6 SEWERAGE AND SEWAGE TREATMENT

6.1 Introduction

6.1.1 This section presents the performance assessment of the existing and committed sewerage systems, the assessment of the sewerage impacts as a consequence of the proposed further development of TKO and the proposed sewerage works for the unsewered development areas and the recommended improvement works to the existing sewerage infrastructure.

6.2 Sewerage Catchment Area, Development and Flow Projections

Sewerage Catchment Area

6.2.1 The sewerage catchment of TKO is delineated on the basis of the existing and planned sewerage systems and is in line with the Environmental and Engineering Feasibility Assessment Studies in Relation to the Way Forward of the Harbour Area Treatment Scheme (EEFS) study. The sewerage catchment boundary encompasses the TKO area and also Planning Areas outside TKO, taking into account of the extensiveness of the sewerage systems and proposed catchment diversions. These include PVS-338 zones 115, 129, 219 and some of the Port Shelter area. It is recommended that part of the Port Shelter sewerage catchment be diverted to TKO under the Port Shelter Sewerage Master Plan (SMP). **Figure 6.1** shows the delineated sewerage catchment boundary in 2016.

6.2.2 PVS denotes Planning Vision Strategy whereas PVS-338 is the zoning system adopted in the 2001-based Territorial Population and Employment Data Matrix (TPEDM). The delineated PVS zones within the sewerage catchment of TKO are shown in **Figure 6.2**.

Development Projections

Planning Year Considered

6.2.3 The planning year studied is defined by the approved OZP for TKO when full development condition is attained. It is considered that the full development condition takes place in Year 2016 within TKO. However, a portion of Port Shelter is hydraulically linked to TKO via the sewerage networks. Since the planning of Port Shelter goes beyond 2016, it is considered more appropriate to adopt the ultimate development scenario as a basis to identify the sewerage impacts within TKO catchment.

Population Estimates

Baseline Condition

6.2.4 Planning information for the TKO sewerage catchment in the Baseline Condition is based on 2001-based TPEDM Scenario II data for Year 2016 whilst the coverage of the sewerage catchment is in line with the EEFS. This scenario assumes that all development proposals will be fully implemented. Planning information at Planning Area level is considered adequate for the purpose of performance assessment and is therefore adopted. The adopted planning information is included in **Appendix 6.1**.

6.2.5 The total number of contributing population associated with the developments within the TKO sewerage catchment for ultimate scenario in year 2016 are presented in **Table 6.1** below:

Table 6.1 Ultimate Population in Year 2016 for TKO Sewerage Catchment in Baseline Condition

Residential Population	Commercial Employed Population	Industrial Employed Population	School Place	Diversion from Port Shelter*
484,318	99,629	10,716	69,511	35,348

Notes: * Design ultimate population is based on Table B of the SENT Development Strategy Review Study provided by EPD's memo to TDD ref. (22) in EP 2/N8.Q/84 XII dated 16 June 2003.

Sewerage Impact Assessment Condition

6.2.6 The Sewerage Impact Assessment (SIA) condition refers to the assessment of the Baseline Condition as the consequence of the further development at TCS, TKL and PSK which relates to the population changes in Areas 65 to 68, 73, 74 and 78. The proposed changes in population within the TCS, TKL and PSK development areas are estimated and given in **Table 6.2**.

6.2.7 Due to great level difference between the existing sewers along Wan Po Road and TKO Stage 1 Landfill Site, sewage from the proposed development (District Open Space with active and passive recreational facilities) in TKO Stage 1 Landfill Site to be discharged by gravity is not possible. Based on the information provided in Preliminary Investigation Report on TKO Stage I Landfill Football Training Centre in July 2004, the estimated average sewage flow is about $53m^3/d$ (about 84 residents and 80 employed population). A pumping station is proposed at the end of Road L861 to convey the collected sewage from the proposed developments at TKO Stage 1 Landfill to the existing trunk sewer under Wan Po Road via a twin 150mm diameter rising main along Road L861 as shown on **Figure 6.3**. The emergency bypass of the pumping station would be connected to the nearest existing drainage outfall at TKO Stage 1 Landfill seawall which is located 500m away from the existing seawater intake at Area 86 i.e. sensitive receiver.

6.2.8 It is similar case for the Administration Building at the WCR toll plaza where connection to the existing gravity sewer in TCS is not feasible (about 1km away). Discharge by gravity sewer is not possible. As the sewage quantity generated from the site (about 80 employed population) is small (about $5m^3/d$), pumping scheme is not considered to be financially viable. It is recommended that the sewage would be collected in holding tank and transferred by lorry to TKO Preliminary Treatment Works (PTW) for treatment. A discharge chamber can be constructed at the inlet of TKO PTW for receiving the sewage collected by lorry. Discharge of sewage should be arranged within office hours of the TKO PTW to facilitate normal plant operators.

6.2.9 The assessment of the SIA condition has not covered the Western Coast Road toll plaza, where the sewage flow is negligible.

