REPORT

Moama Mid-West Drainage Strategy

Report

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Approval for issue

Name	Signature	Date
N Heinrich		18 Feb 2019

We have prepared this report for the sole purposes of Murray River Council ('**Client'**) for the specific purpose of only for which it is supplied ('**Purpose'**). This report is strictly limited to the purpose and the facts and matters stated in it and does not apply directly or indirectly and will not be used for any other application, purpose, use or matter.

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1 Introduction

Murray River Council engaged RPS to undertake an investigation into, and develop a strategy for implementation, for the Moama Mid-West Drainage area (306 ha) as shown in Figure 1. The primary outcome of this engagement is to identify and design (at a concept level) a stormwater management system for the area that aligns with the master plan for the area and Council's stormwater and infrastructure strategies.

The subject area is transitioning from an agricultural land use (broadacre; viticulture) into residential development as set out in the Moama North West Master Plan (MacroPlan Australia, 2009). This transition is occurring at a rapid rate with unprecedented growth in new residential development in this area in recent years.

With this change in land use comes increased peak flows and volumes of stormwater and potential for pollution of local waterways, particularly the adjacent Murray River. Therefore, the management of stormwater becomes a critical aspect that must be properly planned in advance of any intensive development in the area.

The stormwater strategy must set out a feasible plan for the management of increases in:

- Peak flow rates due to increased impervious catchment area associated with residential development
- Stormwater volumes
- Risks of waterway pollution associated with residential development.

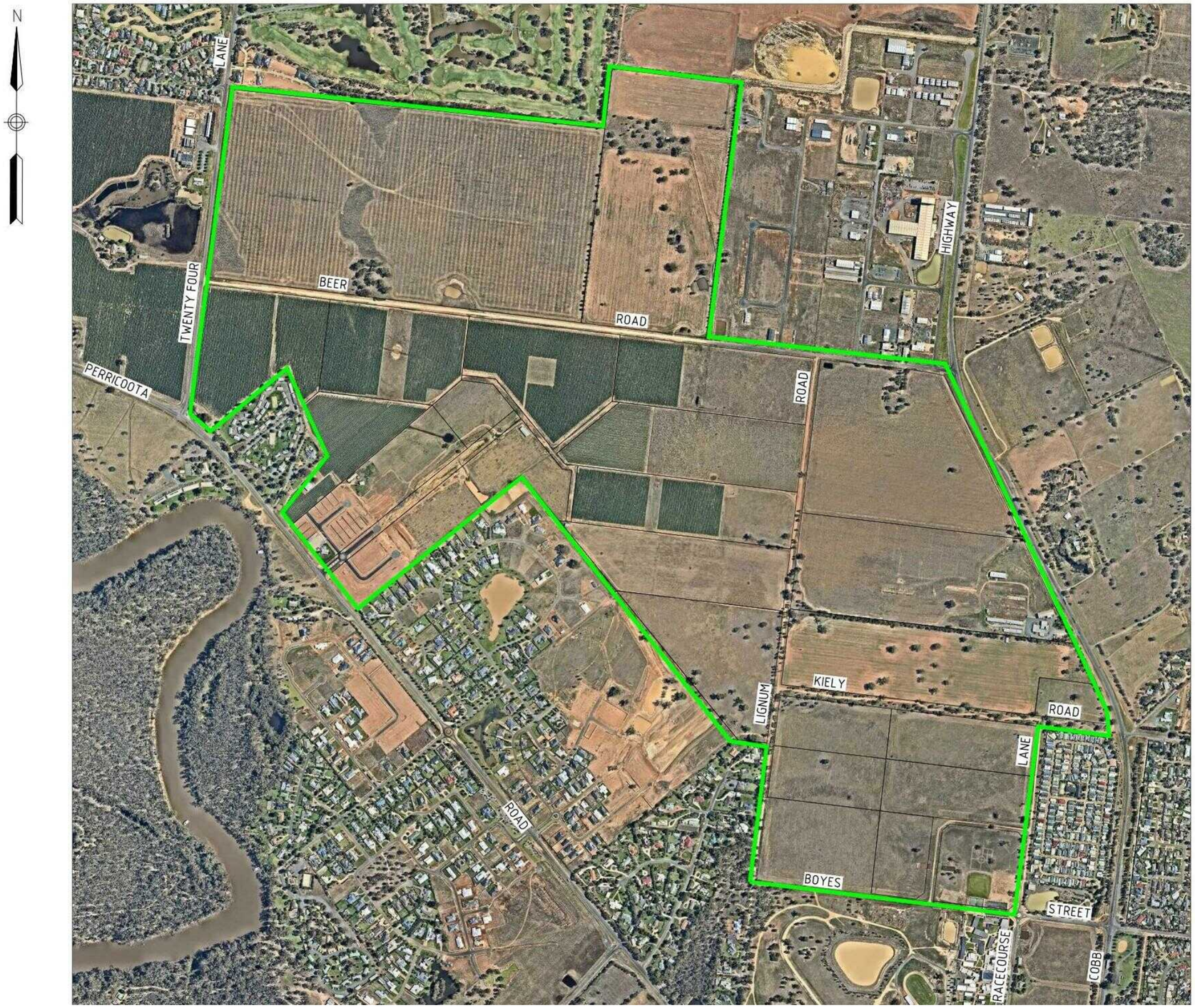

Figure 1 Moama Mid-West study area

2 Literature review

The following previous works provide the foundation and background to this investigation:

- Moama West Flooding and Drainage Investigation (2004)
- Moama West Infrastructure Strategy (2005)
- Moama North West Master Plan (2009)
- Moama Stormwater Management Plan (2010)
- Moama Floodplain Management Study (2001).

The key aspects from these documents that inform this investigation are described in the Sections below.

2.1 Moama West Flooding and Drainage Investigation (2004)

Council initiated this investigation into flooding and drainage behaviour in the Moama West area that includes the main depression across the study area.

The investigation documented the following:

- Murray River flooding characteristics into the depression
- Existing and post-development local stormwater runoff
- Preliminary recommendations for future management of the depression to meet floodwater and local stormwater needs.

The investigation found that the depression is subject to Murray River flooding in events rarer than the 1 in 50-year ARI flood event upon interrogation of the Moama Floodplain Management Study (Sinclair Knight Merz, 2001). Despite this, there is no outlet and floodwaters pond in the depression. It was acknowledged that future development will likely exclude all floodwater from moving into the depression. Other low points connecting the river to the depression require a flood greater than the 1 in 200-year ARI event before water encroaches.

The investigation also undertook modelling to determine local catchment stormwater volumes draining to the depression in the developed state. This found that maximum stormwater ponding in the depression for the 1 in 100-year ARI event was less than 95.0 mAHD and recommended that land below this level be reserved for open space and drainage reserve.

The main conclusions and recommendations of the investigation were:

- Identified that there is limited ability to provide surface relief outfall to the river
- Provide for open space and drainage reserve below 95.0 mAHD for stormwater capture
- The opportunity exists for stormwater retention and reuse in the depression however this must be balanced with the increased level of ponding after stormwater events
- Diversion of runoff from adjacent catchments as far as practical
- Exclude floodwater from the depression
- Maintain connectivity of depression for storage retention throughout the study area

- Provide for a piped outlet to the river (gravity or pumped) and surface relief route through to Twenty-Four Lane
- Provide a constructed lake / wetland system with a four-hectare system proposed to satisfy water quality objectives.

The brief for this investigation largely accords with these findings.

2.2 Moama West Infrastructure Strategy (2005)

The Strategy defined the following principles for new developments in the area in relation to stormwater:

- Retardation to pre-development runoff rates
  - This is to maintain the existing runoff characteristics of the area and downstream
- Surface relief
  - Stormwater flow corridors are to be provided for storage and transmission of stormwater flows more than the design capacity, or the event of failure, of built stormwater infrastructure (pipes, pits, etc.)
- Water Sensitive Urban Design
  - The most likely elements of WSUD identified for this Moama West area included integrated wetlands in detention basins (designed for runoff arising from the 1 in 100-year, 2-hour rainfall event) and gross pollutant traps at stormwater outlets.
  - The Strategy identified the ideal system for the Moama West depression is a series of gravity-fed integrated wetlands to provide an aesthetically pleasing water feature, developed in a staged fashion with specific developments in the area.

The Strategy identified that the use of raw water in the area is usually integrated with stormwater capture, which promotes stormwater reuse. However, the use of detention basins with integrated wetlands needs to maintain a freeboard, or storage airspace, as the detention volume above the normal operating level of the wetland. The Strategy identified internal surface relief corridors and pump stations to ultimately discharge excess stormwater to the Murray River.

This Strategy aligns with the findings of the Moama West Flooding and Drainage Investigation (EarthTech, 2004) as described above.

2.3 Moama North West Master Plan (2009)

The Moama North West Master Plan set out the detailed context and objectives for sustainable residential development of the Moama North West area. The Master Plan covered most of the area as defined in this investigation.

The Master Plan defined the context of the study area with regards to planning requirements, population demographic profile and corresponding residential requirements, and the context of the Plan with regards to strategic Council plans such as the Moama Strategic Land Use Plan 2006-2030, Moama West Infrastructure Strategy 2005, Murray Shire Development Control Plan and Local Environment Plan.

The main elements of the Master Plan include:

- Traffic, transport and movement networks
- Natural environment and landscape
- Recreation and open space linkages

- Physical urban infrastructure.

The Master Plan also incorporated seven key elements of sustainable communities:

- Neighbourhood linkages
- Connected streets
- Pedestrians and cycling
- Integrated open space
- Lot sizes, housing diversity and dwelling density
- Urban water management
- Local activity centres.

The following objectives for urban water management were outlined:

- To facilitate integrated stormwater drainage system with other uses such as road verges, parklands and walking paths which improves the aesthetic appeal
- To ensure that irrigation of low function areas and impervious surfaces are reduced by reducing front setbacks and the length of driveways
- To ensure the use of drought proof and salt-resistant vegetation to reduce water consumption
- To protect the built environment from flooding, inundation and stormwater management
- To facilitate a combined public open space / drainage reserve within the study area.

The main features of the Master Plan associated with water management and the integrated open space are to be respected in this investigation. This primarily requires that the drainage / linear open space area running diagonally across the investigation area in a south-east to north-east direction is maintained and utilised as a key feature of the Moama North West residential area.

2.4 Moama Urban Stormwater Management Plan (2010)

The overall objective of this Stormwater Management Plan was to develop a framework to provide for the ecologically sustainable and cost-effective management of urban stormwater. The Plan also provided a basis for a future stormwater harvesting and reuse strategy.

The Plan was generally limited to existing urban development within Moama, covering 670 ha. The Plan set out the catchment values and objectives, mostly surrounding water quality impacts to:

- Visual amenity of waterways (Murray River) and floodplain wetlands
- Recreational opportunities of waterways and wetlands
- Maintenance and health of riparian vegetation
- Aquatic ecosystems
- Consumptive use (urban, livestock and irrigation water supply)
- Increased stormwater harvesting and reuse.

The Plan also defined Council objectives of new developments, in summary:

- Design includes permanent stormwater quality control measures

- Developments consider opportunity for stormwater harvesting and reuse with a focus on community accessible water features
- No adverse impact to downstream receiving waters
- Water Sensitive Urban Design elements incorporated (broadly through stormwater absorption, retention and reuse)
- Pollutant loads limited to ecologically sustainable levels through permanent water quality control measures.

Several issues were identified, and a range of structural and non-structural options prioritised and costed for future implementation to meet the above objectives in relation to existing development.

2.5 Moama Floodplain Management Study (2001)

The implications of this Floodplain Management Study are adequately addressed in the review of the Moama West Flooding and Drainage Investigation (EarthTech, 2004) that referenced this Study and the relevant flood levels pertaining to the study area.

The Moama West Flooding and Drainage Investigation (EarthTech, 2004) found that the main depression across the study area is rarely subject to flooding, there is no outlet to encroaching floodwaters (i.e. floodwaters pond in the depression) and upstream development around the Perricoota Road / Lignum Lane area will likely exclude all floodwaters from the residential areas.

In addition, the Murray Shire Local Environment Plan 2011 flood planning maps do not highlight any flood risk in the study area, as shown in Figure 2.

3 Existing conditions and constraints

Figure 1 shows the study area, which displays the following characteristics.

3.1 Land use

The study area is currently used for broadacre agriculture and viticulture traversed by two unsealed public access roads (Beer Road and Lignum Lane). These agricultural pursuits within the study area are bounded on all sides by residential, industrial and recreational developments in the Moama north-west area which can give rise to conflict through agricultural operations impacting on residential amenity.

3.2 Topography and drainage

The site topography is slightly undulating however the range of undulation is limited to about 4.0 m across the entire study area. The site is characterised by a main, linear depression running south-east to north-west with other minor localised depressions. The variation in topography is shown in the Drawings in Appendix C.

The existing site drains to the internal depressions with no natural outlet below RL 94.0 mAHD. In extreme events, stormwater can move north-west into the Golf Club property when water levels exceed RL 94.5 mAHD. The current land use for agricultural purposes provides significant opportunity for soil infiltration. Any runoff that collects in the depressions is naturally disposed via soil infiltration or evaporation.

With no natural outlet to the study area, the undulation in topography provides natural low areas (below RL 94.5 mAHD) for storage of stormwater awaiting disposal by pumping. These low areas also provide opportunity for location of public open spaces. Whilst these are significant opportunities, it does impact on the development yield of the study area (i.e. number of developable lots).

3.3 Flooding

The study area is potentially subject to flooding arising from large Murray River flood events as described in Section 2.1. The Moama West Flooding and Drainage Investigation (EarthTech, 2004) found that the main depression across the study area is rarely subject to flooding, there is no outlet to encroaching floodwaters (i.e. floodwaters pond in the depression) and upstream development around the Perricoota Road / Lignum Lane area will likely exclude all floodwaters from the residential areas.

This is confirmed in the Murray Shire Local Environment Plan 2011 flood planning maps that show no flood risk in the study area. The relevant flood planning map is provided in Figure 2.

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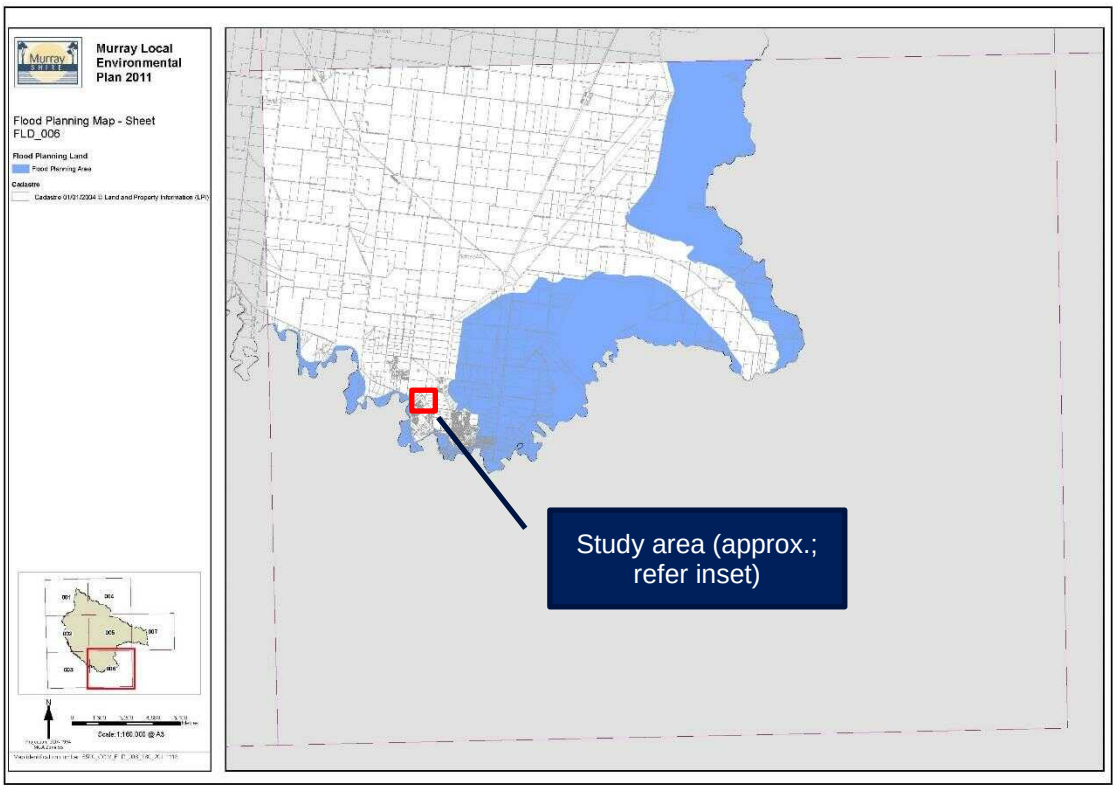

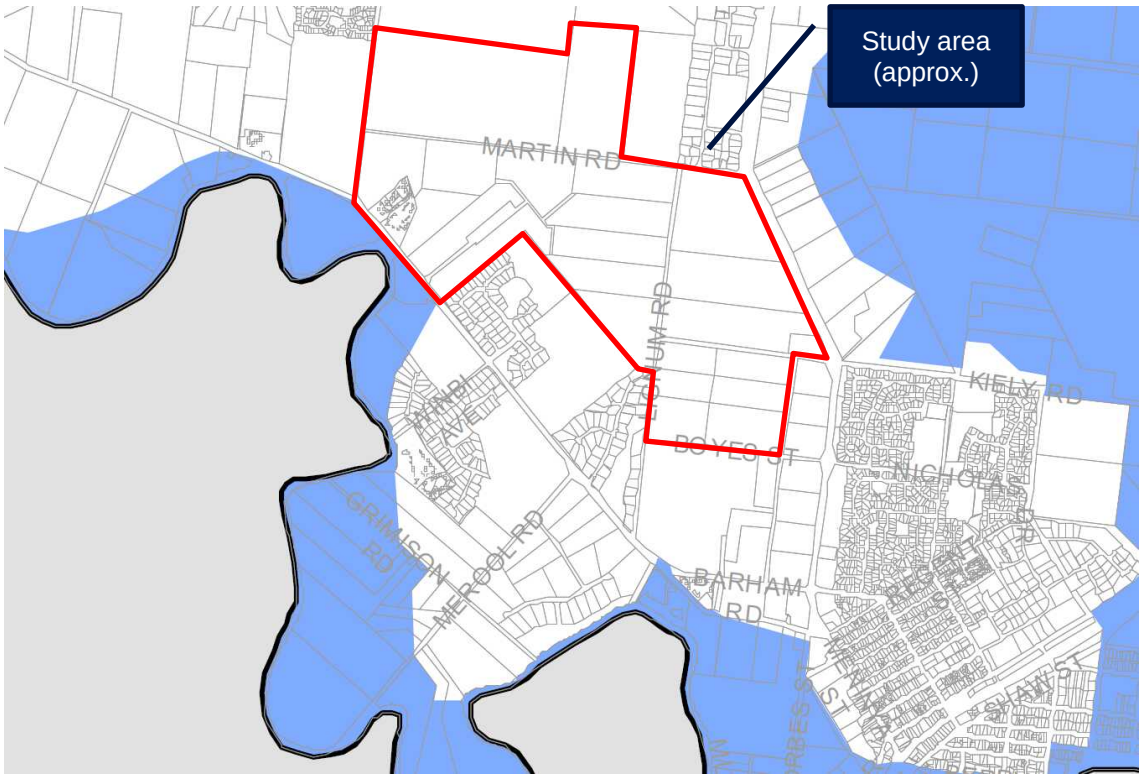

Figure 2 Excerpt from Murray Shire Local Environment Plan (2011) flood planning map

3.4 Native vegetation

The Murray Shire Local Environment Plan 2011 biodiversity map, shown in Figure 3, highlights small areas of terrestrial biodiversity in the east of the study area. Site inspections reveal this mapping represents remnant, probably high-value, Grey Box tree communities that would ideally be retained post-development as natural spaces within the residential area and drainage reserve.

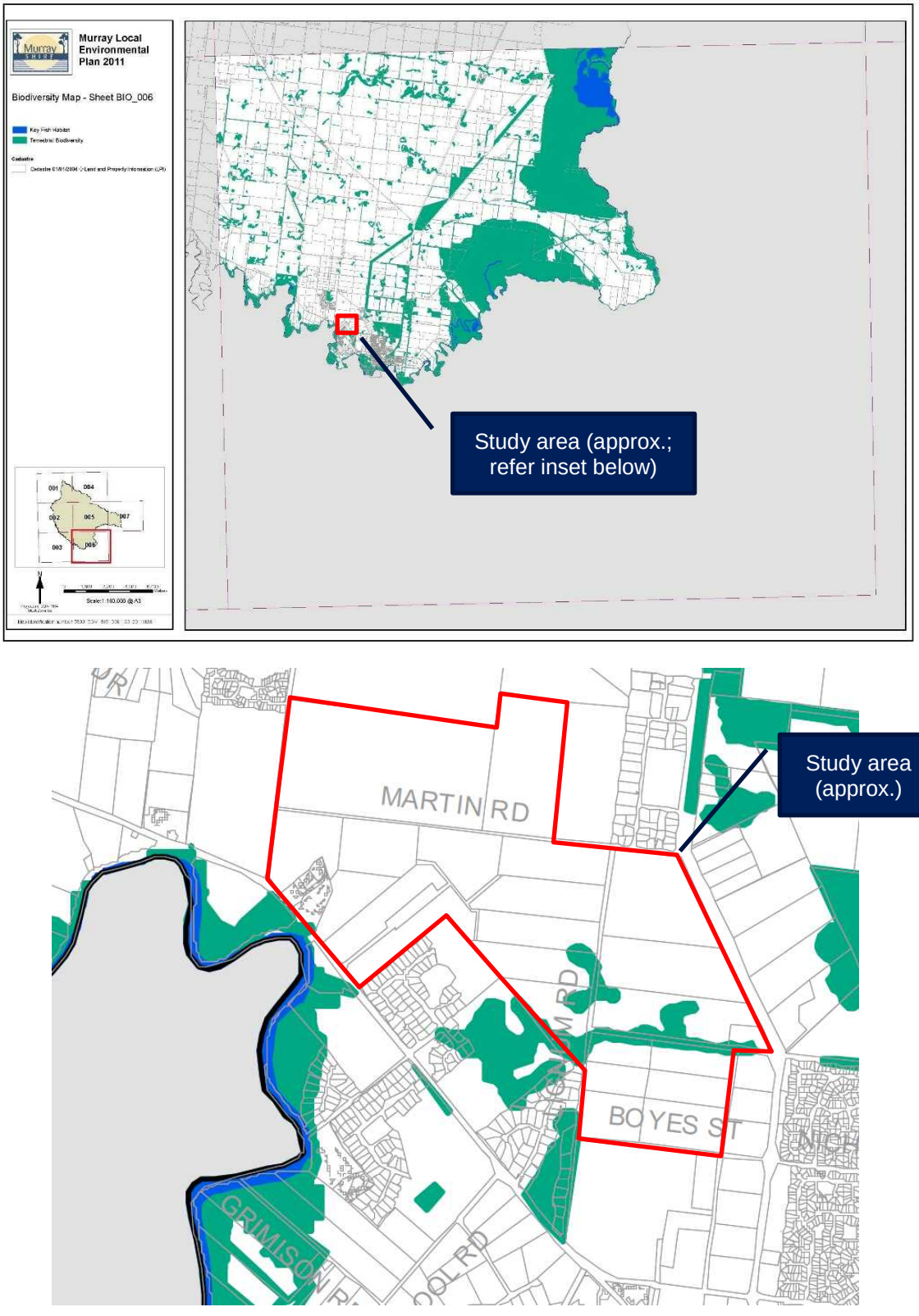

Figure 3 Excerpt from Murray Shire Local Environment Plan (2011) biodiversity map

3.5 Soils

The study area is within the Bunnaloo soil landscape, which covers the entire township of Moama and surrounds (refer Figure 4). A soil survey undertaken for the Moama Sewage Treatment Plant in the mid-1990s to the north of the study area show that the area is comprised of yellow-red-brown medium to heavy clays (Red and Brown Chromosol) down to 3-4 m depth (refer example soil log and landscape information in Appendix A). Key limitations of these soils are susceptibility to erosion and the presence of sodic subsoils.

This is generally consistent with soil conditions visually observed within the study area during site inspections. The soil conditions present an increased risk of erosion and sediment movement. The low hydraulic conductivity of the medium to heavy clays limits opportunity for disposal of stormwater via infiltration however these soils are well-suited for use in a storage basin.

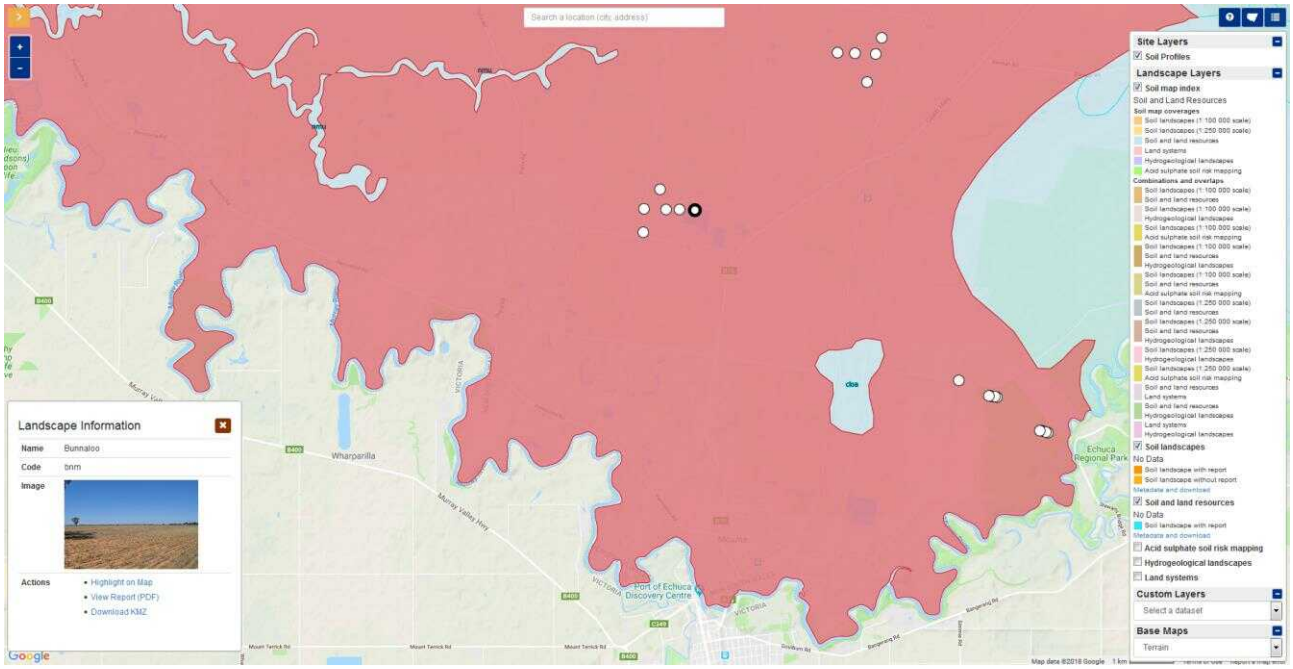

Figure 4 Bunnaloo landscape extent (eSpade NSW Soil and Land Information, http://www.environment.nsw.gov.au/eSpade2WebApp#)

3.6 Groundwater conditions

The nearest routinely-monitored groundwater bore is located nearby to Womboota, approximately 20 km north-west of the study area. This bore, identified as GW036765.3.3, reveals a current water level of 9.06 m below the monitoring point (assumed to be ground level), as read on 11 July 2018. Recent water level history, as shown in Figure 5, suggests that the groundwater level varies between 7-10 m below ground level with variation due to seasonal conditions (i.e. water table rises in wet years such as 2010-11, falls in drier years).

Given the proximity to the Murray River, groundwater levels in the study area are expected to be similar to the normal summer river level, which is consistent at approximately 86.5 mAHD. This level is 7-11 m below ground level across the study area.

The existing groundwater conditions are not expected to present constraints to stormwater infrastructure development.

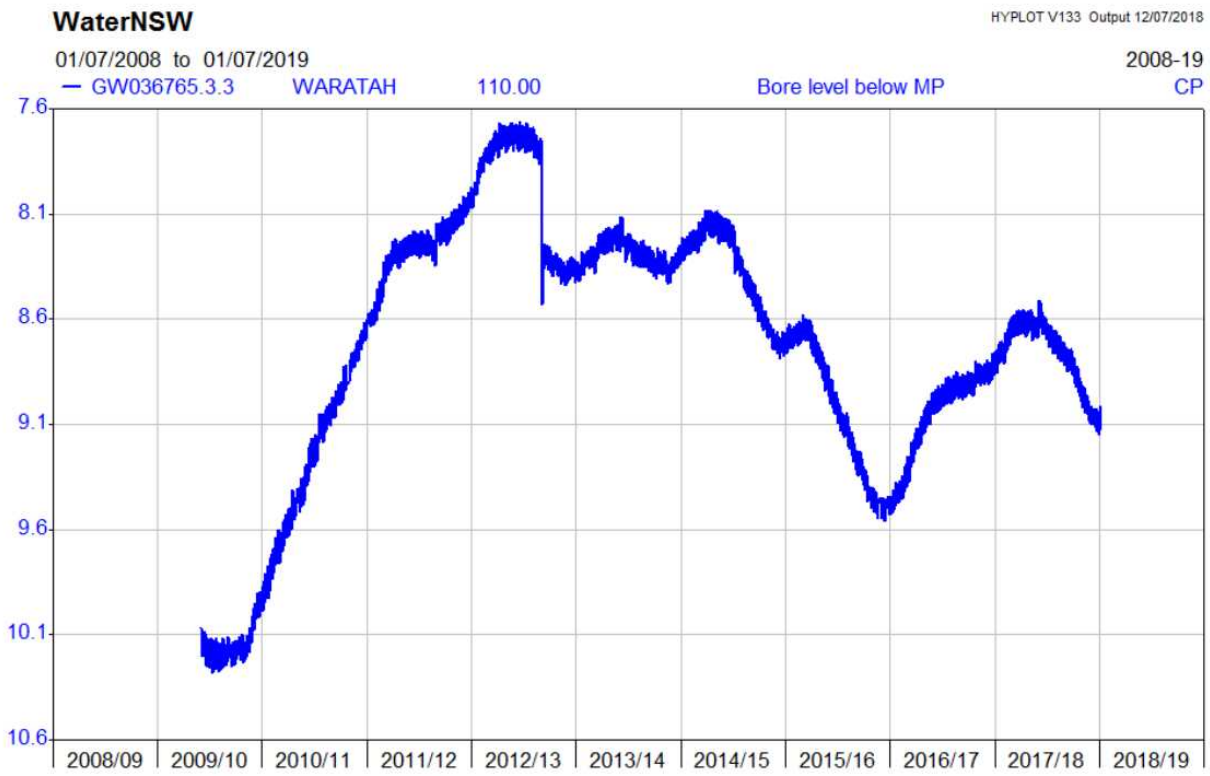

Figure 5 GW036765.3.3 historical water level data

3.7 Existing stormwater infrastructure

There is no formal stormwater infrastructure within the study area apart from table drains and culverts servicing Beer Road and Lignum Lane. However, adjacent developments include stormwater management infrastructure, and this is shown in the Drawings in Appendix C. Stormwater reuse infrastructure adjacent to the study area is also shown in the Drawings.

3.8 Proposed development

The entire study area is expected to be developed into residential housing. The Moama North West Master Plan (MacroPlan Australia, 2009) outlines the expected future development of the study area and is provided in Appendix B.

3.9 Site constraints

The main site constraints pertaining to stormwater management upon residential development of the study area include:

- The site is a basin with (effectively) no natural drainage outlet
- Soil conditions are not conducive to stormwater disposal via infiltration
- The small areas of existing native vegetation cover would ideally be preserved post-development
- Current market conditions have increased the rate of residential development in the study area, particularly adjacent to Perricoota Road. Council is also receiving pre-development application interest

for other land titles in the study area. There is conflict between residential development and the preservation of open space for a drainage reserve

- Land titles form development boundaries within the study area, and different property ownership means that development is occurring in an ad-hoc manner, presenting difficulties in applying a strategic approach to catchment scale drainage across multiple land titles and owners
- The most feasible discharge locations to the Murray River have no associated floodplain or wetland for final treatment to improve water quality prior to entering the waterway
- Required footprint of stormwater management infrastructure could be extensive given the lack of natural drainage outlet (i.e. discharge required to be pumped) and this may limit opportunity for residential development yield. However, the Moama North West Master Plan (MacroPlan Australia, 2009) has defined a generous linear open-space / drainage reserve following the main depression for this purpose, generally aligning with the RL 94.5 mAHD contour.

3.10 Potential opportunities

The site also presents a range of opportunities with stormwater management:

- The topography and soils are well suited to stormwater capture and storage
- Potential for stormwater reuse – the study area can be connected to adjacent stormwater harvesting and reuse infrastructure, irrigation of the public open space and augmentation of the raw water supply into the residential estates
- Establishment of natural public open spaces with integrated stormwater infrastructure (i.e. detention basins) within the residential area. The linear nature of the main depression also provides for recreation and pedestrian/cyclist access connectivity between the Recreation Reserve, the Rich River Golf Club and existing residential areas on Perricoota Road and Twenty-Four Lane
- Improvements in stormwater quality through establishment of stormwater reuse systems and water sensitive urban design.

4 Water quality

Stormwater from Moama is ultimately discharged to the Murray River. Water quality in the Murray catchment and the Murray River has been affected by urban development, irrigation drainage, changes in land use and land management practices with resulting increases in turbidity, nutrient levels, bacterial pollution and pesticide levels in the rivers.

The Moama Urban Stormwater Management Plan (DLM Environmental Consultants Pty Ltd, 2010) describes the water quality objectives, indicators and trigger levels for the reach of the Murray River appropriate to Moama. These are reproduced in Table 1 below.

Table 1 Water quality objectives

Criteria	Objective	Indicator	Trigger level
Protection of Aquatic Ecosystems	Maintaining or improving the ecological condition of water bodies and riparian zones over the long term	Total Phosphorus Total Nitrogen Chlorophyll-a Turbidity Salinity (EC) Dissolved Oxygen pH	0.05 mg/L 0.5 mg/L 0.005 mg/L 6 – 50 NTU 125 – 2200 µS/cm 85 – 100% 6.5 – 8.5
Secondary Contact Recreation	Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed	Faecal Coliforms Enterococci Algae & BGA	1000 cfu/100 mL 230 per 100 mL 15,000 cells/mL
Primary Contact Recreation	Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed	Turbidity Faecal coliforms Enterococci Protozoa Algae & BGA Chemical Contaminants	Approx. 6 NTU 150 cfu/100 mL 35 per 100 mL Absent 15,000 cells/mL None
Livestock Water Supply	Protecting water quality to maximise the production of healthy livestock	Faecal Coliforms Algae & BGA Salinity	100 cfu/100 mL 11,500 cells/mL 3000 – 10,000 µS/cm
Irrigation Water Supplies	Protecting the quality of waters applied to crops and pasture	Algae & BGA Salinity Thermotolerant Coliform	Not visible 280 µS/cm Varies – depending on whether food or non-food crops (Refer ANZECC Guidelines)
Drinking Water	Refers to the quality of drinking water drawn from the raw water source before any treatment	Faecal coliforms Salinity pH Dissolved Oxygen	0 800 - < 1500 µS/cm 6.5 – 8.5 6.5 mg/L

Criteria	Objective	Indicator	Trigger level
Homestead Water	Protecting water quality for domestic use in homesteads including drinking, cooking and bathing	Faecal coliforms	0
		Total Dissolved Solids	500 – 1000 mg/L
		Turbidity	5 NTU
		pH	6.5 – 8.5

The change in land use of the study area from broadacre agriculture to residential development presents potential changes in the risk profile to stormwater quality. These changes are broadly described in Table 2.

