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SURFACE/STORM WATER MANAGEMENT STRATEGY:

Brears Road, Yarrawonga

October 2023

Document history

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1 Introduction

Alluvium Consulting Australia Pty Ltd (Alluvium) has been engaged by Bressan Parks Land Pty Ltd to prepare a Storm Water Management Strategy (SWMS) in support of its permit application for the Yarrawonga land located on the east side of Brears Road and north side of Murray Valley Highway (ie 10, 22, 38 & 4/52 Brears Rd, Lots 4&5 Jacqueline Ct).

The purpose of this SWMS is to propose management strategies for:

- Stormwater quantity
- Stormwater quality

Through meeting these objectives, this SWMS acts as a critical component of the development servicing strategy and ensures stormwater is managed in accordance with Council's requirements. Information with respect to stormwater assets are provided at a concept design level.

Reference material

- Australian Rainfall & Runoff (2019) – Engineers Australia
- Urban Stormwater Best Practice Environmental Management Guidelines (1999)
- Brears Road, Yarrawonga – Native Vegetation Assessment (Nature Advisory, Aug 2023)
- Arboricultural Assessment & Report – 10, 22 & 38 Brears Road and 4 & 5 Jacqueline Court, Yarrawonga (Treemap Arboriculture, Aug 2023)
- Rivere Yarrawonga – Reverse Briefing Document (DC8 Studio, July 2023)
- Infrastructure Servicing Report – Rivere LLC Yarrawonga (Breese Pitt Dixon, Aug 2023)

2 Site overview

The project site on Brears Road covers an area of 11.27 ha (red dash). The site is generally bound by Brears Road to the west and Murray Valley Highway to the south. The area of the proposed planning permit application from herein is referred to as the 'subject site' (refer to Figure 1).

Figure 1. Site location (in red dash)

The subject site is currently zoned Low Density Residential. The proposed development site is made up of the existing Riverlands Caravan Park together with additional landholdings of various sizes, some of which have existing dwellings and sheds etc (see Figure 1). The northern boundary of the site directly fronts Crown land which is part of the Murray River system. Within the northeastern boundary of the subject, a 10m utilities easement (drainage) runs in a southwest-northeast direction and will need to be accommodated in the future development (refer to Figure 2).

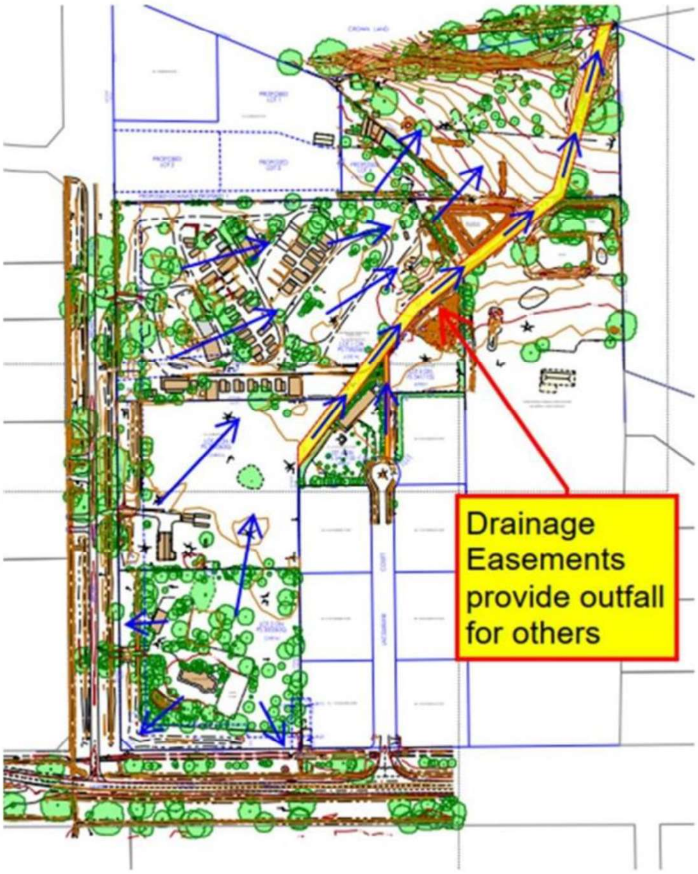

Figure 2. Current 10m drainage easements (Breese Pitt Dixon, Aug 2023)

2.1 Topography

Figure 3 presents the topography across the site. Elevation ranges from 126.5 m AHD at the southwestern corner of the subject site, to 119 m AHD at the north-eastern boundary of the subject site. The topography of the subject site is very gentle with grades typically ranging from 0% to 1.3% and falling in a north-easterly direction.

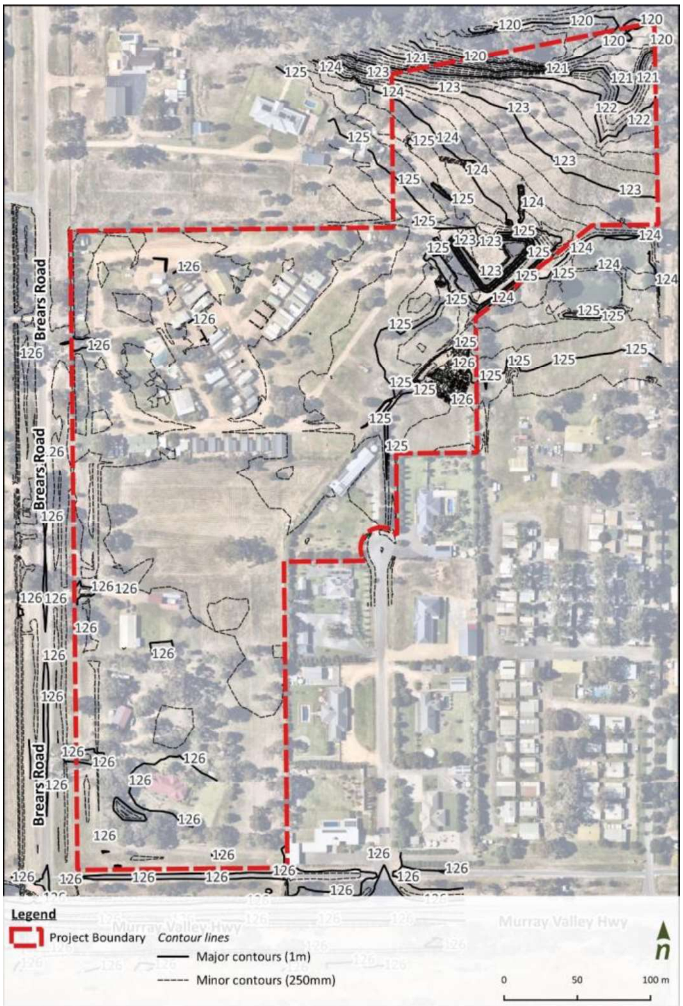

Figure 3. Topography of the Brears Road site

2.2 Existing flood extent

A 1% AEP flood overlay exists on the Moira Planning Scheme, which covers a portion of the subject site as shown in Figure 4.

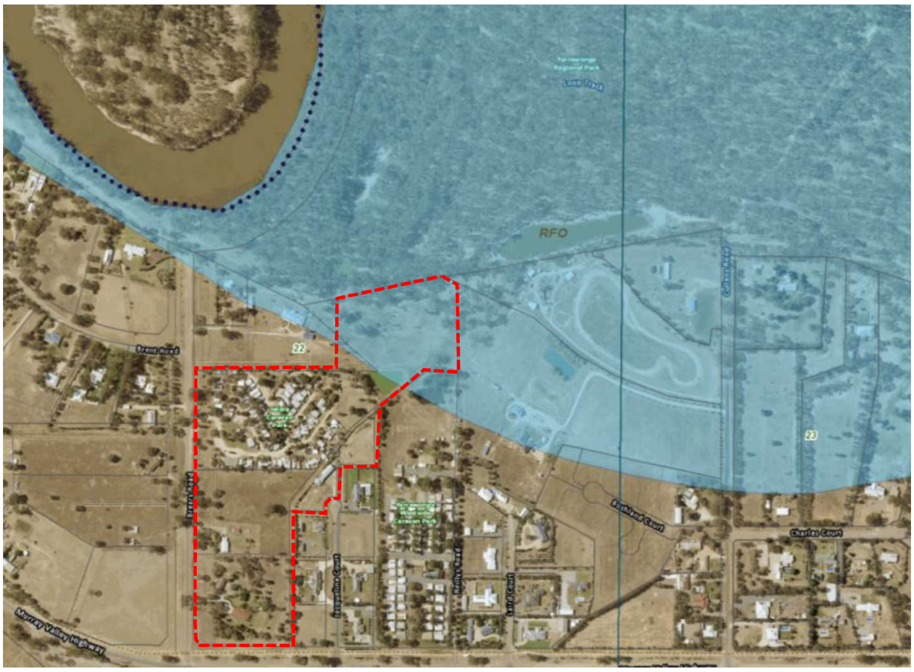

Figure 4. Flood overlay as per the Moira Planning Scheme

However the overlay on the planning sceme is only an approximate representation of the inundation extent. In contrast a detailed 1% AEP flood level contour atlas has been prepared by the Goulburn Broken Catchment Management Authority for the Murray River floodplain (see Figure 5). This contour atlas includes designated flood levels, and a 1% AEP flood level of RL123.7m AHD applies to the subject site.

