PLANNING PROPOSAL ASSOCIATED WITH BOUNDARY ADJUSTMENT AND FUTURE DWELLING ENTITLEMENT

LOT 11 DP1226788 & LOT 841 DP1253894

OLD SOUTH ROAD

MITTAGONG. NSW. 2575

WATER CYCLE MANAGEMENT STUDY

Prepared by SOWDES
22 July 2022

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Water Cycle Management Study

Executive Summary.

This *Water Cycle Management Study* has been prepared in support of a Planning Proposal submission to the Wingecarribee Shire Council which is seeking an amendment to the relevant provisions within the Wingecarribee Local Environmental Plan (2010) regarding a proposed boundary adjustment and the retention of residential building entitlements on a portion of land that will be less than the minimum Lot size for building entitlements within the land zoning. The parcels of land associated with the development proposal are identified as Lot 11 DP1226788 and Lot 841 DP1253894 located at Old South Road, Mittagong comprising 41.70 hectares of 'C3 - Environmental Management' zoned lands which form the operational site for the Mittagong Airfield. The relevant provisions within the Wingecarribee Local Environmental Plan (2010) that the Planning Proposal is seeking an amendment are contained within 'Part 4 – Principal Development Standards' – subsection '*4.2A - Erection of dwelling houses and dual occupancies on land in certain rural and environment protection zones'*.

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 Wingecarribee Shire 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 and guidelines 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 design process by contributing to the information source and providing general commentary on the overall recommendations and findings.

The subject site is located approximately 2 kilometres due east of the residential precincts within the township of Mittagong and is formally accessed from the southern aspect of the Old South Road traffic corridor. The property is an irregular shaped parcel of land with the northern facing boundary following the alignment of Old South Road and the western facing boundary being bordered by the Diamond Fields Road traffic corridor from where there is a second but rarely used gated entrance to the site.

The two parcels of land that make up the holding are themselves irregularly shaped with Lot 11 DP1226788 which comprises 37.28 hectares formed over two portions of 35.99 and 1.277 hectares that are separated by a 10.06 metre wide unformed road reserve, and Lot 841 DP1253894 comprising the residual area of 4.434 hectares in a somewhat 'L' shape forming what is effectively the eastern half of the sealed runway at the airfield.

The proposed boundary adjustment will seek to redistribute the boundaries such that the airfield operations will be contained within a single portion of land that comprises 31.06 hectares (proposed Lot 843) and the residual portion which is seeking to retain the building entitlement already associated with the site is to comprise 10.64 hectares in the southwest quarter of the holding (proposed Lot 844).

A portion of forested land within the southern half of the site (that also continues into the adjoining land to the south – Lot 12 DP1226788) is burdened by a registered Positive Covenant (DP1226788) in favour of Water NSW that prohibits the clearing or harvesting of native vegetation without the written approval from the agency. It is noted that the covenant does permit the clearing of native vegetation within the delineated area to the extent necessary for the purposes of an asset protection zone for bush fire protection around a future dwelling subject to formal development approval and with the written consent of the agency. This clause within the Positive Covenant has been used to identify a potential dwelling envelope within the proposed Lot 844 which will have the smallest impact on existing native vegetation, and where the requirements to establish an asset protection zone for bush fire protection purposes can also be used for the disposal of secondary treated effluent.

This Water Cycle Management Study is divided into four sections; the first being an overview and the triggers for the Planning Proposal submission and a detailed description of the development property and surrounding landscape; the second section is a stormwater quality assessment for the transition of pervious to impervious areas associated with a future residential dwelling development within the proposed Lot 844 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 nominated dwelling envelope in the proposed Lot 844; and the forth section is a wastewater management assessment for a future residential dwelling development within the proposed Lot 844.

Within the Water Cycle Management Study assessment a 'potential building envelope' having a nominal area of 600m² has been identified within the proposed Lot 844 which is based on a raft of 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). Whilst this report has based its determinations and recommendations on a conceptual location for a 'potential building envelope' within the proposed Lot 844 it is recognised that any future development application for the construction of a residential dwelling within the Lot 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 Planning Proposal to amend Part 4 – Principal Development Standards' – subsection '*4.2A - Erection of dwelling houses and dual occupancies on land in certain rural and environment protection zones'* of the Wingecarribee Local Environmental Plan (2010) will be able to satisfy the requirements of the Neutral or Beneficial Effect on water quality as required under '*Chapter 8 – Sydney Drinking Water Catchment'* of the Biodiversity Conservation SEPP (2021).

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Figure 1. Recent aerial view of the development property showing the proposed boundary adjustment and the nature of the vegetation formations within and surrounding the site. The captured area has a general fall from the southwest to the northeast with stormwater runoff from the southern aspect of the airfield operations directed into a formed channel that can be seen at the rear of the built structures adjacent to the runway.

1/. Overview of the Planning Proposal Submission, Description of the Land and Proposed Boundary Adjustment.

The Berrima District Aero Club as the operators of the Mittagong Airfield are seeking to undertake a boundary adjustment between two portions of land that make up the airfield operations to enable separation and sale of a section of the site that is excess to the needs of the facility. The airfield is made up of two portions of land identified as Lot 11 DP1226788 and Lot 841 DP1253894 that have a combined area of 41.70 hectares with an existing residential building entitlement. The boundary adjustment would seek to secure the residential building entitlement within the separated portion of land (proposed Lot 844) however it will be less than the minimum Lot size associated with the land zoning that attracts building entitlements. The land is zoned as 'C3 – Environmental Management' with a minimum Lot size of 40 hectares for building entitlement hence the proponents are seeking an amendment to the Wingecarribee Local Environmental Plan (2010) through the submission of a Planning Proposal to effectively facilitate the transfer of the building entitlement to the proposed smaller Lot. The relevant provisions within the Wingecarribee LEP (2010) which the Planning Proposal seeks to amend are contained in 'Part 4 – Principal Development Standards' – subsection '*4.2A - Erection of dwelling houses and dual occupancies on land in certain rural and environment protection zones'*.

The development site is located approximately 2 kilometres to the east of the residential precincts on the southern aspect of the Mittagong township at the junction of Old South Road and Diamond Fields Road with Old South Road running adjacent to the northern boundary and Diamond Fields Road along the western boundary. The main entrance to the site is from the Old South Road frontage with a recessed gateway located approximately midway along the length of the runway formation, and there is a second but rarely used entrance on the western aspect of the site from the Diamond Fields Road traffic corridor with a gate located approximately midway along the length of the western boundary.

Whilst being located on the fringe of the developed urban areas the site is not serviced by a Council maintained reticulated water supply, gravity sewer system, or stormwater drainage infrastructure thereby requiring any future residential development on the land to be self-sufficient in the provision of these facilities and services.

The site is an irregular shaped parcel of land that has operated as the Mittagong Airfield since it was originally established by the Royal Australian Airforce in the 1940's. The terrain throughout the northern portion of the site is relatively flat as it forms the operational area of the airfield's runways and includes associated administration buildings and hangers that are leased by private plane owners. The sealed portion of the runway which is formed in a southwest to northeast alignment measures approximately 1.20 kilometres in length and 10 metres wide. The southern half of the site which is effectively the remaining area to the south of the line of hanger buildings slopes from the crest of a small hill located in the southern corner of the holding in an arc from the southeast, through to the east, north and west, and then around to the southwest. The average slope of the terrain from the crest of the hill down to the airfield operations approximates 11.50% however the bottom half of the slope is slightly less at an average grade of 10%.

The subject property is formed from two parcels of land – Lot 11 DP1226788 which comprises 37.28 hectares, and Lot 841 DP1253894 at the eastern end of the site which comprises 4.434 hectares. The larger parcel of land - Lot 11 DP1226788 is comprised of two portions that are separated from each other by a 10.06 metre wide unformed road that is essentially an extension of the Diamond Fields Road corridor. The separation of the lands either side of the unformed road reserve results in a small triangular fillet in the western corner that is 1.277 hectares in area. The airfield operations are presently undertaken over the two parcels of land with approximately 530 metres of the 1.20 kilometre runway and verges on the eastern end of the runway falling into the smaller of the parcels of land – Lot 841 DP1253894. The proposed boundary adjustment will ensure that the airfield operations are contained within a single parcel of land and separate the residual portion of land in the southwestern quarter of the current holding to its own title.

The vegetation formations throughout the property are quite varied with what is essentially managed grasslands within the lower portion of the site surrounding the airfield operations whilst the southern half of the site is set to a rather dense stand of dry sclerophyll forest formations. The northern and western aspects of the runway strip are used as a vegetation buffer zone from the adjoining road network whilst the strips of land either side of the runway are maintained with low growing vegetation formations that are regularly mown to facilitate operational and emergency management activities.

