Terraco Ref: 17085

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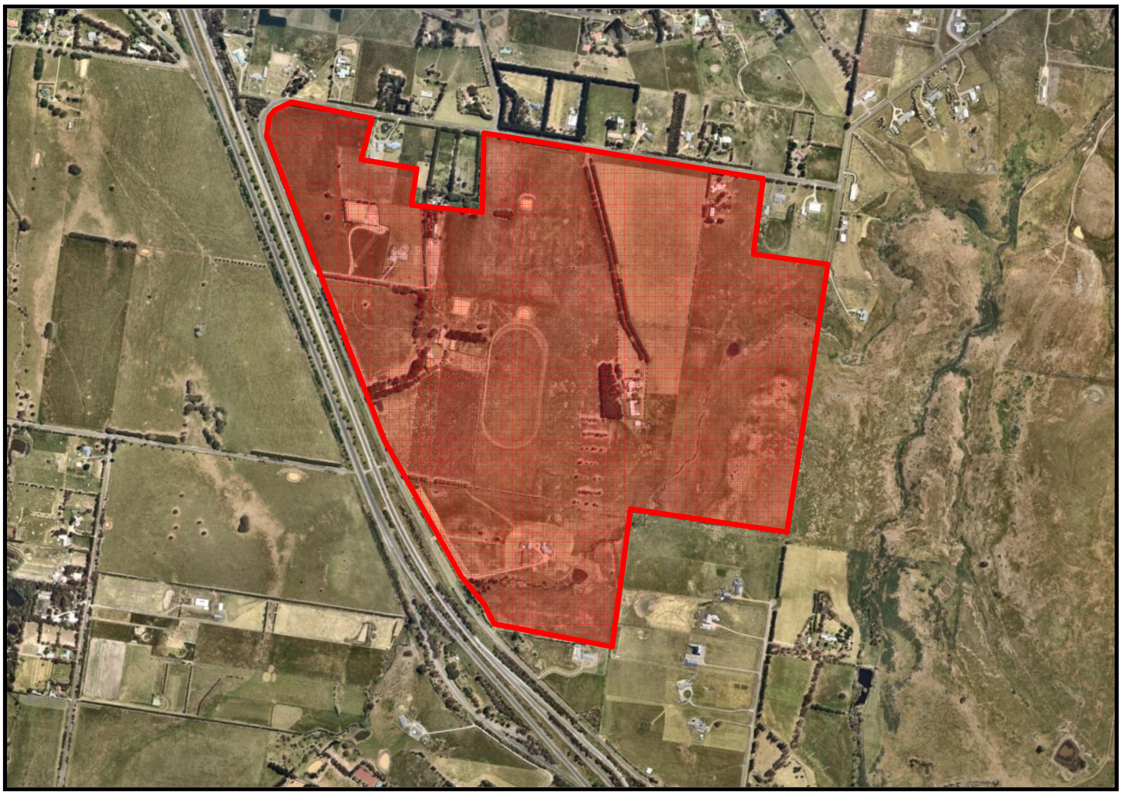

Bennett Road, Gisborne
Drainage / Culvert Sizing Report

August 2020

Version 2

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Introduction

This report is to assist in the application for an Overall Development Plan at Bennett Road, Gisborne. The report details the drainage infrastructure requirements at critical locations for the proposed development.

The report assesses the catchment area of the ephemeral creek/drainage line that traverses the Development Plan area and feeds into Jacksons Creek to the east of Coney Court. The purpose of the assessment is to outline the overall indicative response for locations where vehicle or pedestrian infrastructure will be constructed over the creek.

The Development Plan does not envisage a notable increase in runoff to the creek due to the minimal 2ha lot sizes and the objective to detain and maintain lot runoff to current rural guidelines. This report is therefore focused upon drainage infrastructure at the two creek crossings denoted below.

Two locations have been identified in accordance with the Concept Plans submitted as part of the application. Location 1 is a proposed road crossing on the existing waterway that runs through the site in the unmade Brooking Road reserve. Location 2 is a potential proposed pedestrian crossing located within the existing and unmade Coney Court road reserve. Both crossings will require the installation of culverts underneath so the waterway may maintain its existing flow path.

The existing upstream culvert entering the site in the south-west corner located underneath the Calder Freeway is a 2.55m diameter circular pipe, which has likely been sized to cater for a 1% AEP (100 year storm event) due to the size and use of the road.