Table 6.2 Proposed Changes in Population at TCS, TKL and PSK in Year 2016

Development Area	Planning Area	Baseline Condition			SIA Condition			Change in Percentage			Change in Population		
		Residential	School Place	Employment	Residential	School Place	Employment*	Residential	School Place	Employment*	Residential	School Place	Employment*
Town Centre South	65	37,032	5,730	2,750	15,656	3,240	2,750	-58%	-43%	0%	-21,376	-2,490	0
	66	4,108	1,316	2,548	10,774	0	2,548	+162%	-100%	0%	+6,666	-1,316	0
	67	14,030	2,912	2,558	0	3,870	2,558	-100%	+33%	0%	-14,030	+958	0
	68	0	0	30	6,323	0	30	N/A	0%	0%	+6,323	0	0
	Sub-total	*55,170*	*9,958*	*7,886*	*32,753*	*7,110*	*7,886*	-41%	-29%	0%	*-22,417*	*-2,848*	*0*
Tiu Keng Leng	73	36,010	5,948	3,931	33,184	5,555	3,931	-8%	-7%	0%	-2,826	-393	0
	74	26,259	989	3,931	14,850	2,580	3,931	-43%	+161%	0%	-11,409	+1,591	0
	Sub-total	*62,269*	*6,937*	*7,862*	*48,034*	*8,135*	*7,862*	*-23%*	*+17%*	*0%*	*-14,235*	*+1,198*	*0*
Pak Shing Kok	78	2,157	335	297	5,245	335	297	+143%	0%	0%	+3,088	0	0

Notes:

- * - Assuming the employment within the development areas under the SIA Condition remains unchanged from the Baseline Condition for conservatism.
- "+" and "-" signs indicate elevation and depletion against the baseline line values, respectively.
- N/A denotes Not Applicable.

6.2.10 The total number of contributing population associated with the proposed further development at TCS, TKL and PSK for ultimate scenario are presented in **Appendix 6.1** and are summarised in **Table 6.3** below:

Table 6.3 Ultimate Population in Year 2016 associated with Further Development proposed at TCS, TKL and PSK for TKO Sewerage Catchment

Residential Population	Commercial Employed Population (E2 to E5)	Industrial Employed Population (E1)	School Place	Diversion from Port Shelter*
450,838	99,709	10,716	67,861	35,348

Notes: * Design ultimate population is based on Table B of the SENT Development Strategy Review Study provided by EPD's memo to TDD ref. (22) in EP 2/N8.Q/84 XII dated 16 June 2003.

Flow Projections

Average Dry Weather Flows

6.2.11 Average dry weather flows (ADWF) were estimated by applying appropriate unit sewage flow factors to the population data. Reference was made to the unit flow factors as recommended in the Sewerage Manual Part 1 (DSD, 1995) and the EEFS Final Report.

6.2.12 With the exception of industrial developments, the adopted unit flow factors are consistent with the recommendations of the Sewerage Manual. The adopted unit flow factor for industrial employed population of 1,000 l/h/d is in line with the recommendation of the EEFS Final Report. The recommended unit flow factors are tabulated below:

Table 6.4 Recommended Unit Flow Factors

Development Type	Unit	Unit Flow Factor (l/h/d)
Residential		
Low Cost Rental	person	175
R1	person	240
R2	person	300
R3	person	370
Village	person	240
Government/Institution/Community	person	240
Commercial		
Job Types E2 to E5	employee	350
Industrial		
Job Type E1*	employee	1,000
Schools		
School	school place	25

Notes:
Based on Sewerage Manual Part 1 (DSD, 1995).
* denotes in line with EEFS Final Report.

Baseline Condition

6.2.13 The evaluated ultimate ADWF for the TKO sewerage catchment by development type are presented in **Table 6.5** and the details of planning and flow data are included in **Appendix 6.1**:

Table 6.5 Ultimate ADWF in Year 2016 for TKO Sewerage Catchment

Development Type	ADWF (m^3/d)
Residential	107,606
Commercial (E2 to E5)	34,870
Industrial (E1)	10,716
School	1,738
Diversion from Port Shelter*	10,585
TOTAL	***165,515***

Notes: * Design ultimate flows are based on Table B of the SENT Development Strategy Review Study provided by EPD's memo to TDD ref. (22) in EP 2/N8.Q/84 XII dated 16 June 2003.

Sewerage Impact Assessment Condition

6.2.14 **Appendix 6.1** shows the revised ADWF against the planning data as the result of the proposed further development at TCS, TKL and PSK. The changes in ADWF within TCS, TKL and PSK are summarized in **Table 6.6**:

Table 6.6 Proposed Changes in ADWF at TCS, TKL and PSK in Year 2016

	Planning Area	Baseline Condition (m^3/d)			SIA Condition (m^3/d)			Change in Percentage			Change in ADWF (m^3/d)		
		Residential	School Place	Employment	Residential	School Place	Employment	Residential	School Place	Employment	Residential	School Place	Employment
Town Centre South	65	7,348	143	963	4,138	81	963	-44%	-43%	0%	-3,210	-62	0
	66	986	33	892	3,232	0	892	+228%	-100%	0%	+2,246	-33	0
	67	3,367	73	895	0	97	895	-100%	+33%	0%	-3,367	+24	0
	68	0	0	11	1,897	0	11	N/A	0%	0%	+1,897	0	0
	Sub-total	*11,701*	*249*	*2,761*	*9,267*	*178*	*2,761*	-21%	-29%	0%	*-2,434*	*-72*	*0*
Tiu Keng Leng	73	7,301	149	1,451	6,782	139	1,451	-7%	-7%	0%	-519	-10	0
	74	5,770	25	1,451	3,564	65	1,451	-38%	+158%	0%	-2,206	+40	0
	Sub-total	*13,071*	*174*	*2,902*	*10,346*	*203*	*2,902*	*-21%*	*+17%*	*0%*	*-2,725*	*+30*	*0*
Pak Shing Kok	78	798	8	104	1,941	8	104	+143%	0%	0%	+1,143	0	0

Notes:

Assumes the employment within the development areas under the SIA Condition remains unchanged from the Baseline Condition for conservatism.

