PLANNING PROPOSAL

COFFS HARBOUR CITY COUNCIL

Lot 4 &5 DP 41228
Butlers Road, Bonville

December 2019
VERSION 1 - Pre-Exhibition

PLANNING PROPOSAL STATUS (FOR THIS COPY)

Stage	**Version / Date** *(blank until achieved)*
Reported to Council – Initiate s3.33 **Version 1 - Pre_Exhibition**	
Referred to DPIE s3.34(1) **Version 1 - Pre_Exhibition**	
Gateway Determination s3.34(2) **Version 1 - Pre_Exhibition**	
Amendments Required:	
Public Exhibition – Schedule 1 Clause 4 **Version 1 - Exhibition**	
Reported to Council – Initiate Revised PP s3.33 **Version x - Re_Exhibition**	
Reported to Council – Endorsement (or Making of LEP if delegated) s3.36 **Version x - Post Exhibition**	
Endorsed by Council for Submission to Minister for Notification (or Making where not delegated) s3.36(2) **Version x – Post Exhibition**	

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APPENDICES

EXECUTIVE SUMMARY & EXHIBITION INFORMATION

What is a Planning Proposal?

A planning proposal is a document that explains the intended effect of a proposed local environmental plan (LEP) and sets out the justification for making that plan. Essentially, the preparation of a planning proposal is the first step in making an amendment to *Coffs Harbour Local Environmental Plan 2013* ('Coffs Harbour LEP 2013').

A planning proposal assists those who are responsible for deciding whether an LEP amendment should proceed and is required to be prepared by a relevant planning authority. Council, as a relevant planning authority, is responsible for ensuring that the information contained within a planning proposal is accurate and accords with the *Environmental Planning and Assessment Act 1979* and the NSW Department of Planning, Industry and Environment's *A guide to preparing planning proposals* 2018 and *A guide to preparing local environmental plans 2018*.

What is the Intent of this Planning Proposal?

The intent of this Planning Proposal is to amend Coffs Harbour Local Environmental Plan to allow large lot residential development and provide environmental conservation benefit at 75-77 & 81 Butlers Road, Bonville (the subject land). The Planning Proposal will:

- rezone that part of the subject land from Zone RU2 Rural Landscape to part Zone R5 Large Lot Residential and part Zone E2 Environmental Conservation, and
- amend the relevant lot size and terrestrial biodiversity maps accordingly.

BACKGROUND

Proposal	Rezoning for Large Lot Residential and Environmental Conservation purposes
Property Details	Lot 4 & 5 DP 41228, 75-77 & 81 Butlers Road, Bonville
Current Land Use Zone(s)	Part Zone RU2 Rural Landscape & Part Zone E2 Environmental Conservation
Proponent	Resource Design & Management Pty Ltd
Landowner	E & N Aldred (75-77) S Shaw, D Sowden (81)
Location	A location map is included in Figure 1 below

This planning proposal has been prepared in accordance with the Environmental Planning and Assessment Act 1979 and *A guide to preparing planning proposals* (NSW Department of Planning and Environment 2018) and *A guide to preparing local environmental plans* (NSW Department of Planning and Environment 2018).

This planning proposal explains the intended effects of a proposed amendment to Coffs Harbour Local Environmental Plan 2013 ('LEP 2013') to enable large lot residential development on land at Butlers Road Bonville.

The Site

The subject land is located at 75-77 & 81 Butlers Road, Bonville - Lot 4 & 5 DP 41228 and is shown in Figure 1. The subject land is located approximately 13 kms south of the Coffs Harbour City Centre. The subject site is bounded by Butlers Road to the north, Pine Creek State Forest to the west, Keoghs Road to the east and private property to the south. The subject land has an area of 10.13 hectares and is currently zoned part RU2 Rural Landscape and part E2 Environmental Conservation under Coffs Harbour LEP 2013. The existing and proposed zones within the locality are shown in Part 4 (mapping) of this Planning Proposal.

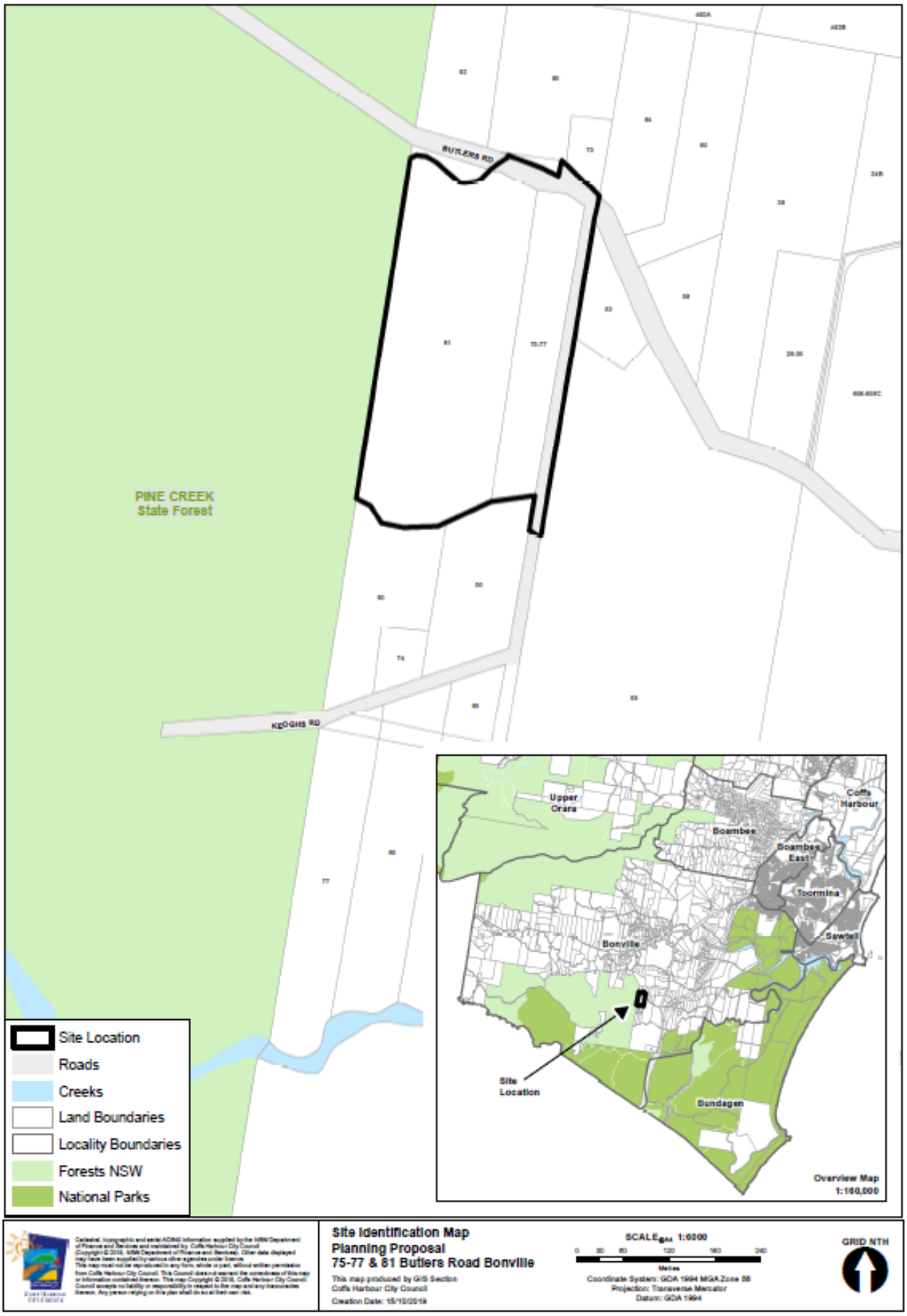

Figure 1: Location Map

PART 1 – OBJECTIVES OR INTENDED OUTCOMES

The objective of this planning proposal is to amend Coffs Harbour LEP 2013 to permit large lot residential development on the subject land, having regard to the environmental constraints affecting the land.

PART 2 – EXPLANATION OF PROVISIONS

The intended outcomes of the planning proposal will be achieved by amending the following Coffs Harbour LEP 2013 maps:

- Coffs Harbour Land Zoning Map (Sheet LZN_006) over 75-77 & 81 Butlers Road, Bonville - Lot 4 & 5 DP 41228 to change land currently zoned RU2 Rural Landscape to part Zone R5 Large Lot Residential and part Zone E2 Environmental Conservation;
- Coffs Harbour Minimum Lot Size Map (Sheet LSZ_006) over 75-77 & 81 Butlers Road, Bonville - Lot 4 &5 DP 41228 to change those parts of the land proposed to be zoned R5 and currently subject to minimum lot size provision AB – 40ha to Y – 1 hectare; and
- Coffs Harbour Terrestrial Biodiversity Map (Sheet CL2_006) over 75-77 & 81 Butlers Road, Bonville - Lot 4 &5 DP 41228 to include areas proposed to be zoned E2 Environmental Conservation as terrestrial biodiversity on the map.

All of the above amendments to LEP 2013 maps are shown in Part 4 (mapping) of this Planning Proposal.

PART 3 – JUSTIFICATION

This part provides a response to the following matters in accordance with "A guide to preparing planning proposals" (NSW Department of Planning and Environment 2018):

- Section A: Need for the planning proposal
- Section B: Relationship to strategic planning framework
- Section C: Environmental, social and economic impact

Section A – Need for the planning proposal

1. Is the planning proposal a result of any strategic study or report?

Yes. This planning proposal has been prepared in response to an application to amend Coffs Harbour Local Environmental Plan 2013 prepared on behalf of the landowners.

Although the subject land is not included within the Bonville candidate area of the Rural Residential Component of Council's Local Growth Management Strategy (LGMS) 2008, it is located within the wider Bonville Large Lot Residential study area. As such, the planning proposal also references a number of detailed environmental studies previously undertaken for the wider Bonville Large Lot Residential rezoning area which informed Planning Proposal PP_2015_COFFS_005_00. The land has been included in the Large Lot Residential chapter (chapter 6) of the recently adopted by Council (not yet endorsed by DPI&E) review of the Local Growth Management Strategy.

2. Is the planning proposal the best means of achieving the objectives or intended outcomes, or is there a better way?

Yes. This planning proposal is the appropriate means of achieving the intended outcomes and is supported by relevant planning studies and adopted planning policies.

3. Is there a net community benefit?

The Net Community Benefit Criteria is identified in the NSW Government's publication *The Right Place for Business and Services*. This policy document has a focus on ensuring growth within existing centres and minimising dispersed trip generating development. It applies most appropriately to planning proposals that promote significant increased residential areas or densities, or significant increased employment areas or the like. An indicative lot layout shows that this planning proposal will enable up to six Large Lot Residential lots to be created under Coffs Harbour LEP 2013. The criteria in the Net Community Benefit test therefore cannot be properly applied to this planning proposal.

Section B – Relationship to strategic planning framework

4. Is the planning proposal consistent with the objectives and actions contained within the North Coast Regional Plan 2036?

The planning proposal is considered to be consistent with the relevant goals, directions and actions within the North Coast Regional Plan 2036 as follows:

GOAL 1 – THE MOST STUNNING ENVIRONMENT IN NSW

- ***Direction 1 - Deliver environmentally sustainable growth***
  - Action 1.1 - Focus future urban development to mapped urban growth areas.
  - Action 1.2 - Review areas identified as 'under investigation' within urban growth areas to identify and map sites of potentially high environmental value.
  - Comment - Although not related to urban development, this planning proposal responds to the environmental attributes of the land in an appropriate manner.
- ***Direction 2 - Enhance biodiversity, coastal and aquatic habitats, and water catchments***
  - Action 2.1 - Focus development to areas of least biodiversity sensitivity in the region and implement the 'avoid, minimise, offset' hierarchy to biodiversity, including areas of high environmental value.
  - Action 2.2 - Ensure local environmental plans manage marine environments, water catchment areas and groundwater sources to avoid potential development impacts.
  - Comment - This planning proposal manages and responds to the environmental attributes of the land in a responsible manner. Appropriate parts of the site have been zoned to reflect their environmental attributes.
- ***Direction 3 - Manage natural hazards and climate change***
  - Action 3.1 - Reduce the risk from natural hazards, including the projected effects of climate change, by identifying, avoiding and managing vulnerable areas and hazards.
  - Action 3.2 - Review and update floodplain risk, bushfire and coastal management mapping to manage risk, particularly where urban growth is being investigated.
  - Action 3.3 - Incorporate new knowledge on regional climate projections and related cumulative impacts in local plans for new urban development.
  - Comment - This planning proposal manages and responds to the environmental attributes of the land in an appropriate manner.

GOAL 2 – A THRIVING, INTERCONNECTED ECONOMY

- ***Direction 8 - Promote the growth of tourism***

  Action 8.1 - Facilitate appropriate large-scale tourism developments in prime tourism development areas such as Tweed Heads, Tweed Coast, Ballina, Byron Bay, Coffs Harbour and Port Macquarie.

  Action 8.2 - Facilitate tourism and visitor accommodation and supporting land uses in coastal and rural hinterland locations through local growth management strategies and local environmental plans.

  Action 8.5 - Preserve the region's existing tourist and visitor accommodation by directing permanent residential accommodation away from tourism developments, except where it is ancillary to existing tourism developments or part of an area otherwise identified for urban expansion in an endorsed local growth management strategy.

  Comment - Additional housing in a rural residential setting will supplement local agri-tourism opportunities.

- ***Direction 11 - Protect and enhance productive agricultural lands***

  Action 11.1 - Enable the growth of the agricultural sector by directing urban and more residential development away from important farmland and identifying locations to support existing and small-lot primary production, such as horticulture in Coffs Harbour.

  Action 11.3 - Identify and protect intensive agriculture clusters in local plans to avoid land use conflicts, particularly with residential and rural residential expansion.

  Action 11.4 - Encourage niche commercial, tourist and recreation activities that complement and promote a stronger agricultural sector, and build the sector's capacity to adapt to changing circumstances.

  Action 11.5 - Address sector-specific considerations for agricultural industries through local plans.

  Comment - This planning proposal includes land that is mapped as Regionally Significant Farmland (see Figure 2), however this site is not currently used for agricultural production and has little agricultural potential as the land is predominantly fragmented to below a sustainable agricultural lot size. Retaining an RU2 zone on the land would result in the retention of rural lands with little or no agricultural potential. The planning proposal has also addressed the Important Farmland Interim Variation Criteria contained in the *North Coast Regional Plan 2036* (see Appendix 3).

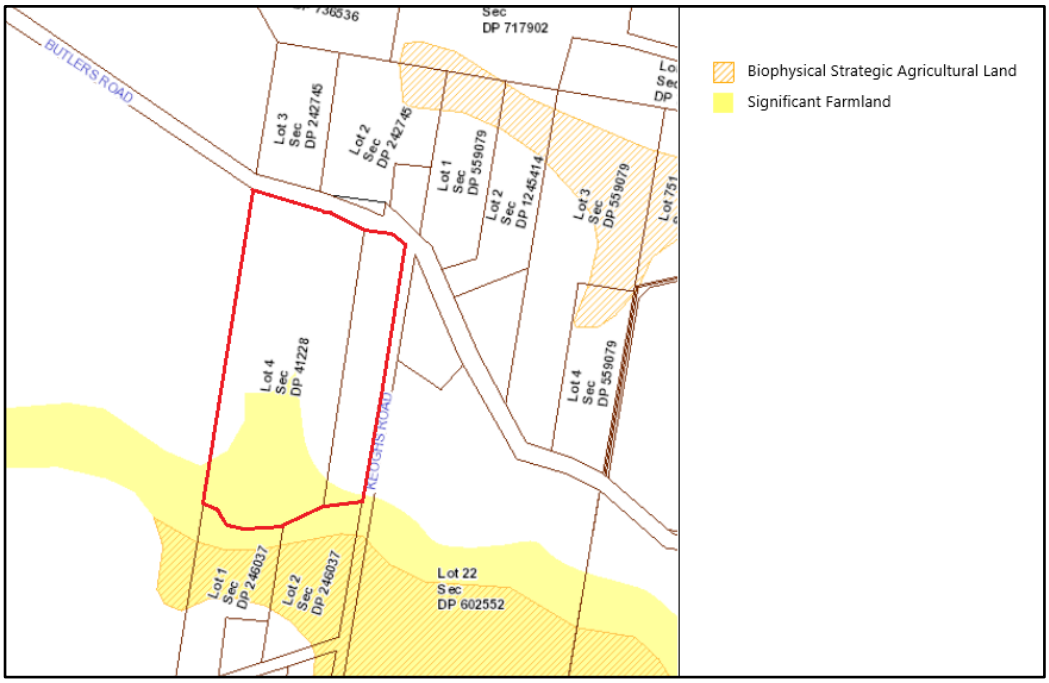

Figure 2: Significant Farmland

- ***Direction 12 - Grow agribusiness across the region***

  Action 12.1 - Promote the expansion of food and fibre production, agrichemicals, farm machinery, wholesale and distribution, freight and logistics, and processing through flexible planning provisions in local growth management strategies and local environmental plans.

  Action 12.2 - Encourage the co-location of intensive primary industries, such as feedlots and compatible processing activities.

