

1. Drainage Proposal

1.1 Site Particulars

- 1.1.1 The application site is abutting the Man Kam To Food control office, and possesses an area of approximately 4,364m².
- 1.1.2 There is a natural open stream directly to the north of the application site.
- 1.1.3 The application site is vacant and unpaved
- 1.1.4 The application site is in close proximity to the Man Kam To Boundary Control Point and a number of open storage yards and warehouse. The land in close proximity is mainly vacant soil land.

1.2 Level and gradient of the subject site & proposed surface channel

- 1.2.1 The application site is entirely vacant and unpaved. It can be separated into two areas; the western portion has a very gentle gradient sloping from South to North from about +8.6mPD to +8.4mPD, and the central portion which is separated by a steep slope from the western portion, has a very gentle gradient sloping from South to North from about 7.2mPD to 7.0mPD. While the Southern portion has a higher gradient sloping from South to North from +10.2mPD to +7.2mPD.
- 1.2.2 An area of approximately 4,364m² is proposed to be filled and paved. The proposed paved area will have a gradient sloping from Southwest to Northeast from about +8.7mPD to +8.3mPD, spanning the half of the site. In the Eastern portion, the proposed paved area will begin at the entrance at the Southern portion of the site will have a greater gradient sloping from South to North from about +10.2mPD to 8.6mPD and then will have a gentle gradient from +8.6mPD to 8.3mPD. The two portions will converge and meet at the middle of the site.
- 1.2.3 The proposed surface channel will be constructed following the proposed gradient of 1:100. As demonstrated in the calculation hereunder, 450mm surface U-channel will be capable to drain the surface runoff accrued at the subject site.
- 1.2.4 Sections at the entrance of the site will be constructed following a 1:30 and 1:50 gradient, as detailed in the drainage plan (Figure 4). As demonstrated in the calculations below, 150mm surface U-channel will be capable to drain the surface runoff at the respective catchment.

1.3 Catchment area of the proposed drainage provision at the subject site.

- 1.3.1 It is noted that the land to the South of the application site commands a higher level. The land to the East of the application site is occupied by temporary open storage and is completely fenced off, and has no opening to the proposed site, other than the stream course. And the land to the West of the Site is occupied by Man Kam To Food Office Building, which is downstream from the site, and we assume that there will be no overland flow from the East and West of the site. There is an existing open channel to the north of the site. As such, an external catchment is only found to the South of the application site (Figure 1).
- 1.3.2 The Site currently receives runoff from the external catchment to the South of the site and this will continue after the proposed development. The runoff is expected to be widespread (rather than at discrete locations), U-channels will be proposed to collect the internal and external drainage.
- 1.3.3 The intercepted stormwater will then be discharged to the existing open streamcourse to the North of the Site via a proposed 450mm diameter underground pipe.
- 1.3.4 All the proposed drainage facilities, including the section of surface channel proposed between the subject site to the streamcourse will be provided and maintained at the applicant's own expense. Also, surface U-channel will be cleaned at regular interval to avoid the accumulation of rubbish/debris which would affect the dissipation of storm water.