The forested vegetation within the portion of the land holding to the south of the line of hangers is covered by a Positive Covenant under Section 88B of the Conveyancing Act of 1919 which benefits Water NSW (formerly the Sydney Catchment Authority) for the retention and protection of approximately 15.09 hectares of native vegetation within the current holding for water quality purposes. The Positive Covenant does however have a clause that allows for the clearing of vegetation 'only to the extent necessary' to establish a residential dwelling and suitable asset protection zones as required for the purposes of bush fire protection under the provisions of the Rural Fires Act 1997. Information submitted as part of the Planning Proposal for the proposed boundary adjustment and dwelling entitlement has identified a suitable site for the construction of a future dwelling within the smaller portion of land that is to be separated from the airfield operations. The site is located approximately 50 metres off the Diamond Fields Road frontage and on the margins of the forested vegetation to minimise the amount of area that would need to be cleared for bush fire protection purposes. The amount of existing forested area under the protection of the Positive Covenant within the proposed Lot 844 seeking the residential dwelling entitlement will represent approximately 9.62 hectares of the current 15.09 hectares, however this will be reduced by approximately 6,800m² to facilitate the future dwelling envelope and surrounding curtilage including the associated asset protection zones for bush fire protection purposes. It is noted that all land area calculations quoted in the above details are subject to the final boundary locations and the extent of clearing necessary to provide a suitable asset protection zone around the footprint of a future dwelling which for the purposes of the above calculations is assumed to be 600m² and achieving a bush fire attack level rating that does not exceed 'BAL-29'.

Stormwater drainage associated with the site is dominated by a natural water course that enters from the western aspect and traverses toward the northeastern corner of the holding along the rear of the line of hangers and other buildings. The drainage system commences in rural lands on the opposite side of the Diamond Fields Road traffic corridor and passes under the road via a single cell concrete boxed culvert and headwall that is located approximately 60 metres north of the western entrance to the site. Overland stormwater drainage entering the western aspect of the site is partially attenuated by a small offline dam located approximately 50 metres inside the boundary with the dam overflow and overland flows in larger rain events being directed into a formed channel that runs parallel to the alignment of the runway behind the line of hangers and other buildings. Surface water runoff from the crest of the hill in the southern corner of the site flows into a broad depression that flows in a more north-northeasterly pattern and begins to spread-out nearing the bottom of the hill as the terrain begins to flatten. The formed drainage channel runs for the entire length of the runway to direct all sources of surface water from the western and southern aspects away for the main operational areas. Stormwater runoff generated within the flatter operational areas of the airfield is shed off the runway surface to the verges either side of the formation and there is a slight fall from the west to the east that directs that flow of water which is generally fairly shallow away from the hangers and other buildings to the eastern end of the site where natural drainage systems are located.

The development site is not identified as being located within mapped flood liable lands however a due-diligence overland flow study has been undertaken of the site as it is burdened by the sources of storm and surface water as detailed in the previous discussion, and the site is located within low-lying and flat lands that are surrounded by sloping ranges and hill formations to the north and south. The main purpose of the overland flow study is to demonstrate that a potential dwelling envelope in the newly created parcel of land in the southwestern quarter of the holding formed from the boundary adjustment can be undertaken without experiencing any significant or adverse impacts in the larger design rain events such as the 1% AEP event. The methodology and results of the overland flow study are discussed in Section 3 of this assessment.

2/. Stormwater Quality Assessment

For the purposes of a stormwater quality assessment and bush fire protection measures a 'potential development envelope' of 600m² has been identified within the western portion of the proposed Lot 844. The site will utilise an existing gated entrance along the western boundary of the Lot, and the building envelope will be 50 metres inside the boundary. The site was selected because of its short travel distance from the Diamond Fields Road traffic corridor, and the fact that it is only surrounded by forested vegetation on the upslope southern aspect with partial forested vegetation to the east and west, and open grasslands to the north. The amount of forested vegetation required to be cleared for the establishment of a building envelope and associated asset protection zone for bush fire protection purposes is minimised by the proposed location as the southern aspect of the site which contains the greater portion of forested vegetation is upslope and therefore requires a lesser buffer separation distance for the asset protection zone than if it were downslope. The eastern and western aspects of the site are slightly downslope of the building envelope and only contain small amounts of forested vegetation, whilst the grasslands to the north of the site are deemed a lesser form of bush fire threat and therefore only require small buffer zones.

The amount of forested vegetation protected by the existing Positive Covenant on the subject site is 15.09 hectares of which approximately 9.62 hectares will be contained within the proposed Lot 844 after the boundary adjustment is registered. The required asset protection zone for bush fire protection associated with the 'potential development envelope' is 6,950m² of which 5,460m² is located within the area delineated by the Positive Covenant, the remaining area is located within the grasslands to the north of the delineated zone. The shape of the asset protection zone around the 'potential development envelope' is not precisely square to the footprint of the building envelope as the corners of the setbacks to the margins of the vegetation are rounded however it is difficult to ensure that selective clearing of vegetation within the boundaries of the required asset protection zone follow the outer limits of the required area therefore a slightly larger area that is 'squared-off' to the footprint of the building envelope is proposed. The 'squaring' of the proposed clearing area to the orientation of the building envelope and the proposed boundaries of the Lot will also facilitate easier definition of the future area to be maintained under the protection of the Positive Covenant. The total area of existing vegetation protected by the Positive Covenant within the proposed 'squared-off' zone around the 'potential development envelope' is 6,800m² of which 1,500m² is actually set to open grasslands and the remaining 5,300m² is classified as 'forest'.

It would appear that the area of forested vegetation has historically been disturbed with evidence in earlier aerial imagery of the site (circa November 2009) of access tracks and less dense vegetation across the southwestern portion of the site – particularly from the existing gateway off Diamond Fields Road and around to the east of the 'potential development envelope'.

The following section details the *MUSIC* modelling assumptions, treatment recommendations and outcomes associated with stormwater runoff for a conceptual future residential dwelling development within the proposed Lot 844.

MUSIC MODELLING			
#	***DESCRIPTION***	***DETAIL***	
2.1	Model Version	6.3.1	
2.2	Rainfall data	Moss Vale geographical region – pluviograph data at 6 minute time steps from 1st January 1997 to 31st December 2001	
2.3	Reduction targets	Total Suspended Solids	≥10%
		Total Phosphorus	≥10%
		Total Nitrogen	≥10%
		Cumulative frequency of reductions	≥98%
2.4	Modelling assumptions / settings	Future residential development of the site will require the removal of approximately 6,800m² of forest and grassland vegetation within the area protected by the existing Positive Covenant for the establishment of a building footprint and associated asset protection zones for bush fire protection purposes.	
2.5		The conceptual built forms associated with a future dwelling development of the site will comprise 600m² of roofed area, 300m² of sealed driveway, and a nominal 100m² of paths and other external hardstand areas.	
2.6		Of the required 6,800m² of forested vegetation surrounding the footprint of a dwelling required to be cleared and managed for bush fire protection purposes approximately 5,300m² is forested vegetation and the remaining area of 1,500m² is grasslands.	
2.7		In the pre-development *MUSIC* model the 5,300m² of forested vegetation to be cleared and managed has been modelled as a 'Forest' source node with a 100% pervious surface, whilst the 1,500m² of grasslands has been modelled as 'Residential' source node as this probably best fits the historical use of the site and also with a 100% pervious surface.	
2.8		In the post-development *MUSIC* model the built forms have been modelled with the source nodes of 'Roof' and 'Sealed Roads' as detailed in Item 2.5 with the remaining land (5,800m²) modelled as 'Residential' with a 5% impervious surface finish - noting that the vegetation within the required asset protection zone is to be fully managed to prevent the spread of fire.	
2.9		The development site is not serviced by a Council maintained reticulated water supply therefore any future residential dwelling will be reliant upon rainwater harvesting for all potable and non-potable demands.	
2.10		The daily reuse of rainwater has been modelled at 1,000 litres per day which is allowing for a five-bedroom equivalent dwelling at 900 litres per day, and a small nominal amount of 100 litres per day for external applications.	

2.11		Rainwater runoff from the roof area of the dwelling will be directed to a 130,000 litre rainwater tank of which 110,000 litres will be used for all domestic demands and the balance of the storage volume in a freeboard zone at the top of the tank to be used for temporary detention of water to regulate the peak discharge of stormwater off the site in the 1% AEP rain event to the same flow rate as the peak discharge in the pre-development conditions. (0.044m³/sec).
2.12		Overflow from the rainwater tank and the surface water runoff from the hardstand areas and managed grounds surrounding the dwelling footprint will be directed to one of three biofiltration raingarden treatment devices to be located at strategic positions within the lower elevations of the site to intercept and treat the majority of stormwater runoff.
2.13		The three biofiltration raingarden treatment devices will be distributed around the site to ensure that there is approximately 1,200m² of landscaped runoff being directed into the devices that separately treat the overflow from the rainwater tank (Biofiltration 1) and the runoff from the hardstand areas (Biofiltration 2), and the remainder of the landscaped area will be directed to a separate treatment device (Biofiltration 3)
2.14		Each of the biofiltration raingarden treatment devices will have a surface area of 50m² and will incorporate the following specific design and filter media characteristics: • Extended detention depth of 250mm • Filter media depth of 600mm • A drainage layer depth of 200mm • Saturated hydraulic conductivity of 200mm/hour • Total nitrogen content of 400mg/kg • Orthophosphate content of 30mg/kg • Vegetated with effective nutrient removal plants • 100Ø socked and slotted draincoil underdrains at the rate 1 per 500mm width of biofiltration media • A 100mm thick layer of 20 to 40mm river rock as mulch over the entire surface area • A layer of geofabric material between the different layers of drainage and filter media materials to maintain installation integrity
2.15		The filtered water from the base of the biofiltration raingarden treatment devices will be piped toward the northern aspect where it will discharge into the formed drainage channel that traverses across the site
2.16		Refer to the accompanying Stormwater Management Site Plan – Ref: 0050322-02A for details of the conceptual location of the proposed treatment measures.

