

Urban Capability Planning Proposal area within South Jerrabomberra

Stormwater Management Assessment

50514075

Prepared for
Queanbeyan City Council

2 October 2014



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Document Information

Prepared for	Queanbeyan City Council
Project Name	Stormwater Management Assessment
Job Reference	50514075
Date	2 October 2014

Document Control

Version	Date	Description of Revision	Prepared By	Prepared (Signature)	Reviewed By	Reviewed (Signature)
A	30/07/2014		SB			
B	2/10/2014		SB		MP	

Version	Reason for Issue	Approved for Release By	Approved (Signature)	Approved Release Date
A	Draft Report for Review	SB		
B	Final Report	SB		2/10/2014

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Executive Summary

Queanbeyan City Council has commissioned a series of land capability studies for a Planning Proposal in the area known as South Jerrabomberra (refer **Appendix A Figure A.1**) to inform Council on potential development constraints to assist with the likely rezoning of the land for urban purposes. This study is part of a brief issued by Council to identify potential geotechnical and stormwater management issues for the site. The geotechnical assessment has been undertaken by ACT Geotechnical Engineers P/L. Cardno were sub-consulted by ACT Geotechnical Engineers P/L to undertake the Stormwater Management assessment which is the subject of this report.

Management of stormwater is an important aspect of the land capability assessment for the site as its three main sub-catchments discharge across the NSW/ACT border to the Canberra suburb of Hume. Discharges to Hume will need to comply with current ACT Government requirements for stormwater quality and quantity control.

The Planning Proposal study area is an extension to the newly rezoned area of South Tralee. An Infrastructure Servicing Report for South Tralee has been prepared by Brown Consulting for the Village Building Co. Cardno undertook a review of this report to determine if the Stormwater Management Strategy recommended for that area would be suitable for adoption in the Planning Proposal area to provide a consistent approach across both developments. The review highlighted some concern over the ability of the strategy to achieve the stated pollutant reduction targets. Based on our experience with WSUD modelling and design, the proposed ponds at the sub-catchment outlets appear to be undersized.

A number of nature conservation, cultural heritage and soil contamination constraints identified in other land capability studies for the area were used to determine the likely extent of urban development. The potential urban extent was then used as the basis for a preliminary examination of a range of stormwater quality and quantity control measures within the three main sub-catchments of the study area.

Preliminary indicative sizes for a range of water quality treatment measures at sub-catchment outlets (similar to the South Tralee strategy) were estimated using generalised sizing relationships developed by Cardno for the Jerrabomberra Creek catchment in 2009. These sizing relations were based on meeting ACT 'Developer' pollutant reduction targets for a range of urban impervious area percentages. These 'Catchment Outlet' treatment measures could be supplemented by a network of local street rain gardens to provide a degree of 'at source' treatment of urban pollutants.

A flow attenuation strategy was also developed to reduce flows in Dog Trap Gully Creek through the Planning Proposal area from the upstream edge of development by converting one or both of two existing farm dams into retarding basins. Flow attenuation storage could also be provided within the 'Catchment Outlet' treatment measures to ensure that flows discharged to Hume are reduced to at least pre-development levels.

An indicative Stormwater Management Plan for the area is shown in **Appendix A Figure A.11**.

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1 Introduction

Queanbeyan City Council issued a brief to undertake an assessment of the urban capability within a Planning Proposal area in South Jerrabomberra with respect to geotechnical and stormwater management constraints. The study was awarded to ACT Geotechnical Engineers P/L who had sub-consulted Cardno (NSWACT) P/L to undertake the stormwater management assessment which is outlined in this report.

The results of this study and other land capability studies commissioned by Council will inform the Planning Proposal which is likely to rezone part of the land for urban purposes. It is also likely to inform a subsequent Development Control Plan which will be applied at development stage.

The outcomes of the project will provide Council with an understanding of soil, contour and other geotechnical constraints relevant to determining possible future land uses, constrained locations and a possible future infrastructure network. Maps will be developed to identify areas which are constrained and therefore not suitable for residential development.

1.1 Planning Area Extent

The Planning Proposal area, shown in **Appendix A Figure A.1**, covers a greenfield area of approximately 111 hectares within the area known as South Jerrabomberra. It is an extension to the newly rezoned area of South Tralee and is bounded to the west by the railway line (ACT border) and south and east by the Tralee Hills.

The area consists of 2 parcels of land in separate ownerships which have all been grazed at some point for agricultural purposes. The land is zoned environmental protection/conservation under two separate environmental planning instruments, namely Yarrowlumla LEP 2002 and Queanbeyan LEP 2012.

Queanbeyan City Council has prepared a planning proposal under section 55 of the Environmental Planning and Assessment Act 1979 for land for the Planning Proposal area. Council received Gateway Approval to proceed with an amendment to the Queanbeyan Local Environmental Plan (South Tralee) 2012 for South Jerrabomberra on 18 September 2013.

1.2 Scope of Work

The scope of work specified in Queanbeyan City Council's brief for the stormwater management assessment is as follows;

1. Review and assessment of relevant information about the site, including information obtained during a site inspection, required to complete the scope of works,
2. Propose how stormwater quality and quantity could be managed for the water supply catchments included in the Planning Proposal area assuming a typical residential mixed use development scenario,
3. The proposed design criteria and key features of any stormwater management system must comply with any applicable Commonwealth, NSW legislative and/or Queanbeyan Council requirements or best practice, and should, in the Consultant's opinion, satisfy the requirements of the ACT Government in its role as receiver of part of the water from this location.

4. Any recommendations are to consider relevant objectives and principles of integrated catchment management, appropriate connections to natural systems, relevant controls or treatment for erosion and sediment control, ecological sustainable development and water sensitive urban design,
5. The proposed stormwater management system is to have regard for that proposed in the Stormwater Management (Infrastructure Servicing Report) prepared by Brown Consulting on behalf of The Village Building Company for proposed development in the South Tralee Development Concept area,
6. The assessment is to comment on, but is not limited to, the consistency or otherwise of design assumptions, flow estimates and proposed treatment methods as recommended in the Brown Consulting study in terms of compliance with Queanbeyan City Council and ACT Government standards. Also, any notable omissions would need to be considered and identified,
7. Liaison with the NSW Environment Protection Authority, relevant ACT Government stormwater infrastructure staff and Queanbeyan City Council as required to complete this review, and
8. Other matters as considered relevant by the consultant.

1.3 Existing Site Conditions

The study Planning Proposal area catchment consists of three main stormwater sub-catchments that each discharge across the NSW/ACT border into the ACT suburb of Hume. The extent and size of these catchments in relation to the study Planning Proposal area are shown in **Appendix A Figure A.2**. For the purposes of this study, and to be consistent with a Site Servicing Report prepared by Brown Consulting for the adjoining South Tralee development, the three catchments have been labelled as Southern, Dog Trap Gully and Central.

The three sub-catchments cover a total area of approximately 287 ha. Preliminary details for the sub-catchments are provided in **Table 1.1**.

Table 1.1: South Jerrabomberra Planning Proposal area sub-catchment details

Sub-catchment	Total Area (ha)	Area within Planning Area (ha)	Catchment Slopes	Current Landuse
Central	96	37	5% – 31%	Rural
Dog Trap Gully	159	69	8% - 30%	Rural
Southern	32	2	8% – 32%	Rural
Total	287	108	7% - 31%	Rural

The catchment slopes range from around 5% to 8% in the lower reaches adjacent to the Goulburn-Cooma railway corridor and NSW/ACT border to up to approximately 30% in the Tralee Hills in the upper reaches of the catchment.

1.4 Site Constraints

Several studies to-date have identified potential constraints on the location and extent of development within the South Jerrabomberra planning area. Information on the following site constraints was provided by Council;

- Potential cultural heritage sites,
- Areas of conservation significance, and
- Areas of possible soil contamination which may require remediation.

Council also advised that development would not be permitted above RL 740 m and on slopes steeper than 20%. A 200 m buffer zone between the eastern boundary of the disused Goulburn-Cooma railway and proposed development would also need to be provided.

The above information was used to estimate the potential extent of development within the South Jerrabomberra Planning Proposal area which is outlined in **Section 3.1**.

1.5 Information Sources

The following data was obtained from several sources for use in the study;

- ACT Government 2004 aerial laser survey data covering most of the study catchment,
- South Tralee survey data,
- Jerrabomberra Creek 10m contour data,
- Nearmap aerial photography

The following guidelines and reports were also used as background information for the study;

- WaterWays Water Sensitive Urban Design General Code (ACTPLA, 2009)
- Queanbeyan Development Design Specification D5 – Stormwater Drainage Design (QCC, 2013)
- Queanbeyan Development Design Specification D7 – Erosion Control and Stormwater Management (QCC, 2013)
- East Lake Pond & Lake at Symonston Feasibility Study, Options Report (ACTPLA, 2009)
- Hume West Industrial Estate, Estate Development Plan (Cardno, 2010)
- South Tralee, Infrastructure Servicing Report – Water Supply, Sewer & Stormwater Management Concept Designs (Brown Consulting, 2013)
- Report on the state of the watercourses and catchments for Lake Burley Griffin (ACT Office of the Commissioner for Sustainability and the Environment, 2012)

1.6 WSUD Targets

Water quality treatment objectives for greenfields development within NSW and the ACT were obtained for the purposes of the study and are outlined as follows.