  Action 12.4 - Facilitate investment in the agricultural supply chain by protecting assets, including freight and logistics facilities, from land use conflicts arising from the encroachment of incompatible land uses.

  Comment - The proposed rezoning will not adversely affect any existing agribusiness.

GOAL 3 – VIBRANT AND ENGAGED COMMUNITIES

- ***Direction 16 - Collaborate and partner with Aboriginal communities***

  Action 16.2 - Ensure Aboriginal communities are engaged throughout the preparation of local growth management strategies and local environmental plans.

  Comment - The wider Bonville Large Lot Residential rezoning included consultation with the Coffs Harbour and District Local Aboriginal Land Council (LALC). This planning proposal also includes reference to direct consultation with the LALC (see Appendix 4).

- ***Direction 18 - Respect and protect the North Coast's Aboriginal heritage***

  Action 18.1 - Ensure Aboriginal objects and places are protected, managed and respected in accordance with legislative requirements and the wishes of local Aboriginal communities.

  Action 18.2 - Undertake Aboriginal cultural heritage assessments to inform the design of planning and development proposals so that impacts to Aboriginal cultural heritage are minimised and appropriate heritage management mechanisms are identified.

  Action 18.3 - Develop local heritage studies in consultation with the local Aboriginal community, and adopt appropriate measures in planning strategies and local plans to protect Aboriginal heritage.

  Comment - The wider Bonville Large Lot Residential rezoning included consultation with the Coffs Harbour and District Local Aboriginal Land Council (CH&DLALC). This planning proposal also includes reference to direct consultation with the CH&DLALC (see Appendix 4). Correspondence from the LALC states: *"having reviewed the proposal would like to express its interest in the future development in regards to Culture and Heritage matters. The CH&D LALC feel the above property has likely Culture and Heritage material due to its location, landform, waterways. Further arrangements in regards to Culture and Heritage matters will need to be made through this office."*

- ***Direction 19 - Protect historic heritage***

  Action 19.1 - Ensure best-practice guidelines are considered such as the Australia ICOMOS Charter for Places of Cultural Significance and the NSW Heritage Manual when assessing heritage significance.

  Action 19.2 - Prepare, review and update heritage studies in consultation with the wider community to identify and protect historic heritage items, and include appropriate local planning controls.

  Action 19.3 - Deliver the adaptive or sympathetic use of heritage items and assets.

  Comment - No items of historic heritage have been identified on or surrounding the subject land.

GOAL 3 – VIBRANT AND ENGAGED COMMUNITIES

- ***Direction 22 - Deliver greater housing supply***

Action 22.2 - Facilitate housing and accommodation options for temporary residents by: preparing planning guidelines for seasonal and itinerant workers accommodation to inform the location and design of future facilities; and working with councils to consider opportunities to permit such facilities through local environmental plans.

Comment - Housing facilitated by this planning proposal may be used to provide accommodation to seasonal and itinerate workers on nearby farms.

- ***Direction 24 - Deliver well-planned rural residential housing areas***

  Action 24.2 - Enable sustainable use of the region's sensitive coastal strip by ensuring new rural residential areas are located outside the coastal strip, unless already identified in a local growth management strategy or rural residential land release strategy approved by the Department of Planning and Environment.

  Comment - This planning proposal looks to provide a small amount of additional housing within a Large Lot Residential zone located outside the coastal strip and immediately adjacent to existing Large Lot residential housing. In this regard, the planning proposal is considered to be of minor significance and that it will achieve the overall intent of the *North Coast Regional Plan* and does undermine the achievement of its vision, land use strategy, goals, direction or actions).

- ***Direction 25 - Deliver more opportunities for affordable housing***

  Action 25.1 - Deliver more opportunities for affordable housing by incorporating policies and tools into local growth management strategies and local planning controls that will enable a greater variety of housing types and incentivise private investment in affordable housing.

  Comment - This planning proposal looks to provide a small number of additional Large Lot Residential zoned allotments that can be used to facilitate affordable housing.

5. Is the planning proposal consistent with council's Community Strategic Plan and Local Growth Management Strategy?

MyCoffs Community Strategic Plan 2030

Council's Community Strategic Plan is based on four key themes: Community Wellbeing; Community Prosperity; A Place for Community; and Sustainable Community Leadership. Within each theme there are a number of objectives, and for each objective there are a number of strategies to assist in achieving the objectives. The planning proposal is generally consistent with the following relevant objectives and strategies within the Plan:

Objective	Strategy
A thriving and sustainable local economy	B1.2 We attract people to work, live and visit in the Coffs Harbour local government area
Liveable Neighbourhoods with a Defined Identity	C1.1 We create liveable places that are beautiful and appealing
	C1.2 We undertake development that is environmentally, socially and economically responsible
A natural environment sustained for the future	C2.1: We protect the diversity of our natural environment.

	C2.2: We use resources responsibly to support a safe and stable climate.
Our leaders give us confidence in the future	D1.2 We undertake effective engagement and are informed

Coffs Harbour Local Growth Management Strategy

The subject land is not included within the Bonville candidate area of the Rural Residential Component of Council's Local Growth Management Strategy (LGMS) 2008, however it is located within the wider Bonville Large Lot Residential study area.

The Bonville Large Lot Residential Investigation Area was rezoned on 19 May 2017. As part of this process, Council at its Ordinary Meeting of 8 December 2016 resolved to adopt Planning Proposal PP_2015_COFFS_005_00 to rezone suitable land within the Bonville Large Lot Residential Investigation Area for large lot residential purposes. At the time of adoption, three additional land parcels, including Lot 4, DP 41228 (81 Butlers Road) and Lot 5, DP 41228 (75-77 Butlers Road), were included post exhibition to address submissions received during the exhibition period for that planning proposal. These lots were included despite the fact that they were not contained within the Bonville Large Lot Residential Candidate area of Council's endorsed Rural Residential Component of the LGMS 2008. Council at its Meeting of 8 December 2016 endorsed their inclusion in Planning Proposal PP_2015_COFFS_005_00 and this was considered to be an addition of minor significance which did not undermine the achievement of the vision, goals or actions of the LGMS.

When seeking endorsement from the former NSW DPE for the planning proposal, Council was advised by the Department that it was not able to endorse the inclusion of these land parcels as they had not been subject to community consultation in accordance with the Gateway Determination. It was suggested by the Department at that time, that consideration of these land parcels for large lot residential purposes could be addressed by individual proponent led planning proposals. On the basis of that advice, these land parcels were included in Council's revised *Coffs Harbour Local Growth Management Strategy – Chapter 6 Large Lot Residential Lands,* in order to enable proponent initiated planning proposals to be submitted to Council seeking the rezoning of suitable land within the subject lots.

Council at its Ordinary Meeting of 22 August 2019 resolved to adopt the *Coffs Harbour Local Growth Management Strategy – Chapter 6 Large Lot Residential Lands* and to seek endorsement from NSW Department of Planning, Industry and Environment for Chapter 6 of the Strategy. In accordance with the resolution, Council has sought endorsement from NSW Department of Planning, Industry and Environment for *Coffs Harbour Local Growth Management Strategy – Chapter 6 Large Lot Residential Lands* pursuant to Direction 24 of the North Coast Regional Plan 2036.

6. Is the planning proposal consistent with applicable state environmental planning policies (SEPP)?

The table provided in Appendix 1 provides an assessment of consistency against each State Environmental Planning Policy relevant to the Planning Proposal.

7. Is the planning proposal consistent with applicable Ministerial Directions (s9.1 directions)?

The table provided in Appendix 2 provides an assessment of consistency against Ministerial Planning Directions relevant to the Planning Proposal.

Section C – Environmental, social and economic impact

8. Is there any likelihood that critical habitat or threatened species, populations or ecological communities, or their habitats, will be adversely affected as a result of the proposal?

No. It is noted that the following was identified in the Flora and Fauna Report by Ecological produced for the wider Bonville Large Lot Residential Planning Proposal (see Appendix 5):

- areas of vegetation on 81 Butlers Rd mapped as potential Endangered Ecological Communities;
- second and third order streams requiring buffers;
- koala records in relatively close proximity;
- a subregional corridor crosses the site as mapped in the Key Habitats and Corridors for Forest Fauna project (Scotts 2003); and
- vegetated areas on the lot suggested to be zoned E2 Environmental Conservation.

It is also noted that the zone layout for the subject land responds to these issues and appropriate parts of the subject land are included within Zone E2 Environmental Conservation. With this in mind, it is unlikely that critical habitat or threatened species, populations or ecological communities, or their habitats, will be adversely affected as a result of the planning proposal.

9. Are there any other likely environmental effects as a result of the planning proposal and how are they proposed to be managed?

Yes. The following is a summary of other likely environmental effects as a result of the planning proposal.

Flood Prone Land

Council's mapping shows that the subject land is prone to some levels of flooding. Indicative flood areas are shown in Figure 3. The area was not mapped in the Bonville Creek Flood Study (Bewsher, 1995). The subject area's most recent modelling was completed in the Bonville Large Lot Residential Investigation Area - Flood Mapping (de Groot and Benson, Dec 2013 – see Appendix 7).

The modelling from this study can be used to a certain degree to inform potential flood impacts on the subject land. The modelling shows a maximum preliminary flood estimate on the lot of around 8.1m AHD. A significant portion of the south west side of lot 4 DP 41228 would be considered a flood way and will be restricted from any habitable building or structure. As this lot is flood prone, any future development application for subdivision on the land would need to comply with clause 7.3 (Flood Planning) of Coffs Harbour LEP 2013, and section E4 Coffs Harbour Development Control Plan, 2015. In particular requirement 3 of the Coffs Harbour DCP states that "*..a minimum building envelope of 400 m² in area of functional proportions above the 100-year ARI*". The zone layout is such that it will be likely to allow enough land for this to be viable on resulting lots, however this will need to be properly assessed at the development application stage when subdivision plans are submitted.

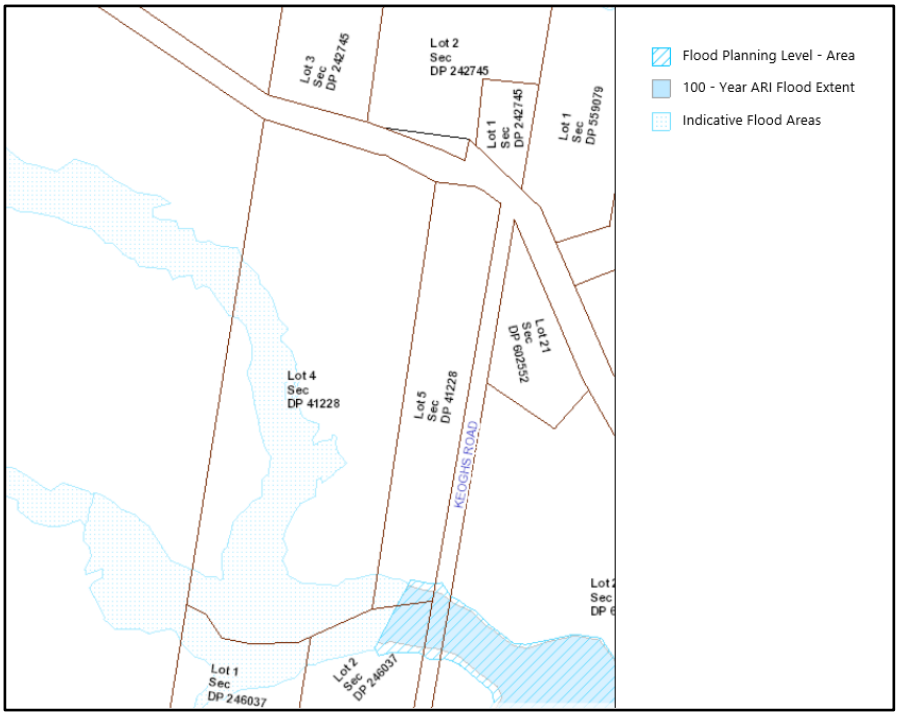

Figure 3: Flood Prone Land

Bushfire Risk

The subject land includes Category 1 Bush Fire Prone Land (refer to Figure 4). The wider Bonville Large Lot residential rezoning planning proposal included a bushfire assessment and this is included in Appendix 6. Appropriate consultation will need to be undertaken with the NSW Rural Fire Service in order to comply with the relevant Local Planning Direction, pending the issuing of a Gateway Determination. Should the Planning Proposal process be completed, all future development applications for subdivision will need to comply with the 'specifications and requirements ' of draft *Planning for Bush Fire Protection 2018* and associated documents.

Future development applications for all development involving bush fire prone lands will be required to comply with either section 4.14 of the EP&A Act 1979 or section 100B of the *Rural Fires Act 1997*, depending on the nature of the proposed development, and the relevant provisions of *Planning for Bush Fire Protection 2006* and *draft Planning for Bush Fire Protection 2018.*

Figure 4: Bush Fire Prone Land

Site Contamination

A review of previous land uses conducted on the subject land indicates that contamination of the site is unlikely given that the main past use has been for low intensity cattle grazing. None of the subject land is identified as former banana cultivation land, or as contaminated land on Council's mapping system.

Acid Sulfate Soils

Council's mapping system indicates that most of the subject land is classified as Class 5 Acid Sulfate Soils (refer to Figure 5), which is the lowest possible risk class. Therefore, it is highly unlikely that subsequent development of the property into large lot residential allotments will disturb acid sulfate soils.

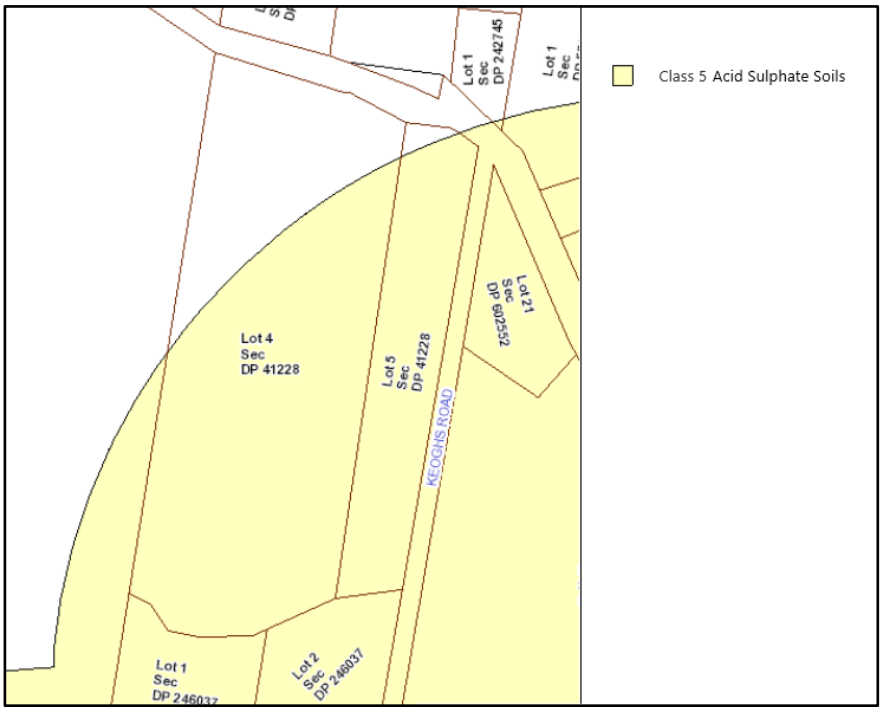

Figure 5: Acid Sulfate Soils

Aboriginal Cultural Heritage

An Archaeological Assessment was carried out to inform the planning proposal CHCC prepared for the wider Bonville Large Lot Residential Investigation Area. This assessment was referred to the Coffs Harbour and District Local Aboriginal Land Council (CH&DLALC) as required by the terms of the Gateway Determination issued for the Bonville Large Lot Residential Investigation Area Planning Proposal. The CH&DLALC reviewed the Archaeological Assessment and recommended that Council undertake a new Aboriginal Cultural Heritage Assessment to obtain a more comprehensive assessment of the Banville Investigation Area, addressing all aspects of cultural heritage.

Ultimately, Coffs Harbour City Council (CHCC) engaged CH&DLALC to undertake inspections of the Bonville Investigation Area to clarify and supplement the findings of the Cultural Heritage Assessment Component of the initial Local Environmental Study. Once the CH&DLALC completed their review and the recommendations were ratified by the LALC Elders' Committee, *Coffs Harbour Local Environmental Plan 2013 (Amendment No.7)* was finalised.

An AHIMS search was undertaken on 5 February 2019 as part of the due diligence process for the subject land and concluded as follows:
***** *No Aboriginal sites are recorded in or near the above location; and*
***** *No Aboriginal places have been declared in or near the above location.*

As part of the current process, pre-lodgement consultation was also undertaken with the CH&DLALC to ascertain whether the Land Council had any specific issues it wanted addressed as part of the preparation of the Planning Proposal. On 8 April 2019, the CH&DLALC advised that *"having reviewed the proposal would like to express its interest in the future development in regards to Culture and Heritage matters. The CH&D LALC feel the above property has likely Culture and Heritage material due to its location, landform, waterways. Further arrangements in regards to Culture and Heritage matters will need to be made through this office"* (see Appendix 4**).**

Wastewater Disposal

The wider Bonville Large Lot residential rezoning planning proposal included a desktop hazard assessment report (see Appendix 8) of the wider study area in relation to site and soil limitations which can effect on-site wastewater management and the potential for subdivision.