Table 2 Risk profile

Existing risks – agriculture	Future risks – residential (construction)	Future risks – residential (ultimate development)
Erosion from exposed soils and sediment movement increasing stormwater TDS / turbidity	Erosion from exposed soils and sediment movement increasing stormwater TDS / turbidity	Gross pollutants such as litter, leaves, garden waste, etc.
Agricultural chemicals toxic to aquatic plants and animals	Escape of construction materials (concrete washdown, solvents, etc.) toxic to aquatic plants and animals	Use of garden chemicals toxic to aquatic plants and animals
Agricultural fertilisers increasing risk of algal blooms and reductions in dissolved oxygen concentrations	Hydrocarbons (fuel, oil and grease) from construction vehicles and machinery	Use of garden fertilisers and chemicals increasing risk of algal blooms and reductions in dissolved oxygen concentrations
Bacterial pollution from livestock manures	Gross pollutants such as construction waste, litter, etc.	Hydrocarbons (fuel, oil and grease) from vehicles
		Sediment movement from exposed soils and areas with low vegetative cover

The key risks to the quality of receiving waters, that may need to be mitigated as part of the stormwater strategy for the study area, are:

- Increases in total suspended solids and turbidity
- Gross pollutants
- Chemical / hydrocarbon / nutrient pollution.

The change in land use to residential development provides greater opportunity for movement of these contaminants into the Murray River. In its existing state, water-borne contaminants such as sediment, chemicals and fertilisers are largely retained on-site as the catchment is fully pervious with no natural outlet. The increased imperviousness of the catchment associated with residential development results in an increased volume of runoff. With a reduced pervious area for natural infiltration, some of this excess water and its contaminant load will necessarily be exported out of the catchment for disposal.

Therefore, the volume of runoff and its contaminant load must be reduced as much as possible prior to disposal to a waterway. Disposal to reuse for irrigation or infiltration (either on- or off-site) presents an ideal opportunity for retention of all water-borne contaminants in the landscape. Direct disposal to the Murray

River should be considered a last resort to be used only in times of extreme runoff events where the benefits of dilution can be realised.

4.1 Stormwater quality testing

Murray River Council has undertaken routine stormwater quality testing across Moama for many years. Water quality testing for the McCulloch Drive stormwater basin within the industrial estate, to the north of the study area, and the Cabernet Drive residential estate basin (immediately adjacent to the south of the study area) has been undertaken since late 2008. Water quality testing has also been undertaken for the Moama Sports fields basin since 2012 and the Recreation Reserve old trotting track storage, both of which are adjacent to the south-eastern end of the study area.

The results from Cabernet Drive are most likely to indicate the key contaminants in stormwater associated with residential development, given it is similar development to that proposed for the study area.

The acceptable limits for each water quality parameter are defined in the Moama Urban Stormwater Management Plan (DLM Environmental Consultants Pty Ltd, 2010) and are defined in Table 3.

These results from the four sampling locations are shown in Figure 6, Figure 7, Figure 8 and Figure 9 below, with a summary and exceedance frequency provided in Table 3.

Table 3 Water quality parameters – acceptable limits

Parameter	Acceptable limit (mg / L)	Range		Frequency of exceedance (%)
Biochemical Oxygen Demand	1500	Cabernet Drive:	2 - 7	-
		Moama Sports Fields:	2 - 10	-
		Old Trotting Track:	2 - 3	-
		Industrial Estate:	2 – 14	-
Total Phosphorous	20	Cabernet Drive:	0.05 - 0.13	-
		Moama Sports Fields:	0.11 - 0.3	-
		Old Trotting Track:	0.12 – 0.31	-
		Industrial Estate:	0.05 - 0.44	-
Total Suspended Solids	30	Cabernet Drive:	16 – 62	12 / 20 samples (60%)
		Moama Sports Fields:	38 - 230	9 / 9 samples (100%)
		Old Trotting Track:	35 - 250	7 / 7 samples (100%)
		Industrial Estate:	9 – 540	12 / 20 samples (60%)
Oil and grease	100	Cabernet Drive:	5 – 7	-
		Moama Sports Fields:	5 - 5	-
		Old Trotting Track:	5 - 5	-
		Industrial Estate:	5 – 10	-
Nitrate and Nitrite as N	100	Cabernet Drive:	0.01 - 0.32	-
		Moama Sports Fields:	0.01 - 0.6	-
		Old Trotting Track:	0.13 – 0.47	-
		Industrial Estate:	0.01 – 0.64	-

These results are consistent with the summary provided in Moama Urban Stormwater Management Plan (DLM Environmental Consultants Pty Ltd, 2010), with water quality well within acceptable limits for Nitrate and Nitrite N, Total Phosphorous, BOD and Oil and grease. The water quality results for total suspended solids exceed the acceptable limit for more than 60% of samples, with two sites consistently exceeding the limit.

This does reflect the nature of the catchment exhibiting fine, dispersive loamy clay soils exposed through reduced groundcover or construction activities. The inclusion of sedimentation basins and wetlands in the stormwater management system will assist in capturing suspended solids. Connection to the existing stormwater reuse network will divert stormwater, and its load of suspended solids, away from waterways to be retained in the landscape.

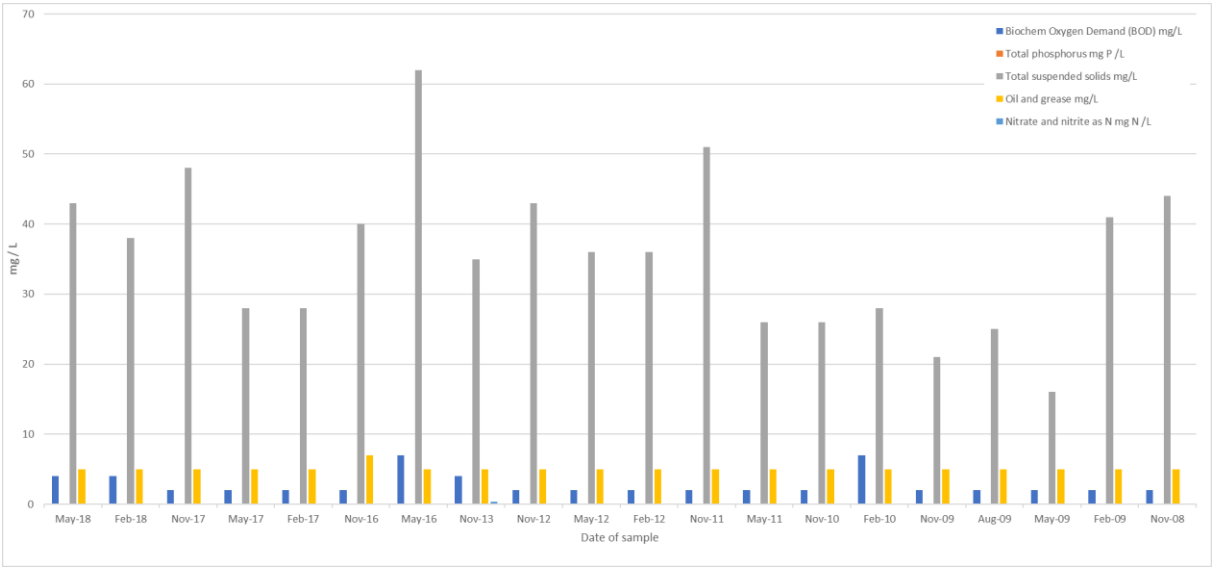

Figure 6 Water quality testing results (Cabernet Drive)

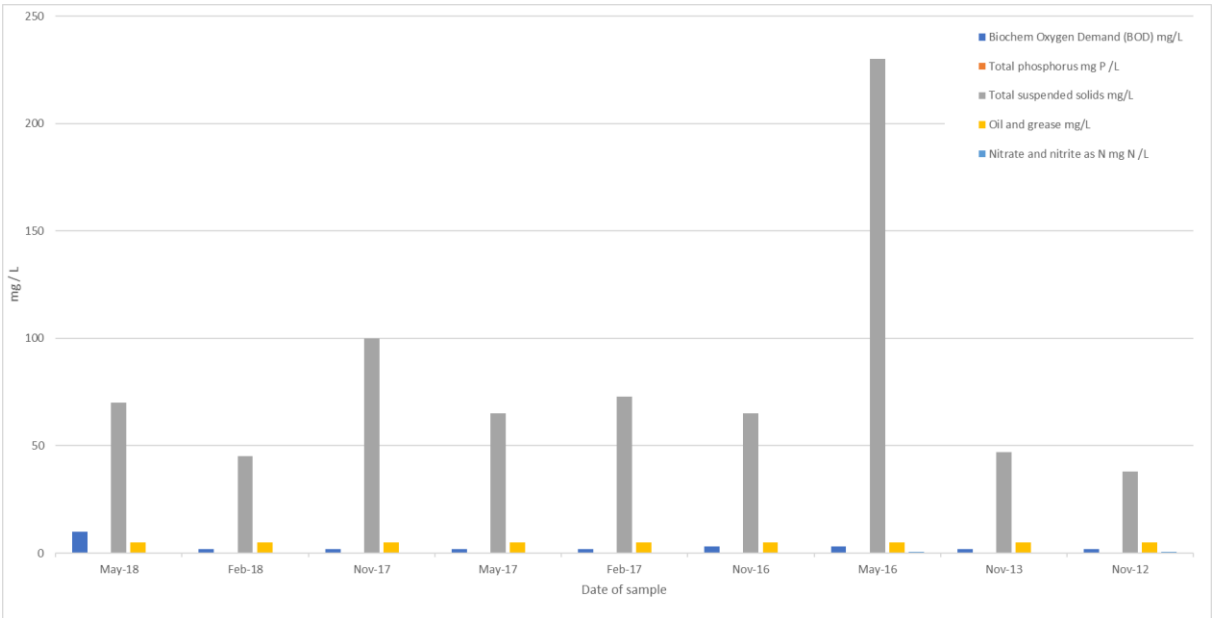

Figure 7 Water quality testing results (Moama Sports Fields)

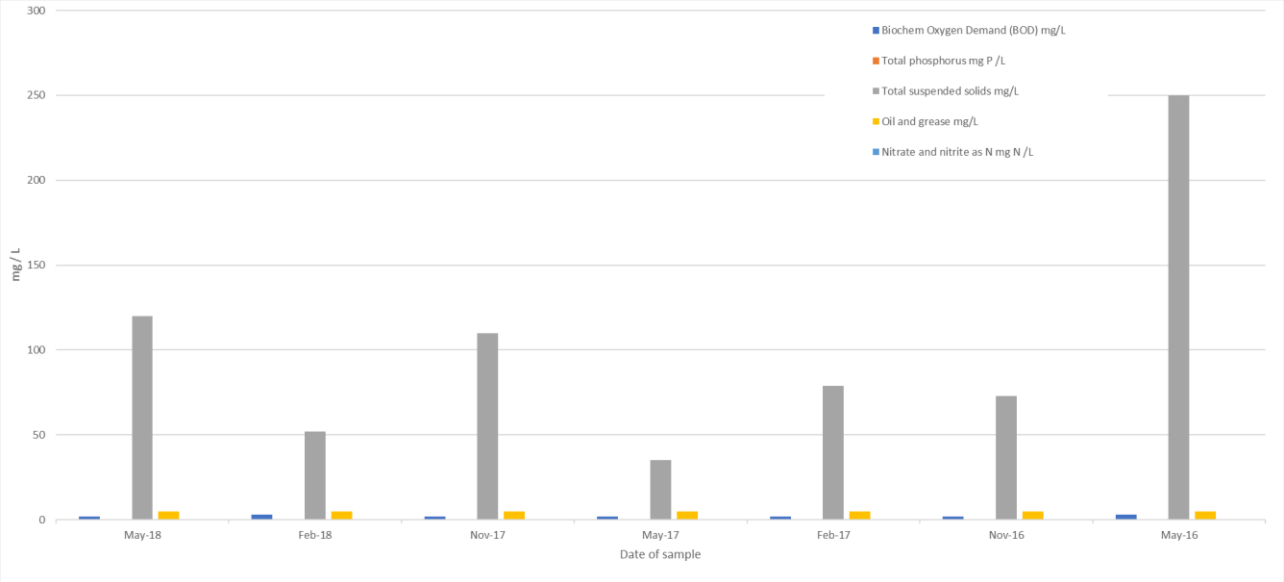

Figure 8 Water quality testing results (Old Trotting Track)

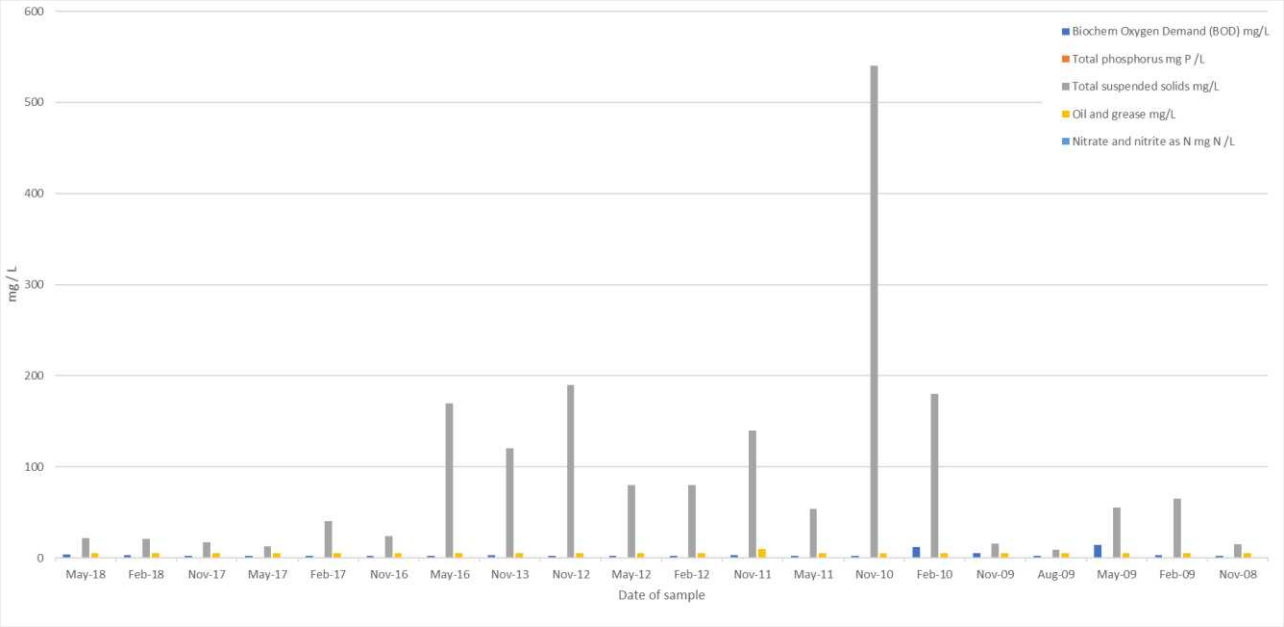

Figure 9 Water quality testing results (Industrial Estate)

5 Hydrology

The hydrology of the study area catchment has been assessed to determine the pre- and post-development hydrological conditions, with a view to understanding the peak flow and volume of stormwater generated for a range of design storm events.

This analysis provides the baseline catchment hydrological characteristics that must be maintained in the ultimate, post-development state using stormwater detention infrastructure.

The study area catchment was assumed to be closed with no external runoff flowing into the catchment from adjacent lands. The catchment defined into several sub-catchments (refer Appendix C) that align with title boundaries which broadly define the expected staging of development.

The analysis was carried out using the ILSAX model within the DRAINS software package to determine the pre- and post-development discharge rates. Storm events of various annual exceedance probability (AEP) were simulated with rainfall hyetographs developed within the DRAINS software.

The site parameters for the DRAINS model were input according to the values shown in Table 4.

Table 4 DRAINS model parameters

Parameter	Value
Rational method procedure	AR&R 1987
Paved depression storage	1 mm
Grassed depression storage	5 mm
Supplementary depression storage	1 mm
Antecedent moisture condition	3
USCS soil type	“C” or “3” (slow infiltration rates)
Sub-catchment areas: • 1 • 2 • 3a • 3b • 4 • 5 • 6 • 7 • 8 Total	Refer Appendix C • 59.6 ha • 26.4 ha • 21.6 ha • 10.8 ha • 40.4 ha • 41.2 ha • 55.5 ha • 23.7 ha • 26.8 ha 306 ha

5.1 Stormwater peak flow assessment

The pre- and post-developed site conditions were modelled to establish the peak rate of discharge for all durations for the 1% AEP storm event as shown in Table 5. Estimated post-developed peak discharge rates are for the un-attenuated catchment assuming 70% impervious site coverage, as per the Infrastructure Development Manual (Local Government Infrastructure Design Association, 2017) for lot sizes 600-1000 m^2.

It is noted that the IDM is referenced in the absence of appropriate design parameters from the Murray Shire Council Engineering Guidelines – Part 3 – Stormwater Drainage Design (GHD Pty Ltd, 2012).

The detention volume required is also stated for each catchment. The detention volume assumes a nil outflow condition in the event of pipe blockage or pump failure, consistent with the requirements of the IDM (Local Government Infrastructure Design Association, 2017). This is appropriate for the assumptions of detention basin operation for this study, as discussed further in Section 6.2.

Table 5 Pre- and post-developed catchment hydrology

Catchment	Design storm AEP (critical duration)	Pre-development peak discharge (m^3/s)	Post-development peak discharge (m^3/s)	Detention volume required (nil outflow condition; ML)
1	1%, 1-hour	5.3	12.0	23.5
2	1%, 1-hour	2.5	5.5	10.4
3a	1%, 1-hour	2.2	4.6	8.5
3b	1%, 1-hour	1.5	2.5	4.3
4	1%, 1-hour	3.3	7.9	15.9
5	1%, 1-hour	3.9	8.5	16.3
6	1%, 1-hour	5.4	11.5	21.9
7	1%, 1-hour	2.5	5.1	9.4
8	1%, 1-hour	2.7	5.7	10.6
			Total	120.8

The peak flow from each sub-catchment, including upstream sub-catchments where applicable, arising from the 1%, 24-hour storm event has been determined to provide the design basis for the surface relief corridors as per the IDM (Local Government Infrastructure Design Association, 2017). These peak flows are shown in Table 6.

Table 6 Surface relief corridors – design peak flow

Surface relief corridor	Contributing sub-catchments	Post-development peak discharge (m^3/s)
Golf Club	1, 2, 3a, 3b, 6, 7 & 8	13.8
Beer Road	2, 3a, 3b	3.4
Drainage reserve within sub-catchment 6	4, 5	4.8
Drainage reserve within sub-catchment 7	4, 5, 6	7.7
Drainage reserve within sub-catchment 8	4, 5, 6, 7	8.4

Surface relief corridor	Contributing sub-catchments	Post-development peak discharge (m^3/s)
Sub-catchment 1 connecting to Beer Road	1	3.5
Sub-catchment 3a draining through to Beer Road	3a, 3b	2.1

The peak flow from each sub-catchment arising from the 3-month, critical duration storm event has been determined to provide the design basis for the vegetated swales conveying frequent stormwater runoff events within the drainage reserve to the detention basins. The total volume arising from the 3-month, critical duration storm event is also defined, as this is the basis for the stormwater reuse storage volume (refer Section 6.3.4. These peak flows are shown in Table 7.

Table 7 Vegetated swales – design peak flow

Sub-catchment	Post-development peak discharge (m^3/s)	Stormwater reuse storage volume (ML)
1	0.99	2.6
2	0.48	1.2
3a	0.41	1.0
3b	0.26	0.5
4	0.64	1.8
5	0.72	1.8
6	1.01	2.5
7	0.46	1.1
8	0.50	1.2

6 Stormwater management system

RPS has prepared the stormwater management system concept for the study area in consideration of the previous planning and strategies for the Moama North West area and the site constraints as described above.

The stormwater management system concept has been developed and refined in conjunction with Council officers. A flow schematic of the system is shown in Figure 10. The system proposed achieves Council's three main objectives as described in the following Sections. The stormwater management system Drawings are included in Appendix C.

It is noted that the drainage reserve boundaries have been determined as follows:

- South of Beer Road (sub-catchments 6, 7 & 8) – the boundary was defined by the Moama North West Master Plan (2009).
- North of Beer Road (sub-catchment 1) – the boundary is defined in this Strategy by the RL 94.5 mAHD contour.
- Sub-catchments 3a & 3b – this drainage reserve utilises the 40 m buffer to the industrial estate as defined in the Moama North West Master Plan (2009).
- Sub-catchment 2 – this drainage reserve is defined in this Strategy, utilising the 40 m buffer to the industrial estate in accordance with sub-catchments 3a & 3b.

RPS

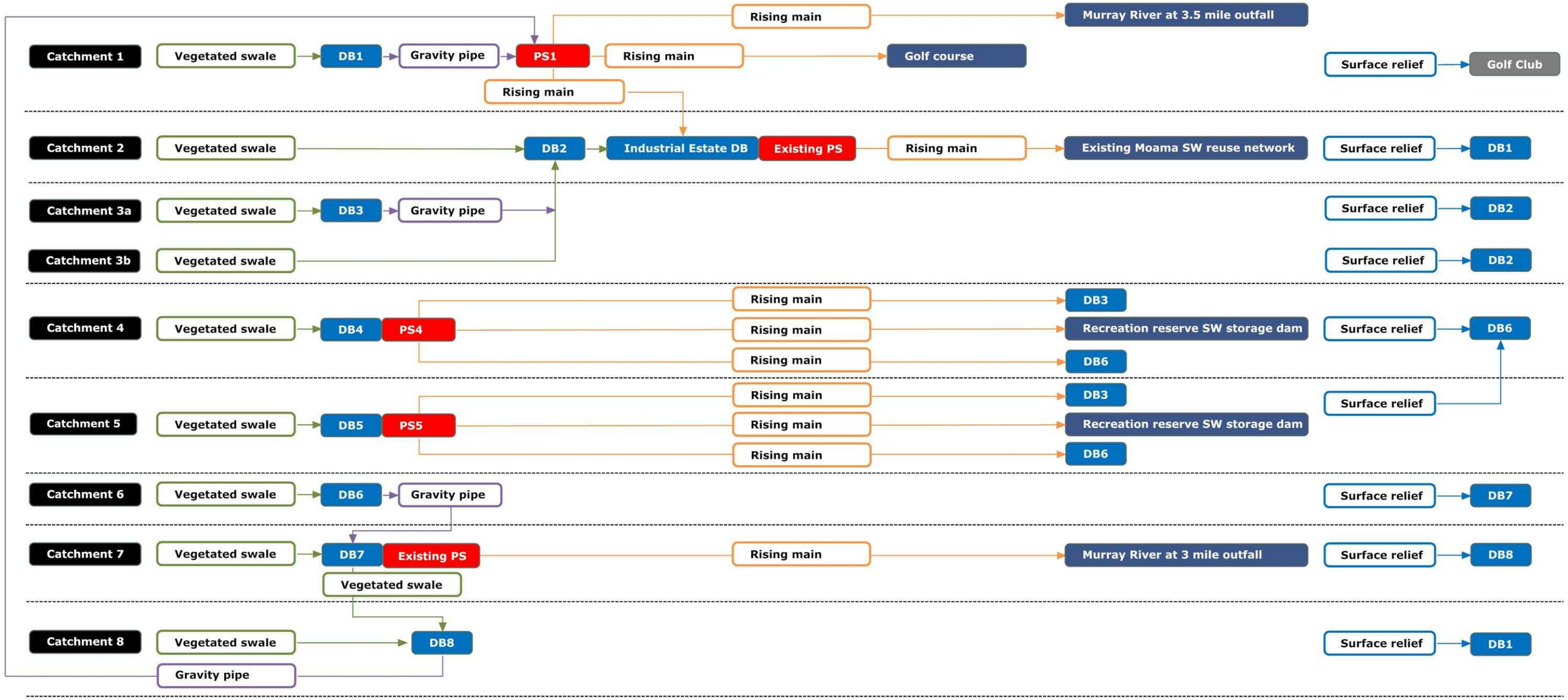

Figure 10 Stormwater management system flow schematic

6.1 Surface relief stormwater flow corridors

Surface relief stormwater flow corridors have been specified for stormwater flow in extreme runoff events. However, the opportunity to utilise natural surface relief flow corridors is limited given the topography of the catchment with effectively no existing natural outlet. Most sub-catchments have surface relief corridors flowing into adjacent sub-catchments. Therefore, surface relief flow corridors must be engineered into the stormwater management system. The design basis for the surface relief flow corridors is the post-development flow for the 1% AEP, 24-hour event.

There is a natural surface relief corridor, albeit only providing relief when water levels rise above RL 94.0 mAHD, for the entire catchment flowing north out of sub-catchment 1. This corridor moves north into the Golf Course which is not expected to cause significant issues given:

- The receiving catchment is fully pervious, with significant natural storage capacity and minimal built infrastructure, meaning that any water movement out of the study area will be limited in its penetration into the Golf Course property
- The corridor would only be engaged in ultra-rare runoff events given the natural capacity in the drainage reserve below RL 94.5 mAHD (refer Section 6.2.1).

The surface relief corridors are described in Table 8 and shown in the Drawings in Appendix C.

6.2 Retardation to pre-development runoff rates

Detention basins are proposed to reduce post-development flows to pre-development levels. However, given that most sub-catchments currently discharge into adjacent sub-catchments with no effective natural outlet, pumping is required for ultimate disposal of stormwater. By simply detaining stormwater flows and concurrently discharging to the downstream catchment at pre-development flow rates, the infrastructure required in the terminal catchment (disposal pump station and storage) would be excessively large.

Therefore, it is proposed that each catchment include a basin that is both a detention basin and a storage basin, whereby stormwater is stored in a surcharge area provided within its own drainage reserve for later (active) disposal or reuse. The storage volume is defined by the runoff generated from the post-development catchment in the 1% AEP, critical duration (one-hour) event. This temporary storage is drawn down via pumping to other stormwater reuse storages or by disposal to the Murray River.

In an effectively closed catchment, this helps to spread the storage of stormwater across the study area through multiple, smaller storages with smaller pump stations and pipelines for disposal.

Stormwater generated from larger, less frequent rainfall events than the design 1% AEP, one-hour duration event will then overflow from each sub-catchment via the surface relief corridors nominated (refer Table 8).

The design pump rate for draw down of the temporary storage is critical to the cost of the pump and pipeline infrastructure. To keep the size and cost of the pump stations as low as reasonably possible, it is proposed that the temporary storage be drawn down within 24 hours. This duration is unlikely to cause injury or death to the wetland plants and turfed areas (by waterlogging) within the detention basin. In addition, 24 hours is unlikely to cause major inconvenience to residents and users of the public open spaces.

The storage volume required in each sub-catchment is defined in Table 8 below, with a description of the nature of that storage and the surface relief location.

Table 8 Detention storage volume requirements in each sub-catchment

Sub-catchment	1% AEP, 1 hr storage requirement (ML)	Storage nature and disposal method	Surface relief
1	23.5	Temporary storage for pumped disposal to reuse via Golf Club and industrial estate or disposal to Murray River	Golf Course
2	10.4	Temporary storage for pumped disposal to stormwater reuse system via industrial estate	Overflow to sub-catchment 1
3a	8.5	Temporary storage for pumped disposal to stormwater reuse system via sub-catchment 2	Overflow to sub-catchment 2
3b	4.3	Temporary storage for pumped disposal to stormwater reuse system via industrial estate	Overflow to sub-catchment 2
4	15.9	Temporary storage for pumped disposal to stormwater reuse system via sub-catchment 5, sub-catchment 3a or sub-catchment 6	Overflow to sub-catchment 6
5	16.3	Temporary storage for pumped disposal to reuse network via recreation reserve, sub-catchment 3a or sub-catchment 6	Overflow to sub-catchment 6
6	21.9	Temporary storage for disposal to reuse or Murray River via sub-catchment 7	Overflow to sub-catchment 7
7	9.4	Temporary storage for disposal to reuse or Murray River	Overflow to sub-catchment 8
8	10.6	Temporary storage for disposal to reuse via Golf Club and industrial estate or disposal to Murray River	Overflow to sub-catchment 1

6.2.1 Drainage reserve natural capacity

The storage capacity of the drainage reserve is about 100 ML between the natural surface level and 94.5 mAHD (the approximate level of the reserve boundary). This is evenly split with approximately half the volume within Catchment 1 with the remaining volume across sub-catchments 6, 7 & 8.

This volume does not include the capacity in the existing drain and detention basins servicing Lakeview / Perricoota Run estates.

This capacity is likely to be preserved with detention basins being excavated below natural ground surface level to provide fill for the residential developments. Hence this natural storage provides valuable additional storage capacity in the closed catchments for capture and storage of surface relief runoff from large, infrequent storm events that exceed the design capacity of the detention basins.

It is estimated that this natural capacity of 100 ML, along with the 65 ML/day pump capacity to the Murray River, provides capability to manage 54 mm of additional runoff per day (i.e. a 77 mm rainfall event assuming 70% impervious catchment), if the detention basins were all already at full supply level from a 1% rainfall event.

Therefore, there is significant capacity within the stormwater management system and natural drainage reserve, to accommodate rainfall events rarer than the 1%, one-hour event.

6.3 Use of Water Sensitive Urban Design measures

The WSUD measures recommended for adoption in the residential stormwater system, to address the key water quality risks as outlined in Section 4, include:

- Gross pollutant traps at stormwater outlets
  - Capture and removal of gross pollutants such as coarse sediment, litter, leaves and other large debris
- Vegetated swales
  - Flow buffering, soil infiltration and capture of coarse sediments with some nutrient removal
- Integrated wetlands and storage in irrigated, vegetated detention basins
  - Fine sediments and nutrient removal
  - Maintenance of a permanent pool / wetland which also acts as raw water storage for the adjacent residential areas
- Stormwater reuse
  - Capture of pollutants and retention in the landscape through irrigation / infiltration by reducing stormwater flows to receiving waters.

These WSUD measures apply to the stormwater system downstream from the residential area stormwater outlet(s). Whilst beyond the scope of this study, it is expected that each residential development will include property and street-scale WSUD measures upstream of the catchment outlet to assist and enhance these WSUD measures described herein. These measures can include rainwater tanks, kerbside raingardens, street tree bioretention, bioretention swales, buffer strips, porous paving, etc.

These WSUD measures relevant to the broader stormwater management system in the study area are described further in the Sections below.

6.3.1 Gross pollutant traps

Gross pollutant traps (GPTs) are recommended for use at all stormwater outlets into the detention basins. These traps will capture coarse sediment, litter, leaves and other large debris from the stormwater stream for appropriate disposal. In addition to capturing gross pollutants that can cause issues with downstream infrastructure (particularly pumps), the use of GPTs will significantly improve the visual amenity of the detention basins in their role as public open space and the function of the integrated wetland.

GPTs are to be located and sized appropriately for the nature and size of the upstream catchment they service. This is to be undertaken as part of the detailed design for the residential development proposed.

6.3.2 Vegetated swales

Vegetated swales are proposed for use within the drainage reserves of each sub-catchment to convey stormwater in lieu of pipes toward, and within, the detention basin. These swales will provide flow buffering, soil infiltration and water quality improvements through capture of coarse sediments and nutrients.

It is proposed that these vegetated swales be sized to convey all flows up to and including the 4 exceedances per year (4EY; 98% AEP) event, equivalent to the 3-month average recurrence interval (ARI) event. Ideally the swales would be constructed on a 0.5% grade to limit ponding and stagnation within the swale however this requirement can be relaxed for swales within a detention basin.

Two local examples are provided in Plate 1 and Plate 2 for Parkview Estate and Murray Gardens Estate respectively (both in Echuca). These examples shown vegetated swales in the base of the detention basin. In both cases, the bed of the swale is rock lined for stability and erosion control where survival of vegetation cover may be compromised through waterlogging.

Plate 1 Parkview Estate (Echuca) vegetated swale (~2 years established)

Plate 2 Murray Gardens Estate (Echuca) vegetated swale (~3 months established)

6.3.3 Integrated wetlands and storage in detention basins

Wetlands and storage are often integrated into detention basins and provide benefits to water quality, recreation and public amenity.

The detention basins are proposed to serve the following functions:

- Detention of stormwater inflows and retardation of peak flow rates from large, infrequent runoff events
- Capture and diversion of stormwater from frequent runoff events for reuse
- Wetland area for water quality improvements, particularly the capture of suspended solids
- Raw water storage (as part of the permanent wetland pool) for local supply to residential estates and public open space. This also provides water security for the permanent pool in the wetland area during long, dry periods.

This is shown schematically in Figure 11.

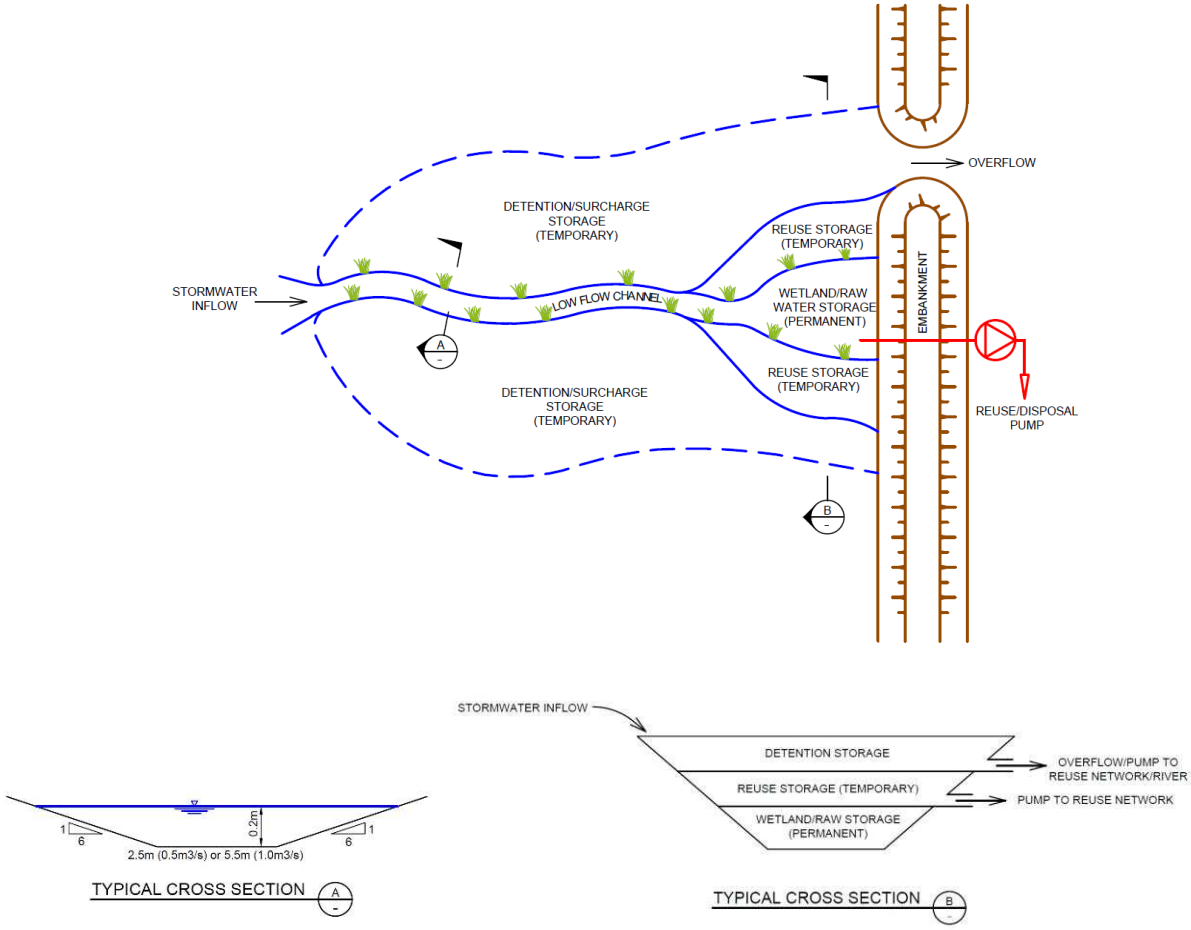

Figure 11 Detention basin storage elements

It has been demonstrated that the main stormwater quality issue is suspended solids (refer Section 4) arising from exposure of dispersive, fine clay soils. Whilst any exposed soil within the catchment area contributes to the mobilisation of soil particles, exposed soil *within the* stormwater management system infrastructure, particularly excavated earthen detention basins, presents a high risk.

