3 AIR QUALITY IMPACT ASSESSMENT

3.1 Introduction

3.1.1 This Chapter presents an assessment of the potential air quality impact arising from the construction and operation of the Project. Mitigation measures have been identified to alleviate the impact and their effectiveness has been evaluated.

3.2 Environmental Legislation, Standards and Guidelines

Environmental Impact Assessment Ordinance

3.2.1 For construction dust, Annex 4 of EIAO-TM specifies a TSP limit concentration averaged over a 1-hour period to be 500 µg/m^3.

3.2.2 For odour impact assessment, Annex 4 of EIAO-TM stipulates an odour limit for odour prediction assessment of 5 odour units based on an average time of 5 seconds at an air sensitive receiver.

3.2.3 Annex 12 of EIA-TM provides the guidelines for conducting air quality assessments under the EIA process, including determination of air sensitive receivers, assessment methodology and impact prediction and assessment.

Air Pollution Control Ordinance

3.2.4 The Air Pollution Control Ordinance (CAP 311) provides for the control of air pollutants from a variety of stationary and mobile sources through the establishment of a set of Air Quality Objectives (AQOs). As of 1st January 2014, a new set of air quality objectives which stipulates maximum concentrations for a range of pollutants, namely nitrogen dioxide (NO_2), sulphur dioxide (SO_2), respirable suspended particulates (RSP), fine suspended particulates (FSP), carbon monoxide (CO), photochemical oxidants (O_3) and lead (Pb) has been in force. The AQOs are listed in **Table 3-1** below.

Table 3-1: Hong Kong Air Quality Objectives

Pollutant	Averaging time	Concentration limit [i] (µg/m^3)	Number of exceedances allowed
Sulphur dioxide	10-minute	500	3
	24-hour	125	3
Respirable suspended particulates (PM_{10}) [ii]	24-hour	100	9
	Annual	50	Not applicable
Fine suspended particulates ($PM_{2.5}$) [iii]	24-hour	75	9
	Annual	35	Not applicable
Nitrogen dioxide	1-hour	200	18
	Annual	40	Not applicable

Pollutant	Averaging time	Concentration limit [i] ($\mu g/m^3$)	Number of exceedances allowed
Ozone	8-hour	160	9
Carbon monoxide	1-hour	30,000	0
	8-hour	10,000	0
Lead	Annual	0.5	Not applicable

Note:

[i] All measurements of the concentration of gaseous air pollutants, i.e., sulphur dioxide, nitrogen dioxide, ozone and carbon monoxide, are to be adjusted to a reference temperature of 293Kelvin and a reference pressure of 101.325 kilopascal.

[ii] Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 μm or less.

[iii] Fine suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 2.5 μm or less.

Air Pollution Control (Construction Dust) Regulation

3.2.5 Mitigation measures for construction sites have been specified in the Air Pollution Control (Construction Dust) Regulation. It also requires Contractors and site agents to inform EPD and adopt dust reduction measures while carrying out "Notifiable Works" or "Regulatory Works" as defined under the regulation. Works relevant to this Project include both "Notifiable Works" (road construction) and "Regulatory Works" (dusty materials handling, excavation).

3.3 Baseline Environmental Condition

3.3.1 Po Toi O is located in a rural area to the south of Clear Water Bay Country Park. Its openness to the South China Sea and the absence of industrial undertakings within 1 km imply that good air quality is anticipated. Po Toi O is home to some village houses and two seafood restaurants.

3.3.2 There is currently no EPD-operated air quality monitoring station located in Po Toi O area. The nearest air quality monitoring station operated by EPD is located at Kwun Tong, but the air quality data is considered inappropriate as the station is located in a mix of industrial/commercial/domestic premises, mildly affected by the open sea. The more appropriate station is the one at Tap Mun where the data will be used to describe the existing air quality in Po Toi O. **Table 3-2** summarizes the annual average concentrations of the air pollutants recorded at the Tap Mun Air Quality Monitoring Station from Year 2010 to Year 2014.

Table 3-2: Annual Average Concentration of Pollutants from Year 2010 to 2014 at EPD's Air Quality Monitoring Station (Tap Mun)

Pollutant	Annual Average Concentration (μg/m^3)					5-year average
	Year 2010	Year 2011	Year 2012	Year 2013	Year 2014	
RSP	41	47	38	49	44	44
SO_2	10	10	11	13	9	11
NO_2	13	12	11	11	10	11
O_3	67	71	71	75	72	71

Reference: Air Quality in Hong Kong 2010-2013 & Air Quality Statistical Summary in Hong Kong 2014

3.3.3 Based on the on-site survey, although Po Toi O is not serviced by public sewers, no significant odour was noted in the area.

