Sewerage Impact Assessment for Proposed Residential Care Home for the Elderly (RCHE) Development at Tung Tsz, Tai Po

C241003W-01-D

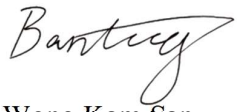
PREPARED FOR

R LEE Architects (HK) Ltd

PREPARED BY

Eddy Ng
BSc(Hons), MHKIOA, MIOA, MMOIA, MIET, MAES, MASHRAE, MHKIEIA, REnv, BEAM Pro

APPROVED BY



Wong Kam San
MSc, CEng, MIOA, MHKIOA, AFCHKRI, MHKIEIA, MHKIQEP

12 May 2025

Contents

1. Background

The applicant, R Lee Architect, intends to develop one 10-storey building block situated at Tung Tsz, Tai Po, New Territories for the Proposed Residential Care Home for the Elderly (RCHE) Development.

The purpose of this report is to conduct a Sewerage Impact Assessment (SIA) to assess the potential sewerage impact arising from the proposed development.

2. Objective

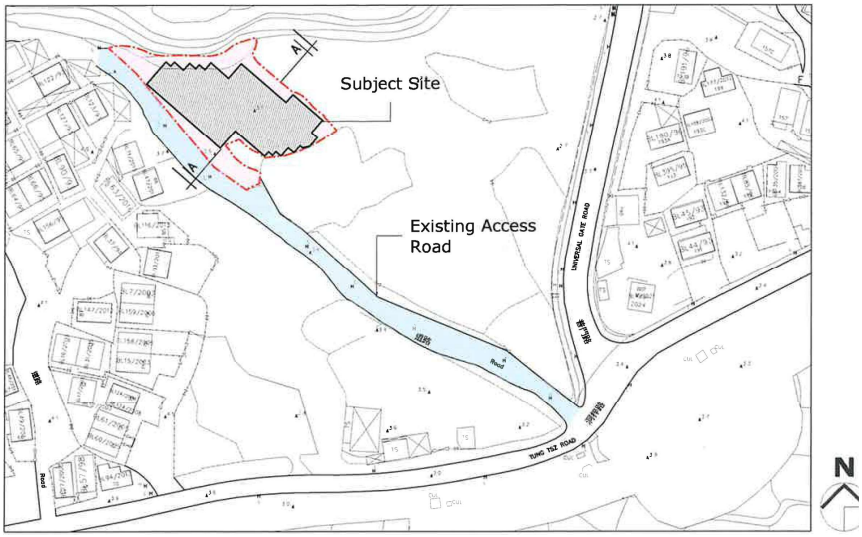
These SIA objectives are to assess the potential sewerage impact arising from the proposed development and recommend mitigation measures, if necessary, to alleviate the impacts.

3. Site Information

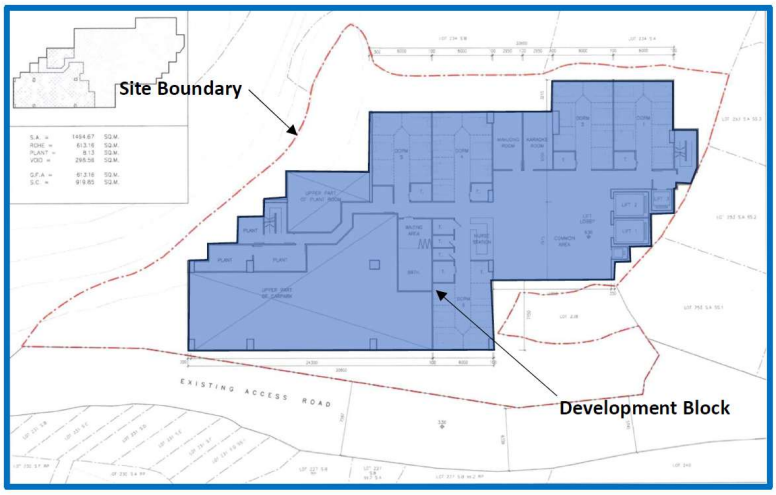
The Premise: D.D.23, Lot 232RP, 232 S.A. RP, 232 S.A.ss. 1 to 14, 232 S.B. RP, 232 S.B. ss 1 to 2, 232 S.C. to 232 S.E., 233 RP, 233 S.A to 233 S.M., 237 S.R. 238, 239 RP, 239 SG.

