Contents

6 SEWERAGE AND SEWAGE TREATMENT IMPLICATIONS

6.1 Legislation, Standards and Guidelines

6.1.1 Introduction

6.1.1.1 Apart from the legislative requirements under the Water Pollution Control Ordinance (WPCO), the following guidelines shall be referenced to for sewerage and sewage treatment implications of the Study:

- Environmental Protection Department (EPD) Report No. EPD/TP 1/05 Guidelines for Estimating Sewage Flows (GESF) for Sewerage Infrastructure Planning Version 1.0; and
- Drainage Services Department (DSD) Sewerage Manual Part 1 (Key Planning Issues and Gravity Collection System) and Part 2 (Pumping Stations and Rising Mains).

6.2 Existing Conditions

6.2.1 Introduction

6.2.1.1 The proposed development atop Siu Ho Wan Depot falls within the North Lantau Sewerage Catchment. The existing and planned sewerage infrastructure within and in the vicinity of the Study Area are briefly described in the following sections.

6.2.2 Existing Sewage Treatment Works

6.2.2.1 Siu Ho Wan Sewage Treatment Works (SHWSTW) was a preliminary sewage treatment works when it was commissioned in 1996. It was subsequently upgraded under the Project PWP Item 4224DS "Outlying Islands Sewerage Stage 1 Phase 1C - Upgrading of Siu Ho Wan Sewage Treatment Plant" to chemically enhanced primary treatment (CEPT). SHWSTW is situated approximately 430m east of the proposed development site. It has a design Average Dry Weather Flow (ADWF) capacity of 180,000 m^3/day and a design peak flow capacity of 3,750 l/s according to information given by DSD.

6.2.2.2 An ultra-violet (UV) disinfection system was implemented in 2006 to receive the CEPT effluent and further improve the effluent quality. It consists of 2 screen inlet channels (1 duty and 1 standby) and 3 UV channels, and has an ADWF capacity of 90,000 m^3/day and peak flow capacity of 1,875 l/s, which is based on the situation where all 3 UV

channels are operating in parallel. Two spare screen channels and one spare UV channel have been reserved for future expansion. An effluent pumping station was also provided downstream of the UV disinfection system to ensure the effluent is discharged to the outfall during high tide condition and in case of insufficient hydraulic head. It has a peak flow capacity of 2,500 l/s and 2 spare channels are reserved for future expansion.

6.2.2.3 Currently SHWSTW receives sewage from Hong Kong International Airport (HKIA), Tung Chung, Disneyland and Penny's Bay, Sunny Bay and Siu Ho Wan. The treated effluent is discharged into the marine waters of North Western Water Control Zone via a DN1840 submarine outfall.

6.2.2.4 It is understood from EIA report of Tung Chung New Town Extension that DSD would fit out the remainder of the treatment units at SHWSTW to its designed maximum handling capacity (180,000 m^3/day) by 2024 in order to cope with the project sewage flows within its catchment.

6.2.3 Existing and Planned Sewerage Network

6.2.3.1 The existing and planned sewerage network adjacent to the development site is shown in **Figure 6.1**. Currently, sewage generated from existing Siu Ho Wan Depot is conveyed from an on-site pumping station (located near northern boundary of existing Siu Ho Wan Depot, SHD) and discharged to SHWSTW via a 200mm diameter rising main across the North Lantau Highway (NLH), Tung Chung Line (TCL) and Airport Express Line (AEL). It eventually discharges to an existing sewage pumping station (ref. XPS7000360) within SHWSTW, which transfers sewage flow to the vortex chamber located in the southeast part of SHWSTW for energy dissipation.

6.2.3.2 According to DSD's drainage record plans, there are existing DN1200 rising main and DN315 gravity sewer that run along Cheung Tung Road and parallel to NLH. The DN1200 rising main conveys sewage from Tung Chung Sewage Pumping Station to SHWSTW, whereas the DN315 gravity sewer combines with the 200mm rising main serving the Siu Ho Wan Depot.

