4 Impact Assessment of Air Quality

4.1 Introduction

This chapter is based on Annex 4 *Criteria for Evaluating Air Quality Impact and Hazard to Life* and Annex 12 *Guidelines for Air Quality Assessment* of *Technical Memorandum on Environmental Impact Assessment Process*. The content of this chapter include assessing current air quality in the Project Area, evaluating potential effect of the Project items to areal air quality, proposing mitigation measures aiming at the negative impact, and evaluating the residual impact and its acceptability.

The main impact of the Project on the air quality is the dust emission during construction. The main sources of dust are from open area excavation, material transportation, traffic on the unpaved roads, and concrete batching and mixing, which are the main pollutant of the project. The transportation vehicles such as truck, bulldozer, etc. will also produce exhaust. From the experience gained in past similar assessments, the emission of NOx, carbon monoxide and particles are limited and have no significant effect on the environment. During river dredging ,dredged silt will produce a stinky smell. Because it only affects limited area, no air sensitive receivers (ASRs) will be influenced.

Based on the *North District Development Program* issued by the Territory Development Department of the HKSAR Government, there is no development program in the EIA study area. The works of *Fanling, Shueng Shui Development Program* are the nearest to the Project Area. In the construction period of the Project, construction of water supply system and construction of "Home Ownership Scheme" will be proceeded at the same time. The minimum distance from these sites to the site of Stage III Project is more than 2 km. Furthermore, some mountains and hills are situated in between. Therefore, the cumulative impact of these programs and Stage III Project will not be considered in the environment assessment.

On the Shenzhen side, the area along the section of Shenzhen River in Stage III Project has been developed. In the construction period, no other large-scale construction activity will be carried out near the Project Area.

Upon the above analysis, the cumulative impact of other projects will not be assessed in this report.

4.2 Regulations and Criteria

4.2.1 *National Regulations and Criteria*

The *Circular About Zoning of Ambient Air Quality Function of Shenzhen City* (*Shenzhen Hunicised Government* [1996] *No.* 362), *Grade II of Environmental Air Quality Standard* (*GB*3095-1996) will be applied to the Project. Part of the standard is listed in Table 4.1:

Table 4.1 National Air Quality Standard (Partial)

Parameter	Maximum Mean Concentration ($\mu g/m^3$)		
	Hourly	Daily	Annual Average
TSP	1000	300	200
RSP	500	150	100
NO_x	150	100	50

4.2.2 *Hong Kong Regulations and Criteria*

Air Pollutant Control Ordinance (*APCO*, *Cap*, 311, 1983) stipulates that the air pollutants exhausted by the fixed and mobile sources need to be controlled. There are many Air Quality Objectives (AQOs) and criteria in the APCO, including airborne dust arising from construction site. The present AQOs specify the concentration of SO_2, CO, NO_2, TSP and RSP in the territory of Hong Kong Special Administrative Region. The standard of TSP, RSP and NO_2 related to the project are listed in Table 4.2.

Table 4.2 Air Quality Objectives (AQOs) in Hong Kong

Parameters	Maximum Mean Concentration ($\mu g/m^3$)		
	Hourly①	Daily②	Yearly
TSP	500③	260	80
RSP		180	55
NO_2		180	55

Notes: ① Not more than three times each year;

② Not more than once each year.

③ It's as guildline, not AQO value.

4. 2. 3 *Criteria Coordination*

Comparing the daily maximum mean concentration in Table 4. 1 and Table 4. 2, the TSP standard of Hong Kong is stricter than that of Shenzhen, but vice versus for RSP. Because the impact of dust is asessed based on specific sensitive receivers, the national standard is implemented on the Shenzhen side while the Hong Kong standard is executed on the Hong Kong side in this assessment.

4. 3 Assessment of Existing Condition

4. 3. 1 *Air Monitoring (Baseline Monitoring)*

On the Hong Kong side, the Yuen Long Air Monitoring Station has accumulated long term data for air quality. These monitoring data can be used to represent the baseline level of the air quality in the area since the station is near the Shenzhen River. On the Shenzhen side, besides the accumulative monitoring results, two representative monitoring stations are selected based on the layout of construction sites and main site transportation routes. The baseline is established after analyzing the relevant data. The locations of the monitoring points are shown in Figure 4. 1.

Monitoring parameters include TSP, RSP, NOx, wind velocity and wind direction.

Monitoring was carried out in January 1999. For analysis of TSP and pM_{10}, weighting method is used, Sampling is conducted at interval of 72 hours for 6 days, and each sample is continuously monitoring for 24 hours a day. For monitoring of NOx, Saltzman method is used. Sampling is implemented at interval of 48 hours over a continuous period of 16 days and each sample is continuous monitored for 24 hours a day. At the same time, wind velocity and wind direction is measured, and surrounding environmental features are recorded.

4. 3. 2 *Assessment of Existing Condition*

It is known from Environmental Quality Report in 1997 edited by Shenzhen Municipal Environmental Protection Bureau that the annual average of TSP in Shenzhen amounts to 95 $\mu g/m^3$, which meets Grade II of the national standard, and the maximum concentration of daily average amounts to 310 $\mu g/m^3$, which exceeds the standard by 0. 16%. Compared with the air quality in 1996, the annual average of TSP

