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

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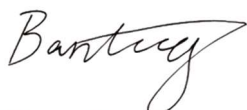
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1.   Background

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

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

2.   Objective

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

3.   Site Information

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

Address: Tung Tsz, Tai Po

Location Plan:

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Development Plan:

Development Schedule:

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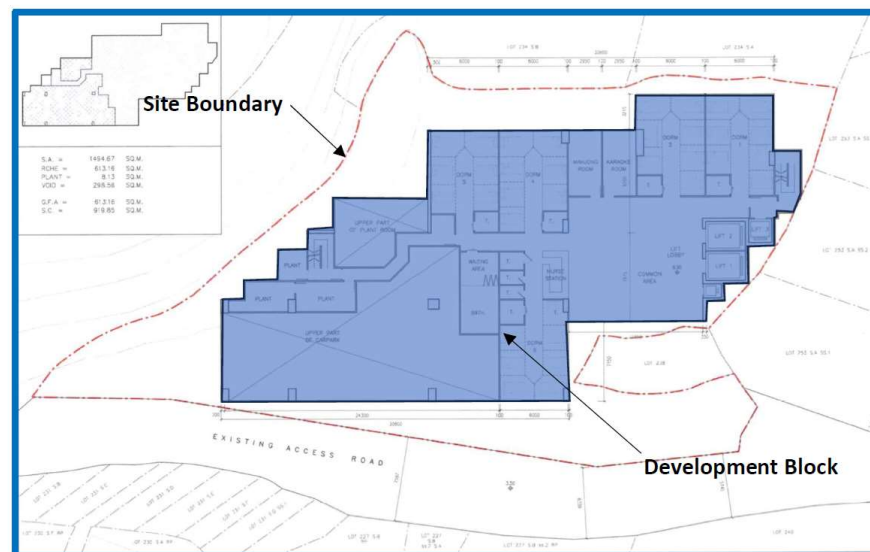
Site Area:	1,494.67m^2
Class of Site:	A
Proposed Plot Ratio for Non-domestic:	5.57 < 9.5
Proposed Site Coverage above for Non-domestic (Above 15m):	61.09% < 80%
Proposed Building Height:	34.50mPD
Absolute Height:	31.0m
Proposed No. of storey:	10 storeys

Proposed Gross Floor Area

LG/F (ENTRANCE & CARPARK)	:	606.13m²	
UG/F (RCHE)	:	613.16 m²	
1/F-5/F (RCHE)	:	916.89m² x 5 storeys = 4584.45 m²	(45 no. of beds x 5 storey)
6/F (RCHE)	:	886.14 m²	(17 no. of suites)
7/F (RCHE)	:	759.44 m²	(11 no. of suites)
8/F (MANAGEMENT OFFICE)	:	764.44 m²	
R/F (SKY GARDEN)	:	110.07 m²	
TOTAL	:	**8323.83 m² (89597 ft²)** **(28 no. of suites & 225 no. of beds)**	

