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Proposed Minor Relaxation of Plot Ratio Restriction for Permitted Flat and Proposed Shop and Services Uses at Lots 4614 and 4615 RP in D.D. 116, Lots 1753 S.B ss.3 (Part), 1753 S.B RP (Part), 1756 S.A (Part), 1756 RP (Part), 1757, 1758 RP and 1760 RP in D.D. 120, and Adjoining Government Land, Tai Kei Leng, Yuen Long, New Territories

Sewerage Impact Assessment (Revision A)

August 2023

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Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
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Contents

1 Introduction

1.1 Background

1.1.1 Mott MacDonald Hong Kong Limited (hereinafter as "MMHK") was commissioned by the Applicant to prepare a Sewerage Impact Assessment (SIA) in support of the proposed minor relaxation of statutory planning control of plot rate of PR3.5 up to PR4.287 for additional residential development and small retail service application abutting Tai Tong Road and Tai Shu Ha Road East, Yuen Long. The location of the development is shown in **Appendix A.**

1.1.2 This report will demonstrate that the additional flats of 55 together with the planned residential development is feasible in terms of its impact on the sewerage system.

1.2 Key Development Parameters

1.2.1 The location and layout of the proposed development is provided in **Appendices A** and **B** and the Development data is given in **Table 1.1** and **Table 1.2** below:-

Table 1.1: Data of the Proposed Residential Development

Items	Details
Area	Approximately 2,540 m^2
Proposed Domestic GFA	10,668 m^2
Proposed Plot Ratio	4.287 (minor relaxation of DPR0.6 and NDPR0.087above permitted 3.5)
No. of Blocks	1
Nos. of Units	Approximately 345 (including 55 additional flats)

Table 1.2: Data of the Proposed Retail Building

Items	Details
Area	Approximately 220 m^2
No. of Blocks	1
No. of storey	1

1.3 Objectives of Report

1.3.1 This SIA report aims to identify the existing and planned sewerage systems in vicinity of the proposed development, to assess the sewerage impacts arising from the proposed development and to identify the required sewerage works, if required, to support the development.

1.4 Structure of the Report

1.4.1 This SIA report contains the following sections in addition to this introduction (Section 1):-

Section 2 – Methodology and Design Parameters for Sewerage Impact Assessment

Covers the approach of the SIA and the parameters used in the assessment.

Section 3 – Existing Sewerage and Estimation of Sewage Flow for the Existing Condition

Discuss the sewage flow under the existing condition and the existing sewerage system.

Section 4 – Estimation of Sewage Flow for the Proposed Development

Discuss the sewage flow generated from the Development.

Section 5 – Sewerage Impact Assessment and Sewage Discharge Arrangement

Discuss the sewerage impact arising from the Development and the potential sewage disposal option for the Development.

Section 6 – Conclusion

Summarise the findings and conclude the sewerage impact arising from the Development.

2 Methodology and Design Parameters for Sewerage Impact Assessment

2.1 General Approach

2.1.1 The SIA is carried out to identify and assess if there are any potential adverse sewerage impacts arising from the proposed development.

2.2 Methodology

Assessment Approach

2.2.1 The following approach and methodology have been adopted in this sewerage impact assessment:-

- Carry out desktop study to collect the relevant information for the assessment. Relevant information for the assessment collected included drainage record plans from Drainage Services Department (DSD) and information as listed in Section 2.2.3;
- Estimate the sewage flow generated from the existing site and the proposed development; and
- Assess the sewerage impacts arising from the proposed development and formulate option to mitigate the sewerage impacts identified. Sewage disposal arrangement for the proposed development will also be proposed.

2.2.2 For the existing and proposed sewerage in vicinity of the proposed development, Colebrook-White equation has been used to assess the hydraulic conditions of the sewerage network.

Design Standards, Guidelines and Reference

2.2.3 The sewage flow generated from the proposed development is estimated based on the following standards, guidelines and references for the sewerage design:-

- Sewerage Manual published by Drainage Services Department (DSD);
- Guidelines for Estimating Sewage Flows (GESF) for Sewerage Infrastructure published by Environmental Protection Department (EPD); and
- Commercial and Industrial Floor Space Utilisation Survey conducted by Planning Department (PlanD).

2.3 Design Parameters and Assumptions

Unit Flow Factors

2.3.1 The category of the components of the Unit Flow Factors adopted in the assessment are indicated in **Table 2.1**.

Table 2.1: Unit Flow Factors

Scenario	Category / Use	Unit	Unit Flow Factor	
For existing developments and proposed development	Domestic Flow for Private Housing (R2)	m^3/d per resident	0.27	(i)
	J4 Wholesale & Retail	m^3/d per employee	0.28	(ii)
	J11 Community, Social & Personal Services	m^3/d per employee	0.28	(iii)

Remark:-

(i) According to the Guidelines for Estimating Sewage Flows (GESF) issued by EPD, unit flow factor for private housing unit (R2) are 0.27 m^3/d.
(ii) According to the Guidelines for Estimating Sewage Flows (GESF) issued by EPD, unit flow factor for Wholesale & Retail (J4) is 0.28 m^3/h/d.
(iii) According to the Guidelines for Estimating Sewage Flows (GESF) issued by EPD, unit flow factor for Community, Social & Personal Services (J11) is 0.28 m^3/h/d.

Catchment Inflow Factors

2.3.2 The Catchment Inflow Factors (P_{CIF}) cater for the net overall ingress of water or wastewater to the sewerage system. They are catchment-dependent and applicable to major sewerage facilities of a catchment. It is not applicable to new catchments which have no connection from existing sewerage system which are deemed to be free from misconnections and pipe defects. Therefore, the PCIF is not applicable in estimating the total flows from the new development project.

2.3.3 With reference to EPD Technical Paper - Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning (GESF) - Table T-4, for the existing sewerage system in Yuen Long, the P_{CIF} of 1.0 for catchments will be adopted.

Peaking Factors

2.3.4 Peaking factors cater for seasonal / diurnal fluctuation and normal amount of infiltration and inflow. The peaking factors shall be in accordance with Table T-5 of the GESF and are shown in **Table 2.2**.

Table 2.2: 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) 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 ($6/N^{0.0175}$, 1.6)
(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	Max ($3.9/N^{0.065}$, 2.4)	Max ($2.6/N^{0.065}$, 1.6)

Note:

N = Contributing population in thousands

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

2.3.5 Peaking factors (excluding stormwater allowance) are applicable to planning sewerage facilities flow from new upstream sewerage systems which essentially have no misconnections and defects for infiltration. Thus, peaking factor excluding stormwater allowance has been used for the proposed sewers. For existing sewers, peaking factor including stormwater allowance has been adopted.

Roughness

2.3.6 For the proposed sewerage network, polyethylene pipe will be used. A roughness value of 1.5 mm, similar to uPVC material pipe under poor slimed condition in accordance with Sewerage Manual – Table 5, has been adopted for polyethylene pipe. For existing clayware sewer, a roughness value of 3mm for slimed sewer in poor condition has been adopted.

2.4 Planned Population and Employee Data of the Proposed Development

2.4.1 The development parameters and design population of the proposed development are shown in **Table 2.3** and **Table 2.4** below. The layout plan of the proposed development could be referred to **Appendix A1**.

Table 2.3: Design Parameters for the Proposed Development

Development Parameters	
Site Area (m^2)	About 2,540
Proposed Domestic Plot Ratio	4.2
Proposed No. of Units	About 345
Estimated Population (i)	966
Non-Domestic Facilities (m^2)	About 220 (Retail)

Remarks:

(i) The population is estimated with the average number of occupants, 2.8 occupants per unit for Yuen Long according to 2021 Population Census.

Table 2.4: Estimated Employee Number and Serving Population for the Development

Type	Category / Use	Population / No. of Staff
Proposed Residential Development		
Residential	R2	966
Residential - Employee	J11	18 (i) (ii)
Proposed Retail Building		
Retail - Employee	J4	8 (iii)

Remarks:-

(i) It is assumed there would be 2 security guards and 2 managing staffs for housing block.