The decentralised sewerage modelling within the report indicated that the recommended lot density for subdivision allows one onsite wastewater management system per 4,000m^2. As the minimum lot size proposed within this planning proposal is one allotment per 10,000m^2 (one hectare), this indicates that wastewater disposal within the subject land will be able to comply with applicable requirements when subsequent subdivision occurs.

10. How has the planning proposal adequately addressed any social and economic effects?

It is unlikely that the planning proposal would result in adverse social or environmental effects. Should the planning proposal progress to completion, the social and economic impact of development for large lot residential purposes of the land will be neutral / minor for the following reasons:

- The potential lot yield is not high enough to be socially detrimental or create excessive demands on existing services.
- Subsequent development of the subject land is included in a Developer Contributions Plan, to ensure that any additions to local infrastructure can be levied to applicants.

- Subdivision to create new allotments will be influenced by the existing smaller sized holdings and the location of existing dwellings.
- New large lot residential allotments will be similar in land use and character to surrounding properties.
- There is sufficient social infrastructure in the area to cater for the proposed minimal increase in large lot residential allotments, created as a result of the Planning Proposal.

Section D – State and Commonwealth interests

11. Is there adequate public infrastructure for the planning proposal?

Yes. Adequate public infrastructure exists to service the subject land. A sealed road fronts two sides of the subject land and the electricity network is adequate to cater for future subdivision. The National Broadband Network (NBN) is available in the area to provide wireless internet services to subscribers who wish to connect.

12. What are the views of State and Commonwealth public authorities consulted in accordance with the Gateway determination?

A Gateway determination has not been issued by NSW Planning, Industry and Environment as yet, thus consultation with public authorities and government agencies has not yet been undertaken.

At this stage in the process there does not appear to be any matters of interest to Commonwealth authorities in relation to the planning proposal. In this regard, it is proposed that the authorities listed below be consulted with in relation to the planning proposal, and that this consultation be undertaken concurrent with public exhibition of the planning proposal:

- NSW Rural Fire Service;
- NSW Environment, Energy and Science - Biodiversity and Conservation; and
- NSW Department of Primary Industries (Agriculture).

PART 4 – MAPPING

Existing mapping and proposed mapping amendments to Coffs Harbour LEP 2013, as described in **Part 2** of this planning proposal are shown below.

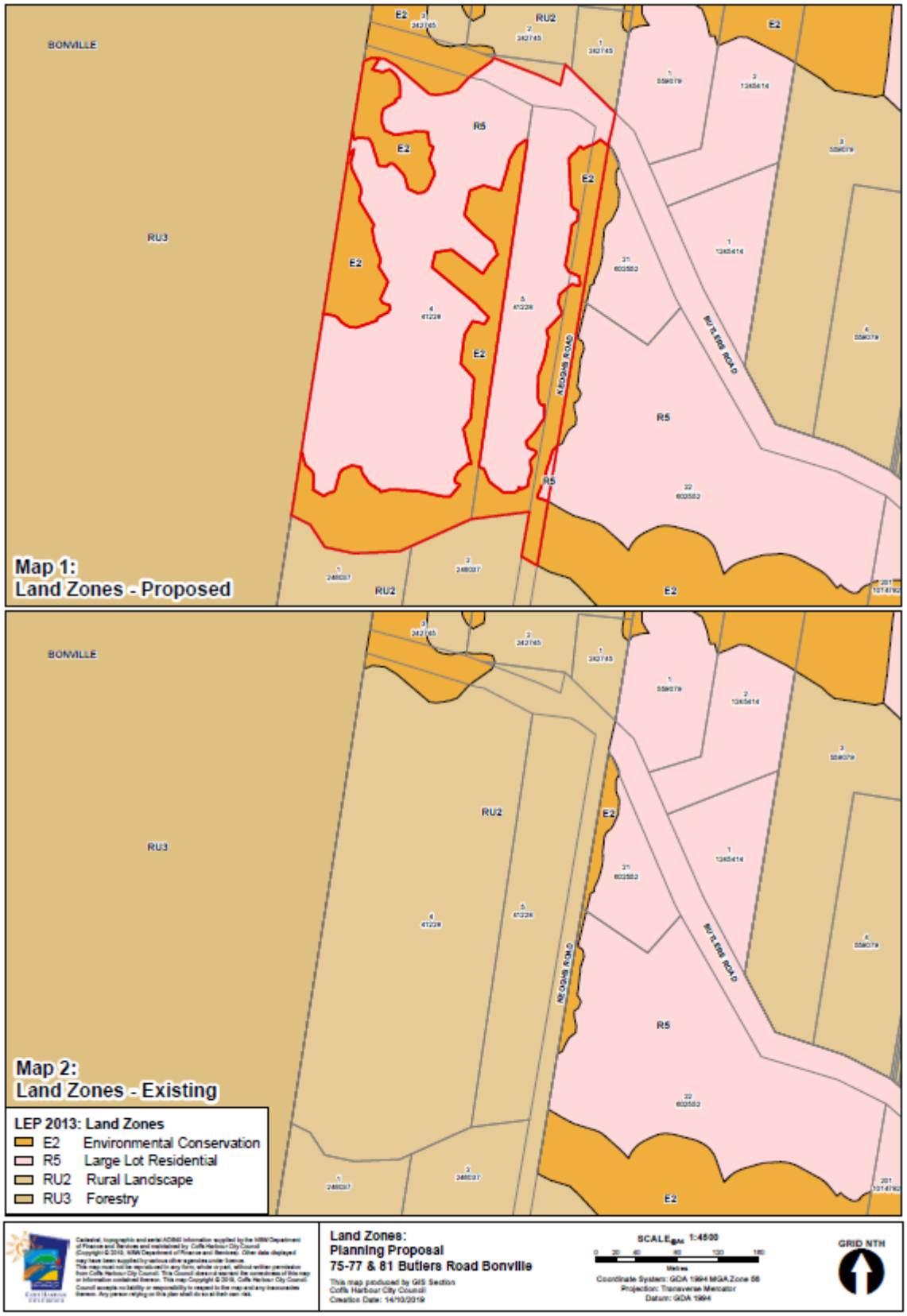

Figure 5: Land zoning map comparison – existing and proposed

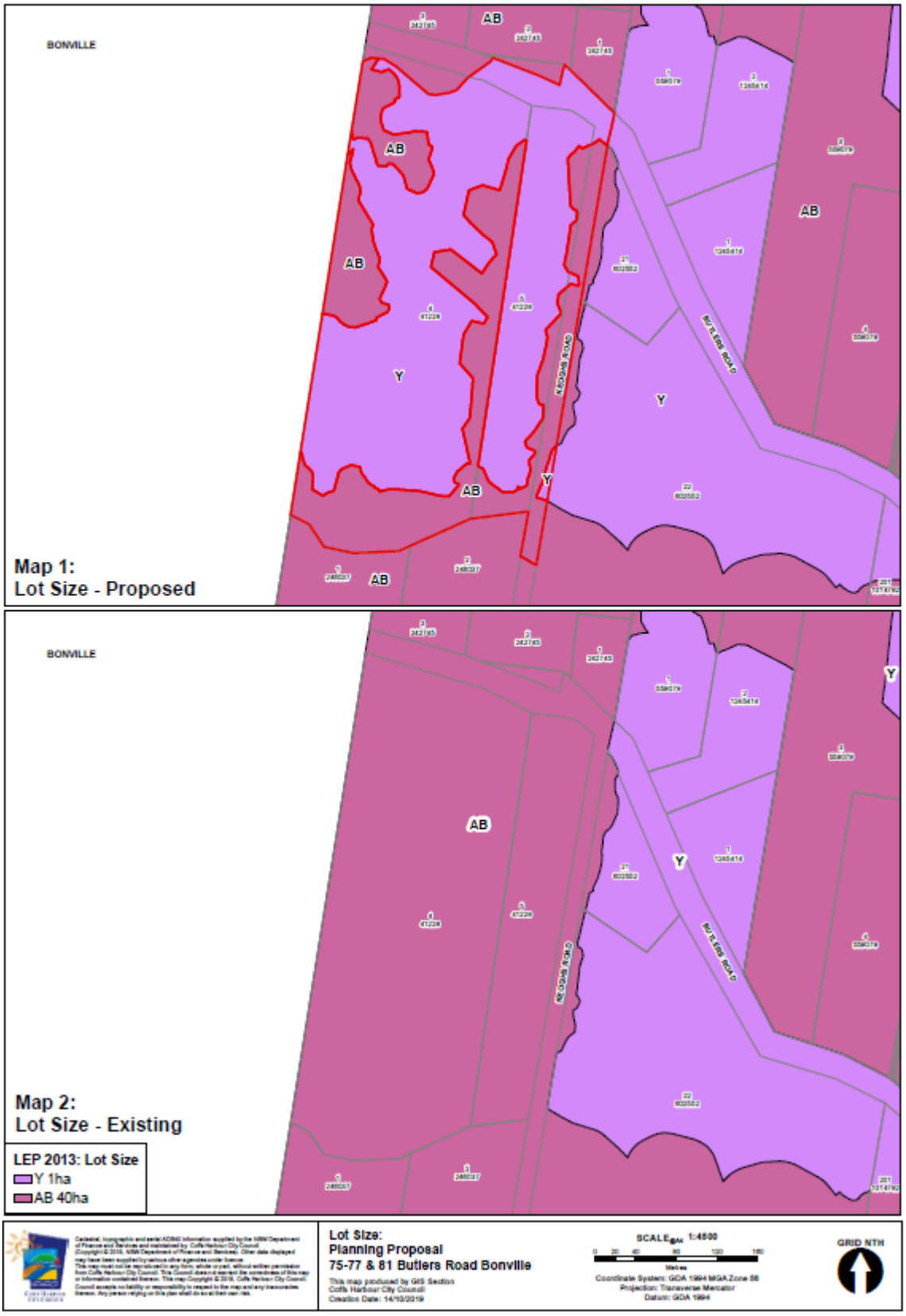

Figure 6: Lot size map comparison – existing and proposed

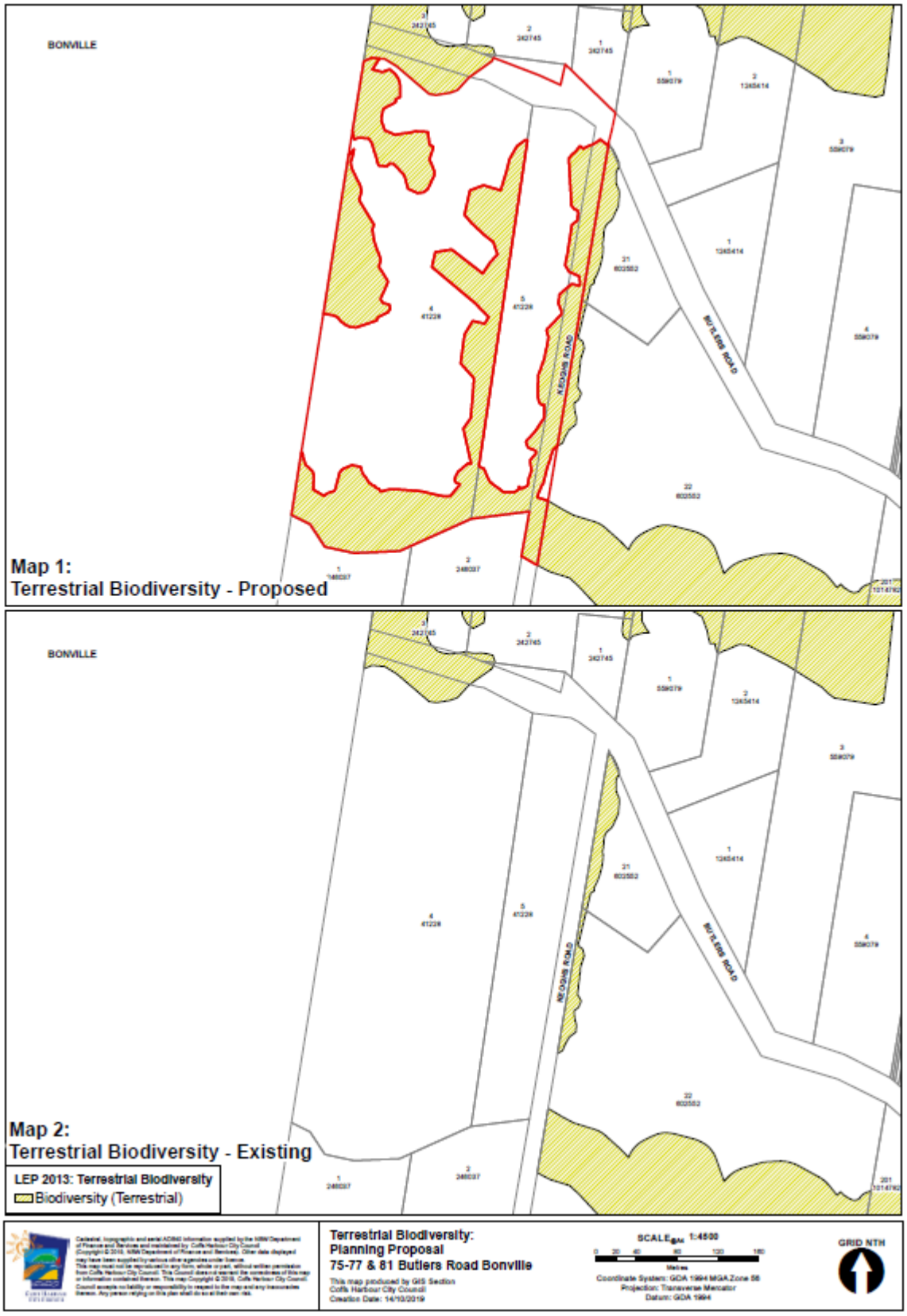

Figure 7: Terrestrial biodiversity map comparison – existing and proposed

Technical Notes:

- *An amended version of this map sheet will be created and supplied to NSW Department of Planning, Industry and Environment if Council resolves to initiate the planning proposal.*

PART 5 – COMMUNITY CONSULTATION

The Gateway determination issued by the Department of Planning, Industry and Environment will specify the community consultation requirements that must be undertaken for the planning proposal. Council considers that the planning proposal should be exhibited for 28 days, given that it is not a principal LEP and does not seek to reclassify public land.

Public Exhibition of the planning proposal will include the following:

Advertisement

Placement of an advertisement in the Coffs Harbour Advocate.

Consultation with affected owners and adjoining landowners

Written notification of the public exhibition to the proponent, the landowner and adjoining/adjacent landowners.

Website

The planning proposal will be made publicly available on Council's Have Your Say Website at: https://haveyoursay.coffsharbour.nsw.gov.au/

Note: Following public exhibition, this section of the planning proposal will be updated to include details of the community consultation.

PART 6 –PROJECT TIMELINE

A project timeline is yet to be determined however the anticipated timeframes are provided below in Table 1, noting that the Gateway Determination issued by the Department of Planning, Industry and Environment will specify the date that the planning proposal is to be completed.

Table 1: Anticipated Timeline

Milestone	Anticipated Timeframe
Decision by Council to initiate the planning proposal	December 2019
Commencement (date of Gateway determination)	January 2020
Peer review & provision of additional information (if required)	February 2020
Public exhibition & agency consultation	March 2020
Consideration of submissions	April – May 2020
Reporting to Council for consideration	May 2020
Submission to Minister to make the plan (if not delegated) Submission to Minister for notification of the plan (if delegated)	June - July 2020

APPENDIX 1 – CONSIDERATION OF STATE ENVIRONMENTAL PLANNING POLICIES

State Environmental Planning Policy	Applicable	Consistent	Comment
SEPP No 1 – Development Standards	No	N/A	This policy does not apply. Exceptions to development standards are considered under Clause 4.6 of Coffs Harbour LEP 2013. The planning proposal does not recommend the amendment of existing provisions relating to development standards.
SEPP No 19 – Bushland in Urban Areas	No	N/A	Coffs Harbour City Council is not listed in Schedule 1 of this policy and thus the policy does not apply to this planning proposal.
SEPP No 21 – Caravan Parks	No	N/A	Caravan parks are prohibited in the R5 zone and therefore this policy does not apply.
SEPP No 33 – Hazardous and Offensive Development	No	N/A	This policy does not apply. This planning proposal does not contain specific provisions that reference hazardous and offensive development.
SEPP No 36 – Manufactured Home Estates	No	N/A	Caravan parks (and therefore manufactured home estates) are prohibited in the R5 zone and therefore this policy does not apply.
SEPP No 44 – Koala Habitat Protection	Yes	Yes	This SEPP encourages the conservation and management of natural vegetation areas that provide habitat for koalas to ensure that permanent free-living populations will be maintained over their present range. The subject land contains mapped primary koala habitat that is already zoned E2 Environmental Conservation. The Flora and Fauna Report produced for the wider Bonville Large Lot Residential Planning Proposal also notes koala records in relatively close proximity to the land. The proposed zone layout for the subject land reflects these findings.
SEPP No 50 – Canal Estate Development	No	N/A	This policy does not apply. This planning proposal does not contain specific provisions that reference or propose canal estate development.
SEPP No 55 – Remediation of Land	Yes	Yes	A review of previous land uses of the site indicates that contamination of the site is unlikely. Past uses comprise low intensity stock grazing. The land is not mapped by CHCC as former banana cultivation land. No contamination of the site is anticipated from these activities. Searches of the land contamination register, record of notices and contaminated sites notified to Environmental Protection Authority have not identified any contamination risks for the subject land. As a result, contamination risks are considered minimal and manageable within recognised remediation procedures and industry approved best practice guidelines.