1.6.1 NSW Department of Environment & Climate Change

In October 2007, the NSW Department of Environment & Climate Change (DECC) released draft treatment objectives as part of a program of consultation on the “Managing Urban Stormwater: Environmental Targets”. These objectives included:

- 85% retention of the average annual load of TSS
- 65% retention of the average annual load of TP
- 45% retention of the average annual load of TN

1.6.2 Queanbeyan City Council

Water quality targets for new development in Queanbeyan, specified in the Council’s ‘Queanbeyan Development Design Specification D7 – Erosion Control and Stormwater Management, are shown in **Table 1.2**.

Table 1.2: Queanbeyan City Council stormwater treatment pollutant load (ARQ)

Pollutant	Objective
Suspended Solids (SS)	80% retention of average annual load
Sediment	100% retention of sediment greater than 0.125mm for flows up to the 3 month ARI peak flow
Oil & Grease	No visible oils for flows up to the 3 month ARI peak flow
Litter	100% retention of litter greater than 5 mm for flows up to the 3 month ARI peak flow
Total Phosphorus (TP)	65% retention of average annual load
Total Nitrogen (TN)	65% retention of average annual load

1.6.3 ACT Government

The pollutant reduction targets specified in the WaterWays Water Sensitive Urban Design General Code (ACTPLA, 2009) are shown in **Table 1.3**.

Table 1.3: ACT Targets for reduction in average annual pollutant exports

Pollutant	Developer	Regional
Total Suspended Solids (TSS)	60%	85%
Total Phosphorus (TP)	45%	70%
Total Nitrogen (TN)	40%	60%

2 Previous WSUD Studies

A number of recent studies within the Jerrabomberra Creek catchment that are relevant to the development of the South Jerrabomberra area are outlined as follows.

2.1 Jerrabomberra Creek/East Lake (ACT)

A study was undertaken by Cardno in 2009 on behalf of the ACT Government to undertake water quality and quantity modelling of the whole of the Jerrabomberra Creek catchment under existing development conditions as of 2009 and estimated conditions for potential future development within the NSW and ACT areas of the creek catchment. For NSW, the future conditions included estimates and assumptions for development within the South Jerrabomberra area.

One of the principal aims of the study was to examine options for providing regional WSUD measures to attain the ACT Regional water quality reduction targets for discharges from Jerrabomberra Creek to the Jerrabomberra Wetlands Nature Reserve and Lake Burley Griffin. The achievement of Regional water quality objectives for the downstream wetlands and lake was to be achieved by a combination of regional WSUD measures provided by the ACT Government and local WSUD measures provided by Developers within existing and future NSW and ACT developments.

This included an allowance for water quality treatment from the South Jerrabomberra area (referred to as Tralee in the report) via an indicative size of a major lake or a major regional biofilter required to meet NSW DECC stormwater treatment targets. It was estimated that a 4 ha regional biofilter would meet the draft 2007 NSW DECC targets. However, it should be noted that this represents a single lumped facility for modelling purposes for the assumed extent of the Tralee area assessed (refer **Appendix A Figure A.8**) which is much larger than the Planning Proposal area for this study. It is recognised that a number of treatment trains consisting of a series of WSUD measures would be provided for individual developments within the area including South Tralee and the study Planning Proposal area.

2.2 Hume West Industrial Estate (ACT)

The design of the Hume West Industrial Estate was undertaken by Cardno in 2009 for the ACT Land Development Agency. The design included a number of WSUD measures to achieve the Developer pollutant reduction targets specified in the ACT Government's Waterways Code.

The industrial estate is of significance to the Planning Proposal area as flows from it will discharge to and through the industrial estate. The WSUD strategy adopted for South Jerrabomberra will need to ensure that the quantum and quality of runoff discharged to Hume West meets ACT WSUD objectives and does not adversely impact on the performance of WSUD facilities provided in the industrial estate.

The location of stormwater outlets that discharge runoff from the South Jerrabomberra Planning Proposal area to Hume are shown in **Appendix A Figure A.2**.

2.3 South Tralee (NSW)

The South Tralee development area adjoins the South Jerrabomberra study area to the north. An Infrastructure Servicing Report outlining water supply, stormwater, and sewer management concept designs was recently prepared by Brown Consulting for the Village Building Co.

The proposed stormwater management strategy for South Tralee consists primarily of a series of GPT, wetland and pond treatment trains along the western boundary of South Jerrabomberra and several retarding basins within the development upstream. The pollutant reduction targets adopted for the development are the ACT Regional targets shown in **Table 1.3**. This was based on the fact that the site discharges to the ACT and the lack of regional treatment measures downstream before flows enter the Jerrabomberra Wetland Nature Reserve and Lake Burley Griffin.

The Infrastructure Servicing Report states that stormwater quality and quantity control and improvements using WSUD principles will be primarily achieved at the proposed treatment trains along the western border of the development.

2.4 South Tralee Stormwater Management Review

Cardno undertook a review of the Stormwater Management section of the South Tralee Infrastructure Servicing Report. The Stormwater Management and Stormwater Concept plans prepared by Brown Consulting are provided as **Appendix A Figures A.9 and A.10** respectively.

The aim of the review was to provide a desktop examination of the design assumptions, flow estimates and treatment methods proposed to comply with Queanbeyan City Council and ACT Government design standards. The review was also to ascertain if the principles of the Stormwater Management Strategy would be suitable for the South Jerrabomberra Planning Proposal area and thereby provide a consistent management approach over the two development areas.

2.4.1 Hydrological Modelling

In relation to the xprafths hydrological modelling undertaken, the model parameters listed are considered acceptable for best practice drainage design. It is noted that the impervious fraction adopted for residential development is 70% which, in accordance with Table 1.1 of Council's Handbook of Drainage Design Criteria, implies that all residential development will be multi-dwelling.

The estimated existing catchment conditions 100 year ARI flows at the outlets of the Dog Trap Gully and Central sub-catchments were compared to the results of xpswmm modelling of the same catchments undertaken by Cardno in 2009 for the Hume West Industrial Estate. The flows were found to be similar and are considered to be acceptable given that two different hydrological models were used with be some minor differences in the adopted sub-catchments parameters.

On the above basis, it is considered that the reported flow rates for the South Tralee Sheppard and Raws sub-catchments should also be reasonable estimates.

A comparison of the 100 year ARI flow rates for the Dog Trap Gully and Central sub-catchments is provided in **Table 2.1**.

The flow attenuation strategy proposed for South Tralee is in accordance with current design practice and is therefore considered to be acceptable. The strategy proposes to provide sufficient flow attenuation within the proposed outlet pond/wetland facilities in conjunction with two smaller upstream basins in the Central and Raws sub-catchments to reduce post-development outflows to Hume to pre-development levels.

Table 2.1: Estimated sub-catchment outlet existing 100 year ARI flow rates (m³/s)

Sub-Catchment	Brown Consulting			Cardno		
	Inflow	Outflow	Bypass	Inflow	Outflow	Bypass
Dog Trap Gully	32.0	18.3	9.3	28.9	19.2	9.5
Central	24.5	8.3	14.3	19.8 *	10.7	10.0

* Includes bypass flow from Dog Trap Gully sub-catchment

2.4.2 Water Quality Modelling

Brown Consulting undertook water quality modelling of existing and post-development catchment conditions using MUSIC (Model of Urban Stormwater Improvement Conceptualisation). Cardno is unable to comment on the MUSIC modelling parameters used as these were not included in the Infrastructure Servicing Report extract provided by Council.

Pollutant Reduction Targets

The pollutant reduction targets adopted for South Tralee are the ACT Regional targets shown in **Table 1.3**. These targets are slightly less than Council's targets shown in **Table 1.2**. The rationale for selecting the ACT Regional targets was the fact that South Tralee discharges directly to the ACT and currently there are no regional treatment facilities in the downstream Jerrabomberra Creek catchment. Further discussion on reduction targets that could be adopted for development in the South Jerrabomberra area is provided in **Section 3.2.1**.

Concept WSUD Measures

As stated previously, it is proposed that stormwater management for South Tralee will be primarily achieved by the provision of treatment trains (GPTs, wetlands and ponds) along the southern border of the development.

Cardno have concerns regarding the stated sizes of the wetlands and ponds in these treatment train systems. Based on Cardno's considerable experience with modelling and sizing of wetlands and ponds in similar catchments in both the ACT and NSW, these facilities appear to be too small to achieve the stated reductions in Total Phosphorus and Total Nitrogen. It is recommended that an independent review of the MUSIC models be undertaken to check if the sizing is appropriate for the stated pollutant reduction targets.