4. Drainage Impact Assessment

i) Catchment Areas
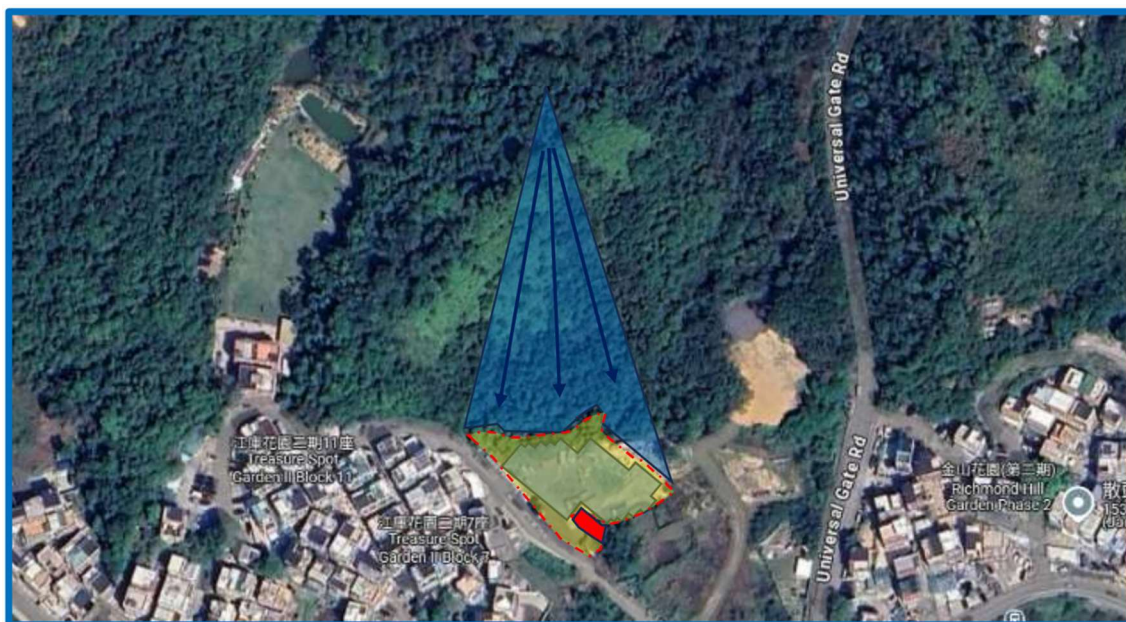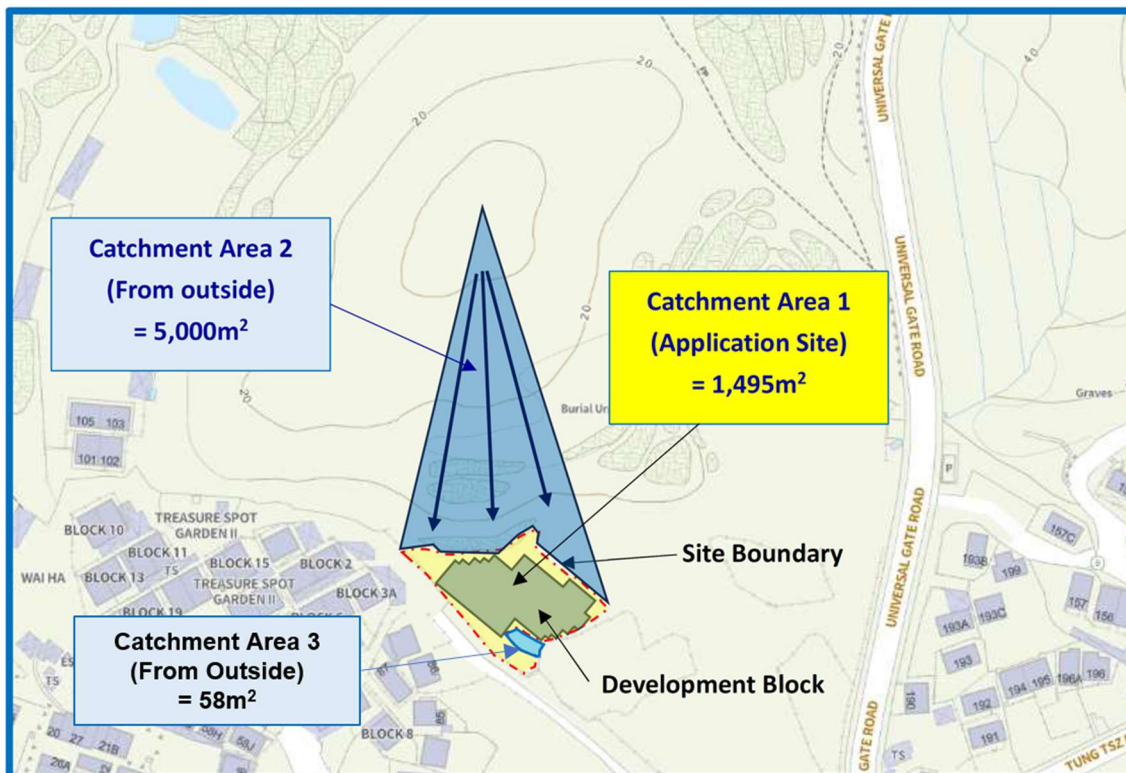
Catchment Area 1 (Application Site, existing, concrete paved) = 1,495m^2
Catchment Area 1 (Application Site, proposed to be paved with asphalt) = 1,495m^2
Catchment Area 2 (From the adjacent hillside, grass land) = 5,000m^2
Catchment Area 3 (Lot No. 238, DD 23) = 58m^2