"+" and " -" signs indicate elevation and depletion, respectively, against the baseline line value

N/A denotes Not Applicable

6.2.15 The evaluated ultimate total ADWF within TKO catchment, with the further development proposed at TCS, TKL, PSK and TKO Stage 1 Landfill are shown in **Table 6.7** below:

Table 6.7 Ultimate ADWF in Year 2016 for TKO Sewerage Catchment, with Further Development at TCS, TKL, PSK and TKO Stage 1 Landfill

Development Type	ADWF (m^3/d)
Residential	103,615
Commercial (E2 to E5)	34,898
Industrial (E1)	10,716
School	1,697
Diversion from Port Shelter*	10,585
TOTAL	***161,510***

Notes: * Design ultimate flows are based on Table B of the SENT Development Strategy Review Study provided by EPD's memo to TDD ref. (22) in EP 2/N8.Q/84 XII dated 16 June 2003.

Peaking Factors

6.2.16 Peak wet weather flows (PWWF) are used in the assessment of hydraulic adequacy of the sewerage systems, TKO Preliminary Treatment Works (PTW) and the Harbour Area Treatment Scheme (HATS) Stage I Tunnel section from TKO to Kwun Tong. Peaking factors including stormwater allowance in accordance with the Sewerage Manual were applied to the ADWF to establish the peak flows. A flow rate of 240 l/h/d, was adopted in the evaluation of equivalent population for determination of the peaking factors. The recommended peaking factors are presented in **Table 6.8** below:

Table 6.8 Recommended Peaking Factors for Sewers and PTWs

Population	Peaking Factor for Sewers*	Population	Peaking Factor for PTWs*
< 1,000	8	< 10,000	4
1,000 – 5,000	6	10,000 – 25,000	3.5
5,000 – 10,000	5	25,000 – 50,000	3
10,000 – 50,000	4	> 50,000	$3.9/N^{0.075}$
> 50,000	$7.3/N^{0.165}$		

Notes:

* denotes peaking factors including stormwater allowance based on Sewerage Manual Part 1 (DSD, 1995).
N denotes equivalent population / 1,000.
Equivalent population = ADWF (m^3/d) / 0.24.
Reference has been made to Section 4.7.2 of Sewerage Manual Part 1 (DSD, 1995) for calculation of peaking factor of PTW with population greater than 50,000.

Peak Wet Weather Flow

6.2.17 Peaking factor including stormwater allowance in accordance with Sewerage Manual have been adopted in the flow estimation to provide a conservative basis for the performance assessment of the sewerage system. It is also noted that some sections of the existing sewerage system in TKO are suffering from ground settlement and may therefore lead to ingress of stormwater or ground water into the sewers.

Baseline Condition

6.2.18 The total projected ultimate peak flows for the TKO sewerage catchment are evaluated and shown in **Table 6.9** below:

Table 6.9 Ultimate PWWF in Year 2016 at TKO PTW

ADWF (m^3/d)	Equivalent Population	Peaking Factor *	PWWF (m^3/s)
165,515	689,646	2.39	4.58

Notes:
* denotes peaking factors including stormwater allowance based on Sewerage Manual Part 1 (DSD, 1995).
PWWF = ADWF x Peaking Factor
Reference has been made to Section 4.7.2 of Sewerage Manual Part 1 (DSD, 1995) for calculation of Peaking Factor of PTW with population greater than 50,000.

Sewerage Impact Assessment Condition

6.2.19 With the proposed further development at TCS, TKL, PSK and TKO Stage 1 Landfill, the total projected ultimate flows for the TKO sewerage catchment are evaluated and presented in **Table 6.10** below:

Table 6.10 Ultimate PWWF in Year 2016, with Revised Flows due to Further Development at TCS, TKL, PSK, and TKO Stage 1 Landfill, at TKO PTW

ADWF (m^3/d)	Equivalent Population	Peaking Factor *	PWWF (m^3/s)
161,510	672,958	2.39	4.47

Notes:
* denotes peaking factors including stormwater allowance based on Sewerage Manual Part 1 (DSD, 1995).
PWWF = ADWF x Peaking Factor
Reference has been made to Section 4.7.2 of Sewerage Manual Part 1 (DSD, 1995) for calculation of Peaking Factor of PTW with population greater than 50,000.

6.3 Existing & Committed Sewerage Infrastructure

Introduction

6.3.1 Sewage flows generated by developments within the TKO sewerage catchment are collected by the existing and committed sewerage systems en route to the TKO PTW for preliminary treatment. There are proposed works under the TKO Sewerage and Port Shelter Sewerage projects which are associated with this catchment. The treated effluent from TKO PTW is discharged into the existing Harbour Area Treatment Scheme (HATS) Stage I Tunnel System for conveyance to the Stonecutters Island Sewage Treatment Works (SCISTW) for chemical treatment and ultimate disposal into the western approaches of the Victoria Harbour.

Sewerage System

Existing Sewerage Systems

6.3.2 The TKO sewerage catchment comprises two major sewerage systems. They are referred to as the Northwest and the South Systems in respect of their locations relative to the TKO PTW. **Figure 6.1** shows the sewerage layout of the TKO catchment.