(ii) For the club house, it is assumed there would be 3.3 workers per GFA (in 100 m^2) for Community, Social & Personal Services according to Figure 9: Worker Density by Industry Group of "Commercial and Industrial Floor Space Utilization Survey" published by Plannings Department.

(iii) It is assumed there would be 3.5 workers per GFA (in 100 m^2) for Retail Trade according to Figure 9: Worker Density by Industry Group of "Commercial and Industrial Floor Space Utilization Survey" published by Plannings Department.

3 Existing Sewerage and Estimation of Sewage Flow for the Existing Condition

3.1 Existing Sewerage System

3.1.1 There is no existing public sewerage system serving the Site. Based on sewerage record from DSD, there is a 200mm to 450mm diameter sewage pipeline located along Tai Tong Road (ID: FWD1042941, FWD1043890 and FWD1043891) at the north of the proposed site. The existing sewage pipeline along Tai Tong Road collects sewage from The Brand (via Existing Manhole FMH1035400) and joins with another set of 200mm to 300mm diameter sewage pipeline along Shap Pat Heung Road at existing manhole FMH1036051. The sewage collected by two sets of sewage pipeline along Tai Tong Road and along Shap Pat Heung Road will be discharged to 750mm diameter sewers along Shap Pat Heung Road via a 300mm diameter sewer (ID: FWD1043910) and a 450mm diameter sewer (ID: FWD1043909).

3.1.2 According to drawings from Building Department, there is a sewage treatment plant within Sereno Verde to handle and treat the sewage generated from Sereno Verde. The treated effluent from Sereno Verde is then discharged to the existing channel next to Tai Shu Ha Road East. It is also observed that the sewage generated from Reach Summit is discharged to existing manhole FMH1064703 for discharge based on drawings from Building Department.

3.1.3 The existing sewerage system near to the proposed development is shown in **Appendix B**. The catchments of existing sewerage system are presented in **Appendix B1**.

3.2 Estimated Sewage Flow from the Existing Site Area

3.2.1 At present, the site area is a paved car park with no sewerage facilities. Thus, no sewage flow generation is expected under existing condition within the site area.

4 Estimation of Sewage Flow for the Proposed Development

4.1 Estimated Sewage Flow for the Proposed Development

4.1.1 Based on the Development parameters and sewage unit flow factors as mentioned in Section 2, the estimated Average Dry Weather Flow (ADWF) for the proposed development with associated facilities is approximately 268.1 m^3/day. Details of the sewage flow estimation are given in **Table 4.1** below.

Table 4.1: Sewage Flow Estimation for Proposed Development

Type	Population / No. of Staff (nos.)	Unit Flow Factor (m^3/h/d)	Average Dry Weather Flow (m^3/d)
Proposed Residential Development			
Residential (R2)	966	0.27	260.82
Residential - Employee (J11)	18	0.28	5.04
		Sub-total =	265.86
Proposed Retail Building			
Retail - Employee (J4)	8	0.28	2.24
		Sub-total =	2.24
		Total =	268.10

5 Sewerage Impact Assessment and Sewage Discharge Arrangement

5.1 Sewage Discharge Arrangement

5.1.1 As discussed in Section 3, there is a 200mm to 450mm diameter sewage pipeline located along Tai Tong Road at the north of the proposed site.

5.1.2 Also, as mentioned in Section 4, the ADWF generated from the proposed development is 268.1 m^3/d. The sewage generated from the proposed residential development is proposed to be discharged to the proposed manhole FMH-01 and the sewage generated from the retail building will be discharged to the proposed manhole FMH-02.

5.1.3 For conveying the sewage flow from the Development to the existing manhole FMH1035400, new polyethylene sewers of 300 mm diameter are proposed to collect sewage from the proposed development to the existing manhole FMH1035400 via proposed pipes FMD-P1 and FMD-P2. The proposed sewage discharge arrangement refers to **Appendix C**.

5.2 Sewerage Impact Assessment

5.2.1 The hydraulic capacities of the proposed sewers for the proposed development have been assessed using Colebrook-White equation. The results are summarised in **Table 5.1** below and details of the calculation are attached in **Appendix D**.

Table 5.1: Hydraulic Capacities of Existing Sewers along Tai Tong Road under Existing and Proposed Flow Condition

Upstream Manhole	Downstream Manhole	Pipe Size (mm)	Utilization under Existing Flow Condition	Utilization under Proposed Flow Condition
Sewerage Network along Tai Tong Road (Sub-catchment 1)				
FMH1035400*	FMH1035401	200	9%	91%
FMH1035401	FMH1036053	450	7%	11%
FMH1036053	FMH1036051	450	27%	42%
Sewerage Network along Shap Pat Heung Road (Sub-catchment 2)				
FMH1060002	FMH1060022	250	10%	10%
FMH1060022	FMH1060023	250	12%	12%
FMH1060023	FMH1060024	250	11%	11%
FMH1060024	FMH1060062	250	9%	9%
FMH1060062	FMH1060063	250	1%	1%
FMH1060063@	FMH1036052	200	10%	10%
FMH1036052	FMH1036051	300	1%	1%
300mm and 450mm diameter sewers (ID: FWD1043910 & FWD1043909) along Shap Pat Heung Road (Sub-catchments 1 & 2)				
FMH1036051	FMH1036050	300	15%#	23%#
FMH1036051	FMH1036049	450		

Remark: -

1. * The downstream existing manhole connected to the proposed pipe (i.e. FMD-P1 and FMD-P2).
2. @ For FMD1002480, it consists of two 200mm pipes. it is assumed that the cumulative peak sewage flow is equally divided between 2 pipes.
3. # Combined capacity of the 300mm and 450mm diameter sewers (ID: FWD1043910 & FWD1043909).

5.2.2 Based on the hydraulic calculation, the existing sewers along Tai Tong Road and Shap Pat Heung Road are below 50% except the 200mm sewer between manholes FMH1035400 and FMH1035401 which is about 91% and the sewers are capable of discharging sewage flow generated from the proposed Development.

5.2.3 For the proposed sewers (PE pipes) connecting the proposed Development to the existing sewers along Tai Tong Road, the hydraulic result is summarised in **Table 5.2** below and details of the calculation are attached in **Appendix D**. A reduction in flow area has also been added to check for the proposed sewers for future rehabilitation if necessary.

Table 5.2: Hydraulic Capacities of Proposed Sewers to Sewers along Tai Tong Road under Proposed Flow Condition

Upstream Manhole	Downstream Node	Pipe Size (mm)	Utilization under Proposed Flow Condition	Utilization under Proposed Flow Condition with Flow Area Reduced for Rehabilitation
FMH-01*	FMH-02	300	50%	56%
FMH-02@	FMH1035400	300	51%	57%

Remark: -
1. * The discharge manhole for the proposed residential development.
2. @ The discharge manhole for the proposed retail building.

5.2.4 Based on the hydraulic calculation, the sewage flow from the proposed development is well within the capacity of the existing and proposed sewage pipelines with utilisation below or equal to 60% even taking account of reduced size for proposed sewers taking account of future rehabilitation. Thus, it is considered that there is no adverse sewerage impact arising from the Development.