Table 2.1. Summary of the different surface types identified in the pre-development and post-development conditions and the associated pollutant parameter within the *MUSIC* model.

Surface Type	Source Node	Pre-development	Post development
Forested vegetation	Forest – 100% pervious	5,300m²	
Grassland and low shrub vegetation	Residential – 100% pervious	1,500m²	
Dwelling envelope	Roof – 100% impervious		600m²
Access carriageway and paths	Sealed Roads – 100% impervious		400m²
Landscaped asset protection zone	Residential – 5% impervious		5,800m²
	Total	6,800m²	6,800m²

Table 2.2. Base flow pollutant concentrations used in the pre and post development stormwater model.

Concentration (mg/L-log_{10})						
	Suspended solids		**Phosphorus**		**Nitrogen**	
Surface type	mean	std. dev	mean	std. dev	mean	std. dev
Roof	1.20	0.17	-0.85	0.19	0.11	0.12
Sealed roads	1.20	0.17	-0.85	0.19	0.11	0.12
Residential	1.20	0.17	-0.85	0.19	0.11	0.12
Forest	0.78	0.13	-1.52	0.13	-0.52	0.13

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

Concentration (mg/L-log_{10})						
	Suspended solids		**Phosphorus**		**Nitrogen**	
Surface type	mean	std. dev	mean	std. dev	mean	std. dev
Roof	1.30	0.32	-0.898	0.25	0.30	0.19
Sealed roads	2.43	0.32	-0.30	0.25	0.34	0.19
Residential	2.15	0.32	-0.60	0.25	0.30	0.19
Forest	1.60	0.20	-1.10	0.22	-0.05	0.24

Figure 2.1. Image of the southwestern portion of the Mittagong Airfield circa November 2009 showing areas of cleared vegetation around the site of the potential development envelope (yellow coloured oval shape), and the tracks that were used through the site for access that are clearly linked to the existing gated entrance off Diamond Fields Road.

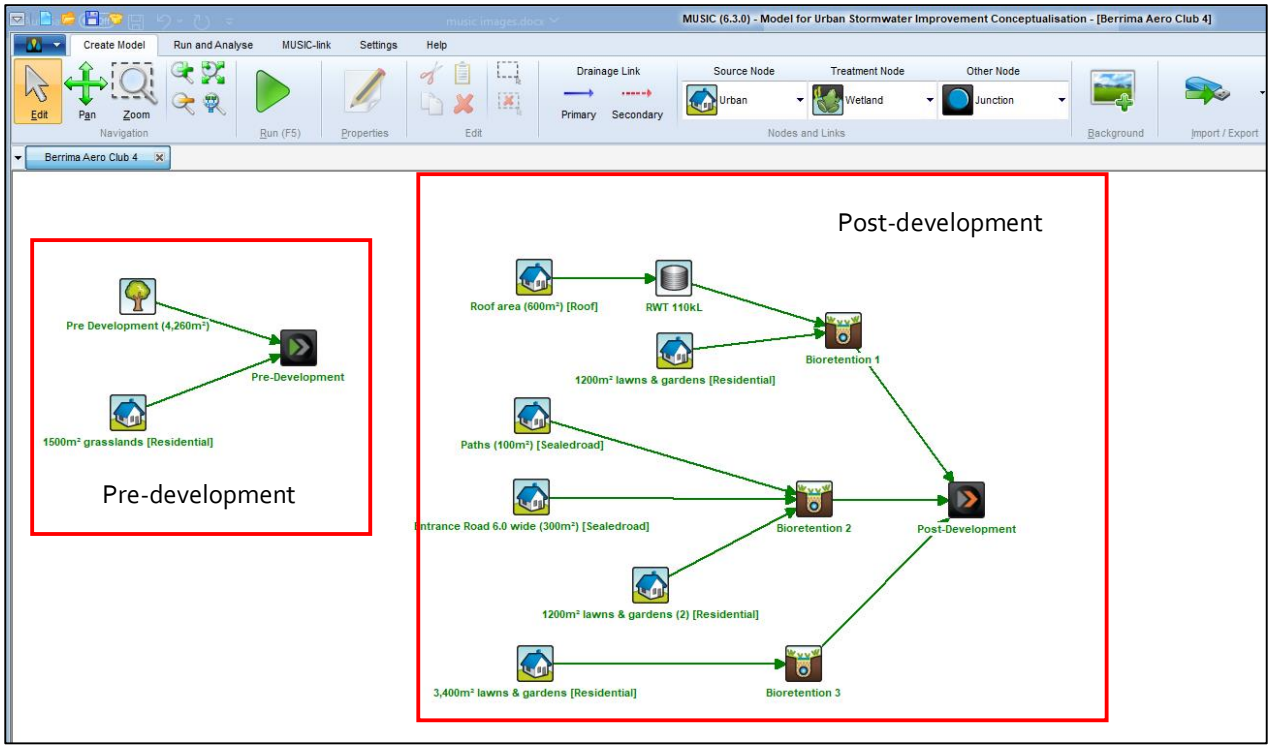


Figure 2.2. Layout of the source, treatment and receiving nodes in the *MUSIC* stormwater model.

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 target reductions between 50% and 98% of all 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 2.4. 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	75.10	0.160	1.57
Post development loading	30.10	0.080	1.35
Reduction %	59.92	49.50	14.01

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 between 50th and 98th frequency percentiles. The following images (Figures 3 to 5) of the pre-development and post-development cumulative frequency charts for the flow weighted daily mean values for suspended solids and phosphorus demonstrate that pollutant reductions proposed by the respective treatment measures are achieved for the required frequency of occurrences, whilst the post-development reductions for nitrogen are less than the pre-development for greater than 70% of all occurrences.

Despite the post development total nitrogen concentrations exceeding the pre-development levels at the lower frequency of events it is noted in these events that the residual concentration of pollutant where the post-development concentrations crosses the pre-development levels at around the 70% frequency level the value of 0.6 mg/L is much less than -1 standard deviation below the mean concentration levels of 2.8 mg/L for the 'All Urban' development class as defined by Duncan in 1999 and 2006 and highlighted in the chart in Figure 2.6. The selection of 'All Urban' as the control parameter is based on the end land use of the site and the fact that the figures used in these charts form the basis for some of the baseline parameter values used within the *MUSIC* model.

In the respective images the pre-development outcomes are represented by the red lines whilst the post-development outcomes are in blue.

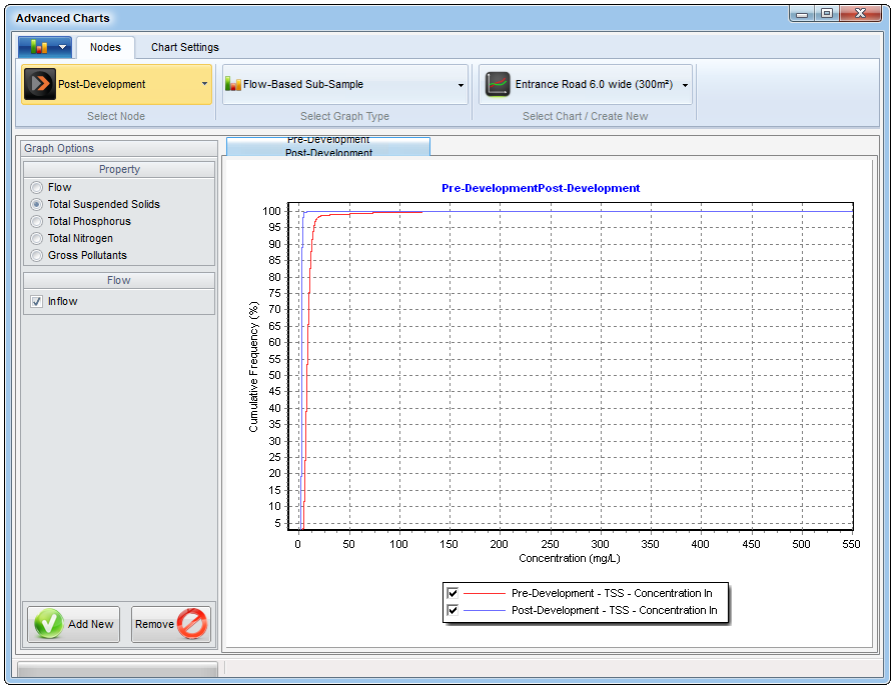


Figure 2.3. Comparison of the pre-development and post-development outcomes for Total Suspended Solids (TSS).