Using the designated 1% AEP flood level and field survey for the site, the actual extent of inundation has been mapped by Alluvium. As shown in Figure 6, the actual extent of the 1% AEP flood inundation is less than that shown on the Moira Planning Scheme.

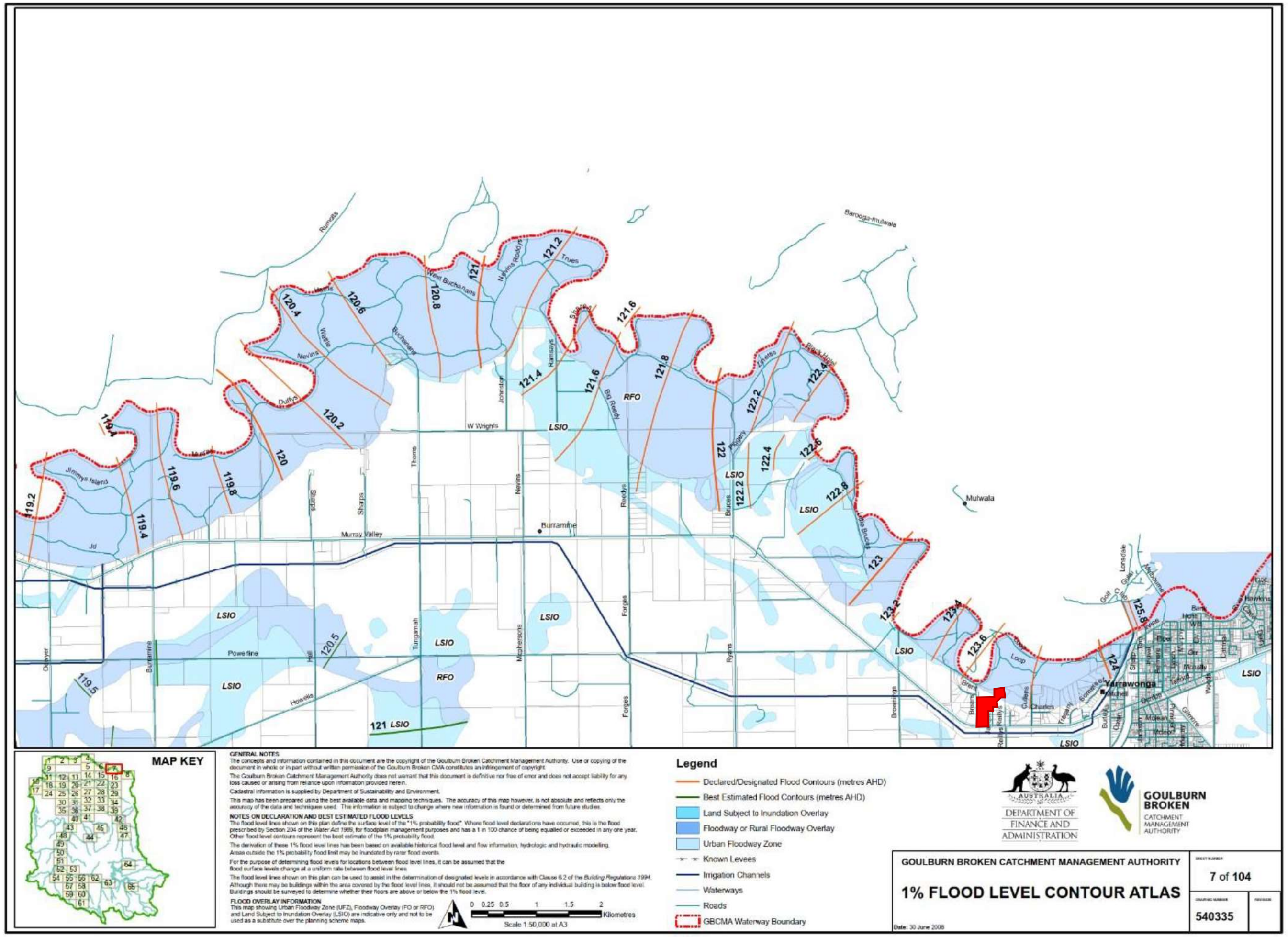

Figure 5. 1% Flood level contour atlas with the subject site shown in red (Goulburn Broken Catchment Management Authority)

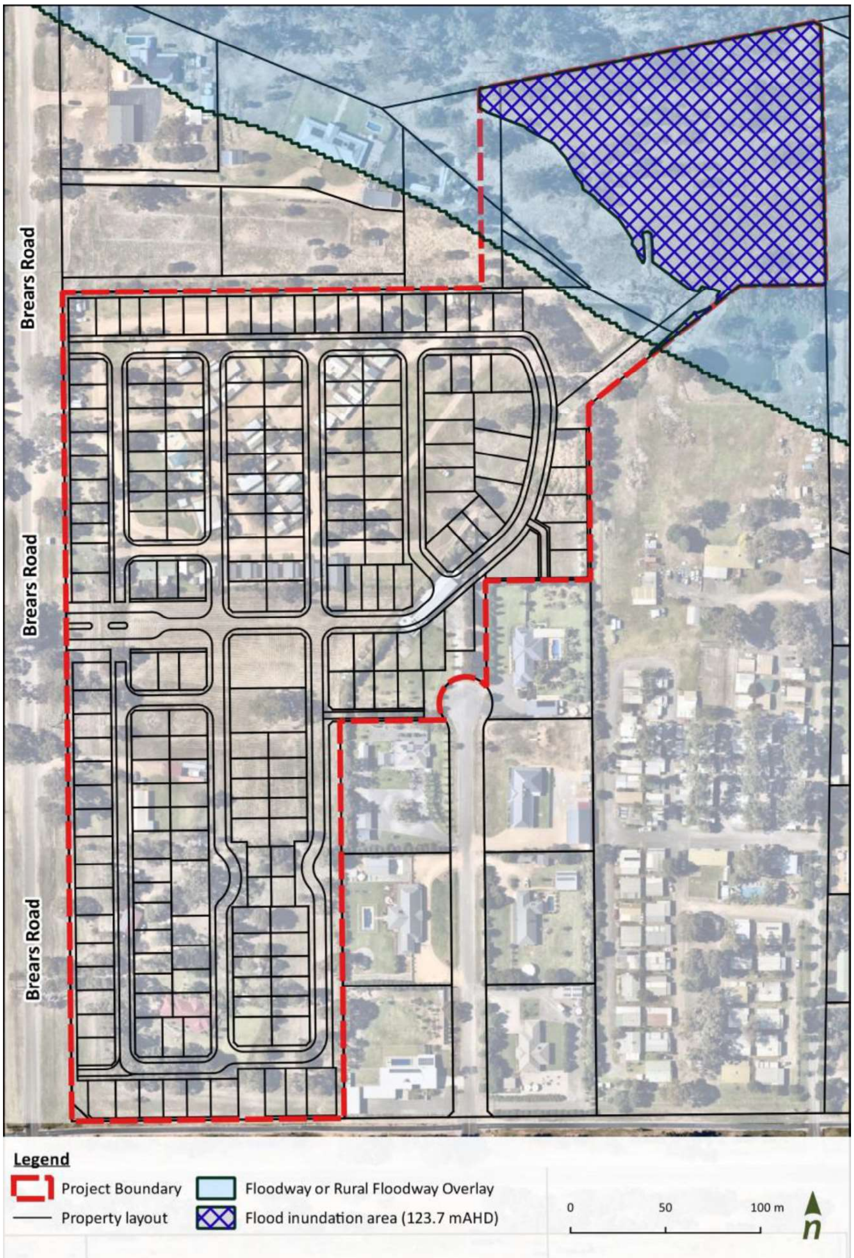

Figure 6. Existing flood extent

2.3 Native Vegetation Assessment

A native vegetation assessment has been prepared by Treemap Arboriculture and Nature Advisory. The tree protection zones with high retention value were identified and mapped as shown in Figure 7. These high value retention zones will influence the location of the proposed WSUD assets.