APPENDIX 1 – CONSIDERATION OF STATE ENVIRONMENTAL PLANNING POLICIES

State Environmental Planning Policy	Applicable	Consistent	Comment
SEPP No 64 – Advertising and Signage	Yes	Yes	The planning proposal is consistent with the aims or provisions of this SEPP. Advertising signage is unlikely on the subject land and is also subject to the provisions of Coffs Harbour Local Environmental Plan 2013 and Development Control Plan 2015.
SEPP No 65 – Design Quality of Residential Apartment Development	No	N/A	This policy does not apply. This planning proposal will not result in buildings that are three or more storeys in height.
SEPP No 70 – Affordable Housing (Revised Schemes)	Yes	Yes	This may become relevant for future development applications but is not a consideration at this stage.
SEPP (Aboriginal Land) 2019	No	N/A	This policy does not apply. This policy presently only applies to the Central Coast Local Government Area.
SEPP (Affordable Rental Housing) 2009	Yes	Yes	The planning proposal is consistent with the aims or provisions of this SEPP. Future development may incorporate housing delivered under this SEPP and relevant provisions will be given detailed consideration during the assessment of a development application.
SEPP (Building Sustainability Index: BASIX) 2004	Yes	Yes	The planning proposal is consistent with the aims or provisions of this SEPP. Future development incorporating BASIX affected buildings will be subject to the provisions of this SEPP.
SEPP (Coastal Management) 2018	No	N/A	This policy does not apply as the subject land is not located within the Coastal Zone footprint.
SEPP (Concurrences) 2018	Yes	Yes	The planning proposal is consistent with the aims or provisions of this SEPP. Future development requiring concurrence will be subject to the provisions of this SEPP.
SEPP (Educational Establishments and Child Care Facilities) 2017	Yes	Yes	The planning proposal is consistent with the aims or provisions of this SEPP. Any future development incorporating a child care centre or the like would be subject to the provisions of this SEPP.
SEPP (Exempt and Complying Development Codes) 2008	Yes	Yes	The planning proposal is consistent with the aims or provisions of this SEPP. This SEPP is not specifically relevant in the context of the planning proposal.
SEPP (Housing for Seniors or People with a Disability) 2004	No	N/A	Seniors housing is prohibited in the R5 zone and therefore this policy does not apply.

APPENDIX 1 – CONSIDERATION OF STATE ENVIRONMENTAL PLANNING POLICIES

State Environmental Planning Policy	Applicable	Consistent	Comment
SEPP (Infrastructure) 2007	Yes	Yes	The planning proposal is consistent with the aims or provisions of this SEPP. This planning proposal does not contain provisions that contradict or hinder the application of this SEPP.
SEPP (Mining, Petroleum Production and Extractive Industries) 2007	Yes	Yes	The planning proposal is consistent with the aims or provisions of this SEPP. This planning proposal does not contain provisions that contradict or hinder the application of this SEPP.
SEPP (Miscellaneous Consent Provisions) 2007	Yes	Yes	The planning proposal is consistent with the aims or provisions of this SEPP. This planning proposal does not contain provisions that contradict or hinder the application of this SEPP.
SEPP (Primary Production and Rural Development) 2019	Yes	Yes	The planning proposal is consistent with the aims or provisions of this SEPP as: • The site is not state significant farmland. • The site is included in Council's Local Growth Management Strategy (2019). • The site is not used for productive agricultural uses and therefore the impact on the overall availability of rural lands for this purpose will be negligible. • The land is small in area and is inappropriately located for sustainable agriculture, given its proximity to adjacent large lot residential land.
SEPP (State and Regional Development) 2019	Yes	Yes	This planning proposal does not contain provisions that contradict or hinder the application of this SEPP.
SEPP (State Significant Precincts) 2005	No	N/A	This planning proposal does not relate to a state significant precinct.
SEPP (Urban Renewal) 2010	No	N/A	This planning proposal does not relate to an urban renewal precinct.
SEPP (Vegetation in Non-Rural Areas) 2017	Yes	Yes	The planning proposal is consistent with the aims or provisions of this SEPP. This planning proposal does not contain provisions that contradict or hinder the application of this SEPP.

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
1. Employment and Resources			
1.1 Business and Industrial Zones	Applies when a relevant planning authority prepares a planning proposal that will affect land within an existing or proposed business or industrial zone (including the alteration of any existing business or industrial zone boundary).	N/A	This planning proposal does not affect land within an existing or proposed business or industrial zone.
1.2 Rural Zones	Applies when a relevant planning authority prepares a planning proposal that will affect land within an existing or proposed rural zone (including the alteration of any existing rural zone boundary). Under this direction a planning proposal must: (a) not rezone land from a rural zone to a residential, business, industrial, village or tourist zone.	No - Justifiably inconsistent for reasons listed.	This planning proposal includes land that is mapped as Regionally Significant Farmland, however this site is not currently used for agricultural production and has little agricultural potential as the land is predominantly fragmented to below a sustainable agricultural lot size. Retaining an RU2 zone on the land would result in the retention of rural lands with little or no agricultural potential. The planning proposal has addressed the Important Farmland Interim Variation Criteria contained in the *North Coast Regional Plan 2036* (see Appendix 3). For these reasons the provisions of the Planning Proposal that are inconsistent are considered to be "of minor significance". An approval for a variation to this s9.1 Direction is considered to be reasonable under the circumstances.
1.3 Mining, Petroleum Production and Extractive Industries	Applies when a relevant planning authority prepares a planning proposal that would have the effect of: (a) prohibiting the mining of coal or other minerals, production of petroleum, or winning or obtaining of extractive materials, or (b) restricting the potential development of	Yes	This planning proposal does not: (a) prohibit the mining of coal or other minerals, production of petroleum, or winning or obtaining of extractive materials, or (b) restrict the potential development of resources of coal, other minerals, petroleum or extractive materials which are of State or regional significance.

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
	resources of coal, other minerals, petroleum or extractive materials which are of State or regional significance by permitting a land use that is likely to be incompatible with such development.		
1.4 Oyster Aquaculture	Applies when a relevant planning authority prepares any planning proposal that proposes a change in land use which could result in: (a) adverse impacts on a Priority Oyster Aquaculture Area or a "current oyster aquaculture lease in the national parks estate"; or (b) incompatible use of land between oyster aquaculture in a Priority Oyster Aquaculture Area or a "current oyster aquaculture lease in the national parks estate" and other land uses.	N/A	This planning proposal does not affect land within a Priority Oyster Aquaculture Area or a "current oyster aquaculture lease in the national parks estate".
1.5 Rural Lands	Applies when a relevant planning authority prepares a planning proposal that: (a) will affect land within an existing or proposed rural or environment protection zone (including the alteration of any existing rural or environment protection zone boundary), or (b) changes the existing minimum lot size on land within a rural or	No - Justifiably inconsistent for reasons listed.	The property is a relatively isolated parcel of rural land. Its use for rural purposes has the potential to conflict with existing adjoining large lot residential development. The size of the property is insufficient to be a viable agricultural holding. The land can be developed in accordance with its environment capacity and any potential impacts contained within the site. This planning proposal includes land that is mapped as Regionally Significant Farmland and as such, the planning proposal has addressed the Important Farmland Interim Variation Criteria contained in the

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
	environment protection zone.		*North Coast Regional Plan 2036* (see Appendix 3). For these reasons the provisions of the Planning Proposal that are inconsistent are considered to be "of minor significance". An approval for a variation to this s9.1 Direction is considered to be reasonable under the circumstances.
2 Environment and Heritage			
2.1 Environment Protection Zones	(4) A planning proposal must include provisions that facilitate the protection and conservation of environmentally sensitive areas. (5) A planning proposal that applies to land within an environment protection zone or land otherwise identified for environment protection purposes in a LEP must not reduce the environmental protection standards that apply to the land (including by modifying development standards that apply to the land). This requirement does not apply to a change to a development standard for minimum lot size for a dwelling in accordance with clause (5) of Direction 1.5 "*Rural Lands*".	Yes	It is noted that the following was identified in the Flora and Fauna Report by Ecological produced for the wider Bonville Large Lot Residential Planning Proposal (see Appendix 5): • areas of vegetation on 81 Butlers Rd mapped as potential Endangered Ecological Communities; • second and third order streams requiring buffers; • koala records in relatively close proximity; • a subregional corridor crosses the site as mapped in the Key Habitats and Corridors for Forest Fauna project (Scotts 2003); and • vegetated areas on the lot suggested to be zoned E2 Environmental Conservation. It is also noted that the zone layout for the subject land responds to these issues and appropriate parts of the subject land are included within Zone E2 Environmental Conservation. With this in mind, it is unlikely that critical habitat or threatened species, populations or ecological communities, or their habitats, will be adversely affected as a result of the planning proposal.

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
2.2 Coastal Protection	Applies to land that is within the coastal zone, as defined under the Coastal Management Act 2016 – comprising the coastal wetlands and littoral rainforests area, coastal vulnerability area, coastal environment area and coastal use area – as identified in *State Environmental Planning Policy (Coastal Management) 2018.* (4) A planning proposal must include provisions that give effect to and are consistent with: (a) the objects of the *Coastal Management Act 2016* and objectives of the relevant coastal management areas, (b) the NSW Coastal Management Manual and associated Toolkit; and (c) the NSW Coastal Design Guidelines 2003, and (c) any relevant Coastal Management Program that has been certified by the Minister, or any Coastal Zone Management Plan under the *Coastal Protection Act 1979* that continues to have effect under the *Coastal Management Act 2016*.	N/A	This planning proposal does not affect land within the Coastal Zone footprint.

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
2.3 Heritage Conservation	A planning proposal must contain provisions that facilitate the conservation of: (a) items, places, buildings, works, relics, moveable objects or precincts of environmental heritage significance to an area, in relation to the historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic value of the item, area, object or place, identified in a study of the environmental heritage of the area, (b) Aboriginal objects or Aboriginal places that are protected under the *National Parks and Wildlife Act 1974*, and (c) Aboriginal areas, Aboriginal objects, Aboriginal places or landscapes identified by an Aboriginal heritage survey prepared by or on behalf of an Aboriginal Land Council, Aboriginal body or public authority and provided to the relevant planning authority, which identifies the area, object, place or landscape as being of heritage significance to Aboriginal culture and people.	The Planning Proposal will require further investigation to determine whether it is consistent with this particular Direction.	No items of historic (post-European) heritage have been identified on or surrounding the subject land. With regard to Aboriginal cultural heritage, an AHIMS search was undertaken on 5 February 2019 as part of the due diligence process for the subject land and concluded as follows: ***** *No Aboriginal sites are recorded in or near the above location; and* ***** *No Aboriginal places have been declared in or near the above location.* Planning proposal pre-lodgement consultation was also undertaken with the CH&DLALC to ascertain whether the Land Council had any specific issues it wanted addressed as part of the preparation of the Planning Proposal. On 8 April 2019, the CH&DLALC advised that *"having reviewed the proposal would like to express its interest in the future development in regards to Culture and Heritage matters. The CH&D LALC feel the above property has likely Culture and Heritage material due to its location, landform, waterways. Further arrangements in regards to Culture and Heritage matters will need to be made through this office"* (see Appendix 4**).** As such, it may be considered appropriate to consult with the CH&DLALC under section 3.34(2)(d) of the Act and/or to comply with the requirements of relevant section 9.1 Directions, should a Gateway determination be issued by the NSW Department of Planning, Industry and Environment.
2.4 Recreation Vehicle Areas	A planning proposal must not enable land to be developed for the purpose of a recreation vehicle area	N/A	This planning proposal does not enable land to be developed for the purpose of a recreation vehicle area.

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
	(within the meaning of the *Recreation Vehicles Act 1983*): (a) where the land is within an environment protection zone, (b) where the land comprises a beach or a dune adjacent to or adjoining a beach, (c) where the land is not within an area or zone referred to in paragraphs (a) or (b) unless the relevant planning authority has taken into consideration: (i) the provisions of the guidelines entitled *Guidelines for Selection, Establishment and Maintenance of Recreation Vehicle Areas, Soil Conservation Service of New South Wales, September, 1985*, and (ii) the provisions of the guidelines entitled *Recreation Vehicles Act, 1983, Guidelines for Selection, Design, and Operation of Recreation Vehicle Areas, State Pollution Control Commission, September 1985.*		
3. Housing, Infrastructure and Urban Development			
3.1 Residential Zones	(3) This direction applies when a relevant planning authority prepares a planning	Yes	The provision of additional large lot residential land will broaden lifestyle choices in a suitable location. Affordable housing options are also

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
	proposal that will affect land within: (a) an existing or proposed residential zone (including the alteration of any existing residential zone boundary), (b) any other zone in which significant residential development is permitted or proposed to be permitted. (4) A planning proposal must include provisions that encourage the provision of housing that will: (a) broaden the choice of building types and locations available in the housing market, and (b) make more efficient use of existing infrastructure and services, and (c) reduce the consumption of land for housing and associated urban development on the urban fringe, and (d) be of good design. (5) A planning proposal must, in relation to land to which this direction applies: (a) contain a requirement that residential development is not permitted until land		potentially available to R5 Large Lot Residential zoned land. Appropriate planning controls are also contained within *Coffs Harbour Local Environmental Plan 2013 and Development Control Plan 2015* to ensure that development within R5 Large Lot Residential zoned land is of good design.

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
	is adequately serviced (or arrangements satisfactory to the council, or other appropriate authority, have been made to service it), and (b) not contain provisions which will reduce the permissible residential density of land.		
3.2 Caravan Parks and Manufactured Home Estates	Applies when a relevant planning authority prepares a planning proposal. In identifying suitable zones, locations and provisions for caravan parks in a planning proposal, the relevant planning authority must: (a) retain provisions that permit development for the purposes of a caravan park to be carried out on land, and (b) retain the zonings of existing caravan parks, or in the case of a new principal LEP zone the land in accordance with an appropriate zone under the Standard Instrument (Local Environmental Plans) Order 2006 that would facilitate the retention of the existing caravan park. In identifying suitable zones, locations and provisions for manufactured home estates (MHEs) in a planning proposal, the	N/A	Caravan parks or manufactured home estates are prohibited in both the RU2 Rural Landscape and R5 Large Lot Residential zones. Therefore this planning proposal does not affect existing or proposed provisions relating to caravan parks or manufactured home estates.

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S9.1 Direction	Applicable	Consistent	Comment
	relevant planning authority must: (a) take into account the categories of land set out in Schedule 2 of SEPP 36 as to where MHEs should not be located, (b) take into account the principles listed in clause 9 of SEPP 36 (which relevant planning authorities are required to consider when assessing and determining the development and subdivision proposals), and (c) include provisions that the subdivision of MHEs by long term lease of up to 20 years or under the *Community Land Development Act 1989* be permissible with consent.		
3.3 Home Occupations	Planning proposals must permit home occupations to be carried out in dwelling houses without the need for development consent.	Yes	This proposal does not affect home occupation provisions under LEP 2013.
3.4 Integrating Land Use and Transport	Applies when a relevant planning authority prepares a planning proposal that will create, alter or remove a zone or a provision relating to urban land, including land zoned for residential, business, industrial, village or tourist purposes. A planning proposal must locate zones for urban purposes and include provisions that give effect	N/A	This planning proposal does not create, alter or remove a zone or a provision relating to urban land and therefore this s9.1 Direction does not apply.