Figure 1: Catchment Area

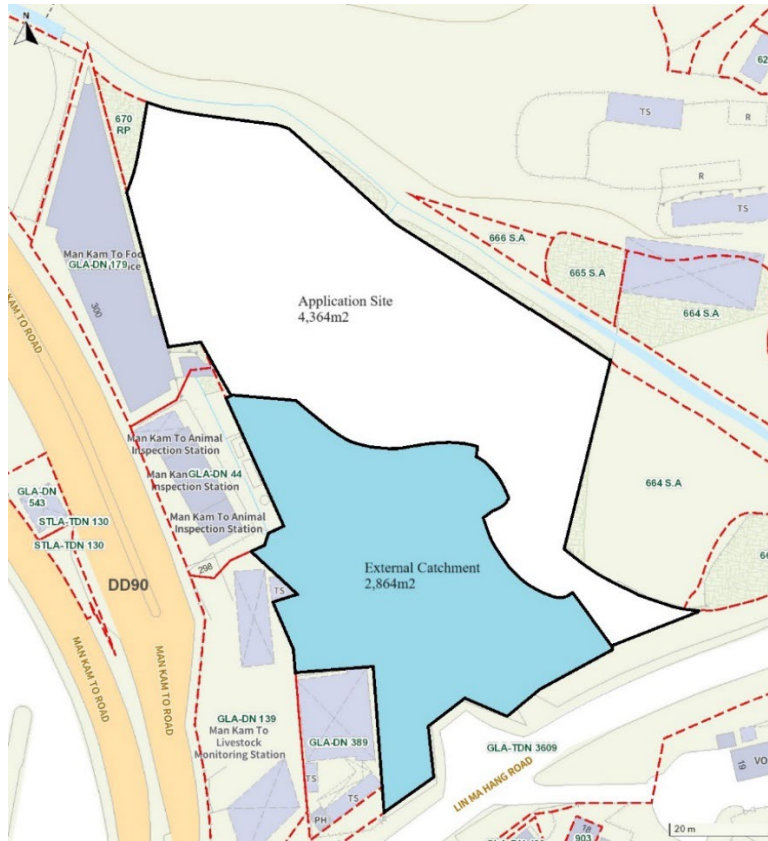
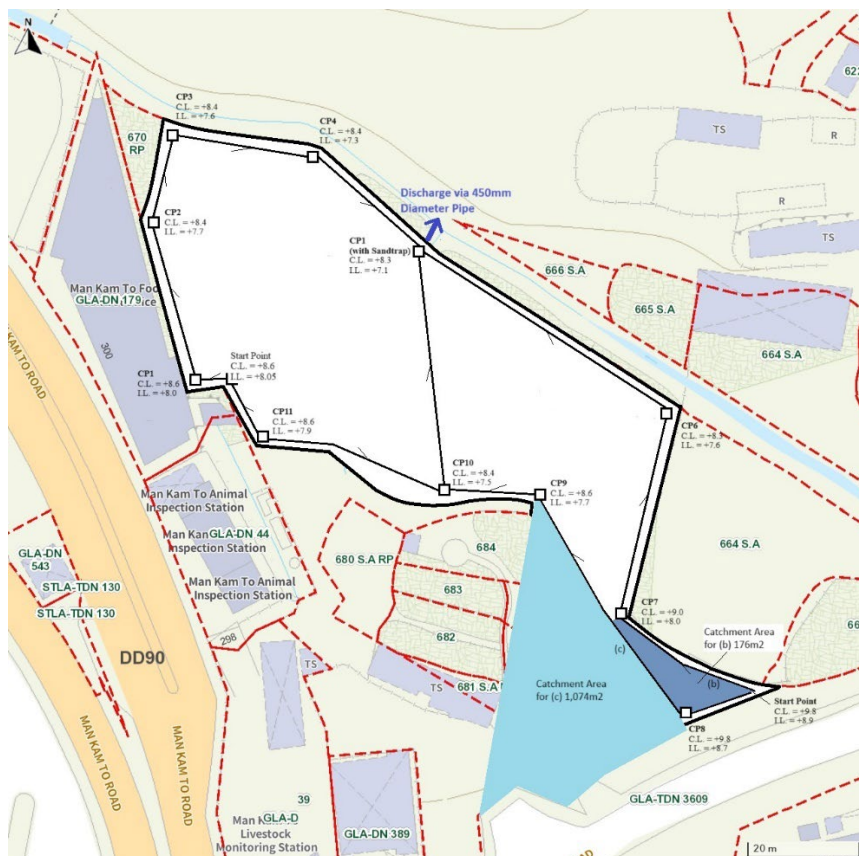


Figure 2: Catchment Area for Section (b) and (c)



- 2.1.3 Subject to the below calculations, it is determined that 450mm surface U-channel which is made of concrete along the site periphery is adequate to intercept storm water passing through and generated at the application site.
- 2.1.4 The intercepted stormwater will then be discharged to the existing natural stream to the north of the application site as shown in Figure 5 via a proposed 450mm diameter underground pipe.
- 2.1.5 The flow capacities of the proposed U-channel are calculated using the Chart for the Rapid Design of Channels. Runoff from corresponding Site Catchments (calculated based on a return period of 50 years), the capacity estimations are included below.

3 Drainage Calculation for the proposed Provision of Drainage Facilities at the Application Site

3.1 Runoff Estimation

- 3.1.1 Rational method is adopted for estimating the designed run-off

$$Q=0.278 C \times I \times A$$

Table 1: Runoff Coefficients

Surface Characteristics	Runoff Coefficient
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	0.15-0.2

Assuming that:

- I. The total catchment area is about 7,228m², including the area of external catchment of approximately 2,864m² and the existing site area of about 4,364 m²;
- II. Approximately 4,642 m² is hard paved, and therefore the value of run-off co-efficient (k) is taken as 0.95.
- III. Approximately 2,586 m² is unpaved and covered in heavy soil, and therefore the value of run-off co-efficient (k) is taken at 0.25.

