PLANNING PROPOSAL FOR LAND REZONING

LOTS 70, 73 & 77 DP1006688

407 - 457 CROOKWELL ROAD

KINGSDALE. NSW. 2580

WATER CYCLE MANAGEMENT STUDY

SUPERSEDES THE ORIGINAL REPORT PREPARED BY SEEC - DATED 22 DECEMBER 2022

Prepared by SOWDES
10 December 2024

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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 comprising three separate portions identified as Lots 70, 73 and 77 DP1006688 – 407 to 457 Crookwell Road, Kingsdale from a current zoning status of 'RU6 – Transition' to a mix of 'R2 – Low Density Residential' and 'R5 – Large Lot Residential'. The land rezoning opportunity has been identified in the *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 subject site is located at the intersection of the Crookwell Road and Chinamans Lane which is just on the northwestern outskirts of the city of Goulburn, directly opposite existing developed urban land release areas. The site is bordered by two separate formed roads; the Crookwell Road traffic corridor along the eastern boundary which is a Transport for NSW (TfNSW) classified road, and Chinamans Lane along the southern boundary. The site covers an area of 50.85 hectares which is comprised of three separate registered portions – two of which are held in one ownership, and the other is held in separate ownership, however throughout this submission they will be referenced as though they are a single parcel of land.

The property which has historically been used for livestock production is predominantly set to open paddocks of improved pastures and native grasslands, however there is a few discontinuous rows of radiata pine trees throughout to serve as wind breaks, and there is a scattering of eucalyptus trees and several exotic trees around the curtilage of an existing dwelling within the eastern portion of the holding. The curtilage is in a defined area comprising several rural sheds and is predominantly surrounded by managed lands with access to the existing dwelling being from the Crookwell Road traffic corridor which borders the eastern boundary of the property.

The development property is burdened by several easements that influence the design of the proposed rezoning and future subdivision; a 24.385 metre wide easement for high pressure gas supply which traverses diagonally across the northern portion of the holdings, a separate 4.50 metre wide easement for optic fibre cable that sits immediately adjacent to the southern edge of the high pressure gas supply easement, and a 6 metre wide easement for 'water supply' that is used to transfer water from Wingecarribee Dam in the Southern Highlands to the city during periods of extreme drought. The water supply easement enters the property in the northeast quarter and sweeps through the northern portion of the property in a large radius curve before exiting into the neighbouring property to the west.

The terrain throughout the property has a general fall from the northeast toward the south-southwest and is dominated by a series of both defined and undefined drainage depressions located at three distinct locations across the site.

The first of the systems runs through the northern half of the site in a northeast to southwest alignment and exits the property where there is a right-angled bend in the boundary that forms the southern aspect of the northern half. The second system is located in the northwest corner of the holding and for the length of its pathway through the property stays on the northern aspect of the high-pressure gas supply easement thereby only burdening two of the proposed Lots in a future subdivision of the land. The final mapped drainage corridor is located in the southeast quarter of the property which directs surface water runoff from the Crookwell Road traffic corridor and adjoining lands on the opposite side of the roadway through the lower southern half of the property. The first and third identified drainage systems merge just outside the lower southwestern corner of the site within the neighbouring property to the west.

A conceptual subdivision design for the property has been prepared which allows for varying Lots sizes based largely on the natural drainage regimes associated with the topography of the land and the proximity of environmentally sensitive areas, and the restrictions on land development around the aforementioned easements. The largest portion of the site which is south of the gas supply easement has been identified as being suitable for 'R2 Low Density Residential' land zoning with minimum Lot sizes of at least 700m², whilst the land on the northern side of the gas supply easement has been identified as 'R5 Large Lot Residential' land zoning with the minimum Lot size of 2 hectares. A small portion of land on the western side of the site that drains toward the west but still on the southern side of the gas supply easement has been identified as future larger Lots with a minimum Lot size of 4,000m².

The potential yield for all land zones is 248 Lots in the 'R2' zoned area, 3 Lots of at least 2 hectares in the 'R5' zoned area on the northern side of the gas supply easement, and a further 5 Lots of 4,000m² in the western draining lands. In addition to the Lot yield potential the proposed development would include a new internal road network and several reserves for drainage, biodiversity values and vegetation management, and the protection of an area of Aboriginal Heritage.

At present the development site is not directly benefited by a Council maintained water supply or gravity sewer system however any future development of the land will require the installation of a reticulated water supply, a gravity sewer system and several pump stations, inter-allotment stormwater drainage services, and ancillary infrastructure to most of the Lots. All 'R2' zoned Lots on the southern side of the high-pressure gas main will be fully serviced by the aforementioned infrastructure, and the five 4,000m² 'R5' zoned Lots on the southern side of the gas main will also be serviced by the reticulated water supply.

The larger Lots in the 'R5' zone on the northern side of the gas main will not be serviced by the reticulated water supply, and all 'R5' zoned Lots will not be connected to the gravity sewer system thereby each of these Lots will need to be self-sufficient in the management of onsite generated effluent, and stormwater drainage.

The aims and objectives of the Water Cycle Management Study report are to:

- Satisfy the Objectives as detailed in Direction 3.3 'Sydney Drinking Water Catchments' of the Ministerial Directions which commenced 21st November 2022
- Provide a detailed description of the development property and an overview of the natural drainage patterns affecting the site along with other constraint areas.
- Present details of the proposed development of the land and how stormwater drainage and water quality will be managed
- Detail the proposed stormwater treatment measures for the changes in surface finishes associated with the internal roads and new residential allotments
- Discuss the measures to be undertaken during the civil construction phases of the future subdivision works
- Conclude the submission with a summary of the water quality outcomes and any site-specific recommendations, and highlight any other matters for consideration.

Whilst this report has based its determinations and recommendations on a proposed subdivision design that is subject to a raft of considerations and approvals it is recognised that the next stage of the development process following rezoning of the land is the submission of a formal subdivision application that will include detailed engineering plans and addressing any matters for concern that may arise during the land rezoning assessment process.

It is considered that the proposed rezoning of the land from the current 'RU6 – Transition' to a blend of both 'R2 – Low Density Residential' and 'R5 – Large Lot Residential' and a subsequent subdivision of the land to create a total of 256 allotments plus internal access roads and ancillary infrastructure is consistent with the intent of the Goulburn Mulwaree Council Urban and Fringe Housing Strategy (2020), and the neutral or beneficial effect (NorBE) on water quality as required for all developments within the Sydney Drinking Water Catchment.

It is highlighted that due to the need to undertake changes to the original subdivision layout that was prepared in December 2022 which has been brought about by engagement with external agencies this Water Cycle Management Study replaces an original report prepared by *Strategic Environmental and Engineering Consulting* (SEEC) dated 22nd December 2022.

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10th December 2024

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."

Further to the demand for the typical 700sqm house block, there is an emerging trend for more compact living close to the urban core. Recent development activity and increasing supply in this form of higher density development indicate the acceptance of the market to sacrifice large block sizes for more compact living with improved proximity and access.

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."