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
	to and are consistent with the aims, objectives and principles of: (a) *Improving Transport Choice – Guidelines for planning and development* (DUAP 2001), and (b) *The Right Place for Business and Services – Planning Policy* (DUAP 2001).		
3.5 Development Near Regulated Airports and Defence Airfields	Applies when a relevant planning authority prepares a planning proposal that will create, alter or remove a zone or a provision relating to land in the vicinity of a licensed aerodrome.	N/A	This planning proposal does not affect land within the vicinity of a regulated airport or defence airfield.
3.6 Shooting Ranges	Applies when a relevant planning authority prepares a planning proposal that will affect, create, alter or remove a zone or a provision relating to land adjacent to and/or adjoining an existing shooting range.	N/A	This planning proposal does not affect, create, alter or remove a zone or a provision relating to land adjacent to and/ or adjoining an existing shooting range.
4. Hazard and Risk			
4.1 Acid Sulfate Soils	Applies when a relevant planning authority prepares a planning proposal that will apply to land having a probability of containing acid sulfate soils as shown on the Acid Sulfate Soils Planning Maps.	No, however justifiably inconsistent for reasons listed.	The site has a low risk of containing acid sulphate soils as the site includes approximately two thirds of the land within Class 5 as shown on the acid sulphate soils risk maps. Future building envelopes are not expected to disturb potential Class 5 acid sulfate soils and guidelines are available for the management of acid sulfate soils within the mapped areas. Compliance with *Clause 7.1* of *Coffs Harbour LEP 2013* is a necessary requirement when preparing development applications to ensure

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S9.1 Direction	Applicable	Consistent	Comment
			that development does not disturb, expose or drain acid sulfate soils and cause environmental damage. For these reasons, the provisions of the planning proposal that are inconsistent are considered to be "of minor significance".
4.2 Mine Subsidence and Unstable Land	Applies when a relevant planning authority prepares a planning proposal that permits development on land that: (a) is within a mine subsidence district, or (b) has been identified as unstable in a study, strategy or other assessment undertaken: (i) by or on behalf of the relevant planning authority, or (ii) by or on behalf of a public authority and provided to the relevant planning authority.	Yes	This planning proposal does not apply to land that: (a) is within a mine subsidence district, or (b) has been identified as unstable in a study, strategy or other assessment undertaken: (i) by or on behalf of the relevant planning authority, or (ii) by or on behalf of a public authority and provided to the relevant planning authority.
4.3 Flood Prone Land	Applies when a relevant planning authority prepares a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land. A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy and the principles of the *Floodplain Development Manual 2005* (including the *Guideline on Development Controls on Low Flood Risk Areas*). A planning proposal must not rezone land within the	No, however justifiably inconsistent for reasons listed.	Council's mapping shows that the subject land is prone to some levels of flooding. Indicative flood areas are shown in Figure 2 within Part 3 (9) of the planning proposal**.** The area was not mapped in the Bonville Creek Flood Study (Bewsher, 1995). The subject area's most recent modelling was completed in the Bonville Large Lot Residential Investigation Area - Flood Mapping (de Groot and Benson, Dec 2013 – see Appendix 7). The modelling from this study can be used to a certain degree to inform potential flood impacts on the subject land. The modelling shows a maximum preliminary flood estimate

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S9.1 Direction	Applicable	Consistent	Comment
	flood planning areas from Special Use, Special Purpose, Recreation, Rural or Environment Protection Zones to a Residential, Business, Industrial, Special Use or Special Purpose Zone. A planning proposal must not contain provisions that apply to the flood planning areas which: (a) permit development in floodway areas, (b) permit development that will result in significant flood impacts to other properties, (c) permit a significant increase in the development of that land, (d) are likely to result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services, or (e) permit development to be carried out without development consent except for the purposes of agriculture (not including dams, drainage canals, levees, buildings or structures in floodways or high hazard areas), roads or exempt development. A planning proposal must not impose flood related development controls above the residential flood planning level for residential development on land, unless a relevant		on the lot of around 8.1m AHD. A significant portion of the south west side of the lot would be considered a flood way and will be restricted from any habitable building or structure. As the lot is flood prone, any future development application for subdivision on the land would need to comply with clause 7.3 (Flood Planning) of Coffs Harbour LEP 2013, and section E4 Coffs Harbour Development Control Plan, 2015. In particular requirement 3 of the Coffs Harbour DCP states that "*..a minimum building envelope of 400 m^2 in area of functional proportions above the 100-year ARI*". The zone layout is such that it will be likely to allow enough land for this to be viable on resulting lots, however this will need to be properly assessed at the development application stage when subdivision plans are submitted. For these reasons, the provisions of the planning proposal that are inconsistent are considered to be "of minor significance".

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S9.1 Direction	Applicable	Consistent	Comment
	planning authority provides adequate justification for those controls to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General). For the purposes of a planning proposal, a relevant planning authority must not determine a flood planning level that is inconsistent with the *Floodplain Development Manual 2005* (including the *Guideline on Development Controls on Low Flood Risk Areas*) unless a relevant planning authority provides adequate justification for the proposed departure from that Manual to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).		
4.4 Planning for Bushfire Protection	Applies when a relevant planning authority prepares a planning proposal that will affect, or is in proximity to land mapped as bushfire prone land. In the preparation of a planning proposal, the relevant planning authority must consult with the Commissioner of the NSW Rural Fire Service following receipt of a Gateway determination under section 56 of the Act, and prior to undertaking community consultation in satisfaction of section 57 of the Act, and take into account any comments so made. A planning proposal must:	Referral to NSW Rural Fire Service is required prior to confirmation of consistency with this particular Direction.	The subject land includes Category 1 Bush Fire Prone Land. The wider Bonville Large Lot residential rezoning planning proposal included a bushfire assessment and this is included in Appendix 6. Appropriate consultation will be undertaken with the NSW Rural Fire Service as part of the LEP preparation process. Further consultation with the NSW Rural Fire Service will be necessary pending the issuing of a Gateway Determination. Upon making of the subject Planning Proposal, all future development applications for subdivision will need to comply with the 'specifications and requirements' of draft *Planning for Bush Fire Protection 2018* and associated documents.

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
	(a) have regard to *Planning for Bushfire Protection 2006*, (b) introduce controls that avoid placing inappropriate developments in hazardous areas, and (c) ensure that bushfire hazard reduction is not prohibited within the APZ. A planning proposal must, where development is proposed, comply with the following provisions, as appropriate: (a) provide an Asset Protection Zone (APZ) incorporating at a minimum: (i) an Inner Protection Area bounded by a perimeter road or reserve which circumscribes the hazard side of the land intended for development and has a building line consistent with the incorporation of an APZ, within the property, and (ii) an Outer Protection Area managed for hazard reduction and located on the bushland side of the perimeter road, (b) for infill development (that is development within an already subdivided area), where an appropriate APZ cannot be achieved, provide for an appropriate performance standard,		Future development applications for all development involving bush fire prone lands will be required to comply with either s4.14 of the EP&A Act 1979 or s100B of the *Rural Fires Act 1997,* depending on the nature of the proposed development and the relevant provisions of *Planning for Bush Fire Protection 2006 and* draft *Planning for Bush Fire Protection 2018.*

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S9.1 Direction	Applicable	Consistent	Comment
	in consultation with the NSW Rural Fire Service. If the provisions of the planning proposal permit Special Fire Protection Purposes (as defined under section 100B of the *Rural Fires Act 1997*), the APZ provisions must be complied with, (c) contain provisions for two-way access roads which link to perimeter roads and/or to fire trail networks, (d) contain provisions for adequate water supply for firefighting purposes, (e) minimise the perimeter of the area of land interfacing the hazard which may be developed, (f) introduce controls on the placement of combustible materials in the Inner Protection Area.		
5. Regional Planning			
5.4 Commercial and Retail Development along the Pacific Highway, North Coast	Applies when a relevant planning authority prepares a planning proposal for land in the vicinity of the existing and/or proposed alignment of the Pacific Highway. (4) A planning proposal that applies to land located on "within town" segments of the Pacific Highway must provide that: (a) new commercial or retail development must be concentrated	Yes	This planning proposal will not affect commercial and retail land along the Pacific Highway, North Coast.

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
	within district centres rather than spread along the Highway; (b) development with frontage to the Pacific Highway must consider impacts that the development has on the safety and efficiency of the highway; and (c) for the purposes of this paragraph, "within town" means areas which prior to the draft LEP have an urban zone (e.g. Village, residential, tourist, commercial and industrial etc.) and where the Pacific Highway is less than 80km/hour. (5) A planning proposal that applies to land located on "out-of-town" segments of the Pacific Highway must provide that: (a) new commercial or retail development must not be established near the Pacific Highway if this proximity would be inconsistent with the objectives of this Direction. (b) development with frontage to the Pacific Highway must consider the impact the development has on the safety and		

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
	efficiency of the highway. (c) For the purposes of this paragraph, "out-of-town" means areas which, prior to the draft local environmental plan, do not have an urban zone (e.g.: "village", "residential", "tourist", "commercial", "industrial", etc.) or are in areas where the Pacific Highway speed limit is 80 km/hour or greater. (6) Notwithstanding the requirements of paragraphs (4) and (5), the establishment of highway service centres may be permitted at the localities listed in Table 1, provided that the Roads and Traffic Authority is satisfied that the highway service centre(s) can be safely and efficiently integrated into the highway interchange(s) at those localities.		
5.10 Implementation of Regional Plans	Planning proposals must be consistent with a Regional Plan released by the Minister for Planning.	Yes	The *North Coast Regional Plan 2036* applies to the Coffs Harbour LGA and includes actions on environmental, economic and social (community) opportunities, as well as maintaining character and housing. Specific responses to relevant strategic directions and the accompanying actions contained within the *North Coast Regional Plan 2036* are provided in Part 3, Section A (3) and Section B (4) above.

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S9.1 Direction	Applicable	Consistent	Comment
			This planning proposal looks to provide a small amount of additional housing within a Large Lot Residential zone located outside the coastal strip and immediately adjacent to existing Large Lot residential housing. In this regard, the planning proposal is considered to be of minor significance and that it will achieve the overall intent of the *North Coast Regional Plan* and does undermine the achievement of its vision, land use strategy, goals, direction or actions). This planning proposal also includes land that is mapped as Regionally Significant Farmland and as such, the planning proposal has also addressed the Important Farmland Interim Variation Criteria contained in the *North Coast Regional Plan 2036* (see Appendix 3). It is considered that the planning proposal will result in development that supports the intent of the actions contained within the *North Coast Regional Plan 2036* and is therefore considered to be consistent with that Plan.
5.11 Development of Aboriginal Land Council Land	This direction applies when a planning authority prepares a planning proposal for land shown on the Land Application Map of State Environmental Planning Policy (Aboriginal Land) 2019; or an interim development delivery plan published on the Department's website on the making of this direction.	N/A	This direction is not applicable to the Coffs Harbour Local Government Area.
6. Local Plan Making			

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

6.1 Approval of Referral Requirements	A planning proposal must: (a) minimise the inclusion of provisions that require the concurrence, consultation or referral of development applications to a Minister or public authority, and (b) not contain provisions requiring concurrence, consultation or referral of a Minister or public authority unless the relevant planning authority has obtained the approval of: (i) the appropriate Minister or public authority, and (ii) the Director-General of the Department of Planning (or an officer of the Department nominated by the Director-General), prior to undertaking community consultation in satisfaction of section 57 of the Act, and (c) not identify development as designated development unless the relevant planning authority: (i) can satisfy the Director-General of the Department of Planning (or an officer of the Department nominated by the Director-General) that the class of development is	Yes	The planning proposal does not include provisions that require the concurrence, consultation or referral of development applications to a Minister or public authority. It does not identify development as designated development.

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
	likely to have a significant impact on the environment, and (ii) has obtained the approval of the Director-General of the Department of Planning (or an officer of the Department nominated by the Director-General) prior to undertaking community consultation in satisfaction of section 57 of the Act.		
6.2 Reserving Land for Public Purposes	(4) A planning proposal must not create, alter or reduce existing zonings or reservations of land for public purposes without the approval of the relevant public authority and the Director-General of the Department of Planning (or an officer of the Department nominated by the Director-General).	Yes	The planning proposal does not create, alter or reduce land reserved for a public purpose.
6.3 Site Specific Provisions	Applies when a relevant planning authority prepares a planning proposal that will allow a particular development to be carried out. (4) A planning proposal that will amend another environmental planning instrument in order to allow a particular development	Yes	The planning proposal looks to rezone the site to an existing zone already applying in the environmental planning instrument that allows that land use without imposing any development standards or requirements in addition to those already contained in that zone.

APPENDIX 2 – CONSIDERATION OF MINISTERIAL PLANNING DIRECTIONS

S9.1 Direction	Applicable	Consistent	Comment
	proposal to be carried out must either: (a) allow that land use to be carried out in the zone the land is situated on, or (b) rezone the site to an existing zone already applying in the environmental planning instrument that allows that land use without imposing any development standards or requirements in addition to those already contained in that zone, or (c) allow that land use on the relevant land without imposing any development standards or requirements in addition to those already contained in the principal environmental planning instrument being amended. (5) A planning proposal must not contain or refer to drawings that show details of the development proposal.		

APPENDIX 3 – IMPORTANT FARMLAND INTERIM VARIATION CRITERIA

Important Farmland Interim Variation Criteria		
Land may be suitable for uses other than farmland if:		
Principle	**Requirement**	**Comment**
Agricultural capability	The land is isolated from other important farmland and is not capable of supporting sustainable agricultural production	The subject land has not been used for productive agricultural activities for a considerable period of time and the land is predominantly fragmented to below a sustainable agricultural lot size.
Land use conflict	The land use does not increase the likelihood of conflict and does not impact on current or future agricultural activities in the locality	There will be little potential for land use conflict on adjoining lands as a result of the rezoning given that adjoining and surrounding lands have recently been rezoned for large lot residential purposes.
Infrastructure	The delivery of infrastructure (utilities, transport, open space, communications and stormwater) required to service the land is physically and economically feasible at no cost to State and Local Government	Infrastructure to support the future subdivision of the subject land is already available to surrounding large lot residential lands and can be further augmented at no cost to any level of government.
Environment and Heritage	The proposed land uses do not have an adverse impact on areas of high environmental value, and Aboriginal or historic heritage significance	Based on information currently available, the proposal is unlikely to give rise to any adverse impact on areas of high environmental value. Appropriate parts of the site are proposed to be zoned to reflect their environmental attributes. The Coffs Harbour & District Local Aboriginal Land Council have been consulted during the preparation of this Planning Proposal and have advised that they would like to be involved in the future development of the site (see Appendix 4).
Avoiding risk	Risks associated with physically constrained land are identified and avoided, including: • flood prone; • bushfire prone; • highly erodible; • severe slope; and • acid sulfate soils.	The subject land is identified as containing indicative flood areas, is bushfire prone and contains class 5 acid sulfate soils. These risks have been addressed in the preparation of this Planning Proposal and will be further investigated and considered at the development application stage. The subject land is not considered to be highly erodible or as containing a severe slope (it can be best described as being gently undulating).

APPENDIX 4 - CH&DLALC CORRESPONDENCE

Coffs Harbour & District Local Aboriginal Land Council
Cnr Pacific Highway & Arthur Street, Coffs Harbour NSW 2450
PO Box 6150, Coffs Harbour Plaza NSW 2450
Phone (02) 6652 8740 Fax: (02) 6652 5923

Ref: 17102

8th April 2019

Attention: Harpreet Jenkins

RE: Planning Proposal for Lot 4 DP 41228, 81 Butlers Road, Bonville

Coffs Harbour and District Local Aboriginal Land Council (CH&D LALC), after having received contact from you in regards to the Planning Proposal for the property mentioned above and having reviewed the proposal would like to express its interest in the future development in regards to Culture and Heritage matters.
The CH&D LALC feel the above property has likely Culture and Heritage material due to its location, landform, waterways.

Further arrangements in regards to Culture and Heritage matters will need to be made through this office.

If you have any questions in relation to this matter, please call me on (02) 66 528740.

Yours truly,

Aj Perkins
Programs Coordinator: Culture & Heritage
CH&D LALC

APPENDIX 5 - FLORA AND FAUNA ASSESSMENT

Bonville Rural Residential

Local Environment Study

Prepared for
Coffs Harbour City Council

August 2013

DOCUMENT TRACKING

ITEM	DETAIL
Project Name	Bonville Local Environment Study
Project Number	12COFECO-0020
Project Manager	Peter Knock 6651 5484 35 Orlando Street, Coffs Harbour
Prepared by	Peter Knock
Reviewed by	Liz Brown
Approved by	Julian Wall
Status	Draft
Version Number	1
Last saved on	21 August 2013
Cover photo	Typical landscape Bonville Study Area, Peter Knock

This report should be cited as 'Eco Logical Australia 2013. *Bonville Local Environment Study*. Prepared for Coffs Harbour City Council'.

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Graham Fry (CHCC).

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Abbreviations

ABBREVIATION	DESCRIPTION
APM	Australian Paper Manufactures
ATLAS	Wildlife Database records Administered by National Parks & Wildlife Service
BIG Club	Bonville International Golf Club
CBD	Central Business District
CHCC	Coffs Harbour City Council
CKPoM	Coffs Harbour Koala Plan of Management
DCP	Development Control Plan
DoPI	Department of Planning and Infrastructure
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EPBC	Environment Protection and Biodiversity Conservation Act 1999
GIS	Geographic Information System
GPS	Global Positioning System
LEP	Local Environment Plan
LES	Local Environment Study
LGA	Local Government Area
NES	National Environmental Significance
NOW	NSW Office of Water
NPWS	National Parks and Wildlife Service (now known as Office of Environment and Heritage)
OEH	Office of Environment and Heritage
PHaCS	Priority Habitats and Corridors Strategy
PMST	Protected Matters Search Tool
RAMA	Routine Agricultural Management Activity
RoTAP	Rare or Threatened Australian Plants
SEPP	State Environmental Planning Policy
TSC Act	Threatened Species Conservation Act
VMP	Vegetation Management Plan
VRZ	Vegetated Riparian Zone
WM Act	Water Management Act

Executive Summary

The Bonville Local Environmental Study (LES) considers an area covering approximately 1860 hectares (ha) of coastal flats, undulating hills and steep slopes. The area a coastal location has experienced landuse utilisation from forestry and agricultural development for approximately the last 150 years. Currently the area is supplying a range of rural residential living opportunities, with development demand likely to increase under the current planning proposal and with recent approvals for residential development centred on the BIG club (Bonville International Golf Club) lands.

