Appendix C

Revised Drainage Impact Assessment

Hong Kong International Innovation and Technology Hub Limited

Section 12A Planning Application for Proposed Innovation and Technology Hub at Various Lots in D.D. 82 and D.D. 86 and Adjoining Government Land, Man Kam To, New Territories

Drainage Impact Assessment

Final | Feb 2025

Job number

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ARUP

Contents

1 Introduction

1.1 Background

The Applicant proposes amendments to the Approved Man Kam To Outline Zoning Plan No. S/NE-MKT/4 ("the OZP") by rezoning the Application Site from "Agriculture" ("AGR"), "Green Belt" ("GB") and "Government, Institution or Community" ("G/IC") to a tailor-made "Other Specified Uses" ("OU") annotated "Innovation and Technology Hub", with a maximum non-domestic gross floor area (GFA) of 365,180m^2 and a maximum domestic GFA of 170,400m^2 (including dormitory) and maximum building heights (BH) of 80, 90, 110 and 120 meters above principal datum (mPD) for four sub-areas respectively, to facilitate the development of the proposed Innovation and Technology (I&T) Hub.

Currently, the Application Site is largely vacant with vegetation and inactive farmland, and covers a portion of the access road from Lin Ma Hang Road leading to the existing River Ganges Pumping Station.

The Application Site, with a site area of about 125,863m^2, is located at Man Kam To in the North District. It is on a gentle sloping from site level of about 6mPD near Ping Yuen River to 25mPD near the eastern foot of Lo Shue Ling. The Application Site includes the Development Site (of an area about 102,461m^2) and remaining land parcels adjoining the Development Site for better rationalisation of boundary and land use zoning.

1.2 Objectives

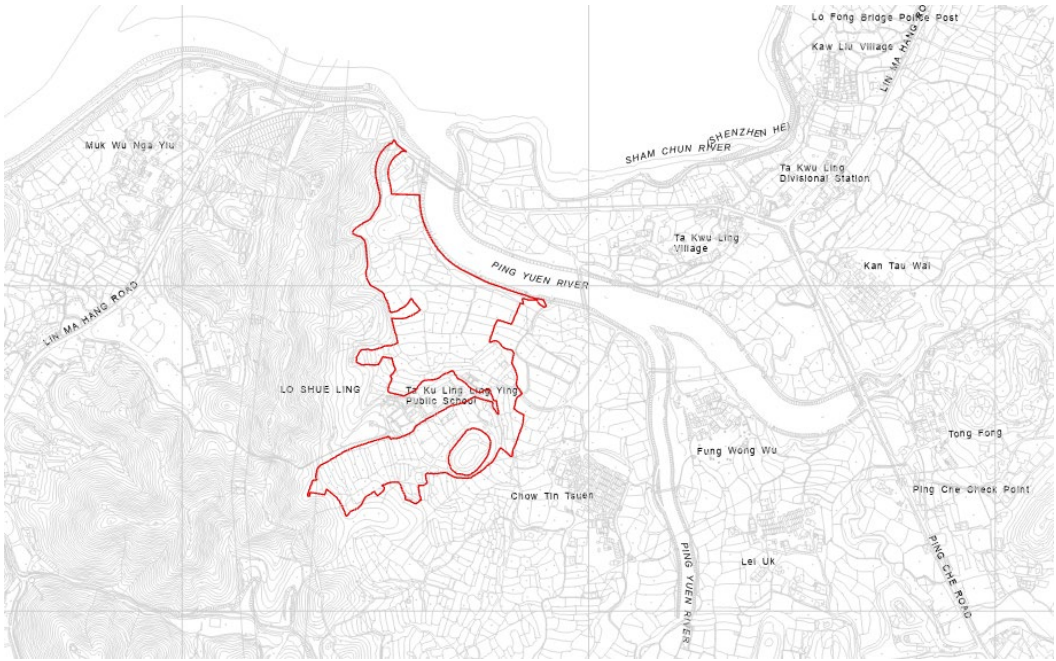
The objective of this report is to provide an assessment of the impact of storm water flow generation as a result of the proposed development at the Application Site on the connecting public drainage system adjacent to the Application Site and to propose mitigation measures (if any).

2 Project Outline

2.1 Subject Development

The Application Site is located in Man Kam To, New Territories, bounded by Ping Yuen River to the northeast, Lo Shue Ling to the west and Chow Tin Tsuen to the east. There is an existing public school surrounded by the site, as shown in **Figure 2.1**. In the vicinity of the Site there are mainly scattered village houses and agricultural land. A master layout plan of Indicative Scheme in the Development Site is enclosed in **Appendix A**.

Figure 2.1: Location Plan of the Development Site



2.2.1 The development parameters of the Indicative Scheme are presented in **Table 2.1**:

Table 2.1: Key Development Parameters Table

	Indicative Scheme
Application Site Area (1)	About 125,863 m^2
Development Site Area	About 102,461 m^2
Total Plot Ratio (2)	5.23
- Non-Domestic PR	3.57
- Domestic PR	1.66
Total Gross Floor Area	535,580 m^2
- **Non-Domestic GFA**	365,180 m^2
R&D Centre	*268,780 m^2*
Data Centre	*86,400 m^2*
Commercial Centre	*9,276 m^2*
Kindergarten (3)	*724 m^2*

-	**Domestic GFA**		170,400 m^2
	Ancillary Dormitories		*63,900 m^2*
	Other Residential Uses		*106,500 m^2*
-	**Clubhouse GFA** (4)		3,500 m^2
Building Height			
1.	*R&D Centre*	Building Height	83m
		mPD	90mPD
		No. of Storeys (5)	16
2.	*Data Centre*	Building Height	73m
		mPD	80mPD
		No. of Storeys (5)	12
3.	*Commercial Centre*	Building Height	30m
		mPD	37mPD
		No. of Storeys (5)	6
4.	*Ancillary Dormitories*	Building Height	99-102.15m
		mPD	110mPD
		No. of Storeys (6)	30-31
5.	*Other Residential Uses*	Building Height	99-105.3m
		mPD	120mPD
		No. of Storeys (6)	30-32
Anticipated No. of Working Population			6,207
6.	*R&D Centre* (7)		*5,375*
7.	*Data Centre* (8)		*432*
8.	*Commercial* (9)		*400*
No. of Units			3,712
9.	*Ancillary Dormitories*		*1,392*
10.	*Other Residential uses*		*2,320*
Average Flat Size (10)			35.5 m^2
Anticipated Population (11)			10,022
11.	*No. of Tenants of Ancillary Dormitories*		*3,758*
12.	*No. of Population of Other Residential Uses*		*6,264*
Local Open Space			Not less than 13,126 m^2
13.	For *Workers*		*Not less than 3,104 m^2*
14.	For *Residents*		*Not less than 10,022 m^2*
Target Completion Year			2028

