Appendix 8

DRAINAGE IMPACT ASSESSMENT

AtkinsRéalis

Application for Amendment of Plan Under Section 12A of the Town Planning Ordinance (Cap. 131)
Gain Million Development Limited

16 October 2026

Drainage Impact Assessment (DIA) Report

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1. Introduction

1.1 Background

1.1.1 This Drainage Impact Assessment (DIA) Report is prepared by AtkinsRealis Asia Limited on behalf of the Applicant, Gain Million Development Limited, in support of a Section 12A Planning Application for the Proposed Amendment to the Approved Lam Tei and Yick Yuen Outline Zoning Plan No. S/TM-LTYY/14 from "Comprehensive Development Area", "Green Belt" and "Residential (Group B) 3" Zones to "Residential (Group B) 4" Zone at Lot Nos. 837 RP (Part), 839 S.A RP (Part), 841 (Part), 1035 RP, 1037 RP and 2527 S.F RP (Part) in D.D. 130 and Adjoining Government Land, Lam Tei, Tuen Mun, to facilitate a Proposed Residential Development with supporting commercial uses and social welfare facilities (Proposed Development).

1.2 Purpose of this Report

1.2.1 This DIA considers the potential drainage impact due to the Proposed Development. The objective of the DIA is to identify, assess and mitigate – if required – the potential adverse drainage impacts which may arise from the Proposed Development.

1.3 Abbreviations

1.3.1 The following abbreviations are used in this Report:

DIA	Drainage Impact Assessment
DSD	Drainage Services Department
DRA	Drainage Reserve Area
HKPSG	Hong Kong Planning Standards and Guidelines
NBA	Non-Building Area
OZP	Outline Zoning Plan
SDM	Stormwater Drainage Manual

2. Site Characteristics

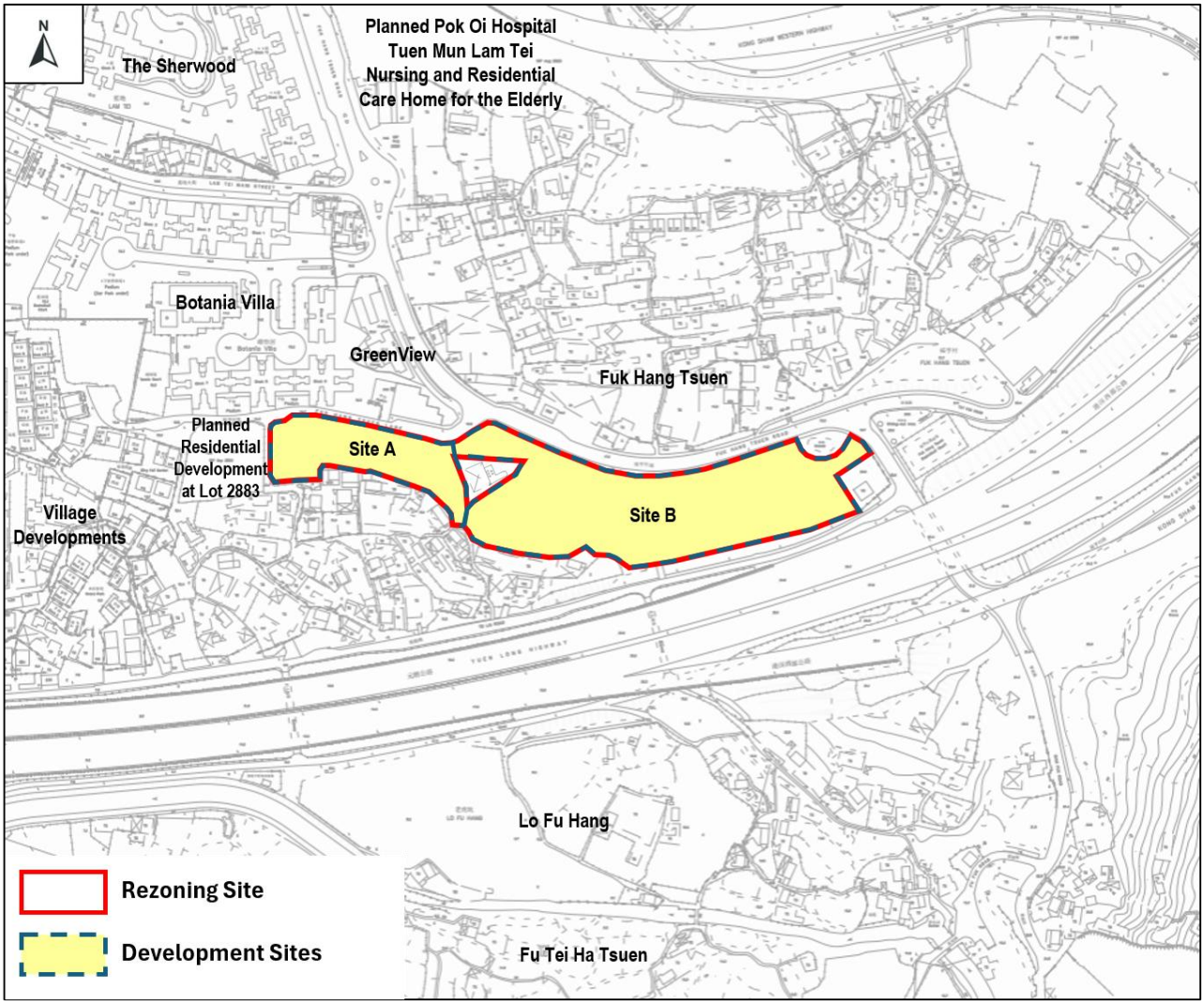
2.1 Rezoning Site and Development Sites

2.1.1 The Rezoning Site is currently zoned “CDA”, with minor portions falling within the “R(B)3” and “GB” zones, under the Approved Lam Tei and Yick Yuen Outline Zoning Plan No. S/TM-LTYY/14 (“Approved OZP”).

2.1.2 The Rezoning Site has a total site area of approximately 14,036m^2 and comprises two Development Sites, namely Site A, located on the western side, with a site area of approximately 3,325m^2 and Site B, located on the eastern side, with a site area of approximately 10,711m^2.

2.1.3 **Figure 2.1** illustrates the location and boundaries of the Rezoning Site and the two Development Sites. The sites currently consist of open storage areas and vegetation.