Address: Tung Tsz, Tai Po

Location Plan:



Development Plan:



Development Schedule: Proposed Residential Care Home for the Elderly (RCHE) Development

Site Area:	1,494.67m^2
Class of Site:	A
Proposed Plot Ratio for Non-domestic:	5.57 < 9.5
Proposed Site Coverage above for Non-domestic (Above 15m):	61.09% < 80%
Proposed Building Height:	34.50mPD
Absolute Height:	31.0m
Proposed No. of storey:	10 storeys

Proposed Gross Floor Area		
LG/F (ENTRANCE & CARPARK)	606.13 m^2	
UG/F (RCHE)	613.16 m^2	
1/F-5/F (RCHE)	916.89 m^2 x 5 storeys =4584.45 m^2	47 no. of beds x 5 storeys (including Isolation Room)
6/F (RCHE)	886.14 m^2	18 no. of beds
7/F (RCHE)	759.44 m^2	11 no. of beds
8/F (MANAGEMENT OFFICE)	764.44 m^2	12 no. of beds for Staff Quarter
R/F (SKY GARDEN)	110.07 m^2	
TOTAL	8323.83 m^2	276 no. of beds

4. Sewage Impact Assessment

4.1. Design Parameter and Assumptions

The sewage flow estimation, assessment and evaluation of impacts are based on the following established principals and guidelines of Hong Kong:

- EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning No.: EPD/TP 1/05 (GESF)
- Hong Kong Planning Standards and Guidelines (HKPSG)
- Drainage Services Department Sewerage Manual, Third Edition, May 2013

The estimate of sewage demands for the proposed development is based on the latest development parameter provided by the Architect.

4.2. Unit Flow Factors

To derive the unit flow factor for visitors, it is assumed that visitors will stay maximum 8 hrs per day within the development site. The sewage flow will be from two sources, one from flushing and the other from use of wash basin. The unit flow factors from flushing use, has assumed flushing water consumption of 0.1m^3/person/day for 16 hours of typical domestic residents, employees and students usage. The unit flow factor from the wash basin use has assumed a consumption of 0.03m^3/person/day on 8 hours daily basis. This results in UFF of 0.08m3/person/day.

According to the GESF, the unit flow factor (UFF) of the proposed RCHE development and the existing development is shown in **Table 1** below.

Table 1 – Unit Flow Factor (UFF) of the Proposed RCHE Development and the Existing Development

Type	UFF, Planning for Future (m^3/person/day)
Domestic	
Modern Village	0.27
Institutional and special class	0.19
Commercial	
J11 Community, Social & Personal Services	0.28
Visitor	0.08

4.3. Peaking Factors

The peaking factors to cater for seasonal/diurnal flow variations, and infiltration and inflow due to storm events are made reference to EPD's GESF and shown in **Table 2**.

Table 2 – 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
(a) For 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	$\text{Max}\left(\frac{7.3}{N^{0.15}}, 2.4\right)$	$\text{Max}\left(\frac{6}{N^{0.175}}, 1.6\right)$
(b) 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	$\text{Max}\left(\frac{3.9}{N^{0.065}}, 2.4\right)$	$\text{Max}\left(\frac{2.6}{N^{0.065}}, 1.6\right)$

Notes of Table T-5:

(1) N is the contributing population in thousands.

In this analysis, peaking factors (excluding stormwater allowance) is adopted since the proposed development area is well developed and there are essentially no misconnections and defects for infiltration.

4.4. Estimated Sewage Flow from the Proposed Development

With reference to the GESF, sewage flow estimation for the proposed development is provided in **Table 3**.

No. of Residents/Employees
a) No. of Residents = 276 beds (Adopted from latest engineering information)
b) No. of Employees = 120 Nos. (About 2 times as recommended by Code of Practice for Resident Care Home)
c) No. of Visitors = 79 Nos. per day (Assuming number of visits for each resident is twice a week: 276 x 2/7 = 79)

Table 3 – Estimation Sewage Generated by the Proposed Development

Site	Use	Global Unit Flow Factor (m^3/person/day)	No. of Residents/Employees	ADWF (m^3/day)
Tung Tsz, Tai Po	RCHE (Institutional and special class)	0.19	276 residents	52.44
	RCHE (J11, Community, Social & Personal Services)	0.28	120 staff	33.6
	Visitor	0.08	79 per day	6.32
Total			475	92.36

Sewer Pipe Design:
For sewer pipe, one quarter (1/4) full bore is used to allow space for a core of air in centre of the stack and the air keeps fluctuations to a minimum.

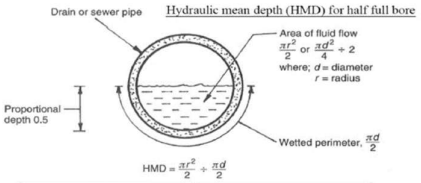
Minimum velocity of 0.7m/s (smaller than 300mm diameter) is used for maintaining self-cleansing purpose.

To facilitate inspection and cleaning, pipe should not be less than 200mm diameter.

Peak Flow = (ADWF) (P) = (92.36)(6) = 554.16 m^3/day or 0.00641m^3/s

1/4 full bore, velocity of 0.7m/s and 225mm pipe is used.