Therefore, it is proposed that all detention basins be established and maintained with 100% groundcover throughout the year. This will require irrigation and maintenance of basin vegetation with the use of summer grasses (i.e. kikuyu, couch) to establish water-efficient year-round groundcover and appealing public open space areas.

It is also proposed that detention basins incorporate batter slopes of 1:10 (vertical:horizontal) or preferably less, with maximum depth of 2.5 m to realise the following benefits:

- Reduced erosion risk on basin batters
- Increased vegetated surface area for flow buffering and capture of suspended solids in high flow events
- Improvement in basin safety with easy egress from the basin in all conditions (dry, wet, submerged)
- Improved establishment and persistence of vegetation
- Facilitates the use of detention basins for recreation, such as informal sports, cycling tracks, exercise, dog walking, etc.

Figure 12 Example vegetated detention basin with maintained kikuyu grass cover (Parkview Estate, Echuca)

6.3.3.1 Wetlands

The integration of wetlands into the base of the detention basins is an important part of the treatment train to help improve stormwater quality in reducing total suspended solids. Whilst the detailed design for the wetlands is beyond the scope of this study, to be undertaken by the each developer as part of their estate design, MUSIC modelling (refer Section 6.4) for the proposed treatment train has been undertaken in each sub-catchment to identify the improvements in water quality arising from the use of integrated wetlands in the detention basins.

The elements of an effective, constructed wetland for improving stormwater quality are shown in Figure 13 and Figure 14 below.

It is proposed that to maximise hydraulic efficiency a high length to width aspect ratio be adopted. Figure 15 from WSUD Engineering Procedures: Stormwater (Melbourne Water, 2005) shows the hydraulic efficiency of a range of constructed wetland configurations, with a linear wetland configuration providing the best conditions for stormwater treatment. WSUD Book 2: Planning and Management (Landcom, 2009) confirms this, recommending that aspect ratios for wetland be in the range of 1:4 to 1:10 (width:length), with higher values preferred.

The nature of the drainage reserve that extends across the study area is conducive to providing a linear wetland configuration (for sub-catchments 6, 7 & 8). Similar configurations can easily be adopted for the remaining sub-catchments with similar, long depressions where the detention basins have been proposed.

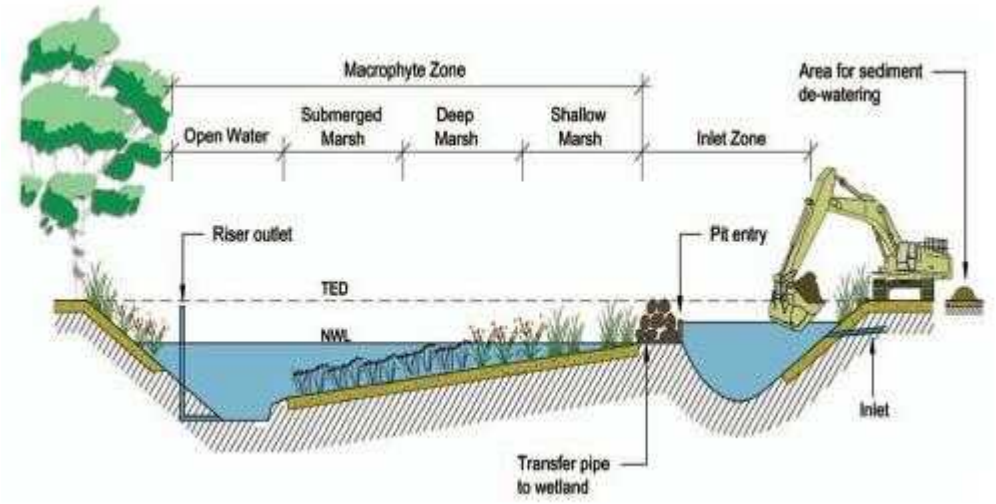

Figure 13 Constructed wetland elements elevation view (Melbourne Water, 2005)

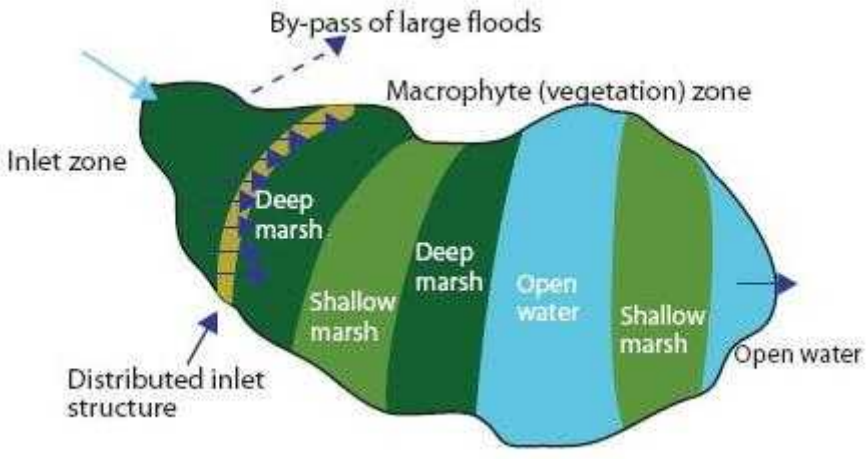

Figure 14 Constructed wetland elements plan view (Melbourne Water, 2005)

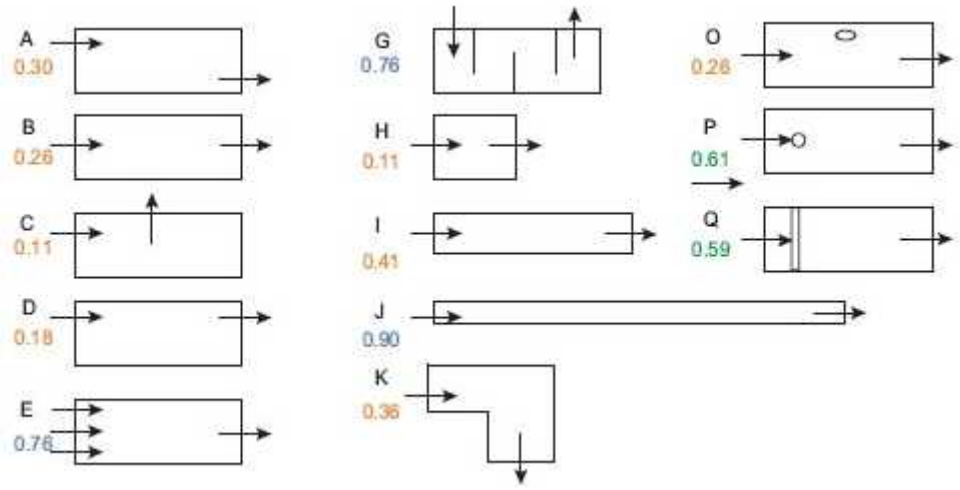

Figure 15 Hydraulic efficiency of various constructed wetland configurations (range 0 (poor conditions for stormwater treatment) to 1 (best) (Melbourne Water, 2005)

6.3.4 Stormwater reuse

As shown in Figure 11, part of the integrated storage volume in the detention basins is identified for stormwater reuse. The storage of stormwater for reuse is temporary, with this volume drawn down via pumping after a runoff event for direct reuse, substitution for raw water or distribution into the stormwater reuse network (extended throughout the study area as shown in the Drawings in Appendix C).

The proposed reuse volume integrated into the detention basins is sized to capture all runoff events up to the 3-month / 0.25-year average recurrence interval (ARI) event (4 exceedances per year; 4EY or 98% AEP). As shown indicatively in Figure 16, this provides a storage volume with the potential to capture and divert over 90% of all runoff generated from a catchment. The provision of additional diversion, or storage, capacity above this level only provides incremental increases in stormwater capture volumes and at disproportionate cost for the infrastructure required for these large, but infrequent, storm events.

The stormwater reuse storage volume requirements in each sub-catchment are shown in Table 7. It is proposed that this volume is drawn down via pumping over a 24-hour period after the runoff event, requiring a relatively small pump.

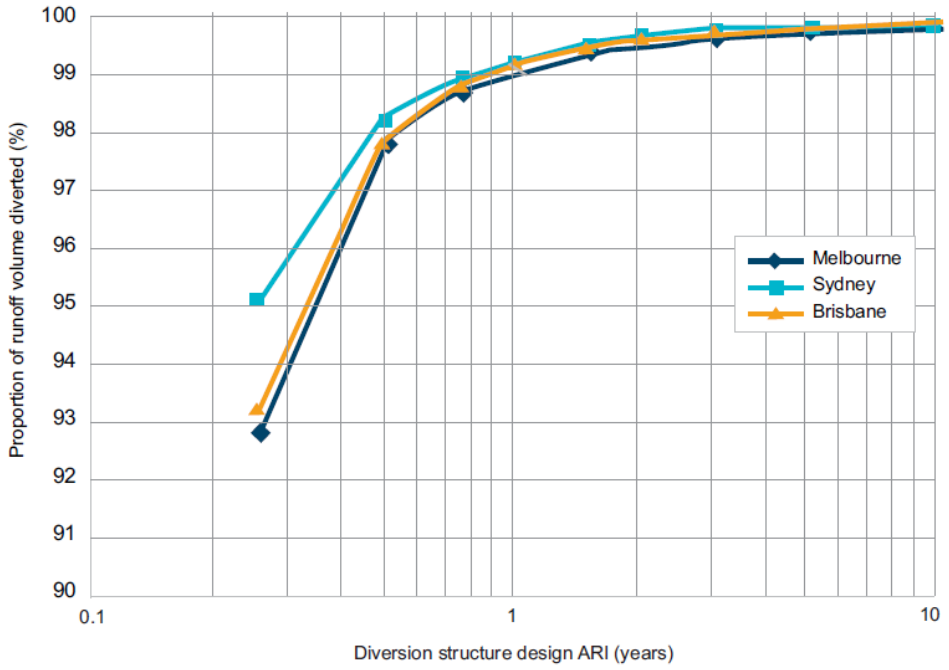

Figure 16 Relationship between diversion capacity and annual runoff volume diverted (Wong, 2000)

6.4 Water quality modelling

Preliminary water quality modelling has been undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) to assess the effectiveness of the proposed WSUD measures in the stormwater system downstream from the residential area stormwater outlet. Additional property and street-scale WSUD measures upstream of the catchment outlet (expected, but unknown at this time) will further enhance water quality outcomes, meaning that this modelling is conservative.

WSUD Book 2: Planning and Management (Landcom, 2009) proposes the following targets for water quality improvement in water sensitive urban design:

- 45% reduction in Total Nitrogen (TN)
- 65% reduction in Total Phosphorous (TP)
- 85% reduction in Total Suspended Solids (TSS).

As described in Section 4, Total Suspended Solids are the primary risk to receiving waterway quality, with water quality sampling suggesting nutrient pollution is a lower risk. Therefore, the proposed WSUD measures aim to reduce the stormwater TSS load as far as practical, which can be demonstrated through modelling. MUSIC simulates the generation of pollutants from a residential development and measures the efficiency of the proposed WSUD measures in removing those pollutants from stormwater runoff using a treatment train approach.

The assessment was undertaken using 6-minute rainfall data obtained from the eWater pluviograph toolkit (Echuca Aerodrome) for the period 2008-2010 inclusive. The treatment train is consistent for each sub-catchment and is shown in Figure 17. (Note that the wetland is located within the catchment detention basin.)

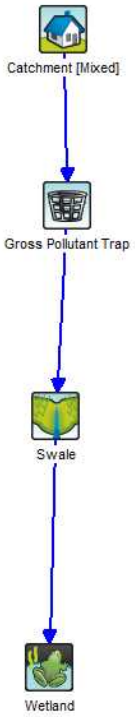

Figure 17 Sub-catchment treatment train

Table 9 below demonstrates the effectiveness of the treatment train in achieving the water quality targets for each sub-catchment, taken at the end node (wetland). The stated targets for pollutant reduction are easily achieved in each sub-catchment with the treatment train proposed.

Table 9 Treatment train effectiveness

Sub-catchment	Parameter	Sources	Residual load	% Reduction
1	Flow (ML/yr)	91.6	74.9	18.2
	TSS (kg/yr)	19,600	464	97.6
	TP (kg/yr)	39	4.59	88.2
	TN (kg/yr)	266	84.8	68.2
	Gross pollutants (kg/yr)	4,610	0	100.0
2, 3a & 3b	Flow (ML/yr)	91.3	74.8	18.1
	TSS (kg/yr)	18,000	464	97.4
	TP (kg/yr)	38.8	4.6	88.2
	TN (kg/yr)	265	85.4	67.8
	Gross pollutants (kg/yr)	4,590	0	100.0
4	Flow (ML/yr)	62.1	50.8	18.2

Sub-catchment	Parameter	Sources	Residual load	% Reduction
	TSS (kg/yr)	13,200	320	97.6
	TP (kg/yr)	26.6	3.14	88.2
	TN (kg/yr)	186	60.1	67.8
	Gross pollutants (kg/yr)	3,120	0	100.0
5	Flow (ML/yr)	63.7	52.3	17.8
	TSS (kg/yr)	13,600	330	97.6
	TP (kg/yr)	26.8	3.24	87.9
	TN (kg/yr)	183	61.7	66.3
	Gross pollutants (kg/yr)	3,200	0	100.0
6	Flow (ML/yr)	85.4	69.8	18.3
	TSS (kg/yr)	17,400	432	97.5
	TP (kg/yr)	36.2	4.28	88.2
	TN (kg/yr)	255	79.3	68.9
	Gross pollutants (kg/yr)	4,300	0	100.0
7	Flow (ML/yr)	37.3	27.7	25.6
	TSS (kg/yr)	7,920	170	97.8
	TP (kg/yr)	15.1	1.69	88.8
	TN (kg/yr)	107	31.2	70.9
	Gross pollutants (kg/yr)	1,870	0	100.0
8	Flow (ML/yr)	37.3	27.7	25.6
	TSS (kg/yr)	7,920	170	97.8
	TP (kg/yr)	15.1	1.69	88.8
	TN (kg/yr)	107	31.2	70.9
	Gross pollutants (kg/yr)	1,870	0	100.0

7 Concept stormwater design

The concept stormwater design, as shown in the Drawings in Appendix C, includes several discrete elements. The key design parameters for these elements is given below.

- Detention basins
  - Volume sized to store runoff from the 1% AEP, one-hour storm event
  - 1:10 batters
  - 2.5 m active storage depth (bed to FSL)
- Pipelines
  - Pumped: 15-25 m total dynamic head (inclusive of 5 m static head)
  - Gravity: 0.5 m static head
  - PN8 HDPE 100
  - Capacity to empty the detention basin volume in 24 hours
- Surface relief corridors
  - Capacity to pass the peak catchment flow from a 1% AEP, 24-hour storm event
  - 1:1,000 bed gradient
  - Bed width varies according to required flow capacity
  - 1v:4h or 1v:6h batters
  - Maintained grass vegetated surface (Manning's n 0.04)
  - 1.0 m flow depth
- Low flow swales
  - Capacity to pass the peak catchment flow from a 4EY; 98% AEP event (3-month ARI)
  - 1:200 bed gradient
  - 2.5 m or 5.5 m bed width
  - Maintained grass vegetated surface (Manning's n 0.04)
  - 1v:6h batters
  - 0.2 m flow depth
- Pump stations
  - Electric submersible pump in a wet well configuration
  - Duty only (no requirement for standby pump)
  - Capacity to empty the detention basin volume in 24 hours
  - Duty point as defined – maximum head 25 m
  - Automatic operation sensed by basin water level.

7.1 Budget cost estimate

A budget estimate of the concept stormwater strategy proposed has been prepared to provide an indication of the likely costs of implementation. This estimate, provided in Appendix D, is indicative only and includes significant contingency to reflect the concept nature of the strategy.

The budget cost estimate of the stormwater strategy is $10.7M ex GST inclusive of 40% contingency and 10% for management, design and approvals requirements. This works out to $35,000 per ha of the development area.

It is important to note that the costs of this development are borne by the developers, not Council. Whilst there is benefit to the Council and broader community in establishing stormwater reuse infrastructure, this infrastructure primarily provides for effective stormwater management and disposal which is a mandatory requirement for development. In addition, there is significant financial benefit to the developer in the establishment of green public open spaces in providing an attractive residential estate.

7.2 Implementation

The timing of implementation of the strategy has been a key consideration as the study area includes multiple landowners. Implementation is facilitated through the following considerations:

- The selection of the catchments reflects title boundaries under single ownership
- The catchment areas can be developed independently with opportunity to establish stormwater reuse and disposal infrastructure that contributes to the overall strategy with minimal future redundancy or duplication
- The establishment of detention storage within the drainage reserve in sub-catchments 6, 7 and 8 is flexible with common bed and full supply levels. This presents opportunity to incorporate existing development in the adjacent Dungala, Perricoota Run and Lakeview residential estates

The stormwater infrastructure development responsibility generally lies with each sub-catchment owner for all works within their sub-catchment, with the following clarifications:

- Sub-catchments 1 and 8: Cost of PS1, pipelines 1.1, 2.1 & 8.1 shared by owners or funded by Council and recovered via s94 Developer's Contributions
- Sub-catchment 3b: Detention Basin 2 (part; 30% volume attributable to 3b)
- Sub-catchment 3a: Pipeline 3.1 in entirety
- Sub-catchment 4: Pipeline 4.1 (part; alignment within catchment) and Pipeline 3.2 through to DB3 (or Beer Road table drain depending on timing of development of sub-catchment 3)
- Sub-catchment 5: Pipeline 5.1 through to Recreation Reserve Storage and Pipeline 4.1 (part; alignment within catchment and through to outfall in sub-catchment 6)
- Sub-catchment 6: Pipeline 6.1 in entirety
- Sub-catchment 7: Pipeline 7.1 in entirety.

8 Recommendations

It is recommended that Council:

- Endorse and encourage the implementation of new stormwater management and reuse infrastructure for integration into existing stormwater networks
- Adopt the concept stormwater management strategy to guide and integrate development in the defined Moama Mid-West area
- Enforce the preservation of the green public open space / drainage reserve as outlined in the Moama North West Masterplan (MacroPlan Australia, 2009) and in the strategy
- Enforce the preservation of the natural capacity of the drainage reserve with development below RL 94.5 mAHD prohibited (or the natural capacity otherwise maintained)
- Enforce the preservation of the existing natural surface relief corridor north from Lot 11 / DP701453 into the Golf Course, with overland flows uninhibited above RL 94.5 mAHD
- Enforce the development of detention basins as irrigated, maintained, vegetated Public Open Space areas, with basin geometry suitable for recreational use when dry
- Endorse and encourage the use of Water Sensitive Urban Design measures in residential development to mitigate peak stormwater flows and volumes, and improve stormwater quality, as follows:
  - Estate scale:
    - Use of gross pollutant traps at all stormwater outlets into detention basins
    - Use of vegetated swales over concrete conduits wherever possible
    - Establish a dedicated stormwater reuse storage volume within detention basins
    - Integration of wetlands within the detention basins for stormwater treatment, with wetland design in accordance with Water Sensitive Urban Design Engineering Procedures: Stormwater (Melbourne Water (2005)
    - Establish a dedicated raw water storage volume within detention basins as a permanent pool to sustain wetland ecology
    - Maximise reuse of stormwater at-source within the estate for irrigation of parks and gardens
  - Street / individual property scale:
    - Use of rainwater tanks for attenuation of stormwater peak flows and volumes from rooftops
    - Use of kerbside raingardens, street tree bioretention, bioretention swales, buffer strips, porous paving and other WSUD measures wherever possible within residential developments.

9 References

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Appendix A

Example soil log (Moama STP site)

NSW SOIL AND LAND INFORMATION SYSTEM

Soil Essentials Report

SITE DETAILS

Site Location:	SITE 4 PROFILE F
Map Reference:	MGA Grid Reference: Zone 55, 296903E, 6009355N. 7825 ECHUCA (1:100000) map sheet.
Profile Details:	MOAMA SEWERAGE AUGMENTATION SCHEME Survey (1000999), Profile 6, collected by Miss Jenni Lang on 01 August, 1994
Physiography:	floodplain under woodland grass understorey on alluvium lithology and used for improved pasture. local relief extremely low (< 9m).
Soil Type:	
Base of observation:	
Profile Field Notes:	

SOIL DESCRIPTION

Layer 0

Layer 1

0.00 - 0.10 m Horizon	dark yellowish brown (brown) (10YR 4/4) [moist] medium heavy clay, field pH is 8.1

Layer 2

0.10 - 1.25 m Horizon	dark yellowish brown (brown) (10YR 4/6) [moist] medium clay, field pH is 7.5

Layer 3

1.25 - 1.85 m Horizon	light yellowish brown (dull yellow orange) (10YR 6/4) [moist] medium clay, field pH is 7.9

Layer 4

1.85 - 2.95 m Horizon	yellowish brown (dull yellowish brown) (10YR 5/4) [moist] medium heavy clay with massive structure, field pH is 5.7

Layer 5

2.95 - 4.25 m Horizon	strong brown (bright brown) (7.5YR 5/6) [moist] medium heavy clay with massive structure, field pH is 5.7

LABORATORY TESTS

Sample Code	Upper Bnd.	Lower Bnd.	% Clay 517.99_CL	USCS 550.02	pH 4A1	EC 3A1	OC 6A1	Bray Phos 9E1	Phos Sorb 9I1	Exch Al 15F2_AL	Exch Ca 15F1_CA	Exch K 15F1_K	Exch Mg 15F1_MG	Exch Na 15F1_NA
WEL/94/8/10(1)	0.00	0.10			8.1						4.7	1.1	14	5.1
WEL/94/8/11(1)	0.10	1.25			7.5						6.4	0.9	13	9
WEL/94/8/12(1)	1.25	1.85			7.9						4.1	0.81	14	9.8
WEL/94/8/13(1)	1.85	2.95			5.7						2.7	0.47	10	7.5
WEL/94/8/14(1)	2.95	4.20			5.7						2.6	0.46	9.1	6.7

For information on laboratory test data and units of measure, please see: Soil survey standard test methods

Report generated on 11/07/2018 at 04:40 PM

To contact us, email: soils@environment.nsw.gov.au

Appendix B

Moama NW Master Plan (2009)

MacroPlan Australia
Setting New Standards

Moama North West Masterplan | Book of Plans

FINAL ISSUE

22 January 2009

PREPARED FOR MURRAY SHIRE

MACROPLAN AUSTRALIA PTY LTD
SYDNEY | MELBOURNE | BRISBANE | PERTH

MacroPlan Australia
Setting New Standards

Contact Information

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REPORT CONTACT
Jessica Cutting
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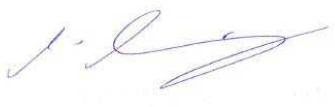
MELBOURNE

Signed[+]



.....
Dated 22 January 2009

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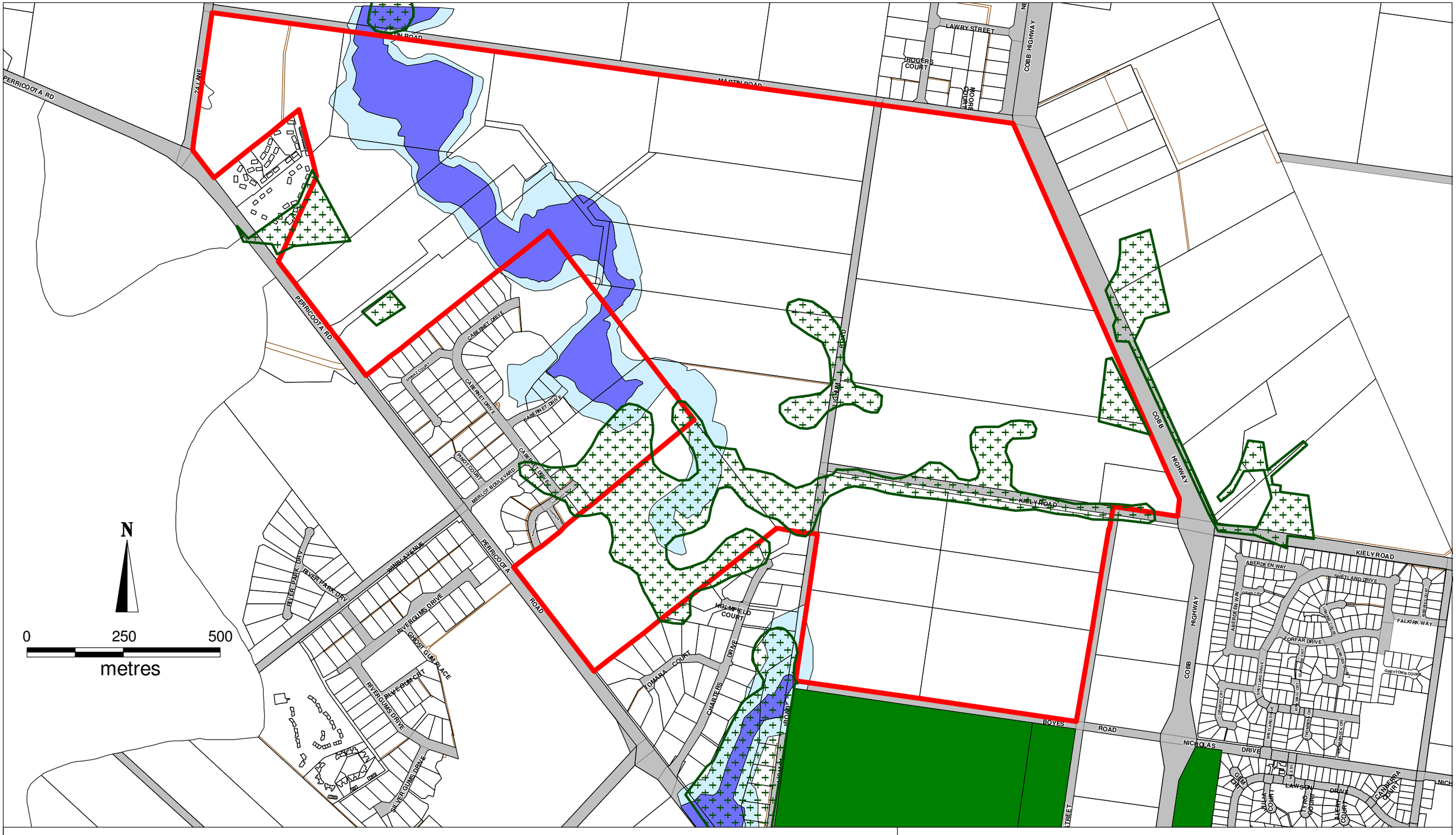
[+] This document has been reviewed by the State Manager – Planning Group, MacroPlan Australia.
This document is for discussion purposes only unless signed and dated by the person(s) identified.

MacroPlan Australia
Setting New Standards

Contents



Legend

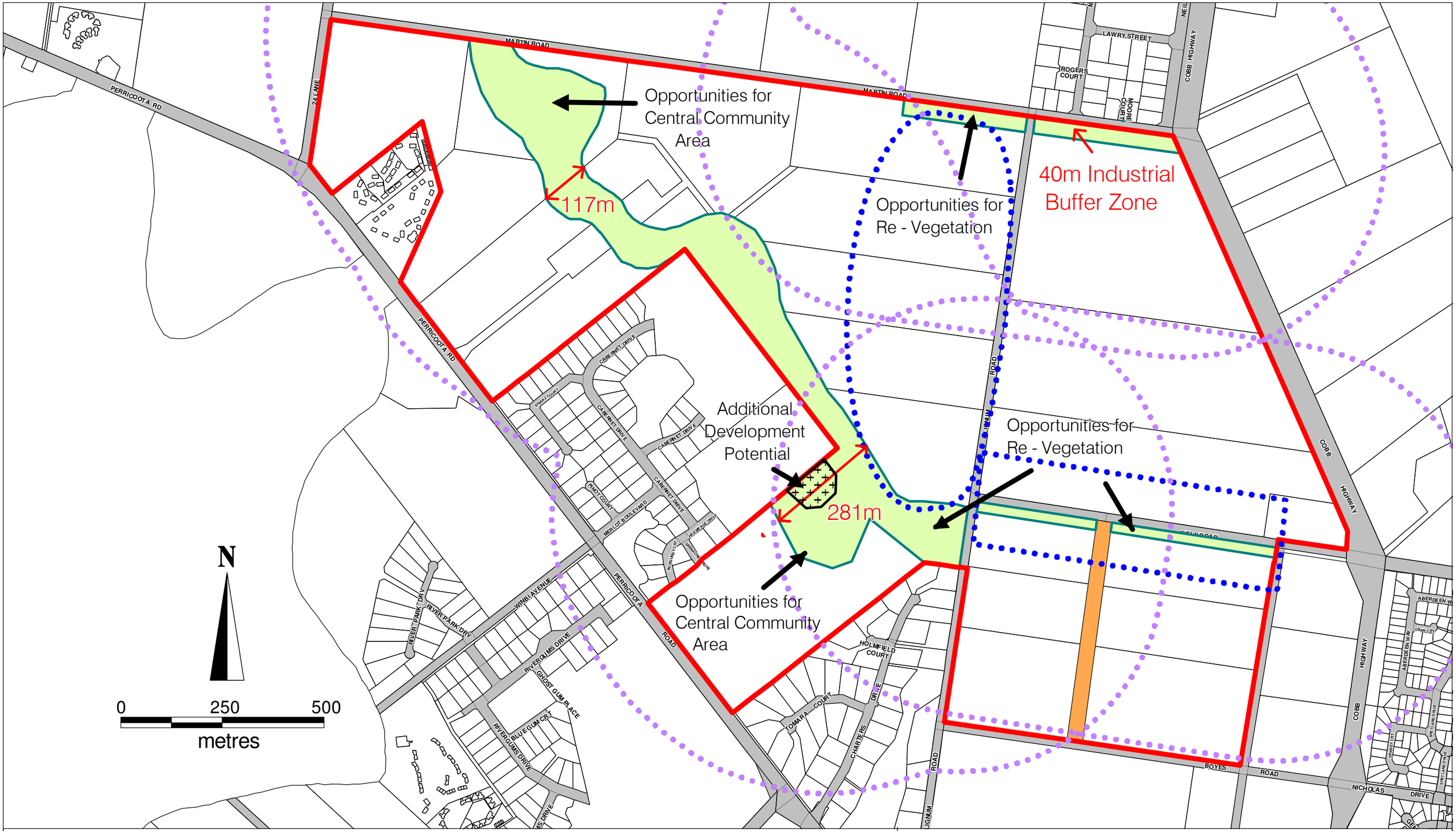
- Study Boundary
- Cadastral Boundary
- Easement
- Major Depression
- Moderate Depression
- Open Space
- Vegetation

Moama North West Masterplan

Map 1: Constraints Plan

MacroPlan Australia

Source : MacroPlan Australia 2008; Murray Shire Council 2007; Earth Tec Engineering 2003.



Legend

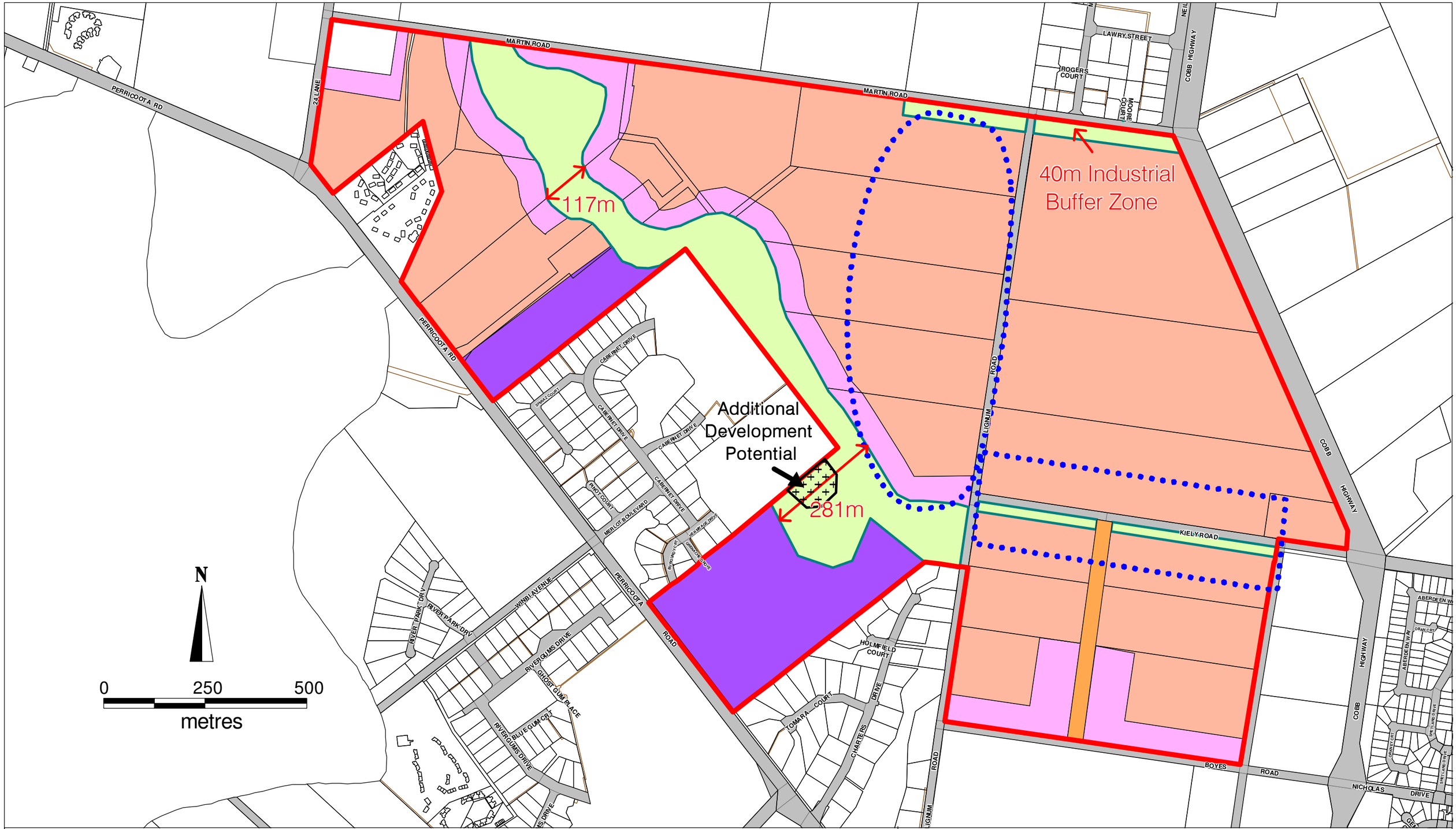
- Study Boundary
- Cadastral Boundary
- Proposed Drainage/ Linear Open Space
- Shared Space
- 500m Open Space Walkability Catchment
- Additional Development Potential
- Investigation Areas (Subject to Review)

Moama North West Masterplan

Map 2: Drainage / Open Space Plan

MacroPlan Australia

Source : MacroPlan Australia 2008; Murray Shire Council 2007; Earth Tec Engineering 2003.



