LAND REZONING PROPOSAL

LOTS 2 to 5 DP62157, LOT 2 DP1180093, LOTS 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and LOT 29 DP750015

BRISBANE GROVE ROAD

BRISBANE GROVE. NSW. 2580

WATER CYCLE MANAGEMENT STUDY

Prepared by SOWDES
23 November 2021

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Water Cycle Management Study

Executive Summary.

This *Water Cycle Management Study* has been prepared in support of a submission to the Goulburn Mulwaree Council for the rezoning of a parcel of land identified as Lots 2 to 5 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 – Brisbane Grove Road, Brisbane Grove from a current mixed zoning status of 'RU6 – Transition' and 'RU1 – Rural Landscape' to 'R5 Large Lot Residential'. The land rezoning opportunity has been identified in the recently commissioned *Urban and Fringe Housing Strategy* undertaken on behalf of the Goulburn Mulwaree Council by Elton Consulting which was adopted by Council in July 2020.

The development site falls within the boundaries of the defined Sydney Drinking Water Catchment hence this submission has been undertaken in accordance with the information requirements of both the Goulburn Mulwaree Council and Water NSW best practice publications titled '*Water Sensitive Design Guide for Rural Residential Subdivisions*' (May 2021), '*Using MUSIC in Sydney's Drinking Water Catchment*' (June 2019), and '*Developments in the Drinking Water Catchment – Water Quality Information Requirements*' (June 2018). Where practical and appropriate, the recommendations, constraints and conditions from the above listed documents have taken precedence in the modelling and design process such that any water quality issues, environmental concerns, and matters pertaining to public amenity have been addressed. The proponents have been involved throughout the modelling and design process by contributing to the information source and providing general commentary on the overall recommendations and findings. The submission of a *Water Cycle Management Study* to Water NSW for assessment of the land rezoning proposal also satisfies the Ministerial Directions obligations under the Section 9.1 of the Environmental Planning and Assessment Act (1979) – Direction 5.2 Sydney Drinking Water Catchments.

The subject site is located approximately midway along the length of the Brisbane Grove Road traffic corridor which is just on the southern outskirts of the city of Goulburn. Brisbane Grove Road lies between the Braidwood Road to the west which is a Traffic for NSW (TfNSW) classified road and Windellama Road to the east. Brisbane Grove Road also provides a transit link for traffic generated in areas to the south and southeast of Goulburn to the southern part of the city where there is direct connection to the Hume Highway, and also provides service access to several rural holdings and smaller lifestyle allotments that line either side of the road formation, and to Corrinyah Road that junctions to the south that also services several rural land holdings.

The nominated land to be included within the rezoning proposal covers a total area of 63.37 hectares which is comprised of 21 presently separate registered parcels totalling 43.42 hectares, a portion of 16.929 hectares from a larger and separate holding identified as Lot 2 DP1180093, and a 3.012 hectare portion of freehold land still held in the name of a former land owner that was

created for possible future road allocation but has never been dedicated as such. Of the 16.929 hectares within Lot 2 DP1180093 approximately 5.44 hectares is currently zoned 'RU1 – Primary Production'. A separate portion of unformed Council Road reserve on the western end of the development site comprising 6,890m² will be utilised as part of the access provisions for the development.

The combined portions of land which are set to open paddocks of improved pastures and native grasslands form part of a larger viable rural enterprise that has historically and is still currently used for grazing by stock, growing cereal crops, and silage production.

The conceptual subdivision design will create a total of 27 allotments, all of which will be at least 2 hectares in area and seeking residential permissibility, and the construction of a new through road formation that will provide direct access to all but 6 of the proposed Lots which will be accessed from Brisbane Grove Road. All portions of land included within the proposal are located on the northern side of the Brisbane Grove Road traffic corridor with the exception of one isolated portion (Lot 4 within the proposal) which is located on the southern side of the road and is large enough without any adjustments to satisfy the proposed minimum Lot size of 2 hectares for the rezoned lands and can therefore attract building entitlements.

This Water Cycle Management Study is divided into four sections; the first being an overview and the triggers for the rezoning submission, and a detailed description of the development property and surrounding landscape; the second section is a stormwater quality assessment for the civil works associated with a proposed future subdivision of the land and satisfying the Neutral or Beneficial Effect requirements; the third section is an assessment of the potential or likelihood for overland stormwater drainage and flood impacts to affect the proposed future subdivision of the land; and the forth section is a wastewater management assessment for each of the proposed Lots created by a future subdivision of the land.

Within the Water Cycle Management Study assessment a 'potential building envelope' having a nominal area of 600m² has been identified within each of the proposed Lots is based on a raft of subdivision design elements including but not limited bush fire protection measures and water quality impacts as recommended in the publication titled '*Water Sensitive Design Guide for Rural Residential Subdivisions*' (May 2021).

The following key summaries apply to the development and are detailed in the following pages:

- The proponent is seeking to rezone the land in accordance with Section 4.4.1 of the *Urban and Fringe Housing Strategy* study and in doing so establish the basis upon which to undertake a subdivision of the land that will create a total of 27 allotments each with a minimum Lot size of 2 hectares and a new access through road

- The proposed new internal access roadway will create a hardstand surface that will invariably have a detrimental effect on water quality and therefore will need to be treated within the scope of the subdivision civil works to achieve a neutral or beneficial effect on water quality in accordance with Water NSW 'NorBE' guidelines.
- The development property is burdened by a defined drainage depression that runs through the eastern third of the site and conveys surface water runoff from sources originating on the opposite side of the Brisbane Grove Road corridor through to the banks of the Mulwaree River to the north of the site.
- The northern and northwestern portions of the development property, and to a lesser extent the extreme northeastern corner are partially burdened by mapped flood liable lands. The extent of flood migration into the proposed development site and associated impacts is variable, however all proposed Lots that will be potentially burdened by flood have been designed such that there is adequate land area above the identified 1% AEP flood levels for suitable dwelling envelopes including freeboard provisions, the siting of effluent management areas, and road formations to occur with consideration to the relevant development controls and matters pertaining to general safety within flood liable lands.
- The land rezoning proposal is such that of the existing portions of land proposed Lots 1 to 6 of the conceptual subdivision design could effectively be sold and developed without the need for any new major civil works as they are accessible from the Brisbane Grove Road corridor, and they are large enough without any boundary adjustments to satisfy the minimum Lot size provision for the zoning to seek residential building permissibility. If this option were to be adopted then the subdivision of the land could be staged as the remaining Lots require access via a proposed new internal through road that would need to be constructed to create two access / egress junctions located at either end of the development site along the Brisbane Grove Road corridor prior to release of the blocks.
- The conceptual subdivision as proposed in the accompanying plans meets the Neutral or Beneficial Effect (NorBE) criteria, and each of the new Lots are deemed suitable to support a residential development incorporating an on-site wastewater management facility. Future dwellings within the proposed subdivision will be required to submit individual development applications to Council which will include a detailed assessment of the proposed onsite wastewater management system relative to the size of the daily effluent loading being generated by the proposed dwelling.

Whilst this report has based its determinations and recommendations on a conceptual subdivision design that is subject to a raft of considerations and approvals, and on the location of a 'potential building envelope' within the proposed new Lots it is recognised that any future development application for the construction of a residential dwelling within the Lots will be required to submit an independent stormwater quality and wastewater management assessment in support of any such development at the time of lodging a formal development application to Council which is based on a specific dwelling and site design.

It is considered that the proposed rezoning of the land from the current RU6 – '*Transition*' and 'RU1 – Primary Production' to R5 – *Large Lot Residential'* and a subsequent subdivision of the land to create a total of 27 allotments plus an internal access road will be able to satisfy the requirements of the Neutral or Beneficial Effect on water quality as required under the Sydney Drinking Water SEPP (2011).

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23 November 2021

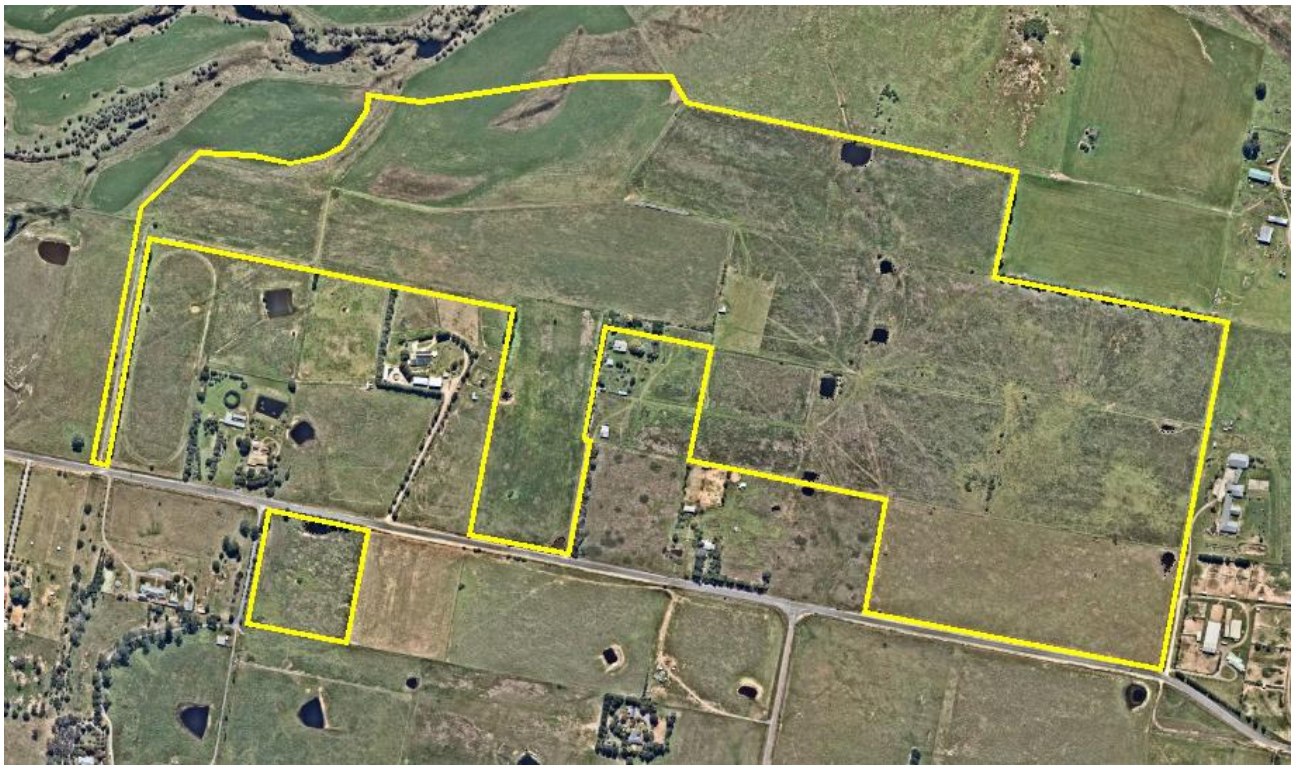

Figure 1. Recent aerial view of the development property which is outlined in yellow showing the nature of the vegetation formations within and surrounding the site. The captured area has a general fall from the south to the north with the banks of the Mulwaree River just to the north outside of the image.

1/. Overview of the Rezoning Submission, Description of the Land and Proposed Subdivision.

The Goulburn Mulwaree Council commissioned *Elton Consulting* to undertake an *Urban and Fringe Housing Strategy* study for the urban centres of both Goulburn and Marulan which was completed and adopted by Council in July 2020. To gain an appreciation of how the aforementioned study triggers the submission of the land rezoning application being the subject of this assessment the following extracts have been taken directly from the completed report to provide context;

"This Urban and Fringe Housing Strategy (Strategy) investigates and identifies areas suitable for the provision of additional housing to assist Goulburn Mulwaree Council (Council) meet the housing demands generated by expected continued population growth.

The Strategy has been prepared in response to both the limited supply of residential land available to meet the short and medium term needs of the community and the directions of the South East and Tablelands Regional Plan 2036.

The scope of the Strategy includes looking at the urban areas of Goulburn and Marulan and identifying opportunities for an additional recommended 3,500 dwellings over the next 18 years to 2036. The Strategy also considers land for large lot residential development (typically greater than 2ha and often referred to as rural residential development) particularly on the urban fringe of Goulburn.

Growth across the LGA has been strong over the past decade increasing by 14 percent. In Marulan population growth has been significant with an increase in population between 2006 and 2016 of 27 percent.

With the Goulburn Mulwaree LGA expected to reach between 33,350 and 37,202 residents by 2036, approximately 5,000 to 7,000 additional residents are expected. Given the drivers of growth include proximity to economically viable regions and affordable housing, these growth rates may increase over time if prices in Sydney and the ACT continue to rise. Advances in technology and improvements in transport, for example higher speed rail, may further stimulate growth.

The majority of recent growth has been through residential subdivisions in Goulburn and Marulan. These new subdivisions have typically provided R2 Low Density Residential zoned land with a minimum lot size of 700sqm. The market responded well to these releases driving demand for additional land as the currently zoned land nears full utilisation.

Anecdotal evidence gained through the initial community and stakeholder engagement process indicated demand for large lot residential blocks (2ha). This was corroborated by Council analysis of rural residential lot uptake on the western and south western Goulburn fringes over the past decade. Council found that 200 of the 290 lots registered had a dwelling approved, or a development application lodged. Most of which were within 2 years of lot registration. The relatively low subdivision costs associated with creating these lots has resulted in this form of development being the preference of proponents looking to rezone land. These products offer diversity in lifestyle choice. Given the current and expected demand for residential land in Goulburn and Marulan it would be anticipated that small volumes of large lot residential land will be absorbed by the market, however, the actual annual demand is difficult to determine."

The development property is located on the southern outskirts of the city of Goulburn and is identified within the *Urban and Fringe Housing Strategy* study as a locality suitable for rezoning to 'R5 – Large Lot Residential' to help meet future land and housing demands. The property falls within the *Brisbane Grove* study precinct which is currently a mix of 'RU1 – Primary Production' and 'RU6 – Transition' zoned lands and has been identified with an overall potential yield of 132 Lots at a minimum area of 2 hectares. The Brisbane Grove development precinct is located on the southern side of both the Hume Highway traffic corridor and the Mulwaree River which is prone to periodic flooding which according to the study logistically separates this area from the urban areas of Goulburn and would therefore adversely impact any extension of existing utilities and services necessary for continued urban development in this zone - thereby leaving it ideally suited for the development of large-Lot self-sufficient residential blocks.

The proponent is seeking to rezone the land in accordance with Section 4.4.1 of the *Urban and Fringe Housing Strategy* study and in doing so establish the basis upon which to undertake a subdivision of the land that will create a total of 27 allotments each with a minimum Lot size of 2 hectares, plus a new internal access road. The property falls within the *Brisbane Grove* study precinct which is currently a mix of 'RU1 – Primary Production' and 'RU6 – Transition' zoned lands and has been identified with an overall potential yield of 132 Lots at a minimum area of 2 hectares.

Access to the development property is from the Brisbane Grove Road traffic corridor which runs between the Braidwood Road to the west and the Windellama Road transit route to the east. There are several land holdings accessed via the Brisbane Grove Road traffic corridor and more recently it has been used an alternate route to the city whilst major road and bridge works were being undertaken on a section of road that affected normal traffic movements to and from the southeastern aspect of the city. The Braidwood Road traffic corridor which lies approximately 700 metres to the west of the site is a TfNSW classified road that provides an important transport link between Goulburn and the south coast region of the state. The road is a bitumen sealed formation that also provides access to many rural land holdings between Goulburn and Braidwood, and to several smaller localities that lie in between. The posted speed limit along Brisbane Grove Road is 80kph.

The nominated land to be included within the rezoning proposal covers a total area of 63.37 hectares which is comprised of the entire land area associated with 21 separately registered parcels totalling 43.42 hectares, a 16.929 hectare portion of land from a larger and separate holding identified as Lot 2 DP1180093 comprising mixed land-use zones, and a 3.012 hectare portion of freehold land still held in the name of a former land owner that was created for possible future road allocation but has never been dedicated as such. The untitled freehold portion of land is effectively located along the entire length of the development lands on the northern side of the Brisbane Grove Road traffic corridor and measures 1.50 kilometres long by 20.115 metres wide running in an east → west alignment. The proponent has commenced application for the possessory acquisition of the untitled freehold portion of land through the NSW Land Registry Services under 'possessory title' provisions.