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ii) Design Manuel

In evaluating the drainage impact arising from the Propose Development, the following sources of information have been specifically referred to:

- Stormwater Drainage Manual (SDM) Fifth Edition, January 2018
- Storm Drainage Manual (SDM) – Corrigendum No. 1/2022
- DSD's Advice Note No. 1 – Application of the Drainage Impact Assessment Process to Private Sector Projects; and
- Drainage Record Plan obtained from the GeoInfo map Services of the Lands Department (https://www.map.gov.hk/gm/?lg=en)

iii) Design Method

a) Rational Method (DSD STORMWATER DRAINAGE MANUAL 7.5.2)

$Qp = 0.278CiA$

Where

Qp = peak runoff in m^3/s

C = runoff coefficient (dimensionless)

i = rainfall intensity in mm/hr

A = catchment area in km^2

b) Runoff Coefficient

In Hong Kong, a value of C = 1.0 is commonly used in developed urban areas. In less developed areas, appropriate C values in order to ensure that the design would be fully cost-effective.

Surface Characteristics	Runoff coefficient, C*
Asphalt	0.70-0.95
Concrete	0.80-0.95
Brick	0.70-0.85
Grassland (heavy soil**)	
Flat	0.13-0.25
Steep	0.25-0.35
Grassland (sandy soil)	
Flat	0.05-0.15
Steep	0.15-0.20

The existing site has been concreted while majority of vegetations have been cleared, C1 of the existing site is taken as 0.8 conservatively.

The surface of the site will be covered by Asphalt, C1 of the proposed developed site should be 0.95 and the surface of the adjacent hill side is Grassland (sandy soil, steep),

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the C2 should be 0.2. The Lot No. 238, DD 23 is mainly Grassland (sandy soil, flat), the C3 should be 0.15.

c) 6.6.1 Village Drainage and Main Rural Catchment Drainage Channels
'Village Drainage' refers to the local stormwater drainage system within a village. A stormwater drain conveying stormwater runoff from an upstream catchment but happens to pass through a village may need to be considered as either a 'Main Rural Catchment Drainage Channel' or 'Village Drainage', depending on the nature and size of the upstream catchment. In any case, the impact of a 50-year event should be assessed in the planning and design of village drainage system to check whether a higher standard than 10 years is justified. (50 Years is used.)

d) Rainfall Intensity

Table 2d – Intensity-Duration-Frequency (IDF) Relationship of North District Area
for durations not exceeding 240 minutes

Duration (min)	Extreme Intensity (mm/h) for various Return Periods T (year)						
	2	5	10	20	50	100	200
240	29.0	38.2	44.5	50.7	59.1	65.6	72.3
120	42.4	54.9	63.2	71.2	81.8	89.8	97.8
60	62.0	77.1	86.1	94.3	104	111	118
30	85.7	103	113	122	133	141	148
15	108	129	141	151	164	173	182
10	120	141	155	168	187	203	219
5	139	162	177	192	214	231	251

Notes:
1. based on continuous rainfall recorded at GEO rain gauges N05 (40 years), N34 (24 years), N46 (24 years), N33 (24 years), N35 (24 years), N36 (24 years), N45 (24 years) and HKO rain gauges EPC (31 years), SSH (20 years), TKL (38 years), R24 (40 years), R29 (39 years), R30_KAT (34 years), SEK (27 years) up to 2023.

2. rainfall IDF relationships are derived from regional frequency analysis of extreme rainfall of local rain gauges.

3. the trends of the extreme rainfalls observed at HKO Headquarters are used to infer the trends at other locations.

i (rainfall intensity) = 214mm/hr (Duration of 5 min is adopted as conservative approach)

e) Climate Change
Climate change is taken into account in drainage system capacity check calculation. 10.4% Rainfall intensity increase for mid-21st century (2041 – 2060) is included referring to SDM, Table 28.

