Annex A Replacement Pages of Revised Drainage Impact Assessment

List of Tables

Table 4-1 Estimated Peak Flow for the Application Site 11
Table 4-2 Estimation of Peak Flow and Drainage Capacity Check 12
Table 4-3 Estimation of Peak Flow and Drainage Capacity After Upgrading works is Considered 13

List of Figures

Figure 2.1 Application Site Location & Its Environs
Figure 3.1 Overview of Existing Surface Runoff Flow Path at the Vicinity of the Application Site
Figure 3.2 Overview of Existing Drainage, Proposed Drainage & Catchment Area

List of Appendices

Appendix A Master Layout Plan and Sectional Drawings
Appendix B Peak Runoff Estimation of Sub-catchments and Subject Site after the completion of Proposed Development
Appendix C Estimation of Drainage Flow from Proposed Development and Detailed Hydraulic Calculation
Appendix D Estimation of Drainage Flow from Proposed Development and Detailed Hydraulic Calculation (After considered Upgrading Works)

2. SITE CONTEXT

2.1. Site Location and Its Environs

2.1.1. The proposed development is located at Ping Che Road from the north to northeast, the unnamed village road to the east, village, agricultural land and open storage area to the south and west.

2.1.2. ***Figure 2.1*** shows the Site location and its environs.

2.2. Proposed Development Scheme

2.2.1. The proposed site area of the application site is 17,822m^2, with a plot ratio of 5.9 for domestic use and 1.1 for non-domestic use. The total GFA for domestic use is 105,145 m^2, and the 19,603 m^2 for non-domestic use. The proposed development will consist of 5 blocks of residential tower ranging from 47 to 48-storey (excluding basement) in height, provided 2,205 residential unit, and 1 block of commercial tower with 35-storey (excluding basement) in height. The non-domestic use consisted of retail, office, hotel or service apartment, clubhouse, day care centre for the elderly and child care centre, and a proposed on-site Sewerage Treatment Plant (STP) within the Application Site.

2.2.2. The Master Layout Plan (MLP) and Sectional Drawing of the proposed development are shown in ***Appendix A.*** Based on the tentative implementation programme, the planned population intake would be in year 2032.

2.3. Existing Drainage Condition

2.3.1. Drainage information was obtained from the GeoInfo Map services of the Lands Department to gather the background information on drainage infrastructure in the vicinity of the Application Site. Concerned drainage network was identified for estimation of the potential impact to the downstream drainage associated with the proposed development. Stormwater runoff from Proposed Development is collected at the terminal manhole and discharged to existing public stormwater network along the Ping Che Road at the northeast side of the site, flowing to northwest direction and into the Ping Yuen River. The size of the existing stormwater pipe along Ping Che Road is relatively small ranging from 375mm to 600mm.

2.4. Planned Drainage Facilities in the vicinity

2.4.1. With reference to Project Profile prepared for "Remaining Phase Development of the New Territories North (NTN) – NTN New Town and Man Kam To" (NTN Development) in May 2021, (ESB-341/2021), the application site fall within the NTN development. The NTN includes the following individual works items.

- Item F.1, Part I, Schedule 2 - Sewage treatment works with an installed capacity of more than 15,000 m3 per day
- Item F.2, Part I, Schedule 2 - Sewage treatment works- (a) with an installed capacity of more than 5,000 m3 per day
- Item F.3, Part I, Schedule 2 - A sewage pumping station- with an installed capacity of more than 300,000 m3 per day
- Item I.2, Part I, Schedule 2 - A flood storage pond more than 10 ha in size
- Item I.1(b), Part I, Schedule 2 - Drainage channel or river training and diversion works which discharges or discharge into an area which is less than 300 m from the nearest boundary of an existing or planned (i) site of special scientific interest; (ii) site of cultural heritage; (iii) marine park or marine reserve; (iv) fish culture zone; (v) wild animal protection area; (vi) coastal protection area; or (vii) conservation area

2.4.2. In December 2017, Planning Department (PlanD) and Civil Engineering and Development Department (CEDD) completed Preliminary Feasibility Study on Developing the New Territories North (NTN) (the Preliminary NTN Study). It is noted that a proposed drainage works and a Drainage Master Layout Plan have been formulated.

2.4.3. During the course of study, relevant details and construction programme cannot be obtained from North Development Office (NDO) of CEDD, the Project Proponent of the NTN Development.

4. DRAINAGE IMPACT ASSESSMENT

4.1. Site Condition

4.1.1. The existing Application Site is used as an open storage, it is partially covered with vegetation (~35% vegetation; ~65% paved). The flow path of the existing stormwater surface runoff is illustrated in ***Figure 3.1***, which indicates that the runoff from immediate upstream will flow through the Application Site, and the runoff will flow further downstream based on the topography. The existing surface runoff is expected to free flow along the surface towards northwest direction, and finally discharge to Ping Yuen River.

4.1.2. The Application Site contains an approximate area of 17,822 m^2. The surface runoff within the Application Site after development and the treated effluent from on-site STP will be collected and discharge through the terminal manhole (P1: STMH-01) at the Application Site and connected to the existing 450mm public storm water manhole (D3: SMH1003243. The at grade greenery area will be maintained at minimum of 20% and the proposed permeable material paving for the Application Site will be at least 15%, subject to detail design at later stage.