A separate portion of unformed Council Road reserve on the western end of the development site that junctions off Brisbane Grove Road running in a south-southwest to north-northeast alignment and comprising 6,890m² will be utilised as part of the proposed access provisions for the development. Approximately 5.44 hectares of the proposed lands within Lot 2 DP1180093 that is included within the subdivision proposal occur within existing 'RU1' zoned lands therefore being outside the current mapped 'RU6' zoned lands, however the nominated dwelling envelopes within all of the Lots associated with the conceptual subdivision design will fall within the margins of the existing 'RU6' zoned lands and the rezoning proposal will seek to amend the existing boundaries of the 'RU6' zoning to incorporate the additional 'RU1' lands.

The development property is an irregular shaped parcel of land that follows several boundary lines and fences and wraps around and between other privately owned lands that adjoin some of these boundaries. One of the separate portions of land (Lot 20 DP976708) that is surrounded by the subject lands comprises a 'locally significant' heritage listed homestead identified by the property name of 'Sofala' which is presently accessed by a Right of Carriageway over a portion of one the parcels of land that is included within the rezoning proposal (proposed Lot 3). It is proposed that the existing Right of Carriageway benefiting the homestead within 'Sofala' will be retained as the block does not have direct frontage or access to Brisbane Grove Road.

The northern and northwestern portions of the development property, and to a lesser extent the extreme northeastern corner is partially burdened by mapped flood liable lands. The extent of flood migration into the proposed development site and associated impacts is variable, however all proposed Lots that will be potentially burdened by flood have been designed such that there is adequate land area above the identified 1% AEP flood levels for suitable dwelling envelopes including freeboard provisions, the siting of effluent management systems, and road formations to occur with consideration to the relevant development controls and matters pertaining to general safety within flood liable lands. It is further noted that all burdened Lots will have evacuation pathways that lead upslope and away from the mapped 1% AEP flood levels.

The terrain around the development site is quite variable with a broad but shallow ridge line that runs through the eastern portion where a proposed internal access through road will be formed. The ridge is aligned in a south → north pattern and there is a general fall either side of the ridge to the east and west at average grades of 5°. The majority of the land within the development site to the west of the ridge line has a general fall from the south toward the north at relatively minor but consistent grades of less than 5° with the lower northern portion which represents the margins of the flood prone lands within proposed Lots 13 to 20 having a plateau characteristic with grades of less than 3°. Proposed Lots 3 and 12 of the subdivision development which are located approximately midway along the length of the development site on the northern side of Brisbane Grove Road and between two privately owned land holdings are slightly different to the remainder of the site in that they are located on the eastern side of the small hillock and have a general fall from a high point along the western boundary near to the common boundary between the two in an arc formation from the north through to the east and around to the south at an average grade of 5°.

The isolated portion of land on the southern side of Brisbane Grove Road has a simple fall from the south toward the north at an average grade of less than 5° with a slight rise along the northern boundary formed by the road carriageway outside that creates a dam in the lower northern portion of the block.

At the time of the site assessment the vegetation formations throughout the property which is presently and has historically been used as part of a larger viable rural enterprise was set to a mix of improved pastures, fallow cropping paddocks, and riparian corridors that follow a defined drainage depression that traverses through the site. The development property is operated as an ongoing farming venture that is focused on livestock development and the rotational cropping of cereals and improved pastures with silage production in large round bales for internal feed demands. The site is bordered by single and often discontinuous rows of old radiata pine trees within adjoining land holdings at various locations around the perimeter of the holding, with only a few scattered trees within the section of unformed road that adjoins the rear of the 'Sofala' homestead block, and a few old conifers near to the top of the ridge within the eastern third of the site where the internal road will be formed of any real consequence or note. The remainder of the development site is set to grassland or cropping vegetation formations.

Future Subdivision Proposal.

The conceptual design for the subdivision of the land will create a total of 27 allotments, 26 of which will be located within the subject lands on the northern side of the Brisbane Grove Road traffic corridor, and the remining Lot (proposed Lot 4 of the subdivision) will be realised from an existing portion of land that is isolated but large enough without any boundary adjustments to seek residential building entitlements once the land is rezoned. For the purposes of this assessment and from this point forward, unless specifically mentioned the proposed Lot 4 will not be deemed to be included in any general description of the 'development property' or 'development site' as it can satisfy the relevant provisions as a separate portion of land without inclusion or reliance upon other civil or planning provisions.

The land rezoning proposal is such that of the existing portions of land proposed Lots 1 to 6 of the conceptual subdivision design could effectively be sold and developed without the need for any new major civil works as they are accessible from the Brisbane Grove Road corridor, and they are large enough without any boundary adjustments to satisfy the minimum Lot size provision for the zoning to seek residential building permissibility. Minor civil works such as entrance crossovers, boundary fencing, and the registration of 'Right of Carriageway' provisions over two of the Lots are all that would be required for these particular Lots. If this option were to be adopted then the subdivision of the land could be staged as the remaining Lots require access via a proposed new internal through road that would need to be constructed to create two access / egress junctions located at either end of the development site along the Brisbane Grove Road corridor prior to release of the blocks, however such a staging of the subdivision would not have an adverse impact on water quality as the only matters to be considered would be the carriageways leading into the Lots, and the individual onsite effluent management systems.

It is proposed that two - possibly three of the proposed Lots will be accessed via a Right of Carriageway over the adjoining Lot, however in all proposed instances the Right of Carriageway will only benefit one Lot. The number of Right of Carriageway access provisions will be determined by any staging of the subdivision development as a Stage 1 would require the establishment of two access easements (burden Lot 1 to benefit Lot 6, burden Lot 2 to benefit Lot 5), however in Stage 2 the easement over Lot 2 to Lot 5 would be removed as Lot 5 would then have a direct access to the new internal through road, however a new Right of Carriageway easement will be required over Lot 5 to benefit Lot 7.

The proposed internal road formation will have two junction points with the Brisbane Grove Road traffic corridor; the first being on the western end of the development precinct where an existing unsealed 3 metres wide gravel track is formed within a gazetted Council road along the western boundary of Lots 25 and 35 in Deposited Plan 976708, and the other being approximately 245 metres to the east of the junction of Corrinyah Road with Brisbane Grove Road. The nominated junction locations are able to satisfy the 'line of sight' requirements for geometric road design and traffic safety with uninterrupted vision for at least 250 metres in each direction from the respective re-entry points. The internal road alignment will essentially follow the higher elevations of the site with the exception of the most northern end of the carriageway which will be required to cross a defined drainage depression.

Of the proposed 26 allotments on the northern side of Brisbane Grove Road all but 5 would be accessed from the proposed internal access road. The overall length of the proposed internal access road from junction point to junction point is 2 kilometres and it is assumed that the posted speed limit for the new internal access road would be 60kph in accordance with Council's 'Geometric Road Design' Specification – D1.27 – Table D1.8. The formation of the new internal access road will comply with Goulburn Mulwaree Council engineering requirements for rural roads which incorporates a 20-metre-wide road reserve, a 9-metre-wide bitumen sealed formation in the centre of the reserve with 1-metre-wide shoulders on either side of the sealed formation, and grass lined drainage swales and verges for the remainder of the road reserve widths.

The isolated Lot 4 on the southern side of the Brisbane Grove Road will need to re-establish an access to the site within the northwest corner, however with Council consent as part of a subdivision proposal a few of the conifer trees that are located within the road reserve at the front of the property would need to be removed to improve the 'line of sight' provisions looking to the east when egressing the block. It is not practical to create an entrance to the block from the northeastern corner as an alternate access / egress option as the terrain drops quite significantly below the road level, and the same visibility constraints would effectively apply from the opposite direction.

Section 5.9.1.1 'Buffer Distances' and Table 5.1 'Buffers Between Rural Activities and Rural Dwellings' of the Council's Development Control Plans require prescribed separation distances from various forms of rural land use depending upon which category or categories are most applicable to the neighbouring and/or surrounding properties. The development site is surrounded by 'RU1 – Primary Production' zoned lands on the northern and northwestern aspect

which are used for grazing of livestock and seasonal production of fodder crops and silage, whilst the eastern aspect which is also zone as 'RU1' has two land holdings; one is a small rural holding with a small number of livestock, whilst the adjoining block to the southeast has for many years operated as an equine breeding and training facility. The adjoining and nearby lands to the south of the site and on the opposite side of the Brisbane Grove Road reserve are all zoned 'RU6 – Transition'.

With reference to Table 5.1 of the DCP the minimum setback from 'grazing lands' is 80 metres, or alternatively 60 metres with a 20-metre-wide vegetated buffer zone in the outer 20 metres. The conceptual subdivision design has shown an 80 metre separation distance from the proposed boundary lines along the northern aspect of the development that adjoins 'RU1' zoned lands and any nominated dwelling envelope (Lots 13 to 22), whilst all other setbacks around the perimeter of the development site have been shown as 60 metres and in some instances will be assuming a 20 metre vegetated buffer zone where applicable – for example proposed Lots 23 and 24. For some of the Lots where the 60 metre setback has been identified the additional 20 metre width of an adjoining road corridor creates an effective buffer distance of 80 metres.

It is a subjective argument as to whether or not the two existing Lots to the east of the site that are also zoned 'RU1' and the remaining 'RU6' zoned lands that surround the subject development area are large enough and capable of supporting 'rural enterprises' as defined in the DCP as opposed to essentially being hobby farms and/or lifestyle blocks. Hence some of the Lots, - particularly Lots 13 to 17 that are to the north of current 'RU6' zoned lands will be seeking a variation to reduce the buffer zones along their respective southern boundaries against the provisions of Table 5.1 in accordance with Section 5.9.1.2 'Variations to Buffers'.

To support the submission of a variation to Section 5.9.1.1 of the DCP the following Table summarises the details of the individual land holdings that surround the development site – excluding the 'RU1' zoned lands that lie to the north, and it can be assumed by the respective land sizes that these blocks are not large enough to support extensive agricultural or rural activities of a type that could cause nuisance or disturbance to any future dwellings within the proposed subdivision:

Address	Lot & DP	Zoning	Land area (ha)
223 Brisbane Grove Road	Lot 6 DP803430	RU1	14.62
221 Brisbane Grove Road	Lot 5 DP803430	RU1	15.77
242 Brisbane Grove Road	Lot 2 DP1055961	RU6	42.36
47 Corrinyah Road	Lot 1 DP1055961	RU6	9.924
16 Corrinyah Road	Lot 50 DP976708, Lot 1 DP658685	RU6	2.94
157 Brisbane Grove Road	Lots 40, 41 & 42 DP976708	RU6	6.83
Brisbane Grove Road	Lots 51, 52 & 53 DP976708	RU6	6.83
111 Brisbane Grove Road	Lots 22 to 25, 35, 37 & 38 DP976708	RU6	14.65

All identified dwelling envelopes within the proposed Lots have been placed such that the distance from the front entrance to the site does not exceed 100 metres, and for all Lots it is not possible to construct a dwelling more than 150 metres from the respective front entrances due to the actual depths of the individual blocks whilst also avoiding the 1% AEP flood extents where applicable, and at the same time satisfying the Council's Development Control Plan setback provisions.

2/. Stormwater Quality Assessment

The conceptual design for the subdivision of the land will include the construction of a new internal through road that will junction off the northern aspect of Brisbane Grove Road in two locations; the first being on the western end of the development precinct where an existing unsealed 3 metres wide gravel track is formed within a gazetted Council road along the western boundary of Lots 25 and 35 in Deposited Plan 976708, and the other being approximately 245 metres to the east of the junction of Corrinyah Road with Brisbane Grove Road. The internal road will provide direct access to 21 of the proposed Lots on the northern side of the Brisbane Grove Road whilst the remaining 5 Lots will be accessed from the Brisbane Grove Road traffic corridor.

The alignment of the new internal access road has largely been designed to follow the higher elevations of the development property to avoid traversing too close to any drainage constraints however the defined drainage system that runs through the eastern portion of the site will need to be crossed in the lower northern portion to permit a through-road formation. Crossing of the drainage system will be designed and constructed to Council's engineering standards and allow for the safe and continuous passage of overland flows during the 1% AEP rain event.

The formation of the new internal access road will comply with the Goulburn Mulwaree Council engineering requirements for rural roads and incorporates a road reserve that for the majority of its length will be 20-metres-wide (slightly wider adjacent to Lot 12), a 9-metre-wide bitumen sealed formation in the centre of the reserve with 1-metre-wide shoulders on either side of the sealed formation, and grass lined drainage swales and verges for the remainder of the road reserve widths. The overall length of the road reserve when measured from junction point to junction point is 2 kilometres and the total area within the reserve is 4.05 hectares. It is assumed that the posted speed limit for the new internal access road would be 60kph in accordance with Council's 'Geometric Road Design' Specification – D1.27 – Table D1.8.

The new internal access road will create a hardstand surface that will invariably have an adverse impact on water quality and therefore will need to be treated within the scope of the subdivision civil works to achieve a neutral or beneficial effect on water quality in accordance with Water NSW 'NorBE' guidelines. It is proposed that the roadway will be drained in small sections via grass-lined swales and mitre drains to a series of small farm dams to be constructed at strategic locations immediately adjacent to the road reserve within several of the new Lots. There will be a total of seven small dams, ranging in surface area from 700m² to 1,000m² depending upon the area of catchment draining to the dam, and each will have a permanent pool storage volume of between 450m³ and 750m³. Surface water runoff from the edges of the road will pass over a narrow buffer strip treatment device equal in area to 5% of the upstream catchment area before flowing into the roadside drainage swales and then onto the individual dams. Outflows from the dams will be directed to downstream receiving points which are either dams, or defined drainage corridors. Existing dams within the property have not been included within any water quality assessment as they are deemed to be performing a water quality and/or attenuation benefit prior to the subdivision development hence separation of their current function from any possible future function is not a realistic representation of the site conditions.

Stormwater runoff, management, and treatment of hardstand areas within the individual Lots will be a matter for consideration at the time of individual residential development – suffice to mention that the Lots are large enough at a minimum of 2 hectares to manage all stormwater onsite without the need for an inter-allotment stormwater drainage system. It will be a requirement at residential development application stage for the individual Lots to demonstrate how they meet and satisfy the water quality and NorBE criteria.

There is a single registered groundwater bore on the property which is located in the front southeast corner of the proposed Lot 3, adjacent to a small dam that is setback a short distance from the roadside boundary. The drill log for the bore indicates that it is a relatively low yielding source of water (0.17 litres/sec) that was only drilled to a depth of 36 metres. The bore is still operative and supplies drinking water for stock and some external water demands around the farm shed precinct via an elevated water tank on a stand within the eastern portion of proposed Lot 12. The bore will be retained within Lot 3 of the subdivision however its connection and supply arrangements to the remainder of the site will be discontinued, as will the elevated tank in proposed Lot 12, particularly if the subdivision of the land is undertaken as a staged development where proposed Lot 3 is separated prior to the remaining Lots being created.

Assuming that a staged approach was adopted for the subdivision of the land in which 'Stage 1' released the Lots that could be directly access via Brisbane Grove Road then the extent of land disturbance would be limited to access crossovers, short lengths of access carriageways associated with Right of Carriageway easements, and re-fencing of existing boundary lines. The works are minor, and any water quality issues can be managed by simple erosion and sediment control measures. However, for any subsequent staging of the subdivision for the release of the remaining Lots would require the construction of the new internal access through road and associated stormwater management structures so a stormwater quality assessment including *MUSIC* modelling associated with this scope of civil works has been undertaken to demonstrate compliance with the NorBE criteria as detailed in the Water NSW publication titled '*Using MUSIC in Sydney's Drinking Water Catchment*' (June 2019). All other sources of land disturbances within the subdivision would be associated with development of the individual Lots whereby it would be a condition of development approval to demonstrate compliance with the NorBE objectives and outcomes.

The following section details the *MUSIC* modelling assumptions, treatment recommendations and outcomes associated with stormwater runoff from the proposed new internal access road.