Council's drainage response has been considered. "AustRoads Guide to Road Design Part 5: Drainage General and Hydrology Considerations" Table 4.3 states that the suggested ARI for flood immunity for culvert and bridge drainage is 10 years. An annual exceedance probability of 5% (20 year storm event) was chosen for the calculations provided in this report, which is more conservative than AustRoads recommendations. Both culverts have been sized using the Rational Method and rainfall data as per Australian Rainfall and Runoff 2019 (ARR2019). Results from the Rational Method were then inputted on a Colebrook-White Chart to obtain approximate culvert sizes. Calculations are provided in the following sections of this report, and an overview of the rational method and its variables is provided on the following page.

A RORB model will be created at the time of subdivision of 134 McGregor Road (the lot adjoining the crossings). At that time the detailed design will be determined and will be applied as a permit condition for the development of that lot.

An initial feasibility estimate of development costs has been prepared by Terraco and included as an appendix to this report; it is a conservative estimate.

Formulae

Rational Method

Used to calculate flow rates for each catchment.

$Q = 0.278 * C * I * A$

Where Q = Flow Rate (m^3/s)
C = Runoff Coefficient (as per IDM Table 10)
I = Rainfall Intensity (mm/hr) (determined using BOM Rainfall IFD Charts)
A = Catchment Area (km^2)

Time of Concentration

Used as an input for BOM rainfall IFD charts, to determine Rainfall Intensity.

$t_c = 0.76 * A^{0.38}$

Where t_c = Time of Concentration (hrs)
A = Catchment Area (km^2)

Location 1: Proposed Internal Road Crossing

Location 1 is a proposed road crossing of the waterway in the Brooking Road unmade road reserve. Calculations are provided below.
See Sheet 1 (appended) for location and catchment sizes.
See Colebrook-White Chart 1 (appended) for pipe size determination.

Location 1 - Road Crossing		
ACTUAL FLOW - AEP = 5%		
Catchment Type	**Runoff Coefficient C**	**Area A (ha)**
Residential Road Reserve	0.75	28.65
Lots (2ha+)	0.30	254.73
Total	0.340	279.38

Variable	**Equation**	**Value**
Time of Concentration	$t_c = 0.76*A^{0.38}$ (hrs) (A in km^2)	1.123
Time of Concentration	t_c*60 (mins)	67
Intensity	I (mm/hr)	28.4
Actual Flow	Q = 0.278*CIA (m^3/s)	7.4931
Actual Flow	Q (L/s)	7493.1
Approx. Pipe Size	Colebrook-White Chart (k=0.60mm)	**1950mm**

Using the calculated flow rate (Q, L/s) above and an assumed hydraulic gradient (S) of 1 in 300 (generally the absolute flattest grade to run a pipe, and therefore the worst case scenario), and inputting those two values into a Colebrook-White chart (assumed pipe roughness k=0.60mm), an approximate pipe size was determined.

Based on preliminary studies, the proposed road crossing at location 1 will require a 1950mm circular culvert to cater for a 5% AEP storm event. A pipe arrangement of similar capacity such as a box culvert or twin culverts may also be acceptable to reduce the amount the road reserve needs to be built up, subject to detailed design and council approval.

As a cross-check, the catchment was added to the Regional Flood Frequency Estimation Model, which is freely available online. Results using this tool are provided below.

RFFE Lower Confidence Limit (5%) = 1.58 m^3/s
RFFE Discharge = 4.67 m^3/s
Rational Method Actual Flow Rate (Q) = 7.49 m^3/s
RFFE Upper Confidence Limit (95%) = 13.80 m^3/s

Actual Flow Rate (Q) calculated by hand is within the confidence limits of results provided via the Regional Flood Frequency Estimation Model.

Location 2: Proposed Pedestrian Crossing

Location 2 is a proposed pedestrian crossing of the waterway in the Coney Court road reserve, between the existing Coney Court bowl and the proposed roads court bowl. Calculations are provided below.
See Sheet 2 (appended) for location and catchment sizes.
See Colebrook-White Chart 2 (appended) for pipe size determination.