4.1.3. Due to the geographical characteristics, the existing surface runoff from the project site are flowing towards northwest direction, and existing project site is receiving runoff from the direct upstream Catchment A. The Proposed Development elevated the level of Application Site from 14.3 mPD to 16.0 mPD, it is expected that the runoff from immediate upstream of the site will be disrupted and intercepted. Therefore, U-channel is proposed along the site boundary at the east of the Application Site to cater the runoff from the Catchment A, collected by the terminal manhole (P2: STMH-02) and discharged to the existing 375mm public stormwater manhole (SMH1003241). The flow from The preliminary drainage plan is shown in ***Figure 3.2***, the detailed drainage plan will be submitted at later detailed design stage.

4.2. Peak Flow Estimation

4.2.1. The peak flow from the Proposed development and Catchment A is calculated from equation (1) as mentioned in ***Section 3.2.3***. Detailed calculation is tabulated in ***Appendix B*** and summarized in ***Table 4-1*** below.

Table 4-1 Estimated Peak Flow for the Application Site

Catchment	Area (m^2)	Paved Area (%)	Unpaved Area (%)	Runoff under 1 in 50 years scenario (m^3/s)	Receiving Terminal Stormwater Manhole	Receiving Public Stormwater Manhole
Proposed Development						
Catchment A	6,123	30	70	0.283	STMH-02	SMH1003241
Application Site	17,822	20	80	1.094	STMH-01	SMH1003243
STP	-	-	-	0.024	STMH-01	SMH1003243
Total:		-	-	**1.401**		
Existing Scenario						
Application Site	17,822	35	65	0.758	N/A	N/A
Total:		**35**	**65**	**0.758**		

4.3. Potential Impact on Public Stormwater System due to Surface Runoff

4.3.1. The Application site is currently slightly hilly land and partially covered by greenery, while the proposed development is basically built on the paved surface.

4.3.2. The site formation work is expected to increase the level from 14.3mPD to 16.0mPD. As discussed in ***Section 4.1.3***, U-channel drainage is proposed along the site boundary at the east of the Application Site to cater the upstream runoff, collected by the proposed STMH-02 and discharged to the existing 375mm public stormwater manhole (SMH1003241).

4.3.3. There is also expected to be a decrease in overall greenery area within the Application Site after proposed development, the greenery is reduced from ~35% to ~20%. According to the DIA hydraulic calculations presented in ***Table 4-1*** and ***Appendix B***, it is anticipated that surface runoff will increase, going from 0.758m^3/s to 1.118m^3/s. The runoff from Application Site and treated effluent from on-site STP together with storm water from Catchment A will be collected and discharge through the STMH-01 and STMH-02 and connected to the existing 450mm public storm water manhole. In this connection, the proposed development will lead to increase of 1.401 m^3/s in peak flow at existing drainage system along Ping Che Road, taking stormwater from Catchment A into consideration.

4.3.4. The Colebrook-White and Manning frictional resistance equations with reference to the Stormwater Drainage Manual (Fifth Edition) are used to calculate the hydraulic capacities of

the stormwater drainage pipes.

4.3.5. As defined in Section 6.6.2 in Stormwater Drainage Manual, 50 years of the return periods for an Urban Drainage Branch System is adopted for the assessment. According to the calculation as tabulated in ***Appendix B***, the total flows from the Application Site under 1 in 50 years storm event are found to be 1.118 m^3/s after the Proposed Development, as summarized in ***Table 4-1***.

4.3.6. The hydraulic calculation of runoff from Application site and Catchment A is also included in the calculation to assess the adequacy of the proposed stormwater pipe, the calculation is shown in ***Appendix C*** and summarized in ***Table 4-2.***

Table 4-2 Estimation of Peak Flow and Drainage Capacity Check

Manhole		Catchment	Total Flow from Catchment (m^3/s)	Percentage of Capacity
From	To			
STMH-02	SMH1003241	Catchment A	0.283	89%
SMH1003241	SMH1003242	Catchment A	0.283	**261%**
SMH1003242	SMH1003243	Catchment A	0.283	**230%**
STMH-01	SMH1003243	Application Site + STP	1.118	90%
SMH1003243	SMH1003246	Application Site + STP + Catchment A	1.401	**457%**
SMH1003246	SMH1003247	Application Site + STP + Catchment A	1.401	**505%**
SMH1003247	SMH1003249	Application Site + STP + Catchment A	1.401	**504%**
SMH1003249	SMH1003248	Application Site + STP + Catchment A	1.401	**513%**
SMH1003248	SMH1003250	Application Site + STP + Catchment A	1.401	**618%**
SMH1003250	SMH1003252	Application Site + STP + Catchment A	1.401	**488%**

*Note: The segments exceeding the capacity are **bolded***

4.3.7. Based on the hydraulic calculation shown in ***Appendix C*** and ***Table 4-2***, the stormwater flow for existing public drainage will exceed the capacity after development, ranged from 230% to 618%. The drainage impact is anticipated.