Remarks:
(1) Application Site includes the Development Site and remaining land parcels adjoining the Development Site for better rationalisation of boundary and land use zoning.
(2) PR calculations are based on the area of Development Site. May not add up due to rounding.
(3) The kindergarten with 6-classroom of about 724m^2 GFA fulfils the minimum floor space requirement specified in the EBD's Operation Manual for Pre-primary Institute. Indicative only, subject to detailed design.
(4) According to APP-104, a maximum area of 3,500m^2 can be applied for GFA concession for a development with domestic GFA of >100,000m^2 to 125,000m^2. The clubhouse GFA (intended for use by residents of Other Residential Uses) is proposed to be exempted from GFA calculation.
(5) The no. of storeys excludes basement carparks.
(6) The no. of storeys excludes 1-storey lobby and basement carparks.
(7) An assumption of 50m^2 per worker is assumed for R&D Centre, with reference to Employment Density Guide (3rd Ed.) in the UK.
(8) An assumption of 200m^2 per worker is assumed for Data Centre, with reference to Employment Density Guide (3rd Ed.) in the UK.

[9] An assumption of 25m^2 per worker is assumed for commercial uses (retail, F&B), with reference to HKPSG Chapter 5.
[10] Average flat size is assumed as 35.5m^2 which has excluded area required for corridor, lift shaft, lobby, staircase, etc.
[11] A person per flat (PFF) ratio of 2.7 is assumed, according to the average household size of the Territory and North District in 2021 Census.

2.2 Project Interface

No foreseeable interaction or conflict with other development projects in the vicinity of the Application Site was identified when this DIA was conducted.

3 Existing Drainage

3.1 Existing Drainage Network

The Application Site locates at the east flank of Lo Shue Ling. Surface run-off from Lo Shue Ling runs freely through the application site and discharges to the U channel along the west bank of Ping Yuen River. There is no existing drainage pipe within the application site. Detailed existing drainage network information is found on GEOINFO MAP in **Appendix B**.

Four catchments associated with the existing drainage system were identified based on the existing topography, namely B1 to B4. Catchment Plans of existing Site and proposed development are shown in **Appendix C**. Basic information of the 4 catchments are summarised in **Table 3.1**.

Table 3.1: Existing Drainage Catchments

No.	Area (m^2)	Outlet
B1	37,866	SBP1007220
B2	35,414	SCH1023991
B3	45,887	SBP1007222
B4	176,604	SBP1007223

Based on the preliminary calculation of the catchment area, the capacity of the outlet (SCH1023991) of catchment B2 is not sufficient.

The capacity checking of existing drainage system is presented in **Appendix E**.

4 Assumptions and References

4.1 Climate Change

Climate change is taken into account in existing drainage system capacity check calculation. 16.0% Rainfall intensity increase for end of 21st century (2081-2100) is included referring to Stormwater Drainage Manual CORRIGENDUM No. 1/2022, Table 28. The design allowance in end of 21st century of 12.1% rainfall increase is included referring to Stormwater Drainage Manual CORRIGENDUM No. 1/2022, Table 31

4.2 Desilting

Referring to SDM 2018 section 9.3(a), 10% reduction in flow area is adopted in capacity checking of pipe/channel for taking into account of the effects to flow capacity due to materials deposited on the pipe/channel bed.

5 Drainage Impact Assessment for the Proposed Development

5.1 Catchment Area Changes

Comparing the existing and the proposed catchment area, it can be found that:

a) The existing catchment areas within Site is almost 100% unpaved. The proposed catchment areas within Site will be 25% unpaved and 75% hard-paved referring to Mater Layout Plan.

b) The rest of the catchment area will remain the same as before.3

Table 5.1 Summary of Development Parameters

Development Parameters	Existing Site	Development Site
Area (m^2)	About 102,461 m^2	About 102,461 m^2
% of Hard-paved Area/ Unpaved Area	Hard-paved Area: 0% Unpaved Area: 100%	Hard-paved Area: 75% Unpaved Area: 25%
Statutory Land Use Zoning	AGR / GB / G/IC	OU

5.2 Assessment Results

Referring to the summary of catchment area changes in **Table 5.1**, the proposed catchment area of surface run-off discharging to the existing drainage pipe is increased and some catchment areas are changed from unpaved to hard-paved. The sub-catchment is changed due to the development. the original outlet of sub-catchment B is now abandoned. Both sub-catchment A2 and A3 is now discharged to box culvert SBP1007222. As a result, the hydraulic capacity of east drainage system has been checked and the result shows that there is no adverse impact caused by the catchment area change. The capacity checking of east drainage system is presented in **Appendix E**.

It is worth noting that Ta Ku Ling Ling Ying Public School (TKLLYPS) and Chow Tin Tsuen (CTT) are adjacent to the Development Site. However, the Development Site locates in the upstream of the TKLLYPS and CTT. Therefore the increase of runoff caused by the Development Site will not affect TKLLYPS and CTT.

In addition, the capacity of Ping Yuen River is roughly estimated as $311m^3/s$[1]. The increased stormwater runoff is about 1% of the Ping Yuen River capacity.

[1] Due to the lack of information, the capacity is calculated under the following assumption: Width: 53m; Side slope: 1/2; Bottom slope: 0.003; Roughness: 0.02. The assumption is made based on GEOINFO MAP and River Tour photo found on DSD website.
https://www.dsd.gov.hk/EcoDMS/EN/River_Channels/Ping_Yuen_River/River_Tour.html

A drainage storage tank with the volume of increased stormwater run-off is suggested to reduce the impact from the Development Site to Ping Yuen River. Further study will be carried in later stage of the study.

5.3 Proposed Drainage Diversion

To suit the arrangement of proposed development, the existing drainage system adjacent to the Application Site are required to be diverted:

Catchment A1

As there is no existing drainage pipe within the catchment A1. In order to prevent the runoff from Lo Shue Ling, a u-channel is proposed along the west boundary of the site. UC01 is 1000mm wide and will be discharged to the catchpit SCH1023989. Access to the u-channel and the drains will be provided to DSD for future operation and maintenance.