(i) Northwest System

6.3.3 The Northwest System collects sewage generated from the majority of the residential developments in TKO, including Po Lam, Tsui Lam, Hang Hau, Tiu Keng Leng, Pak Shing Kok, TKO Town Centre and Siu Chik Sha.

6.3.4 There is a sewerage connection from the Hong Kong University of Science and Technology (HK UST) to the Northwest System via a 450mm diameter sewer. The HK UST tunnel collects sewage from Tai Po Tsai, Pik Shui Sun Tsuen, Ta Kwu Leng San Tsuen, HK UST and an additional development in Tai Po Tsai. Another sewerage connection is lately completed at Hang Hau Road via a 450mm diameter sewer. This newly built sewerage is catered for planned developments in Silverstrand, Mang Kung Uk and Clear Water Bay Peninsula.

6.3.5 The collected flows from the Northwest System drain to an inflow chamber located near Tin Chau Road at Hang Hau. At the inflow chamber, the flow discharges to a 2,400mm internal diameter sewage tunnel which runs through Planning Area 78, 103, 106 and 108. The tunnel has a nominal depth range of 5m to 9m, except for the section which passes through a hillside where the depth is up to 150m. The peak flow capacity of the sewage tunnel varies from 3.15m^3/s to 4.88 m^3/s. The sewage tunnel is connected to a 2,500mm diameter sewer at a roundabout on Shek Kok Road and eventually discharges into the TKO PTW nearby.

(ii) South System

6.3.6 The South System covers mainly the industrial area in Tai Chik Sha (including TKO Industrial Estate and Area 137) which has a total area of approximately 180 ha. Sewage generated from the industrial area is collected by the sewers at Chun Yat Street, Chun Kwong Street, Chun Ying Street, Chun Wang Street and Chun Choi Street, which are then connected to the trunk sewer located along Wan Po Road. The system will also serve the future Area 137 planned to accommodate a total employed population of 11,500. 500mm DI rising mains have already been laid along Wan Po Road (between Area 137 and junction at Chun Wang Road) to cater for the development of Area 137. The trunk sewer, of which

the diameter is 1,650mm, is connected to the sewage tunnel of the Northwest System at Shek Kok Road before discharging to TKO PTW.

Planned Sewerage Works

6.3.7 There are recommended sewerage improvement works associated with the TKO sewerage catchment under the TKO SMP and Port Shelter SMP. Though the planned sewerage works under the Port Shelter and TKO Sewerage projects go beyond 2016, the impacts of these proposed works are therefore taken into consideration in the performance assessment.

6.3.8 In general, the TKO SMP has recommended the provision of sewerage connections to nine TKO villages. These include the Shui Bin Village, Ming Oi New Village, TKO Upper Old Village, Boon Kin Village, Mau Wu Tsai Village, Hang Hau Lower Old Village, Wo Tong Kong Village, Au Tau Village and Sun Tei Village of which the locations are indicated on Figure 6.1. There is no programme to implement the proposed works.

6.3.9 Under the Port Shelter SMP, sewage flows are to be transferred into the TKO sewerage catchment from the areas south of Ho Chung, including Silverstrand and Clearwater Bay areas. The existing HK UST sewage tunnel conveys flows from the areas south of Ho Chung whilst flow from Silverstrand and Clearwater Bay areas will be delivered by means of pumping and gravity respectively. The proposed works are in stages. Stage 1 works were fully completed. Stage 2 and 3 works are being designed and the implementation programmes are under detailed planning.

Sewage Treatment Works

6.3.10 Sewage collected from the catchment is conveyed by the existing and committed sewerage systems to the existing TKO PTW for treatment. Sited at the junction of Shek Kok Road and Wan Po Road in Area 85, the PTW was upgraded under the Strategic Sewage Disposal Scheme, SSDS (now known as HATS) Stage I in 1996. The upgrading works included the coarse screen, raw sewage pumps, fine screens and vortex grit tanks. The upgraded PTW now has a capacity of 5.55m^3/s, with a standby unit of 0.6m^3/s. A layout of the PTW is shown in **Figure 6.4**. Capacities of the individual treatment units are shown in **Table 6.11** below:

Table 6.11 TKO PTW Treatment Unit Capacities

Treatment Unit	No. of Units	Capacity of Each Unit (m^3/s)
Inlet Pumps	2 duty 3 duty 1 duty + 1 standby	0.75 1.15 0.60
Coarse Screens	1 duty + 1 standby	4.50
Fine Screens	4 duty + 1 standby	1.72
Grit Removal	2 duty 2 duty	1.90 1.50

6.3.11 Based on EEFS Final Report (Table 2-10), the average flow to the TKO PTW for 1999 to 2002 is 72,733m^3/d.

6.3.12 Under normal conditions, the treated effluent is discharged into the HATS Stage I Tunnel System en route to SCI STW for further treatment and ultimate disposal to sea.

6.3.13 In the event of extreme conditions, such as breakdown of major equipment that would affect normal operation of the plant, the excess flows will be directly discharged into the Tathong Channel via an existing 1,320mm diameter submarine outfall. The capacity of the submarine outfall is approximately 3.0 m^3/s (Feasibility Study for Intensification and Extension of TKO New Town WP12 (Dec. 1998)). EPD have raised concerns about the functionality of this submarine outfall since it is being idled. According to the advice from Sewage Treatment Division of DSD, the condition of the submarine outfall would be checked as follow:-

(i) There is a monthly flushing programme to check if the outfall is working properly. The present outfall is in good working condition despite its use has been terminated after the HATS deep tunnel commissioning in December 2001.