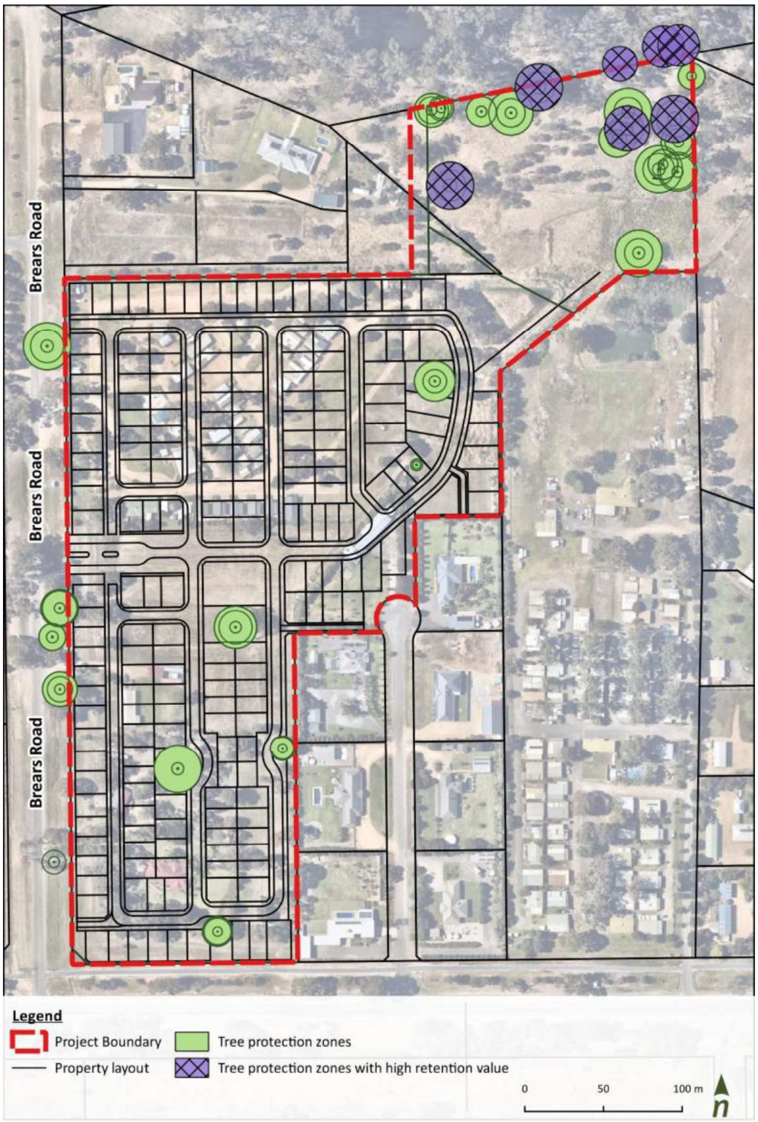

Figure 7. Tree protection zone with high retention value

Figure 7 shows that the tree protection zones with high retention value are mainly located at the northeast of the subject site and close to the ultimate outfall location. The proposed drainage system and assets should avoid these designated zones. The allotment layout of the subject site was also designed to avoid the identified tree protection zones for key trees to be retained within the site.

3 Criteria for SWMS

The criteria for the proposed strategy, based on the analysis of existing conditions and drainage authority requirements are as follows:

- Meet best practice pollutant removal targets through proposing a wetland system prior to discharge to the receiving waterway,
- Convey major flows through the site along road reserves,
- Convey minor flows through local catchments in a piped network.

4 Catchment conditions

According to the boundaries of River Basins of Vicotria defined by Australian Water Resources Council (AWRC), the subject site is categorised to be within the catchment of the Broken River. Stormwater runoff generated from the subject site, however, outfalls in a north-easterly direction and directly into Murray River (refer to Figure 8).

Figure 8. Major Catchment outfall (subject site shown in red dash)

4.1 Existing conditions catchment

The subject site is currently used as a caravan park and no formal stormwater drainage assets has been constructed through the site. Under existing conditions, surface runoff generated with the subject site primarily flows in a north-easterly direction into the receiving waterway located within Crown land to the north. However, due to the existing high points located in the western portion of the subject site, runoff from localised catchments flow in a northerly and westerly direction to Brears Road The existing conditions surface runoff is shown in Figure 9 below.

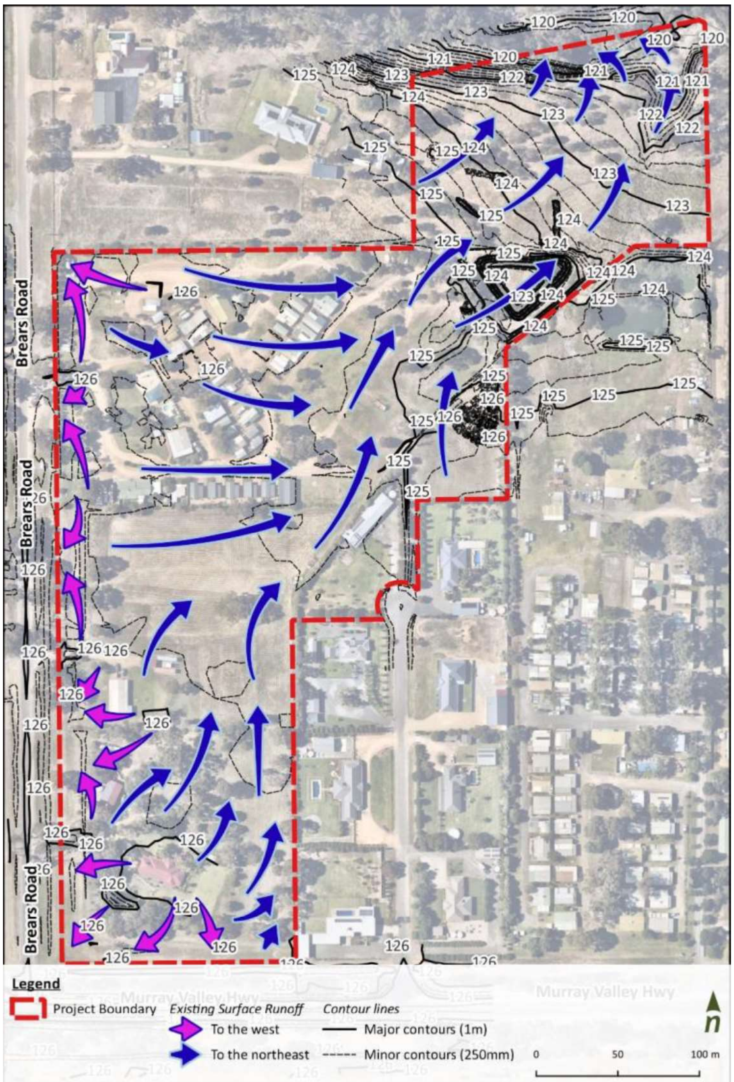

Figure 9. Existing surface runoff (subject site shown in red)

4.2 Hydrologic analysis

The hydrological conditions of the subject site were established using the rational method, which was used to estimate the peak design flows from the subject site under existing (i.e. pre-development) and post-development conditions.

The following design rainfall parameters were adopted for the Brears Road area based upon the Bureau of Meteorology's (BOM) "Intensity Frequency Duration (IFD) Tool – AR&R 2019) (see Figure 10).