3.4 Air Sensitive Receivers

3.4.1 The assessment area for air quality impact is defined by a distance of 500 m from the proposed works boundary as shown in **Figure 3-1**. Within the assessment area, representative Air Sensitive Receivers (ASRs) have been identified for this assessment, in accordance with the Annex 12 of the EIAO-TM. Domestic premises, hotel, hostel, hospital, clinic, nursery, temporary housing accommodation, school, educational institution, office, factory, shop, shopping centre, home for the aged and recreational activity areas are classified as ASRs.

3.4.2 ASRs in the vicinity of the proposed works boundary are identified for the assessment and the locations of these ASRs and their nearest horizontal separation from the proposed sewer and rising mains pipes and odour emission point of sewage treatment plant (STP) are tabulated in **Table 3-3**. Locations of the representative ASRs and the assessment points are shown in **Figure 3-1**.

Table 3-3: Representative Air Sensitive Receivers

ASR	Description	Land Use	Ground mPD	Nearest Horizontal Separation(m) From Proposed		No. of Storey
				Pipes	Odour Emission Point	
PTO_A1	Village House in PTOCR 28	Village	6	3	80	2
PTO_A2	Village House in PTOCR 23	Village	3.7	2.1	97	2
PTO_A3	Village House in PTOCR 7	Village	4	1	147	3
PTO_A4	Village House in PTOCR 7A	Village	4.1	0.95	208	3
PTO_A5	Village House in PTOCR 3A	Village	4.5	3.9	257	2

ASR	Description	Land Use	Ground mPD	Nearest Horizontal Separation(m) From Proposed		No. of Storey
				Pipes	Odour Emission Point	
FV_A1	Fairway Vista House 3	Village	23.1	1.5	284	3
FV_A2	Fairway Vista House 12	Village	7.5	1.6	350	3
REC_A1	Grassland	Recreation	23.1	38	194	1
TEM_A1	Hung Shing Temple	Place of Worship	4.1	5.2	180	1

* PTOCR = Po Toi O Chuen Road

3.5 Identification of Pollution Sources

3.5.1 Air Pollutant Control Ordinance (APCO) (Cap311) and EIAO-TM stipulate statutory Air Quality Objective (AQO) for 7 criteria air pollutants including NO_2, SO_2, FSP, RSP, CO, O_3 and lead.

Construction Phase

3.5.2 The Project involves provision of village sewerage to the unsewered areas of Po Toi O with 800m of gravity sewers and 400m of rising mains, construction of local sewage treatment plant with reprovision of road facilities (about 893m^2) and construction of a submarine outfall. The works are planned to commence in year 2017 for completion by year 2021. The major potential air quality impact during construction phase of the Project would be dust impact arising from:

- Excavation and slope cutting for site formation work for the proposed sewage treatment plant
- Materials handling
- Excavation for pipeline installation for the village sewerage
- Dredging and disposal of excavated/dredged materials,
- Backfilling
- Building construction, and installation of electrical and mechanical equipment.
- Wind erosion of open sites and stockpiling areas.

3.5.3 The major dust impact arising from the construction of the proposed sewage treatment plant would be the excavation and slope cutting for site formation work. Based on the site condition, the excavation rate is limited to about 11.9 m^3 per day only. Appropriate dust control measures should be implemented during the construction stage in accordance with the requirements in the Air Pollution Control (Construction Dust) Regulation. Given the small scale works involved with proposed mitigation measures as stated in **Section 3.8**, adverse dust impact is not expected.

3.5.4 The potential dust generating construction activities associated with the sewers works will mainly be excavation of a localised scale. It is expected that the sewers works will be carried out sections by sections. Under normal practice, the sewers would be constructed in section of about 10m to 20m at any one time and each work front would be separated by a clearance distance. For such typical arrangement, construction works for each section would normally be completed in about 29 working days. Given each section of the works would be of a small scale, localised and short-term, it would not reveal useful information by performing dust dispersion modelling for this type of transient dust generation activities. Moreover, based on this small scale of works and the limited excavation rate, 1-2 dump truck(s) would be allowable on site for unloading materials. Therefore, extensive excavation and transportation of dusty material are highly unlikely. With the implementation of practicable dust suppression measures stipulated in the Air Pollution Control (Construction Dust) Regulation, adverse construction dust impact at the ASR is not expected during construction of the Project.