4.3.8. Based on the EIA Project Profile and Study brief for Development of New territories North (NTN) New Town and Man Kam To Development (NTN Development) (ESB-341/2021), Designated Projects including Sewerage Treatment Works (Item F.1 and/or Item F.2), Sewerage Pumping Station(s) (Item F.3), Drainage channel or river training and diversion

works (Item I.1(b)) and a flood storage pond more than 10 ha in size (Item I.2, Part I) are included in the NTN Development.

4.3.9. The implementation details of NTN Development are yet to be confirmed, no programme and details can be obtained during the course of study, the changes and upgrading of sewerage and drainage system cannot be identified at this stage. It is expected to have upgrade works of drainage system, however the assessment is evaluate based on the existing scenario without NTN development in place for completeness is expected and the hydraulic calculation is provided in ***Appendix C***.

4.3.10. A hydraulic assessment was conducted, which the upgrading on existing drainage network is taken into account and provided in ***Appendix D***. A minimum pipe diameter, yet feasible to cater the surface runoff discharged from the application site after development is proposed. The results showed that the pipes with 375mm diameter required to be updated to 600mm, and 450mm pipes required to be updated to 900mm and 1050mm respectively. The summary of the hydraulic calculation is summarized in ***Table 4-3***.

Table 4-3 Estimation of Peak Flow and Drainage Capacity After Upgrading works is Considered

Pipe Segment	Maximum Capacity of Sewer (m^3/s)	Catchment	Total Flow from Catchment (m^3/s)	Percentage of Used Capacity
P2 – D1	0.318	Catchment A	0.283	89%
D1 – D2	0.374	Catchment A	0.283	76%
D2 – D3	0.424	Catchment A	0.283	67%
P1 – D3	1.245	Application Site + STP	1.118	90%
D3 – D4	1.895	Application Site + STP + Catchment A	1.401	74%
D4 – D5	1.714	Application Site + STP + Catchment A	1.401	82%
D5 – D6	1.717	Application Site + STP + Catchment A	1.401	82%
D6 – D7	1.686	Application Site + STP + Catchment A	1.401	83%
D7 – D8	2.100	Application Site + STP + Catchment A	1.401	67%
D8 – D9	2.655	Application Site + STP + Catchment A	1.401	53%

*Note: The segments exceeding the capacity are **bolded***

4.3.11. Further assessment will be conducted to determine if upgrading works by the Project is required. If there is exceedance or the drainage upgrading works by CEDD for NTN

Development is not yet available before the intake of population of the proposed development, mitigation measures and/or upgrading works will be proposed and implemented by the Project.

4.3.12. The size and detailed arrangement of the proposed internal drainage system for the proposed development will be further reviewed in the detailed design stage. Submission will be made to Building Department for approval in due course.

4.4. Mitigation Measures

U-Channel

4.4.1. Due to the alteration of the surface level of Application Site by the proposed development, a series of U-channel drainage is proposed to install along the eastern site boundary of the Application Site. The U-channel is used to accommodate the surface runoff flowing from upstream Cathcment A. The preliminary drainage layout is shown in Figure 3.2, the detailed drainage plan is subjected to detailed design stage later.

4.4.2. For collecting surface runoff within the Proposed Development and upstream catchment, the design of site drainage and disposal of various site effluents generated within the Application Site should follow the relevant guidelines and practices as given in ProPECC PN1/23. Proper drainage facilities will also be provided to discharge the surface runoff to the public drain.

Greenery and Pervious Material

4.4.3. The existing greenery to pavement ratio at the Application Site stands at 0.35 greenery: 0.65 pavement area. In order to mitigate the potential adverse impacts resulting from the proposed development, at-grade greenery and green roof within the proposed development will be maximized as far as practicable. Additionally, the proposed development will incorporate pervious paving material at hard landscape area (except EVA) when feasible. In summary, it is targeted to provide the total greenery and pervious paving area constituting of around 40% of site area, which is equivalent to existing greenery area on site.

Blue-Green Infrastructure

4.4.4. The proposed development will explore and study for incorporation of appropriate blue-green infrastructure following TC(W) No. 9/2020 Blue-Green Drainage Infrastructure" issued by DEVB in July 2020 and the recently issued DSD guidelines for blue-green infrastructure.

The rainwater harvesting and detention pond will be considered. In the case of proposed development, the Stormwater Harvesting System (SHS) is installed to collect and treat the stormwater entering the storage tank during rainstorm events, and potentially reuse it toward fulfilling the needs in residences, service trades, hotel and service apartments such as toilet flushing, water features, car washing, street cleansing etc. The layout plan and design of SHS and retention pond are subjected to detailed design stage later.

4.4.5. Application of floodable area and drainage facility co-use in drainage management will also be considered during detailed design stage when practicable.

Others

4.4.6. The applicant will be responsible for the construction of all necessary drainage system, including the proposed pipe connected to the public stormwater drain as well as other internal drainage infrastructure within the application site.