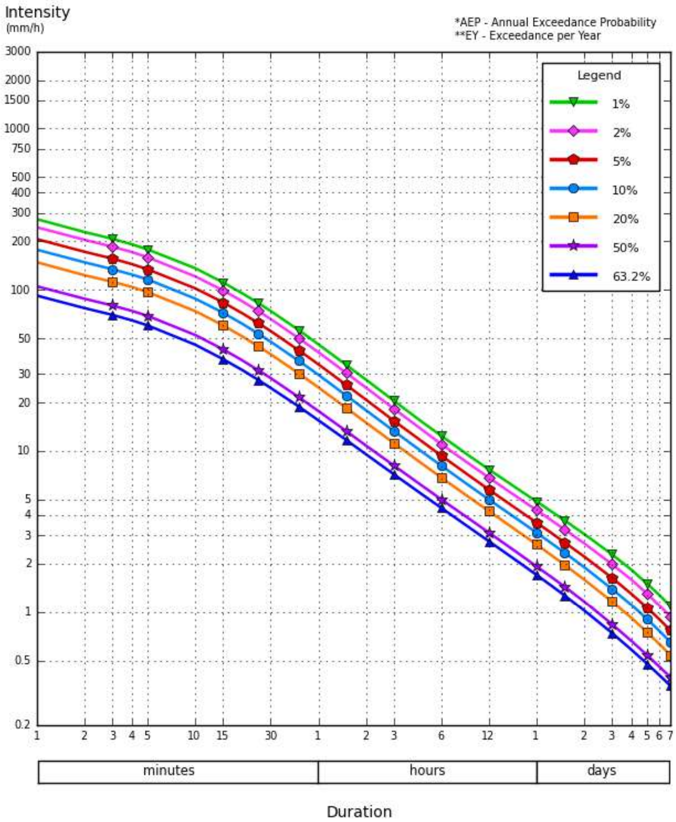

Figure 10. Design rainfall intensities for the Brears Road site

4.3 Proposed Sub-catchment Areas

Catchment delineation was conducted based on available contour data and the proposed road network. Under existing conditions flow paths are solely determined by the existing topography of the subject site. When the area is developed flow paths will be largely determined by the road and drainage network. Two major catchment types were considered in this report, these are referred to as the "External Catchment" and the "Internal Catchment". For the purposes of this report, the term "External catchment" refers to any land outside of the subject site.

Considering the existing topography and the minor / major drainage system philosophy, the subject site presents three different sub-catchment delineation plans in accordance with corresponding pre- and post-development conditions. Regarding the pre-development scenario, in particular, the sub-catchment delineation was focused on the western portion of the subject site in order to assess the peak flow contributing to Brears Road. The size and description of sub-catchments in each plan are provided in Table 1, Table, 3 and Table 4. Moreover, stormwater runoff outflowing to Brears Road under 1% AEP event conditions are summarised in Table 2.

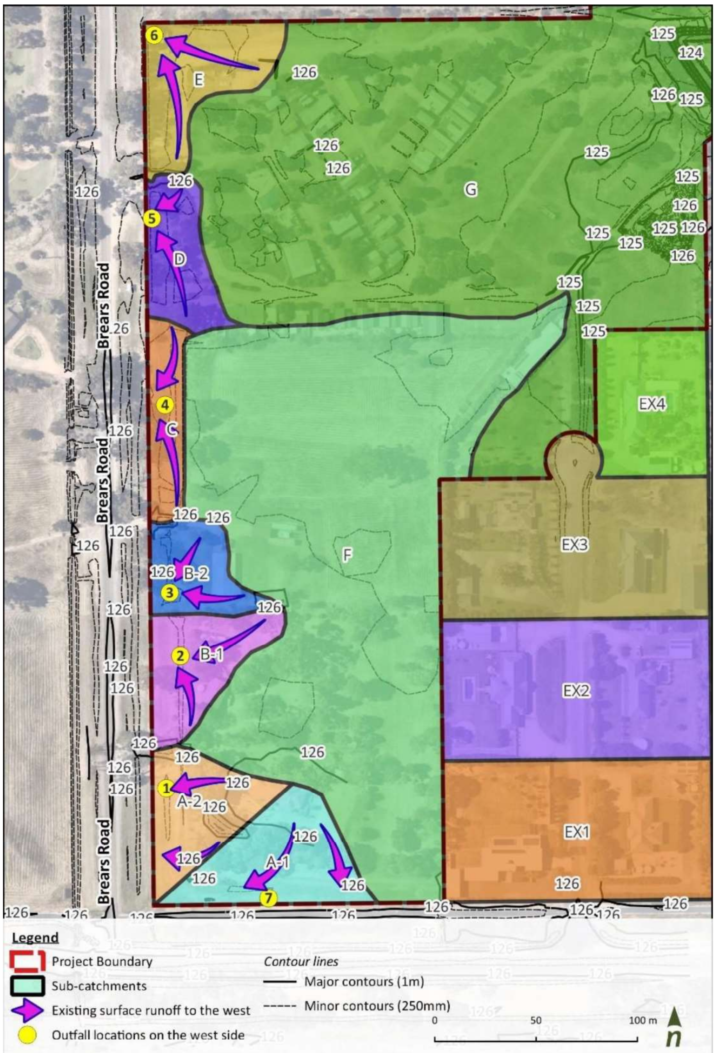

Figure 11. Catchment plan for under existing conditions

Commented [JM1]: Need summary table showing existing conditions 1% AEP peak flow rate.

Table 1. Sub-catchments for the subject site (under pre-development conditions)

Sub-catchment	Area (ha)	Comment
A-1	0.35	Sub-catchment A-1 outfalls south to Murray Valley Highway
A-2	0.28	Sub-catchment A-2 outfalls west to Brears Road
B-1	0.27	Sub-catchment B-1 outfalls west to Brears Road
B-2	0.20	Sub-catchment B-2 outfalls west to Brears Road
C	0.18	Sub-catchment C outfalls west to Brears Road
D	0.23	Sub-catchment D outfalls west to Brears Road
E	0.32	Sub-catchment E outfall west to Brears Road
F	3.16	Sub-catchment F outfalls north east through Sub-catchment G
G	6.29	Sub-catchment G outfalls north east into receiving waterway in Crown land
EX1	0.93	External Catchment 1 outfalls north through External Catchment 2
EX2	0.93	External Catchment 2 outfalls north through External Catchment 3
EX3	0.98	External Catchment 3 outfalls north west through Sub-catchment g
EX4	0.4	External Catchment 4 outfalls south west through External Catchment 3

Table 2. Existing conditions flows outflowing to Brears Road (refer to Figure 11 for flow locations)

Location	Contributing catchment	Area (ha)	tc (min)	I (1% AEP-mm/h)	Existing conditions flows (1% AEP) (m^3/s)
1	A-2	0.28	7.24	157.37	0.03 m^3/s
2	B-1	0.27	7.84	152.71	0.03 m^3/s
3	B-2	0.20	7.41	156.11	0.03 m^3/s
4	C	0.18	7.85	152.67	0.02 m^3/s
5	D	0.23	7.14	158.19	0.03 m^3/s
6	E	0.32	8.00	151.53	0.04 m^3/s
7	A-1	0.35	7.40	156.16	0.04 m^3/s

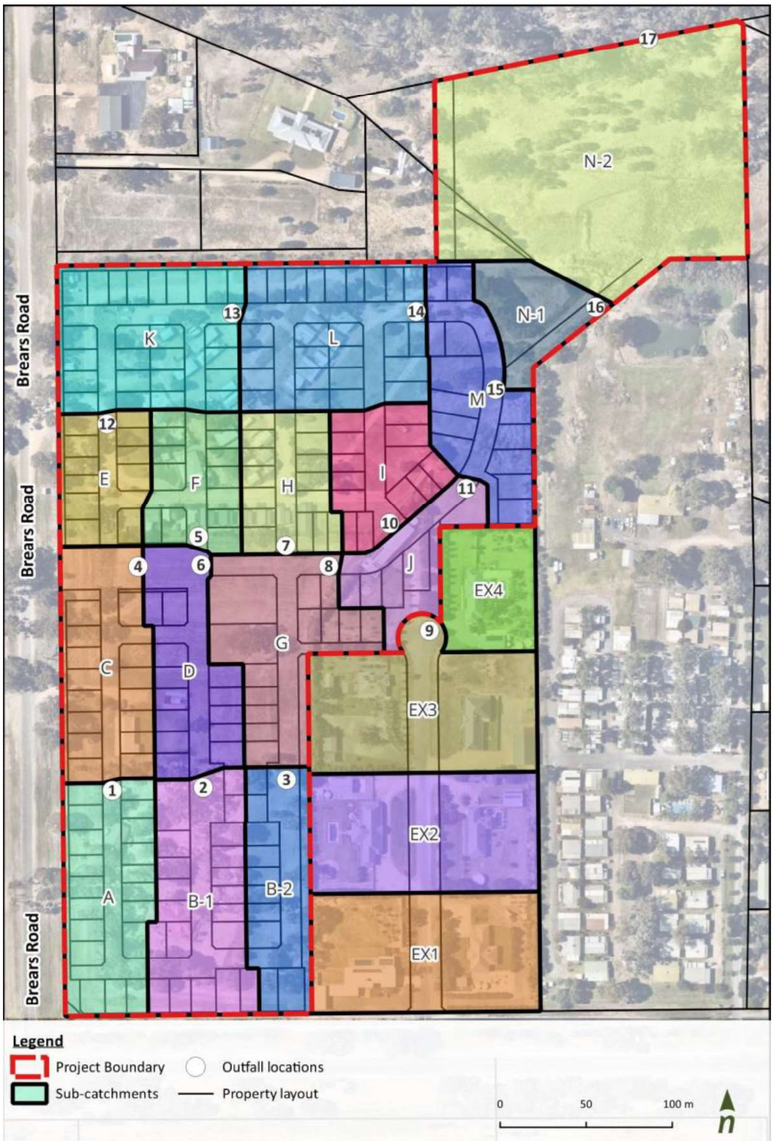

Figure 12. Catchment plan for the ultimate drainage system (for minor drainage scenario)