Location 2 - Pedestrian Crossing		
ACTUAL FLOW - AEP = 5%		
Catchment Type	**Runoff Coefficient C**	**Area A (ha)**
Residential Road Reserve	0.75	28.66
Lots (2ha+)	0.30	316.98
Total	0.337	345.64

Variable	**Equation**	**Value**
Time of Concentration	$t_c = 0.76*A^{0.38}$ (hrs) (A in km^2)	1.218
Time of Concentration	t_c*60 (mins)	73
Intensity	I (mm/hr)	26.8
Actual Flow	Q = 0.278*CIA (m^3/s)	8.6862
Actual Flow	Q (L/s)	8686.2
Approx. Pipe Size	Colebrook-White Chart (k=0.60mm)	**2100mm**

Using the calculated flow rate (Q, L/s) above and an assumed hydraulic gradient (S) of 1 in 300 (generally the absolute flattest grade to run a pipe, and therefore the worst case scenario), and inputting those two values into a Colebrook-White chart (assumed pipe roughness k=0.60mm), an approximate pipe size was determined.

Based on preliminary studies, the proposed pedestrian crossing at location 2 will require a 2100mm circular culvert to cater for a 5% AEP storm event. A pipe arrangement of similar capacity such as a box culvert or twin culverts may also be acceptable to reduce the amount the road reserve needs to be built up, subject to detailed design and council approval.

As a cross-check, the catchment was added to the Regional Flood Frequency Estimation Model, which is freely available online. Results using this tool are provided below.

RFFE Lower Confidence Limit (5%) = 2.42 m^3/s
RFFE Flow Rate = 7.48 m^3/s
Rational Method Actual Flow Rate (Q) = 8.69 m^3/s
RFFE Upper Confidence Limit (95%) = 23.30 m^3/s

Actual Flow Rate (Q) calculated by hand is within the confidence limits of results provided via the Regional Flood Frequency Estimation Model.

Conclusion

Location 1, the proposed internal road crossing, will require a 1950mm circular culvert or equivalent to cater for a 5% AEP storm event.

Location 2, the proposed pedestrian crossing, will require a 2100mm circular culvert or equivalent to cater for a 5% AEP storm event. Note that the need for a pedestrian crossing is yet to be determined by council, this report is simply to provide further information to assist in the feasibility for provision of a crossing at that location. An appropriate "environmental" response would suggest that such a formalised crossing as outlined would not be appropriate or needed for the rare times the creek would carry water. A crossing with culverts sized to a smaller and more frequent storm event, such as a 20% AEP, with excess flows (in more uncommon storm events) travelling over the crossing could have merit as a more appropriate pedestrian crossing solution.

Each crossing would require significant earthworks to build up the crossing in order to provide sufficient cover on the culverts, though slimmer culvert profiles of equivalent capacity may be utilised at the detail design stage to minimise this.

These results come with several disclaimers as to their accuracy. Firstly, the catchment areas were approximated based purely on contours, and do not consider roadside swales or drainage infrastructure that may introduce other catchments or remove sections of the catchment on the attached plans. Secondly, the AEP used for the preceding calculations was chosen as it is considered (in the preliminary calculations stage) to be an overestimate, as it's likely that council may recommend a 10% or 20% AEP instead to align with AustRoads and commonly adopted guidelines, reducing pipe size requirements.

As previously mentioned, A RORB model will be created at the time of subdivision of 134 McGregor Road (the lot adjoining the crossings) to further detail requirements.
The detailed design will be undertaken at subdivision stage to align with the results of the RORB model and achieve a design that is acceptable to council. The waterway crossings will be designed in accordance with Melbourne Water's Waterway Crossing Guidelines. Detailed design of the crossings will need to be undertaken with the applicable stage of the development.

This report and associated calculations should be treated as indicative only, and details are to be clarified at the design stage.