The capacity of the pipe:
Q = V x A = (0.7)(π)[$(0.225)^2$/4] x 0.25 = 0.00696m^3/s > 0.00641m^3/s, **OK**



Depth of flow	HMD
0.25	Pipe dia. (m) / 6.67
0.33	Pipe dia. (m) / 5.26
0.50	Pipe dia. (m) / 4.00
0.66	Pipe dia. (m) / 3.45
0.75	Pipe dia. (m) / 3.33
Full	Pipe dia. (m) / 4.00

69

Chezy"s formula: $V = C\sqrt{m \times i}$

where V = velocity of flow = 0.7m/s

m = hydraulic mean depth (HMD) → HMD = 0.225 / 6.67 = 0.0337

C = Chezy coefficient = $(0.0337)^{1/6}/(0.015(\text{concrete pipe}))$ = 37.89

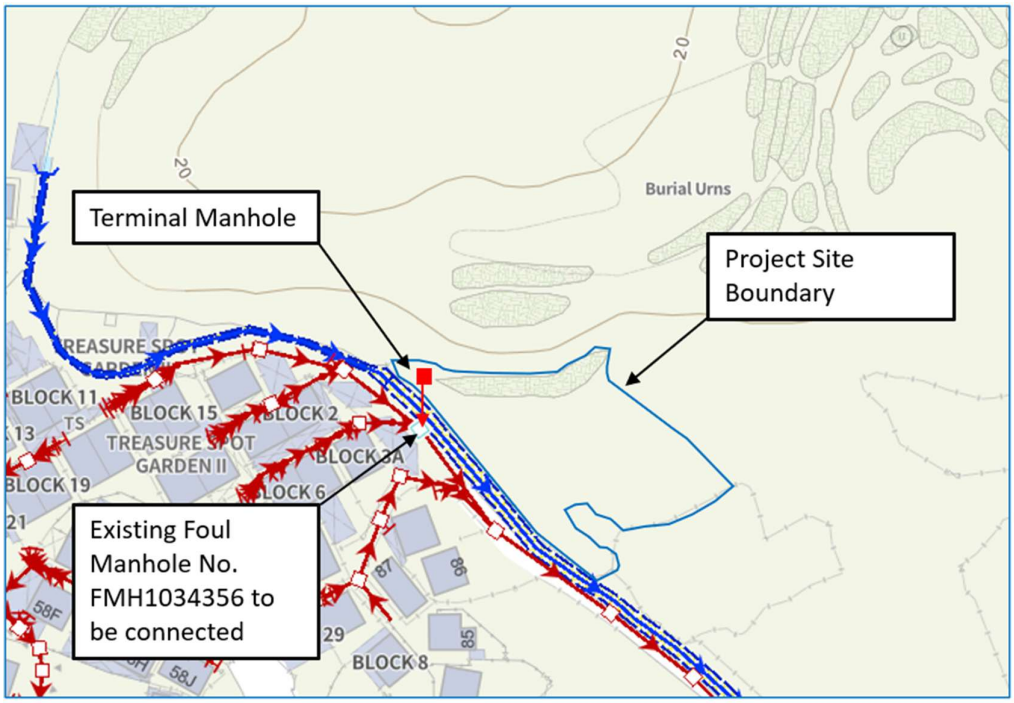
$0.7 = 37.89 \times (0.0337 \times i)^{0.5}$

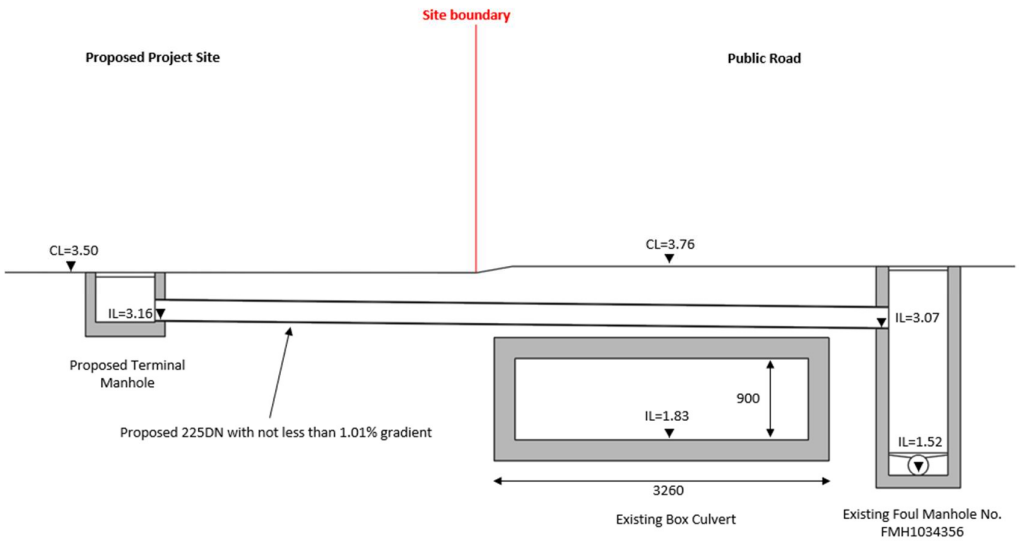
$(0.7/37.89)^2 = 0.0337 \times i$

Thus i = 0.0101 or **1.01%** (i = inclination)

4.5. Total Combined Sewage Flow

The foul water from the developing site will be discharged into the nearby existing Foul Manhole No. FMH1034356 (as shown below). The downstream invert level of the proposed DN225 sewer will be around 3.07mPD. The foul water will be transferred to the nearby TKRSPS No. 7 with an ADWF of about 7,800 m^3/day. The Project proponent shall be responsible for the construction and maintenance of the proposed sewerage drainage system.