Significant areas of native vegetation; regrowth and remnant natural habitats occur throughout the study area. These provide a range of habitats for a limited number of threatened fauna species including areas of mapped Endangered Ecological Communities (EECs).

Significant environmental values for the Bonville LES study are:

- Vertebrate animal species recorded - 170
- Vascular plant species - 197
- Threatened plants - 1 (from previous study)
- Threatened animals species recorded during current survey - 8
- Threated animals recorded from all studies - 18
- Native vegetation cover - 25 % of study area
- Exotic vegetation cover - 15 % of study area
- Hardwood plantation cover - 10% of study area
- Mapped Endangered Ecological Communities approximately - 38 ha
- Mapped Rainforest - < 2 ha

Environmental values collated from this study have been combined with data from statutory planning requirements such as existing environmental protection zones, koala habitat and drainage buffers in an environmental constraints analysis process (Figure 11). Environmental constraints have been then represented in suggested zones (Figure 12) for the whole study but note only select areas will likely receive rezoning planning approval.

This analysis provides a comprehensive spatial representation of all environmental constraints to be considered in conjunction with other planning themes (bushfire and engineering constraints) in the full planning assessment for the future Bonville rural residential land rezoning and release.

1 Introduction

This report was commissioned by Coffs Harbour City Council (CHCC) as part of a local consortium of consultants headed by Geoff Smyth Consulting and de Groot & Benson Pty. Ltd. in preparation for an amendment to the Draft Coffs Harbour Local Environment Plan 2013 (DLEP 2013) in regards to the proposed rural residential release area for Bonville.

1.1 STUDY AREA

The Bonville study area is located approximately 13 kilometres (km) south of the Coffs Harbour Central Business District on the western side of the Bonville extension to the Pacific Highway on the North Coast of NSW (Figure 1). The study area covers approximately 1860 ha (Figure 2).

The current land uses in the Bonville locality consist of existing rural residential subdivisions and agriculture (including intensive horticulture cropping), private recreation (Bonville Golf Resort) and small rural allotments. The study area is bounded by Boambee and Pine Creek State Forests to the north, west and south and Bongil Bongil National Park to the east. The Pacific Highway defines the eastern boundary of the study area, with the old Pacific Highway (now Pine Creek Way) as the main access road running north-south through the study area. The roads providing access to the upper and lower Bonville Valley from Pine Creek Way (north to south) are as follows:

- Titans Close;
- Irvines Road;
- Williams Road;
- North Bonville Road (linking to Cassidy's Road and Bradford Drive);
- Bonville Station Road;
- Glennifer Road (linking to Crossmaglen Road);
- East Bonville Road; and
- Butlers Road.

1.2 PAST AND PRESENT ENVIRONMENT

An understanding of the settlement history of an area, the demographic and the industries that utilised its local resources can provide valuable information on present day environmental values.

The Bonville and wider Coffs Harbour area were settled later than surrounding areas (during the 1870's – 1880's), preceded by southerly areas such as the Bellinger Valley (during the 1840's -1860's) and northerly areas such as the Clarence Valley (during 1838) (Yeates 1990). This pattern of settlement was a consequence of available navigable river systems which were utilised to access extensive floodplain forests. The impetus for coastal exploration by early settlers was timber-getting, particularly for rainforest timbers such as *Toona australis* (Red Cedar). Bonville and Pine Creeks were similarly utilised for access to their timber resources from the late 1800's by floating Red Cedar logs down-stream to the mouth of Bonville Creek for loading onto ocean-going steamers (Andren 1988).

By the late 1880's enough cleared land existed to allow farming enterprises to commence between Bonville and Pine Creeks. Road access to Coffs Harbour (via bullock dray) was formed once the Coffs

Jetty was built in 1892. In 1903 the main industry in the Bonville area was dairying after the establishment of a cheese factory.

Timber mills were established in 1912 at Crossmaglen with tramways built to access the north-coast railway under construction which was completed by mid-1920's. The North Coast rail line further enhanced the trading ability of the local farming and timber extraction industries. After the Second World War agricultural development continued including small horticulture enterprises. Timber plantations were established in the 1960's and 70's on ex-dairy properties as part of a proposed paper processing industry.

Present day Bonville retains small scale industries, a primary school, a local hall, a fuel station and a post office. Following the recent completion of the Pacific Highway bypass local business has seen a decline with a fuel station and fruit stalls closing largely due to reduced traffic.

The area currently caters for rural residential living through small rural landholdings, existing rural residential subdivisions, a caravan park and an over 50's retirement village. A recent Master Plan approval for an expansion of residential living using the Bonville Golf Course lands will continue the growth of this sector.

1.3 OBJECTIVES

Bonville has been identified as a priority release area under the Rural Residential Study (CHCC 2009). To allow rezoning for rural residential purposes environmental studies are required to assist the planning process. In particular this study aims to identify significant flora and fauna habitats, threatened species and important wildlife corridors that exist within the study area.

This study does not include a comprehensive flora and fauna survey. The objectives of the study are to highlight the ecological values of the area through habitat assessment, a range of limited and targeted fauna survey techniques, review of previous studies and conservation planning initiatives. The process will identify major ecological values that should be maintained or enhanced, and outlines any ecological constraints to the development process.

The scope of work includes the following tasks:

- Prepare a detailed vegetation map which identifies major plant assemblages within the study area and connective importance of vegetation;
- Identify areas of significant vegetation within the study area via field investigations. Significant flora would include listed RoTAP species and species listed under the Threatened Species Conservation Act 1995 (TSC Act) or the National Parks and Wildlife Act 1974 (NPW Act);
- Identify threatened flora and fauna recorded within a one km radius of the site or which could utilise the existing habitats within the study area;
- Conduct a limited fauna survey utilising spotlighting and Anabat detection techniques;
- Assess the conservation significance of all fauna identified habitats, particularly their importance as linkages in a regional context and their resilience to potential development;
- Identify measures for the conservation of flora and fauna within the meaning of the TSC Act and the Fisheries Management Act 1994 (FM Act) and their habitats;
- Identify measures for the conservation of existing wildlife corridor values and / or any connective importance of vegetation within the study area and adjoining lands, including buffer zones to protect remnant vegetation and riparian areas; and

- Outline measures for the long-term management of conservation / open space areas proposed within the study area, including measures for revegetation, rehabilitation, ownership and access.

Figure 1: Locality

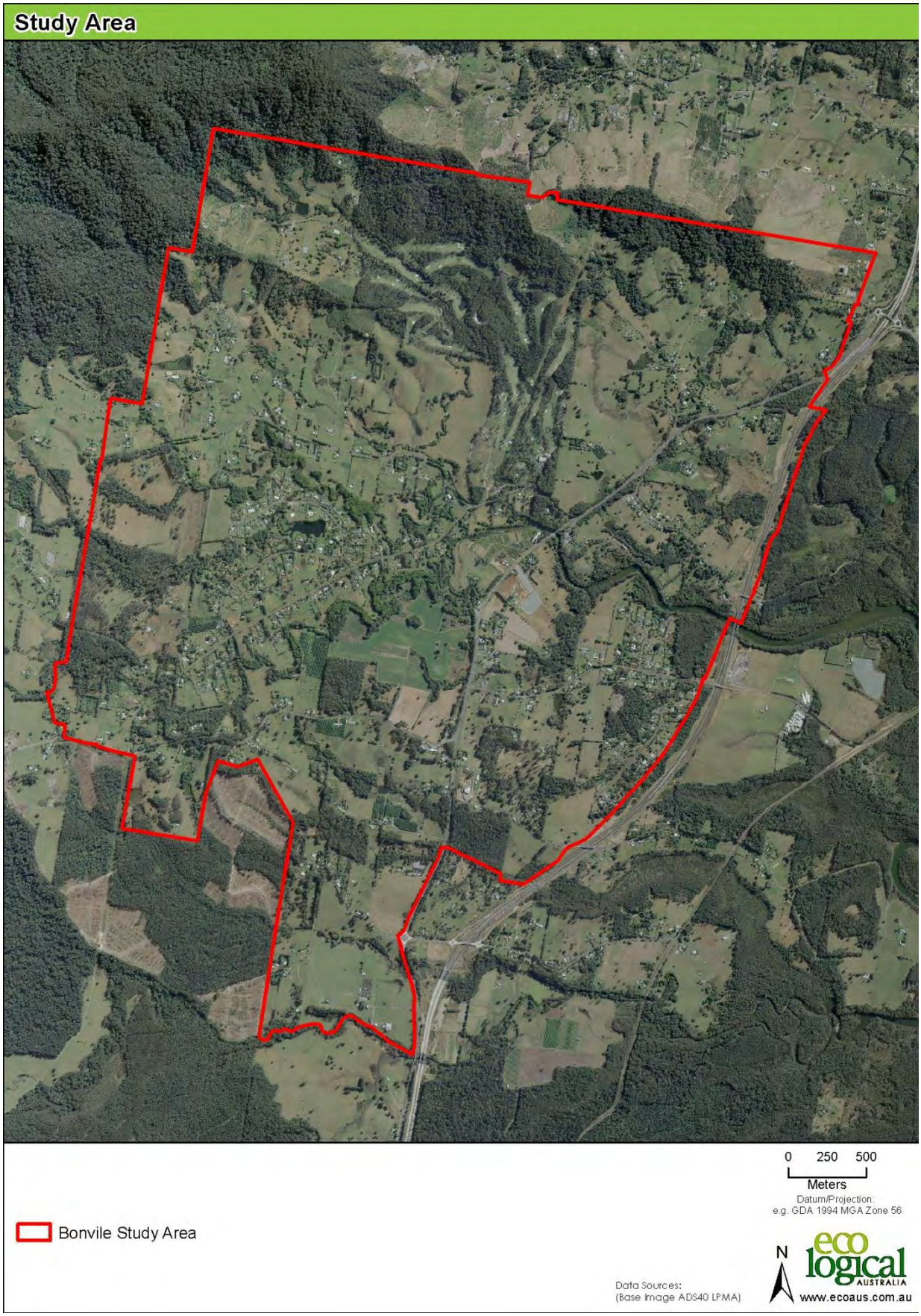

Figure 2: Bonville study area

2 RELEVANT LEGISLATION AND POLICIES

2.1 THE ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (EPBC ACT)

The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) establishes a requirement for Australian Government environmental assessment and approval of:

- actions that are likely to have a significant impact on matters of national environmental significance;
- actions that are likely to have a significant impact on the environment on Commonwealth land;
- actions taken on Commonwealth land that are likely to have a significant impact on the environment anywhere; and
- Actions by the Commonwealth that are likely to have a significant impact on the environment anywhere.

The matters of national environmental significance (commonly referred to as matters of NES) are:

- World Heritage properties and National heritage places.
- Wetlands of international importance (Ramsar wetlands).
- Listed migratory species, threatened species and ecological communities.
- Commonwealth marine areas.
- Nuclear actions (including uranium mining).

It is considered that the majority of these matters, areas, actions, species or ecological communities are unlikely to be affected by the proposal. Certain migratory species will periodically utilise the study area for habitat. The recently listed (2012) nationally threatened species Koala (*Phascolarctos cinereus*) occupies the study area. A discussion of the relevant issues relating to Koalas and their habitat is presented in Section **Error! Reference source not found.** of this report.

2.2 ENVIRONMENTAL PROTECTION AND ASSESSMENT ACT 1979 (EP&A ACT)

The Environmental Protection and Assessment Act 1979 (EP&A Act) is the principal planning legislation in NSW. Part 3 of the EP&A Act sets the framework for preparation of environmental planning instruments such as LEPs.

Parts 3A, 4 and 5 of the EP&A Act indicate the decision making processes for assessment of proposed development and activities. When deciding if a proposal should be approved, the consent / determining authority (Coffs Harbour City Council, and Department of Planning and Investment) must consider a range of environmental matters including maintenance of biodiversity and the likely impact on threatened species, populations or ecological communities.

Part 5A of the EP&A Act requires proponents to consider likely impacts on threatened species, populations or ecological communities, or their habitats. While the assessment of impacts is conducted at the development application stage, this report highlights environmental values considered a

constraint to development. There are a number of threatened species known to occur in the study area including one Endangered Ecological Community (EEC). These species and their habitats are taken into account in the planning process and documented in the results section of this report.

2.3 THREATENED SPECIES CONSERVATION ACT 1995 (TSC ACT)

The Threatened Species Conservation Act 1995 (TSC Act) and amendments in 2002 and 2005 identifies threatened species, communities and populations. The TSC Act indicates the assessment process for proposed development that is likely to have a significant effect on biodiversity. This Local Environment Study (LES) takes into account species likely to occur within the available habitat based on existing records of threatened species and new occurrences identified through field surveys. Threatened species records are generally more prevalent on public land where more survey effort has been performed compared to private tenure.

This LES builds on existing threatened species knowledge by considering previously undocumented records for the Bonville valley. These records are presented in the Section 4 of this report.

2.4 WATER MANAGEMENT ACT 2000 (WM ACT)

The *Rivers and Foreshores Improvement Act 1948* (RFI Act) has been repealed and the controlled activity provisions in the *Water Management Act 2000* (WM Act) have now commenced. A controlled activity approval under the WM Act is required for certain types of developments and activities that are carried out in or within 40 metres (m) of a river, lake or estuary.

The WM Act provides a number of mechanisms for protection of water sources via the water management planning process. If a ‘controlled activity' is proposed on ‘waterfront land', an approval is required under Section 91(2) of the WM Act. ‘Controlled activities' include the construction of buildings or carrying out of works, the removal of material or vegetation from land by excavation or any other means and the deposition of material on land by landfill or otherwise. ‘Waterfront land' is defined as ‘the bed of any river or lake, and any land lying between the river or lake and a line drawn parallel to and 40 metres inland from either the highest bank or shore’.

Approvals for controlled activities are administered by NSW Office of Water (NOW) and a set of guidelines have been developed to assist applicants who are considering carrying out a controlled activity on waterfront land. The guidelines provide information on the design and construction of a controlled activity, and other mechanisms for the protection of waterfront land and include:

- In-stream works;
- Laying pipes & cables in watercourses;
- Outlet structures;
- Riparian corridors;
- Vegetation Management Plans; and
- Watercourse crossings.

These guidelines are available from:

www.water.nsw.gov.au/Water-licensing/Approvals/Controlled-activities/Controlled-activities/default.aspx

A section describing riparian corridors and associated vegetated buffers has been incorporated into the CHCC Draft Development Control Plan (DCP) Component for Biodiversity (B8.4). The vegetation buffer criteria have been incorporated into this ecological assessment process as they are a potential restriction on development. They provide a mechanism for maintaining and improving the connectivity of isolated and fragmented patches of riparian vegetation and developing a robust wildlife corridor network. The proponents' responsibility under the WM Act is to assess impact and adjacency to 'waterfront land' (i.e. within 40 m) and to apply guidelines for permits required under s91 of the WM Act.

Riparian buffers based on stream order for all drainage lines in the study area are depicted in Figure 10 of this report.

2.5 LOCAL AND STATE PLANNING INSTRUMENTS

2.5.1 Coffs Harbour City Council Local Environment Plan (LEP) 2000

The majority of the study area is zoned as 'Rural 1A Agricultural Zone' under the Coffs Harbour City Council LEP 2000 (Figure 3). The existing rural residential subdivisions on Bradford Road and Bonville Station Road are zoned as 'Rural 1B Living'. Bonville Golf Resort is zoned as 'Open Space 6C Private Recreation'. Two parcels of land east and west of the Bonville Golf Resort are zoned as 'Residential 2E Tourist'. The majority of the forest remnants and drainage lines within the valley are zoned 'Environmental Protection 7A' (Figure 3) and are focused on protection of Primary and Secondary Koala Habitat. There is one Public Reserve (Open Space 6A) within the study area at the western end of the Bradford Road subdivision, Baker Drive Reserve.

The aim of the *Rural 1A* zone is to provide for the preservation of existing or potentially productive agricultural land. Its objectives are to enable development which is compatible with agricultural practices, with the amenity and character of the rural environment of the area and which can be adequately serviced (CHCC, 2000).

The aim of the Rural 1B zone is to provide for rural residential living opportunities. Its objectives are to enable development which is compatible with the character and amenity of the rural living environment of the area and to ensure that development is adequately serviced (CHCC, 2000).

The aim of the Open Space 6E Private Recreation zone is to provide for private recreation and associated services. The objectives of this zone are to enable development for private recreation or tourism and other land uses compatible with the surrounding area, and to ensure that development is within the environmental capacity of the land and is adequately serviced (CHCC, 2000).

The aim of the Residential 2E Tourist zone is to provide for tourist accommodation and recreational land uses. Its objectives are to enable tourist development and other development that is compatible with the surrounding environment and to provide for development that is within the environmental capacity of a high density residential environment and can be adequately serviced (CHCC, 2000).

