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- Civil & Structural Engineers
- Road & Bridge Design
- Sewer & Stormwater Design
- Project Management
- Water & Sewer Infrastructure
- Irrigation Infrastructure
- Pipeline Construction
- Engineering Survey
- Site Safety Management
- General Drafting Services

Stormwater & Sewerage Services Review

Proposed Cinema Development

148 Rouse Street
Tenterfield, 2372

Client: Mills Gorman Architects on behalf of Mr Chris Hsu

Version 1

Malcolm Whitton ____________________ Date: 17 Sept 2021
Managing Director Whitton Engineering

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The report relies on information supplied by the client and the Principal Contractor.

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Conclusions to the report are professional opinions and subsequent requests for further work or information will be subject to additional fees.

1. Overview

Whitton Engineering has been commissioned by Mills Gorman Architects, to carry out a Stormwater & Sewerage Services Review for the proposed cinema complex development at 148 Rouse St, Tenterfield.

Part 1 of the review is to evaluate the performance of the existing stormwater services in a 1% (1 in 100) AEP event and to assess the capability of the proposed modifications to the stormwater system under the same conditions.

Part 2 of the report will evaluate the proposed development and supply a draft stormwater drainage layout for the roof and carpark for the purpose of the Development Application.

Part 3 will review the existing sewer services and supply a draft proposed layout for the purpose of the Development Application.

Throughout the report the following abbreviations will be used.

Tenterfield Shire Council	TSC
Mills Gorman Architects	MGA
Whitton Engineering	WEDS

2. Part 1 Existing Stormwater System and Proposed Changes under 1%AEP conditions

The existing stormwater system drains a 59.41 Ha section of Tenterfield's Streets as shown in Image 1 below .

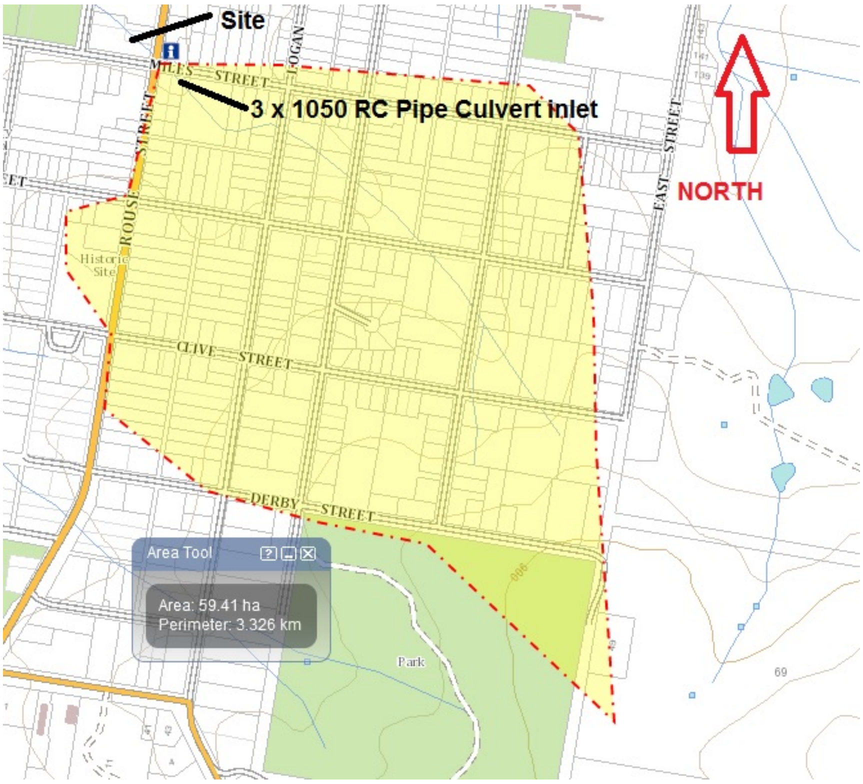
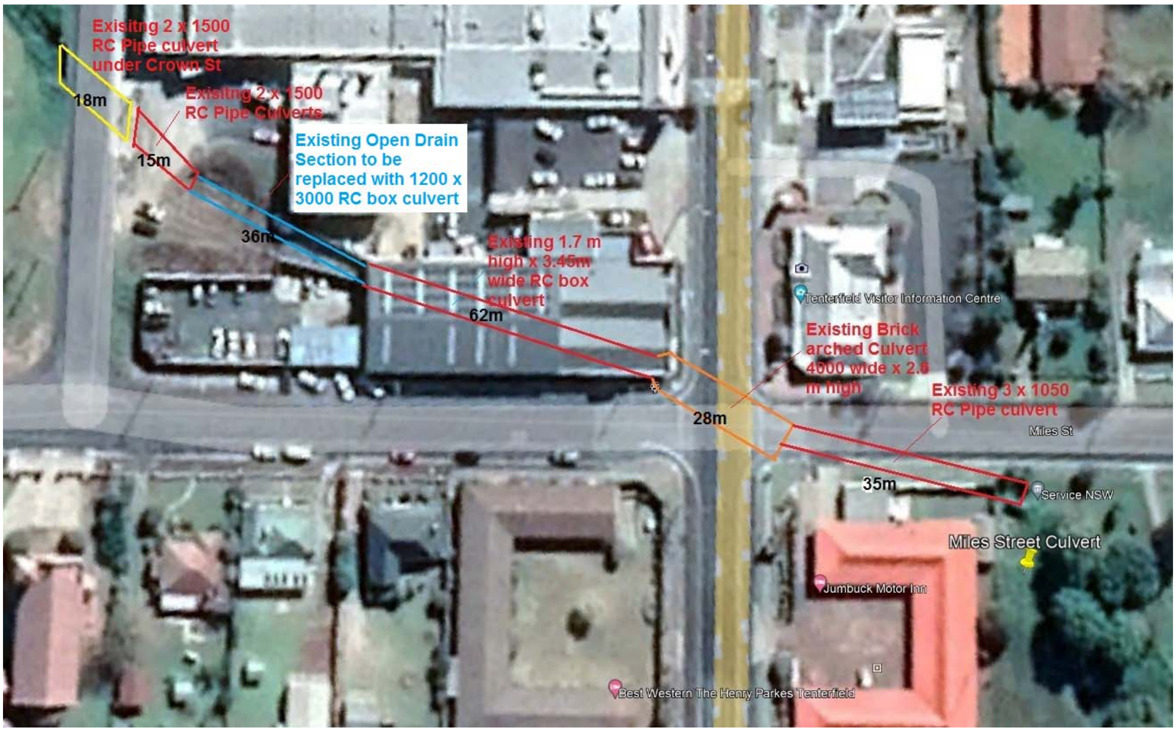