Table 3. Sub-catchments for the subject site (in minor drainage scenario of post-development)

Sub-catchment	Area (ha)	Comment
A	0.70	Sub-catchment A outfalls north through Sub-catchment C
B-1	0.78	Sub-catchment B-1 outfalls north through Sub-catchment D
B-2	0.52	Sub-catchment B-2 outfalls north through Sub-catchment G
C	0.71	Sub-catchment C outfalls east through sub-catchment D
D	0.58	Sub-catchment D outfalls east through Sub-catchment G
E	0.40	Sub-catchment E outfalls north through Sub-catchment K
F	0.44	Sub-catchment F outfalls south through Sub-catchment D
G	0.77	Sub-catchment G outfalls north east through Sub-catchment J
H	0.45	Sub-catchment H outfalls south through Sub-catchment G
I	0.45	Sub-catchment I outfalls south through Sub-catchment J
J	0.37	Sub-catchment J outfalls north east through Sub-catchment M
K	0.91	Sub-catchment K outfalls east through Sub-catchment L
L	0.92	Sub-catchment L outfalls east through Sub-catchment M
M	0.65	Sub-catchment M outfalls north east through Sub-catchment N-1
N-1	0.33	Sub-catchment N-1 outfalls north east through Sub-catchment N-2
N-2	2.30	Sub-catchment N-2 outfalls north into receiving waterway in Crown land
EX1	0.93	External Catchment 1 outfalls north through External Catchment 2
EX2	0.93	External Catchment 2 outfalls north through External Catchment 3
EX3	0.98	External Catchment 3 outfalls north through Sub-catchment J
EX4	0.4	External Catchment 4 outfalls south west through External Catchment 3

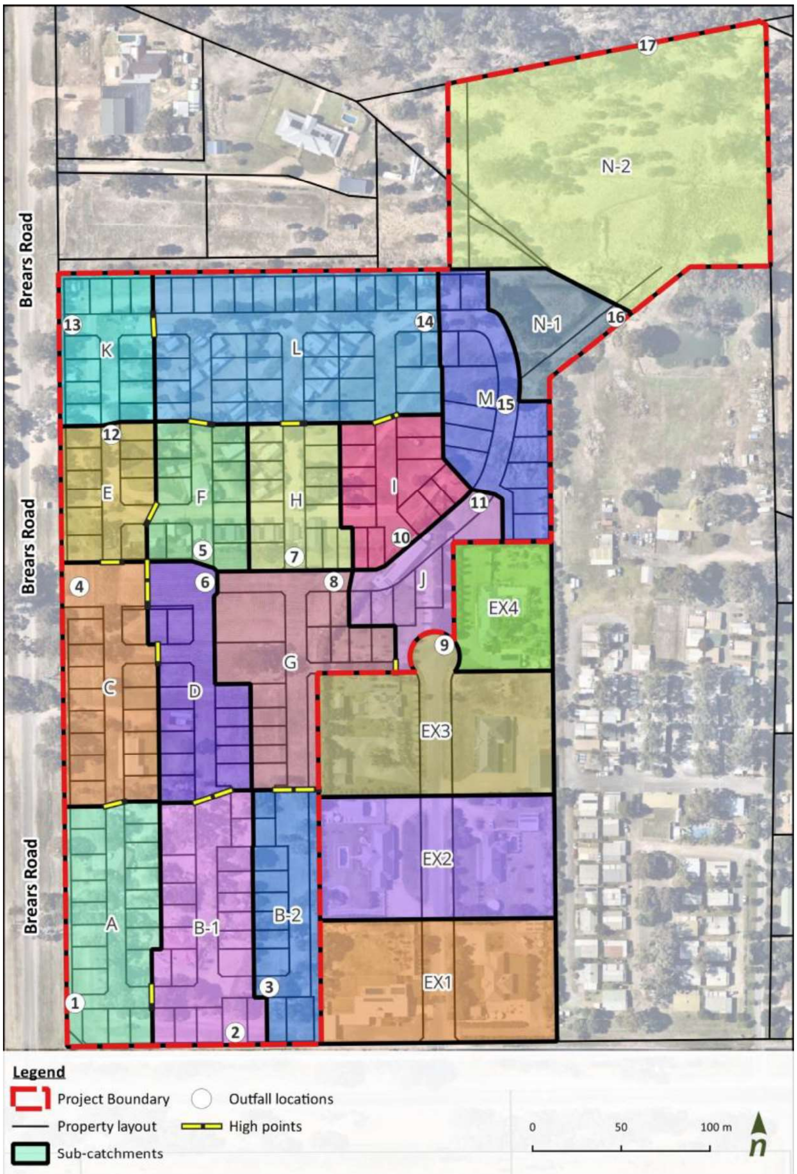

Figure 13. Catchment plan for the ultimate drainage system (for major drainage scenario)

Table 4. Sub-catchments for the subject site (in major drainage scenario of post-development)

Sub-catchment	Area (ha)	Comment
A	0.70	Overland "gap" flow (ie 1% AEP minus pipe) from sub-catchment A outfalls west to Brears Road
B-1	0.78	Overland "gap" flow (ie 1% AEP minus pipe) from sub-catchment B-1 outfalls south to Murray Valley Highway
B-2	0.52	Sub-catchment B-2 outfalls south through Sub-catchment B-1
C	0.71	Overland "gap" flow (ie 1% AEP minus pipe) from sub-catchment C outfalls west to Brears Road
D	0.58	Sub-catchment D outfalls east through Sub-catchment G
E	0.40	Sub-catchment E outfalls north Sub-catchment K
F	0.44	Sub-catchment F outfalls south through Sub-catchment D
G	0.77	Sub-catchment G-2 outfalls east through Sub-catchment J
H	0.45	Sub-catchment H outfalls south through Sub-catchment G
I	0.45	Sub-catchment I outfalls south through Sub-catchment J
J	0.37	Sub-catchment J outfalls north east through Sub-catchment M
K	0.46	Sub-catchment K outfalls west to Brears Road
L	1.37	Sub-catchment L outfalls east through Sub-catchment M
M	0.65	Sub-catchment M outfalls north east through Sub-catchment N-1
N-1*	0.33	Sub-catchment N-1 outfalls north east through Sub-catchment N-2
N-2*	2.30	Sub-catchment N-2 outfalls north east into receiving waterway in Crown land
EX1	0.93	External Catchment 1 outfalls north through External Catchment 2
EX2	0.93	External Catchment 2 outfalls north through External Catchment 3
EX3	0.98	External Catchment 3 outfalls north through Sub-catchment J
EX4	0.4	External Catchment 4 outfalls south west through External Catchment 3

**Convey stormwater through a 10-metre swale located within the drainage easement*

5 Stormwater Quantity – Proposed Strategy

5.1 Objectives

Considering the proximity to the Murray River floodplain to the north, no retardation works for controlling stormwater quantity are provided for the ultimate development of the subject site. However, all roadways are still designed to be able to convey 1% AEP flows. Therefore, portions of the site will be graded to Brears Road to accommodate the 1% flood events. With respect to the subject site the key principles are:

- Convey minor and major drainage flows into receiving waterway located at the northeastern boundary of the subject site
- Convey minor drainage flows via the subdivisional pipe networks
- Convey major drainage flows via the network of subdivisional road reserves
- Major/Gap flows outfalling to Brears Road are controlled back to the equivalent predeveloped peak flow rate for events up to the 1% AEP event.