6 Conclusion

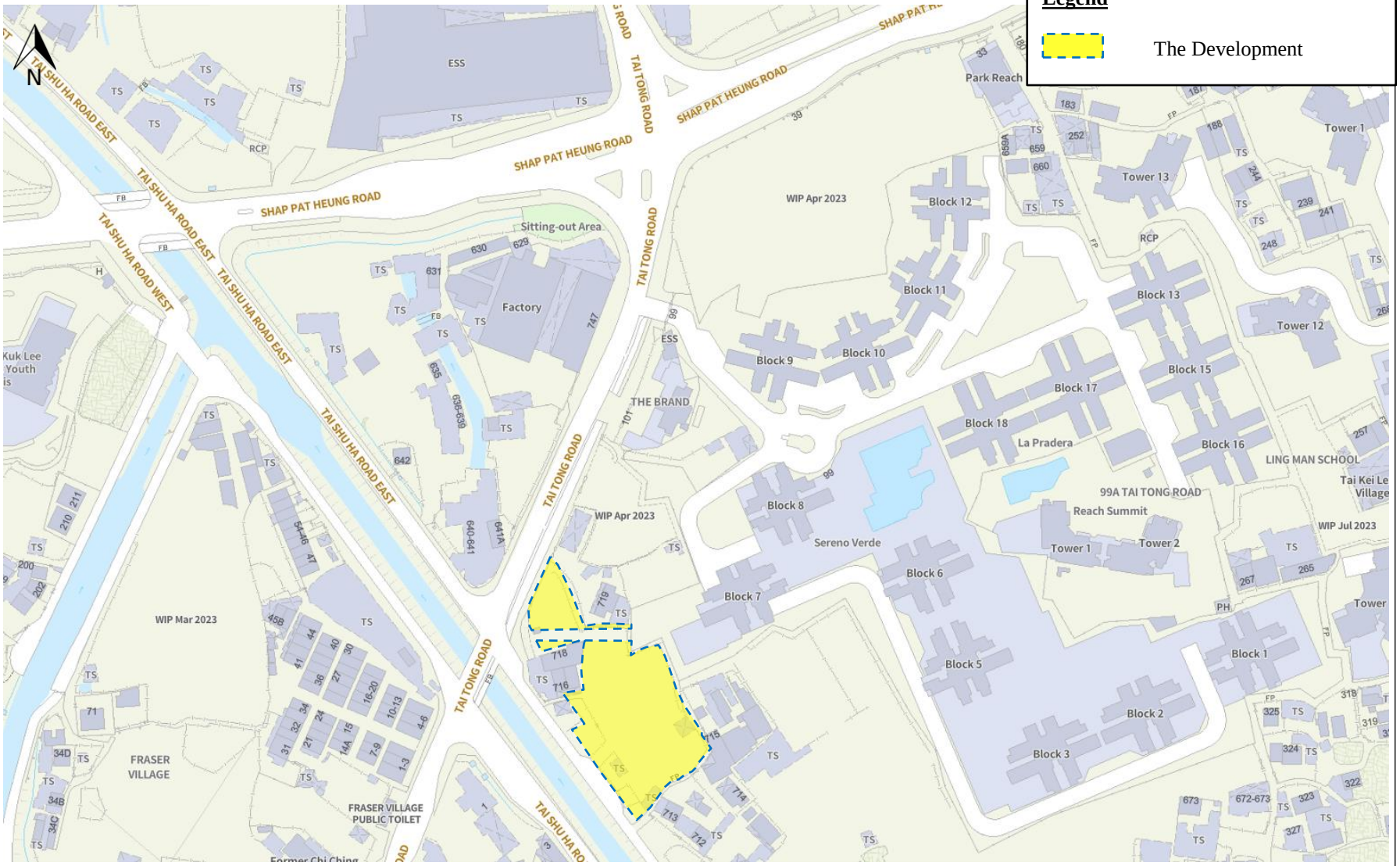
6.1.1 The estimated Average Dry Weather Flow (ADWF) for the proposed whole development is approximately 268.1 m^3/day. The sewage generated will be discharged at a proposed manhole FMH-01. Sewage flow is then conveyed by two proposed 300mm sewers (PE pipes) connecting the existing manhole FMH1035400, and then to 200mm to 450mm diameter sewage pipeline along Tai Tong Road and Shap Pat Heung Road.

6.1.2 Based on the hydraulic calculation, the sewage flow from the proposed development is within the capacity of the existing and proposed sewage pipelines. However, it should be noted that the additional impact for the 55 flats and 220m^2 retails generate sewage flow of 43.8 m^3/d only which is 16% of the whole planned development. In view of the nearby development, possible upgrade is anticipated. The minor increase in the sewerage flow of 43.8m^3/d is very minor and thus, it is considered that there is no adverse sewerage impact arising from the Development site.

Appendices

Appendix A

Location Plan of the Development



Project	**Proposed Minor Relaxation of Plot Ratio Restriction for Permitted Flat and Proposed Shop and Services Uses at Lots 4614 and 4615 RP in D.D. 116, Lots 1753 S.B ss.3 (Part), 1753 S.B RP (Part), 1756 S.A (Part), 1756 RP (Part), 1757, 1758 RP and 1760 RP in D.D. 120, and Adjoining Government Land, Tai Kei Leng, Yuen Long, New Territories**
Title	**Location Plan**

Date	Scale	File
Aug 2023	N.T.S.	

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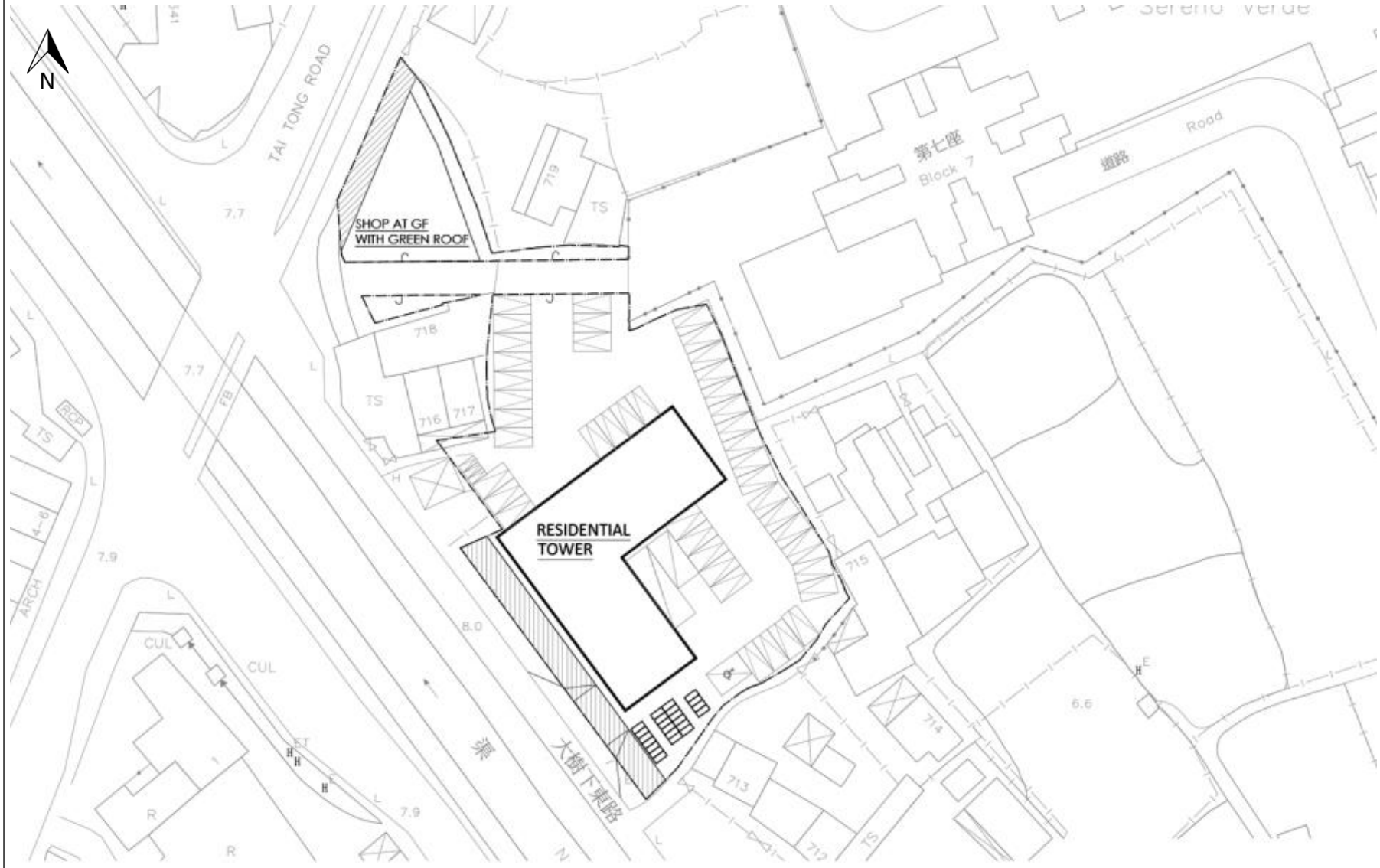
Appendix A

