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Planning Proposal

Lots 3 & 4 DP1069441, south Mudgee
(Land bound by Spring Flat Road and Sydney Road)

Burrundulla Pty Limited

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Dec-15
(Our Reference: 19429 - rezoning - P01g)
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LIST OF CONTENTS

APPENDICES

Appendix A – Maps
Appendix B – Plans
Appendix C – Archaeological Assessment and AHIMS search
Appendix D – Groundwater and Salinity Study

EXECUTIVE SUMMARY

This submission is made by Barnson Pty Ltd to Mid-Western Regional Council on behalf of the Burrundulla Pty Limited, seeking support in principle for the rezoning of rural land under the Mid-Western Regional Local Environmental Plan 2012. The proposal seeks Council's support to rezone approximately 55.9ha of the southern part of the site from the RU4 - Primary Production Small Lots zone to R5 – Large Lot Residential zone, with a corresponding minimum lot size of 2ha. The remaining 71.9ha of the northern part of the site is proposed to remain zoned RU4 – Primary Production.

The subject land is located in the south Mudgee area and consists of two (2) lots with a total area of 139ha, being Lots 3 & 4 DP1069441 located on the southern side of Sydney Road. The subject land extends to the north and south of Sydney Road / Castlereagh Highway and has frontage to Spring Flat Road along its western boundary.

The submission follows a review of Council's Mudgee and Gulgong Urban Release Strategy (URS) 2014 which includes the proposal, recommending a minimum lot size of 2ha per lot, with Council supporting it for release from 2015+ as resolved at its meeting of 5 November 2014. The land was initially considered for rezoning in 2013 following a review of the Mid-Western Regional Comprehensive Land Use Strategy (2009) which identified Spring Flat Road as a 'hard edge' for urban growth in the south side of the town "*because it provides a clear edge between urban and rural uses*".

The Strategy identifies land north of Spring Flat Road as an opportunity for large lot residential subdivision to 4,000m^2. The subject land, which adjoins this edge defined by Spring Flat Road is considered a suitable extension of future large lot residential subdivision as submitted in this proposal.

Based on a preliminary assessment, the subject is predominantly cleared and limited in productivity to low intensity grazing such that its highest and best use is not being economically achieved. The subject land has sealed road frontage to Spring Flat Road and is recognised for its suitability for large lot rural residential subdivision with a minimum lot size of 2ha as an extension to the southern boundary for the area identified as potential large lot residential along Spring Flat Road.

The submission consists of two copies of this report, including:

- Planning Report prepared by Barnson Pty Ltd;
- Maps and Plans by Mid-Western Regional Council and Barnson;
- Aboriginal Archaeology Assessment by Mudgee Local Aboriginal Lands Council
- Preliminary Site Investigation prepared by Barnson
- Groundwater and Salinity Study

1.0 OVERVIEW OF SITE CHARACTERISTICS

1.1 Site Location

The subject land extends south of Sydney Road / Castlereagh Highway and has frontage to Spring Flat Road along its western boundary. Refer to **Figure 1 -** location plan.

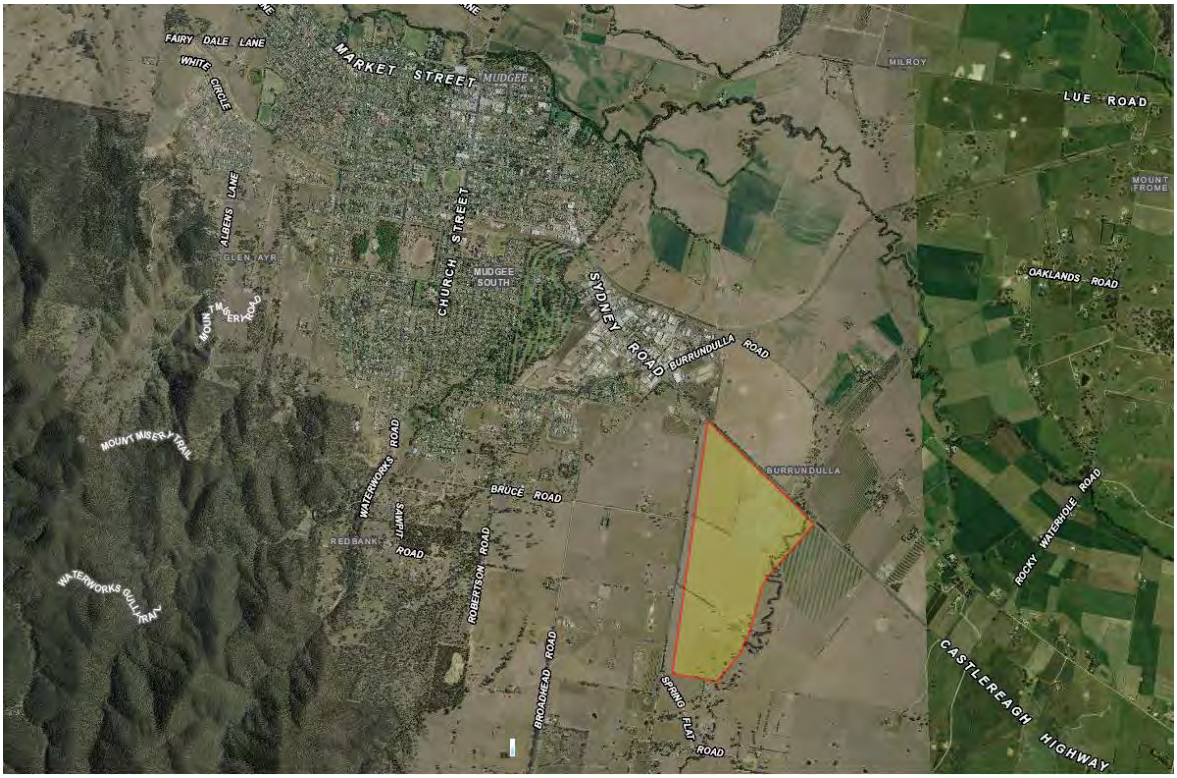


Figure 1 - *aerial view location plan of site, located on the south-eastern edge of Mudgee*

1.2 Property Description & Zonings

The subject land consists of two (2) lots legally described as:

- Lot 3 DP1069441 located on the southern side of Sydney Road and eastern side of Spring Flat Road;
- Lot 4 DP1069441 located on the southern side of Sydney Road.

The subject land is currently zoned RU4 - Primary Production Small Lots pursuant to the Mid-Western Regional Local Environmental Plan 2012 (the LEP). Refer to LEP map, in **Appendix A**.

The proposed rezoning is for 55.9ha of the site to R5 - Large Lot Residential, with a minimum lot size of 2ha pursuant to the LEP. Refer to proposed plan of subdivision at **Appendix B.** Land ownership is described in **Table 1**.

Table 1: Property description, lot size and preferred zoning

Description		Area
Existing		
Lot 3	DP1069441	15ha
Lot 4	DP1069441	124ha
Total area		**139ha (desktop cadastre)**
Proposal		
Proposed R5 – Large Lot Residential zone		55.9ha
Remaining RU4 zone		83.1ha

1.3 Landform and Topography

Soils of the site are included in the group 'Craigmore', these soils generally occur within and around Mudgee, and on the eastern and western side of the Cudgegong River. Soil types within the group include: Non-calcic Brown Soils and Red Earths on very old Quaternary alluvium. Yellow Podzolic-Solodic Soils intergrades on lower areas and some leached loams on lower terraces adjacent to major streams (Lawrie, B.W. and Murphy, J.W. (1998), Soil Landscapes of the Dubbo 1:250 000 Sheet, Department of Land and Water Conservation of NSW, Sydney).

In broad geological terms, the area lies upon Quaternary rocks described as '*alluvial silt, clay, sand with variable humic content, sporadic peddle to cobble sized unconsolidated conglomeratic lenses*'. Underlying this series of rocks is the Narrabeen and Sydney Basin Groups of rocks of Triassic and Permian ages (NSW Mineral Resources, 1:100 000 Geological Map, 2000).

A description on salinity is not available.

The subject land generally has a mild fall to the northeast with surface runoff draining into minor streams that traverse the site into Oakey Creek, which meanders adjacent to the eastern boundary of Lot 4, flowing in a northerly direction into the Cudgegong River. Some surface runoff is captured by two 'off line' dams which located towards the middle of the site. The near level form of the land ensures that future development will require minimal earthworks thereby preserving the natural drainage regime across the site.

1.4 Land-uses

The subject land is cleared, with Lot 4 featuring two farm sheds towards its eastern boundary. The land is currently used as low intensity grazing land featuring cattle and sheep. Advice from the owners on past land uses is that the land has a long history of livestock grazing, with no portion of the land ever established for intensive agriculture purposes. Refer to **Photos 1 - 3.**

The known history of the site is also documented in the Preliminary Site Investigation report prepared under separate cover by Barnson. This report finds that the proposed area of rezoning (which excludes the shearing shed and surrounds at the south-eastern corner) is considered suitable for the proposal.

Photo 1: *View from south-eastern corner of Lot 4 looking north-west from Sydney Road. Scar Tree can be seen left of centre surrounded by a herd of cattle*

Photo 2: *View from Spring Flat Road at south-western corner of Lot 3 looking north east, noting farm sheds to right side of picture*

Photo 3: *View from Spring Flat Road at south-western corner of Lot 3 looking north, noting western boundary fence and tree corridor along western boundary*

1.5 Surrounding Development

The surrounding development is summarised as follows:

- To the north on the opposite side of Sydney Road is pastoral grazing land which extends east to Burrundulla Road and north to the Water Treatment Plant and Pumping Station;
- To the south-east is farmland used for livestock grazing and viticulture;
- To the south is a number of small rural lots used for livestock grazing and housing;
- To the west on the opposite side of Spring Flat Road is a number of small rural lots used for livestock grazing and an olive grove.

Refer to Aerial Map in **Appendix A**.

Noting the mix of land uses in the surrounds and its fragmented state, the proposed rezoning of 55.9ha of the land to R5 - Large Lot Residential, with a minimum lot size of 2ha is considered to provide a compatible density and land use that is unlikely to result in any significant conflicts with adjoining land uses, nor adversely impact on sustainable agricultural practices in the locality.

1.6 Flora and Fauna

The subject land is predominantly cleared having a long established use as low intensity grazing land. Corridors / stands of established eucalypt trees are noted across the subject land, with a corridor along the western boundary of Lot 3 fronting Spring Flat Road, a corridor forming the riparian zone along Oakey Creek, corridors along either side of Sydney Road and stands towards the south-western corner of Lot 4. Vegetation apart from these is limited to grasses.

No fauna was observed onsite, however it is acknowledged that the site may be inhabited on occasion by roaming kangaroos and certain avian species. Based upon this it is unlikely that any flora shall be disturbed as part of any future development relating to the possible rezoning of the site, and no core habitat for local fauna will be threatened.

1.7 Heritage

There are no heritage items listed for the subject site in the New South Wales Heritage Register (NSW Heritage Council, 2010) or the Mid-Western Local Environmental Plan 2012.

The National Parks and Wildlife Act 1974 provides for the protection of Aboriginal relics/sites across New South Wales regardless of significance, land tenure and whether or not they are recorded in the NPWS Sites Register. It is an offence to knowingly damage, deface, cause or permit the destruction of an Aboriginal relic or place without the prior written consent of the director general of NPWS.

An Archaeology Assessment including detailed site investigation has been carried out by the Mudgee Local Aboriginal Lands Council and is attached at **Appendix C.** The investigation located a Scar Tree towards the south eastern corner of the site with the assessment recommending retention of this tree. As a result the proposed boundary for rezoning as shown on the Concept Plan has been positioned to locate the Scar Tree on land to be transferred through boundary adjustment to the southern neighbouring rural lot, which is also owned by the applicant. The use of this neighbouring land remains for agricultural purposes.

Apart from the findings of the Archaeology Assessment, no Aboriginal heritage items or sites have been recorded at or near the subject site in the New South Wales Heritage Register (NSW Heritage Council, 2010). Refer to **Appendix C** for searches conducted utilising the Aboriginal Heritage Information Management System (AHIMS).

1.8 Flooding

Oakey Creek and its tributaries traverse through Lot 4, flowing north towards the Cudgegong River, however it is not considered a significant watercourse. A check of Council's Flood Map in the Mudgee Local Creeks Flood Study 2008 confirms that the site is not flood prone land, noting it is above the 1:100 year ARI flood level and Probable Maximum Flood Event as shown on the Map. The land however is identified as groundwater vulnerable on Council's "Groundwater Vulnerability Map", therefore effluent disposal requires consideration (refer to **Section 2.3** and **Section 3.2** for further comment).

1.9 Noise

Noise measurements of background levels have not been undertaken onsite. The main contributor to noise in the vicinity is considered to be created by traffic movement along Sydney Road and use of farming machinery on neighbouring farmland.

From inspection, noise levels generated by traffic along Sydney Road and from operation of farming machinery in the surrounds are relatively low such that low density residential development may be carried out on the land subject to adequate setback / separation.

1.10 Services

Water & sewer **-** The proposed rezoning of 55.9 ha of the site to low density residential with a minimum lot size of 2ha is premised upon incorporating on-site rainwater harvesting and on-site effluent disposal. As such Council applies a minimum lot size of 2ha for large lot residential land in the Bombira area on the north side of Mudgee where connection to water and sewer mains is not proposed. Accordingly, connection to the water and sewer mains is considered unnecessary.

Should connection to town water and sewer be deemed necessary, this would need to be the subject of further assessment and discussion with Council as the local water authority. Refer to **Sections 2.3 and 4.2** for further comment on effluent disposal and water supply.

Stormwater **-** Noting on-site rainwater harvesting is proposed for water supply to future housing development, best practice stormwater management features may be incorporated such as nutrient reduction measures, on site detention and filtration for use as potable water and landscape irrigation.

Power / communications **-** Both electricity and telecommunications services are available to the subject land.

1.11 Access

The subject land has sealed road access with frontage to Sydney Road and Spring Flat Road. Access via Spring Flat Road as a collector road may be achieved and is preferable so as to avoid direct entry / egress from Sydney Road which is a classified State Main Road.

As part of any future development of the site, a new road will form part of the land subdivision which will require provision of an intersections with Spring Flat Road as indicated in the Concept Plan attached at **Appendix B**. Additional detail can be provided as required by Council.

1.12 Bushfire

A review of Mid-Western Regional Council's Bushfire Prone Land Map (as provided by NSW Rural Fire Service) confirms that both portions of the subject site are substantially clear from the boundaries of bushfire prone land. Refer to Map **in Appendix B**.

Notwithstanding, with a predominant vegetation classification of **Grasslands** some level of bushfire risk is acknowledged. Future development of the land as large lot residential would result in a transformation of the site to **Managed land** thereby reducing the risk of grassfires.

2.0 PROPOSED DEVELOPMENT

2.1 General

The proposal seeks Mid-Western Regional Council's support to rezone approximately 55.9 ha of the subject land from the RU4 - Primary Production Small Lots zone to R5 – Large Lot Residential zone, with a corresponding minimum lot size of 2ha pursuant to the Mid-Western Regional Local Environmental Plan 2012. The remaining 83.1ha of the site is proposed to remain zoned RU4 – Primary Production.

The intention of rezoning the land in this manner is to permit the future subdivision of the land and its development for rural residential purposes consistent with the objectives of the R5 - Large Lot Residential zone.

Significantly, the land (Lots 3 & 4 DP 1069441) adjoins an area on the western side of Spring Flat Road that is zoned part RU4 - Primary Production Small Lots and part R5 - Large Lot Residential, which is identified as a 'hard edge' for urban growth in the Mid-Western Regional Comprehensive Land Use Strategy (2009). This is "*because it provides a clear edge between urban and rural uses*".

The Strategy identifies land north (or west) of Spring Flat Road as an opportunity for large lot residential subdivision to 4,000m^2 which is understood to be achievable subject to provision of reticulated water and sewer as per the minimum lot size provisions applying to the Bombira rural - residential locality on the north side of Mudgee (reference LEP Cl.4.1(3)(a)). It is noted that in Bombira, a minimum lot size of 2ha otherwise applies where on-site effluent disposal and water supply is otherwise proposed, which is consistent with the principles of this Planning Proposal.

2.2 Lot Yield

The subject land comprises of two lots having a total area of approximately 139 hectares. Under the current RU4 - Primary Production Small Lots zone, the minimum lot size is 20ha whereby a compliant subdivision would permit a maximum of 6 lots, subject to demonstrating that the land is both suitable and viable for intensive agriculture. As indicated in the Land Capability Map contained in Council's Strategy, the land is a combination of Class 1, 2 and 3 suitable to crop planting (but not suited to continuous cultivation) and livestock grazing, however if subdivided into 6 x 20ha+ lots in separate ownership, such activities would not likely be viable given insufficient area.

The land is cleared and vacant with sealed main road frontage and is therefore well placed to support subdivision and future rural residential development which is consistent with the principle of adopting a 'hard edge' to residential development extending into the south of Mudgee, as recognised in Council's Comprehensive Land Use Strategy.

The proposed minimum lot size of 2ha per lot is consistent with the recommendations of the Mudgee and Gulgong Urban Release Strategy. Accordingly the minimum lot size to accompany this proposal is 2ha. Based on this minimum lot size, the potential lot yield is indicated in **Table 2**, as follows.

Table 2: Potential Lot Yield

Lot	DP	Owner	Lot Size	Existing RU4 zone
3 & 4	1069441	Burrundulla P/L	139ha	6 lots @ 20ha+/lot
				Proposed R5 zone
Consolidated lot		Burrundulla P/L	139ha	
- Oakey Ck offset areas**		Burrundulla P/L	- 8.1ha*	
- farmland & buildings		Burrundulla P/L (Lot 34)	- 4ha	
- area remaining as RU4 zoning		Burrundulla P/L	- 71ha	
NET AREA		Individual owners	55.9ha	25 lots @ 2ha/lot
Proposed lot yield			**55.9ha**	**25 lots @ 2ha+/lot**

** Approximate measurement ** for potential transfer*

With a 7.6ha buffer along Oakey Creek for potential future transfer to the southern neighbouring land (by way of boundary adjustment), the total developable area to be rezoned is approximately 55.9ha with a maximum potential lot yield calculated to be 25 lots.

The subdivision yield is to be finalised following rezoning whereupon a detailed plan of proposed subdivision and services shall be prepared.

2.3 Water supply and effluent disposal

Council's Urban Release Strategy 2014 recommends that Council undertake further analysis into costs of providing reticulated water and sewer to service future subdivision of the subject site, following its rezoning. As part of initial consultation with Council, it was identified that Council's current planning controls require reticulated water and sewer for subdivision of land in the R2 – Low Density Residential zone with a corresponding minimum lot size of 4,000m^2 (or 2,000m^2 for some R2 zoned areas). In comparison the proposal seeks a minimum lot size of 2ha, providing a maximum yield of 1/5th that could be achieved with a lot minimum lot size of 4,000m^2.

Noting that 4,000m^2 per lot is considered towards the upper limit in lot size of cost feasible urban subdivision with reticulated water and sewer, as reflected in Mid-Western LEP 2012, it is submitted that requiring reticulated water and sewer with a minimum lot size of 2ha is uneconomic and does not achieve a reasonable return on the cost of installing these services. Accordingly, Council's consideration is sought for on-site effluent disposal and water supply through rainwater collection, with details of these as follows:

2.3.1 Sewerage Disposal

It is proposed that on-site effluent disposal systems be installed at each new lot. The final design of the systems shall conform with AS1547:2010, On-site domestic wastewater management. As per table K1 of AS1547:2010, for sites that maybe groundwater vulnerable, a secondary (aerated) treatment system is recommended.

For a secondary (aerated) treatment system, all household wastewater flows to the septic tank where settlement and primary breakdown of material takes place. It then flows into a second tank where the treatment system is installed and by aeration, converts it into biologically clean clear odour-free water. The water is then lightly disinfected before it is automatically irrigated onto the garden and/or lawn through a sprinkler system, or it can be disposed of below ground if required.

The hydrogeological study has been prepared and demonstrates the land is suitable for onsite effluent disposal without impacting on groundwater. A copy of the Groundwater and Salinity Study is attached as Appendix D.

2.3.2 Water supply

It is proposed that a dwelling on each lot be serviced with a rainwater tank, with rainwater collected being sufficient to service general residential needs. Based on data from the Bureau of Meteorology, Mudgee has a recorded average of 674.3mm/year of rainfall for the years 1870 – 2014. Assuming a rainfall catchment area (roof area) of 300m^2, being for a medium-large sized dwelling plus garage and shed, the annual rainfall collected is calculated at 202kL/year.

To assess water consumption, this is modelled with the Hunter Water usage calculator on a 4 person household, providing a calculation of 174kL/year. Therefore, based on average annual supply and consumption of rainwater, a surplus of supply is achieved. Given the yearly variation in rainfall it is recommended that water tanks be specified for future dwellings with a capacity of at least 200kL, being approximately 1 year rainfall collected.

3.0 SITE OPPORTUNITIES – SUBSTANTIAL PUBLIC BENEFIT

3.1 Existing constraints and opportunities to development

The land subject to the proposed rezoning is approximately 55.9ha of the site and is currently zoned RU4 - Primary Production Small Lots under the provisions of the Mid-Western Regional Local Environmental Plan 2012, with a minimum lot size of 20ha. This minimum lot size carries over from the previous Interim LEP 2008 whereby the land was zoned Intensive Agriculture with a minimum lot size of 20ha.

Whilst most agriculture zoned land surrounding Mudgee has been retained from the previous Interim LEP in terms of zoning and minimum lot size, over the past 5 years Mudgee has experienced significant growth in housing with limited supply of large lot residential / rural-residential land to accommodate future demands for this.

The current zoning as RU4 - Primary Production Small Lots effectively limits the use of the land to its current use as grazing land. The current zone and corresponding minimum lot size of 20ha which advocates intensive agriculture enterprise is not considered the highest and best use of the subject site. This is due to declining financial returns on intensive agriculture enterprises and the high costs of licensed commercial water supply for such enterprises, noting the land has never been used for intensive agriculture enterprises. Further, the classification of the land which is advised as Classes 1, 2 and 3 is suitable to crop planting (but not suited to continuous cultivation) and livestock grazing, however if subdivided into 6 x 20ha+ lots in separate ownership, such activities would not likely be viable given insufficient area.

The resultant current use as low intensity grazing land is lower in cost than intensive agriculture enterprises, however also lower in potential return and is therefore not considered the highest and best use of the land given the strong demand for housing in Mudgee.