5.2 Drainage System

The proposed internal drainage system should be designed and constructed in accordance with the minor / major drainage system philosophy.

The sub-catchments and the location of flows at key points of interest are shown in Figure 12 and Figure 13.

5.3 Minor Drainage System

The minor drainage system would consist essentially of an underground piped network and should be designed to accommodate a 20% annual exceedance probability (AEP) rainfall event. The calculations adopted a 20% AEP runoff coefficient of 0.68 for residential areas, based on a combined fraction impervious for the site of 0.75.

Table 5. Minor flows (refer to Figure 12 for flow locations)

Location	Contributing catchment	Area (ha)	tc (min)	I (20% AEP-mm/h)	Minor flows (20% AEP) (m^3/s)	Indicative pipe size (mm)
1	A	0.70	7.8	83.35	0.11 m^3/s	**450mm*
2	B-1	0.78	7.8	83.19	0.12 m^3/s	**525mm*
3	B-2	0.52	8.9	78.57	0.08 m^3/s	**450mm*
4	A, C	1.41	7.7	83.42	0.22 m^3/s	450mm
5	F	0.44	7.3	85.41	0.07 m^3/s	300mm
6	A, C, B-1, D, F	3.20	9.9	74.18	0.45 m^3/s	675mm
7	H	0.45	7.4	84.76	0.07 m^3/s	300mm
8	A, B-1, B-2, C, D, G, F, H	4.94	10.0	73.62	0.69 m^3/s	750mm
9	EX1, EX2, EX3, EX4	3.23	10.2	73.31	0.24 m^3/s	525mm
10	I	0.45	7.4	84.96	0.07 m^3/s	375mm
11	A, B-1, B-2, C, D, G, F, H, I, J, EX1, EX2, EX3, EX4	9.00	9.3	76.55	1.03 m^3/s	900mm
12	E	0.40	7.3	85.52	0.07 m^3/s	300mm
13	E, K	1.31	8.5	80.25	0.20 m^3/s	***525mm*
14	E, K, L	2.23	9.5	75.71	0.32 m^3/s	600mm
15	A, B-1, B-2, C, D, G, F, H, I, J, EX1, EX2, EX3, EX4, E, K, L, M	11.87	8.7	79.15	1.50 m^3/s	1050mm
16	A, B-1, B-2, C, D, G, F, H, I, J, EX1, EX2, EX3, EX4, E, K, L, M, N-1	12.20	9.1	77.48	1.51 m^3/s	1050mm
17	A, B-1, B-2, C, D, G, F, H, I, J, EX1, EX2, EX3, EX4, E, K, L, M, N-1, N-2	14.50	9.6	75.25	1.53 m^3/s	1050mm

**Pipe will be upsized to capture flows up to the 2% AEP event, to manage 1% AEP discharge to Brears Rd to pre-development*
***Pipe will be upsized to capture flows up to the 10% AEP event, to manage 1% AEP discharge to Brears Rd to pre-development*

The minor drainage network is to connect to the proposed sediment basin/wetland located at the northeast of the subject site.

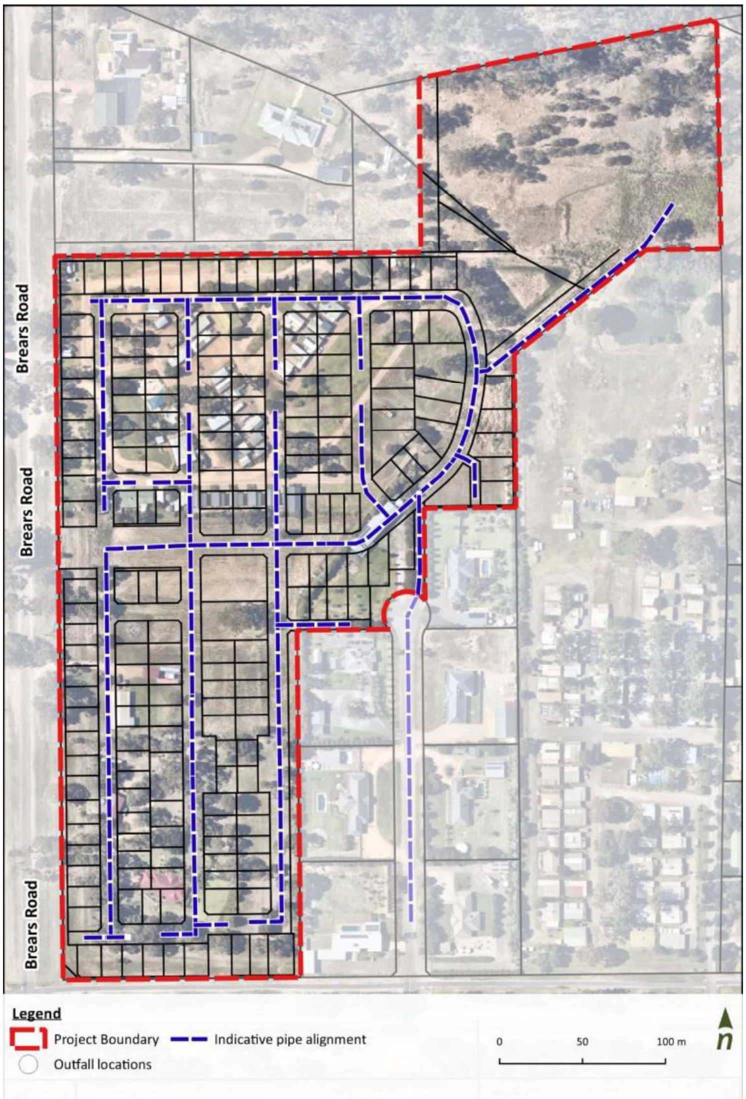

Figure 14. Indicative pipe network (minor drainage system shown in blue dashed line)

Stormwater quantity criteria:

- ✓ Convey minor flows (20% AEP) through residential catchments in a piped network
  - ✓ Maximum pipe size of 1050 mm

5.4 Major Drainage System

The major drainage system will convey the 1% AEP flows through the study area. This consists of the road reserves throughout the development. Generally, the flows required to be conveyed in road reserves will be the 1% AEP flow minus the pipe flow (ie 20% AEP) which will be contained within the minor piped drainage system. The calculations adopted a 1% AEP runoff coefficient of 0.85 for residential areas, based on a fraction impervious of 0.75.

Table 6. Ultimate major flows (refer to Figure 13 for flow locations)

Location	Contributing catchment	Area (ha)	tc (min)	I (1% AEP -mm/h)	Major flows (1% AEP) (m^3/s)	Gap flow (m^3/s)
1	A	0.70	8.5	147.52	0.25 m^3/s	**0.04 m^3/s*
2	B-1, B-2	1.30	8.5	147.87	0.46 m^3/s	**0.07 m^3/s*
3	B-2	0.52	10.7	132.97	0.16 m^3/s	0.09 m^3/s
4	C	0.71	8.3	149.40	0.25 m^3/s	**0.03 m^3/s*
5	F	0.44	7.6	154.97	0.16 m^3/s	0.09 m^3/s
6	F, D	1.01	9.4	140.31	0.34 m^3/s	0.19 m^3/s
7	H	0.45	7.9	152.63	0.16 m^3/s	0.09 m^3/s
8	F, D, H, G	2.23	10.0	136.02	0.72 m^3/s	0.41 m^3/s
9	EX1, EX2, EX3, EX4	3.23	13.3	122.15	0.51 m^3/s	0.29 m^3/s
10	I	0.45	7.8	153.35	0.17 m^3/s	0.09 m^3/s
11	F, D, H, G, I, J, EX1, EX2, EX3, EX4	6.28	12.5	125.79	1.40 m^3/s	0.80 m^3/s
12	E	0.40	7.5	155.37	0.15 m^3/s	0.09 m^3/s
13	E, K	0.86	7.9	152.20	0.31 m^3/s	**0.06 m^3/s*
14	L	1.37	10.0	136.19	0.45 m^3/s	0.25 m^3/s
15	F, D, H, G, I, J, EX1, EX2, EX3, EX4, L, M	8.03	10.5	134.08	2.04 m^3/s	1.16 m^3/s
16**	F, D, H, G, I, J, EX1, EX2, EX3, EX4, L, M, N-1	8.36	11.2	130.85	2.07 m^3/s	1.18 m^3/s
17**	F, D, H, G, I, J, EX1, EX2, EX3, EX4, L, M, N-1, N-2	10.66	12.5	125.71	2.21 m^3/s	1.26 m^3/s