Image 1 Catchment area for existing culvert system

The existing system is one of the oldest stormwater (if not the oldest) pieces of infrastructure in the township of Tenterfield. The layout is shown in Image 2 below. The original brick arch structure under Rouse Street was constructed in the early 1900's and was extended with the 3750 x 1700 formed box culvert under 148 Rouse St when the site was developed in the 1950s. The triple cell 1050 Reinforced Concrete Pipe (RPC) culverts to the east were installed in the 1970s. The twin cell 1500 RPC under Crown St were installed around that time. The extension to the Crown St culverts was done in conjunction with the BILO development around 2005. The Open drain section in from the existing building on 148 Rouse St to the extension to the 1500 RCP under Crown St was rock lined at this time.

The Development proposed will entail the replacement of the open drain section from the western side of the existing buildings on 148 Rouse St to the twin cell 1500 RCP with a 1200mm high x 3000mm wide Reinforced Concrete Box Culvert on a poured concrete base. The Culverts will then have a carpark constructed over them. Custom concrete interfaces with access/ inspection openings will incorporated to each end.

Image 2 Site Layout.



2.1 Methodology

The catchment area of the culvert system was ascertained using the contour maps supplied by the NSW Spatial Services on the Six Maps viewer and shown in Image 1 above. The data was then fed into the ARR Regional Flood Frequency Estimation Model using the location of the Miles St Culvert as the discharge point and the centroid being the cul de sac at the end of Jubilee Street. The resulting catchment was modelled on a teardrop shape corresponding to the area of 59.41 Ha. The results are shown in Section 2.2

The output volume of 5.07 m^3/s was then applied to the sections of the system in turn with the calculated area of discharge from each section being used for review of the next. Culvert section capacities were calculated and the results shown.