MUSIC MODELLING			
#	*DESCRIPTION*	*DETAIL*	
2.1	Model Version	6.3.0	
2.2	Rainfall data	Goulburn geographical region – pluviograph data at 6 minute time steps from 1st January 1995 to 31st December 1999	
2.3	Reduction targets	Total Suspended Solids	≥10%
		Total Phosphorus	≥10%
		Total Nitrogen	≥10%
		Cumulative frequency of reductions	≥98%
2.4	Modelling assumptions / settings	The proposed internal access through road will be within a dedicated reserve that is no less than 20 metres wide and will cover a total land area 4.0520 hectares	
2.5		The pre-development model has an equivalent area for the new road as an 'agricultural' source node with 100% pervious fraction with the exception of a section of existing unsealed carriageway of 960m² along the western aspect of the development site within the Council road reserve that has been attributed the parameters of an 'unsealed road' with 50% impervious fraction.	
2.6		The road which measures 2 kilometres from junction point to junction point will have a 9-metre-wide bitumen sealed formation in the centre of the reserve with 1-metre-wide shoulders and for the majority of the formation it is assumed that there will be a 3% crossfall either side of the centre line.	
2.7		The roadway will be formed in a series of small catchment sections and the surface water runoff from each section will pass over a narrow buffer strip treatment device equal in area to 5% of the upstream catchment area before flowing into the roadside drainage swales (refer to Table 2.1 for the road catchment areas and the Stormwater Management Site Plan – Ref: 0050421-01B for the catchment distributions).	
2.8		The post-development model has the impervious fraction for the 'urban' source node of a 'sealed road' as 45% to cater for the average width of the sealed section including shoulders within the overall width of the road reserve (9 metres within a 20 metre wide reserve = 45%).	
2.9		The verges either side of the sealed formation will be finished as grass lined drainage swales that are constructed at an average grade of 3%, 250mm deep with vegetation height of 200mm, 3.50 metres wide at the top and have a base width of 500mm.	
2.10		The end of each grass swale will have short sections that tail-out via the equivalent of mitre drains to a series of small farm dams to be constructed in the front corner of the nominated Lots immediately adjacent to the road reserve.	

2.11		Each swale has been modelled with an effective treatment length that is equal to half the combined length of both sides of the road section being treated to allow for potential areas within the swales that may receive less runoff and therefore be less efficient.
2.12		Where a swale terminates on the opposite side of the road to the corresponding catchment dam a piped culvert will be constructed under the roadway to allow that portion of the runoff to drain into the nominated dam
2.13		There will be a total of seven small dams that will have the relevant catchment area and construction details in accordance with the details within Table 2.1 – there has been no reuse of the water in the dams included within the modelling assumptions.
2.14		The portion of road where it crosses the existing drainage line (which is defined in the calculations as 'road catchment #4') will be formed with a slight rise in the centre such that it cambers over the drainage system with a straight-back kerb and gutter along each outer edge that will collect the surface water runoff and direct it to the two dams within Lots 21 and 22 that are located on either side of the high point.
2.15		Unless required otherwise to mitigate any potential for creating or causing nuisance within or to adjoining Lots the outflows from the dams will be allowed to passively discharge over a weir wall arrangement or tail-out drain and flow overland to the nearest downstream receiving node.
2.16		The area calculations and pollutant parameters used in the *MUSIC* model are summarised in Table 2.2

Table 2.1. Summary of the defined road catchment areas and the proposed dams forming part of the water quality treatment measures

Road catchment #	Area (m²)	Length (m)	Dam Lot #	Dam area (m²)	Dam volume (m³)	Detention depth (mm)
1	3,500	175	2	700	450	500
2	3,730	185	25	700	450	500
3	3,820	190	22	700	450	500
4 (split)	2,070	100	21,22	700	450	500
5	3,410	170	21	700	450	500
6	6,850	320	20	700	450	500
7	6,800	330	14	1,000	750	500
8	10,540	520	13	1,000	750	500
Totals	40,520	2,000 (rounded up)				

Table 2.2. Summary of the different surface types identified in the pre-development and post-development conditions and the associated pollutant parameter within the *MUSIC* model.

	Pre-development	Post development
Agricultural 100% pervious	39,560m²	
Unsealed Road 50% impervious	960m²	
Sealed Road 45% impervious		40,520m²
Total	40,520m²	40,520m²

Table 2.3. Base flow pollutant concentrations used in the pre and post development stormwater model.

Concentration (mg/L-log₁₀)						
	Suspended solids		Phosphorus		Nitrogen	
Surface type	mean	std. dev	mean	std. dev	mean	std. dev
Agriculture	1.30	0.13	-1.05	0.13	0.04	0.13
Sealed roads	1.20	0.17	-0.85	0.19	0.11	0.12
Unsealed Roads	1.20	0.17	-0.85	0.19	0.11	0.12

Table 2.4. Storm flow pollutant concentrations used in the pre and post development stormwater model.

Concentration (mg/L-log₁₀)						
	Suspended solids		Phosphorus		Nitrogen	
Surface type	mean	std. dev	mean	std. dev	mean	std. dev
Agriculture	2.15	0.31	-0.22	0.30	0.48	0.26
Sealed roads	2.43	0.32	-0.30	0.25	0.34	0.19
Unsealed Roads	3.00	0.32	-0.30	0.25	0.34	0.19

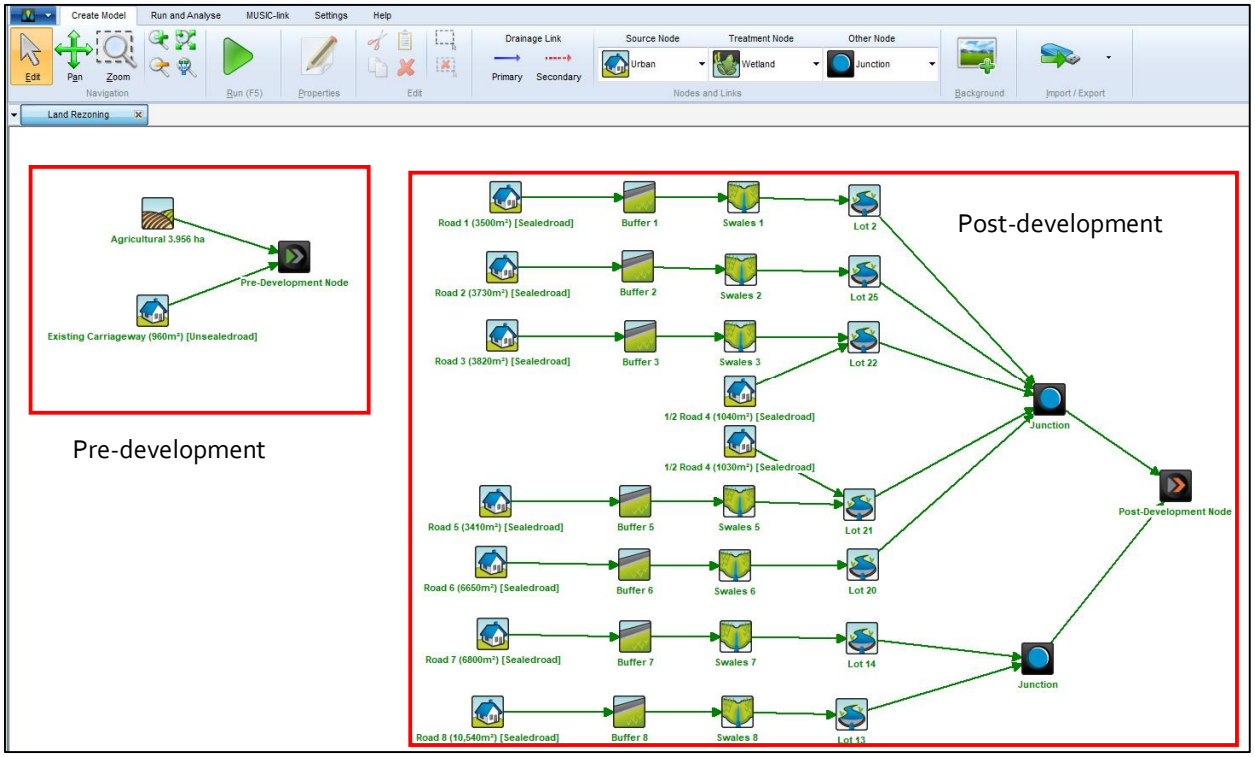

Figure 2.1. Layout of the source, treatment and receiving nodes in the *MUSIC* stormwater model.

The Results.

The modelling results are measured on two scales; the reduction of pollutant concentrations between the pre-development and post-development stages by 10% for suspended solids, phosphorus and nitrogen, and the reduction of these pollutants by the design reductions in at least 98% of occurrences. The first of these measures are summarised in Table 4 which demonstrates that the residual pollutant concentrations between the pre-development and post-development stages have achieved the objectives of the NorBE (Neutral or Beneficial Effect) criteria by achieving a minimum of 10% reduction for all three pollutant types.

Table 2.5. Comparison of the residual pre and post development pollutant concentrations for the development model

	Annual pollutant loading (kg/year)		
	TSS	TP	TN
Pre development loading	688.0	1.41	7.18
Post development loading	69.20	0.49	5.75
Reduction %	89.64	65.25	19.92

The second of these measures is the frequency at which these pollutant reductions achieve the objectives, with a neutral or beneficial effect (NorBE) being satisfied if the pollutant reductions are attained in 98% of occurrences. The following images (Figures 3 to 5) of the pre and post development cumulative frequency charts for the flow weighted daily mean values for suspended solids, phosphorus and nitrogen demonstrate that pollutant reductions proposed by the respective treatment measures are achieve for the required frequency of occurrences. In the respective images the pre-development outcomes are represented by the red lines whilst the post-development outcomes are in blue.

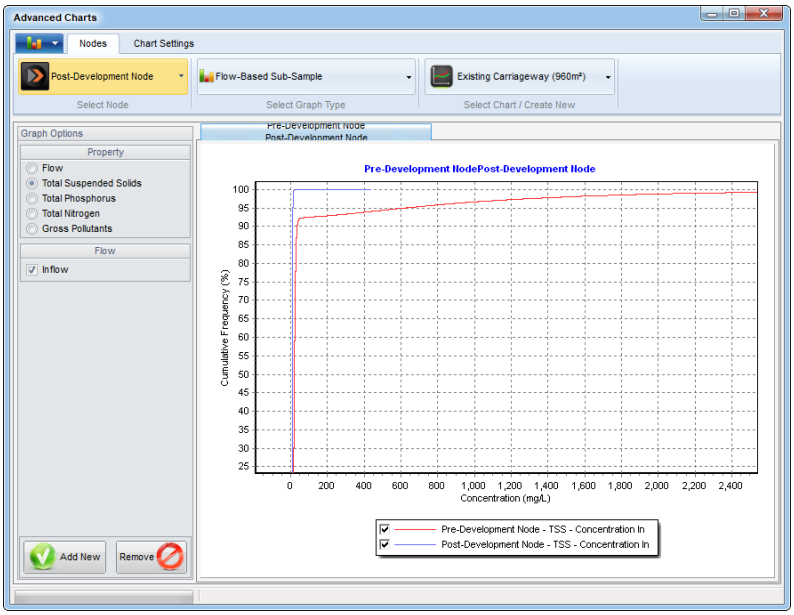

Figure 2.2. Comparison of the pre-development and post-development outcomes for Total Suspended Solids (TSS).

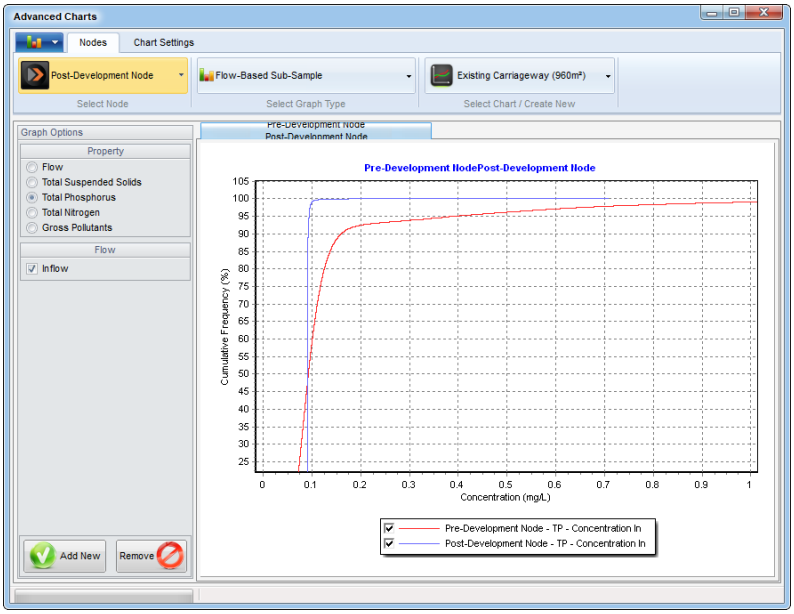

Figure 2.3. Comparison of the pre-development and post-development outcomes for Total Phosphorus (TP).

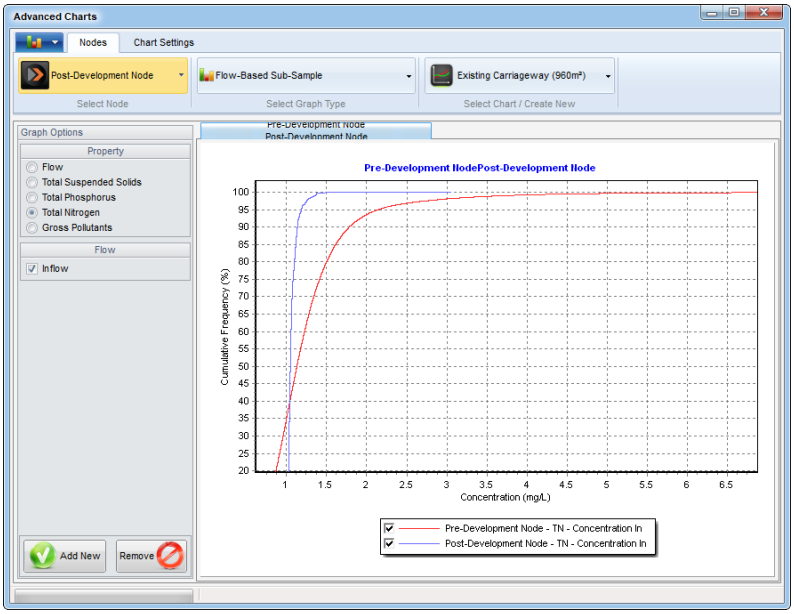

Figure 2.4. Comparison of the pre-development and post-development outcomes for Total Nitrogen (TN).

The proposed stormwater conveyance and treatment measures as detailed above demonstrate that the passive undertakings will satisfy the objectives of the NorBE guidelines. It is noted that at the time of lodging a formal application to Goulburn Mulwaree Council for the subdivision of the land an appropriate *Soil and Water Management Plan* and an *Erosion and Sediment Control Plan* will need to be submitted as part of the stormwater quality undertakings for consideration and approval by Council and Water NSW.

3/. Stormwater drainage and flood impacts.

The development property is burdened by a defined drainage depression that runs through the eastern third of the site and conveys surface water runoff from sources originating on the opposite side of the Brisbane Grove Road corridor through to the banks of the Mulwaree River to the north of the site. The western side of the ridge line within the eastern third of the property drains into this defined drainage depression and there is a series of dams within the development property that are scattered along the drainage line.

The Mulwaree River is subject to relatively frequent flood events of varying magnitudes, and a recent flood study of the city undertaken by WMA Water in 2016 that included the section of the Mulwaree River adjacent to the northern portion of the development property identified that flood affectation burdened parts of the proposed development site. The 2016 flood study identified both riverine flows and sources of external overland flows as contributing sources of flood water that impact the site, with zones of hydraulic hazard, flood storage, and flood fringe also burdening the northern portions of the site. The convergence of the defined drainage depression that runs through the site with the Mulwaree River occurs well to the north of the proposed boundaries of the development property, however additional stormwater and flood modelling has been undertaken of the development site and surrounding upstream catchment areas to determine the extent of overland flows that occur within the site and contribute to all aspects of flooding of the river system.

To ascertain the impacts (if any) of overland flows and surface water drainage on the proposed rezoning and subdivision a preliminary (pre-development) flood and stormwater model was undertaken of the site and surrounding catchment area using a combination of Lidar mapping and detailed contour survey of the property. To create a terrain profile for the stormwater drainage and flood impact assessment outside of the property LiDAR information was obtained for the development area from the Geoscience Australia '*Elevation and Depth Foundation Spatial Data'* website (ELVIS). The defined catchment area and development property is captured within a single dataset which has a grid area of 2km x 2km (Goulburn201107-LID1-AHD_7486146_55_0002_0002) which was downloaded as 2 metre grid Digital Elevation Model metadata item.