Appendix A1

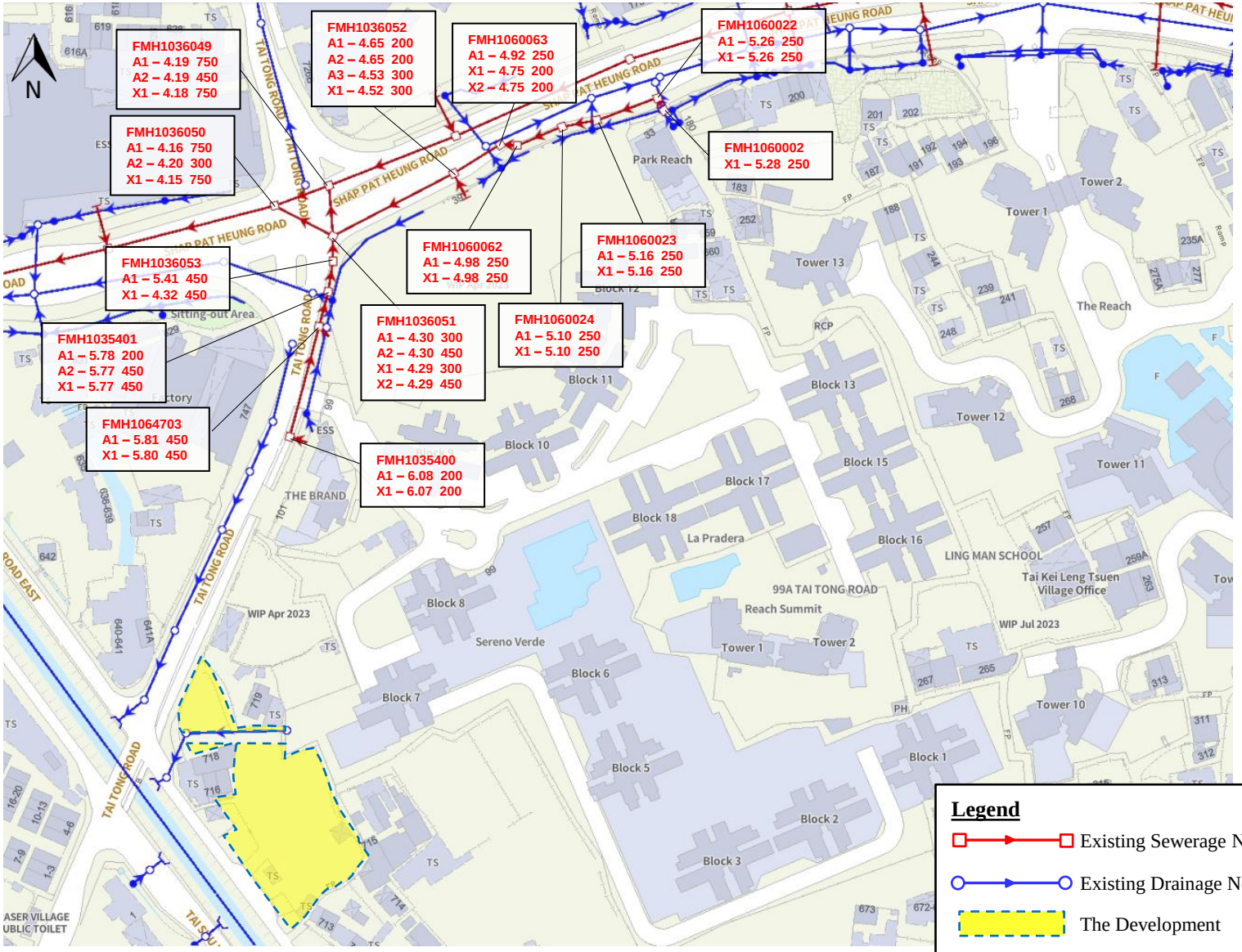
Layout Plan for the Development



Project	**Proposed Minor Relaxation of Plot Ratio Restriction for Permitted Flat and Proposed Shop and Services Uses at Lots 4614 and 4615 RP in D.D. 116, Lots 1753 S.B ss.3 (Part), 1753 S.B RP (Part), 1756 S.A (Part), 1756 RP (Part), 1757, 1758 RP and 1760 RP in D.D. 120, and Adjoining Government Land, Tai Kei Leng, Yuen Long, New Territories**	MOTT MACDONALD
Title	**Layout Plan of the Development**	**Appendix A1**
Date Aug 2023	**Scale** N.T.S.	**File**

Appendix B

Existing Sewerage System



Project	**Proposed Minor Relaxation of Plot Ratio Restriction for Permitted Flat and Proposed Shop and Services Uses at Lots 4614 and 4615 RP in D.D. 116, Lots 1753 S.B ss.3 (Part), 1753 S.B RP (Part), 1756 S.A (Part), 1756 RP (Part), 1757, 1758 RP and 1760 RP in D.D. 120, and Adjoining Government Land, Tai Kei Leng, Yuen Long, New Territories**
Title	**Existing Sewerage System**

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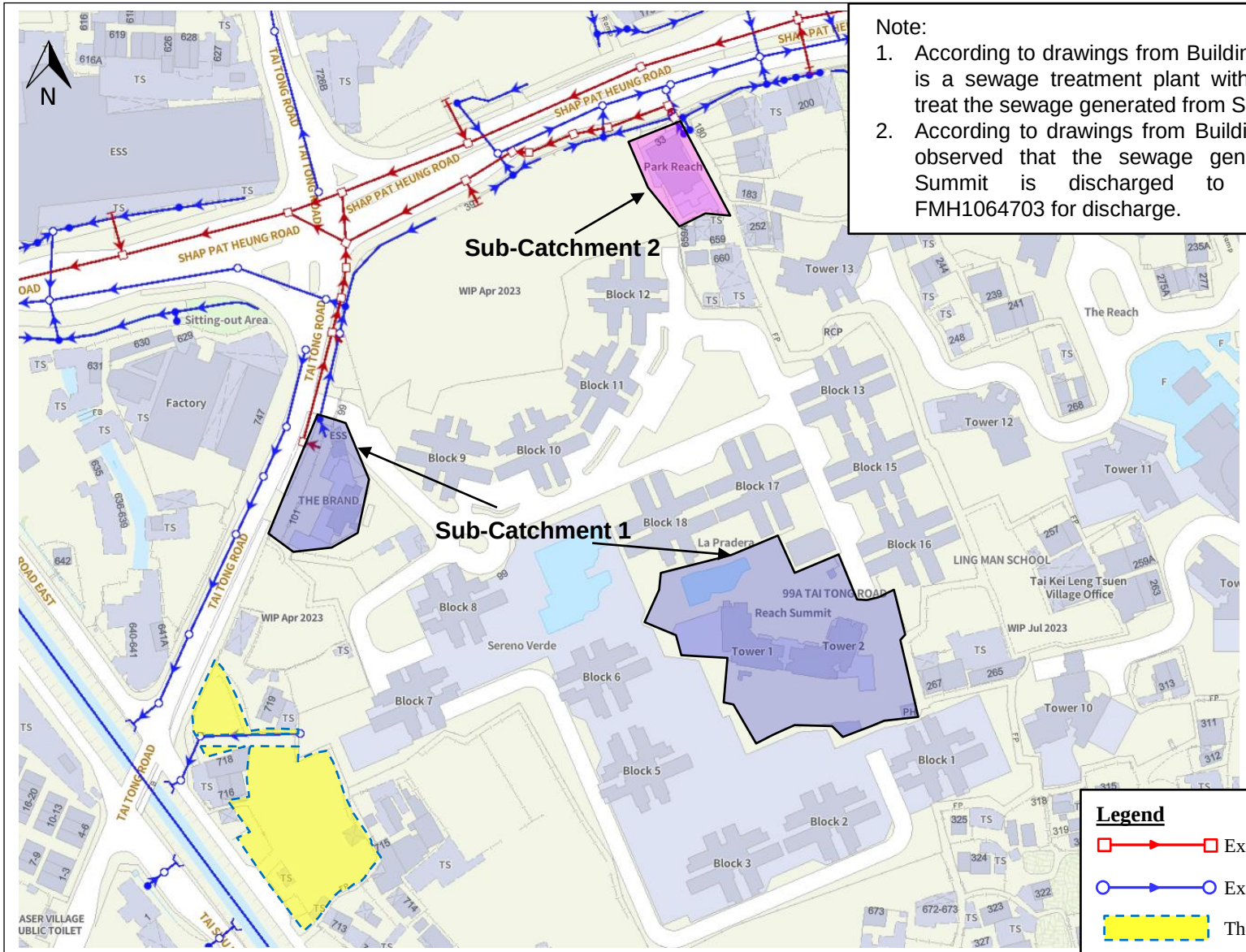
Appendix B

Date	Scale	File
Aug 2023	N.T.S.	