** Gap flows are controlled back (via upsized pipes) to the equivalent predeveloped peak flow rate of events up to the 1% AEP event (see Table 7)*

*** Gap flows are conveyed through a 10m swale to the ultimate outfall location at the northeast corner of the subject site*

Table 7. Comparison of controlled gap flows and existing 1% AEP flows flowing to Brears Road

Contributing catchments in developed conditions (Figure. 13 / Table. 6)	Overall gap flow (m^3/s)	Contributing catchments in existing conditions (Figure. 11 / Table. 2)	Overall existing 1% AEP flows (m^3/s)	Check
A, B-1, B-2	0.10 m^3/s	A-1, A-2, B-1	0.11 m^3/s	OK
C	0.03 m^3/s	B-2, C	0.05 m^3/s	OK
E, K	0.06 m^3/s	D, E	0.07 m^3/s	OK

Design safety criteria for overland flows along road reserves is covered in DELWP's 2019 document titled "Guidelines for Development in Flood Affected Areas". The technical basis for the DELWP guideline is based on ARR2019, Book 6 – Chapter 7: Safety Design Criteria". The ARR2019 documentation identifies that the two key elements to consider are "human stability" and "vehicle stability". For both situations the metric of velocity and depth is used as the defining criteria.

Human Stability

There are two modes of stability loss associated with people in flood waters, namely "toppling instability" and "sliding instability". There are also two categories of people to consider, with that being adults and children (see Figure 15).

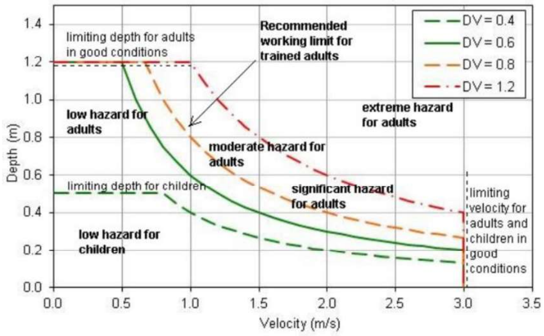

Figure 15. Safety criteria for people in varying flow conditions (source ARR2019)

As shown in Figure 15, the limiting criteria is children. The guidelines recommend that the DxV product is less than $0.4m^2/s$ with a maximum depth stability limit of 0.5m and a maximum velocity stability limit of 3m/s. However as shown below the criteria associated with small vehicle stability is more limiting than the children stability criteria.

Vehicle Stability

There are two modes of stability loss associated with vehicles in flood waters, namely "floating instability" and "sliding instability" (see Figure 16). There are also three categories of vehicles to consider, with that being small cars, large cars and large 4WD vehicles (see Figure 17).

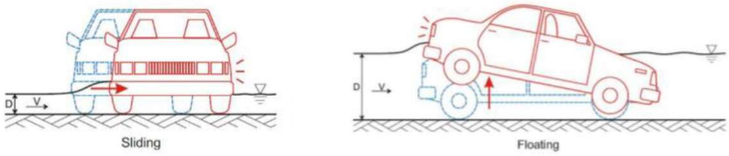

Figure 16. Typical modes of vehicle instability (source ARR)

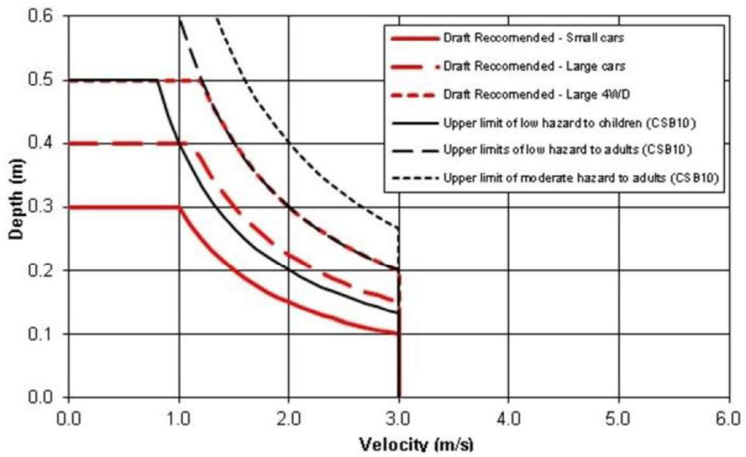

Figure 17. Safety criteria for vehicles in varying flow conditions (source ARR2019)

As shown in Figure 17, the limiting criteria is small cars. The guidelines recommend a limiting DxV product of $0.30m^2/s$ with a maximum depth stability limit of 0.3m and a maximum velocity stability limit of 3m/s.

Based on the road width and slope, and the maximum allowable nature strip cross-fall of 1 in 15, the capacity that can be contained within the main road reserves is shown in Table 8. This capacity has been determined using HEC-RAS based on the DELWP 2019 document "Guidelines for Development in Flood Affected Areas" and Council's requirement that 1% AEP design flows must be contained within the road reserve and must not enter any part of private allotments:

- Manning's 'n' = 0.020
- Limiting DxV product of 0.30 m2/s
- Maximum depth (at lip of kerb) of 0.30 m
- Maximum velocity limit of 3 m/s

Table 8. Road Reserve capacity flows

Road width	Slope	Road capacity (m^3/s)
10.5 m	1.0 %	1.9
10.5 m	0.5 %	2.2
12 m	1.0 %	2.1
12 m	0.5 %	2.4

Based upon the above information all overland flows can be safely contained within the proposed road reserves and swale. Figure 18 shows the overland flow paths through the subject site.

Stormwater quantity criteria:

- ✓ Convey internal major flows through road reserves and pipe system
    - Maximum gap flow through roadways within the subject site = 1.16 m^3/s

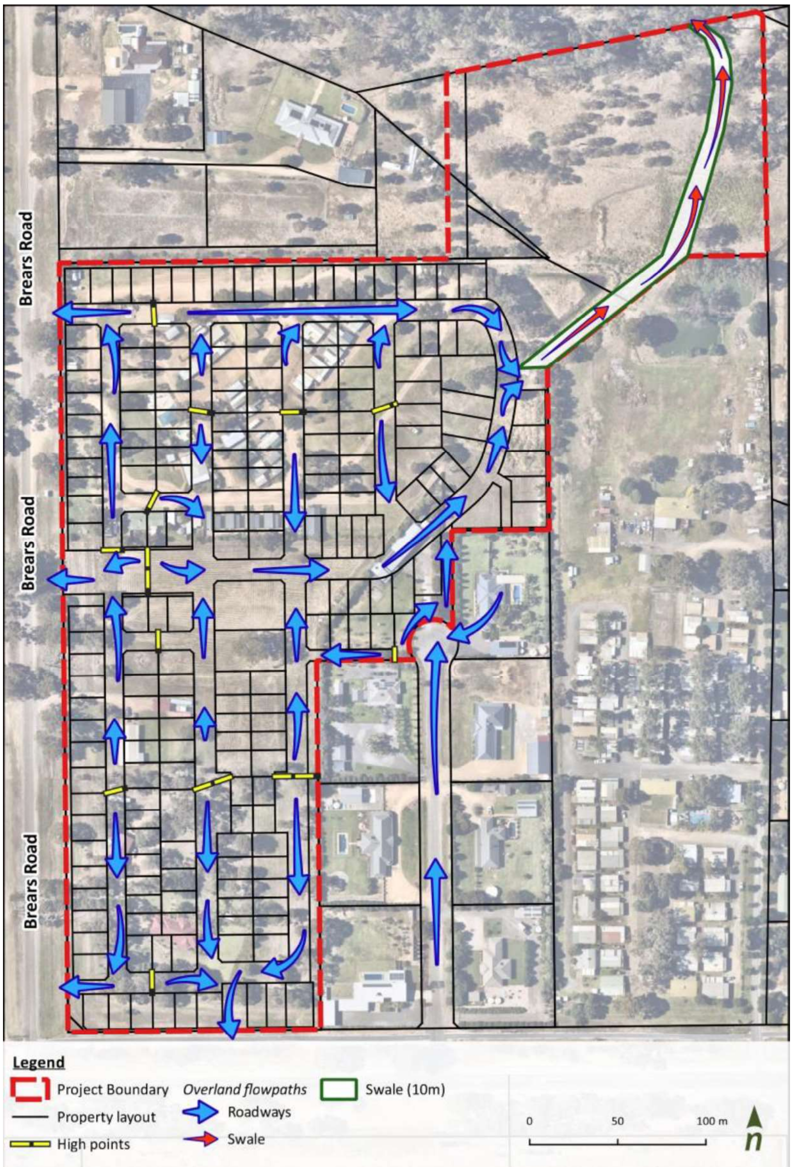

Figure 18. Overland flow paths

At the end of Jacqueline Court, the drainage pipe and swale will be constructed to grade stormwater runoff generated from the external catchments to the north and further flow through the green link in the proposed development layout (see Figure 18).

