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Proposed Residential Development 20 & 20A Cantwell Road, Lochinvar

Stormwater Management Report

Trustee of the Roman Catholic Church for the Diocese of Maitland Newcastle

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LAND DEVELOPMENT • BUILDINGS • INFRASTRUCTURE

CIVIL, STRUCTURAL & ENVIRONMENTAL ENGINEERING,
WATER & WASTEWATER, BUILDING DESIGN & PROJECT ADVISORY

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1	Original Issue	TS	24/10/24	AS	24/10/24	AS	24/10/24
2	Minor amendments	TS	16/12/24	AS	16/12/24	AS	16/12/24
3	Minor amendments	TS	28/01/25	AS	28/01/25	AS	28/01/25

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List of Acronyms

AEP	Annual Exceedance Probability
LGA	Local Government Area
MCC	Maitland City Council
MOES	Manual of Engineering Standards

Executive Summary

This stormwater strategy has been prepared to support and inform a Development Application (DA) for the proposed residential development on Lot 1 DP1299958 and Lot 2 DP1299958 (20 & 20A Cantwell Road, Lochinvar).

The subject land comprises approximately 14.6 hectares of currently semi-rural land. The Site is bound to the west by Cantwell Road and is traversed by an unnamed third order tributary of Lochinvar Creek. The watercourse approximately bisects the Site (north/south), draining in a northernly direction. The proposed development ultimately drains to this existing watercourse.

Centralised stormwater management controls at the subdivision level have been designed to limit post development peak flow rates to predevelopment conditions for 1EY, 10%, 5% and 1% AEP critical storm durations. Modelling confirmed that a combined bioretention / detention basin at the outlet of the eastern and western catchments successfully limited post development peak flow rates and demonstrated the overall post development stormwater runoff quantity will not impact on downstream flooding.

A stormwater quality treatment train was developed in MUSICX to demonstrate that the retention of nominated pollutants (Total Suspended Solids, Nitrogen, Phosphorous and Gross Pollutants) will meet Maitland City Councils (MCC's) current nominated targets. The proposed treatment train comprises gross pollutant traps and bioretention basins.

A flood model was prepared to predict the extent of flooding during the 1% AEP event. This model has been used to quantify any impacts from the proposed civil works on the existing flood environment, and to size a culvert crossing to ensure the proposed roadway is not overtopped during the 1% event. This modelling confirmed that the proposed residential development will have a negligible impact on the existing flood environment, will not impact adjoining properties, and all proposed roads and development lots will not be impacted by the 1% AEP flood.

"Stormwater Management Plan, Staged Residential Subdivision, Lots 2, 3, 4, 5, 6 & 9 DP747391 & Lots 12 & 13 DP12219648, CNR New England Highway & Wyndella Road Lochinvar" by ADW Johnson (Rev D, July 2024) details the proposed Stormwater Management Plan for the adjoining residential subdivision to the east. A portion of this adjoining residential development will discharge along the proposed developments eastern boundary, which will then be diverted to proposed Basin 2 prior to discharging into the existing watercourse located within the Site. Note that this report has assumed that stormwater runoff from this external development will meet MCC's guidelines for volume rate of flow and runoff quality prior to discharging into the proposed development.

1 Introduction

1.1 Background

This stormwater strategy has been prepared to support and inform a Development Application (DA) for a proposed residential development on Lot 1 DP1299958 and Lot 2 DP1299958 (20 & 20A Cantwell Road, Lochinvar).

1.2 Site description

The subject land is known as 20A and 20 Cantwell Road, Lochinvar (Lot 1 DP1299958 and Lot 2 DP1299958). It comprises approximately 14.6 hectares of currently semi-rural land. The Site is bound to the west by Cantwell Road and is traversed by an unnamed third order tributary of Lochinvar Creek. The site location is shown on Figure 1.

The watercourse approximately bisects the Site (north/south), draining in a northernly direction. Both halves of the Site generally drain to this watercourse.

The Site is not currently improved by any dwellings or miscellaneous structures. The Site is zoned R1 (General Residential) and C3 (Environmental Management) pursuant to Maitland Local Environmental Plan 2011. The Site is wholly within the Maitland City Council LGA.

1.3 Proposed development

The proposed development comprises the creation of approximately 138 residential lots within the Site boundary as indicated on Figure 2.

1.4 Objectives

The objectives of this report are to investigate the likely impacts of the interaction of the development with its stormwater and flooding environment and make recommendations to meet guidelines regarding volume rate of flow and runoff quality.

1.5 Available data

The following available information was utilised in the preparation of this strategy:

- A proposed subdivision layout plan by Monteath & Powys Pty Ltd (shown on Figure 2).
- Site detail survey from Monteath and Powys Pty Ltd.
- MCCs Manual of Engineering Standards (MOES) – Stormwater Drainage.
- Australian Rainfall and Runoff, Institution of Engineers 2019.
- ELVIS (Elevation Information System) Foundation Spatial Data.
- Aerial Imagery (Near Maps).
- “Lochinvar Flood Study” by WMA Water (Rev 4, July 2019).
- “Stormwater Management Plan, Staged Residential Subdivision, Lots 2, 3, 4, 5, 6& 9 DP747391 & Lots 12 & 13 DP12219648, CNR New England Highway & Wyndella Road Lochinvar” by ADW Johnson (Rev D, July 2024).

2 Stormwater Management Strategy

The proposed stormwater management strategy for the development is outlined for each catchment below.

The predevelopment and post development catchment plans are provided on Figures 3 and 4, respectively.

A general arrangement of the proposed stormwater plan is provided on Figure 5.

Subsequent sections of this report will demonstrate that the stormwater strategy will achieve all the relevant target criteria.

2.1 Catchments 1 and 2

To ensure that the relevant environmental objectives are achieved in a financially sustainable manner, water quality and detention measures has been considered during the early development stages. The proposed stormwater management plan for Catchments 1 and 2 include:

- Catchments 1A and 2 will be urbanised during the proposed development. They are separated by an existing watercourse that runs through the Site and have therefore been considered independently in relation to volume rate of flow and water quality.
- Catchment 1B will be partiadeveloped but will bypass proposed Basin 1 and discharge directly into the existing watercourse.
- Lot and road areas will be drained by a conventional pit and pipe drainage network located in the street or in inter-allotment drainage where required. The pipe network will comprise the minor system subject to MCC's normal minor design standard of 10% AEP. The road network would form most of the major network standard of 1% AEP.
- Construction of a permanent dry combined bioretention / detention basin on the north-eastern boundary of Catchment 1 (Basin 1) and the southern boundary of Catchment 2 (Basin 2).
- Discharge from both basins will be controlled by a combination of biofiltration media sub soil drainage, low-level discharge pipes, low level outlet pipes and an increased pit inlet level.

2.2 Catchment 3

"Stormwater Management Plan, Staged Residential Subdivision, Lots 2, 3, 4, 5, 6& 9 DP747391 & Lots 12 & 13 DP12219648, CNR New England Highway & Wyndella Road Lochinvar" by ADW Johnson (Rev D, July 2024) details the proposed Stormwater Management Plan for this adjoining residential subdivision, inclusive of Catchment 3. Catchment 3 is an external catchment that drains to the Sites eastern boundary via the proposed adjoining residential subdivision (DA/2023/415) to the east.

Catchment 3 will ultimately drain to proposed Basin 2 before discharging to the existing watercourse located within the Site. Note that this report has assumed that "Stormwater Management Plan, Staged Residential Subdivision, Lots 2, 3, 4, 5, 6& 9 DP747391 & Lots 12 & 13 DP12219648, CNR New England Highway & Wyndella Road Lochinvar" by ADW Johnson (Rev D, July 2024) will be amended to ensure stormwater runoff from the adjoining residential development will meet MCC's guidelines for volume rate of flow and runoff quality prior to discharging into the proposed development.

3 Volume Rate of Flow

3.1 Criteria

Discharge from the proposed development has been limited to the Site's predevelopment rates for the 1EY, 10%, 5% and 1% AEP events.

3.2 Methodology

For large developments utilising detention basin storages, the Time Area Hydrograph Routing method is usually the most appropriate tool for determining basin volumes. The DRAINS software package, published by Watercom Pty Ltd, has been used to investigate the catchments and the ameliorating effects of the proposed basins. This works by translating rainfall hyetographs into runoff hydrographs over sub catchments and subsequently adding the resulting hydrographs together to quantify design rates of flow and runoff volumes.

3.2.1 Catchment hydrology

MCC's MOES publishes parameters to be adopted in DRAINS models as provided in Table 3-1 below.

Table 3-1: MCC's MOES modelling parameters.

Parameter	Value
Soil Type	As reported (3)
Antecedent Moisture Content	3
Grassed Depression Storage	5mm
Paved Depression Storage	1mm

The existing site consists primarily of vegetated rural land with shrub and tree coverage. In accordance with MOES, a surface roughness coefficient (n*) of 0.35, 0.21 and 0.01 was adopted for predeveloped pervious catchment areas, developed pervious catchment areas and impervious catchment areas, respectively. MOES also required that residential development (lot sizes < 1000m^2) adopt a site impervious percentage of 0.6 or 60%, and road reserve adopt an impervious percentage of 0.7 or 70%. The predeveloped catchments were modelled as 0% impervious based on aerial imagery.

"Stormwater Management Plan, Staged Residential Subdivision, Lots 2, 3, 4, 5, 6& 9 DP747391 & Lots 12 & 13 DP12219648, CNR New England Highway & Wyndella Road Lochinvar" by ADW Johnson (Rev D, July 2024) details the proposed Stormwater Management Plan for this adjoining residential subdivision, inclusive of Catchment 3. Within ADW Johnson's report, Catchment 3 was modelled as 0% impervious with a n* of 0.035 for the predeveloped case. These parameters were adopted by this model. **Note that Catchment 3 was modelled as undeveloped within the pre and post development DRAINS model within this report as it is assumed that stormwater runoff from the adjoining residential development will meet MCC's guidelines for volume rate of flow prior to discharging into the proposed development.**

3.2.2 Rate of flow

A predevelopment time area hydrograph routing model was developed using DRAINS. The model was run for 1EY, 10%, 5% and 1% AEP events.

Preliminary basins were then sized considering post development catchments, and the outlet configuration was determined to ensure that outflow for 1EY, 10%, 5% and 1% AEP events would be less than predevelopment flows. A Stage / Discharge table was utilised to model the outlet structures for both proposed basins within DRAINS, inclusive of inlet orifices, an increased pit level and a spillway. Both Stage / Discharge tables are provided in Appendix A.

3.3 Results

3.3.1 Proposed Basin 1

DRAINS was iteratively run to design the detention component of the proposed basin yielding the following results as shown on Figure 5:

Top of Bank	= R.L. 26.50
Internal Batters	=1V:5H
Q100 Top Water Level	= R.L. 25.93
Detention Invert Level	= R.L. 24.60
Peak Detention Volume	= 2603m^3
Outlet Control Pit (Internal Dimensions)	= 0.9m x 0.9m at S.L. 25.50 & I.L. 24.00
Inlet Orifice	= 1x ø130mm at I.L. 24.60
Outlet Pipe	= 1x ø750mm at I.L 24.00
Spillway	= 7m long at R.L. 26.00

The final DRAINS model data for the predevelopment and post development scenarios for the 1EY, 10%, 5% and 1% AEP events are presented in Appendix A, and the results are shown in Appendix B.

Results for outflow of the predevelopment and post development catchments (with onsite detention) at the catchment outlet are summarised in Table 3-2.

Proposed Basin 1 had a TWL of 25.76 during the 5% AEP event, resulting in a maximum temporary water depth of 1.16m.

Table 3-2: Proposed Basin 1 Discharge Rates.