Legend

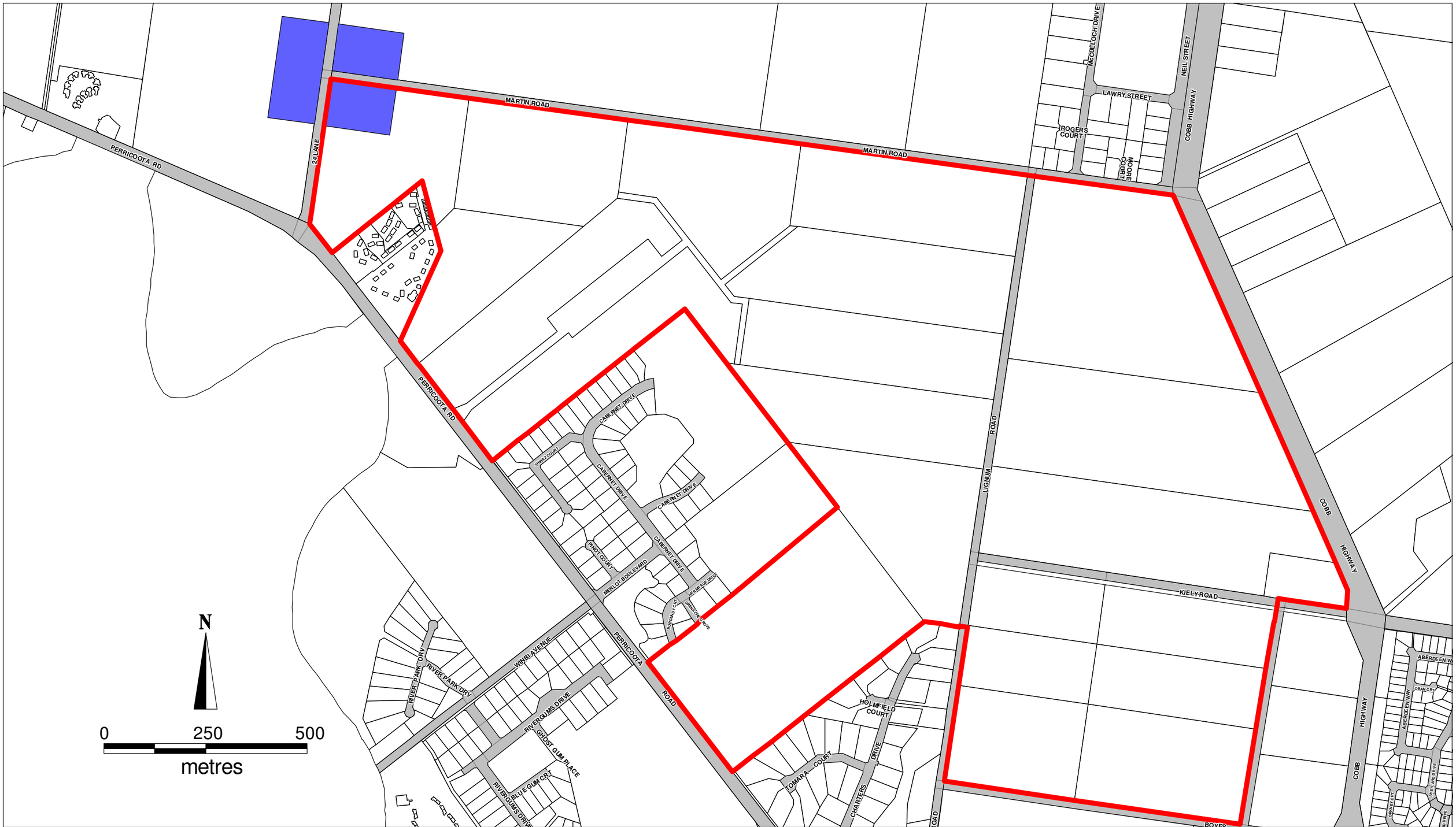
- Study Boundary
- Cadastral Boundary
- Investigation Areas (Subject to Review)
- Additional Development Potential
- Residential (Standard)
- Residential (Medium Density)
- Residential (Transition)
- Shared Space

Moama North West Masterplan

Map 3: Residential Plan

MacroPlan Australia

Source : MacroPlan Australia 2008; Murray Shire Council 2007; Earth Tec Engineering 2003.



Legend

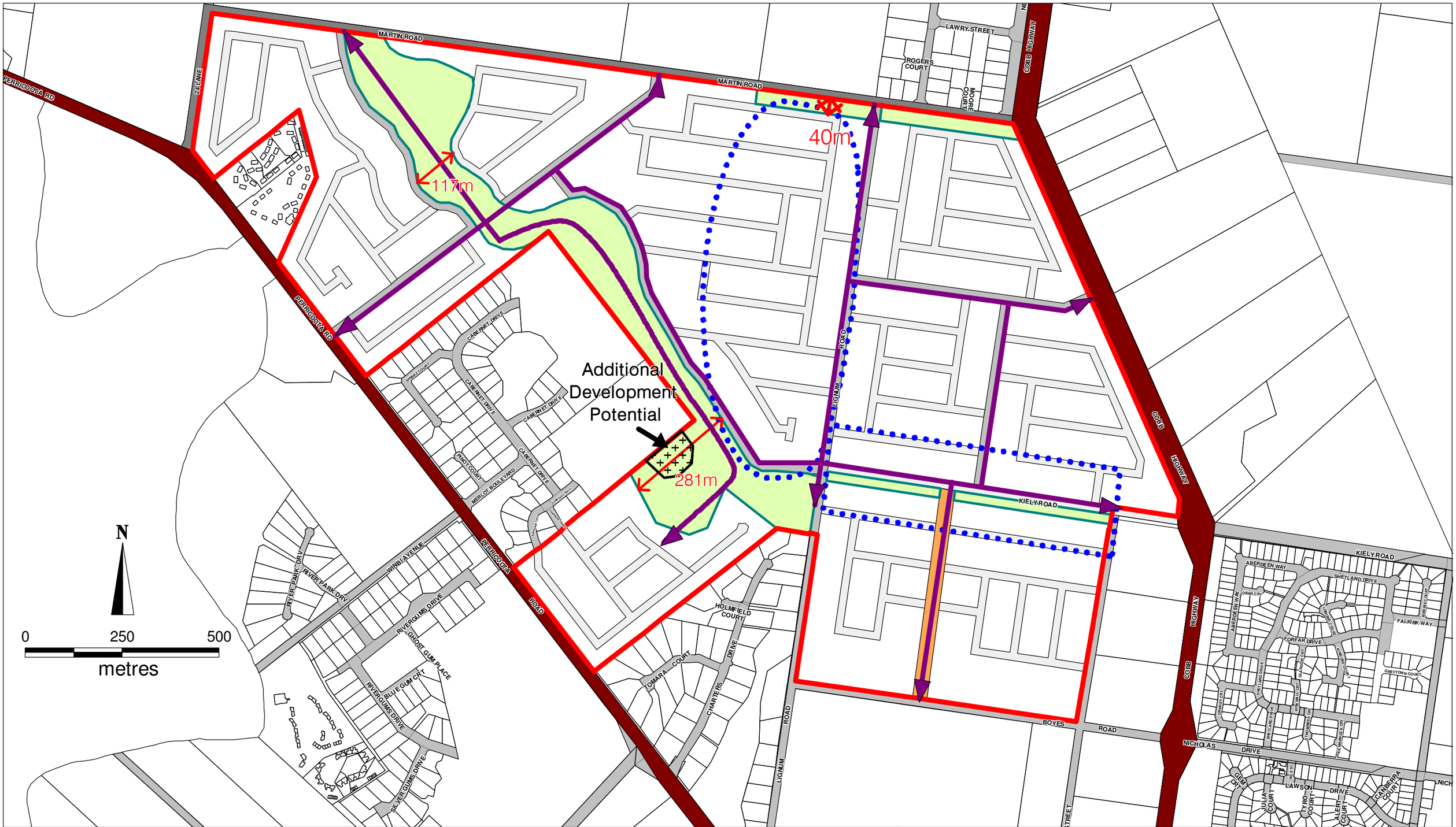
- Study Boundary
- Cadastral Boundary
- Local Activity Centre

Moama North West Masterplan

Map 4: Local Activity Centre Plan

MacroPlan Australia

Source : MacroPlan Australia 2008; Murray Shire Council 2007; Earth Tec Engineering 2003.



Legend

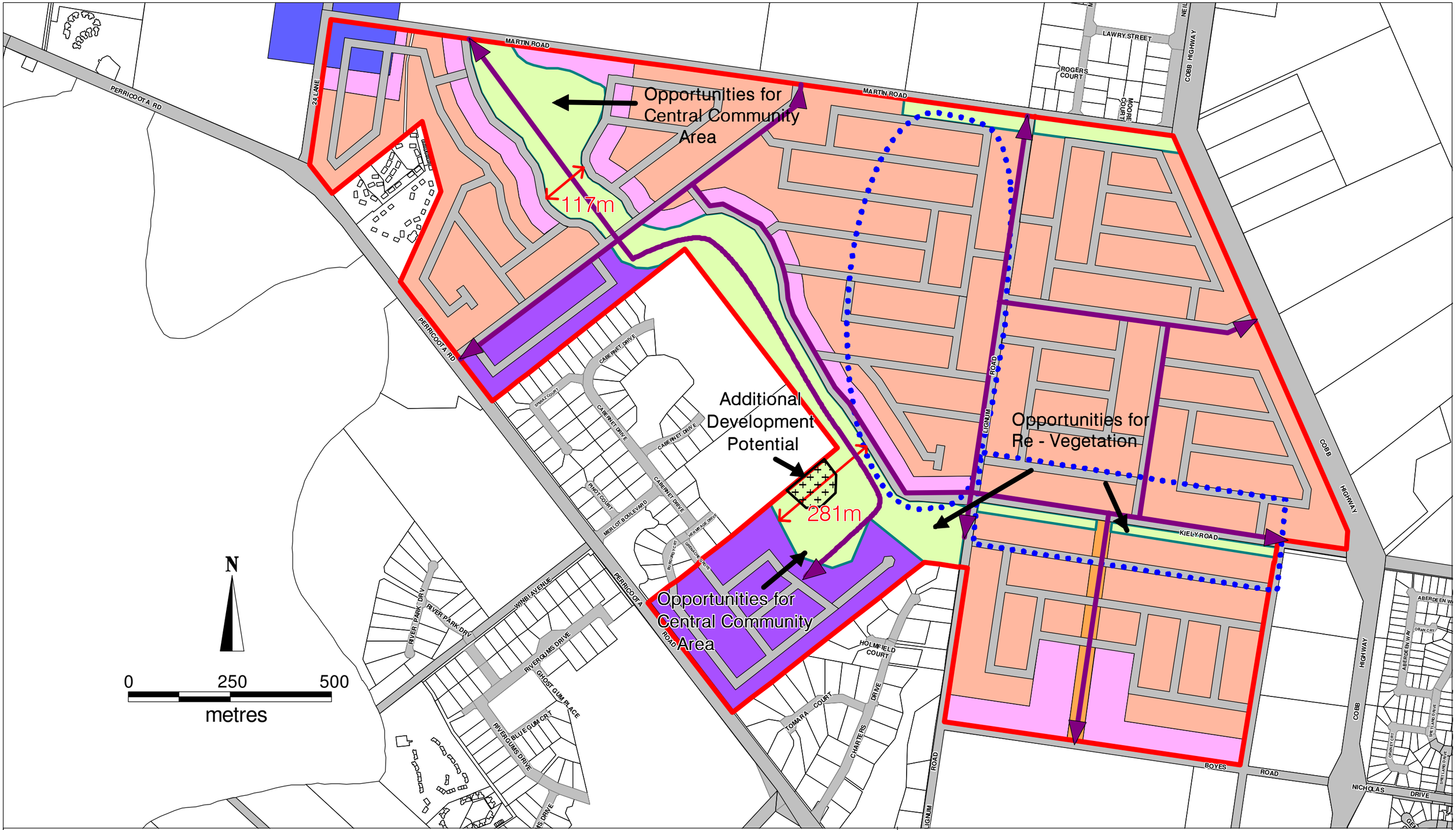
- Study Boundary
- Cadastral Boundary
- Investigation Areas (Subject to Review)
- Proposed Drainage / Linear Open Space
- Arterial Road
- Sub Arterial Road
- Collector
- Local
- Pedestrian & Cycle Linkages
- Shared Space
- Additional Development Potential

Moama North West Masterplan

Map 5: Movement Network Plan

MacroPlan Australia

Source : MacroPlan Australia 2008; Murray Shire Council 2007; Earth Tec Engineering 2003.



Legend

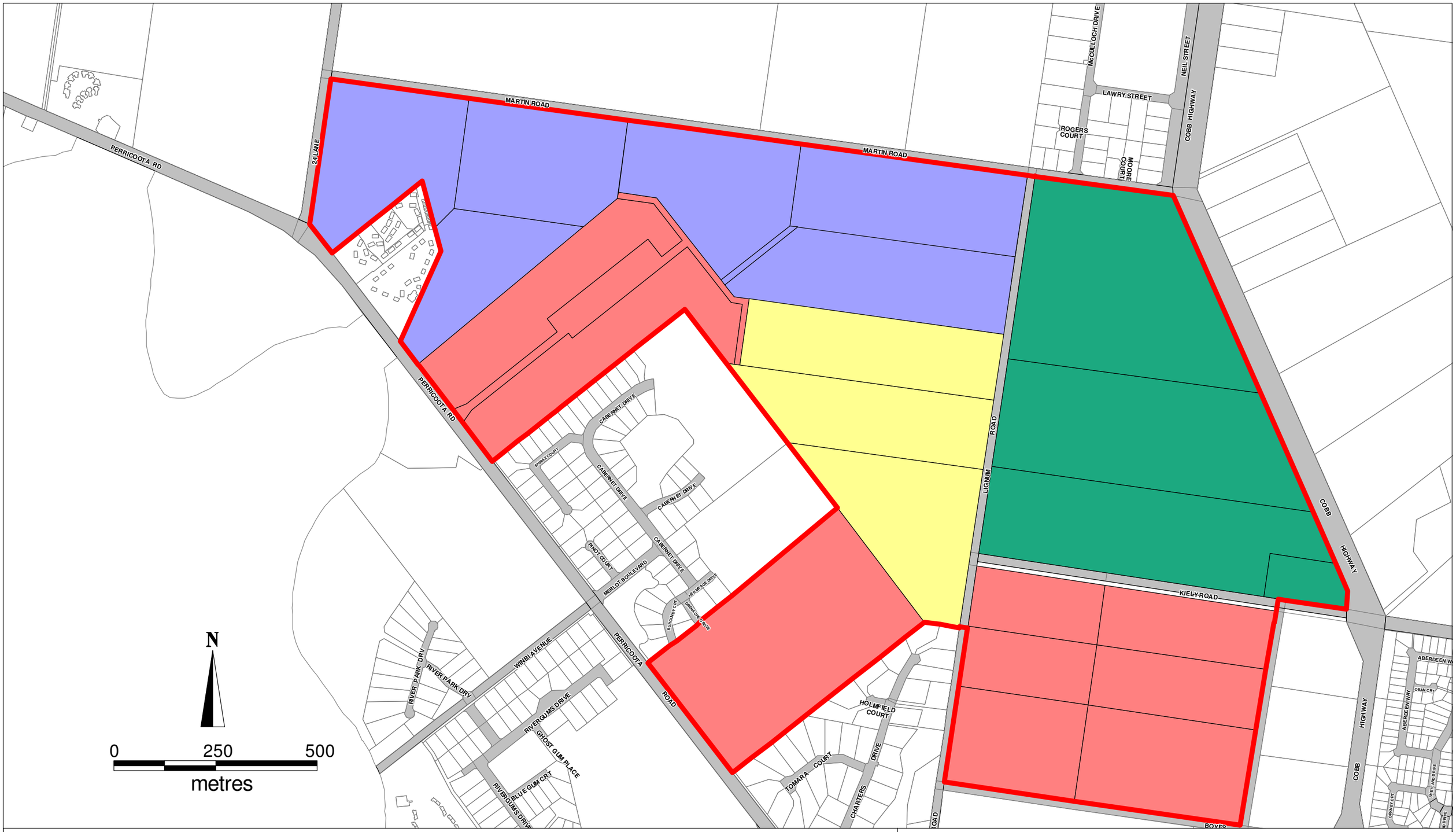
- Study Boundary
- Cadastral Boundary
- Road
- Investigation Area (Subject to Review)
- Residential (Standard)
- Residential (Medium Density)
- Residential (Transition)
- Shared Space
- Local Activity Centre
- Proposed Drainage/ Linear Open Space
- Pedestrian & Cycle Linkages
- Additional Development Potential

Moama North West Masterplan

Map 6: Master Plan

MacroPlan Australia

Source : MacroPlan Australia 2008; Murray Shire Council 2007; Earth Tec Engineering 2003.



Legend

- Study Boundary
- Cadastral Boundary
- Immediate
- Short Term
- Medium Term
- Long Term

Moama North West Masterplan

Map 7: Staging Plan

MacroPlan Australia

Source : MacroPlan Australia 2008; Murray Shire Council 2007; Earth Tec Engineering 2003.

N

0 250 500

metres

Legend

- Study Boundary
- Cadastral Boundary
- Road
- Water Treatment Plant
- Raw Water Pump Station
- Sewer Pump Station
- Sewered Area
- Filtered Water Main
- Raw Water Main
- Sewer Gravity Pipes
- Sewer Rising Pipes
- Storm Water Pipe
- Storm Water Detention Basin

Moama North West Masterplan

Map 9 : Service Infrastructure

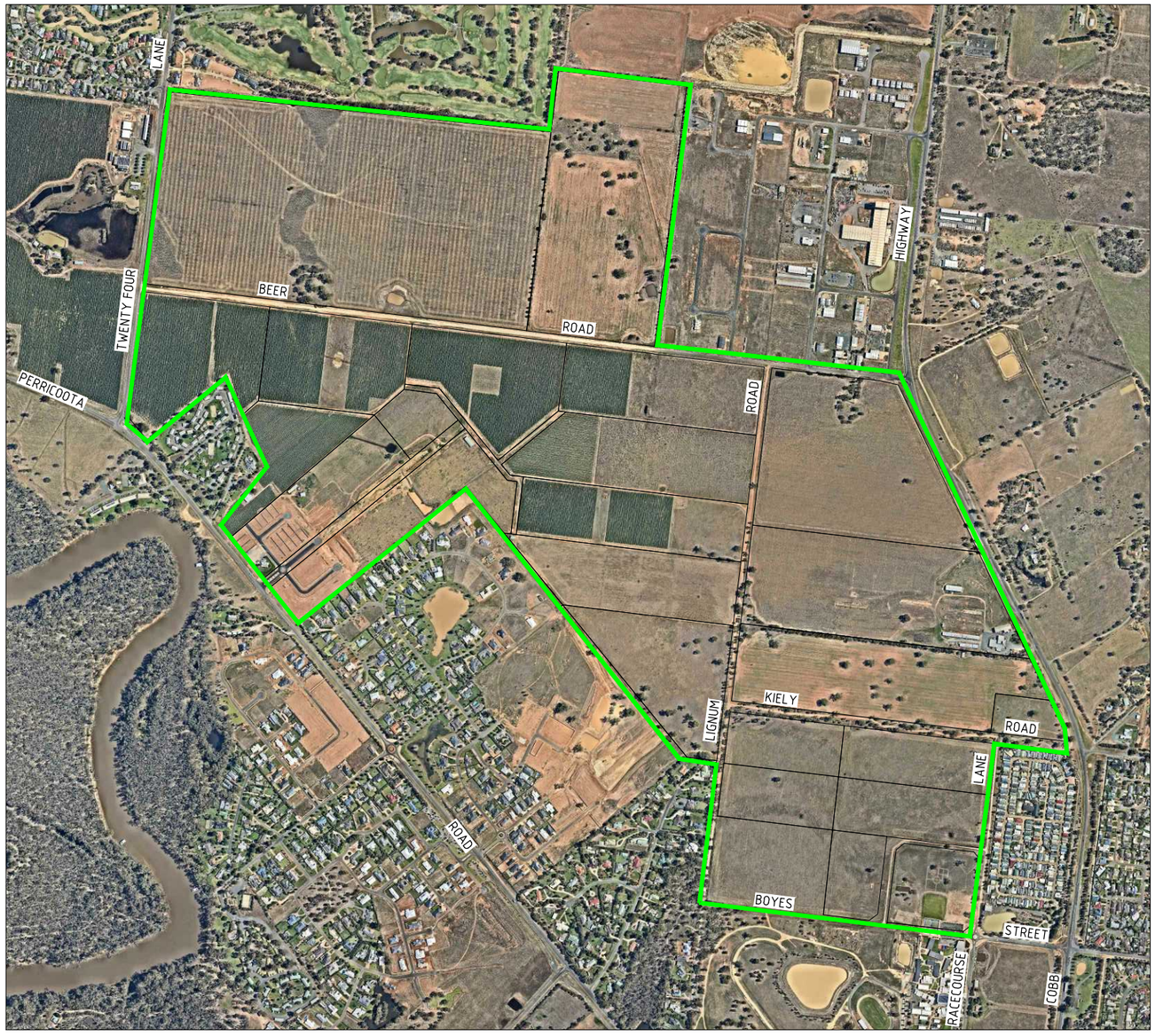
MacroPlan Australia

Source : MacroPlan Australia 2008; Murray Shire Council 2007; Earth Tec Engineering 2003.

Appendix C

Stormwater management system

MOAMA MID-WEST DRAINAGE STRATEGY



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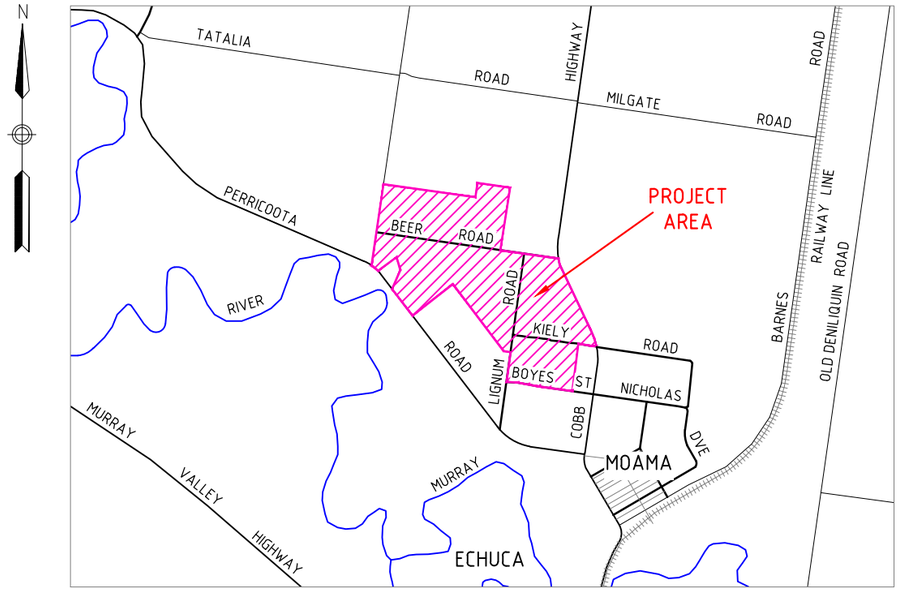

LOCALITY PLAN
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DRAWING INDEX

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- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

ONE CALL SYSTEM DIAL 1100 DIAL BEFORE YOU DIG

CAUTION

OVERHEAD POWER AND UNDERGROUND CABLES IN THE VICINITY. SERVICES TO BE LOCATED PRIOR TO COMMENCEMENT OF WORKS

Rev.	Description	Drn	Ckd	App	Date
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Job Manager	N. HEINRICH	28/11/18

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Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: LOCALITY PLAN AND NOTES

Drawing Status: CONCEPT DESIGN

Consultant Drawing No.: 18055-01 | Sheet.: 01/26 | Rev.: B

Client Drawing No.: 18055-01 | Rev.: B

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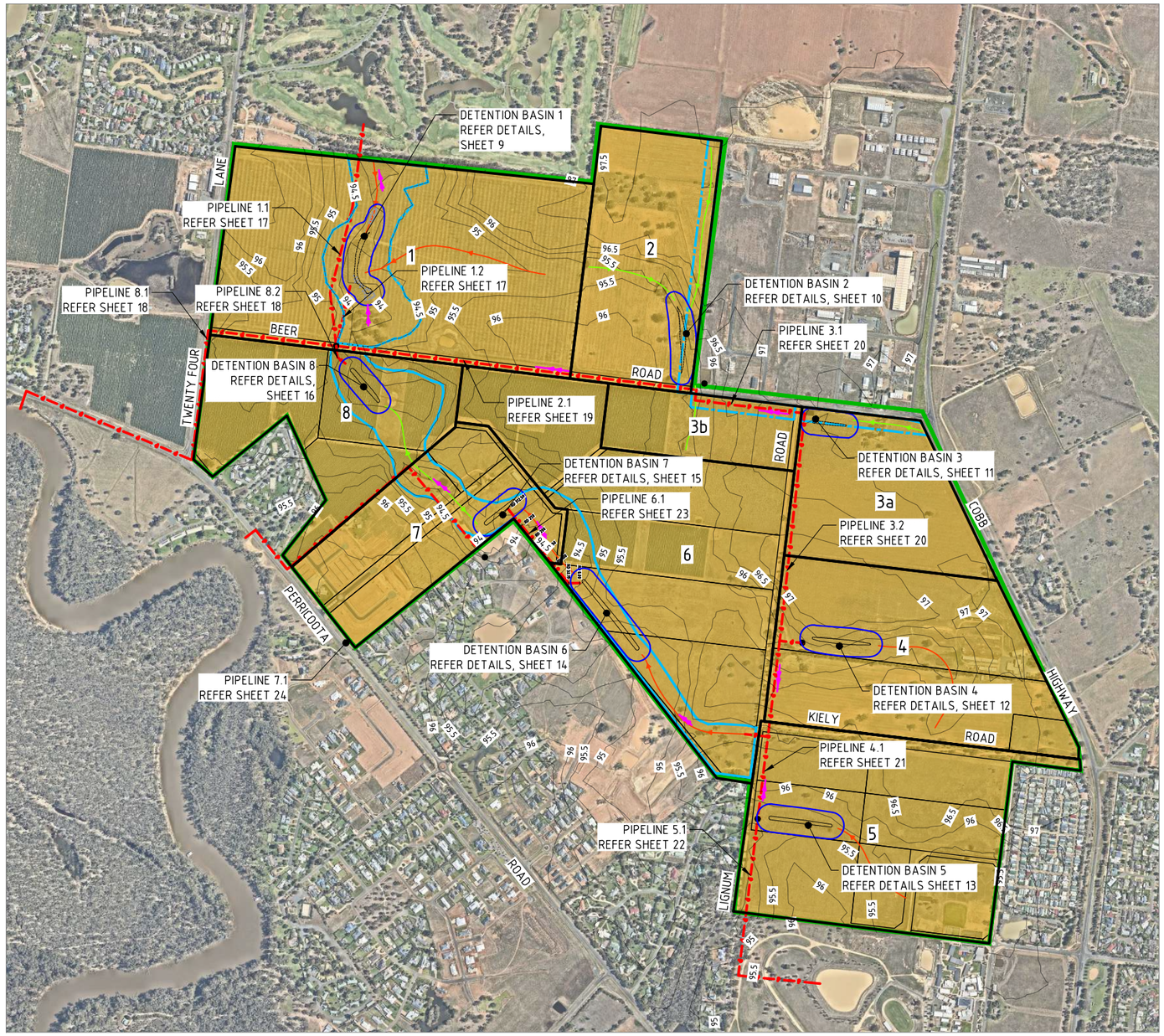

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- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION
- EXISTING INFRASTRUCTURE

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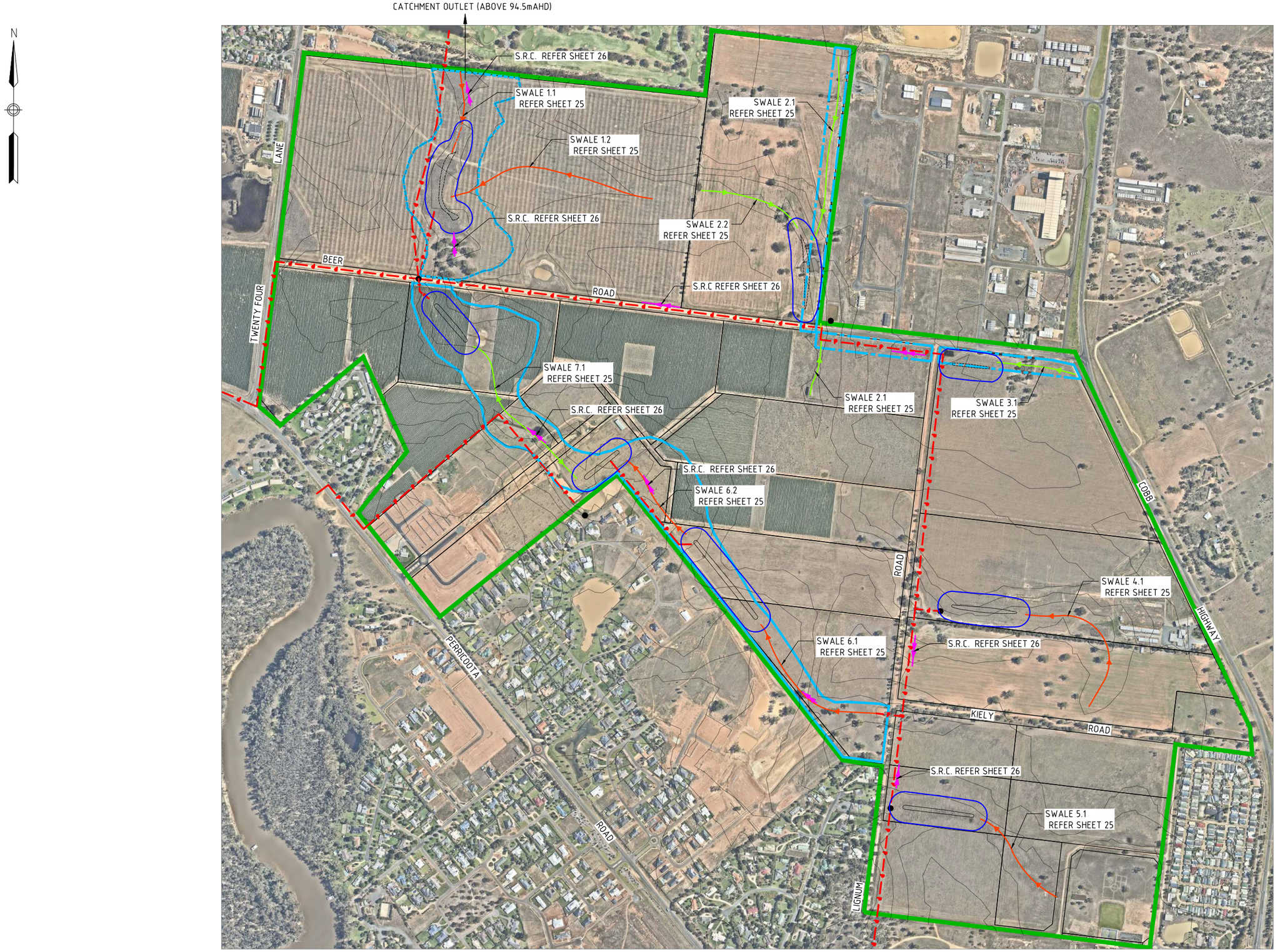

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- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

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Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: SURFACE RELIEF CORRIDOR (S.R.C) AND SWALE LOCATIONS

Drawing Status: CONCEPT DESIGN

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Client Drawing No.: 18055-03 | Rev.: B

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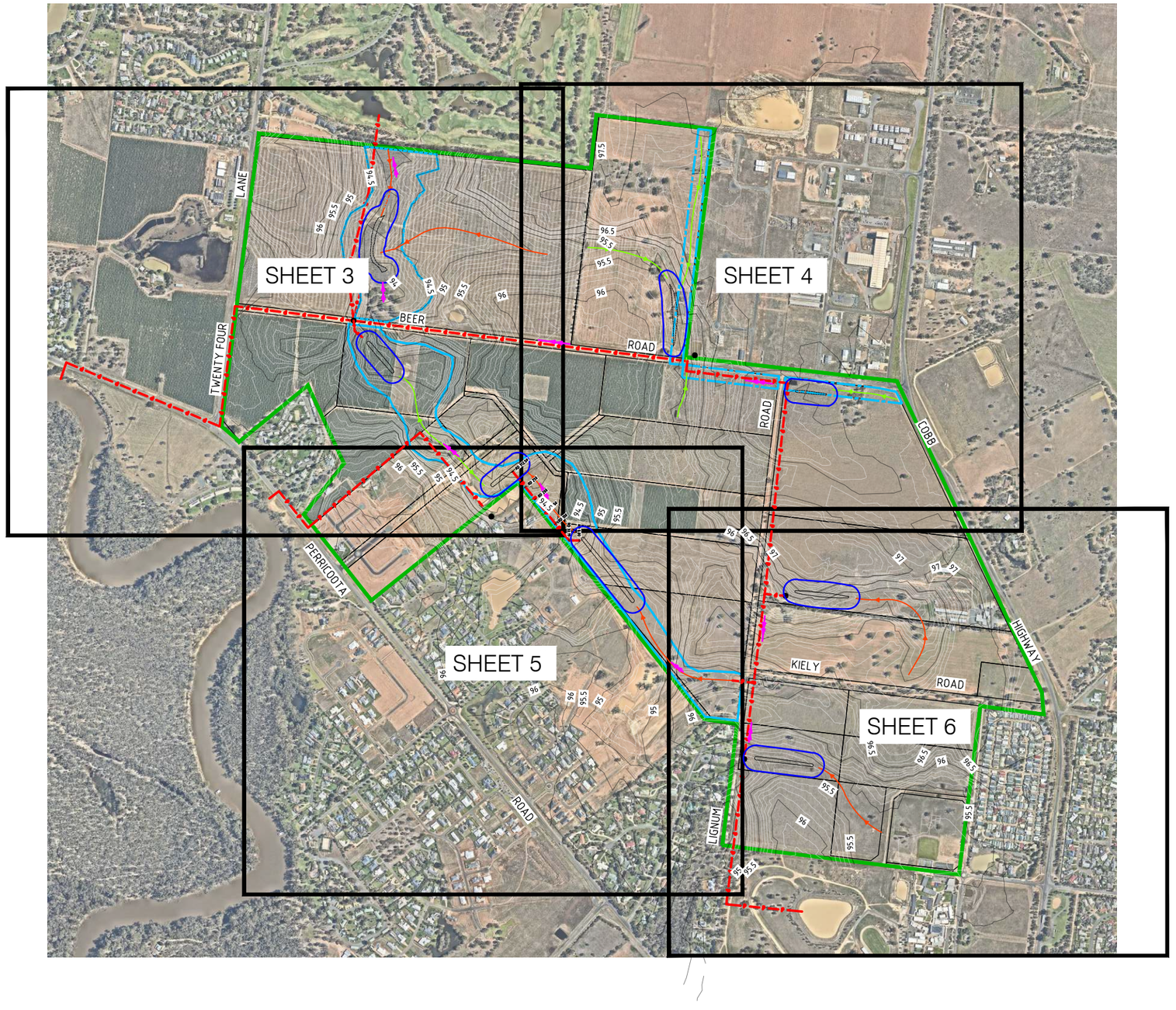

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- DRAINAGE RESERVE (RL 94.5 CONTOUR)
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- DETENTION BASIN
- PUMP STATION

PLAN
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Project: MOAMA MID-WEST DRAINAGE STRATEGY

Drawing Status: CONCEPT DESIGN

Title: LOCALITY AND KEY PLAN

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Client Drawing No. 18055-04 | Rev. B