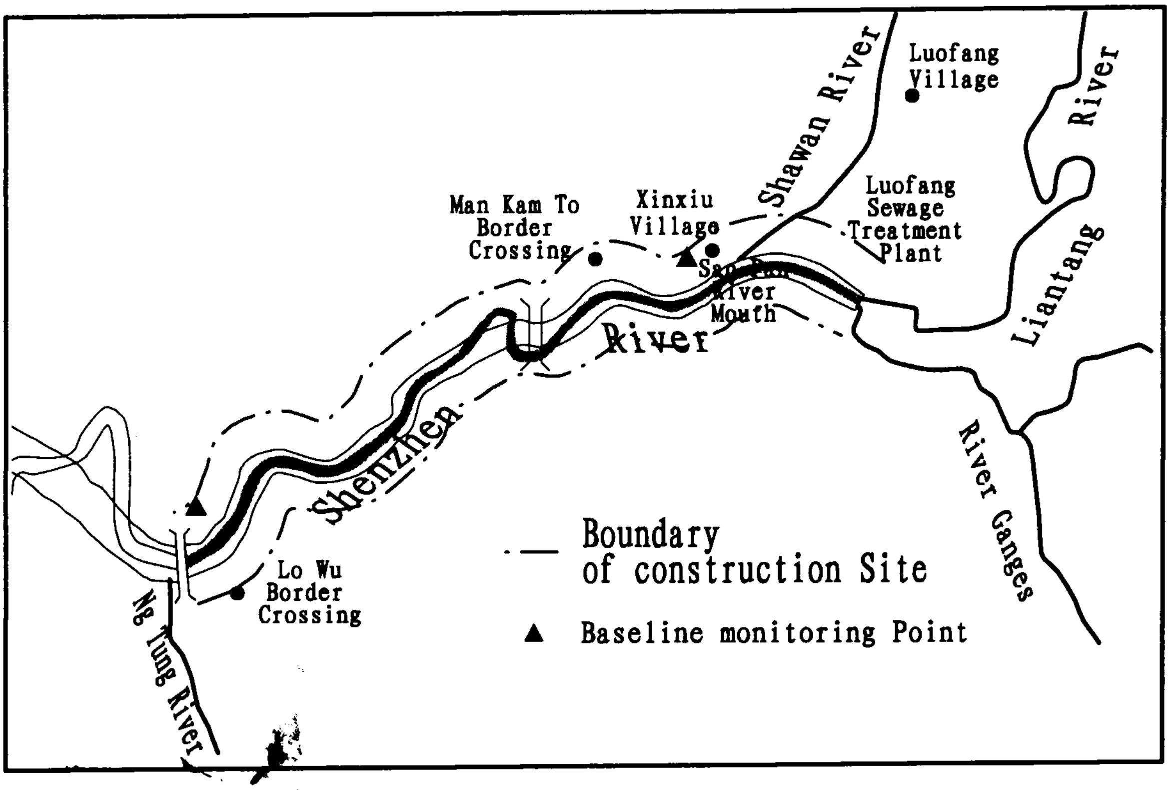

Figure 4. 1 **Location of Air Baseline Monitoring Points**

decreases by 29. 6% and in 12 monthly average figures. The annual average of dust-fall in 1997 amounts to 6. 32 t/km^2 · m, which exceeds the stardard by 40. 0%. The annual average of NOx is 0. 054 $\mu g/m^3$, which exceeds the national standard of Grade II, and its maximum daily average amounts to 0. 208 $\mu g/m^3$, which exceeds the standard by 1. 1 times. The daily average of NOx exceeds the standard by 7. 8%. Upon the air monitoring data in Yuen Long in 1996, the annual average of TSP in Hong Kong amounts to 94 $\mu g/m^3$, which exceeds the Hong Kong standard. Since 1992, the TSP in Hong Kong has been at a high level and its annual average had slightly changed. Compared with the data in 1995, the TSP concentration is slightly low but still on the high side. Six of the nine monitoring stations recorded that the TSP failed to meet the AQOs. The concentration of NO_2 is high in Hong Kong. In calm weather, exhaust from vehicles could be accumulated in air leading potential actinic oxidation reaction, which failed the short-time AQOs several times in 1996. Compared with the concentration in 1991, the overall average and roadside concentration of NO_2 increased by about 20% in 1996, owing to the increase of diesel engine driven vehicles.

Figure 4. 2 shows that the average concentration profile of TSP of the two stations in

Yuen Long (1996) and at South Lake Preliminary School (SLPS) (1997), which is near the Shenzhen River. Dust concentration is higher in winter with the maximum monthly average of TSP at SLPS station in January and at Yuen Long in December 1996. The air pollution is less in summer. The minimum monthly average of TSP at SLPS station is July and Yuen Long June 1996 due to rainfall and better dispersion of the pollutants in summer.

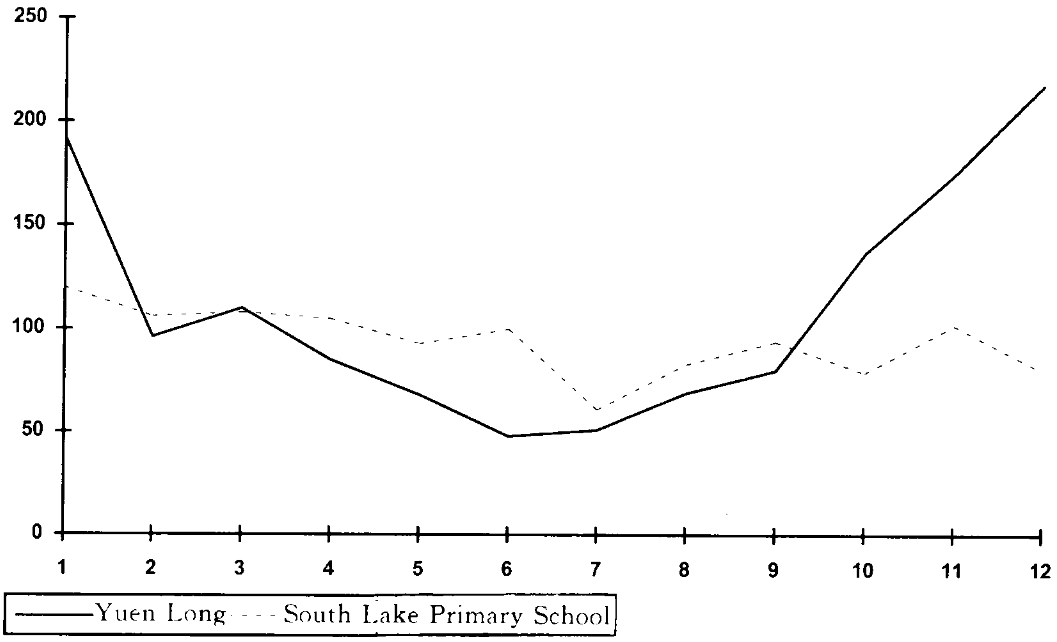

Figure 4. 2 **Seasonal Variation of TSP in Yuen Long** (1996) **and South Lake Primary School** (1997)