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f) Calculations of Water Flow

Existing Situation
$Q_p = 0.278\ CiA$
C1 = 0.8 (Concrete) (Existing Site)
C2 = 0.2 (Grass Land, Sandy Soil, Steep) (Adjacent Area)
C3 = 0.15 (Grass Land, Sandy Soil, Flat) (Adjacent Area)
i = 214 mm/hr
A1 = 1,495m^2 (0.001495km^2) (Existing Site)
A2 = 5,000m^2 (0.005000km^2) (Adjacent Hill Side)
A3 = 58m^2 (0.000058km^2) (Lot No. 238, DD 23)

$Q_p = 0.278 \times 214 \times ((0.8 \times 0.001495) + (0.2 \times 0.005000) + (0.15 \times 0.000058))$
$Q_p = 0.1312\ m^3/s$ or 7,872 l/min

Proposed Development Situation
$Q_p = 0.278\ CiA$
C1 = 0.95 (Asphalt) (Application Site)
C2 = 0.2 (Grass Land, Sandy Soil) (Adjacent Area)
C3 = 0.15 (Grass Land, Sandy Soil, Flat) (Adjacent Area)
i = 214 mm/hr
A1 = 1,495m^2 (0.001495km^2) (Existing Site)
A2 = 5,000m^2 (0.005000km^2) (Adjacent Hill Side)
A3 = 58m^2 (0.000058km^2) (Lot No. 238, DD 23)

$Q_p = 0.278 \times 214 \times ((0.95 \times 0.001495) + (0.2 \times 0.005000) + (0.15 \times 0.000058))$
$Q_p = 0.1445\ m^3/s$ or 8,670 l/min

By considering Future Site Runoff with climate change increase to mid-21st Century and deposition of sediment, 10.4% and 10% of discharge is added respectively.

$Q_{p(Design)} = Q_p \times 10.4\% \times 10\% = 0.1755\ m^3/s$ or 10,529 l/min

For conservative calculations, all catchment areas are combined for all U-Channels.

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g) Design of U-channel

GEO Technical Guidance Note No. 43 (TGN 43) Guidelines on Hydraulic

Figure 1 - Chart for the rapid design of U-shaped and half-round channels up to 600 mm

Note: (1) Refer to the latest CEDD Standard Drawings for the details of U-shaped (U) and half-round (HR) channels.
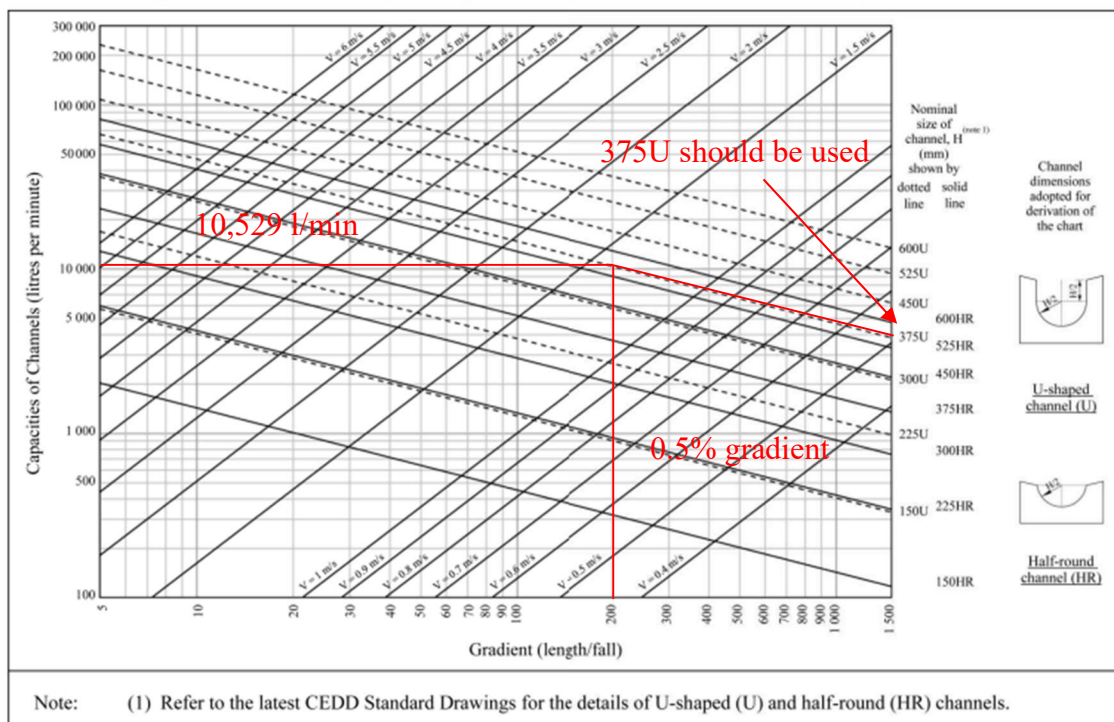
For 10,529 l/min, 375 U-channel will be used