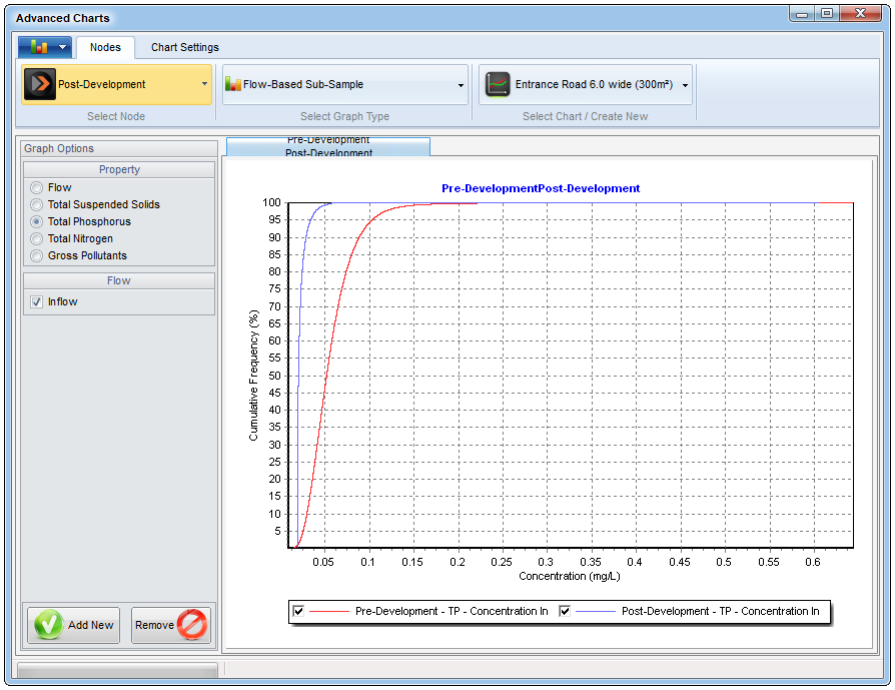


Figure 2.4. Comparison of the pre-development and post-development outcomes for Total Phosphorus (TP).

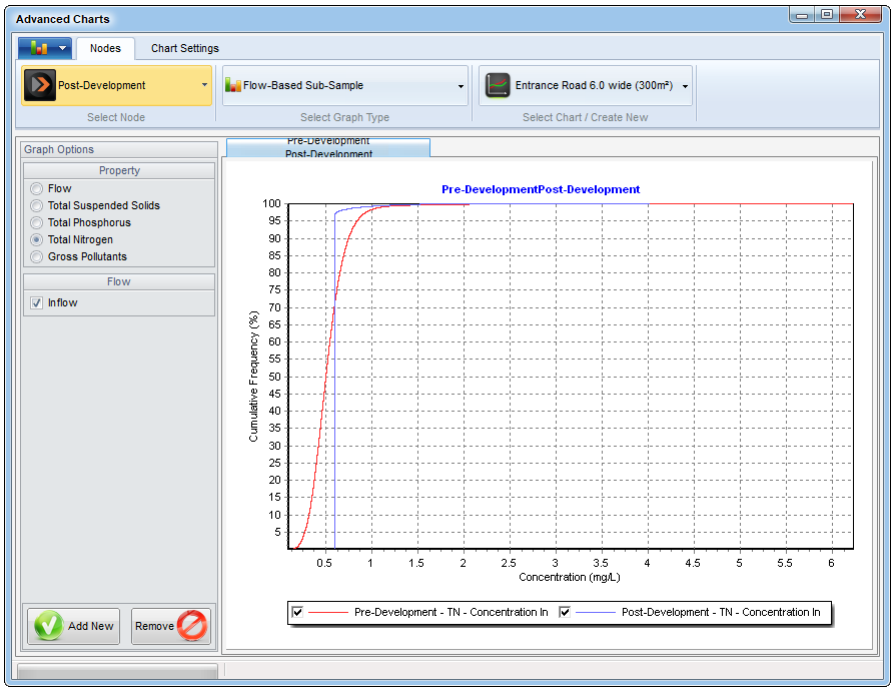


Figure 2.5. Comparison of the pre-development and post-development outcomes for Total Nitrogen (TN).

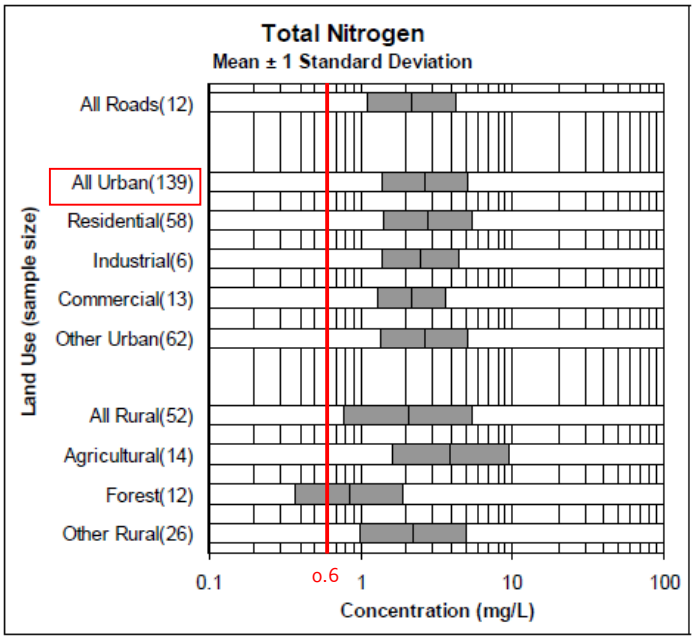


Figure 2.6. Residual values for the post-development nitrogen reductions up to the 70th frequency percentile of events marked in red. The pollutant chart is based on the work by H.P Duncan ('Urban Stormwater Quality: A Statistical Overview' – Catchment Hydrology CRC, 1999) and modified works ('Australian Runoff Quality Guidelines – Engineers Australia, 2006).

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 Wingecarribee Shire Council for the construction of a residential dwelling 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.

Stormwater drainage associated with the site is dominated by a natural water course that enters from the western aspect and traverses toward the northeastern corner of the holding along the rear of the line of hangers and other buildings. The drainage system which is classified as 'Category 3' riparian corridor within Wingecarribee LEP 'Natural Resources Sensitivity Map (NRS_007) commences in rural lands on the opposite side of the Diamond Fields Road traffic corridor and passes under the road via a single cell concrete boxed culvert and headwall that is located approximately 60 metres north of the western entrance to the site. Overland stormwater drainage entering the western aspect of the site is partially attenuated by a small offline dam located approximately 50 metres inside the boundary with the dam overflow and overland flows in larger rain events being directed into a formed channel that runs parallel to the alignment of the runway behind the line of hangers and other buildings. The drainage channel that runs through the site is located approximately 40 metres downslope and to the northwest of the 'potential development envelope' within the proposed Lot 844, whilst the small attenuation dam is located another 10 metres further north of the drainage channel.

Surface water runoff from the crest of the hill in the southern corner of the site flows into a broad depression that flows in a more north-northeasterly pattern and begins to spread-out nearing the bottom of the hill as the terrain begins to flatten. The formed drainage channel runs for the entire length of the runway to direct all sources of surface water from the western and southern aspects away for the main operational areas. Stormwater runoff generated within the flatter operational areas of the airfield is shed off the runway surface to the verges either side of the formation and there is a slight fall from the west to the east that directs that flow of water which is generally fairly shallow away from the hangers and other buildings to the eastern end of the site where natural drainage systems are located.

The development site is not identified as being located within mapped flood liable lands however a due-diligence overland flow study has been undertaken of the site as it is burdened by the sources of storm and surface water as detailed above, and the site is located within low-lying and flat lands that are surrounded by sloping ranges and hill formations to the north and south. The main purpose of the overland flow study is to demonstrate that a 'potential dwelling envelope' in the proposed Lot 844 can be undertaken without experiencing any significant or adverse impacts in the larger design rain events such as the 1% AEP event.

To ascertain the impacts (if any) of overland flows and surface water drainage on the proposed development site a preliminary (pre-development) flood and stormwater model was undertaken of the site and surrounding catchment area using a combination of different sources of information. To create a terrain profile for the stormwater drainage and flood impact assessment both within and 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 which was downloaded as 2 metre grid Digital Elevation Model metadata item is captured within four adjoining datasets that have a grid area of 2km x 2km.