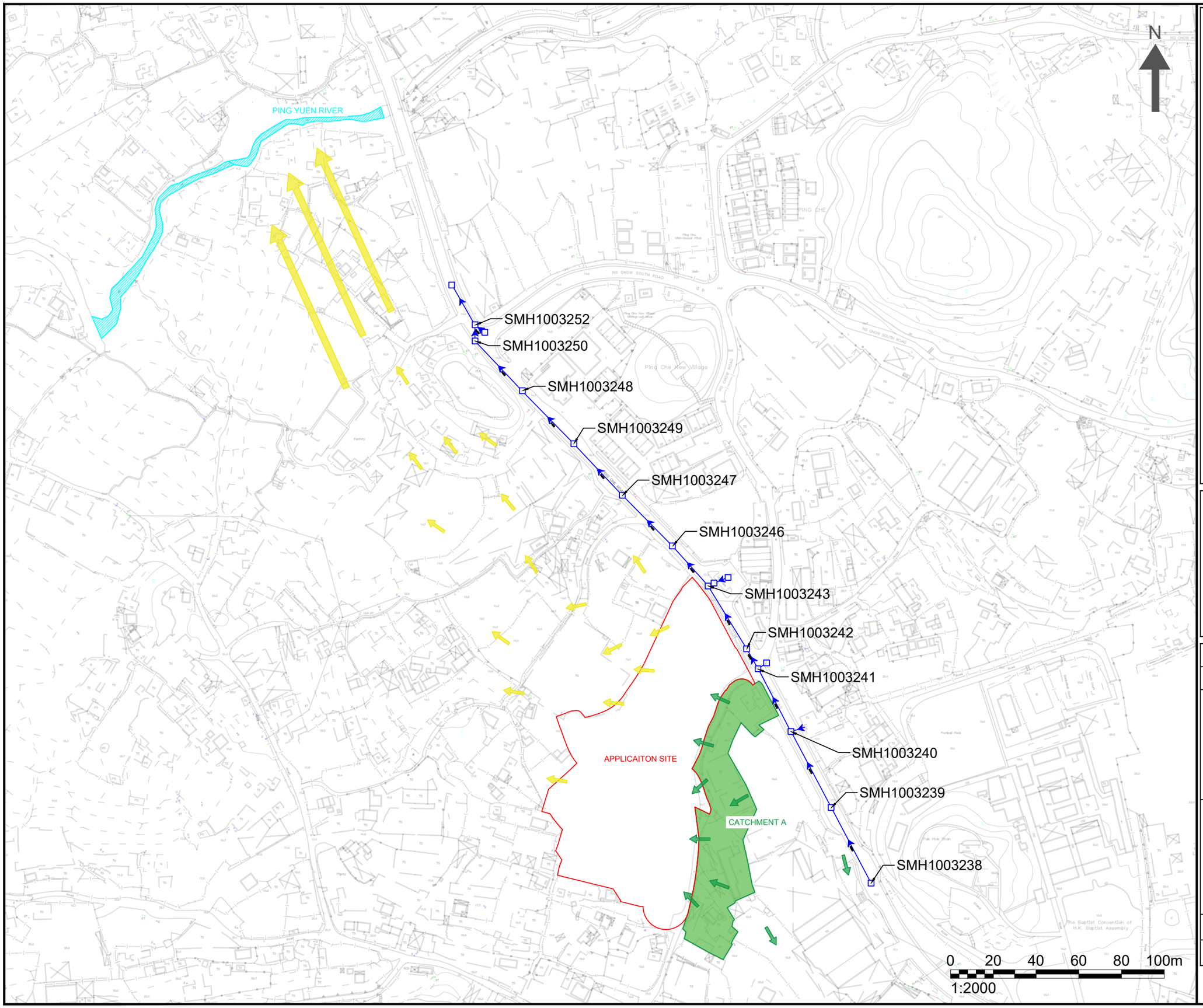
4.4.7. No fertilisers or pesticides will be routinely used for vegetation management in landscape area in accordance with the General Specification for Building (2012 edition) by Architectural Services Department (ASD). During heavy rainfall, trace of pollutants may be wash-off and is often bound or adsorbed onto particles (i.e. loose soil or litter). The stormwater drainage system on site will be equipped with silt trap to remove the particles and associated pollutants. The stormwater discharge will satisfy the effluent standards and requirements stipulated in the WPCO-TM, notably, with respect to prohibited substances as stated in clauses 8.4 and 9.1, as the case may be.

4.4.8. Layout of major drainage channels within the Proposed Development will be submitted to the relevant authorities. All drainage facilities shall be designed and constructed to conform to the requirements laid down in:

- The Stormwater Drainage Manual, DSD
- The General Specification for Civil Engineering Works, Hong Kong Government
- The DSD Standard Drawings

Figure 3.1

Overview of Existing Surface Runoff Flow Path at the Vicinity of the Application Site



NOTES :

APPLICATION SITE

CATCHMENT AREA

EXISTING DRAINAGE & MANHOLE

EXISTING SURFACE RUNOFF FLOW PATH FROM UPSTREAM

EXISTING SURFACE RUNOFF FLOW PATH TO DOWNSTREAM

PING YUEN RIVER

Consultant

Allied Environmental Consultants Limited

Project No. : 2127

Drawing By : CS

Project :