Appendix B1

Existing Catchment Plan



Note:

1. According to drawings from Building Department, there is a sewage treatment plant within Sereno Verde to treat the sewage generated from Sereno Verde.
2. According to drawings from Building Department, It is observed that the sewage generated from Reach Summit is discharged to existing manhole FMH1064703 for discharge.

Legend

- Existing Sewerage Network
- Existing Drainage Network
- The Development

Project	**Proposed Minor Relaxation of Plot Ratio Restriction for Permitted Flat and Proposed Shop and Services Uses at Lots 4614 and 4615 RP in D.D. 116, Lots 1753 S.B ss.3 (Part), 1753 S.B RP (Part), 1756 S.A (Part), 1756 RP (Part), 1757, 1758 RP and 1760 RP in D.D. 120, and Adjoining Government Land, Tai Kei Leng, Yuen Long, New Territories**
Title	**Existing Sewerage Catchment Plan for Assessed Sewers**

Date	Scale	File
Aug 2023	N.T.S.	

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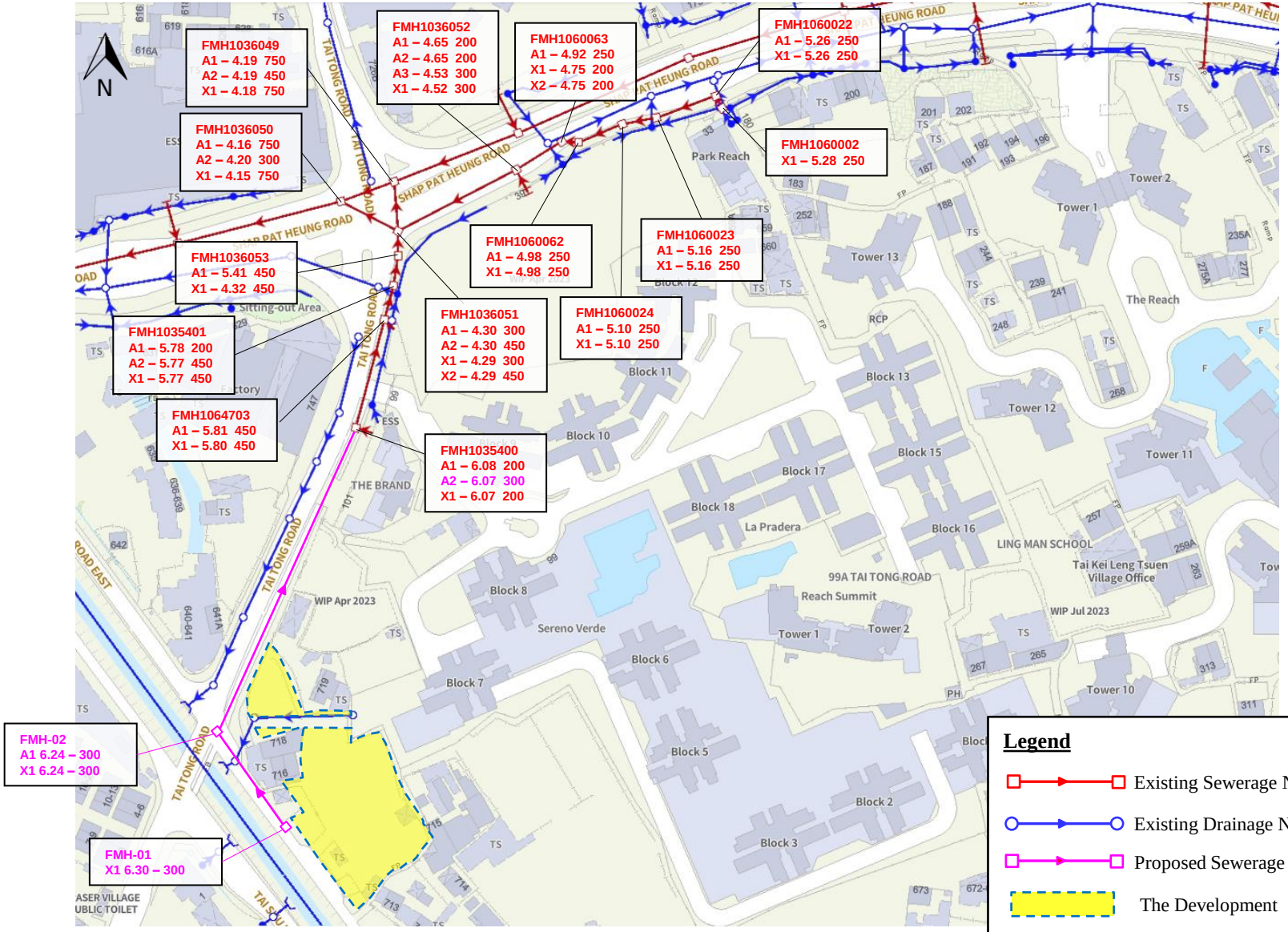
Appendix B1

Appendix C

Proposed Sewerage System



Project	**Proposed Data Centre Development at Lot Nos. 301 S.A & 301 R.P. in DD355 at Pun Shan Street , Tsuen Wan, N. T.**
Title	**Proposed Sewerage System**
Date Aug 2023	**Scale** N.T.S. **File**

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Appendix C

Appendix D

Hydraulic Calculation

Appendix D.1 - Sewage Flow for Existing Condition
Sub-Catchment 1

The Brand

	Residential		
Estimated No. of Flats =	28	Flats	
Average Household Size =	2.8	Persons per Flat	According to 2021 Population Census, average household size in Yuen Long is 2.8 persons per flat.
Population =	79	Persons	
Global Unit Flow Factors =	0.27	m^3/d per person	Domestic Flow Private Housing (R2)
Sewage Flow (ADWF) =	**21.33**	**m^3/d**	
	0.25	**l/s**	

Reach Summit

	Residential		
Estimated No. of Flats =	504	Flats	
Average Household Size =	2.8	Persons per Flat	According to 2021 Population Census, average household size in Yuen Long is 2.8 persons per flat.
Population =	1412	Persons	
Global Unit Flow Factors =	0.27	m^3/d per person	Domestic Flow Private Housing (R2)
Sewage Flow (ADWF) =	**381.24**	**m^3/d**	
	4.41	**l/s**	

Reach Summit Swimming Pool

	Swimming Pool		
Pool Volume =	264	m^3	Assumed 1.2m deep
Turnover Rate =	6	hrs	
Surface Loading Rate of Filter =	48	$m^3/m^2/hr$	Filteration Rate = 48 $m^3/m^2/h$
Filter Areas Required =	0.92	m^2	
Backwash Duration =	3	min/day	
Backwash Flow Rate =	30	$m^3/m^2/hr$	
Average Design Flow for swimming pool backwashing =	**1.38**	m^3/day	
	0.02	l/s	
Instant peak flow =	27.50	m^3/hr	
	7.64	l/s	

Sub-Catchment 2
Park Reach

	Residential		
Estimated No. of Flats =	63	Flats	
Average Household Size =	2.8	Persons per Flat	According to 2021 Population Census, average household size in Yuen Long is 2.8 persons per flat.
Population =	177	Persons	
Global Unit Flow Factors =	0.27	m^3/d per person	Domestic Flow Private Housing (R2)
Sewage Flow (ADWF) =	**47.79**	**m^3/d**	
	0.55	**l/s**	