Section 1-1

The tentative occupation year of the proposed development is 2030. However, projection of the tertiary planning units in 2030 is not available. Given that the projected population at Tai Po area in year 2027 is the highest among 2021 to 2031 according to the Common Spatial Data Infrastructure (CSDI), year 2027 is adopted for estimating the sewage impact of the proposed project. Sewage flow from the existing development with projection to year 2027 is estimated based on the Projections of Population Distribution 2023-2031 available on CSDI. Additional flow contributed by the proposed RCHE development has been incorporated into the existing sewerage system to investigate the cumulative impact. Detailed calculations of the estimated sewage flow contribution to TKRSPSNo.7 are given in **Appendix A**.

Sewage demands arising from existing demands and the proposed development have been estimated and are summarized in **Table 4** below. Detailed breakdown of population and sewage flow are presented in **Appendix A**.

Table 4 – Contribution of Existing and Planned Sewage Flow to TKRSPS No. 7 in 2027

	TPU Zone (Subunit)	Location	Projections of Population Distribution Year 2027	ADWF	
				Increment (m^3/day)	Cumulative (m^3/day)
Existing Sewerage Catchment	728 (35)	Tung Tsz Village	895	241.54	4340.28
	728 (8)	Treasure Spot Garden II	521	140.68	
	728 (38)	San Tau Kok	1132	305.68	
	728 (37)	Po Sam Pai	1506	406.54	
	728 (25)	Ting Kok Village	2831	764.45	
	728 (27)	Soka Gakkai Recreational Centre	638	178.61	
	728 (28)	Lo Tsz Tin	1517	409.64	
	728 (30)	Lung Mei, Wong Chuk Tsuen & Tai Mei Tuk	2849	769.11	
	728(7)	Treasure Spot Garden	1318	355.85	
	728(13)	Shuen Wan Chan Uk	1950	526.53	
	722(37)	Tung Tsz Shan Road Garden	895	241.54	
Planned Sewerage Catchment	728 (8)	Proposed RCHE	475	92.36	92.36
Total					4432.64

4.6. Potential Impact to Sewerage Facilities

Detailed hydraulic assessment on the existing sewerage pipeline systems are presented in **Appendix A**.

The total ADWF from the proposed development is estimated to be 92.36 m^3/day at year 2027. The combined sewage flow contribution to TKRSPS No. 7 is estimated to be 4432.64 m^3/day at year 2027. Given that the ADWF of TKRSPS No. 7 is 7800 m^3/day according to the Project Profile PP-560/2017 available from EPD website, the capacity of TKRSPS No. 7 is adequate to meet the demands within its service area at year 2030. According to the hydraulic calculations on the cumulative impact to the downstream sewerage system in **Appendix A**, the existing sewerage system is adequate to handle the additional sewage flow generated from the proposed development. As such, the increased sewage flow from the proposed development will have no adverse impact to the existing sewerage system.

5. Conclusion:

The total estimated ADWF from the proposed development is 92.36 m^3/day. The combined sewage flow from all existing and proposed development to the TKRSPS No. 7 is estimated to be 4432.64 m^3/day at year 2027. The design capacity of the TKRSPS No. 7 is 7800 m^3/day which is adequate to meet demands within its service area and able to cater for the additional sewage flow from the proposed development. The estimated cumulative flows from the existing and proposed development are well below the sewerage system design capacity.

As such, the increase sewage flow from the proposed development will have no adverse impact on Tolo Harbour Water Control Zone.

Appendix A
Hydraulic Calculations

Appendix A1 - Projections of Population Distribution of the Assessment Area (Year 2023-2031)

	Population [1]						
TPU Zone	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
711, 712, 721 & 728	18300	17700	18200	19600	19400	18900	18700

Population Estimation of Specific Location in the TPU Zone					**2027**
TPU Zone (Subunit) [2]	**No.**	**Location**	**OZP Zone**	**Approx. Site Area (m2)**	**Population**
728 (35)	1	Tung Tsz Village	V	46700	895
728 (8)	2	Treasure Spot Garden II	V	27200	521
728 (38)	3	San Tau Kok	V	59100	1132
728 (37)	4	Po Sam Pai	V	78600	1506
728 (25)	5	Ting Kok Village	V	147800	2831
728 (27)	6	Soka Gakkai Recreational Centre	G/IC	33300	638
728 (28)	7	Lo Tsz Tin	V	79200	1517
728 (30)	8	Lung Mei, Wong Chuk Tsuen & Tai Mei Tuk	V	148700	2849
728(7)	9	Treasure Spot Garden	V	68800	1318
728(13)	10	Shuen Wan Chan Uk	V	101800	1950
728(14)	11	The Beverly Hills	n.a.	106500	2040
728(16)	12	Sam Mun Tsai Village	R(D)	50600	969
711 (3)	13	Wu Kau Tang	V	27880	534
			Total	976180	18700