Figure 19. Connection of conveyance from external catchments to ultimate outfalls.

5.5 Retardation

As stated in Section 5.1., there is no requirement for permanent retardation on the subject site due to the direct outfall connection to the Murray River floodplain.

6 Proposed stormwater quality treatment system

Alluvium understands that a key principle for the development of the Brears Road area is that all stormwater is to be treated to BPEMG (Best Practice Environmental Management Guidelines) before being discharged from the study area. As such, the Brears Road site will require numerous treatment techniques in order to achieve the targeted reduction in pollutant load concentrations. The following BPEMG targets have been adopted:

- 70% removal of the total Gross Pollutant load
- 80% removal of the total Suspended Solids
- 45% removal of the total Nitrogen
- 45% removal of the total Phosphorus

A MUSIC (Model for Urban Stormwater Improvement Conceptualisation) model was developed to estimate the pollutant loads generated from the developed conditions scenario. The model was used to size the WSUD assets, including wetland and sediment basins required to meet the pollutant reduction targets.

The key modelling inputs for the MUSIC model are meteorological data:

- Rainfall
- Evapotranspiration

The MUSIC template was built based on the Bureau of Meteorology (BoM) rainfall station located at the Dookie Agricultural College (Station ID: 081013), and climate data between 1961 to 1970 were extracted. This MUSIC template was used due to the completeness of the 6-minute interval climate data and being geographically most appropriate for the Brears Road site.

Consistent with the infrastructure servicing report prepared by Breese Pitt Dixon (2023), a constructed wetland system is to be built at the north east corner of the subject site. Hence, stormwater runoff generated from the subject site will outfall in an north-easterly driection to the proposed downstream constructed wetland (refer to Figure 21).

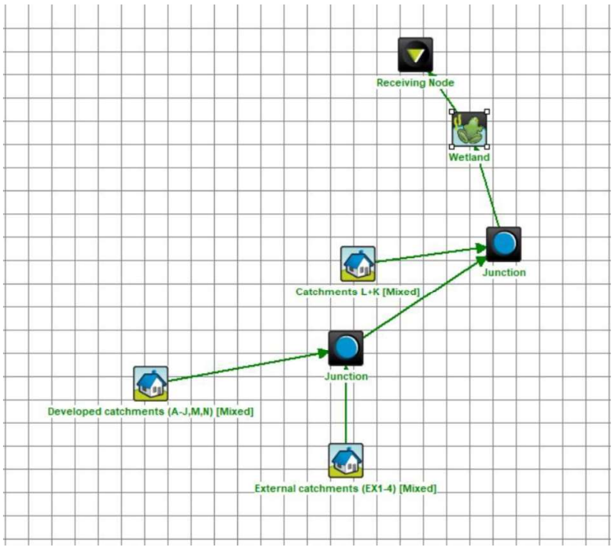

Figure 20. MUSIC model for the subject site

The configuration of the revised treatment train (wetland and sediment basin) is provided in Table 9. Wetland performance is given in Table 10, demonstrating the design meets the best practice pollutant removal targets.

Table 9. Treatment asset parameters

	Wetland 1
NWL area, m^2	2,100
Average depth, m	0.4
Inlet pond area, m^2	400
Inlet pond average depth, m	1.5
Extended detention, m	0.35
Residence time, h	72

Table 10. Overall treatment performance of the system

Parameter	**Total sources**	**Residual load**	**Percent removed (%)**
Total Suspended Solids (kg/yr)	6,850.0	1,510.0	78.0
Total Phosphorus (kg/yr)	14.6	4.9	66.7
Total Nitrogen (kg/yr)	105.0	57.2	45.7
Gross Pollutants (kg/yr)	1,490.0	0.0	100.0

Table 11. Sediment basin design parameters and checks

	Parameter	**Sediment Basin**
Conditions	Contributing Catchment (ha)	14.5
	Area of Basin (m^2)	400
Capture Efficiency	Settling Velocity of Target Sediment (mm/s) [Particle size 125 µm]	11
	Hydraulic Efficiency (λ)	0.11
	Permanent Pool Depth, dp (m)	0.5
	Extended detention depth, de	0.35
	Number of CTSR's, n	1.12
	Depth below permanent pool that is sufficient to retain sediment, d* (m)	0.50
	Design Discharge (m^3/s) [4EY]	0.29
	Capture Efficiency	95.0%
	Check (>95%)	OK
Sediment Storage	Sediment Loading rate, Lo (m^3/ha/yr)	2
	Desired clean-out frequency, Fr	5
	Storage volume required, St	138
	Available sediment storage volume	264.3
	Check (Available storage > required storage)	OK
Sediment dewatering	Depth for dewatering area (m)	0.5
	Area required for dewatering (m^2)	276

A conceptual layout of the wetland and sediment basin are shown in Figure 21 below, which is designed to have Normal Water Level (NWL) of 121.6 m AHD. Provision has been made for 1 in 6 batter slopes and a dry-out area.

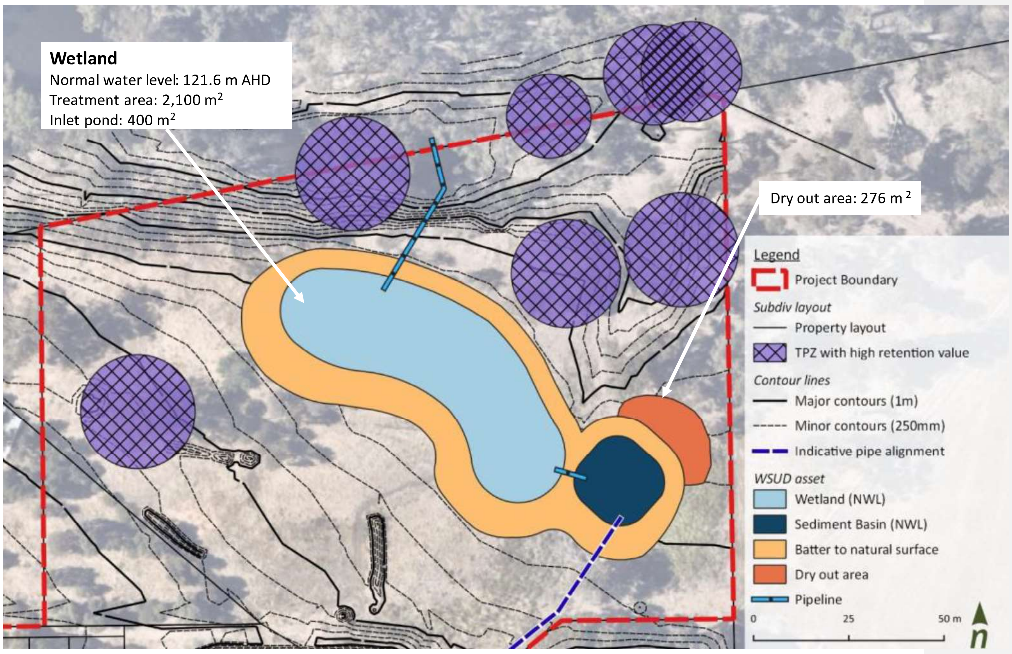

Figure 21. Wetland concept layout for Brears Road site

7 Drainage Assets Required

The above strategies have outlined the assets required to deal with the quality and quantity issues associated with stormwater at the subject site. A summary of the key development drainage assets required is shown in Table 12.

Table 12. Development drainage assets

Asset type	Description	Size	Responsibility
Pipe network	Minor flows pipe network	Varies, up to 1050mm	Developer
Drainage Reserve	Wetland with sediment basin	Footprint: 2100 m^2 with the sediment pond of 400 m^2	Developer

8 Conclusion

This SWMS has proposed management strategies for stormwater quantity and quality. Through meeting these objectives, this SWMS acts as a critical component of the development servicing strategy and ensures storm water is managed in accordance with Council’s requirements.

The SWMS has considered the ultimate infrastructure requirements for the current application associated with the development of the Brears Road site.