6.2.3.3 Under Agreement No. CE 6/2012(DS) "Construction of Additional Sewage Rising Mains and Rehabilitation of the Existing Sewage Rising Main between Tung Chung and Siu Ho Wan - Investigation, Design and Construction", it is proposed to construct an additional DN1200 sewage

rising main and rehabilitate the existing DN1200 sewage rising main between Tung Chung Sewage Pumping Station and SHWSTW.

6.2.3.4 According to the approved EIA report for Tung Chung New Town Extension (TCNTE) Study (AEIAR-196/2016), a twin DN600 rising mains was proposed to run along the footpath at the rear of the existing seawall at existing Siu Ho Wan Depot. The rising mains will then cross below TCL, AEL and NLH, then along an existing drainage reserve and maintenance access road, where they will follow a similar alignment as the new DN1200 rising main, and discharge to SHWSTW.

6.3 Methodology and Design Criteria

6.3.1 Objectives and Procedures

6.3.1.1 The following approach is adopted in carrying out this sewerage assessment:

- Identify the scope of the development;
- Determine the sewage generation of the development;
- Identify the existing and planned sewerage systems within and in the vicinity of the proposed development boundary;
- Examine the impact arising from new sewage generation from the proposed development on SHWSTW; and
- Propose sewerage works.

6.3.1.2 The assessment has been carried out in accordance with the guidelines set out in EPD Report No. EPD/TP1/05 Guidelines for Estimating Sewage Flows (GESF) for Sewerage Infrastructure Planning Version 1.0 and DSD's Sewerage Manual.

6.3.2 Development Parameters

6.3.2.1 The site area is approximately 30ha and developing the site involves re-planning and phased migration of the operating depot. The Development would comprise of about 108 towers for approximately 14,000 residential units. This sewerage impact assessment is based on the development parameters shown in **Table 6.1** below.

Table 6.1 Development parameters

Type	Proposed Development
Residential (with club houses)	14,000 flats 37,800 population
Commercial (Mainly Retail)	about 30,000m^2 GFA
School	3 nos. (@30 classrooms)
Kindergarten	4 nos. (@6 classrooms)

6.3.3 Unit Flow Factors – Domestic Flows

6.3.3.1 Unit flow factor (UFF) used for domestic sewage flow estimation of residential population in the Study Area and North Lantau are shown in **Table 6.2**.

Table 6.2 Unit flow factors for domestic flows

Type	Unit Flow Factor (m^3/person/day)[1]
Public Rental	0.190
Private R1	0.190
Private R2	0.270
Private R3	0.370
Private R4	0.370
Traditional Village	0.150
Modern Village	0.270
Institutional and special class	0.190
Temporary and non-domestic	0.150
Mobile residents	0.190
General Residential – Permanent housing in North Lantau (for catchment wide planning)	0.230

Note:

[1] EPD's Report No. EPD/TP 1/05 Guidelines for Estimating Sewage Flows (GESF) for Sewerage Infrastructure Planning Version 1.0.

6.3.4 Unit Flow Factors – Commercial and Institutional Flows

6.3.4.1 The unit flow factors for commercial and institutional flows due to commercial and employed population are shown in **Table 6.3**.

6.3.4.2 The total unit flow generated from an employee in a particular trade is the sum of the unit flow factor of the employee and the unit flow factor of commercial activities of a particular trade under consideration.

Table 6.3 Unit flow factors for commercial and institutional flows

Type	Unit Flow Factor (m^3/employee/day) [1]
Commercial Employee	0.080
Commercial activities	
(a) Specific trades:	
J2	0.250
J3	0.100
J4	0.200
J5	-
J6	-
J7	-
J8	-
J9	0.150
J10	1.500
J11	0.200
J12	-

Type	Unit Flow Factor (m^3/employee/day) [1]
(b) General – territorial average	0.200
School student	0.040

Note:

[1] EPD's Report No. EPD/TP 1/05 Guidelines for Estimating Sewage Flows (GESF) for Sewerage Infrastructure Planning Version 1.0.

6.3.5 Peaking Factors

6.3.5.1 Peaking factors cater for seasonal/diurnal fluctuation and normal amount of infiltration and inflow. The peaking factors adopted in this study are shown in **Table 6.4**.