The aim of the 7A zoning is to protect and enhance sensitive natural habitat and waterway catchments. Its objectives are to protect habitat values and water quality and enable development which does not adversely impact upon these, to enable development that is within the environmental capacity of the land and can be adequately serviced, and to enable protection of archaeological sites of Aboriginal significance (CHCC, 2000). The zoning nomenclature under the CHCC LEP 2000 is now superseded by the new standard instrument and any reference to zones will be as per the draft LEP 2013 (CHCC DLEP, 2013).

2.5.2 Coffs Harbour City Council Draft Local Environment Plan (DLEP) 2013

The new draft instrument LEP (DLEP 2013) is not yet finalised, but its zonings are in similar context with those of the previous LEP 2000. The planning process of this study will express proposed zonings in

line with the DLEP 2013 format. An example of this is instead of '7A Environmental Protection' under the new DLEP the zone will be 'E2 - Environmental Conservation' or 'E3 - Environmental Management'.

One significant difference between LEP 2000 and DLEP 2013 is the introduction of Water zones (1 and 2) over Bonville and Burgess Creeks (Figure 3). These zones allow for the protection of natural waterways and additionally permissibility of recreation facilities respectively. Table 1 shows the previous zones for the Bonville study area and corresponding current zones under the DLEP 2013.

Table 1: Local environment zones

LEP 2000	Draft LEP 2013
Rural 1A Agriculture	RU2 Rural Landscape
Residential 2A Low Density Zone	R1 General Residential
Rural 1B Living Zone	R5 Large Lot Residential
Open Space 6A Public Recreation Zone	RE1 Public Recreation
Open Space 6C Private Recreation Zone	RE2 Private Recreation
Environmental Protection 7A Habitat and Catchment Zone	E2 Environmental Conservation
Environmental Protection 7A Habitat and Catchment Zone	E3 Environmental Management
Environmental Protection 7A Habitat and Catchment Zone	W1 Natural Waterways
Environmental Protection 7A Habitat and Catchment Zone	W2 Recreational Waterways
Special Uses Zone 5A Community Purposes Zone	SP2 Special Purposes Infrastructure

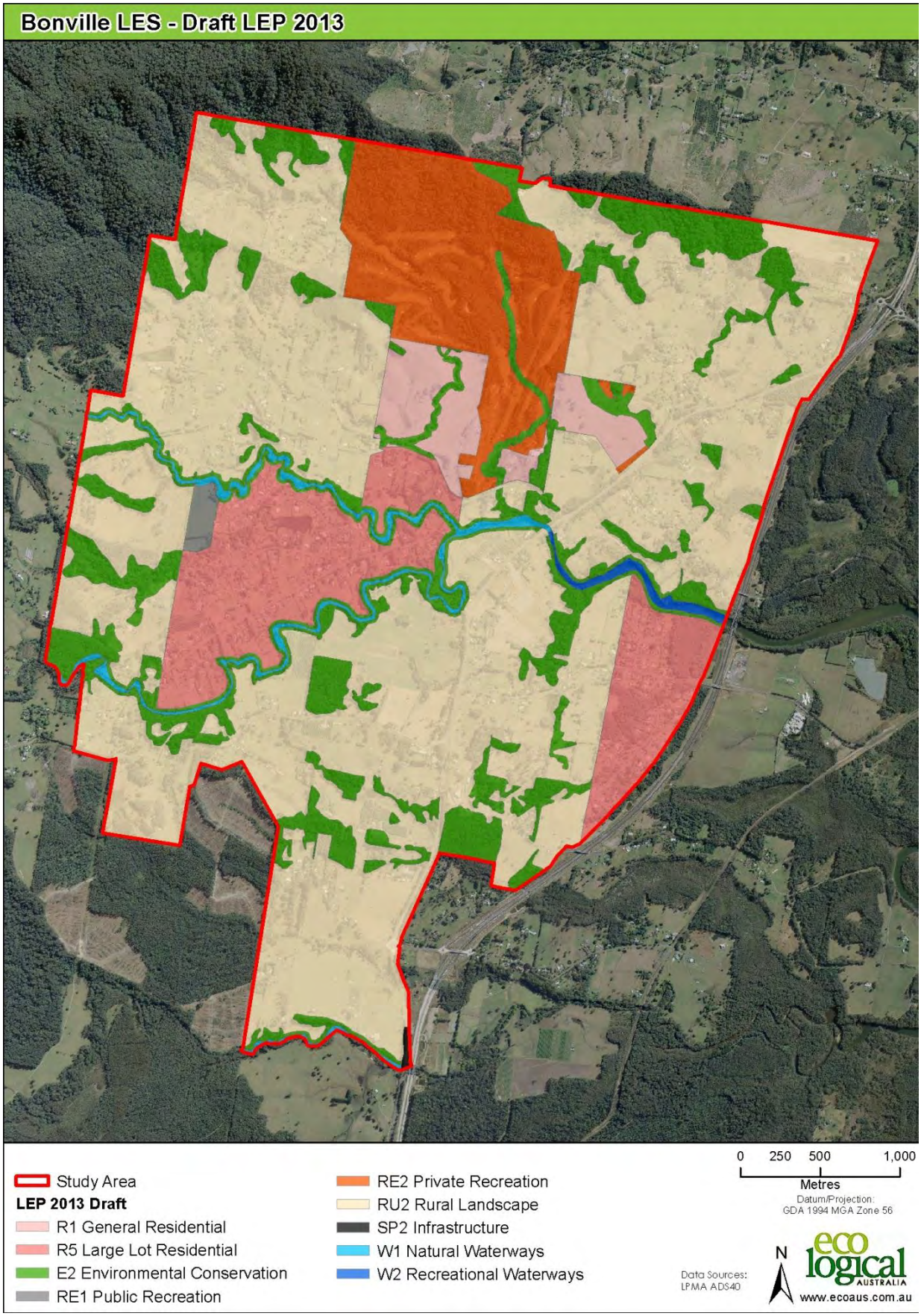

Figure 3: Draft Local Environment Plan 2013

2.5.3 State Environmental Planning Policy (SEPP) 14: Coastal Wetlands

This Policy ensures coastal wetlands are preserved and protected for environmental and economic reasons. SEPP 14 provides that mapped wetlands in coastal Local Government areas should not be cleared, drained or filled or have a levee constructed on them without the consent of CHCC and the concurrence of the Director- General of the Department of Planning.

No SEPP 14 Coastal Wetlands are found within the study area.

2.5.4 State Environmental Planning Policy (SEPP) 26: Littoral Rainforests

This Policy protects littoral rainforests, a distinct type of rainforest well suited to harsh salt-laden and drying coastal winds. The Policy requires that the likely effects of proposed development be thoroughly considered in an environmental impact statement.

The legal definition of Littoral Rainforest under SEPP 26 includes that which occurs on headlands as well as on sand. This is consistent with the definition of the EPBC-listed 'Critically Endangered' *Littoral Rainforest and Coastal Vine Thickets of Eastern Australia* ecological community.

No SEPP 26 Littoral Rainforest is mapped within the study area, or any rainforest communities equating to an EEC definition.

2.5.5 State Environmental Planning Policy (SEPP) 44: Koala Habitat Protection

This Policy aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure a permanent free-living population over their present range and reverse the current trend of Koala population decline.

SEPP 44 does not apply to the study area as the CHCC Comprehensive Koala Plan of Management (CKPoM) addresses Koala habitat protection issues within the Coffs Harbour Local Government Area (LGA).

2.5.6 CHCC Comprehensive Koala Plan of Management (CKPoM)

The study area contains both Primary and Secondary Koala Habitat under the CKPoM (Figure 4). There is, however, a need to revise the Koala habitat mapping as it was based on aerial photography that is more than 15 years old. The CKPoM (Lunney et. al., 1999) was constructed from LGA-wide vegetation mapping program performed by Fisher, Body and Gill from aerial photography flown in 1996. The CKPoM utilised this vegetation mapping and Koala population survey information to delineate a three-tiered habitat model.

The underlining vegetation mapping has been revised for this LEP process which has implications for Koala habitat emphasis and interpretation. This concept is discussed further in the vegetation mapping section of this report (Section 4).

Primary Koala Habitat

The objective of this habitat zone under the CKPoM is:

To prevent further clearing, disturbance, fragmentation or isolation of existing primary koala habitat, and where appropriate, restore habitat and encourage sympathetic management to ensure the maintenance of koalas.

The consent authority shall not grant consent to the carrying out of development on areas identified as Primary Koala Habitat, whether zoned 7(A) or otherwise, which will remove the following tree species: Tallowwood (Eucalyptus microcorys), Swamp Mahogany (E. robusta), Broad-leaved Paperbark (Melaleuca quinquenervia), Flooded Gum (E. grandis), Blackbutt (E. pilularis), Forest Red Gum (E. tereticornis), Small-fruited Grey Gum (E. propinqua), or Forest Oak (Allocasuarina torulosa), unless the

development will not destroy, damage or compromise the values of the land as koala habitat. In assessing an application the consent authority shall take into consideration:

- *That there should be zero net loss of Primary Koala Habitat;*
- *The threats to koalas which may result from the development.*
- *The likely impacts to adjacent or nearby Primary Koala Habitat and existing or potential koala movement corridors;*
- *All other options for preventing or ameliorating impacts from the development on koalas; Whether the land is accredited under the Timber Plantation (Harvest Guarantee) Act1995*

Secondary Koala Habitat

In regard to this habitat zone, the CKPoM objective is:

"To minimise further loss, fragmentation or isolation of existing secondary koala habitat and the creation of barriers to koala movement and, where appropriate, to encourage restoration of koala habitat.

Areas of Secondary Koala Habitat contribute to the overall habitat available to Koalas and play a vital role in linking areas of Primary Koala Habitat. They are also important to dispersing and juvenile koalas, provide seasonal and drought foraging habitat, and may act as fire refuges.

The consent authority shall not grant consent to the carrying out of development on areas identified as Secondary Koala Habitat which will remove the tree species listed above unless the development will not significantly destroy, damage or compromise the values of the land as koala habitat. In assessing an application the consent authority shall take into consideration:

- *that there will be minimal net loss of Secondary Koala Habitat;*
- *the level of significance to koalas of the trees proposed to be removed;*
- *the number of trees proposed to be removed in relationship to the extent and quality of adjacent or nearby Primary and/or Secondary Koala Habitat;*
- *the threats to koalas which may result from the development;*
- *all other options for protecting koala trees as listed above;*
- *the impacts to existing or potential koala movement corridors; and*
- *whether the land is accredited under the Timber Plantation (Harvest Guarantee) Act 1995.*

The consent authority shall not grant consent to the carrying out of development in areas identified as Secondary Koala Habitat unless the proposal demonstrates that appropriate measures are taken to:

- *minimise barriers to koala movement;*
- *reduce the risk of koala mortality by road kill by appropriate road design, lighting and traffic speed limits;*
- *minimise the removal of koala tree species listed above under Tertiary Koala Habitat;*
- *provide preferred Koala trees in landscaping where suitable;*
- *minimise threats to Koalas by dogs i.e. banning of dogs or confining of dogs to Koala proof yards;*
- *minimise removal or disturbance of Tertiary Koala Habitat in fire protection zones, including fuel reduced zones and radiation zones".*

A comprehensive Koala fauna survey was not undertaken as part of the current LES survey effort. However active searching for Koala sign was performed at sites where potential Koala habitat was present. An evaluation of Koala activity within the study area is outlined fully in Sections 4 and 5 of this report.

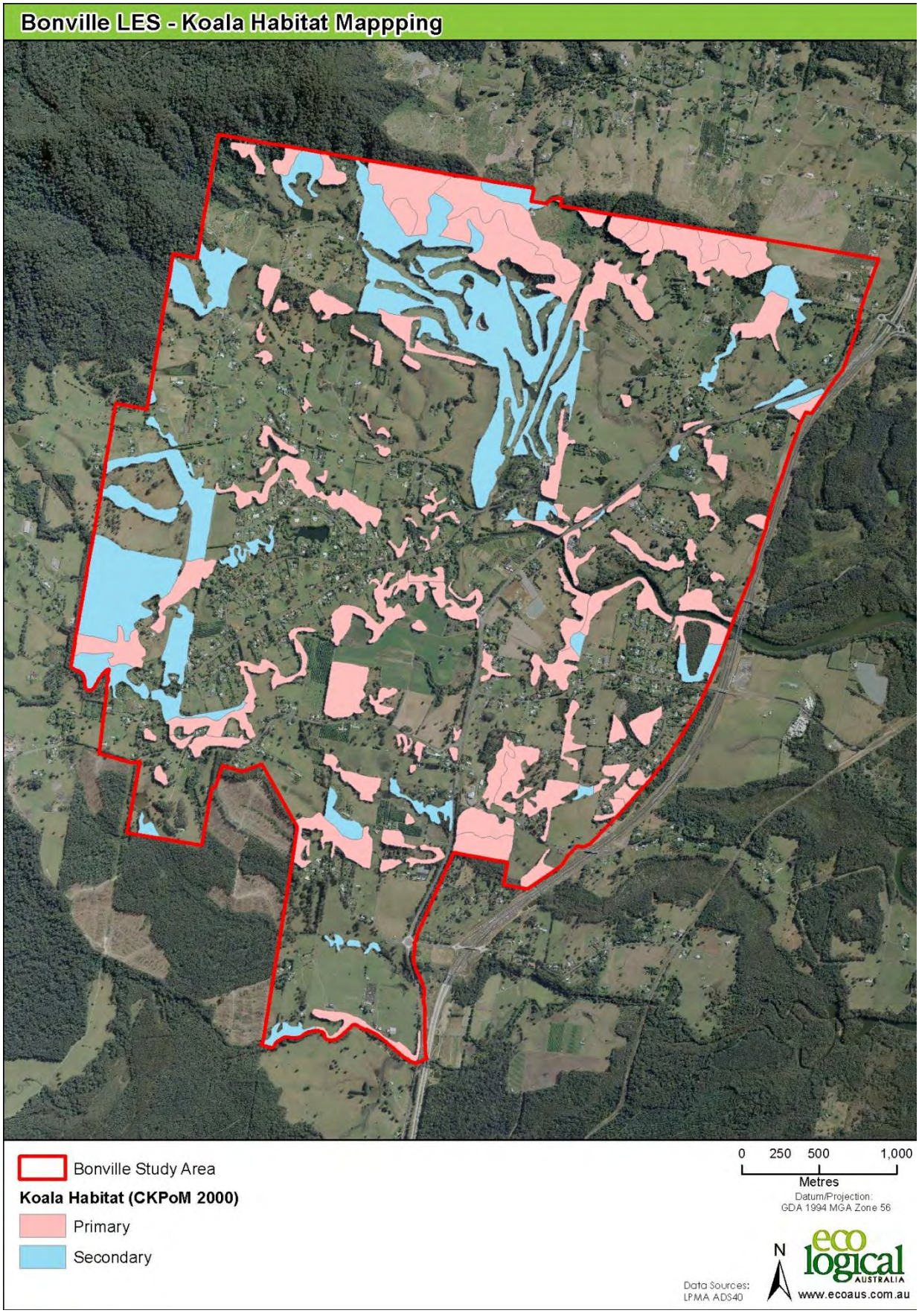

Figure 4: Koala habitat mapping (CKPoM)

2.5.7 State Environmental Planning Policy (SEPP 71): Coastal Protection

This Policy aims to protect and manage the natural, cultural, recreational and economic attributes of the NSW coast and to ensure that the type, bulk, scale and size of development is appropriate for the location and protects and improves the natural scenic quality of the surrounding area.

Developments to which SEPP 71 applies include lands categorised as 'sensitive coastal locations'. These include "*land within 100m of land reserved or dedicated under the National Parks and Wildlife Act 1974 as National Parks estate; and land within 100m above mean high water mark of the sea, a bay or an estuary".*

A very small portion of the study area is located on the edge of the coastal zone, east of Pine Creek Way surrounding Williams Road and Bonville Station Road. This area is located within 100 m of Bongil Bongil National Park and the tidal section of Bonville Creek. SEPP 71 applies to this land and requires that consideration be given to the impacts of development upon existing wildlife corridors and threatened species, populations and EECs, water quality of coastal water bodies, heritage and cultural places (including values, customs, beliefs and traditional knowledge of Aboriginal people) and the likely impact of coastal processes and hazards (e.g. sea level rise) upon the development and vice versa. Any development application for subdivision of land mapped as SEPP 71 requires a Master Plan to be submitted to the Director General for consideration and approval.

2.5.8 SEPP (Rural Lands) 2008

This policy aims to facilitate the orderly and economic use and development of rural lands for rural and related purposes by identifying the Rural Planning Principles and the Rural Subdivision Principles. In this way SEPP (Rural Lands) 2008 aims to assist in the proper management, development and protection of rural lands for the purpose of promoting the social, economic and environmental welfare of the State.

The broad aims of the Rural Planning Principles are to highlight the importance of rural lands and agriculture to the social and economic wellbeing of the State and rural communities, to identify and protect natural resources for the maintenance of biodiversity and water quality, to ensure current and potential productive and sustainable activities can be carried out in rural areas without conflict and with appropriate levels of services and infrastructure.