Event	Predevelopment discharge rate (m^3/s)	Post development discharge rate with OSD (m^3/s)	Difference (%)
1EY	0.06	0.06	0
10% AEP	0.65	0.61	-6.9
5% AEP	0.94	0.89	-5.2
1% AEP	1.78	1.52	-14.6

3.3.2 Proposed Basin 2

DRAINS was iteratively run to design the detention component of the proposed basin yielding the following results as shown on Figure 5:

Top of Bank	= R.L. 28.80
Internal Batters	=1V:5H, 1V:1H
Q100 Top Water Level	= R.L. 28.22
Detention Invert Level	= R.L. 27.00
Peak Detention Volume	= 1328m^3
Outlet Control Pit (Internal Dimensions)	= 1.5m x 1.2m at S.L. 27.60 & I.L. 26.00
Inlet Orifice	= 2x ø370mm at I.L. 27.00
Outlet Pipe	= 1x ø1050mm at I.L 26.00
Spillway	= 7m long at R.L. 28.15

The final DRAINS model data for the predevelopment and post development scenarios for the 1EY, 10%, 5% and 1% AEP events are presented in Appendix A, and the results are shown in Appendix B.

Results for outflow of the predevelopment and post development catchments (with onsite detention) at the catchment outlet are summarised in Table 3-3.

Proposed Basin 2 had a TWL of 27.94 during the 5% AEP event, resulting in a maximum temporary water depth of 0.94m.

Table 3-3: Proposed Basin 2 Discharge Rates.

Event	Predevelopment discharge rate (m^3/s)	Post development discharge rate with OSD (m^3/s)	Difference (%)
1EY	0.26	0.25	-4.6
10% AEP	1.75	1.72	-1.7
5% AEP	2.31	2.30	-0.4
1% AEP	3.52	3.20	-9.1

3.4 Discussion

The proposed development, with the inclusion of proposed Basins 1 and 2, and the proposed outlet structures, will not produce an outflow larger than predevelopment flow rates during the 1EY, 10%, 5% and 1% AEP events.

4 Stormwater Runoff Quality

4.1 Criteria

Treatment targets for the proposed development were adopted from MCC's MOES and are shown in Table 4-1.

Table 4-1: Stormwater treatment objectives.

Pollutant	Stormwater treatment objectives
Total Suspended Solids (TSS)	80% retention of average annual load
Total Phosphorous (TP)	45% retention of average annual load
Total Nitrogen (TN)	45% retention of average annual load
Gross Pollutants (GP)	70% retention of average annual load

4.2 Methodology

The development was modelled using MUSICX published by eWater Limited, which is the current best practice tool for estimating the ameliorating effects of proposed stormwater quality improvement devices in a treatment train approach.

MUSICX uses real historical continuous rainfall records (over several years) as input and compares the theoretical pollutant generation within the catchment to the final theoretical export rate (usually expressed in kg/year) to determine a treatment train effectiveness expressed in percentage points that are directly comparable to the guidelines in Table 4-1.

4.2.1 Catchments 1 and 2

For the proposed development, Catchments 1A, 1B and 2 were considered. A MUSICX model was constructed comprising pavement areas, road reserves and landscaping areas to examine whether gross pollutant traps (GPTs) and combined bioretention / detention Basins 1 and 2 can achieve the required stormwater treatment objectives for the proposed development. The MUSICX model layout is provided in Appendix C.

4.2.2 Catchment 3

"Stormwater Management Plan, Staged Residential Subdivision, Lots 2, 3, 4, 5, 6 & 9 DP747391 & Lots 12 & 13 DP12219648, CNR New England Highway & Wyndella Road Lochinvar" by ADW Johnson (Rev D, July 2024) included MUSIC modelling and results for Catchment 3. Catchment 3 was included in the MUSICX model, assuming it has been treated prior to discharging into the proposed development. Catchment 3 was modelled and treated with a generic treatment node within MUSICX to achieve similar water quality targets to those obtained within ADW Johnson's report. A summary of the water quality targets achieved by ADW Johnson, and this report have been compared in Table 4-2 below.

Table 4-2: Comparison of Catchment 3's water quality targets.

Pollutant	ADW Johnson - Average Annual Surface Generation	ADW Johnson - Achieved Reduction (Pollutants Retained)	GCA - Average Annual Surface Generation	GCA - Achieved Reduction (Pollutants Retained)
Total Suspended Solids (TSS; kg/year)	1600	80.7%	1817	80%
Total Phosphorous (TP; kg/year)	3.21	64.4%	3.17	45%
Total Nitrogen (TN; kg/year)	22	48.2%	24.63	45%
Gross Pollutants (GP; kg/year)	335	100%	351.6	70%

4.2.3 Gross Pollutant Trap

Gross pollutant traps (Humes HumeGard) are proposed as secondary treatment devices for the road reserve areas and any lot areas which outlet to the street drainage network. Table 4-3 provides the parameters utilised when modelling the GPTs within MUSICX.

Table 4-3: Gross pollutant trap parameters.

Parameter	Basin 1		Basin 2
HumeGard Model	HG24	HG15	HG18
High Flow Bypass (Treatment Flow Rate)	1.05m^3/s	0.1 m^3/s	0.6m^3/s
TSS Removal Efficiency	50%		
TP Removal Efficiency	40%		
TN Removal Efficiency	26%		
GP Removal Efficiency	90%		

4.2.4 Bioretention

Bioretention is proposed as a tertiary treatment device. Basins 1 and 2 are to be constructed as combined detention / bioretention basins at the outlets of Catchment 1 and 2, respectively. Table 4-4 provides the parameters utilised when modelling the bioretention basins within MUSICX.

Table 4-4: Gross pollutant trap parameters.

Parameter	Basin 1	Basin 2
Invert Surface Level	1199m^2	721m^2
Extended Detention Depth	0.2m	0.2m
Filter Media Surface Area	30m^2	30m^2
Filter Media Depth	0.4m	0.4m
Filter Media Saturated Hydraulic Conductivity	180mm/hr	180mm/hr

4.3 Results

The achieved pollutant retention achieved by GPTs, and combined bioretention / detention Basin 1 is provided below in Table 4-5.

Table 4-5: Basin 1 – Achieved pollutant retention.

Pollutant	Average Annual Surface Generation	Average Annual Export	Achieved Reduction (Pollutants Retained)	Target Reduction (Pollutants Retained)
Total Suspended Solids (TSS; kg/year)	6563	815.9	87.5%	80%
Total Phosphorous (TP; kg/year)	10.91	5.5	50%	45%
Total Nitrogen (TN; kg/year)	62.1	32.9	46.9%	45%
Gross Pollutants (GP; kg/year)	968.2	39.41	95.9%	70%

The achieved pollutant retention achieved a GPT, and combined bioretention / detention Basin 2 is provided below in Table 4-6.

Table 4-6: Basin 2 – Achieved pollutant retention.

Pollutant	Average Annual Surface Generation	Average Annual Export	Achieved Reduction (Pollutants Retained)	Target Reduction (Pollutants Retained)
Total Suspended Solids (TSS; kg/year)	6629	706.2	89.4%	80%
Total Phosphorous (TP; kg/year)	11.2	5.6	49.7%	45%
Total Nitrogen (TN; kg/year)	67.3	36.2	46.2%	45%
Gross Pollutants (GP; kg/year)	100	0	100%	70%

4.4 Discussion

The above results indicate the proposed development will comply with Council's standard for water quality control if constructed in accordance with Figure 5.

5 Flooding

A flood model was prepared to predict the extent of flooding during the 1% AEP event. This model has been used to quantify any impacts from the proposed civil works on the existing flood environment, and to size a culvert crossing to ensure the proposed roadway is not overtopped during the 1% event. The flood modelling methodology and results are outlined below.

5.1 Methodology

For this assessment, a TUFLOW hydrologic model was developed. The model utilised detailed survey (for within the development site) overlaid on top of a 1m Digital Elevation Model (DEM) obtained from the ELVIS Foundation Spatial Data portal (for outside of the development site) to define an appropriate surface model of the study area.

The model was constructed using a 1m grid cell resolution. Land use coverage was determined using aerial imagery to distinguish between cleared land and areas of remanent vegetation. The floodplain was assigned a Manning's 'n' roughness coefficient of 0.07, with remaining areas being assigned an 'n' value of 0.04. The chosen roughness coefficients were adopted from the "Lochinvar Flood Study" by WMA Water (Rev 4, July 2019), which is generally considered the baseline references for the existing flood environment in the broader Lochinvar Creek catchment. The boundary conditions of the model were placed suitable distance upstream and downstream of the Site boundary as to not impact the results.

The 1% AEP flood model for the existing environment was calibrated against the 1% AEP flood model provided within the "Lochinvar Flood Study" by WMA Water (Rev 4, July 2019) until good agreement was found. The 1% AEP flood results map (extract) from the "Lochinvar Flood Study" is provided in Appendix D for information.

5.2 Blockage Assessment

A Guide to Flood Estimation, Book 6 – Flood Hydraulics (ARR 2019) was used to determine factors based on the existing upstream catchment for Culvert 1. A blockage assessment worksheet from ARR was completed (Appendix E), resulting in 15% design blockage factor being identified as suitable for the 1% AEP event.

5.3 Results

The TUFLOW model was simulated for the 1% AEP event with the existing surface model and environment, and with the post development surface model which includes the proposed works and culvert. This produced a water surface elevation (WSE) map, as shown in Figures 6 and 7. The resulting proposed design of Culvert 1 is summarised below in Table 5-1.

Table 5-1: Culvert 1 Design Details

	1800 x 1200 RCBC (5 Cells)
Design Event AEP	1%
Controlling Spill Level (m AHD)	28.30
U/S IL (m AHD)	24.05
D/S IL (m AHD)	23.75
Length (m)	54.9
Slope (%)	0.55
Flow (m^3/s)	33.4
Blockage Factor (%)	15
U/S Headwater Level (m AHD) (incl 15% Blockage Factor)	26.95
Freeboard (m)	1.35

The predevelopment 1% AEP WSE results were subtracted from their respective post development counterparts to demonstrate the impact of the development on the existing flood environment. The differences in WSE are shown in Figure 8. The impacts are shown spatially so the limit of impacts can be determined. Where differences in WSE are less than 50mm, results are not shown.

Figure 8 indicates:

- Maximum increase in WSE (approx. 0.5m) occurs immediately upstream of the proposed culvert headwall. This result is anticipated, as almost any structure constructed within a floodway will increase the headwater levels immediately upstream. However, the flooding is constrained to the proposed drainage reserve and will not encroach upon the proposed roadway or residential lots.
- The WSE along the southern boundary shows a negligible change in WSE at the southern site boundary.
- Changes to the existing flood environment are very minor downstream of the proposed culvert. There is no change in WSE on the northern boundary of the Site.

Based on these results, the proposed residential development will have a negligible impact on the existing flood environment, will not impact adjoining properties, and all proposed roads and development lots will not be impacted by the 1% AEP flood.

6 Summary and Conclusions

The strategy for managing stormwater runoff from the proposed development includes:

- Capture of stormwater from most of the lot and road areas by conventional pit and pipe drainage networks located in the street or in inter-allotment drainage where required.
- Construction of combined bioretention / detention Basin 1 on the north-eastern boundary of Catchment 1A, and combined bioretention / detention Basin 2 on the southern boundary of Catchment 2.
- Catchment 1B will bypass proposed Basin 1 and drain directly to the existing watercourse.
- Catchment 3A and 3B will ultimately drain to proposed Basin 2. Catchments 3A and 3B form part of an existing residential development on the Sites eastern boundary. This report has assumed that the stormwater management plan relating to this external residential development will be amended to ensure stormwater runoff will meet MCC's guidelines for volume rate of flow and runoff quality prior to discharging into the proposed development.

Post development outflows are less than or equal to predevelopment outflows for the 1EY, 10%, 5% and 1% AEP events. The development will not increase the risk or likelihood of mainstream erosion in smaller flood events.

Water quality modelling indicates that constructing Basin 1 and 2 as a bioremediation basin and the inclusion of GPTs will allow the development to meet regional guidelines for best practice for retention of TSS, TN, TP and GP.