It is also noted that as housing development extends south from the existing urban edge towards Spring Flat Road (as advocated by Council's Strategy), this will increase likely land use conflict with existing agricultural enterprises. Land on the western side of Spring Flat Road which is zoned RU4 - Primary Production Small Lots (and further south R5 - Large Lot Residential) is constrained from agricultural enterprise due to its heavily fragmented nature with lots in separate ownership and ranging generally in size from 6ha - 12ha (ie. large lot rural residential) with their use mostly limited to low intensity grazing. Consequently the subject site with sealed road frontage to Spring Flat Road is recognised for its suitability for large lot rural residential subdivision, as an extension to and as the southern boundary for the area identified as potential large lot residential along the western side of Spring Flat Road.

As low density housing on lots of 2ha or more, this subdivision density would suitably act to provide a buffer between agricultural enterprises on land to the south and housing to the west.

3.2 Consideration of proposed zoning

3.2.1 Objectives of R5 Large Lot Residential zone

The proposed rezoning of approximately 55.9ha of the subject land from the RU4 - Primary Production Small Lots zone to R5 – Large Lot Residential zone, with a corresponding minimum lot size of 2ha permits a wide range of rural, residential and non-residential related development as indicated in the 'Permitted with consent' land use table for the zone:

Aquaculture; Bed and breakfast accommodation; Cellar door premises; Dual occupancies; Dwelling houses; Garden centres; Home industries; Intensive plant agriculture; Landscaping material supplies; Markets; Neighbourhood shops; Plant nurseries; Roadside stalls; Secondary dwellings; Serviced apartments; Waste or resource transfer stations; Water recycling facilities; (plus any used not specified as prohibited)

Consideration of the rezoning proposal against the zone objectives is provided as follows:

Objectives of zone

- *To provide residential housing in a rural setting while preserving, and minimising impacts on, environmentally sensitive locations and scenic quality.*

Comment - The proposal provides an indicative supply of 25 rural-residential lots ranging from 2ha minimum within an existing rural area near the southern urban edge of Mudgee. By virtue of the relatively large lot areas proposed, the scenic quality of the existing rural landscape may be preserved including retention of its established tree corridors along Spring Flat Rd and Oakey Creek where transfer of this land with a boundary adjustment is proposed.

Being mostly cleared land, few trees will require removal and future landscaping associated with rural-residential housing should serve to enhance scenic value. Lots containing existing stands of established trees will not require these to be cleared given the ample area available to locate and build a dwelling with all-weather access. The relatively flat nature of the land and its central position within the valley floor of Mudgee also ensures that distant views of the hills to the east and west and their scenic quality will not be affected.

- *To ensure that large residential lots do not hinder the proper and orderly development of urban areas in the future.*

Comment - Council's Strategy identifies land west of Spring Flat Road as an opportunity for large lot residential subdivision to 4,000m^2, forming a 'hard edge' to the town.

The proposed rezoning of the land to R5 - Large Lot Residential would not affect this outcome as advocated by the Strategy, whilst with a 2ha minimum lot size it would suitably create a low density residential buffer area or soft 'transition zone' between such development on the western side of Spring Flat Road and existing agricultural enterprises to the south of the site. The key merit of this is that its future development as a soft transition zone with 2ha lots envisages a more visually sensitive outcome than a 'hard edge' with smaller 4,000m^2 lots as advocated by the Strategy west of Spring Flat Road.

- *To ensure that development in the area does not unreasonably increase the demand for public services or public facilities.*

The site has sealed road access from Spring Flat Road and sealed road frontage to Sydney Road. Given this existing road network, traffic generation resulting from the future development of 25 rural-residential lots is not considered excessive in terms of the traffic capacities and existing traffic generation on these roads.

The proposed minimum lot size of 2ha is premised upon a future low density rural residential subdivision not requiring connection to water and sewer mains services, notwithstanding the subdivision may be designed to enable provision of such services as they extend from south Mudgee in the future in accordance with Council's Strategy.

In terms of demands on community services, rates and developer contributions collected from future subdivision would assist towards funding such services. The future initial development of 25 rural-residential homes does not represent a significant increase to Mudgee's housing stocks such that community services could reasonably accommodate such growth.

- *To minimise conflict between land uses within this zone and land uses within adjoining zones.*

Comment - Land use in the surrounds is predominantly characterised by low intensity livestock grazing, with some intensive agriculture including viticulture and olive groves. It is noted that the subject site has a long standing history in its use as low intensity grazing land.

Given the predominance of low intensity grazing on the site and surrounds, and Council's Strategy advocating low density residential development to the west of Spring Flat Road, the proposed 2ha minimum lot size would suitably create a low density residential transition zone between such development on the north side of Spring Flat Road and existing agricultural enterprises to the south.

By providing such a transition zone, or 'soft edge' (rather than a 'hard edge' as advocated by the Strategy), land use conflict between agricultural activities to the south and higher density residential development to the west (as per the Strategy) may be minimised. As such the proposed rezoning would not conflict with future development or use of the surrounds, subject to sufficient setbacks being provided which may be determined at the Development Application stage for subdivision, whilst also providing a low density residential buffer to existing agricultural enterprises to the south.

3.2.2 Other LEP provisions for consideration

Clause 6.4 - Groundwater vulnerability

Cl.6.4 requires Council's consideration in the determination of a Development Application (DA) for development on land that is groundwater vulnerable. Whilst the Planning Proposal does not seek development consent for the accompanying concept subdivision plan, it is acknowledged that a future DA for subdivision would require consideration of this matter.

Subject to support of the Planning Proposal and subsequent rezoning of the land, a detailed Groundwater Assessment may be submitted accompanying a DA for subdivision subject to the requirements of Cl.6.4(3) of the LEP. As stated in **Section 2.3.1**, if the hydrological study determines that such development would likely impact on groundwater water quality and cause its contamination, the proponent would enter into negotiations to connect Mudgee's reticulated sewer network.

3.3 Land use conflict

As discussed in **Sections 3.1 and 3.2** above, the proposed 2ha minimum lot size is intended at providing a transition zone between future low density residential development to the north, and existing agricultural activities to the south. Noting that Council's LEP and Strategy adopt low density residential development to the north and south of the existing Mudgee township as a transition to rural surrounds (including Bombira where a minimum of 2ha applies), the proposal would maintain this principle.

With the subdivision plan being a concept plan only and not the subject of a Development Application, the plan may be revised as necessary subject to Council's and the Minister's endorsement of the Planning Proposal.

To address industrial operational noise caused by farming machinery, a future plan of subdivision could include measures such as:

- a rear setback control requiring a minimum prescribed setback (to be determined) from each boundary;
- nominated building envelopes for future housing on each lot.

Compared with the recent industrial and residential subdivision along Depot Road and Lions Drive in south Mudgee the proposal is less sensitive to noise impacts by virtue of the proposed low density of housing lots, such that land use conflict in this regard may be satisfactorily managed.

With regard to existing agriculture to the south, the proposed low density residential zoning with lots of 2ha or more would suitably act to provide a buffer between agricultural enterprises on land to the south. As such, this approach is adopted by Council's LEP whereby low density residential development to the north and south of the existing Mudgee township provide a suitable transition to rural surrounds.

To address potential impacts from existing agriculture of crop spraying, a future plan of subdivision could include a rear setback control and / or nominated building envelopes similar to those suggested above. Noting the Planning Proposal does not seek formal approval of the proposed subdivision plan, the plan may be revised at Development Application stage subject to the proposed rezoning of the land being endorsed by Council and the Minister.

3.4 Summary of opportunities and constraints

The main planning opportunities relating to the proposed rezoning of the subject land, include the following:

Location **-** The site is located on the southern edge of Mudgee with neighbouring land to the west of Spring Flat Road identified in Council's Strategy for large lot residential subdivision to 4,000m^2. Due to the fragmented form and multiple ownership of this neighbouring land, its future rezoning and development may be delayed thereby increasing demand for other rural land available and suitable for large lot residential development. The location of the site in this regard close to the urban edge of Mudgee makes it suitable for large lot residential development, providing a transition to larger lot farm land to the south.

Environment **-** The site is predominantly cleared in its current state as grazing land, with no likely presence of any threatened or endangered flora and fauna.

Land use compatibility with surrounds **-** The surrounding lands comprise a mix of land uses including grazing lands, large lot residential subdivision, and a cellar door / café. Based upon this mix of land uses, the proposed rezoning of the land to large lot residential and its future rural-residential use is considered compatible with the surrounding land uses.

Potential land supply **-** An indicative supply of 25 rural-residential lots as shown in the Concept Plan will provide a positive contribution to Mudgee's future supply of rural-residential land.

Access **-** The subject land has sealed road access from Spring Flat Road. The proposed Concept Plan provides for access to be achieved from within the site for most lots, and ensures that no individual driveways to Sydney Road / Castlereagh Highway are required.

Services **–** The proposal requests on-site effluent disposal and on-site water supply, which is assessed as achievable based on the minimum lot size of 2ha. Stormwater shall be collected on site for domestic consumption and irrigation purposes. Both electricity and telecommunications services are also available to the subject land.

Land use suitability - The subject site is located on the southern edge of Mudgee and benefits from sealed main road access via Spring Flat Road, with close proximity to the Castlereagh Highway / Sydney Road, whilst being physically removed from sensitive conservation lands to the east and west.

No physical constraints are identified that would hinder the future subdivision and development of the land for rural - residential purposes, noting:

a) The subject land provides an opportunity to be designed in such a manner as to ensure visual and acoustic privacy, both from within the development and its surrounds;

b) Based on the Preliminary Site Investigation, the subject land proposed for rezoning has no known contamination issues, noting that the shearing shed and its surrounds have been excluded from the proposed rezoning area. The proposed rezoning area has not been occupied by any activity with the potential to cause any significant soil contamination;

c) There are no obvious signs of salinity over the subject land;

d) The subject land does not appear to be flood prone land;

e) The site is located outside the boundaries of Bushfire Prone Lands to the west;

f) The site does not contain any known items of heritage significance, nor is it located close to any known items of heritage;

g) The tree corridor associated with the riparian zone for Oakey Creek may be retained in one lot with the future option of transferring this land to the southern neighbouring land by way of a boundary adjustment.

h) The subject land is not identified as prime agricultural land that would be viable for subdivision into 20ha lots (as permitted under the current RU4 zoning) that would support sustainable agricultural enterprise given their combined classification as Classes 1, 2 and 3 land and limited area;

i) It is also unlikely that additional land can be acquired to make the subject land worthwhile for sustainable agricultural use;

j) The proposed rezoning of approximately 55.9ha of the subject land to R5 - Large Lot Residential with a minimum lot size of 2ha is considered a higher and more appropriate use of the subject land, in that it provides an opportunity for a development capable of providing a positive physical, social and economic contribution to the Mudgee, noting its limited existing rural-residential land supply.

4.0 STRATEGIC CONTEXT

4.1 Contribution to Land Supply

Due to its location and few constraints the subject land can be readily incorporated into Council's plans for future large lot residential development in Mudgee.

From review of residential development in Mudgee it is apparent the town has experienced significant residential growth over the past 5 - 10 years including the development of large lot rural residential land in Bombira on the north side of Mudgee, with few vacant lots. The result is that there appears to be scope for supporting further large lot rural - residential development consistent with the principles of Council's Land Use Strategy. The Strategy identifies a take up rate of 6 - 8 rural residential lots/year, whereby the Concept Plan for 25 lots would provide between 3 - 4 years of land supply.

4.2 Key Council Strategies

The rationale for supporting the rezoning can be found in Council's key planning strategies and instruments. The following is a brief summary of local government planning strategies and instruments which are relevant to future planning of the site:

4.2.1 Mudgee and Gulgong Urban Release Strategy 2014

The site is identified for future rezoning and release as part of Council's Urban Release Strategy 2014 (URS). The URS identifies the site within Urban Release Area No.22, with a recommended minimum lot size of 2ha and recommended release from 2020+.

Following Council's endorsement of the draft URS for public exhibition at its Meeting of 20 August 2014, two submissions were made regarding the proposal by Raine & Horne and the proponent. Both submissions sought rezoning of the land in accordance with the Planning Proposal, within revised timing for its release from 2015+ which Council endorsed in its review of submissions at its Meeting of 5 November 2014, hence the timing of this submission.

4.2.2 Mid-Western Regional Comprehensive Land Use Strategy

The Mid-Western Regional Comprehensive Land Use Strategy ("the Strategy") dated October 2009 provides *"a basis for identifying options...to meet long term urban and rural growth needs... and provide direction for targeted growth in specific areas."*

The Strategy prepared by Parsons Brinkerhoff consultants was adopted in 2009. In relation to the South Mudgee area, the Strategy specifically recognises Spring Flat Road as the boundary for future low density residential development to the south of Mudgee, with a minimum of 4,000m^2/ lot, subject to connection to reticulated water and sewer. The proposed rezoning represents a minor variation to the Strategy in that the proposal seeks only to shift the boundary of future residential from land west of Spring Flat Road to land with frontage to Spring Flat Road, whilst proposing on-site effluent disposal and water supply as detailed in **Section 2.3** of this report. On this basis it is considered generally consistent with the principles of the Strategy as applied to South Mudgee / Spring Flat Road area.

4.2.3 Mid-Western Regional Local Environmental Plan 2012

The general objectives of the plan support the rezoning of approximately 55.9ha of the subject land to R5 - Large Lot Residential for rural-residential type development, as the land is appropriately located having regard to environmental constraints, accessibility and existing land-use patterns. The general objectives also support the rezoning of the site for large lot rural residential as it achieves orderly and efficient development of the site. Consideration of the zone objectives as provided in **Section 4.2** of this report indicate that future subdivision and rural - residential development of the land may be carried out in an orderly manner without adversely impacting on the surrounds.

4.3 Section 117 Directions

Pursuant to Section 117(2) of the *Environmental Planning and Assessment Act, 1979*, any relevant planning direction issued by the Minister must be followed by Council upon determining to prepare a new Local Environmental Plan (LEP) or an amendment to its LEP as initiated by a Planning Proposal.

The directions that are relevant to the proposal are identified as follows:

- Direction 1.2 - Rural Zones
- Direction 1.5 - Rural Lands

4.3.1 Direction 1.2 - Rural Zones

Consideration is given to this direction whereby the proposal seeks rezoning of rural land to permit large lot residential subdivision. As stated, the objective of this direction is *to protect the agricultural production value of rural land.*

In circumstances where a Planning Proposal is not consistent with this Direction and not identified for potential rezoning under the Council's Strategy, a study in support of the proposal is required *which gives justification to the objectives of this direction.*

As discussed in this report, the subject land is not identified as prime agricultural land that would be viable for subdivision into 20ha lots (as permitted under the current RU4 zoning) that would support sustainable agricultural enterprise given their combined classification as Classes 1, 2 and 3 land, and limited area. The land in its current state has a relatively low level of agricultural production noting its use for low intensity grazing.

Given the land's relatively low productivity and that 20ha lot subdivision as permitted under its zoning would likely reduce such productivity, it is submitted that the current zoning reflects a relatively low productive value of the land. Based on this, its rezoning of 55.9ha of the subject land to R5 - Large lot residential would not result in a significant loss of productive agricultural land in the region.

4.3.2 Direction 1.5 - Rural Lands

Consideration is given to this direction which applies where *a planning proposal affects land within an existing rural zone*, and where the proposal *changes the existing minimum lot size on land within a rural zone.*

The direction requires the proposal to be consistent with the rural planning and subdivision principles listed in *State Environmental Planning Policy (Rural Lands)* 2008. Notwithstanding, a planning proposal may be inconsistent with the Direction (and the SEPP) if the proposal is justified by a strategy that identifies the land for future rezoning (that the proposal is consistent with), and the strategy has been endorsed by the Department of Planning.

In the circumstances of this Planning Proposal for rezoning of 55.9ha of the site to R5 - Large lot residential, the site is identified for such rezoning and development under the Mid-Western Urban Release Strategy 2014, as discussed in **Section 4.2.1**. Accordingly this report requests Council's consideration of the proposal as consistent with its Strategy.

5.0 CONCLUSION

Rezoning of the land is generally consistent with the objectives set out in Council's planning instruments, and planning strategies including the Mid-Western Regional Comprehensive Land Use Strategy, the Mudgee and Gulgong Urban Release Strategy 2014, and the Mid-Western Regional Local Environmental Plan 2012. Rezoning of 55.9ha of the subject land to R5 - Large Lot Residential under the LEP would facilitate a future large lot rural - residential subdivision in close proximity to existing services and facilities.

The site presents few physical constraints to development. It would result in:

- Development that is suitable in the locality;
- Development that would be compatible with adjoining and adjacent land uses, including potential large lot residential development on the western side of Spring Flat Road;
- Development that shall support demand for low density rural residential housing that provide for rural lifestyle;
- Development to ensure appropriate and sufficient supply of rural-residential land in and around Mudgee.

Council is encouraged to support this Planning Proposal and take all necessary steps to amend the Mid-Western Regional Local Environmental Plan 2012 to rezone 55.9ha of the subject land to R5 - Large Lot Residential with a minimum lot size of 2ha, thereby enabling rural-residential subdivision and development of the subject land.

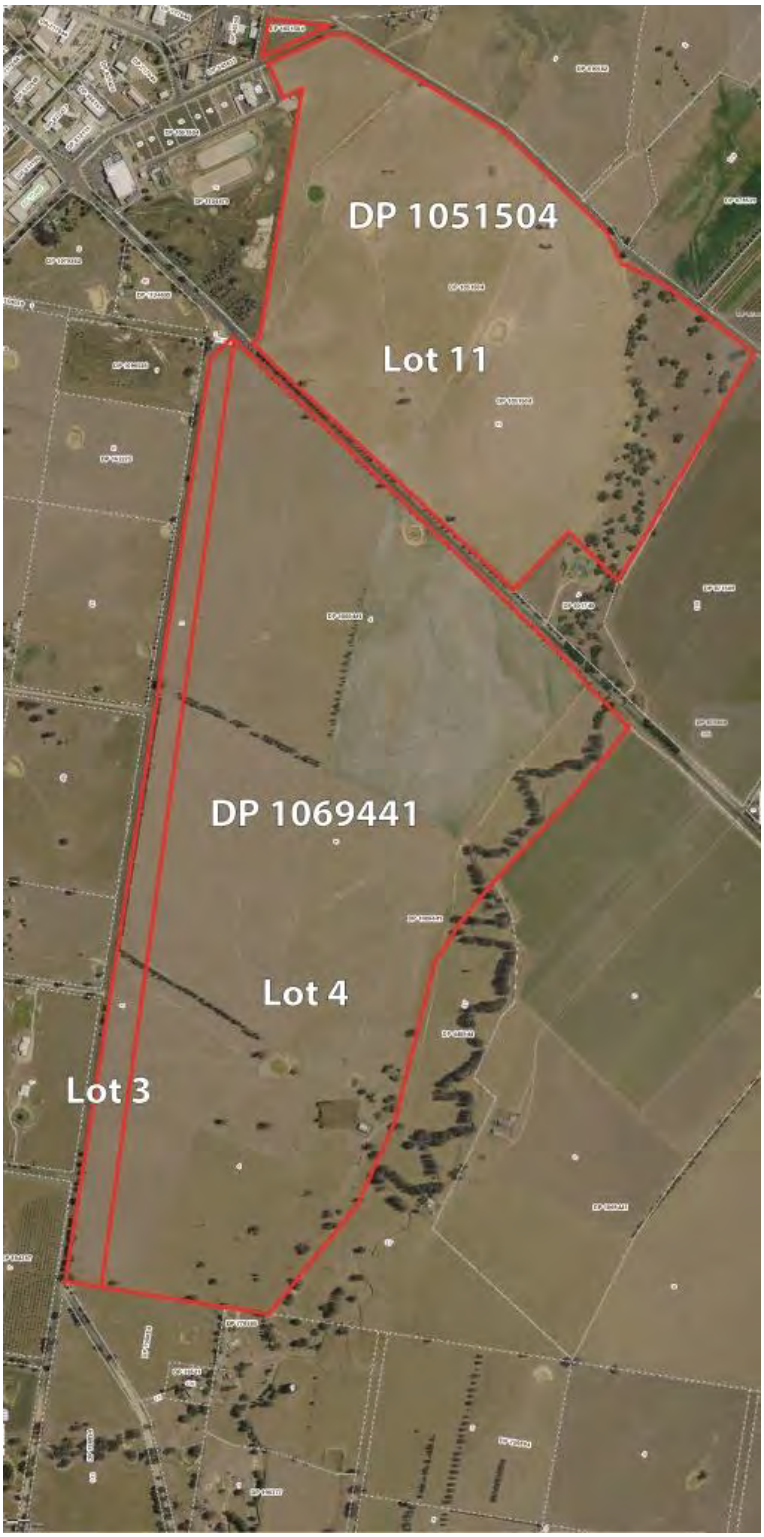
We would be happy to meet with Council representatives to discuss this matter further and should Council require any further information please contact the undersigned at our Mudgee office.

Yours faithfully

BARNSON PTY LTD

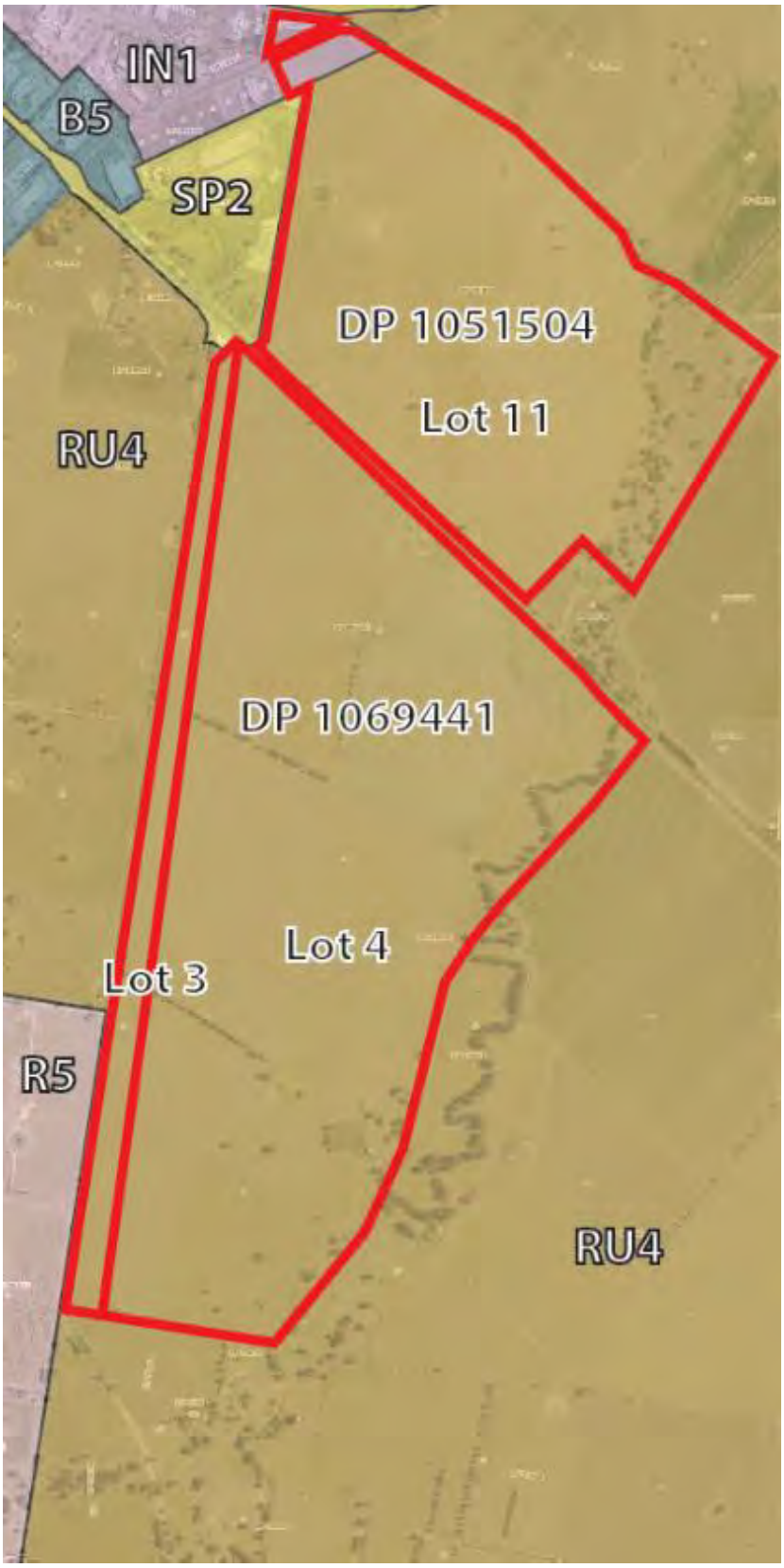
Luke Morris
BE MIEAust CPEng (Reg)
DIRECTOR

Appendix A



Aerial Map - subject land and surrounds.