APPLICATION FOR AMENDMENT OF PLAN UNDER SECTION 12A FOR THE TOWN PLANNING ORDINANCE (CAP. 131) FOR MIXED USE DEVELOPMENT AT LOTS 796 AND 1008RP IN D.D. 77 AND ADJOINING GOVERNMENT LAND IN PING CHE, TA KWU LING, NEW TERRITORIES

Drawing Title :

OVERVIEW OF EXISTING SURFACE RUNOFF FLOW PATH AT THE VICINITY OF APPLICAITON SITE

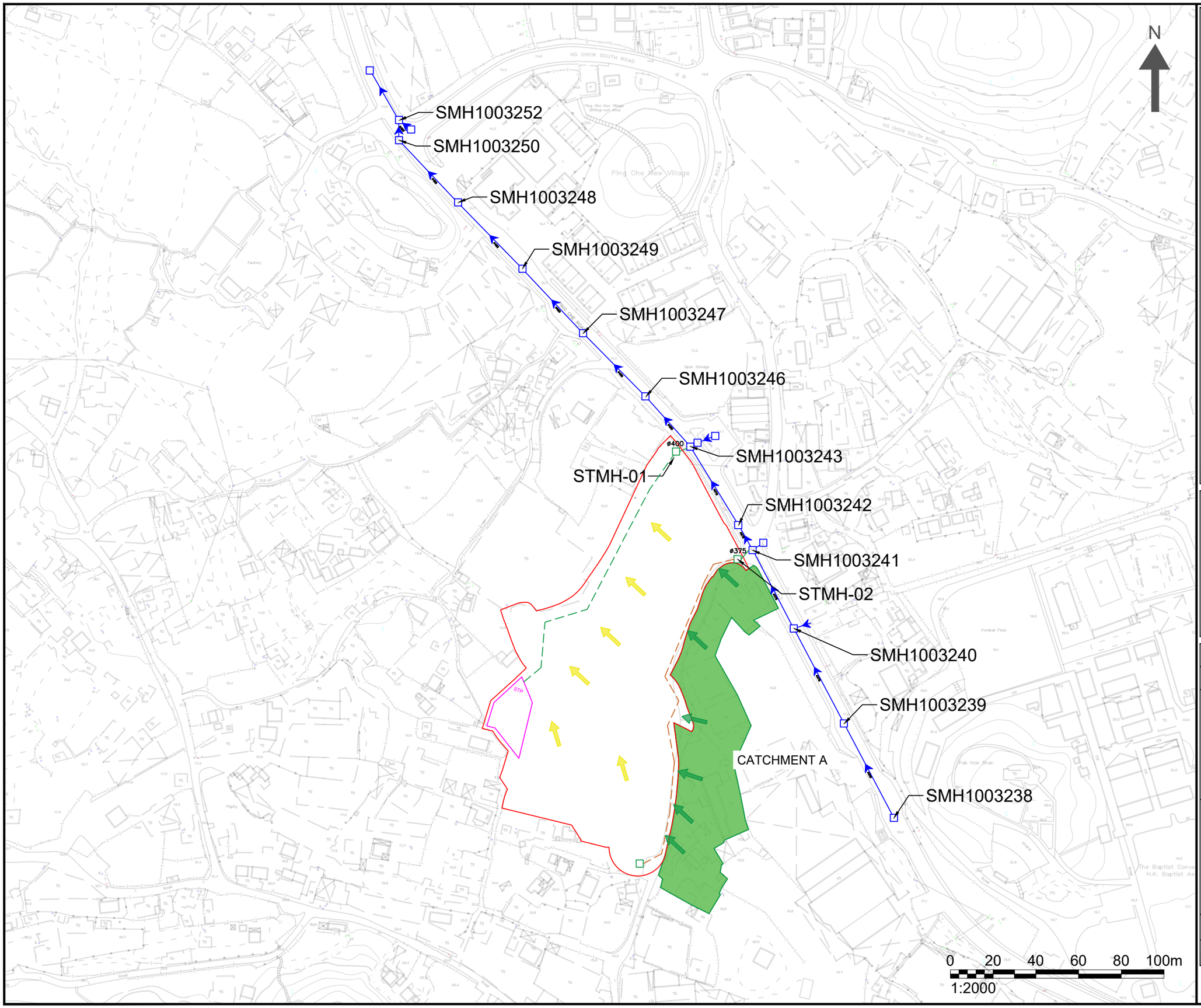
Drawing No :	Revision :
FIGURE 3.1	2
Scale :	Date :
AS SHOWN	FEB 2024

A3 420 x 297

C:\USERS\NGANCHUNSANG\SYNOLOGYDRIVE\2127 PING CHE DD77\05 REPORT\01 AEC REPORT\03 DIA\ISSUE 3\[2127] DIA FIG 3.1_EXISTING FLOW PATH_ISSUE 3_WORKING.DWG

Figure 3.2

Overview of Existing Drainage, Proposed Drainage & Catchment Area



NOTES :