Table 6.4 Peaking factors for various population ranges

Population Range	Peaking Factor (including stormwater allowance) for facility with existing upstream sewerage	Peaking Factor (excluding stormwater allowance) for facility with new upstream sewerage[1]
Sewers		
< 1,000	8	6
1,000 – 5,000	6	5
5,000 – 10,000	5	4
10,000 – 50,000	4	3
> 50,000	Max ($7.3/N^{0.15}$, 2.4)	Max ($6/N^{0.175}$, 1.6)
Sewage Treatment Works, Preliminary Treatment Works and Pumping Stations		
< 10,000	4	3
10,000 – 25,000	3.5	2.5
25,000 – 50,000	3	2
> 50,000	Max ($3.9/N^{0.065}$, 2.4)	Max ($2.6/N^{0.065}$, 1.6)

Notes:

[1] EPD's Report No. EPD/TP 1/05 Guidelines for Estimating Sewage Flows (GESF) for Sewerage Infrastructure Planning Version 1.0.

N = Contributing population in thousands.

$$\text{Contributing population} = \frac{\text{Calculated total average flow } (m^3/\text{day})}{0.27\ (m^3/\text{person/day})}$$

6.4 Sewage Flow Estimation

6.4.1.1 The site area is approximately 30ha and developing the site involves re-planning and phased migration of the operating depot. The Development would comprise of about 108 towers for approximately 14,000 residential units. Commercial, recreational and educational uses are also planned for the proposed development. This sewerage impact

assessment is based on the development parameters shown in **Table 6.1**.

6.4.1.2 The estimated sewage flows generated by the proposed development is summarised in **Table 6.5**. Detailed calculations are enclosed in **Appendix 6.1.**

Table 6.5 Sewage flow estimation from the proposed development

Proposed Development	ADWF (m^3/day)
Proposed development atop Siu Ho Wan Depot[1]	12,076 Say (12,100)
Siu Ho Wan depot (Depot Replanning Works + Siu Ho Wan Station)[2]	1,229
Total	13,329

Notes:
[1] EPD's Report No. EPD/TP 1/05 Guidelines for Estimating Sewage Flows (GESF) for Sewerage Infrastructure Planning Version 1.0
[2] Sewage flow estimation for SHO and SHD Replanning Works extracted from Table 6.5 of the Railway EIA Report.

6.4.1.3 As discussed in **Section 2.4**, the Proposed Development will be implemented in 4 phases based on the depot replanning and migration progress. Subject to Government approval process, population intake is anticipated to begin in Year 2026 and the project is tentatively assumed to be completed by Year 2038, subject to review at the detailed design stage. Tentative population built-up programme for SIA purpose is summarised in **Table 6.6**.

Table 6.6 Tentative population built-up programme

Phase	1	2	3	4	Total
Design Population	9,633	8,883	9,310	9,974	**37,800**
Recreational Facility (Club House) (No. of Employee)[1]	298	301	673	378	**1,650**
Commercial / Retail (No. of Employee)[1], [2]	1,500				**1,500**
Kindergarten (No. of Student / Staff)[1]	195	195	195	195	**780**
School (No. of Student / Staff)[1]		1,245	1,245	1,245	**3,735**
Anticipated Population Intake Year	2026 - 2027	2030	2034	2035 - 2038	

Notes:
[1] Number of employee and student/staff are for sewage flow estimation purpose only.
[2] Opening of the commercial/retail facilities will be subject to market conditions.

6.4.1.4 The year-by-year sewage flow build-up on the estimated sewage flows generated by each phase of the development is shown in **Table 6.7**. Detailed calculations are enclosed in **Appendix 6.1**.