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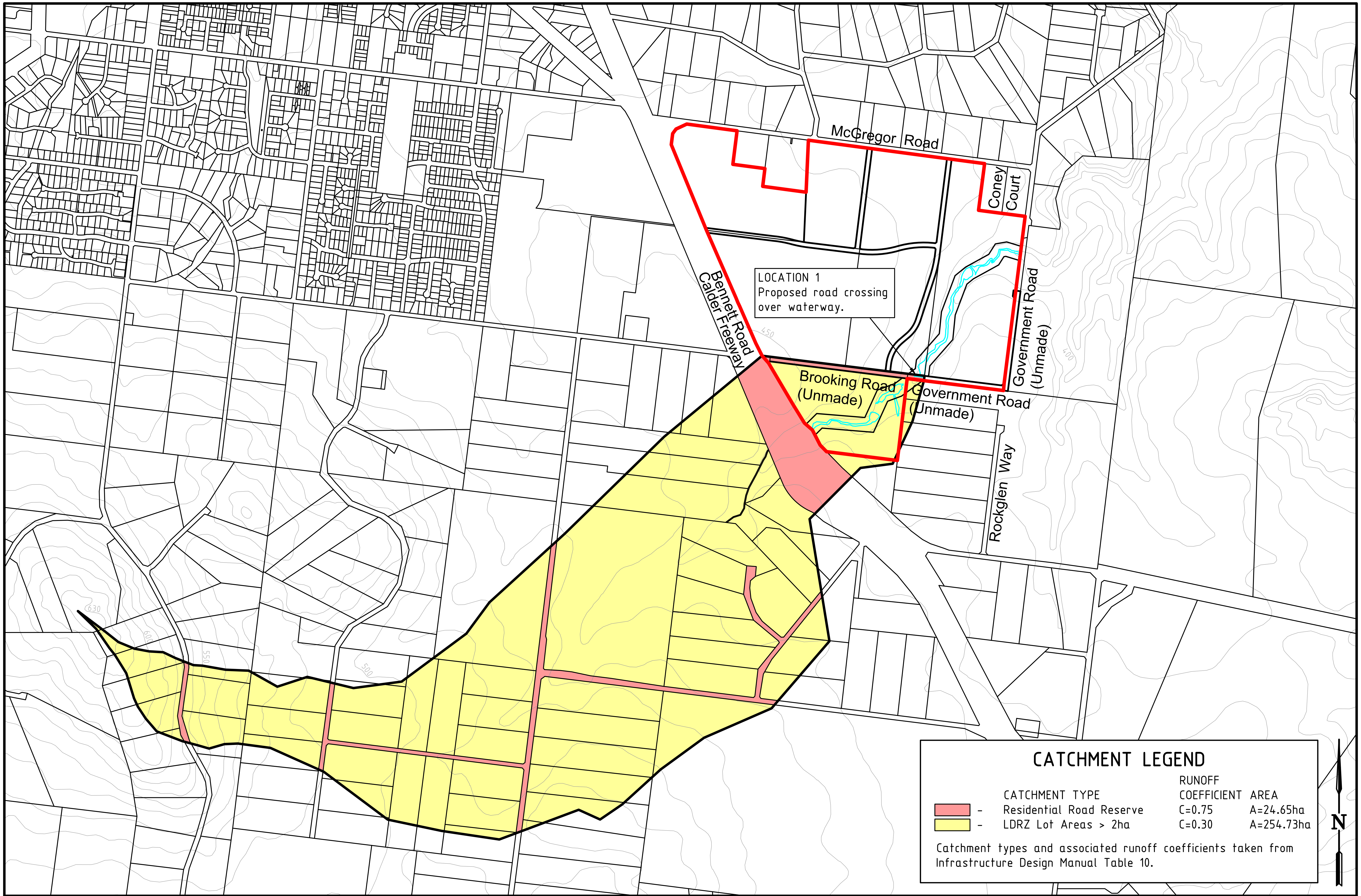
References

Bureau of Meteorology. (n.d.). *Design Rainfall Data System (2016)*. Retrieved January 30, 2020, from Bureau of Meteorology: http://www.bom.gov.au/water/designRainfalls/revised-ifd/

Concrete Pipe Association of Australasia. (n.d.). *Colebrook-White Charts.* Retrieved January 30, 2020, from Concrete Pipe Association of Australasia: https://www.cpaa.asn.au/General/design-manuals.html

Haddad, K., & Rahman, A. (n.d.). *Regional Flood Frequency Estimation Model*. Retrieved from Regional Flood Frequency Estimation Model: https://rffe.arr-software.org/

Local Government Infrastructure Design Association. (2020). *Infrastructure Design Manual.* Tongala: Local Government Infrastructure Design Association.



CATCHMENT LEGEND

	CATCHMENT TYPE	RUNOFF COEFFICIENT	AREA
(red) -	Residential Road Reserve	C=0.75	A=24.65ha
(yellow) -	LDRZ Lot Areas > 2ha	C=0.30	A=254.73ha

Catchment types and associated runoff coefficients taken from Infrastructure Design Manual Table 10.