Catchment A2 &A3

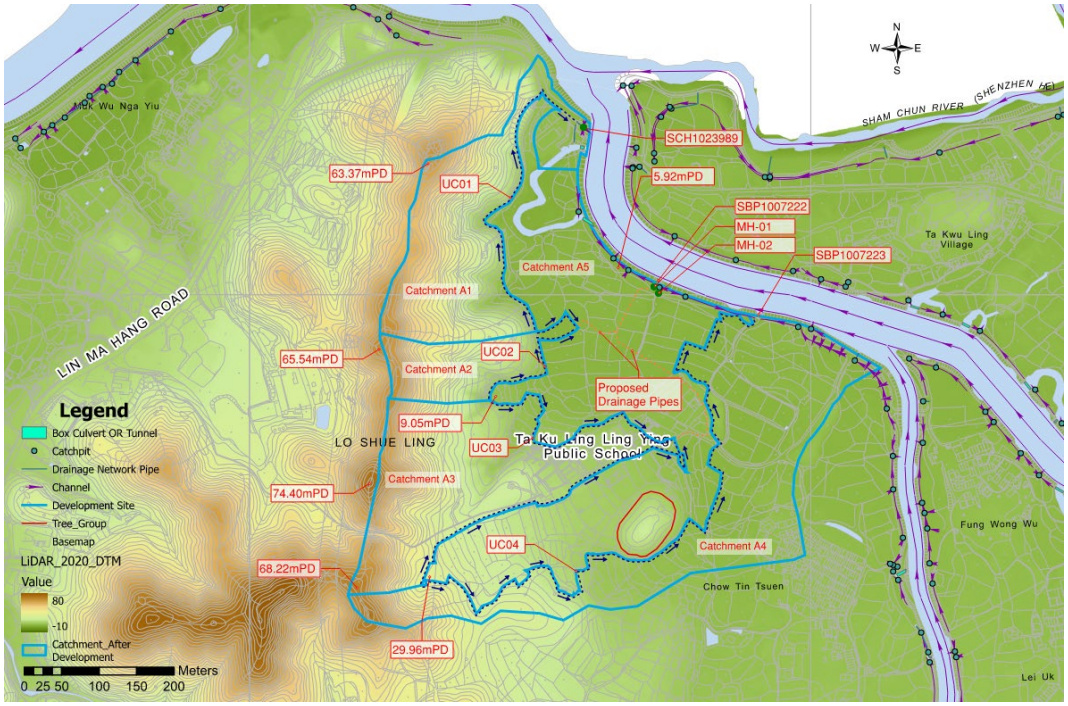
As there is no existing drainage pipe within the catchment A2 & A3. In order to prevent the runoff from Lo Shue Ling, two u-channels are proposed along the west boundary of the site. UC02 is 700mm wide and UC03 is 1100mm wide. The rainwater collected by UC02 and UC03 will be discharged to the proposed manhole MH-01 through the new proposed drainage pipes within the Development Site. MH-01 will be connected to the existing box culvert SBP1007222. Access to the u-channel and the drains will be provided to DSD for future operation and maintenance.

Catchment A4

As there is no existing drainage pipe within the catchment A4. In order to prevent the runoff from Lo Shue Ling, a u-channel is proposed along the west boundary of the site. UC04 is 1200mm wide and will be discharged to the existing box culvert SBP1007223. Access to the u-channel and the drains will be provided to DSD for future operation and maintenance.

The catchment associated with the proposed drainage diversion were identified based on the existing topography and proposed development plan. The catchment plan after development and drainage diversion Scheme is illustrated in **Appendix D**. The proposed u-channels are indicated in **Figure 5.1**.

Figure 5.1: Location Plan of the Proposed u-channels



It is worth noting that there are existing drainage pipes along the bank of Ping Yuen River within the study boundary. During the development of the proposed site, the existing drainage pipes will be preserved and maintained from any possible damage.

5.4 Proposed Storage Tank

The proposed development will cause an increase in surface water runoff. In order to avoid adverse impacts to Ping Yuen River during the rainy days, a storage tank is proposed on site to collect the extra flow.

The volume of the storage tank will be able to hold the extra flow after development. The surface water will be drained to the storage tank by gravity and discharge to Ping Yuen River by pump. The storage tank will be located on the basement 1 floor. The volume of the storage tank is calculated as follows:

$$V_s = (Q_{After} - Q_{Before}) \times T_c$$

V_s - Volume of storage tank

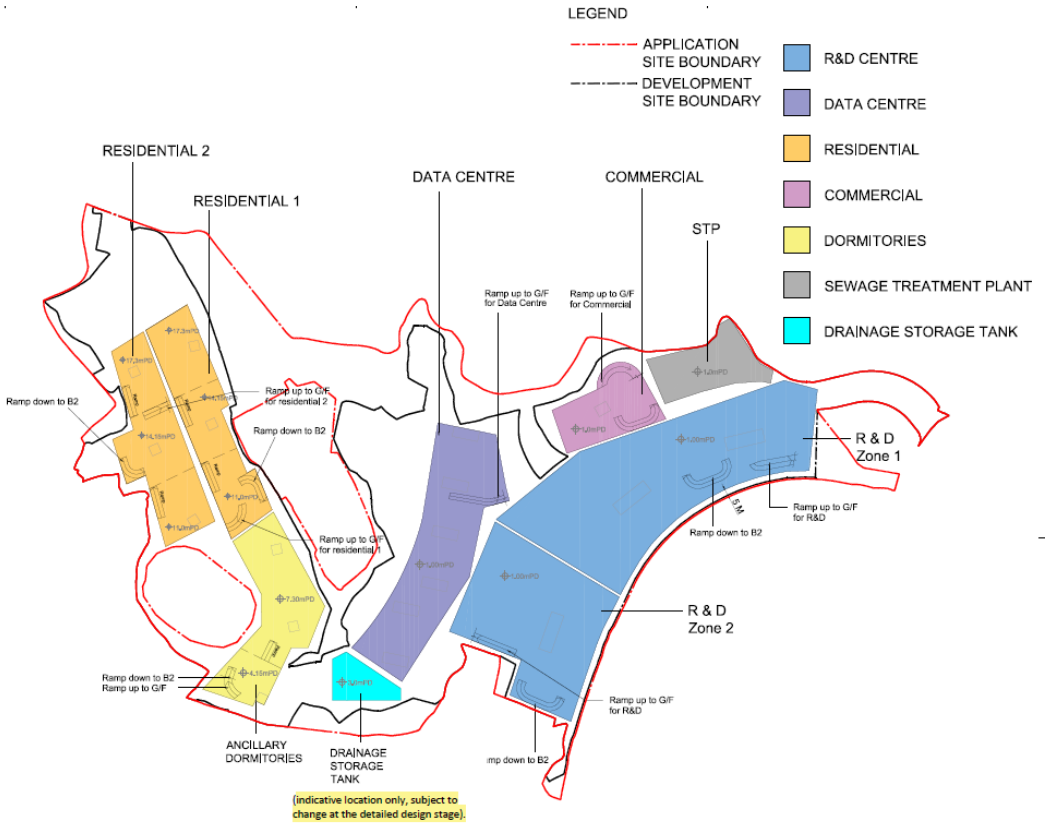
Q_{After} - Total flow after development

Q_{Before} - Total flow before development

T_c - Time of concentration

The volume of the storage tank is calculated to be 2541m^3. The proposed dimension of the storage tank is 25m × 35m ×4m(H). The proposed location of the storage tank is indicated on **Figure 5.2**. Detailed calculation could be referred to **Appendix E.**

Figure 5.2: Indicated Location of the Proposed Storage Tank



5.5 Proposed Stormwater Manhole

The proposed stormwater terminal manhole MH-01 and MH-02 are located at the northeast corner of the Site to receive stormwater flow from the Application Site. It will be connected to the existing 1950ø box culvert drain.