3 Stormwater Management Strategy

This section outlines the developed of a concept stormwater management strategy for the South Jerrabomberra Planning Proposal area based on a review of previous studies in the area and background information provided by Council.

3.1 Assumed Development Extent

The information provided by Council on potential site constraints was overlain onto a single plan (refer **Appendix A Figure A.7**) in order to provide a preliminary estimate of the possible extent of development within the study Planning Area. The assessment of the potential development extent was based on the following assumptions.

- The areas shown as 'high' conservation significance (marked red) in **Appendix A Figure A.4** would be restricted from development.
- The areas shown as having a potentially 'high' cultural heritage significance (also marked red) in **Appendix A Figure A.5** would be restricted from development.
- Potential areas of soil contamination shown in **Appendix A Figure A.6** could be remediated if necessary and made available for development.
- All areas in the upper portion of the catchment with slopes steeper than 20% would also be restricted from development. Small isolated areas in the lower catchment with slopes steeper than 20% could be made suitable for development by regrading.
- A 40 m wide riparian zone corridor along the extent of Dog Trap Gully Creek. This creek has been classified as a 2nd order watercourse by the NSW Office of Water.
- A 200 m buffer zone extending from the eastern boundary of the Goulburn-Cooma railway would be excluded from residential development. This area could however be used for recreational and stormwater management facilities and related supporting infrastructure such as access roads and pedestrian paths.

Based on the above and the constraints overlay plan, the estimated maximum area available for development in each sub-catchment is shown in **Table 3.1**.

Table3.1: Estimated areas available for development in South Jerrabomberra Planning Proposal area

Sub-Catchment	Planning Area (ha)	Constrained Area (ha)	Net Developable Area (ha)
Central	37	20	17
Dog Trap Gully	72	40	32
Southern	2	1	1

The net developable areas shown above will most likely consist of a mixture of different urban landuses. For the purposes of this study, the average imperviousness of these areas has been assumed to be 60%. It has also been assumed that the constrained areas will not contain any form of development, except for the railway buffer zone, and therefore will have an imperviousness of 0%. The buffer zone has been assumed to have an imperviousness of 10%.

3.2 Stormwater Quality Management

3.2.1 Pollutant Reduction Targets

Cardno sought advice from the Infrastructure Planning section of the ACT Economic Development Directorate as to whether or not the ACT Regional targets (as recommended for South Tralee) would be acceptable to the ACT Government for the South Jerrabomberra area. It was subsequently advised that the ACT Government is having some difficulty in meeting their Regional targets and is currently undertaking an internal review which will most likely result in these targets being relaxed.

Notwithstanding the above, it is noted that the report on the state of the watercourses and catchments for Lake Burley Griffin issued by the ACT Office of the Commissioner for Sustainability and the Environment in 2012 recommends that phosphorus reduction targets be maintained. It is stated that these targets are an important factor for the long term reduction of chemically bound phosphorus in Lake burly Griffin sediments which will help reduce the frequency and severity of algal blooms in the lake.

Based on the above advice and recommendations, an acceptable strategy could be to adopt the ACT Developer targets for Total Suspended Solids and Total Nitrogen and Council's target for Total Phosphorus as shown in **Table 3.2**.

Table 3.2: Suggested pollutant reduction targets for South Jerrabomberra

Pollutant	Reduction Target
Total Suspended Solids (TSS)	60%
Total Phosphorus (TP)	65%
Total Nitrogen (TN)	40%

Council would need to discuss this issue further with the ACT Government as part of the rezoning process in order to obtain agreement on reduction targets that would be acceptable to the ACT Government.

3.2.2 'Catchment Outlet' Treatment Strategy

The stormwater management strategy adopted for South Tralee is essentially a 'Catchment Outlet' strategy whereby the majority of stormwater treatment is achieved by a treatment train at the lower end of each sub-catchment prior to discharge across the NSW/ACT border to Hume. Given that the South Jerrabomberra sub-catchments are relatively steep in the middle to upper sections of the Planning Proposal area, a 'Catchment Outlet' strategy has merit. Trying to construct even small ponds and/or wetlands in these areas of the sub-catchments where ground slopes are in the order of 10% or more could be problematic.

The WSUD sizing relations developed for the East Lake study were used to obtain an indication of the size of a pond, wetland or biofilter that would be required at each sub-catchment outlet to meet the ACT Developer pollutant reduction targets. Estimated pond, wetland and biofilter sizes using these sizing relationships are shown in **Table 3.3**. It should be noted that these are indicative generalised sizes and should only be used for preliminary planning purposes.

It should also be noted that the estimated sizes are based on meeting the ACT Developer reduction targets. The targets suggested for South Jerrabomberra are the same with the exception of Total Phosphorus which is 20% higher. The additional phosphorus removal required could be provided by other WSUD facilities in the catchment as discussed in **Section 3.2.3**.

Table 3.3: Indicative size of ‘Catchment Outlet’ WSUD measures

Sub-Catchment	Surface Area (ha)			
	Wetland Only	Pond Only	Biofilter Only	Treatment Train
Central	1.6	0.9	0.4	1.2
Dog Trap Gully	2.7	1.4	0.6	2.0
Southern	-	-	0.1	-

WSUD facilities of the sizes shown above, in conjunction with an upstream gross pollutant trap (eg. a CDS unit or equivalent), could readily be accommodated in the 200 m wide railway buffer zone with the exception of the Southern sub-catchment which is predominantly of ‘high’ conservation significance. Due to the relatively small area available for development in the Southern sub-catchment and its location at the top of the catchment, it would be preferable to provide treatment facilities at the downstream end of the developable area rather than at the downstream end of the sub-catchment.

Rather than provide a single pond, wetland or biofilter at sub-catchment outlets, it would be preferable to provide a treatment train consisting of some or all of these elements. A suggested treatment train could consist of the following;

- A gross pollutant trap to trap litter and coarse sediments,
- An off-line wetland with extended detention to treat flows up to 3 moth ARI,
- An on-line pond to treat flows between 3 month and 1 year ARI and to provide flow attenuation storage for flows up to 100 year ARI, and
- An off-line biofilter could also be included to provide further polishing of outflows from the off-line wetland.

As the development area in the Southern sub-catchment is small, a single biofilter at the drainage outlet of the developable area would most likely be sufficient to meet required pollutant reduction targets.

3.2.3 ‘Distributed’ Treatment Strategy

A ‘distributed’ treatment strategy could be adopted for the Central and Dog Trap Gully sub-catchments by providing a series of small rain gardens in the suburban street network in addition to the above suggested ‘catchment outlet’ treatment train. The rain gardens would provide ‘at source’ treatment of urban pollutants (particularly Total Phosphorus and Total Nitrogen) and, depending on the number provided, could result in a considerable reduction in the required sizes of the components of the downstream treatment train.

3.3 Stormwater Quantity Management

3.3.1 Downstream Flow Constraints

Attenuation of peak flows from the developable area of each sub-catchment would be required to reduce discharges to Hume to pre-development levels. The permissible discharges reported in Brown Consulting's Infrastructure Servicing Report for South Tralee are considered to be acceptable limits for peak flow. However, it should be noted that although peak flows would be reduced to pre-development levels, the volume of runoff discharged from the urbanised South Jerrabomberra sub-catchments would be increased above existing levels for all storm events. This could be a potential problem for discharges from the Dog Trap Gully sub-catchment which will enter the WSUD pond in Hume West adjacent to the Tralee / Pethard Street roundabout. The additional flow volume in storm events up to 100 year ARI storm event could cause the pond to overtop. Modelling will therefore need to be undertaken to ensure that discharges from Dog Trap Gully Creek are reduced sufficiently to prevent this from occurring.

3.3.2 Flow Attenuation Measures

It is recommended that the flow attenuation strategy proposed for South Tralee be adopted for the South Jerrabomberra Planning Proposal area. The majority of flow attenuation would be provided within the 'Catchment Outlet' treatment trains for each sub-catchment with additional flow attenuation provided upstream at appropriate locations within the developed urban area.

For the Dog Trap Gully sub-catchment, it is recommended that one or both of the two existing farm dams on Dog Trap Gully Creek at the upper end of the Planning Proposal area be converted to retarding basins. Outflows from the basin(s) should be reduced to the extent that, when combined with inflows to the creek from the downstream urban area drainage system, the potential for erosion in Dog Trap Gully Creek due to increased urban runoff is minimised.

The South Tralee Infrastructure Servicing Report makes mention of a proposed retarding basin in the Central catchment area. However, this basin is not shown on the Concept Stormwater Plan (refer **Appendix A Figure A.10**). It is assumed that this basin will be provided on the existing watercourse at the upstream edge of the development to reduce the size of the piped drainage diversion shown around the development perimeter. A portion of the South Jerrabomberra Planning Proposal area in the Central sub-catchment would discharge to the watercourse downstream of the pipe diversion from the retarding basin. This basin may provide sufficient flow attenuation to compensate for higher flows discharged to the watercourse from the South Jerrabomberra Planning Proposal area. If not, sufficient flow attenuation would need to be provided in the 'Catchment Outlet' treatment train to cater for this section of the South Jerrabomberra Planning Proposal area.