A flood model has been created to assess the extent of flooding during the 1% AEP event. This model was able to size a culvert crossing to ensure the proposed roadway was not overtopped during the 1% AEP event. The post development flood model showed a negligible change in WSE at the southern site boundary as a result of the proposed works. There were no impacts on the upstream or downstream flood environment or neighbouring properties.

Figures

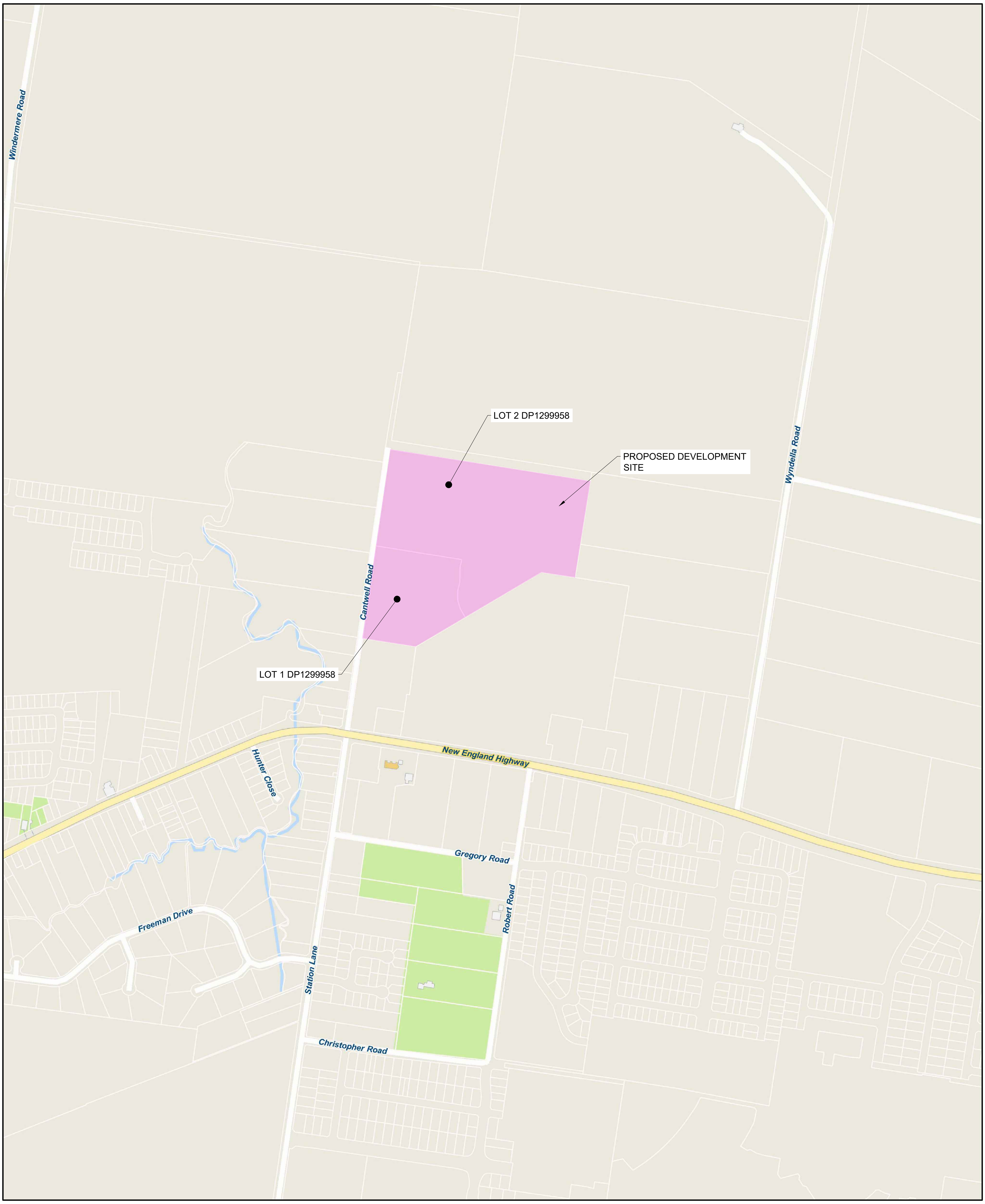
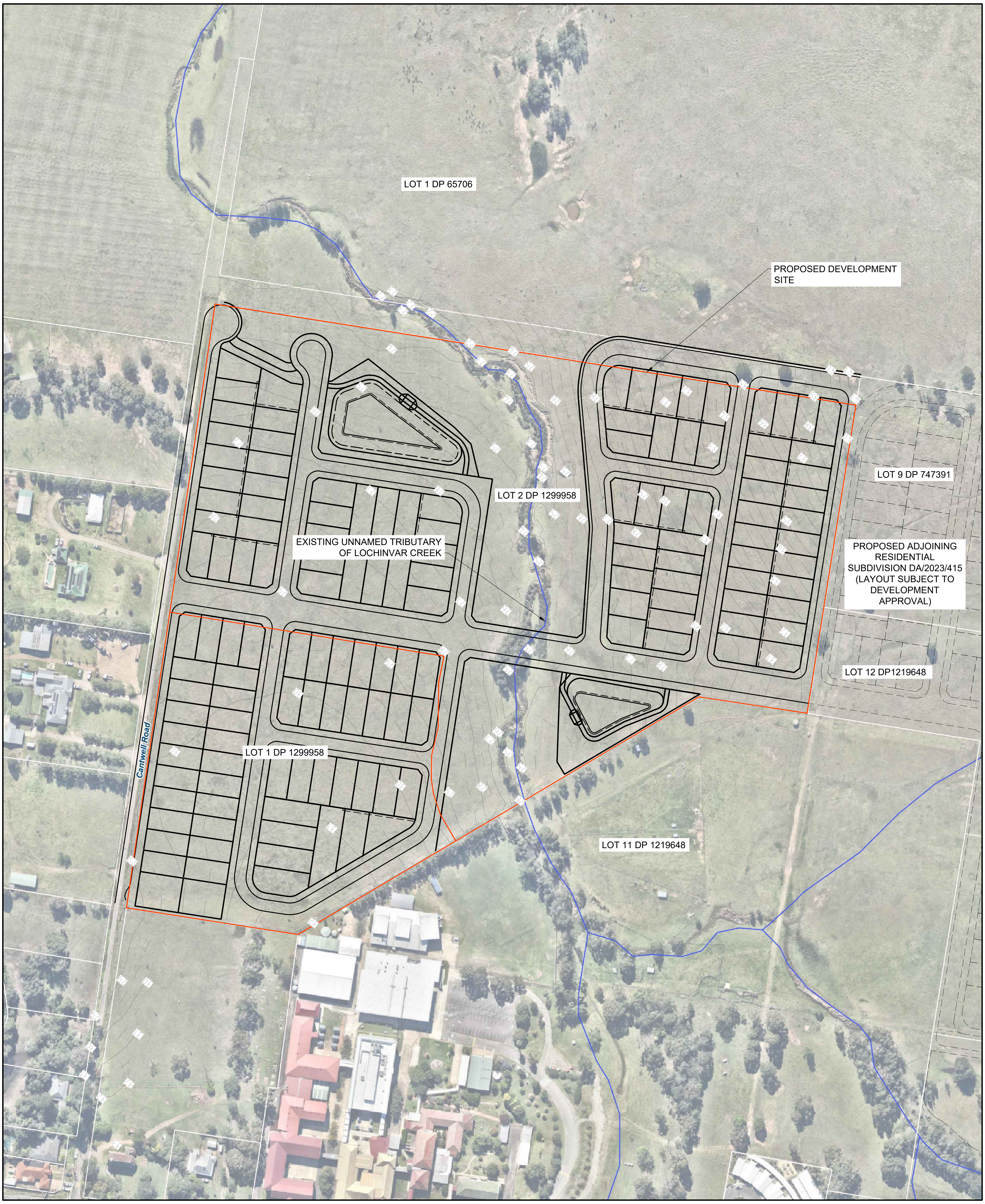


FIGURE 1
LOCALITY PLAN

1:8000 0 160 320 480 m

DATE: 23/10/24

DWG REF: 23290 F01 LOCALITY r1



LEGEND

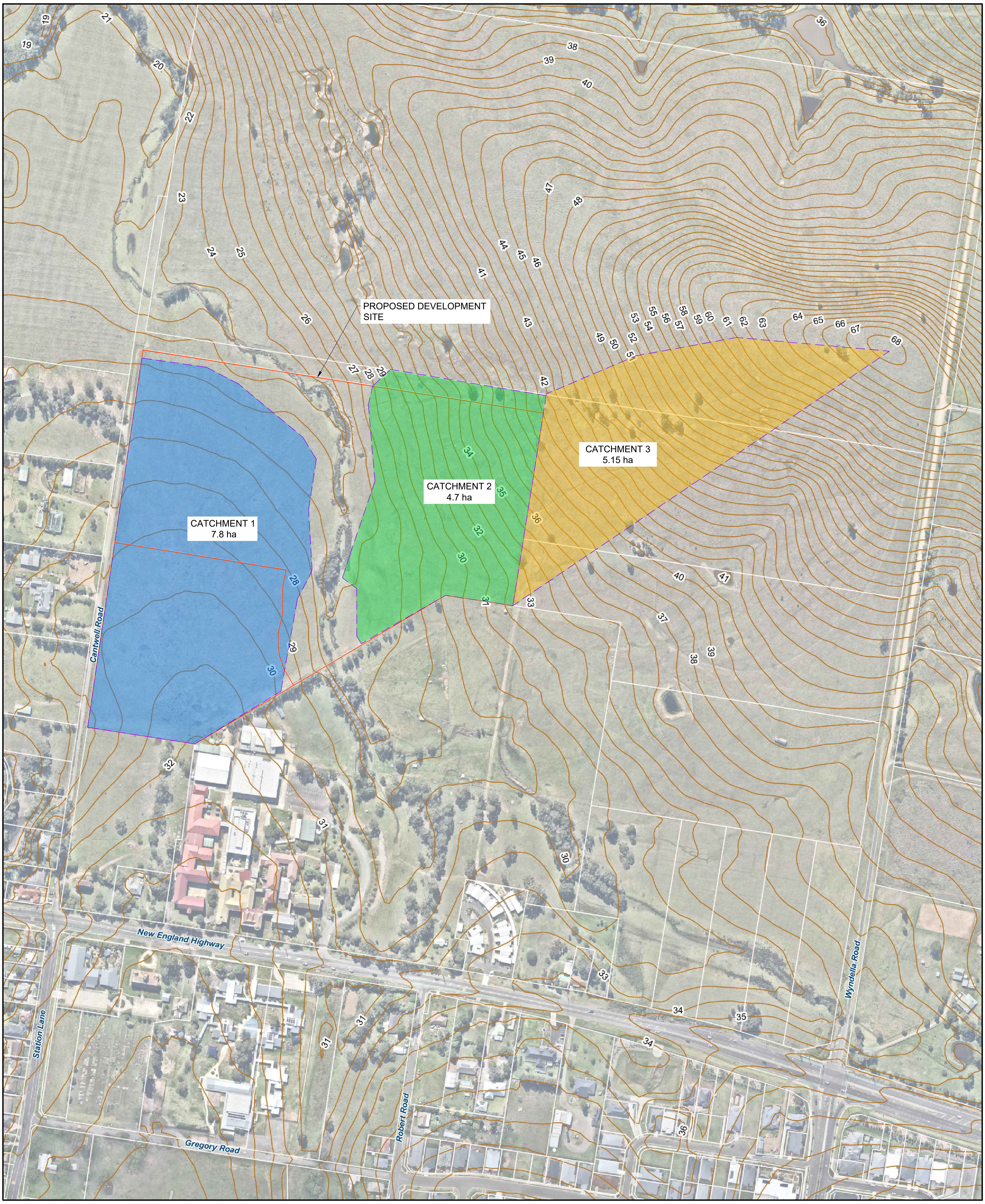
SURVEYED MAJOR NATURAL CONTOURS (1m INTERVAL)