The catchment plan after development and the proposed manholes are presented in **Appendix D**.

5.6 Flooding Susceptibility

The proposed site exhibits ground levels ranging from approximately +7.0mPD to +24.0mPD from riverside to west and riverside may be subject to tidal influences. The water level of the Ping Yuen River at Lin Ma Hang Road, based on rainstorm data from Corrigendum No. 1/2024 without adjustments for climate change, has been provided by DSD and is detailed in **Table 5.2**. The extreme water level anticipated under the most severe scenario (200A) is measured at 7.538mPD.

Table 5.2 Water Level of Ping Yuen River at Lin Ma Hang Road based on Rainstorm as per Corrigendum No. 1/2024 without Climate Change Adjustment

50A (mPD)	50B (mPD)	200A (mPD)	200B (mPD)
7.021	6.375	7.538	6.496

According to Corrigendum No. 1/2022, the Mean Sea Level Rise for a 1 in 200 return period attributed to Climate Change by the end of the 21st Century is projected at 0.47m (Referenced from Table 29 of Corrigendum No. 1/2022 SDM). Additionally, Storm Surge escalation for the same return period due to Climate Change by the end of the 21st Century is estimated at 0.34m (Referenced from Table 30b of Corrigendum No. 1/2022 SDM). Consequently, the design extreme water level in the Ping Yuen River, factoring in climate change effects, is estimated at 8.348mPD, surpassing the intended ground level along riverside in the Development Site.

To mitigate potential flooding risks, it is recommended to construct a flood wall along the site where ground level is lower than 8.348mPD. According to SDM2018, 200mm freeboard is considered to the flood wall. Therefore, the top level of the flood wall is round up to be 8.550mPD.

The ground level of the main entrance in the north of the Development is 8mPD. It is proposed to install flood barrier during extreme rainfall situation.

Stormwater accumulated within the site will be directed to a storage tank and subsequently pumped to the Ping Yuen River post peak flow to manage drainage effectively. Flood valve should be installed at the end of the outlet pipe to pretend backflow.

6 Conclusion

Capacity of the existing public drainage system adjacent to the proposed development has been checked. The hydraulic capacity of the existing 1950ø public drain along Ping Yuen River on the east of the Application Site is sufficient.

U-channels are proposed along the Site boundary for diverting the stormwater running from Lo Shue Ling.

In general, there is no adverse drainage impact caused by the Application Site on the surrounding.

Appendix A

Master Layout Plan

LEGEND

- APPLICATION SITE BOUNDARY
- DEVELOPMENT SITE BOUNDARY
- SITE FORMATION LEVEL
- SITE RUN-IN/OUT
- ACCESS TO BASEMENT CARPARK
- R&D CENTRE
- DATA CENTRE
- RESIDENTIAL
- COMMERCIAL
- ANCILLARY DORMITORIES
- CLUBHOUSE
- LANDSCAPE AREA
- SEWAGE TREATMENT PLANT
- PROMENADE

N

PROPOSED FOOTBRIDGE

R 1 32 storeys ◆120mPD
R 2 31 storeys ◆120mPD
R 3 31 storeys ◆120mPD
R 4 32 storeys ◆120mPD
R 5 33 storeys ◆120mPD
CH 1 4 storeys ◆34.7mPD
Existing School
AD 1 31 storeys ◆110mPD
KINDERGARTEN 1 storey ◆15.5mPD
AD 2 31 storeys ◆110mPD
AD 3 32 storeys ◆110mPD
FUNG SHUI WOODLAND
DC 1 12 storeys ◆80mPD
DC 2 12 storeys ◆80mPD
DC 3 12 storeys ◆80mPD
C 1 6 storeys ◆37mPD
STP 2 storeys ◆17mPD
R&D 1 16 storeys ◆90mPD
R&D 2 16 storeys ◆90mPD (Transport Interchange on the ground floor)
R&D 3 16 storeys ◆90mPD
EVA

ACCESS ROAD TO EXISTING SCHOOL
DRIVEWAY / EVA
PROPOSED FOOTBRIDGE
10M PROMENADE
EXISTING PUMPING STATION

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Rev.	Date	Description

Notes
1. Do not scale drawings. Dimensions govern.
2. Verify dimensions in field. Notify WCWP of discrepancies.
3. Dimensions in mm unless otherwise noted.
4. Not for construction unless expressly certified.