Table 6.7 Year-by-year sewage flow build-up for the proposed development atop Siu Ho Wan Depot

Year	ADWF (m^3/day)
2026	3,736
2027	3,736
2028	3,736
2029	3,736
2030	6,318
2031	6,318
2032	6,318
2033	6,318
2034	9,168
2035	12,100
2036	12,100
2037	12,100
2038	12,100

6.5 Proposed Development Sewerage Network

6.5.1.1 The proposed sewerage network is independent from the existing sewerage network so as to avoid impacts to existing sewerage network and to ensure clear demarcation on the operation, management and maintenance responsibilities from the depot. Separate sewerage systems are deemed necessary by the Project Proponent to ensure clear demarcation between railway and MTR property on the operation, management and maintenance responsibilities. Similar arrangements have been applied to other MTR property developments atop operating depots; therefore a similar approach has been adopted under this

project. **Figure 6.1** shows the sewerage layout proposed under this study.

6.5.1.2 The Government has identified available capacity of about 13,400m^3/day for accepting the sewage arising from the proposed development atop Siu Ho Wan depot and the Siu Ho Wan Depot site for treatment at the SHWSTW. This available capacity is sufficient to cater sewage arising from the SHD Topside Development and SHO and SHD Replanning Works as the total sewage discharge is 13,329 m^3/day (**Table 6.5**). No adverse impact to SHWSTW is therefore anticipated.

6.5.1.3 The inlet chamber of SHWSTW is located on the southeast side. It is noted that the inlet chamber of SHWSTW is located higher than the ground levels of adjacent Cheung Tung Road and the maintenance access road (ground level of approximately +5.6mPD to +7.7mPD). Due to such level difference, the provision of on-site sewage pumping stations is required to overcome the topographical constraint.

6.5.1.4 A new sewerage system will be provided to serve the proposed development. It is currently proposed that the sewage generated from the proposed development to be collected from the sewerage system (including local pump sumps / sewage pumping stations and associated rising mains) and then discharged to the ultimate sewage pumping station via rising mains. **Figure 6.2** shows the conceptual design of the sewerage system within the development. The ultimate sewage pumping station will be located at ground level of the eastern boundary of the proposed development and discharged to SHWSTW via twin rising mains with size of 450mm diameter. The rising mains will cross below the TCL and AEL and NLH, then along an existing drainage reserve and maintenance access road and finally discharge to SHWSTW. The crossing of twin rising mains below TCL and AEL and the NLH will be carried out by pipe jacking with jacking pit located adjacent to the ultimate sewage pumping station and receiving pit within existing drainage reserve area. The pipe jacking arrangement will be designed not to conflict with existing utilities. Precautionary and monitoring measures will be implemented.

6.5.1.5 The velocity of the proposed twin rising mains is provided in **Table 6.8** below:

Table 6.8 Velocity of the Proposed Twin Rising Mains

Peak Flow (L/s)[1]	419
Proposed pipe size (mm)	2nos. DN450
Velocity (m/s)[2]	1.3

Note:
[1] Detailed calculations are provided in **Appendix 6.1**.
[2] The velocity check is based on equation: Flow (Q) = Pipe Area (A) x Velocity (V).

6.5.2 Enhancements and Additional Provisions

6.5.2.1 Due to the key concerns of the ecological sensitivity of The Brothers Marine Park in The Brothers (islands) within the vicinity to the site, the following provisions are proposed for the proposed DN450 rising mains to enhance the sewerage network reliability and minimize environmental impacts due to system failure or in case of emergency situations:

- Twin rising mains would be provided for the proposed sewerage network. It is proposed to use both mains as duty from an economical and operational point of view. Should one of the duty mains be suspended from operation for maintenance, the remaining one would still be able to deliver the peak flow from the proposed development to SHWSTW at a higher velocity (exceeding 3m/s) during that period.
- High density polyethylene (HDPE) or ductile iron pipe for proposed DN450 rising mains would be adopted. Further protection on proposed DN450 rising mains with concrete surround (whole length) will be provided to prevent the rising mains from bursting. With the above proposed measures, it is expected there will be no bursting discharge from rising mains. There will be no impact on water quality or ecology due to sewer bursting discharge.

6.5.2.2 Emergency discharge of sewage from the proposed development is minimised. The occurrence of any single emergency event has been considered due to the following risks: pump failure; power failure; and stormwater infiltration causing excessive inflow to the sewage pumping stations.

