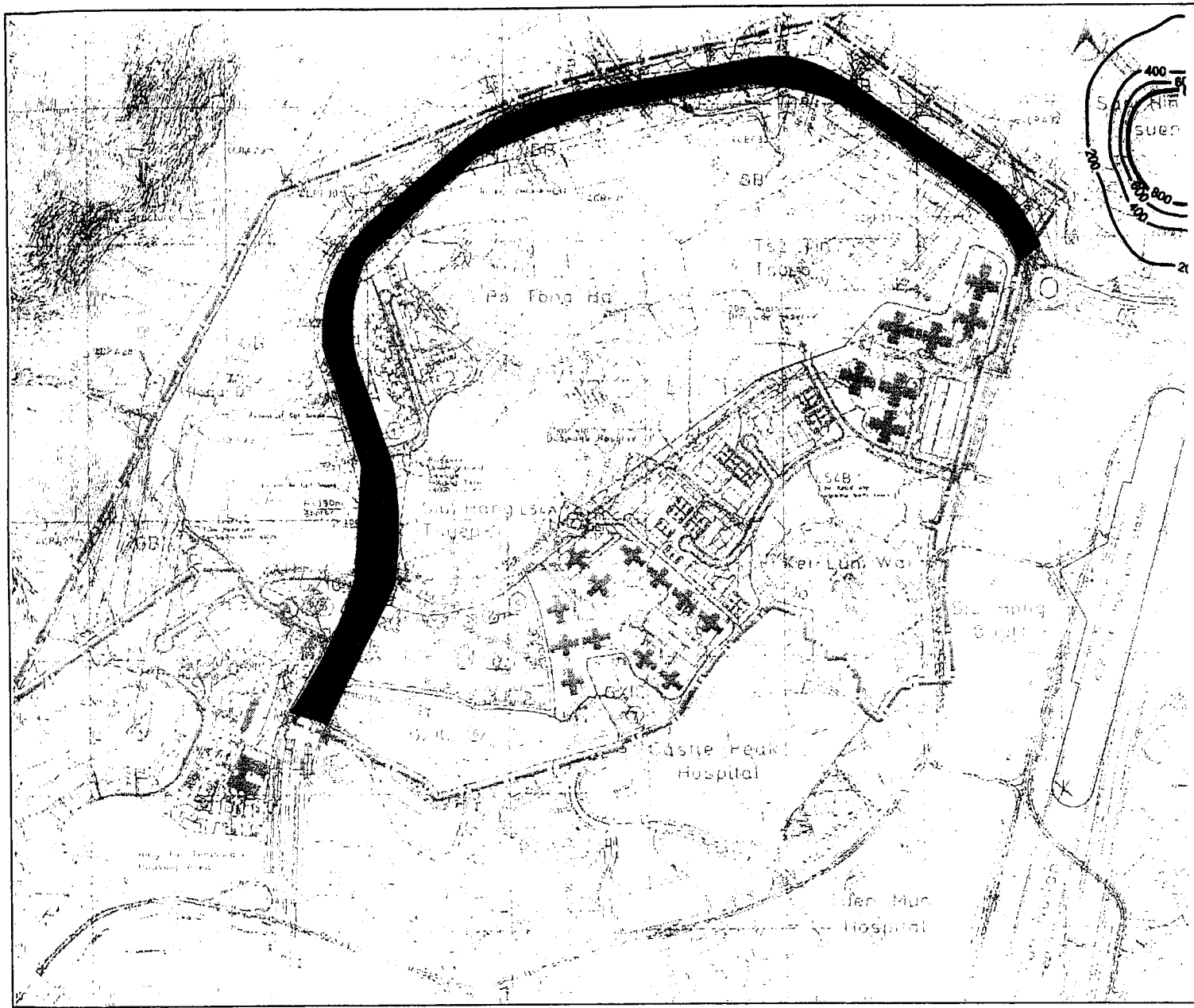

FIGURE 4.7c

ISOPLETHS OF SULPHUR DIOXIDE AT 30 m ABOVE GROUND

FILE: C1707z19
DATE: 20/10/98

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N

KEY

CONCENTRATIONS OF SO_2 IN μgm^{-3}
AQO CRITERIA (SO_2) 800 μgm^{-3}

ROAD D7

NOT TO SCALE

FIGURE 4.7d