Figure 2.1 - Location of the Rezoning Site



3. Previously Approved Scheme

3.1 General Approach

3.1.1 Based on the Approved Scheme (Application No. A/TM-LTYY/249), a new drainage system will be provided within the previous Application Site to convey the surface runoff into a terminal manhole which will connect to the 1050mm diameter drain pipeline underneath Yuen Long Highway through a new 750mm diameter drain pipe. The surface runoff from the proposed development will eventually discharge through the existing pipelines to Lo Fu Hang Channel. The internal drainage system comprises perimeter covered u-channels and road drainage system. Surface runoff from the car park will be collected by gullies and then discharge into the road drainage system. Stormwater collected from the buildings will be discharged via vertical down pipes into the road drainage system. The surface run-off from the internal road will also be discharged via road gullies into this new drainage system.

3.1.2 There are totally three existing 1050mm diameter and four 1200mm diameter stormwater pipelines at the downstream of the terminal manhole of the previous Application Site. They are named as 1050mm dia.(A)-(C) and 1200mm dia.(A)-(D) as shown in **Appendix A** and their associated catchment areas under existing condition are summarised in **Table 3.1** and as shown in **Appendix B**.

Table 3.1 – Existing Catchment Area for Downstream Pipes

Existing Pipelines	Total Catchment Area (m^2)	Extent of Sub-catchment	Runoff under 1 in 50-yr Storm (m^3/s)
1050mm dia. (A)	84,438	A-1, A-2, A-3	2.55
1050mm dia. (B)	97,504	A-1, A-2, A-3, B	3.04
1050mm dia. (C)	97,504	A-1, A-2, A-3, B	3.02
1200mm dia. (A)	100,762	A-1, A-2, A-3, B, C	3.19
1200mm dia. (B)	100,762	A-1, A-2, A-3, B, C	3.17
1200mm dia. (C)	104,652	A-1, A-2, A-3, B, C, D	3.38
1200mm dia. (D)	105,712	A-1, A-2, A-3, B, C, D, E	3.37

3.1.3 The proposed catchment areas of these pipelines under the Approved Scheme are shown in **Appendix B**. The estimated surface runoff discharges to these pipelines associated with the Proposed Development are summarized in **Table 3.2** below.

Table 3.2 – Proposed Catchment Area for Downstream Pipes under the Approved Scheme

Existing Pipelines	Total Catchment Area (m^2)	Extent of Sub-catchment	Runoff under 1 in 50-yr Storm (m^3/s)
750mm dia. (new pipe)	15,731	F	0.76
1050mm dia. (A)	92,908	A-1, A-3, A-4, A-5, F	3.14
1050mm dia. (B)	105,974	A-1, A-3, A-4, A-5, B, F	3.62
1050mm dia. (C)	105,974	A-1, A-3, A-4, A-5, B, F	3.60
1200mm dia. (A)	109,232	A-1, A-3, A-4, A-5, B, C, F	3.77
1200mm dia. (B)	109,232	A-1, A-3, A-4, A-5, B, C, F	3.75
1200mm dia. (C)	113,122	A-1, A-3, A-4, A-5, B, C, D, F	3.95
1200mm dia. (D)	114,182	A-1, A-3, A-4, A-5, B, C, D, E, F	3.94

3.1.4 The surface runoff from the Approved Scheme (sub-catchment F) will be discharged through a new 750mm diameter pipe which will have a capacity of 1.01 m³/s (utilization = 78.2%) to the existing 1050mm diameter pipeline. The surface runoff will be discharged to the existing Lo Fu Hang Channel and then to the Tuen Mun River eventually.

3.1.5 As shown in **Table 3.1** and **Table 3.2**, the surface runoff contributed from the existing catchment area and the future development area to the downstream existing pipes under a 1-in-50 years rainstorm are summarized in **Table 3.3** below.

Table 3.3 – Summary of Future Discharge Capacity for Downstream Pipelines (1 in 50-yr Rainstorm) under the Approved Scheme

Existing Pipelines	Existing Runoff Discharge (m³/s)	Future Runoff Discharge (m³/s)	Additional Runoff (m³/s)	Capacity of the Pipelines (m³/s)	Future Utilization of the Pipelines
1050mm dia. (A)	2.55	3.14	0.59	3.53	88.8%
1050mm dia. (B)	3.04	3.62	0.58	4.53	80.0%
1050mm dia. (C)	3.02	3.60	0.58	4.98	72.2%
1200mm dia. (A)	3.19	3.77	0.58	5.06	74.5%
1200mm dia. (B)	3.17	3.75	0.57	5.44	68.9%
1200mm dia. (C)	3.38	3.95	0.57	5.96	66.3%
1200mm dia. (D)	3.37	3.94	0.57	5.84	67.5%

3.1.6 As shown above, the existing drainage pipelines will have sufficient capacity to cater for the additional runoff generated by the Approved Scheme.

4. Present Proposed Scheme

4.1 Changes under the Present Proposed Scheme

4.1.1 The Present Proposed Scheme comprises 546 residential units with an estimated residential population of 1,420 persons, together with retail, clubhouse and social welfare facilities. Compared with the Approved Scheme, the landscaping area has been reduced, resulting in a corresponding increase in paved, road and developed area. The drainage assessment has therefore been updated to reflect the revised development layout and land-use composition.

4.2 Drainage Review for the Present Proposed Scheme

4.2.1 Similar to the Approved Scheme, a new drainage system will be provided within the Rezoning Site to convey surface runoff to a proposed terminal manhole. The proposed terminal manhole will connect to the existing 1050 mm diameter drainage pipeline underneath Yuen Long Highway through a new 750 mm diameter precast concrete drainage pipe. The proposed drainage works under the Present Proposed Scheme are shown in **Appendix C**. The catchment plans for the existing condition, Approved Scheme and Present Proposed Scheme are shown in **Appendix B**.

4.2.2 The overall catchment boundaries and total catchment areas of the downstream pipelines under the Present Proposed Scheme remain unchanged from those under the Approved Scheme. However, the land-use composition within the Rezoning Site has been updated to reflect the reduction in landscaping area and corresponding increase in paved, road and developed area. The drainage catchment of the Rezoning Site remains 15,731 m², comprising approximately 3,146.2 m² of grassland area and 12,584.8 m² of paved, road and developed area. As different runoff coefficients are adopted for grassland and paved surfaces, the surface runoff discharging to the downstream pipelines has been recalculated. The revised calculations are presented in **Appendix D** and summarized in **Table 4.1**.