The primary objective of the modelling is to determine the existing overland flow patterns and stormwater depths within the development property and to conservatively estimate for the 1% AEP rain event where residential dwellings, access and egress provisions, public roads, and effluent management systems should not be located for each of the proposed new Lots. It was initially proposed that a combination of programs such as RAFTS, DRAINS and HEC-RAS would be employed to undertake the assessment modelling however as of November 2020 the agents responsible for distributing licenses and support for the RAFTS model ceased to issue new licences and instead have replaced the older software with a new product. The new software is distributed by Innovyze Pty Ltd and is named *'ICMOne SC'* which is a stormwater and flood modelling program incorporating 1D network and 2D scaled mesh operations to perform both above and below ground hydrology and hydraulic simulations.

The digital elevation model was imported into the software to create a terrain profile which was paired with a georeferenced aerial image of the catchment area for ease of identification, correlation, and result assessment purposes. As no previous flood modelling of the development areas is available for use or comparison the current recommended guidelines for rainfall information, urban hydrology, and flood modelling as prescribed by Engineers Australia and Australian Rainfall and Runoff (2019) was adopted. Design parameterisation and rainfall data for the site was obtained directly through the Australian Rainfall & Runoff Data Hub and the Bureau of Meteorology portal.

A range of IFD (intensity, frequency, and duration) information and Annual Exceedance Probability options were gathered to enable comparison modelling to be performed however most of the data was focused on the 1% AEP durations as this is the critical storm of interest for the development. As the upstream catchment area is reasonably uniform and comprised of similar land use and surface types a single model has been prepared that has adopted a uniform roughness coefficient (Manning's 'n') of 0.020 that addresses both open spaces with grass and crop groundcover vegetation and road pavements and driveways in accordance with Table 6.2.2 of the AR&R2019 guidelines, and an initial loss of 16mm and a continuing loss of 2.7mm per hour has been modelled in accordance with the storm loss figures from the Australian Rainfall & Runoff Data Hub for the geographical area.

The catchment area under review covers 302 hectares and is broken down into approximately 78,680 meshing triangles that have an average area of 68.25m², and each 'working' face allows normal flow conditions from one mesh triangle to the next. The large model area validates the effective upstream catchment that enters the development property by identifying other drainage regimes that occur outside, around and beyond the property.

Within the 1-hour storm ensemble of 10 different temporal patterns the maximum water level and hydraulic hazard was essentially the same across each of the patterns with just the timing of peak water level varying. For analysis purposes the 1-hour storm with temporal pattern #1 run for a 90-minute duration was adopted as this tended to have an earlier peak in the rainfall intensity with a constant rainfall pattern continuing until the end of the run, and it was possible to observe how long the depths of water remained after the peak rain event.

The model comprised a catchment area of approximately 302 hectares which included adjoining upslope properties to the south of the Brisbane Grove Road corridor to gauge the impact of all external sources of surface water runoff that potentially burden the site. The modelling results for the 1% AEP storm event indicates that the eastern third of the site is affected by overland flows that run in a south to north pattern along an existing defined drainage corridor. The depth of stormwater within these areas is variable, however there is clear migration of external stormwater from the southern side of the Brisbane Grove Road corridor into the property, particularly in the eastern third. The same modelling clearly maps the flow of internal and external sources of stormwater that burden the remainder of the site with the lower northern portions of proposed Lots 13 to 20 most likely to be burdened or impacted by flood fringe or storage zones and/or areas of hydraulic hazard, whilst the northeastern corner of the site

incorporating proposed Lots 24 and 25 has a localised depression that could generate temporary ponding and runoff during the larger rain and storm events. It is noted within the modelling results that the nominated dwelling envelopes within the flood affected Lots are well outside any impacted areas, and, apart from a small section in the western corner of the property where the proposed internal access through road is located and where the existing drainage line is crossed the remainder of the carriageway does not appear to be burdened by localised flood or large rain events. To help clearly define the main areas of flow and depth that burden the development property water depths of 30mm or less have been turned off within the model.

The site-specific modelling does not include the flooding directly associated with the Mulwaree River as the catchment under consideration did not include the river, and nor was it attempting to vary the flood levels or extents associated with the study undertaken on behalf of the Council, however the extent of mapped flood liable lands resulting from the Council's study has been combined with the results from the site-specific modelling within the site plans to produce an overall constraints profile. The 1% AEP flood levels are identified in the site plans by yellow dashed lines The results of the site-specific modelling clearly define where the upstream sources of surface water actually flow and which sources directly impact the development site, and by doing so allow for a detailed design of the proposed subdivision and identify the options for the placement of potential dwelling envelopes and effluent management areas. Refer to Figure 3.1 for 1% AEP maxima stormwater depth and extent details.

The modelling results have also been converted into a second level of risk assessment – a hydraulic hazard (flood depth and velocity) assessment based on the guidelines within Chapter 7 of Book 6 within AR&R2019 – Section 7.2. The model has categorised the hydraulic hazard into six separate risk profiles in accordance with the hazard curves and properties tables based on work undertaken by Smith et al. (2014).

The hydraulic hazard is a measure of the risk to human life and evacuation opportunities as a consequence of water depths and flows velocities with a scaling chart system used to identify suitable thresholds for different population demographic groups, structures, and vehicular transport options for evacuation situations. The hydraulic hazard is comprised of six critical levels, with levels 1 to 3 being acceptable for a range of human occupancy and transport options, whilst levels 4 to 6 are essentially unsuitable for people and vehicles but may be suitable for different types of building structures – although Level 6 is essentially not suitable for any form of land use.

The modelling results for the post-development conditions indicate that all hydraulic hazards across the site where created are within the lower end of the risk scale ranging from Level 1 to level 2 which is generally suitable for all demographic groups, buildings and most transport options, with the exception of water storage bodies such as dams as they are by default deeper than 1 metre and therefore in the higher end of the scale. Refer to Figure 3.2 for the 1% AEP maxima hydraulic hazard details of the post-development model and to Figure 3.3 for the Hazard risk curves and classification tables from Chapter 7, Book 6 of AR&R2019.

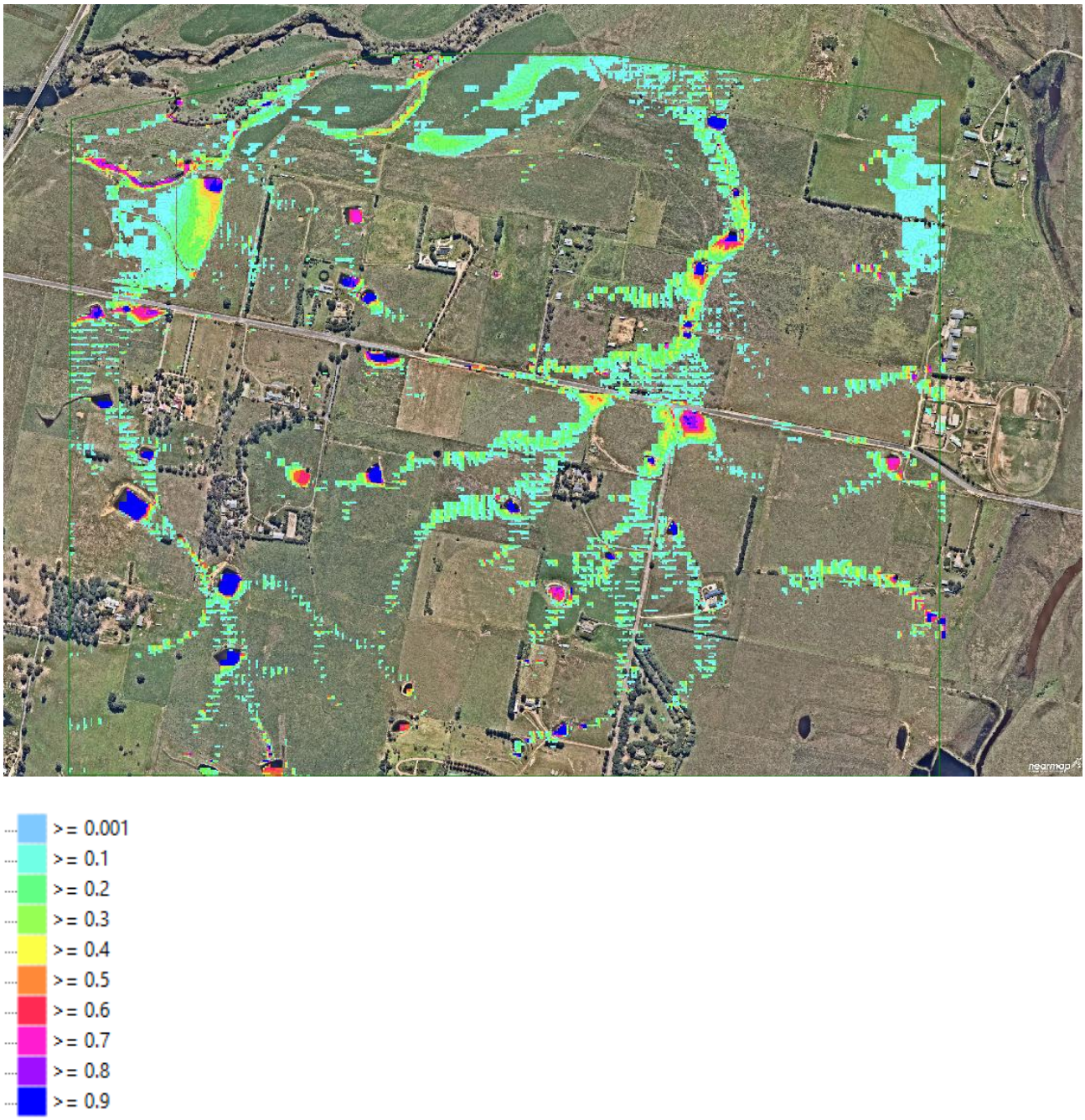

Figure 3.1. 1% AEP maxima stormwater depth and extent details of the pre-development model. Water depths of 30mm and less have been isolated. This image has been overlaid with a subdivision layout for reference purpose and is available to be view in the separate A1 sized site plan titled "Stormwater Drainage and Flood Impact Site Plan" – Ref: 0050421-01C.

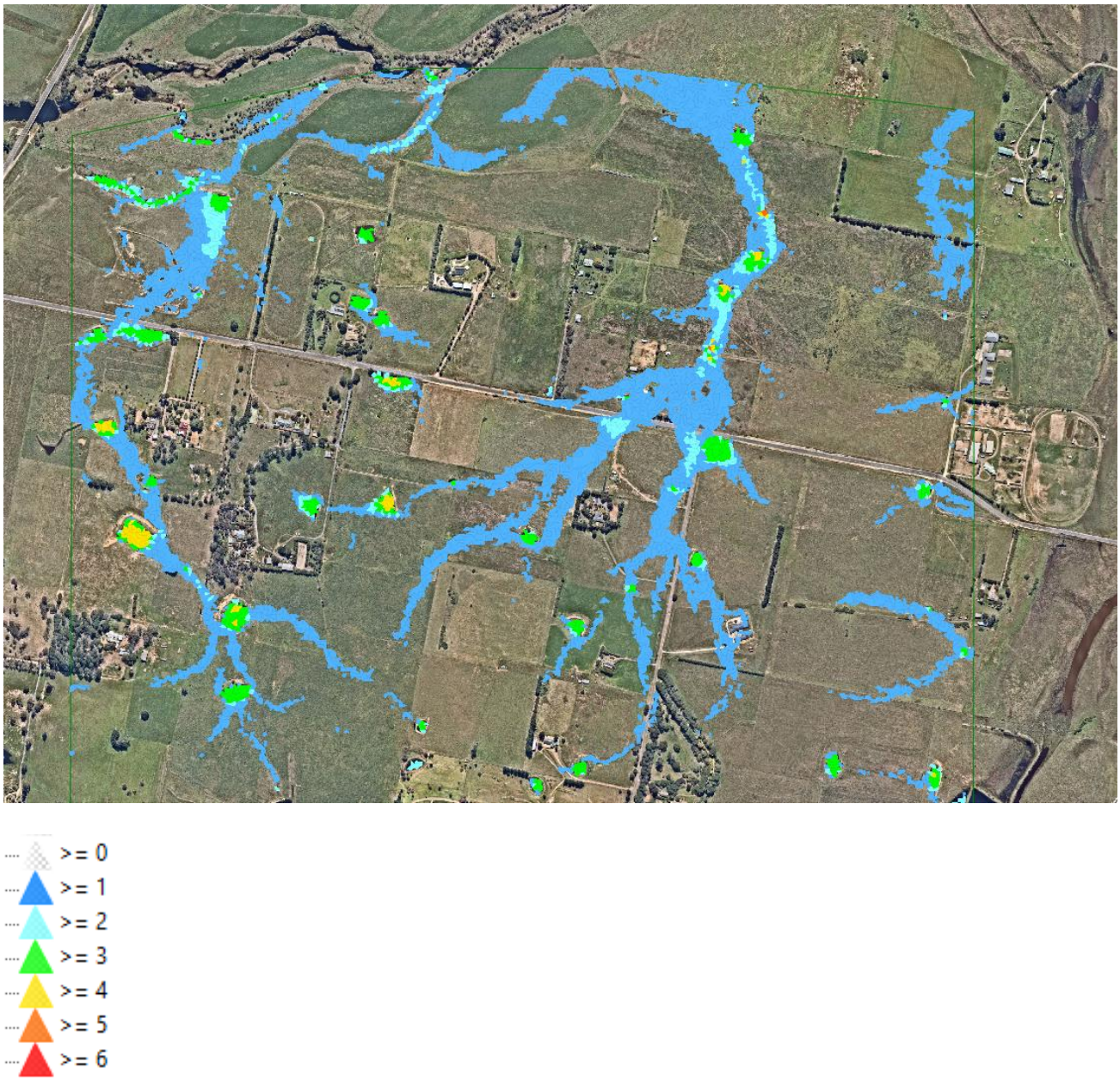

Figure 3.2. 1% AEP maxima hydraulic hazard details of the pre-development model.

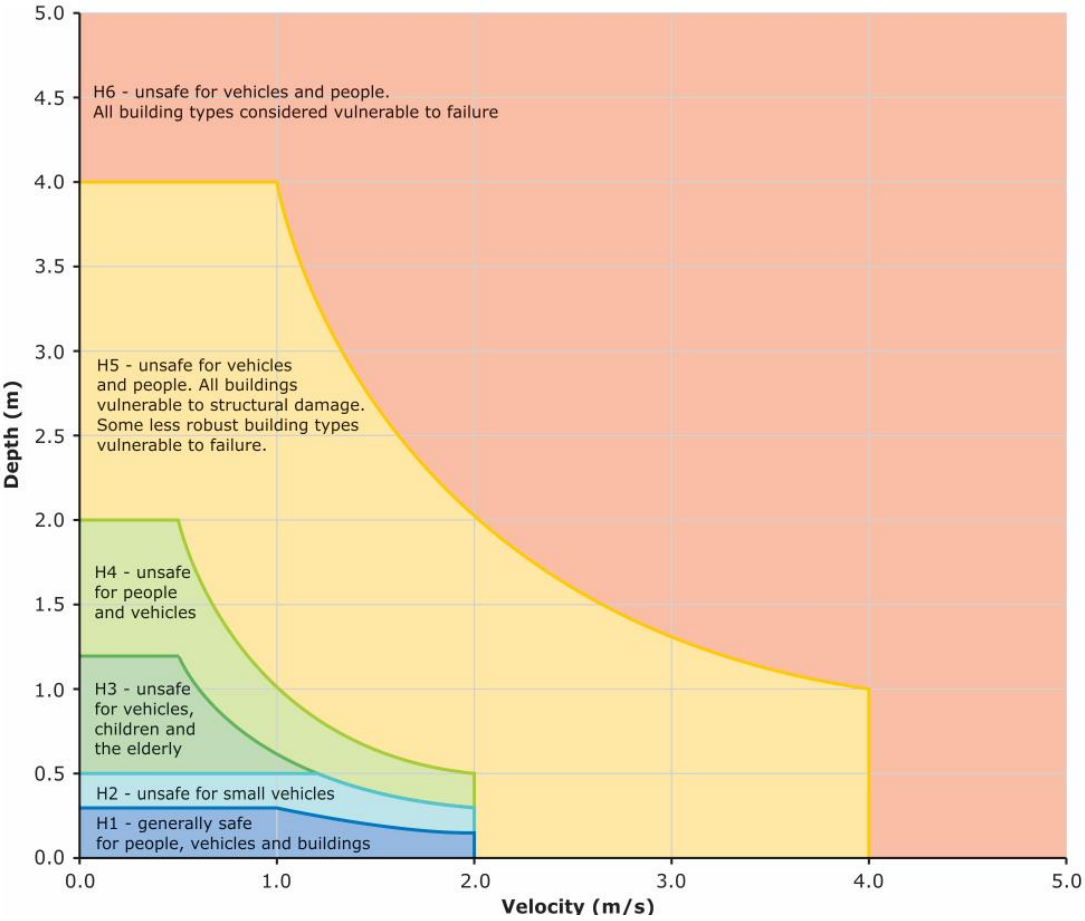

Table 6.7.3. Combined Hazard Curves - Vulnerability Thresholds (Smith et al., 2014)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

Table 6.7.4. Combined Hazard Curves - Vulnerability Thresholds Classification Limits (Smith et al., 2014)

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)
H1	D*V ≤ 0.3	0.3	2.0
H2	D*V ≤ 0.6	0.5	2.0
H3	D*V ≤ 0.6	1.2	2.0
H4	D*V ≤ 1.0	2.0	2.0
H5	D*V ≤ 4.0	4.0	4.0
H6	D*V > 4.0	-	-

Figure 3.3. Hazard risk curves and classification tables from Chapter 7, Book 6 of AR&R2019.