(ii) Presently, there is a hydrographic survey conducted every two years to check the outfall condition. The last hydrographic survey conducted was carried out in June 2002 and its condition is in order.

6.3.14 As the Eastern Channel and Inner Junk Bay area would be utilised for water sport recreation, the potential accidental discharge through the sewage overflow at the seawall on the south of Area 86 development would need to be considered in the water quality study (see Section 5).

HATS Stage I Tunnel Section from Tseung Kwan O to Kwun Tong

6.3.15 A drop shaft and tunnel was constructed as part of the HATS Stage I works to convey the treated effluent from TKO PTW to SCI STW. The apparent capacity of the HATS Stage I Tunnel from TKO to Kwun Tong of 4.89 m^3/s may impose a constraint when compared with the capacity of the TKO PTW (c.f. 5.55 m^3/s). The apparent design peak flow capacities of the Stage I Tunnels in accordance with the Final Report of Further Development of SSDS Stage III/IV and PPFS (October 1999) are listed in **Table 6.12** below:

Table 6.12 HATS Stage I Tunnel System Capacity

Tunnel Link	Apparent Peak Flow Capacity (m^3/s)*
TKO ◊ Kwun Tong	4.89
Kwun Tong ◊ To Kwa Wan	14.81
To Kwa Wan ◊ SCI STW	21.80

Notes: * based on Final Report of Further Development of SSDS Stage III/IV and PPFS.

6.3.16 Based on HATS EEFS Final Report (Section 2.7.6), there is no capacity constraint with respect to the HATS Stage I system. Thus, it is confirmed that the HATS Stage I Tunnel System has adequate hydraulic capacity to handle the preliminary treated effluent from TKO PTW.

6.3.17 The existing TKO PTW occupies part of Area 85. The land to its south is reserved for the extension of the TKO PTW. The extension area is planned to be used for upgrading of the TKO PTW so as to allow sewage from Tseung Kwan O to be treated locally and TKO to be separated from the HATS, for the long term use. Such arrangement is to cater for the long term development needs and maintaining sustainable developments in Kowloon and Tseung Kwan O.

6.4 Sewerage Impact Assessment

Introduction

6.4.1 Section 6.2 revealed that the projected ultimate population for TKO sewerage catchment are 484,318 and 453,318, whilst the ultimate sewage flows are 165,515m^3/d and 161,510m^3/d, for Baseline and SIA condition respectively. Intuitively, the decreased ADWF (4,005m^3/d) will not cause any adverse impacts on the sewerage infrastructures.

6.4.2 Although there is an overall reduction in population and flows as a consequence of the proposed development in TCS, TKL and PSK within TKO catchment, it is noted that there are local increases of population and flows in Planning Area 66, 68 and 78 (see **Table 6.2** and **6.6**). These local effects on the existing and committed sewerage system were assessed with the use of hydraulic model. The constructed model is depicted in **Figures 6.5**, **6.6** and **6.7**.

6.4.3 According to the sewerage records and the proposed works in TKO catchment, there were no existing or planned sewerage systems to serve the developments at Planning Area 65B, 68 and 78. Sewerage systems connecting these planning areas to the existing sewerage system are proposed. Well-developed sewerage systems have been constructed in TKL and thus no proposed sewerage works are proposed under this SIA except for the GIC cluster in Area 72 (along Road L721).

6.4.4 Improvement works are also proposed to rectify the sewerage infrastructure identified with hydraulic inadequacies in the performance assessment.

Proposed Sewerage Systems for TCS and PSK

6.4.5 Sewerage records and the latest drawings showing the planned sewerage works within the TKO catchment indicated that there are no existing nor planned sewerage system to convey the flows arising from Planning Area 65B, 68 and Pak Shing Kok (Planning Area 78) to the existing trunk sewerage system along Po Yap Road and Wan Po Road respectively. Therefore, new sewerage systems are proposed to discharge the flows to the existing trunk sewers.

6.4.6 Planning Areas 67 and 68 are located at the most southern part of TCS. It is proposed to construct a new foul sewerage system comprising 600mm diameter sewers to convey flows from Planning Areas 67 and 68 to the existing 1,050mm diameter sewers along three newly constructed roads, namely Road L661, Road L671 and Road L672. The 1,050mm diameter sewers will then discharge into the existing trunk sewers in Po Yap Road as shown in **Figure 6.8**, which also illustrate the alignments of the proposed sewers.

6.4.7 Planning Area 65B is located near the Bauhinia Garden and there is no sewerage system to collect the flows arising from this proposed residential area. Therefore, it is proposed to construct a new sewerage system of 600mm diameter along Road L651 to the existing 1,050mm diameter sewer along Road L661. (See **Figure 6.8** for the proposed 600mm diameter sewer alignment.)

6.4.8 There is an existing 750mm diameter sewer at the junction of Road L781 and Wan Po Road. A sewerage system with 300mm diameter sewers along Road L781 is proposed to drain the flows arising from Pak Shing Kok development into this 750mm diameter sewer. The proposed alignment is shown in **Figure 6.9**.