Table 4.1 – Proposed Catchment Area for Downstream Pipes under the Proposed Scheme

Existing Pipelines	Total Catchment Area (m²)	Extent of Sub-catchment	Revised runoff under 1 in 50-yr Storm (m³/s)
750mm dia. (new pipe)	15,731	F	0.78
1050mm dia. (A)	92,908	A-1, A-3, A-4, A-5, F	3.04
1050mm dia. (B)	105,974	A-1, A-3, A-4, A-5, B, F	3.50
1050mm dia. (C)	105,974	A-1, A-3, A-4, A-5, B, F	3.48
1200mm dia. (A)	109,232	A-1, A-3, A-4, A-5, B, C, F	3.64
1200mm dia. (B)	109,232	A-1, A-3, A-4, A-5, B, C, F	3.62
1200mm dia. (C)	113,122	A-1, A-3, A-4, A-5, B, C, D, F	3.82
1200mm dia. (D)	114,182	A-1, A-3, A-4, A-5, B, C, D, E, F	3.81

4.2.3 The revised peak runoff from the Proposed Development, corresponding to Sub-catchment F, is approximately 0.78 m³/s. The runoff will be conveyed through a new 750 mm diameter precast concrete drainage pipe to the existing downstream 1050 mm diameter drainage pipeline. Based on the calculation presented in **Appendix D**, the proposed 750 mm diameter pipe has a full-bore capacity of approximately

1.01 m³/s and a utilization of approximately 77.8%. The proposed pipe is therefore capable of conveying the revised design flow while maintaining at least 10% flow capacity allowance for siltation. The surface runoff will subsequently be discharged through the existing downstream drainage system to Lo Fu Hang Channel and eventually to Tuen Mun River.

4.2.4 As shown in **Tables 3.1** and **4.1** and based on the calculations presented in **Appendix D** with reference to the catchment areas shown in **Appendix B**, the existing and future runoff discharges to the downstream drainage pipelines under a 1-in-50-year rainstorm are summarized in **Table 4.2**.

Table 4.2 – Summary of Future Discharge Capacity for Downstream Pipelines (1 in 50-yr Rainstorm)

Existing Pipelines	Existing Runoff (m^3/s)	Revised Future Runoff (m^3/s)	Revised Additional Runoff (m^3/s)	Capacity of the Pipelines (m^3/s)	Revised Utilization of the Pipelines
1050mm dia. (A)	2.55	3.04	0.49	3.53	86.0%
1050mm dia. (B)	3.04	3.50	0.46	4.53	77.4%
1050mm dia. (C)	3.02	3.48	0.46	4.98	69.9%
1200mm dia. (A)	3.19	3.64	0.45	5.06	72.0%
1200mm dia. (B)	3.17	3.62	0.45	5.44	66.7%
1200mm dia. (C)	3.38	3.82	0.44	5.96	64.1%
1200mm dia. (D)	3.37	3.81	0.44	5.84	65.3%

4.2.5 As shown in **Table 4.2**, the existing downstream drainage pipelines have sufficient capacity to convey the revised design flows under the Present Proposed Scheme. The maximum utilization occurs at the existing 1050 mm diameter (A) pipe and is approximately 86.0%, which is below the adopted 90% capacity criteria and maintains at least 10% flow capacity allowance for siltation. No upgrading of the existing downstream drainage pipelines is therefore required.

4.3 Drainage Reserve Area for an Existing 900 mm Stormwater Drainage Pipe

4.3.1 As advised by DSD, an existing 900 mm diameter stormwater drainage pipe maintained by DSD is located within the Rezoning Site based on DSD records. A Drainage Reserve Area (DRA) is proposed along the alignment of the existing pipe. No structure or structural support should be erected within the DRA without the prior written consent of DSD. The DRA will provide free and unrestricted access for future inspection, repair and maintenance of the existing stormwater drainage pipe.

4.3.2 With the provision of a DRA, the existing 900 mm diameter public stormwater drain can be retained without diversion. No modification to the existing pipe is proposed under the Present Proposed Scheme.

5. Conclusion

5.1.1 The drainage assessment has been updated to reflect the corrected rainfall-intensity calculations and the revised land-use composition within the Rezoning Site. The revised peak runoff from the Rezoning Site is approximately 0.78 m³/s and will be conveyed through a proposed 750 mm diameter precast concrete drainage pipe to the existing downstream drainage system. The proposed 750 mm diameter pipe has a full-bore capacity of approximately 1.01 m³/s and a utilization of approximately 77.8%.

5.1.2 The existing downstream 1050 mm and 1200 mm diameter drainage pipelines have sufficient capacity to convey the revised design flows under a 1-in-50-year rainstorm. The maximum utilization is approximately 86.0% at the existing 1050 mm diameter (A) pipe, which is below the adopted 90% capacity criterion. Therefore, no upgrading of the existing downstream drainage pipelines is required.