$$\begin{aligned} \text{Difference in Land Datum} &= 10.2\text{m} - 8.3\text{m} = 1.9\text{m} \\ L &= 118.5\text{m} \\ \text{Average fall} &= 1.60\text{m in } 100\text{m} \end{aligned}$$

According to the Brandsby-Williams Equation adopted from the “Stormwater Drainage Manual – Planning, Design and management” published by the Drainage Services Department (DSD),

$$\begin{aligned} \text{Time of Concentration (t}_c\text{)} &= 0.14465[L/(H^{0.2} \times A^{0.1})] \\ t_c &= 0.14465[118.5/(1.6^{0.2} \times 7,228^{0.1})] \\ t_c &= 6.446 \text{ minutes} \end{aligned}$$

The rainfall intensity i is determined by using the Gumbel Solution:

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

Where i = Extreme mean intensity in mm/hr
 td = Duration in minutes ($td \leq 240$)
 a, b, c = Storm constants given in the table below

Table 2: Storm Constants for Different Return Periods of North District Area

Return Period T(years)	2	5	10	20	50
a	1004.5	1112.2	1157.7	1178.6	1167.6
b	17.24	18.86	19.04	18.49	16.76
c	0.644	0.614	0.597	0.582	0.561

$$i = \frac{1167.6}{[6.446 + 16.76]^{0.561}}$$

$$i = 200.1 \text{ mm/hr}$$

$$\text{By Rational Method, } Q = 0.95 \times 200.1 \text{ mm/hr} \times 4,642 / 3600$$

$$+ 0.25 \times 200.1 \text{ mm/hr} \times 2,586 / 3600$$

$$Q = 281 \text{ l/s} = 0.281 \text{ m}^3/\text{s} = 16,861 \text{ l/min}$$

In accordance with the Chart of the Rapid Design of Channels in “Geotechnical Manual for Slopes” (Appendix I), 450mm surface U-channel in 1:100 gradient is considered adequate to dissipate all the stormwater accrued by the application site. The intercepted stormwater will then be discharged to the existing natural stream to the north of the application site as shown in Figure 4.

4 Drainage Calculation for section (b) of the proposed Provision of Drainage Facilities at the Application Site

4.1 Runoff Estimation

4.1.1 Rational method is adopted for estimating the designed run-off

$$Q = 0.278 C \times I \times A$$

Assuming that:

- I. The catchment area is about 176m²;
- II. The entire area of 176 m² is proposed to be hard paved, and therefore the value of run-off co-efficient (k) is taken as 0.95.

$$\text{Difference in Land Datum} = 9.8\text{m} - 9.0\text{m} = 0.8\text{m}$$

$$L = 22\text{m}$$

$$\text{Average fall} = 3.64\text{m in } 100\text{m}$$

According to the Brandsby-Williams Equation adopted from the “Stormwater Drainage Manual – Planning, Design and management” published by the Drainage Services Department (DSD),

$$\begin{aligned} \text{Time of Concentration (t}_c) &= 0.14465[L/(H^{0.2} \times A^{0.1})] \\ t_c &= 0.14465[22/(3.64^{0.2} \times 176^{0.1})] \\ t_c &= 1.466 \text{ minutes} \end{aligned}$$

The rainfall intensity i is determined by using the Gumbel Solution:

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

Where i = Extreme mean intensity in mm/hr
 td = Duration in minutes ($td \leq 240$)
 a, b, c = Storm constants given in the table below

Table 2: Storm Constants for Different Return Periods of North District Area

Return Period T(years)	2	5	10	20	50
a	1004.5	1112.2	1157.7	1178.6	1167.6
b	17.24	18.86	19.04	18.49	16.76
c	0.644	0.614	0.597	0.582	0.561

$$\begin{aligned} i &= 1167.6/[1.466+16.76]^{0.561} \\ i &= 229.1 \text{ mm/hr} \end{aligned}$$

$$\begin{aligned} \text{By Rational Method, } Q &= 0.95 \times 229.1 \text{ mm/hr} \times 176 / 3600 \\ Q &= 11 \text{ l/s} = 0.011 \text{ m}^3/\text{s} = 638 \text{ l/min} \end{aligned}$$

In accordance with the Chart of the Rapid Design of Channels in "Geotechnical Manual for Slopes" (Appendix II), 150mm surface U-channel in 1:30 gradient is considered adequate to dissipate all the stormwater accrued by the catchment area.