Performance Assessment for Sewerage System

Introduction

6.4.9 The performance of the existing and committed sewerage infrastructure was assessed for ultimate scenario incorporating planning information reflective of the approved OZP condition and also flows from Port Shelter. Hydraulic model of the sewerage systems was constructed using the InfoWorks software on the basis of sewerage record plans collected from DSD, as-built drawings for Contract No. TK43/96 and Contract No. TK53/01, and details collected on the proposed works under the Port Shelter SMP and TKO SMP. The flows of 10,585m^3/d from Port Shelter are discharged into nodes no. V420-10 and V250-10 in the hydraulic model. Sewers of diameter 450mm and above are included in the hydraulic model. Peak flows are used in the assessment of hydraulic adequacy of the sewerage system, TKO PTW and HATS Stage I Tunnel section from TKO to Kwun Tong.

6.4.10 Planning information at Planning Area level was adopted for the evaluation of sewage flows. The flows were assigned to appropriate manholes of the hydraulic model as inflows from the respective developments. The cumulative peak flows conveyed by the sewerage system were used in the assessment for hydraulic adequacy.

6.4.11 Information on the existing sewerage networks is sourced from the Drainage Record Plans obtained from DSD on 21 August 2002 under this Study.

Baseline Condition

6.4.12 The performance assessment results showed that there were some existing sewers identified as hydraulic inadequate in the model under the ultimate flows. Moreover, it is assessed that some sewers were surcharged due to backwater effect.

6.4.13 In accordance with the Sewerage Manual, the long-term goal is to implement sewerage improvement works to eliminate all surcharged conditions. The Sewerage Manual recognises the practical constraints for upgrading all existing sewerage systems to ensure that there will be no surcharge of the sewerage systems at any time. The Sewerage Manual states that when some sewers are surcharged but with some freeboard, improvement of these sewers should not need to be accorded as top priority if the following is satisfied:

- A minimum freeboard of 1 m; and
- A minimum factor of safety against overflow of 1.15, i.e. overflow will not occur at a flow rate of (1.15 times Peak Flow).

6.4.14 Surcharged sewers measuring a total length of 655m ranging from 450mm to 1,050mm diameter were identified under peak flow condition and the details are listed in **Appendix 6.2**. Under the 1.15 times peak flow condition, the total length of surcharged sewers is 2,052m with a similar range of pipe sizes. **Table 6.13** and **6.14** summarize the pipe size and length of the identified surcharged sewers.

Table 6.13 Summary of Surcharged Sewers under Peak Flows at Baseline Condition

Pipe Dia. (mm)	Length (m)
450	308
525	96
600	55
675	164
1,050	32
Total	**655**

Table 6.14 Summary of Surcharged Sewers under 1.15 x Peak Flows at Baseline Condition

Pipe Dia. (mm)	Length (m)
450	596
525	569
600	388
675	305
900	15
1,050	32
1,650	147
Total	**2,052**

6.4.15 There are no risks of overflow at these surcharged sewers under the different flow conditions as the available freeboards are greater than 1 m. The surcharged sewers under peak flow and 1.15 times peak flow conditions are illustrated in **Figures 6.10, 6.11** and **6.12**. See **Appendix 6.3** for details of the performance assessment results for the existing and committed sewerage systems.

6.4.16 Some 302m of existing sewers ranging from 450mm to 1,650mm diameter were identified with adverse gradients. It is understood that some areas of TKO are suffering from ground settlement. Table 6.15 below is a listing of the sewers with backfall:

Table 6.15 Existing Sewers with Adverse Gradient

Ref. No. in Fig. 6.4 to 6.6	Link Ref.	D/S Node	Location	Length (m)	Pipe Dia. (mm)	U/S I.L. (mPD)	D/S I.L. (mPD)
1	18_39.1	18_42	Within TKO Industrial Estate, along Chun Choi Street near Chun Ying Street	42	900	-0.530	-0.340
2	4_33.1*	2_81	Along Po Fung Road near Po Lam Road North	60	675	1.800	1.810
3	10_72.1	10_73	Along Po Yap Road near Wan Po Road	69	1,650	-1.840	-1.790
4	30_36.1	30_39	In Choi Ming Court Estate Road to Road P2	15	900	2.790	3.000
5	30_42.1	30_45	In Road P2 near Tong Ming Court	21	900	2.760	2.840
6	V20_20.1*	18_51	At the junction of Chun Kwong Street and Chun Ying Street	40	450	-0.370	-0.090
7	V220_100.1*	V220_110	Near Nan Fung Plaza Tower 3	55	450	1.050	1.140

Remark: Sewer sections marked with *are revealed to be surcharged in the hydraulic models in both "Peak Flow" and "1.15x Peak Flow" scenarios of SIA condition (**Appendix 6.3** refers). The remaining sections are not surcharged and thus, not recommended to be upgraded in term of cost-effectiveness. Please refer to Para. 6.5.4 for justifications.

Sewerage Impact Assessment Condition

6.4.17 It is noted that similar performance assessment results as under the Baseline Condition are identified for the SIA Condition and the details are listed in **Appendix 6.3**. However, the surcharged condition is improved due to the reduced population, especially in TKL. Therefore, it is assessed that less sewers are surcharged as compared with the Baseline Condition under the 1.15 x Peak Flow Scenario. **Tables 6.16** and **6.17** present summaries of the surcharged sewers under SIA.