3.5.5 Potential odour impact may arise from excavation of potential odorous sediments under soil or concrete surface. Temporary stockpiles of odorous excavated material and the waste disposal are also identified as odour sources. However, due to the limited quantity of excavated soil for the Project, odour impact during the construction phase of Project is anticipated to be acceptable if control measures as stated in **Section 3.8.4** are implemented. Potential odour impact during construction stage shall not be assessed quantitatively.

3.5.6 Based on the best available information at time of preparation of this EIA, there is no concurrent project in Po Toi O area in the construction phase of the Project. Given the small scale works involved for the Project, potential dust impact arising from the Project should be limited. With the mitigation measures and continual monitoring and review of dust impact in the area, adverse cumulative dust impact would not be anticipated.

Operational Phase

3.5.7 Based on the nature of the Project, no air pollutants set out in AQOs shall be generated during the operational phase of the Project. The only identifiable potential impact would be odour impact arising from the operation of the proposed sewage treatment plant.

3.5.8 Hydrogen sulphide produced during sewage treatment is the main odour source. The vent gas will be de-odourized prior to discharge into the atmosphere. The primary idea on the de-odourizing system (DO system) is to adopt biotrickling filters and/or activated carbon filters. While the exact type or combination of the DO system has not been confirmed, the ultimate goal is to achieve removal efficiency of at least 99.5%. All equipment will be stored underground with an exhaust emission point at +17.75mPD for dispersion.

3.6 Assessment Methodology

Construction Phase

3.6.1 Under the APCO, dust suppression measures stipulated in the Air Pollution Control (Construction Dust) Regulation should be implemented and detailed in **Section 3.8**. With effective implementation of these mitigation measures, adverse construction dust impacts are not expected at the ASRs. Quantitative assessment is therefore considered not necessary.

3.6.2 Audit and monitoring program during the construction phase of this Project has been formulated and is presented in the Environmental Monitoring and Audit Manual prepared under this study.

Operation Phase

Meteorology

3.6.3 The wind speed and wind direction are the two major features affecting the odour dispersion. Low wind speeds can allow for accumulation of odour which may be swept off site when the wind speed increases. At high wind speeds, odour emissions can become significant. Seasonal wind data were reviewed in order to design the most appropriate exhaust location of the proposed sewage treatment plant.

3.6.4 PATH MM5 data was utilized as the meteorological data during modelling for four PATH grids (37, 25), (38, 25), (37, 24) and (38, 24). The hourly input data include wind direction, wind speed, atmospheric stability class, mixing height, temperature and others. Minimum mixing height of 121m recorded in King's Park weather station in year 2010 was adopted.

Model Description

3.6.5 Significant odour impact is anticipated if the STP is not properly designed and/or operated. Gaussian model ISCST3 was used for modelling potential effects from odour within the 500m assessment area of the Project (see **Section 3.4.1**).

3.6.6 The odour criterion is based on an averaging time of 5 seconds. The model output corresponds more closely to a maximum 15-minute average concentration. This matter relates to the Pasquill-Gifford vertical dispersion parameter used in the ISCST3 model which is fully documented in the Workbook on Atmospheric Dispersion Estimates. With reference to the "Odour Modelling - Why and How, Richard A. Duffee et al" and the "Odour Control - A Concise Guide, Warren Spring Laboratory", the conversion of maximum 15-minute average odour to 5-second average odour are shown in **Table 3-4**. The overall conversion factors under different stability classes are applied to the model so that the predicted outputs are in 5-second average concentration.

Table 3-4: Summary of Conversion Factors from 1-hour to 5-second

Stability Class	Conversion Factor
A, B	22.3
C	8.50
D	6.90
E, F	6.55

Emission Strength

3.6.7 At-source odour concentration inside the sewage treatment plant was assessed based on the inflow quality, flow rate, and preliminary design of the plant and the data was used as input to the ISCST3 model as provided in **Table 3-5** below.

Table 3-5: Design Parameter of the Sewage Treatment Plant

Design Parameter	Strength
De-odourizing treatment capacity	1,500 m^3/hr
Air velocity at exhaust	3.32 m/s
Exhaust diameter	400mm
Exhaust location	+17.75 mPD
Exhaust temperature	Ambient temperature
H_2S concentration at the inlet	20 ppm
H_2S concentration at the exhaust	<0.1 ppm (99.5% removal efficiency)
Exhaust Odour Concentration [1]	200 OU/m^3

* All information in the table was provided by DSD unless otherwise stated.