4/. Wastewater Management Assessment.

The purpose of the wastewater management assessment at the proposed land rezoning stage is to determine the suitability of proposed new Lots seeking residential building entitlements to support a residential development incorporating an on-site wastewater management facility and reviewing the available treatment and disposal options. Site investigations were conducted over two days in September and November 2021 and included:

- Identification and/or confirmation of any constraints shown within the Water NSW "Site Design Analysis Tool" mapping instruments included within Appendix B
- Detailed description of site characteristics.

A total of 22 soil samples were undertaken across the site to determine the existing conditions and look for any significant variations in soil characteristics, and each was analysed for the basic chemical and physical characteristics which are summarised in the accompanying soil logs. It is noted that at the time of the site inspections various parts of the site – particularly close to a defined drainage corridor in the eastern third of the site were quite wet resulting from recent rains that precluded effective soil testing in those areas using a hydraulically operated coring device thereby all samples were undertaken using a 75mm diameter hand operated augur. Refer to Figure 4.1 for an aerial image of the property and the locations of the soil samples.

As a general description based on the average conditions encountered across the site the soil profile is comprised of a shallow loam topsoil to 200mm with a rather abrupt transition into a sandy clay loam to clay loam at the termination depths, and some samples did display light clay properties in the lower extractions. The majority of the soil columns were moist due to recent and frequent rain events, and coupled with the fact that large areas of active ground cover vegetation was non-existant as the grasses and crops across the site had effectively been sprayed-out to control a major infestation of noxious weeds meant that there was no significant transpiration of subsoil moisture. Several of the sample sites encountered layers of weathered gravels, weakly structured quartz fragments, and small nodules of magnaferous concretions at varying depths below the surface level, and all but two of the samples were able to attain depths of at least 900mm.

The terrain around the development site is quite variable with a broad but shallow ridge line that runs through the eastern portion where the proposed internal access road will be formed. The ridge is aligned in a south to north pattern and there is a general fall either side of the ridge to the east and west at average grades of 5°. The majority of the land within the development site to the west of the ridge line has a general fall from the south toward the north at relatively minor but consistent grades of less than 5° with the lower northern portion which represents the margins of the flood prone lands within proposed Lots 13 to 20 having a plateau characteristic with grades of less than 3°. Proposed Lots 3 and 12 of the subdivision development which are located approximately midway along the length of the development site on the northern side of Brisbane Grove Road and between two privately owned land holdings are slightly different to the remainder of the site in that they are located on the eastern side of the small hillock and have a

general fall from a high point along the western boundary near to the common boundary between the two in an arc formation from the north through to the east and around to the south at an average grade of 5°. The isolated portion of land on the southern side of Brisbane Grove Road has a simple fall from the south toward the north at an average grade of less than 5° with a slight rise along the northern boundary formed by the road carriageway outside that creates a dam in the lower northern portion of the block.

The significant factors of the development area:

1. The development property will not be serviced by a Council maintained reticulated water supply or a gravity sewer system thereby requiring all Lots to be self-sufficient in the provisions of these facilities.
2. In the WaterNSW NorBE tool, the un-sewered 27 Lot subdivision is a 'Module 4' class of development - "*moderately complex developments that are a high risk to water quality*".
3. The assessment has addressed the potential water quality impacts as defined within the Current Recommended Practice guidelines titled *Water Sensitive Design for Rural Residential Subdivision* (Water NSW - 2021) and any potential concerns that have been identified in that process. The subdivision assessment has used the Sydney Catchment Authority *Site Design Analysis Tool* information as a basis for design considerations (copies of which are attached in Appendix B), however where appropriate, revised information based on the findings of the actual site inspections have been used.
4. Within each of the proposed Lots a 'potential building envelope' having a nominal area of 600m² has been identified. The location of the 'potential building envelopes' within each of the Lots is based on a combination of considerations and not simply limited to wastewater management objectives hence these locations are not intended to be fixed or tied to title.
5. An 'indicative effluent management area' has been positioned within each Lot adjacent to the nominated dwelling envelopes to meet the required setbacks from buildings, Lot boundaries, easements, and areas identified within previous sections of this Water Cycle Management Study that are prone to stormwater inundation during large rain events. The nominated effluent management areas are highlighted by either a magenta-coloured rectangle with solid colouring of 100m² or an orange-coloured rectangle with cross-diagonal hatching of 500m² within the accompanying site plan, Ref: 0050421-01C.
6. Whilst the individual Lots are relatively large in area (minimum of 2 hectares) and not necessarily constrained by site characteristics such as soil texture, depth, slope, or climate, the combination of Lot configurations, existing defined drainage corridors, extents of mapped flood liable lands, and the identified areas of overland stormwater drainage suggest that some of the Lots may be 'slightly constrained' in relation to effluent management opportunities and therefore will require a detailed site analysis and design at the time of future residential land development.
7. The wastewater management assessment and subsequent recommendations have been undertaken with reference to the relevant standards; ("AS/NZS 1547:2012 On-site Domestic Waste Management"), the guidelines; "On-site Sewage Management for Single Households" (1998), "Design and Installation of On-site Wastewater Systems" (Water NSW 2019), and the Goulburn Mulwaree Council Development Control Plan.

Figure 4.1. Aerial image of the property showing the location of the soil samples undertaken as part of the wastewater management site analysis

Constraints

1/. For developments that occur within the boundaries of the Sydney drinking water catchment a site analysis tool that identifies potential geophysical constraints for the proposed site in relation to natural features such as soil, drainage, slope, vegetation, permeability, phosphorus sorption capacity, precipitation, and certain other parameters has been made available for reference by wastewater management consultants and other land planners.

In relation to this development the site analysis tool indicates that the parameters of drainage and soil depth in particular may be a potential constraint throughout the property. Using these potential constraint maps as a guide for siting the potential building envelopes and the effluent disposal systems, some if not all the potential constraints can in the first instance be confirmed, and thereafter as necessary be avoided or addressed by appropriate design and siting measures.

The development property is burdened by a defined drainage depression that runs through the eastern third of the site and conveys surface water runoff from sources originating on the opposite side of the Brisbane Grove Road corridor through to the banks of the Mulwaree River to the north of the site. The western side of the ridge line within the eastern third of the property drains into this defined drainage depression and there is a series of dams within the development property that are scattered along the drainage line. The northern and northwestern portions of the development property and to a lesser extent the extreme northeastern corner are partially burdened by mapped flood liable lands. The extent of flood migration into the proposed development site and associated impacts is variable, however all proposed Lots that will be potentially burdened by flood have been designed such that there is adequate land area above the identified 1% AEP flood levels for suitable dwelling envelopes including freeboard provisions. The other factor to consider in the design of the subdivision and future wastewater management systems is the location of roadside drainage swales along the proposed internal access road and the position of the new dams treating the stormwater runoff from the roadway.

The location of the nominated effluent management areas within the accompanying plan of subdivision has been specifically undertaken to ensure that each system is at least 40 metres from any open channel, farm dam, drainage or conveyance pathway and therefore 'drainage' as a potential constraint can be overcome.

A total of 22 soil samples undertaken across the development property consistently achieved depths of at least 900mm with relative ease with the exception of two core sites which encountered refusal approximately 700mm below the surface. The majority of the sampled soil profiles comprised a silty loam to sandy loam topsoil of 200mm to 300mm, with a sandy clay loam to clay loam below to the termination depths (further details of the individual samples are contained in the following sections of this report). It is anticipated that the samples undertaken across the site are a fair indication of the anticipated soil depths and conditions to be encountered within the areas suitable for effluent management and it is therefore considered that soil depth or condition will not be a constraint for the development.

Notwithstanding the possible limitations imposed by various geophysical constraints, an examination and assessment of the existing site and soil characteristics within each of the nominated effluent disposal areas has determined that the natural conditions are conducive for effluent disposal purposes. Refer to the attached 'Water Sensitive Design Mapping Constraints' overlay images in Appendix B of this report for graphic representation and details of the site characteristics discussed in this section.

2/. In addition to the site analysis tools referenced above, an online modelling tool is used to check that the effluent plume associated with a proposed wastewater treatment system does not migrate outside the property boundary or to environmentally sensitive receiving points.

The modelling outcomes identified as the *WEM Summary* (Wastewater Effluent Model Summary) from the Water NSW NorBE Assessment portal produces a predictive plume representing the anticipated migration of effluent, nitrogen, phosphorus and faecal coliforms based on the combined measures of effluent treatment, disposal method and disposal area location.
The resulting plume is a prediction based on a combination of factors including the site's soil characteristics, the topography, daily loading and treatment methodologies.

By achieving a plume for all four constituent parameters that remain inside the property boundary whilst also not effecting sensitive environmental receptors then the design is deemed to satisfy the Neutral or Beneficial Effect (NorBE) criteria for wastewater management assessment purposes.

A model for each of the proposed effluent management systems predicting the respective effluent plumes has been prepared with the summary results presented at the end of the detailed soil summary sheets that follow this section.

3/. The development property is located within the 'Sydney Basin – Goulburn Fractured Rock Groundwater Source' as defined in the W*ater Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* administered under 'Section 50 of the Water Management Act (2000)', which sets out prescribed activities and conditions for water supply works associated with a groundwater source – including bores.

Part 9 > Clause 40 > Subclause (1) states that a water supply work approval must not be granted or amended to authorise the construction of a water supply work which, in the Minister's opinion, is or is proposed to be located:

a/. within 250 metres of the plume associated with a contamination source listed in **Schedule 3**, or
b/. between 250 metres and 500 metres of the plume associated with a contamination source listed in **Schedule 3**, unless the Minister is satisfied that no drawdown of water will occur within 250 metres of the plume associated with the contamination source, or

c/. at a distance specified by the Minister that is more than 500 metres from the plume associated with a contamination source listed in **Schedule 3,** if a greater distance is determined by the Minister to be necessary to protect a water source, the environment or public health or safety

Schedule 3 of the W*ater Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* specifically defines an onsite sewage disposal system or septic tank as a contamination source, irrespective of the use of water from the bore. Whilst the development proposal is not for a 'water supply approval' as defined under the Water Management Act, the installation of a wastewater management system must still consider the effect of such an installation on existing and possible future water supply works.

Where the proposed location of an effluent disposal area may be less than 100 metres of an identified groundwater bore then a 'draw down analysis' similar to that prescribed by Cromer, Gardner and Beavers '*An Improved Viral Die-off Method to Estimate Setback Distances'* (2001) may be undertaken to demonstrate that the proposed lesser separation distance will be suitable.

In relation to this assessment a search of the Water NSW 'Groundwater Data Base' for any registered bores within 500 metres of the centroid of the development property has been undertaken which has resulted in several findings which is not an uncommon occurrence within a rural residential area that are not serviced by a Council maintained reticulated water supply.

The nearest of the identified groundwater bores (GW073390) is actually located within the front southeast corner of the proposed Lot 3 within the subdivision development and is identified by a small cover structure over the pump system. The bore is still operative and supplies drinking water for stock and some external water demands around the farm shed precinct via an elevated water tank on a stand within the eastern portion of proposed Lot 12. The bore will be retained within Lot 3 of the subdivision however its connection and supply arrangements to the remainder of the site will be discontinued, as will the elevated tank in proposed Lot 12. Once separated from the existing infrastructure the bore could be reinstated if desired by a future owner of the benefited Lot 3 – but only for non-potable purposes.

All remaining groundwater bores identified within the search are located greater than 100 metres from the nearest identified effluent management system and therefore a draw-down analysis is not deemed necessary at this time, however individual Lots should undertake their own assessment of any potential development impacts at the time of lodging a formal application to Council for residential dwelling development.

It is considered that the separation distance between the existing bores and the nearest of the proposed new effluent management areas will be at least 100 metres, and therefore 'groundwater sources' will not be a constraint for the proposed development.

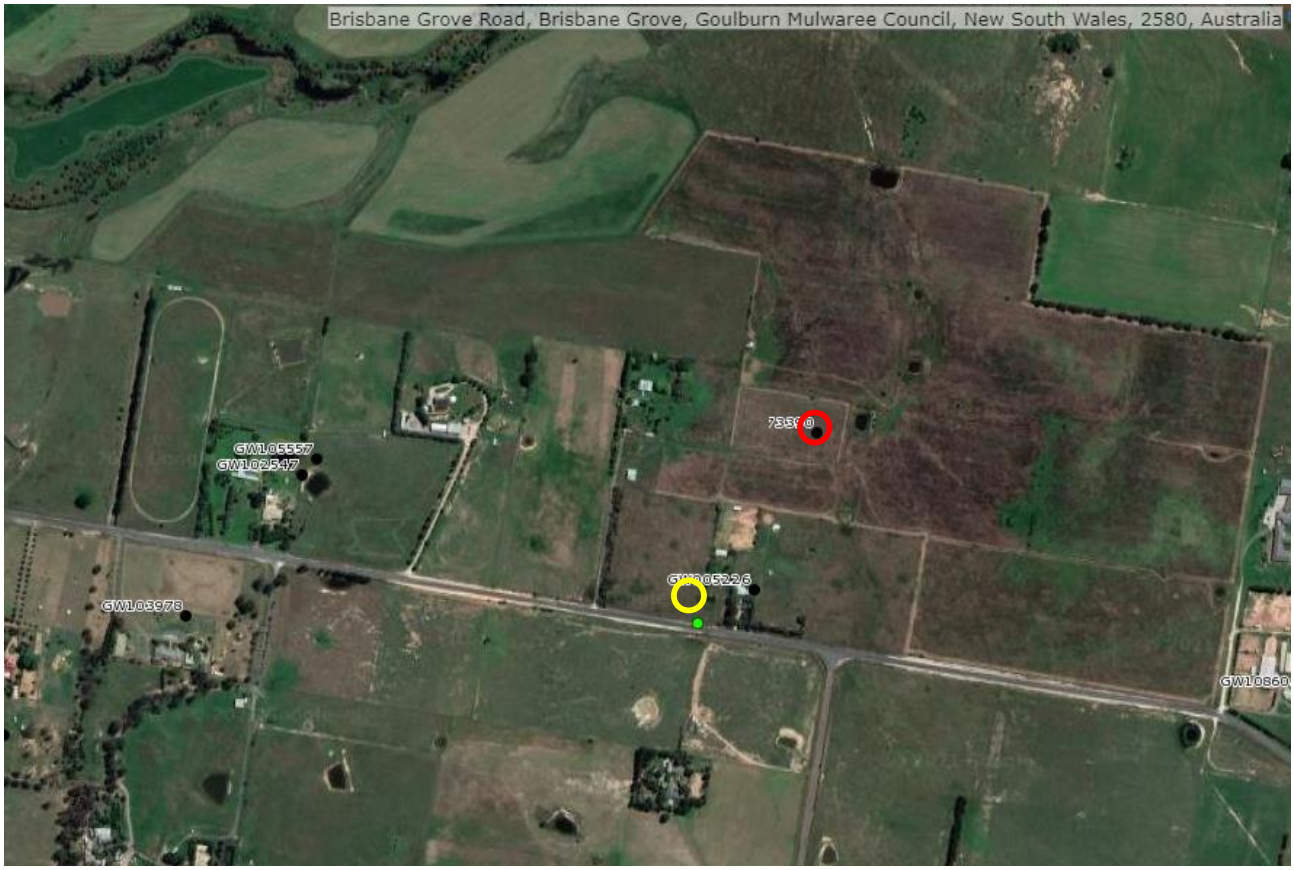

Figure 4.2. Image from the Water NSW Groundwater Data Base showing the location of the registered groundwater bore within the property (yellow circle) and the proximity of other bores in the surrounding land holdings. The bore position shown to the northeast shown a s a red circle is actually related to the bore that is located within the yellow circle, it is simply shown using a centroid reference rather than the actual position reference.