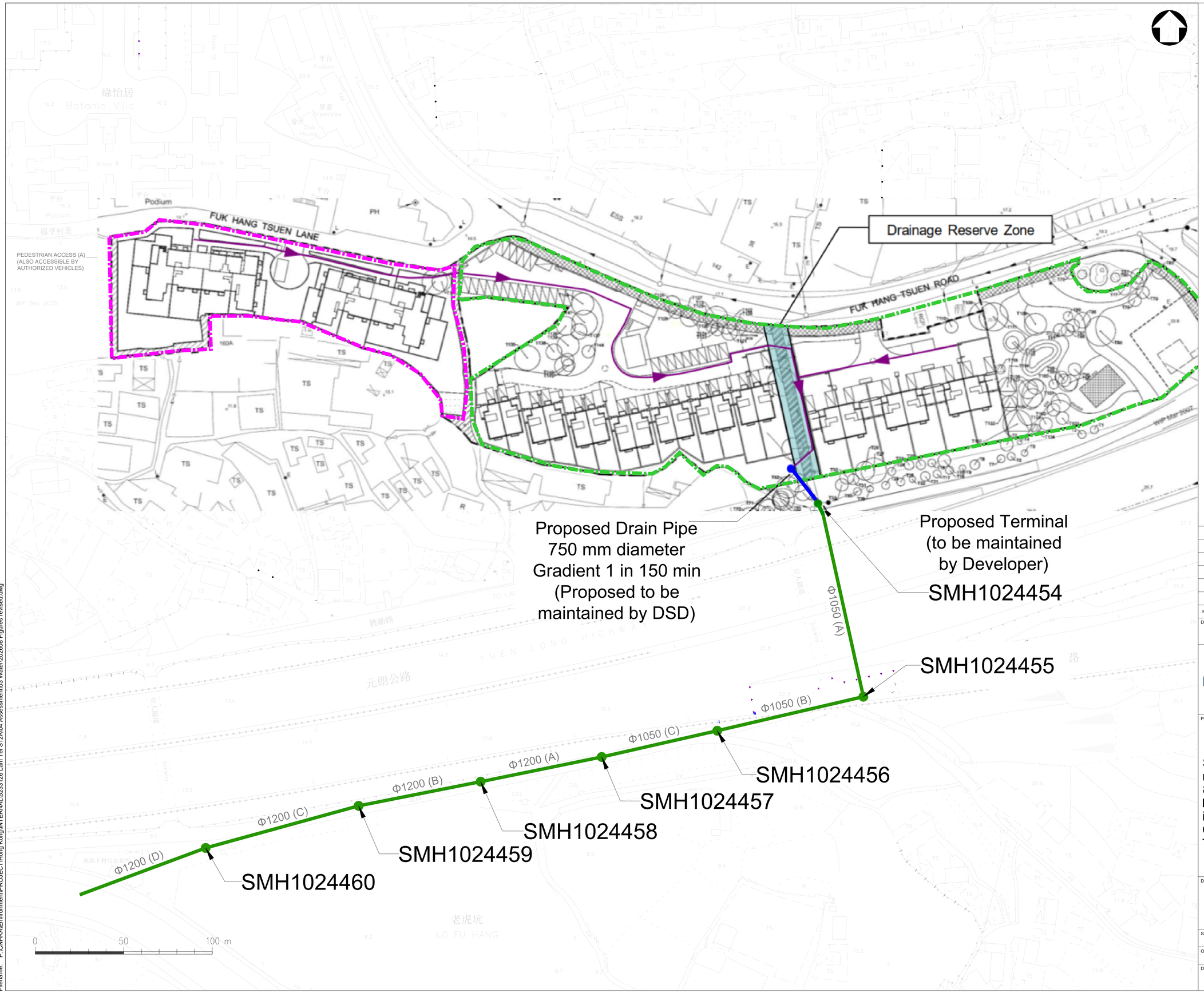
5.1.3 The surface runoff from the Proposed Development will ultimately discharge through the existing downstream drainage system to Lo Fu Hang Channel and Tuen Mun River. Subject to implementation of the proposed drainage arrangement and detailed design verification of the proposed pipe levels and gradient, the Proposed Development is not anticipated to cause an adverse drainage impact or increase the flood risk in the surrounding area.

5.1.4 A Drainage Reserve Area will also be provided for the existing 900 mm diameter stormwater drainage pipe within the Rezoning Site to facilitate future inspection, repair and maintenance without requiring diversion of the pipe.

APPENDICES

Appendix A.

Proposed Drainage Network under the Previously Approved Planning Scheme



LEGEND:

- REZONING SITE BOUNDARY
- SITE A BOUNDARY
- SITE B BOUNDARY
- EXISTING DRAINAGE PIPELINE AT DOWNSTREAM
- PROPOSED TERMINAL DRAIN
- PROPOSED DRAINAGE SYSTEM WITHIN THE REZONING SITE (INDICATIVE ONLY, SUBJECT TO DETAILED DESIGN)

Rev.	Date	Description	By	Chk'd	App'd
A	JUL 2026	FIRST ISSUE	AC	WKC	AF

Drawing Status: PRELIMINARY SUBMISSION

Suitability: -

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Project Title

Section 12A Planning Application for rezoning Lot Nos. 837 RP (part), 839 S.A RP (part), 841 (part), 1035 RP, 1037 RP and 2527 S.F RP (part) in D.D. 130 and Adjoining Government Land at Lam Tei, Tuen Mun

Drawing Title

PROPOSED DRAINAGE NETWORK OF THE REZONING SITE UNDER PREVIOUS APPROVED PLANNING SCHEME

Scale	Designed	Drawn	Checked	Authorised
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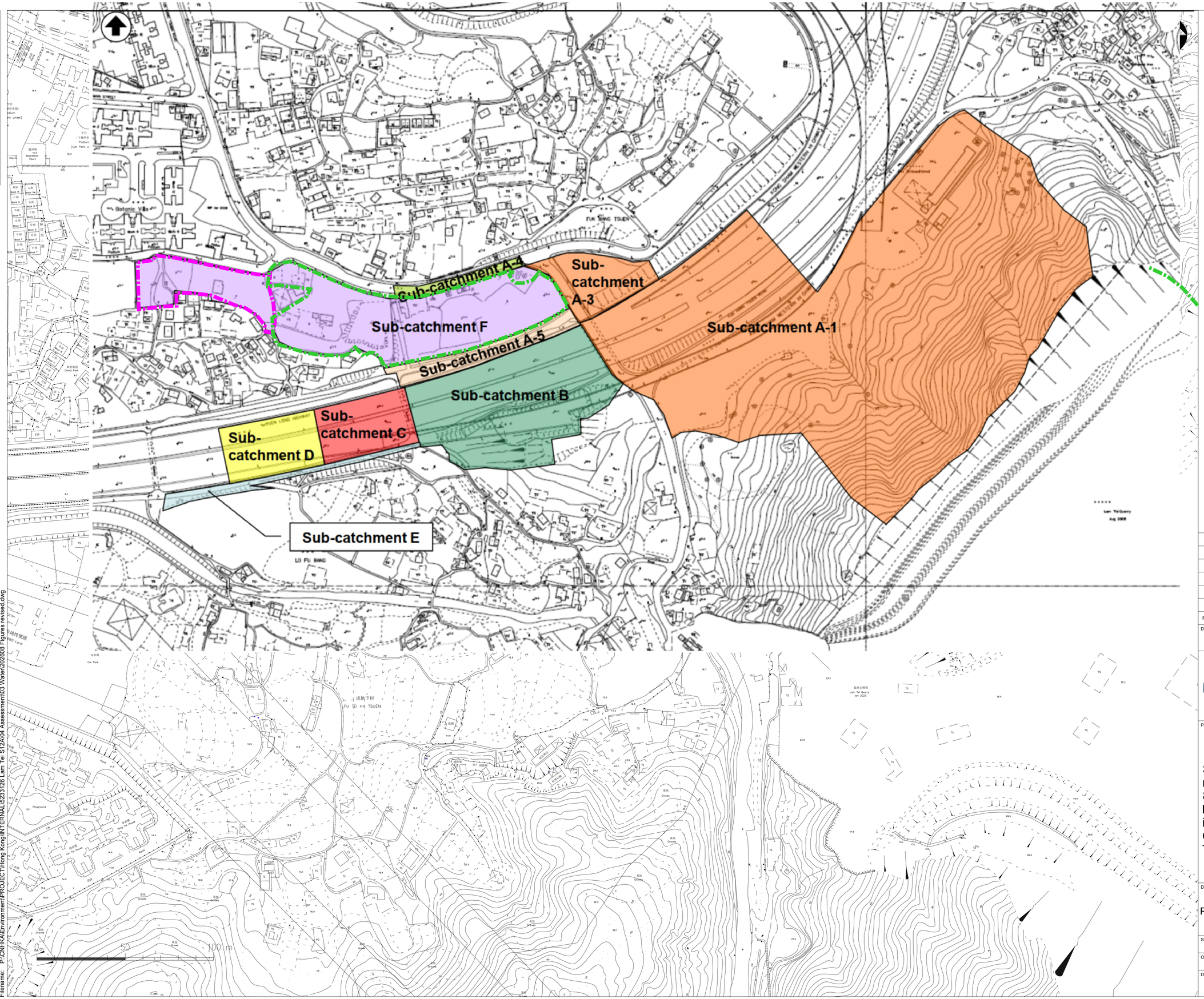
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Appendix B.