EXISTING PARENT LOT BOUNDARY

FIGURE 2
SITE PLAN

1:2500 0 50 100 150 m

DATE: 28/01/25



LEGEND

LICDEM NATURAL CONTOURS (1m INTERVAL)

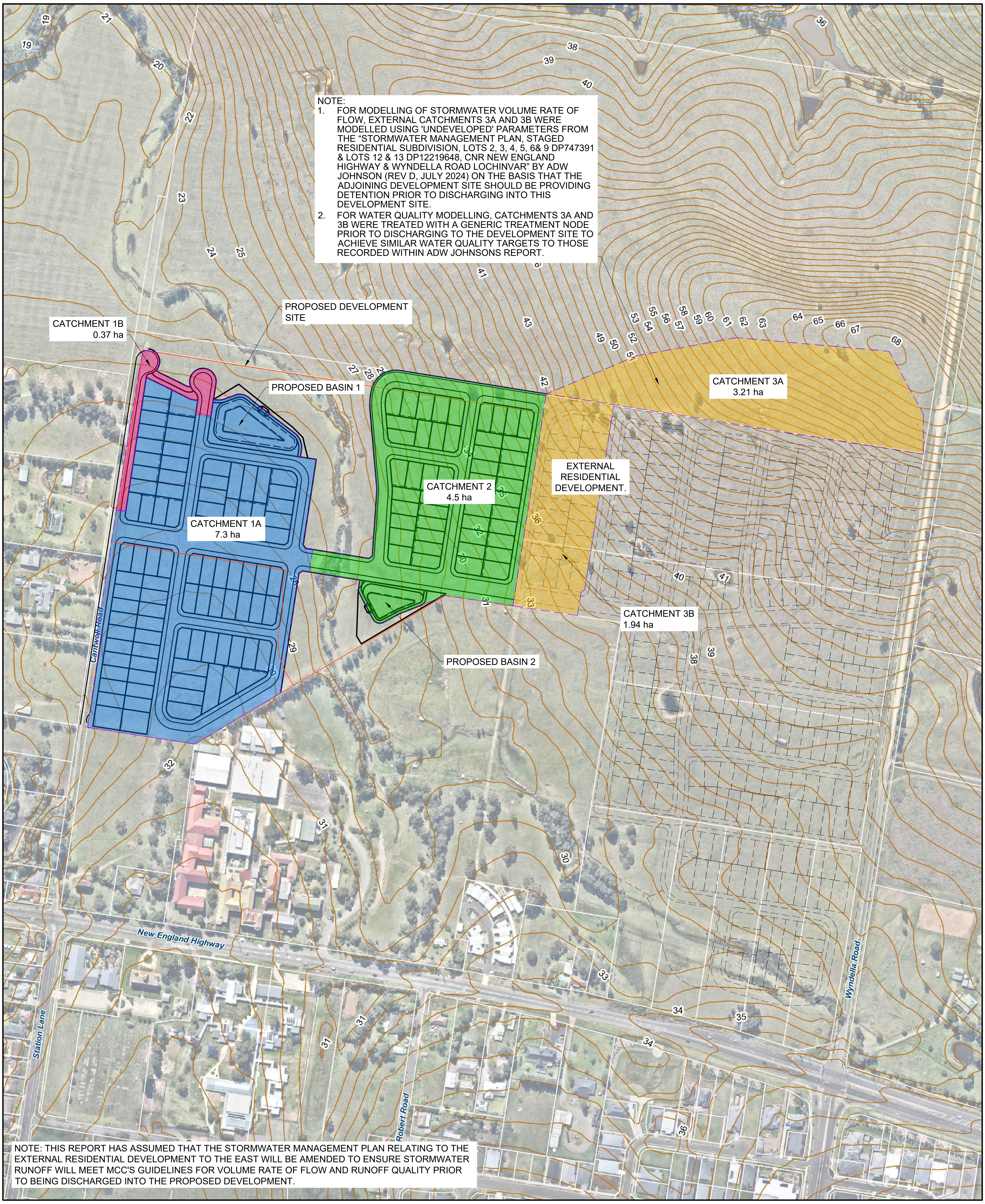
EXISTING PARENT LOT BOUNDARY

FIGURE 3
PREDEVELOPMENT CATCHMENT PLAN

1:4000 — 0, 80, 160, 240 m

DATE: 23/10/24

DWG REF: 23290 F03 PREDEV CATCHMENT PLAN r1



LEGEND

LICDEM NATURAL CONTOURS (1m INTERVAL)

EXISTING PARENT LOT BOUNDARY

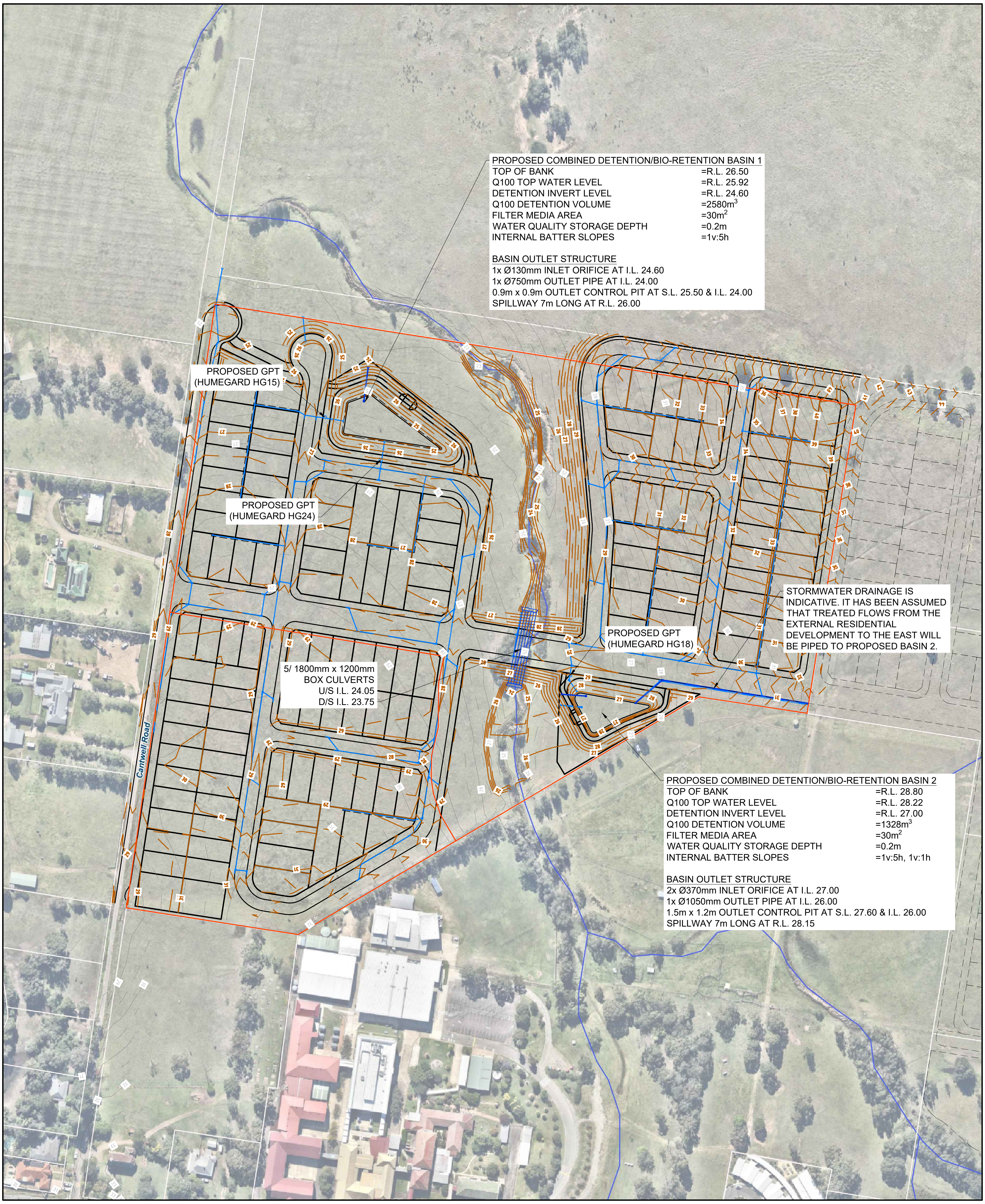
FIGURE 4

POST DEVELOPMENT CATCHMENT PLAN

1:4000 0 80 160 240 m

DATE: 28/01/25

DWG REF: 23290 F04 POSTDEV PLAN r3



LEGEND

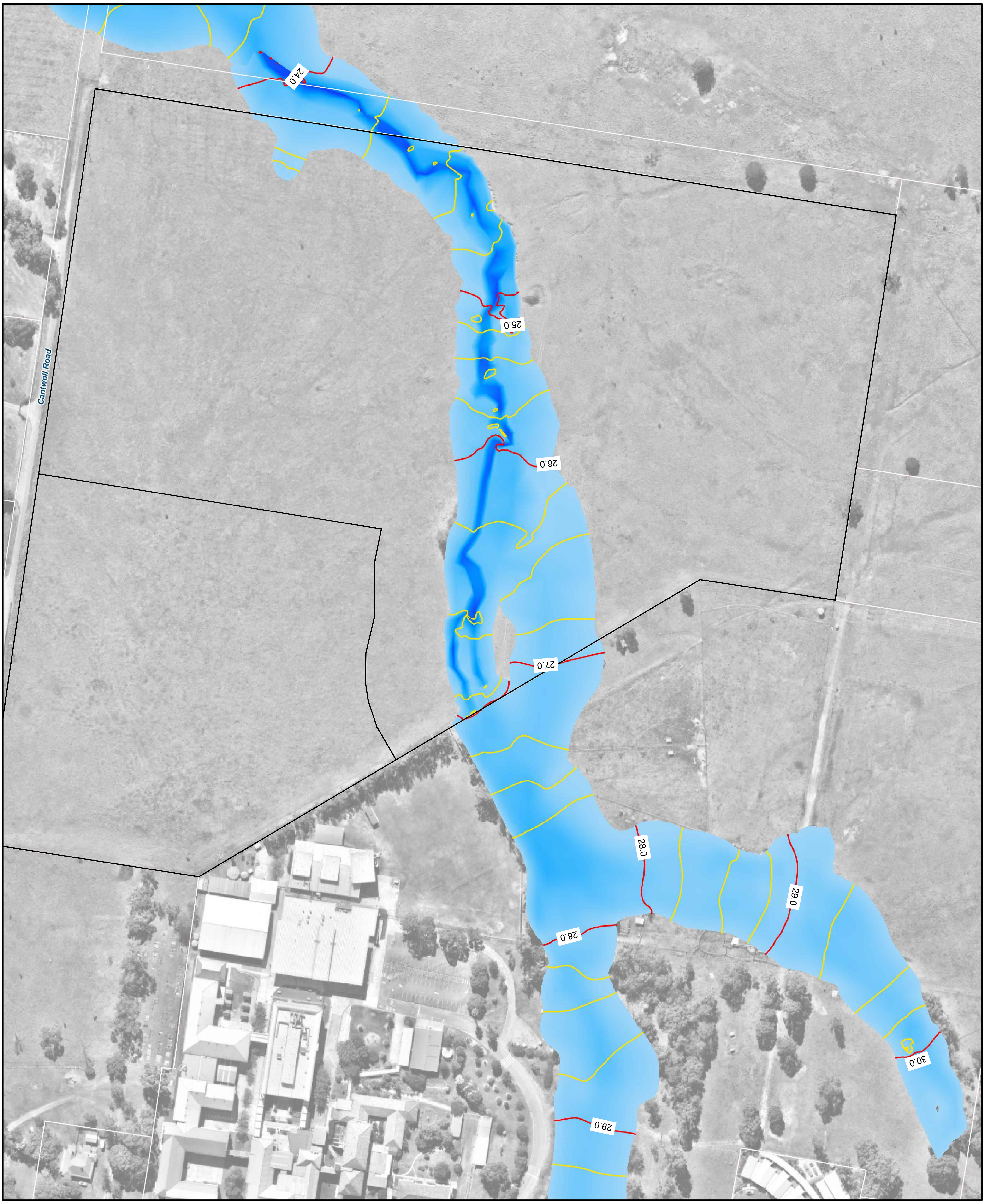
- SURVEYED MAJOR NATURAL CONTOURS (1m INTERVAL)
- MAJOR DESIGN CONTOURS (1m INTERVAL)
- EXISTING PARENT LOT BOUNDARY