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h) Design of Pipe

Hydraulic mean depth (HMD) for half full bore

$$HMD = \frac{\pi r^2}{2} \div \frac{\pi d}{2}$$

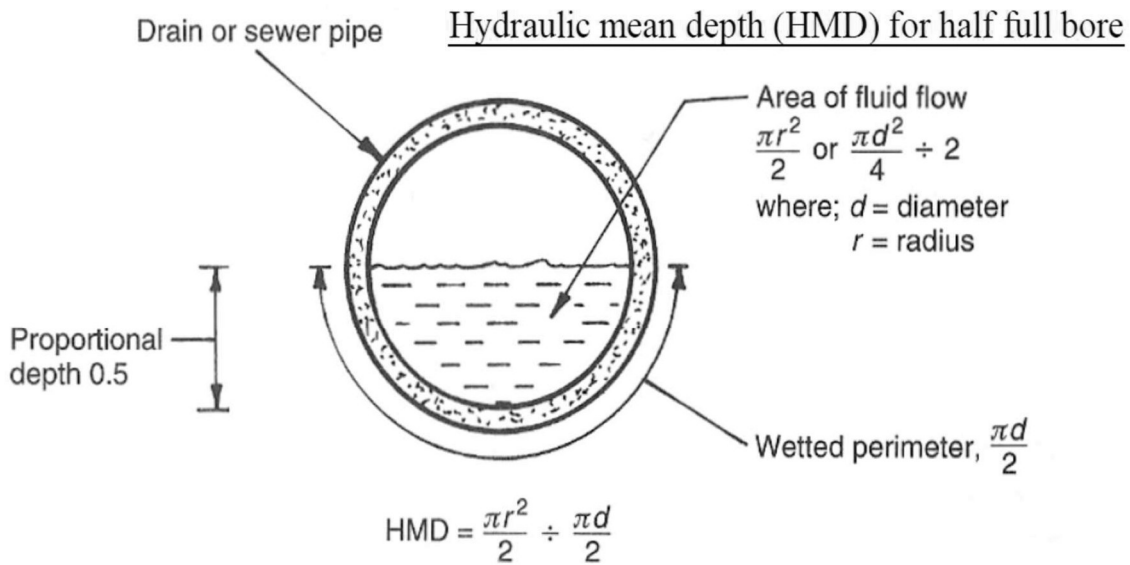| Depth of flow	HMD
0.25	Pipe dia. (m) / 6.67
0.33	Pipe dia. (m) / 5.26
0.50	Pipe dia. (m) / 4.00
0.66	Pipe dia. (m) / 3.45
0.75	Pipe dia. (m) / 3.33
Full	Pipe dia. (m) / 4.00

69

The 0.5 full bore, velocity of 1.7m/s and 600mm pipe is used.