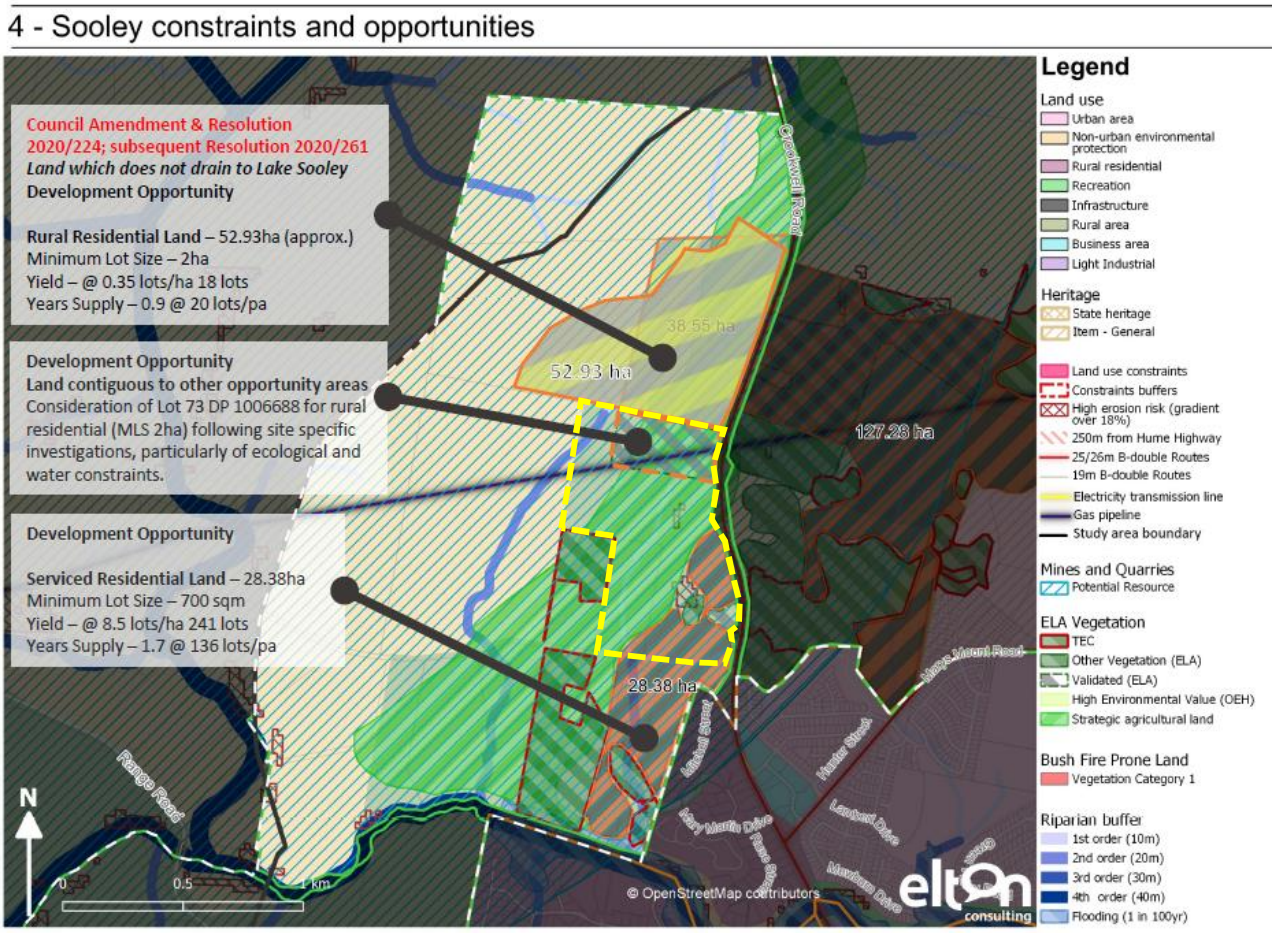

Image from the *Urban and Fringe Housing Strategy* report prepared by Elton Consulting showing the 'Sooley' development precinct and identified land rezoning opportunities. The boundary of the development site is highlighted by the dashed yellow lines in the centre of the image.

The development property is located on the northwestern outskirts of the city of Goulburn and is identified within the *Urban and Fringe Housing Strategy* study as a locality suitable for rezoning to a mix of both 'R2 -Low Density Dwelling' and 'R5 – Large Lot Residential' to help meet future land and housing demands. The property which falls within the *Sooley* development precinct and is currently zoned 'RU6 – Transition' has been identified within the study with an overall potential yield of 241 smaller Lots not less than 700m² in area, and 18 large Lots with a minimum area of 10 hectares – however these numbers may have been modified since the study was originally released. The development property is located within the eastern portion of the *Sooley* development precinct which is situated on the northwestern edge of the city and is an ideal location to leverage off existing services, utilities, and infrastructure that presently extends to established urban land developments to the immediate south of the site.

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. The site is burdened by two separate but adjacent easements for high-pressure gas supply and optic fibre cables that run diagonally through the northern portion of the holding which in part regulates the potential subdivision design and Lot sizes due to various constraints and permissible activities within specified distances around the easements. A third easement for water supply that is designed to transfer raw water from the Wingecarribee Dam in the Southern Highlands during periods of extreme drought also burdens the property – but to a lesser extent due its alignment and location through the site.

The conceptual subdivision design will potentially create a total of 248 smaller residential Lots not being less than 700m² and 5 Lots that average slightly more than 4,000m² on the southern side of the high-pressure gas and optic fibre easements, and an additional 3 Lots of at least 2 hectares in area on the northern side of the easements. Separate to the proposed residential allotments will be several reserves for drainage, biodiversity values and vegetation management, and the protection of an area of Aboriginal Heritage along with a network of new internal roads. It is assumed that an existing dwelling and several rural structures will be demolished, and therefore all new Lots will be seeking residential dwelling permissibility.

The development site is bordered by two separate named and formed roads that have a minimum corridor width of 20 metres:
1/. Crookwell Road along the eastern boundary which is a TfNSW classified road that provides an important transport link between Goulburn and other regional cities and townships to the north such as Crookwell and Bathurst. The road is a bitumen sealed formation that provides access to many rural land holdings between Goulburn and Crookwell, and to several smaller localities that lie between Crookwell and Bathurst. The posted speed limit along the section of Crookwell Road that lies parallel to the eastern boundary of the site is presently 100kph commencing from the southeast corner of the holding. It is noted that the width of the road reserve is variable along the property frontage with the minimum width at any point being 36 metres, and in some locations the width increases to be greater than 50 metres.

2/. Chinamans Lane which runs along the southern boundary of the development site commencing from the Crookwell Road traffic corridor and extending to the west where it links with Range Road which is a local road that services rural holdings between Goulburn and the village of Grabben Gullen. Chinamans Lane services several small and large rural holdings between the banks of the Wollondilly River and city's raw water storage facility at Sooley Dam.

The development property covers a total area of 50.85 hectares which is comprised of three separate portions: Lots 70, 73 and 77 in Deposited Plan 1006688. Lots 70 and 77 which comprise the bulk of the lands (41.18 hectares) are under the one ownership whilst Lot 73 which is in the northern portion of the holding is under separate ownership. The proponent of the rezoning submission has the option to purchase both sites upon successful approval of the application.

The existing dwelling within the site is currently accessed via a sealed carriageway that enters the property from the eastern aspect off the Crookwell Road traffic corridor. The carriageway is formed along the crest of a hill and meanders through a defined curtilage comprised of several rural sheds and structures before gradually sweeping down a part of the hill on the southern aspect and terminating at the existing dwelling.

The property is burdened by an overhead power transmission line that enters the property from the southern aspect and runs north → south through the site to service several adjoining properties further to the north with a feed line branching of this supply to service the existing dwelling. As mentioned previously, the development property is burdened by several easements that influence the design of the proposed rezoning; a 24.385 metre wide easement for high pressure gas supply which traverses diagonally across the northern portion of the holdings, a separate 4.50 metre wide easement for optic fibre cable that sits immediately adjacent to the southern edge of the high pressure gas supply easement, and a 6 metre wide easement for 'water supply' that can be used to transfer water from Wingecarribee Dam in the Southern Highlands during periods of extreme drought that enters the property in the northeast quarter and sweeps through the northern portion of the property in a large radius curve before exiting into the neighbouring property to the west.

The terrain throughout the property has a general fall from the northeast toward the south-southwest and is dominated by a series of defined drainage depressions located at three distinct locations across the site. The first of the systems runs through the northern half of the site in a northeast to southwest alignment and exits the property where there is a right-angled bend in the boundary that forms the southern aspect of the northern half. The second system is located in the northwest corner of the holding and for the length of its pathway through the property stays on the northern aspect of the high-pressure gas supply easement thereby only burdening two of the proposed larger 2 hectare Lots in a future subdivision of the land. The final mapped drainage corridor is located in the southeast quarter of the property which directs surface water runoff from the Crookwell Road traffic corridor and adjoining lands on the opposite side of the road through the lower southern half of the property. The first and third identified drainage systems merge just outside the lower southwestern corner of the site within the neighbouring property to the west. The conceptual subdivision design has identified the natural flow of stormwater across the site and accordingly has included dedicated reserves for the purposes of drainage at strategic locations which may be used in part or in full depending upon the final calculation requirements.

On either side of the main drainage line that runs through the northern half of the property is a series of slopes and ridges that combine to form a 'moderately' undulating topography through the central portion of the site. The slopes on the eastern and western sides of the central drainage depression are variable and, in some cases, terraced with the average slope being around 10° - however there are areas where the slope may exceed 15° in small sections. The elevation changes between the drainage depression through the centre of the site and the top of the adjoining ridge lines vary by approximately 20 to 25 metres whilst the distance from the centre of the drainage line to the top of the ridge lines averages between 110 and 120 metres, although some distances are slightly longer.

In the northwestern portion of the site there is a gentle and somewhat consistent fall averaging 5° from the crest of the western ridge line toward the western boundary and toward the drainage depression that runs through this portion of the site. The southern portion of the site has a general fall from the crest of a hillock where the existing dwelling and curtilage are located in an arc formation from the west and around to the southwest and then to the south at variable grades that average between 10° and 15°, the steeper section being the lower slopes to the west. The lower southeast corner of the site has significantly less slope with a more pronounced east to west fall of less than 5° following the alignment of the drainage depression that burdens the southern aspect of the site.

The vegetation formations throughout the property which has historically been used for grazing by sheep and cattle are dominated open paddocks of improved pastures and native grasslands, however over the past 5 or so years the property has seen less pasture improvement and only light grazing. There are a few rows of old radiata pine trees across the site, one in the northern portion where the larger 2 hectares Lots are proposed, and another along the ridge line around the curtilage in the central-eastern portion of the site. The pine trees are formed in single rows however due to their age many are now displaying signs of necrosis and die-back with gaps appearing between some of the trees. Scattered across the slopes that surround the existing dwelling and curtilage are numerous eucalyptus trees that are quite well spaced and without overlapping canopies.

The subject site is surrounded by a mix of both small and large rural holdings to the north, east, and west that are also set to open grasslands and improved pastures with some scattered trees – particularly on the eastern aspect. The southern aspect of the site is dominated by urban land developments with small Lots and a few small rural holdings. The two road corridors that border the eastern and southern boundaries of the site and are variable in width form a physical barrier between the development property and the adjoining developments.