From 4th to 20th January 1998, the air quality baseline montoring of TSP, RSP, NOx, wind direction and wind velocity was measured near the sluice gate of Dongshen Water Supply Board on the north bank of the Shenzhen River (Xinxiu Village) and Lo Wu Border Crossing (Qiaoshe). Table 4. 3 shows the monitoring results.

Table 4. 3 shows that both concentrations of TSP and RSP at the two monitoring points meet both the national and Hong Kong standard. Figure 4. 2 indicates that in winter air contains higher content of dust, and TSP and RSP do not exceed the national and Hong Kong standard in spring and summer. The concentrations of NOx at both monitoring points exceed the national standard by 50%, since northerly wind is prevailing in the monitoring period and the monitoring point is situated to the leeward

of the Lo Wu District with large traffic volume of diesel vehicle.

Table 4. 3 **The Statistic of Air Baseline Monitoring Results** (μg/m³)

Parameters		Xinxiu Village	Qiaoshe	Areragc
Daily average of TSP	Maximum	200	194	197
	Minimum	92	73	83
	Mean	152	147	150
Daily average of RSP	Maximum	39	51	45
	Minimum	22	35	29
	Mean	31	43	37
Daily average of NO_x	Maximum	404	355	380
	Minimum	36	36	36
	Mean	200	182	191

To sum up, two parameters of TSP and RSP along the Shenzhen River basicallg meet the relevant standard of Shenzhen and Hong Kong, except for NOx with high exceeding standard ratio. The reason is that northerly wind is prevailing in the monitoring period and the monitoring point is situated in the leeward of Lo Wu District, where the traffic flow of diesel vehicles is large.

Besides TSP and RSP, sensory assessment on scent from the river is also carried out. It is found that the whole river gives off strong smell except for the reference point in upstream.

The construction activities of Stage III Project (such as sediment dredging, silt transportation) may worsen the situation. The mitigation measures provided in Section 4. 7 would reduce the amount of odour produced.

4. 4 Sensitive Receivers

Main air sensitive receivers are residential areas. They are shown in Figure 4. 3.

On the Shenzhen side, the sensitive receivers and their nearest distance to the boundary of the construction site are:

(1) Dormitory of Lo Wu Border Inspection Station (28 m)

(2) Lo Wu No. 4 Village (68 m)