Existing Catchment Plan and Proposed Catchment Plans for the Approved Scheme and Present Proposed Scheme



LEGEND:

- REZONING SITE BOUNDARY
- SITE A BOUNDARY
- SITE B BOUNDARY

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A	JUL 2026	FIRST ISSUE	AC	WKC	AF

Drawing Status: PRELIMINARY SUBMISSION

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Project Title

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Drawing Title

EXISTING CATCHMENT PLAN FOR 1050 MM AND 1200 MM DIA. PIPE AND PRESENT PROPOSED SCHEME

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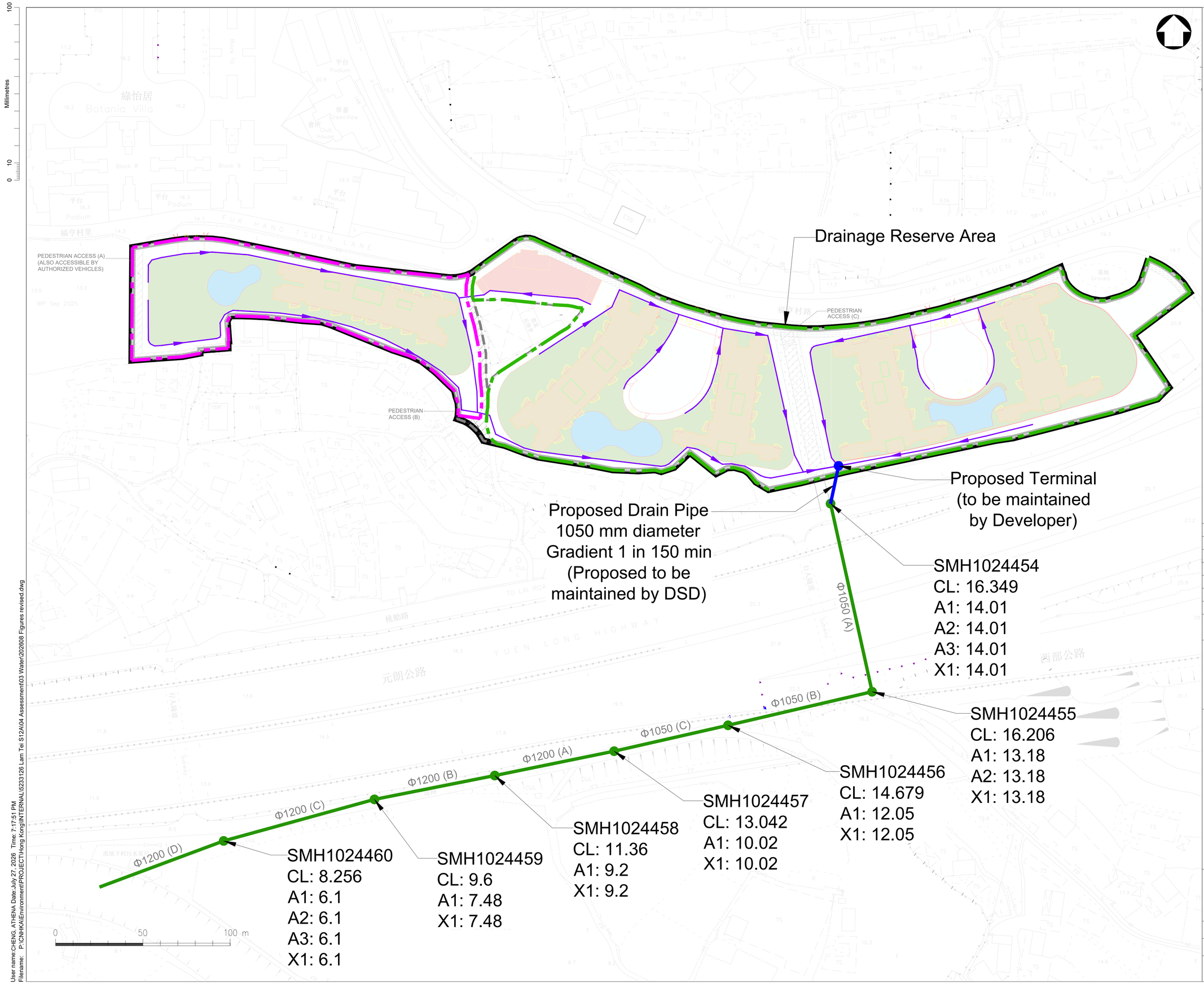
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Appendix C.

Proposed Drainage Network of the Rezoning Site under the Present Proposed Scheme



LEGEND:

- REZONING SITE BOUNDARY
- SITE A BOUNDARY
- SITE B BOUNDARY
- EXISTING DRAINAGE PIPELINE AT DOWNSTREAM
- PROPOSED TERMINAL DRAIN
- PROPOSED DRAINAGE SYSTEM WITHIN THE REZONING SITE (INDICATIVE ONLY, SUBJECT TO DETAILED DESIGN)

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Drawing Title

PROPOSED DRAINAGE NETWORK OF THE REZONING SITE UNDER PRESENT PROPOSED SCHEME

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Appendix D.

Proposed Runoff Estimation and Drainage Pipe Capacity Checking

Appendix D Proposed Runoff Estimation and Drainage Pipe Checking

Objective Determine the runoff to the downstream drainage system under the previously approved and proposed conditions, taking into account the updated rainfall intensity and revised land-use composition within the Rezoning Site.