Appendix D.2 - Sewage Flow for Proposed Condition

Sewage Flow from proposed residential and retail development

	Residential Building		
Estimated No. of Flats =	345	Flats	
Average Household Size =	2.8	Persons per Flat	According to 2021 Population Census, average household size in Yuen Long is 2.8 persons per flat.
Population =	966	Persons	
Global Unit Flow Factors =	0.27	m^3/d per person	Domestic Flow Private Housing (R2)
Sewage Flow (ADWF) =	**260.82**	**m^3/d**	
	3.02	**l/s**	
	Residential Building		
Population =	4	Persons	It is assumed there would be 2 security guards and 2 managing staffs for housing block.
J11 Community, Social & Personal Services- Global Unit Flow Factors =	0.28	m^3/d per employee	
Sewage flow =	**1.12**	**m^3/d**	
	0.01	l/s	
	Clubhouse		
Estimated GFA of Building =	420.00	m^2	
Population =	14	Persons	It is assumed there would be 3.3 workers per GFA (in 100 m2) for Community, Social & Personal Services according to Figure 9: Worker Density by Industry Group of "Commercial and Industrial Floor Space Utilization Survey" published by Plannings Department.
J11 Community, Social & Personal Services- Global Unit Flow Factors =	0.28	m^3/d per employee	
Sewage flow =	**3.92**	**m^3/d**	
	0.05	l/s	
Sewage Discharge to	FMH-01		
	Retail Building		
Estimated GFA of Building =	220.00	m^2	
Population =	8	Persons	It is assumed there would be 3.5 workers per GFA (in 100 m2) for Retail Trade according to Figure 9: Worker Density by Industry Group of "Commercial and Industrial Floor Space Utilization Survey" published by Plannings Department.
J4 Wholesale & Retail - Global Unit Flow Factors =	0.28	m^3/d per employee	
Sewage flow =	**2.24**	**m^3/d**	
	0.03	l/s	
Sewage Discharge to	FMH-02		

Appendix D.3 - Sewer Pipeline Information and Culmulative Peak Sewage Flow Calculation (Existing Condition)

Peaking Factor based on Factor: Including Stormwater

Foulwater Drains Capacity Design Check (By Colebrook White Equation)

where V = velocity (m/s)

g = 9.81 (ms^{-2})

R = hydraulic radius (m)

s = Slope of pipe / hydraulic gradient

v = kinematic viscosity (m^2/s)

Ks = pipe roughness (mm)

Assumptions:

For circular pipes flowing full,

$$V = -\sqrt{(8gDs)}\log\left(\frac{Ks}{3.7D} + \frac{2.51v}{D\sqrt{(2gDs)}}\right)$$

For partially full pipes or pipes with non-circular cross-sections,

$$V = -\sqrt{(32\,gRs)}\log\left(\frac{ks}{14.8R} + \frac{1.255\,v}{R\sqrt{(32\,gRs)}}\right)$$

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	$\mathrm{Max}\left(\frac{7.3}{N^{0.171}}, 2.4\right)$	$\mathrm{Max}\left(\frac{6}{N^{0.171}}, 1.6\right)$
(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	$\mathrm{Max}\left(\frac{3.9}{N^{0.171}}, 2.4\right)$	$\mathrm{Max}\left(\frac{2.6}{N^{0.171}}, 1.6\right)$

Pipe roughness for Proposed PE Pipeline = 1.5 mm (Similar roughness value of uPVC material pipe under poor slimed condition in accordance with Sewerage Manual - Table 5 has been adopted for polyethylene pipe)

Pipe roughness for Existing Sewage Pipeline (<=600 dia.) = 3 mm (Refer to Sewerage Manual Part 1 - Table 5: Clayware)

Transitional flow and water at 15 degree celsius, i.e. kinematic viscosity is 1.14 x 10^{-6} m^2/s

Hydraulic Calculation and Utilisation for 200mm to 450mm Existing Sewers along Tai Tong Road

			Pipe Information													Result			
Pipe no.	From	To	Size (mm)	Length (m)	U.S. Invert Level (mPD)	D.S. Invert Level (mPD)	Gradient 1 in	Culmulative Daily Sewage Flow (l/s)	Catchment Inflow Factor	Culmulative Daily Sewage Flow with Catchment Inflow Factor (l/s)	Contributing Population	Peaking Factor	Instant Peak Flow from Swimming Pool (l/s)	Culmulative Peak Sewage Flow (l/s)	Culmulative Peak Sewage Flow (m^3/s)	Pipe Full Flow Capacity (l/s)	Pipe Full Flow Velocity (m/s)	Utilization (%)	Flow Capacity Check
Sewerage Network along Tai Tong Road (Sub-catchment 1)																			
FWD1042941	FMH1035400	FMH1035401	200	52.4	6.07	5.78	181	0.25	1.00	0.25	79	8.00	0.00	1.98	0.0020	22	0.70	9%	OK
FWD1043890	FMH1035401	FMH1036053	450	9.8	5.77	5.41	27	4.66	1.00	4.66	1491	6.00	7.64	35.60	0.0356	497	3.12	7%	OK
FWD1043891	FMH1036053	FMH1036051	450	7.9	4.32	4.30	393	4.66	1.00	4.66	1491	6.00	7.64	35.60	0.0356	130	0.82	27%	OK

Hydraulic Calculation and Utilisation for 200mm to 300mm Existing Sewers along Shap Pat Heung Road

			Pipe Information													Result			
Pipe no.	From	To	Size (mm)	Length (m)	U.S. Invert Level (mPD)	D.S. Invert Level (mPD)	Gradient 1 in	Culmulative Daily Sewage Flow (l/s)	Catchment Inflow Factor	Culmulative Daily Sewage Flow with Catchment Inflow Factor (l/s)	Contributing Population	Peaking Factor	Instant Peak Flow from Swimming Pool (l/s)	Culmulative Peak Sewage Flow (l/s)	Culmulative Peak Sewage Flow (m^3/s)	Pipe Full Flow Capacity (l/s)	Pipe Full Flow Velocity (m/s)	Utilization (%)	Flow Capacity Check
Sewerage Network along Shap Pat Heung Road (Sub-catchment 2)																			
FWD1081043	FMH1060002	FMH1060022	250	3.2	5.28	5.26	159	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	43	0.87	10%	OK
FWD1081044	FMH1060022	FMH1060023	250	21.5	5.26	5.16	215	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	37	0.75	12%	OK
FWD1081062	FMH1060023	FMH1060024	250	11.3	5.16	5.10	189	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	39	0.80	11%	OK
FWD1081063	FMH1060024	FMH1060062	250	15.5	5.10	4.98	129	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	47	0.97	9%	OK
FWD1081064	FMH1060062	FMH1060063	250	4.8	4.98	4.92	80	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	60	1.23	1%	OK
FMD1002480 (1)	FMH1060063	FMH1036052	200	18.9	4.75	4.65	189	0.55	1.00	0.55	177	8.00	0.00	2.21	0.0022	22	0.69	10%	OK
FWD1043892	FMH1036052	FMH1036051	300	47.3	4.52	4.30	215	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	60	0.85	1%	OK

Hydraulic Calculation and Utilisation for downstream 450mm and 300mm pipes of manhole FMH1036051

			Pipe Information					Capacity	
Pipe no.	From	To	Size (mm)	Length (m)	U.S. Invert Level (mPD)	D.S. Invert Level (mPD)	Gradient 1 in	Pipe Full Flow Capacity (l/s)	Pipe Full Flow Velocity (m/s)
Sewerage Network along Shap Pat Heung Road (Downstream of Subcatchments 1 & 2)									
FWD1043910	FMH1036051	FMH1036050	300	22.3	4.29	4.20	248	56	0.79
FWD1081044	FMH1036051	FMH1036049	450	17.0	4.29	4.19	170	199	1.25
Total Pipe Full Flow Capacity of FWD1043910 and FWD1081044 (l/s)								254	
Culmulative Daily Sewage Flow with Catchment Inflow Factor from FWD1043891 and FWD1043892 (l/s)								5.21	
Contribution Population								1668	
Peaking Factor								6.00	
Instant Peak Flow from Swimming Pool from FWD1043891 and FWD1043892 (l/s)								7.64	
Culmulative Peak Sewage Flow (l/s)								39	
Utilization (%)								15%	

Remarks:

1. For FMD1002480, it consists of two 200mm pipes. it is assumed that the cumulative peak sewage flow is equally divided between 2 pipes.