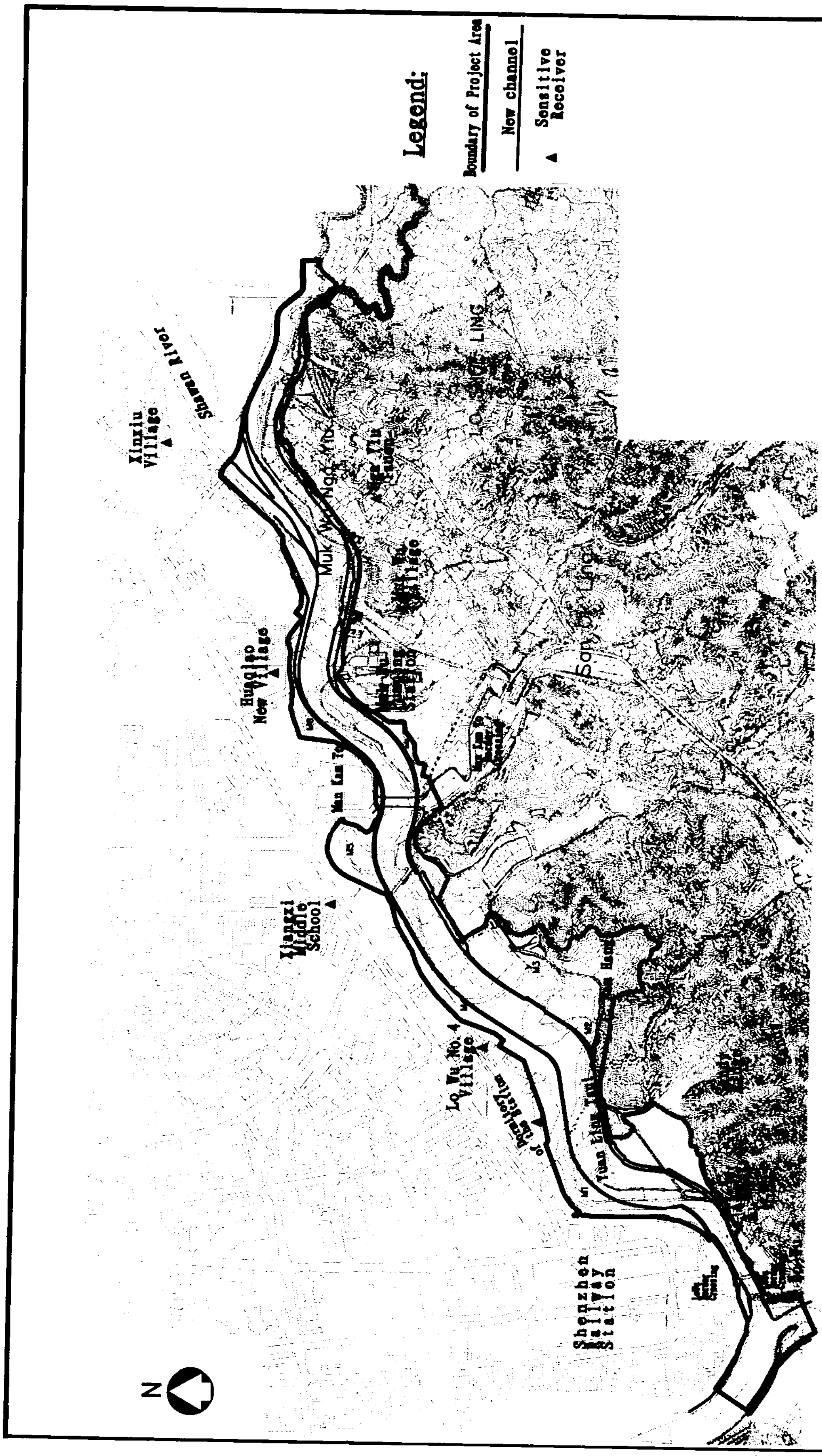

Figure4.3 Location of Air Sensitive Receivers Affected by Stage III Project

(3) Xiangxi Middle School (180 m)

(4) Huaqiao New Village (113 m)

(5) Xinxiu Village (188 m)

For the borrow area in Shuijingdaliang Village of Buji Townin Shenzhen, the sensitive receivers and their nearest distance to the border of the construction site are:

(1) ShangbaYue (100 m)

(2) Shuijingdaliang (400 m)

On the Hong Kong side, the sensitive receivers and their nearest distance to the boundary of the construction site are:

(1) Lo Wu Village (66 m)

(2) Lo Wu Public School (32 m)

(3) Muk Wu Tsuen (140 m)

(4) Nga Yiu Tsuen (78 m)

4.5 Model Prediction

4.5.1 *Model Selection*

Fugitive Dust Model (FDM) and Industrial Source Complex (ISC) are the models designed to support the environmental management of USEPA. For this evaluation, FDM, which is accepted by USEPA and Hong Kong EPD, is selected to predict the potential impact of construction activities. FDM is specified for calculating the dust dispersing concentration from fugitive dust sources, but ISC considers smoke descending, dispersion caused by buoyancy, smoke rising, default value of wind velocity and vertical temperature grabs, which are unnecessary for dust mode calculation. ISC is therefore not adopted, although it could solve different kinds of pollution sources such as point source, non-point source, volume source and line source. The line source in ISC is modelled as a chain of volume sources or a lengthened non-point source. Different from ISC, FDM can considers the pollution source as point source, line source and non-point source. It does not consider the impact of pollution buoyancy and does not include the equation of smoke rising as ISC does. FDM is based on

Gauss Smoke Flow Model with improved gradient transport and descending calculation The pollution sources are divided into a series of particles with different radius. FDM is used to calculate the gravity descending velocity and deposit velocity of each group of particles, as well as the concentration and deposit amount for each receiver.

Gauss Dispersing Model, mentioned in the inception report, is not adopted in the EIA as FDM is more advanced. As FDM is based on Gauss Smoke Flow Model and keeps mass conservation, it is more reliable. For more detailed information, refer to the Annex 4.

4.5.2 *Model Verification*

The average concentration or total amount of deposited particles on each receiver for any arbitrary combination of pollution sources can be calculated. Moreover, the highest and second highest concentration in each receiver in each special period can also be figured out.

This model has been successfully used and verified in Stage I and Stage II of the Shenzhen River Regulation Project.

It is verified that FDM in the analysis of dust concentration near the fugitive dust source is better than other models. In the analysis of a large number of samples, ISC model also has produced satisfactory results but the predicted concentrations of the highest and second highest are on the higher side.

4.5.3 *Relevant Assumptions*

(1) Water content in waste solids

Because the dredged material for Stage I, II and III of the Project is from the Shenzhen River, if there is no abrupt change in the Shenzhen River, the dredged material of Stage III Project should be similar to that of Stage I and II. Based on *the EIA Reports for Stage I & II of the Shenzhen River Regulation Project*, the natural water content in dredged material ranges from 53% to 64%, which keeps in semi-fluid state. Thus no aeolian erosion of dredged material would take place.

(2) Particle size distribution

The default particle size distribution of FDM, which has been successfully used in Stage I and Stage II of the Shenzhen River Regulation Project, will continue to be adopted in this EIA. The values of the particles with diameters of 0-2. 5, 2. 5-5, 5-10, 10-15 and >15 μm are 0. 0262, 0. 0678, 0. 1704, 0. 1536 and 0. 5820 respectively.

(3) Fine sand content

Based on *the EIA Report of Shenzhen River Regulation Project in Shenzhen and Hong Kong (Stage I and Stage* Ⅱ), the fine sand in filling material used for construction of embankment amounts to 29% of the specified particle size distribution. According to AP-42 of USEPA (see Table 11. 2. 1—1, the western road for transporting open coal), the fine sand content in the material of road surface is 8. 4% (it is adopted in the environmental assessment of Stage I and Stage Ⅱ). According to *the EIA Report of Shenzhen River Regulation Project in Shenzhen and Hong Kong (Stage I and Stage* Ⅱ), 13. 5% is taken for the moisture content in the material.

(4) Dust emission

Estimation of dust emission is made reference to the AP-42 of USEPA, related information of Stage I and Stage Ⅱ , and to the assemption that Stage III construction is similar to Stage I and Stage Ⅱ construction. The assessment covers the pollutant emitted from spoil ground and vehicles running on the access road to south and north construction sites. Part of the disposed material will be dumped at Nam Hang, and others will be sent to the dumping zone around East Sha Chau in Hong Kong, and the sea near Neilingding Island in Shenzhen. Due to high moisture content, dust emission is negligible. According to the regulations of Shenzhen, all concrete made by commercial company must be used for the construction. Dust emitted from the production of precast concrete unit is not included in the study. On the Hong Kong side,specialist licence is required for production of precast concrete block and relevant regulations for air pollutant emission and control measures should be followed.