6.5.2.3 To mitigate the risks of pump and/or power failure, the following measures are proposed for the proposed sewage pumping stations to minimise the possibility of emergency discharge:

a) 100% standby pumping capacity within each Sewage Pumping Station (SPS), with spare pump up to 50% pumping capacity stockpiled in each SPS for any emergency use. The standby pump will be automatically take off the failed duty pump;

b) dual-feed power supply for each SPS;

c) emergency storage tank providing up to 3-hours ADWF capacity at the ultimate SPS. This emergency storage will be provided adjacent to the wet well chamber. The inlet of the emergency storage will be at the same level as the invert level of incoming pipe of wet well chamber. It is noted that this emergency storage will be provided at the ultimate SPS located at ground level of the eastern end of the proposed development and will consider all sewage flow from the development;

d) Monitoring and Control System (MACS) providing real-time notification of alert signal in emergency situation;

e) Project Proponent's term contractor to provide 24-7 emergency repair service in the case of emergency situation;

f) Qualified personnel appointed by the Project Proponent carrying out regular inspection, routine maintenance and repairing of the facilities and equipment.

6.5.2.4 For the proposed 3-hours ADWF emergency storage capacity (equivalent to 1 hour peak flow) at the ultimate SPS, it should be noted that, unlike other government pumping stations which are typically unmanned and hence require mobilizing off-site maintenance staff to travel to the site during emergency, the ultimate SPS will be manned within the Project boundary. Besides, the Project Proponent will appoint a maintenance contractor to provide 24 hours attendance for instant maintenance and emergency repair to ensure there will be no overflow that will affect the downstream water quality in the unlikely event of total pump failure.

6.5.2.5 To mitigate the risk of excessive inflow of stormwater to the sewage pumping stations, the design peak flow capacity of each SPS in the proposed development has considered a peaking factor which includes stormwater allowance.

6.5.2.6 Considering the possible emergency situations and respective risks, as well as the practicality of construction, the above mitigation measures are considered the most appropriate and practical measures to deal with the emergency situations of the proposed SPSs within the proposed development atop Siu Ho Wan Depot development. Therefore it is considered that emergency discharge for the proposed SPSs are of low likelihood. Chances of emergency discharge are minimised and thus no adverse impact on water quality or ecology due to emergency discharge from the sewage pumping stations in the proposed development atop Siu Ho Wan Depot is anticipated.

6.5.2.7 Operational manual of sewage pumping stations would be prepared during detailed design stage.

6.6 Impacts and Mitigations

6.6.1 Siu Ho Wan Sewage Treatment Works (SHWSTW)

6.6.1.1 As discussed in **Section 6.5**, The Government has identified available capacity of about 13,400m^3/day to accept the total sewage arising from the proposed development atop Siu Ho Wan depot and the Siu Ho Wan Depot site for treatment at the SHWSTW. Therefore, no impact to SHWSTW is anticipated.

6.6.1.2 One of the possible proposals for discharging the collected sewage from the proposed SHD Topside Development is via a break pressure chamber to the proposed rectangular channel constructed under DSD Contract DC/2016/01 at SHWSTW. This proposal would require to modify the proposed rectangular channel to cater for the additional sewage flow from the proposed development atop Siu Ho Wan depot. The arrangement and detailed design of the connection works will be developed in detailed design stage if necessary.

6.6.2 Existing Sewers and Rising Mains

6.6.2.1 A new separate sewerage system will be provided to serve the proposed development atop Siu Ho Wan Depot. No sewage flow from the proposed development will discharge directly to existing sewers and rising mains. Therefore, the proposed development induces no impact to existing sewers and rising mains.

6.6.3 Septicity and Odour Assessment

6.6.3.1 Septicity will occur if lack of oxygen in the sewerage system after the dissolved oxygen is depleted by aerobic biological activity. This will lead to the production of hydrogen sulphide (H_2S) and potential to

create odour nuisance. Septicity becomes a problem when the retention time of sewage in the mains is long and the temperature is high.