Methodology

1. Determine the catchment areas and boundaries contributing to the proposed 750 mm diameter connection and the existing downstream 1050 mm and 1200 mm diameter pipes.
2. Determine the runoff directions and land uses to assign suitable runoff coefficients to the catchments
3. Determine the rainfall intensity for the catchments using the Stormwater Drainage Manual (SDM) formula.
4. Incorporate the mid 21st century rainfall increase due to climate change parameter to the calculated rainfall intensity.
5. Use the Rational Method stated in the SDM to estimate the runoff contributing to the downstream drainage system.
6. Use the Colebrook-White Equation to determine the capacity of the downstream drainage pipes, and check against the revised design flow.

1. Determine the Catchment for the Downstream Drainage

Existing catchment area of the Application Site

Portion	Overall Catchment Area (m2)	Grassland Area (m2)	Paved Area (m2)	Extent of Sub-catchment
Application Site	15,731	4,670	11,061	F

Proposed catchment area of the Rezoning Site

Portion	Overall Catchment Area (m2)	Grassland Area (m2)	Paved Area (m2)	Extent of Sub-catchment
Rezoning Site	15,731	3,146	12,585	F

Previously approved catchment area of the 1050 to 1200 pipeline

Existing Pipelines	Overall Catchment Area (m2)	Grassland Area (m2)	Paved Area (m2)	Extent of Sub-catchment
1050 mm diameter (A)	92,908	60,377	32,531	A-1, A-3, A-4, A-5, F
1050 mm diameter (B)	105,974	66,910	39,064	A-1, A-3, A-4, A-5, B, F
1050 mm diameter (C)	105,974	66,910	39,064	A-1, A-3, A-4, A-5, B, F
1200 mm diameter (A)	109,232	66,910	42,322	A-1, A-3, A-4, A-5, B, C, F
1200 mm diameter (B)	109,232	66,910	42,322	A-1, A-3, A-4, A-5, B, C, F
1200 mm diameter (C)	113,122	66,910	46,212	A-1, A-3, A-4, A-5, B, C, D, F
1200 mm diameter (D)	114,182	67,970	46,212	A-1, A-3, A-4, A-5, B, C, D, E, F

Proposed catchment area of the 1050 to 1200 pipeline

Existing Pipelines	Overall Catchment Area (m2)	Grassland Area (m2)	Paved Area (m2)	Extent of Sub-catchment
1050 mm diameter (A)	92,908	58,853	34,055	A-1, A-3, A-4, A-5, F
1050 mm diameter (B)	105,974	65,386	40,588	A-1, A-3, A-4, A-5, B, F
1050 mm diameter (C)	105,974	65,386	40,588	A-1, A-3, A-4, A-5, B, F
1200 mm diameter (A)	109,232	65,386	43,846	A-1, A-3, A-4, A-5, B, C, F
1200 mm diameter (B)	109,232	65,386	43,846	A-1, A-3, A-4, A-5, B, C, F
1200 mm diameter (C)	113,122	65,386	47,736	A-1, A-3, A-4, A-5, B, C, D, F
1200 mm diameter (D)	114,182	66,446	47,736	A-1, A-3, A-4, A-5, B, C, D, E, F

* Sub-catchment A-2 represents the previous condition arrangement and is reconfigured into Sub-catchment F under the proposed condition.

2. Determine the Rainfall Intensity for the Catchment

The rainfall intensity for the catchment was determined with reference to Section 4.3.3 of the Stormwater Drainage Manual, Corrigendum No. 1/2024 issued by the Drainage Services Department. The Corrigendum recommends the use of the Intensity-Duration-Frequency (IDF) relationship based on rainfall statistics at HKO Headquarters for general application, except for Tai Mo Shan, West Lantau and North District areas. The IDF data for durations not exceeding 240 minutes can be expressed using the following a,b,c formula:

$$i = \frac{a}{(t_d + b)^c}$$

where: $i = extreme\ mean\ intensity\ in\ mm/hr$

$t_d = duration\ in\ minutes\ (t_d \leq 240), and$

$a, b, c = storm\ constants\ for\ the\ corresponding\ return\ period, as\ presented\ in\ Table\ 5a\ of\ DSD's\ SDM$

For this assessment, a 1-in-50-year return period has been adopted in accordance with the design standard for an urban drainage branch system. The rainfall intensity has been determined using the intensity-duration-frequency relationship in Section 4.3.3 of DSD's Stormwater Drainage Manual. The corresponding storm constants for each return period have been adopted from Table 5a of DSD's SDM. The calculated rainfall intensities have been adjusted by a factor of 1.111 to account for the adopted mid-21st-century rainfall increase due to climate change.

$a = 451.3, b = 2.46, c = 0.337$

$t_d = 9.29\ min$

$$i = \frac{451.3}{(9.29 + 2.46)^{0.337}}$$

$i \approx 196.7\ mm/hr$

The revised extreme mean rainfall intensity is calculated, with reference to SDM Corrigendum No. 1/2022 (Table 28 Rainfall Increase due to Climate Change)

$i_{revised} = i * 1.111$

$= 196.7 * 1.111$

$\approx 218.6\ mm/hr$

Revised Condition

For 1050 mm diameter (A) pipe:

Distance (L) = 220 m

Average slope (H) = (Change in height/L)

H = (80-32)/220

H = 21.64%

Area of catchment (A) = 92,908 m2

t0 = 5.48 min

tf = Length of pipe/Velocity (assume stream velocity = 3 m/s)

Length of pipe = 685 m

tf = 3.81 min

td = 9.29 min

SDM Corrigendum No. 1/2024
Section 4.3.3

$$i = \frac{a}{(t_d + b)^c}$$

where i is the rainfall intensity

Return period	2	5	10	20	50	100	200	500	1000	
$i =$	137.9	161.7	174.2	185.0	196.7	203.5	209.8	216.9	221.1	mm/hr
$i_{revised} (i * 1.11) =$	153.2	179.6	193.5	205.6	218.6	226.0	233.1	241.0	245.6	mm/hr

The adopted revised i for 1-in-50-year storm is 218.6 mm/hr

For 1050 mm diameter (B) pipe:

t0 = 5.48 min

tf = Length of pipe/Velocity (assume stream velocity = 3 m/s)

Length of pipe = 745 m

tf = 4.14 min

td = 9.62 min

Return period	2	5	10	20	50	100	200	500	1000	
$i =$	136.3	159.9	172.4	183.2	194.9	201.7	208.1	215.2	219.4	mm/hr
$i_{revised} (i * 1.11) =$	151.4	177.6	191.5	203.5	216.5	224.0	231.1	239.1	243.8	mm/hr