The capacity of the pipe:

$Q = V \times A = (1.7) \times \pi \times (0.600/2)^2 \times 0.5 = 0.2403 \text{ m}^3/\text{s} > 0.1755 \text{ m}^3/\text{s}$, OK

Chezy's formula:
$V = C\sqrt{(m \times i)}$
where
V = velocity of flow = 1.7m/s
m = hydraulic mean depth (HMD) → HMD = 0.600 / 4.00 = 0.1500
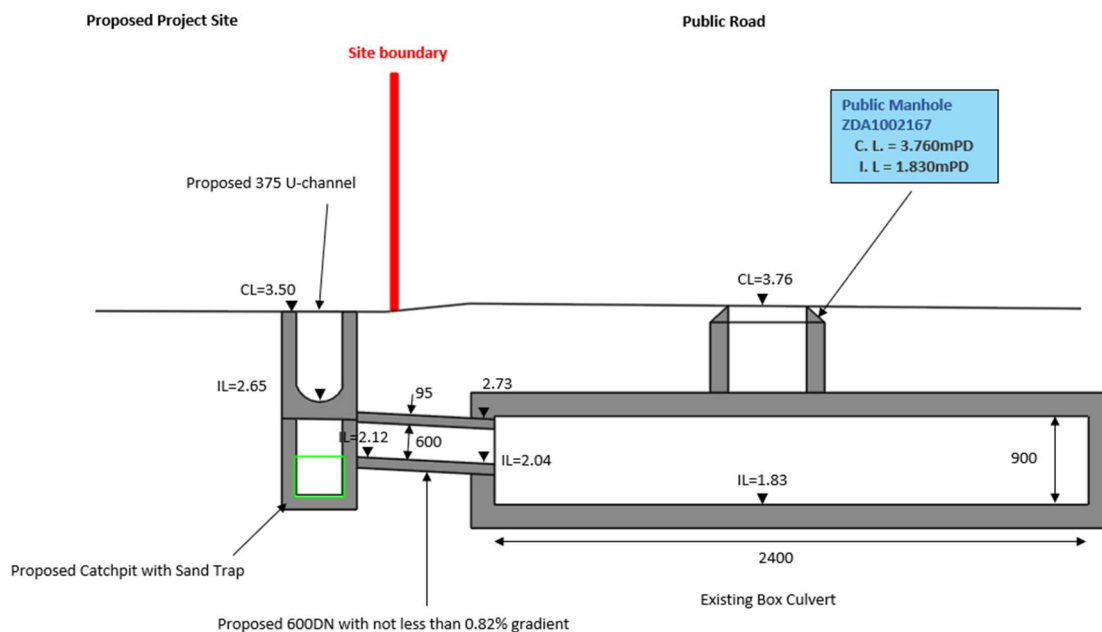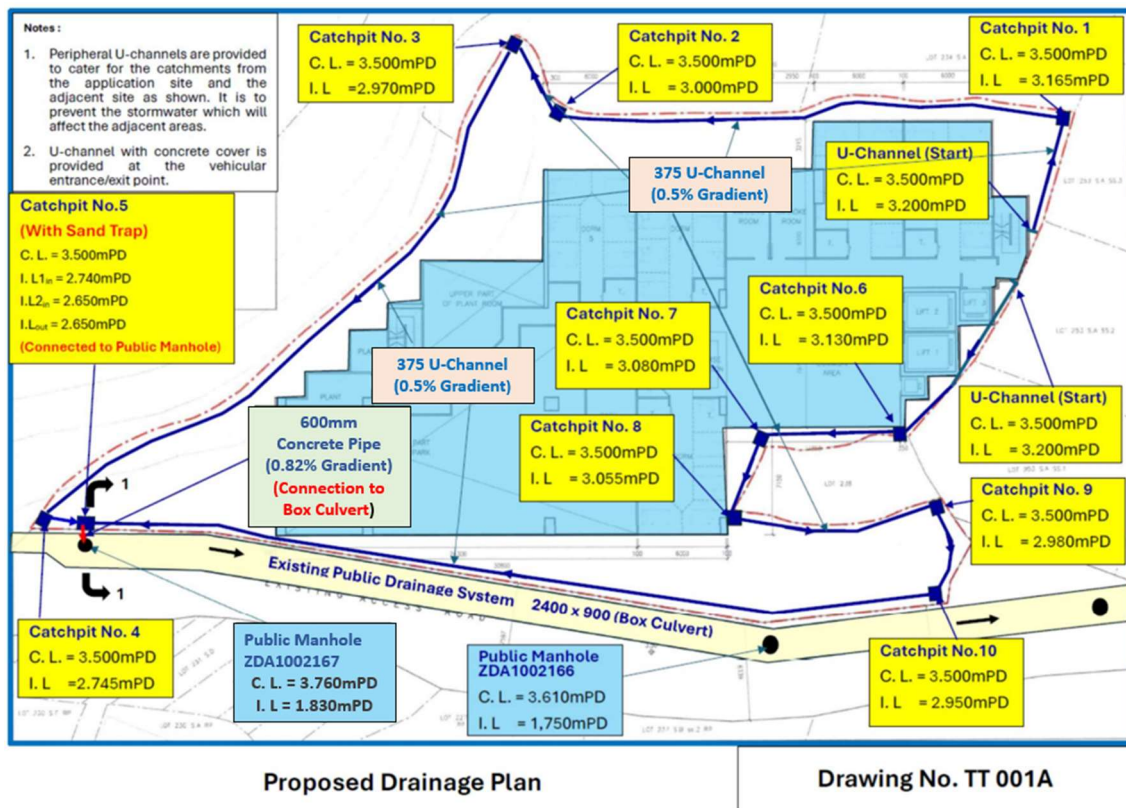C = Chezy coefficient = $(0.1500)^{1/6}/(0.015(\text{concrete pipe}))$= 48.59
$1.7 = 48.59 \times (0.1500 \times i)^{0.5}$
$(1.7/48.59)^2 = 0.1500 \times i$
Thus $i = 0.0082$ or 0.82% (i = inclination or gradient as 1/X)