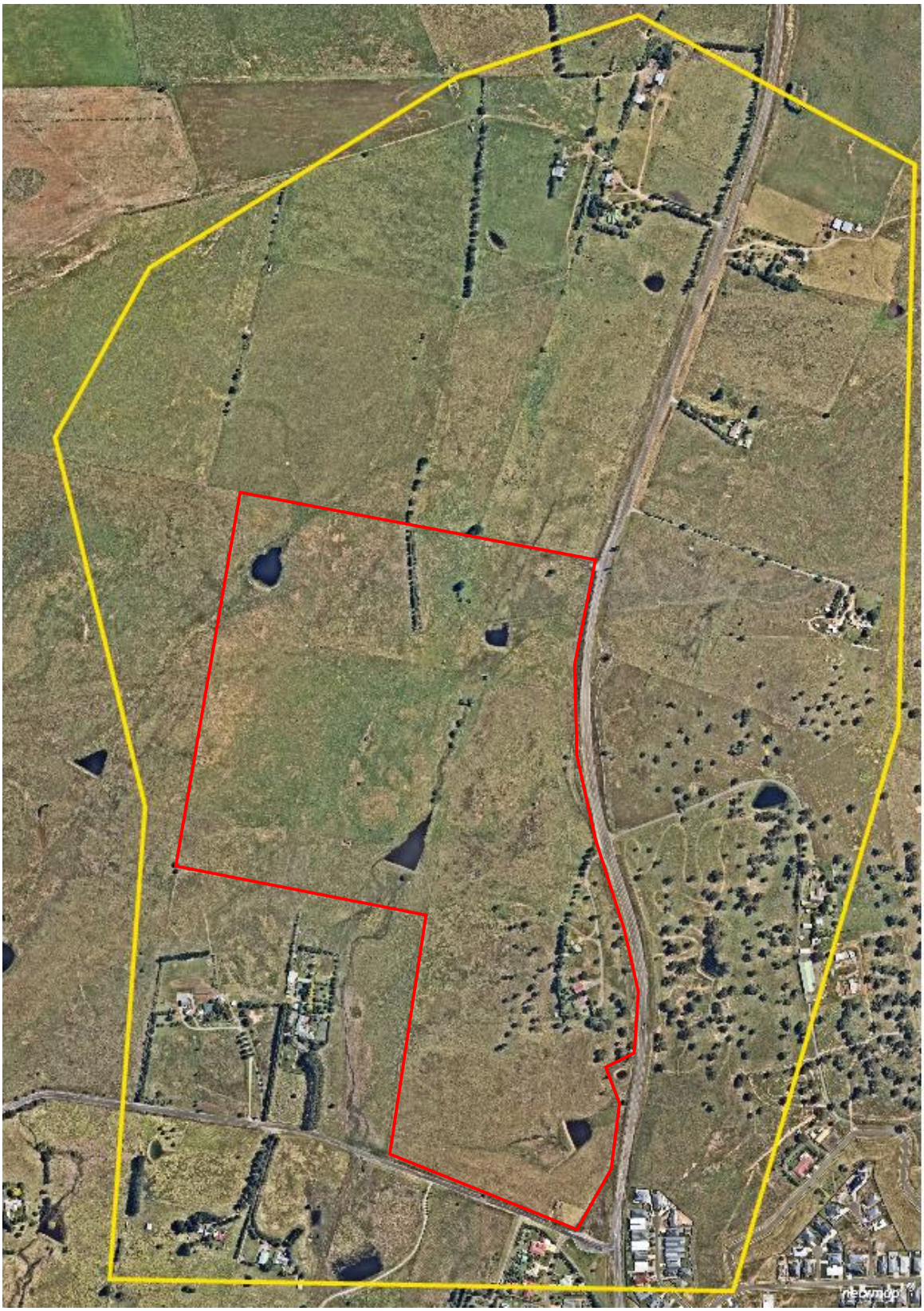

Figure 1. Recent aerial image of the development site (red) and the contributing catchment area within the bounds of the yellow line to the north, northeast, and east of approximately 107 hectares which generates overland flows and surface water runoff that burdens the site. It is noted that the surface types within the catchment areas are comprised of homogonous vegetation types and land uses associated with historical agricultural activities.

Future Subdivision Proposal.

Prior to preparing a conceptual subdivision design the identification and delineation of potential constraints associated with the rezoning of lands that are subject to periodic flooding and/or overland flows must be considered to satisfy the provisions of 'Section 9.1 of the Environmental Planning and Assessment Act (1979) – Direction 4.1 Flooding'. Direction 4.1 (2) and 4.1 (3) state that a planning proposal must not contain provisions that apply to the '*flood planning area*' which permit development in '*floodways*', result in significant impacts to other properties, or permit development for the purposes of residential accommodation in '*high hazard*' areas. Each of the terms in previous sentence that are in italics have very specific definitions within the NSW Government Department of Planning and Environment publication titled 'Flood Risk Management Manual – The policy and manual for the management of flood liable land' (June 2023), and these components need to be identified in the preliminary stages of the subdivision design to determine where development cannot occur.

In accordance with the Local Planning Direction 4.1 'Flooding' areas of the site identified as being within the flood planning area are to be zoned 'C2 – Environmental Conservation' which would therefore prohibit any future use of the land for residential or other development purposes. Within the context of a separate 'Local Flood and Overland Flow Study' prepared for the land rezoning proposal which is assessing the major overland flows that burden the site the 'flood planning area' is defined as: the extent areas which act as floodways as well as areas where the depth of water in the 1% AEP rain event that is greater than 100mm. This approach is consistent with the methodology adopted by GRC Hydro for the recently conducted *Marulan Floodplain Risk Management Study* (2023) that was undertaken on behalf of the Goulburn Mulwaree Council.

By applying the aforementioned methodology to determine the flood planning area the parts of the site that are not suitable for residential development purposes were identified along with the flow paths and extents of other design events such as the probable maximum flood to determine the most appropriate layout of a future subdivision of the land. Due to the nature of the major overland flow paths that dissect the site, and further to communications with Goulburn Mulwaree Council Strategic Planners the proposed subdivision layout was required to demonstrate that access and egress from all parts of the property can be maintained in design events up to and including the 1% AEP. To achieve access and egress in the 1% AEP design rain event trafficable concrete drainage culverts will be required at three strategic locations where the internal roadways are proposed to cross the drainage corridors.

In addition to the constraints on the subdivision design associated with overland flows other constraints such as biodiversity values and Aboriginal Cultural Heritage, and design considerations such as perimeter roads for bush fire protection purposes and adequate areas for the placement of inground infrastructure have been included in the proposed subdivision layout.

The conceptual subdivision design for the development property will include a mix of 'R2 – Low Density Residential' Lots with a minimum Lots size of 700m² and 'R5 – Large Lot Residential' allotments that will vary between 4,000m² and 2 hectares in area.

The location of the existing easements for high-pressure gas supply and optic fibre cable in the northern portion of the site significantly influences the distribution of land use zones and the design of the future subdivision, including Lot layout and road locations. There are certain restrictions related to permissible activities around and near both easements, the most limiting of which is generally associated with the high-pressure gas supply line as it is the wider of the two and has very specific and documented controls. The third easement that houses the water supply lines is less of a concern for the subdivision design as it is predominantly located along the margins of the defined drainage depression that runs through the northern portion of the site and therefore sits within an area that realistically is not suited for any other type of development purpose.

In lieu of the limitation imposed by the existing easements in the northern portion of the site and in combination with the natural topography the land area to the north of the easements is proposed to be zoned as 'R5 – Large Lot Residential' with a minimum Lot size of 2 hectares. The available land area on the northern side of the easements less provisions for a perimeter access road will generate no more than 3 Lots in this zone. The northwestern portion of the site that sits on the western side of the ridge line but also on the southern side of the existing easements will also be zoned as 'R5 – Large Lot Residential' however the Lot sizes here will be 4,000m² which is large enough to manage onsite generated effluent within the boundary of the Lot and thereby remove the need to provide gravity sewer in this portion of the site. The available land area in this portion of the site less provisions for a perimeter access road will generate no more than 5 Lots. It is noted that an earlier report prepared by ACT Geotechnical Engineers Pty Ltd (Ref: KA/C12356) which addresses the soil conditions and wastewater management requirements for any of the proposed Lots not directly connected to the reticulated sewer system is deemed to still be applicable to the revised subdivision layout as the study area within the site essentially remains the same.

The southern side of the two main easements comprises approximately 35.40 hectares of the overall land holding and is proposed to be zoned as 'R2 – Low Density Residential'. The conceptual subdivision design has demonstrated that approximately 248 residential allotments could be created in this area along with provisions for an internal road network and dedicated reserves in strategic locations for drainage, biodiversity values and vegetation management, and for the protection of areas of Aboriginal Heritage. The road network through this portion of the site will occupy approximately 8.342 hectares of land whilst the dedicated reserves will cover a combined area of 6.814 hectares. The resulting available land area for residential purposes therefore becomes 19.344 hectares which yields an average Lot size of 780m².

Access to the development site will be from the existing road corridors on the southern and eastern aspects with new entrances to be created at each location via dedicated turning lanes. The Crookwell Road traffic corridor is presently sign-posted with a 100kph speed limit commencing from the southeast corner of the development property – just north of the intersection with Chinamans Lane, however this might be reduced once the subdivision proceeds. The internal road network will be formed in corridors that have a minimum width of at least 18 metres with the carriageway portion being at least 11 metres wide between kerbs.