Notes:

[1] Population data are extracted from CSDI Projections of Population Distribution 2023-2031_TPU

[2] TPU Zone No. is extracted from CSDI TPUSU_2021_Layer

Sewerage system of The Beverly Hills, Sam Mun Tsai Village and Wu kau Tang is not connected to TKRSPS No.7

Appendix A2 - Unit Flow Factor of Different Types of Flow

Type	Planning For Future (m3/person/day) [1]
Domestic	
Modern Village [1]	0.27
Institutional and special class [1]	0.19
Commercial	
J11 Community, Social & Personal Services [1]	0.28
Visitor [2]	0.08

Notes:
[1] Unit Flow Factors are extracted from EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05
[2] Unit Flow Factors are calculated based on assumption. Please refer to Section 4.2 for detailed assumption.

Appendix A3 - Existing and Planned Sewage Flow Contributing to TKRSPS No. 7 in 2027

	TPU Zone (Subunit) [1]	No.	Location	OZP Zone	Type of Flow	Projections of Population Distribution Year 2027 [2][3][4]	ADWF			
							Increment (m3/day)	Cumulative (m3/day)		
Existing Sewerage Catchment	728 (35)	1	Tung Tsz Village	V	Modern Village	895	241.54	4340.28		
	728 (8)	2	Treasure Spot Garden II	V	Modern Village	521	140.68			
	728 (38)	3	San Tau Kok	V	Modern Village	1132	305.68			
	728 (37)	4	Po Sam Pai	V	Modern Village	1506	406.54			
	728 (25)	5	Ting Kok Village	V	Modern Village	2831	764.45			
	728 (27)	6	Soka Gakkai Recreational Centre	G/IC	J11 Community, Social & Personal Services	638	178.61			
	728 (28)	7	Lo Tsz Tin	V	Modern Village	1517	409.64			
	728 (30)	8	Lung Mei, Wong Chuk Tsuen & Tai Mei Tuk	V	Modern Village	2849	769.11			
	728(7)	9	Treasure Spot Garden	V	Modern Village	1318	355.85			
	728(13)	10	Shuen Wan Chan Uk	V	Modern Village	1950	526.53			
	722(37)	-	Tung Tsz Shan Road Garden	V	Modern Village	895	241.65			
Planned Sewerage Catchment	728 (8)	-	Proposed RCHE	G/IC	Institutional and special class	276	52.44	92.36		
					J11 Community, Social & Personal Services	120	33.6			
					Visitor	79	6.32		ADWF of TKRSPS No. 7 (m3/day) [5]	Adequate Capacity
Total						16447	4432.64		7800	Yes

Notes:
[1] TPU Zone No. Refer to CSDI TPUSU_2021_Layer.
[2] Population data are estimated from CSDI Projections of Population Distribution 2023-2031_TPU.
[3] Consider that the scale and characteristic of Tung Tsz Shan Road Garden is similar to Tung Tsz Village, population figure of Tung Tsz Village is adopted for estimating the population of Tung Tsz Shan Road Garden as conservative approach.
[4] No of visitors of the proposed RCHE is estimated by assuming each resident will be visited twice a week.
[5] ADWF of TKRSPS No. 7 is captured from Project Profile PP-560/2017 available from EPD website.
Sewerage system of Treasure Spot Garden and Shuen Wan Chan Uk is not affected by the proposed development as no interchange in between before entering TKRSPS. No.7

Appendix A4 - Capacity Performance of Existing and Proposed Sewers in 2027

$$V = -2\sqrt{2gdS}\log\left(\frac{k}{3.7d} + \frac{2.51\nu}{d\sqrt{2gdS}}\right)$$

Where k is equivalent roughness with value equals 1.5mm for existing sewers
v is kinematic viscosity of fluid =1.14x10^-6 m2/s and g is the gravity=9.81 m/s2,
V is velocity, d is the diameter of the sewer and S is the gradient of the sewer

Table A4-1 Impact Assessment of the Proposed Sewers to the Existing Sewers along Access Road near Treasure Spot Garden II

Manhole [1]		ADWF (m3/d)	Accumulated ADWF (m3/d)	Contributing Population	Peaking Factor [3]	Peak Flow (m3/d)	Peak Flow (L/s)	Pipe Parameter [1]					Velocity (m/s) [2]	Capacity (L/s)	Peak Flow/Capacity (%)	Adequate Capacity
Upstream Manhole No.	Downstream Manhole No.							Diameter (mm)	Length (m)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Gradient (S), m/m				
FMH1034356	FMH1034301	233.04	233.04	996	6	1398.26	16.18	225.00	175.09	1.50	0.10	0.0079	1.02	40.63	40%	YES

Notes:
[1] Manhole No. and pipe information are extracted from geoinfo map
[2] Velocity is calculated by Colebrook-White Equation given in Appendix A4
[3] Peaking Factor can refer to Table T-5 of EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05
[3] Although the assessed sewerage system only serves less than a half buildings of Treasure Spot Garden II, the total ADWF and population is adopted for conservative approach.