The assumptions made include;

- o Mannings n values used are shown in Table 1 below. 0.011 smooth concrete standard RCP, 0.016 rough concrete.
- o Lengths are approximate where not picked up by Survey
- o No losses were assumed at transition areas where extensions were joined to existing sections
- o Size of original Culvert from Authors memory of inspection carried out in 1999. Not able to enter at this time due to confined space requirements. Very conservative estimate.
- o cross sectional area from previous section outflow was used at start of new section and then adapted as flow velocity increase or decrease resulted in new cross sectional area at outflow of section.

Table 1 Assumptions and Values Used

Section	Length	Slope	Mannings n	Comments
3 x 1050 RCP	35 m	1:200	0.011	Slope actually greater than 1:200
Brick Arched Culvert	28 m	1:200	0.016	Slope unknown but not applicable due large sectional area of culvert. treat as a 4000 wide RCBC
1.7 m high x 3.45 m wide RC box culvert	62 m	1:100	0.016	Slope measured using spirit level closer to 1:80 but 1: 100 adopted
Large Open drain	36 m	1: 30	Analysis ignored as the drain cross sectional area from the detailed survey is 11 times larger than the cross section of the 1%AEP design flow rate as calculated in 2.2 below	
New 1.2 m high x 3.0 m wide RC box culvert	36 m	1:30	0.011	Proposed new culvert under carpark
2 x 1500 RCP extension to existing RCP	15 m	1:100	0.011	Slope known as WEDS designed extension in 2005
2 x 1500 RCP under Crown St	18 m	1:100	0.016	Rough concrete as old pipes

Calculations, Results and design capacities are shown based on Manning's equation and the Maximum Capacity discharge, velocity and percentage of the current discharge to maximum design capacity is shown.

2.2 Regional Flood Frequency Estimation Results

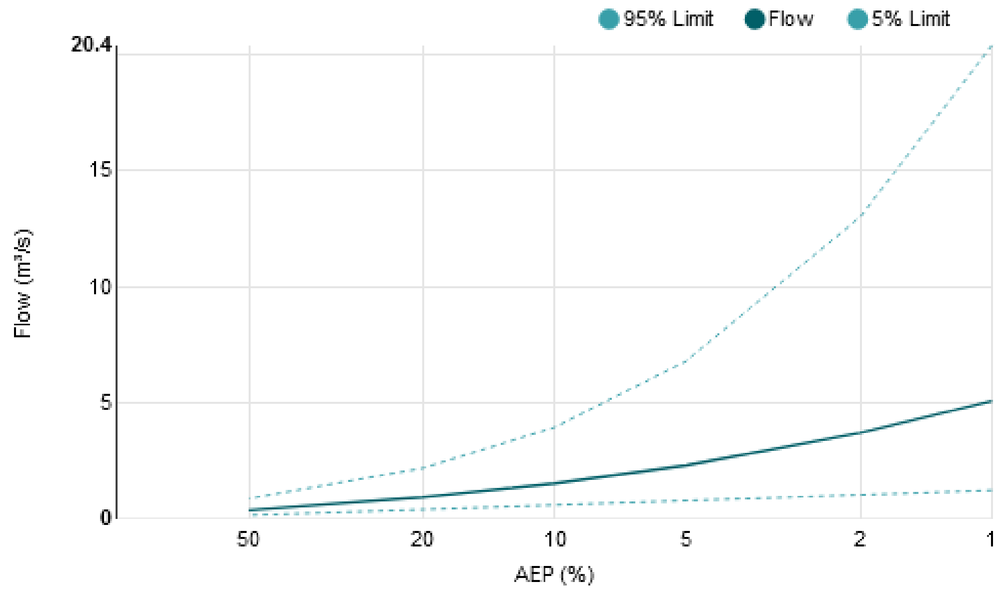


Image 3 Calculated Volume at Outlet

Table 2 Data

Input Data

Catchment Name	Miles Stree Culverts
Latitude (Outlet)	-29.057699
Longitude (Outlet)	152.018905
Latitude (Centroid)	-29.060705
Longitude (Centroid)	152.021927
Catchment Area (km^2)	0.5941
Distance to Nearest Gauged Catchment (km)	24.17
50% AEP 6 Hour Rainfall Intensity (mm/h)	7.60574
2% AEP 6 Hour Rainfall Intensity (mm/h)	16.29854
Rainfall Intensity Source (User/Auto)	Auto
Region	East Coast
Region Version	RFFE Model 2016 v1
Region Source (User/Auto)	Auto
Shape Factor	0.58
Interpolation Method	Natural Neighbour
Bias Correction Value	-0.83