5 Drainage Calculation for Section (c) of the proposed Provision of Drainage Facilities at the Application Site

5.1 Runoff Estimation

5.1.1 Rational method is adopted for estimating the designed run-off

$$Q = 0.278 C \times I \times A$$

Assuming that:

- I. The catchment area for section (c) of the proposed drainage facility is about 998m²;
- II. Approximately 272 m² is hard paved, and therefore the value of run-off co-efficient (k) is taken as 0.95.
- III. Approximately 726 m² is unpaved and covered in heavy soil, and therefore the value of run-off co-efficient (k) is taken at 0.25.

$$\text{Difference in Land Datum} = 10.2\text{m} - 8.6\text{m} = 1.6\text{m}$$

$$\begin{aligned} L &= 57\text{m} \\ \text{Average fall} &= 2.81\text{m in } 100\text{m} \end{aligned}$$

According to the Brandsby-Williams Equation adopted from the “Stormwater Drainage Manual – Planning, Design and management” published by the Drainage Services Department (DSD),

$$\begin{aligned} \text{Time of Concentration (t}_c) &= 0.14465[L/(H^{0.2} \times A^{0.1})] \\ t_c &= 0.14465[57/(2.81^{0.2} \times 998^{0.1})] \\ t_c &= 3.338 \text{ minutes} \end{aligned}$$

The rainfall intensity i is determined by using the Gumbel Solution:

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

Where i = Extreme mean intensity in mm/hr
 td = Duration in minutes ($td \leq 240$)
 a, b, c = Storm constants given in the table below

Table 2: Storm Constants for Different Return Periods of North District Area

Return Period T(years)	2	5	10	20	50
a	1004.5	1112.2	1157.7	1178.6	1167.6
b	17.24	18.86	19.04	18.49	16.76
c	0.644	0.614	0.597	0.582	0.561

$$\begin{aligned} i &= 1167.6/[3.338+16.76]^{0.561} \\ i &= 185.4\text{mm/hr} \end{aligned}$$

$$\begin{aligned} \text{By Rational Method, Q} &= 0.95 \times 185.4\text{mm/hr} \times 272 / 3600 \\ &\quad + 0.25 \times 185.4\text{mm/hr} \times 726 / 3600 \\ Q &= 23\text{l/s} = 0.023\text{m}^3/\text{s} = 1359 \text{ l/min} \end{aligned}$$

In accordance with the Chart of the Rapid Design of Channels in “Geotechnical Manual for Slopes” (Appendix II), 150mm surface U-channel in 1:50 gradient is considered adequate to dissipate all the stormwater accrued by the catchment area.