Flow attenuation for flows from the small Southern sub-catchment development area could be provided with the recommended outlet biofilter.

4 Conclusions

Based on the discussions and recommendations made in the previous sections of this report, it is concluded that a satisfactory Stormwater Management Strategy is achievable for the South Jerrabomberra Planning proposal area. The strategy suggested is similar to that proposed for the adjacent South Tralee area and thereby provides a level of consistency across both development areas.

An independent assessment of the water quality modelling for South Tralee should be undertaken to ensure that the proposed strategy meets the stated pollutant removal targets.

An indicative Stormwater Management Strategy for the South Jerrabomberra Planning Proposal area is outlined in **Appendix A Figure A.11**.

Appendix A

FIGURES



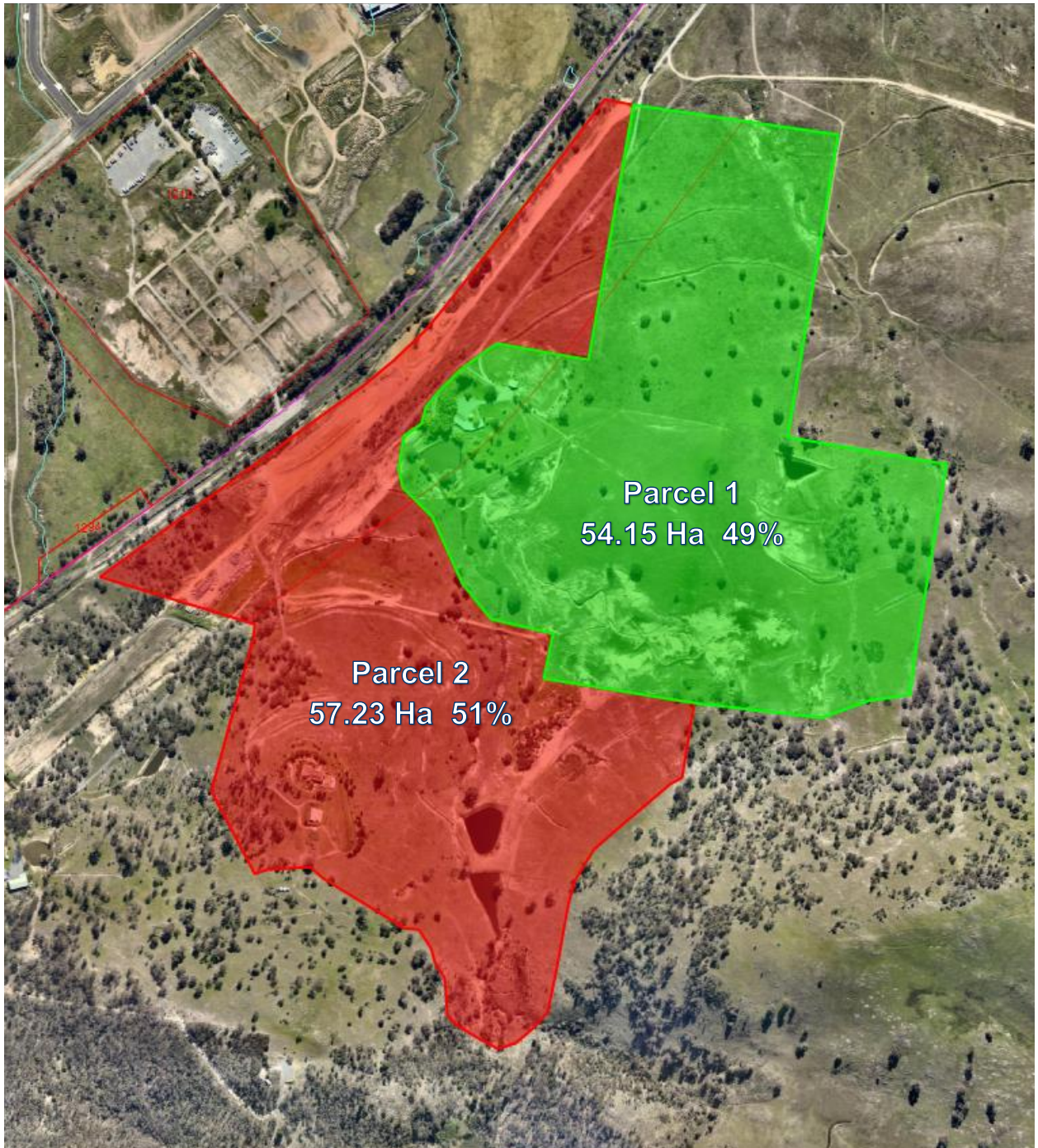


Figure A.1: South Jerrabomberra Planning Proposal area extent

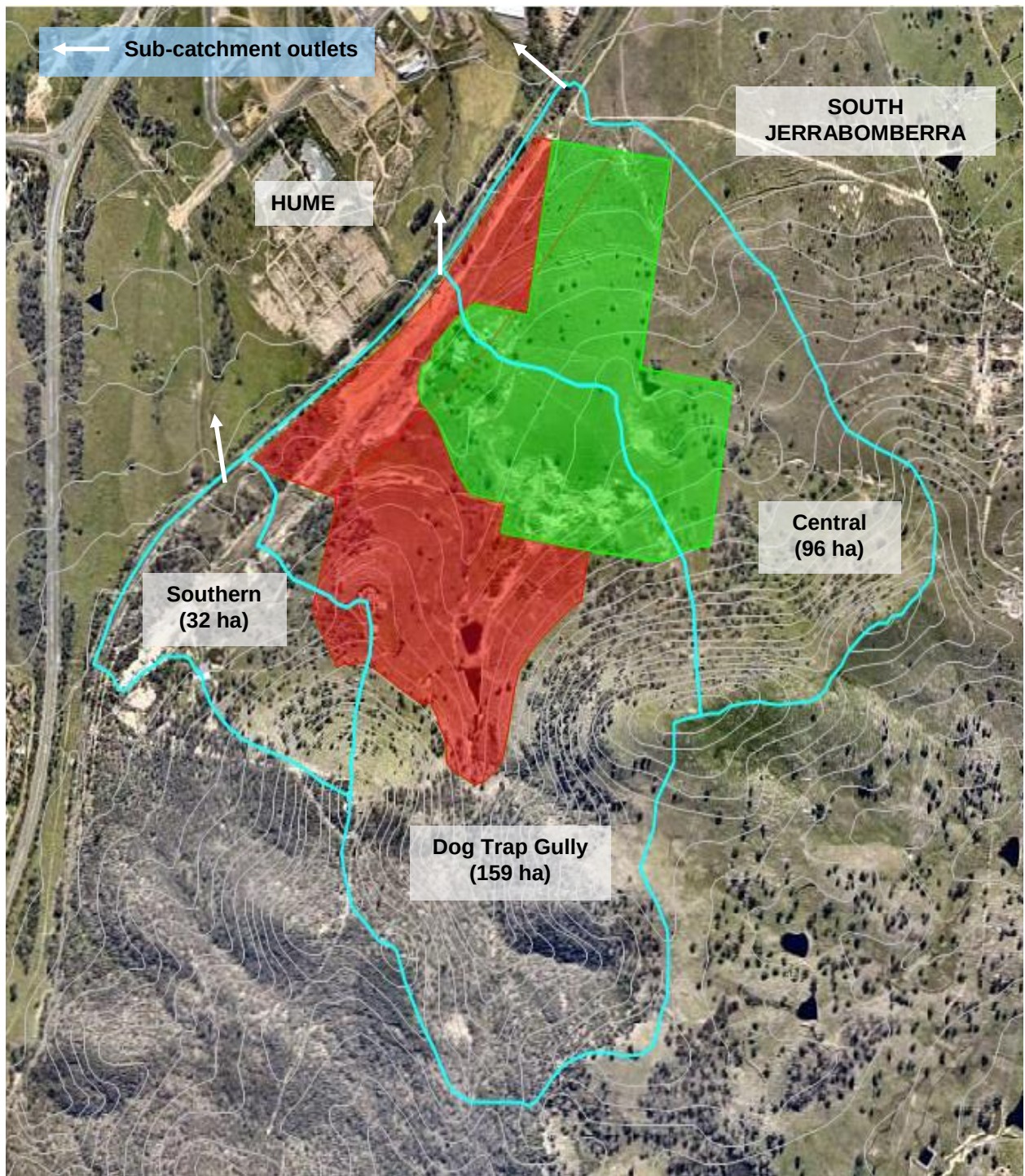


Figure A.2: South Jerrabomberra Planning Proposal area catchments

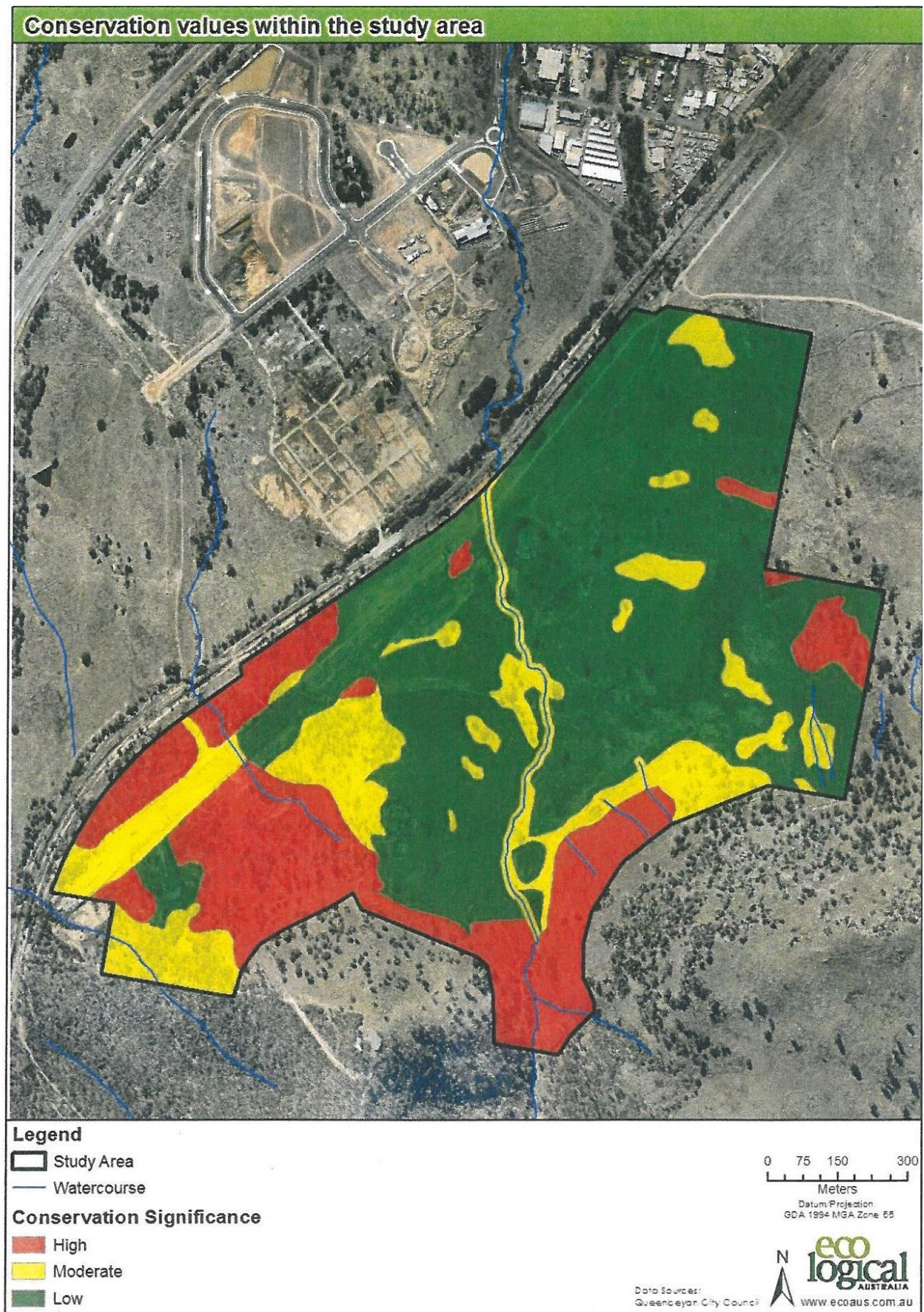


Figure A.3: Map of conservation values

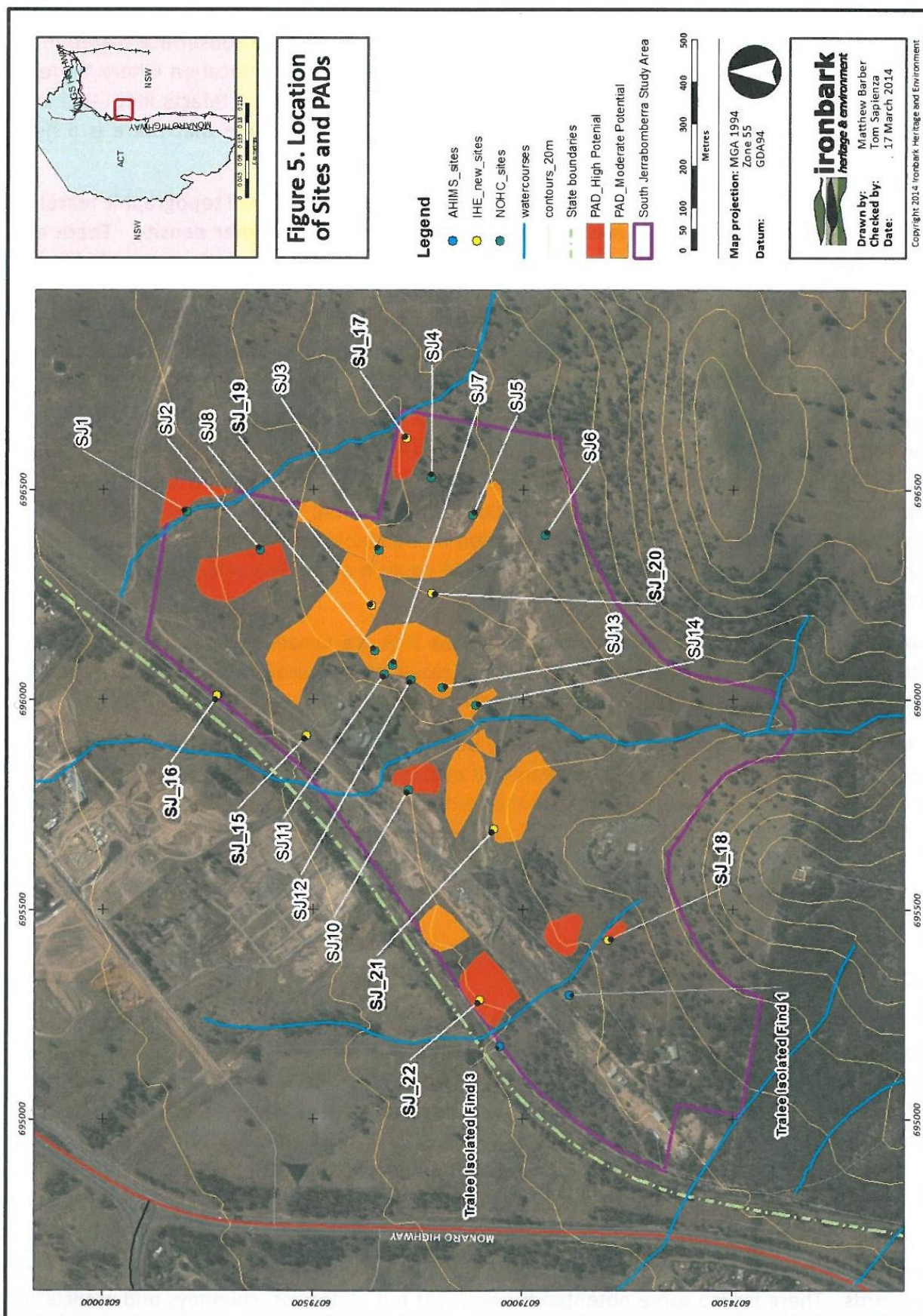


Figure A.4: Areas of potential cultural heritage significance



Figure A.5: Areas of potential soil contamination