Key Plan

Client
Hong Kong International Innovation Tech Hub

Consultants

Issue
Planning Application

BD Ref: BD 2/9188/10 (PT. II)
FSD Ref: FP 8/9584/VII <131>

Authorized Person

Project
The Nexus

Project Number: 20027
Date: 20230629
Scale: 1:3000 at A3
Drawn/Approved: CL/TL

Title
Master Layout Plan

Number: MLP-001
Revision: -

LEGEND

APPLICATION SITE BOUNDARY

DEVELOPMENT SITE BOUNDARY

R&D CENTRE

DATA CENTRE

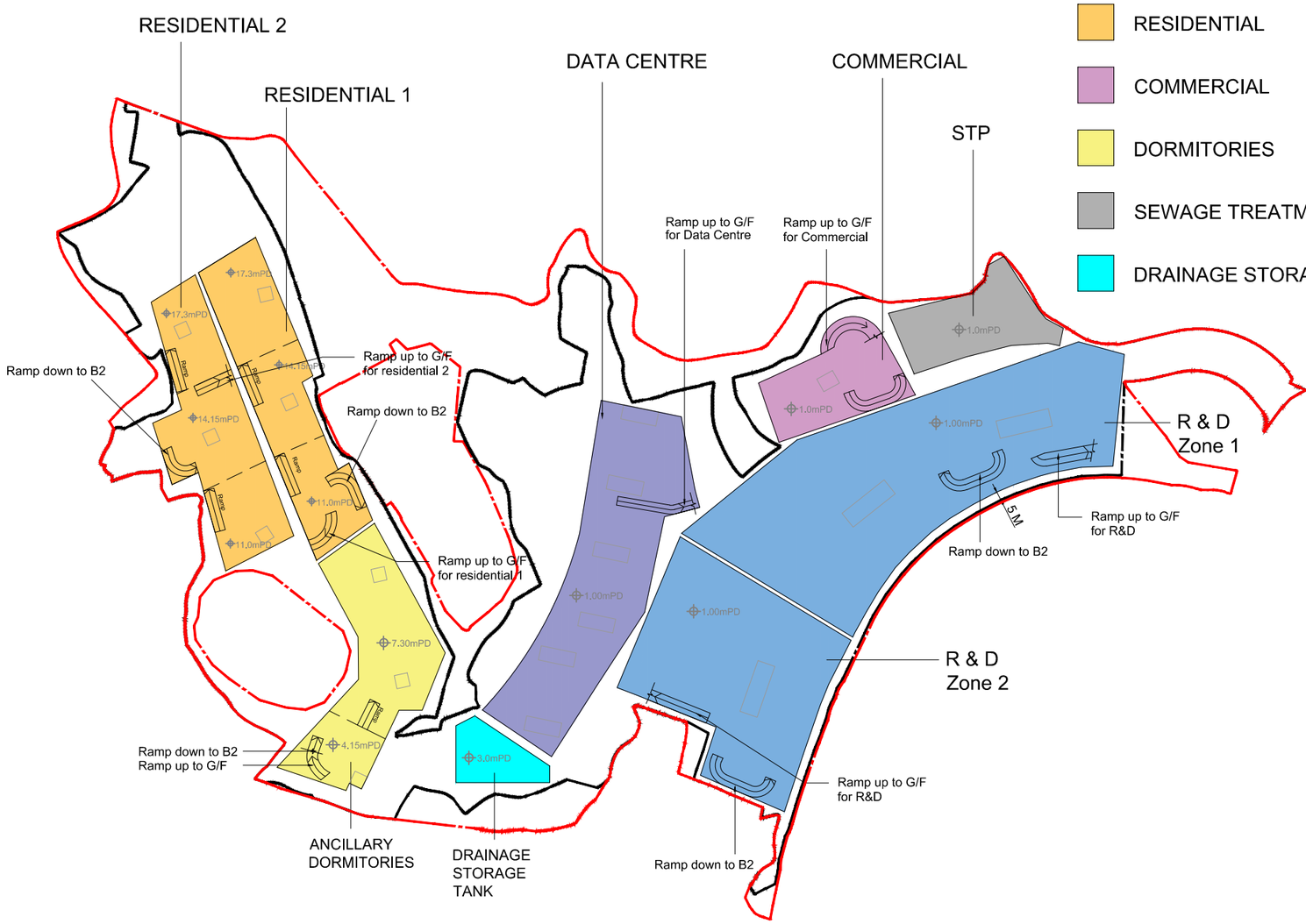
RESIDENTIAL

COMMERCIAL

DORMITORIES

SEWAGE TREATMENT PLANT

DRAINAGE STORAGE TANK



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Rev.	Date	Description

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Key Plan

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Hong Kong International Innovation Tech Hub