The adopted revised i for 1-in-50-year storm is 216.5 mm/hr

For 1050 mm diameter (C) pipe:

t0 = 5.48 min

tf = Length of pipe/Velocity (assume stream velocity = 3 m/s)

Length of pipe = 789 m

tf = 4.38 min

td = 9.86 min

Return period	2	5	10	20	50	100	200	500	1000	
$i =$	135.1	158.6	171.1	181.9	193.6	200.4	206.8	214.0	218.3	mm/hr
$i_{revised} (i * 1.11) =$	150.1	176.2	190.1	202.1	215.1	222.6	229.8	237.7	242.5	mm/hr

The adopted revised i for 1-in-50-year storm is 215.1 mm/hr

For 1200 mm diameter (A) pipe:

t0 = 5.48 min

tf = Length of pipe/Velocity (assume stream velocity = 3 m/s)

Length of pipe = 825 m

tf = 4.58 min

td = 10.06 min

Return period	2	5	10	20	50	100	200	500	1000	
$i =$	134.2	157.6	170.0	180.9	192.6	199.3	205.8	213.0	217.3	mm/hr
$i_{revised}(i * 1.11) =$	149.1	175.1	188.9	200.9	213.9	221.5	228.6	236.6	241.4	mm/hr

The adopted revised i for 1-in-50-year storm is 213.9 mm/hr

For 1200 mm diameter (B) pipe:

t0 = 5.48 min

tf = Length of pipe/Velocity (assume stream velocity = 3 m/s)

Length of pipe = 860 m

tf = 4.78 min

td = 10.26 min

Return period	2	5	10	20	50	100	200	500	1000	
$i =$	133.3	156.6	169.0	179.8	191.5	198.3	204.8	212.0	216.4	mm/hr
$i_{revised}(i * 1.11) =$	148.1	174.0	187.8	199.8	212.8	220.3	227.5	235.6	240.4	mm/hr

The adopted revised i for 1-in-50-year storm is 212.8 mm/hr

For 1200 mm diameter (C) pipe:

t0 = 5.48 min

tf = Length of pipe/Velocity (assume stream velocity = 3 m/s)

Length of pipe = 900 m

tf = 5.00 min

td = 10.48 min

Return period	2	5	10	20	50	100	200	500	1000	
$i =$	132.3	155.6	167.9	178.7	190.4	197.2	203.7	211.0	215.4	mm/hr
$i_{revised}(i * 1.11) =$	147.0	172.8	186.6	198.6	211.6	219.1	226.4	234.4	239.3	mm/hr

The adopted revised i for 1-in-50-year storm is 211.6 mm/hr

For 1200 mm diameter (D) pipe:

t0 = 5.48 min

tf = Length of pipe/Velocity (assume stream velocity = 3 m/s)

Length of pipe = 948 m

tf = 5.27 min

td = 10.75 min

Return period	2	5	10	20	50	100	200	500	1000	
$i =$	131.1	154.3	166.6	177.4	189.1	195.9	202.5	209.8	214.2	mm/hr
$i_{revised}(i * 1.11) =$	145.7	171.4	185.1	197.1	210.1	217.7	224.9	233.1	237.9	mm/hr

The adopted revised i for 1-in-50-year storm is 210.1 mm/hr

3.1 Determine Proposed Flow to the 750 mm, 1050 mm and 1200 mm Diameter Pipes

SDM Cl. 7.5.2

Assumptions:

1. The whole catchment can be described by four types of catchment characteristics - grassland, paved, road, and developed areas.
2. A runoff coefficient of 0.30 has been adopted for grassland areas, with reference to the range of 0.25 to 0.35 for steep grassland in Clause 7.5.2 of the SDM.
3. A runoff coefficient of 0.95 has been adopted for paved, road and developed areas, with reference to the range of 0.80 to 0.95 for concrete surfaces in Clause 7.5.2 of the SDM. The upper end of the range has been adopted as a conservative assumption.

The proposed peak runoff to each downstream pipe is calculated using the Rational Method.

SDM Cl. 7.5.2

$$Q_p = 0.278 i \sum_{j=1}^{m} C_j A_j$$

where $Q_p = Peak\ runoff\ in\ m^3/s$
$i = Rainfall\ intensity\ in\ mm/hr$
$C_j = Runoff\ coefficient$
$A_j = Catchment\ area\ in\ km^2$
$m = Number\ of\ sub-catchments$

3.2 Calculation of Proposed Peak Runoff

For Proposed Rezoning Site:

$i_{revised}$ =	218.6	mm/hr		
Grassland area =	3,146	m2 =	0.003146	km2
Paved area =	12,585	m2 =	0.012585	km2
Grassland runoff coefficient =	0.3			
Paved runoff coefficient =	0.95			

$Q_p = 0.278(218.6)((0.30*0.003146)+(0.95*0.012585))$
$Q_p = 0.7838$ m3/s
≈ 0.78 m3/s

For 1050 mm diameter (A)

$i_{revised}$ =	218.6	mm/hr		
Grassland area =	58,853	m2 =	0.058853	km2
Paved area =	34,055	m2 =	0.034055	km2
Grassland runoff coefficient =	0.3			
Paved runoff coefficient =	0.95			

$Q_p = 0.278(218.6)((0.30*0.058853)+(0.95*0.034055))$
$Q_p = 3.0385$ m3/s
≈ 3.04 m3/s

3.3 Summary of Revised Flow for a 1-in-50-Year Rainstorm

Revised peak runoff = 0.278 × revised rainfall intensity × [(0.30 × grassland area in km²) + (0.95 × paved area in km²)]

	Rezoning Site	1050 mm diameter (A)	1050 mm diameter (B)	1050 mm diameter (C)	1200 mm diameter (A)	1200 mm diameter (B)	1200 mm diameter (C)	1200 mm diameter (D)	
Flow	0.78	3.04	3.50	3.48	3.64	3.62	3.82	3.81	m3/s

4.1 Existing Drainage Capacity of the Downstream 1050 mm and 1200 mm Diameter Pipes Based on the Revised Flows in Section 3.3

Assumptions:

1. Pipe roughness is 0.6 mm.
2. Transitional flow is assumed, with water at 15°C, with a kinematic viscosity is 1.14 * 10^-6 m2/s.
3. Pipe geometries and gradients are based on the existing downstream drainage system.