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 a residential dwelling, access and egress provisions, and effluent management systems should not be located for each of the proposed Lot 844. The software used to undertake the modelling 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 generally the design 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 0.10 that addresses both forested vegetation formations and the open grasslands associated with the adjoining rural activities in accordance with Table 6.2.2 of the AR&R2019 guidelines, and an initial loss of 39mm and a continuing loss of 4.6mm 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 285 hectares and is broken down into approximately 48,100 meshing triangles that have an average area of 59.27m², and each 'working' face allows normal flow conditions from one mesh triangle to the next. The large model area validates the effective upstream catchment area generating runoff that enters the site 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 285 hectares which included adjoining upslope properties to the south of the development property 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 western quarter of the proposed Lot 844 is affected by overland flows that runs in a southwest to northeast pattern along an existing formed drainage corridor. The depth of stormwater within these areas is variable, however there is clear migration of external stormwater from the rural lands on the opposite side of Diamond Fields Road that flow under the road formation and enter the western corner of the block. Within the model it is also apparent that a small volume of runoff is generated within the Diamond Fields Road corridor adjacent to the western boundary of the property that runs down the slope and merges with the flows from the rural lands to the west, however apart from these two sources the 'potential development envelope' is not adversely burdened by any other sources of overland flow. It is also evident within the model that the overland flows from the opposite side of Diamond Fields Road are retarded behind the height of the road formation with the depth of water at the culvert crossing becoming quite deep and eventually overtopping the road which invariably broadens the effective area of water inundation within the development property.

To help clearly define the main areas of flow and depth that burden the development property water depths of 50mm or less have been turned off within the model. Refer to Figures 3.1 and 3.2 for the 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 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. It is also noted that the proposed access carriageway which commences at the existing gated entrance off Diamond Fields Road is outside the extent of overland flows and depths, and outside the hydraulic hazard zones.

Refer to Figure 3.3 for the 1% AEP maxima hydraulic hazard details and to Figure 3.4 for the Hazard risk curves and classification tables from Chapter 7, Book 6 of AR&R2019.

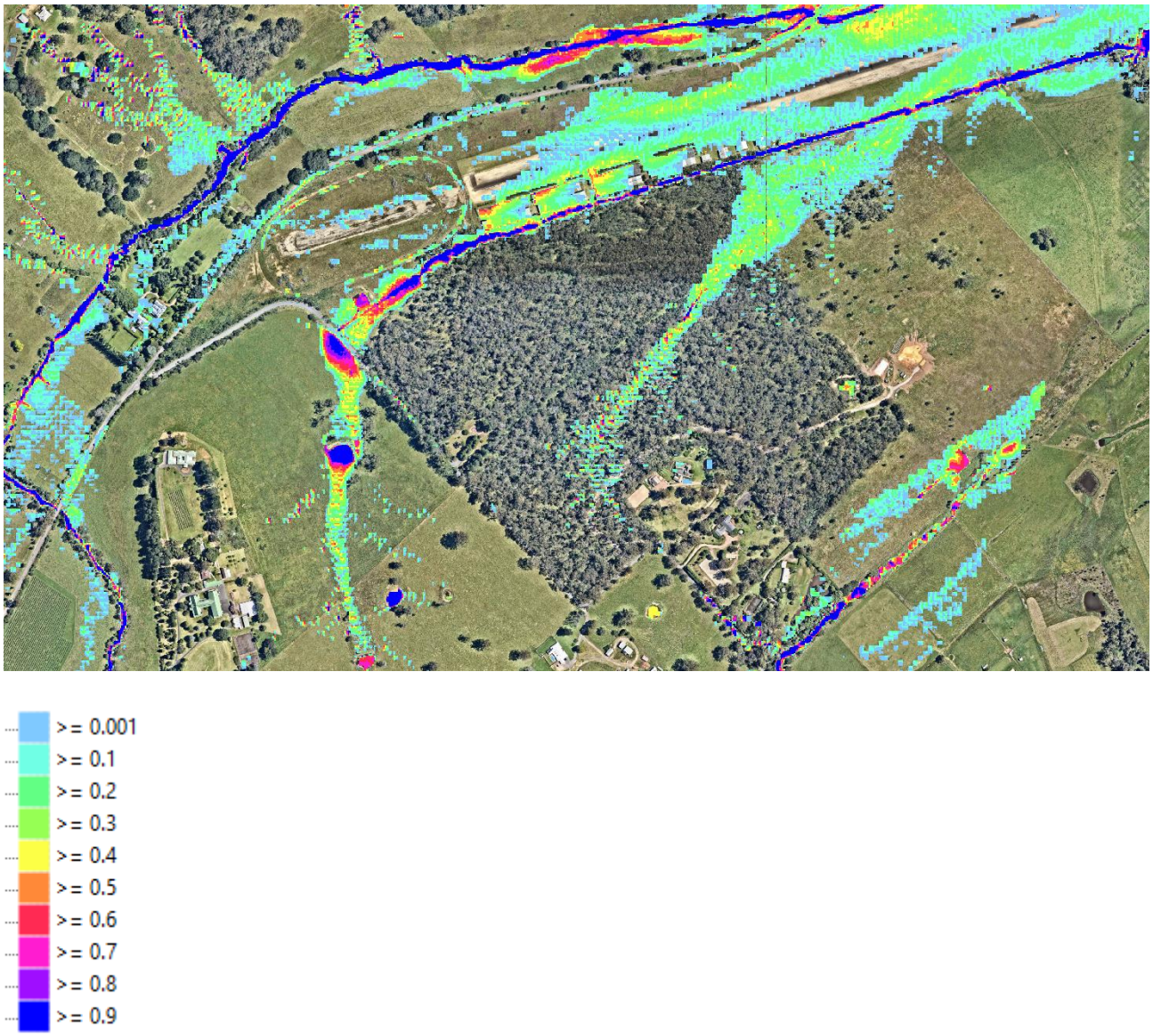


Figure 3.1. 1% AEP maxima stormwater depth and extent details of the contributing catchment for the pre-development model. Water depths of 50mm and less have been isolated.

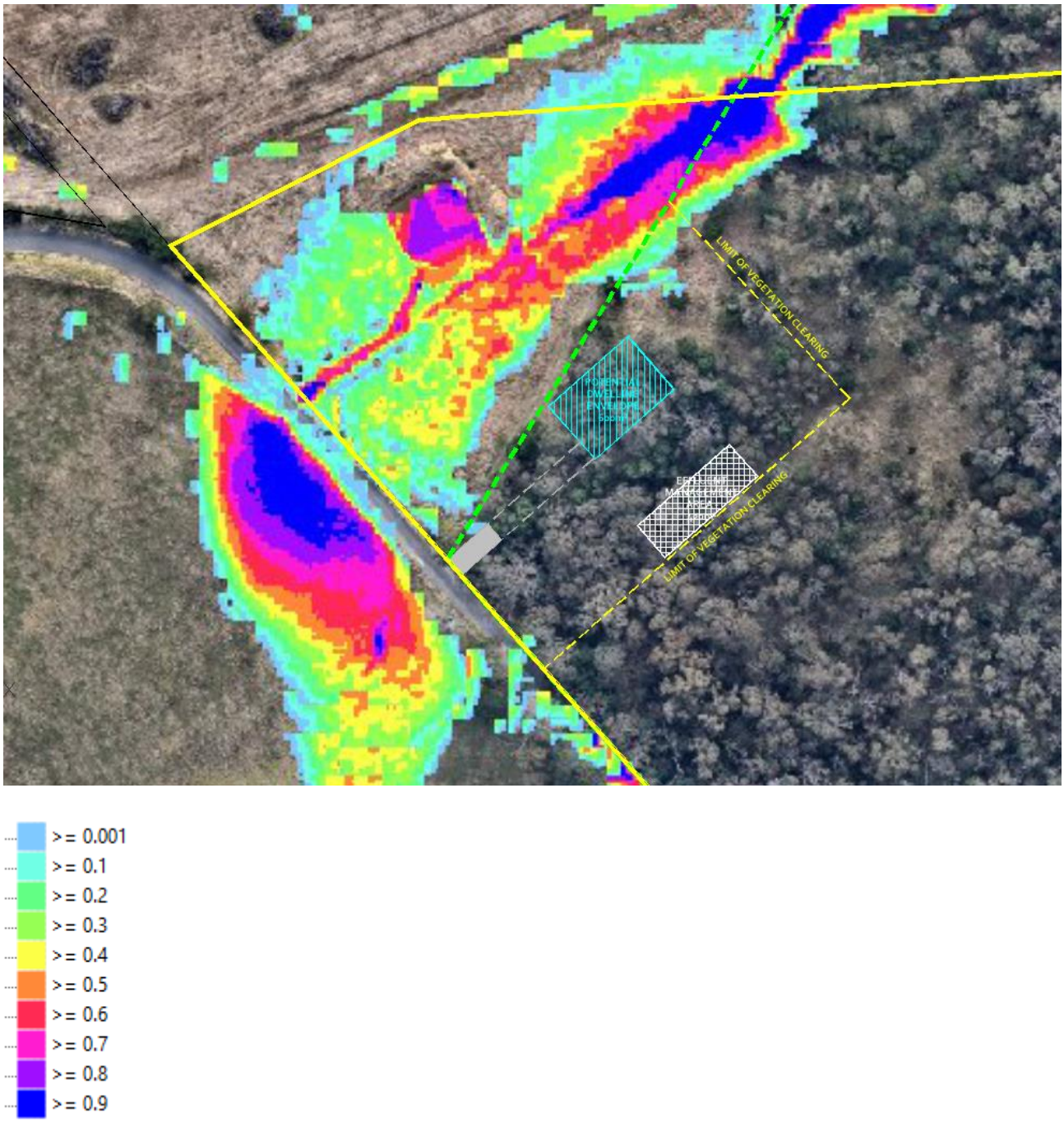


Figure 3.2. 1% AEP maxima stormwater depth and extent details around the 'potential development envelope' for the pre-development model. Water depths of 50mm and less have been isolated.