Consultants

Issue
Planning Application

BD Ref: BD 2/9188/10 (PT. II)
FSD Ref: FP 8/9584/VII <131>

Authorized Person

Project
The Nexus

Project Number	Date
20027	20240822
Scale	Drawn/Approved
1:3000 at A3	CL/TL

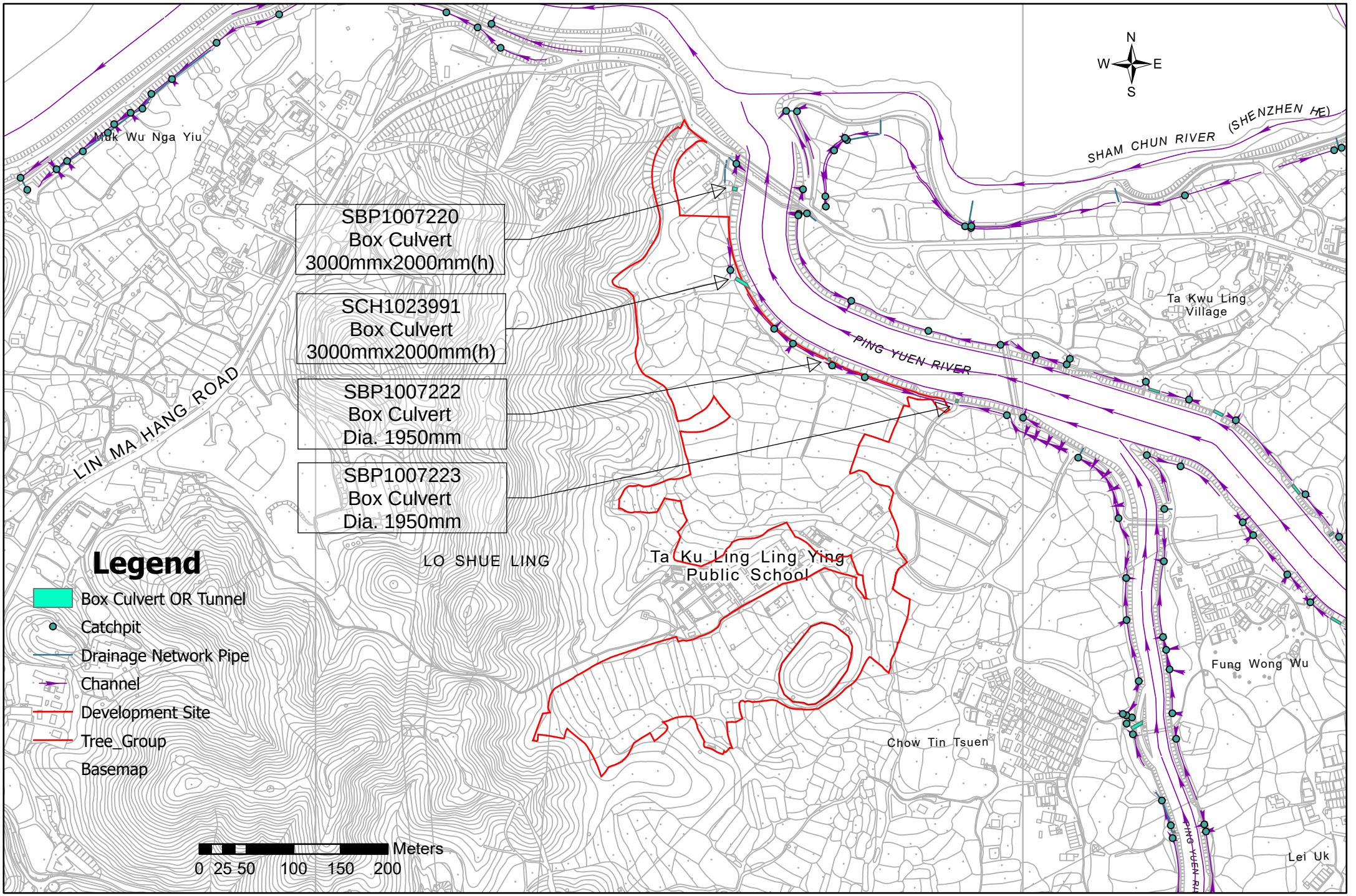
Title
B1 Basement Level

Number	Revision
B1-003	-

Appendix B

Existing Drainage Network Information

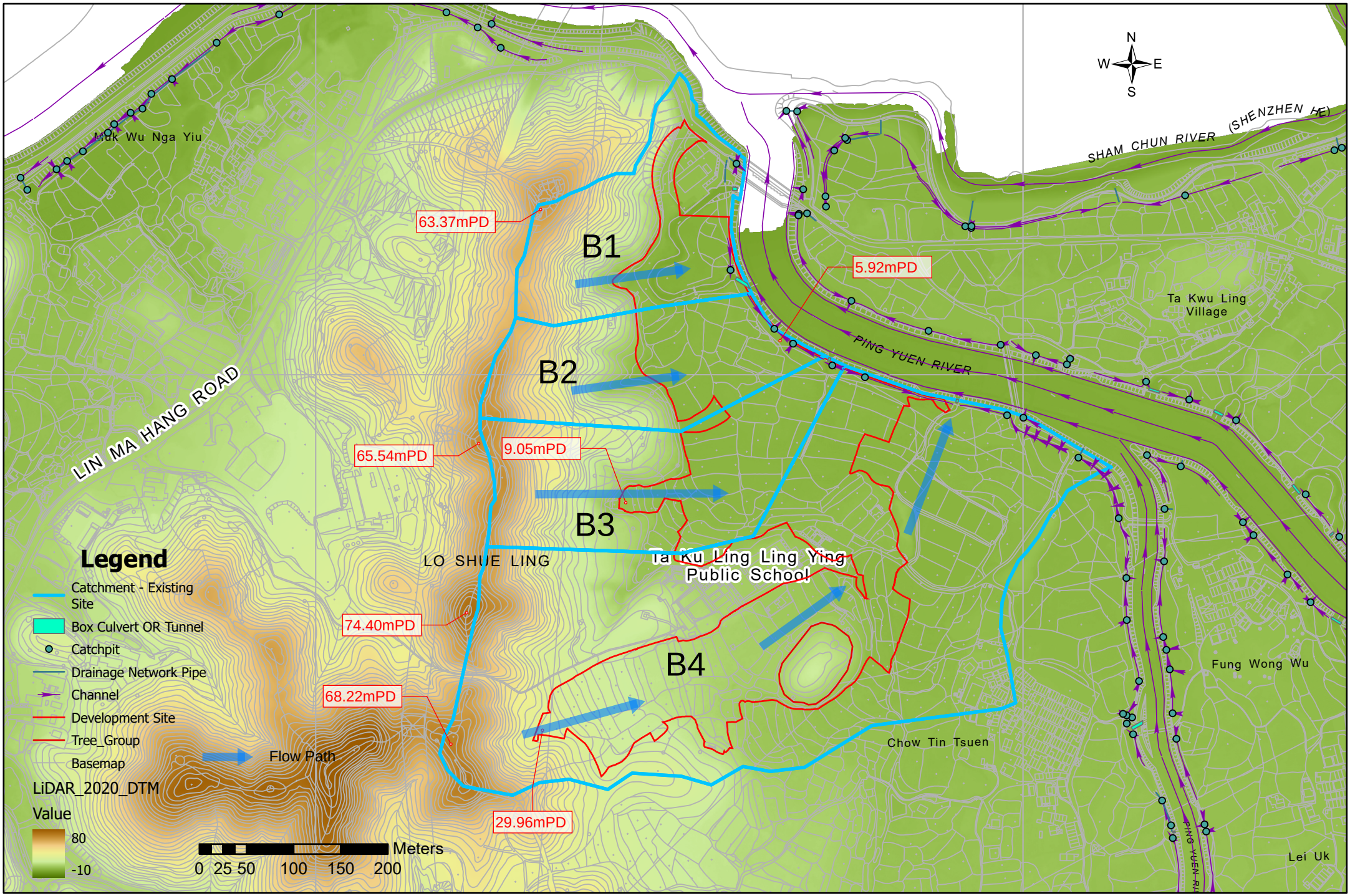
Appendix B - Detailed Existing Drainage Network Information



Appendix C

Catchment Plans of Existing Site

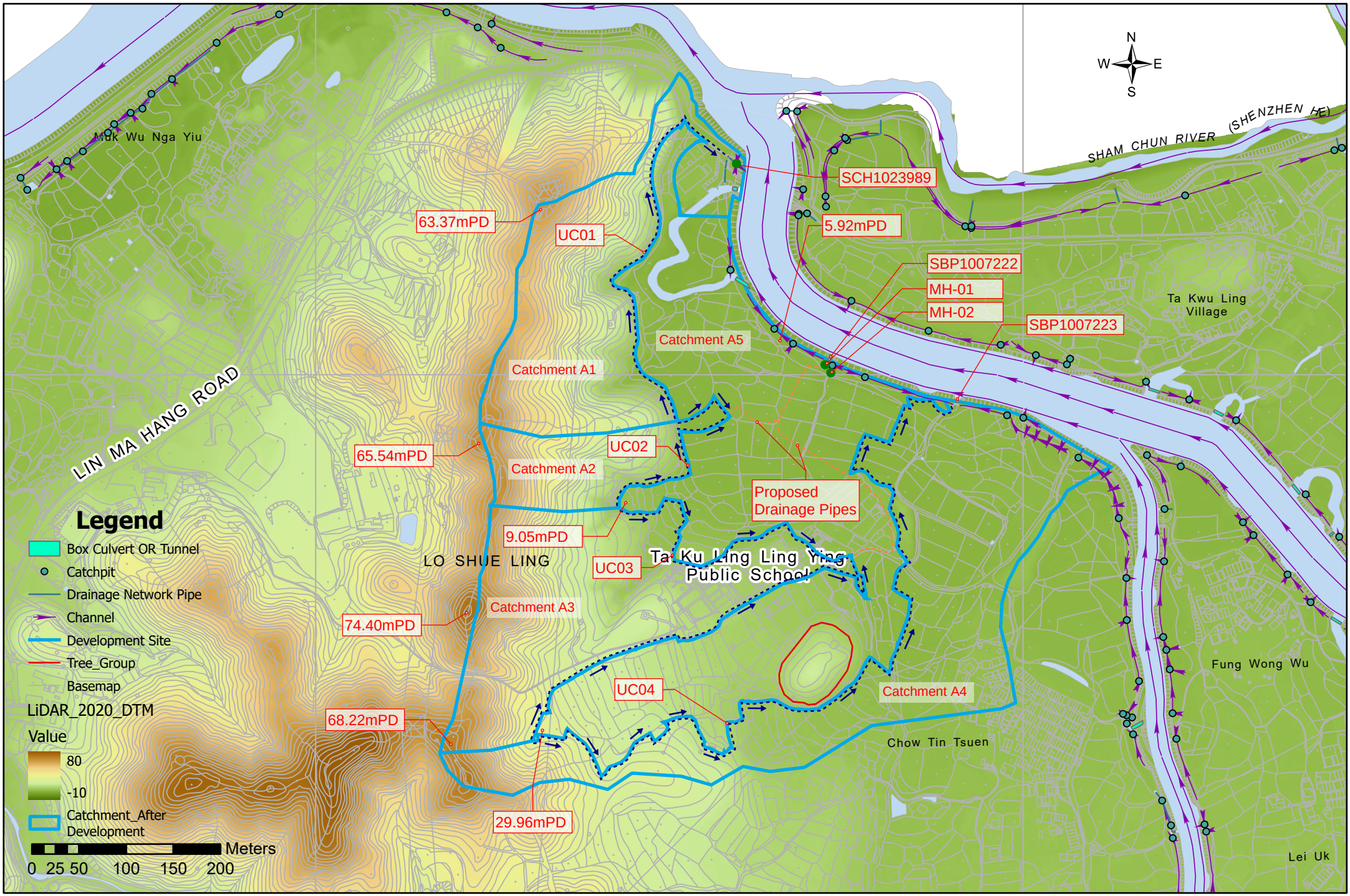
Appendix C - Catchment Plan of Existing Site