Table 6.16 Summary of Surcharged Sewers at Peak Flow under SIA Condition

Pipe Dia. (mm)	Length (m)
450	343
525	96
600	55
675	164
1,050	32
Total	**690**

Table 6.17 Summary of Surcharged Sewers at 1.15 x Peak Flow under SIA Condition

Pipe Dia. (mm)	Length (m)
450	486
525	569
600	388
675	305
1,050	32
Total	**1,780**

6.4.18 **Figures 6.13**, **6.14** and **6.15** show the performance assessment of the existing and proposed sewerage system under SIA Condition.

Checking of the Hydraulic Model

6.4.19 In order to verify the accuracy of the hydraulic performance assessment, a comparison on the planning parameters and model results of the hydraulic model between this study and a previous similar study, Feasibility Study for Intensification and Extension of the TKO New Town has been carried out. A Technical Note on the comparison of which a copy is attached in Appendix 6.6, has been prepared and submitted to EPD. The comparison reveals that there is a good agreement in the hydraulic model results from the two studies and demonstrated that the hydraulic model under this Study has achieved an acceptable level of accuracy.

6.4.20 As mentioned earlier, the hydraulic model constructed was based on DSD's drainage record obtained in 2002. It was realized that there are differences in invert levels of node nos. 10_69, 2_48 and 2_63 between the hydraulic model input data and DSD's drainage records (2003 version):

Nodes	2002	2003
2_48	5.10	5.11
2_63	2.75	2.76
10_69	-1.657	-1.71

It is noted that the difference in drainage record is relatively minor and would not result in changes to the findings of assessment and would not vary the extent of the surcharged sewers under both Peak and 1.15x Peak conditions and hence variation to the extent of the recommended sewerage upgrading works would not be resulted. Nevertheless, the latest situation including the population figures and pipe asset data should be taken into account in the detailed design stage of the recommended upgrading works.

TKO Preliminary Treatment Works

6.4.21 The capacity of the TKO PTW is 5.55 m^3/s after completion of the upgrading works in 1996. The total ultimate catchment flow under the baseline condition (based on current OZP) is estimated to be 4.58 m^3/s. It is concluded that the TKO PTW has adequate capacity to cater for the total flows generated by the TKO sewerage catchment in ultimate scenario.

6.4.22 The total flows arriving at the TKO PTW, with the proposed further development at TCS, TKL and PSK, are projected to be 4.47m^3/s, which is less than that of Baseline Condition. Therefore, TKO PTW is capable of handling the projected ultimate flows (c.f. capacity = 5.5m^3/s).

HATS Stage I Tunnel Section from Tseung Kwan O to Kwun Tong

6.4.23 The current assessment of the HATS Stage I Tunnel section from TKO to Kwun Tong is based on a design capacity of 4.89 m^3/s in accordance with the Final Report of the SSDS Stage III/IV and PPFS. It is understood from the Final Report of HATS EEFS that there is no capacity constraint of the HATS Stage I Tunnel System.

6.4.24 The hydraulic adequacy of the HATS Stage I Tunnel section from TKO to Kwun Tong was assessed on the basis of the projected sewage flows arriving at the TKO PTW. It is understood that under normal conditions, the treated effluent from the PTW will be discharged to the tunnels for transfer to Kwun Tong en route to SCI STW for further treatment followed by final disposal to sea.

6.4.25 The peak flow capacity of the tunnel between TKO PTW and Kwun Tong Sewage Pumping Station (SPS) is 4.89 m^3/s. The system capacity has already been confirmed by the EEFS to be adequate. This would also be adequate to convey the projected treated effluent from TKO PTW in ultimate scenario of 4.58 m^3/s under Baseline Condition.

6.4.26 The estimated flows under SIA Condition are less than that under the Baseline Condition, it is therefore concluded that no further impacts to the overall performance of the HATS Stage I Tunnel System would be anticipated under SIA Condition.

6.5 Recommended works

Scope of Works

6.5.1 There are new sewerage systems proposed for the further development at TCS and PSK. The total length of the proposed new 600mm and 300mm sewers are 1,203m and 1,081m at TCS and PSK respectively. The proposed sewerage works for TCS and PSK will be covered by the infrastructure provision by CEDD under the TCS (between 10/2007 and 11/2009) and PSK (between 9/2008 and 7/2010) construction packages.

6.5.2 The SIA of Section 6.4 has identified sewers measuring a total length of 690m in the existing and committed sewerage systems which would be subjected to surcharge or suffering from adverse gradients under peak flow condition.

6.5.3 In accordance with the finding from hydraulic model, two sections (links ref. 4_33.1, V20_20.1 and V220_100.1) of the sewers with adverse gradient (as shown in Table 6.15) are found to be surcharged. We would recommend to upgrade these three sections of sewers, to rectify the surcharge problems.

6.5.4 For the sewer sections with links ref. 18_39.1, 10_72.1, 30_36.1 and 30_42.1 presented in Table 6.15, the problem is relatively minor without any surcharge revealed from the hydraulic model. It should also be noted that upgrading of these sections of sewers will require lowering of the invert levels of the downstream sewerage networks in order to cope with the upgrading works. Therefore, having taken the cost-effectiveness of the works into consideration, it is not recommended to upgrade these adverse gradient sewers without surcharge problem. Instead, conditions of these sewers should be monitored by DSD during their routine maintenance works. Should the conditions become worse, the sewers could be rectified by DSD in future.