Appendix D.4 - Sewer Pipeline Information and Culmulative Peak Sewage Flow Calculation (Proposed Condition)

Peaking Factor based on Factor: Including Stormwater / Not Including Stormwater for Proposed Pipes

Foulwater Drains Capacity Design Check (By Colebrook White Equation)

where V = velocity (m/s)

g = 9.81 (ms^{-2})

R = hydraulic radius (m)

s = Slope of pipe / hydraulic gradient

v = kinematic viscosity (m^2/s)

Ks = pipe roughness (mm)

Assumptions:

For circular pipes flowing full,

$$V = -\sqrt{(8gDs)}\log\left(\frac{Ks}{3.7D} + \frac{2.51v}{D\sqrt{(2gDs)}}\right)$$

For partially full pipes or pipes with non-circular cross-sections,

$$V = -\sqrt{(32\,gRs)}\log\left(\frac{ks}{14.8R} + \frac{1.255\,v}{R\sqrt{(32\,gRs)}}\right)$$

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	$\mathrm{Max}\left(\frac{7.3}{N^{0.142}}, 2.4\right)$	$\mathrm{Max}\left(\frac{6}{N^{0.142}}, 1.6\right)$
(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	$\mathrm{Max}\left(\frac{3.9}{N^{0.142}}, 2.4\right)$	$\mathrm{Max}\left(\frac{2.6}{N^{0.142}}, 1.6\right)$

Pipe roughness for Proposed PE Pipeline = 1.5 mm (Similar roughness value of uPVC material pipe under poor slimed condition in accordance with Sewerage Manual - Table 5 has been adopted for polyethylene pipe)

Pipe roughness for Existing Sewage Pipeline (<=600 dia.) 3 mm (Refer to Sewerage Manual Part 1 - Table 5: Clayware)

Transitional flow and water at 15 degree celsius, i.e. kinematic viscosity is 1.14 x 10^{-6} m^2/s

Proposed Sewer From The Development Site

Pipe Information																Result			
Pipe no.	From	To	Size (mm)	Length (m)	U.S. Invert Level (mPD)	D.S. Invert Level (mPD)	Gradient 1 in	Culmulative Daily Sewage Flow (l/s)	Catchment Inflow Factor	Culmulative Daily Sewage Flow with Catchment Inflow Factor (l/s)	Contributing Population	Peaking Factor	Instant Peak Flow from Swimming Pool (l/s)	Culmulative Peak Sewage Flow (l/s)	Culmulative Peak Sewage Flow (m^3/s)	Pipe Full Flow Capacity (l/s)	Pipe Full Flow Velocity (m/s)	Utilization (%)	Flow Capacity Check
Proposed Sewer From The Development Site																			
FMD-P1 (2)	FMH-01	FMH-02	300	42.2	6.30	6.24	703	3.08	1.00	3.08	985	6.00	0.00	18.47	0.02	37	0.52	50%	OK
FMD-P2 (3)	FMH-02	FMH1035400	300	121.6	6.24	6.07	715	3.11	1.00	3.11	995	6.00	0.00	18.65	0.02	36	0.51	51%	OK

Hydraulic Calculation and Utilisation for 200mm to 450mm Existing Sewers along Tai Tong Road

Pipe Information																Result			
Pipe no.	From	To	Size (mm)	Length (m)	U.S. Invert Level (mPD)	D.S. Invert Level (mPD)	Gradient 1 in	Culmulative Daily Sewage Flow (l/s)	Catchment Inflow Factor	Culmulative Daily Sewage Flow with Catchment Inflow Factor (l/s)	Contributing Population	Peaking Factor	Instant Peak Flow from Swimming Pool (l/s)	Culmulative Peak Sewage Flow (l/s)	Culmulative Peak Sewage Flow (m^3/s)	Pipe Full Flow Capacity (l/s)	Pipe Full Flow Velocity (m/s)	Utilization (%)	Flow Capacity Check
Sewerage Network along Tai Tong Road (Sub-catchment 1)																			
FWD1042941	FMH1035400	FMH1035401	200	52.4	6.07	5.78	181	3.36	1.00	3.36	1074	6.00	0.00	20.13	0.0201	22	0.70	91%	OK
FWD1043890	FMH1035401	FMH1036053	450	9.8	5.77	5.41	27	7.77	1.00	7.77	2486	6.00	7.64	54.25	0.0542	497	3.12	11%	OK
FWD1043891	FMH1036053	FMH1036051	450	7.9	4.32	4.30	393	7.77	1.00	7.77	2486	6.00	7.64	54.25	0.0542	130	0.82	42%	OK

Hydraulic Calculation and Utilisation for 200mm to 300mm Existing Sewers along Shap Pat Heung Road

Pipe Information																Result			
Pipe no.	From	To	Size (mm)	Length (m)	U.S. Invert Level (mPD)	D.S. Invert Level (mPD)	Gradient 1 in	Culmulative Daily Sewage Flow (l/s)	Catchment Inflow Factor	Culmulative Daily Sewage Flow with Catchment Inflow Factor (l/s)	Contributing Population	Peaking Factor	Instant Peak Flow from Swimming Pool (l/s)	Culmulative Peak Sewage Flow (l/s)	Culmulative Peak Sewage Flow (m^3/s)	Pipe Full Flow Capacity (l/s)	Pipe Full Flow Velocity (m/s)	Utilization (%)	Flow Capacity Check
Sewerage Network along Shap Pat Heung Road (Sub-catchment 2)																			
FWD1081043	FMH1060002	FMH1060022	250	3.2	5.28	5.26	159	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	43	0.87	10%	OK
FWD1081044	FMH1060022	FMH1060023	250	21.5	5.26	5.16	215	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	37	0.75	12%	OK
FWD1081062	FMH1060023	FMH1060024	250	11.3	5.16	5.10	189	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	39	0.80	11%	OK
FWD1081063	FMH1060024	FMH1060062	250	15.5	5.10	4.98	129	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	47	0.97	9%	OK
FWD1081064	FMH1060062	FMH1060063	250	4.8	4.98	4.92	80	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	60	1.23	1%	OK
FMD1002480 (1)	FMH1060063	FMH1036052	200	18.9	4.75	4.65	189	0.55	1.00	0.55	177	8.00	0.00	2.21	0.0022	22	0.69	10%	OK
FWD1043892	FMH1036052	FMH1036051	300	47.3	4.52	4.30	215	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	60	0.85	1%	OK

Hydraulic Calculation and Utilisation for downstream 450mm and 300mm pipes of manhole FMH1036051

Pipe Information								Capacity	
Pipe no.	From	To	Size (mm)	Length (m)	U.S. Invert Level (mPD)	D.S. Invert Level (mPD)	Gradient 1 in	Pipe Full Flow Capacity (l/s)	Pipe Full Flow Velocity (m/s)
Sewerage Network along Shap Pat Heung Road (Downstream of Subcatchments 1 & 2)									
FWD1043910	FMH1036051	FMH1036050	300	22.3	4.29	4.20	248	56	0.79
FWD1081044	FMH1036051	FMH1036049	450	17.0	4.29	4.19	170	199	1.25
Total Pipe Full Flow Capacity of FWD1043910 and FWD1081044 (l/s)								254	
Culmulative Daily Sewage Flow with Catchment Inflow Factor from FWD1043891 and FWD1043892 (l/s)								8.32	
Contribution Population								2663	
Peaking Factor								6.00	
Instant Peak Flow from Swimming Pool from FWD1043891 and FWD1043892 (l/s)								7.64	
Culmulative Peak Sewage Flow (l/s)								58	
Utilization (%)								23%	

Remarks:

1. For FMD1002480, it consists of two 200mm pipes. it is assumed that the cumulative peak sewage flow is equally divided between 2 pipes.
2. The sewage generated from the proposed residential development will be discharged into proposed manhole FMH-01.
3. The sewage generated from the proposed retail building will be discharged into proposed manhole FMH-02.