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Ver	Revision Description	Date
6		
5		
4		
3		
2		
1	Original Issue	28/01/2020
0	Draft	-

Drafted	Checked
J.Sens	P.Bowe
Jan 2020	Jan 2020
Approved	

Notes/Legend

Contours shown on plan indicate the approximate existing surface.
Contour interval 10m.
Indicative catchment area shown is based on existing surface contours, and does not consider existing drainage infrastructure.

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Scale (m) NTS

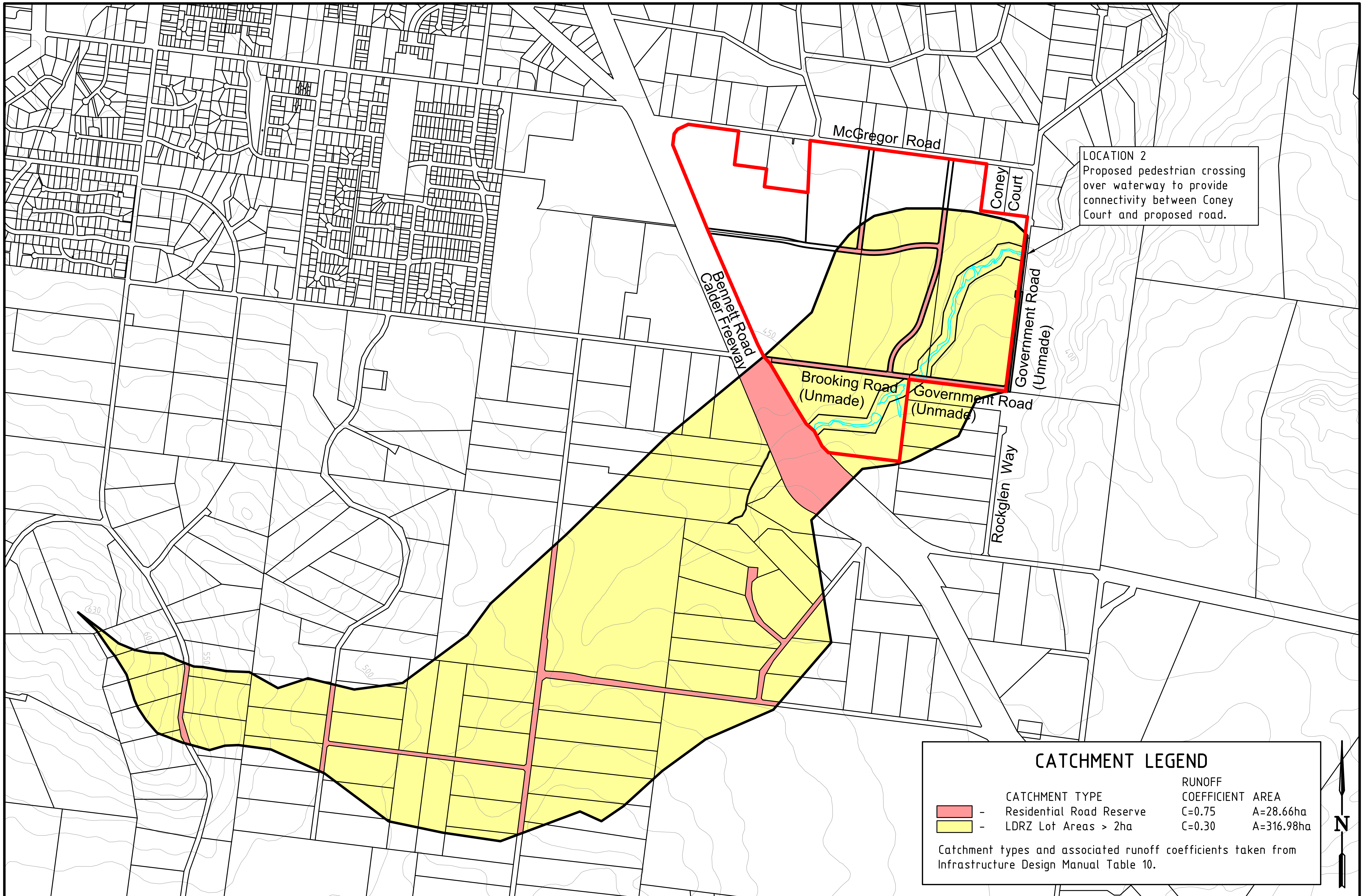
All lengths are in metres and all levels are to Australian Height Datum (Original Sheet Size is A3)