FIGURE 5
STORMWATER MANAGEMENT PLAN

1:2500 0 50 100 150 m

DATE: 28/01/25

DWG REF: 23290 F05 STORMWATER MGT PLAN r3



LEGEND

PEAK FLOOD LEVEL CONTOURS

- INTERMEDIATE FLOOD CONTOURS (0.25m AHD)
- MAJOR CONTOURS (1.0m AHD)

PEAK DEPTH (m)

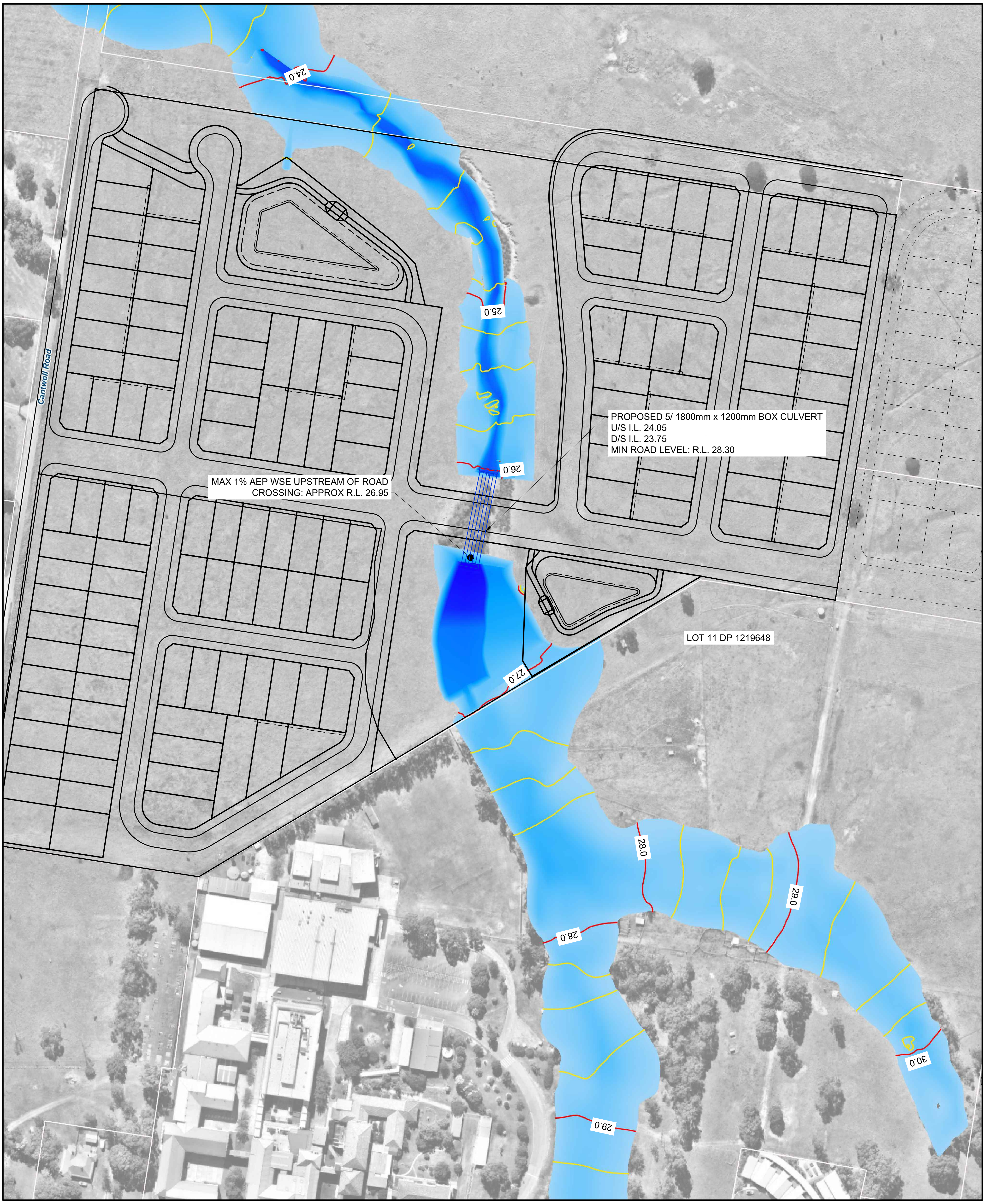
- 0.00
- 0.75
- 1.50
- 2.25
- 3.00

FIGURE 6
PREDEVELOPMENT 1% AEP WATER SURFACE ELEVATION

1:2000 0 40 80 120 m

DATE: 23/10/24

DWG REF: 23290 F06 PREDEV 1 AEP WSE r1



LEGEND

PEAK FLOOD LEVEL CONTOURS

- INTERMEDIATE FLOOD CONTOURS (0.25m AHD)
- MAJOR CONTOURS (1.0m AHD)

PEAK DEPTH (m)

- 0.00
- 0.75
- 1.50
- 2.25
- 3.00

FIGURE 7

POST DEVELOPMENT 1% AEP WATER SURFACE ELEVATION

1:2000 — 0, 40, 80, 120 m

DATE: 28/01/25

DWG REF: 23290 F07 POSTDEV 1 AEP WSE r3

LEGEND

Δ WSE (m)

- -1.00
- -0.80
- -0.60
- -0.40
- -0.20
- 0.00
- 0.20
- 0.40
- 0.60
- 0.80
- 1.00

FIGURE 8

WATER SURFACE ELEVATION IMPACT - 1% AEP EVENT

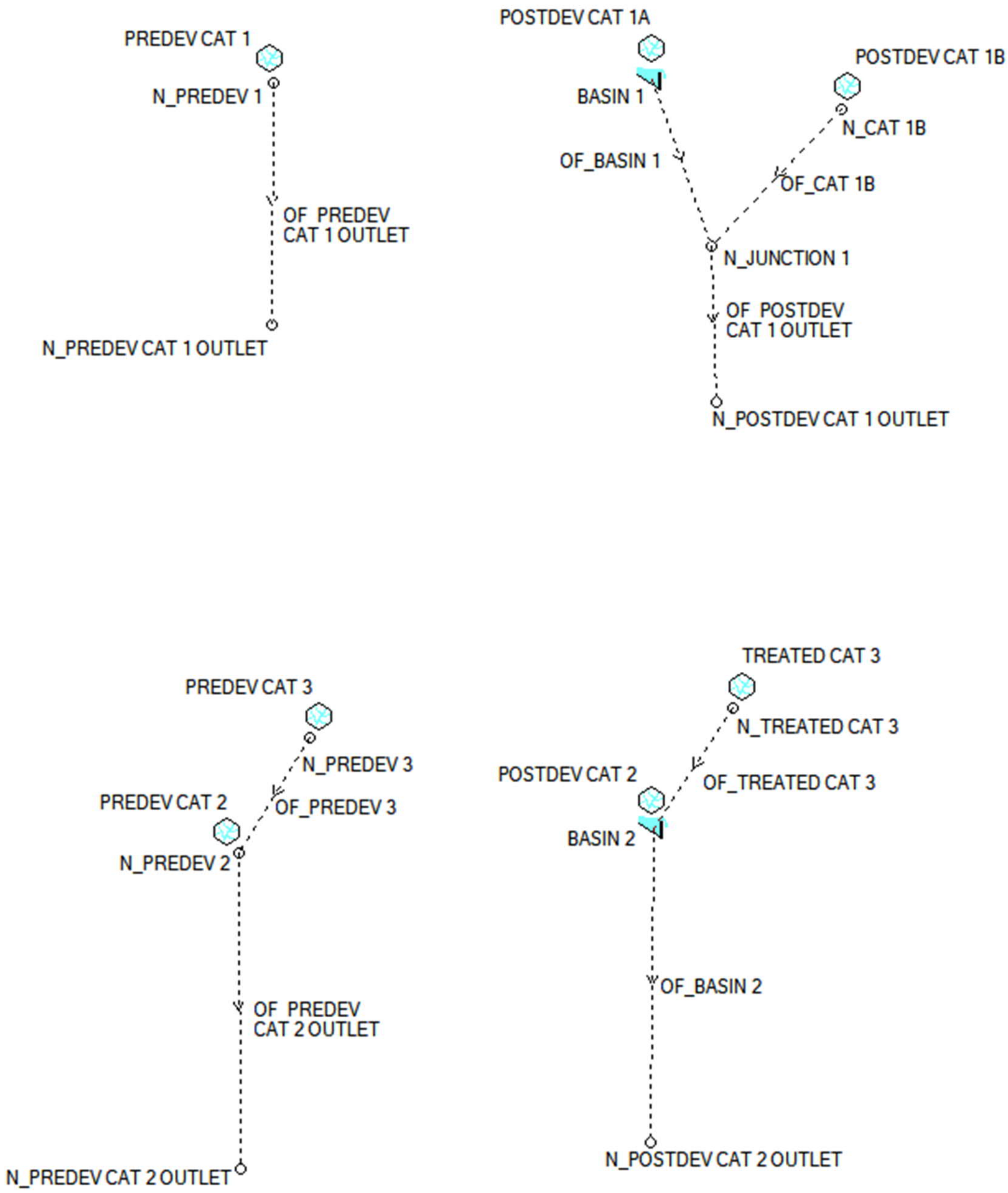
1:1500 — 0, 30, 60, 90 m

DATE: 16/12/24

DWG REF: 23290 F08 DELTA 1 AEP WSE r2

Appendix A

DRAINS Data


PREDEV CAT 1
N_PREDEV 1
OF PREDEV
CAT 1 OUTLET
N_PREDEV CAT 1 OUTLET
POSTDEV CAT 1A
BASIN 1
POSTDEV CAT 1B
N_CAT 1B
OF_BASIN 1
OF_CAT 1B
N_JUNCTION 1
OF POSTDEV
CAT 1 OUTLET
N_POSTDEV CAT 1 OUTLET
PREDEV CAT 3
N_PREDEV 3
OF_PREDEV 3
PREDEV CAT 2
N_PREDEV 2
OF PREDEV
CAT 2 OUTLET
N_PREDEV CAT 2 OUTLET
TREATED CAT 3
N_TREATED CAT 3
POSTDEV CAT 2
OF_TREATED CAT 3
BASIN 2
OF_BASIN 2
N_POSTDEV CAT 2 OUTLET

DRAINS Data

PIT / NODE DETAILS Version 15

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss	Inflow Hydrograph	Pit is	Internal Width (mm)	Inflow is Misaligned	Minor Safe Pond Depth (m)	Major Safe Pond Depth (m)
N_PREDEV 1	Node					28		0		298	-90		4		No					
N_PREDEV CAT 1 OUTLET	Node					24		0		297	-266		5		No					
N_PREDEV 2	Node					28		0		272.8	-650.8		199059		No					
N_PREDEV CAT 2 OUTLET	Node					26		0		274	-881.2		199060		No					
N_POSTDEV CAT 2 OUTLET	Node					26		0		572.8	-862		199071		No					
N_JUNCTION 1	Node					23.5		0		617.2	-208		268147		No					
N_POSTDEV CAT 1 OUTLET	Node					22.5		0		620.8	-322		268153		No					
N_CAT 1B	Node					25		0		712	-108.4		268156		No					
N_PREDEV 3	Node					30		0		324.4	-566.8		711290		No					
N_TREATED CAT 3	Node					30		0		632.8	-545.2		711311		No					