Table 3 Discharge Data

AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	0.360	0.150	0.860
20	0.920	0.390	2.17
10	1.51	0.580	3.93
5	2.29	0.770	6.79
2	3.69	1.02	13.0
1	5.07	1.22	20.4

2.3 Existing 3 x 1050 mm Reinforced Concrete Pipe Culverts

1% AEP volume 5.07 m^3/s
Max Capacity 1050 mm RCP @ Slope 1:200 n 0.011 = 2.4 m^3/s
3 cell max discharge = 7.2 m^3/s
Cross Sectional area of Flow = 2.0 m^2/s
Velocity = 2.5 m/s
Current Capacity under 1% AEP = 70% of total capacity for this section

2.4 Existing Brick Arched Culvert 4000 mm wide x 2400 mm

$$V = \frac{1}{n} \times R^{2/3} \times S^{1/2}$$

$$Q = aV = \frac{1}{n} a \times R^{2/3} \times S^{1/2}$$

Table 4

roughness (n)	0.016	
Wetted Perimeter	5.10	m
Hydraulic Radius R	0.41	m
Slope S	0.005	
Cross Section Area a	2.08	m^2

Velocity V	2.43	m/s
Flow Volume Q	5.05	m^3/s

Area of Arch Culvert = 8.2 m2
Max Capacity Arch Culvert @ Slope 1:200 n 0.016 = 29.44 m^3/s

Current Capacity under 1% AEP = 18% of total capacity for this section

Flow Slows down slightly and then spreads out into the bigger area of the original culvert.

2.5 1.7 m high x 3.45 m wide RC box culvert

$$V=\frac{1}{n}\times R^{2/3}\times S^{1/2}$$

$$Q = aV = \frac{1}{n}a\times R^{2/3}\times S^{1/2}$$

Table 5

roughness (n)	0.016	
Wetted Perimeter	4.85	M
Hydraulic Radius R	0.42	M
Slope S	0.005	
Cross Section Area a	2.03	m^2
Velocity V	2.47	m/s
Flow Volume Q	5.02	m^3/s

Area of RC Box Culvert = 5.86 m^2
Maximum Calculated Capacity =17.49 m^3/s
Current Capacity under 1% AEP = 34% of total capacity for this section

Flow velocity increases and corresponding cross sectional area increases

2.6 New 1.2 m high x 3.0 m wide RC box culvert

$$V=\frac{1}{n}\times R^{2/3}\times S^{1/2}$$

$$Q = aV = \frac{1}{n}a\times R^{2/3}\times S^{1/2}$$

Table 6

roughness (n)	0.011	
Wetted Perimeter	3.56	m
Hydraulic Radius R	0.23	m
Slope S	0.033	
Cross Section Area a at start	2.03	m^2
Cross Section Area a at end	0.82	m^2
Velocity V	6.20	m/s
Flow Volume Q	5.09	m^3/s

Area of RC Box Culvert = 3.6 m2
Maximum Calculated Capacity =33.79m^3/s

Capacity under 1% AEP at start of Box Culverts = 56% of total capacity for this section based on area of flow
Capacity under 1% AEP at end of Box Culverts = 14% of total capacity for this section based on volumetric flow

Due to steep slope of the proposed section, the flow velocity increases from 2.47 m/s to 6.2 m/s at discharge hence corresponding reduction in cross sectional area from 2.03 m^2 to 0.82 m^2. As the flow progresses down the culvert system, the capacity of the culverts increases dramatically.

2.7 Existing 2 x 1500 RC Pipe Culvert

$$V=\frac{1}{n}\times R^{2/3}\times S^{1/2}$$

$$Q = aV = \frac{1}{n}a\times R^{2/3}\times S^{1/2}$$

Table 7

roughness (n)	0.011	
Wetted Perimeter	3.02	M
Hydraulic Radius R	0.37	M
Slope S	0.010	
Cross Section Area a	1.12	m2
Velocity V	4.70	m/s
Flow Volume Q	5.26	m3/s

Area of Pipe Culvert = 3.5 m2
Current Capacity under 1% AEP = 32% of total capacity for this section

Flow velocity decreases and corresponding cross sectional area increases due to the reduction in culvert slope.