Future subdivision of the site will include a reticulated water supply throughout the 'R2' and 'R5' 4,000m² zoned Lots on the southern side of the high-pressure gas main whilst the 'R2' zoned Lots will also be serviced with gravity sewer and interallotment stormwater drainage infrastructure. The reticulated water supply system will be installed to meet the requirements of the Council's engineering standards – including design layout and achieving minimum pressures and flow rates to meet the provisions of "AS2419.1.2021 - *Fire hydrant installations System design, installation and commissioning*" in relation to hydrant outlet spacing and locations. A detailed design of the stormwater drainage system for the internal road network capable of managing flows in the design events will be undertaken at the time of submitting the subdivision application.

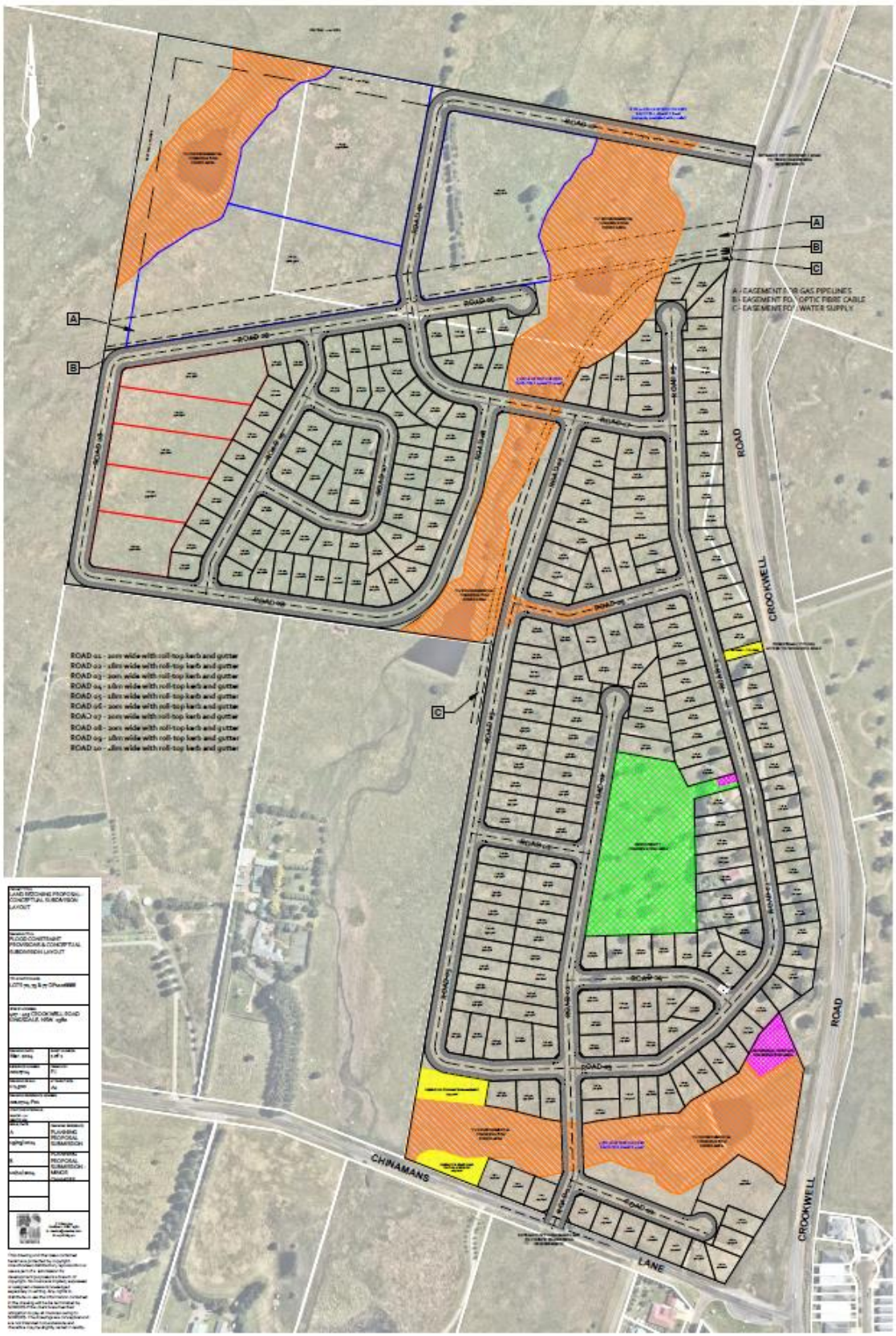

Figure 2. Reduced image of the conceptual subdivision layout showing the areas of 'C2 – Environmental Conservation' zoning as orange diagonal shading, Aboriginal Heritage as magenta coloured shading, biodiversity values as light green coloured shading, proposed stormwater and sewer infrastructure reserves and pedestrian / bicycle access as yellow coloured shading, the road network, and proposed Lots. Refer to the accompanying pdf version of the plan (Ref: 0010724-F01-B) for enlarged detail of the conceptual subdivision layout.

2/. Stormwater drainage and overland flows.

The development property and surrounding lands are not identified in any current planning or mapping instruments as being within flood liable lands, however preliminary 'high level' studies have been undertaken for the Council as a separate exercise to the recently adopted *Goulburn Floodplain Risk Management Study and Plan* to identify areas outside of the mainstream riverine flooding that may be adversely affected by overland flows in large rain events. The subject development site is burdened by general overland flows associated with surface water runoff originating within adjoining lands and properties to the north, east, and to a lesser degree to the northwest of the site. A separate 'Local Flood and Overland Flow Study' has been prepared by SOWDES to assess the impacts of existing overland flow from these external sources and from stormwater drainage generated within the site on the land rezoning proposal and potential future residential subdivision development for the land.

The development property is burdened by a series of both defined and undefined episodic drainage corridors that traverse through the site in a varying array of alignments however these corridors are not a named river or creek system but are low-order upstream tributaries that eventually discharge into the Wollondilly River which is located further to the south of the site. The main sources of overland flows and surface water that burden the development site emanate from the northern, northeastern, and eastern aspects and form three separate flow pathways.

The first of the three drainage systems has an upstream catchment area that drains into the central portion of the property and comprises an area of approximately 68.10 hectares with the furthest part of the catchment being approximately 800 metres from the northern boundary. This catchment contains land on either side of the Crookwell Road traffic corridor and is comprised of homogonous land uses and surface finishes which are dominated by open paddocks of grasslands for stock grazing. The range of design rain event modelling undertaken as part of the Local Flood and Overland Flow Study indicates there are several locations along the Crookwell Road traffic corridor where surface water that is generated to the northeast of the development property crosses the roadway and enters the upstream catchment thereby directly contributing to the flow of water that burdens the site. The overland flow that runs through the central portion of the property travels in a north - south alignment within a defined channel of varying width and comprises two dams and a series of small hollows and ponds that form a chain of storage zones within the modelled rain events. One of the dams is located where the gas and communication easements cross the site, whilst the other is located on either side of the property's southern boundary adjacent to where there is a right-angled bend in the perimeter fence line.

A separate catchment area of approximately 22.50 hectares also commences on the northern aspect of the site however it is separated from the main catchment by a ridge line that runs in a north – south alignment. Overland flow within this catchment enters the northwestern corner of the site and continues to flow in a northeast – southwest alignment with a single dam near to the northwest corner of the property within the flow path.

Outflows from the dam and high-flow bypass water around the dam exit the western boundary of the property just to the north of the existing gas and communication easements.

The third drainage corridor that flows through the site is associated with a catchment area of approximately 16.63 hectares that is mostly generated on the eastern side of the Crookwell Road traffic corridor and includes surface water runoff from the roadway. The upstream end of the eastern catchment is located in privately owned lands on the opposite side of Crookwell Road and flows in a northeast to southwest alignment, exiting the property and crossing Crookwell Road approximately 180 metres to the north of the intersection of Crookwell Road and Chinamans Lane. The Crookwell Road reserve has a slight 'offset' where some of the surface water from the roadway is directed via a concrete drainage channel to a small dam that is located adjacent to the roadway and just outside the eastern boundary of the development property. Overflow from the roadside dam and the overland flows from the property to the east both enter the southeastern portion of the development site and flow into a moderate sized dam. In the larger rain events or when there has been a prolonged period of wet weather outflows from the dam along with general surface water runoff from the southern portion of the property below the existing dwelling and curtilage flow in an east - west alignment across the lower southern aspect of the site and exit the property near to the southwest corner adjacent to Chinamans Lane. The overland flows that cross the southern aspect of the site merge with the continued flow of water from the central portion of the site within the neighbouring property to the west, and the combined flows then continue in a north – south pattern and cross Chinamans lane enroute to the Wollondilly River.

The conceptual subdivision of the land does not propose to alter the existing flow paths or dams, the only impact of the proposed subdivision development on existing overland flows will be associated with the installation of box culverts within the drainage corridors to facilitate the construction of the proposed internal road network. The conceptual subdivision design includes three crossings of the existing drainage corridors; one over the southern drainage line for an entrance off Chinamans Lane; one that crosses the central drainage channel approximately 130 metres south of the existing gas and communications easements; and the third is located along the northern boundary and also crosses the central drainage corridor approximately 100 metres west from where the northern property entrance will junction off Crookwell Road.