(5) Materiel transportation

According to the Project design, 10 t self-loading trucks will be used for construction. The speed of the vehicles on the spoil ground and other areas is 15 km/h and 30 km/h respectively.

(6) Area of the spoil ground

Upon the design document, total area of the spoil ground in Nam Hang is 82,000 m^2.

(7) Traffic volume

According to the Design Report, the section of river course involved in Stage III Project is 4094 m long. In prelimany design the traffic volume is about 138 vehicles per day.

Based on the above assumptions, construction programe and the arrangement of disposal sites, the estimated daily dust amount emitted from the spoil ground and construction site on embankment, as well as various construction activities in building Man Kam To Bridge and Lo Wu Bridge are listed in Table 4.4. The vehicles running on the unpaved road and wind erosion of the construction site are the main sources of dust during construction.

Table 4.4 Estimated Amount of Dust Emission from Construction Activity (kg/day)

Construction Area	Construction Activity	Estimated Amount of Dust Emission
Earth dumping zone	Unloading from trucks	0.75
	Trucks' running on unpaved offset line	30.9
	Erosion on the construction site	46.1
Road between earth dumping zone and dyke	Trucks'running on unpaved offset line	431.8
Dyke construction zone	Loading on trucks	0.75
	Operation of bulldozer	90
	Alternation of dyke	118
	Trucks' running on unpaved offset line	566.4
	Erosion on the construction site	195
Construction site of Shuijin borrow area	Loading on trucks	0.48
	Operation of bulldozer	36
	Trucks' running on unpaved offset line	49.4
	Erosion on the construction site	36.5
From Shuijin borrow area to Xiaoguan	Trucks' running on unpaved offset line	213.8

4.5.4 *Simulated Forecasting*

Ore-hour continuous data for wind speed and direction and other data are obtained from Shenzhen Meteorological Observatory. The data since 1994 are in the EIA. The average daily concentrations of TSP with different distance are calculated by FDM model in the construction period of Lo Wu to Man Kam To and ofMan Kam To to the mouth of the Ping Yuen River (River Ganges). The estimated concentrations of the sensitive receivers are listed in Table 4. 5. The mean value for whole area of Xinxiu Village and Qiaoshe is 149 $\mu g/m^3$, which is used as background value. Upon the analysis in Section 4. 3, this forecast value is on conservative side.

Table 4. 5 Maximum Daily Mean Concentration of TSP of the Sensitive Recipients without Mitigation Measures

Sensitive Receivers		Location	TSP Emission ($\mu g/m^3$)	Estimated Concentration of TSP ($\mu g/m^3$)
On the Shenzhen side	1	Dormitory of the Station (28m)	279	428①
	2	Lo Wu No. 4 Village (68m)	186	335①
	3	Xiangxi Middle School (180m)	90	239
	4	Huaqiao New Village (113m)	136	285
	5	Xinxiu Village (188m)	51	200
Borrow Area in Daliang Village	1	Shangbayue	118	267
	2	Shuijingdaliang Village (400m)	27	176
On the HongKong side	1	Lo Wu Village (66m)	188	337②
	2	Lo Wu Public School (32. 5m)	252	401②
	3	Muk Wu Tsuen (140m)	112	261②
	4	Nga Yin Tsuen (78m)	168	317②

Notes: ①: Exceeding the National Standard of daily mean concentration of TSP
②: Exceeding the Hong Kong Standard of daily mean concentration of TSP

4. 6 Impact Assessment

4. 6. 1 *Construction Period*

(1) Dust

Table 4. 5 gives the maximum daily mean concentration of TSP at the sensitive receivers simulated by model without mitigation measures.

If no mitigation measures are taken, after the superposition of the TSP from the Project and the background concentration, there are two and four sensitive receivers' concentration exceeding the Standard on the Shenzhen side and the Hong Kong side respectively. Among all the sensitive receivers, owing to the influence of the easterly prevailing wind, and the proximity to the watercourse and waste disposal site, the dormitory of border inspection station on the Shenzhen side will be the most affected one. Due to the proximity of the Shenzhen River construction site, Lo Wu Village and Lo Wu Public School on the Hong Kong side will also be significantly affected.

1) Dust from the stocking area in Daliang Village

The two sensitive points at the borrow area in Daliang Village are Shangbayue and Shuijing Daliang Village, for which the predicted TSP concentrations meet Grade Ⅱ of national standard.

2) Bridges renewal project

The activities of foundation excavation, concrete placement, demolition of old bridge and material transportation in bridge renewal project would produce dust. Since foundation excavation is conducted under water, no dust will be produced. In addition, as commercial concrete which require no mixing on-site, is used in the construction, no cemest dust is produced during batching. As static explosion is to be applied in the demolition of old bridge, little dust is expected. The dust emitted from material transportation vehicle is listed in Table 4. 4. Among all of the sensitive receivers, the Lo Wu Control Port Building, Man Kam To Police Post and Huaqiao New Village are the sensitive receivers close to Man Kam To Bridge and Lo Wu Bridge, on which the impact have been assessed. As vehicles used in bridge renewal construction only account for a small part of the Project, it has minimal impact on surrounding area. In short, construction of the bridge renewal Projece will have no dust problem.

(2) Exhaust

Exhaust from fuel-burning machines and vehicles will increase the NOx content in the air and affect the air quality. From the experience of similar assessment, small number of fuel-burning machines and vehicles used for construction emits limited amount of NOx, CO and particles and thus has no siguificant impact on the environment.

(3) Odour

Disturbance of the river body and discarding of dredged mud will produce offensive odour, which has unfavorable effect on sensitive receivers.