6.5.5 Based on the findings, there should be no major hydraulic problem in the sewerage network and treatment works. Urgent rectification work or interim measure is not required. However, it is recommended to upgrade relevant sections of the sewers to relieve the projected hydraulic bottlenecks and those pipes with adverse gradients in the sewerage systems in future. The recommended sewerage improvement works has a total length of 1,563m and are shown in **Figures 6.16, 6.17, 6.18** and listed in **Appendix 6.4**.

Table 6.18 Summary of Recommended Sewerage Upgrading Works

Existing Pipe Size (mm)	Upgrading Pipe Size (mm)	Pipe Length (m)
450	600	599
525	700	354
525	900	96
600	900	193
675	900	305
1,050	1,500	16
	Total	**1,563**

Remark : By Implementation of the above upgrading works, the bottlenecked sewers will be removed and thus, there is no need to upgrade all the problematic sewers presented in Table 6.17.

6.5.6 The hydraulic modelling results of the sewerage network with the provision of recommended upgrading works are presented in Appendix 6.3. It should be noted that the predicted hydraulic performance of the upgraded network is satisfactory without sign of surcharge.

6.5.7 However, it should be noted that the available free boards in the surcharged manholes are all within the tolerable condition as stated in Section 5.1.1 of Sewerage Manual Part 1. There should be no urgency in the implementation of the above upgrading works. It is suggested that such upgrading works could be carried out when opportunity arises, e.g. in conjunction with road works and/or nearby sewerage projects. As new road works and sewerage projects are not envisaged in these areas in the near future, these upgrading works are recommended to be carried out when such opportunity arises in the long term.

6.5.8 It should be noted that, during implementation of the upgrading works in future, adequate interim measures, such as temporary flow diversion, should be provided in order not to disrupt the operation of the sewerage system.

Cost Estimates

6.5.9 The total capital cost associated with the construction of new sewers at TCS and PSK is $12M whilst that for the recommended sewerage upgrading works is $9M. Appendix 6.5 shows the details of the capital cost estimates for the recommended works.

6.6 Summary

6.6.1 The performance of the existing and committed sewerage infrastructure under full development condition for the ultimate scenario was assessed and formed the Baseline Condition. The development projections for 2016 studied is reflective of the approved OZP condition.

6.6.2 The SIA Condition takes into account of the recommended development proposal for TKO sewerage catchment which involves TCS, TKL and PSK.

6.6.3 The adopted unit flow factors are generally based on the recommendations of the Sewerage Manual Part 1 (DSD, 1995) and are in line with the EEFS. The total flows generated by the TKO sewerage catchment are estimated to be 165,515m^3/d and 161,510m^3/d for Baseline and SIA Conditions respectively.

6.6.4 The recommended peaking factors are based on the Sewerage Manual. The estimated peak flow is 4.58m^3/s for Baseline Condition whilst peak flow of 4.47m^3/s is estimated under SIA Condition. These peak flows are used in the hydraulic assessment of the existing and committed sewerage systems, TKO PTW and the HATS Stage I Tunnel section from TKO to Kwun Tong.

6.6.5 The performance assessment results have identified surcharged sewers measuring a total length of 690m with diameters ranging from 450mm to 1,050mm under the SIA peak flow condition. Under 1.15 times of the SIA peak flow condition, the total length of surcharged sewers is 1,780m with a similar range of pipe sizes. The analyses indicated that there are no risks of overflow under the various flow conditions as the available freeboards exceed 1m. Works to improve these surcharged sewers are not accorded as top priority in accordance with the Sewerage Manual. In addition, some 302m of sewers were identified with adverse gradients.

6.6.6 Whilst there is an overall reduction in population and flows as a consequence of the reduction of development density in further development in TCS, TKL and PSK within TKO catchment, it is noted that there are local increases of population and flows in Planning Area 66, 68 and 78. The performance assessment results showed that these local effects did not cause any additional adverse impacts on the sewerage system.

6.6.7 The TKO PTW was assessed to be adequate to convey the total ultimate catchment flows under both Baseline and SIA Conditions under this Study. In accordance with the EEFS Final Report, the HATS Stage I Tunnel section from TKO to Kwun Tong was assessed to be adequate to handle the projected flows under both Baseline and SIA Conditions.

6.6.8 According to the sewerage records and the proposed works in TKO catchment, there were no existing or planned sewerage systems to serve the developments at Planning Area 65B, 68 and Pak Shing Kok. New sewers of 300mm and 600mm diameter with total lengths of approximately 1,203m and 1,081m are proposed to connect these areas to the existing sewerage system. The cost for the proposed new sewers is about $12M.

6.6.9 Sewerage improvement works to the existing and committed sewerage infrastructure were recommended when opportunity arises, e.g. in conjunction with road works and/or nearby sewerage projects, in future. It is proposed to upgrade the existing sewers with pipes of diameters ranging from 450mm to 1,050mm in order to relieve the identified hydraulic inadequacies and surcharged condition. The capital cost for the upgrading works is about $9M. The proposed upgrading works are tabulated in **Table 6.19** below:

Table 6.19 Summary of Recommended Sewerage Upgrading Works

Existing Pipe Size (mm)	Upgrading Pipe Size (mm)	Pipe Length (m)
450	600	599
525	700	354
525	900	96
600	900	193
675	900	305
1,050	1,500	16
	Total	**1,563**

6.6.10 The Sewerage Master Plan for TKO is presented in **Figure 6.19** for reference.