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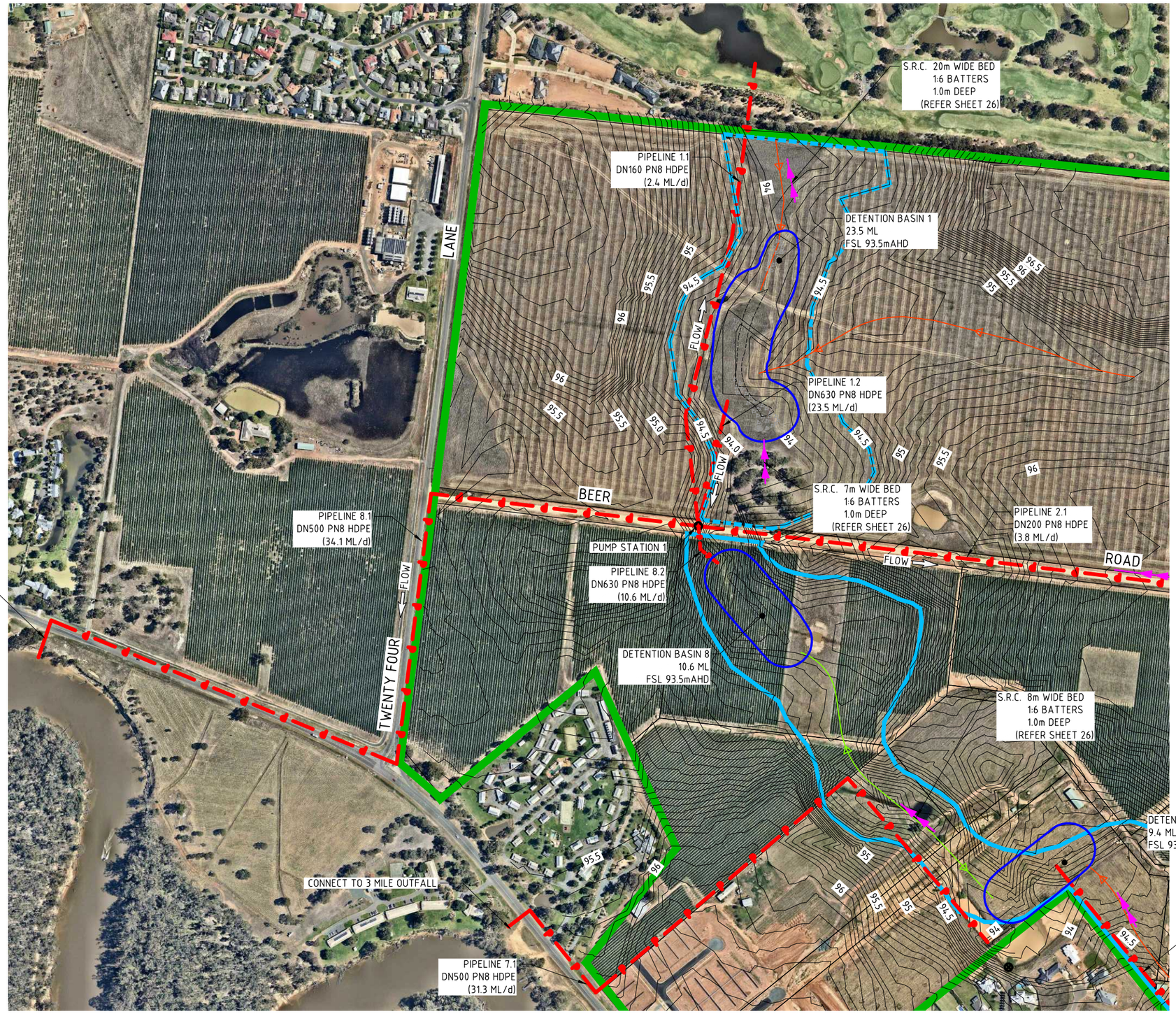

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- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

PLAN
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30 AT A1

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Job Manager	N. HEINRICH	28/11/18

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Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: DETAILED LAYOUT SHEET 1 OF 4

Drawing Status: CONCEPT DESIGN

Consultant Drawing No. 18055-05 | Sheet. 05/26 | Rev. B

Client Drawing No. 18055-05 | Rev. B

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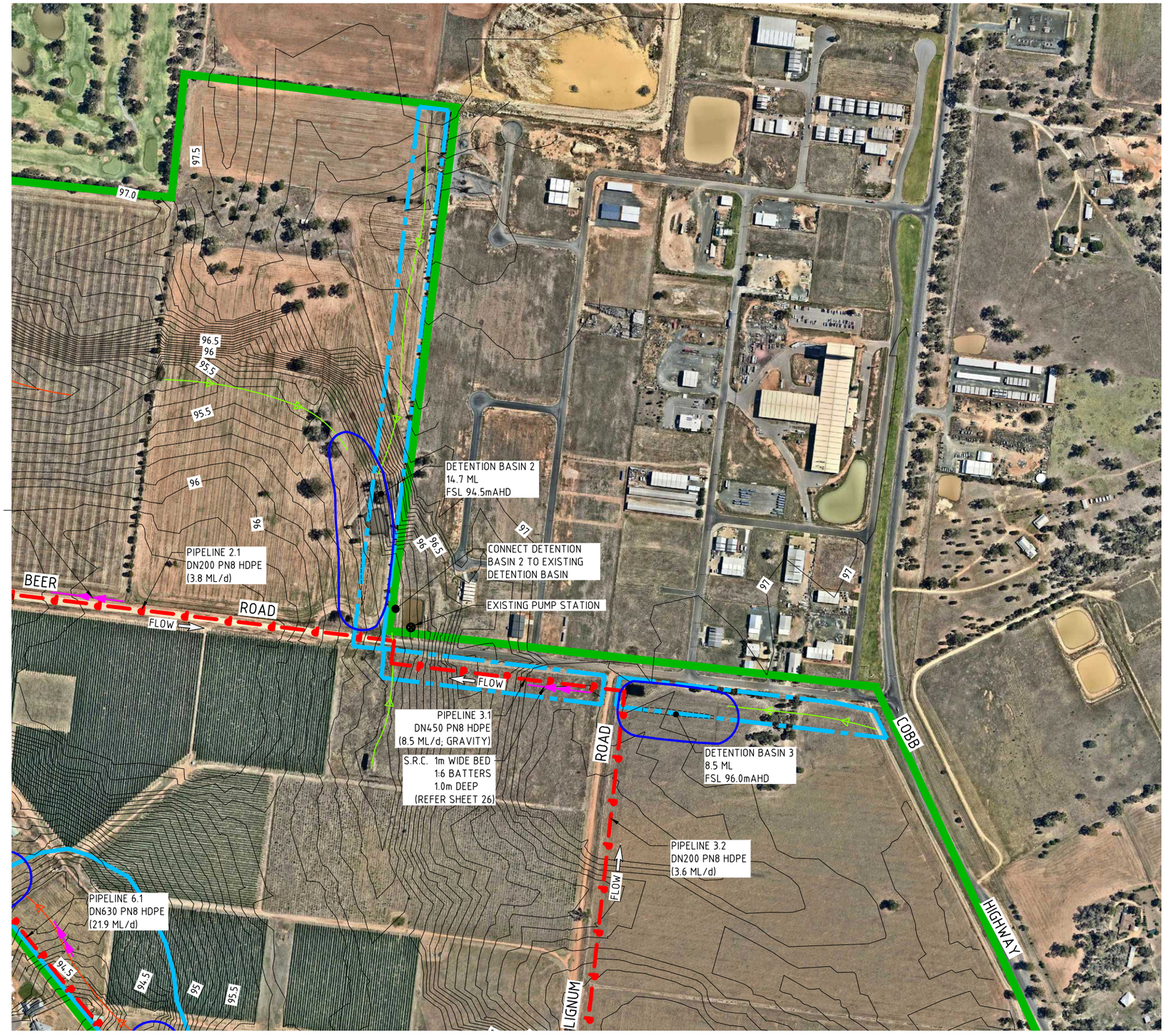

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- SUB-CATCHMENT BOUNDARY
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- DRAINAGE RESERVE (RL 94.5 CONTOUR)
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- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

PLAN

SCALE 1:3000

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Job Manager	N. HEINRICH	28/11/18

Client: murray river council

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Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: DETAILED LAYOUT SHEET 2 OF 4

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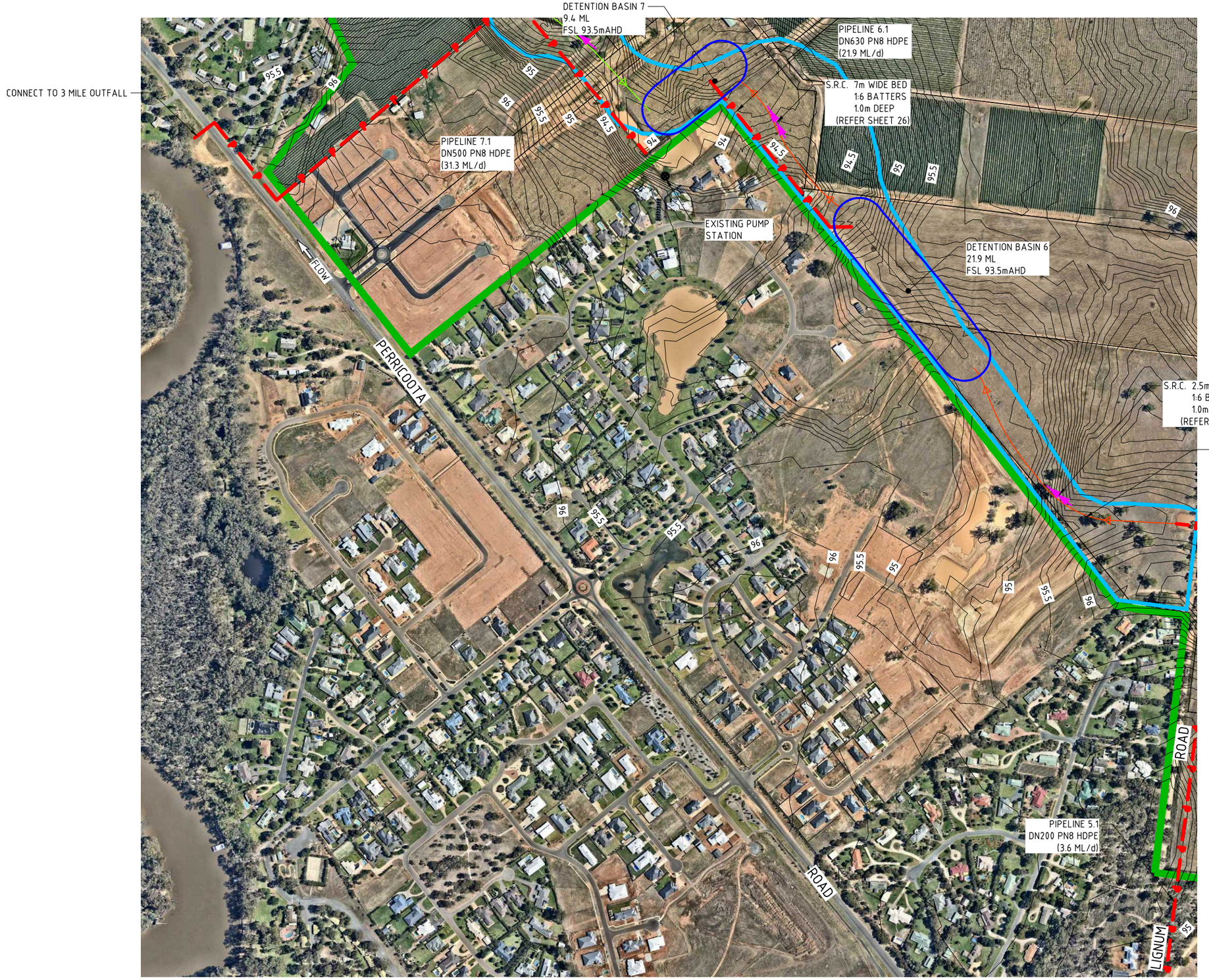

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- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

PLAN

SCALE 1:3000

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30 AT A1

Rev.	Description	Drn	Ckd	App	Date
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Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

RPS
SUITE 12, 33 NISH ST (PO BOX 1317)
ECHUCA, VICTORIA, 3564
T: (03) 5481 0300
F: (03) 5480 6755

Project: MOAMA MID-WEST DRAINAGE STRATEGY

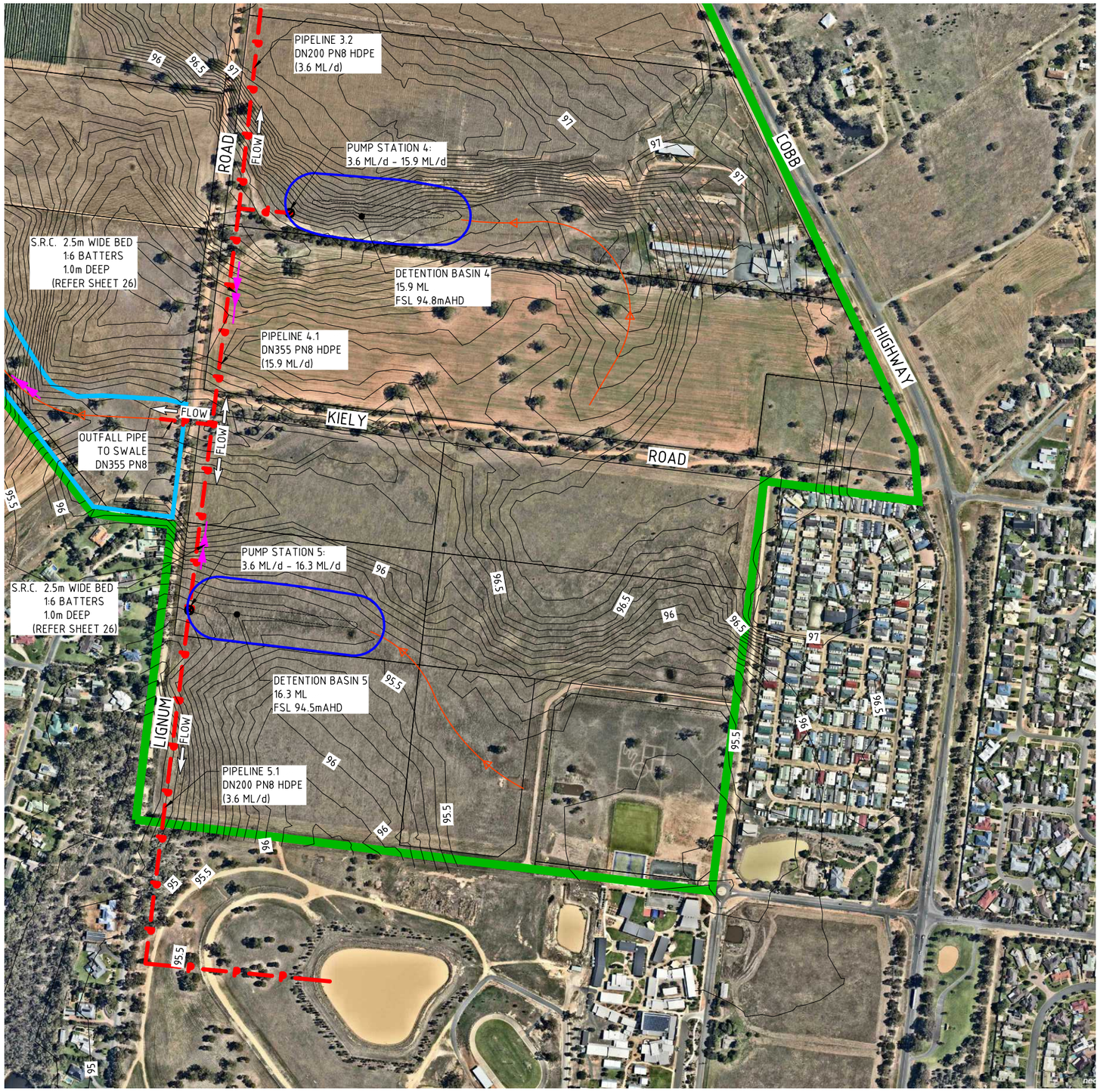
Drawing Status: CONCEPT DESIGN

Title: DETAILED LAYOUT
SHEET 3 OF 4

Consultant Drawing No. 18055-07 | Sheet. 07/26 | Rev. B

Client Drawing No. 18055-07 | Rev. B

N



LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

PLAN
SCALE 1:3000

1:3000 0 50 100 150 200 250 300m
30 AT A1

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
A	ISSUED FOR CLIENT REVIEW	SG	NH	NH	28/11/2018

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Scale 1:300 Sheet A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

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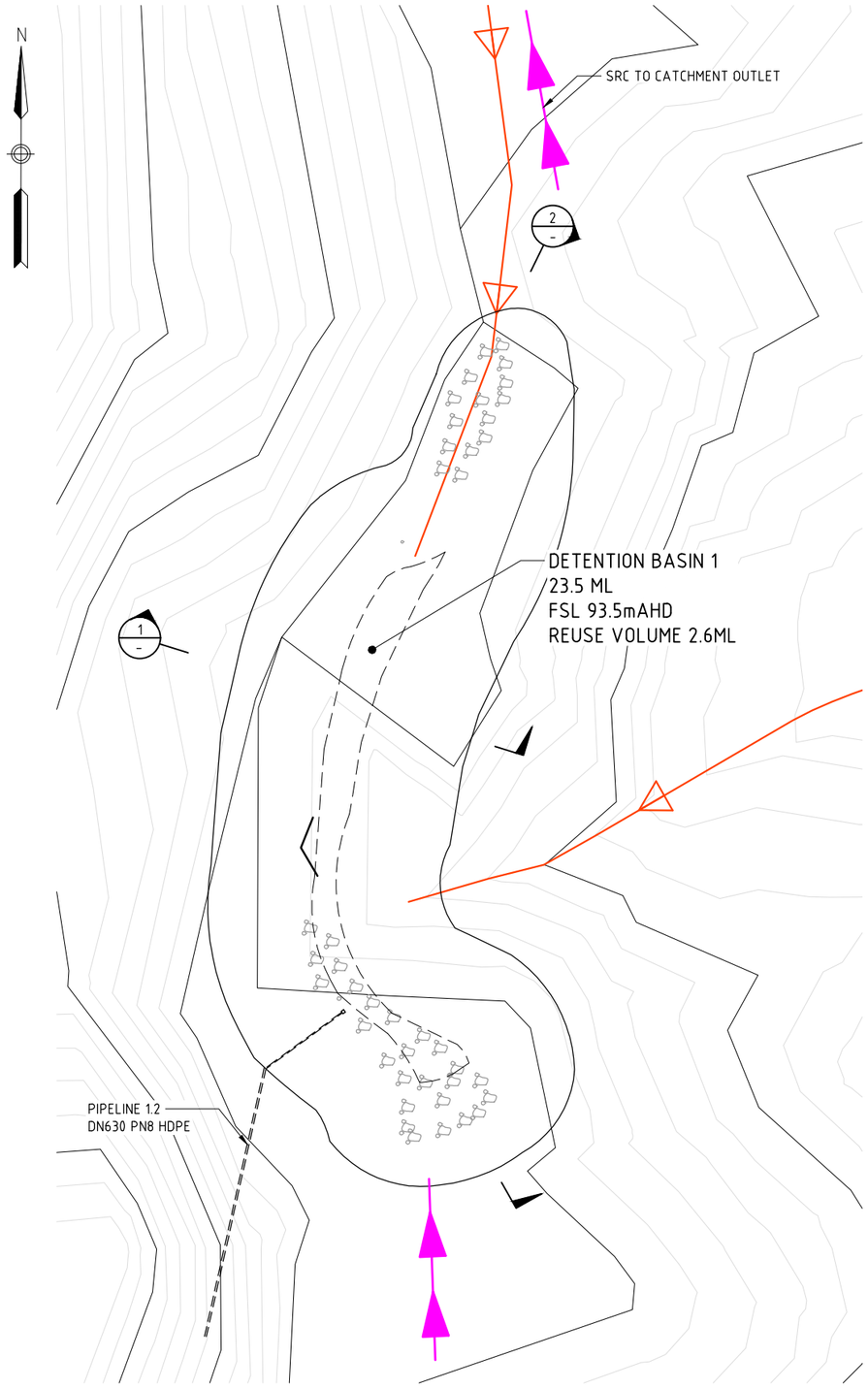
Project: MOAMA MID-WEST DRAINAGE STRATEGY

Drawing Status: CONCEPT DESIGN

Title: DETAILED LAYOUT SHEET 4 OF 4

Consultant Drawing No. 18055-08 | Sheet. 08/26 | Rev. B

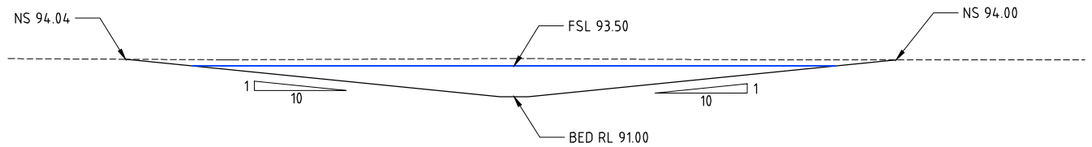
Client Drawing No. 18055-08 | Rev. B



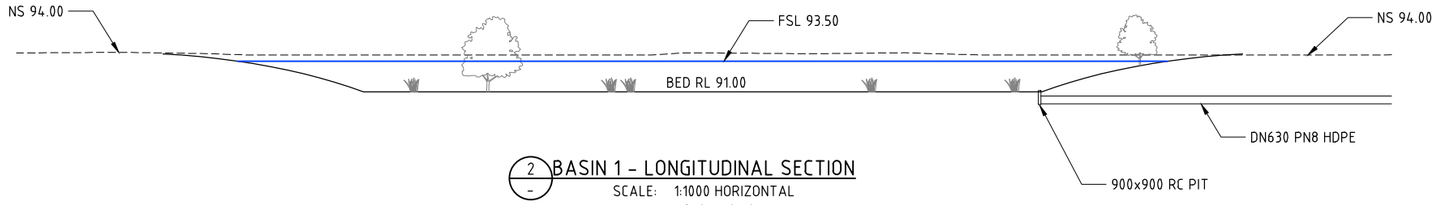
BASIN 1 - PLAN
SCALE 1:1000

LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION



1 BASIN 1 - CROSS SECTION
SCALE 1:250



2 BASIN 1 - LONGITUDINAL SECTION
SCALE: 1:1000 HORIZONTAL
1:250 VERTICAL

1:250 0 5 10 15 20 25m
5 4 3 2 1 AT A1

1:1000 0 20 40 60 80 100m
20 10 AT A1

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
A	ISSUED FOR CLIENT REVIEW	SG	NH	NH	28/11/2018

DOCUMENTS ISSUED DO NOT BEAR ORIGINAL SIGNATURES. EVIDENCE OF VERIFICATION AND APPROVAL MAY BE OBTAINED FROM THE COMPANY.

Scale: VARIES | Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

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SUITE 12, 33 NISH ST (PO BOX 1317)
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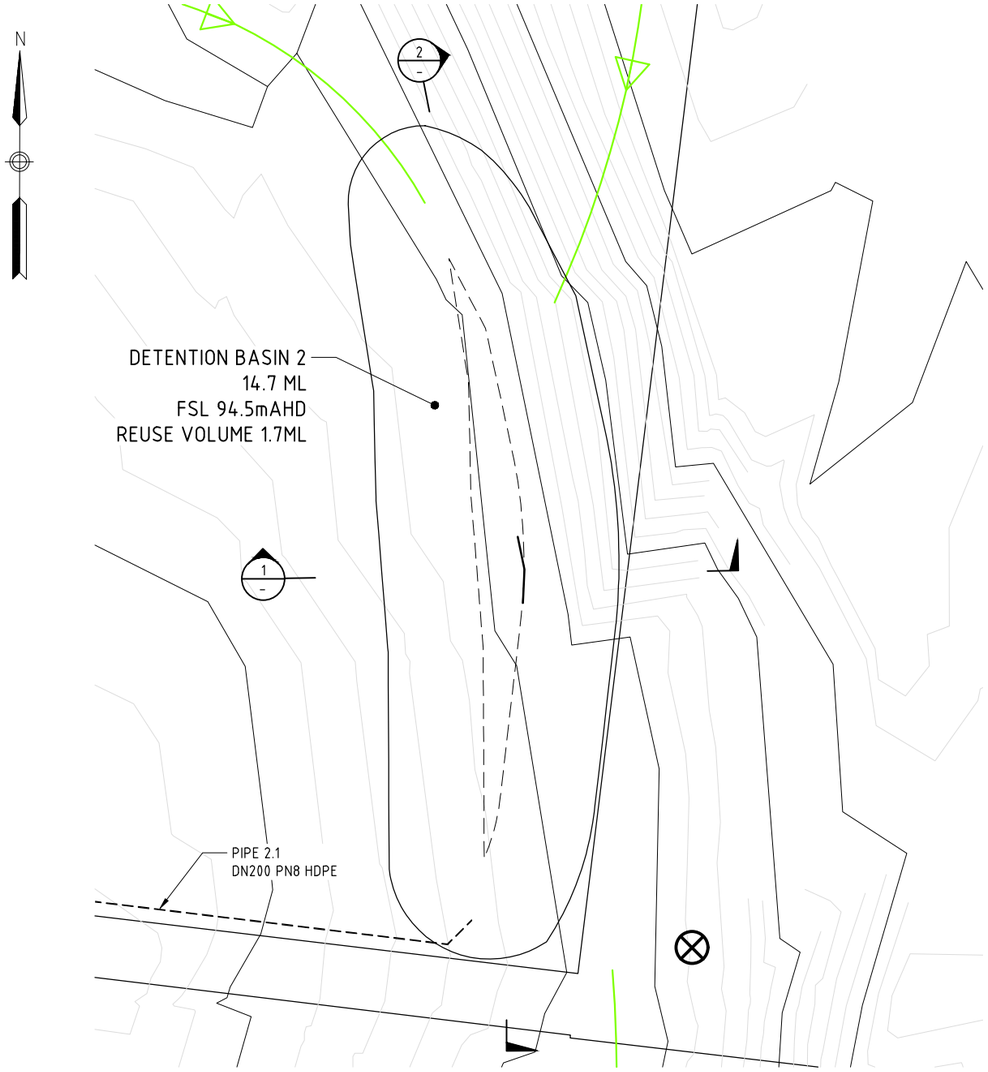
Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: DETENTION BASIN DETAILS
SHEET 1 OF 8

Drawing Status: CONCEPT DESIGN

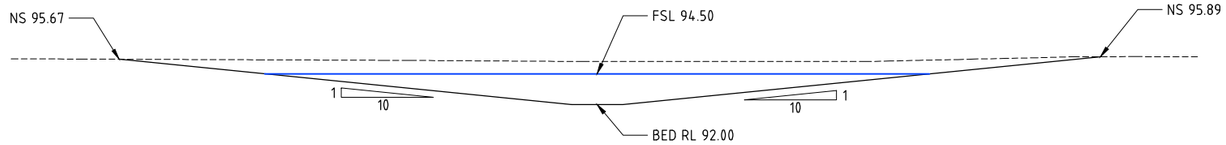
Consultant Drawing No.: 18055-09 | Sheet.: 09/26 | Rev.: B

Client Drawing No.: 18055-09 | Rev.: B

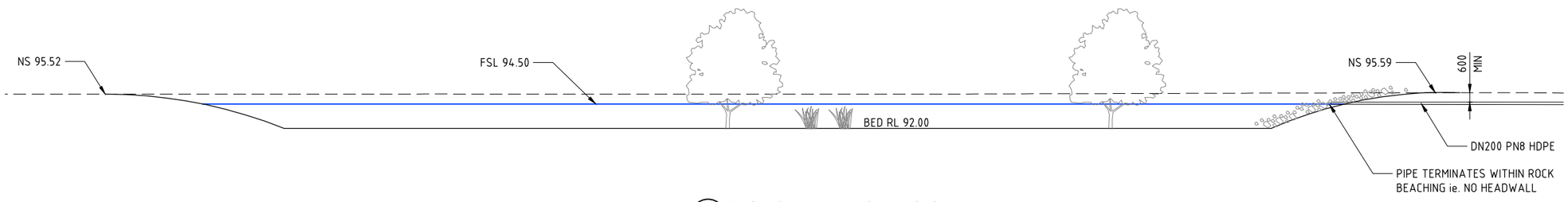


BASIN 2 - PLAN
SCALE 1:1000

LEGEND:
- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION



1 - BASIN 2 - CROSS SECTION
SCALE 1:250



2 - BASIN 2 - LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:500
VERTICAL 1:250

1:250 0 5 10 15 20 25m — 5 4 3 2 1 — AT A1
1:500 0 10 20 30 40 50m — 10 8 6 4 2 — AT A1
1:1000 0 20 40 60 80 100m — 20 10 — AT A1

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
A	ISSUED FOR CLIENT REVIEW	SG	NH	NH	28/11/2018

DOCUMENTS ISSUED DO NOT BEAR ORIGINAL SIGNATURES. EVIDENCE OF VERIFICATION AND APPROVAL MAY BE OBTAINED FROM THE COMPANY.

Scale: VARIES | Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

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Project: MOAMA MID-WEST DRAINAGE STRATEGY

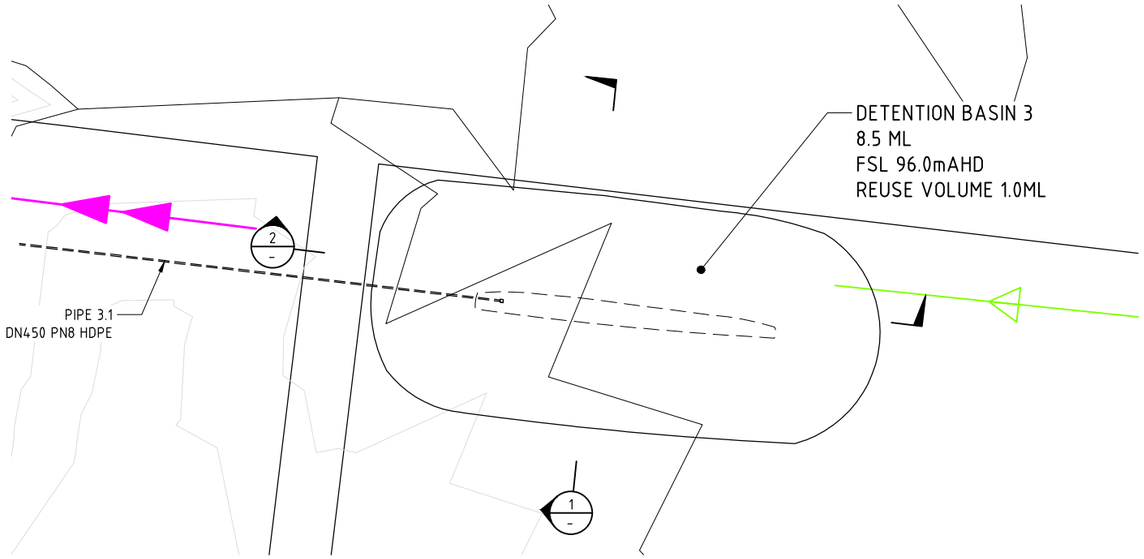
Drawing Status: CONCEPT DESIGN

Title: DETENTION BASIN DETAILS SHEET 2 OF 8

Consultant Drawing No. 18055-10 | Sheet. 10/26 | Rev. B

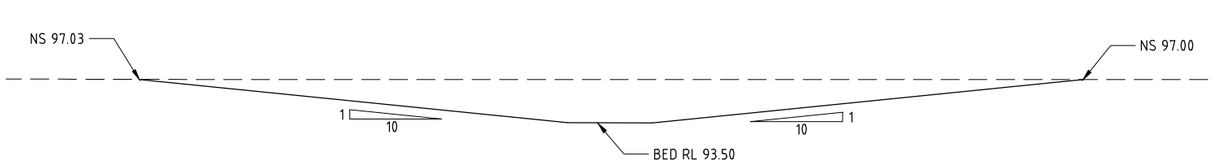
Client Drawing No. 18055-10 | Rev. B

N

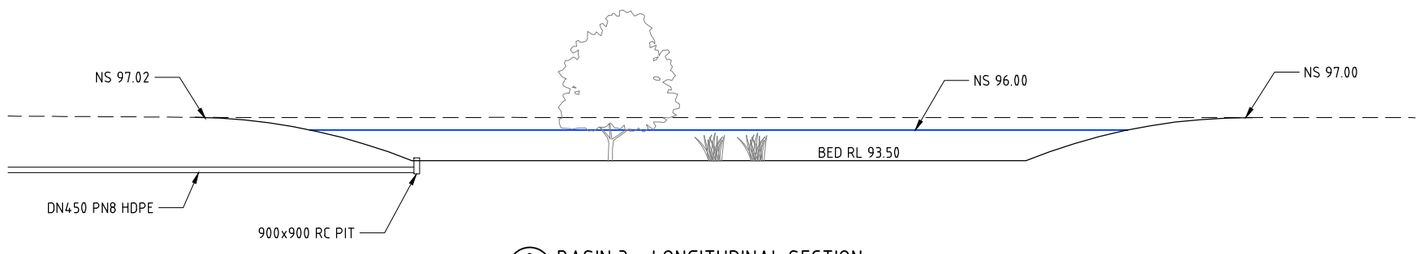


BASIN 3 - PLAN
SCALE 1:1000

LEGEND:
- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION



1 / - BASIN 3 - CROSS SECTION
SCALE 1:250



2 / - BASIN 3 - LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:500
VERTICAL 1:250

1:250 0 5 10 15 20 25m
5 4 3 2 1 AT A1

1:500 0 10 20 30 40 50m
10 8 6 4 2 AT A1

1:1000 0 20 40 60 80 100m
20 10 AT A1

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
A	ISSUED FOR CLIENT REVIEW	SG	NH	NH	28/11/2018

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Scale: VARIES | Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

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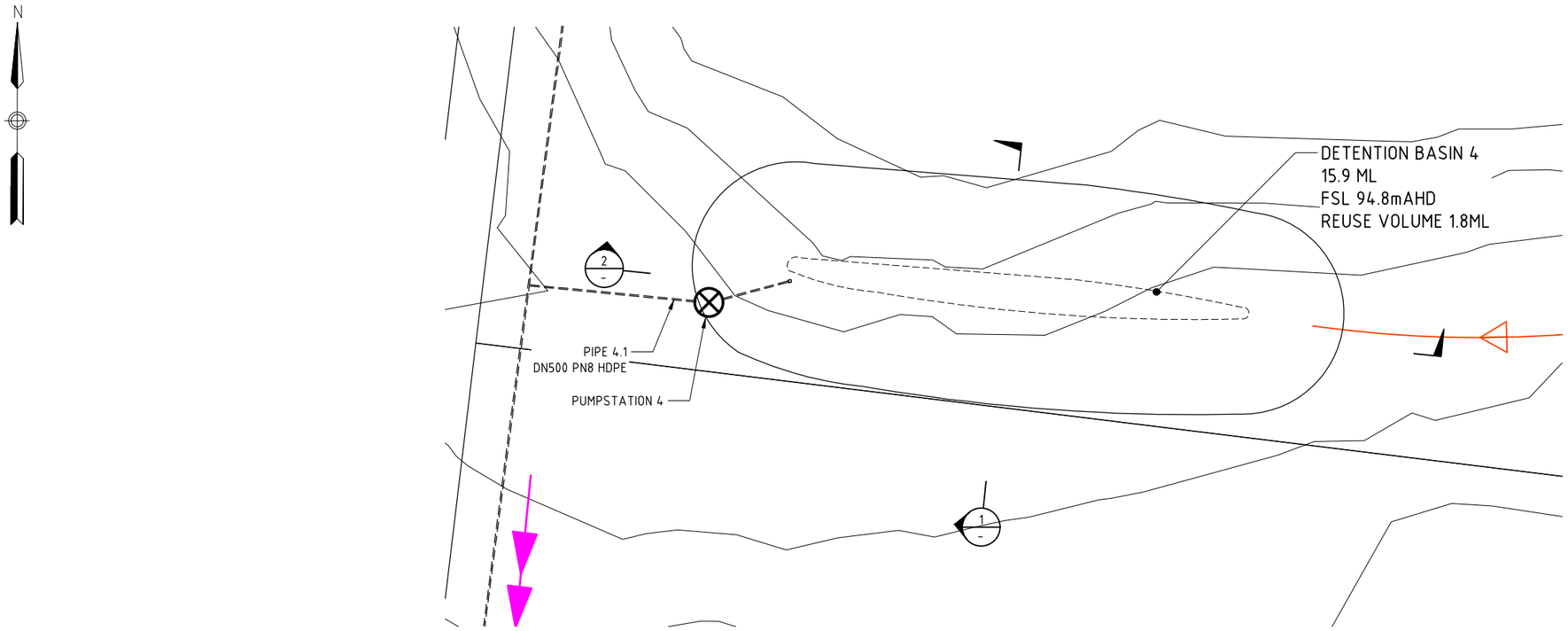
Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: DETENTION BASIN DETAILS
SHEET 3 OF 8

Drawing Status: CONCEPT DESIGN

Consultant Drawing No. 18055-11 | Sheet. 11/26 | Rev. B

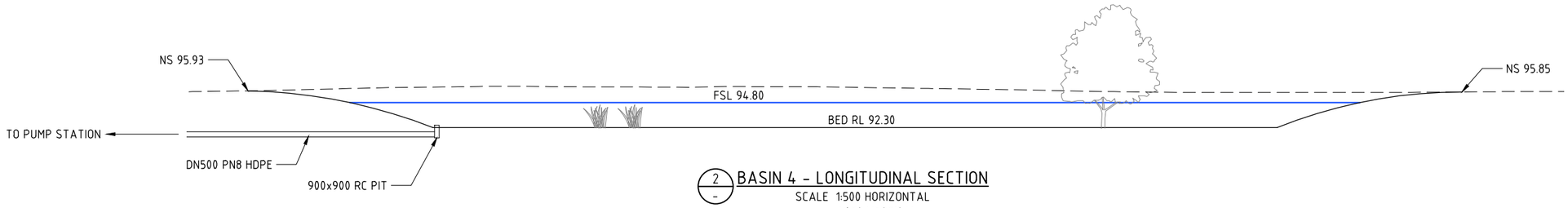
Client Drawing No. 18055-11 | Rev. B



BASIN 4 - PLAN
SCALE 1:1000

LEGEND:
- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

1 – BASIN 4 - CROSS SECTION
SCALE 1:250



2 – BASIN 4 - LONGITUDINAL SECTION
SCALE 1:500 HORIZONTAL
1:250 VERTICAL

1:250 0 5 10 15 20 25m
5 4 3 2 1 AT A1

1:500 0 10 20 30 40 50m
10 8 6 4 2 AT A1

1:1000 0 20 40 60 80 100m
20 10 AT A1

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
A	ISSUED FOR CLIENT REVIEW	SG	NH	NH	28/11/2018

DOCUMENTS ISSUED DO NOT BEAR ORIGINAL SIGNATURES. EVIDENCE OF VERIFICATION AND APPROVAL MAY BE OBTAINED FROM THE COMPANY.