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iv) Drainage Plan

Notes:

1. Peripheral U-channels are provided to cater for the catchments from the application site and the adjacent site as shown. It is to prevent the stormwater which will affect the adjacent areas.

2. U-channel with concrete cover is provided at the vehicular entrance/exit point.

Catchpit No. 3
C. L. = 3.500mPD
I. L = 2.970mPD

Catchpit No. 2
C. L. = 3.500mPD
I. L = 3.000mPD

Catchpit No. 1
C. L. = 3.500mPD
I. L = 3.165mPD

U-Channel (Start)
C. L. = 3.500mPD
I. L = 3.200mPD

375 U-Channel (0.5% Gradient)

Catchpit No.5 (With Sand Trap)
C. L. = 3.500mPD
I. L1$_{in}$ = 2.740mPD
I.L2$_{in}$ = 2.650mPD
I.L$_{out}$ = 2.650mPD
(Connected to Public Manhole)

Catchpit No.6
C. L. = 3.500mPD
I. L = 3.130mPD

Catchpit No. 7
C. L. = 3.500mPD
I. L = 3.080mPD

375 U-Channel (0.5% Gradient)

U-Channel (Start)
C. L. = 3.500mPD
I. L = 3.200mPD

600mm Concrete Pipe (0.82% Gradient) (Connection to Box Culvert)

Catchpit No. 8
C. L. = 3.500mPD
I. L = 3.055mPD

Catchpit No. 9
C. L. = 3.500mPD
I. L = 2.980mPD

Existing Public Drainage System 2400 x 900 (Box Culvert)