2.8 Existing 2 x 1500 RC Pipe Culvert under Crown St

$$V = \frac{1}{n} \times R^{2/3} \times S^{1/2}$$

$$Q = aV = \frac{1}{n} a \times R^{2/3} \times S^{1/2}$$

Table 8

roughness (n)	0.016	
Wetted Perimeter	3.80	m
Hydraulic Radius R	0.42	m
Slope S	0.010	
Cross Section Area a	1.60	m2
Velocity V	3.51	m/s
Flow Volume Q	5.62	m3/s

Area of Pipe Culvert = 3.5 m^2
Current Capacity under 1% AEP = 45%

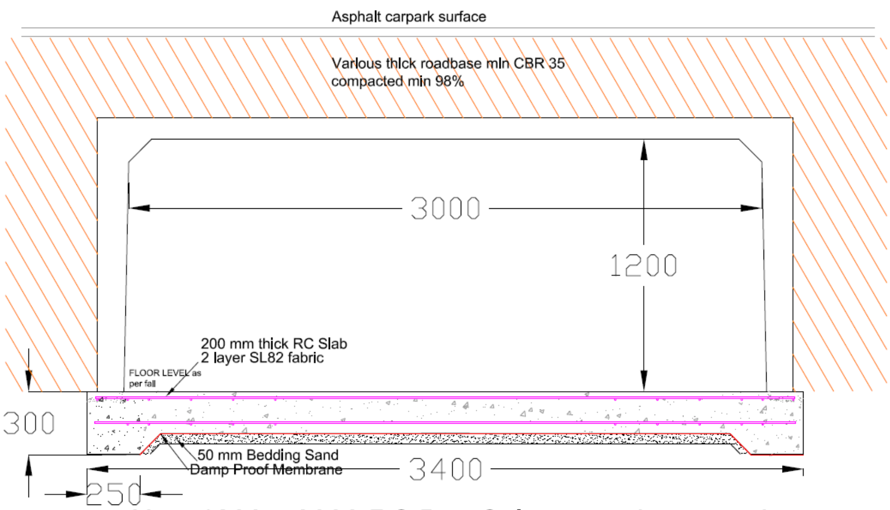
Flow velocity decrease and corresponding cross sectional area increases. Flows increase due to inflows from road and carparks.

2.9 Summary

In terms of culvert capacity, the first section comprising the triple cell 1050 mm RCPs is the closest to 1%AEP at 70%. This is considered reasonable as using the next size down in RCP pipe diameters being 3 x 900 mm RCP would not have the required area to meet the $5m^3/s$ flow rate. Hence the designer would have been required to use the next size up being 3 x 1050 mm RCP or a combination of 900 & 1050 RCPs which is generally not done. Both the existing Arch Culvert and the RCBC under the existing buildings have a large amount of excess capacity. In terms of the proposed pipe culverts under the new carpark, it is generally accepted in design that the cross sectional area of the new upstream pipes be equivalent to the downstream section. In this case the proposed 1200 x 3000 RCBC's have a cross sectional area of 3.6 m^2 and the downstream twin cell 1500 RCP's have a cross sectional area of 3.5 m^2 satisfying this design criteria. While the cross sectional area in total of the proposed 1200 x 3000 RCBCs is smaller than the cross sectional area of the existing upstream RCBC under the building there is no foreseeable problems with surcharging due the gradient and the capacity of the proposed RCBCs being only 56% of total capacity required at the start of the proposed culvert section as detailed in Section 2.6 above. The concept cross section of the proposed RCBC's id shown below in Image 4.

Overall the existing culvert system with the proposed additions will have adequate capacity to handle a 1%AEP rainfall event.

Image 4 Concept cross section of Proposed Reinforced Concrete Box culverts under Carpark



New 1200 x 3000 RC Box Culverts under carpark
Typical Section

3 Part 2 Draft Stormwater Drainage for New Development

This Section of the report will evaluate the proposed development and supply a draft stormwater drainage layout for the roof and carpark. Currently the existing stormwater from the site discharges to

(a) Rouse Street Kerb & Gutter (RStK&G)
(b) into an existing main which runs under the BILO complex (BILO main)
(c) Directly into the RCBC under the existing building (ExRCBC)
(d) Onto Miles Street and into existing Stormwater Pits which discharge into the ExRCBC (MStPits)
(e) Into the open channel drain section to the West of the existing building