Figure 4: Drainage Plan

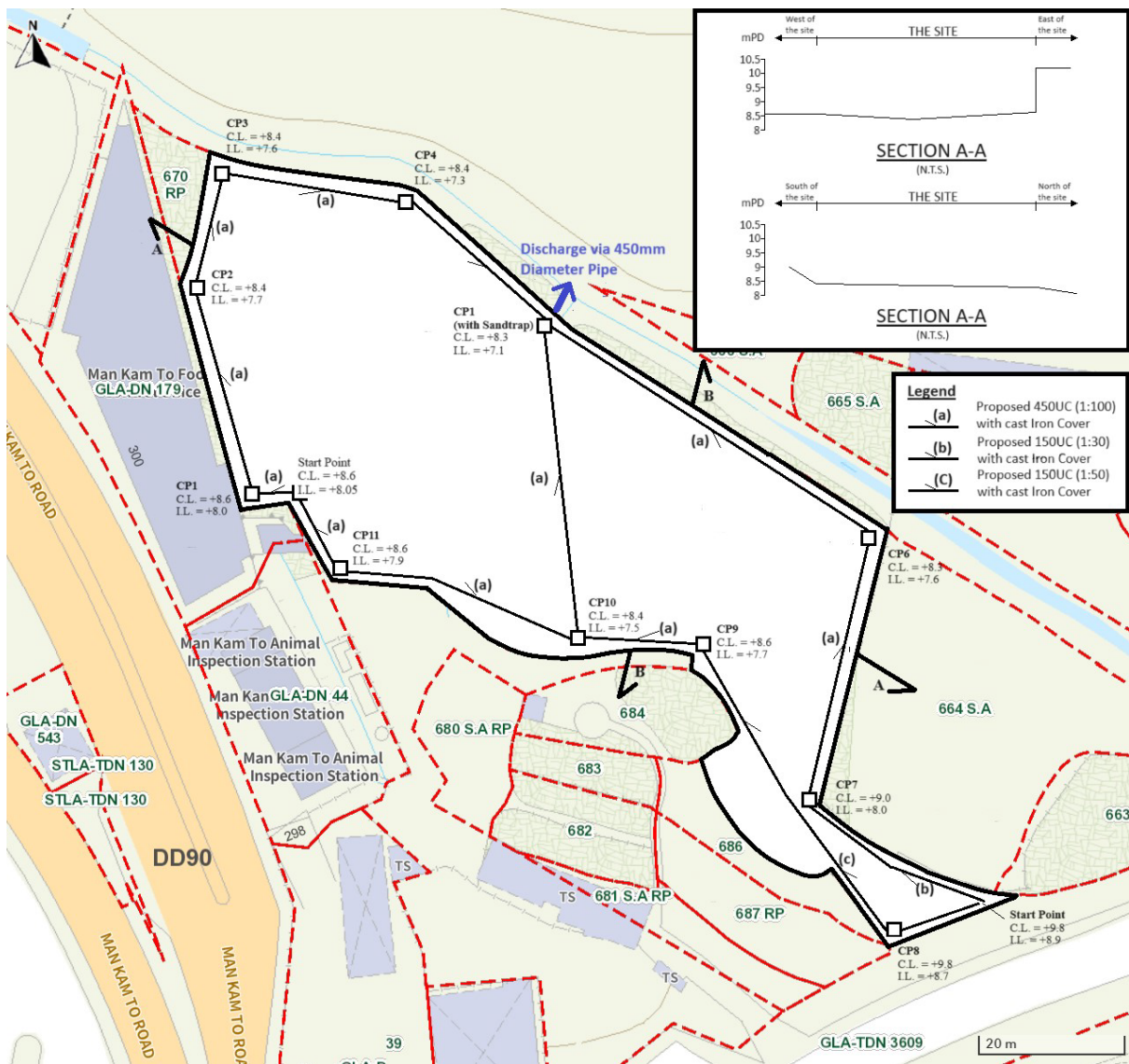
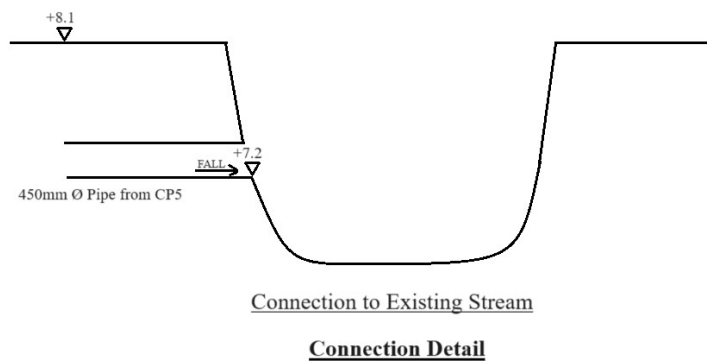


Figure 5 Connection Detail



6 Checking the Capacity of the 450mm Diameter underground pipe

Manning Equation

$$V = R^{2/3} \times S_f^{0.5} / n$$

$$R = \frac{\pi r^2}{2\pi r}$$

$$R = \frac{r}{2}$$

$$\text{Diameter} = 0.45\text{m}$$

$$r = 0.45\text{m}/2 = 0.225\text{m}$$

$$R = 0.225\text{m}/2 = 0.1125\text{m}$$

$$n = 0.012 \text{ s/m}^{1/3}$$

(Table 13 of Stormwater Drainage Manual)

$$V = [0.15^{2/3}] \times [0.01^{0.5}] / 0.012$$

$$V = 1.94\text{m/sec}$$

$$\text{Maximum Capacity } Q_{\text{Max}} = V \times A$$

$$A = \pi r^2$$

$$A = \pi \times 0.225^2$$

$$A = 0.159\text{m}^2$$

$$Q_{\text{Max}} = 1.94\text{m/sec} \times 0.159\text{m}^2$$

$$Q_{\text{Max}} = 0.309\text{m}^3/\text{sec}$$

$$0.309\text{m}^3/\text{sec} > 0.281\text{m}^3/\text{sec}$$

$$Q_{\text{Max}} > Q$$

A 450mm diameter pipe has sufficient capacity to discharge the runoff estimation from the catchment area