Lot 11 forms part of "Burrundulla" holding but is excluded for the purposes of this Planning Proposal



Zoning Map - Indicating existing zoning of subject site and surrounds as RU4 - Primary Production Small Lots, minimum lot size - 20ha, pursuant to Mid-Western Regional LEP 2012.

Lot 11 forms part of "Burrundulla" holding but is excluded for the purposes of this Planning Proposal

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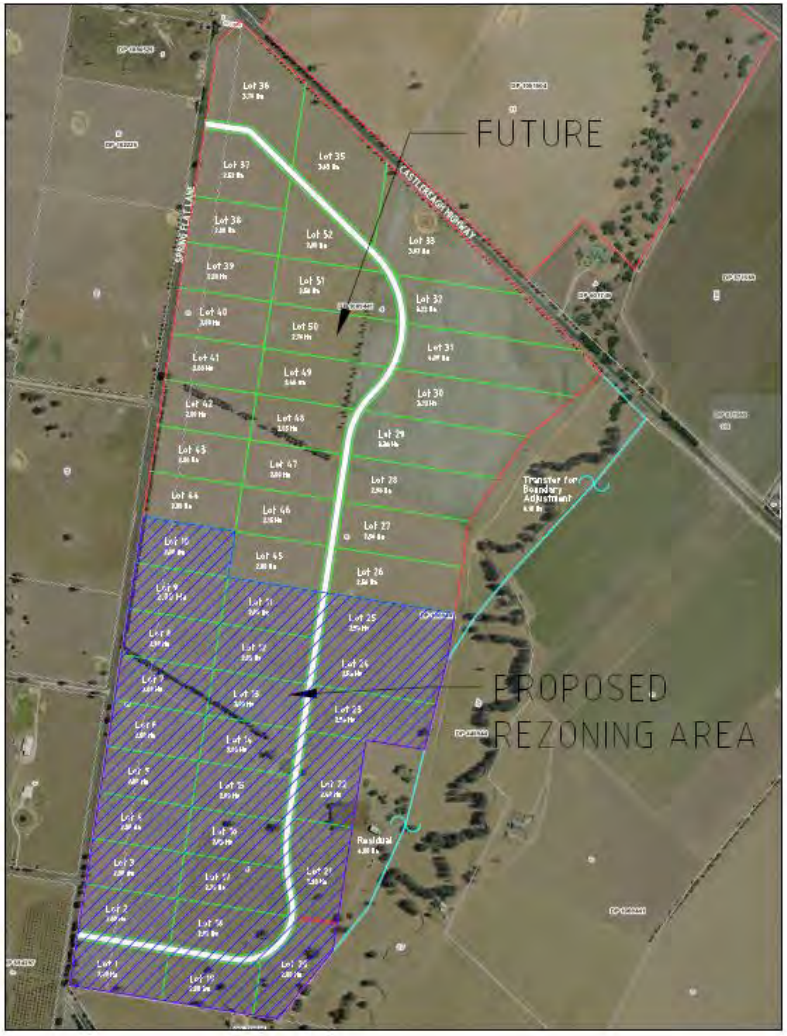

PROPOSED REZONING AREA
55.9 Ha
FUTURE AREA
71.9 Ha

PROPOSED SUBDIVISION PLAN

Rezoning Location Map - The hatched area of the site is proposed for rezoning to R5 - Large Lot Residential with a minimum lot size of 2ha.

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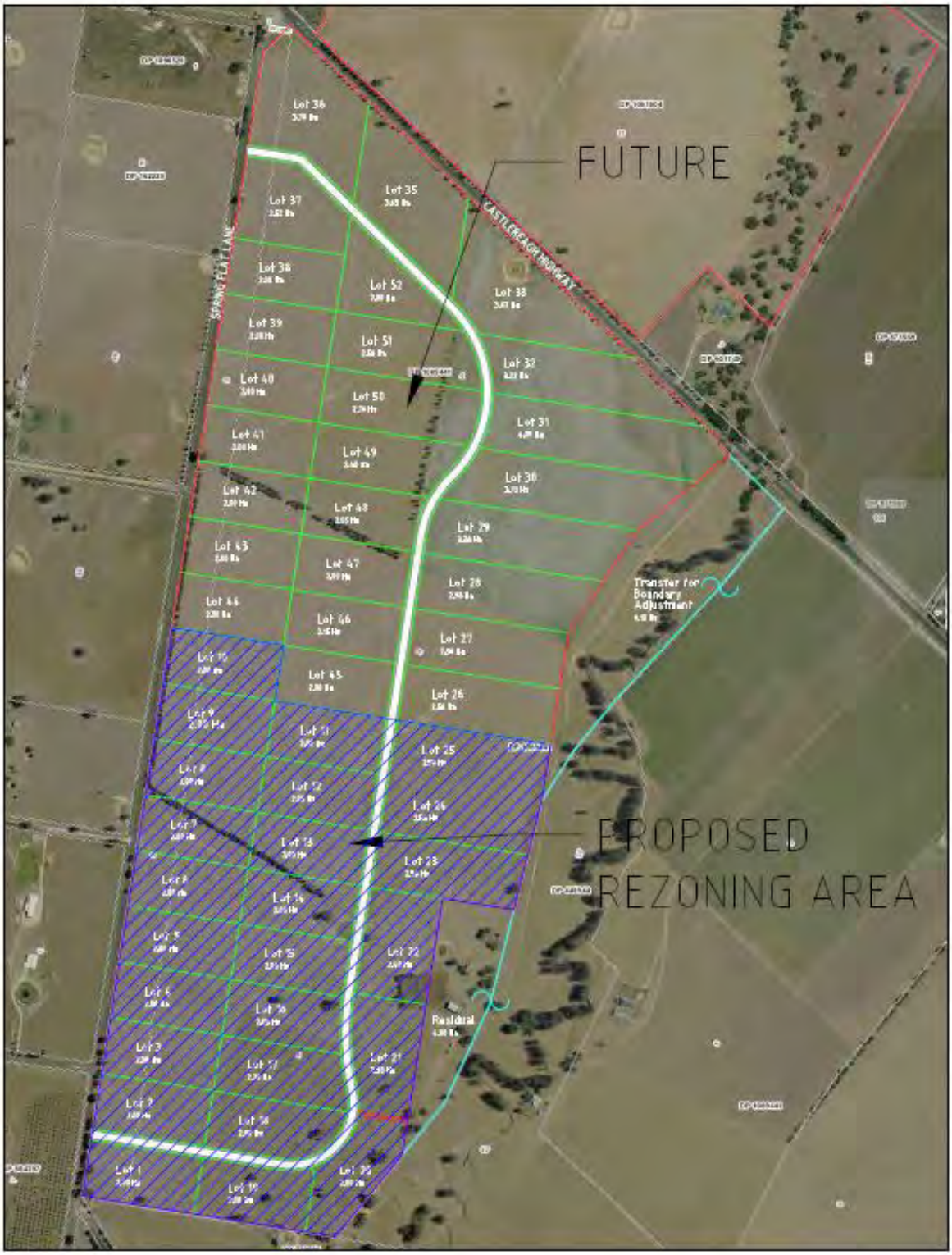
Rezoning Map - The site is proposed for rezoning to R5 - Large Lot Residential with a minimum lot size of 2ha.

Appendix B - Concept Plan of subdivision



Concept Plan for 25 lots

Appendix C

Archaeological Assessment and AHIMS search results

Office of Environment & Heritage

AHIMS Web Services (AWS)
Search Result

Your Ref Number :
Client Service ID : 97855

Cheryl Brown

Date: 15 April 2013

PO Box 1967
Hurstville New South Wales 2220

Attention: Cheryl Brown

Email: cheryl.brown@environment.nsw.gov.au

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lot : 4, DP:DP1069441 with a Buffer of 50 meters, conducted by Cheryl Brown on 15 April 2013.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.

A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

barnson
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Office of Environment & Heritage
NSW

AHIMS Web Services (AWS)
Search Result

Your Ref Number :
Client Service ID : 97854

Date: 15 April 2013

Cheryl Brown

PO Box 1967
Hurstville New South Wales 2220

Attention: Cheryl Brown

Email: cheryl.brown@environment.nsw.gov.au

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lot : 3, DP:DP1069441 with a Buffer of 50 meters, conducted by Cheryl Brown on 15 April 2013.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.

A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

Appendix D

Groundwater and Salinity Study

Groundwater and salinity study

Lot 3 & 4 DP1069441, Spring Flat Road, Mudgee NSW

Ref: R6151s
Date: 8 October 2015

Envirowest Consulting *Pty Ltd* ABN 18 103 955 246
• 9 Cameron Place, PO Box 8158, Orange NSW 2800 • Tel (02) 6361 4954 •
• Fax (02) 6360 3960 • Email admin@envirowest.net.au • Web www.envirowest.net.au •

Environmental
Geotechnical
Asbestos
Services

Client:	Burrundulla Pty Ltd c/- Barnson Pty Ltd 4/108 110 Market Street Mudgee NSW 2850
Assessor:	Dave Langston BNEWS Environmental Scientist
Checked by:	Leah Desborough BEnvSc Senior Environmental Scientist
Authorising Officer:	Greg Madafiglio PhD Senior Environmental Scientist
Report number:	R6151s
Date:	8 October 2015

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Executive summary

Background

A large lot residential subdivision is proposed at Lots 3 and 4 DP1069441 Spring Flat Road, Mudgee NSW. The final subdivision design will have a minimum lot size of 2ha and access roads. The lots will be serviced by on-site effluent management systems. Historical land-use of the site is agriculture and grazing. The site is located in a groundwater vulnerable area and Mid-Western Regional Council have requested a hydrogeological assessment to determine the potential impacts on groundwater from the proposed development.

Objectives of the investigation

A site investigation was undertaken to assess the existing salinity conditions of the soil and groundwater and determine the impact of the development on groundwater.

Investigation

A soil and groundwater investigation was undertaken of the site. An initial investigation and desktop review was undertaken to collect existing information on groundwater and around the site and assess the likelihood of salinity across the site. A detailed investigation was undertaken on 28 and 29 July 2015.

The detailed site investigation included landscape description, soil investigation, laboratory analysis and groundwater investigation. The soil profile investigation was undertaken by constructing 69 boreholes up to 12m in depth. Representative soil samples were collected and analysed for pH, electrical conductivity, colour, dispersion, texture, chlorides and exchangeable sodium percentage.

Soil moisture levels under land-use scenarios were modelled using rainfall data to estimate infiltration. Soil moisture and infiltration was simulated by the CLASS U3M-1D model with daily rainfall inputs from 1980 to 2014. Surface water flow containing sediment, nitrogen and phosphorus were modelled using land-use balances.

The impact of the development on water infiltration and salinity was discussed and best practice procedures recommended which will minimise the effects on groundwater.

Conclusions

The existing land-use is pasture. No bare areas from salinity were identified. The erosion hazard and erodibility is low.

Soils on the site comprised topsoil of grey to brown silty clay over grey, brown sandy clays, with rounded quartz rich river gravels and weathered metasediment. Quaternary alluvium are located on the flats. The Mudgee (LEP) maps indicate the site is located within a vulnerable groundwater area.

The Mid-Western Regional Council has classified the site as a *'high risk'* area based on original groundwater investigations which were commissioned to create a classifying system based on the hydrogeological landscape. The scale and input factors are believed to be the reason why the Piambong Creek HGL was given the *'high risk'* category.

Recent work by DPI has revised the original Piambong Creek HGL and created the Biraganbil HGL.

The site is located within the Biraganil hydro-geological landscape and has a moderate land salinity, salt export, water quality classification and likelihood of occurrence with high confidence level.

The investigation identified that topsoils samples were determined to be non-saline. Subsoils over the site were classified as non-saline to slightly saline with electrical conductivity of less than 4dS/m.

Majority of soils were non-saline to slightly saline. Moderately saline soils were encountered in MW3 and 4 at a depth greater than 1.0m in small soil substrates.

Infiltration of groundwater over most of the site will not result in mobilisation of salts. Groundwater was encountered in MW2 located in the north eastern section of the site from 10m. Electrical conductivity of groundwater from MW2 was 5.12mg/L which is classed as low salinity. No groundwater was identified in MW1, MW3 and MW4 to a depth of 15m in sandy to gravelly clay.

No groundwater discharge areas were identified on the site.

Modelling of soil moisture levels over the past 34 years indicated variations in infiltration occur with the amount of rainfall pre and post development. Infiltration under the three land-use scenarios will be reduced in the development. Reduced soil moisture is a result of the increase in runoff due to impermeable areas (roads, roofs, driveways) and increase in deep rooted vegetation extracting soil moisture from depth. The establishment of trees by future owners will offset any additional infiltration from lawn over watering.

The risk of surface contamination from the proposed land-use is less than the current land-use. From the nutrient and sediment modelling the nutrient activities will be reduced as a result of reduced agricultural activates. On-site effluent application systems will be sized to ensure no infiltration. Nutrients will be utilised by vegetation. Site-specific on-site effluent assessments should be undertaken for each lot.

No impact on groundwater is expected from the development if recommendations are adopted. A slight increase in soil moisture is experienced at 3m depth post development under the effluent and lawn irrigation area which is less than 10% of the total development site. The slight increase in moisture will be mitigated by additional tree planting. The development will not impact on quantity or quality of both unconfined and confined aquifers.

Recommendations

Planning and development controls are recommended to prevent mobilisation of salt in the soil and groundwater resulting in on and off-site impacts. Controls include:

- Establishment of parkland areas with native species which do not require irrigation
- Plantings of deep rooted vegetation along roads
- Design road levels similar to natural soil levels to minimise excavations
- Wastewater systems to comprise surface and sub-surface irrigation

Contents

page

1. Introduction

A large lot residential subdivision is proposed Lots 3 and 4 DP1069441 Spring Flat Road, Mudgee NSW. The subdivision will include residential lots, access roads. A groundwater and salinity assessment is required as part of the development process.

2. Scope of work

Envirowest Consulting Pty Ltd was commissioned by Barnson on the behalf of Burrundulla Pty Ltd, to undertake a groundwater investigation and salinity study of Lots 3 and 4 DP1069441 Spring Flat Road Mudgee NSW. The objective was to assess the existing conditions and possible future impact of the proposed development on soil, groundwater and salinity.

3. Site identification

Address	Lots 3 and 4 DP1069441 Spring Flat Road Mudgee NSW 2850
Client	c/ Barnson 4/108 110 Market Street Mudgee NSW 2850
Deposited plans	Lots 3 and 4 DP1069441
Universal grid reference	UTM Zone 55H, 744837mE, 6387079mN
Locality map	Figure 1
Site plan	Figure 2
Photographs	Figure 10
Area	Approximately 139 hectares
Dates of inspection and assessment	28 and 29 July 2015

4. Proposed development

The proposed development is a residential subdivision. A preliminary lot layout has been proposed. The proposed lots will have hard surface areas comprising roofs and driveways where rainfall will run-off into stormwater pipes and permeable areas comprising lawns and gardens where infiltration into the soil will occur. Roads, footpaths and a stormwater system will be constructed throughout the estate. The existing dams on the property will be remediated and a new stormwater system created to transfer stormwater off the estate to Oaky Creek.

5. Site condition and surrounding environment

5.1 Land-use

The current land-use is stock grazing on semi-improved pasture. The site is currently vacant.

5.2 Vegetation

The site has been cleared of native tree species. Eucalypts occur along fence lines and as isolated species across the site. Pasture species are native grasses and legumes with weeds. The weed species include Mallow weed, cape weed, clover, couch grass, flatweed and khaki weed.

5.3 Topography

The site is predominantly located on a mid-slope. Aspect is predominantly north east and slopes are gently inclined and generally less than 2%. Elevation ranges between 469 and 2495 metres above sea level. The lowest elevation occurs on the northern boundary and along the eastern boundary where Oaky Creek traverses the site. No groundwater seepage or discharge areas were observed on the site.

5.4 Soils and geology

The site is located within the Craigmore Soil Landscape. Soil in the Craigmore landscape consists of non-calcic brown soils and Red earths on very old Quaternary alluvium. Yellow podzolic-solodic soils intergrades on lower lying areas.

Lithology of the site is dominantly alluvial deposits consisting of metasediments from the Capertee Rise.

Soils on the site comprised topsoil of dark, grey to brown silty clay, sandy clay to clay loam over grey, light to dark brown silty clay, grey, yellow brown to dark brown, brownish red sandy clay, dark greyish brown gravelly clay with rounded quartz rich river gravels and weathered metasediments with depth and horizons of light brown light clay. Predominantly the site is composed of Quaternary alluvium on the flats of the site.

5.5 Surface water

Three dams have been formed within the site and are fed by the natural slope of the site forming a shallow drainage line running south-west to north-east. Surface water over the site predominantly flows north east and into Oaky Creek.

The Oaky Creek empties into the Macquarie River approximately 3.7km north-west of the site.

5.6 Groundwater

The Department of Primary Industries Office of Water identifies the site within the Cudgegong Valley Alluvium Groundwater Management Unit. The management unit has an area of 38km^2 with approximately 2.54 GL consumed per year. Average salinity levels are less than 1500mg/L.

A search of the NSW DPI groundwater database located 26 bores within 1.5km of the site. These bores are predominantly located around the site except south east. Bores are licensed for domestic, irrigation, monitoring, stock and public/municipal supplies. The groundwater in the area can be dived into two general aquifer types. A shallow unconfined gravel dominated aquifer which is confined to areas of drainage lines, creeks and seasonal springs. The deeper aquifer is at a depth greater than 20m in shale and or limestone.

Unconfined groundwater was identified in the monitoring well (MW2) constructed near Oakly Creek at a depth of greater than 10m.

6. Groundwater and soil salinity investigation

The groundwater and soil salinity investigation comprised a desktop study, field assessment and soil analysis. The desktop study included a review of soil landscape maps, hydro-geological landscapes and groundwater databases. Soil moisture modelling was also undertaken.

The field assessment included an initial site investigation and detailed profile descriptions and soil analysis in a grid pattern over the site. The soil and landscape information collected provided an adequate description of the physical processes on the site to enable salinity issues to be identified and managed.

6.1 Soil landscape maps

Soil landscape data was reviewed for information regarding soil types in the locality, occurrence of salinity, erosion and sodic soils.

6.2 Groundwater

An investigation of registered bores in the area was undertaken to determine the depth and salinity of the groundwater. The groundwater information was obtained from a review of the NSW Department of Primary Industries, Office of Water.

Water criteria for salinity are presented in Tables 1 and 2. The conversion from EC (dS/m) to total dissolved solids or TDS (mg/L) is undertaken by applying the conversion factor of 640 for an average concentration of salts present (Lillicrap and McGhie 2002).

Table 1. Drinking water criteria for salinity (ADWG 2004)

Criteria	EC (dS/m)	Total dissolved solids -Salinity (mg/L)
Good quality drinking water	0.78	500
Acceptable based on taste	0.78-1.56	500-1000
Unsatisfactory taste	1.56	Greater than 1000
Seawater	Greater than 55	-

Table 2a. Total dissolved solids of water for agricultural use (Reid 1990)

Class	Description	Total dissolved solids -Salinity (mg/L)
1	Low salinity	0-175
2	Medium salinity	175-500
3	High salinity	500-1500
4	Very high salinity	1500-3500
5	Extremely high salinity	>3500

Table 2b Guidelines on salinity class determination (Dubbo City Council Urban Salinity Plan)

Electrical conductivity (dS/m)	Salinity class
>15	Extreme
6-15	High
2-6	Moderate
0-2	Low

6.3 Mudgee LEP (2012) Groundwater Vulnerability

The Mudgee LEP (2012) Groundwater Vulnerability – describes the area within the site as vulnerable to depletion and contamination as a result of development. A further report entitled *Rural, Residential, Industrial & Residential Strategy* (2003) compiled by Andrews Neil on behalf of the Mudgee Shire Council reference the *Salinity Risk Assessment of the Central West Catchment* (2000) which classified the site as part of the Piambong Creek catchment area and a salinity hazard rating of high. The report may include areas that are not a saline risk: the classification was determined from soil and geological maps and has limitations of scale.

6.4 Hydro-geological landscapes

Recent work revised the broad classification the Piambong Creek defined in 2000 and focused on detail investigations and creation of new HGLS. The relevant HGL under the revitalised hydro-geological landscape data is the Biraganbil Hydrogeological Landscape. The new vulnerability mapping utilises the DRASTIC technique which is a composite description of all the major geologic and hydro-geologic factors that affect and control groundwater movement into, through and out of an area. It involves the overlaying of various hydro-geological settings via a Geographical Information System (GIS). Each hydro-geological setting describes topography, soil type, bedrock type, estimate of rainfall and net recharge depth to watertable (DTWT), aquifer yield, relative conductivity and any particular features associated with the setting that are available (Figure 6).