Macedon Ranges Shire Council - Gisborne

Bennett Road Precinct Indicative Catchment Plan

Location 1 - Proposed Road Crossing

Drawing file:	LTO Ref:	Council Ref:	Water Auth. Ref:	Our Ref:	Version	Sheet
17085 Catchment.dwg	-	-	-	17085	1	1 of 2



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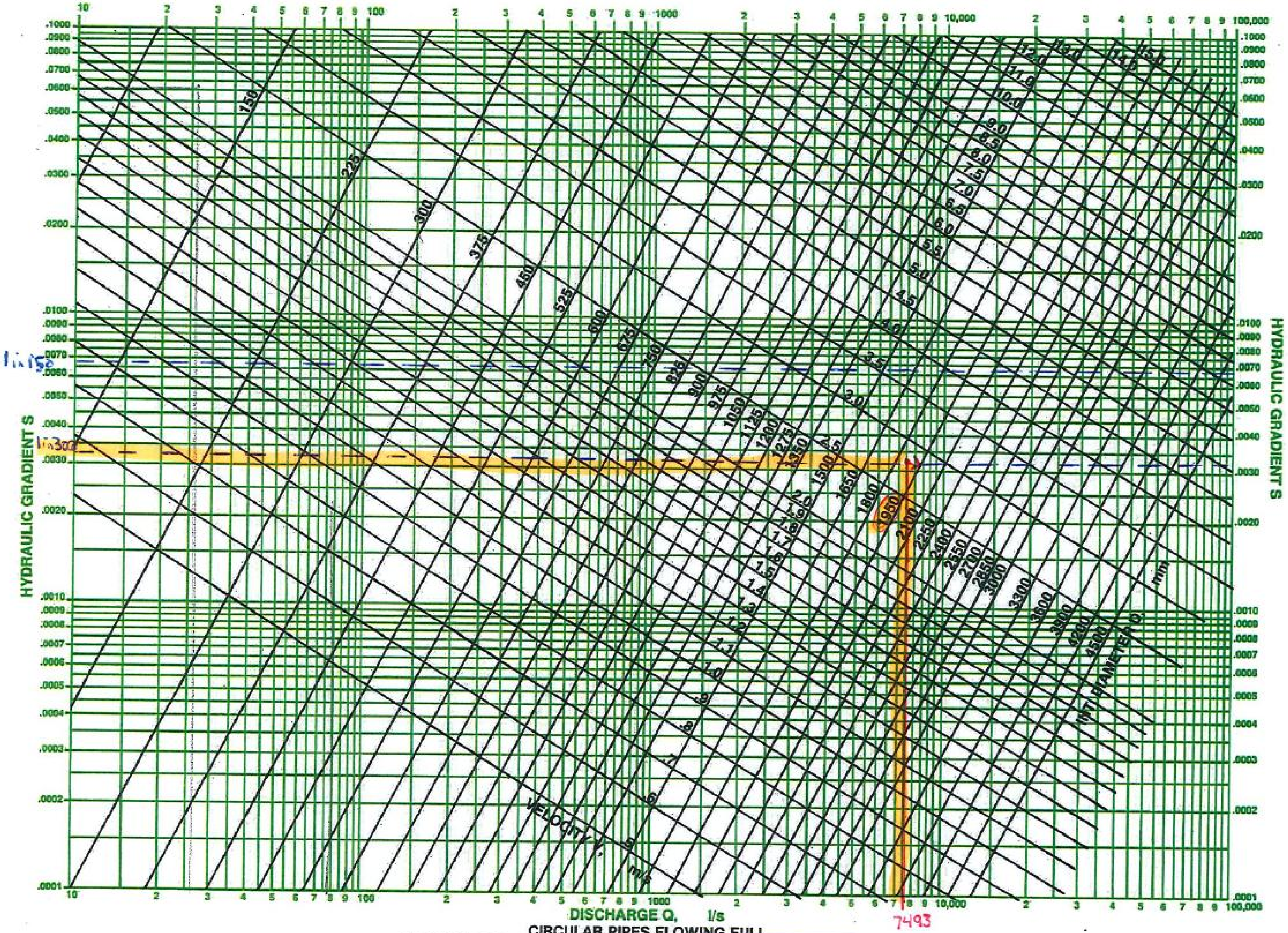
Macedon Ranges Shire Council - Gisborne

Bennett Road Precinct
Indicative Catchment Plan

Location 2 - Proposed Pedestrian Crossing

Drawing file:	LTO Ref:	Council Ref:	Water Auth. Ref:	Our Ref:	Version	Sheet
17085 Catchment.dwg	-	-	-	17085	1	2 of 2