Preliminary overland flow modelling of the post-development site conditions has provided a base upon which refined hydraulic design and modelling can be undertaken to ensure that the flow of water within the drainage corridors where the road crossings are proposed equals the pre-development flow rates. The post-development modelling that has been undertaken in association with the flood and overland flow assessment has identified the minimum requirements for road design levels and culvert sizing at the proposed crossing locations such that 'low risk' and safe evacuation can be achieved in the design rain events up to and including the 0.2% AEP which exceeds the requirements prescribed by Council's Strategic Planners.

It is noted that when reviewing the post-development flood and overland flow model results there is a slight afflux of water at these locations however refined modelling will increase the number and/or size of the box culverts cells at these locations to minimise the backwater effects and achieve flow rates that equal the pre-development conditions. Additional modelling of the road crossings has not been undertaken at this stage in the event that changes are required to the conceptual subdivision layout.

Figure 3 on the following page shows the extent of the 1% AEP water depths and levels that generate overland flows to and through the development site. Refer to the 'Local Flood and Overland Flow Study' report document for expanded details of the drainage catchment, and for detailed model results for both the pre-development and post-development scenarios.

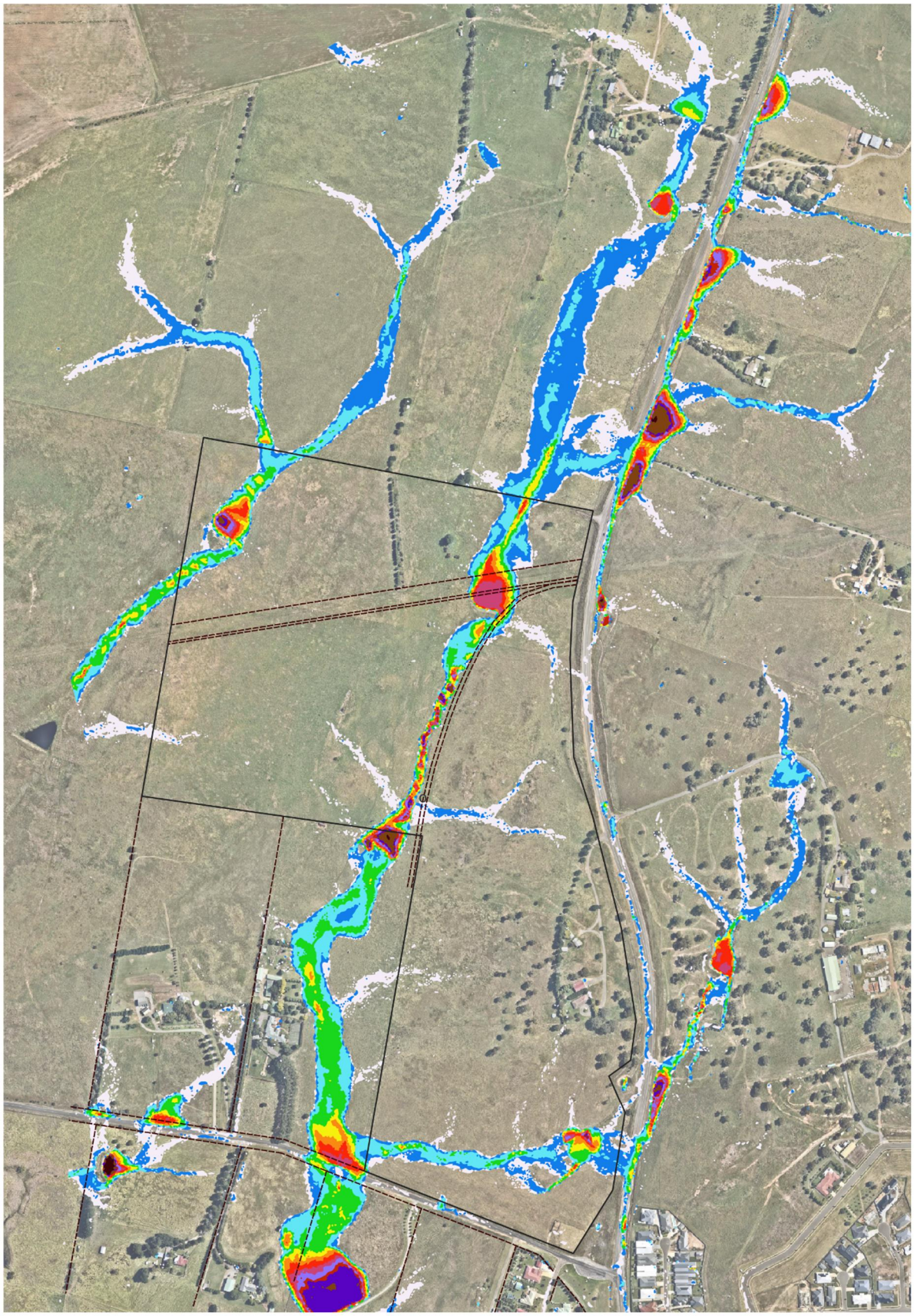

Figure 3. Image from the 1% AEP pre-development model showing the overland flow pathways through the defined catchment area that eventually reach the northern and eastern boundaries of the development site and then flow through the property along established drainage corridors and channels. The image shows the dendritic nature of surface water runoff within the site, noting that water depths less than 25mm have been turned off for clarity.

3/. Water Quality Assessment.

A water quality assessment for the post-development subdivision layout has been undertaken to demonstrate that the provisions of the neutral or beneficial effect (NorBE) criteria can be achieved. The assessment has divided the main portion of the developed site which comprises approximately 30.77 hectares into 11 separate sub-catchment areas of varying size based on the natural terrain and proposed road network with each sub-catchment comprising a mix of both residential allotments and sections of the proposed internal roadways. The development areas around Lots 1 to 3 on the western side of the southern entrance off Chinamans Lane, the larger rural Lots to the north of the gas line easement, and the dedicated reserves for drainage and conservation purposes have not been included in the water quality assessment as these are areas either have no change in surface type or they can manage the surface water runoff and water quality requirements quite simply either through small Lot scale treatment measures or the use of swales and farm dams in the larger Lots.

The individual sub-catchment areas vary in size from 0.543 hectares to 6.048 hectares and are identified in Figure 4 with large red numbers and red coloured outlines. The boundary for each area has been determined by a combination of factors such as the location of the road reserves, the natural breaklines and runoff zones within the terrain, and the logical position for an end-of-line treatment system which is conveyed by the road corridors and a piped stormwater drainage infrastructure. The proportion of residential land to road reserve within each catchment is varied, refer to Table 1 for a break-up of the catchment areas and the distribution of source types.

Table 1. Sub-catchment areas and stormwater runoff source details

Sub-catchment #	Area (m²)	Number of Lots	Total Residential Lot Area (m²)	Total Road Reserve Area (m²)
1	1,3630	10	9550	4080
2	1,7260	18	1,3090	4170
3	2,7330	26	2,0930	6400
4	5,1650	39	3,2860	1,8790
5	3,8190	37	3,0470	7720
6	1,5870	12	9460	6410
7	1,9900	16	1,3620	6280
8	1,4370	15	1,1840	2530
9	6,0480	54	3,9240	2,1240
10	5430	4	3000	2430
** 11	4,3110	16	3,0440	1,2670
Totals	30,7720	247	21,4500	9,2720

** 'Catchment 11' comprises a mix of 11 x R2 residential Lots of 700m² or greater, and the 5 x R5 Lots on the western side of the ridge. The percentage of effective impervious area in each Lot when developed will vary due to the difference in Lot sizes.

It is noted from the above sub-catchment Table that 'catchment 11' comprise the 5 x 4,000m² Lots on the western side of the development property along with 11 x R2 Lots of 700m² or greater. This cluster of residential Lots has been included in the water quality assessment as they drain to a section of the proposed road system, and in combination they represent a potential zone for water quality impacts.

Within the water modelling assessment the pre-development conditions have been attributed the parameters of 'Agricultural' land use with a 100% pervious fraction. The existing internal access carriageways and residential dwelling with rural sheds and outbuildings have not been included in the pre-development site conditions, and for the purposes of the land rezoning proposal their exclusion does not adversely influence the proposed water treatment measures or outcomes.

In the post-development assumptions, the residential Lots have been modelled as 'Residential' but with a 100% pervious fraction. This is based on the provision that at future residential development stages the individual Lots will be required to meet the NorBE requirements by providing Lot-scale treatment measures to achieve a suitable level of pollutant reductions prior to discharging from the site. By doing so the quality of the water from the residential Lots entering the stormwater drainage system throughout the site will be at least equal to or better than the pre-development conditions. It is assumed that each Lot would use a combination of rainwater tanks and small biofiltration treatment devices to meet these criteria. The treated water leaving the individual Lots is not lost from the drainage system hence the inclusion of the residential Lots as 100% pervious within the post-development models.

The new internal road system will comprise a mix of 18-metre and 20-metre-wide roads; each with a formed carriageway that is at least 11 metres wide in accordance with Council's engineering requirements. Within the 20 metre roadways the engineering requirements stipulate a pedestrian footpath on either side of the carriageway, whilst the 18 metre roadways only require a pedestrian footpath on one side of the carriageway. As a conservative approach to the percentage of effective impervious area in the roadways all roads have been modelled with the parameters for 'sealed roads' and an impervious fraction of 70%. The higher impervious percentage allows for the possibility of wider footpaths for other shared uses such as bicycle riding and disabled persons in wheelchairs, and other infrastructure and road furniture that may be constructed or installed within the reserves.