Individual roof sections have been grouped together into larger units depending upon where they discharge to as detailed above. Carpark areas have been broken down based on concept areas flowing to each Pit as shown on WEDS 2123 Sheet SW.1

3.1 Methodology

Roof
Calculation of Roof Area and application of applicable multiplier from AS3500.3.2
5 min rainfall intensity for Tenterfield ARI 20 years = 169 mm
Gutters assumed 8000 sq mm and gutter slope 1:500
All downpipes to be 100 mm
Discharge Calculated

Surface Areas
Calculation of Area
5 min rainfall intensity for Tenterfield ARI 20 years = 169 mm
Pits minimum 600 x 600
Discharge to Pit calculated

Pit to Pit volumes calculated including cumulative totals
All pipes laid at 1:100 min
Pipe sizes identified
Total discharges calculated

3.2 Results

Table 9 shows the roof areas and the calculated discharge and the location of the discharge. Table 10 contains the data for the carpark areas. Table 11 is a summary of the Pipe sizes required.

Table 9 Roof Stormwater Data

Roof	Area (m2)	Discharge(l/s)	Discharge Location
R1	414	21.5	Ex BILO Main
R2	427	22.2	Rouse St K & G
R3	508	26.4	Rouse St K & G
R4	167	8.7	Miles St Ex RCBC
R5	269	14.0	Pit 4
R6	414	21.5	Miles St Ex RCBC
R7	414	21.5	Pit 5
R8	200	10.4	Pit 9

Table 10 Carpark Area Stormwater Data

Carpark Area	Area (m2)	Discharge(l/s)	Discharge Location
A1	550	25.8	PIT 1
A2	513	24.1	PIT 2
A3	663	31.0	PIT 3
A4	697	32.7	PIT 4
A5	435	20.4	PIT 6
A6	100	5.0	PIT 7

Table 11 Stormwater Pipeline Data

Pipeline	Pipe (mm)	Discharge l/s	Discharge Location
SWL1	150	25.8	PIT 1 TO PIT 2
SWL2	225	50.0	PIT 2 TO PIT 3
SWL3	300	81.0	PIT 3 TO NEW RCBC
SWL4	225	46.7	PIT 4 TO PIT 5
SWL5	300	68.2	PIT 5 TO NEW RCBC
SWL6	150	21.5	PIT 6 TO PIT 10
SWL7	100	5.0	PIT 7 TP PIT 8
SWL8	100	5.0	PIT 8 TO PIT 9
SWL9	150	15.4	PIT 9 TO PIT 10
SWL10	225	36.9	PIT 10 TO NEW RCBC

3.3 Summary

The main aim of the concept stormwater design is to ensure that the new development does not result in a significant increase in the discharge volumes to a particular area. It is proposed to discharge as much stormwater as possible into the new RCBC under the proposed carpark with eventual discharge to the Crown St culverts. Based on the concept provided in WEDS 2123 Sheet SW.1 and with the data supplied above, it can be shown that the discharge locations have similar areas to the existing development. While it must be noted that the time of concentration will increase due to additional roof areas it is considered that no adverse impacts on the existing systems (in particular the Rouse Street pipeline network) will result. Detailed Design and Specification will be supplied as part of the conditions of the approved Development Application prior to a Construction Certificate being issued.

4 Part 3 Review of existing sewerage services and draft proposed connections layout.

The existing sewerage infrastructure to 148 Rouse St comprises of a Tenterfield Shire Council 150 NB main which extends south under the existing BILO complex and terminates at an Inspection Opening (IO) at the rear of the existing workshop building on the site. The existing toilets and other facilities are connected in this location as shown on WEDS 21-23 SW.2

The Proposed development will require 4 (four) new Sewer connections as shown on WEDS 21-23 SW.2. Each new tenancy will require a new connection with the Cinema tenancy utilising the existing connection. The Child Care centre will require an extension to the main using a minimum 100 NB Mainline.

Detailed Design and Specification will be supplied as part of the conditions of the approved Development Application prior to a Construction Certificate being issued.