6.5 Hydraulic model

An unsaturated moisture movement model is appropriate to evaluate the hydraulic flows of the existing and proposed land-use. The moisture model selected was CLASS U3M-1D as released by CRC Catchment Hydrology (Vaze *et al*. 2004).

6.6.1 Inputs

The model inputs are daily rainfall and evaporation. The model used climate data from 1980 to 2014 (SILO) under pre and post land-use scenarios (Table 3) to predict soil moisture and excess soil moisture. The pre development land-use of the development area is comprised of improved pasture. The post development land-use comprised rural-residential lots and roadways. The vegetated areas will be planted to trees as offset for possible over irrigation of lawns.

The model input data was rainfall and evaporation for the inferred climate at Mudgee as obtained from SILO. Six land-use scenarios (Table 3) were applied across the time period for pre and post development scenarios in the land-use areas.

Table 3. Land-use in the soil moisture model

Land-use	Pre development (ha)	Post development (ha)	Rainfall parameter
Improved grazing	139	0	100% Rainfall
Urban	0	122	Evaporation plus 1mm/day
Road verges	0	1.35	Rainfall (allowance for road runoff)
Roads	0	4.4	Run off site
Urban-open space (parkland)	0	0	100% Rainfall in permeable areas
Tree areas	0	0	Rainfall plus 1mm/day (allowance for lawn overwatering)
Total	139	128	

Other parameters applied in the model are soil type and depth and default values (Table 4).

Table 4. Model parameters

Parameter	Data/description
Soil profile	Layer 1 2000-6000
	Layer 2 1200-2000
	Layer 3 100-1200
	Layer 4 0-100 (topsoil)
Land-use	Pasture, lawn, verges – pasture, default climate
Soil hydraulic parameters	Layer 1 Sandy clay loam
	Layer 2 Sandy clay
	Layer 3 Sandy clay
	Layer 4 Silty loam (topsoil)
	CLASS U3M-1D
Time step	Default
Root distribution	Default

6.6.2 Outputs

The outputs from the model are soil moisture and excess soil moisture by layer in 10 cm increments. Excess soil moisture is the lateral drainage component and is the difference between available moisture and saturated soil moisture.

6.7 Nutrient model

A simulation model was developed to predict surface runoff, sediment loss, nitrogen and phosphorus export, pre and post development. Land-use of the site was divided into pasture, sealed roads, residential and road verges. The area for each land-use pre and post development was estimated from site walkover, topographical map, subdivision plans and an aerial photograph. The site was classified into the different land-use areas pre and post development. These areas are summarised in Table 5.

Table 5. Land use areas for nutrient model

Land-use areas (ha)	Pre	Post
Improved grazing	126	0
Disturbed landscapes	8.4	0
Remediated gullies	0	0
Roads (earth)	4	0
Roads (sealed)	0	4.4
Lawns (irrigated)	0	10.6
Urban	0	112
Road verges	0	1.35
Trees	0	0
Total	139	128

Land-use on site are as follows;

- *Improved grazing* is the main pre-development land-use. Superphosphate is regularly applied and clovers and other pasture species sown to improve pasture. The pasture area is assumed to be improved for sediment loss and feed.
- *Disturbed landscapes* refers to the drainage line that has been established with addition of contour banks and minimal earthworks to accommodate dams on site.

- *Remediated gullies* is the section along the drainage line which will be improved post development.
- *Roads (earth)* is a calculation of farm tracks and roads that have been created on site pre development.
- *Roads (sealed)* is a calculation of culverted roads that will be on-site post development.
- *Lawns* were calculated estimating average lot size. Building lots were estimated to have an area of 0.4 ha, it was therefore estimated that on average there could potentially be 0.2 ha of lawn.
- *Urban* refers to community areas or parks.
- *Road verges* were estimated to be approximately 3m wide.
- *Trees* refers to vegetation cover over the site which is recommended.

Sediment, nitrogen and phosphorus export was estimated for low, median and high scenarios for each land-use class as detailed in Appendix 1 (Chafer 2003).

6.8 On-site effluent

An assessment for suitability of typical on-site effluent system was undertaken over the site. Site-specific on-site effluent assessments should be undertaken for each lot. Inspection of topography and soil profile was undertaken across the site to enable recommendation of suitable treatment and application system. Calculations for effluent application area was based on organic matter, nitrogen and phosphorus levels. Wastewater flows were based on a four bedroom household using tank water. Assessment of the site was undertaken as per AS NZS1547-2012 *On-site domestic wastewater management*.

6.9 Initial site investigation

An initial site investigation was conducted by collecting information on vegetation, slope, bare areas and other indicators of salinity at four locations across the site (Figure 2).

6.10 Detailed profile descriptions and laboratory analysis

Fourteen boreholes were constructed with an EVH truck mounted hydraulic drilling rig with solid auger on 28 and 29 June May 2015 to provide information on the soil profiles and enable sampling. The boreholes were constructed at various local elevations on the site (Figure 3). Deep boreholes were constructed along the drainage line to a depth of 18m (MW1, MW2, MW3 and MW4). The deep boreholes were located to intercept shallow groundwater. A 50mm diameter monitoring well was installed in BH1 (MW1), BH2 (MW2), BH3 (MW3) and BH4 (MW4). Ten boreholes were drilled up to a depth of 2 metres. Soil samples were collected from MW1, MW2, MW3 and MW4 at 100mm, 200mm, 300mm, 500mm, and 500mm intervals to the depth of the borehole and are expected to provide an adequate description of subsoil salinity conditions.

The soil profile was described for colour, texture and moisture. Representative soil samples were analysed for pH, electrical conductivity and dispersion.

Soil electrical conductivity (EC) results of the 1:5 (soil:water suspension) were converted to saturated extracts (ECe). EC values are converted to ECe by using a multiplier factor (Charman and Murphy, 1991), which is dependent on the soil texture (Table 6). Saline soils are defined as those with an electrical conductivity (ECe) greater than 4 dS/m (Charman and Murphy, 2001). Soil salinity ratings and effects on plant growth are presented in Table 7.

Table 6. ECe texture based conversion factors (Charman and Murphy 2001)

Soil texture	Conversion factor
Loamy sand, clayey sand, sand	23
Sandy loam, fine sandy loam, light sandy clay loam	14
Loam, loam fine sandy, silt loam, sandy clay loam	9.5
Clay loam, silty clay loam, fine sandy clay loam	8.6
Sandy clay, silty clay, light clay	7.5
Light medium clay, medium clay, heavy clay	5.8

Table 7. Soil salinity ratings based on ECe readings

Salinity rating	ECe (dS/m)*	Effects on Plants
Non saline (NS)	0-2	Salinity effects negligible
Slightly saline (SS)	2-4	Very salt sensitive plant growth restricted
Moderately saline (MS)	4-8	Salt sensitive plant growth restricted
Highly saline (HS)	8-16	Only salt tolerant plants unaffected
Extremely saline (ES)	>16	Only extremely tolerant plants unaffected

*ECe - Electrical conductivity of a saturated extract

Soil with ECe below 2 dS/m will have negligible effects on plant growth and soil stability. Soil with ECe of between 2 and 4 dS/m may restrict very salt sensitive plant growth. Soil with ECe between 4 and 8 dS/m will restrict the growth of salt sensitive plants.

Samples were analysed for dispersion using the Emerson aggregate test. Table 8 details the eight dispersion classes.

Table 8. Emerson dispersion classes

Class	Description
1	Highly dispersive (slakes, complete dispersion)
2	Moderately dispersive, slakes, some dispersion
3	Slightly dispersive, slakes, some dispersion after remoulding
4	Non-dispersive, slakes, carbonate or gypsum present
5	Non-dispersive, slakes, dispersion in shaken suspension
6	Non-dispersive, slakes, flocculates in shaken suspension
7	Non-dispersive, no slaking, swells in water
8	Non-dispersive, no slaking, does not swell in water

7. Results and discussion

7.1 Soil landscape maps

The site is located within the Craigmore Soil Landscape. Soil in the Craigmore landscape consists of non-calcic brown soils and Red earths on very old Quaternary alluvium. Yellow podzolic-solodic soils intergrades on lower lying areas.

Lithology of the site is dominantly alluvial deposits consisting of metasediments from the Capertee Rise.

Soils on the site comprised topsoil of dark, grey to brown silty clay, sandy clay to clay loam over grey, light to dark brown silty clay, grey, yellow brown to dark brown, brownish red sandy clay, dark greyish brown gravelly clay with rounded quartz rich river gravels and weathered metasediments with depth and horizons of light brown light clay. Predominantly the site is composed of Quaternary alluvium on the flats of the site.

7.2 Mudgee LEP (2012) Groundwater Vulnerability

The *Rural, Residential, Industrial & Residential Strategy* (2003) and *Salinity Risk Assessment of the Central West Catchment* (2000) classified the site as part of the Piambong Creek catchment

area and a salinity hazard rating of high. This classification has been revised due to recent work which maps at a higher detail. The revised HGL that covers the site is the Biraganbil Hydro-geological Landscape outlined in section 7.2.

7.2 Hydro-geological landscapes

The majority of the site is located within the Biraganbil Hydro-geological Landscape. The site and associated hydro-geological landscapes are depicted in Figure 6.

Lithology of the Biraganbil Hydro-geological Landscape consists of felsic volcanic sediments in the Mudgee and Gulgon area. Felsic volcanic sediments in this HGLS are slightly to moderately weathered with shallow vertically bedded sediments a common feature on steep hill crests and ridges. Lower colluvial slopes consist of clays, coarse sands and minor gravels. Valley floors consist of scattered gravels within a sandy and clay matrix.

Soils are mainly Red Podzolic Sands on mid to upper slopes and Yellow Soloth Soils on lower slopes and in depressions. Local surface water catchments are medium (100-1000 Ha). Recharge to the groundwater system is deep and catchment wide. Streams are generally ephemeral and receive discharge from groundwater as base flow.

Recharge is seasonal however there is a lag in groundwater discharge response due to climatic patterns. Depth to water table typically ranges form 25-40m with a low specific yield.

The Biraganil HGL has a moderate land salinity, salt export, water quality classification and likelihood of occurrence with high confidence level.

7.3 Groundwater

7.3.1 OEH registered bores

Twenty six registered water bores were identified within a 1.5km radius of the site on the NSW Government Department of Primary Industries website (2015) (Figure 7). Data known about each bore from the Department of Primary Industries website is summarised in Appendix 3. Bores are predominantly located surrounding the site, except to the south east of the site.

The bores are predominantly located around the site except south east. Bores are licensed for domestic, irrigation, monitoring, stock and public/municipal supplies.

Water-bearing zones (WBZ's) and standing water levels were recorded for approximately 18 bores. The Department of Primary Industries website shows that SWL's and WBZ's in bores (for which data was recorded) indicate two possible aquifer types in the area. One aquifer shows a shallow unconfined gravel dominated aquifer which is confined to areas of drainage lines, creeks and seasonal springs. The deeper aquifer is at a depth greater than 20m in shale and or limestone. (Appendix 5 and Figure 7).

A salinity description was recorded for six bores. All were considered to contain non-saline water, with descriptions of 'good', '0-500ppm' and '500-1000ppm'. '

7.3.2 On-site groundwater

Groundwater was encountered in a monitoring well constructed on site (MW2) at a depth of 10 metres in sandy clay. The standing water level was 13.365m and total electrical conductivity of 0.008 dS/m (approximately 5.21mg/L) which is considered low salinity.

MW2 was located in the north-eastern section of the site (Figure 3) adjacent to the Oaky Creek drainage line which flows through the site north to south. The creek is currently dry and is usually a seasonal water body but has not flowed for a number of years. Bore are located along this drainage line. Bores are suspected of being recharged from the subsurface flows associated with the creek.

Unconfined groundwater may occur along the drainage line following periods of high rainfall.

7.4 Site investigation

The site has a historical land-use of grazing. Minor amounts of cropping are expected to have occurred on the site.

The site has been cleared of native tree species. Eucalypts occur along fence lines and as isolated species across the site. Pasture species are native grasses and legumes with weeds. The weed species include Mallow weed, cape weed, clover, couch grass, flatweed and khaki weed. Vegetation cover was greater than 80% across the majority of the site. Bare areas were due to farm tracks and desiccation resulting from low rainfalls.

The majority of the site was very gently sloping towards the north-east with slopes ranging from 0 to 2%.

No bare areas or indicators of salinity were observed on the site.

7.5 Soil characteristics

Boreholes were constructed to depths of 2.0m. Monitoring wells were constructed to depths up to 18.0m with all wells greater than 15.0m. Borelogs are presented in Appendix 6.

7.5.1 Texture and colour

Soils on the site comprised topsoil of dark, grey to brown silty clay, sandy clay to clay loam over grey, light to dark brown silty clay, grey, yellow brown to dark brown, brownish red sandy clay, dark greyish brown gravelly clay with rounded quartz rich river gravels and weathered metasediments with depth and horizons of light brown light clay. Predominantly the site is composed of Quaternary alluvium on the flats of the site (Table 9 and Appendix 6).

The soil was generally dry to moist throughout the profile. No mottling or indicators of seasonally shallow groundwater were observered.

7.5.2 Salinity (electrical conductivity)

All topsoils samples were determined to be non-saline. Subsoils in the majority of the site were classified as non-saline to slightly saline with electrical conductivity of less than 4dS/m (Figure 3).

The electrical conductivity of subsoils samples collected in the boreholes 1, 2, 3 and 4 (MW1-MW4) were in the non-saline to slightly saline range. Only BH3 between 9 and 11.5m contained soil in the moderately saline range. (Table 9).

Table 9. Soil colour, texture, pH, EC and ECe (detailed profile descriptions)

Borehole No – MW1depth (mm) (monitoring well)	Soil colour	Soil texture	pH	EC1:5	ECe (dS/m)	Emerson aggregate test
1-100 (MW1)	Olive	Silty clay	6.05	0.05	0.38	3
1-200 (MW1)	Olive	Sandy clay loam	6.23	0.3	0.29	2
1-300 (MW1)	Olive	Sandy clay loam	5.88	0.3	0.29	2
1-500 (MW1)	Yellowish brown	Sandy clay loam	6.26	0.08	0.75	2
1-1000 (MW1)	Yellowish red	Sandy clay	7.06	0.10	0.98	1
1-1500 (MW1)	Yellowish red	Sandy clay	7.40	0.11	0.83	2
1-2000 (MW1)	Yellowish red	Sandy clay	7.66	0.16	1.2	2
1-2500 (MW1)	Yellowish red	Loam fine sandy	7.75	0.17	1.62	2
1-3000 (MW1)	Yellowish red	Loam fine sandy	8.29	0.26	2.47	2
1-3500 (MW1)	Yellowish red	Gravelly sandy loam	8.05	0.11	1.54	2
1-4000 (MW1)	Yellowish red	Gravelly sandy loam	8.17	0.10	1.4	2
1-4500 (MW1)	Reddish yellow	Gravelly sandy loam	8.00	0.07	0.98	2
1-5000 (MW1)	Yellowish red	Gravelly clayey sand	7.81	0.09	2.16	2
1-5500 (MW1)	Yellowish red	Gravelly clayey sand	7.53	0.08	1.92	2
1-6000 (MW1)	Yellowish red	Gravelly clayey sand	7.58	0.09	2.16	2
1-6500(MW1)	Yellowish brown	Gravelly clayey sand	7.67	0.07	1.68	2
1-7000 (MW1)	Brownish yellow	Gravelly sandy loam	8.13	0.09	1.26	2
1-7500 (MW1)	Yellow	Gravelly sandy loam	8.36	0.09	1.26	2
1-8000 (MW1)	Brownish yellow	Gravelly sandy loam	8.51	0.14	1.96	2
1-8500 (MW1)	Brownish yellow	Gravelly clayey sand	8.47	0.14	3.36	3
1-9000 (MW1)	Brownish yellow	Gravelly clayey sand	8.67	0.16	3.84	3
1-9500(MW1)	Yellow	Sandy clayey loam	8.63	0.12	1.14	3
1-10000(MW1)	Yellow	Sandy clay loam	8.60	0.13	1.24	3
1-10500(MW1)	Olive yellow	Clay loam	8.37	0.10	0.86	3
1-11000(MW1)	Olive yellow	Silty clay loam	8.21	0.10	0.86	2
1-11500(MW1)	Yellow	Silty clay loam	8.27	0.10	0.86	2
1-12000(MW1)	Olive yellow	Silty clay loam	8.23	0.09	0.77	3
1-12500(MW1)	Olive yellow	Silty clay loam	8.12	0.08	0.77	2
1-13000(MW1)	Olive yellow	Silty clay loam	8.16	0.09	0.77	3
1-13500(MW1)	Yellow	Silty clay loam	7.98	0.08	0.77	5
1-14000(MW1)	Olive yellow	Silty clay	8.00	0.11	0.83	2
1-14500(MW1)	Olive yellow	Silty clay loam	8.09	0.08	0.77	2
1-15000(MW1)	Olive yellow	Silty clay	8.01	0.07	0.53	2
1-15500(MW1)	Olive yellow	Silty clay	8.09	0.07	0.53	3
1-16000(MW1)	Olive yellow	Clay loam	7.92	0.07	0.60	3
1-16500(MW1)	Olive yellow	Clay loam	7.95	0.07	0.6	3
1-17000(MW1)	Olive yellow	Silty clay loam	7.60	0.06	0.52	5
1-17500(MW1)	Olive yellow	Clayey sand	7.87	0.07	1.61	5
1-18000(MW1)	Olive yellow	Clayey sand	7.90	0.07	1.61	5
2-100 (MW2)	Dark yellowish brown	Clay loam	5.79	0.06	0.52	2
2-200 (MW2)	Yellowish red	Clay loam	6.09	0.03	0.26	2
2-300 (MW2)	Red	Clay loam	6.11	0.05	0.43	5
2-500 (MW2)	Red	Clay loam	6.21	0.06	0.52	5
2-1000 (MW2)	Red	Clayey sand	6.61	0.03	0.69	5
2-1500 (MW2)	Red	Clayey sand	6.68	0.03	0.69	5
2-2000 (MW2)	Red	Gravelly clayey sand	6.48	0.02	0.46	5
2-2500 (MW2)	Yellowish red	Gravelly sandy loam	6.66	0.02	0.28	5
2-3000 (MW2)	Yellowish red	Gravelly sandy loam	6.93	0.02	0.28	5
2-3500 (MW2)	Reddish yellow	Gravelly clayey sand	6.84	0.02	0.46	5
2-4000 (MW2)	Yellowish red	Gravelly clayey sand	7.10	0.02	0.46	5
2-4500 (MW2)	Yellowish red	Gravelly clayey sand	7.23	0.02	0.46	5
2-5000 (MW2)	Reddish yellow	Gravelly loamy sand	7.15	0.02	0.29	5
2-5500 (MW2)	Yellowish red	Gravelly sandy clayey loam	7.12	0.03	0.29	2
2-6000 (MW2)	Strong brown	Sandy clayey loam	7.44	0.03	0.69	2
2-6500 (MW2)	Strong brown	Gravelly clayey sand	7.52	0.03	0.69	2

2-7000 (MW2)	Reddish yellow	Gravelly clayey sand	7.48	0.03	0.46	2
2-7500 (MW2)	Brownish yellow	Gravelly clayey sand	6.89	0.02	0.92	3
2-8000 (MW2)	Yellowish brown	Gravelly clayey sand	7.23	0.04	0.15	2
2-8500 (MW2)	Yellowish brown	Gravelly sandy clay	7.31	0.03	0.23	2
2-9000 (MW2)	Yellowish brown	Gravelly sandy clay	7.38	0.04	0.3	2
2-9500 (MW2)	Strong brown	Gravelly clayey sand	7.32	0.02	0.46	3
2-10000(MW2)	Strong brown	Gravelly sandy clay	7.32	0.03	0.23	3
2-10500(MW2)	Strong brown	Gravelly sandy clay	7.21	0.03	0.23	3
2-11000(MW2)	Strong brown	Gravelly sandy clay	7.11	0.04	0.3	2
2-11500(MW2)	Yellow	Light clay	7.04	0.04	0.3	5
2-12000(MW2)	Yellow	Light clay	7.08	0.04	0.5	5
2-12500(MW2)	Yellow	Light clay	6.59	0.05	0.38	5
2-13000(MW2)	Yellow	Light clay	6.77	0.03	0.23	3
2-13500(MW2)	Yellow	Light clay	6.35	0.04	0.3	5
2-14000(MW2)	Reddish yellow	Light clay	6.55	0.05	0.38	5
2-14500(MW2)	Reddish yellow	Light clay	6.72	0.04	0.3	5
2-15000(MW2)	Reddish yellow	Light clay	6.79	0.03	0.23	5
2-15500(MW2)	Brownish yellow	Sandy clay	6.83	0.03	0.23	5
2-16000(MW2)	Brownish yellow	Sandy clay	6.72	0.03	0.23	5
2-16500(MW2)	Brownish yellow	Sandy clay	6.70	0.04	0.3	5
2-17000(MW2)	Brownish yellow	Gravelly sandy clay	6.68	0.04	0.3	5
2-17500(MW2)	Yellow	Sandy clay	6.71	0.04	0.3	5
2-18000(MW2)	Yellow	Sandy clay	6.86	0.04	0.3	5
3-100 (MW3)	Dark brown	Sandy clay loam	4.72	0.02	0.19	2
3-200 (MW3)	Brown	Loam fine sandy	4.84	0.02	0.28	2
3-300 (MW3)	Red	Silty clay	5.96	0.03	0.23	1
3-500 (MW3)	Red	Silty clay	5.86	0.18	1.35	1
3-1000 (MW3)	Yellowish red	Silty clay	7.50	0.45	3.38	1
3-1500 (MW3)	Yellowish red	Sandy clay	7.62	0.42	3.15	1
3-2000 (MW3)	Strong brown	Sandy clay loam	8.08	0.26	2.47	1
3-2500 (MW3)	Yellowish brown	Silty clay	7.96	0.22	1.65	1
3-3000 (MW3)	Yellowish brown	Silty clay	7.98	0.24	1.8	1
3-3500 (MW3)	Yellowish brown	Gravelly sandy clayey loam	8.12	0.22	2.09	1
3-4000 (MW3)	Yellowish brown	Gravelly sandy clayey loam	7.80	0.23	2.19	1
3-4500 (MW3)	Brownish yellow	Sandy clay loam	8.23	0.26	2.47	1
3-5000 (MW3)	Brownish yellow	Gravelly sandy clay	8.54	0.26	1.95	1
3-5500 (MW3)	Strong brown	Gravelly sandy clay	8.48	0.24	1.8	1
3-6000 (MW3)	Yellowish brown	Gravelly sandy clay	8.45	0.20	1.5	1
3-6500 (MW3)	Yellowish brown	Gravelly sandy clay	8.46	0.25	1.88	1
3-7000 (MW3)	Yellowish brown	Gravelly sandy clay	8.66	0.19	1.43	1
3-7500 (MW3)	Yellowish brown	Gravelly sandy clay	8.71	0.21	1.58	1
3-8000 (MW3)	Yellowish red	Gravelly sandy clay	8.94	0.44	3.3	1
3-8500 (MW3)	Yellowish red	Gravelly sandy clay	8.78	0.41	3.08	1
3-9000 (MW3)	Reddish yellow	Gravelly sandy clay	9.06	0.61	4.58	1
3-9500 (MW3)	Reddish yellow	Gravelly sandy clay	8.79	0.51	3.83	1
3-10000 (MW3)	Yellowish red	Gravelly sandy clay	8.93	0.57	4.28	1
3-10500(MW3)	Yellowish red	Gravelly sandy clay	8.96	0.53	3.98	1
3-11000(MW3)	Brownish yellow	Gravelly sandy clay	9.15	0.58	4.35	1
3-11500(MW3)	Brownish yellow	Gravelly sandy clay	9.07	0.55	4.13	1
3-12000(MW3)	Brownish yellow	Gravelly sandy clay	8.83	0.52	3.9	1
3-12500(MW3)	Brownish yellow	Gravelly sandy clay	8.39	0.28	2.1	1
3-13000(MW3)	Brownish yellow	Gravelly sandy clay	8.65	0.29	2.18	1
3-13500(MW3)	Brownish yellow	Gravelly sandy clay	8.66	0.29	2.18	1
3-14000(MW3)	Yellowish brown	Gravelly sandy clay	8.70	0.29	2.18	1
3-14500(MW3)	Yellowish brown	Gravelly sandy clay	8.38	0.37	2.78	1
3-15000(MW3)	Yellowish brown	Gravelly sandy clay	8.36	0.25	1.88	3
3-15500(MW3)	Yellowish brown	Gravelly sandy clay	8.39	0.20	1.5	3
3-16000(MW3)	Brownish yellow	Gravelly sandy clay	8.32	0.21	1.43	3
3-16500(MW3)	Brownish yellow	Gravelly sandy clay	8.10	0.19	1.43	3
3-17000(MW3)	Brownish yellow	Gravelly sandy clay	8.40	0.19	1.43	3