ISOPLETHS OF SULPHUR DIOXIDE AT 60 m ABOVE GROUND

FILE: C1707z20
DATE: 19/02/98

Environmental Resources Management

ERM

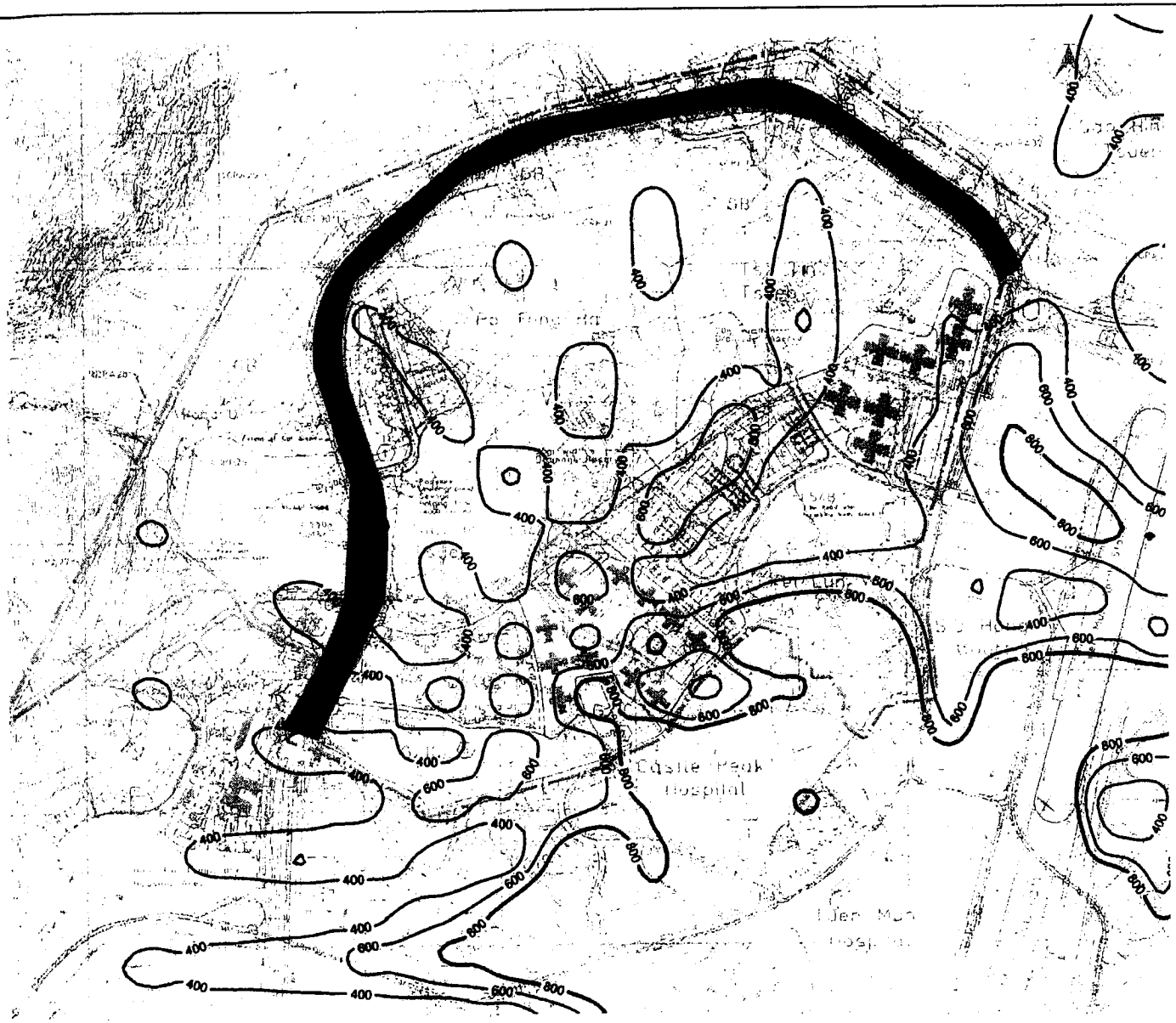

FIGURE 4.7e

ISOPLETHS OF SULPHUR DIOXIDE AT 90m ABOVE GROUND

FILE: C1707z21
DATE: 19/02/99

Environmental Resources Management

ERM