If appropriate mitigation measures are adopted(dredging silt will be transported off the site at once),odour has a little impact.

1) Origin and hazard of offensive odour

① Properties and sources of offensive odour

Offensive odour originates from gaseous compounds, which make the living environment unpleasant to live in. Sometimes it might cause vomit and affect health. It is one of hazards harming smell sensing system and causing diseases. The ordinances of the

Law of Air Pollution Control of P. R. China specify the regulation to control offensive odour pollution. In recent years, the emission standard and resident area standard for offensive odour have been established in China.

Until now, there are 4,000 odour-producing compounds that human can sense, among which, dozens of compounds are harmful to health, such as thiols, ammonia, hydrogen sulfide, methanethiol, N, N-dimethyl methanamine, formaldehyde, styrene, n-butyric acid and phenols and so on. Some odour compounds carried by wastewater and waste solid are discharged into water body. This also makes aquatic life such as fish odour offensive.

The classification, name, property and source of common odour compounds are shown on Table 4. 6.

Table 4. 6 **Common Odour Substances**

Classification	Compound Name	Molecular Formula	Odour Property	Pollution Source
Thiols	Methanethiol	CH_3SH	Oniony; Rotten cabbage odour	Medicine and pesticide production; rubber processing; oil refining, etc.. factories
	Ethanethiol	C_2H_5SH		
	2-Propanethiol	$(CH_3)_2CHSH$		
Sulfoethers	Thiobis Methane	$(CH_3)_2S$	Garlicky and leeky	Kraft pulp and pesticide production; oil Refining etc.. factories
	Thiobis Ethane	$(C_2H_7)_2S$		
	Thiobis Propane	$(C_3H_7)_2S$		
	Thiobis Benzene	$(C_6H_5)_2S$		
Sulfides	Hydrogen Sulfide	H_2S	Rotten egg odour, stimulating odour	Kraft pulp oil refining and fertilizer production factories
Aldehydes	Formaldehyde	HCHO	Stimulating odour	Factories Motor exhaust; oil refining; petrochemical production factories
	Acetaldehyde	CH_3CHO		
	2-Propenal	$CH_2{=}CH-CHO$	Unpleasant lachrymatory odour	
Indole	3-Methylindole	C_9H_9N	Ordure odour	Ordure treatment plant, compost
Carbozylic acids	Acetic acid	CH_3COOH	Stimulating odour	Bone glue, grease and fish intestines and animal bone, etc. chemical products
	Propionic acid	C_2H_5COOH		
	Butyric acid	C_3H_7COOH		
Amides	n-Butyramide	$C_3H_7CONH_2$	Sweaty	Petrochemical plant
Amines	Methanamine	CH_3NH_2	Rotten fish odour	Bone glue, grease and fish intestines and animal bone, etc. chemical products
	Ethylamine	$C_2H_5NH_2$		
	Diethylamine	$(C_2H_5)_2NH_2$		
Phenols	Phenol	C_6H_5OH	Unpleasant smell	Metal smelting works chemical plant
	Thiolphenol	C_6H_5SH		

② **Odour-Production mechanism**

The odour relates to the molecular structure of odour-producing compound. For instance, two alkyls connecting to sulfate will form thiobis methane and methythio ethane, which is sulfoethers producing odour. With variety of sulfur position in the molecular structure, the odour property might change. For example, exchanging the position of S and N in ethyl thiocyanate structure will transform oniony smell into mustard smell of thiocarbimide ether. The functional groups of sulfenyl-, sulfhydryl- and thiocyanato-in variety of compound's structure, which produce offensive odour, are generally called as odour-producing group. Some other organic compounds, such as phenol, formaldehyde, acetone and n-butyric acid etc. , which contain no sulfur atom but group of -OH, -CHO, -COOH and -CO-, which also give out odour and act as odour-producing group.

③ **Smell sense mechanism**

People sense odour with their smell sersory organ. There is olfactory epithelial in the upper part of the nasal cavity, which is composed of olfactory mucous membrane and olfactory surface mucus formed by olfactory cells (sensory cell), sustenticiar cells, and base cells. Olfactory cell is in the terminal of the olfactory cell, which stretches the nerve cilium into the mucus under the olfactory surface mucus. The olfactory nerve fiber is stretched from the olfactory cell into the bowman's gland, and is conveyed into the cranial olfactory nerve centre through two accesses.

④ **Hazard:**

The six aspects of hazards caused by offensive odour are as follows: (1) damaging human respiratory system. When people smell odour suddenly, they will automatically restrain breath with decreasing breath frequency and depth or even stopping breath. The normal breath function is thus obstructed. (2) damaging circulation system. With the breath alternation, the pulse and blood pressure will change. The stimulating odour such as ammonia could cause blood pressure down then up, and pulse slow then fast. (3) damaging digestive system. Frequent contact with odour could make one anorexia, sick and even vomiting and proceed to cause digestive function failing. (4) damaging endocrine system. Frequent stimulation by offensive odour could make endocrine system dysfunction and affect human metabolism. (5) damaging nerve system. Being stimulated by one or several kinds of low-concentration odour substance for a long time, people will lose the smell sense and fatigue. People cannot identify odour after smelling it for a long time, which cause the loss of first level of protection function for smell sense. But the brain nerve is still under stimulation and is damaging. Finally, it will cause pallium under endure exciting and restrain the balancing function of the pallium. (6) Affecting spirit. The odour could make people dysphoria, absent minded, decrease working efficiency, sense and memory loss, as well as affecting human thinking.

⑤ Evaluation and prevention

Human can smell trace scent. For example, human can sense 4×10^{-9} mg/L of artificial musk. In the process of epidemiology survey, testing and evaluation of the type, property, extent of pollution and intensity of odour from pollution sources, the methods of inquiry and method of smelling are adopted to supplement chemical analysis of trace gases.