For each sub-catchment zone all stormwater from the road drainage system is modelled to pass through an end-of-line gross pollutant trap – either a proprietary product or formed in-situ, and the combined sources of stormwater runoff (road system and inter-allotment drainage) will pass through a small 'dry' detention basin before being treated in a biofiltration basin. The 'dry' detention basin will generally be shallow for public safety considerations, and outside of rain events they will present as a grass covered depression or bowl. The conceptual location of the 'dry' detention basins would be above the high-water level associated with the 1% AEP design rain event, possibly within the margins of the 'C2' zoned areas or between the 'C2' zoned areas and the road reserves where suitable land area allows.

The size of the individual 'dry' detention basins will be determined by hydrological modelling and calculations to ensure that the post-development peak flow rate in all rain events up to and including the 1% AEP does not exceed the pre-development flow rates for the same catchment area, and it is noted that the post-development peak flow rate is calculated on the combination of the undeveloped residential Lots plus the road reserve with a 70% impervious fraction. As an example of the detention requirements, hydrological modelling for the design rain event (being the 1% AEP) for the largest of the defined sub-catchments which is just over 6 hectares in area has determined that a small 'dry' detention basin having a nominal detention volume of 250m³ with a 200mm orifice regulated base outlet would be sufficient to ensure that the post-development discharge flow rate is less than the pre-development flow rate for the same area, along with some minor attenuation of that flow. All other sub -catchment areas which range in size from 0.54 hectares to 5.16 hectares would require proportionally smaller basins to achieve the same post-development peak discharge provisions. It would be a requirement for each 'dry' detention basin that the overflow route from the basin be directed around and away from the biofiltration basin to help prevent the high -flow bypass washing across the surface area and causing damage to the plants and surface zones. The peak flow rate for 1% AEP post-development rainfall event for each sub-catchment area is presented in Table 2. At this preliminary submission stage and until more detailed design work is undertaken for each sub-catchment area the proposed 'dry' detention basins have not been included in the models.

The outflows from the 'dry' detention basins would be directed to the individual biofiltration basins which for simplicity have been modelled with the characteristics:

- An extended detention depth of 200mm
- A 50mm to 100mm layer of 20mm to 40mm rock mulch over the filter media
- The surface area sown with effective nutrient removal plants.
- A filter media depth of 600mm
- A filter media surface area equal to the surface area of the extended detention zone
- A drainage layer depth of 200mm
- A saturated hydraulic conductivity of 200mm/hour
- A total nitrogen content within the filter media of 400mg/kg
- An orthophosphate within the filter media content of 40mg/kg
- An underdrain system that discharges to the downstream drainage corridor.

The required surface area for each biofiltration basin which is summarised in Table 2 is varied based on the size of the sub-catchment area and the proportion of residential Lots to roadways. The conceptual location for each biofiltration basins is shown in Figure 4 as a solid green rectangle which is drawn to scale with the corresponding sub-catchment number next to the basin in the same green colour for identification purposes. It may be possible in the detailed design of the subdivision at a future development application stage that the biofiltration basins for each sub-catchment area are actually formed from a series of smaller basins to achieve a distributed treatment system as opposed to a focused end-of-line system, this would allow greater options and design flexibility with the discharge of water from the fully developed site.

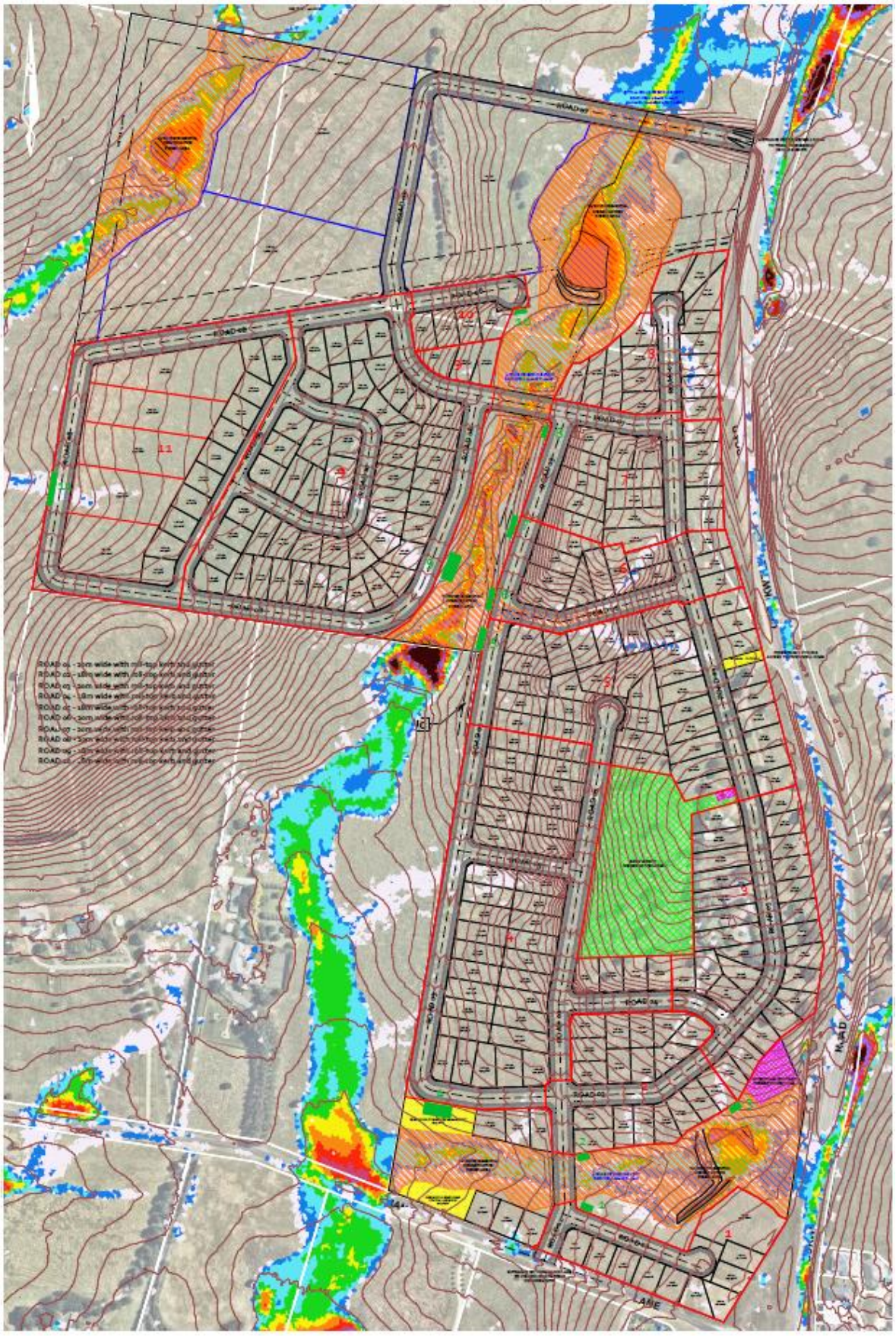

Figure 4. Image showing the proposed subdivision layout with the individual sub-catchment areas and identifying numbers in red, and the proposed location of the corresponding biofiltration basin in dark green. The extents of the 1% AEP water depths are also included to demonstrate the proposed biofiltration basins are outside of the affected areas. Refer to the accompanying drawing '0010724-S01-B' for an enlarged and clearer version of this image.

As a conservative approach to the modelling the individual biofiltration basins have been modelled with a high-flow bypass that is much less than 50% of the 1EY rainfall for the contributing sub-catchment area. For the largest of the sub-catchment areas (#9) the high-flow bypass flow rate has been modelled as 0.050m³/sec which is much less than 50% of the actual 1EY post-development flow rate of 0.659m³/sec. For the other sub-catchment areas, the adopted figures in the models are also much less than 50% of the hydrologically calculated flows for the 1EY rainfall events, refer to Table 2 for the 1EY peak flow rate for each sub-catchment area.

Table 2. Biofiltration basin area requirements and peak flow rates for the individual sub-catchment areas.

Sub-catchment #	Biofiltration Basin Area (m²)	1EY Post-Development Flow Rate (m³/sec)	1% AEP Post-Development Flow Rate (m³/sec)
1	50	0.175	0.408
2	50	0.221	0.51
3	50	0.347	0.805
4	250	0.659	1.572
5	100	0.486	1.115
6	80	0.204	0.488
7	80	0.254	0.598
8	30	0.184	0.418
9	250	0.771	1.836
10	30	0.07	0.169
11	120	0.548	1.289

The proposed subdivision will be constructed in stages to meet market demands and in accordance with the economic and business decisions of the developers, however the first stage of the development irrespective of the number of Lots created must include construction of the road network such that there are at least two entrance / exit options from the site to satisfy the provisions of the NSW Rural Fire Service for developments in bush fire prone lands. This condition will mean that at least a part of proposed roads 01, 03, and 07 that together provide a continued trafficable route through the property will need to be constructed in the first stage of the civil works. Whilst 'staging' has not been addressed within this assessment it is noted that the division of the site into smaller sub-catchment areas based on the natural terrain and road network will most likely be the main determining factor in the delineation of the different stages, and accordingly the construction of the proposed stormwater drainage and water quality treatment infrastructure.