- APPLICATION SITE
- CATCHMENT AREA
- PROPOSED ON-SITE SEWAGE TREATMENT PLANT
- EXISTING DRAINAGE & MANHOLE
- PROPOSED DRAINAGE & MANHOLE
- PROPOSED U-CHANNEL DRAINAGE
- SURFACE RUNOFF FLOW PATH FROM UPSTREAM AFTER DEVELOPMENT
- SURFACE RUNOFF FLOW PATH FROM PROJECT SITE AFTER DEVELOPMENT

Consultant

Allied Environmental Consultants Limited

Project No. : 2127

Drawing By : CS

Project :

APPLICATION FOR AMENDMENT OF PLAN UNDER SECTION 12A FOR THE TOWN PLANNING ORDINANCE (CAP. 131) FOR MIXED USE DEVELOPMENT AT LOTS 796 AND 1008RP IN D.D. 77 AND ADJOINING GOVERNMENT LAND IN PING CHE, TA KWU LING, NEW TERRITORIES

Drawing Title :

OVERVIEW OF EXISTING DRAINAGE, PROPOSED DRAINAGE & CATCHMENT AREA

Drawing No :	Revision :
FIGURE 3.2	2
Scale :	Date :
AS SHOWN	FEB 2024

A3 420 x 297

C:\USERS\NGANCHUNSANG\SYNOLOGYDRIVE\2127 PING CHE DD77\05 REPORT\01 AEC REPORT\03 DIA\ISSUE 3\[2127] DIA FIG 3.2_DRAINAGE OVERVIEW_ISSUE 3_WORKING.DWG

Appendix B

Peak Runoff Estimation of Sub-catchments and Subject Site after the completion of Proposed Development

Appendix A Peak Runoff Estiamtion

Peak Runoff Estimation of Subcatchments and Subject Site **after** the completion of Proposed Development

Catchment	Total Area of the Catchment (m^2)	Land Use		Topography		Average Slope, H (m per 100m)	Flow Distance, L (m)	Inlet Time, t_o (min) [1]	Flow Time, t_f (min) [2]	Duration, t_c (min) [3]	50 - year return period				Runoff Coefficient, C [6]	Rainfall Increase due to Climate Change, % [7]	50 - year return period	
		Surface Characteristics	Area (m^2)	Inlet invert level (mPD)	Outlet invert level (mPD)						Storm Constant, a [4]	Storm Constant, b [4]	Storm Constant, c [4]	Extreme Mean Intensity, i (mm/hr) [5]			Peak Runoff, Qp (m3/s) [8]	Total Peak Runoff, Qp (m3/s) [8]
Application Site	17822	Concrete	14258	16.0	16.0	0.00	232	5.00	0	5.00	451.3	2.46	0.337	229.27	0.95	16.0	1.001	1.094
		Grass	3564												0.35		0.092	
Catchment A	6123	Concrete	4286	17.2	14.7	1.27	196	11.32	0	11.32	451.3	2.46	0.337	186.46	0.95	16.0	0.245	0.283
		Grass	1837												0.35		0.039	
STP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.024
Existing Condition																		
Application Site	17822	Concrete	11584	16.1	14.3	0.77	232	13.29	0	13.29	451.3	2.46	0.337	178.22	0.95	16.0	0.632	0.758
		Grass	6238												0.35		0.125	

Note:

[1] Brandsby William's equation is referenced from Section 7.5.2 in DSD Stormwater Drainage Manual (Fifth Edition).

$$t_o = \frac{0.1446L}{H^{0.2} A^{0.1}}$$

where t_o = time of concentration of a natural catchment (min.)

A = catchment area (m^2)

H = average slope (m per 100 m), measured along the line of natural flow, from the summit of the catchment to the point under consideration

L = distance (on plan) measured on the line of natural flow between the summit and the point under consideration (m)

Time of concentraction for subject site is assumed as 5 min.

[2] t_f is assumed to be 0 for conservative estimation.

[3] $t_c = t_o + t_f$

[4] Storm constants are referenced to Table 3a in DSD Stormwater Drainage Manual (Fifth Edition) based on corresponding return periods.

[5] Intensity-Duration-Frequency calculation is referenced from Section 4.3.3 in DSD Stormwater Drainage Manual (Fifth Edition).

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

where i = extreme mean intensity in mm/hr,

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

a, b, c = storm constants given in Tables 3a, 3b, 3c and 3d.

[6] Runoff coefficient is referenced from Section 7.5.2 in DSD Stormwater Drainage Manual (Fifth Edition). For conservative estimation, coefficient of 0.35 is assumed for unpaved area while that of 0.95 for paved area.

[7] Rainfall increase precentage due to climate change is referenced from Table 28 in DSD Stormwater Drainage Manual (Fifth Edition) and Corrigendum No. 1/2022. 16.0% for End of 21st Century is adopted as worst case scenario.