7 Checking the Capacity of the Natural Stream

Manning Equation

$$V = R^{2/3} \times S_f^{0.5} / n$$

$$R = \frac{L \times D}{2D + L}$$

$$L = 2.8\text{m}$$

$$D = 1.5\text{m}$$

$$R = [2.8 \times 1.5] / [2 \times 1.5 + 2.8]$$

$$R = 0.72\text{m}$$

$$n = 0.035 \text{ s/m}^{1/3}$$

(Table 13 of Stormwater Drainage Manual, Assuming straight, Natural stream, with weeds and stones, in fair condition)

$$V = [0.72^{2/3}] \times [0.01^{0.5}] / 0.035$$

$$V = 2.30\text{m/sec}$$

$$\text{Maximum Capacity } Q_{\text{Max}} = V \times A$$

$$A = L \times D$$

$$A = 2.8 \times 1.5$$

$$A = 4.2\text{m}^2$$

$$Q_{\text{Max}} = 2.3\text{m/sec} \times 4.2\text{m}^2$$

$$\begin{aligned}
 Q_{\text{Max}} &= 9.68\text{m}^3/\text{sec} \\
 9.68\text{m}^3/\text{sec} &> 0.281\text{m}^3/\text{sec} \\
 Q_{\text{Max}} &> Q
 \end{aligned}$$

The runoff estimation is only a small fraction of the existing streamcourse's capacity

8 Checking the Adequacy of Fence Gapping for Overland Flow

Assuming that

- i. The area of external catchment of approximately 2,864m²;
- ii. Approximately 278 m² is hard paved, and therefore the value of run-off co-efficient (k) is taken as 0.95.
- iii. Approximately 2,586 m² is unpaved and covered in heavy soil, and therefore the value of run-off co-efficient (k) is taken at 0.25.
- iv. As the overland flow is from the external catchment to the South of the site, we assume the overland flow is received along the fencing at the Southern border only, which is about 104m in length (L)
- v. We assume the overland flow from the external catchment is widespread.
- vi. The gapping in the fencing is set at 10cm (D)
- vii. The capacity of the gapping is closest to a concrete lined channel in good condition (n=0.014 s/m^{1/3})

8.1.1 Overland Flow From External Catchment

Runoff Estimation

Rational method is adopted for estimating the designed run-off

$$Q = 0.278 C \times I \times A$$

$$\begin{aligned}
 \text{Difference in Land Datum} &= 10.2\text{m} - 8.4\text{m} = 1.8\text{m} \\
 L &= 76\text{m} \\
 \text{Average fall} &= 2.37\text{m in } 100\text{m}
 \end{aligned}$$

According to the Brandsby-Williams Equation adopted from the "Stormwater Drainage Manual – Planning, Design and management" published by the Drainage Services Department (DSD),

$$\begin{aligned}
 \text{Time of Concentration (t}_c\text{)} &= 0.14465[L/(H^{0.2} \times A^{0.1})] \\
 t_c &= 0.14465[76/(2.37^{0.2} \times 2,864^{0.1})] \\
 t_c &= 4.17 \text{ minutes}
 \end{aligned}$$

The rainfall intensity i is determined by using the Gumbel Solution:

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

Where i = Extreme mean intensity in mm/hr
 td = Duration in minutes ($td \leq 240$)
 a, b, c = Storm constants given in the table below

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Return Period T(years)	2	5	10	20	50
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b	17.24	18.86	19.04	18.49	16.76
c	0.644	0.614	0.597	0.582	0.561

$$i = 1167.6/[4.17+16.76]^{0.561}$$

$$i = 211.0\text{mm/hr}$$

$$\text{By Rational Method, } Q = 0.95 \times 211.0\text{mm/hr} \times 278/3600$$

$$+ 0.25 \times 211.0\text{mm/hr} \times 2,586/3600$$

$$Q = 54\text{l/s} = 0.054\text{m}^3/\text{s}$$

8.1.2 Adequacy of Fencing Gap

Manning Equation

$$V = R^{2/3} \times S_f^{0.5} / n$$

$$R = \frac{L \times D}{2D + L}$$

$$L = 104\text{m}$$

$$D = 0.1\text{m}$$

$$R = [104 \times 0.1] / [2 \times 0.1 + 104]$$

$$R = 0.10\text{m}$$

$$n = 0.014 \text{ s/m}^{1/3}$$

(Table 13 of Stormwater Drainage Manual)

$$V = [0.10^{2/3}] \times [0.01^{0.5}] / 0.014$$

$$V = 1.54\text{m/sec}$$

$$\text{Maximum Capacity } Q_{\text{Max}} = V \times A$$

$$A = L \times D$$

$$A = 104 \times 0.1$$

$$A = 10.4\text{m}^2$$

$$Q_{\text{Max}} = 1.54\text{m/sec} \times 10.4\text{m}^2$$

$$Q_{\text{Max}} = 15.99\text{m}^3/\text{sec}$$

$$15.99\text{m}^3/\text{sec} > 0.054\text{m}^3/\text{sec}$$

$$Q_{\text{Max}} > Q$$

The 10cm gapping is more than adequate to receive the overland flow from the external catchment.