3-17500(MW3)	Brownish yellow	Sandy clay	8.40	0.19	1.43	3
3-18000(MW3)	Brownish yellow	Sandy clay	8.40	0.22	1.65	3
4-100(MW4)	Dark brown	Loam fine sandy	4.58	0.04	0.56	5
4-200(MW4)	Light brownish grey	Loam fine sandy	4.75	0.02	0.28	5
4-300(MW4)	Light grey	Sandy clay loam	6.05	0.02	0.19	2
4-500(MW4)	Yellowish red	Clayey sand with gravel	6.75	0.07	1.61	2
4-1000(MW4)	Yellow	Fine sandy clay loam	5.45	0.25	2.15	1
4-1500(MW4)	Brownish yellow	Clayey sand with gravel	6.10	0.21	4.83	1
4-2000(MW4)	Yellowish brown	Sandy clay with gravel	6.28	0.31	2.33	1
4-2500(MW4)	Yellowish brown	Sandy clay	6.94	0.34	2.55	2
4-3000(MW4)	Yellowish brown	Sandy clay	6.93	0.36	2.7	2
4-3500(MW4)	Yellowish brown	Sandy clay with gravel	7.17	0.28	2.1	2
4-4000(MW4)	Yellowish brown	Sandy clay with gravel	7.40	0.34	2.55	2
4-4500(MW4)	Yellowish brown	Sandy clay with gravel	7.38	0.38	2.85	2
4-5000(MW4)	Yellowish brown	Sandy clay with gravel	7.75	0.36	2.7	1
4-5500(MW4)	Yellowish brown	Sandy clay with gravel	7.54	0.34	2.55	1
4-6000(MW4)	Yellowish brown	Sandy clay	7.61	0.36	2.7	1
4-6500(MW4)	Yellowish brown	Sandy clay	7.48	0.30	2.25	1
4-7000(MW4)	Reddish brown	Sandy clay	8.20	0.40	3	1
4-7500(MW4)	Reddish brown	Sandy clay	8.02	0.35	2.63	1
4-8000(MW4)	Dark yellowish brown	Sandy clay	7.38	0.31	2.33	1
4-8500(MW4)	Yellowish brown	Sandy clay	7.53	0.35	2.63	2
4-9000(MW4)	Yellowish brown	Sandy clay with gravel	7.66	0.30	2.25	2
4-9500(MW4)	Yellowish brown	Sandy clay with gravel	7.90	0.26	1.95	2
4-10000(MW4)	Yellowish brown	Sandy clay with gravel	7.95	0.22	1.65	2
4-10500(MW4)	Yellowish brown	Sandy clay with gravel	8.17	0.22	1.65	2
4-11000(MW4)	Brownish yellow	Sandy clay with gravel	7.96	0.28	2.1	3
4-11500(MW4)	Brownish yellow	Sandy clay with gravel	8.01	0.24	1.8	2
4-12000(MW4)	Brownish yellow	Sandy clay with gravel	8.11	0.30	2.25	2
4-12500(MW4)	Brownish yellow	Sandy clay with gravel	8.20	0.27	2.03	2
4-13000(MW4)	Brownish yellow	Sandy clay with gravel	8.16	0.37	2.28	2
4-13500(MW4)	Brownish yellow	Light clay	8.04	0.32	2.4	2
4-14000(MW4)	Brownish yellow	Sandy clay	7.52	0.28	2.1	2
4-14500(MW4)	Brownish yellow	Sandy clay	7.53	0.25	1.88	2
4-15000(MW4)	Brownish yellow	Sandy clay	7.65	0.26	1.95	2
4-15500(MW4)	Olive yellow	Sandy clay	7.59	0.23	1.73	2
4-16000(MW4)	Olive yellow	Sandy clay with gravel	8.02	0.25	1.88	5
4-16500(MW4)	Olive yellow	Sandy clay with gravel	7.75	0.23	1.73	2
4-17000(MW4)	Olive yellow	Sandy clay with gravel	7.69	0.22	1.65	2
4-17500(MW4)	Olive yellow	Sandy clay with gravel	7.11	0.20	1.5	2
4-18000(MW4)	Olive yellow	Sandy clay with gravel	7.40	0.17	1.28	5

7.5.3 pH

The topsoil was slightly acidic (Table 9). The pH generally increased with increasing depth. Subsoil was generally neutral to slightly alkaline.

7.5.4 Emerson aggregate test

Topsoil on site was generally non-dispersive to moderately dispersive and subsoil on the site ranged from highly dispersive to non-dispersive with depth (Table 9).

7.6 Indicators of salinity

7.6.1 Bare soil

No bare soil resulting from sheet erosion or salinity were present on site

7.6.2 Salt crystals

No salt crystals present on site.

7.6.3 Vegetation indicators
No highly salt tolerant plant species are present on site.

7.6.4 Die back
No vegetation or tree die back was observed on or surrounding the site.

7.6.5 Effects on buildings
The existing dwelling located east of the site has no evidence of salinity impact.

7.6.6 Conditions of roads
No evidence of surface undulations or break-up of bitumen on the roads surrounding the site.

7.7 Soil moisture model
The soil moisture varies with rainfall in all land-use scenarios of the CLASS U3M model. Soil moisture at 1m depth under pastoral and residential land-use are saturated seasonally or under periods of high rainfall (Figure 9). At the 3 metres soil depth in the pastoral residential land-uses the soils are not saturated in the simulation period. (Figure 10).

No excess soil moisture is observed at 3m depth in pastoral land-use. It is a reasonable assumption that lateral moisture movement will occur on the clayey subsoils of low permeability and unsaturated flows will be utilized by trees located in buffer areas.

Management of areas with elevated salinity with permanent vegetation will prevent mobilization of salts in the surface or subsurface (Table 10).

Table 10. Excess soil moisture at 3m depth from the simulation

Land-use	Total excess moisture at 3m 1980 to 2014 (m/m^3)
Pasture (Pre-development)	0
Lawn + irrigation (post-development)	0.35 (0.35%)

7.8 Nitrogen
Nitrogen soil levels in the grazing system are typically low with concentrated areas around animal wastes. Nitrogen fertilisers are also used in cropping operations and biological synthesis occurs in legumes. Off-site movement occurs from sediment loss. Water soluble nitrogen has potential to leach into the groundwater.

Post development sources of nitrogen are from fertilisers applied to lawns. Post development fertilisation will only occur in a small proportion of the site that is lawns and gardens. Nitrogen fertilisation is not expected to occur on the road verge. Nitrogen fertiliser will not be required in native gardens. The impact from lawn fertilisers will be less than the impact of animal wastes. Maintained gardens and lawns will have the capacity to utilise the nitrogen applied. The impact of nitrogen fertiliser post development will be reduced.

The nutrient balance indicates the development will decrease nitrogen export by 824 kg/year under the median scenarios (Table 11). Reduced pasture area has resulted in a decrease in the nitrogen loss.

Table 11. Land-use nitrogen export pre and post development (kg/year)

Land-use areas	Pre-development	Post-development	Impact
Native bushlands	0.00	0.00	0.00
Disturbed landscapes	100.8	0.00	100.80
Remediated gullies	0.00	0.00	0.00
Improved pasture	1121.4	0.00	1121.4
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	26.4	-26.40
Roads (earth)	8.80	0.00	8.80
Urban (lawns)	0.00	22.0	-22.00
Urban (open space)	0.00	358.40	-358.40
TOTAL	**1231.0**	**406.80**	**824.2**

7.9 Phosphorus

The main phosphorus sources pre-development are from animal waste and fertilisers. Cattle and sheep are currently grazed on the site. Off-site movement of phosphorus will occur in sediments and susceptible times are when vegetation cover is low.

Stock numbers will decrease in the post development land-use. Domestic pet numbers on the site are expected to increase. The majority of domestic pet scats are expected to be disposed to landfill by collection of the scats by owners or removal with kitty litter. The result will be a decrease contribution of phosphorus on the site.

Phosphorus binds to soil and the primary method of movement is in sediments. Vegetation cover is expected to be higher post development resulting in filtering of runoff, reduced sediment loads exported and consequently lower phosphorus export.

The nutrient balance indicates the development will decrease phosphorus export by 141 kg/year under the median scenarios (Table 12). Riparian planting and wetland design can reduce phosphorus levels at stormwater discharge areas.

Table 12. Land-use phosphorus exports pre and post development (kg/year)

Land-use areas	Pre-development	Post-development	Impact
Native bushlands	0.00	0.00	0.00
Disturbed landscapes	10.42	0.00	10.42
Remediated gullies	0.00	0.00	0.00
Improved pasture	170.10	0.00	170.10
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	7.92	-7.92
Roads (earth)	6.88	0.00	6.88
Urban (lawns)	0.00	19.29	-19.29
Urban (open spaces)	0.00	19.04	-19.04
TOTAL	**187.40**	**46.25**	**141.14**

7.10 Sediment

The nutrient balance indicates the development will reduce sediment by 29,052 kg/year under the median scenario (Table 13). Sediments are reduced due to the decrease in contribution from the pasture area.

Table 13. Land-use sediment export pre and post development (kg/year)

Land-use areas	Pre-development	Post-development	Impact
Native bushlands	0.00	0.00	0.00
Disturbed landscapes	7308.0	0.00	7308.0
Remediated gullies	0.00	0.00	0.00
Improved pasture	65520	0.00	65520.0
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	836.0	-836.0
Roads (earth)	560.0	0.00	560.0
Urban (lawns)	0.00	3180.0	-3180.0
Urban (open spaces)	0.00	40320.0	-40320.0
TOTAL	**73,388.00**	**44,336.00**	**29,052.00**

7.1 Effluent application

Waste water calculations were based on a four bedroom household using tank water. Calculations indicate that approximately 600L/day waste water would be created. Based on the soil textures and to limit nutrients reaching the groundwater table, surface or sub-surface irrigation application systems would be the recommended application system to be used for the proposed 2ha lot subdivision. An overview of the systems and benefits are included in Table 10.

The application area needed to adequately dispose of waste water based on phosphorus, nitrogen and organic matter would be 444m^2 (Appendix 2 and 3). Proposed lot sizes are adequate for effective effluent disposal (Figure 14).

Irrigation application systems will minimise environmental impacts by creating a greater buffer distance to groundwater that can be achieved by absorption systems. Irrigation systems will utilise evapotranspiration as part of effluent disposal.

Table 14. Preferred application system

Application system	Treatment system	Site limitations of the application system	Modifications to mitigate constraints	Suitability and benefits
Surface irrigation	Secondary	Waterways Property boundaries	Required buffer distance from intermittent and permanent water ways and property boundaries	Yes, system above the groundwater table, possible nutrient removal systems can be applied by owners, effluent distributed over a large application area allowing even distribution.
Sub-surface	Secondary	Waterways Property boundaries	Required buffer distance from intermittent and permanent water ways and property boundaries	Yes, system above the groundwater table, possible nutrient removal systems can be applied by owners, effluent distributed over a large application area allowing even distribution.

7.12 Garden fertilisers and chemicals

Minor usage of herbicides may occur post development on lawns. All fertilisers and agricultural chemicals will be utilised by the vegetation or degrade rapidly in the environment. No impact on surface water or groundwater will occur.

No industrial activities including bulk storage or use of chemicals will occur in the development.

7.13 Other contaminants

7.13.1 Greywater reuse

NSW Health approves the following methods for greywater reuse:

- Bucketing: Generally only small volumes of greywater are reused and the action is unlikely to occur during wet weather. Risk of overwatering and therefore impact on groundwater is low.
- Greywater diversion devices: Does not require Council approval if conditions relating to installation and use are met. Conditions include undertaking checks and maintenance of the irrigation system, use biodegradable detergents low in phosphorus, sodium, boron and chloride, no irrigation during rain, undertake a water balance prior to installation, monitor soil and plant response to irrigation, do not overwater and notify the local water utility of the device. Notification to the local water utility (Mudgee City Council) ensures Council is aware the system is in place and can check on compliance. Conditions ensure the water is used sustainably with minimal impact on the groundwater.
- Greywater treatment system: Requires approval from Council. Council can regulate the suitability and number of systems in the locality and check on the satisfactory operation of the system. Regulation of the system ensures minimal impact on groundwater.

7.13.2 Car washing

Minor washing of cars by householders is expected to be undertaken post development. Most car owner clean cars in commercial washing bays. Small numbers of cars will be washed either on permeable areas resulting in infiltration or non-permeable areas with water moving into the reticulated stormwater system and off-site. Water and detergents infiltrating permeable areas will be utilised by vegetation. Some deeper infiltration may occur but volumes are not expected to be significant. Car washing is not expected to occur during rain.

8. Soil and water impact assessment

8.1 Soil

Surface soil was non-saline. Subsoils in the majority of the site were classified as non-saline to slightly saline. Moderate saline subsoil was at a depth greater than 1.0m. Excavation works from the development are not expected to intercept the saline subsoil, following adoption of the recommendations in this report

8.2 Water

8.2.1 Surface water

Runoff will be directed into a stormwater system. The pipes will discharge into the drainage line which will be modified to form a stormwater management system. The existing dams located on site which are fed by contour banks will be decommissioned. If stormwater retention basins are required on site they will be lined and vegetation planted to minimise the interaction between the groundwater and stormwater management system.

8.2.2 Groundwater

8.2.2.1 Recharge

Groundwater recharge has potential to increase as a result of irrigation of lawns. Modelling has shown under a number of scenarios that soil moisture increases will not be significant and the proposed planting of deep-rooted vegetation as street trees, parkland and along the drainage lines will aid in the extraction of soil moisture within the profile and reduce the occurrence of deep infiltration. The increase in infiltration in the north-east area from lawn areas will be utilized by trees planted downslope along the drainage line.

Additional infiltration in the non-saline areas from possible over irrigation of lawn will not contribute to salinity. Large areas of impervious surface (roads and roof areas) will increase in rainfall runoff and reduce infiltration. Deep infiltration of groundwater within the area is expected to be similar pre and post development.

8.2.2.2 Discharge

No shallow groundwater discharge areas were identified on the site. It is possible the drainage line that traverses the site in the south west of the site is a drainage area at times of high rainfall. Effective stormwater design and tree planting will lower the groundwater table and move surface water off site limiting the influence of the development on site.

8.2.2.3 Clause 6.1 of the Mudgee LEP 2012

(1) The objective of this clause is to provide for the appropriate management of land that is subject to salinity and the minimisation and mitigation of adverse impacts from development that contributes to salinity.

Response: The development and groundwater at the site is described in the Groundwater and Salinity report prepared by Envirowest Consulting Pty Ltd (Report number R6151s).

(2) Before determining a development application for development that, in the opinion of the consent authority, may affect the process of salinisation or is proposed to be carried out on land affected by groundwater salinity, the consent authority must consider the following:

(a) whether the development is likely to have any adverse impact on salinity processes on the land;

(b) whether salinity is likely to have an impact on the development;

(c) Any appropriate measures proposed to avoid, minimise or mitigate the potential impacts of the development.

Response:

The development has a low potential to adversely affect groundwater and groundwater dependent ecosystems. Groundwater and groundwater dependent ecosystems may be impacted by use of fertilisers on lawns and gardens, greywater reuse and car washing. The post development impact is expected to be similar or less than under the pre-development agricultural land-use.

Post development lawn inputs will only occur in a small proportion of the site that is lawns and gardens. Nitrogen fertiliser will not be required in native gardens. The impact from lawn fertilisers will be managed by riparian vegetation and stormwater design which will removed any potential increase in nitrogen rich fertilizers. Maintained gardens and lawns will have the capacity to utilise the nitrogen applied. The impact of nitrogen inputs post development will be reduced.

The post development scenario is expected to result in a decrease in contribution of phosphorus, nitrogen and suspended sediments. Fertilizer use in the residential subdivision with be less than the agricultural land-use. Stock numbers will decrease in the post development land-use while domestic pet numbers on the site are expected to increase. The majority of domestic pet scats are expected to be disposed to landfill by collection of the scats by owners or removal with kitty litter disposed as refuse to landfill.

Minor usage of herbicides may occur post development on lawns. All fertilisers and agricultural chemicals are not residual and will be utilised by the vegetation or degrade rapidly in the environment. No impact on surface water or groundwater will occur.

NSW Health approves the following methods for greywater reuse:

- Bucketing: Generally only small volumes of greywater are reused and the action is unlikely to occur during wet weather. Risk of overwatering and therefore impact on groundwater is low.
- Greywater diversion devices: Does not require Council approval if conditions relating to installation and use are met. Conditions include undertaking checks and maintenance of the irrigation system, use biodegradable detergents low in phosphorus, sodium, boron and chloride, no irrigation during rain, undertake a water balance prior to installation, monitor soil and plant response to irrigation, do not overwater and notify the local water utility of the device. Notification to the local water utility (Mudgee City Council) ensures Council is aware the system is in place and can check on compliance. Conditions ensure the water is used sustainably with minimal impact on the groundwater.
- Greywater treatment system: Requires approval from Council. Council can regulate the suitability and number of systems in the locality and check on the satisfactory operation of the system. Regulation of the system ensures minimal impact on groundwater.

Minor washing of cars by householders is expected to be undertaken post development. Most car owners clean cars in commercial washing bays. Small numbers of cars will be washed either on permeable areas resulting in infiltration or non-permeable areas with water moving into the reticulated stormwater system and off-site. Water and detergents infiltrating permeable areas will be utilised by vegetation. Some deeper infiltration may occur but volumes are not expected to be significant. Car washing is not expected to occur during rain.

No industrial activities including bulk storage or use of chemicals will occur in the development.

(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

(a) The development is designed, sited and will be managed to avoid any significant adverse environmental impact, or
(b) If that impact cannot be avoided by adopting feasible alternatives – the development is designed, sited and will be managed to minimise that impact, or
(c) If that impact cannot be minimised – the development will be managed to mitigate that impact.

No impacts from the development are expected if additional implementations are adopted. Offset contingences have also been proposed to provide additional assurance.

Mitigation measures will be adopted within the development to off-set the unlikely impacts on groundwater quality. The mitigation measures will comprise planting of deep-rooted vegetation off-sets in proposed open space adjacent the development and along Oaky Creek. Additional planting will occur depending on stormwater design. The vegetation will intercept groundwater and nutrients and will reduce the potential impact on groundwater quality.

Deep-rooted vegetation comprising native species selected from the species list provided in DCC Water Wise and Salt Tolerant Plants list (no date) will be planted in proposed open space. Trees

will also be planted along road verges as part of the street scaping which will additionally mitigate any impact.

8.3 Vegetation

Most of the site contains annual species which are shallow rooted. No impact from saline soils and groundwater on the vegetation was observed.

Pasture grasses will be replaced with introduced garden species including deep rooted perennials. Garden species to be planted will be shallow rooted or salt tolerant and no impact on growth is expected. Trees will be planted in open spaces and along Oaky Creek. The proposed residential development will contain irrigated and unirrigated lawns with plantings of shrubs and trees. Ecowise gardens of native and drought tolerant species will be promoted in the development. Costs associated with irrigation will ensure overwatering and leaching does not occur. On-site shallow groundwater is not expected to be a viable source of irrigation water due to the unreliable shallow groundwater aquifer. The use of fertiliser and herbicides on lawn will be utilised by plants and will not move out of the rooting zone.

The new land-use will contain a mix of shallow and deep rooted vegetation. Species planted in lawns will utilise soil moisture all year round compared to the current pasture species mix which are mostly summer active only. Trees will be planted along roadways and garden areas.

8.4 Infrastructure

Non to slightly saline soils were identified to a depth of 1.0m across the majority of the site which is below the footing depth for residential buildings. Moderately saline soils were identified from 1.0m in areas of the assessment area. Excavations are expected to not be at depths greater than 1.0m. Groundwater is present at depths greater than building depths. No special construction requirements addressing salinity are expected to be required for infrastructure including roads and buildings in the remainder of the site.

8.5 Pollution risk control

The subsoil is clay with depth of greater than 10 metres to groundwater. The soil layer provides significant filtration and absorption capacity to reduce contamination loading.

Occasional fertilizer and chemical use is expected from the residential land-use. Fertilisers will be utilised by plants. All agricultural chemicals degrade rapidly in the environment. No impact on surface water or groundwater will occur.

The site currently has a grazing land-use. Waste from the animals contains significant nutrients and pathogens which has potential to move in surface water flows.

Stock will be excluded in the post development land-use. Domestic pet numbers on the site are expected to increase. The majority of domestic pet scats are expected to be disposed to landfill by collection of the scats by owners or removal with kitty litter. The result will be a decrease contribution by animals to nutrients on the site.
Vegetation cover around the dwellings and in the nature strips will provide a biofilter resulting in reduced sediment loads exported. Nutrient impact on surface water will be reduced post development.