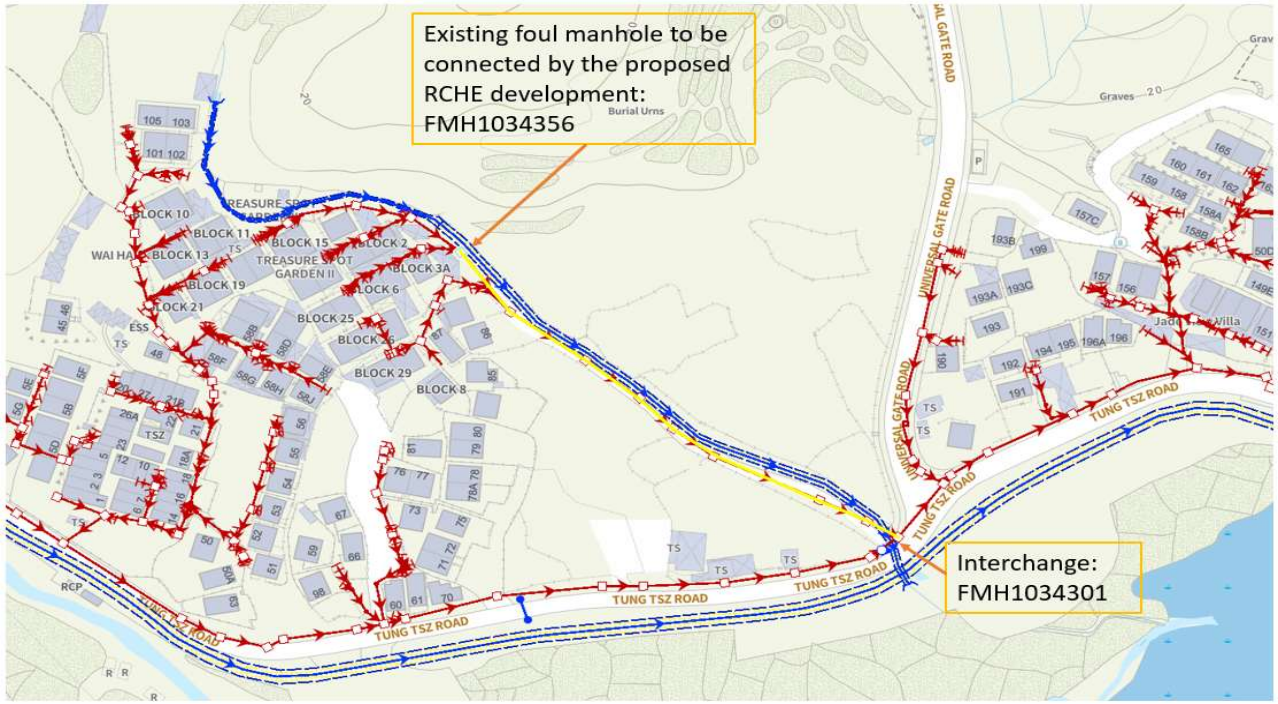


Table A4-2 Cumulative Impact Assessment of the Proposed Sewers to the Existing Sewers along Tung Tsz Road (Before Rising Main)

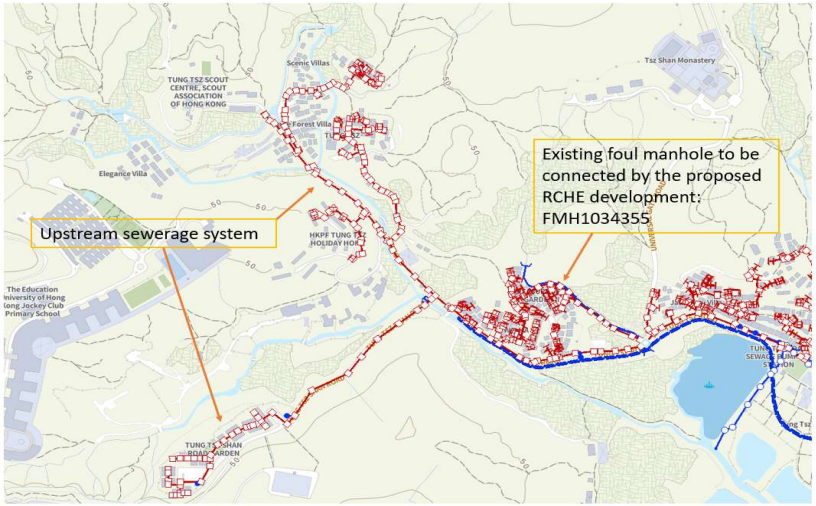
Manhole [1]		ADWF (m3/d)	Accumulated ADWF (m3/d)	Contributing Population	Peaking Factor [3]	Peak Flow (m3/d)	Peak Flow (L/s)	Pipe Parameter [1]					Velocity (m/s) [2]	Capacity (L/s)	Peak Flow/Capacity (%)	Adequate Capacity
Upstream Manhole No.	Downstream Manhole No.							Diameter (mm)	Length (m)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Gradient (S), m/m				
FMH1034301	FMH1034312	305.68	1021.91	2786	5	5109.56	59.14	375.00	281.67	0.09	-1.42	0.0054	1.17	129.42	46%	YES