7. Appendix 1 – IFD DATA Tenterfield

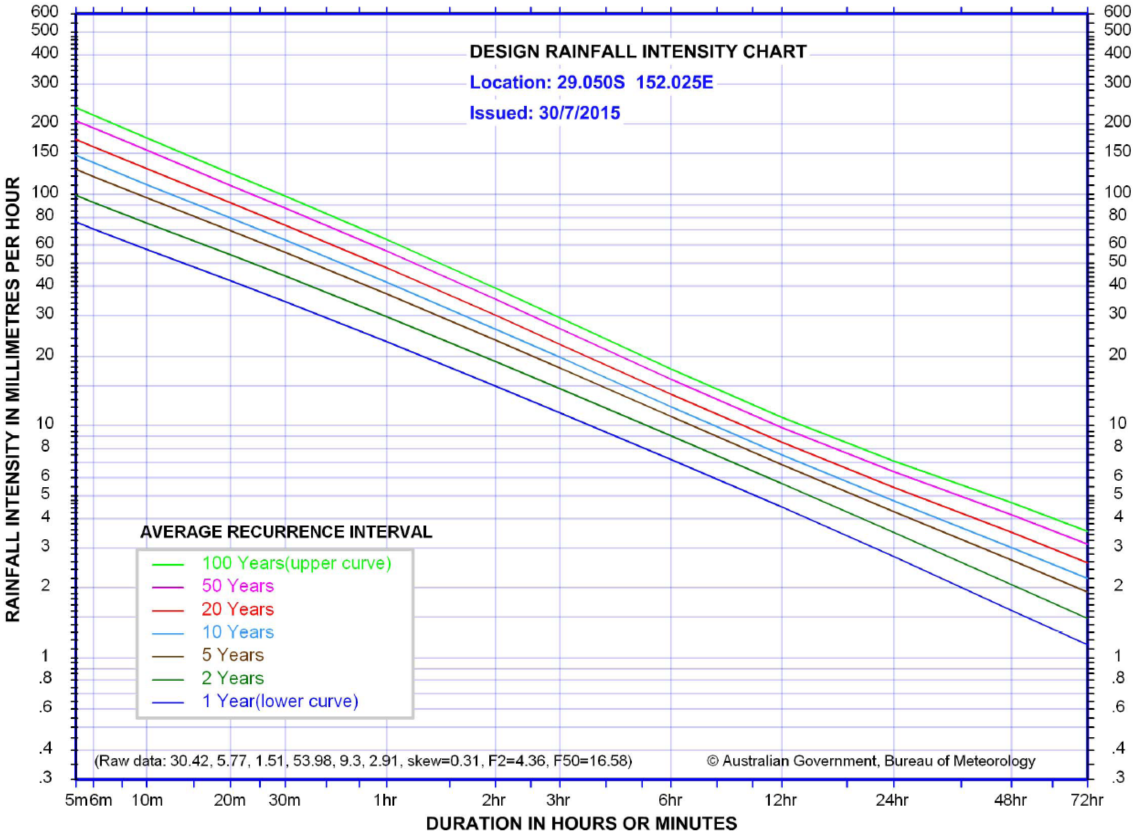
Table A1 IFD Table
for Tenterfield

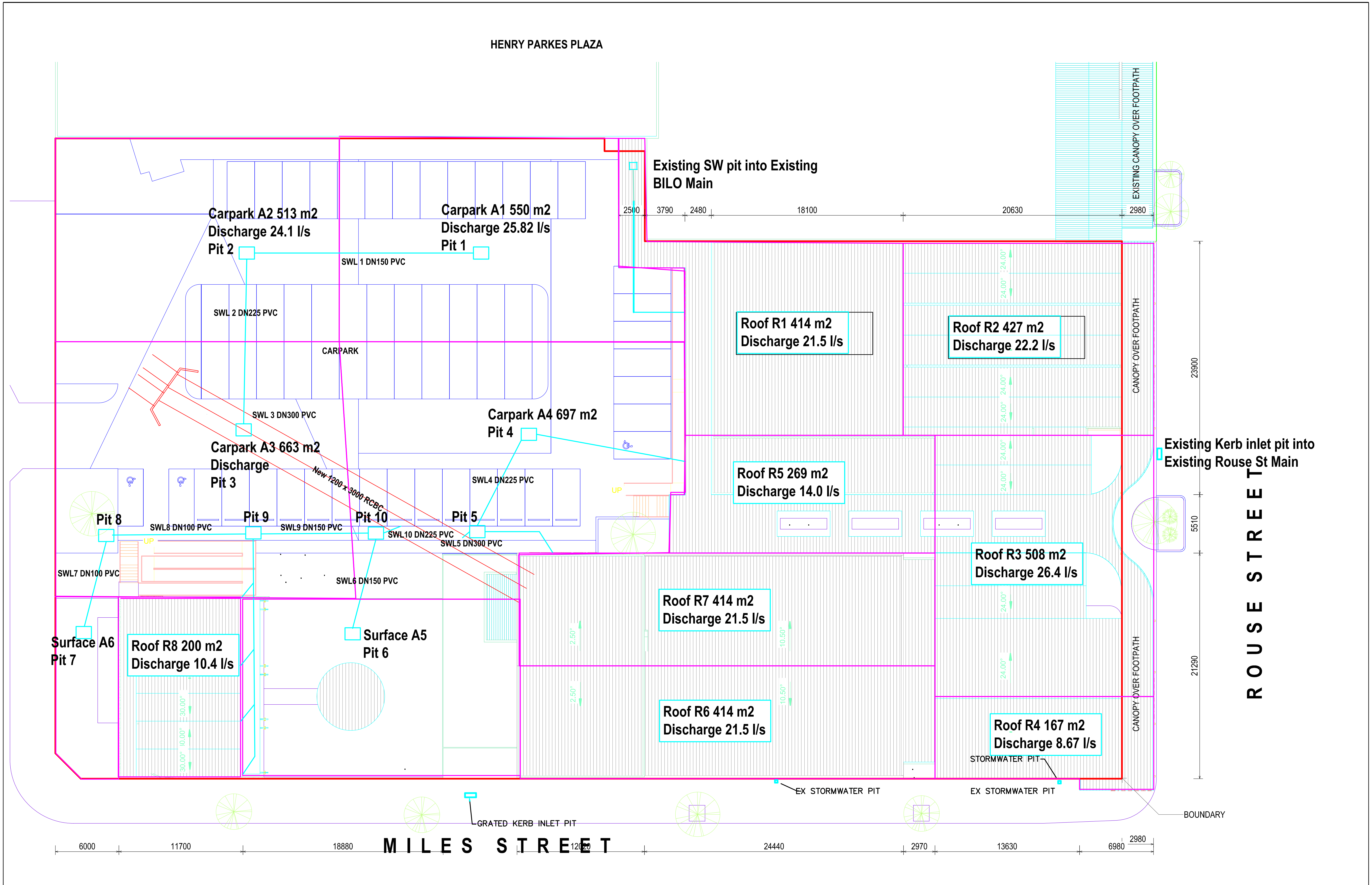
Duration	ARI		
minutes	5	20	100
5	126.79	169.47	230.59
6	118.51	158.06	214.64
8	105.60		189.94
10	95.97	127.16	171.64
12	88.36		157.23
14	82.20		145.64
15	79.47		140.51
16	77.01		135.90
18	72.65		127.76
20	68.78	90.17	120.56

Table A2: Runoff Coefficients for
Tenterfield

Fraction impervious f	Runoff Coefficient		
	C10	C2	C100
0	0.32	0.27	0.38
0.1	0.38	0.32	0.45
0.2	0.43	0.37	0.52
0.3	0.49	0.42	0.59
0.4	0.55	0.47	0.66
0.5	0.61	0.52	0.73
0.6	0.67	0.57	0.80
0.7	0.73	0.62	0.87
0.8	0.78	0.67	0.94
0.9	0.84	0.72	1.00
1	0.90	0.77	1.00

Image A1 IFD Chart Tenterfield





ISSUE	DATE	REASON FOR ISSUE	SIGNED	APPROV
A	14/09/2021	DA Application		
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SURVEYED: Tent SurV
DESIGNED: WEDS
DRAWN: WEDS
CHECKED: CLIENT
ACCEPTED: MG

DATUM: AHD

BENCHMARK

SCALES: CUSTOM

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CLIENT: Mills Gorman Architects

Cinema Development

SITE PLAN LOT LAYOUT COMPLETE
AERIAL OVERLAY
STAGES 1-8 LOTS 1 -104 COMPLETE

JOB NUMBER

FILE NAME

ARCHIVE FILE

ISSUE A

DATE 14/09/2021

SHEET NUMBER 1 OF 2 SHEETS

PLAN No. WEDS 21-23-SW.1