[8] Rational method for peak runoff estimation is referenced from Section 4.3.3 in DSD Stormwater Drainage Manual (Fifth Edition).

$$Q_p = 0.278\, C\, i\, A$$

where Q_p = peak runoff in m^3/s

C = runoff coefficient (dimensionless)

i = rainfall intensity in mm/hr

A = catchment area in km^2

Appendix C

Estimation of Drainage Flow from Proposed Development and Detailed Hydraulic Calculation

Peak Runoff Estimation of Subcatchments and Subject Site **after** the completion of Proposed Development

ID	From	ID	To	Diameter, D (m) [1]	Cross-section Area, A (m^2) [2]	Wetted Perimeter, P (m) [2]	Hydraulic Radius, R (m) [3]	Length of Pipe, L (m) [1]	Inlet Invert Level (mPD) [1]	Outlet Invert Level (mPD) [1]	Slope, s [4]	Pipe Roughess, k (m) [5]	Velocity, V (m/s) [6]	Full Capacity, Q (m^3/s) [7]	Contributing Catchment Area [8]	Return Periods (Year) [9]	Additional Peak Flow, Q (m^3/s)	Total Flow from All Catch-ment Area (m^3/s)	Occupancy (%)
P2	STMH-02	D1	SMH1003241	0.375	0.099	1.178	0.084	6.7	15.82	15.58	0.036	0.0006	3.20	0.318	Catchment A	50	0.283	0.283	89%
D1	SMH1003241	D2	SMH1003242	0.375	0.099	1.178	0.084	14.2	15.58	15.52	0.004	0.0006	1.09	0.108	Catchment A	50	0.000	0.283	261%
D2	SMH1003242	D3	SMH1003243	0.375	0.099	1.178	0.084	50.0	15.52	15.25	0.005	0.0006	1.24	0.123	Catchment A	50	0.000	0.283	230%
P1	STMH-01	D3	SMH1003243	0.500	0.187	1.571	0.119	4.5	15.20	14.75	0.100	0.0006	6.67	1.245	Application Site + STP	50	1.118	1.118	90%
D3	SMH1003243	D4	SMH1003246	0.450	0.143	1.414	0.101	35.3	14.75	14.30	0.013	0.0006	2.14	0.307	Application Site + STP + Catchment A	50	0.000	1.401	457%
D4	SMH1003246	D5	SMH1003247	0.450	0.143	1.414	0.101	47.9	14.30	13.80	0.010	0.0006	1.94	0.277	Application Site + STP + Catchment A	50	0.000	1.401	505%
D5	SMH1003247	D6	SMH1003249	0.450	0.143	1.414	0.101	47.7	13.80	13.30	0.010	0.0006	1.94	0.278	Application Site + STP + Catchment A	50	0.000	1.401	504%
D6	SMH1003249	D7	SMH1003248	0.450	0.143	1.414	0.101	49.5	13.30	12.80	0.010	0.0006	1.91	0.273	Application Site + STP + Catchment A	50	0.000	1.401	513%
D7	SMH1003248	D8	SMH1003250	0.450	0.143	1.414	0.101	45.7	12.10	11.78	0.007	0.0006	1.59	0.227	Application Site + STP + Catchment A	50	0.000	1.401	618%
D8	SMH1003250	D9	SMH1003252	0.450	0.143	1.414	0.101	9.0	11.60	11.50	0.011	0.0006	2.01	0.287	Application Site + STP + Catchment A	50	0.000	1.401	488%

[1] With reference to the Drainage Plan and Geoinfo Map.
[2] According to Section 9.3 in DSD Stormwater Drainage Manual (Fifth Edition), 5% / 10% reduction in flow area based on channel gradient is taken into account for the effects to flow capacity due to materials deposited on the bed.
[3] Hydraulic Radius = Cross-section Area / Wetted Perimeter
[4] Slope = (Inlet Invert Level - Outlet Invert Level) / Length of Pipe
[5] Surface roughness is assumed to be 6.0mm for slimed concrete pipe with poor condition as worst case scenario, with reference to Table 14 in DSD Stormwater Drainage Manual (Fifth Edition).

Treated e! Surface roughness is assumed to be 6.0mm for slimed concrete pipe with poor condition as worst case scenario, with reference to Table 14 in DSD Stormwater Drainage Manual (Fifth Edition).

[6] Velocity is calculated based on Colebrook-White equations.

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

m Section 7.5.2 in DSD Stormwater Drainage Manual (Fifth Edition).

$\bar{V}$ = cross-sectional mean velocity (m/s)
R = hydraulic radius (m)
S_f = friction gradient (dimensionless)
C = Chézy coefficient ($m^{1/2}/s$)
n = Manning coefficient ($s/m^{1/3}$)
f = Darcy-Weisbach friction factor (dimensionless)
k_s = surface roughness (m)
ν = kinematic viscosity (m^2/s)
g = acceleration due to gravity (m/s^2)
C_{HW} = Hazen-William coefficient (dimensionless)

With Reference to Table 14 in DSD Stromwater Drainage Manual (Fifth Edition),
Kinematic viscosity is 0.000001306 m/s.
Gravitational acceleration is $9.8 m/s^2$.

[7] Capacity = Length of Pipe × Velocity
[8] Bold and underlined subcatchment ID stands for stormwater in those subcatchments flowing into the corresponding pipe.
[9] With reference to Table 3 of Section 6.6.2 in DSD Stormwater Drainage Manual (Fifth Edition), 50 years of return period has been adopted.