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Not Used	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Leng	id
BASIN 2	27	847		None						575.2	-632.8	No			199066
	27.5	1033													
	28	1238													
	28.5	1537													
	28.8	1630													
BASIN 1	24.6	1360		None						574	-86.8	No			268140
	25	1662													
	25.5	2173													
	26	2730													
	26.5	3268													

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough	Lag Time or Factor	Gutter Length (m)	Gutter Slope %	Gutter FlowFactor	Rainfall Multiplier
PREDEV CAT 1	N_PREDEV	7.8	0	100	0	0	0	0	-1	135	-1	-1	3.5	-1	-1	0.35	-1	0				1
PREDEV CAT 2	N_PREDEV	4.7	0	100	0	0	0	0	-1	100	-1	-1	3.5	-1	-1	0.35	-1	0				1
POSTDEV CAT 2	BASIN 2	4.5	59	41	0	0	0	0	50	50	-1	3	3	-1	0.01	0.21	-1	0				1
POSTDEV CAT 1A	BASIN 1	7.4	61	39	0	0	0	0	50	50	-1	3	3	-1	0.01	0.21	-1	0				1
POSTDEV CAT 1B	N_CAT 1B	0.21	40	60	0	0	0	0	10	10	-1	3	3	-1	0.01	0.21	-1	0				1
PREDEV CAT 3	N_PREDEV	5.15	0	100	0	0	0	0	-1	100	-1	-1	7	-1	-1	0.035	-1	0				1
TREATED CAT 3	N_TREATED	5.15	0	100	0	0	0	0	-1	100	-1	-1	7	-1	-1	0.035	-1	0				1

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	Rl (m)	Chg (m)	RL (m)	etc (m)

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)	Height of S (m)	Chg (m)	Bottom Elev (m)	Height of S (m)	etc etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storr (m)	SafeDepth Minor Storr (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %		id	U/S IL	D/S IL	Length (m)
OF_PREDEV CAT 1 OUTLET	N_PREDEV	N_PREDEV	0.1				Overflow	0.3	0.3	0.4	5	0		17	28	24	1
OF_PREDEV CAT 2 OUTLET	N_PREDEV	N_PREDEV	0.1				Overflow	0.3	0.3	0.4	5	0		199063	28	26	1
OF_BASIN 2	BASIN 2	N_POSTDE	0.1	27			Overflow	0.3	0.3	0.4	5	0		199072	26.5	26	1
OF_BASIN 1	BASIN 1	N_JUNCTIC	0.1	24.6			Overflow	0.3	0.3	0.4	5	0		268142	24	23.5	1
OF_POSTDEV CAT 1 OUTLET	N_JUNCTIC	N_POSTDE	0.2				Overflow	0.3	0.3	0.4	5	0		268149	23.5	22.5	50
OF_CAT 1B	N_CAT 1B	N_JUNCTIC	0.1				Overflow	0.3	0.3	0.4	5	0		268155	25	23.5	10
OF_PREDEV 3	N_PREDEV	N_PREDEV	0.1				Overflow	0.3	0.3	0.4	5	0		711298	30	28	1
OF_TREATED CAT 3	N_TREATED	BASIN 2	0.1				Overflow	0.3	0.3	0.4	5	0		711309	30	28	1

PIPE COVER DETAILS

Name	Type	Dia (mm)	Safe Cover	Cover (m)

This model has no pipes with non-return valves

BASIN 1 - STAGE / DISCHARGE RELATIONSHIP FOR BASIN WITH STAGED CONTROL STRUCTURE

	MAIN CONTROL STRUCTURES				OVERFLOW STRUCTURES					
Elevation	**Pipe**		**Pit**		**Spillway**		**Check Pipe Inlet Control**		**Stage**	**Total Outflow**
RL	For H/D < 1.2 : Q=1.32D^.87H^1.63		Q=1.67LH^1.5		Q=1.67LH^1.5		For H/D < 1.2 : Q=1.32D^.87H^1.63			
	For H/D > 1.2 : Q=1.62D^1.87H^.63						For H/D > 1.2 : Q=1.62D^1.87H^.63			
	Pipe Dia (D), m	0.130	Weir Length (L), m	3.6	Weir Length (L), m	7	Pipe Dia (D), m	0.750		
	Assuming Square Edged		Pit Inlet (RL), m	25.50	Weir Invert (RL), m	26.00	*Assuming Square Edged*			
Increment	Pipe Invert (RL), m	24.60	min	24.93			Pipe Invert (RL), m	24.00		
0.1				1.343						
	No. Pipes	1		1.043			No. Pipes	1		
	H (m)	Q (cumecs)	H (m)	Q (cumecs)	H (m)	Q (cumecs)	H (m)	Q (cumecs)		
24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.45	24.60	0.00
24.70	0.10	0.01	0.00	0.00	0.00	0.00	0.70	0.57	24.70	0.01
24.80	0.20	0.01	0.00	0.00	0.00	0.00	0.80	0.71	24.80	0.01
24.90	0.30	0.02	0.00	0.00	0.00	0.00	0.90	0.89	24.90	0.02
25.00	0.40	0.02	0.00	0.00	0.00	0.00	1.00	0.95	25.00	0.02
25.10	0.50	0.02	0.00	0.00	0.00	0.00	1.10	1.00	25.10	0.02
25.20	0.60	0.03	0.00	0.00	0.00	0.00	1.20	1.06	25.20	0.03
25.30	0.70	0.03	0.00	0.00	0.00	0.00	1.30	1.12	25.30	0.03
25.40	0.80	0.03	0.00	0.00	0.00	0.00	1.40	1.17	25.40	0.03
25.50	0.90	0.03	0.00	0.00	0.00	0.00	1.50	1.22	25.50	0.03
25.60	1.00	0.04	0.10	0.19	0.00	0.00	1.60	1.27	25.60	0.23
25.70	1.10	0.04	0.20	0.54	0.00	0.00	1.70	1.32	25.70	0.58
25.80	1.20	0.04	0.30	0.99	0.00	0.00	1.80	1.37	25.80	1.03
25.90	1.30	0.04	0.40	1.52	0.00	0.00	1.90	1.42	25.90	1.42
26.00	1.40	0.04	0.50	2.13	0.00	0.00	2.00	1.46	26.00	1.46
26.10	1.50	0.05	0.60	2.79	0.10	0.37	2.10	1.51	26.10	1.88
26.20	1.60	0.05	0.70	3.52	0.20	1.05	2.20	1.55	26.20	2.60
26.30	1.70	0.05	0.80	4.30	0.30	1.92	2.30	1.60	26.30	3.52
26.40	1.80	0.05	0.90	5.13	0.40	2.96	2.40	1.64	26.40	4.60
26.50	1.90	0.05	1.00	6.01	0.50	4.13	2.50	1.68	26.50	5.82
26.60	2.00	0.06	1.10	6.94	0.60	5.43	2.60	1.73	26.60	7.16
26.70	2.10	0.06	1.20	7.90	0.70	6.85	2.70	1.77	26.70	8.62

BASIN 2 - STAGE / DISCHARGE RELATIONSHIP FOR BASIN WITH STAGED CONTROL STRUCTURE

	MAIN CONTROL STRUCTURES				OVERFLOW STRUCTURES					
Elevation	**Pipe**		**Pit**		**Spillway**		**Check Pipe Inlet Control**		**Stage**	**Total Outflow**
RL	For H/D < 1.2 : Q=1.32D^.87H^1.63		Q=1.67LH^1.5		Q=1.67LH^1.5		For H/D < 1.2 : Q=1.32D^.87H^1.63			
	For H/D > 1.2 : Q=1.62D^1.87H^.63						For H/D > 1.2 : Q=1.62D^1.87H^.63			
	Pipe Dia (D), m	0.370	Weir Length (L), m	5.4	Weir Length (L), m	7	Pipe Dia (D), m	1.050		
	Assuming Square Edged		Pit Inlet (RL), m	27.60	Weir Invert (RL), m	28.15	*Assuming Square Edged*			
Increment	Pipe Invert (RL), m	27.00	min	27.57			Pipe Invert (RL), m	26.00		
0.1				1.343						
	No. Pipes	2		1.043			No. Pipes	1		
	H (m)	Q (cumecs)	H (m)	Q (cumecs)	H (m)	Q (cumecs)	H (m)	Q (cumecs)		
27.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.38	27.00	0.00
27.10	0.10	0.03	0.00	0.00	0.00	0.00	1.10	1.61	27.10	0.03
27.20	0.20	0.08	0.00	0.00	0.00	0.00	1.20	1.85	27.20	0.08
27.30	0.30	0.16	0.00	0.00	0.00	0.00	1.30	2.09	27.30	0.16
27.40	0.40	0.25	0.00	0.00	0.00	0.00	1.40	2.19	27.40	0.25
27.50	0.50	0.33	0.00	0.00	0.00	0.00	1.50	2.29	27.50	0.33
27.60	0.60	0.37	0.00	0.00	0.00	0.00	1.60	2.39	27.60	0.37
27.70	0.70	0.40	0.10	0.29	0.00	0.00	1.70	2.48	27.70	0.69
27.80	0.80	0.44	0.20	0.81	0.00	0.00	1.80	2.57	27.80	1.25
27.90	0.90	0.47	0.30	1.48	0.00	0.00	1.90	2.66	27.90	1.95
28.00	1.00	0.50	0.40	2.28	0.00	0.00	2.00	2.75	28.00	2.75
28.10	1.10	0.54	0.50	3.19	0.00	0.00	2.10	2.83	28.10	2.83
28.20	1.20	0.57	0.60	4.19	0.05	0.13	2.20	2.92	28.20	3.05
28.30	1.30	0.60	0.70	5.28	0.15	0.68	2.30	3.00	28.30	3.68
28.40	1.40	0.62	0.80	6.45	0.25	1.46	2.40	3.08	28.40	4.54
28.50	1.50	0.65	0.90	7.70	0.35	2.42	2.50	3.16	28.50	5.58
28.60	1.60	0.68	1.00	9.02	0.45	3.53	2.60	3.24	28.60	6.77
28.70	1.70	0.71	1.10	10.40	0.55	4.77	2.70	3.32	28.70	8.09
28.80	1.80	0.73	1.20	11.85	0.65	6.13	2.80	3.40	28.80	9.52
28.90	1.90	0.76	1.30	13.37	0.75	7.59	2.90	3.47	28.90	11.06
29.00	2.00	0.78	1.40	14.94	0.85	9.16	3.00	3.55	29.00	12.71
29.10	2.10	0.81	1.50	16.57	0.95	10.82	3.10	3.62	29.10	14.44

Appendix B

DRAINS Results

DRAINS Results - 1EY

DRAINS results prepared from Version 2023.10.8682.19045

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivir (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
PREDEV CAT 1	0.057	0	0.057	0	54.52	0	1EY AEP, 1 hour burst, Storm 6
PREDEV CAT 2	0.041	0	0.041	0	45.54	0	1EY AEP, 1 hour burst, Storm 6
POSTDEV CAT 2	0.584	0.584	0	2.28	14.17	0	1EY AEP, 5 min burst, Storm 1
POSTDEV CAT 1A	0.98	0.98	0	2.28	14.17	0	1EY AEP, 5 min burst, Storm 1
POSTDEV CAT 1B	0.041	0.041	0	0.87	5.4	0	1EY AEP, 5 min burst, Storm 1
PREDEV CAT 3	0.223	0	0.223	0	9.29	0	1EY AEP, 1 hour burst, Storm 6
TREATED CAT 3	0.223	0	0.223	0	9.29	0	1EY AEP, 1 hour burst, Storm 6

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)			Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF_PREDEV CAT 1 OUTLET	0.057	0.057	4.837	0.008	0	12	0.58	1EY AEP, 1 hour burst, Storm 6
OF_PREDEV CAT 2 OUTLET	0.263	0.263	4.837	0.02	0.02	12	1.1	1EY AEP, 1 hour burst, Storm 6
OF_BASIN 2	0.251	0.251	4.837	0.019	0.02	12	1.1	1EY AEP, 45 min burst, Storm 8
OF_BASIN 1	0.03	0.03	4.837	0.005	0	12	0.47	1EY AEP, 1.5 hour burst, Storm 10
OF_POSTDEV CAT 1 OUTLET	0.056	0.056	4.837	0.008	0	12	0.56	1EY AEP, 20 min burst, Storm 5
OF_CAT 1B	0.041	0.041	4.837	0.006	0	12	0.53	1EY AEP, 5 min burst, Storm 1
OF_PREDEV 3	0.223	0.223	4.837	0.018	0.02	12	1.03	1EY AEP, 1 hour burst, Storm 6
OF_TREATED CAT 3	0.223	0.223	4.837	0.018	0.02	12	1.03	1EY AEP, 1 hour burst, Storm 6

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
BASIN 2	27.4	369.3	0.251	0	0.251
BASIN 1	25.43	1420.1	0.03	0	0.03

Run Log for 23290 DRAINS r3

{\colortbl;\red0\green0\blue0;\red192\green0\blue0;}Run Log for 23290 DRAINS r3.drn - DRAINS run at 15:14:13 on 28/1/2025 using Watercom Drains v2023.10.8682.19045

Flows were safe in all overflow routes.