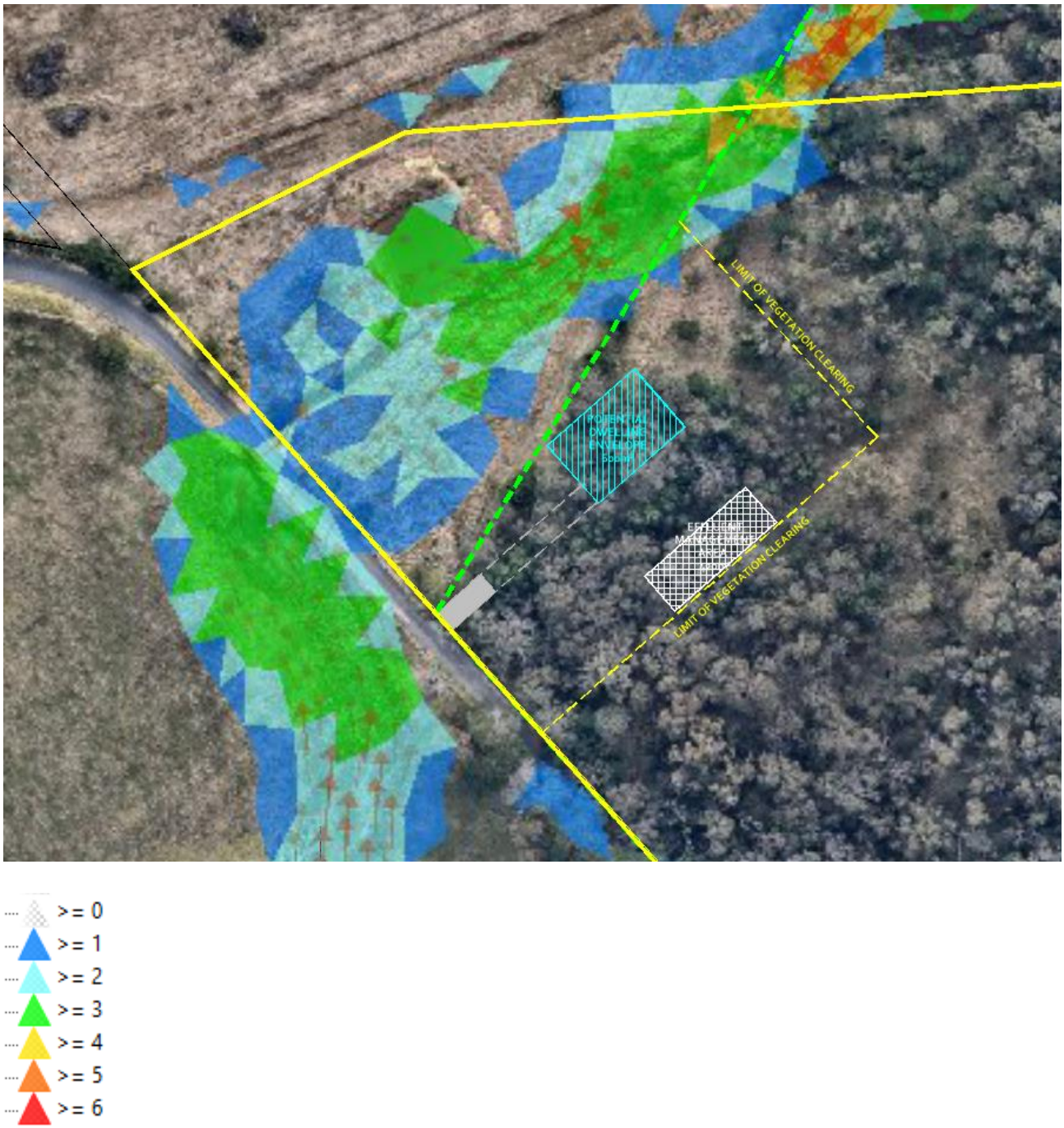


Figure 3.3. 1% AEP maxima hydraulic hazard details around the 'potential development envelope' for the pre-development model.

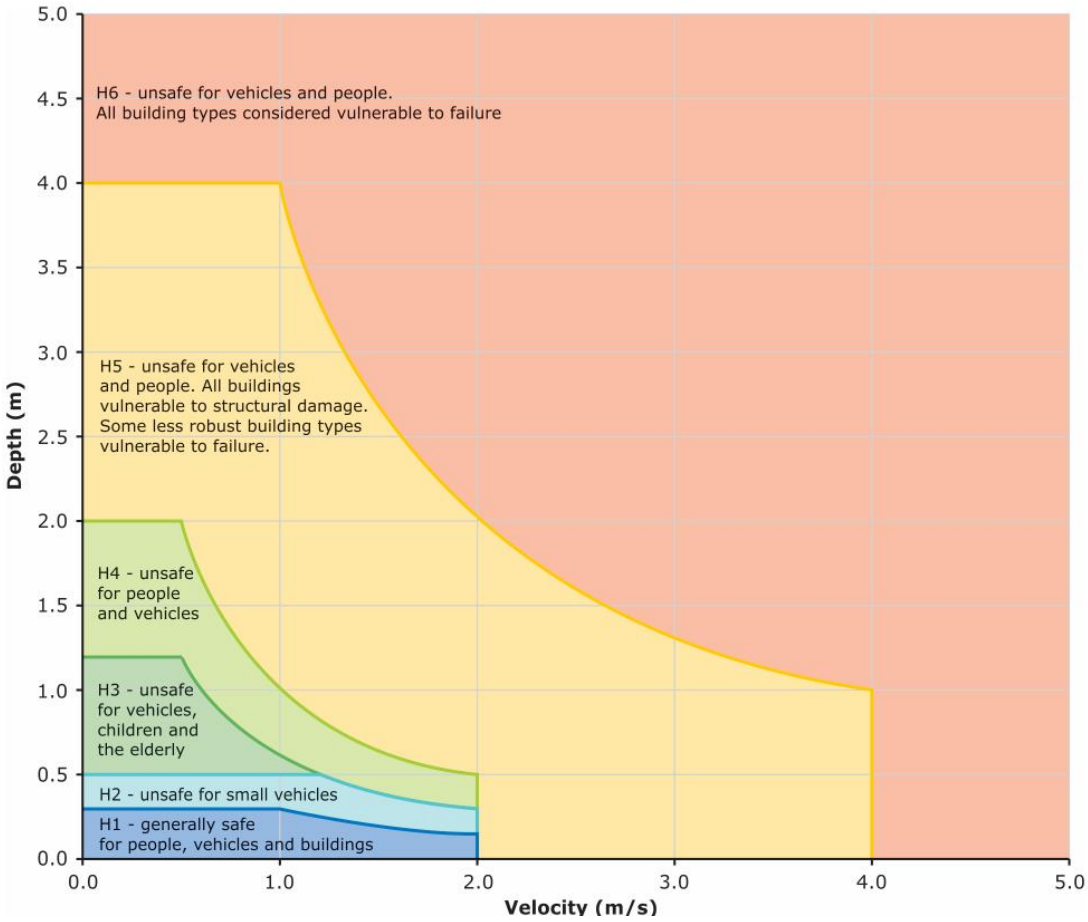


Table 6.7.3. Combined Hazard Curves - Vulnerability Thresholds (Smith et al., 2014)

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 3.4. 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 Planning Proposal stage is to determine the suitability of the proposed Lot 844 seeking to retain the existing residential building entitlement to support an on-site wastewater management facility and reviewing the available treatment and disposal options.

A single soil sample was taken adjacent to the 'potential development envelope' to determine the nature of the existing site conditions which was analysed for 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 around the margins of the forested vegetation were quite wet resulting from recent rains that precluded effective soil testing in certain parts of the site close to the identified effluent management area. The wet conditions alos meant that use of a hydraulically operated coring device was not an option thereby sampling was undertaken using a 75mm diameter hand operated augur. As a general description, the soil profile is comprised of a shallow loam topsoil to 300mm with a rather abrupt transition into a sandy clay loam to clay loam at the termination depth of 1 metre with light clay properties in the lower extractions.

The terrain throughout the southern half of the site which is effectively the area to the south of the line of hanger buildings slopes from the crest of a small hill located in the southern corner of the holding in an arc from the southeast, through to the east, north and west, and then around to the southwest. The average slope of the terrain from the crest of the hill down to the airfield operations approximates 6.50° however the bottom half of the slope is slightly less at an average grade of 5°. The terrain immediately around the 'potential development envelope' has a general fall from the southeast toward the northwest between 5° and 10° and begins to 'plateau-out' to less than 5° on the northern aspect. The grasslands areas to the north of the 'potential development envelope' where the surface water drainage channel is located represents a general change in grade and slope direction tending to fall toward the northeast at less than 3°.