9 Conclusion

- 9.1 The applicant will be responsible for the construction and ongoing maintenance of the drainage facilities.
- 9.2 Potential drainage impacts that may arise from the Site after construction of the Proposed Development have been assessed. Thus, existing stormwater system will have sufficient capacity to receive stormwater runoff from the Proposed Development and surrounding catchments.
- 9.3 Adequate measures are provided at the resources of the applicant to prevent the site from being eroded and flooded
- 9.4 External catchment is taken into account such that flooding susceptibility of the adjoining areas would not be adversely affected by the proposed development.

Appendix I: Chart of the Rapid Design of Channels (Entire site, 450U-Channel, 1:100 Gradient)

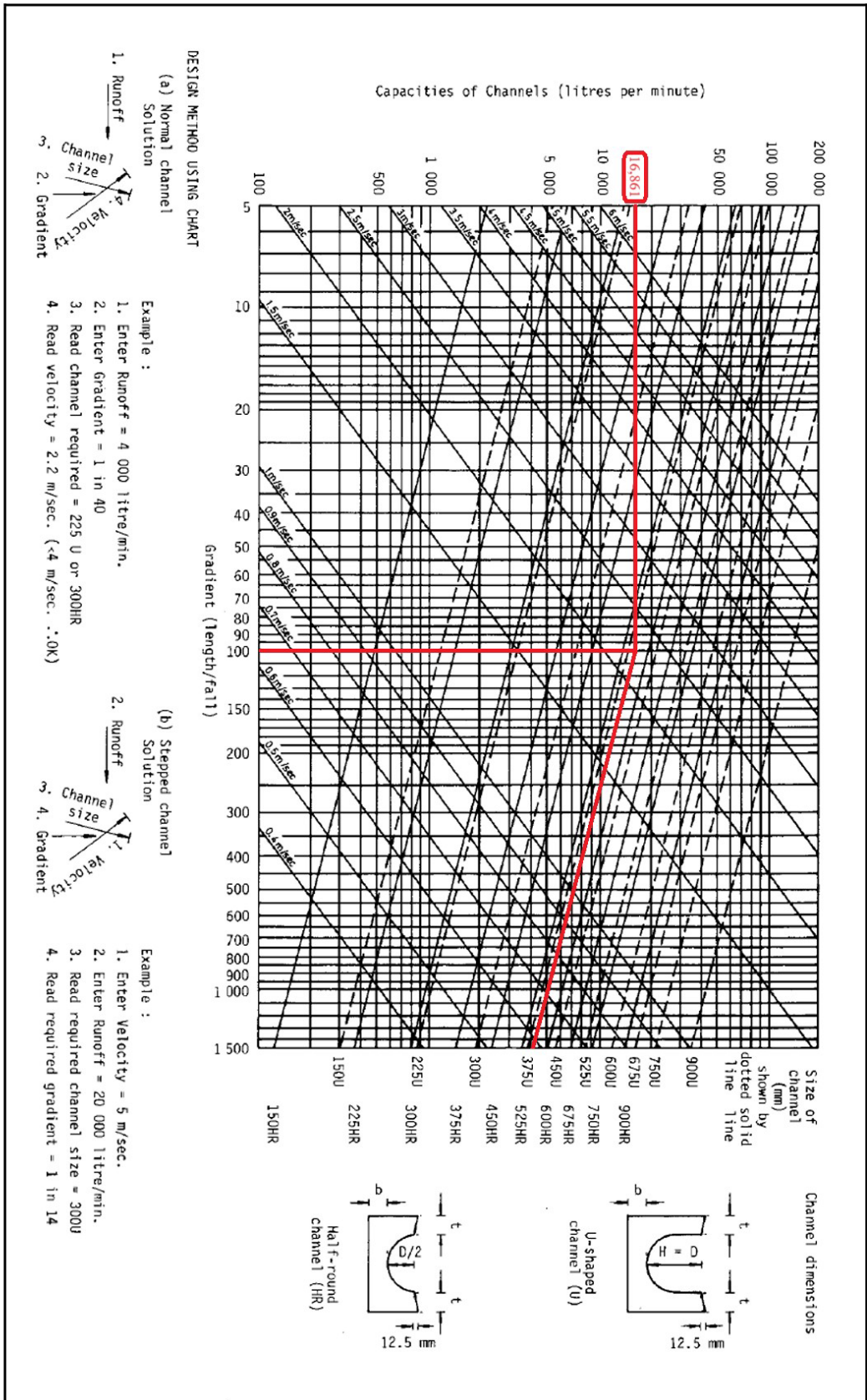


Chart for the Rapid Design of Channels in the Geotechnical Manual for Slopes (Second Edition) (GCO, 1984)