DRAINS Results - 10%

DRAINS results prepared from Version 2023.10.8682.19045

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivir (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
PREDEV CAT 1	0.651	0	0.651	0	39.12	0	10% AEP, 45 min burst, Storm 2
PREDEV CAT 2	0.469	0	0.469	0	32.67	0	10% AEP, 45 min burst, Storm 1
POSTDEV CAT 2	1.254	1.115	0.139	1.76	10.94	0	10% AEP, 5 min burst, Storm 1
POSTDEV CAT 1A	2.085	1.87	0.214	1.76	10.94	0	10% AEP, 5 min burst, Storm 1
POSTDEV CAT 1B	0.121	0.084	0.047	0.79	4.89	0	10% AEP, 15 min burst, Storm 3
PREDEV CAT 3	1.463	0	1.463	0	5.15	0	10% AEP, 15 min burst, Storm 4
TREATED CAT 3	1.463	0	1.463	0	5.15	0	10% AEP, 15 min burst, Storm 4

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF_PREDEV CAT 1 OUTLET	0.651	0.651	4.837	0.035	0.05	12	1.56	10% AEP, 45 min burst, Storm 2
OF_PREDEV CAT 2 OUTLET	1.745	1.745	4.837	0.062	0.15	12.01	2.35	10% AEP, 15 min burst, Storm 4
OF_BASIN 2	1.725	1.725	4.837	0.062	0.14	12.01	2.32	10% AEP, 20 min burst, Storm 3
OF_BASIN 1	0.581	0.581	4.837	0.032	0.05	12	1.53	10% AEP, 1.5 hour burst, Storm 4
OF_POSTDEV CAT 1 OUTLET	0.605	0.605	4.837	0.033	0.05	12	1.54	10% AEP, 1.5 hour burst, Storm 4
OF_CAT 1B	0.121	0.121	4.837	0.012	0.01	12	0.83	10% AEP, 15 min burst, Storm 3
OF_PREDEV 3	1.463	1.463	4.837	0.056	0.12	12.01	2.17	10% AEP, 15 min burst, Storm 4
OF_TREATED CAT 3	1.463	1.463	4.837	0.056	0.12	12.01	2.17	10% AEP, 15 min burst, Storm 4

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
BASIN 2	27.87	876.4	1.725	0	1.725
BASIN 1	25.7	2023.6	0.581	0	0.581

Run Log for 23290 DRAINS r3

{\colortbl;\red0\green0\blue0;\red192\green0\blue0;}Run Log for 23290 DRAINS r3.drn - DRAINS run at 15:14:29 on 28/1/2025 using Watercom Drains v2023.10.8682.19045

Flows were safe in all overflow routes.

DRAINS Results - 5%

DRAINS results prepared from Version 2023.10.8682.19045

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivir (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
PREDEV CAT 1	0.943	0	0.943	0	36.67	0	5% AEP, 45 min burst, Storm 5
PREDEV CAT 2	0.676	0	0.676	0	27.59	0	5% AEP, 30 min burst, Storm 10
POSTDEV CAT 2	1.602	1.146	0.456	1.93	12.02	0	5% AEP, 15 min burst, Storm 5
POSTDEV CAT 1A	2.625	1.922	0.704	1.93	12.02	0	5% AEP, 15 min burst, Storm 5
POSTDEV CAT 1B	0.153	0.083	0.07	0.74	4.58	0	5% AEP, 15 min burst, Storm 10
PREDEV CAT 3	1.875	0	1.875	0	4.82	0	5% AEP, 15 min burst, Storm 5
TREATED CAT 3	1.875	0	1.875	0	4.82	0	5% AEP, 15 min burst, Storm 5

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)			Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF_PREDEV CAT 1 OUTLET	0.943	0.943	4.837	0.043	0.08	12	1.81	5% AEP, 45 min burst, Storm 5
OF_PREDEV CAT 2 OUTLET	2.31	2.31	4.837	0.074	0.19	12.01	2.61	5% AEP, 15 min burst, Storm 4
OF_BASIN 2	2.302	2.302	4.837	0.074	0.19	12.01	2.6	5% AEP, 15 min burst, Storm 7
OF_BASIN 1	0.858	0.858	4.837	0.041	0.07	12	1.76	5% AEP, 1 hour burst, Storm 3
OF_POSTDEV CAT 1 OUTLET	0.891	0.891	4.837	0.041	0.07	12	1.79	5% AEP, 1 hour burst, Storm 3
OF_CAT 1B	0.153	0.153	4.837	0.014	0.01	12	0.9	5% AEP, 15 min burst, Storm 10
OF_PREDEV 3	1.875	1.875	4.837	0.065	0.16	12.01	2.41	5% AEP, 15 min burst, Storm 5
OF_TREATED CAT 3	1.875	1.875	4.837	0.065	0.16	12.01	2.41	5% AEP, 15 min burst, Storm 5

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
BASIN 2	27.94	967.4	2.302	0	2.302
BASIN 1	25.76	2173.2	0.858	0	0.858

Run Log for 23290 DRAINS r3

{\colortbl;\red0\green0\blue0;\red192\green0\blue0;}Run Log for 23290 DRAINS r3.drn - DRAINS run at 15:14:53 on 28/1/2025 using Watercom Drains v2023.10.8682.19045

Flows were safe in all overflow routes.

DRAINS Results - 1%

DRAINS results prepared from Version 2023.10.8682.19045

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
PREDEV CAT 1	1.781	0	1.781	0	28.94	0	1% AEP, 30 min burst, Storm 10
PREDEV CAT 2	1.261	0	1.261	0	23.11	0	1% AEP, 25 min burst, Storm 6
POSTDEV CAT 2	2.237	1.805	0.432	1.45	9.02	0	1% AEP, 5 min burst, Storm 1
POSTDEV CAT 1A	3.694	3.028	0.666	1.45	9.02	0	1% AEP, 5 min burst, Storm 1
POSTDEV CAT 1B	0.236	0.126	0.11	0.55	3.44	0	1% AEP, 5 min burst, Storm 1
PREDEV CAT 3	2.963	0	2.963	0	3.62	0	1% AEP, 5 min burst, Storm 1
TREATED CAT 3	2.963	0	2.963	0	3.62	0	1% AEP, 5 min burst, Storm 1

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)			Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF_PREDEV CAT 1 OUTLET	1.781	1.781	4.837	0.063	0.15	12.01	2.36	1% AEP, 30 min burst, Storm 10
OF_PREDEV CAT 2 OUTLET	3.52	3.52	4.837	0.095	0.29	12.01	3.08	1% AEP, 5 min burst, Storm 1
OF_BASIN 2	3.199	3.199	4.837	0.09	0.27	12.01	2.95	1% AEP, 20 min burst, Storm 4
OF_BASIN 1	1.429	1.429	4.837	0.055	0.12	12.01	2.16	1% AEP, 45 min burst, Storm 6
OF_POSTDEV CAT 1 OUTLET	1.516	1.516	4.837	0.057	0.13	12.01	2.21	1% AEP, 25 min burst, Storm 8
OF_CAT 1B	0.236	0.236	4.837	0.019	0.02	12	1.03	1% AEP, 5 min burst, Storm 1
OF_PREDEV 3	2.963	2.963	4.837	0.085	0.25	12.01	2.89	1% AEP, 5 min burst, Storm 1
OF_TREATED CAT 3	2.963	2.963	4.837	0.085	0.25	12.01	2.89	1% AEP, 5 min burst, Storm 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
BASIN 2	28.22	1327.6	3.199	0	3.199
BASIN 1	25.92	2580	1.429	0	1.429

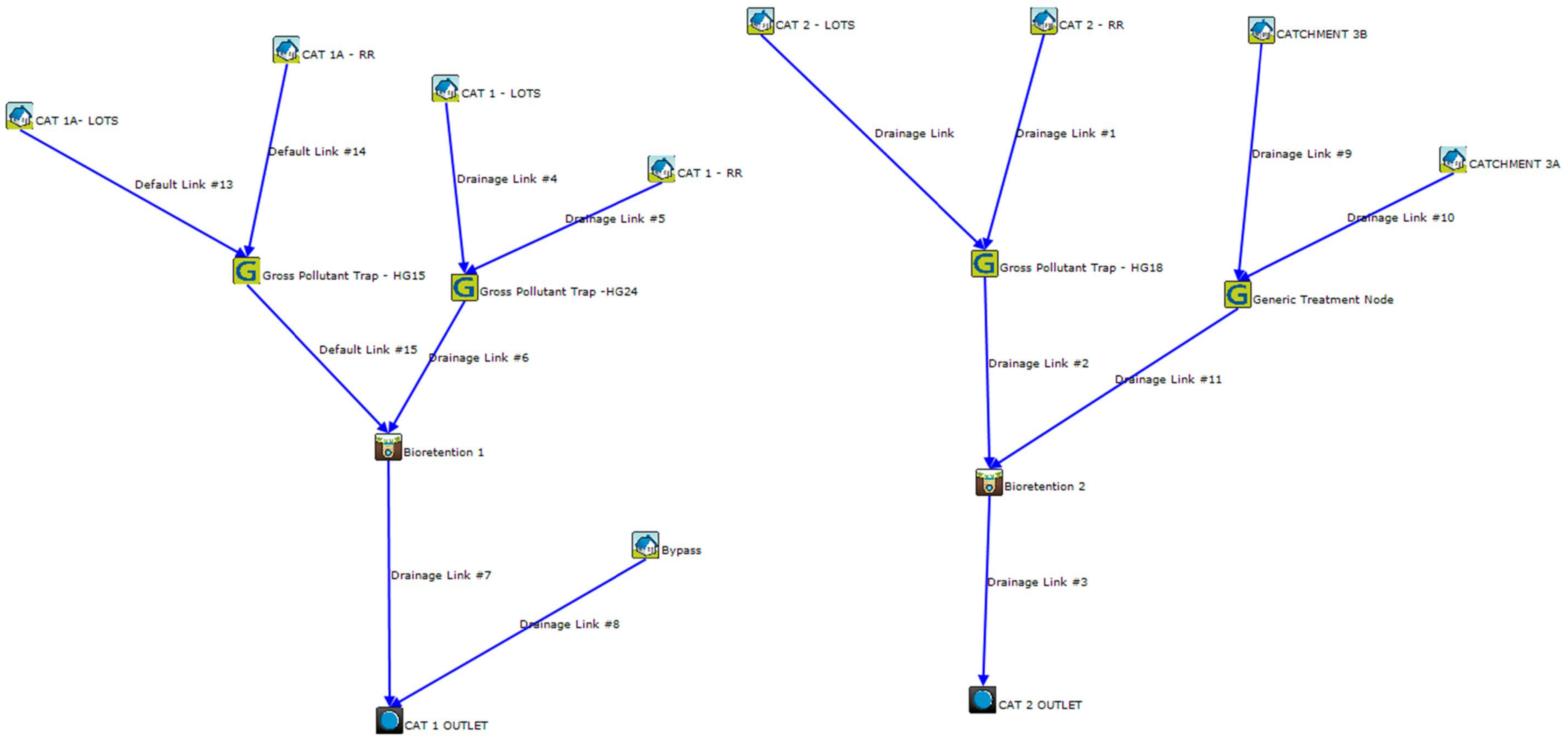
Run Log for 23290 DRAINS r3

{\colortbl;\red0\green0\blue0;\red192\green0\blue0;}Run Log for 23290 DRAINS r3.drn - DRAINS run at 15:15:07 on 28/1/2025 using Watercom Drains v2023.10.8682.19045

Flows were safe in all overflow routes.