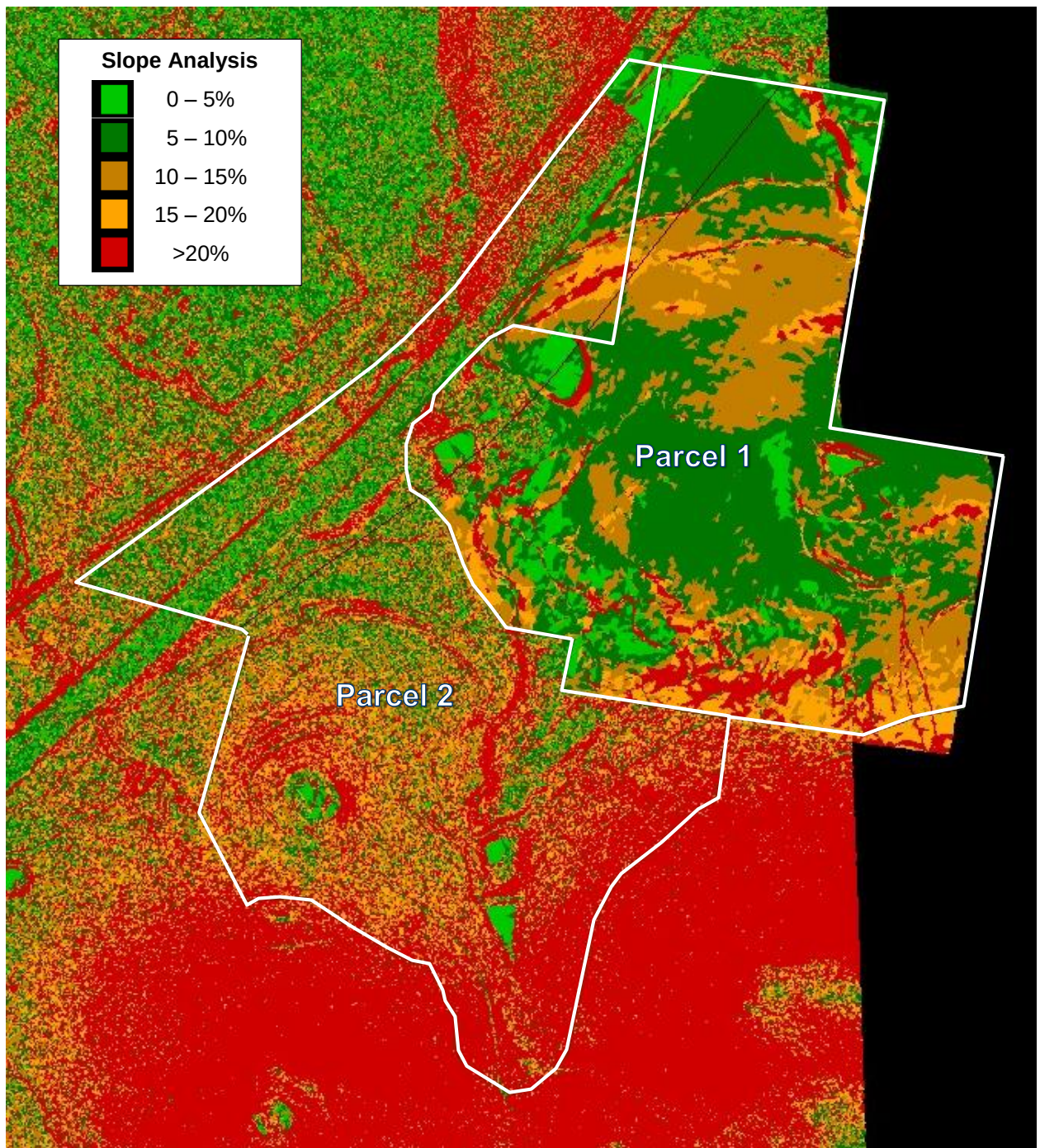


Figure A.6: Preliminary terrain slope analysis

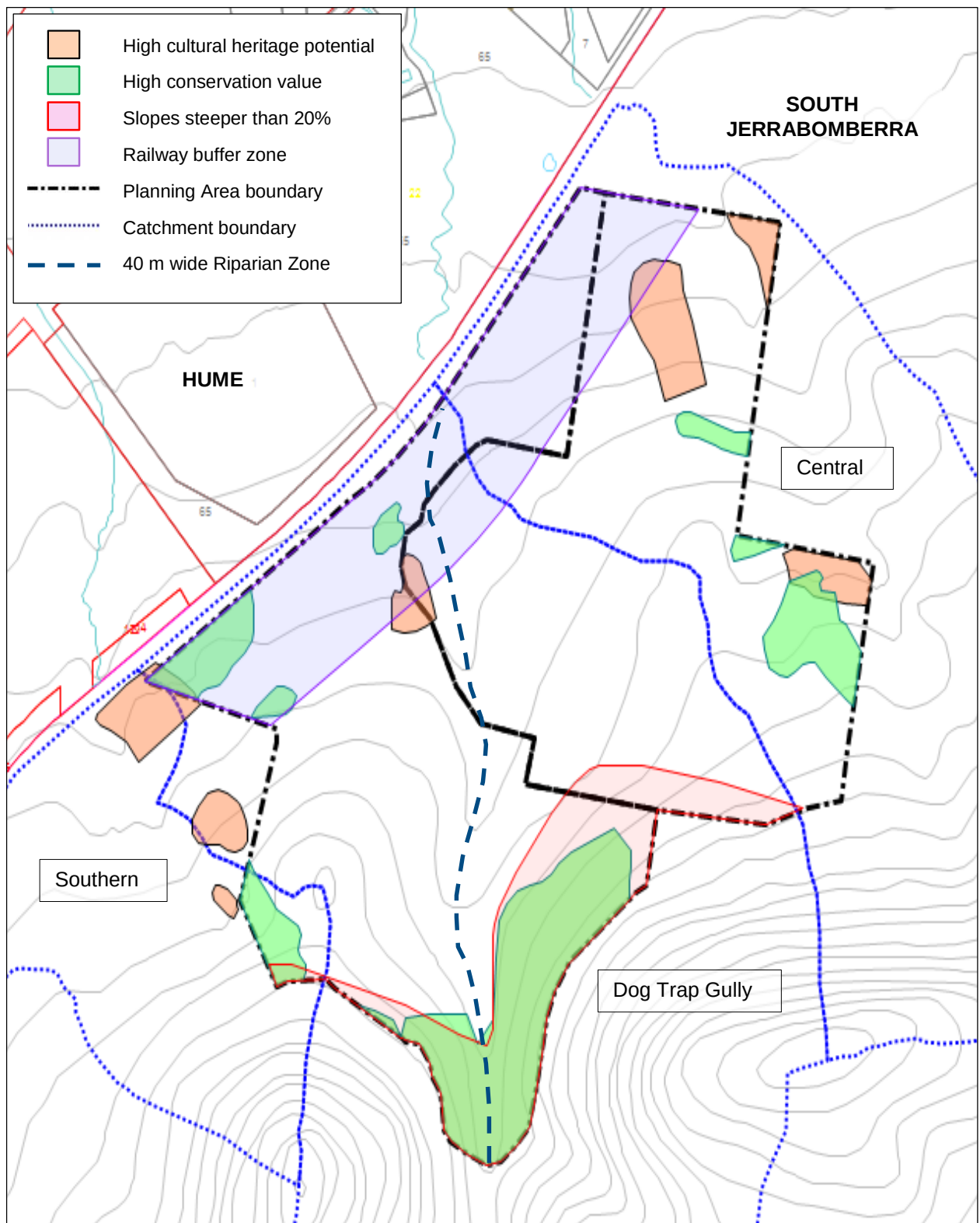


Figure A.7: Site constraints overlay map

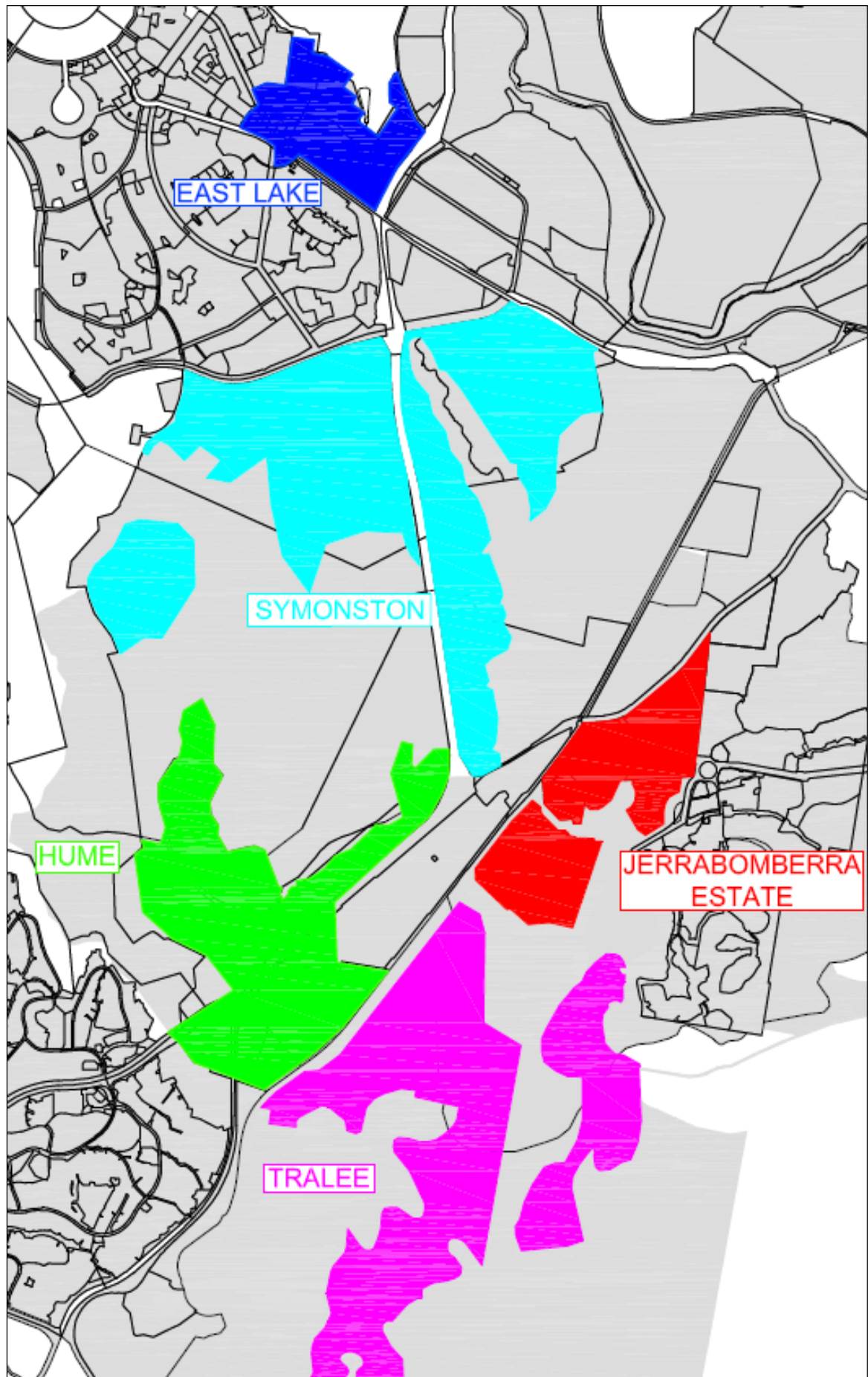


Figure A.8: Assumed future ACT & NSW development areas within the Jerrabomberra Creek catchment (East Lake Options Study, 2009)

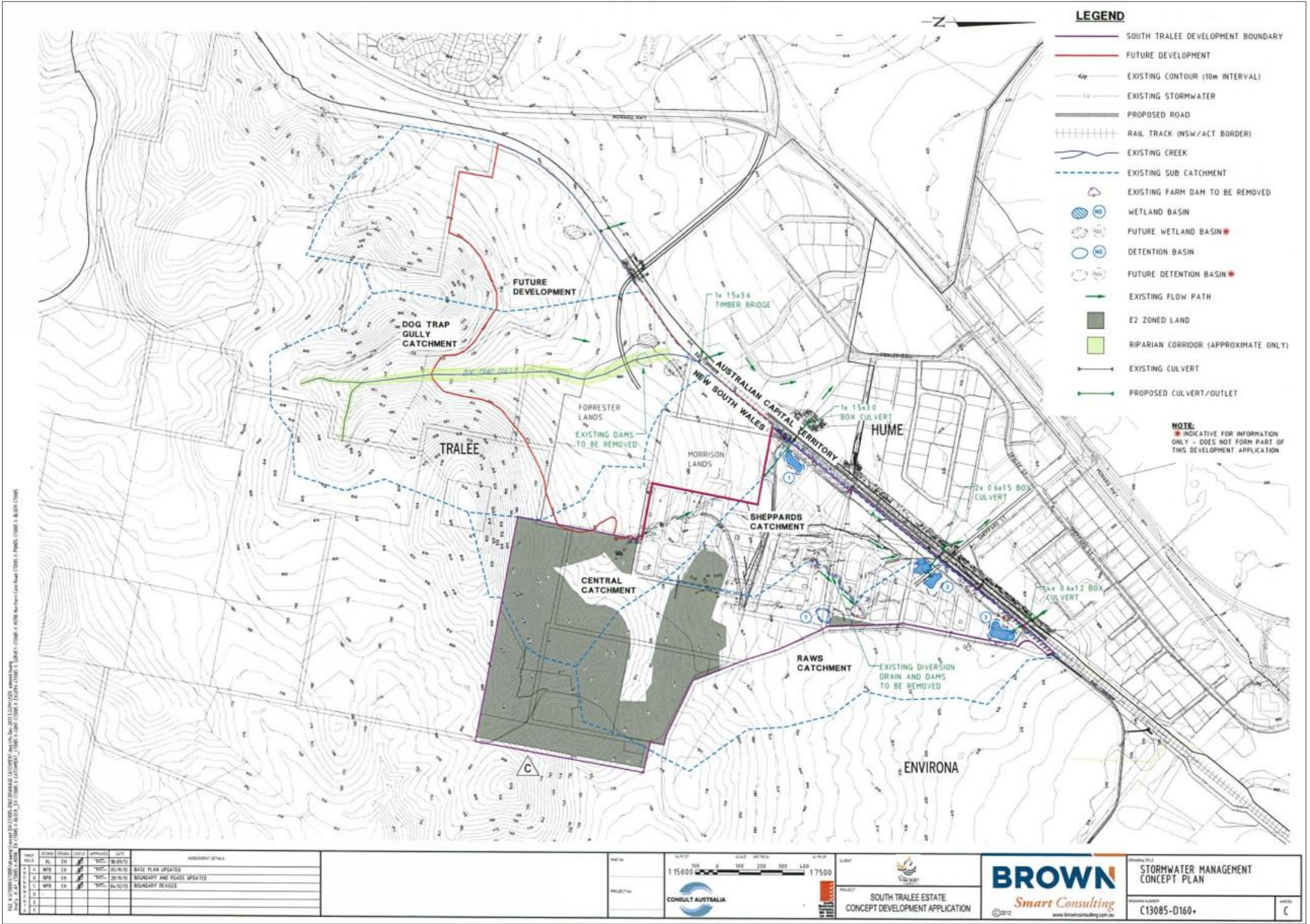
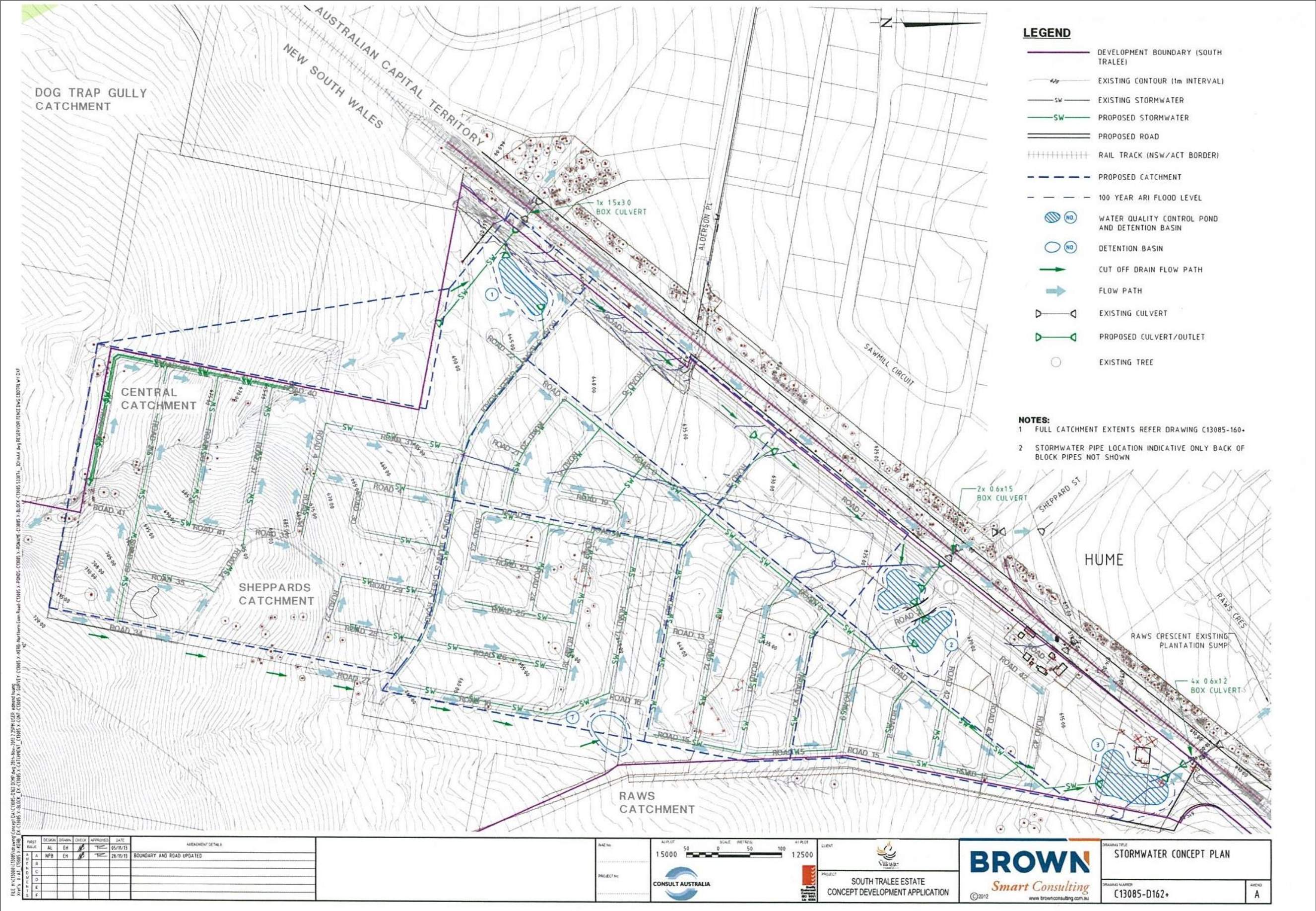