SDM Table 12

Using the Colebrook-White Equation to Determine the Drainage Capacity

$$\bar{V} = -\sqrt{32gRS_f}\log[\frac{k_s}{14.8R} + \frac{1.255v}{R\sqrt{32gRS_f}}]$$

Full-bore capacity for 1050 mm diameter (A) pipe:

Pipe diameter =	1050	mm
Pipe roughness =	0.6	mm
Length of pipe =	60	m
Upstream invert =	14.06	mPD
Downstream invert =	13.22	mPD
Hydraulic gradient, Sf =	0.014	
Gradient 1 in =	71.43	
Full-bore capacity =	3.53	m3/s

The downstream 1050 mm diameter (A) pipe can be classified as "Urban Drainage Branch System" and should thus be designed for 1-in-50 years return period rainstorm.

The revised flow of 3.04 m3/s is 86% of the full-bore capacity of 3.53 m3/s. **OK**

Therefore, the current downstream 1050 mm diameter (A) pipe is capable of conveying the revised flow while maintaining 10% flow capacity allowance for siltation.

Full-bore capacity for 1050 mm diameter (B) pipe:

Pipe diameter =	1050	mm
Pipe roughness =	0.6	mm
Length of pipe =	44	m
Upstream invert =	13.22	mPD
Downstream invert =	12.21	mPD
Hydraulic gradient, Sf =	0.023	
Gradient 1 in =	43.56	
Full-bore capacity =	4.53	m3/s

The downstream 1050 mm diameter (B) pipe can be classified as "Urban Drainage Branch System" and should thus be designed for 1-in-50 years return period rainstorm.

The revised flow of 3.50 m3/s is 77% of the full-bore capacity of 4.53 m3/s. **OK**

Therefore, the current downstream 1050 mm diameter (B) pipe is capable of conveying the revised flow while maintaining 10% flow capacity allowance for siltation.

Full-bore capacity for 1050 mm diameter (C) pipe:

Pipe diameter =	1050	mm
Pipe roughness =	0.6	mm
Length of pipe =	36	m
Upstream invert =	11.96	mPD
Downstream invert =	10.96	mPD
Hydraulic gradient, Sf =	0.028	
Gradient 1 in =	36.00	
Full-bore capacity =	4.98	m3/s

The downstream 1050 mm diameter (C) pipe can be classified as "Urban Drainage Branch System" and should thus be designed for 1-in-50 years return period rainstorm.

The revised flow of 3.48 m3/s is 70% of the full-bore capacity of 4.98 m3/s. **OK**

Therefore, the current downstream 1050 mm diameter (C) pipe is capable of conveying the revised flow while maintaining 10% flow capacity allowance for siltation.

Full-bore capacity for 1200 mm diameter (A) pipe:

Pipe diameter =	1200	mm
Pipe roughness =	0.6	mm
Length of pipe =	35	m
Upstream invert =	9.96	mPD
Downstream invert =	9.46	mPD
Hydraulic gradient, Sf =	0.014	
Gradient 1 in =	70.00	
Full-bore capacity =	5.06	m3/s

The downstream 1200 mm diameter (A) pipe can be classified as "Urban Drainage Branch System" and should thus be designed for 1-in-50 years return period rainstorm.

The revised flow of 3.64 m3/s is 72% of the full-bore capacity of 5.06 m3/s. **OK**
Therefore, the current downstream 1200 mm diameter (A) pipe is capable of conveying the future flow while maintaining 10% flow capacity allowance for siltation.

Full-bore capacity for 1200 mm diameter (B) pipe:

Pipe diameter =	1200	mm
Pipe roughness =	0.6	mm
Length of pipe =	40	m
Upstream invert =	8.31	mPD
Downstream invert =	7.65	mPD
Hydraulic gradient, Sf =	0.017	
Gradient 1 in =	60.61	
Full-bore capacity =	5.44	m3/s

The downstream 1200 mm diameter (B) pipe can be classified as "Urban Drainage Branch System" and should thus be designed for 1-in-50 years return period rainstorm.

The revised flow of 3.62 m3/s is 67% of the full-bore capacity of 5.44 m3/s. **OK**
Therefore, the current downstream 1200 mm diameter (B) pipe is capable of conveying the future flow while maintaining 10% flow capacity allowance for siltation.

Full-bore capacity for 1200 mm diameter (C) pipe:

Pipe diameter =	1200	mm
Pipe roughness =	0.6	mm
Length of pipe =	48	m
Upstream invert =	7.09	mPD
Downstream invert =	6.14	mPD
Hydraulic gradient, Sf =	0.020	
Gradient 1 in =	50.53	
Full-bore capacity =	5.96	m3/s

The downstream 1200 mm diameter (C) pipe can be classified as "Urban Drainage Branch System" and should thus be designed for 1-in-50 years return period rainstorm.

The revised flow of 3.82 m3/s is 64% of the full-bore capacity of 5.96 m3/s. **OK**
Therefore, the current downstream 1200 mm diameter (C) pipe is capable of conveying the future flow while maintaining 10% flow capacity allowance for siltation.

Full-bore capacity for 1200 mm diameter (D) pipe:

Pipe diameter =	1200	mm
Pipe roughness =	0.6	mm
Length of pipe =	37	m
Upstream invert =	6.14	mPD
Downstream invert =	5.44	mPD
Hydraulic gradient, Sf =	0.019	
Gradient 1 in =	52.63	
Full-bore capacity =	5.84	m3/s

The downstream 1200 mm diameter (D) pipe can be classified as "Urban Drainage Branch System" and should thus be designed for 1-in-50 years return period rainstorm.

The revised flow of 3.81 m3/s is 65% of the full-bore capacity of 5.84 m3/s. **OK**
Therefore, the current downstream 1200 mm diameter (D) pipe is capable of conveying the future flow while maintaining 10% flow capacity allowance for siltation.

4.2 Existing size of pipe connecting the outlet point of the Rezoning Site with revised flow

Discharge flow = 0.78 m3/s
Diameter of pipe = 750 mm

Assumption
Pipe material = Precast concrete
Pipe diameter = 750 mm
Pipe roughness = 0.6 mm
Min. design gradient = 1 in 150
Full-bore capacity = 1.01 m3/s
Utilization = 78%

* The hydraulic capacity shall be reconfirmed against the final pipe length and proposed upstream/downstream invert levels during detailed design.

The revised flow of 0.78 m3/s is 78% of the full-bore capacity of 1.01 m3/s. **OK**
Therefore, the proposed 750 mm diameter pipe connecting the outlet point of the Rezoning Site to the downstream drainage system is capable of conveying the future flow while maintaining at least 10% flow capacity allowance for siltation.

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