Appendix C

MUSICX Model Layout



CAT 1A- LOTS
CAT 1A - RR
CAT 1 - LOTS
CAT 1 - RR
Default Link #13
Default Link #14
Drainage Link #4
Drainage Link #5
Gross Pollutant Trap - HG15
Gross Pollutant Trap -HG24
Default Link #15
Drainage Link #6
Bioretention 1
Bypass
Drainage Link #7
Drainage Link #8
CAT 1 OUTLET
CAT 2 - LOTS
CAT 2 - RR
CATCHMENT 3B
CATCHMENT 3A
Drainage Link
Drainage Link #1
Drainage Link #9
Drainage Link #10
Gross Pollutant Trap - HG18
Generic Treatment Node
Drainage Link #2
Drainage Link #11
Bioretention 2
Drainage Link #3
CAT 2 OUTLET

Appendix D

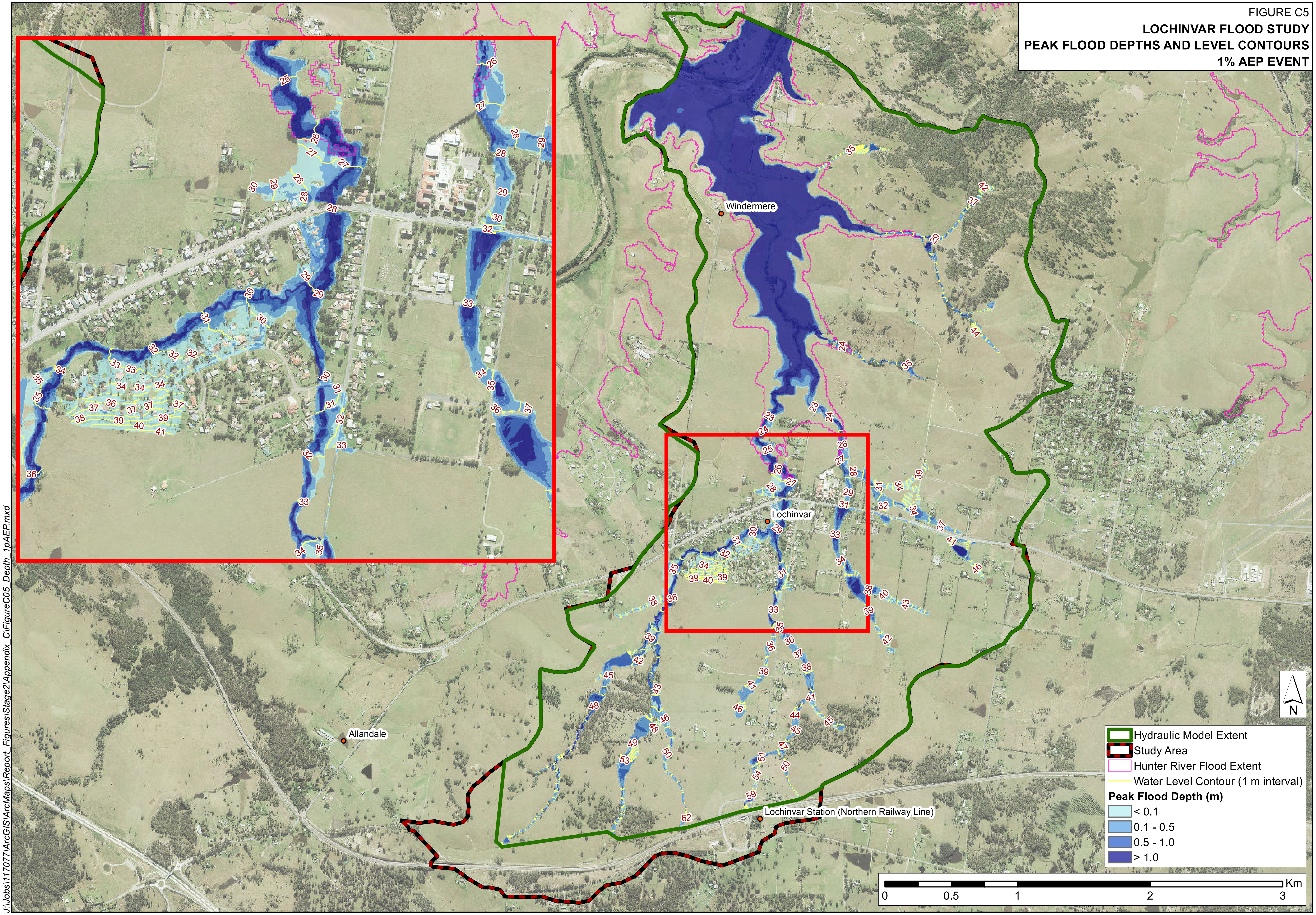
Lochinvar Flood Study - 1% AEP

FIGURE C5

LOCHINVAR FLOOD STUDY

PEAK FLOOD DEPTHS AND LEVEL CONTOURS

1% AEP EVENT



J:\Jobs\117077\ArcGIS\ArcMaps\Report_Figures\Stage2\Appendix_C\FigureC05_Depth_1pAEP.mxd

Appendix E

Culvert Blockage Assessment

BLOCKAGE ASSESMENT FORM

STRUCTURE : CULVERT 1

OPENING WIDTH:......1.8......m

DEBRIS TYPE/MATERIAL/L_{10}/SOURCE AREA - *There may be more than one material type to consider!*

Debris Type/Material	L_{10}	Source Area	How Assessed
Non-floating	1.5m	Rural (generally) with swamp riparian forest watercourse.	L10 based on typical stream width and larger items unlikely to reach culverts without snagging.

DEBRIS AVAILABILITY (HML) – *for the selected debris type/size and its source area*

Availability	Typical Source Area Characteristics	Notes
High	• *Dense forest, thick vegetation, extensive canopy, difficult to walk through with considerable fallen limbs, leaves and high levels of floor litter.* • *Streams with boulder/cobble beds and steep bed slopes and banks showing signs of substantial past bed/bank movements.* • *Arid areas, where loose vegetation and exposed loose soils occur and vegetation is sparse.* • *Urban areas that are not well maintained and/or old paling fences, sheds, cars and/or stored loose material etc., are present on the floodplain close to the water course.*	
Medium	• *State forest areas with clear understory, grazing land with stands of trees* • *Source areas generally falling between the High and Low categories.*	
Low	• *Well maintained rural lands and paddocks, with minimal outbuildings* • *Streams with moderate to flat slopes and stable beds and banks.* • *Arid areas where vegetation is deep rooted and soils resistant to scour* • *Urban areas that are well maintained with limited debris present in the source area.*	

DEBRIS MOBILITY (HML) - *for the selected debris type/size and its source area*

Mobility	Typical Source Area Characteristics	Notes
High	• *Steep source area with fast response times and high annual rainfall and/or storm intensities and/or source areas subject to high rainfall intensities with sparse vegetation cover.* • *Receiving streams that frequently overtop their banks.* • *Main debris source areas close to streams*	
Medium	• *Source areas generally falling between the High and Low categories.*	
Low	• *Low rainfall intensities and large, flat source areas.* • *Receiving streams that Infrequently overtop their banks.* • *Main source areas well away from streams*	

DEBRIS TRANSPORTABILITY (HML) - *for the selected debris type/size and stream characteristics*

Transportability	Typical Transporting Stream Characteristics	Notes
High	• *Steep bed slopes (> 3%).and/or high stream velocity (V>2.5m/sec)* • *Deep stream relative to vertical debris dimension ($D>0.5L_{10}$)* • *Wide streams relative to horizontal debris dimension. ($W>L_{10}$)* • *Streams relatively straight and free of constrictions/snag points.* • *High temporal variability in maximum stream flows*	
Medium	• *Streams generally falling between High and Low categories*	
Low	• *Flat bed slopes (< 1%).and/or low stream velocity (V<1m/sec)* • *Shallow stream relative to vertical debris dimension ($D<0.5L_{10}$)* • *Narrow streams relative to horizontal debris dimension.($W<L_{10}$)* • *Streams meander with frequent constrictions/snag points.* • *Low temporal variability in maximum stream flows*	

BLOCKAGE ASSESMENT FORM

SITE BASED DEBRIS POTENTIAL 1%AEP (HML) - *for the selected debris type/size arriving at the site*

Debris Potential	Combinations of the Above (any order)	Notes
DP_{High}	HHH or HHM	
DP_{Medium}	MMM or HML or HMM or HLL	
DP_{Low}	LLL or MML or MLL	Eg. MML, therefore DP_{Low} selected

AEP ADJUSTED SITE DEBRIS POTENTIAL (HML) - *for the selected debris type/size*

Event AEP	At Site 1% AEP Debris Potential			AEP Adjusted At Site Debris potential
	DP_{High}	DP_{Medium}	DP_{Low}	
AEP > 5% *(frequent)*	Medium	Low	Low	LOW
AEP 5% - AEP 0.5%	High	Medium	Low	MEDIUM
AEP < 0.5% *(rare)*	High	High	Medium	HIGH

Debris Blockage

MOST LIKELY DESIGN INLET BLOCKAGE LEVEL (B_{DES}%) *for the selected debris type/size*

Control Dimension Inlet Width W (m)	At-Site Debris Potential (Generally)		
	High	Medium	Low
$W < L_{10}$	100%	50%	25%
$W \geq L_{10} \leq 3^*L_{10}$	20%	10%	0%
$W > 3^*L_{10}$	10%	0%	0%

Event AEP	Bdes %
AEP > 5% *(frequent)*	0%
AEP 5% - AEP 0.5%	10%
AEP < 0.5% *(rare)*	20%

Refer Guideline if opening H<0.33W

BLOCKAGE ASSESMENT FORM

Barrel Blockage

The following tables are only relevant to sites subject to a significant debris load of sediment. Where inlet blockage and barrel blockage are both likely, the blockage producing the greatest impact on flood behaviour should be used in design.

LIKELIHOOD OF SEDIMENT BEING DEPOSITED IN THE BARREL OR WATERWAY (HML)

Peak Velocity Through Structure (m/sec)	Mean Sediment Size Present				
	Clay/Silt 0.001 to 0.04 mm	Sand 0.04 to 2 mm	Gravel 2 to 63 mm	Cobbles 63 to 200 mm	Boulders >200 mm
>= 3	L	L	L	L	M
1.0 to < 3.0	L	L	L	M	M
0.5 to < 1.0	L	L	L	M	H
0.1 to < 0.5	L	L	M	H	H
< 0.1	L	M	H	H	H

Likelihood of Sediment: LOW

Cobbles and boulders do not appear to be present within or upstream of the area.

MOST LIKELY DESIGN BARREL BLOCKAGE (Bdes%) ***for sediment of a particular mean size is then;***

Likelihood That Deposition Occurs	AEP Adjusted Sediment Potential		
	High	**M**edium	**L**ow
High	100%	60%	25%
Medium	60%	40%	15%
Low	25%	15%	0%

Event AEP	Bdes %
AEP > 5% (frequent)	0%
AEP 5% - AEP 0.5%	15%
AEP < 0.5% *(rare)*	25%

For modelling blockage mechanism (type, location and timing), refer to Guideline Table 8