The site area is considered important as it forms part of the Macquarie River catchment. ANZECC (2000) has determined water quality indicators for river systems in regard to various environmental values (Table 15). The environmental values relate to the protection of:

- aquatic ecosystems
- aquatic foods
- primary contact recreation
- secondary contact recreation
- drinking water
- visual amenity
- irrigation water supplies
- homestead water supplies
- livestock water supplies
- human consumption of fish

The irrigation water quality indicators are considered appropriate for the catchment. The potential impact of the development on each water quality indicator has been assessed (Table 15). Potential issues relate to current and future land-use and management of the site.

The impact of the development on each water quality indicator will be negligible.

8.6 Earthworks

Minimal earthworks are expected for the development. The roads will be designed to ensure road levels are as close as possible to the existing natural levels to ensure saline-subsoils are not exposed. Subsoils in the majority of the site were classified as non-saline to slightly saline.

8.7 Other impacts of the development

Nil

Table 15. Impacts of development on water quality (Environmental objectives)

Indicator	Objective	Impact of development
Nitrogen	5 mg/L	Nitrogen may be applied to the site as fertilisers. Nitrogen will be used by plants, digested by microbes or volatilised into the atmosphere. Infiltration for nitrogen into the subsoil and impact on groundwater systems will not occur. AWTS systems can create effluent with significant nitrogen concentration. The on-site application area is designed to apply the effluent over a sufficient area to prevent off-site movement. Nitrogen will be used by plants, digested by microbes or volatilised into the atmosphere. Infiltration for nitrogen into the subsoil and impact on groundwater systems will not occur. Maintenance of groundcover by minimal cultivation and no grazing are important factors in reducing nitrogen export. Nutrient modelling indicates nitrogen will decrease on site.
Faecal coliform	<10 cfu/100mL to 10,000cfu/100mL	Effluent treatment from AWTS can include disinfection and impact will be negligible. No impact on faecal coliform levels is expected to result from the development.
Aluminium	5 mg/L	No impact.
Iron	0.2 mg/L	No impact.
Manganese	0.2 mg/L	No impact.
Dissolved oxygen	>6.5 mg/L	No effluent applied to the site. Vegetated areas are expected to be managed. No impact.

Phosphorus	0.05mg/L	Phosphorus may be applied to the site as fertilisers or in domestic pet scats. Domestic pet scats are expected to be removed by collection by owners or disposal of kitty litter and will not significantly contribute to phosphorus levels on the site. Phosphorus will be used by plants and absorbed in the soil. AWTS systems can create effluent with significant phosphorus concentration. The on-site application area is designed to apply the effluent over a sufficient area to prevent off-site movement. Phosphorus will be used by plants and absorbed in the soil. Nutrient modelling indicates phosphorous will decrease on site post development. Riparian planting and will additionally reduce phosphorus levels at stormwater discharge areas.
pH	between 6.0 and 8.5	Fertilisers have a declining influence on pH and effects off-site will be negligible.
Cyanobacteria	-	Cyanobacteria are dependent on the levels of nitrogen, phosphorus and water temperature. The development will not increase nitrogen and phosphorus therefore will have negligible impact. No cyanobacteria are present in fertilisers.
Conductivity	-	Exposure of saline soils and off-site movement will be minimised by adoption of recommendations including minimising depth of cut and implementation of erosion and sediment control plans. No impact expected.
Turbidity	-	Negligible impact due to small size of the development and the absence of any disturbed areas on site. Effluent from AWTS is typically low in suspended solids.

9. Management recommendation

9.1 Design

The development water and soil design will include:

- Promote plantings of deep rooted vegetation along roads and public space
- Establishment of parkland areas with native species which do not require irrigation
- Design road levels similar to natural soil levels to minimise excavations
- Lots should be designed to ensure adequate area available for irrigation while maintaining required buffer distances

9.2 Buildings

Soil saturated extract electrical conductivity (EC_e) was determined to be less than 1.61 dS/m in the soil samples tested within the expected footing depth range of 0.6m (exposure classification B2). The lowest soil pH was 4.6 (exposure classification B1). Design characteristic strength for concrete is a minimum 32MPa and minimum curing requirement is continuous curing for at least 7 days will be required for the most aggressive sites (Appendix 4). Minimum reinforcement cover for concrete in soils is 50mm (Appendix 4). Site specific testing should be undertaken to classify the soil for footing design and construction in accordance with AS2870-2011 and confirm exposure classification (Appendix 4).

9.3 Exposure classification for concrete

Soil saturated extract electrical conductivity (EC_e) was determined to be <4dS/m in the soil samples tested (Table 9). The soil pH ranged between 4.6 and 9.1. Exposure classification for concrete is B1. Minimum design characteristic strength for concrete is 32MPa and minimum curing requirement is continuous curing for at least 7 days (Appendix 4). Minimum reinforcement cover for concrete in soils is 50mm (Appendix 4).

10. Conclusions

The existing land-use is pasture. No bare areas from salinity were identified. The erosion hazard and erodibility is low.

Soils on the site comprised topsoil of grey to brown silty clay over grey, brown sandy clays, with rounded quartz rich river gravels and weathered metasediment. Quaternary alluvium are located on the flats. The Mudgee (LEP) maps indicate the site is located within a vulnerable groundwater area.

The Mid-Western Regional Council has classified the site as a *'high risk'* area based on original groundwater investigations which were commissioned to create a classifying system based on the hydrogeological landscape. The scale and input factors are believed to be the reason why the Piambong Creek HGL was given the *'high risk'* category.

Recent work by DPI has revised the original Piambong Creek HGL and created the Biraganbil HGL.

The site is located within the Biraganil hydro-geological landscape and has a moderate land salinity, salt export, water quality classification and likelihood of occurrence with high confidence level.

The investigation identified that topsoils samples were determined to be non-saline. Subsoils over the site were classified as non-saline to slightly saline with electrical conductivity of less than 4dS/m.

Majority of soils were non-saline to slightly saline. Moderately saline soils were encountered in MW3 and 4 at a depth greater than 1.0m in small soil substrates.

Infiltration of groundwater over most of the site will not result in mobilisation of salts. Groundwater was encountered in MW2 located in the north eastern section of the site from 10m. Electrical conductivity of groundwater from MW2 was 5.12mg/L which is classed as low salinity. No groundwater was identified in MW1, MW3 and MW4 to a depth of 15m in sandy to gravelly clay.

No groundwater discharge areas were identified on the site.

Modelling of soil moisture levels over the past 34 years indicated variations in infiltration occur with the amount of rainfall pre and post development. Infiltration under the three land-use scenarios will be reduced in the development. Reduced soil moisture is a result of the increase in runoff due to impermeable areas (roads, roofs, driveways) and increase in deep rooted vegetation extracting soil moisture from depth. The establishment of trees by future owners will offset any additional infiltration from lawn over watering.

The risk of surface contamination from the proposed land-use is less than the current land-use. From the nutrient and sediment modelling the nutrient activities will be reduced as a result of reduced agricultural activates. On-site effluent application systems will be sized to ensure no infiltration. Nutrients will be utilised by vegetation. Site-specific on-site effluent assessments should be undertaken for each lot.

No impact on groundwater is expected from the development if recommendations are adopted. A slight increase in soil moisture is experienced at 3m depth post development under the effluent and lawn irrigation area which is less than 10% of the total development site. The slight increase in

moisture will be mitigated by additional tree planting. The development will not impact on quantity or quality of both unconfined and confined aquifers.

11. Recommendations

Planning and development controls are recommended to prevent mobilisation of salt in the soil and groundwater resulting in on and off-site impacts. Controls include:

- Establishment of parkland areas with native species which do not require irrigation
- Plantings of deep rooted vegetation along roads
- Design road levels similar to natural soil levels to minimise excavations
- Wastewater systems to comprise surface and sub-surface irrigation

11. Report limitations and intellectual property

This report has been prepared for the use of the client to achieve the objectives given the clients requirements. The level of confidence of the conclusion reached is governed by the scope of the investigation and the availability and quality of existing data. Where limitations or uncertainties are known, they are identified in the report. No liability can be accepted for failure to identify conditions or issues which arise in the future and which could not reasonably have been predicted using the scope of the investigation and the information obtained.

The investigation identifies the actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing is interpreted by geologists, engineers or scientists who then render an opinion about overall conditions, the nature and extent of likely impacts of the proposed development, and appropriate remediation measures. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, and no sub surface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock or time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. It is thus import to understand the limitations of the investigation and recognise that we are not responsible for these limitations.

This report, including data contained, its findings and conclusions, remain the intellectual property of Envirowest Consulting Pty Ltd. A licence to use the report for the specific purpose identified is granted for the persons identified in that section after full payment for the services involved in preparation of the report. This report should not be used by persons or for purposes other than those stated, and not reproduced without the permission of Envirowest Consulting Pty Ltd.

12. References

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Figures

North

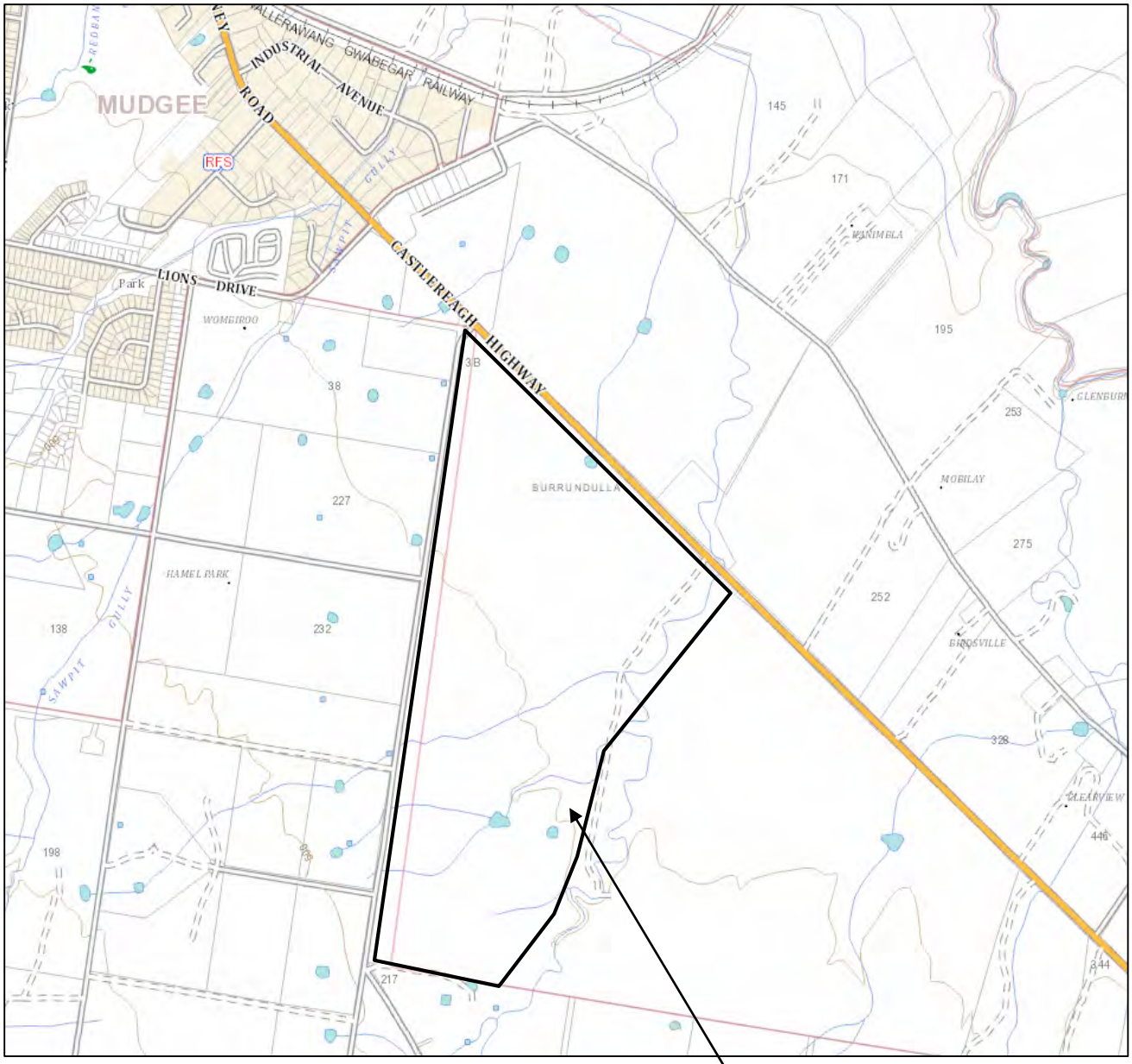


Figure 1: Locality plan		
Lot 3 & Lot 4 DP1069441, Mudgee NSW		
	Envirowest Consulting Pty Ltd	
Job – R6151s	Drawn by: DL	Date: 8/10/2015

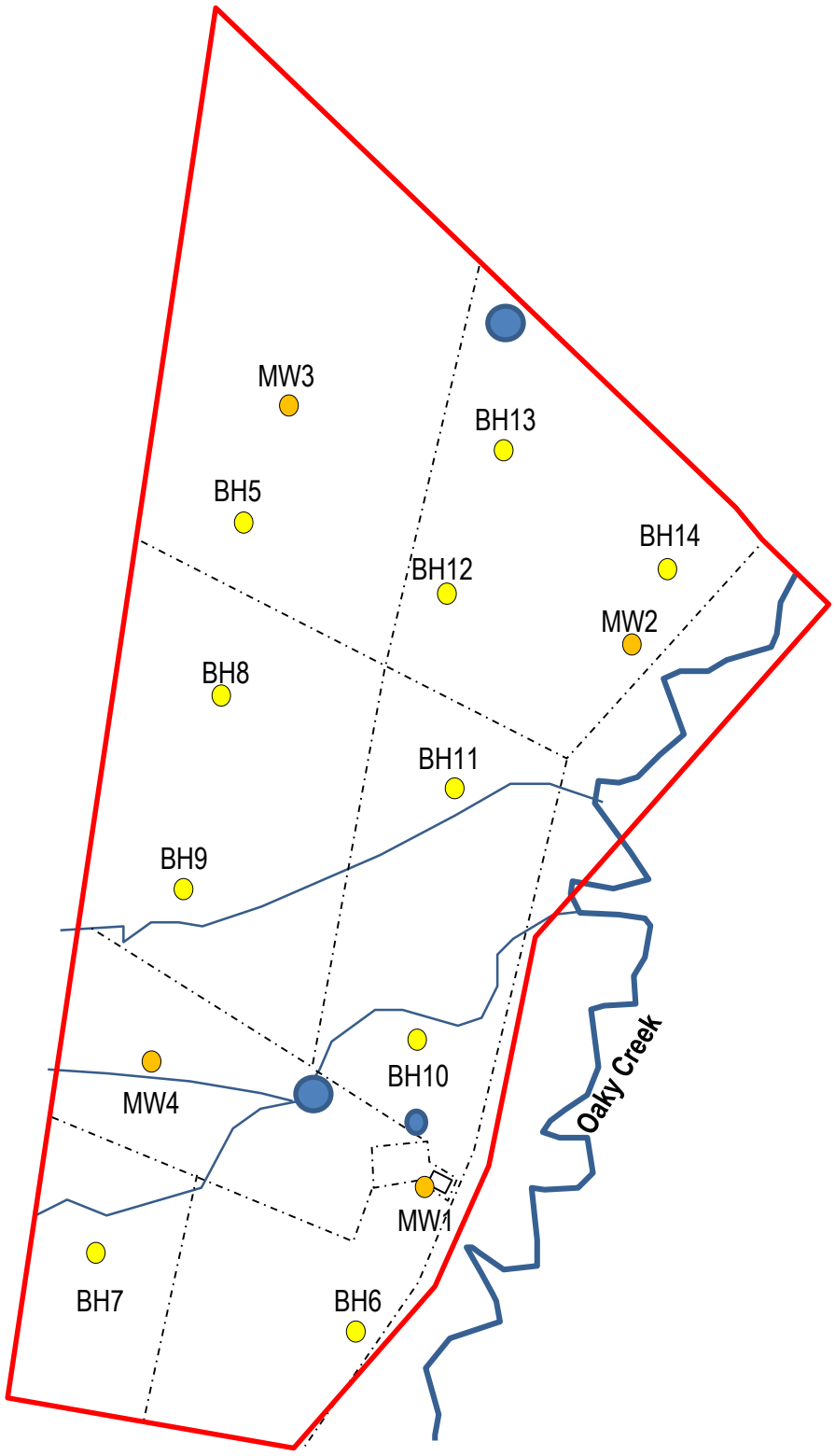
Approximate Scale 1: 10,000

0 100 200 400m

Legend

- Shed
- Lot boundary
- Dam
- Creek
- Drainage depression
- Fence
- Shed

Figure 2: Site plan		
Lot 3 & Lot 4 DP1069441, Mudgee NSW		
	Envirowest Consulting Pty Ltd	
Job: R5737c	Drawn by: DL	Date:8/10/2015



Legend

- Shed
- Lot boundary
- Dam
- Creek
- Boreholes
- Drainage depression
- Fence
- Shed
- Monitoring wells

Approximate Scale 1: 10,000

0 100 200 400m

Figure 3: Site plan- Sample locations		
Lot 3 & Lot 4 DP1069441, Mudgee NSW		
	Envirowest Consulting Pty Ltd	
Job – R5735s	Drawn by: DL	Date: 8/10/2015

Salinity Risk Assessment for the Central West Catchment Final Outcomes

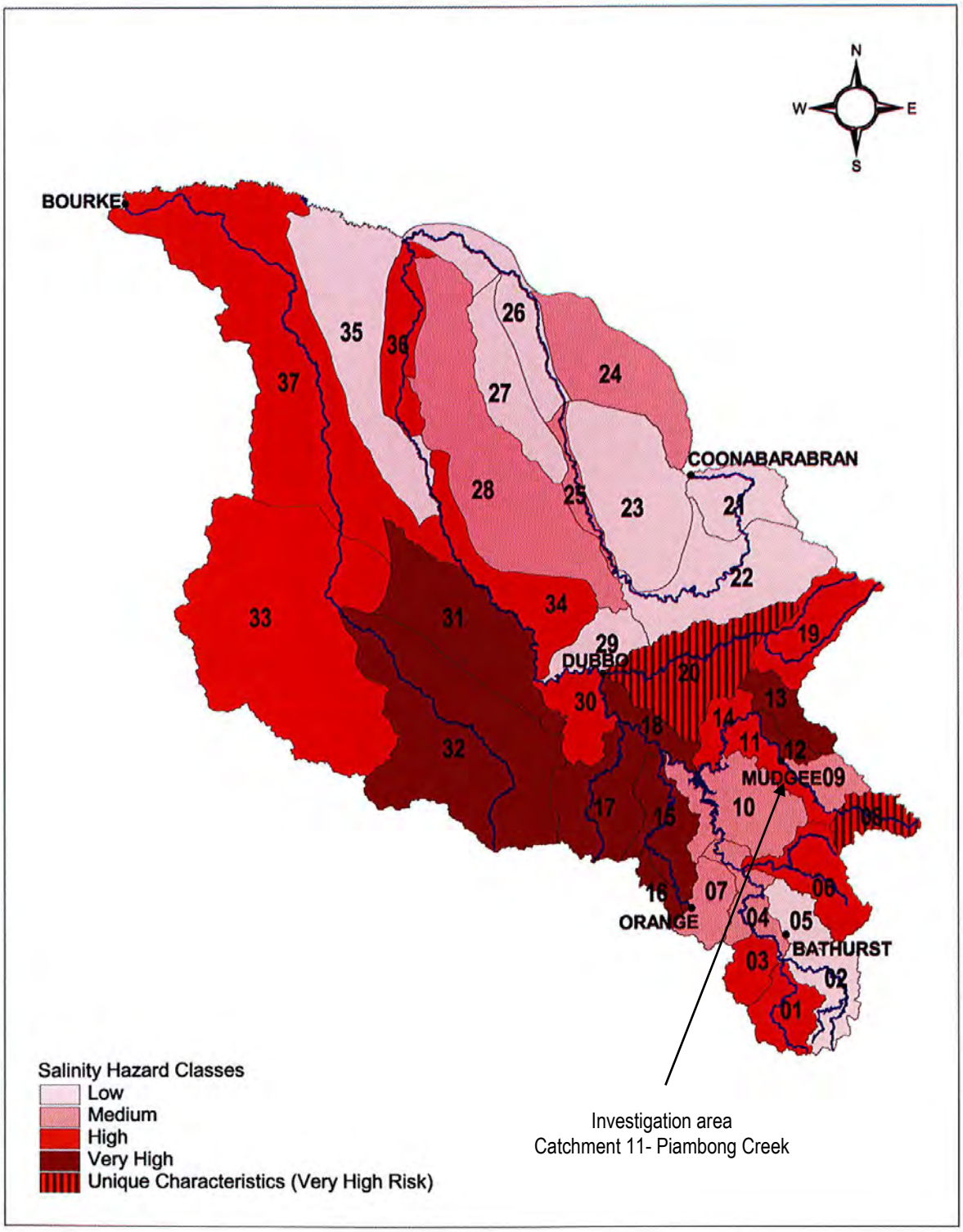


Figure 4: Salinity Risk Assessment of the Central West Catchment (2000)		
Lot 3 & Lot 4 DP1069441, Mudgee NSW		
	Envirowest Consulting Pty Ltd	
Job: R6151s	Drawn by: DL	Date: 8/10/2015