CATCHMENT 1.1

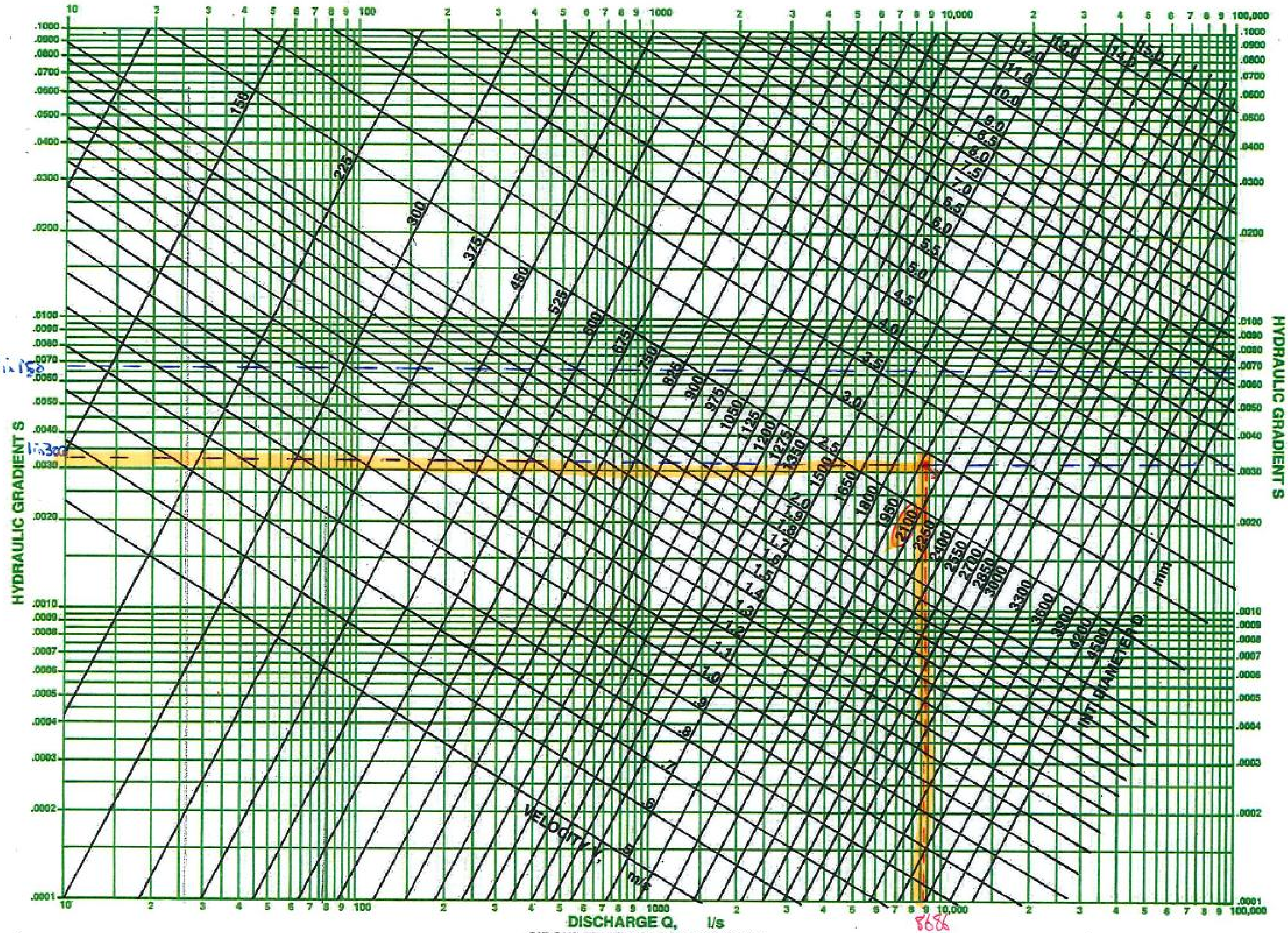


DISCHARGE Q, l/s

CIRCULAR PIPES FLOWING FULL

COLEBROOK-WHITE FORMULA k = 0.60mm

CATCHMENT 2.2



CIRCULAR PIPES FLOWING FULL

COLEBROOK-WHITE FORMULA k = 0.60mm