Based on a combination of the site characteristics and assessments, and the aforementioned constraints mapping and modelling it is considered that each Lot will be best serviced by treating the household sewage to a higher- secondary standard before discharge to either an absorption disposal bed system, or for the blocks with shallower soil conditions – to a land application area with irrigation distribution. The higher quality of effluent treatment prior to disposal will help to minimise any cumulative environmental impacts on groundwater or surface water considerations, and the internal transfer pumping system within the treatment units will allow the effluent to be discharged within parts of the individual Lots that may be upslope from the collection and treatment system. The use of the internal pump transfer system will allow better use of the Lots that may be constrained by downslope drainage constraints, and therefore support greater flexibility in Lot site designs. The Lots that are less suitable for absorption disposal due to shallow soil conditions and/or the proximity of drainage features have been identified with a 500m² surface irrigation disposal area which is identified by an orange-coloured rectangle with diagonal hatching. The sites more suitable to absorption disposal have 100m² magenta coloured rectangles identifying the effluent disposal area, and distribution of the discharging effluent should be achieved by a purpose designed system that allows even application over the entire base area with an equal flow discharge rate. Where a surface irrigation disposal system is proposed it has been assumed that the required area will be a fully managed lawn cover.

Conclusion

The conceptual subdivision as proposed in the accompanying plans meets the Neutral or Beneficial Effect (NorBE) criteria, and each of the proposed Lots are deemed suitable to support a residential development incorporating an on-site wastewater management facility. Future dwellings within the proposed subdivision will be required to submit individual development applications to Council which will include a detailed assessment of the proposed onsite wastewater management system relative to the size of the daily effluent loading being generated by the proposed dwelling.

The preferred treatment system for all Lots is via secondary treatment unit whilst the size of the effluent disposal areas is based on the equivalent of a six bedroom dwelling that is reliant upon rainwater harvesting as the primary source of all potable and non-potable water uses. It is recognised that other wastewater management options are available and viable, however more detailed assessment at the time of a future residential development of the individual Lots will provide a better analysis and then refinement of these options based on the site layout and potential loading values.

The following sections provide a summary of the individual soil samples, and separate *WEM Plume Maps* for each of the proposed Lots based on treatment with a Secondary Treatment System (STS) and the appropriate form of effluent disposal. The WEM modelling has assumed each Lot has a six-bedroom equivalent dwelling with non-reticulated water supply. The general information sheet for each of the WEM models are essentially the same so to avoid unnecessary duplication only the details of Lot 1 have been included as an example for all. It is noted that the size of the nominated effluent disposal areas shown within the site plan are actually larger than the minimum land areas requirements which based on the loading and soil characteristics are only 45m² for the absorption disposal method and 411m² for the surface irrigation disposal method.

The wastewater management assessment is supported by the accompanying Wastewater Management Site Plan – Ref: 0050421-01D and the Stormwater Drainage & Flood Impact Site Plan – Ref: 0050421-01C which also has a visual representation of the results from the stormwater drainage and flood impact assessment to highlight the 'non-development' areas of the site.

The following additional information is provided in the following appendices which are at the conclusion of this section:

- Appendix A - Recommended Buffer Distance for On-site Wastewater Management Systems in the Sydney Drinking Water Catchment
- Appendix B - Water Sensitive Design Constraints Maps

Table 4.1. Wastewater Management System Summary for Each Lot

Lot #	Treatment System	Absorption disposal	Surface Irrigation
1	Secondary Treatment System (STS)	☑	
2	Secondary Treatment System (STS)	☑	
3	Secondary Treatment System (STS)	☑	
4	Secondary Treatment System (STS)		☑
5	Secondary Treatment System (STS)	☑	
6	Secondary Treatment System (STS)	☑	
7	Secondary Treatment System (STS)	☑	
8	Secondary Treatment System (STS)		☑
9	Secondary Treatment System (STS)	☑	
10	Secondary Treatment System (STS)	☑	
11	Secondary Treatment System (STS)		☑
12	Secondary Treatment System (STS)	☑	
13	Secondary Treatment System (STS)	☑	
14	Secondary Treatment System (STS)	☑	
15	Secondary Treatment System (STS)	☑	
16	Secondary Treatment System (STS)	☑	
17	Secondary Treatment System (STS)	☑	
18	Secondary Treatment System (STS)	☑	
19	Secondary Treatment System (STS)		☑
20	Secondary Treatment System (STS)	☑	
21	Secondary Treatment System (STS)	☑	
22	Secondary Treatment System (STS)	☑	
23	Secondary Treatment System (STS)	☑	
24	Secondary Treatment System (STS)	☑	
25	Secondary Treatment System (STS)	☑	
26	Secondary Treatment System (STS)	☑	
27	Secondary Treatment System (STS)		☑

Soil Sample 1

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Simple slope to open depression	**Topography:** Southeast to northwest		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78669 **Longitude:** 149.72424
Elevation: 641m	**Aspect:** Northerly	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<20mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak				
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.02 / 5.2		gradual	A2
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			abrupt	B1
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.0			
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.0		gradual	B2A
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 2

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Simple slope to open depression	**Topography:** Southeast to northwest		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78687 **Longitude:** 149.72524
Elevation: 643m	**Aspect:** Southerly	**Slope:** 5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak				
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.04 / 5.2		gradual	A2
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			abrupt	B1
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 4.9			
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 4.9		gradual	B2A
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 3

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 = Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Simple slope to open depression	**Topography:** West to east		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78710 **Longitude:** 149.72667
Elevation: 640m	**Aspect:** Southerly	**Slope:** 5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<20mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<20mm		polyhedral weak	earthy	moist, weak				
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.03 / 5.1		gradual	A2
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B1
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 4.9			
	600-700	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 4.9		gradual	B2A
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 4

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Simple slope to open depression	**Topography:** Southwest to northeast		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78607 **Longitude:** 149.72781
Elevation: 639m	**Aspect:** Easterly	**Slope:** 5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<30mm		polyhedral moderate	rough ped	moist, firm	0.04 / 5.0		abrupt	B1
	300-400	sandy clay loam	<30mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<30mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<30mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.0		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	800-900	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.0		gradual	B2A
	900-1000	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 5

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Crest to simple slope	**Topography:** Slopes in all directions from crest		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78582 **Longitude:** 149.72621
Elevation: 643m	**Aspect:** 360°	**Slope:** 5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.3		abrupt	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm			gradual	B1A
	500-600	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.1			
	600-700	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	700-800	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.0		abrupt	B2A
	900-1000	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 6

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Simple slope to open depression	**Topography:** Southwest to north-northeast		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78442 **Longitude:** 149.72780
Elevation: 632m	**Aspect:** Easterly	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, imperfectly drained		A1
	100-200	silty loam	<20mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.01 / 4.9			
	300-400	silty loam	<20mm		polyhedral weak	earthy	moist, weak				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B1
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.01 / 4.8			
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	800-900	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 4.9			
	900-1000										C

Soil Sample 7

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Simple slope to open depression	**Topography:** West to east		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.79178 **Longitude:** 149.70537
Elevation: 638m	**Aspect:** Arc west to south and east	**Slope:** 5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.3		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.0		abrupt	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm				
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm			gradual	B2A
	800-900	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm	0.01 / 5.0			
	900-1000	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm				

Soil Sample 8

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Crest to simple slope and open depression	**Topography:** East to west-northwest		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78331 **Longitude:** 149.72516
Elevation: 641m	**Aspect:** Westerly	**Slope:** 5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1/ A2
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak				
	200-300	sandy clay loam	<30mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.3		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm	0.03 / 5.3		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm				
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm				
	800-900	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm	0.03 / 5.0		gradual	B2A
	900-1000	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm				

Soil Sample 9

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Simple slope top open depression	**Topography:** East to west-northwest		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78473 **Longitude:** 149.72483
Elevation: 640m	**Aspect:** North-northwest	**Slope:** 5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.04 / 5.3			
	300-400	sandy loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B1
	400-500	sandy loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.3		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 5.0		abrupt	B2A
	900-1000	light clay	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 10

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Simple slope to open depression	**Topography:** East to west		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78557 **Longitude:** 149.72461
Elevation: 641m	**Aspect:** Arc from north to west	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.02 / 5.3			
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B1
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 5.3			
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	800-900	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 4.8		gradual	B2A
	900-1000	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 11

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Simple slope to open depression	**Topography:** West to east		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78554 **Longitude:** 149.72189
Elevation: 641m	**Aspect:** Arc from north to east and southeast	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.00 / 5.4			
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B1
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.0		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.1		gradual	B2A
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 12

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Simple slope to open depression	**Topography:** West to east		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.79178 **Longitude:** 149.70537
Elevation: 641m	**Aspect:** Arc north to east to south	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1/ A2
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak				
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.00 / 5.5			
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B1
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.5		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2A
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.4			
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 13

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 22 September 2021
Landform: Simple slope then flat	**Topography:** South to north		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78223 **Longitude:** 149.72236
Elevation: 634m	**Aspect:** Northerly	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<20mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<20mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.04 / 5.3		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.3		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2A
	800-900	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 5.0			
	900-1000	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 14

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 3 November 2021
Landform: Simple slope to open depression	**Topography:** Northwest to southeast		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78633 **Longitude:** 149.71813
Elevation: 648m	**Aspect:** Southerly	**Slope:** 5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<40mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<40mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.03 / 5.0			
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B1
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 4.9		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2A
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 4.9			
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 15

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 3 November 2021
Landform: Simple slope to open depression	**Topography:** South to north		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78407 **Longitude:** 149.71872
Elevation: 647m	**Aspect:** Northerly	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.03 / 4.9			
	300-400	silty loam	<20mm		polyhedral weak	earthy	moist, weak				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B1
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 4.9			
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 4.7		gradual	B2
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 16

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 3 November 2021
Landform: Simple slope to open depression	**Topography:** South to north		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78249 **Longitude:** 149.72071
Elevation: 637m	**Aspect:** Northerly	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.03 / 5.0		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm	0.04 / 4.9			
	600-700	clay loam	<20mm		polyhedral moderate	rough ped	dry, firm			gradual	B2A
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	dry, firm				
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	dry, firm	0.02 / 4.8			
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	dry, firm				

Soil Sample 17

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 3 November 2021
Landform: Simple slope to open depression	**Topography:** South to north		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78264 **Longitude:** 149.72022
Elevation: 640m	**Aspect:** Northerly	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<40mm	firm	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	silty loam	<30mm		polyhedral weak	earthy	moist, weak	0.03 / 5.0			
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B1
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.0		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800										C
	800-900										
	900-1000										

Soil Sample 18

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 3 November 2021
Landform: Simple slope	**Topography:** Southwest to northeast		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78334 **Longitude:** 149.72081
Elevation: 642m	**Aspect:** Northerly	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<20mm	firm	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<20mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy loam	<20mm		polyhedral weak	earthy	moist, weak	0.04 / 5.0		gradual	B1
	300-400	sandy loam	<20mm		polyhedral weak	earthy	moist, weak				
	400-500	sandy loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B1A
	500-600	sandy loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.3			
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	800-900	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 4.8			
	900-1000	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 19

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 3 November 2021
Landform: Simple slope to open depression	**Topography:** South to north		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78317 **Longitude:** 149.71870
Elevation: 637m	**Aspect:** Northerly	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<20mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<20mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy loam	<20mm		polyhedral weak	earthy	moist, weak	0.01 / 5.4			
	300-400	sandy loam	<20mm		polyhedral weak	earthy	moist, weak			gradual	B1
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, weak				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, weak	0.01 / 5.2			
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.01 / 4.8		gradual	B2A
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 20

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 3 November 2021
Landform: Simple slope to open depression	**Topography:** South to north		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78303 **Longitude:** 149.71651
Elevation: 634m	**Aspect:** Northerly	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak				
	200-300	sandy loam	<20mm		polyhedral weak	earthy	moist, weak	0.02 / 5.5		gradual	A2
	300-400	sandy loam	<20mm		polyhedral weak	earthy	moist, weak			gradual	B1
	400-500	sandy loam	<20mm		polyhedral moderate	rough ped	moist, weak				
	500-600	sandy loam	<20mm		polyhedral moderate	rough ped	moist, weak	0.02 / 5.3			
	600-700	sandy loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	800-900	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.0			
	900-1000	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 21

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 3 November 2021
Landform: Simple slope to flat	**Topography:** Southeast to northwest		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.78297 **Longitude:** 149.71546
Elevation: 632m	**Aspect:** Northerly	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<10mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderatelywell drained		A1
	100-200	silty loam	<10mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy loam	<10mm		polyhedral weak	earthy	moist, weak	0.01 / 5.3		gradual	B1
	300-400	sandy loam	<10mm		polyhedral weak	earthy	moist, weak				
	400-500	sandy loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.3			
	600-700	sandy loam	<10mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	700-800	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	800-900	sandy clay loam	<10mm		polyhedral moderate	rough ped	dry, firm	0.01 / 5.2		gradual	B2A
	900-1000	sandy clay loam	<10mm		polyhedral moderate	rough ped	dry, firm				

Soil Sample 22

Site Details: Lots 2 to 6 DP62157, Lot 2 DP1180093, Lots 10 to 19, 21, 39, 43 to 45 & 54 DP976708, and Lot 29 DP750015 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 3 November 2021
Landform: Simple slope to open depression	**Topography:** South to north		**Sample #:** 1
Vegetation: Grasslands & improved pastures	**Land Use:** Rural residential & primary production		**GPS Coordinates** **Latitude:** -34.79178 **Longitude:** 149.70537
Elevation: 649m	**Aspect:** North and east	**Slope:** 5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 20mm per day, set at a conservative rate for secondary treated effluent discharging within a weakly structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<40mm	firm	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1/ A2
	100-200	silty loam	<40mm		polyhedral weak	earthy	moist, weak				
	200-300	sandy clay loam	<30mm		polyhedral moderate	rough ped	moist, firm	0.04 / 5.3		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm			gradual	B2
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	dry, firm	0.03 / 5.3			
	600-700										C
	700-800										
	800-900										
	900-1000										

Standard WEM Model General Information Summary – Typical for All Lots

NorBE Assessment

WEM Summary

version 3

General Information

WEM model ID	2428142	Associated DA number	
Model description	STS to absorption disposal		
Consultancy	SOWDES	Consultant	sowdes@sowdes.com
Consultant reference number	0050421		
Council	Goulburn Mulwaree	Assessing officer	
Nominated lot	13//976708	Associated lots	
Development class	Subdivision unsewered >=4 lots		

Lot	Section	Plan
2		62157
3		62157
4		62157
5		62157
10		976708
11		976708
12		976708
13		976708
14		976708
15		976708
16		976708
17		976708
18		976708
19		976708
21		976708
39		976708
43		976708
44		976708
45		976708
29		750015
54		976708
2		1180093

Date of model run 11/26/2021 8:19:40 AM

WEM Model Run Summary

Model run outcome **Satisfied**

Any of the sub-surface plumes reaches:

Lot boundary	No
Drainage depression	No
Top bank of watercourse	No

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WEM Summary

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Another disposal field or onsite stormwater management system	**No**
Within 50m, and up gradient of,a licensed drinking water bore	**No**