Appendix D

Catchment Plans of Indicative Scheme in the Development Site

Appendix D - Catchment Plans of Indicative Scheme in the Development Site



Appendix E

Drainage Capacity Checking Calculation

Drainage Impact Assessment

Capacity Checking for Existing Drainage

Runoff Coeff., C = 0.95 (Paved)
0.15 (Flat Grassland)
0.35 (Steep natural slope)

Return Period = 50 years Urban Drainage Branch Systems
200 years Urban Drainage Trunk Systems

Rainfall Intensity, $I = a / (T_c + b)^c$ (Gumbel solution)
T = 50 years
where : a = 474.6
b = 2.9
c = 0.371
(Table 3d, Corrigendum No.1/2024, Stormwater Drainage Manual, Fifth Edition)

Inlet Time, $T_0 = 0.14465 L / H^{0.2} / A^{0.1}$ (Bransby Williams Equation)
where : L = Longest distance measured on the line of natural flow between the submit and the point under consideration (m)
H = Average slope (m per 100m)
A = Sub-catchment area (m2)

Peak Runoff ,Q = IA

Pipe Capacity $Q_p=VA$

$$\overline{V} = -\sqrt{32gRS_f}\,\log\left[\frac{k_s}{14.8R} + \frac{1.255\nu}{R\sqrt{32gRS_f}}\right]$$

(By Colebrook-White Equation)

Roughness Coeff., Ks = 0.60 mm (Circular Box culvert / pre-cast concrete pipe)

Ks = 3.30 mm (channel, Trowel finish)

Kinematic Viscosity, u = 0.0000012 m^2/s

Acceleration due to gravity g = 9.81 m/s^2

Calculation for Inlet Time for Natural Catchment plus WSD Catchwater Catchment

Catchment	L (m)	U/S G/L (mPD)	D/S G/L (mPD)	H (m/100m)	A (m^2)	T_o (min)
B1	318	63.37	5.17	18.30	37,866	8.96
B2	305	64.60	5.85	19.26	35,414	8.57
B3	417	65.27	4.50	14.57	45,887	12.07
B4	668	72.38	4.72	10.13	176,604	18.17

295770
295,771

Climate Change Factor (%) = 16.00% (Table 28, Stormwater Drainage Manual CORRIGENDUM No. 1/2022, for rainfall increase at End of 21st Century 2081 – 2100)

Design Allowence (%)= 12.10% (Table 31, Stormwater Drainage Manual CORRIGENDUM No. 1/2022, for rainfall increase at End of 21st Century around 2090)

Table 1 Capacity Checking of Existing Pipe & Box Culvert (T = 50 years) for Existing Drainage

Contributing Catchment	Area (m^2)			Accumulated Factored Area A, (m^2)	L (m)	H (m/100m)	T_o (min.)	T_f (min.)	T_c (min.)	I (mm/hr)	I (mm/hr) incl. Climate C	Q (m^3/s) incl. Climate C	Existing Downstream Drainage														
	steep natural slope	flat grassland	Paved										Upstream Stormwater Manhole Ref	Downstream Stormwater Manhole Ref	size of channel / culvert / pipe width (m)	height (m)	Length (m)	US GL (mPD)	Invert Level US (mPD)	DS (mPD)	Slope (S_0)	A (m^2)	P (m)	R = A/P (m)	$32gRS_f$ m^2/s^2	Capacity (m^3/s)	Velocity (m/s)	Flow %
B1	18,035	14,756		8525	-	-	8.96	0.02	9.44	186.81	242.92	0.58		SBP1007220	3.00	2.00	4.78	4.980	2.21	-	0.0040	6.00	10.00	0.60	0.75	21.62	3.60	28%
B2	16,405	16,405		8203			8.57	0.09	0.09	316.03	410.95	0.94		SCH1023991	0.60	-	8.49	5.610	-	-	0.0040	0.28	1.88	0.15	0.19	0.43	1.53	216%
B3	18,624	18,624		9312			12.07	0.02	9.47	186.68	242.75	0.63		SBP1007222	1.95	-	3.62	4.760	-	-	0.0040	2.99	6.13	0.49	0.61	7.79	2.61	8%
B4	57,678	57,678		28839			18.17	0.02	0.11	315.28	409.98	3.28		SBP1007223	1.95	-	3.67	5.150	-	-	0.0040	2.99	6.13	0.49	0.61	9.49	3.18	35%
												5.42														39.34		14%

Drainage Impact Assessment

Capacity Checking for Proposed Drainage

Runoff Coeff., C = 0.95 (Paved)
0.15 (Flat Grassland)
0.35 (Steep natural slope)

Return Period = 50 years Urban Drainage Branch Systems
200 years Urban Drainage Trunk Systems

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Peak Runoff ,Q = IA

Pipe Capacity $Q_p = VA$

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

(By Colebrook-White Equation)

Roughness Coeff., Ks = 0.60 mm (Circular Box culvert / pre-cast concrete pipe)
Ks = 0.15 mm (D.I. pipe with epoxy lining, poor condition)
Ks = 3.30 mm (channel, Trowel finish)

Kinematic Viscosity, u = 0.0000012 m^2/s

Acceleration due to gravity g = 9.81 m/s^2

Calculation for Inlet Time for Natural Catchment plus WSD Catchwater Catchment

Catchment	L (m)	U/S G/L (mPD)	D/S G/L (mPD)	H (m/100m)	A (m^2)	T_o (min)
A1	207	65.64	6.77	28.44	45,850	5.24
A2	253	65.54	6.34	23.40	16,772	7.36
A3	399	29.74	7.36	5.61	53,180	13.77
A4	668	72.38	5.55	10.00	77,507	19.78
A5	701	29.96	5.92	3.43	102,461	25.00