Using the aforementioned assumptions and treatment details as the basis of the water quality model within the *MUSIC* program the objectives of the NorBE criteria is achieved in each sub-catchment area, and for the development as a whole if modelled collectively. The *MUSIC* model submitted with this assessment has a pre-development node for each sub-catchment area along with a corresponding post-development pollutant source and treatment train model. The drainage links can simply be created or deleted for each set of sub-catchment areas to review and assess the effectiveness of the proposed treatment measures which are summarised in Table 3.

Table 3. Summary of the MUSIC model results for each sub-catchment and the combined sub-catchments .

Sub-catchment #		Suspended Solids	Total Phosphorus	Total Nitrogen
1	Pre-Development	137.00	0.56	2.91
	Post-Development	95.90	0.33	2.45
	Reduction (%)	30.00	41.04	15.81
2	Pre-Development	178.00	0.77	3.73
	Post-Development	126.00	0.41	2.95
	Reduction (%)	29.21	47.14	20.91
3	Pre-Development	277.00	1.21	5.92
	Post-Development	204.00	0.65	4.98
	Reduction (%)	26.35	46.12	15.88
4	Pre-Development	527.00	2.20	11.60
	Post-Development	330.00	1.27	9.60
	Reduction (%)	37.38	42.27	17.24
5	Pre-Development	373.00	1.73	8.73
	Post-Development	282.00	0.82	6.08
	Reduction (%)	24.40	52.60	30.36
6	Pre-Development	158.00	0.66	3.45
	Post-Development	75.60	0.35	2.70
	Reduction (%)	52.15	47.74	21.74
7	Pre-Development	195.00	0.87	4.92
	Post-Development	123.00	0.45	3.50
	Reduction (%)	36.92	48.28	28.86
8	Pre-Development	148.00	0.59	3.00
	Post-Development	76.40	0.26	2.19
	Reduction (%)	48.38	55.82	27.00
9	Pre-Development	616.00	2.34	13.30
	Post-Development	475.00	1.60	11.70
	Reduction (%)	22.89	31.62	12.03
10	Pre-Development	55.50	0.22	1.22
	Post-Development	22.80	0.13	1.07
	Reduction (%)	58.92	42.99	12.30
11	Pre-Development	425.00	1.76	9.34
	Post-Development	270.00	1.01	8.22
	Reduction (%)	36.47	42.61	11.99
Combined	Pre-Development	3180.00	12.80	69.10
	Post-Development	2080.00	7.26	55.50
	Reduction (%)	34.59	43.28	19.68

In addition to satisfying the required reductions in concentration for each pollutant type of 10% or greater than the pre-development levels in the post-development conditions, the frequency at which the reductions are achieved is also satisfied. The following images from the combined sub-catchment model run shows the layout of the model with the individual sub-catchment areas for both the pre-development and post-development conditions, and the cumulative frequency charts for each of the three pollutant types.

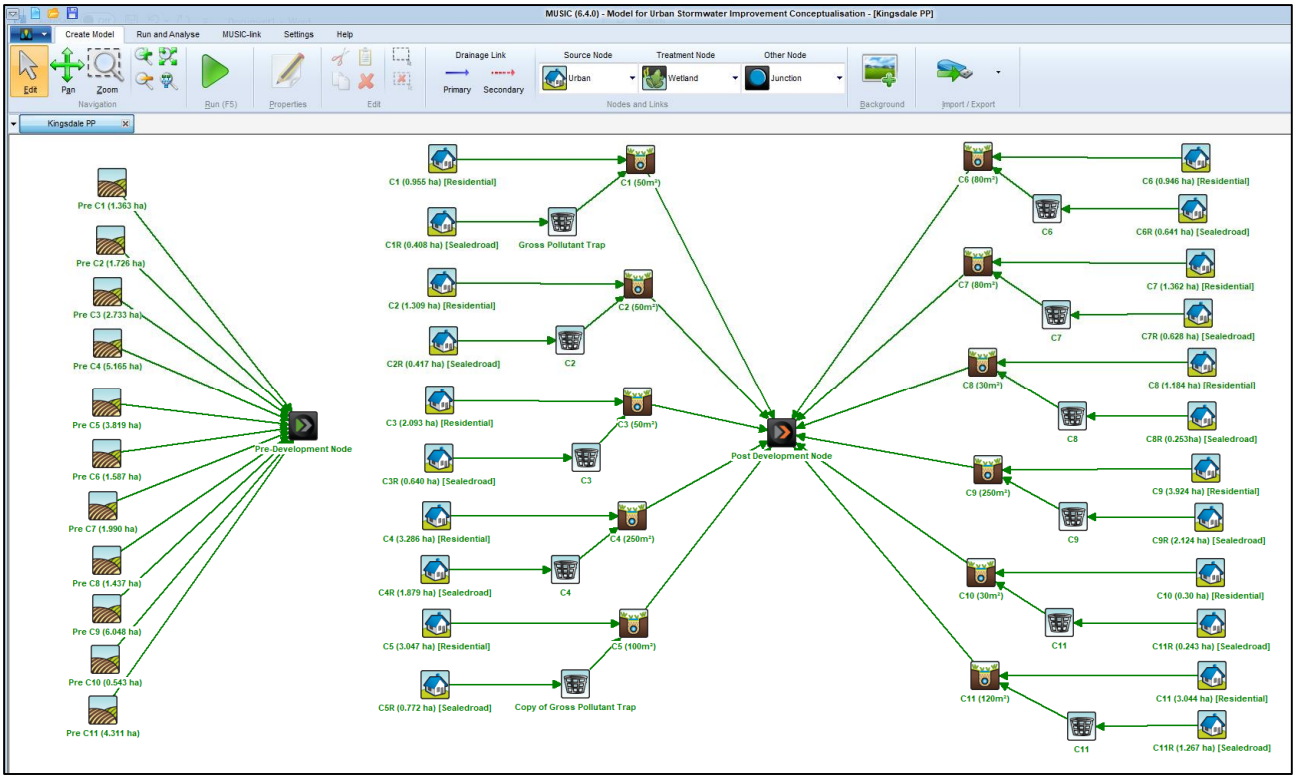

Figure 5. Screenshot from the *MUSIC* model showing the separation of the pre-development nodes into the individual sub-catchment areas and the corresponding post-development source and treatment nodes. The image shows that all nodes are linked to the receiving node, however the individual drainage links can simply be created or deleted to review and assess the treatment measures for each sub-catchment.

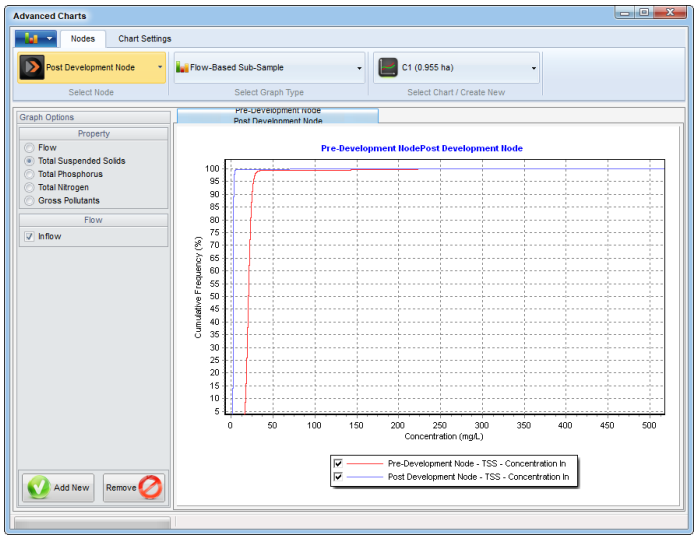

Figure 6. Cumulative frequency graph from the combined sub-catchment model for the total suspended solids

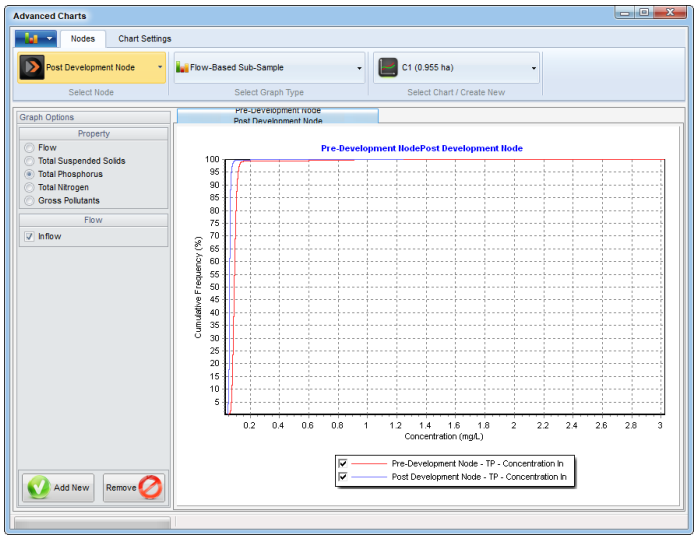

Figure 7. Cumulative frequency graph from the combined sub-catchment model for the total phosphorus

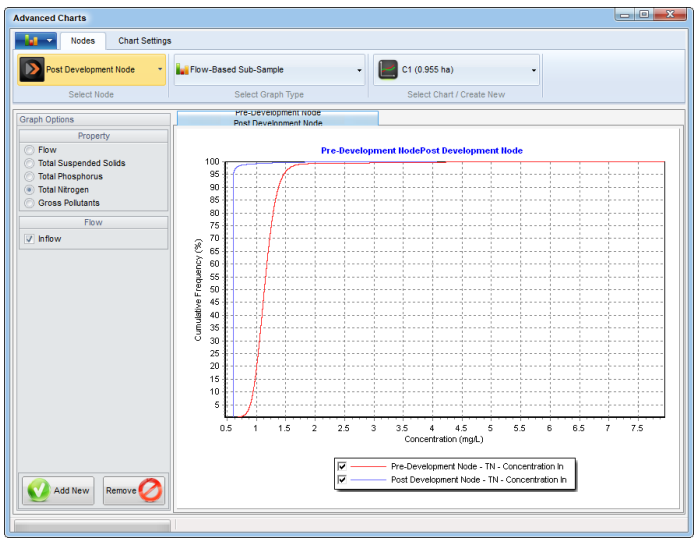

Figure 8. Cumulative frequency graph from the combined sub-catchment model for the total nitrogen

4/. Other Matters and Conclusion.