Catchpit No. 4
C. L. = 3.500mPD
I. L = 2.745mPD

Public Manhole ZDA1002167
C. L. = 3.760mPD
I. L = 1.830mPD

Public Manhole ZDA1002166
C. L. = 3.610mPD
I. L = 1,750mPD

Catchpit No.10
C. L. = 3.500mPD
I. L = 2.950mPD

Proposed Drainage Plan

Drawing No. TT 001A

Proposed Project Site

Public Road

Site boundary

Public Manhole ZDA1002167
C. L. = 3.760mPD
I. L = 1.830mPD

Proposed 375 U-channel

CL=3.50

CL=3.76

IL=2.65

95

2.73

IL=2.12

600

IL=2.04

IL=1.83

900

Proposed Catchpit with Sand Trap

2400

Proposed 600DN with not less than 0.82% gradient

Existing Box Culvert

Section 1-1

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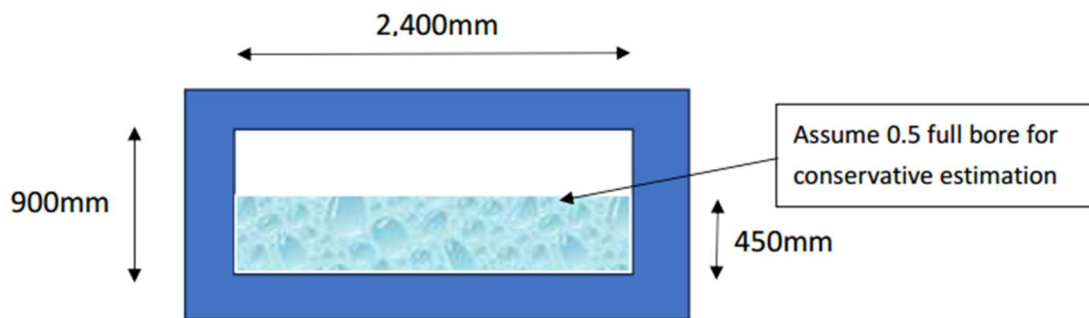## 5.   Calculation of Capacity of existing Box Culvert

Size of existing box culvert = 2,400mm x 900mm

Invert Level ZDA1002167 = 1.83

Invert Level ZDA1002166 = 1.75

Distance between two manholes =60m

Gradient = (1.83-1.75)/60 = 0.00133 or 0.133%

**Typical Cross Section
Of the Existing Box Culvert**

Mannings's formula:
$C = m^{1/6} / n$
Where C = Chezy coefficient
n = coefficient of roughness (0.015 for concrete)
m = hydraulic mean depth (HMD) = area of flow / wetted perimeter

Area of flow = 2.4 x 0.45 = 1.08
Wetted perimeter = 0.45 x 2 + 2.4 = 3.3
m = 1.08 / 3.3 = 0.327

$C = 0.327^{1/6} / 0.015 = 55.34$

Chezy's formula:

$V = C\sqrt{(m \times i)}$

$V = 55.34 \sqrt{(0.327 \times 0.00133)} = 1.154$ m/s

Capacity of the Existing Box Culvert

$Q = 1.154 \times 1.08 = 1.246$ m^3/s > 0.1445 m^3/s

Total flow from the proposed development

$= 0.1445$ m^3/s < 1.246 m^3/s (Adequate Capacity)

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6. Temporary Drainage Arrangements during Construction Stage

Proper measures shall be taken to maintain the existing drainage characteristics of the catchment areas and to minimize drainage impacts associated with the construction works. The principal drainage impacts which are associated with construction of the works have been identified as follows:

(a) Erosion of ground materials;
(b) Sediment transportation to existing downstream drainage system; and
(c) Obstruction to drainage systems.

To ensure proper operation of the site drainage channels and desilting facilities, inspection of the temporary drainage system shall be carried out on a weekly basis and the desilting facilities shall be cleaned on a daily basis.

If excavated materials are not possible to transport away the excavated materials within the same day, the materials should be covered by tarpaulin/ impervious sheets. Stockpiles of construction materials of more than 50m3 in an open area shall also be covered with tarpaulin or similar fabric during rainstorms.

All runoff discharge into the existing drainage system will be settled in a silt trap to ensure no sediment will be discharge into the existing system. Silt traps will normally be provided along the site drainage immediately upstream of the proposed discharge point to the existing Site. The silt traps shall be inspected daily and immediately after each rainstorm.

Liaison shall be carried out with relevant parties regarding temporary drainage arrangements to ensure that the drainage system is functioning adequately.

7. Conclusion

U-channels with catchpits are proposed to convey runoff from the proposed Project site for collection. The collected runoff will be discharge to the existing box culvert by drainage pipe.

The Project Proponent will be responsible for the construction and on-going maintenance of the drainage facilities.

No change of total catchment areas and the increase in stormwater flow is small (from $0.1312 \text{ m}^3/\text{s}$ to $0.1445 \text{ m}^3/\text{s}$), there will be no unacceptable drainage impacts as a result of the proposed development.

The assessment reviews the U-channel and drainage pipe have the sufficient capacity to cater for the drainage flow from the proposed Project site.

Temporary drainage impact mitigation measures and monitoring and audit are proposed to ensure that the existing drainage system will not be affected during the construction stage.