[1] Refer to EIA for Tuen Mun Sewerage - Eastern Coastal Sewerage Extension (2000), H_2S was converted to odour units using 0.0005ppm odour threshold value.

3.7 Prediction of Odour Impact

3.7.1 Standard equipment will be installed in the deodourizing units of the proposed sewage treatment plant. For the purpose of this assessment, an odour removal efficiency of 99.5% as mentioned in **Table 3-5** above has been assumed for the predicted results.

3.7.2 In general, the village houses are three-storey high. Assuming that the height of each floor is 3 m, all ASRs were modelled for three heights (i.e. 1.5m, 4.5m and 7.5m above ground). The modelled results are shown in **Table 3-6.**

Table 3-6: Maximum 5-second Odour Levels for ASRs

ASR	Description	Predicted Maximum 5-second Odour Level (Odour Unit)			
		G/F	1/F	2/F	Maximum
PTO_A1	Village House in PTOCR 28	0.57	0.67	-	0.67
PTO_A2	Village House in PTOCR 23	0.58	0.64	-	0.64
PTO_A3	Village House in PTOCR 7	0.35	0.35	0.35	0.35

ASR	Description	Predicted Maximum 5-second Odour Level (Odour Unit)			
		G/F	1/F	2/F	Maximum
PTO_A4	Village House in PTOCR 7A	0.26	0.26	-	0.26
PTO_A5	Village House in PTOCR 3A	0.22	-	-	0.22
FV_A1	Fairway Vista House 3	0.19	0.22	0.32	0.32
FV_A2	Fairway Vista House 12	0.21	0.35	0.58	0.58
REC_A1	Grassland	0.28	-	-	0.28
TEM_A1	Hung Shing Temple	0.25	-	-	0.25
5-second Odour Criterion :		**5**			

3.7.3 The predicted 5-second average odour levels at various heights at the identified ASRs are well within the odour criterion (i.e. 5 OU in 5-second averaging time).

3.7.4 **Figures 3-2** to **3-4** present the odour concentration contour plots of the predicted maximum 5-second odour levels at 1.5 m, 4.5 m and 7.5 m above ground, respectively. The predicted results demonstrate that the odour concentrations at the selected ASRs are all below the EIAO TM assessment criterion and the contours confirm that the odour emitted from the sewage treatment plant will not cause any exceedance at the reach of the ASRs.

3.8 Mitigation Measures

Construction Phase

Construction Dust Impact

3.8.1. Due to the scale of the works of the Project, the construction works are unlikely to cause unacceptable dust impact on surrounding sensitive receivers if standard control measures are implemented. Dust control measures as part of good construction practice should be implemented to minimize dust nuisance to within the acceptable levels:

- Hoarding of not less than 2.4 m high shall be erected from ground level to surround the construction site for STP along Po Toi O Chuen Road except for a construction site entrance or exit
- As there is limited space in Po Toi O, stockpiling should be avoided. However, if found necessary, the materials should be covered by impervious materials such as tarpaulin
- Good housekeeping to minimize dust generation, e.g. by properly handling and storing dusty materials
- Store cement bags in shelter with 3 sides and the top covered by impervious materials if the stack exceeds 20 bags
- Minimize excavation area as far as possible

- Maintain a reasonable height when dropping excavated materials to limit dust generation
- Cover materials on trucks before leaving the construction site to prevent debris from dropping during traffic movement or being blown away by wind
- Minimize exposed earth after completion of work in a certain area by hydroseeding, vegetating, soil compacting or covering with bitumen
- Carry out dust suppression without excessive wastewater generation, e.g. use mist spray
- Limit vehicle speed within construction site and in Po Toi O to 10km/hr and confine vehicle movement in haul road
- Provide wheel washing at construction site exit to clean the vehicle body and wheel
- Regular maintenance of plant equipment to prevent black smoke emission
- Throttle down or switch off unused machines or machine in intermittent use

3.8.2. According to USEPA AP-42, a dust suppression of 50% can be achieved by watering twice a day. Thus, a dust removal efficiency of 75% is expected by regular watering four times a day. With regular watering for dust suppression, the mitigated dust levels during construction phase should comply with the EIAO-TM guideline limit for all the air sensitive receivers.

3.8.3. Dust impact could be effectively mitigated by inclusion of appropriate contracts clauses (e.g. regular and sufficient watering, enclosure of potential dust sources, etc.) for dust minimisation in the works contract. A control programme can be instigated to monitor the construction process in order to enforce dust controls and modify methods of works to reduce the dust emission down to acceptable levels.