Certain aspects of the proposed subdivision design that either have not be specifically modelled or could be amended and therefore influence the post-development water quality outcomes but have not been factored into this assessment include the following:

- The outer portion of Road 08 between the southern intersections with Road 09 through to the head of the cul-de-sac could be formed without a footpath provision and therefore revert to a grass-lined swale to convey surface water runoff.
- The section of Road 07 between the intersection with Road 08 and Crookwell Road to the northeast possibly does not require a pedestrian footpath on either side of the formation and therefore each side could revert to a rural road construction standard with grass swales and mitre drains. The mitre drains could in turn discharge to small farm dams within each of the larger rural Lots.
- A similar proposition could be argued for the outer portion of Road 03 between the western end of Lot 152 and the intersection with Road 06 where it largely adjoins the neighbouring land holding. This section of the roadway could also revert to a grass-lined drainage swale which would take pedestrians away from any potential flooding risks and provide an opportunity to create passive water quality treatment options.
- The use of rainwater tanks at the individual Lot scale for the purposes of satisfying both BASIX requirements and controlling peak flow rates and attenuation on the overall discharge of water through the biofiltration basins and from the site.
- Other options such as centralised basins and/or wetlands for the collection and treatment of stormwater runoff.

In preparing the Water Cycle Management Study assessment for the land rezoning proposal reference has been made to the 'Site Design and Analysis Tool' (SDAT) that was developed by Water NSW several years ago for developments within the Sydney Drinking Water catchment. The tool which was developed to assist in identifying a range of potential geophysical constraints on development sites confirmed the location of the aforementioned drainage corridors that traverse through the property and highlighted two small areas where the slope exceeded 15° which has also been referenced in the detailed description of the site. Additional information such as soil depth has been highlighted in the tool with typical depths ranging from 450mm to 750mm in the higher elevations of the site to greater than 750mm in the lower drainage channels and corridors. Other geophysical parameters such as salinity, phosphorus sorption capacity, and permeability were not identified as potential constraints on the site.

Whilst not specifically addressed within the Wastewater Management Report that has been prepared by ACT Geotechnical Engineering Pty Ltd as the information would not have been available at the time of writing, the larger 4,000m² and 2 hectare R5 Lots to be created on the southwestern and northern sides of the of the gas main easement are located outside of the mapped flood affected areas and therefore the installation and operation of a wastewater management system should not be a constraint for the proposed Lots.

Refer to Figure 9 for the features from the SDAT tool that apply to the development site.

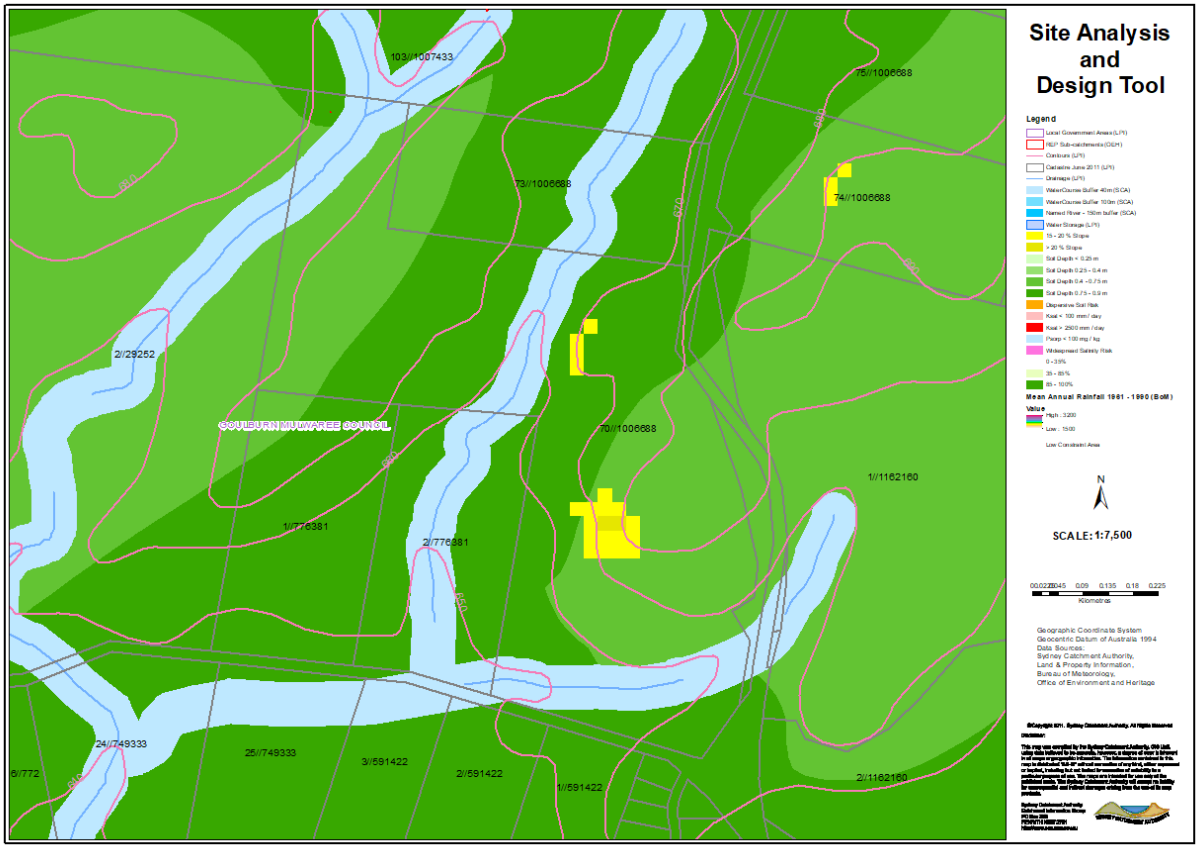

Figure 9. Image from the Site Design and Analysis Tool for the development site and surrounding area. The identified 'potential' constraints are limited to the drainage corridors, two small areas of slope that exceed 15°, and soil depths – although the natural soil depths are not considered to be a constraint for the development.

At the time of lodging a formal application for the subdivision of the land detailed erosion and sediment control plans / soil and water management plans will need to be prepared that reflect the staged nature of the civil works and meet the water quality objectives. The plans will need to consider the protection of the existing drainage corridors and dams, and the re-direction of clean water through and/or around the work zones to mitigate the need for large-scale sediment control measures. Additional sediment control measures and plans will need to be prepared for the civil works associated with the amendments to the existing roads to the south and east that will facilitate approved access to the development site.

Other matters related to the construction, protection, and ongoing maintenance of any proposed water quality treatment measures will be included with a future subdivision of the site, and these will be presented as construction checklists, drawings notes, and site-specific Operational Environmental Management Plans (OEMP). The Operational Environmental Management Plan which will be prepared in consultation with Water NSW will identify the responsible entity for the ongoing maintenance of the individual water quality treatment devices and provide detailed actions for the maintenance of such devices. As necessary, restrictions on individual land titles that provide protection and maintenance of the water quality treatment devices in perpetuity may need to be registered when each stage of the subdivision is seeking to be released.

It is considered that the proposed planning proposal for the rezoning of the existing parcels of land to residential uses will be able to meet the prescriptive requirements and the objectives of the 'neutral or beneficial effect' (NorBE) that applies to all developments within the Sydney Drinking Water catchment. It is further considered that the information submitted in this assessment in combination with other consultancy reporting meets the objectives of Direction 3.3 - 'Sydney Drinking Water Catchment' of the Ministerial Directions issued under Section 9.1(2) of the EP&A Act 1979.

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10th December 2024

References.

- '*Water Sensitive Design Guide for Rural Residential Subdivisions*', Water NSW (May 2021),
- '*Using MUSIC in Sydney's Drinking Water Catchment*', Water NSW (February 2023)
- '*Neutral or Beneficial Effect on Water Quality Assessment Guidelines'*, Water NSW (October 2022)
- '*Developments in the Drinking Water Catchment – Water Quality Information Requirements*', Water NSW (June 2018).