6.6.3.2 The key parameters for formation of septicity are dependent upon the sewage strength, flow rate characteristics, length of the sewerage system, oxygen level and temperature. Based on this conceptual design of sewerage arrangement, the septic issue in the sewage collection network may occur, subject to further assessment in detailed design stage, due to the following main reasons:

a) The sewage in the proposed sewerage system is mainly domestic sewage with no dilution, which has a relatively high organic content favouring the septic issue;
b) Variation of flow pattern resulting in long hydraulic detention time in pump wells in particular during night time period; and
c) Relatively high temperature in hot summer period.

6.6.3.3 All parameters mentioned above favour the generation of septic condition. Hence, septicity control shall be necessary in the proposed sewage collection network. Subject to the detailed design, addition of chemicals such as nitrate salts or sodium chlorite to the sewage is considered as one of the feasible septicity mitigation measures at the proposed pumping station. Active on-line monitoring of sewage septicity and an active septicity treatment/dosage system will be provided in the proposed sewerage system to eliminate any septicity problems.

6.6.3.4 The estimated sewage retention time for each internal SPS and the ultimate SPS at different phases of the proposed development atop Siu Ho Wan Depot is shown in **Table 6.9** and **Table 6.11** respectively. The total estimated retention time for the proposed sewerage system at different phases of the proposed development atop Siu Ho Wan Depot is shown in **Table 6.12**. Detailed calculations are enclosed in **Appendix 6.2**.

Table 6.9 Estimated sewage retention time for each internal SPS at different phases of the proposed development atop Siu Ho Wan Depot

Phase	SPS	ADWF (m^3/day)	Approximate Length of R.M. (from Phase SPS to Ultimate SPS)	Retention time (mins)
1	1a	1,513	905	48
	1b	854	1,377	77
	1c	1,369	417	29
2	2a	1,202	1,403	67
	2b	1,380	1,249	68
3	3a	1,508	708	39
	3b	1,342	978	57
4	4a	463	207	19

Phase	SPS	ADWF (m^3/day)	Approximate Length of R.M. (from Phase SPS to Ultimate SPS)	Retention time (mins)
	4b	1,309	415	29
	4c	1,136	160	20

Notes:
[1] ADWF for each SPS extracted from **Figure 6.2**.

Table 6.10 Estimated sewage retention time for ultimate SPS at different phases of the proposed development atop Siu Ho Wan Depot

Year	Phase	ADWF (m^3/day)	Approximate Length of R.M. (from Phase SPS to Ultimate SPS)	Retention time (mins)
2026-2029	1	3,736	852	117
2030-2033	1+2	6,318	852	75
2034	1+2+3	9,168	852	58
After 2034	1+2+3+4	12,076	852	33

Table 6.11 Total estimated sewage retention time for proposed sewerage system at different phases of the proposed development atop Siu Ho Wan Depot

Year	Phase	ADWF (m^3/day)	Retention time [1] (mins)
2026-2029	1	3,736	(117+77) 194
2030-2033	1+2	6,318	(75+68) 143
2034	1+2+3	9,168	(58+57) 115
After 2034	1+2+3+4	12,076	(33+29) 62

Notes:
[1] Worst case scenario, i.e. longest retention time, in wet wells and rising mains for each phase taken from **Table 6.9**.

6.6.3.5 Based on the preliminary septicity assessment, septicity in the sewage collection network could be significant during dry weather conditions and non-peak hours for the first several years of the development. Referring to **Table 6.11**, the total estimated sewage retention times from Year 2026-2033 are more than 120 minutes. That means septicity in the sewage collection network would probably exist. Provision of effective septicity control measures including but not limited to active on-line monitoring of sewage septicity and active septicity treatment / dosage system will be provided.

6.6.3.6 Odour emission from the pump wells/ sumps is also anticipated. For odour control, the proposed pumping station should be enclosed in building with sufficient ventilation to maintain negative pressure preventing foul air escape from the building. Wet well can be air sealed

and the ventilated foul air should be treated by a deodourization system before discharging into the atmosphere.

6.7 Construction, Operation and Maintenance Responsibilities

6.7.1.1 Refer to **Appendix 6.3** which sets out the requirements for the construction works, operation and maintenance responsibilities for the various proposed sewerage facilities.