The smell of odour substance depends not only on its sort and property, but also on its concentration. Smell varies with the concentration of the odour substance. For instance, if the terrible odour indole is diluted to very low concentration, it will give out a jasmine fragrant. On the contrary, high-concentration perfume could make human unpleasant. The same to Rutanol, when in high-concentration it emits odour. But if it is diluted to low-concentration, it will give out an apple wine fragrant. Therefore, the odour evaluation should be depended on the concentration smelt, but not the smell of substance.

The odour substances could be eliminated by high-temperature burning, burning and catalytic combustion, absorbed by activated carbon, and rinsed with water and deodourizer etc.. The wastewater containing odour substances should be deodourised before being discharged.

⑥ Environmental impact of offensive odour of the project

Municipal domestic sewage is the major source of odour in the Shenzhen River. Domestic sewage could produce many odour substances in the process of oxidation and de-composition, such as ammonia, ammoniacal nitrogen, hydrogen sulfide, methanethiol, thiobis methane, 2-propenal, acetaldehyde, indoles and carboxylic acids etc.. The offensive odour from these compounds affects the surrounding environment significantly. The major odour sources for the Project are domestic sewage, industrial wastewater and garbage dumped into the River. Rotten garbage also produce odour substances before being discharged into the River. Moreover, large quantity of domestic sewage, industrial wastewater and garbage are holding up in the impeded river, which result in further rottening of these materials and lead to more odour substance.

The local standard of Guangdong Province (DB44 27-89) is adopted for odour evaluation. The odour normally is indicated by the odour intensity, which is divided into six grades.

The test method for intensity of offensive odour includes smell test and concentration test. The local standard of Guangdong Province (DB44 27-89) stipulates the use of smell test. A testing group consisting of six people, who have good smell sensory system and do not often contact with odour substances, goes to the monitoring spots to sense the odour intensity with their noses. Then the mean value will be used as the odour intensity. Upon the odour intensity in the Shenzhen River and actual condition, it is decided that the simple method, namely the smell test, will be applied in the EIA. The on-site investigation result shows that except for the reference spot in upstream, all other water quality monitoring spots along the river give out strong offensive odour, which reach Grade Ⅳ of the odour standard. In the area of Stage III Project, there are Lo Wu and Man Kam To Border Crossings with high daily flow of people, especially the Lo Wu Border Crossing. During dredging of the River, the odour will increase due to disturbance of the mud, which will irritate people passing the bridge. Moreover, the mud stockpiled nearby would also emit odour, making people unpleasant. If the dredged silt is carried away at once, it will avoid offensive odour being emitted.

4.6.2 *Operation and Maintenance*

After the completion of Stage III Project, large quantity of mud will be removed, which will greatly improve the water quality of the Shenzhen River. Simultaneously, the flow in the river will be improved and the dilution and diffusion capacity of the river is enhanced. This will also improve the water quality. Therefore, under the same pollution sources , with the completion of Stage III Project, the water quality of the Shenzhen River will be improved and the odour given out from the River will decrease.

The volume of vehicle flow of the Man Kam To New Bridge are the same as that of the old bridge. Therefore, the exhaust from vehicles will not increase after the new bridge has put into operation.

As the workload of dredging work is rather small(less than 500,000 m^2) during maintenance, and dredging is all conducted underwater, no major impact on air quality is expected.

4.6.3 *Risk and Uncertainty of the Assessment*

The model applied in the EIA is accepted internationally and fit for local condition. There is no special uncertainty in the modelling except the followings:

1) The detailed specification of mechanical plant in the EIA is based on the estimate of the Project. The detailed specifation of mechanical plant to be used for the Project is not yet available.

2) The construction contract has not yet been prepared. Hong Kong and Shenzhen may have different requirement to be laid down in the contract. It is assumed that the contract will include all environmental control in the report, which will be carried out.

There is no obvious risk on the uncertainty of air quality assessment. Any uncertainty will not change the conclusion of this environmental impact assessment.

4.7 Mitigation Measures

To reduce dust and odour during the construction period, the following mitigation measures are recommended:

1) The speed of trucks in the construction site and haul road should be restricted within 8 km/h;

2) The speed of bulldozer should be limited within 8 km/h;

3) The haul road should be watered four times a day, and twice a day for construction sites (total efficiency is 75%);

4) Vehicles should be equipped with wheel washing device, or be washed using hose before leaving construction site;

5) The watering device should be used during material loading and unloading;

6) If transporting cement is necessary, sealed tankers should be used with sealed system to cement storehouse;

7) Stockpiling cement in open space should be avoided . Storehouse and store tank should be used for storage;

8) Alarm system should be installed in the cement storehouse. All vent openings should be installed with suitable filter ;

9) Construction site should be cleaned regularly, especially during dry season;

10) Dust-proofing should be considered in selecting construction equipment;

11) Concrete batching should be conducted in wet way for mixing;

12) The stacks of chipped and dusty material should be enclosed to reduce dust. If some stacks cannot be covered for frequent material taking, they should be watered regularly to reduce dust;

13) Stacking dusty material near sensitive receivers and placing the entrance of the construction site near sensitive receivers, if possible should be avoided;

14) Trucks carrying dusty material on haul road should be covered with canvas;

15) Haul road and construction plant should be arranged as far as possible from sensitive receivers;

16) Fixed sprayers to watering material before unloading should be installed;

17) Seepage from the riverbed mud could emit strong offensive odour. Therefore, the handling equipment should be reliably leak free;

18) In the process of concrete batching, dustproof methods should be adopted, such as installing filter to the opening, watering regularly, spraying water at material-loading sites and having partly or wholly enclosed material-loading sites etc.. These measures could reduce dust emission by about 90%. On the Hong Kong side, a licence for concrete batching is required and control regulation should be stressed;

19) The heavily polluted silt should be transported off the site at once to avoid offensive odour impact produced by temporary stockpiling.