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 single residential dwelling is a 'Module 2' class of development - "*less complex developments that are a medium 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 wastewater management 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 the proposed Lot 844 a 'potential building envelope' having a nominal area of 600m² has been identified which is based on a combination of considerations such as effluent management, bush fire protection, and stormwater quality impacts.
5. An 'indicative effluent management area' has been positioned within the proposed Lot 844 to meet the required setbacks from buildings, drainage depressions, dams, 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 area comprising 420m² is highlighted by a white coloured rectangle with diagonal hatching within the accompanying site plan, Ref: 0050322-03A.
6. 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 Wingecarribee Shire Council Development Control Plan.

Constraints

4.1/. 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 'potential development envelope' is burdened by a formed drainage channel that is located approximately 40 metres to the north of the building envelope with a small dam 10 metres further to the north of the channel. The overland flow study detailed within Section 3 of this assessment has identified that surface water runoff generated in rural lands to the west on the opposite side of Diamond Fields Road burdens the site as it enters the western boundary approximately 60 metres downslope from the gated entrance. The proximity of overland flow drainage and the margins of water inundation in the 1% AEP event represent constraints for effluent disposal that is downslope of the building envelope. Therefore, suitably treated effluent will need to be discharged to a dedicated area that is upslope of the building envelope to ensure that it is at least 40 metres away from any open channel, farm dam, drainage or conveyance pathway so that 'drainage' will not be a constraint for the development.

The soil sample undertaken adjacent to the 'potential development envelope' achieved a depth of 1 metre with relative ease without encountering and coarse fraction or refusal, and deeper sampling would have been possible if required. The sampled soil profile comprised a silty loam to sandy loam topsoil to 300mm, with a sandy clay loam to clay loam texture below to the termination depths and it is therefore considered that soil depth or condition will not be a limiting factor for the development. Further details of the soil sample are contained in the following sections of this report.

Notwithstanding the possible limitations imposed by various geophysical constraints, an examination and assessment of the existing site and soil characteristics within the area nominated for effluent disposal 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 drainage and soil depth characteristics discussed in this section.

4.2/. 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 the proposed effluent management system that predicts the extent of the effluent plume has been prepared with the summary results presented at the end of the detailed soil summary sheets that follow this section.

It is noted that within the attached model the alignment of the effluent disposal area has automatically been rotated by approximately 45° to the design alignment which is based on the underlying topographical data within the modelling parameters which cannot be changed at the input level.

4.3/. The development property is located within the 'Sydney Basin – Nepean 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 nominate effluent disposal area has been undertaken which has resulted in a 'nil' finding. As there are no registered bores within 250 metres of the nominated effluent disposal area a draw-down analysis is not required, and it is therefore considered that *groundwater sources* will not be a constraint for the development.

Figure 4.1. Image from the Water NSW Groundwater Data Base confirming that there are no registered bores within 500 metres of the nominated effluent management area.

Based on a combination of the site characteristics and assessment, and the aforementioned constraints mapping and modelling it is considered that a future residential dwelling within the proposed Lot 844 will be best serviced by treating the household sewage to a higher- secondary standard in a NSW Health Department approved Aerated Wastewater Treatment System (AWTS) unit before discharging to a land application area with surface irrigation distribution system.

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 that comes standard within the Aerated Wastewater Treatment System (AWTS) unit will allow the effluent to be discharged within parts of the site that are upslope from the collection and treatment system. The use of the internal pump transfer system will allow better use of the available land area that is otherwise constrained by downslope drainage features, and therefore support greater flexibility in the future design of the Lot.

For irrigation disposal systems the design loading rate can be calculated in a number of ways, with the 'nitrogen loading', 'soil phosphorus sorption capacity', and 'water balance using a nominated irrigation area' (hydraulic calculation) being the primary considerations with the calculation that generates the greatest land area requirement being the 'determining factor'.

To determine the land area requirement for a surface irrigation disposal system, the simplified formula of **A = Q / DLR** applies where;
A is the effective application area subject to direct irrigation from a combination of hose length and spray radius emitted from the sprinkler outlet
Q is the quantity of inflows based on the number of bedrooms at the rate of 200 litres per day for the first four bedrooms and 100 litres per day for each bedroom thereafter for developments within the Sydney Drinking Water catchment that rely on rainwater harvesting as the main source of domestic water supply (in accordance with the 'Designing and Installing On-site Wastewater Systems' guidelines from Water NSW). For a residential dwelling comprising the equivalent of five bedrooms this equates to a potential load of 900 litres per day.
DIR (design irrigation rate). The numbers that determine the land area requirement are automatically generated within the 'WEM' model mentioned previously in Section 2 and are based on the site and development specific inputs such as daily effluent volumes, nitrogen and phosphorus concentrations, soil type and depth, vegetation formations under the area of irrigation, and the capacity of the soils based on texture and profile to assimilate nutrients.

For this development the land area requirement for the water balance (hydraulic) requirements is 250m², the soil phosphorus sorption capacity requires 263m², whilst the area required for the nitrogen loading is 411m², which is the 'determining factor'. The area identified for effluent disposal within the accompanying Wastewater Management Site Plan – Ref: 0050322-03A has been rounded up to 420m².

Whilst the numbers that determine the land area requirement are generated within the WEM model they have been reproduced on the following page in a table format for information purposes.

Conclusion

It has been demonstrated that the conceptual wastewater management treatment system for a future residential dwelling within the proposed Lot 844 as proposed in this assessment and the accompanying Wastewater Management Site Plan meets the Neutral or Beneficial Effect (NorBE) criteria. It is noted however that a future dwelling development within the proposed Lot 844 will be required to submit individual development application to Council once the boundary adjustment has been registered 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 wastewater management treatment system for the site will be via sa econdary treatment unit whilst the size of the effluent disposal areas is based on the equivalent of a five 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 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 soil characteristics with a separate *WEM Plume Map* for the proposed Lot 844 based on the treatment of influent within a Aerated Wastewater Treatment System (AWTS) unit and a surface irrigation effluent disposal system. The WEM modelling has assumed a five-bedroom equivalent dwelling with non-reticulated water supply, and it is noted that the size of the nominated effluent disposal areas shown within the site plan is slightly larger than the minimum surface area requirement of 411m².

The wastewater management assessment is supported by the accompanying Wastewater Management Site Plan – Ref: 0050322-03A and the Stormwater Management Site Plan – Ref: 0050322-02A which also has a visual representation of the results from the overland flow 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
- Appendix C - Land Area Calculation For a Surface Irrigation Disposal System

WASTEWATER MANAGEMENT SYSTEM RECOMMENDATION

Collection and Treatment:

System Type	**Aerated Wastewater Treatment System (AWTS)**
Treatment Level	**Secondary**
Brand	**Equal to FujiClean**
Model	**ACE-1200**
Tank Capacity	**Nominally 1,200 litres – 10 persons per day**
Location (approximate)	**Approximately 10 metres downslope and to the north of the dwelling envelope.**

Disposal Method:

Method	**Surface irrigation**
Dimensions / Area	**Disposal area with an effective irrigation application area of at least 420m²**
Description / Location (approximate)	**The irrigation disposal area will be located approximately 20 metres upslope and to the south of the dwelling envelope (refer to the Wastewater Management Site Plan).**
Proprietary Products	**FujiClean ACE-1200 AWTS unit, quick coupling turf valves with lilac coloured lids, lilac coloured capitol style sprinklers, turf valve keys, lilac coloured hoses for on ground distribution, K-Rain 4000 series 4-port sequencing valve cammed for four zones inside a weather-proof cover, 32Ø uPVC pressure pipe, 32ØPN12.5 PE poly pipe, 'Reclaimed Effluent' warning sign.**

Soil Sample 1

Site Details: Lot 11 DP1226788 & Lot 841 DP1253894 Old South Road, Mittagong. NSW. 2575			**Date of Inspection:** 22 September 2021
Landform: Simple slope to open depression	**Topography:** Southeast to northwest		**Sample #:** 1
Vegetation: Forest and grasslands	**Land Use:** Rural residential		**GPS Coordinates (UTM Zone 56)** **Latitude:** 269415 **Longitude:** 6184702
Elevation: 575m	**Aspect:** Northerly	**Slope:** <5°	**Surface micro-relief:** Elongated Depression

The soil is assessed to have a design irrigation rate (DIR) for surface irrigation purposes of 3.6omm per day, set at a conservative rate for secondary treated effluent discharging within a moderately 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, moderately well 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				

NorBE Assessment

WEM Summary

version 3

General Information

WEM model ID	2567521	Associated DA number	
Model description	AWTS to surface irrigation		
Consultancy	SOWDES	Consultant	sowdes@sowdes.com
Consultant reference number	0050322		
Council	Wingecarribee Shire	Assessing officer	
Nominated lot	11//1226788	Associated lots	
Development class	Subdivision unsewered <=3 lots		
Date of model run	7/17/2022 7:58:18 PM		

Lot	Section	Plan
11		1226788

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
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)	35.0	Width (up slope)(m)	12.0
Proposed area(m2)	420.0	Minimum Required area (m2)	411.0
Number of trenches	0		
Effluent volume proposed (l/day)	900		
Effluent volume calculated (l/day)	900		

WEM Model Inputs

Location

Easting	9620371.065385	Northing	4361208.886161
Slope (m/m)	0.05878	Slope is suitable based on site inspection (Applicable to some disposal systems on steep slopes)	N/A

Development

Development type	Dwellings	Development detail	5 bedrooms
Water supply type	Rainwater	Spa Bath	No

WaterNSW

NorBE Assessment

WEM Summary

version 3

Continuous system use	Yes		
Treatment system	AWTS standard	Disposal system	Irrigation surface

Site

Lot size(m2)	367603		
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)	1.15	Soil structure	High/moderate
Saturated hydraulic conductivity (Ksat)(m/day)	0.75		
Soil texture	Clay loams		

Effluent disposal risk factors

Depth to water table	> 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%
Distance to drainage dpression	> 50
Distance to watercourses and water supply reservoirs	> 120
Distance to licenced drinking water bores	> 150

WEM Plume Map

No image of the plumes is available. This may be because the model has not yet been run or because no image was generated when the model ran.