Scale: VARIES | Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

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SUITE 12, 33 NISH ST (PO BOX 1317)
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Project: MOAMA MID-WEST DRAINAGE STRATEGY

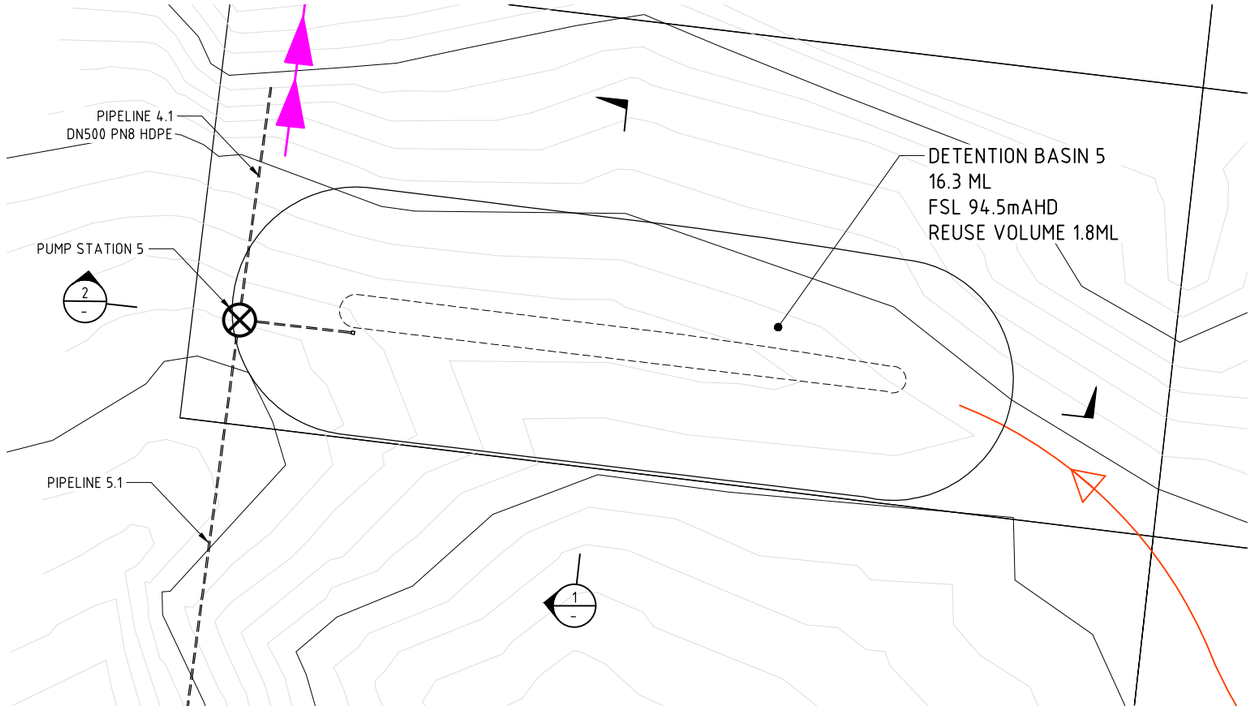
Title: DETENTION BASIN DETAILS
SHEET 4 OF 8

Drawing Status: CONCEPT DESIGN

Consultant Drawing No.: 18055-12 | Sheet: 12/26 | Rev.: B

Client Drawing No.: 18055-12 | Rev.: B

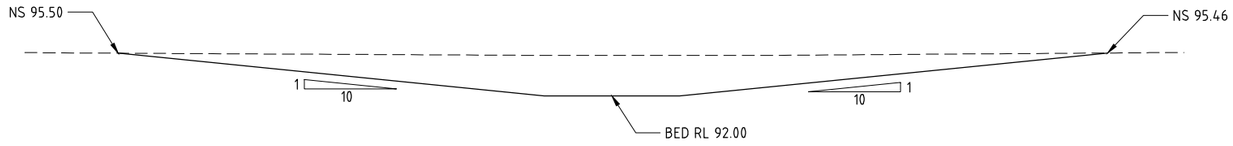
N



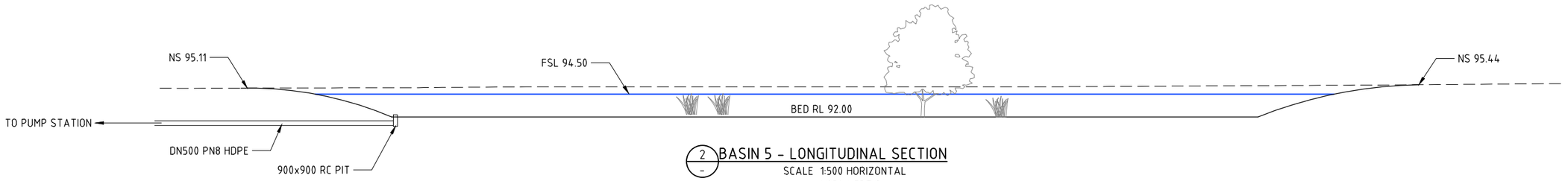
BASIN 5 - PLAN
SCALE 1:1000

LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION



1 - BASIN 5 - CROSS SECTION
SCALE 1:250



2 - BASIN 5 - LONGITUDINAL SECTION
SCALE 1:500 HORIZONTAL
1:250 VERTICAL

1:250 0 5 10 15 20 25m
5 4 3 2 1 AT A1

1:500 0 10 20 30 40 50m
10 8 6 4 2 AT A1

1:1000 0 20 40 60 80 100m
20 10 AT A1

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
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DOCUMENTS ISSUED DO NOT BEAR ORIGINAL SIGNATURES. EVIDENCE OF VERIFICATION AND APPROVAL MAY BE OBTAINED FROM THE COMPANY.

Scale: VARIES | Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

RPS
SUITE 12, 33 NISH ST (PO BOX 1317)
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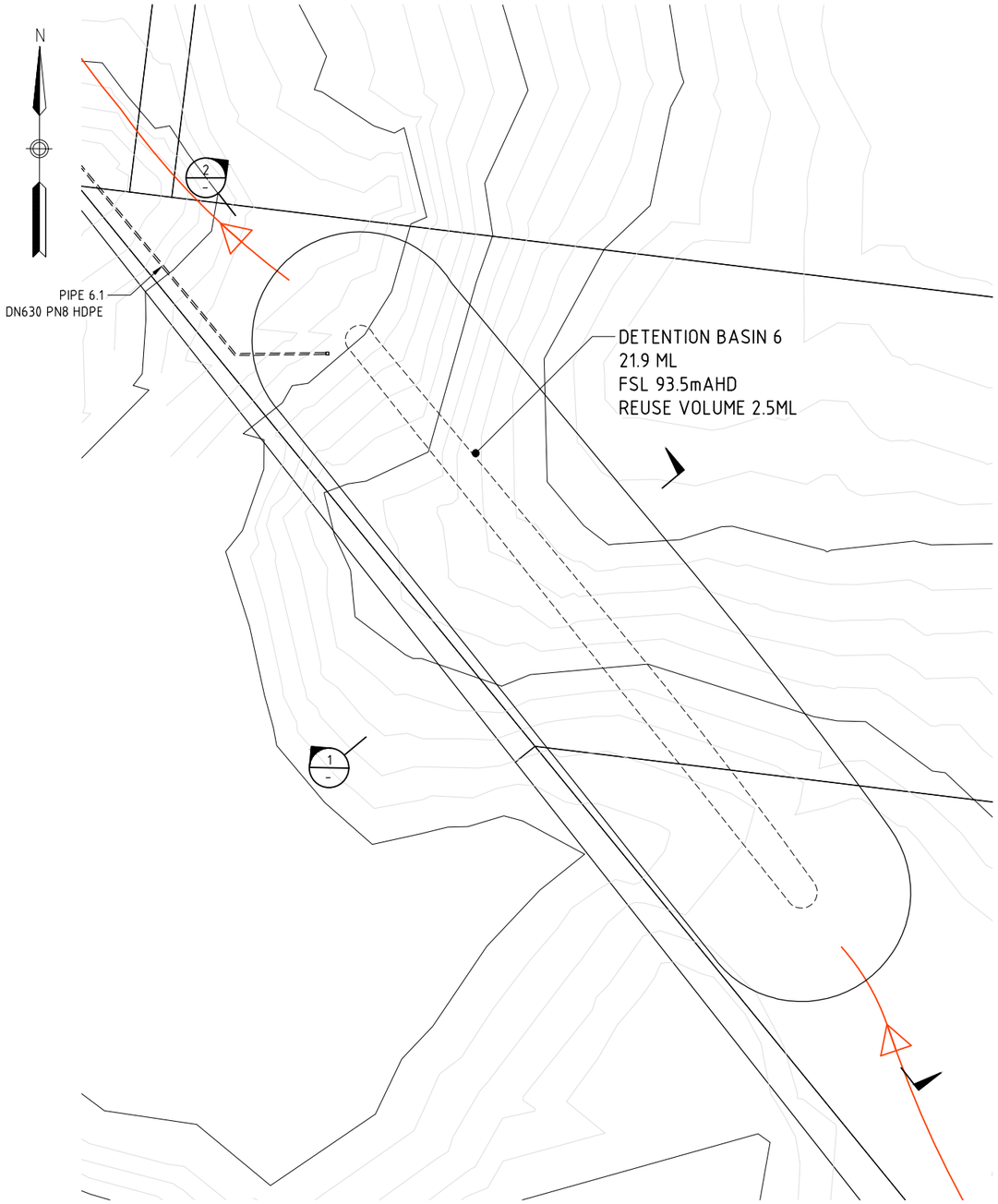
Project: MOAMA MID-WEST DRAINAGE STRATEGY

Drawing Status: CONCEPT DESIGN

Title: DETENTION BASIN DETAILS
SHEET 5 OF 8

Consultant Drawing No.: 18055-13 | Sheet.: 13/26 | Rev.: B

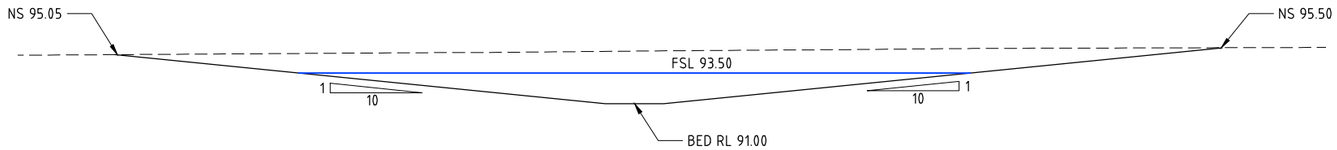
Client Drawing No.: 18055-13 | Rev.: B



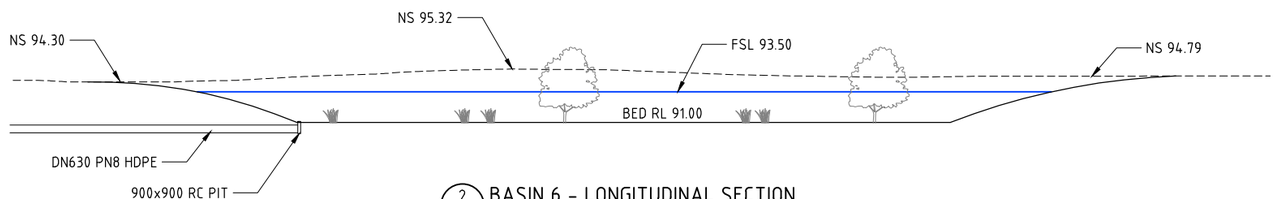
BASIN 6 - PLAN
SCALE 1:1000

LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION



1 - BASIN 6 - CROSS SECTION
SCALE 1:250



2 - BASIN 6 - LONGITUDINAL SECTION
SCALE 1:1000 HORIZONTAL
1:250 VERTICAL

1:250 0 5 10 15 20 25m
5 4 3 2 1 AT A1

1:1000 0 20 40 60 80 100m
20 10 AT A1

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
A	ISSUED FOR CLIENT REVIEW	SG	NH	NH	28/11/2018

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Scale: VARIES | Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

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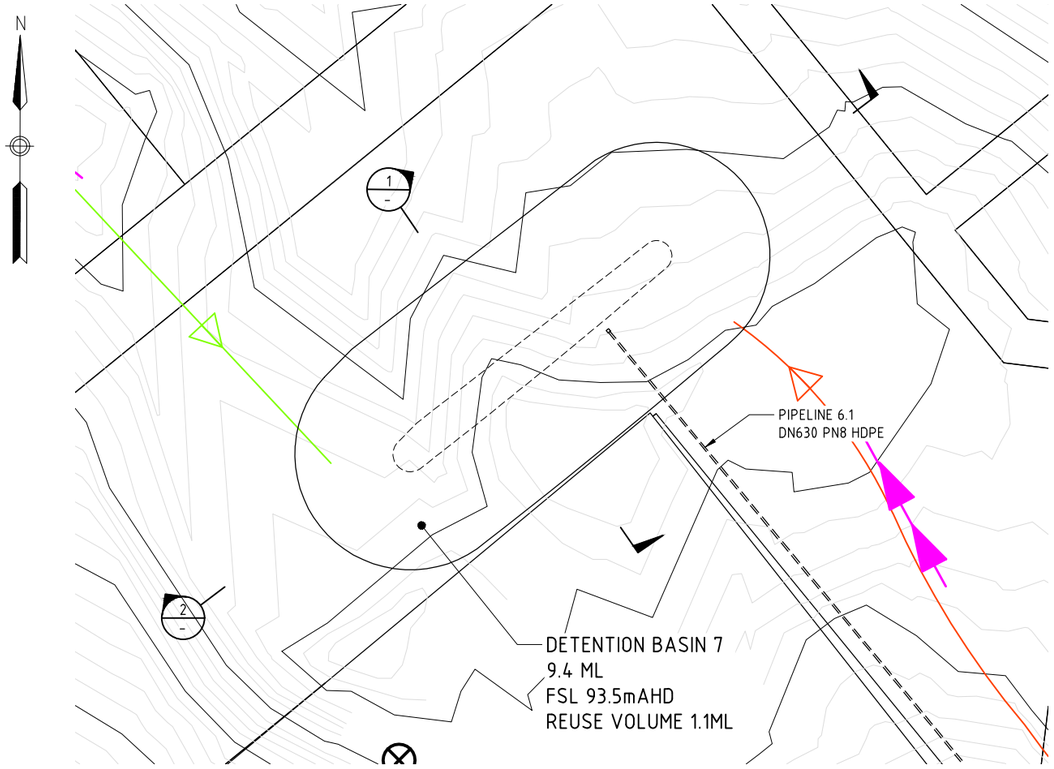
Project: MOAMA MID-WEST DRAINAGE STRATEGY

Drawing Status: CONCEPT DESIGN

Title: DETENTION BASIN DETAILS
SHEET 6 OF 8

Consultant Drawing No.: 18055-14 | Sheet.: 14/26 | Rev.: B

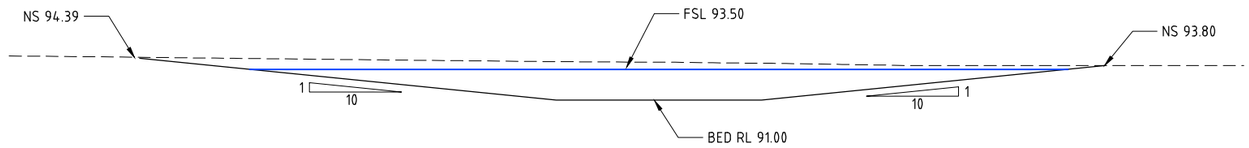
Client Drawing No.: 18055-14 | Rev.: B



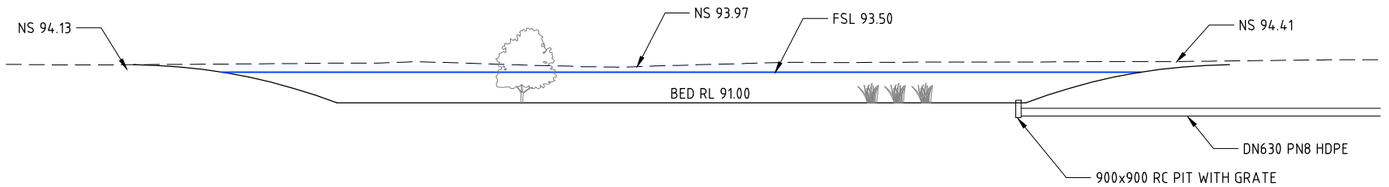
BASIN 7 - PLAN
SCALE 1:1000

LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION



1 - BASIN 7 - CROSS SECTION
SCALE 1:250



2 - BASIN 7 - LONGITUDINAL SECTION
SCALE 1:500 HORIZONTAL
1:250 VERTICAL

1:250 0 5 10 15 20 25m
5 4 3 2 1 AT A1

1:500 0 10 20 30 40 50m
10 8 6 4 2 AT A1

1:1000 0 20 40 60 80 100m
20 10 AT A1

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
A	ISSUED FOR CLIENT REVIEW	SG	NH	NH	28/11/2018

Scale: VARIES | Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

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SUITE 12, 33 NISH ST (PO BOX 1317)
ECHUCA, VICTORIA, 3564
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Project: MOAMA MID-WEST DRAINAGE STRATEGY

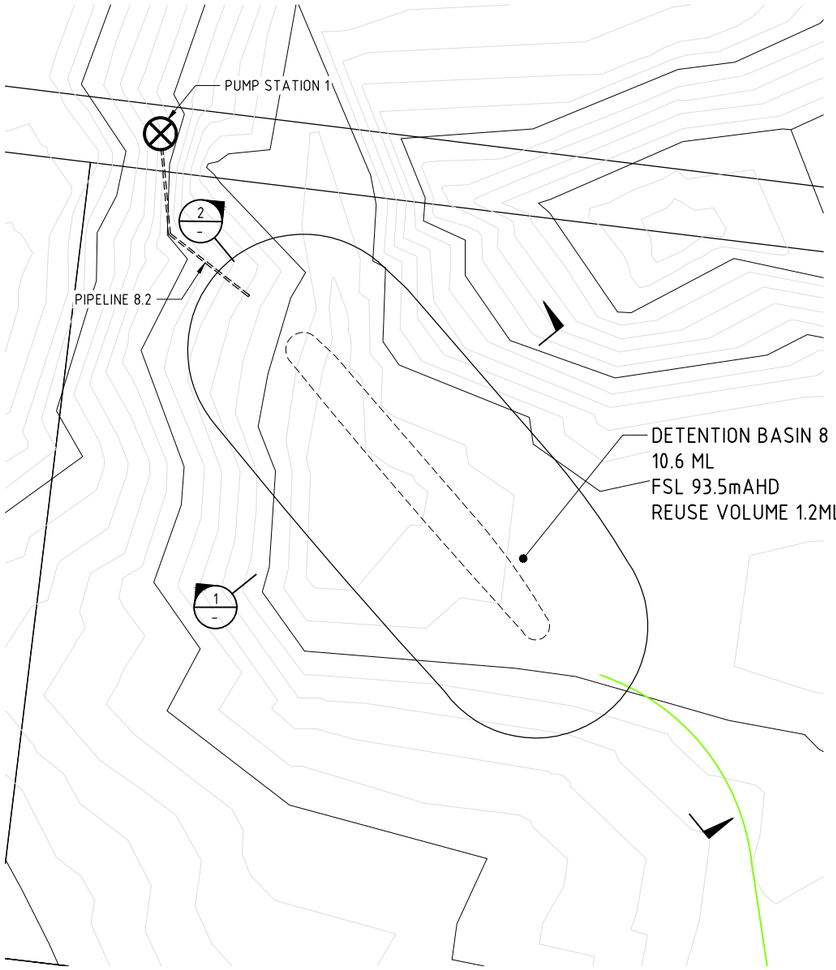
Title: DETENTION BASIN DETAILS SHEET 7 OF 8

Drawing Status: CONCEPT DESIGN

Consultant Drawing No. 18055-15 | Sheet. 15/26 | Rev. B

Client Drawing No. 18055-15 | Rev. B

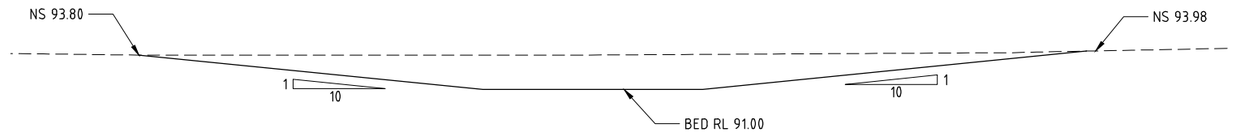
N



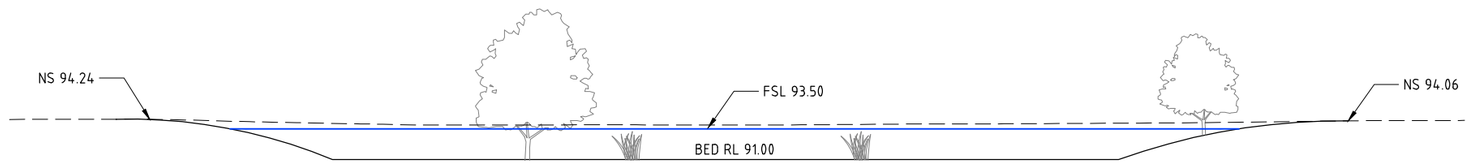
BASIN 8 - PLAN
SCALE 1:1000

LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION



1 BASIN 8 - CROSS SECTION
SCALE 1:250



2 BASIN 8 - LONGITUDINAL SECTION
SCALE 1:500 HORIZONTAL
1:250 VERTICAL

1:250 0 5 10 15 20 25m
5 4 3 2 1 AT A1

1:500 0 10 20 30 40 50m
10 8 6 4 2 AT A1

1:1000 0 20 40 60 80 100m
20 10 AT A1

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
A	ISSUED FOR CLIENT REVIEW	SG	NH	NH	28/11/2018

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Scale: VARIES | Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

RPS
SUITE 12, 33 NISH ST (PO BOX 1317)
ECHUCA, VICTORIA, 3564
T: (03) 5481 0300
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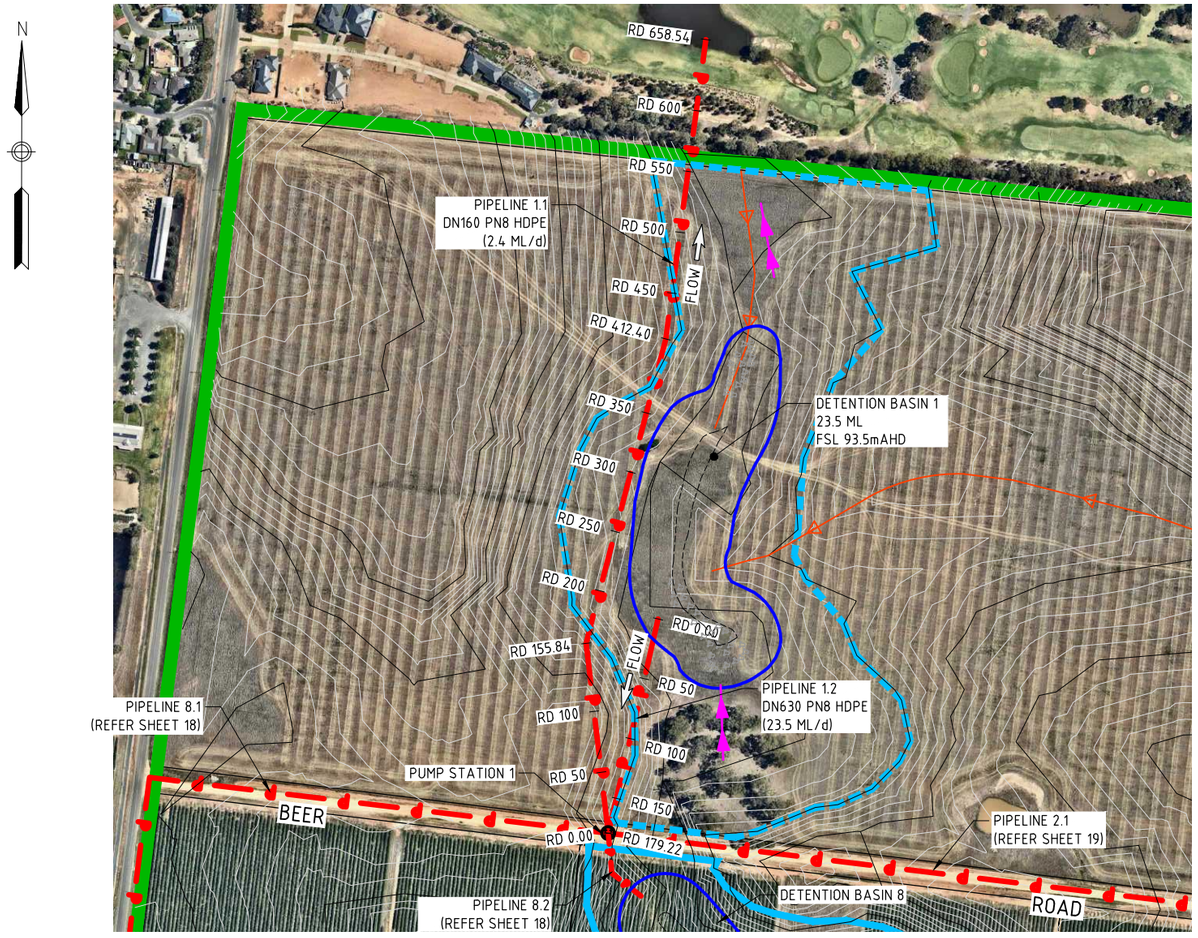
Project: MOAMA MID-WEST DRAINAGE STRATEGY

Drawing Status: CONCEPT DESIGN

Title: DETENTION BASIN DETAILS
SHEET 8 OF 8

Consultant Drawing No. 18055-16 | Sheet. 16/26 | Rev. B

Client Drawing No. 18055-16 | Rev. B

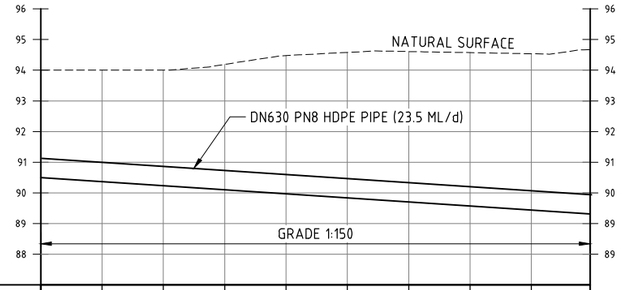


CATCHMENT 1 PIPELINE PLAN

SCALE: 1:2500

LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

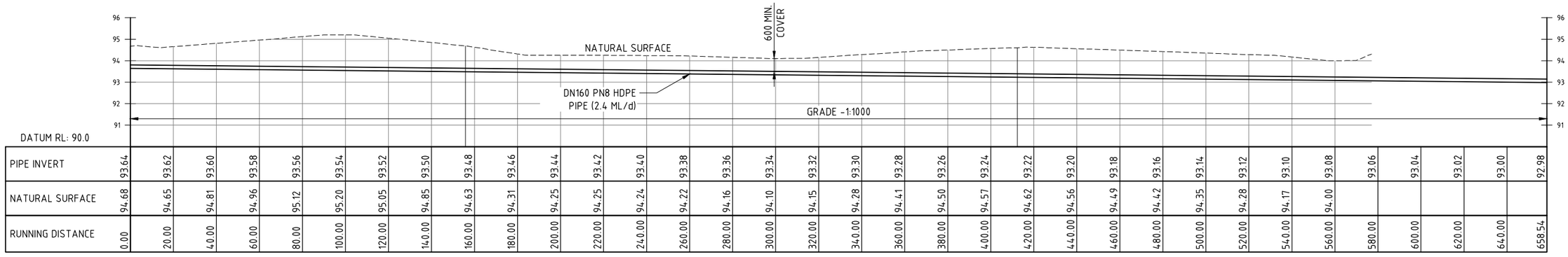


DATUM RL: 87.0

PIPE INVERT	90.50	90.37	90.23	90.10	89.97	89.84	89.70	89.57	89.44	89.31
NATURAL SURFACE	94.00	94.00	94.00	94.19	94.48	94.58	94.61	94.57	94.54	94.68
RUNNING DISTANCE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	179.22

PIPELINE 1.2 - LONGITUDINAL SECTION

SCALE: HORIZONTAL 1:1000
VERTICAL 1:100



DATUM RL: 90.0

PIPE INVERT	93.64	93.62	93.60	93.58	93.56	93.54	93.52	93.50	93.48	93.46	93.44	93.42	93.40	93.38	93.36	93.34	93.32	93.30	93.28	93.26	93.24	93.22	93.20	93.18	93.16	93.14	93.12	93.10	93.08	93.06	93.04	93.02	93.00	92.98
NATURAL SURFACE	94.68	94.65	94.81	94.96	95.12	95.20	95.05	94.85	94.63	94.31	94.25	94.25	94.24	94.22	94.16	94.10	94.15	94.28	94.41	94.50	94.57	94.62	94.56	94.49	94.42	94.35	94.28	94.17	94.00					
RUNNING DISTANCE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	300.00	320.00	340.00	360.00	380.00	400.00	420.00	440.00	460.00	480.00	500.00	520.00	540.00	560.00	580.00	600.00	620.00	640.00	658.54

PIPELINE 1.1 - LONGITUDINAL SECTION

SCALE: HORIZONTAL 1:1000
VERTICAL 1:100

ONE CALL SYSTEM DIAL 1100 DIAL BEFORE YOU DIG

CAUTION

OVERHEAD POWER AND UNDERGROUND CABLES IN THE VICINITY.
SERVICES TO BE LOCATED PRIOR TO COMMENCEMENT OF WORKS

1:100 0 2 4 6 8 10m (2 1) AT A1
1:1000 0 20 40 60 80 100m (20 10) AT A1
1:2500 0 50 100 150 200 250m (50 25) AT A1

Rev.	Description	Drn	Ckd	App	Date
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Scale: VARIES | Sheet: A1

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Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

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ECHUCA, VICTORIA, 3564
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Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: PIPELINE DETAILS SHEET 1 OF 8

Drawing Status: CONCEPT DESIGN

Consultant Drawing No.	Sheet.	Rev.
18055-17	17/26	B

Client Drawing No.	Rev.
18055-17	B

LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
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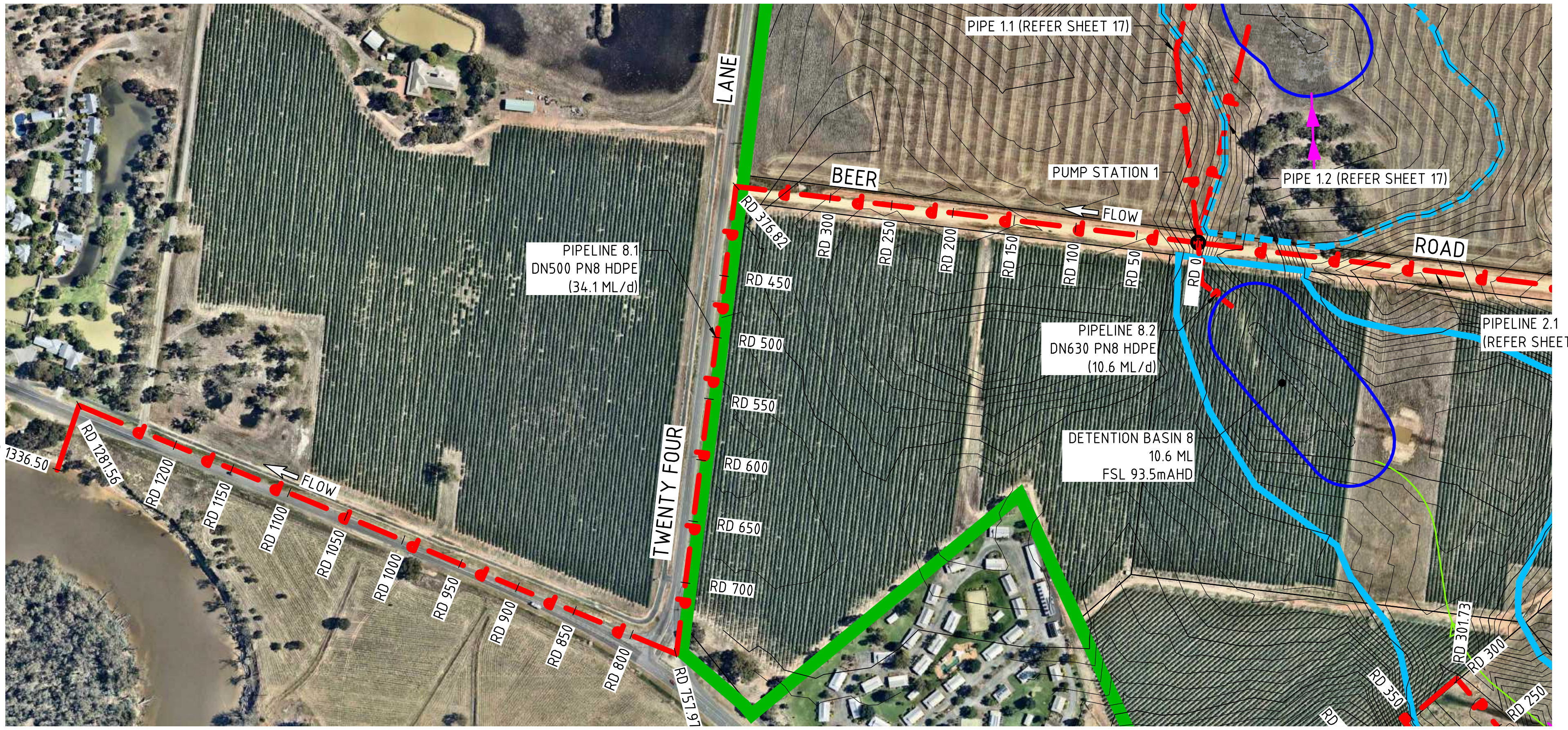
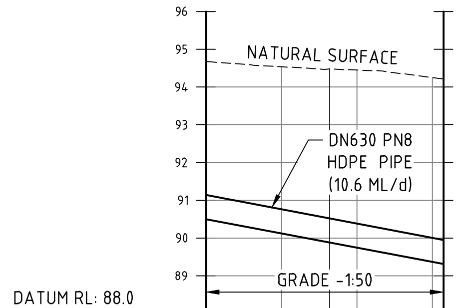
- DETENTION BASIN
- PUMP STATION