Figure A.9



FigureA.10

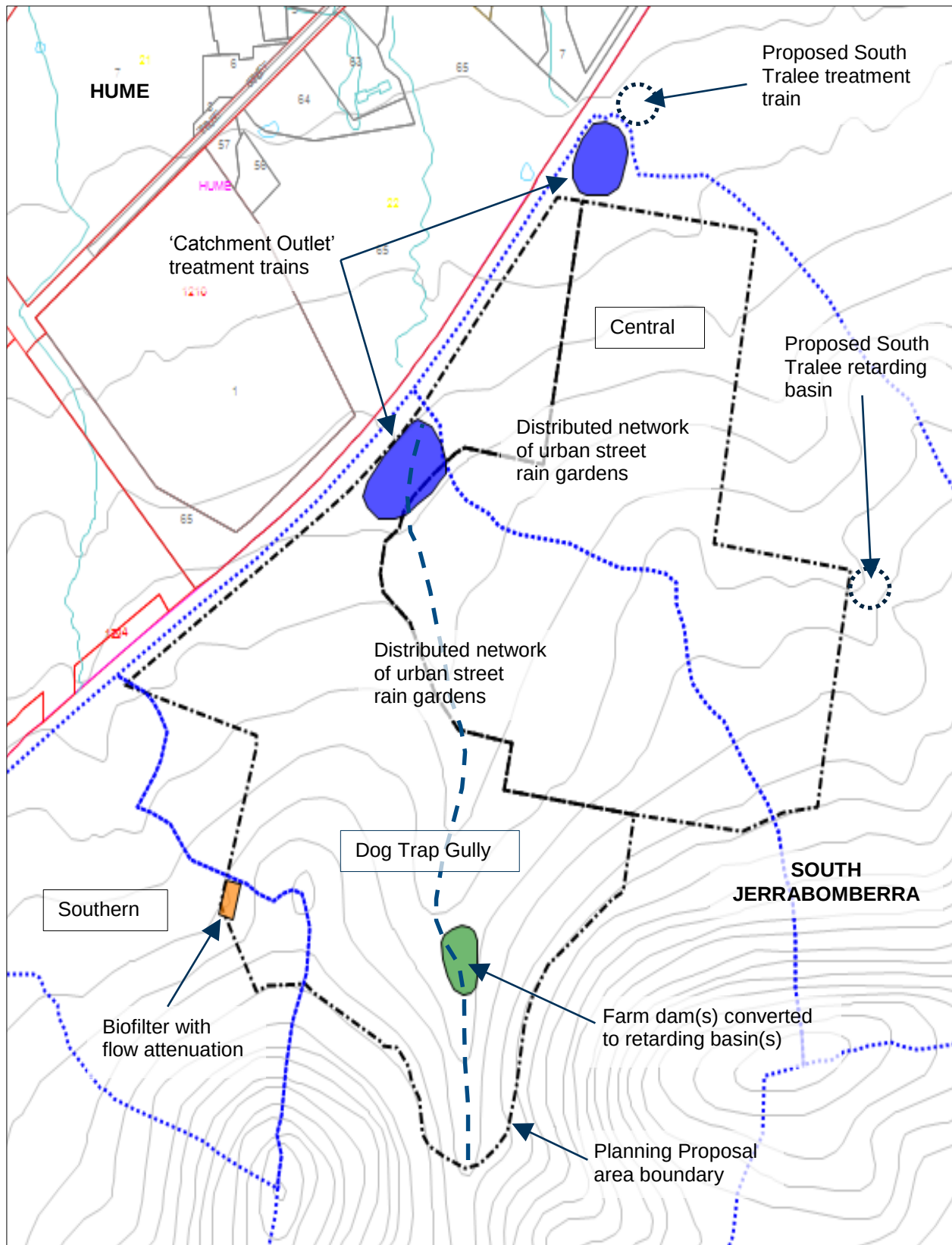


Figure A.11: South Jerrabomberra concept Stormwater Management Plan outline

Appendix B

EAST LAKE STUDY WSUD SIZING
RELATIONS



B.1 Water Quality Modelling Approach

An aim of the water quality assessment for the East Lake study was to establish a simplified relationship for concept sizing of regional ponds or wetlands or biofilters based on catchment area and percentage urbanisation. It was intended that planners and others can use these simplified relations for initial sizing of measures for future development planning purposes.

A series of MUSIC models for concept 2 ha, 10 ha, 40ha and 100 ha catchments which were 40% or 100% urbanised were assembled. All urban areas were initially assumed to be 50% impervious. Sensitivity testing of 30% imperviousness and 70% imperviousness for 100% urbanised catchments was also undertaken.

A separate series of models was assembled for each of the following cases:

- A local pond discharging into a regional pond,
- A local wetland discharging into a regional wetland, and
- A local biofilter discharging into a regional biofilter.

The local and regional ponds, wetlands or biofilters were iteratively sized to achieve the respective ACT Development or Regional targets shown in **Table 1.3**.

B.1.1 Assumed Pond, Wetland and Biofilter Characteristics

The following assumptions were adopted for conceptually sizing ponds:

- An extended detention depth of 0.5 m;
- An assumed average depth of 1.2 m, i.e. the permanent storage volume is 1.2 times the surface area; and
- Low flow pipes were sized such that the pond has around 48 hours of notional detention time.

The following assumptions were adopted for conceptually sizing wetlands:

- An extended detention depth of 0.5 m;
- An assumed average depth of 0.5 m, i.e. the permanent storage volume is 0.5 times the surface area; and
- Low flow pipes were sized such that the wetland has around 48 hours of notional detention time.

The following assumptions were adopted for conceptually sizing biofilters:

- An extended detention depth of 0.3 m;
- The surface area and the filter area are the same;
- A filter depth of 0.6 m;
- A filter median particle diameter of 0.24 mm; and
- A saturated hydraulic conductivity of 120 mm/hr.

For modelling purposes, it was assumed that all inflows would enter the pond, wetland or biofilter (i.e. the pond, wetland or biofilter is on-line on a local watercourse or drainage line).

A notional high flow bypass of 100 m³/s was adopted for assessment purposes.

B.2 Sizing Relationships for Ponds, Wetlands and Biofilters

Based on the results of the various MUSIC runs, the following procedures were proposed for concept sizing of local or regional ponds, wetlands and biofilters with the Jerrabomberra Creek catchment.

Local Ponds

The surface area of a local pond is calculated from the following equation:

$$A_R = F \times (0.767 \times U + 0.533)$$

Where: A_R = ratio of surface area of a pond to the total catchment area (in %)

F = factor which is a function of imperviousness of an urban catchment (refer **Table B.1**)

U = urbanisation of the catchment as a fraction

The volume of a pond can then be determined from the assumed characteristics given in **Section B.1.1**.

Regional Ponds

The surface area of a regional pond is calculated from the following equation:

$$A_R = F \times 2.12$$

The volume of a pond can then be determined from the assumed properties characteristics given in **Section B.1.1**.

Local Wetlands

The surface area of a local wetland is calculated from the following equation:

$$A_R = F \times (0.167 \times U + 1.433)$$

The volume of a wetland can then be determined from the assumed properties characteristics given in **Section B.1.1**.

Regional Wetlands

The surface area of a regional wetland is calculated from the following equation:

$$A_R = F \times (0.250 \times U + 2.70)$$

The volume of a wetland can then be determined from the assumed properties characteristics given in **Section B.1.1**.

Local Biofilter

The surface area of a local biofilter is calculated from the following equation:

$$A_R = F \times 0.34$$

The properties of a biofilter can then be determined from the assumed characteristics given in **Section B.1.1**.

Regional Biofilter

The surface area of a regional biofilter is calculated from the following equation:

$$A_R = F \times 0.38$$

The properties of a biofilter can then be determined from the assumed characteristics given in **Section B.1.1**.

Table B.1: Factor (F) for imperviousness of an urban catchment

Pond	Imperviousness		
	30%	50%	70%
Local Measures	0.76	1	1.24
Regional Measures	1	1	1

Wetland	Imperviousness		
	30%	50%	70%
Local Measures	0.77	1	1.26
Regional Measures	1	1	1

Biofilter	Imperviousness		
	30%	50%	70%
Local Measures	0.85	1	1.23
Regional Measures	0.88	1	1.18

About Cardno

Cardno is a professional infrastructure and environmental services company, with expertise in the development and improvement of physical and social infrastructure for communities around the world. Cardno's team includes leading professionals who plan, design, manage and deliver sustainable projects and community programs. Cardno is an international company listed on the Australian Securities Exchange [ASX:CDD].

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