WaterNSW

NorBE Assessment

WEM Summary

version 3

WEM Plume Map

WaterNSW

Appendix A

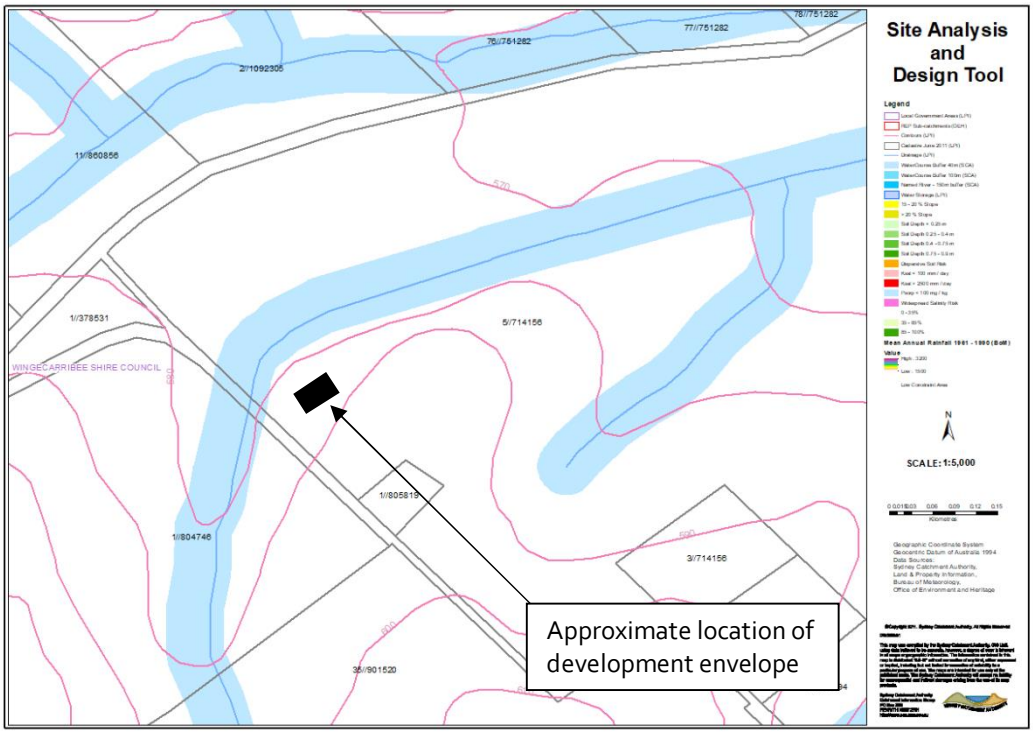
Recommended Buffer Distance for On-site Wastewater Management Systems in the Sydney Drinking Water Catchment

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	

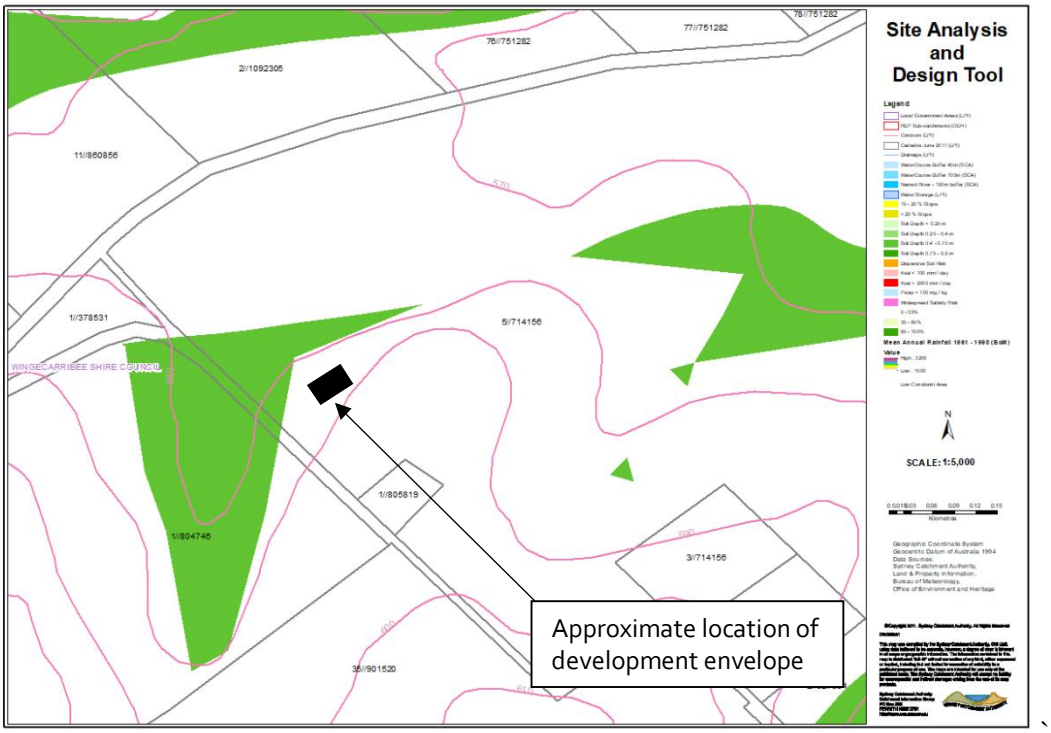
Adopted from 'Designing and Installing On-site Wastewater Systems – A Water NSW Current Recommended Practice (November 2019), Table 2.6 (pages 23 & 24)

Appendix B

Water Sensitive Design Constraints Maps – Drainage and Soil Depth Constraints



Drainage constraints overlay with 40 metres buffer zones.



Soil depth constraints overlay

Appendix C

LAND AREA CALCULATION FOR A SURFACE IRRIGATION DISPOSAL SYSTEM (THE LARGEST AREA IS THE MINIMUM REQUIREMENT)

				Nutrient Area		Hydraulic
				N	P	
	System Type	AWTSS	AWTS Standard			
Cx	Nutrient concentration			30	12	
Q	Daily Flow (six bedrooms)	900				
UR	Plant uptake (refer to Table A2 – page 28)	2lfm	Lawn unmanaged	240	30	
DIR	Design soil depth	1.0				
Soil Type	Soil texture (refer to Table A1 – page 28)	4a	Clay Loams – High / moderate			
BD	Bulk density		1.5			
Np	Soil porosity		0.433962264			
Gs	Soil specific gravity	2.65				
X sorp	Nutrient sorption		400			
DIR	Design Irrigation Rate (refer to Table A1 – page 28)		3.6			
AD	Minimum effluent irrigation area			411	263	250

= Largest land area requirement

Table A1. Design Loading Rates for Hydraulic Loading Sizing

Soil Texture	Soil Structure	Secondary Effluent
Gravels & Sands	Structureless	5
Sandy Loams	Weak	5
Sandy Loams	Massive	5
Loams	High/Moderate	4
Loams	Weak/Massive	4
Clay Loams	High/Moderate	3.6
Clay Loams	Weak	3.6
Clay Loams	Massive	3.6
Light Clays	Strong	2.9
Light Clays	Moderate	2.9
Light Clays	Weak/Massive	2.9
Med-heavy Clays	Strong	2.1
Med-heavy Clays	Moderate	2.1
Med-heavy Clays	Weak/Massive	2.1

(adopted in part from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

Table A2. Plant Nutrient Uptake Rates for Effluent Disposal

CODE	CROP	Total Nitrogen (kg/ha/year)	Total Phosphorus (kg/ha/year)
1gqw	Good quality woodland	90	25
1pqw	Poor quality woodland	65	20
2lfm	Lawn – fully managed (clippings removed)	240	30
2lum	Lawn – unmanaged	120	12
3ip	Improved pasture	280	24
3pp	Perennial pasture	99	11
4stfm	Shrubs and some trees – fully managed	150	16
4stum	Shrubs and some trees - unmanaged	75	8

(adopted and slightly modified from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 52)