Appendix D.5 - Sewer Pipeline Information and Culmulative Peak Sewage Flow Calculation (Proposed Condition with reduction in pipe area for rehabiliation)

Peaking Factor based on Factor:

Including Stormwater for Existing Pipes
Not Including Stormwater for Proposed Pipes

Foulwater Drains Capacity Design Check (By Colebrook White Equation)

where V = velocity (m/s)
g = 9.81 (ms^{-2})
R = hydraulic radius (m)
s = Slope of pipe / hydraulic gradient
v = kinematic viscosity (m^2/s)
Ks = pipe roughness (mm)

For circular pipes flowing full,

$$V = -\sqrt{(8gDs)}\log\left(\frac{Ks}{3.7D} + \frac{2.51v}{D\sqrt{(2gDs)}}\right)$$

For partially full pipes or pipes with non-circular cross-sections,

$$V = -\sqrt{(32\,gRs)}\log\left(\frac{ks}{14.8R} + \frac{1.255\,v}{R\sqrt{(32\,gRs)}}\right)$$

Assumptions:

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	$\mathrm{Max}\left(\frac{7.3}{N^{0.127}}, 2.4\right)$	$\mathrm{Max}\left(\frac{6}{N^{0.127}}, 1.6\right)$
(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	$\mathrm{Max}\left(\frac{3.9}{N^{0.127}}, 2.4\right)$	$\mathrm{Max}\left(\frac{2.6}{N^{0.127}}, 1.6\right)$

Pipe roughness for Proposed PE Pipeline = 1.5 mm (Similar roughness value of uPVC material pipe under poor slimed condition in accordance with Sewerage Manual - Table 5 has been adopted for polyethylene pipe)
Pipe roughness for Existing Sewage Pipeline (<=600 dia.) : 3 mm (Refer to Sewerage Manual Part 1 - Table 5: Clayware)

1. Assumed the lining thickness for rehabiliation is 6mm for 300mm diameter pipe.
2. Transitional flow and water at 15 degree celsius, i.e. kinematic viscosity is 1.14 x 10^{-6} m^2/s

Proposed Sewer From The Development Site

Pipe Information															Result			
Pipe no.	From	To	Size After Rehabilitation (mm)	Length (m)	U.S. Invert Level (mPD)	D.S. Invert Level (mPD)	Gradient 1 in	Culmulative Daily Sewage Flow (l/s)	Catchment Inflow Factor	Culmulative Daily Sewage Flow with Catchment Inflow Factor (l/s)	Contributing Population	Peaking Factor	Instant Peak Flow from Swimming Pool (l/s)	Culmulative Peak Sewage Flow (l/s)	Culmulative Peak Sewage Flow (m^3/s)	Pipe Full Flow Capacity (l/s)	Pipe Full Flow Velocity (m/s)	Utilization (%)	Flow Capacity Check
Proposed Sewer From The Development Site																			
FMD-P1 (2)	FMH-01	FMH-02	288	42.2	6.30	6.24	703	3.08	1.00	3.08	985	6.00	0.00	18.47	0.02	33	0.51	56%	OK
FMD-P2 (3)	FMH-02	FMH1035400	288	121.6	6.24	6.07	715	3.11	1.00	3.11	995	6.00	0.00	18.65	0.02	33	0.50	57%	OK

Hydraulic Calculation and Utilisation for 200mm to 450mm Existing Sewers along Tai Tong Road

Pipe Information															Result			
Pipe no.	From	To	Size (mm)	Length (m)	U.S. Invert Level (mPD)	D.S. Invert Level (mPD)	Gradient 1 in	Culmulative Daily Sewage Flow (l/s)	Catchment Inflow Factor	Culmulative Daily Sewage Flow with Catchment Inflow Factor (l/s)	Contributing Population	Peaking Factor	Instant Peak Flow from Swimming Pool (l/s)	Culmulative Peak Sewage Flow (l/s)	Culmulative Peak Sewage Flow (m^3/s)	Pipe Full Flow Capacity (l/s)	Pipe Full Flow Velocity (m/s)	Utilization (%)	Flow Capacity Check
Sewerage Network along Tai Tong Road (Sub-catchment 1)																			
FWD1042941	FMH1035400	FMH1035401	200	52.4	6.07	5.78	181	3.36	1.00	3.36	1074	6.00	0.00	20.13	0.0201	22	0.70	91%	OK
FWD1043890	FMH1035401	FMH1036053	450	9.8	5.77	5.41	27	7.77	1.00	7.77	2486	6.00	7.64	54.25	0.0542	497	3.12	11%	OK
FWD1043891	FMH1036053	FMH1036051	450	7.9	4.32	4.30	393	7.77	1.00	7.77	2486	6.00	7.64	54.25	0.0542	130	0.82	42%	OK

Hydraulic Calculation and Utilisation for 200mm to 300mm Existing Sewers along Shap Pat Heung Road

Pipe Information															Result			
Pipe no.	From	To	Size (mm)	Length (m)	U.S. Invert Level (mPD)	D.S. Invert Level (mPD)	Gradient 1 in	Culmulative Daily Sewage Flow (l/s)	Catchment Inflow Factor	Culmulative Daily Sewage Flow with Catchment Inflow Factor (l/s)	Contributing Population	Peaking Factor	Instant Peak Flow from Swimming Pool (l/s)	Culmulative Peak Sewage Flow (l/s)	Culmulative Peak Sewage Flow (m^3/s)	Pipe Full Flow Capacity (l/s)	Pipe Full Flow Velocity (m/s)	Utilization (%)	Flow Capacity Check
Sewerage Network along Shap Pat Heung Road (Sub-catchment 2)																			
FWD1081043	FMH1060002	FMH1060022	250	3.2	5.28	5.26	159	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	43	0.87	10%	OK
FWD1081044	FMH1060022	FMH1060023	250	21.5	5.26	5.16	215	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	37	0.75	12%	OK
FWD1081062	FMH1060023	FMH1060024	250	11.3	5.16	5.10	189	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	39	0.80	11%	OK
FWD1081063	FMH1060024	FMH1060062	250	15.5	5.10	4.98	129	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	47	0.97	9%	OK
FWD1081064	FMH1060062	FMH1060063	250	4.8	4.98	4.92	80	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	60	1.23	1%	OK
FMD1002480 (1)	FMH1060063	FMH1036052	200	18.9	4.75	4.65	189	0.55	1.00	0.55	177	8.00	0.00	2.21	0.0022	22	0.69	10%	OK
FWD1043892	FMH1036052	FMH1036051	300	47.3	4.52	4.30	215	0.55	1.00	0.55	177	8.00	0.00	4.43	0.0044	60	0.85	1%	OK

Hydraulic Calculation and Utilisation for downstream 450mm and 300mm pipes of manhole FMH1036051

Pipe Information								Capacity	
Pipe no.	From	To	Size (mm)	Length (m)	U.S. Invert Level (mPD)	D.S. Invert Level (mPD)	Gradient 1 in	Pipe Full Flow Capacity (l/s)	Pipe Full Flow Velocity (m/s)
Sewerage Network along Shap Pat Heung Road (Downstream of Subcatchments 1 & 2)									
FWD1043910	FMH1036051	FMH1036050	300	22.3	4.29	4.20	248	56	0.79
FWD1081044	FMH1036051	FMH1036049	450	17.0	4.29	4.19	170	199	1.25
Total Pipe Full Flow Capacity of FWD1043910 and FWD1081044 (l/s)								254	
Culmulative Daily Sewage Flow with Catchment Inflow Factor from FWD1043891 and FWD1043892 (l/s)								8.32	
Contribution Population								2663	
Peaking Factor								6.00	
Instant Peak Flow from Swimming Pool from FWD1043891 and FWD1043892 (l/s)								7.64	
Culmulative Peak Sewage Flow (l/s)								58	
Utilization (%)								23%	

Remarks:
1. For FMD1002480, it consists of two 200mm pipes. it is assumed that the cumulative peak sewage flow is equally divided between 2 pipes.
2. The sewage generated from the proposed residential development will be discharged into proposed manhole FMH-01.
3. The sewage generated from the proposed retail building will be discharged into proposed manhole FMH-02.