Proposed Front End Design

Length (across slope)(m)	**20.0**	Width (up slope)(m)	**5.0**
Proposed area(m2)	**100.0**	Minimum Required area (m2)	**50.0**
Number of trenches	**0**		
Effluent volume proposed (l/day)	**1000**		
Effluent volume calculated (l/day)	**1000**		

WEM Model Inputs

Location

Easting	**9549343.014122**	Northing	**4326775.901529**
Slope (m/m)	**0.01146**	Slope is suitable based on site inspection (Applicable to some disposal systems on steep slopes)	**N/A**

Development

Development type	**Dwellings**	Development detail	**6 bedrooms**
Water supply type	**Rainwater**	Spa Bath	**No**
Continuous system use	**Yes**		
Treatment system	**AWTS standard**	Disposal system	**Absorption Bed – secondary effluent**

Site

Lot size(m2)	**21902**		
Subject to severe frost	**No**	Bulk density(g/cm3)	**1.50**
Vegetation for nutrient uptake	**Lawn - fully managed (clippings removed)**	Phosphorus sorption (mg/kg)	**400**
Soil depth (to impermeable layer) (m)	**1.00**	Soil structure	**Weak**
Saturated hydraulic conductivity (Ksat)(m/day)	**0.40**		
Soil texture	**Clay loams**		

Effluent disposal risk factors

Depth to water table	**0.4 - 1.0**
Flood potential of disposal system	**Above 1 in 50 year ARI**
Landform score	**Hill crests, convex side slopes and plains**
Run-on and upslope seepage	**None-low, diversion possible**
Rock outcrops, scarp and bedrock	**< 5%**

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Individual Lot WEM Plume Map Summaries

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WEM Summary

WEM Plume Map

version 3

LOT 2

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WEM Summary

WEM Plume Map

version 3

LOT 3

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WEM Summary

WEM Plume Map

version 3

LOT 4

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WEM Summary

WEM Plume Map

LOT 5

version 3


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WEM Summary
WEM Plume Map
LOT 6
version 3
NorBE Assessment
WEM Summary
Legend:
Selected lots
Effluent management area
Phosphorus
Nitrogen
Faecal colifroms
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WEM Summary

WEM Plume Map

version 3

LOT 7

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LOT 8

WEM Summary

WEM Plume Map

version 3

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LOT 9

WEM Summary

version 3

WEM Plume Map

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LOT 10


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WEM Summary
WEM Plume Map
version 3
NorBE Assessment
WEM Summary
Legend:
Selected lots
Effluent management area
Phosphorus
Nitrogen
Faecal colifroms
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LOT 11

WEM Summary

WEM Plume Map

version 3

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WEM Summary

WEM Plume Map

LOT 12

version 3

WaterNSW

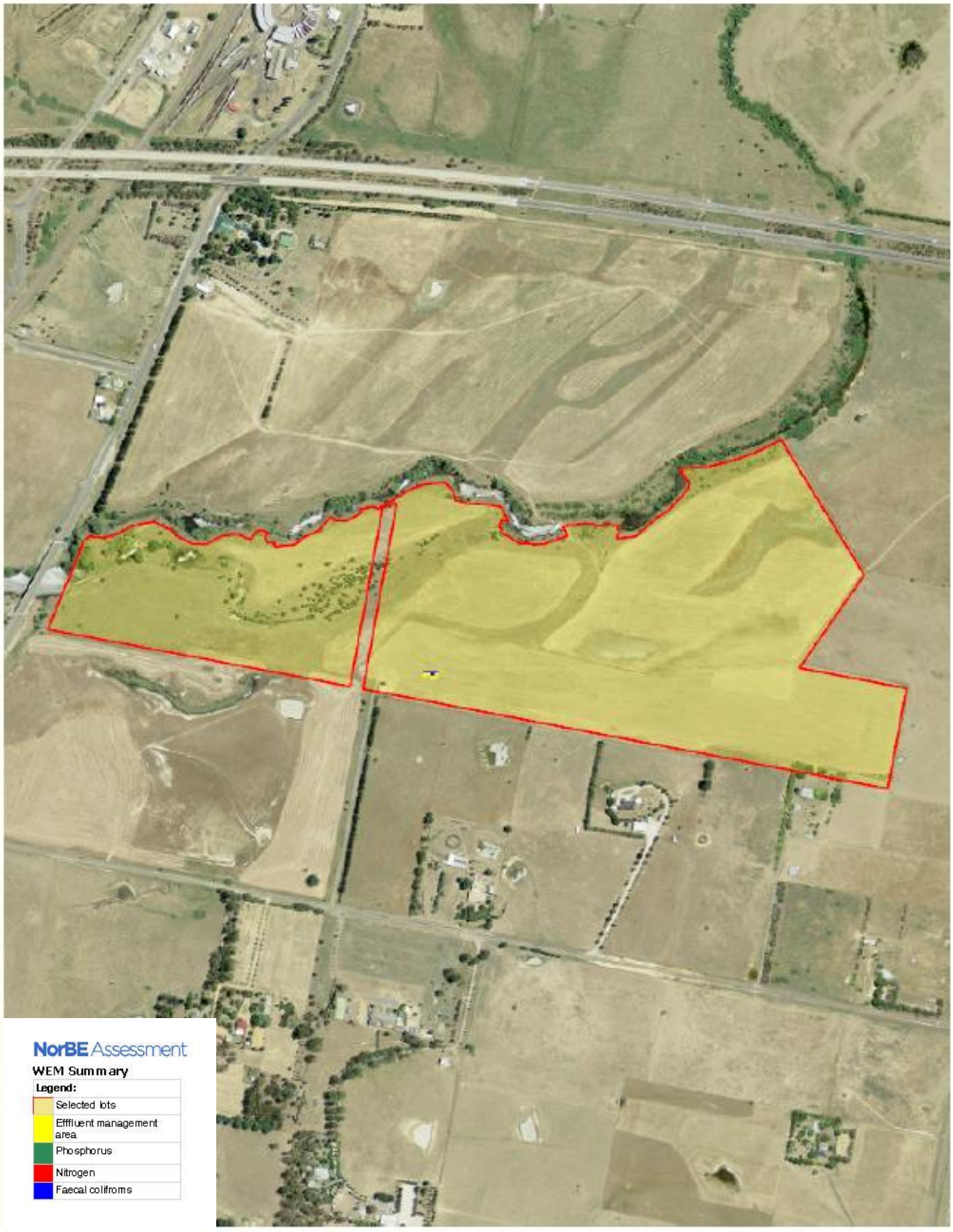
NorBE Assessment

WEM Summary

WEM Plume Map

LOT 13

version 3



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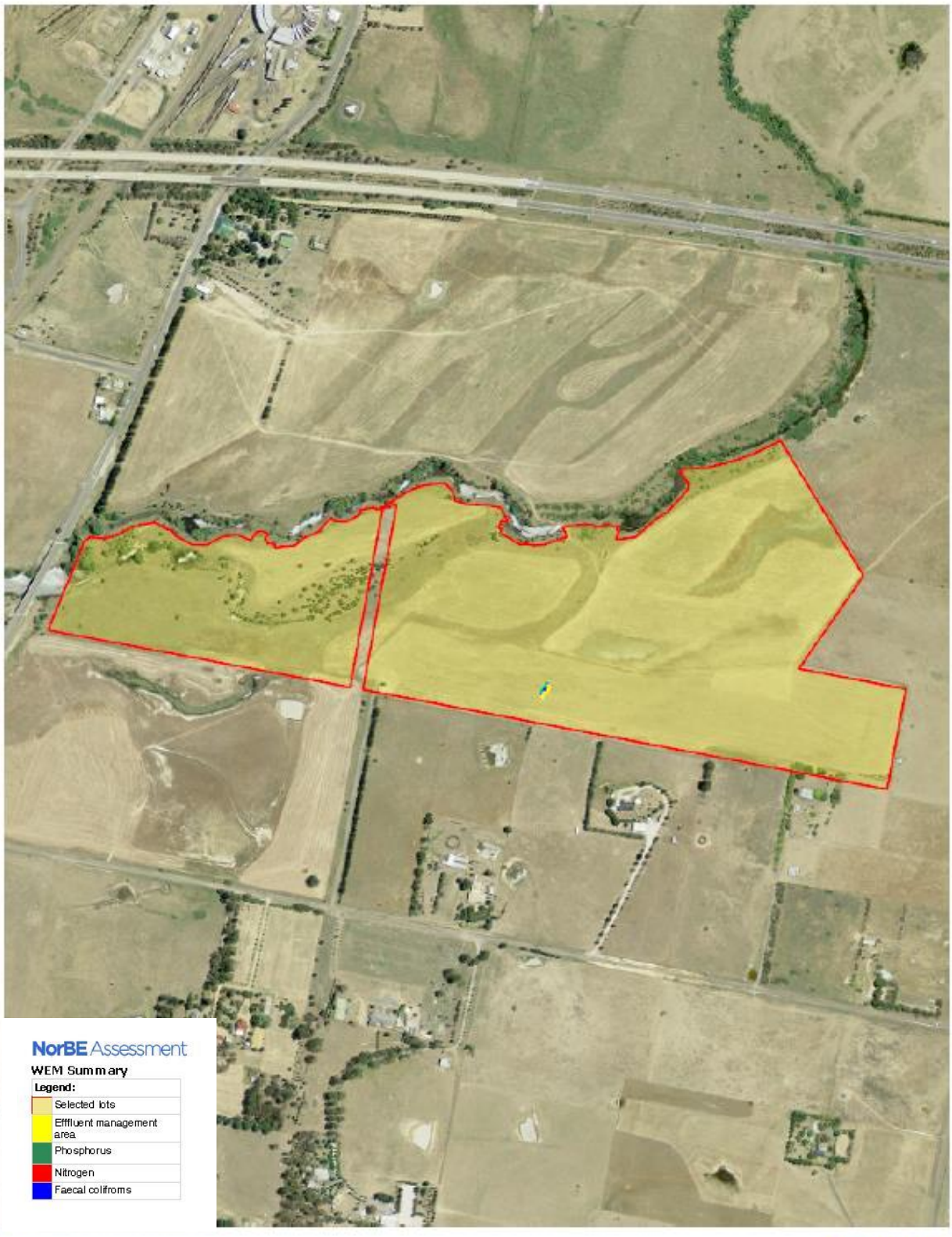
WEM Summary

WEM Plume Map

version 3

LOT 14



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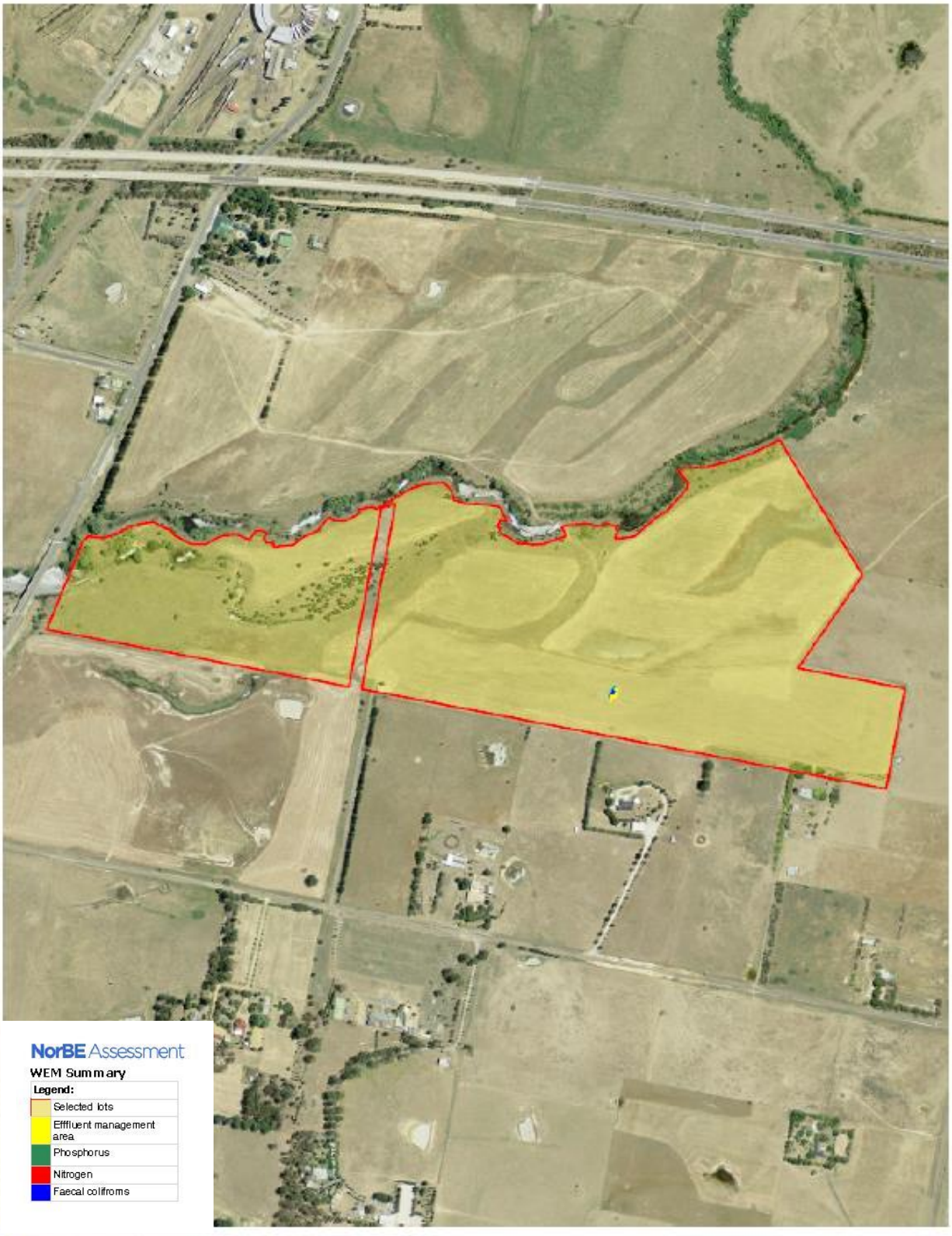
WEM Summary