Notes:

[1] Manhole No. and pipe information are extracted from geoinfo map

[2] Velocity is calculated by Colebrook-White Equation given in Appendix A4

[3] Peaking Factor can refer to Table T-5 of EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05



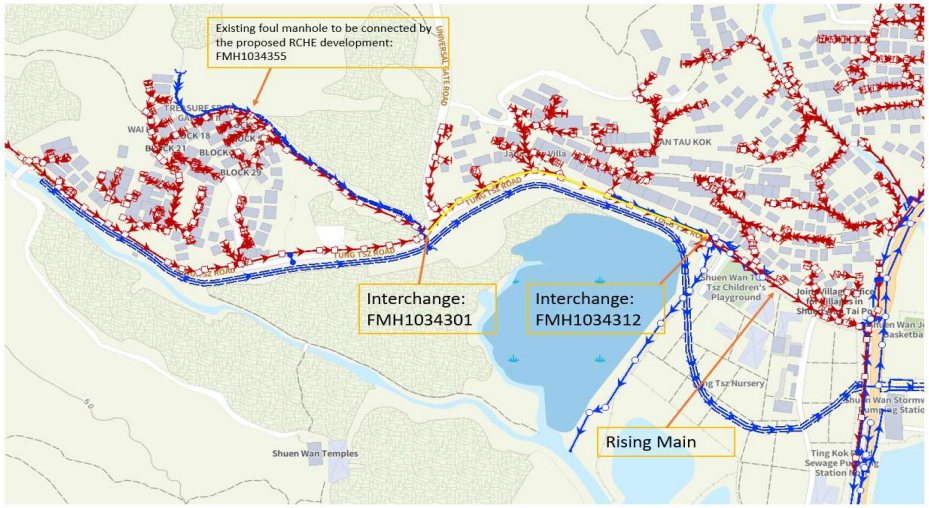
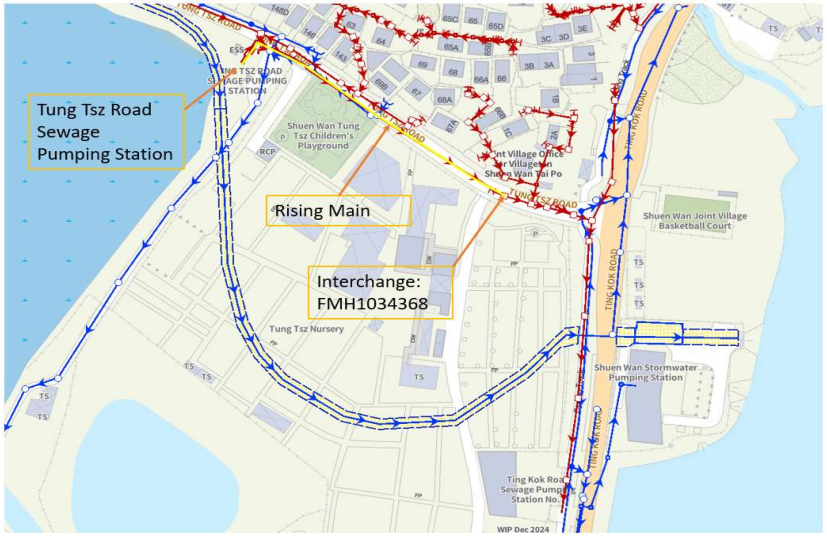


Table A4-3 Cumulative Impact Assessment of the Proposed Sewers to the Existing Sewers along Tung Tsz Road (Rising Main)

Manhole [1]		ADWF (m3/d)	Accumulated ADWF (m3/d)	Contributing Population	Peaking Factor [3]	Peak Flow (m3/d)	Peak Flow (L/s)	Pipe Parameter [1]					Velocity (m/s) [2]	Capacity (L/s)	Peak Flow/Capacity (%)	Adequate Capacity
Upstream Manhole No.	Downstream Manhole No.							Diameter (mm)	Length (m)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Gradient (S), m/m				
Tung Tsz Road Sewage Pumping Station	FMH1034368	0.00	1021.91	2786	5	5109.56	59.14	200.00	137.30	1.31	2.68	-0.0100	2.00	62.83	94%	YES

Notes:
[1] Manhole No. and pipe information are extracted from geoinfo map
[2] With reference to Sewerage Manual - Pumping Stations and Rising Mains published by DSD, the desirable range of velocity of rising mains would be 1 to 2 m/s with a maximum velocity of 3 m/s.
[3] Peaking Factor can refer to Table T-5 of EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05



7. RISING MAINS DESIGN

7.1 HYDRAULIC DESIGN

7.1.1 Steady State Hydraulics

The hydraulic design of rising mains involves the sizing of the mains and its number to meet the pump operational and the velocity requirements. As for the pump operational requirements, please refer to the system head capacity curve in Chapter 3.