Climate Change Factor (%) = 16.00% (Table 28, Stormwater Drainage Manual CORRIGENDUM No. 1/2022, for rainfall increase at End of 21st Century 2081 – 2100)

Design Allowence (%)= 12.10% (Table 31, Stormwater Drainage Manual CORRIGENDUM No. 1/2022, for rainfall increase at End of 21st Century around 2090)

Table 2 Capacity Checking of Existing Pipe & Box Culvert (T = 50 years) for Proposed Drainage

Contributing Catchment	Area (m^2)			Accumulated Factored Area A, (m^2)	L (m)	H (m/100m)	T_o (min.)	T_f (min.)	T_c (min.)	I (mm/hr)	I (mm/hr) incl. Climate C	Q (m^3/s) incl. Climate C	Existing/ Proposed Downstream Drainage													
	steep natural slope	flat grassland	Paved										Upstream Stormwater Manhole Ref	Downstream Stormwater Manhole Ref	size of channel / culvert / pipe width (m)	height (m)	Length (m)	US GL (mPD)	Invert Level US (mPD)	DS (mPD)	Slope (S_0)	A (m^2)	P (m)	R = A/P (m)	$32gRS_f$ m^2/s^2	Capacity (m^3/s)	Velocity (m/s)	Flow %
A1	41,265			14443	-	-	5.24	3.49	8.74	190.95	248.31	1.00		SCH1023989	1.00	1.00	442.00	4.980	2.21	-	0.0040	1.00	4.00	0.25	0.31	2.11	2.11	47%
A2	15,095			5283	-	-	7.36	0.02	7.38	199.91	259.95	0.38		MH-01	1.95	-	3.62	4.760	-	-	0.0040	2.99	6.13	0.49	0.61	9.49	3.18	4%
A3	42,544		10,636	24995	-	-	13.77	0.02	13.79	167.03	217.20	1.51		MH-01	1.95	-	3.62	4.760	-	-	0.0040	2.99	6.13	0.49	0.61	9.49	3.18	16%
A4	23,252	54,255		16276	-	-	13.77	0.02	13.79	167.03	217.20	0.98		SBP1007223	1.95	-	3.67	5.150	-	-	0.0040	2.99	6.13	0.49	0.61	9.49	3.18	10%
A5	20,492	20,492	61,477	68649	-	-	19.78	0.02	19.79	149.03	193.80	3.70		MH-02	1.95	-	3.62	4.760	-	-	0.0040	2.99	6.13	0.49	0.61	9.49	3.18	39%
												7.56															36%

	Q_{After} (m^3/s)	Q_{Before} (m^3/s)	T_c (min.)	V (m^3)
Volume of Storage Tank	7.56	5.42	19.79	2541

Drainage Impact Assessment

Capacity Checking for Proposed Drainage

Runoff Coeff., C = 0.95 (Paved)
0.15 (Flat Grassland)
0.35 (Steep natural slope)

Return Period = 50 years Urban Drainage Branch Systems
200 years Urban Drainage Trunk Systems

Rainfall Intensity, $I = a / (T_c + b)^c$ (Gumbel solution)
T = 50 years
where : a = 474.6
b = 2.9
c = 0.371 (Table 3, Stormwater Drainage Manual, Fifth Edition)

Inlet Time, $T_0 = 0.14465\ L / H^{0.2} / A^{0.1}$ (Bransby Williams Equation)
where : L = Longest distance measured on the line of natural flow between the submit and the point under consideration (m)
H = Average slope (m per 100m)
A = Sub-catchment area (m2)

Peak Runoff ,Q = IA

Pipe Capacity $Q_p = VA$

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

(By Colebrook-White Equation)

Roughness Coeff., Ks = 0.60 mm (Circular Box culvert / pre-cast concrete pipe)
Ks = 0.15 mm (D.I. pipe with epoxy lining, poor condition)
Ks = 3.30 mm (channel, Trowel finish)

Kinematic Viscosity, u = 0.0000012 m^2/s

Acceleration due to gravity g = 9.81 m/s^2

Calculation for Inlet Time for Natural Catchment plus WSD Catchwater Catchment

Catchment	L (m)	U/S G/L (mPD)	D/S G/L (mPD)	H (m/100m)	A (m^2)	T_o (min)
UC01	207	65.64	6.77	28.44	45,850	5.24
UC02	253	65.54	6.34	23.40	16,772	7.36
UC03	399	29.74	7.36	5.61	53,180	13.77
UC04	668	72.38	5.55	10.00	77,507	19.78

Climate Change Factor (%) = 16.00% (Table 28, Stormwater Drainage Manual CORRIGENDUM No. 1/2022, for rainfall increase at End of 21st Century 2081 – 2100)

Design Allowence (%)= 12.10% (Table 31, Stormwater Drainage Manual CORRIGENDUM No. 1/2022, for rainfall increase at End of 21st Century around 2090)

Table 3 Drainage Calculation of the Proposed U Channels

Contributing Catchment	Area (m^2) steep natural slope	Area (m^2) flat grassland	Area (m^2) Paved	Accumulated Factored Area A, (m^2)	L (m)	H (m/100m)	T_o (min.)	T_f (min.)	T_c (min.)	I (mm/hr)	I (mm/hr) incl. Climate C	Q (m^3/s) incl. Climate C	Proposed Downstream Drainage: Upstream Stormwater Manhole Ref	Downstream Stormwater Manhole Ref	size of channel / culvert / pipe: width (m)	height (m)	Length (m)	US GL (mPD)	Invert Level: US (mPD)	Invert Level: DS (mPD)	Slope (S_f)	A (m^2)	P (m)	R = A/P (m)	$32gRS_f$ m^2/s^2	Capacity (m^3/s)	Velocity (m/s)	Flow %
UC04	41,265			14443	-	-	5.24	4.04	9.28	187.74	244.12	0.98	-	-	1.00	1.00	442.00	-	-	-	0.0030	1.00	4.00	0.25	0.24	1.82	1.82	54%
UC03	15,095			5283	-	-	7.36	3.15	10.51	181.13	235.54	0.35	-	-	0.70	0.70	276.00	-	-	-	0.0030	0.49	2.80	0.18	0.16	0.72	1.46	48%
UC02	42,544		10,636	24995	-	-	13.77	7.52	21.29	145.54	189.25	1.31	-	-	1.10	1.10	873.00	-	-	-	0.0030	1.21	4.40	0.28	0.26	2.34	1.93	56%
UC01	23,252	54,255		16276	-	-	19.78	8.59	28.37	132.33	172.08	0.78	-	-	1.20	1.20	1052.00	-	-	-	0.0030	1.44	4.80	0.30	0.28	2.94	2.04	26%