WEM Plume Map

version 3

LOT 15



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WEM Summary

WEM Plume Map

version 3

LOT 16

WaterNSW

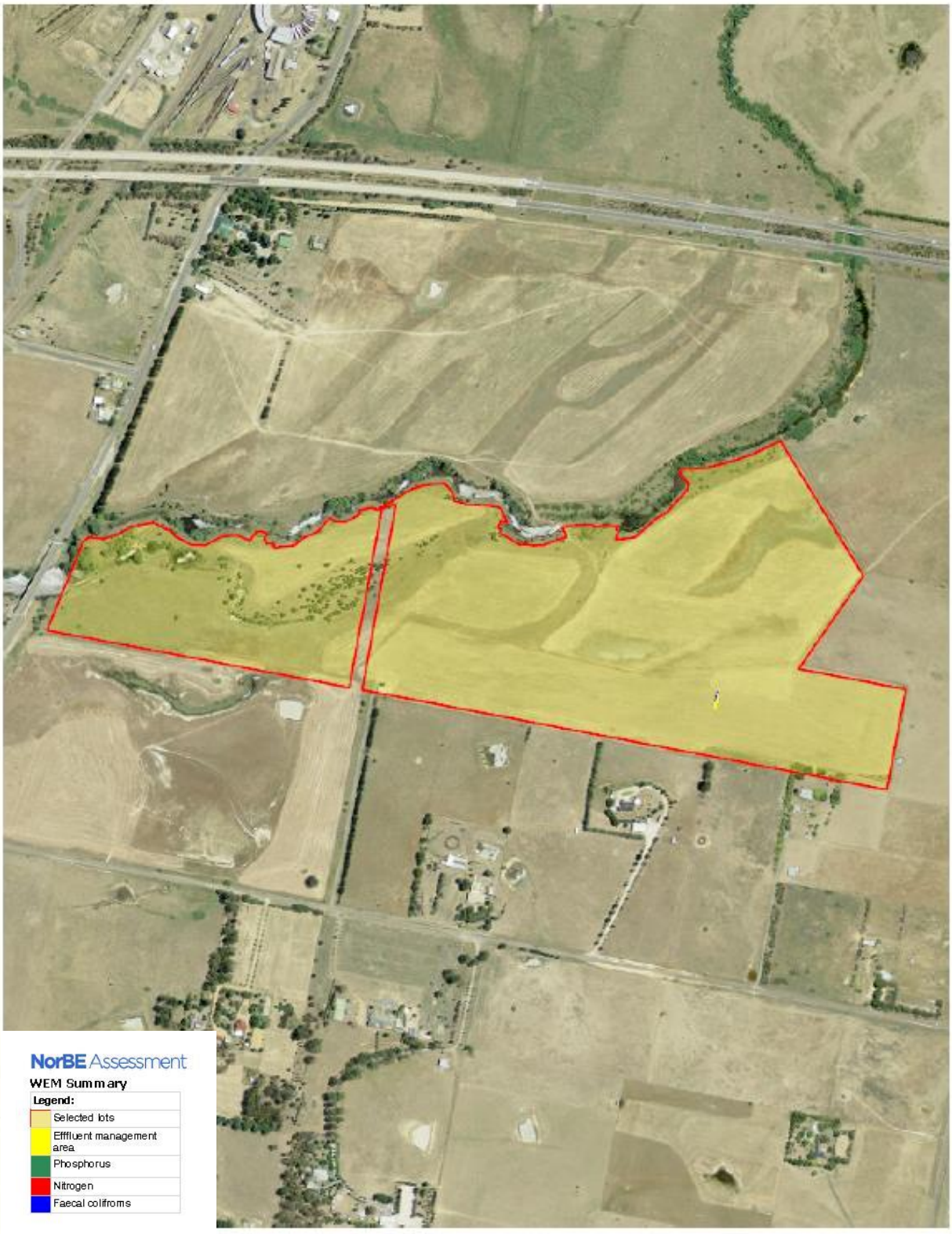
NorBE Assessment

WEM Summary

WEM Plume Map

LOT 17

version 3



WaterNSW

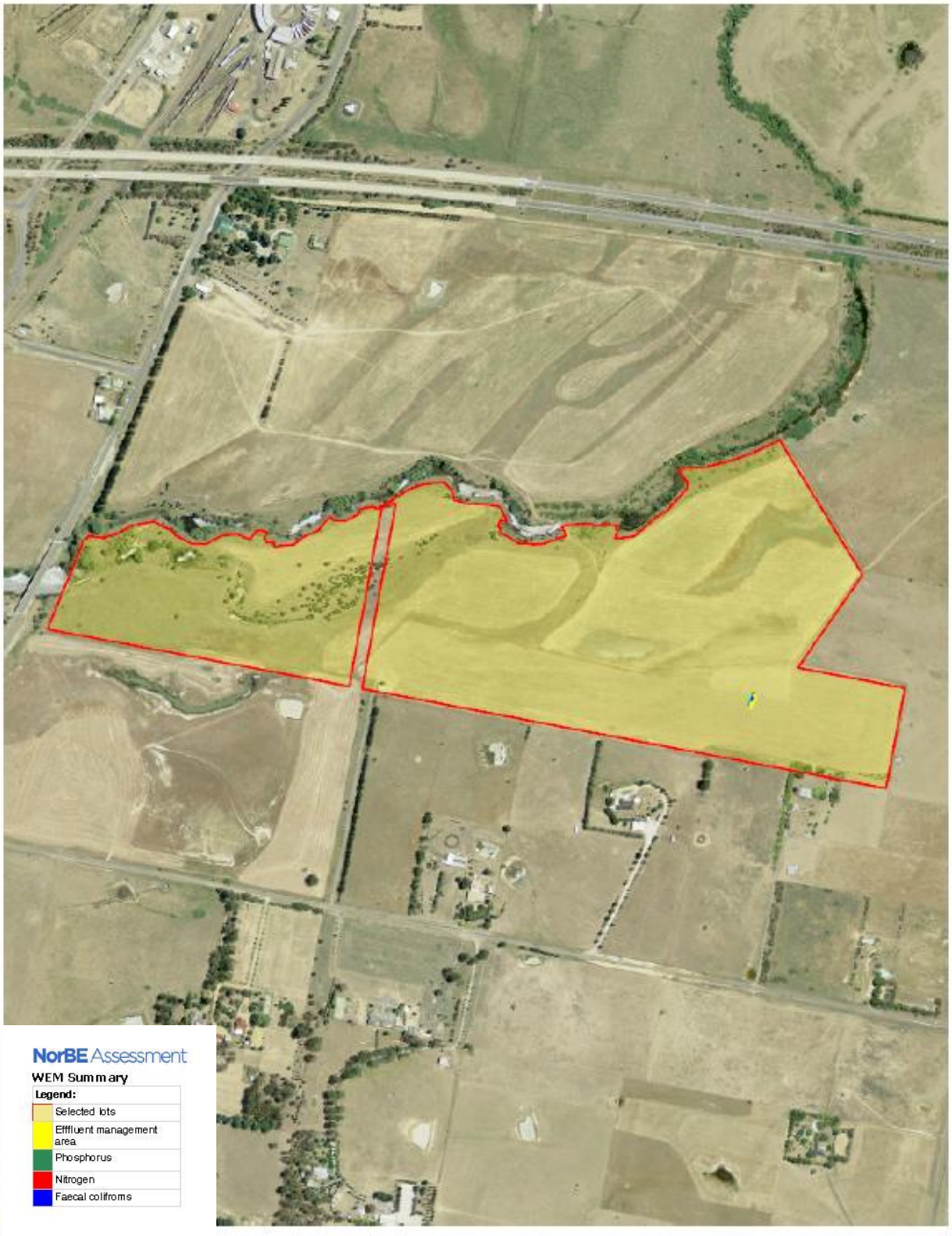
NorBE Assessment

WEM Summary

WEM Plume Map

version 3

LOT 18



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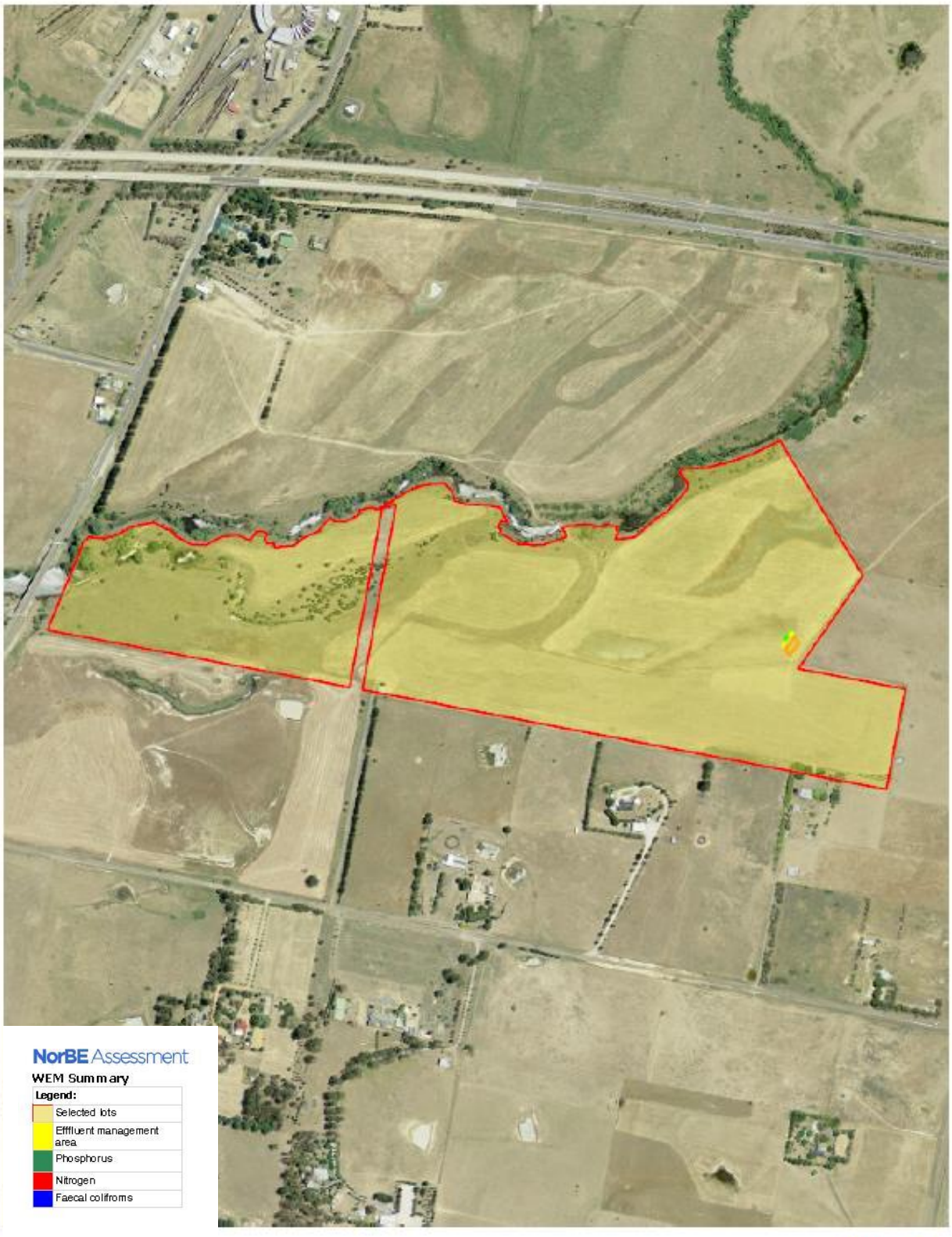
WEM Summary

WEM Plume Map

version 3

LOT 19



WaterNSW


NorBE Assessment
WEM Summary
WEM Plume Map
LOT 20
version 3
NorBE Assessment
WEM Summary
Legend:
Selected lots
Effffluent management area
Phosphorus
Nitrogen
Faecal coliforms
WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

version 3

LOT 21

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

version 3

LOT 22

NorBE Assessment

WEM Summary

WEM Plume Map

version 3

LOT 23

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 24

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 25

version 3

WaterNSW

NorBE Assessment

LOT 26

WEM Summary

WEM Plume Map

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 27

version 3

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Appendix A

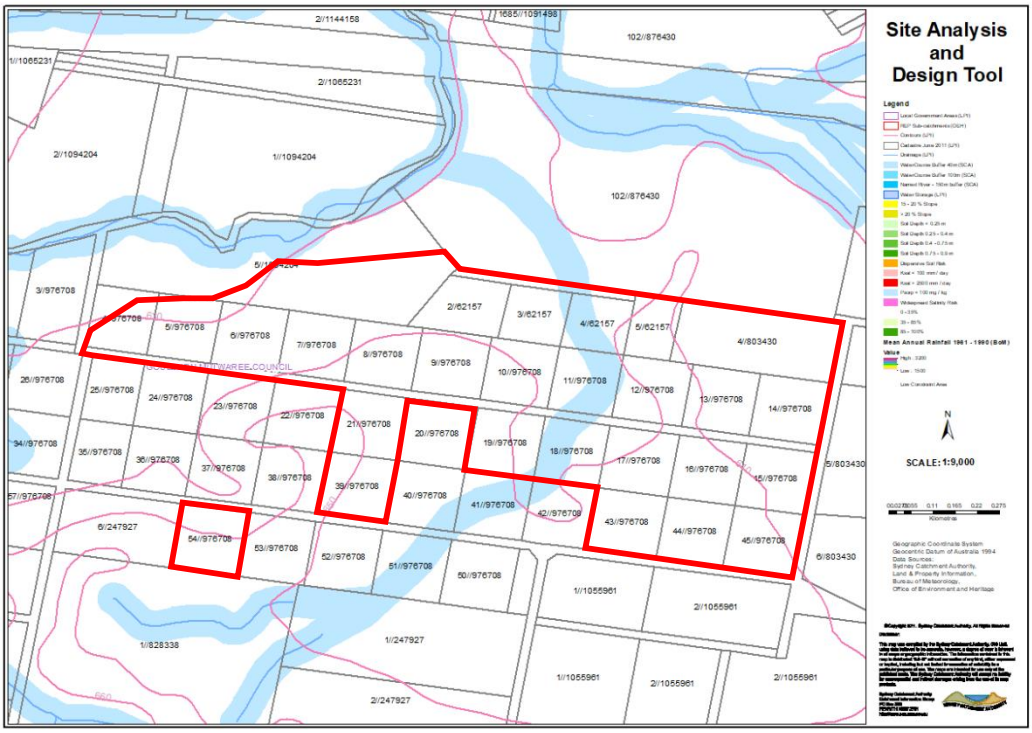
Recommended Buffer Distance for On-site Wastewater Management Systems in the Sydney Drinking Water Catchment

Feature	Level of effluent treatment	Application method	Buffer distance	
			Upslope	Downslope/Flat
Buildings, boundaries, paths and walkways, retaining walls	Primary	Subsoil	4.0m	2.0m
	Secondary (disinfected)	Subsurface and surface irrigation (including drip and trickle)	6.0m	6.0m
Premises boundaries, paths and walkways, recreation areas, in-ground swimming pools	Primary	Subsoil	6.0m	3.0m
	Secondary (disinfected)	Subsurface irrigation	4.0m	2.0m
		Surface irrigation	6.0m	6.0m
In-ground potable water tanks	Primary	Subsoil	15.0m	15.0m
	Secondary (disinfected)	Subsurface and surface irrigation	Not applicable	15.0m
Permanent and intermittent watercourses	Primary	Subsoil	100m from high water level 100m from an SCA named river	
	Secondary (disinfected)	Subsurface and surface irrigation	100m from high water level 100m from an SCA named river	
Bore or well used for domestic consumption	Primary	Subsoil	100m from high water level	
	Secondary (disinfected)	Subsurface and surface irrigation	100m from high water level	
Dam and drainage depression	Primary	Subsoil	40m from high water level	
	Secondary (disinfected)	Subsurface and surface irrigation	40m from high water level	

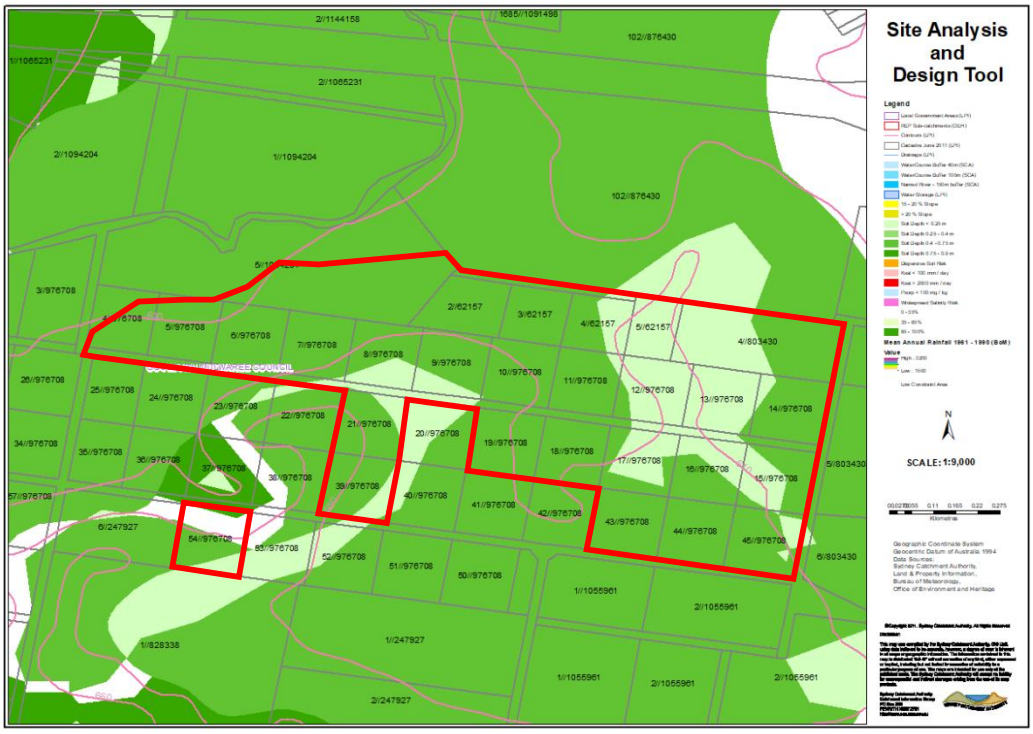
Adopted from 'Designing and Installing On-site Wastewater Systems – A Water NSW Current Recommended Practice (November 2019), Table 2.6 (pages 23 & 24)

Appendix B

Water Sensitive Design – Drainage and Soil Depth Constraints



Drainage constraints overlay with 40 metres buffer zones.



Soil depth constraints overlay