The selection of a suitable size for the rising mains should be based on economic analysis of capital cost and recurrent cost of the pumping system including the power cost. Trial and error approach should be adopted in order to arrive at optimal solution while maintaining the velocity within acceptable limits. The maximum velocity should not exceed 3 m/s which are usually governed by the concerns for the power cost. The desirable range of velocity should be 1 m/s to 2 m/s with due consideration given to the various combinations of number of duty pumps in operation.

Table A4-4 Cumulative Impact Assessment of the Proposed Sewers to the Existing Sewers along Tung Tsz Road (After Rising Main)

Manhole [1]		ADWF (m3/d)	Accumulated ADWF (m3/d)	Contributing Population	Peaking Factor [3]	Peak Flow (m3/d)	Peak Flow (L/s)	Pipe Parameter [1]					Velocity (m/s) [2]	Capacity (L/s)	Peak Flow/Capacity (%)	Adequate Capacity
Upstream Manhole No.	Downstream Manhole No.							Diameter (mm)	Length (m)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Gradient (S), m/m				
FMH1034368	FMH1023880	0.00	1021.91	2786	5	5109.56	59.14	300.00	40.03	2.51	1.73	0.0194	1.93	136.68	43%	YES

Notes:

[1] Manhole No. and pipe information are extracted from geoinfo map

[2] Velocity is calculated by Colebrook-White Equation given in Appendix A4

[3] Peaking Factor can refer to Table T-5 of EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05

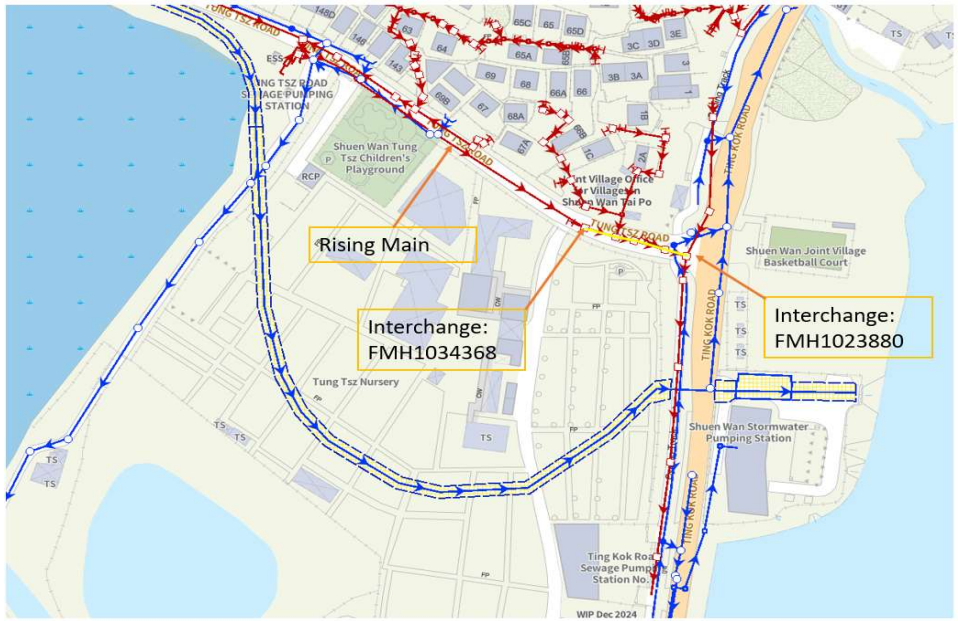


Table A4-5 Cumulative Impact Assessment of the Proposed Sewers to the Existing Sewers along Ting Kok Road

Manhole [1]		ADWF (m3/d)	Accumulated ADWF (m3/d)	Contributing Population	Peaking Factor [3]	Peak Flow (m3/d)	Peak Flow (L/s)	Pipe Parameter [1]					Velocity (m/s) [2]	Capacity (L/s)	Peak Flow/Capacity (%)	Adequate Capacity
Upstream Manhole No.	Downstream Manhole No.							Diameter (mm)	Length (m)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Gradient (S), m/m				
FMH1023880	TKRSPS No.7	2528.34	3550.26	13179	3	10650.77	123.27	600.00	141.87	1.73	1.29	0.0031	1.21	340.85	36%	YES

Notes:

[1] Manhole No. and pipe information are extracted from geoinfo map

[2] Velocity is calculated by Colebrook-White Equation given in Appendix A4

[3] Peaking Factor can refer to Table T-5 of EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05