N



CATCHMENT 8 - PIPELINES
PLAN

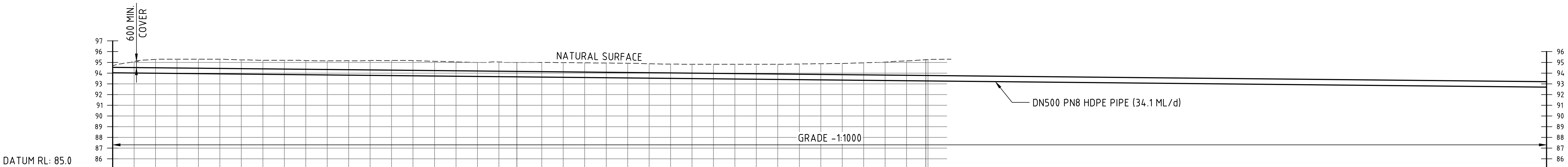
SCALE: 1:2500



PIPE INVERT	90.50	90.12	89.88	89.74	89.31
NATURAL SURFACE	94.68	94.54	94.48	94.45	94.21
RUNNING DISTANCE	0.00	20.00	32.73	40.00	62.89

PIPELINE 8.2 - LONGITUDINAL SECTION

SCALE: HORIZONTAL 1:1000
VERTICAL 1:100



PIPE INVERT	94.68	95.08	95.27	95.30	95.30	95.30	95.23	95.20	95.19	95.17	95.14	95.15	95.17
NATURAL SURFACE	94.68	95.08	95.27	95.30	95.30	95.30	95.23	95.20	95.19	95.17	95.14	95.15	95.17
RUNNING DISTANCE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00

PIPE INVERT	95.17	95.17	95.10	95.05	95.00	95.03	95.00	95.00	94.98	94.96	94.94	94.91	94.87
NATURAL SURFACE	95.17	95.17	95.10	95.05	95.00	95.03	95.00	95.00	94.98	94.96	94.94	94.91	94.87
RUNNING DISTANCE	260.00	280.00	300.00	320.00	340.00	360.00	376.82	400.00	420.00	440.00	460.00	480.00	500.00

PIPE INVERT	94.86	94.84	94.83	94.83	94.83	94.83	94.85	94.88	94.91	94.97	95.05	95.16	95.28
NATURAL SURFACE	94.86	94.84	94.83	94.83	94.83	94.83	94.85	94.88	94.91	94.97	95.05	95.16	95.28
RUNNING DISTANCE	520.00	540.00	560.00	580.00	600.00	620.00	640.00	660.00	680.00	700.00	720.00	740.00	760.00

PIPE INVERT														
NATURAL SURFACE														
RUNNING DISTANCE	780.00	800.00	820.00	840.00	860.00	880.00	900.00	920.00	940.00	960.00	980.00	1000.00	1020.00	1040.00

PIPE INVERT															
NATURAL SURFACE															
RUNNING DISTANCE	1060.00	1080.00	1100.00	1120.00	1140.00	1160.00	1180.00	1200.00	1220.00	1240.00	1260.00	1281.56	1300.00	1320.00	1336.50

PIPELINE 8.1 - LONGITUDINAL SECTION

SCALE: HORIZONTAL 1:2000
VERTICAL 1:200

1:200 0 4 8 12 16 20m AT A1
1:100 0 2 4 6 8 10m AT A1
1:2000 0 40 80 120 160 200m AT A1
1:1000 0 20 40 60 80 100m AT A1
1:2500 0 50 100 150 200 250m AT A1

ONE CALL SYSTEM DIAL 1100 DIAL BEFORE YOU DIG

CAUTION

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Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Scale: VARIES
Sheet: A1

Client: murray river council

RPS
SUITE 12, 33 NISH ST (PO BOX 1317)
ECHUCA, VICTORIA, 3564
T: (03) 5481 0300
F: (03) 5480 6755

Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: PIPELINE DETAILS SHEET 2 OF 8

Drawing Status: CONCEPT DESIGN

Consultant Drawing No. 18055-18 | Sheet. 18/26 | Rev. B

Client Drawing No. 18055-18 | Rev. B

LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
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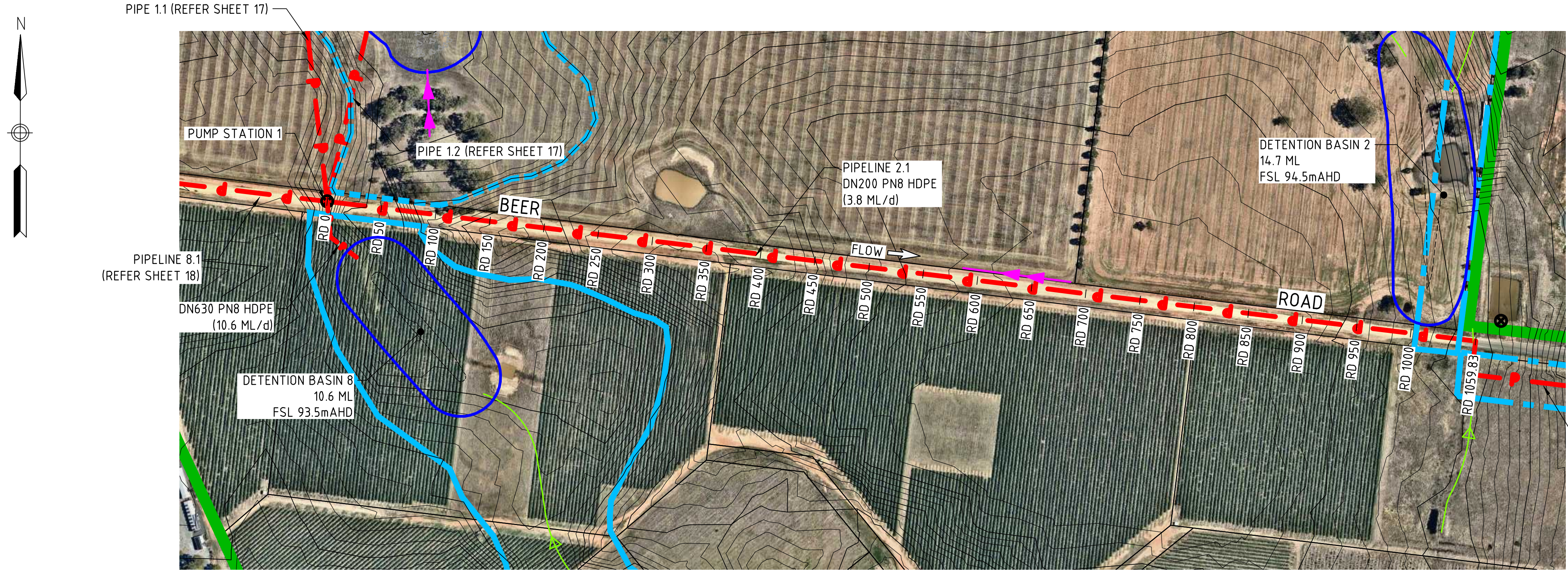
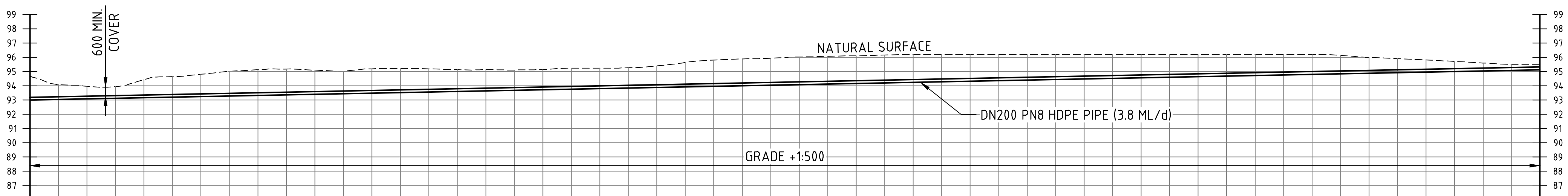
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION



CATCHMENT 2 - PIPELINE PLAN

SCALE: 1:2500



DATUM RL: 86.0

PIPE INVERT	92.99	93.03	93.07	93.11	93.15	93.19	93.23	93.27	93.31	93.35	93.39	93.43	93.47	93.51	93.55	93.59	93.63	93.67
NATURAL SURFACE	94.68	94.08	93.97	93.95	94.44	94.64	94.81	95.01	95.13	95.18	95.10	95.02	95.19	95.20	95.19	95.13	95.13	95.11
RUNNING DISTANCE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	300.00	320.00	340.00

PIPE INVERT	93.71	93.75	93.79	93.83	93.87	93.91	93.95	93.99	94.03	94.07	94.11	94.15	94.19	94.23	94.27	94.31	94.35	94.39
NATURAL SURFACE	95.14	95.24	95.23	95.26	95.39	95.64	95.81	95.89	95.94	96.02	96.07	96.10	96.16	96.20	96.20	96.20	96.20	96.20
RUNNING DISTANCE	360.00	380.00	400.00	420.00	440.00	460.00	480.00	500.00	520.00	540.00	560.00	580.00	600.00	620.00	640.00	660.00	680.00	700.00

PIPE INVERT	94.43	94.47	94.51	94.55	94.59	94.63	94.67	94.71	94.75	94.79	94.83	94.87	94.91	94.95	94.99	95.03	95.07	95.11
NATURAL SURFACE	96.20	96.20	96.20	96.20	96.20	96.20	96.20	96.20	96.20	96.20	96.13	95.99	95.91	95.82	95.71	95.60	95.50	95.50
RUNNING DISTANCE	720.00	740.00	760.00	780.00	800.00	820.00	840.00	860.00	880.00	900.00	920.00	940.00	960.00	980.00	1000.00	1020.00	1040.00	1059.83

PIPELINE 2.1 - LONGITUDINAL SECTION

SCALE: HORIZONTAL 1:2000
VERTICAL 1:200

1:200 — 4 3 2 1 0 4 8 12 16 20m AT A1
1:2000 — 40 20 0 40 80 120 160 200m AT A1
1:2500 — 50 25 0 50 100 150 200 250m AT A1

ONE CALL SYSTEM DIAL 1100 DIAL BEFORE YOU DIG

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Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Scale: VARIES
Sheet: A1

Client: murray river council

RPS
SUITE 12, 33 NISH ST (PO BOX 1317)
ECHUCA, VICTORIA, 3564
T: (03) 5481 0300
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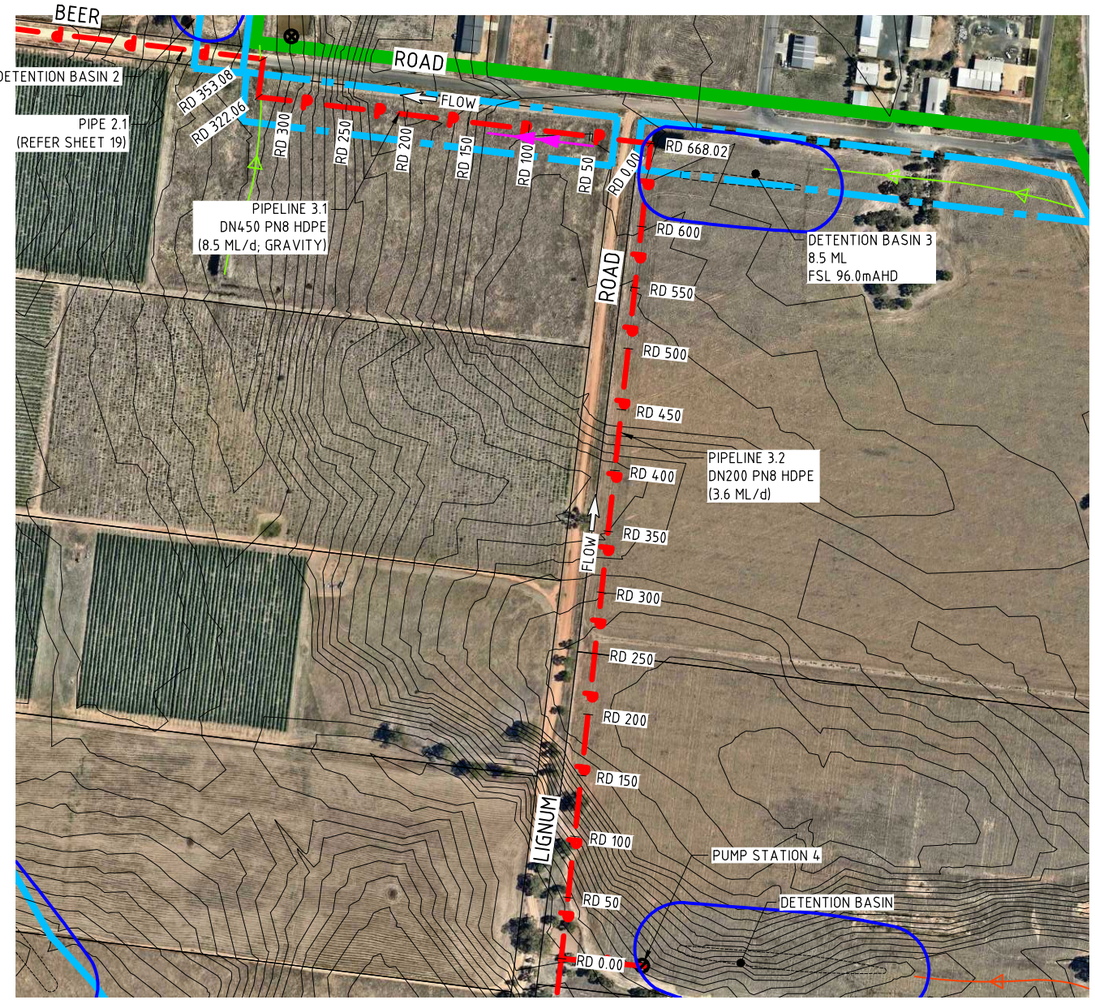
Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: PIPELINE DETAILS
SHEET 3 OF 8

Drawing Status: CONCEPT DESIGN

Consultant Drawing No. 18055-19
Sheet. 19/26
Rev. B
Client Drawing No. 18055-19
Rev. B



CATCHMENTS 3a & 3b PIPELINES PLAN

SCALE: 1:2500

LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
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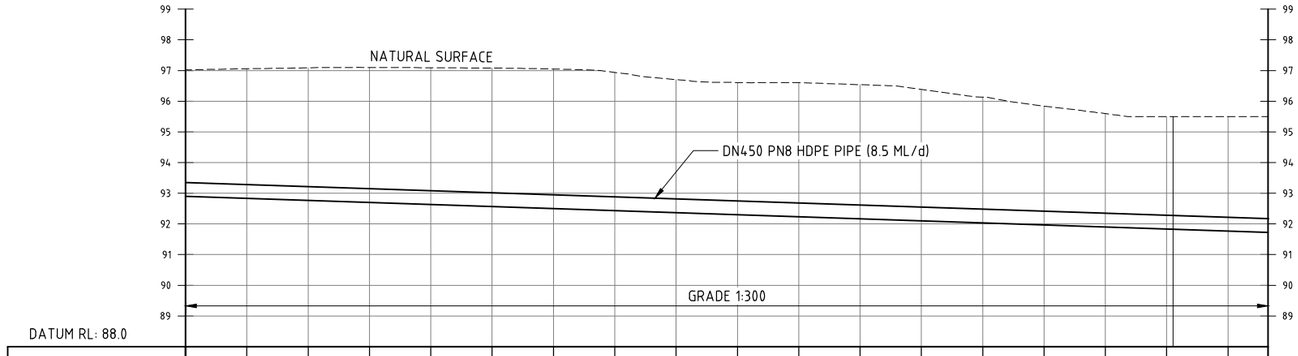
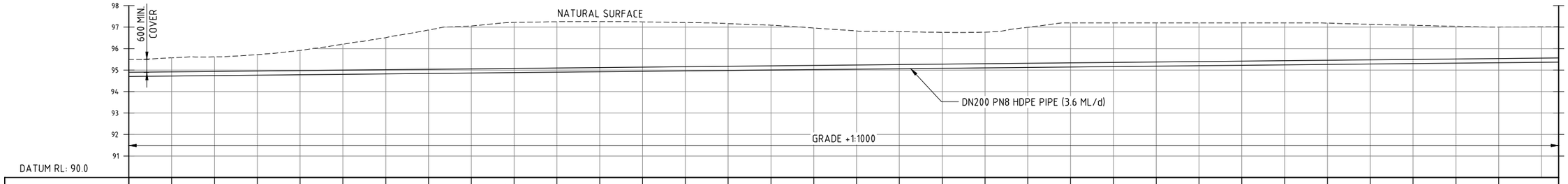
- DETENTION BASIN
- PUMP STATION



RUNNING DISTANCE	PIPE INVERT	NATURAL SURFACE
0.00	92.90	97.02
20.00	92.83	97.06
40.00	92.77	97.09
60.00	92.70	97.10
80.00	92.63	97.09
100.00	92.57	97.08
120.00	92.50	97.05
140.00	92.43	96.94
160.00	92.37	96.70
180.00	92.30	96.61
200.00	92.23	96.60
220.00	92.17	96.54
240.00	92.10	96.38
260.00	92.03	96.13
280.00	91.97	95.84
300.00	91.90	95.60
320.00	91.83	95.50
340.00	91.77	95.50
353.08	91.72	95.50

PIPELINE 3.1 - LONGITUDINAL SECTION

SCALE: HORIZONTAL 1:1000
VERTICAL 1:100



RUNNING DISTANCE	PIPE INVERT	NATURAL SURFACE
0.00	94.70	95.50
20.00	94.72	95.57
40.00	94.74	95.61
60.00	94.76	95.72
80.00	94.78	95.92
100.00	94.80	96.21
120.00	94.82	96.51
140.00	94.84	96.86
160.00	94.86	97.06
180.00	94.88	97.22
200.00	94.90	97.25
220.00	94.92	97.26
240.00	94.94	97.24
260.00	94.96	97.21
280.00	94.98	97.16
300.00	95.00	97.09
320.00	95.02	96.96
340.00	95.04	96.82
360.00	95.06	96.79
380.00	95.08	96.76
400.00	95.10	96.77
420.00	95.12	96.99
440.00	95.14	97.20
460.00	95.16	97.20
480.00	95.18	97.20
500.00	95.20	97.20
520.00	95.22	97.20
540.00	95.24	97.20
560.00	95.26	97.19
580.00	95.28	97.13
600.00	95.30	97.09
620.00	95.32	97.04
640.00	95.34	97.00
668.02	95.37	97.02

PIPELINE 3.2 - LONGITUDINAL SECTION

SCALE: HORIZONTAL 1:1000
VERTICAL 1:100

1:100 0 2 4 6 8 10m (2 1) AT A1

1:2500 0 50 100 150 200 250m (50 25) AT A1

1:1000 0 20 40 60 80 100m (20 10) AT A1

Rev.	Description	Drn	Ckd	App	Date
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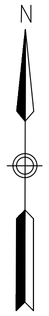
Project: MOAMA MID-WEST DRAINAGE STRATEGY

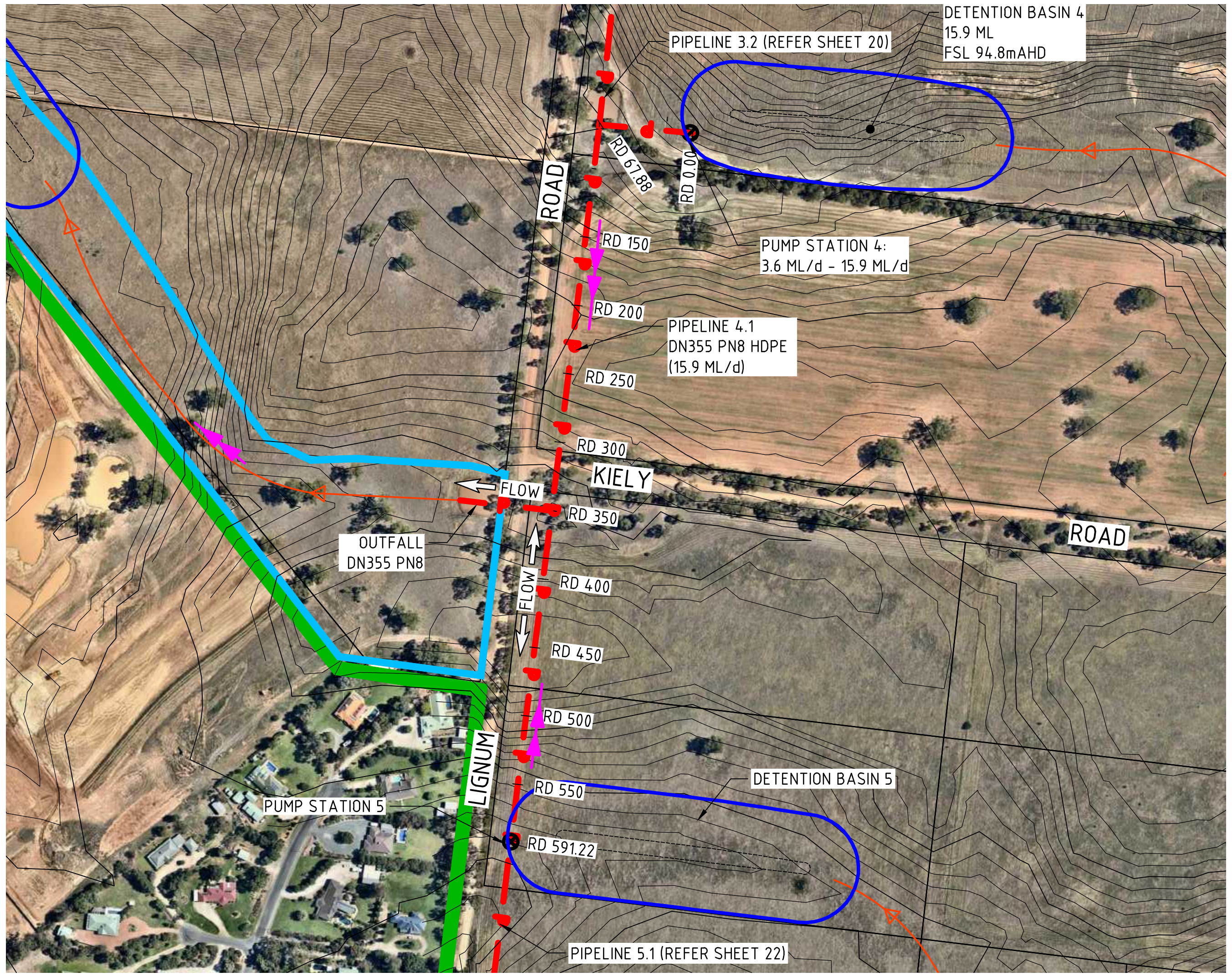
Title: PIPELINE DETAILS SHEET 4 OF 8

Drawing Status: CONCEPT DESIGN

Consultant Drawing No.: 18055-20 | Sheet.: 20/26 | Rev.: B

Client Drawing No.: 18055-20 | Rev.: B





LEGEND:

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- SUB-CATCHMENT BOUNDARY
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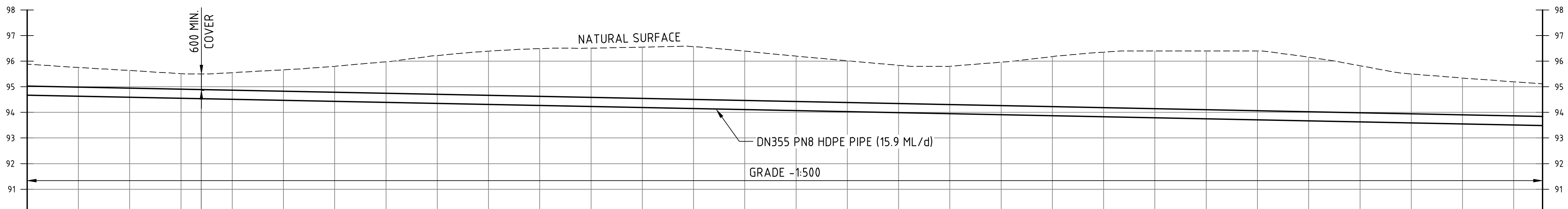
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

CATCHMENT 4 PIPELINE
PLAN
SCALE: 1:2500



DATUM RL: 90.0

PIPE INVERT	94.67	94.63	94.59	94.55	94.54	94.51	94.47	94.43	94.39	94.35	94.31	94.27	94.23	94.19	94.15	94.11
NATURAL SURFACE	95.88	95.75	95.64	95.51	95.50	95.55	95.66	95.80	95.97	96.22	96.39	96.49	96.51	96.55	96.57	96.39
RUNNING DISTANCE	0.00	20.00	40.00	60.00	67.88	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00

PIPE INVERT	94.07	94.03	93.99	93.95	93.91	93.87	93.83	93.79	93.75	93.71	93.67	93.63	93.59	93.55	93.51	93.49
NATURAL SURFACE	96.20	96.01	95.84	95.80	95.96	96.18	96.35	96.40	96.40	96.40	96.16	95.82	95.50	95.34	95.19	95.11
RUNNING DISTANCE	300.00	320.00	340.00	360.00	380.00	400.00	420.00	440.00	460.00	480.00	500.00	520.00	540.00	560.00	580.00	591.22

PIPELINE 4.1 - LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:1000
VERTICAL 1:100

1:100 2 1 0 2 4 6 8 10m AT A1
1:1000 20 10 0 20 40 60 80 100m AT A1
1:2500 50 25 0 50 100 150 200 250m AT A1

ONE CALL SYSTEM DIAL 1100 DIAL BEFORE YOU DIG

CAUTION
OVERHEAD POWER AND UNDERGROUND CABLES IN THE VICINITY. SERVICES TO BE LOCATED PRIOR TO COMMENCEMENT OF WORKS

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
A	ISSUED FOR CLIENT REVIEW	SG	NH	NH	28/11/2018

DOCUMENTS ISSUED DO NOT BEAR ORIGINAL SIGNATURES. EVIDENCE OF VERIFICATION AND APPROVAL MAY BE OBTAINED FROM THE COMPANY.

Scale: VARIES | Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

RPS
SUITE 12, 33 NISH ST (PO BOX 1317)
ECHUCA, VICTORIA, 3564
T: (03) 5481 0300
F: (03) 5480 6755

Project: MOAMA MID-WEST DRAINAGE STRATEGY

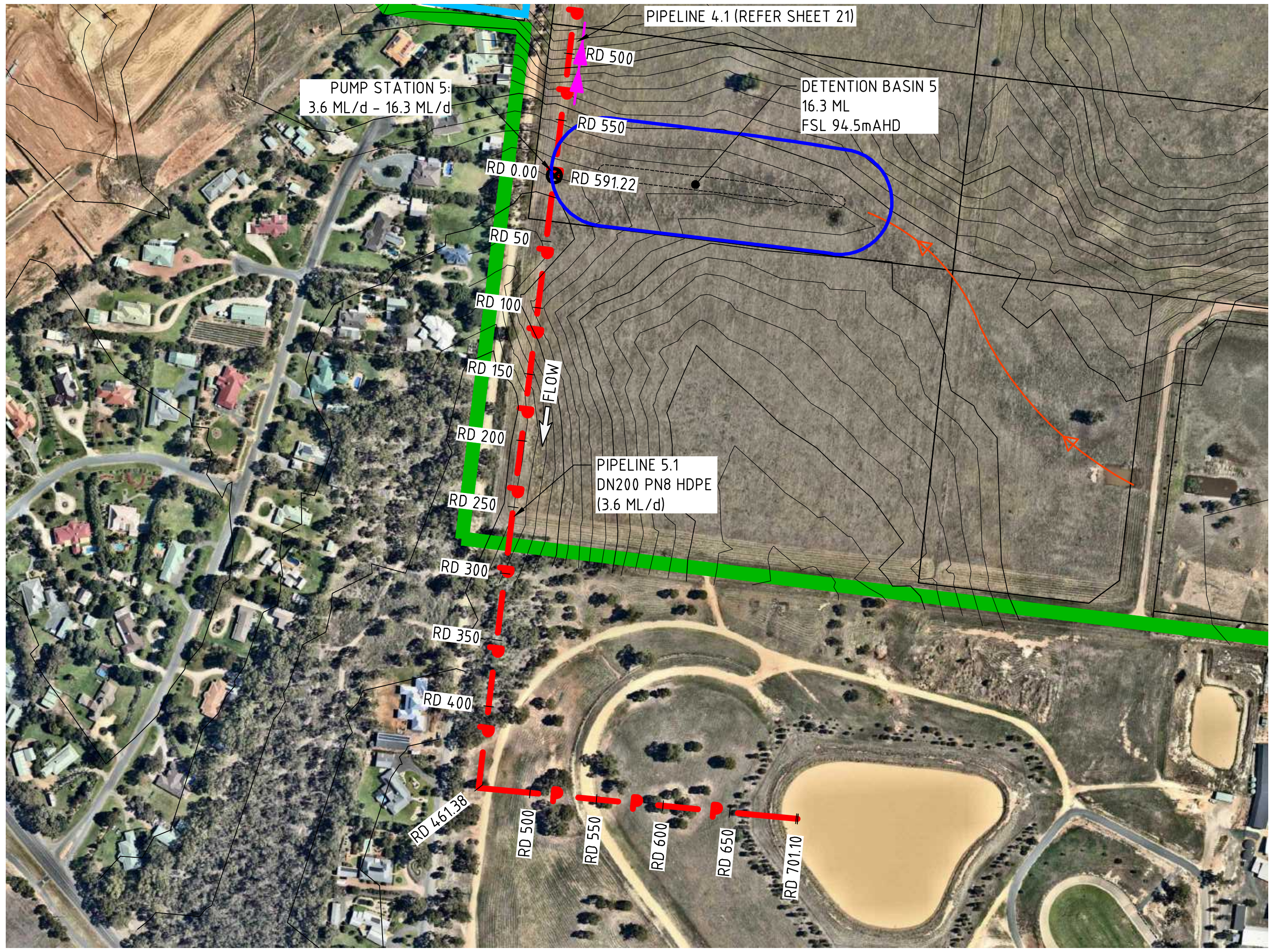
Title: PIPELINE DETAILS SHEET 5 OF 8

Drawing Status: CONCEPT DESIGN

Consultant Drawing No.: 18055-21 | Sheet: 21/26 | Rev.: B

Client Drawing No.: 18055-21 | Rev.: B

N

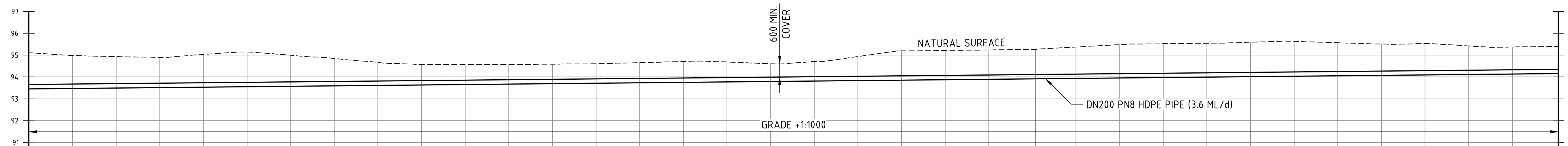


LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

CATCHMENT 5 PIPELINE PLAN

SCALE: 1:2500



DATUM RL: 90.0

PIPE INVERT	93.45	93.47	93.49	93.51	93.53	93.55	93.57	93.59	93.61	93.63	93.65	93.67	93.69	93.71	93.73	93.75	93.77	93.79	93.81	93.83	93.85	93.87	93.89	93.91	93.93	93.95	93.97	93.99	94.01	94.03	94.05	94.07	94.09	94.11	94.13	94.15
NATURAL SURFACE	95.11	94.99	94.94	94.90	95.03	95.15	95.00	94.85	94.67	94.57	94.58	94.58	94.59	94.61	94.65	94.71	94.69	94.60	94.71	94.94	95.20	95.22	95.24	95.26	95.37	95.48	95.52	95.55	95.59	95.63	95.57	95.51	95.53	95.42	95.37	95.40
RUNNING DISTANCE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	300.00	320.00	340.00	360.00	380.00	400.00	420.00	440.00	461.38	480.00	500.00	520.00	540.00	560.00	580.00	600.00	620.00	640.00	660.00	680.00	701.10

PIPELINE 5.1 - LONGITUDINAL SECTION

SCALE: HORIZONTAL 1:1000
VERTICAL 1:100

1:100 0 2 4 6 8 10m 2 1 AT A1
1:1000 0 20 40 60 80 100m 20 10 AT A1
1:2500 0 50 100 150 200 250m 50 25 AT A1

ONE CALL SYSTEM DIAL 1100 DIAL BEFORE YOU DIG

CAUTION
OVERHEAD POWER AND UNDERGROUND CABLES IN THE VICINITY.
SERVICES TO BE LOCATED PRIOR TO COMMENCEMENT OF WORKS

Rev.	Description	Drn	Ckd	App	Date
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A	ISSUED FOR CLIENT REVIEW	SG	NH	NH	28/11/2018

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Scale: VARIES Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

RPS
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ECHUCA, VICTORIA, 3564
T: (03) 5481 0300
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Project: MOAMA MID-WEST DRAINAGE STRATEGY