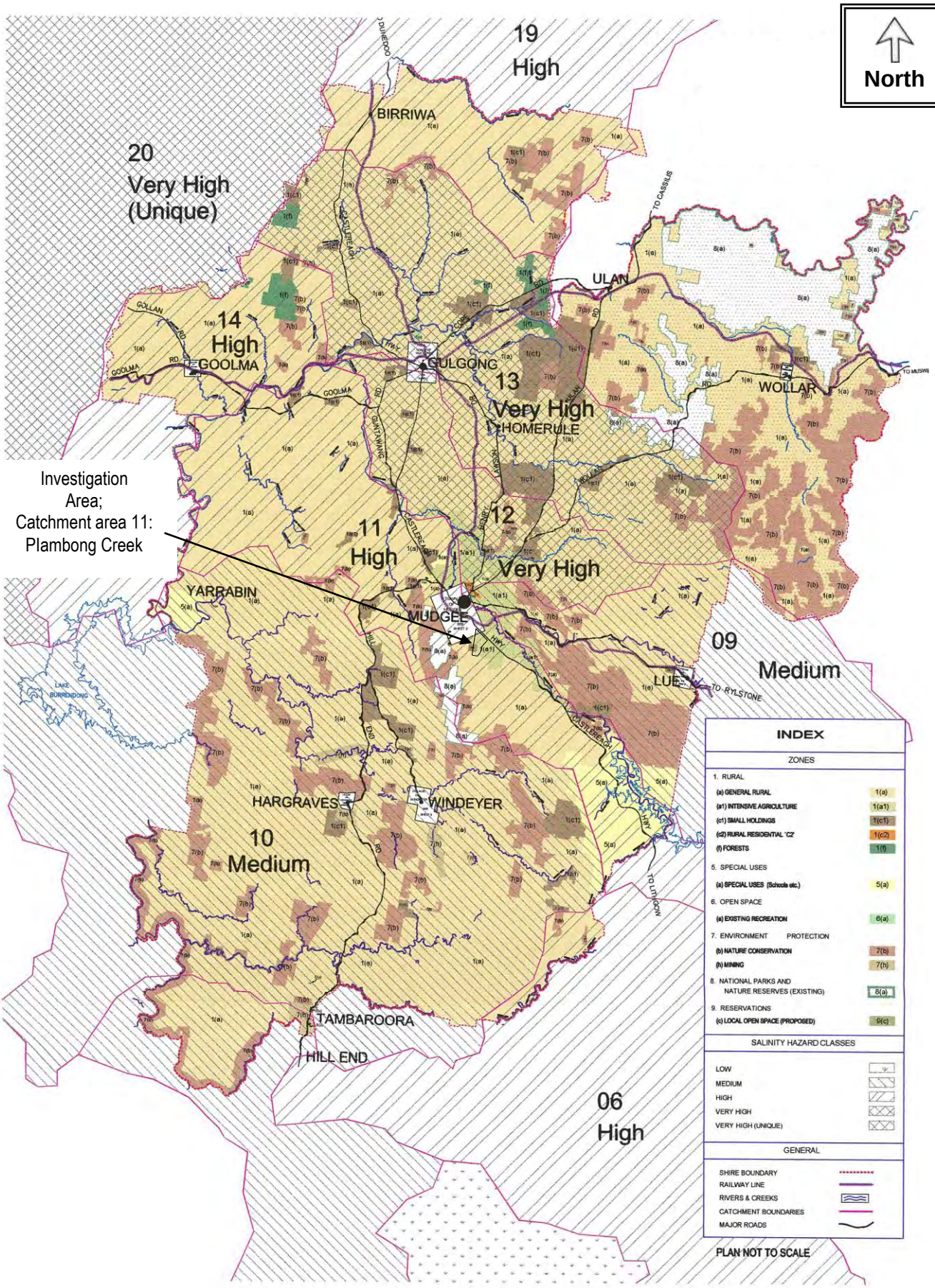


Figure 5: Mudgee Salinity Background Study (2002)		
Lot 3 & Lot 4 DP1069441, Mudgee NSW		
	Envirowest Consulting Pty Ltd	
Job: R6151s	Drawn by: DL	Date: 8/10/2015

HGLS 29. Biraganbil Hydrogeological Landscape System

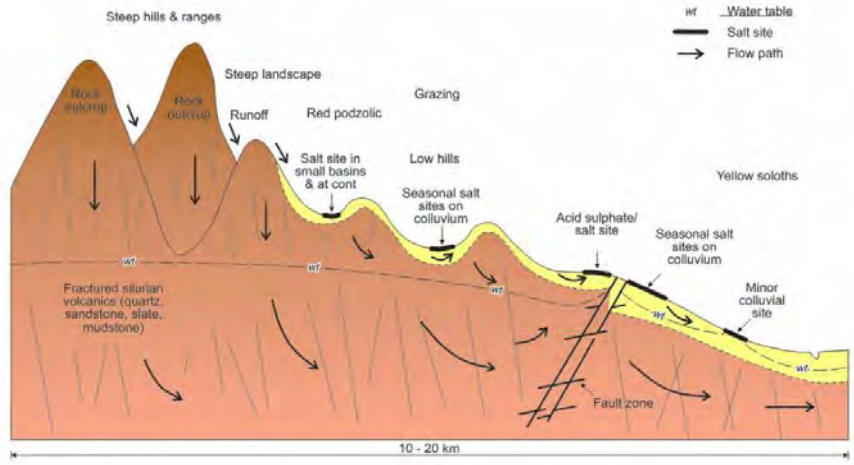
LOCALITIES	Gulgong, Mudgee
TYPE AREA	Biraganbil
GRID REFERENCE	725000mE 6419000mN
GEOLOGY SHEET	Dubbo 1:250,000
CONFIDENCE LEVEL	HIGH

Distribution map

HAZARD

HAZARD ASSESSMENT	**Limited** potential impact	**Significant** potential impact	**Severe** potential impact
High likelihood of occurrence			
Moderate likelihood of occurrence		Biraganbil	
Low likelihood of occurrence			

LANDSCAPE ATTRIBUTES



Conceptual Hydrogeological Landscape cross-section showing the distribution of regolith, landforms, salt sites and flow paths.

Figure 6: Revised HGL 29. Biraganbil Hydrogeological Landscape System

Lot 3 & Lot 4 DP1069441, Mudgee NSW

Envirowest Consulting Pty Ltd

Job: R6151s	Drawn by: DL	Date: 8/10/2015

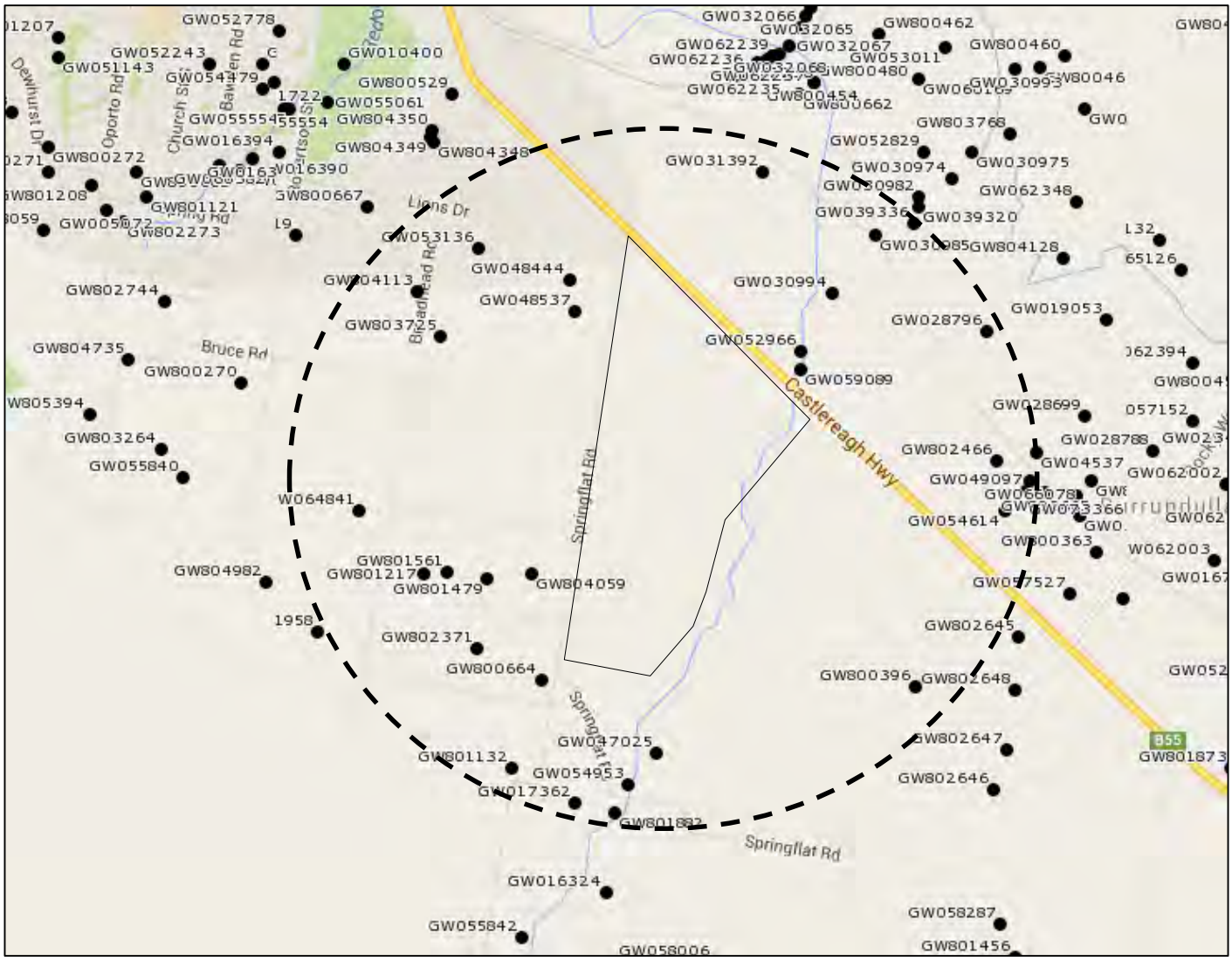
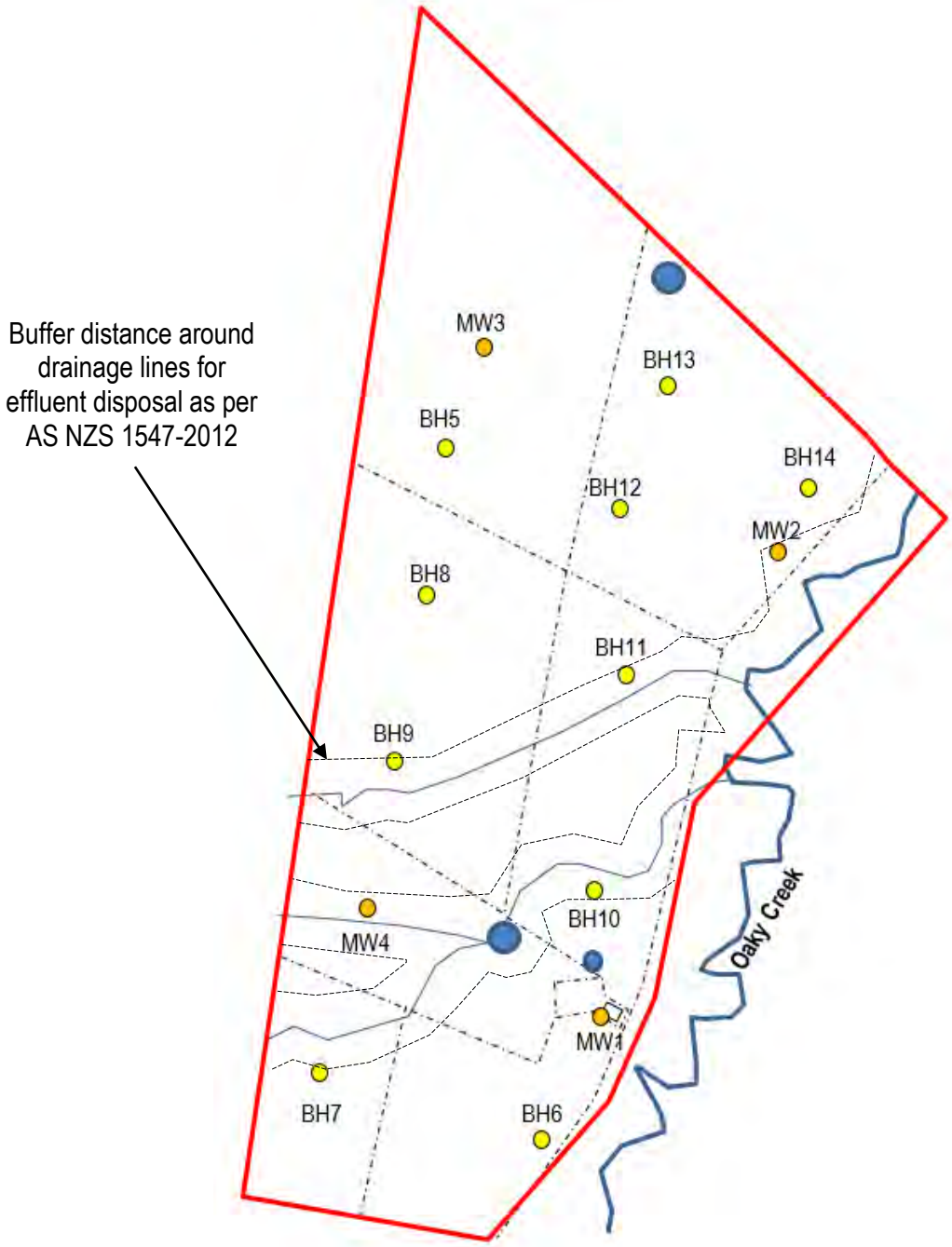


Figure 7: Location of groundwater bores within 1.5km of the site

Lot 3 & Lot 4 DP1069441, Mudgee NSW

Envirowest Consulting Pty Ltd

Job: R6151s	Drawn by: DL	Date: 8/10/2015



Legend

- Shed
- Lot boundary
- Dam
- Creek
- Boreholes
- Drainage depression
- Fence
- Shed
- Monitoring wells

Approximate Scale 1: 10,000

0 100 200 400m

Figure 8: Wastewater buffer distances around waterways

Lot 3 & Lot 4 DP1069441, Mudgee NSW

Envirowest Consulting Pty Ltd

Job: R6151s | Drawn by: DL | Date: 8/10/2015

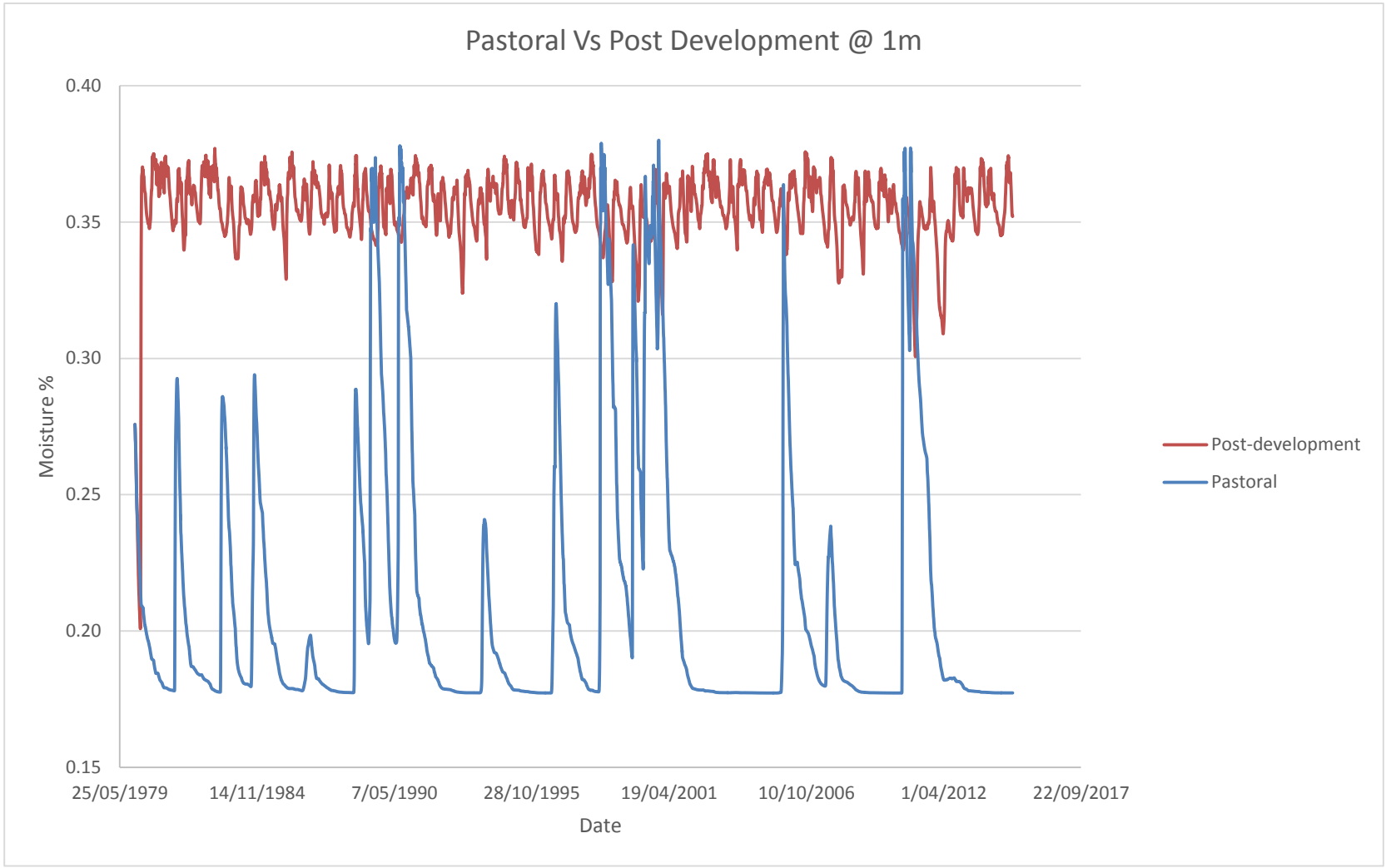


Figure 9. Soil Moisture at 1m		
Lot 3 & Lot 4 DP1069441, Mudgee NSW		
	Envirowest Consulting Pty Ltd	
Job – R6151s	Drawn by: DL	Date: 8/10/2015

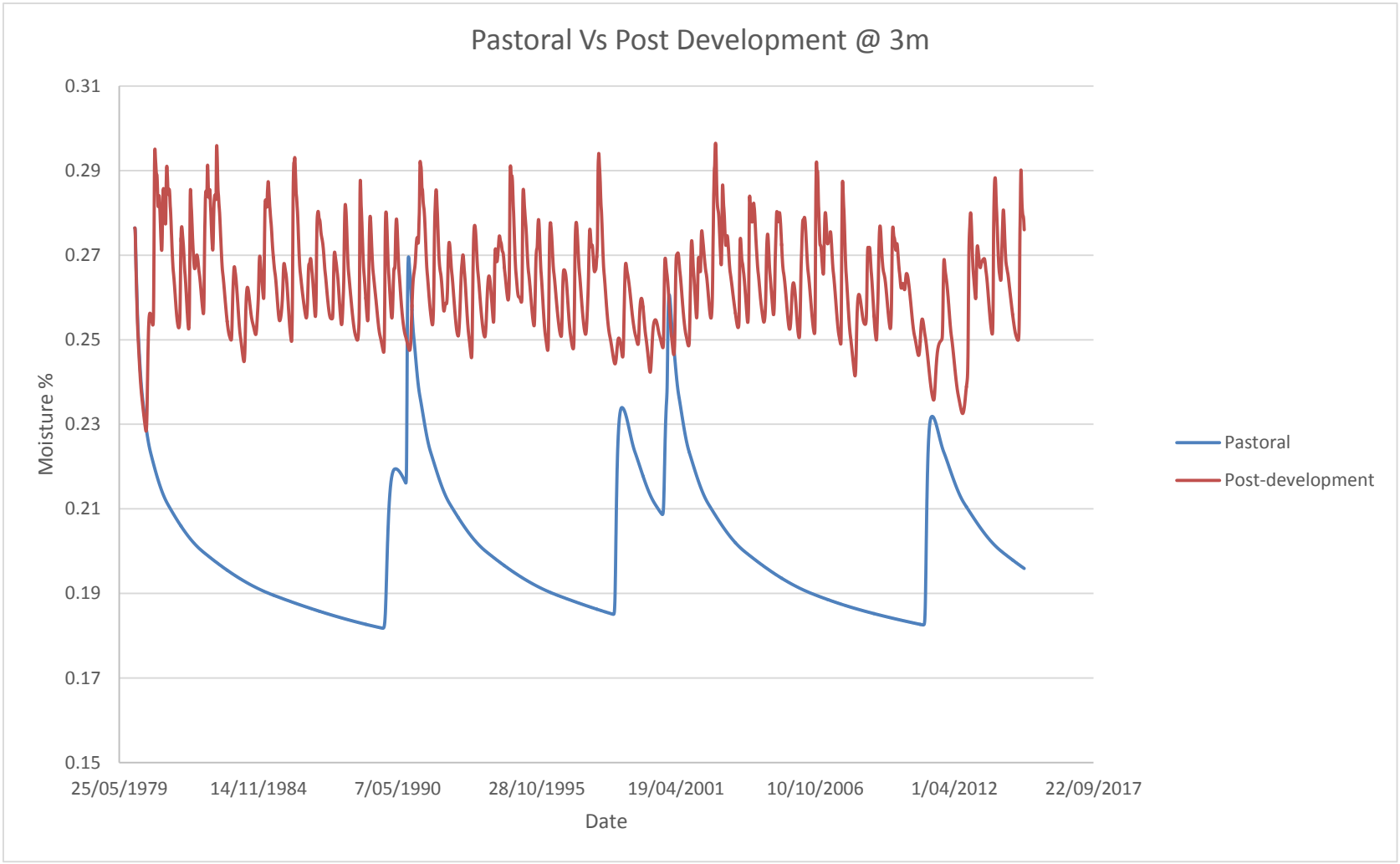


Figure 10. Soil Moisture at 3m		
Lot 3 & Lot 4 DP1069441, Mudgee NSW		
	Envirowest Consulting Pty Ltd	
Job – R6151s	Drawn by: DL	Date: 8/10/2015

Figure 11. Photographs of the site

Looking north across paddocks

North over shearing shed and yards

Looking west over area

Appendices

Appendix 1. Nutrient and sediment modelling
Appendix 2. Monthly water balance determines the wastewater application area required
Appendix 3. Effluent area requirement from organic matter and nutrient balances
Appendix 4. Aggressive soils, extract from Australia Standards, AS 2870-2011, 2011
Appendix 5. Details of registered bores within 1km of the site – NSW Department of Primary Industries
Appendix 6. Field and laboratory sheets
Appendix 7. Reference methods for soil testing

Appendix 1. Nutrient and sediment modelling

Land-use export rates for sediments, nitrogen and phosphorus mg/kg/year (Chafer 2003)

Land use class	Suspended sediment (kg/ha/yr) Low	Median	High
Native bushland	20	40	60
Disturbed landscapes	330	870	2290
Remediated gullies	165	435	1145
Cropped	420	570	720
Pine plantations	65	380	680
Improved pasture	140	520	870
Unimproved pasture	140	190	230
Roads (sealed)	140	190	230
Roads (earth)	25	140	500
Urban	30	300	1200
Urban (open space)	160	360	1000
Rural residential	140	190	230
Industrial	180	200	4800
Commercial	180	200	4800
Golf course	0	10	20
Orchard	490	680	870