Appendix D

Estimation of Drainage Flow from Proposed Development and Detailed Hydraulic Calculation (After Considering Upgrading Works)

Peak Runoff Estimation of Subcatchments and Subject Site **after** the completion of Proposed Development

ID	From	ID	To	Diameter, D (m) [1]	Cross-section Area, A (m^2) [2]	Wetted Perimeter, P (m) [2]	Hydraulic Radius, R (m) [3]	Length of Pipe, L (m) [1]	Inlet Invert Level (mPD) [1]	Outlet Invert Level (mPD) [1]	Slope, s [4]	Pipe Roughess, k (m) [5]	Velocity, V (m/s) [6]	Full Capacity, Q (m^3/s) [7]	Contributing Catchment Area [8]	Return Periods (Year) [9]	Additional Peak Flow, Q (m^3/s)	Total Flow from All Catch-ment Area (m^3/s)	Occupancy (%)
P2	STMH-02	D1	SMH1003241	0.375	0.099	1.178	0.084	6.7	15.82	15.58	0.036	0.0006	3.20	0.318	Catchment A	50	0.283	0.283	89%
D1	SMH1003241	D2	SMH1003242	0.600	0.254	1.885	0.135	14.2	15.58	15.52	0.004	0.0006	1.47	0.374	Catchment A	50	0.000	0.283	76%
D2	SMH1003242	D3	SMH1003243	0.600	0.254	1.885	0.135	50.0	15.52	15.25	0.005	0.0006	1.67	0.424	Catchment A	50	0.000	0.283	67%
P1	STMH-01	D3	SMH1003243	0.500	0.187	1.571	0.119	4.5	15.20	14.75	0.100	0.0006	6.67	1.245	Application Site + STP	50	1.118	1.118	90%
D3	SMH1003243	D4	SMH1003246	0.900	0.573	2.827	0.203	35.3	14.75	14.30	0.013	0.0006	3.31	1.895	Application Site + STP + Catchment A	50	0.000	1.401	74%
D4	SMH1003246	D5	SMH1003247	0.900	0.573	2.827	0.203	47.9	14.30	13.80	0.010	0.0006	2.99	1.714	Application Site + STP + Catchment A	50	0.000	1.401	82%
D5	SMH1003247	D6	SMH1003249	0.900	0.573	2.827	0.203	47.7	13.80	13.30	0.010	0.0006	3.00	1.717	Application Site + STP + Catchment A	50	0.000	1.401	82%
D6	SMH1003249	D7	SMH1003248	0.900	0.573	2.827	0.203	49.5	13.30	12.80	0.010	0.0006	2.94	1.686	Application Site + STP + Catchment A	50	0.000	1.401	83%
D7	SMH1003248	D8	SMH1003250	1.050	0.779	3.299	0.236	45.7	12.10	11.78	0.007	0.0006	2.70	2.100	Application Site + STP + Catchment A	50	0.000	1.401	67%
D8	SMH1003250	D9	SMH1003252	1.050	0.779	3.299	0.236	9.0	11.60	11.50	0.011	0.0006	3.41	2.655	Application Site + STP + Catchment A	50	0.000	1.401	53%

[1] With reference to the Drainage Plan and Geoinfo Map.
[2] According to Section 9.3 in DSD Stormwater Drainage Manual (Fifth Edition), 5% / 10% reduction in flow area based on channel gradient is taken into account for the effects to flow capacity due to materials deposited on the bed.
[3] Hydraulic Radius = Cross-section Area / Wetted Perimeter
[4] Slope = (Inlet Invert Level - Outlet Invert Level) / Length of Pipe
[5] Surface roughness is assumed to be 6.0mm for slimed concrete pipe with poor condition as worst case scenario, with reference to Table 14 in DSD Stormwater Drainage Manual (Fifth Edition).

Treated e Surface roughness is assumed to be 6.0mm for slimed concrete pipe with poor condition as worst case scenario, with reference to Table 14 in DSD Stormwater Drainage Manual (Fifth Edition).

[6] Velocity is calculated based on Colebrook-White equations.

$$\bar{V} = -\sqrt{32gRS_f}\,\log\left[\frac{k_s}{14.8R} + \frac{1.255\nu}{R\sqrt{32gRS_f}}\right]$$ m Section 7.5.2 in DSD Stormwater Drainage Manual (Fifth Edition).

$\bar{V}$ = cross-sectional mean velocity (m/s)
R = hydraulic radius (m)
S_f = friction gradient (dimensionless)
C = Chézy coefficient ($m^{1/2}/s$)
n = Manning coefficient ($s/m^{1/3}$)
f = Darcy-Weisbach friction factor (dimensionless)
k_s = surface roughness (m)
ν = kinematic viscosity (m^2/s)
g = acceleration due to gravity (m/s^2)
C_{HW} = Hazen-William coefficient (dimensionless)

With Reference to Table 14 in DSD Stromwater Drainage Manual (Fifth Edition),
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[9] With reference to Table 3 of Section 6.6.2 in DSD Stormwater Drainage Manual (Fifth Edition), 50 years of return period has been adopted.