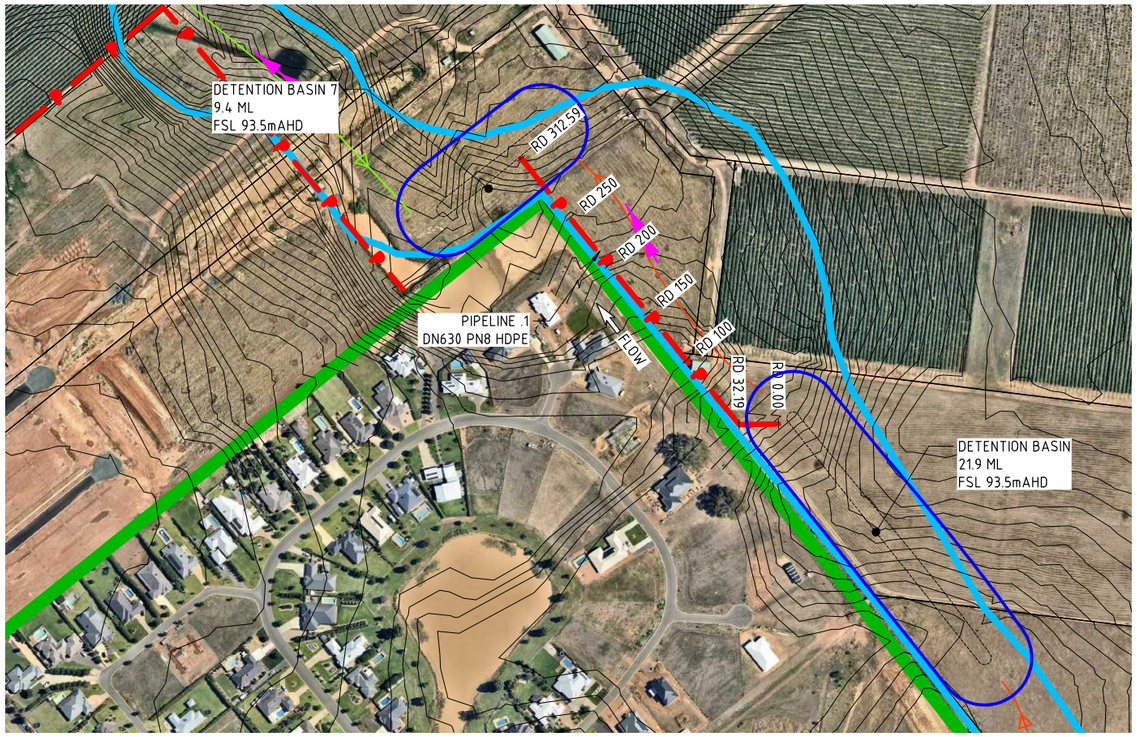
Title: PIPELINE DETAILS SHEET 6 OF 8

Drawing Status: CONCEPT DESIGN

Consultant Drawing No. 18055-22 Sheet. 22/26 Rev. B

Client Drawing No. 18055-22 Rev. B

N

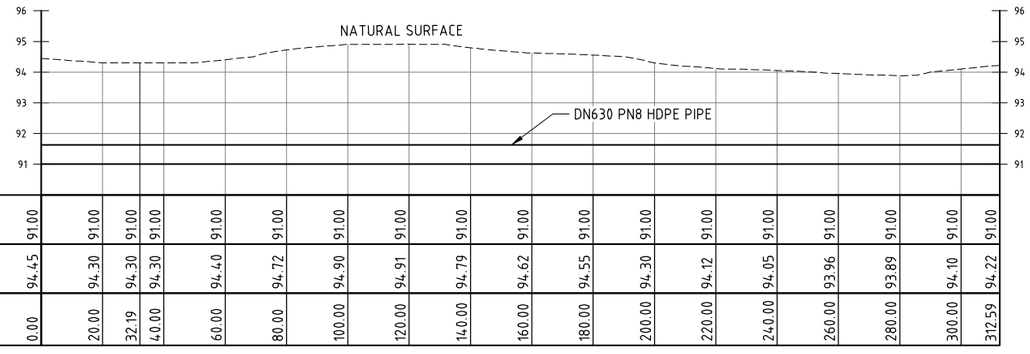


LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

CATCHMENT 6 PIPELINE PLAN

SCALE: 1:2500



PIPE INVERT	91.00	91.00	91.00	91.00	91.00	91.00	91.00	91.00	91.00	91.00	91.00	91.00	91.00	91.00	91.00	91.00	91.00	91.00
NATURAL SURFACE	94.45	94.30	94.30	94.30	94.40	94.72	94.90	94.91	94.79	94.62	94.55	94.30	94.12	94.05	93.96	93.89	94.10	94.22
RUNNING DISTANCE	0.00	20.00	32.19	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	300.00	312.59

PIPELINE 6.1 - LONGITUDINAL SECTION

SCALE: HORIZONTAL 1:1000
VERTICAL 1:100

1:100 0 2 4 6 8 10m (2 1) AT A1

1:1000 0 20 40 60 80 100m (20 10) AT A1

1:2500 0 50 100 150 200 250m (50 25) AT A1

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CAUTION

OVERHEAD POWER AND UNDERGROUND CABLES IN THE VICINITY.
SERVICES TO BE LOCATED PRIOR TO COMMENCEMENT OF WORKS

Rev.	Description	Drn	Ckd	App	Date
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Scale: VARIES | Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

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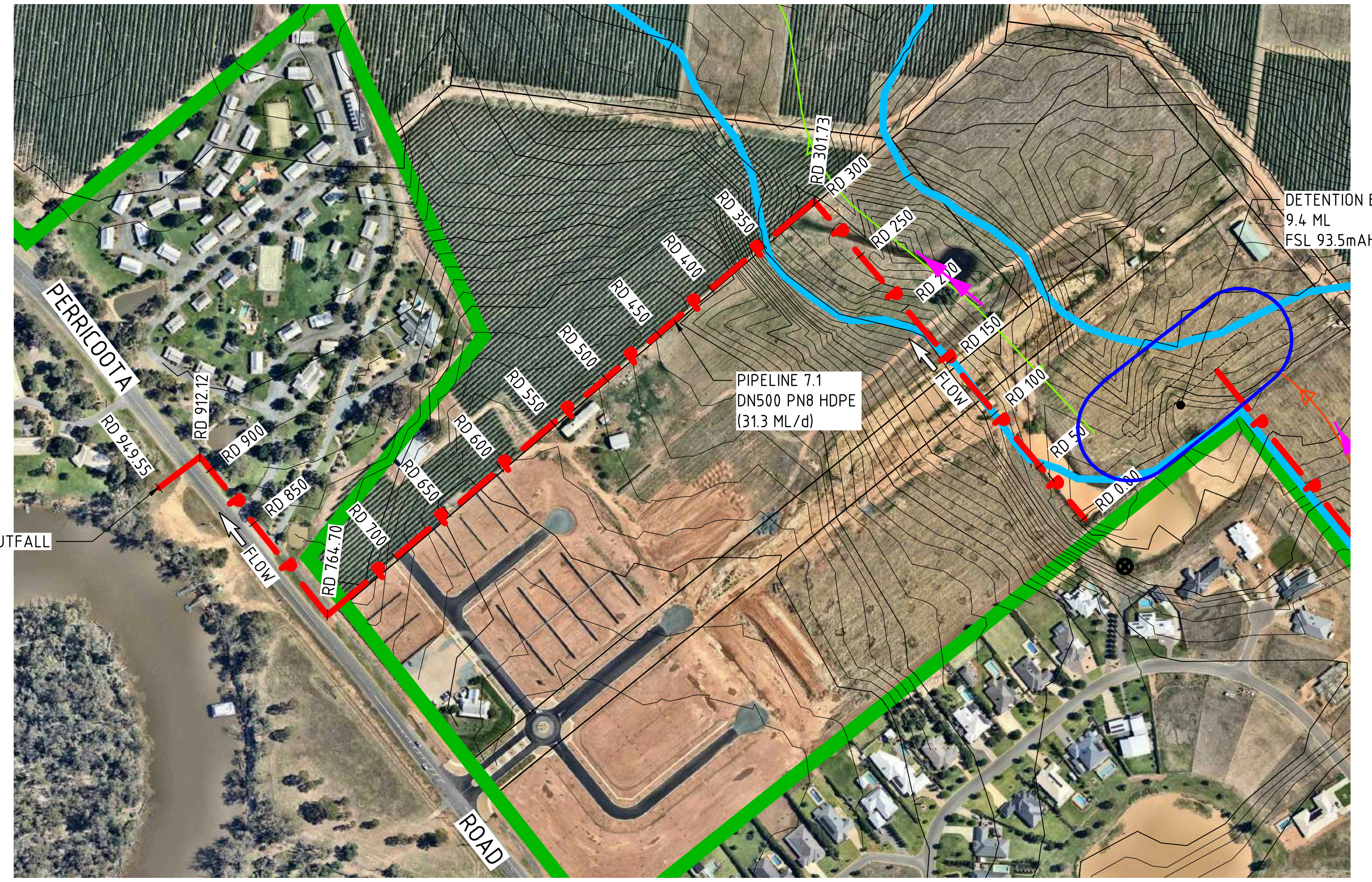
Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: PIPELINE DETAILS SHEET 7 OF 8

Drawing Status: CONCEPT DESIGN

Consultant Drawing No. 18055-23 | Sheet. 23/26 | Rev. B

Client Drawing No. 18055-23 | Rev. B



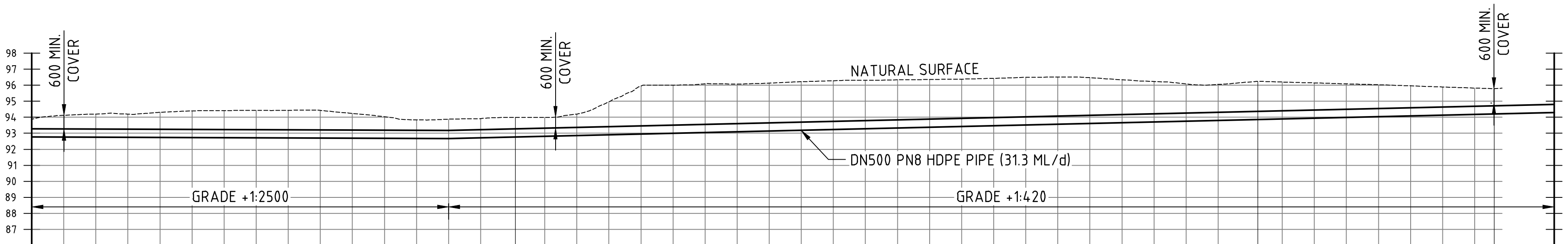
CONNECT TO 3 MILE OUTFALL

LEGEND:

- CATCHMENT BOUNDARY
- SUB-CATCHMENT BOUNDARY
- PIPELINE
- DRAINAGE RESERVE (MASTER PLAN 2009)
- DRAINAGE RESERVE (RL 94.5 CONTOUR)
- DRAINAGE RESERVE (40m BUFFER INDUSTRIAL ESTATE)
- LOW FLOW SWALE - BED WIDTH 2.5m
- LOW FLOW SWALE - BED WIDTH 5.5m
- SURFACE RELIEF CORRIDOR (S.R.C)
- DETENTION BASIN
- PUMP STATION

CATCHMENT 7 PIPELINE PLAN

SCALE: 1:2500



DATUM RL: 86.0

PIPE INVERT	92.78	92.77	92.76	92.75	92.74	92.74	92.73	92.72	92.71	92.70	92.70	92.69
NATURAL SURFACE	93.88	94.12	94.20	94.20	94.31	94.40	94.42	94.43	94.43	94.43	94.24	94.03
RUNNING DISTANCE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00

PIPE INVERT	92.68	92.67	92.72	92.77	92.81	92.86	92.91	92.96	93.00	93.05	93.10	93.14
NATURAL SURFACE	93.84	93.88	93.91	94.00	93.99	94.20	94.96	95.95	96.01	96.09	96.07	96.13
RUNNING DISTANCE	240.00	260.00	280.00	301.73	320.00	340.00	360.00	380.00	400.00	420.00	440.00	460.00

PIPE INVERT	93.19	93.24	93.29	93.33	93.38	93.43	93.48	93.52	93.57	93.62	93.66	93.71
NATURAL SURFACE	96.22	96.28	96.31	96.34	96.36	96.38	96.43	96.49	96.50	96.47	96.34	96.23
RUNNING DISTANCE	480.00	500.00	520.00	540.00	560.00	580.00	600.00	620.00	640.00	660.00	680.00	700.00

PIPE INVERT	93.76	93.81	93.86	93.90	93.95	93.99	94.04	94.09	94.14	94.18	94.21	94.28	94.30
NATURAL SURFACE	96.08	96.05	96.25	96.20	96.15	96.08	96.03	95.96	95.89	95.82	95.78		
RUNNING DISTANCE	720.00	740.00	764.70	780.00	800.00	820.00	840.00	860.00	880.00	900.00	912.12	940.00	949.55

PIPELINE 7.1 - LONGITUDINAL SECTION

SCALE: HORIZONTAL 1:2000
VERTICAL 1:200

1:200 — 4 3 2 1 0 4 8 12 16 20m AT A1
1:2000 — 40 20 0 40 80 120 160 200m AT A1
1:2500 — 50 25 0 50 100 150 200 250m AT A1

ONE CALL SYSTEM DIAL 1100 DIAL BEFORE YOU DIG

CAUTION
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SERVICES TO BE LOCATED PRIOR TO COMMENCEMENT OF WORKS

Rev.	Description	Drn	Ckd	App	Date
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Scale: VARIES | Sheet: A1

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Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

RPS
SUITE 12, 33 NISH ST (PO BOX 1317)
ECHUCA, VICTORIA, 3564
T: (03) 5481 0300
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Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: PIPELINE DETAILS SHEET 8 OF 8

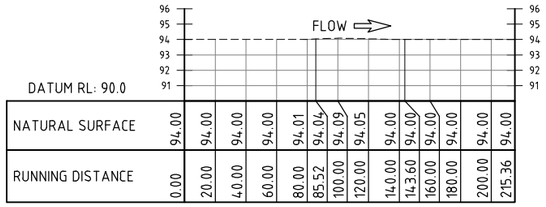
Drawing Status: CONCEPT DESIGN

Consultant Drawing No. 18055-24 | Sheet. 24/26 | Rev. B

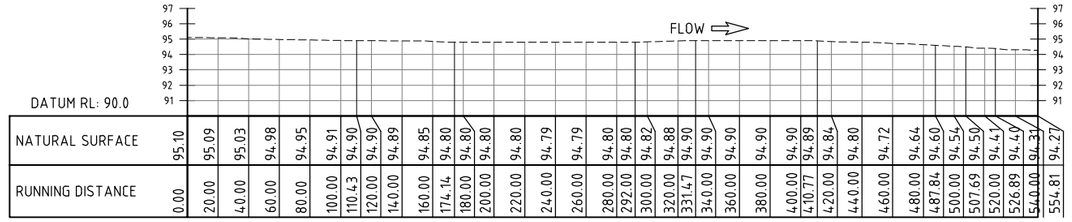
Client Drawing No. 18055-24 | Rev. B

NOTES

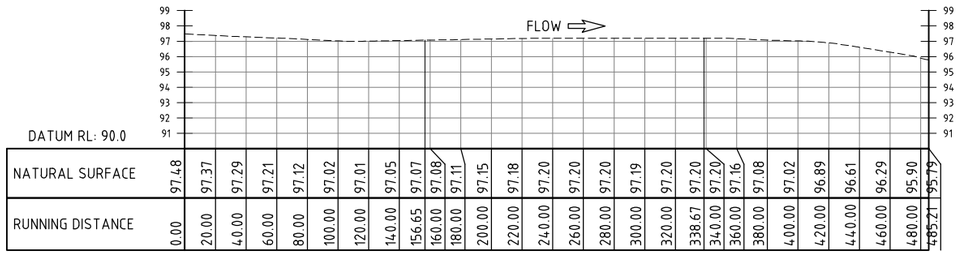
LOW FLOW SWALES ARE OFTEN IN THE BED OF THE SURFACE RELIEF CORRIDOR.



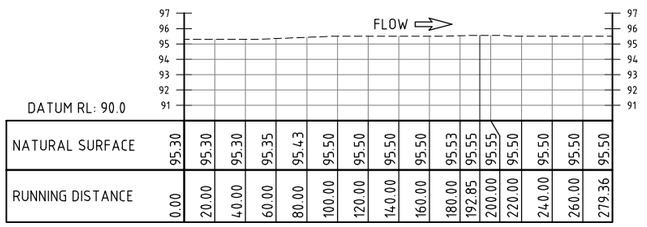
SWALE 1.1 – LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:2000
VERTICAL 1:200



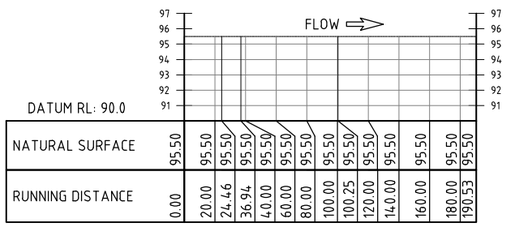
SWALE 1.2 – LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:2000
VERTICAL 1:200



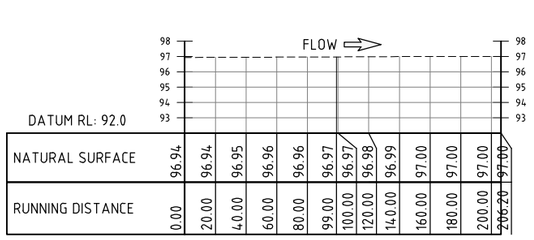
SWALE 2.1 – LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:2000
VERTICAL 1:200



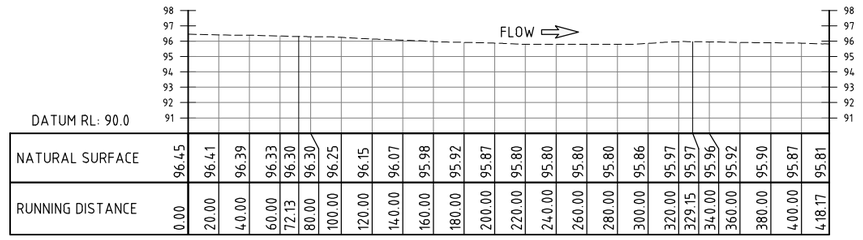
SWALE 2.2 – LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:2000
VERTICAL 1:200



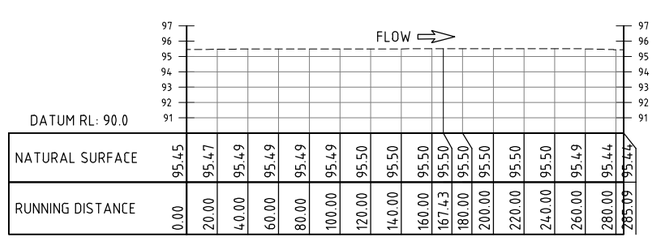
SWALE 2.3 – LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:2000
VERTICAL 1:200



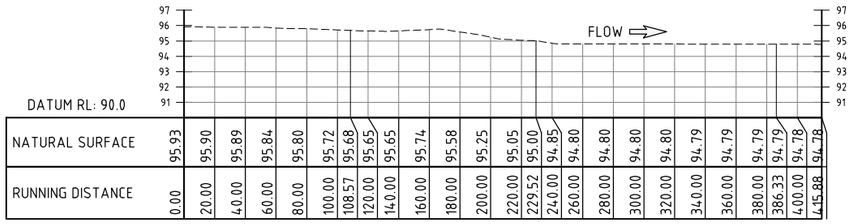
SWALE 3.1 – LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:2000
VERTICAL 1:200



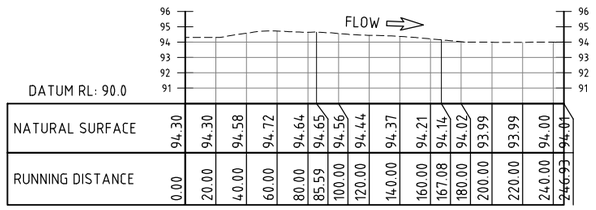
SWALE 4.1 – LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:2000
VERTICAL 1:200



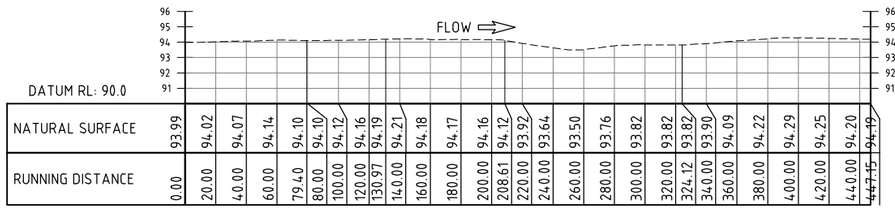
SWALE 5.1 – LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:2000
VERTICAL 1:200



SWALE 6.1 – LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:2000
VERTICAL 1:200



SWALE 6.2 – LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:2000
VERTICAL 1:200



SWALE 7.1– LONGITUDINAL SECTION
SCALE: HORIZONTAL 1:2000
VERTICAL 1:200

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
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Scale: VARIES | Sheet: A1

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Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

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ECHUCA, VICTORIA, 3564
T: (03) 5481 0300
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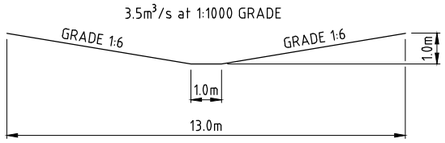
Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: SWALE LONGITUDINAL SECTIONS SHEET 1 OF 1

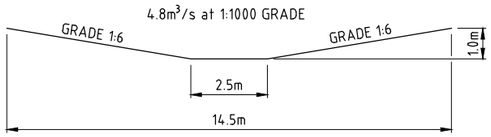
Drawing Status: CONCEPT DESIGN

Consultant Drawing No.: 18055-25 | Sheet.: 25/26 | Rev.: B

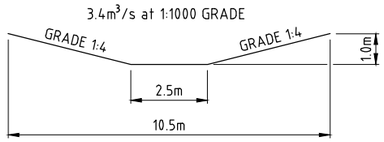
Client Drawing No.: 18055-25 | Rev.: B



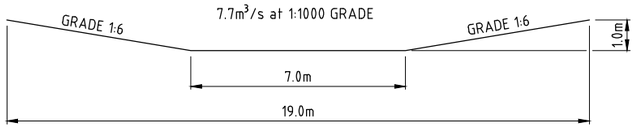
TYPICAL SURFACE RELIEF CORRIDOR
1m WIDE BED WITH 1:6 BATTERS



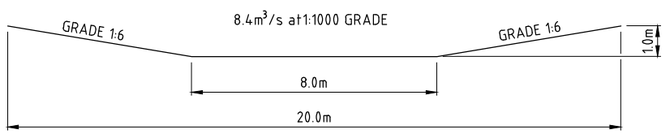
TYPICAL SURFACE RELIEF CORRIDOR
2.5m WIDE BED WITH 1:6 BATTERS



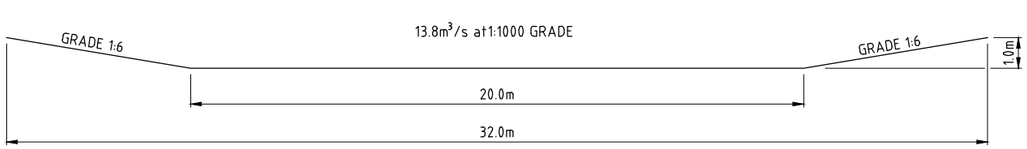
TYPICAL SURFACE RELIEF CORRIDOR
2.5m WIDE BED WITH 1:4 BATTERS



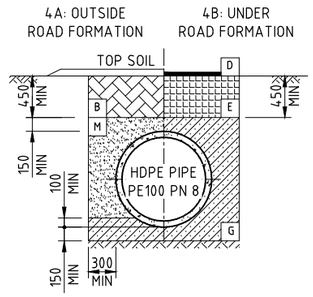
TYPICAL SURFACE RELIEF CORRIDOR
7m WIDE BED WITH 1:6 BATTERS



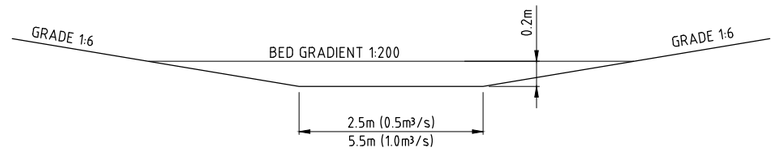
TYPICAL SURFACE RELIEF CORRIDOR
8m WIDE BED WITH 1:6 BATTERS



TYPICAL SURFACE RELIEF CORRIDOR
20m WIDE BED WITH 1:6 BATTERS



TYPICAL BACKFILL DETAILS
NOT TO SCALE



TYPICAL LOW FLOW SWALE
NOT TO SCALE

LEGEND:

B — ORDINARY FILL (INSITU ON-SITE MATERIAL)
OBTAINED FROM PIPE TRENCH OR ELSEWHERE WITH MINIMUM VEGETABLE MATTER AND STONES (NONE GREATER THAN 150 mm). PLACED IN 200 mm LAYERS COMPACTED TO 90% OF THE MAXIMUM DRY DENSITY AT OPTIMUM MOISTURE CONTENT RELATIVE TO THE STANDARD COMPACTION TEST AS SPECIFIED IN AS 1289 5.1.1.

D — BITUMEN SEAL
TO BE 40 mm (MINIMUM) CONSOLIDATED DEPTH OF SIZE 10 TYPE N ASHPHALT. MATERIAL AND APPLICATION METHOD TO BE IN ACCORDANCE WITH VICROADS SPECIFICATION SECTION 407 - HOT MIX ASPHALT

E — CLASS 2 20mm CRUSHED ROCK
MECHANICALLY COMPACTED IN 100 mm LOOSE THICKNESS LAYERS TO ACHIEVE MINIMUM COMPACTION OF 100% OF THE MAXIMUM DRY DENSITY AT OPTIMUM MOISTURE CONTENT RELATIVE TO THE MODIFIED COMPACTION TEST AS SPECIFIED IN AS1289 5.2.2.

G — CLASS 2 20mm CRUSHED ROCK CEMENT TREATED
3% CEMENT TREATED CLASS 2 CRUSHED ROCK MECHANICALLY COMPACTED IN 100mm LOOSE THICKNESS LAYERS TO ACHIEVE MINIMUM COMPACTION OF 98% OF THE MAXIMUM DRY DENSITY AT OPTIMUM MOISTURE CONTENT RELATIVE TO THE MODIFIED COMPACTION TEST AS SPECIFIED IN AS1289 5.2.2.

M — SAND
PLACE 150mm LAYERS COMPACTED TO 90% OF THE MAXIMUM DRY DENSITY AT OPTIMUM MOISTURE CONTENT RELATIVE TO THE STANDARD COMPACTION TEST AS SPECIFIED IN AS 1289 5.1.1.

PUMP SCHEDULE

PUMP STATION	DUTY POINT (ML/d)	DISCHARGE PIPELINE ID
PS1	2.4 @ 25m	1.1
	3.8 @ 25m	2.1
	34.1 @ 15m	8.2
PS4	3.6 @ 25m	3.2
	15.9 @ 15m	4.1
PS5	3.6 @ 25m	5.1
	16.3 @ 15m	4.1
PS7	31.3 @ 15m	7.1

DETENTION BASIN SCHEDULE

DETENTION BASIN	DETENTION VOLUME (ML)	REUSE VOLUME (ML)	FSL (mAHD)
DB1	2.4 @ 25m	2.6	93.5
DB2	3.8 @ 25m	1.7	94.5
DB3	34.1 @ 15m	1.0	96.0
DB4	3.6 @ 25m	1.8	94.8
DB5	15.9 @ 15m	1.8	94.5
DB6	3.6 @ 25m	2.5	93.5
DB7	16.3 @ 15m	1.1	93.5
DB8	31.3 @ 15m	1.2	93.5

PIPELINE SCHEDULE

PIPELINE	SIZE DN	LENGTH (m)	FLOW (ML/d)	MATERIAL	FROM	TO
1.1	160	660	2.4 @ 25m	HDPE CLASS PN8	PS1	GOLF COURSE
1.2	630	180	23.5 @ 0.5m (GRAVITY)		DB1	PS1
2.1	200	1060	3.8 @ 25m		PS1	DB2
3.1	450	350	8.5 @ 0.5m (GRAVITY)		DB3	INDUSTRIAL ESTATE DETENTION BASIN
3.2	200	670	3.6 @ 25m		PS4	DB3
4.1	355	590	15.9 @ 15m		PS4	RECREATION RESERVE STORAGE OR SUB-CATCHMENT 6
5.1	200	700	3.6 @ 25m		DB5	RECREATION RESERVE STORAGE
6.1	630	310	21.9 @ 0.5m (GRAVITY)		DB6	DB7
7.1	500	950	31.3 @ 15m		DB7	MURRAY RIVER @ 3 MILE OUTFALL
8.1	500	1340	34.1 @ 15m		PS1	MURRAY RIVER @ 3.5 MILE OUTFALL
8.2	630	60	10.6 @ 15m		DB8	PS1

Rev.	Description	Drn	Ckd	App	Date
B	FINAL FOR SUBMISSION	SG	NH	NH	06/01/2019
A	ISSUED FOR CLIENT REVIEW	SG	NH	NH	28/11/2018

DOCUMENTS ISSUED DO NOT BEAR ORIGINAL SIGNATURES. EVIDENCE OF VERIFICATION AND APPROVAL MAY BE OBTAINED FROM THE COMPANY.

Scale: N.T.S | Sheet: A1

	Name	Date
Drawn	S. GRAHAM	28/11/18
Design	N. HEINRICH	28/11/18
Checked	N. HEINRICH	28/11/18
Discipline Head	D. DELAHUNTY	28/11/18
Job Manager	N. HEINRICH	28/11/18

Client: murray river council

RPS
SUITE 12, 33 NISH ST (PO BOX 1317)
ECHUCA, VICTORIA, 3564
T: (03) 5481 0300
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Project: MOAMA MID-WEST DRAINAGE STRATEGY

Title: TYPICAL DETAILS SHEET 1 OF 1

Drawing Status: CONCEPT DESIGN

Consultant Drawing No.: 18055-26 | Sheet.: 26/26 | Rev.: B

Client Drawing No.: 18055-26 | Rev.: B

Appendix D

Budget cost estimate

Budget Estimate

Project: Moama Mid West Drainage Investigation
Description: Budget Estimate
Revision: A
Prepared: N Heinrich
Dwg: 18055 Moama MW_RevB_IFR_20190103.pdf
Project no.: 18055
Date: 3/01/2019

Item	Description of Works (refer Dwg)	Quantity	Unit	Rate ($ ex GST)	Subtotal ($ ex GST)	Notes
1.0	**Sub-catchment 1**					
1.1	Project management, overheads, preliminaries, site mob/demob			15%	$ 156,338	
1.2	Detention basin including wetland, swales, inlet and outlet infra	34,500	m3	$ 15	$ 517,500	
1.3	Detention basin landscaping including irrigation and plantings	2.35	ha	$ 25,000	$ 58,750	
1.4	Pipeline 1.1 DN160 including inlet/outlet infra, fittings and ancillary infra	660.00	lin m	$ 90	$ 59,400	
1.5	Pipeline 1.2 DN630 including inlet/outlet infra, fittings and ancillary infra	180	lin m	$ 500	$ 90,000	
1.6	Pipeline 2.1 DN200 including inlet/outlet infra, fittings and ancillary infra	1,060	lin m	$ 110	$ 116,600	
1.7	Pump station 1 (low/high flow) including pit, elec connection, SCADA and commissioning	1	ea	$ 200,000	$ 200,000	
	Sub-total				$ 1,198,588	
2.0	**Sub-catchment 2**					
2.1	Project management, overheads, preliminaries, site mob/demob			15%	$ 78,000	
2.2	Detention basin including wetland, swales, inlet and outlet infra	30,000	m3	$ 15	$ 450,000	
2.3	Detention basin landscaping including irrigation and plantings	1.80	ha	$ 25,000	$ 45,000	
2.4	Connection to existing detention basin	1	ea	$ 25,000	$ 25,000	
	Sub-total				$ 598,000	
3.0	**Sub-catchment 3a**					
3.1	Project management, overheads, preliminaries, site mob/demob			15%	$ 62,138	
3.2	Detention basin including wetland, swales, inlet and outlet infra	18,500	m3	$ 15	$ 277,500	
3.3	Detention basin landscaping including irrigation and plantings	1.15	ha	$ 25,000	$ 28,750	
3.4	Pipeline 3.1 DN450 including inlet/outlet infra, fittings and ancillary infra	360	lin m	$ 300	$ 108,000	
	Sub-total				$ 476,388	
4.0	**Sub-catchment 3b**					
4.1	Project management, overheads, preliminaries, site mob/demob			15%	$ 4,538	
4.2	Drainage swale landscaping including irrigation and plantings (POS, SRC)	1.21	ha	$ 25,000	$ 30,250	
	Sub-total				$ 34,788	
5.0	**Sub-catchment 4**					
5.1	Project management, overheads, preliminaries, site mob/demob			15%	$ 131,805	
5.2	Detention basin including wetland, swales, inlet and outlet infra	32,000	m3	$ 15	$ 480,000	
5.3	Detention basin landscaping including irrigation and plantings	1.80	ha	$ 25,000	$ 45,000	
5.4	Pipeline 3.2 DN200 including inlet/outlet infra, fittings and ancillary infra	670	lin m	$ 110	$ 73,700	
5.5	Pipeline 4.1 DN355 including inlet/outlet infra, fittings and ancillary infra	600	lin m	$ 200	$ 120,000	
5.6	Pump station 4 (low/high flow) including pit, elec connection, SCADA and commissioning	1	ea	$ 160,000	$ 160,000	
	Sub-total				$ 1,010,505	
6.0	**Sub-catchment 5**					
6.1	Project management, overheads, preliminaries, site mob/demob			15%	$ 117,000	
6.2	Detention basin including wetland, swales, inlet and outlet infra	33,000	m3	$ 15	$ 495,000	
6.3	Detention basin landscaping including irrigation and plantings	1.92	ha	$ 25,000	$ 48,000	
6.4	Pipeline 5.1 DN200 including inlet/outlet infra, fittings and ancillary infra	700	lin m	$ 110	$ 77,000	
6.5	Pump station 5 (low/high flow) including pit, elec connection, SCADA and commissioning	1	ea	$ 160,000	$ 160,000	
	Sub-total				$ 897,000	
7.0	**Sub-catchment 6**					
7.1	Project management, overheads, preliminaries, site mob/demob			15%	$ 135,788	
7.2	Detention basin including wetland, swales, inlet and outlet infra	46,000	m3	$ 15	$ 690,000	
7.3	Detention basin landscaping including irrigation and plantings	2.41	ha	$ 25,000	$ 60,250	
7.4	Pipeline 6.1 DN630 including inlet/outlet infra, fittings and ancillary infra	310	lin m	$ 500	$ 155,000	
	Sub-total				$ 1,041,038	
8.0	**Sub-catchment 7**					
8.1	Project management, overheads, preliminaries, site mob/demob			15%	$ 120,975	
8.2	Detention basin including wetland, swales, inlet and outlet infra	17,000	m3	$ 15	$ 255,000	
8.3	Detention basin landscaping including irrigation and plantings	1.22	ha	$ 25,000	$ 30,500	
8.4	Pipeline 7.1 DN500 including inlet/outlet infra, fittings and ancillary infra	950	lin m	$ 380	$ 361,000	
8.5	Pump station 7 (high flow upgrade) including pit, elec connection, SCADA and commissioning	1	ea	$ 160,000	$ 160,000	
	Sub-total				$ 927,475	
9.0	**Sub-catchment 8**					
9.1	Project management, overheads, preliminaries, site mob/demob			15%	$ 124,155	
9.2	Detention basin including wetland, swales, inlet and outlet infra	17,000	m3	$ 15	$ 255,000	
9.3	Detention basin landscaping including irrigation and plantings	1.34	ha	$ 25,000	$ 33,500	
9.4	Pipeline 8.1 DN500 including inlet/outlet infra, fittings and ancillary infra	1,340	lin m	$ 380	$ 509,200	
9.5	Pipeline 8.2 DN630 including inlet/outlet infra, fittings and ancillary infra	60	lin m	$ 500	$ 30,000	
	Sub-total				$ 951,855	
	Direct cost				**$ 7,135,635**	
	Project/contract mgnt, approvals, design, etc			10%	$ 713,564	
	Contingency			40%	$ 2,854,254	
	Total				**$ 10,703,453**	
	GST			10%	$ 1,070,345	
	Total incl GST				$ 11,773,798	