Odour Impact

3.8.4. To minimize odour problem during construction phase, excavation works should be conducted in the shortest time span possible. In the event that on-site storage cannot be avoided, odourous excavated materials should be temporarily stored in covered containers. They should be removed off-site as soon as practically possible within 24 hours to avoid odour nuisance arising. Any leachate from storage skips should be stored in covered buckets and tanks.

<u>Operational Phase</u>

Odour Impact

3.8.5. During the operation phase of the sewage treatment plant, the approach is to enclose all odour sources to minimize potential odour problems. The sewage pumps, screen chamber, wet well, etc. will be located underground and enclosed by a reinforced concrete structure with cover. Deodorizers with forced ventilation will be installed to remove the odour. The deodorizer will provide an overall H_2S removal efficiency of 99.5% or higher. Moreover, the exhaust from the deodorizer will be pointed upward to allow maximum dispersion.

3.8.6. Sludge should be removed regularly to prevent build-up of odourous gas. As the estimated daily production of the sludge is 5.3m^3, it was considered not cost-effective to expand the footprint of the proposed sewage treatment plant to accommodate a sludge dewatering facility. It is proposed that the sludge will be removed for sludge cake making in other STP every 2 days by a sludge tanker. Sludge should be transferred to sludge tanker by coupling method to prevent odour leakage. The tanker will be parked inside the sewage treatment plant for sludge removal where the air is extracted for deodourization.

3.8.7. In addition, the following measures shall be implemented:

- Regular inspection should be conducted to check for leakage of odourous gas
- Maintain the removal efficiency of screenings and grits by flushing the screens and grit sump regularly to prevent build up of solids
- Screenings, grits and worn filters should be stored in sealed containers inside the STP and during removal for disposal
- Maintain the efficiency of MBR membrane by removing organic and inorganic debris with sodium hypochlorite and oxalic acid
- Replace worn activated carbon filter/biotrickling filter to maintain the odour removal efficiency at 99.5%
- Clean all the tanks with water regularly

3.8.8. With the proposed measures to be incorporated into the design, the proposed sewage treatment plant should not cause significant odour impact on the environment.

3.9 Residual Impact

3.9.1. With the implementation of mitigation measures as stated in **Section 3.8**, no residual impacts are anticipated for both the construction phase and operational phase of the Project.

3.10 Environmental Monitoring and Audit Requirements

3.10.1. With the implementation of the proposed dust suppression measures, good site practices and dust monitoring and audit programme, acceptable dust level would be expected at the ASRs during construction phase. Details of the monitoring requirements such as monitoring locations, frequency of baseline and impact monitoring was prepared in the form of EM&A manual as part of the EIA submission.

3.10.2. With the implementation of mitigation measures through the design of the sewage treatment plant as mentioned in **Section 3.8.5 – 3.8.7**, air quality impact on the Project is expected to be acceptable during operational phase. Operational air monitoring is considered unnecessary.

3.10.3. General EM&A requirements were presented in **Chapter 12**.

3.11 Conclusion

3.11.1. Dust generating activities were identified and evaluated. Based on the best available information at time of preparation of this EIA, there is no concurrent project in Po Toi O area in the construction phase of the Project. Given the small scale of the works involved in the Project, extensive excavation and transportation of dusty material are highly unlikely. Mitigation measures including watering of on-site construction area are expected to limit fugitive dust levels to acceptable levels. With proper implementation of mitigation measures, construction dust emissions impacts are anticipated to be acceptable. An EM&A programme will be implemented to ensure construction dust impacts are controlled to acceptable level.

3.11.2. Due to the limited quantity of excavated soil for the Project, odour impact during the construction phase of Project is anticipated to be acceptable if control measures as stated in **Section 3.8.4** are implemented.

3.11.3. During the operational phase of the Project, all the potential odour generating facilities would be enclosed by building structure. The deodorization facility is designed to be able to achieve an odour removal efficiency of 99.5% for the exhaust of the sewage treatment plant. Based on the odour modelling results, no exceedance of 5-OU in 5-second averaging time specified in the EIAO-TM is anticipated. During sludge transportation, it is recommended that the sludge should be carried in enclosed containers to avoid unacceptable odour nuisance. Membrane and filter in the STP should be regularly cleaned and replace to maintain the efficiency of sewage treatment and odour removal. With proper mitigation measures incorporated into the design, odour impacts arising from the proposed sewage treatment plant will be significantly reduced, and are anticipated to be acceptable.