Appendix II: Chart of the Rapid Design of Channels (Entire site, 450U-Channel, 1:100 Gradient)

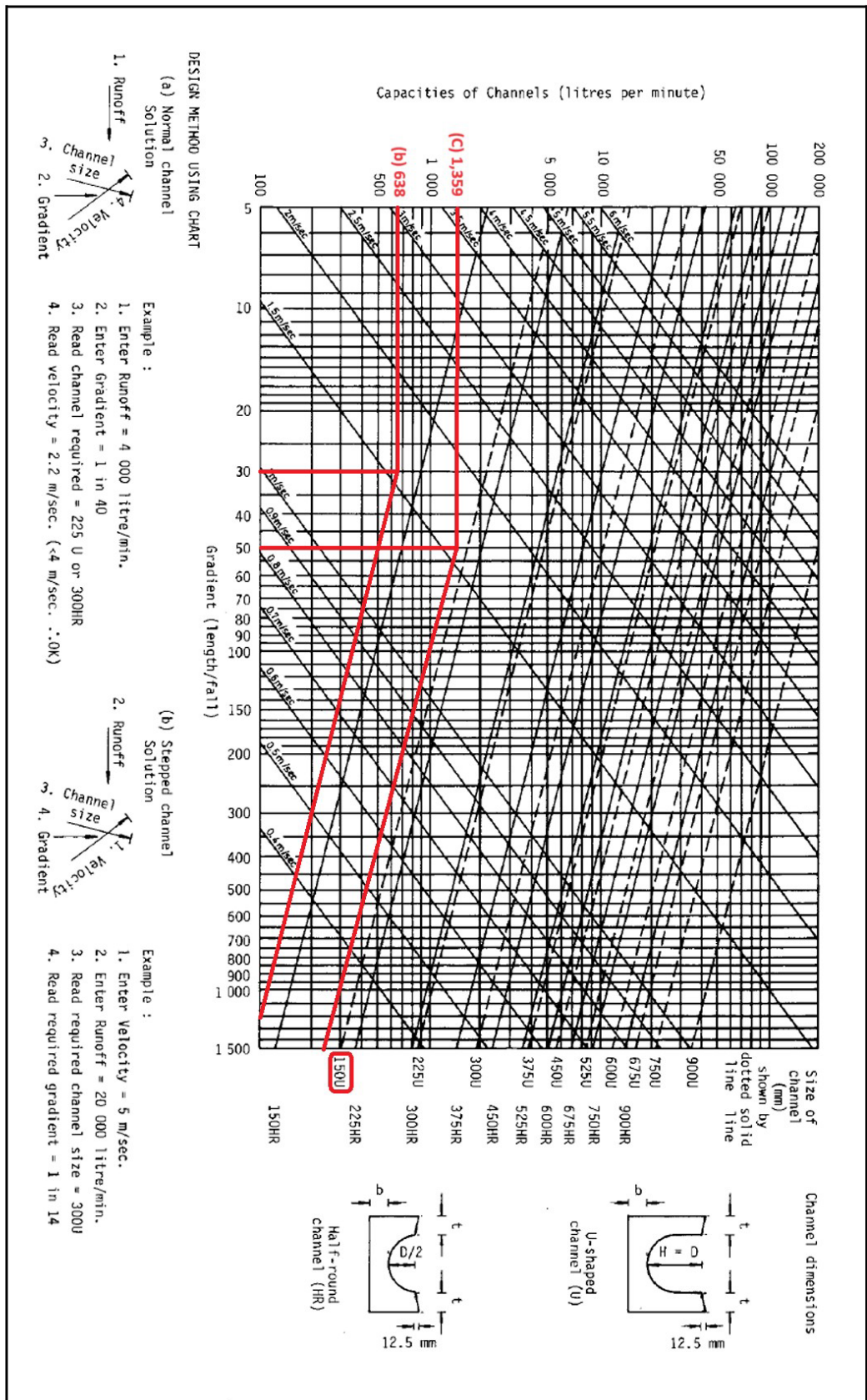


Chart for the Rapid Design of Channels in the Geotechnical Manual for Slopes (Second Edition) (GCO, 1984)