During maintenance and operation , it is unnecessary to take mitigation measures because air impact is rather limited.

4.8 Residual Impact

4.8.1 *Residual Dust Emission after Adoption of the Mitigation Measures*

The impact on the sensitive receivers caused by the residual dust after adopting mitigation measures is assessed. The residual dust emission is listed in Table 4.7 after adopting the mitigation measures described in Chapter 4.7.

Table 4.7 Predicted Dust Emission from Construction Activity (kg/day)

Construction Area	Construction Activity	Predicted Dust Emission	
		With Dust Reduction Measures	Without Dust Reduction Measures
Earth dumping zone	Unloading from trucks	0.75	0.75
	Trucks' running on unpaved offset line	30.9	7.76
	Erosion in the construction site	46.1	23.1
Road between earth piling zone and dykes	Trucks' running on unpaved offset line	431.8	108
Dyke construction zone	Loading on trucks	0.75	0.75
	Operation of bulldozer	90	45
	Alternation of dyke	118	59
	Trucks' running on unpaved offset line	566.4	141.6
	Erosion on the construction site	195	97
Construction site of Shuijin borrow area	Loading on trucks	0.48	0.48
	Operation of bulldozer	36	18
	Trucks' running on unpaved offset line	49.4	12.4
	Erosion on the construction site	36.5	18.3
From Shuijin borrow area to Xiaoguan	Trucks' running on unpaved offset line	213.8	53.5

4.8.2 *Simulated Fonecasting*

The one-hour continuous data of wind speed and direction from the station nearest to the Shenzhen River have been obtained from the Meteorological Station from the station. The data since 1994 is applied to FDM model to compute the TSP concentration in different distance during the overlapping construction period from Lo Wu to Man

Kam To and from Man Kam To to the mouth of the Ping Yuen River (River Ganges). The predicted concentrations of TSP at the sensitive receivers are listed in Table 4. 8. The mean overall value for Xinxiu Village and Qiaoshe is 149 $\mu g/m^3$, which has been used as the background va-lue. It is shown that, upon the analysis in Section 4. 3, this value is conservative.

Maximum daily mean concentration of TSP at sensitive receivers after adopting mitigation measures calculated by the model is shown in Table 4. 8.

Table 4. 8 Maximum Daily Mean Concentration of TSP of Sensitive Recipients after Adopting Mitigation Measures

Sensitive Receiver		Location	TSP Emission ($\mu g/m^3$)	Predicted Concentration of TSP ($\mu g/m^3$)
On the Shenzhen side	1	Dormitary of Lo Wu Station (28m)	114	263
	2	Lo Wu No. 4 village(68m)	76	225
	3	Xiangxi Middle School(180m)	36	185
	4	Huaqiao New Village(113m)	54	203
	5	Xinxiu Village(188m)	20	169
On the Hong Kong side	1	Lo Wu Tsuen(66m)	75	224
	2	Lo Wu Public School(32. 5)	98	247
	3	Muk Wu Tsuen(140m)	46	195
	4	Nga Yiu Tsuen (78m)	68	217

4. 8. 3 *Assessment of Residual Impacts*

The level of dustfall at the sensitive receivers is quite high, especially where the section of Shenzhe River from Lo Wu Bridge to Man Kam To, and from Man Kam To to the mouth of Ping Yuen River are under construction at the same time. However, it should be noted that the occurrence probability of the high wind speed and adverse direction is rather low. In addition, the value fluctuates greatly ranging 50 - 640 $\mu g/m^3$. It is unlikely that high background concentration the construction activity producing high level of dust and the worst meteorological condition take place ot the same time.

It is also indicated from Table 4. 8 that the daily mean TSP at sensitive receiver point will decrease by 15-60% after mitigation measures stated in Section 4. 7 are adopted. Thus the TSP at all the sensitive receivers in Shenzhen and Hong Kong will satisfy the standard concerned.

Therefore, after taking the above mentioned mitigation measures, TSP could be reduced to acceptable level. As the prediction is based on the assumption that the construction activity producing dust encounters the worst meteorological condition with the two heaviest workload construction in Lo Wu Bridge - Man Kam To and Man Kam To-mouth of Ping Yuen River (River Ganges) conducted at the same time. It is considered to be rather conservative.

4.9 Conclusion

1) For air quality in the construction site, TSP and RSP satisfy the related standard of both Shenzhen and Hong Kong. Exceeding-standard ratio of NOx is high because the monitoring points are located in the leeward of prevailingly north wind in Lo Wu District, where there is heavy volume of diesel vehicle. The peculiar smell is obvious due to wastewater discharge and garbage dumping without treatment along Shenzhen River.

2) The impact of the Project on air quality is dust emission in the construction period. Without mitigation measures, the TSP at the two sensitive receivers on the Shenzhen side and four sensitive receivers on the Hong Kong side will exceed the standard concerned. With mitigation measures, however, the daily mean TSP content at the sensitive receiver points will decrease by 15 — 60% and this satisfy the standard concerned on both Shenzhen and Hong Kong sides.

3) During construction, exhaust from the trucks carrying material, bulldozers, etc. would affect air quality to certain extent. Past experience reveals that the amount of exhausted NOx, CO and particle will be rather limited and the impact is insignificant.

4) Bridge reconstruction such as Man Kam To Bridge will cause no impact on air quality.

5) Construction activities might worsen the odour pollution. But if proper mitigation measures are adopted,it will not exceed the 5 odour unit set in Annex 4 of Technical Memorandum on Environmental Impact Assessment Process.

6) As the scale of maintenance dredging is rather small(less than 500,000 m^2), and dredging is all conducted underwater, it has little impact on air quality.

7) According to Annex 4 of Technical Memorandum on Environmental Impact Assessment Process, impact on air quality will be acceptable after adopting mitigation measures.