Land use class	Total Nitrogen (kg/ha/yr) Low	Median	High
Native bushland	0.9	2.4	4
Disturbed landscapes	4.2	12	20
Remediated gullies	2.1	6	10
Cropped	4.2	8.9	13.5
Pine plantations	0.8	2.9	8.3
Improved pasture	4.2	8.9	13.5
Unimproved pasture	1.3	3.2	5.1
Roads (sealed)	2	6	10
Roads (earth)	1.3	2.2	3.1
Urban	2.2	6.1	10
Urban (open space)	1.3	3.2	5.1
Rural residential	2.2	6.1	10
Industrial	4	7.4	10
Commercial	4	7.4	10
Golf course	0	3.2	5
Orchard	1.7	8.9	5

Land use class	Total Phosphorus Low	Median	High
Native bushland	0.01	0.13	0.25
Disturbed landscapes	0.3	1.24	2.2
Remediated gullies	0.15	0.62	1.1
Cropped	0.5	1.35	2.2
Pine plantations	0.1	1.16	2.5
Improved pasture	0.5	1.35	2.2
Unimproved pasture	0.1	0.17	0.25
Roads (sealed)	0.3	1.8	3.4
Roads (earth)	0.3	1.72	3.2
Urban	0.2	1.82	3.6
Urban (open space)	0.1	0.17	0.25
Rural residential	0.2	1.72	3.6
Industrial	1.4	1.82	2.2
Commercial	1.4	1.8	2.2
Golf course	0	0.3	3.6
Orchard	0.1	0.3	0.5

Sediment export kg/yr

LOW	PRE	POST	IMPACT
Native bushland	0.00	0.00	0.00
Disturbed landscapes	2772.00	0.00	2772.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	17640.00	0.00	17640.00
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	616.00	-616.00
Roads (earth)	100.00	0.00	100.00
Urban	0.00	318.00	-318.00
Urban (open space)	0.00	17920.00	-17920.00
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**20512.00**	**18854.00**	**1658.00**

MEDIAN	PRE	POST	IMPACT
Native bushland	0.00	0.00	0.00
Disturbed landscapes	7308.00	0.00	7308.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	65520.00	0.00	65520.00
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	836.00	-836.00
Roads (earth)	560.00	0.00	560.00
Urban	0.00	3180.00	-3180.00
Urban (open space)	0.00	40320.00	-40320.00
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**73388.00**	**44336.00**	**29052.00**

HIGH	PRE	POST	IMPACT
Native bushland	0.00	0.00	0.00
Disturbed landscapes	19236.00	0.00	19236.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	109620.00	0.00	109620.00
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	1012.00	-1012.00
Roads (earth)	2000.00	0.00	2000.00
Urban	0.00	12720.00	-12720.00
Urban (open space)	0.00	112000.00	-112000.00
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**130856.00**	**125732.00**	**5124.00**

Total Nitrogen kg/yr

LOW	PRE	POST	IMPACT
Native bushland	0.00	0.00	0.00
Disturbed landscapes	35.28	0.00	35.28
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	529.20	0.00	529.20
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	8.80	-8.80
Roads (earth)	5.20	0.00	5.20
Urban	0.00	23.32	-23.32
Urban (open space)	0.00	145.60	-145.60
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**569.68**	**177.72**	**391.96**

MEDIAN	PRE	POST	IMPACT
Native bushland	0.00	0.00	0.00
Disturbed landscapes	100.80	0.00	100.80
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	1121.40	0.00	1121.40
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	26.40	-26.40
Roads (earth)	8.80	0.00	8.80
Urban	0.00	22.00	-22.00
Urban (open space)	0.00	358.40	-358.40
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**1231.00**	**406.80**	**824.20**

HIGH	PRE	POST	IMPACT
Native bushland	0.00	0.00	0.00
Disturbed landscapes	168.00	0.00	168.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	1701.00	0.00	1701.00
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	44.00	-44.00
Roads (earth)	12.40	0.00	12.40
Urban	0.00	106.00	-106.00
Urban (open space)	0.00	571.20	-571.20
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**1881.40**	**721.20**	**1160.20**

Total Phosphorus kg/yr

LOW	PRE	POST	IMPACT
Native bushland	0.00	0.00	0.00
Disturbed landscapes	2.52	0.00	2.52
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	63.00	0.00	63.00
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	1.32	-1.32
Roads (earth)	1.20	0.00	1.20
Urban	0.00	2.12	-2.12
Urban (open space)	0.00	11.20	-11.20
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**66.72**	**14.64**	**52.08**

MEDIAN	PRE	POST	IMPACT
Native bushland	0.00	0.00	0.00
Disturbed landscapes	10.42	0.00	10.42
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	170.10	0.00	170.10
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	7.92	-7.92
Roads (earth)	6.88	0.00	6.88
Urban	0.00	19.29	-19.29
Urban (open space)	0.00	19.04	-19.04
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**187.40**	**46.25**	**141.14**

HIGH	PRE	POST	IMPACT
Native bushland	0.00	0.00	0.00
Disturbed landscapes	18.48	0.00	18.48
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	277.20	0.00	277.20
Unimproved pasture	0.00	0.00	0.00
Roads (sealed)	0.00	14.96	-14.96
Roads (earth)	12.80	0.00	12.80
Urban	0.00	38.16	-38.16
Urban (open space)	0.00	28.00	-28.00
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**308.48**	**81.12**	**227.36**

Appendix 2. Monthly water balance determine the wastewater application area required (irrigation systems)

Design wastewater flow	Q	L/day	600	120	L/person/day	5	persons
Design percolation rate	R	mm/wk	28	4	mm/day		
Land area	L	m2	84				
Effective precipitation	EP		0.9	(10% runoff)			

Parameter	**Symbol**	**Formula**	**Units**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**total**
days in month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation	P		mm/month	70	72	46	32	36	41	42	36	49	56	78	72	629
Evaporation	E		mm/month	272.8	221.2	195.3	126	77.5	48	52.7	74.4	102	158.1	207	220	1755
Crop factor	C		-	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.8
Inputs																
Effective Precipitation	EP		mm/month	62.73	64.62	41.4	28.98	32.13	37.17	37.62	32.22	43.83	50.4	70.2	64.8	566
Effluent irrigation	W	QXD/L	mm/month	221.4	200.0	221.4	214.3	221.4	214.3	221.4	221.4	214.3	221.4	214.3	221.4	2607
Inputs		P+W	mm/month	284.2	264.6	262.8	243.3	253.6	251.5	259.0	253.6	258.1	271.8	284.5	286.2	3173
Outputs																
Evaportranspiration	ET	ExC	mm/month	245.52	199.1	175.8	113.4	69.8	43.2	47.4	67.0	91.8	142.3	186.3	198.0	1580
Percolation	B	R/7xD	mm/month	124.0	112.0	124.0	120.0	124.0	120.0	124.0	124.0	120.0	124.0	120.0	124.0	1460
Outputs		ET+B	mm/month	369.5	311.1	299.8	233.4	193.8	163.2	171.4	191.0	211.8	266.3	306.3	322.0	3040
Storage	S	(EP+W)-(ET+B)	mm/month	-85.4	-46.5	-36.9	9.9	59.8	88.3	87.6	62.7	46.3	5.5	-21.8	-35.8	
Cumulative storage	M		mm	0.0	0.0	0.0	9.9	69.7	157.9	245.5	308.2	354.6	360.1	338.3	302.5	

Storage	V	largest M	mm	360.1
		Soil storage	mm	376.0
		Storage required	mm	-15.9
		VxL/1000	m^3	**-1.3**
Irrigation area			m^2	**84**

	water holding capacity	depth (mm)	Totals(mm)
Topsoil	34%	100	34
Subsoil	38%	900	342
			376

Appendix 3. Estimation area requirement from organic matter and nutrient balances (irrigation systems)

Estimated effluent flow	(Q)	600	L/day
Soil depth		1	m

Organic matter balance

BOD (C)	20	mg/L
treated wastewater flow rate (Q)	600	L/day
critical loading rate of BOD (Lx)	3000	$mg/m^2/day$
land area required (A)	**4.0**	m^2

Nitrogen balance

nutrient concentration	37	mg/L
treated wastewater flow rate	600	L/day
critical loading rate of nutrient	50	$mg/m^2/day$
land area required (A)	**444**	m^2

Determination of nitrogen criitical loading rate

Nitrogen load (kg/year)	8.1	kg/year			
Loss 20% denitrification	6.5	kg/year			
Load to soil	146.0	kg/ha/year	assumed irr. area from table	444	m2
Vegetation usage	200.0	kg/ha/year			
Residual (potential leaching)	-54.0	kg/ha/year			

Typical nitrogen uptake (Myers et al. 1984)		
Pastures	300 kg/ha/year	82 mg/m2/day
Pine	350 kg/ha/year	96 mg/m2/day
Eucalypts	180 kg/ha/year	49 mg/m2/day

Phosphorus balance

Phosphorus sorption capacity per metre=			9,000	kg/ha	
Phosphorus sorption capacity of profile=			9,000	kg/ha	
Soil factor			0.33		
Critical loading=		3 $mg/m^2/day$			
P concentation*=		12	mg/L		
P adsorbed=	phosphorus sorption capacity x soil factor				
	2970				
	0.297	kg/m^2			
Puptake=	critical loading x days/year x	50	years		
	54750				
	0.0548	kg/m^2			
Pgenerated=	total phosphorus concentration x wastewater volume in			50	years
	131400000				
	131	kg			
	Pgenerated / (Padsorbed + Puptake)				
Land area required	**373.6**	**m^2**			

Phosphorus sorption

High- 14,400 (900 mg/kg)
Medium- 9,600 (600 mg/kg)
Low- 4,800 (300 mg/kg)

Appendix 4. Aggressive soils, extract from Australian Standards, *AS 2870-2011*, 2011

Exposure classification for concrete in saline soils

Saturated extract electrical conductivity (EC_e), *dS/m*	Exposure classification
<4	A1
4-8	A2
8-16	B1
>16	B2

Notes:

1. Guidance on concrete in saline soils can be found in CCAA T56
2. Exposure classifications are from AS 3600
3. The currently accepted method of determining the salinity level of the soil is by measuring the extract electrical conductivity (*EC*) of a soil and water mixture in deciSiemens per metre (dS/m) and using conversion factors that allow for the soil texture, to determine the saturated extract electrical conductivity (EC_e)
4. The division between a non-saline and saline soil is generally regarded as an EC_e value of 4dS/m, therefore no increase in the minimum concrete strength is required below this value

Exposure classification for concrete in sulfate soils

Exposure conditions			Exposure classification	
Sulfates (expressed as SO_4)*		pH	Soil conditions A**	Soil conditions B†
In soil (ppm)	In groundwater (ppm)			
<5,000	<1,000	>5.5	A2	A1
5,000-10,000	1,000-3,000	4.5-5.5	B1	A2
10,000-20,000	3,000-10,000	4-4.5	B2	B1
>20,000	>10,000	<4	C2	B2

* Approximately 100ppm SO_4 = 80ppm SO_3

** Soil conditions A – high permeability soils (e.g. sands and gravels) that are in groundwater

† Soil conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater

Minimum design characteristic strength (f_c') and curing requirements for concrete

Exposure classification	Minimum f_c' MPa	Minimum initial curing requirement
A1	20	Cure continuously for at least 3 days
A2	25	
B1	32	Cure continuously for at least 7 days
B2	40	
C1	≥50	
C2	≥50	

Minimum reinforcement cover for concrete

Exposure classification	Minimum cover in saline soils * mm	Minimum cover in sulfate soils ** (mm)
A1	See Clause 5.3.2	40
A2	45	50
B1	50	60
B2	55	65
C1	†	70
C2	†	85

* Where a damp-proofing membrane is installed, the minimum reinforcement cover in saline soils may be reduced to 30mm.

** Where a damp-proofing membrane is installed, the minimum reinforcement cover in sulfate soils may be reduced by 10mm.

† Saline soils have a maximum exposure classification of B2.

Appendix 5. Details of registered bores within 1km of the site – NSW Department of Primary Industries- Office of Water.

Bore record No. (Figure 9)	Eastings	Northings	Drilled / Completed depth (m)	Salinity description	Water bearing zones (m)	Standing water level (m)	Date drilled and or tested	Purpose
GW031392	745385	6388609	-	-	-	-	1968	Stock
GW030994	745709	6388015	14.5	-	-	-	1982	Public/ Municipal
GW030985	745925	6388287	16.3	0-500ppm	8-12.5/13-15	-	1982	Public/ Municipal
GW039336	746109	6388344	14.4	-	2.5-12.5	-	1984	Public/ Municipal
GW052966	745546	6387742	-	-	13.7-13.7	-	1980	Domestic
GW059089	745544	6387649	13.7	-	-	-	1975	Stock/ Irrigation/ Domestic
GW028796	746453	6387808	7.3	501-1000ppm	3.9-7.2	-	1967	Irrigation
GW802466	746482	6387189	50.3	-	33.5-50.29	24.38	1999	Irrigation
GW054614	746518	6386947	68.6	-	-	-	1986	Stock/ Domestic
GW047025	744794	6385818	12.2	-	6.1-9.1	-	1977	Irrigation/ Stock/ Domestic
GW054953	744666	6385667	32.9	Good	26.8-27.7	-	1981	Stock/ Domestic
GW801882	744588	6385534	48	-	20-22/28-29/32-33/45-47	12	2002	Stock/ Domestic
GW017362	744397	6385581	7	-	-	-	-	Stock/ Domestic
GW801132	744093	6385759	60	-	-	-	-	Stock/ Domestic
GW800664	744253	6386184	68.6	Good	21.3-35/ 44.2-44.5	-	1998	Domestic
GW802371	743938	6386334	45	-	31-40	12	2000	Stock/ Domestic
GW801479	744001	6386675	56	-	25-26/47-48	-	1999	Stock/ Domestic
GW804059	744214	6386698	66	-	61.1-62	40	2005	Stock/ Domestic
GW801561	743803	6386714	60	-	38.1-56.4	-	1999	Stock/ Domestic
GW801217	743645	6386708	56	-	46-47	20	1999	Stock/ Domestic
GW064841	743389	6387024	22.8	-	0-13.7/19.8-22.8	-	1989	Stock/ Farming
GW053136	743994	6388273	60.9	501-1000ppm	19-57.5	-	1980	Stock/ Irrigation/ Domestic
GW803825	743799	6387857	7.5	972.8mg/L	3.9-7.5	4.74	2008	Monitoring/ Bore
GW804113	743690	6388076	-	-	-	-	2009	Domestic
GW048444	744433	6388108	28.4	-	-	-	-	Stock/ Domestic
GW048537	744456	6387953	12.5	-	7-10	-	1978	Stock

Appendix 6. Field and laboratory sheets

Salinity assessment

Client: Burrundulla Pty Ltd.			**Job no:** 6151	**Date:**	29/7/15
Address:	Springflat				
Borehole:	BH5	**GPS:**	55H 744 725mE 6387 619mN		

Surface description

Slope:	0-1%	Aspect:	North East
Morphological type:	low-slope		
Land-use:	Grazing		
Disturbance:	Nil		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Reed, Couch, love grass		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Dark brown silty clay loam		M				
100 to 200	Light brown silty clay		M				
200 to 500	Light grey silty clay		M				
500 to 850	Light brownish orange silty clay/ light clay		M				
			M				
850-1500	Light brown silty clay with rounded river gravel		M				
1500-2000	Light brown clayey gravel with weathered rock						
EOH							
Notes:							

Salinity assessment

Client: Burrundulla Pty Ltd.			**Job no:** 6151	**Date:** 29/7/15	
Address:	Springflat				
Borehole:	BH6	**GPS:**	55H 744 877mE 6386 358mN		

Surface description

Slope:	0-1%	Aspect:	North East
Morphological type:	low-slope		
Land-use:	Grazing		
Disturbance:	Moderate		
Erosion:	Low		
Coarse fragments:	Nil		
Surface cover:	Oates		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 300	Dark brown silty clay loam		M				
300-1500	Dark brown clayey gravel with rounded river gravel and metasediments		M				
1500-2000	Light brown silty gravel with weathered rock fragments		D				
EOH							
Notes:							

Salinity assessment

Client: Burrundulla Pty Ltd.			**Job no:** 6151	**Date:** 30/7/15	
Address:	Springflat				
Borehole:	BH7	**GPS:**	7444569mE 6386587mN		

Surface description

Slope:	0-1%	Aspect:	North East
Morphological type:	low-slope		
Land-use:	Grazing		
Disturbance:	Low		
Erosion:	Low		
Coarse fragments:	Moderate, coarse gravels and metasediments		
Surface cover:	Oates		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 200	Dark brown silty clay loam		M				
200 to 700	Dark brownish red silty clay		M				
700 to 1200	Light brown silty clay trace gravel		M				
1200 to 2000	Light brown silty clay with trace river gravel and metasediments		M				
EOH							
Notes:							

Salinity assessment

Client: Burrundulla Pty Ltd.			**Job no:** 6151	**Date:** 30/7/15	
Address:	Springflat				
Borehole:	BH8	**GPS:**	744692mE 6387 309mN		

Surface description

Slope:	0-1%	Aspect:	North East
Morphological type:	low-slope		
Land-use:	Grazing		
Disturbance:	Low		
Erosion:	Low		
Coarse fragments:	Nil		
Surface cover:	Clover, Plantain Couch, Native grasses		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 200	Dark brown silty clay loam		M				
200 to 750	Dark brownish red silty clay		M				
750 to 1700	Light brown silty clay with trace gravel		M				
1700 to 2000	Light brown gravelly clay with rounded river gravel and weathered		M				
EOH							
Notes:							

Salinity assessment

Client: Burrundulla Pty Ltd.			**Job no:** 6151	**Date:** 30/7/15	
Address:	Springflat				
Borehole:	BH9	**GPS:**	744 587mE 6387 019mN		

Surface description

Slope:	0-1%	Aspect:	North East
Morphological type:	low-slope		
Land-use:	Grazing		
Disturbance:	Low		
Erosion:	Low		
Coarse fragments:	Metasediments		
Surface cover:	Clover, Couch, Plantain Love grass, Red gum		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Dark brown silty clay loam		M				
100 to 300	Light grey silty clay		M				
300 to 800	Light brown silty clay with trace gravel		M				
800 to 1200	Light Brownish red sandy clay with trace weathered rock and river gravel		M				
1200 to 2000	Light brown silty sand with weathered metasediments and river gravel.		M				
EOH							
Notes:							

Salinity assessment

Client: Burrundulla Pty Ltd.			**Job no:** 6151	**Date:** 30/7/15	
Address:	Springflat				
Borehole:	BH10	**GPS:**	744 958mE 6386 807mN		

Surface description

Slope:	0-1%	Aspect:	North East
Morphological type:	low-slope		
Land-use:	Grazing		
Disturbance:	Low		
Erosion:	Low		
Coarse fragments:	Nil		
Surface cover:	Clover, Milk weed, Kikuyu		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Dark brown silty clay loam		M				
100 to 400	Light grey silty clay		M				
400 to 800	Dark brownish red silty clay		M				
800 to 2000	Dark brownish red silty clay with trace river gravel		M				
EOH							
Notes:							

Salinity assessment

Client: Burrundulla Pty Ltd.			**Job no:** 6151	**Date:** 30/7/15	
Address:	Springflat				
Borehole:	BH11	**GPS:**	745 041mE 6387 120mN		

Surface description

Slope:	0-1%	Aspect:	North East
Morphological type:	lower-slope		
Land-use:	Grazing		
Disturbance:	Low		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Clover, Milk weed, Kikuyu, Couch, Succulent		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Dark brown silty clay loam		M				
100 to 300	Light grey silty clay		M				
300 to 1100	Light brown silty clay		M				
1100 to 1800	Light brown silty clay with trace river gravel and metasediment.		M				
1800 to 2000	Light brownish red silty clay with trace gravel.		M				
EOH							
Notes:							

Salinity assessment

Client: Burrundulla Pty Ltd.	**Job no:** 6151	**Date:** 30/7/15
Address: Springflat		
Borehole: BH12	**GPS:** 745 025mE 6387 491mN	

Surface description

Slope:	0-1%	Aspect:	North East
Morphological type:	lower-slope		
Land-use:	Grazing		
Disturbance:	Low		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Succulent, couch, thistle, plantain		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Dark Brown silty clay loam		M				
100 to 300	Light grey silty clay		M				
30 to 1200	Dark brownish red silty clay		M				
1200 to 2000	Dark brown sandy clay with weathered metasediments and rounded river gravels.		M				
EOH							
Notes:							

Salinity assessment

Client: Burrundulla Pty Ltd.			**Job no:** 6151	**Date:** 30/7/15	
Address:	Springflat				
Borehole:	BH13	**GPS:**	745 136mE 6387 729mN		

Surface description

Slope:	0-1%	Aspect:	North East
Morphological type:	lower-slope		
Land-use:	Grazing		
Disturbance:	Nil		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Succulent, couch, thistle, plantain		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Dark brown silty clay loam		M				
100 to 800	Dark brown silty clay		M				
800 to 1600	Dark brownish red sandy clay with trace rounded river gravel and weathered metasediment		M				
1600 to 2000	Light brown silty clay with trace gravel		M				
EOH							
Notes:							

Salinity assessment

Client: Burrundulla Pty Ltd.			**Job no:** 6151	**Date:** 30/7/15	
Address:	Springflat				
Borehole:	BH14	**GPS:**	745 356mE 6387 513mN		

Surface description

Slope:	0-1%	Aspect:	North East
Morphological type:	lower-slope		
Land-use:	Grazing		
Disturbance:	Nil		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Succulent, couch, thistle, plantain		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Dark brown silty clay loam		M				
100 to 300	Light grey silty clay		M				
300 to 1000	Dark brownish red silty clay with trace gravel		M				
1000 to 1500	Dark red sandy clay with trace river gravel and weathered rock		M				
1500 to 2000	Light reddish brown clayey gravel with weathered metasediments and trace river gravel.		M				
EOH							
Notes:							

Appendix 7. Reference methods for soil testing

Reference Methods:

Colour: Munsell (2000) In 'Munsell Soil Colour Charts' (Gretag Macbeth: NY)

Field texture: McDonald RC, Isbell RF, Speight JG, Walker, Hopkins MS (1990) Australian Soil and Land Survey Field Handbook pp.115-124 (Inkata Press: Melbourne)

PH: AS1289.4.3.1-1997 Method of testing soil for engineering purposes – Soil Chemical Tests-Determination of the pH value of a soil – Electrometric method

Salinity: Rayment GE and Higginson FR (1992) Australian Laboratory Handbook of Soil and Water Chemical Methods (Method 3A1, pp.15-16) (Inkata Press Melbourne) Electrical conductivity of saturated extract is based on conversions of EC (1:5) and soil texture class, to give a more accurate assessment of soil salinity hazard (Salavich PG and Peterson GH (1993) Estimating the electrical conductivity of soil paste extracts from 1:5 soil water suspensions and texture. Australian Journal of Soil Research 31