The Rural Subdivision Principles aim to minimise conflicts, particularly between residential land uses and other rural land uses and to minimise the fragmentation of rural land by considering the natural and physical constraints and opportunities of the land when planning for rural housing.

Matters to be considered in determining development applications for rural subdivisions or rural dwellings:

a) the existing uses and approved uses of land in the vicinity of the development;
b) whether or not the development is likely to have a significant impact on land uses that, in the opinion of the consent authority, are likely to be preferred and the predominant land uses in the vicinity of the development;
c) whether or not the development is likely to be incompatible with a use referred to in the above two points;
d) if the land is not situated within a rural residential zone, whether or not the development is likely to be incompatible with a use on land within an adjoining rural residential zone; and
e) any measures proposed by the applicant to avoid or minimise any incompatibility referred to in paragraph (c) or (d).

Given the surrounding land use is predominantly rural residential or rural agricultural operations, the proposal to rezone selected areas of rural agricultural land as rural residential land seems justified and in keeping with the surrounding land use. Provided CHCC allows for corresponding development of essential services and supporting infrastructure, the proposed rezoning within the Bonville study area will meet the objectives of SEPP (Rural Lands).

2.6 NATIVE VEGETATION ACT 2003 (NV ACT)

The objects of this Act include the protection of "native vegetation of high conservation value having regard to its contribution to such matters as water quality, biodiversity, or the prevention of salinity or land degradation".

Within Clause 7 of this Act, the definition of clearing native vegetation (relevant to the study area) is as follows:

"*cutting down, felling, thinning, logging or removing native vegetation*".

The Minister is the consent authority for clearing native vegetation, and for the purposes of the EP&A Act, the Minister is the consent authority for any development application made under that Act for any clearing that requires development consent.

Land currently zoned Agricultural or Rural Residential requires assessment under the NV Act for vegetation removal.

The maximum clearing distances applying to Routine Agricultural Management Activity (RAMA) and rural infrastructure are as follows:

2.6.1 Small holdings or holdings zoned Rural Residential

A small holding is a single piece of land in the same ownership that is less than 10 ha.

The maximum clearing distances or areas are:

- permanent boundary fence six metres either side (adjoining landholder agreement is needed);
- permanent internal fence three metres either side;
- temporary fence one metre total width of clearing;
- roads and tracks four metres total width of clearing;
- windmills and bores three metres from the structure;
- stockyards three metres from the structure;
- habitable buildings – the asset protection zone identified for the land in a bush fire risk management plan in force under the Rural Fires Act 1997; and
- buildings other than habitable buildings five metres.

There is potential for increased clearing of native vegetation due to rezoning and / or subdivision of land in the Bonville release area due to property boundary and infrastructure management under the range of RAMAs listed above. This issue should be taken into consideration when planning rural residential subdivision layouts.

2.7 PLANTATIONS AND REAFFORESTATION ACT 1999 (PR ACT)

Within the Bonville study area fragments of past hardwood plantations exist that were established post 1958 by the Australian Paper Manufactures, generally on old farm or dairy lands. The main species planted were *Eucalyptus grandis* (Flooded Gum), *E. pilularis* (Blackbutt) and *E. saligna* (Blue Gum).

The paper mill proposed for the area never eventuated and the majority of those lands were either sold to NSW State Forests or private ownership. The most obvious existing plantation lands were converted into the Flooded Gum fairways of the Bonville golf course. Small areas on private land still exist north of Crossmaglen Road and south of North Bonville Road on the western edge of the study area.

Plantations that are retained on private land still hold their plantation status under the PR Act and are therefore able to be logged under the Acts harvest guarantee. Plantation areas will be further discussed in regards to their habitat quality and environmental significance within this document. The recently completed CHCC Class 5 fine-scale vegetation mapping (OEH 2012) defines these areas, but certain plantations have been harvested since the time of photography for that project.

2.8 LOCAL PLANNING POLICY

As part of the change to the new planning instrument DLEP 2013 a set of draft Development Control Plans (DCPs) are also proposed. Included in the draft DCP is component 8B Biodiversity requirements. This DCP provides guidelines for environmental assessment at the Development Application (DA) stage, including vegetation protection of Koala Habitat, EECs, significant wetlands and riparian buffers for drainage lines. The vegetation buffers around drainage lines or waterfront lands are directly related to the conditions from the NSW Office of Water (NOW) and are applied to this study area in the conservation framework (Section 6) and the guidelines in Appendix G.

2.8.1 Priority Habitats and Corridors Strategy (PHaCS)

There has been significant emphasis in conservation planning about addressing functional connectivity of fragmented landscapes. The planning and rezoning stage of land development is an appropriate stage to implement and integrate these criteria. In 2003, the former National Parks and Wildlife Service (NPWS) released the paper and geographic data for *Key Habitats and Corridors for Forest Fauna: A Landscape Framework for Conservation in North-east New South Wales* (Scotts 2003). This set the framework for examining regional scale habitat connectivity.

Local Government has, through the planning process, been encouraged to develop local corridor information. CHCC placed on public display the *Coffs Harbour City Council NSW 2009 Draft Priority Habitats and Corridors Strategy 2010 – 2030*, as the first stage to identifying local corridor networks. A definition of corridors, a key objective of this study, was used in conjunction with other statutory requirements (such as riparian buffers) to create a practical framework for corridor context within the Bonville study area.

2.8.2 Tree Preservation Order

The CHCC Tree Preservation Order (CHCC, 2004) aims to promote the retention of trees and tree cover and to conserve the existing pattern of vegetation, to maintain landscape quality and remaining natural ecosystems; and to encourage the planting of trees to provide integration of trees into existing land uses. Any native vegetation is protected from clearing or damage by the TPO which is administered by CHCC.

Any land zoned as ‘RU2 Rural Landscape’ under CHCC DLEP 2013 (greater than one ha) is governed by the TPO. The TPO states that both CHCC and the Northern Rivers Catchment Management Authority (NR CMA) are responsible for granting consent for vegetation clearing and that a DA is required to remove trees. Land zoned as ‘RU2’ (less than one ha) is not covered by the TPO; however landowners must seek approval from the NR CMA to remove trees under the NV Act.

3 Survey Methodology

This assessment included a desktop assessment of relevant wildlife databases, a review of previous environmental studies and field survey within the study area.

3.1 DATABASE SEARCHES AND LITERATURE REVIEW

A literature review of the aforementioned planning and legislative documents and their associated assessment requirements was conducted prior to fieldwork commencing.

Preliminary lists of species likely to occur within the subject site were obtained by conducting searches of the Office of Environment and Heritage's (OEH) Atlas of NSW Wildlife (Wildlife Atlas), for species and communities listed under the TSC Act. The Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) Protected Matters Search Tool (PMST) for Matters of National Environmental Significance (NES) and species / communities listed under the EPBC Act was also utilised. These data searches were undertaken on 19th June, 2013.

The OEH Wildlife Atlas and PMST data searches were each based upon a 10 by 10 kilometre search window which was then limited to a one km buffer of the study area as per the project brief requirement from CHCC. The resultant lists were filtered to identify threatened and communities species considered likely or with the potential to occur on, or utilise, the subject site and these species appear in bold in Appendices C - F. Common species recorded within the study area were combined with field observations to create an overall flora and fauna species list (Appendices A and B).

3.2 GEOGRAPHIC DATA

A range of Geographic Information System (GIS) datasets were sourced from CHCC which were relevant to the planning and ecological information available for this study.

GIS layers which were utilised included:

- Cadastre (Property boundaries);
- Vegetation mapping (Latest Class 5 fine-scale mapping);
- Drainage (1:25000);
- Contours (derived from LiDAR data);
- LEP 2000 zonings;
- Koala Habitat mapping; and
- Corridor information - regional (OEH) and local (PHaCS).

3.3 SURVEYS

Flora, fauna habitat and limited fauna assessments were conducted over three days (totalling six person days) on the 14th, 16th, and 20th May, 2013. Survey effort during autumn is not optimal for many fauna species that could occupy the range of habitats available within the Bonville area. Certain

species are migratory and will only occupy these landscapes at certain times of the year, such as summer migrant bird species like the Common Koel (*Eudynamys scolopacea)*, Dollarbird (*Eurystomus orientalis*), and Channel-billed Cuckoo (*Scythrops novaehollandiae*). Other species (e.g. frogs) are more easily detected during warm and rainy weather primarily by their call. Reptiles (particularly snakes) are less active during the colder months and are therefore not highly represented during autumn surveys.

Selection of land parcels for targeted survey was based upon on the patch size of remnant vegetation, representative vegetation types, proximity to potential development precincts and the agreement of landholders in granting access for surveys. Not all discreet vegetation patches were surveyed and assessed due to landholder access restrictions and availability at time of survey. All roads within the study area were also utilised to ascertain the vegetation and fauna habitat condition assessments.

Meandering transects were performed within vegetation units which were selected to validate mapped vegetation types, condition, significant species and significant habitat features. Active searches for wildlife evidence was undertaken, particularly searches for Koala faecal pellets under the main primary listed Koala feed tree species in the valley (e.g. Tallowwood and Swamp Mahogany). Searches for Koala activity were also undertaken within numerous road reserves where suitable habitat was located.

The locations of significant features or threatened species sightings were recorded with a Global Positioning System (GPS). As part of ELA's scientific licence agreement significant records are supplied back to the Wildlife Atlas (OEH).

Diurnal fauna survey effort included actively searching for any animal evidence including tracks, scats or scratch marks on trees. Nocturnal survey effort included spotlighting, stag-watching and night-long microbat echolocation call recording.

3.3.1 Vegetation assessment

The OEH and CHCC have recently completed the *Coffs Harbour Class 5 Vegetation Mapping Project* for the entire LGA (OEH 2012). The class system of vegetation mapping is defined as Class 1 (coarse) to Class 5 (fine). The Coffs Harbour vegetation mapping is therefore fine-scale mapping utilising high resolution digital imagery and produced at a scale of less than 1:5000. The minimum mappable unit is defined as 0.25 ha which is the smallest polygon size for a discreet vegetation patch.

The program for this fine-scale mapping process was conducted over a two year time frame and was informed with over 3,500 site specific vegetation plots.

It is expected that changes occur over time from the original vegetation layer including losses through clearing and re-growth of certain vegetation units, some of which underpin Koala habitat definition. Landuse changes also occur with increased or decreased disturbance regimes affecting the vegetation significance and fauna habitat quality. Loss of vegetation through clearing or thinning is the most obvious possible change with re-growth usually only detectable over a longer time frame.

Any anomalies from the original vegetation mapping have been revised via field-based verification where possible. It is believed most discrepancies are associated with the data age and coding errors during the initial study resulting from limited private property access to ground-truth vegetation polygons.

3.3.2 Vegetation condition

The vegetation quality was assessed using parameters such as intactness, diversity, history of disturbance and weed invasion. This somewhat subjective rating scheme is not solely based on hard evidence and quantifiable criteria but utilises Class 5 vegetation mapping as a basis for the assessment. Much information can be inferred from the vegetation communities information, landuse history and weed composition combined with field-based verification of specific sites.

Three categories were used to describe the condition of vegetation communities:

- Good: Vegetation still retains the species and structural characteristics of its pre-European equivalent. Such vegetation has usually changed minimally over time and displays resilience to weed invasion due to intact ground cover, shrub and canopy layers.
- Moderate: Vegetation generally still retains its structural integrity but has been disturbed and has lost some component of its original species complement. Weed invasion can be significant in such remnants.
- Poor: Vegetation that has lost most of its species and is significantly modified structurally. Often such areas have a discontinuous canopy of the original tree cover and very few shrubs. Exotic species (such as introduced pasture grasses or weeds) replace much of the indigenous ground cover or are co-dominant with the original indigenous species.

3.3.3 Fauna habitat

The fauna survey of the study area was limited to a few specific techniques outlined below (spotlighting and microbat call recording). Habitat assessment generally searched for signs of fauna presence (e.g. tracks, scats, hair, bone and feathers) and habitat features necessary to support the lifecycle of certain fauna guilds (e.g. Koalas food trees and hollow-bearing trees for gliders and owls). Fauna species were determined by opportunistic occurrence by sight or listening for their calls (e.g. birds and frogs).

Recording threatened species during surveys confirms their presence however a lack of threatened species records cannot necessarily be used to argue the species' absence when suitable habitat is present. Threatened species are often difficult to detect due to their general rarity, seasonal occupation or cryptic nature. Suitable habitat is therefore one of the most important factors to consider when determining the potential presence of threatened species.

Fauna habitats within the study area were assessed by examining characteristics such as the structure and floristic composition of the canopy, understorey and ground vegetation. The structure and composition of the litter layer and other habitat attributes important for feeding, roosting and breeding was also considered. The following criteria were used to evaluate fauna habitat values:

- Good: A full range of fauna habitat components are usually present (e.g. old-growth trees, hollow-bearing trees, fallen timber and foraging resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
- Moderate: Some fauna habitat components are often missing (e.g. old-growth trees, hollow-bearing trees and fallen timber), although linkages with other remnant habitats in the landscape are usually intact but sometimes degraded.
- Poor: Many fauna habitat elements in low quality remnants have been lost, including old-growth trees (e.g. due to past timber harvesting or land clearing) and fallen timber, and tree canopies

are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive past clearing.

The vegetation condition and fauna habitat assessment generally consider similar components of habitat from different perspectives (either flora or fauna). The main driver of condition is usually land use history and time since particular land uses have commenced or ceased. For example, a cleared area which is in a re-growth phase may have a poor vegetation condition ranking but under the fauna habitat criteria may be ranked higher because it provides a crucial habitat connection between good quality habitat patches. Instead of producing a condition statement from these two perspectives a single vegetation / fauna habitat condition layer will be produced to depict the overall status of the vegetation communities within the study area. Water features (e.g. dams) are not included as a habitat feature in this layer. It is acknowledged that water features provide a range of resources for numerous fauna guilds; however the objective of this component was to classify vegetated areas.

3.3.4 Targeted fauna survey

A limited range of targeted fauna survey methods were undertaken, as described below.

Spotlighting

This fauna survey technique targets arboreal, flying and large ground-dwelling mammals, nocturnal birds, reptiles and amphibians (in appropriate seasons). Spotlighting was conducted on foot at two locations for a total of six person hours using hand-held 50 watt spotlights and a 100 watt variable spotlight.

Microchiropteran Bat Surveys

Ultrasonic Anabat Bat detection (Anabat^{tm}Titley Electronics) was used to record and identify the echolocation calls of microchiropteran bats foraging at five sites throughout the study area. All Anabat Bat detectors were set to record bat vocalisations throughout the night, with the recording commencing at 6pm and finishing at 6am. Additionally a hand-held unit was used during spotlighting sessions, allowing the user to follow the flight of a bat. This increases the clarity of the recorded call profile and generally improves the ability to identify the call of the species. Calls recorded were analysed by Alicia Scanlon of Eco Logical Australia (ELA) and results are presented in Appendix C.

Koala Habitat Assessment

The fauna habitat assessment process included active searches for Koala signs. Koala feed trees, particularly *E. microcorys* (Tallowwood) and *E. robusta* (Swamp Mahogany), were searched for Koala scats at their base and immediate surrounds. The search technique was based on the SPOT assessment technique (Philips and Callahan 2000) where a time-based search under appropriate trees within habitat patches is undertaken. A full SPOT survey was not conducted as habitat patches were generally small and linear, and the aim was to detect koala activity. All habitat patches and suitable roadside reserves were accessed and searched for Koala activity.

Opportunistic Sightings

Opportunistic recordings of species were made through observation methods such as incidental sightings, identifying bird calls and sighting indirect evidence of species presence (e.g. scats, nests, roost sites, feathers, hair, tracks, diggings and feeding marks on and around trees). Common species are recorded in Appendix A and significant records or signs corresponding to threatened species were marked with GPS and mapped in Section 4 and Appendix D.

3.3.5 Survey limitations

The field investigations conducted as part of this study are not considered to comprise a comprehensive flora and fauna survey. Selected fauna survey detection techniques were used as described in Section 3.3.4. Not all vegetation remnants could be accessed and therefore were not assessed (e.g. for Koala presence). Flora searches were based on the random meander technique and not comprehensive plot-based assessment.

Survey effort was conducted during autumn (May 2013) which is not considered as an optimal time to detect certain fauna gilds (e.g. reptiles and frogs). Microbat species are generally considered to be less active during winter however good species diversity was obtained through the Anabat echolocation recordings.

The large study area was not fully accessible during the current assessment due to access restrictions and time constraints.

4 Results

4.1 VEGETATION INFORMATION

The vegetation community information provided in this report is sourced from the Class 5 vegetation mapping recently completed by OEH and CHCC for the Coffs Harbour LGA (OEH 2012). This mapping product utilised the latest aerial digital imagery (2009) to produce a high resolution and accurate digital product. A summary and full vegetation description report documenting all vegetation communities in the CHCC LGA can be sourced on the CHCC website (OEH 2012).

Where site access was possible the vegetation layer for this study was ground-truthed via field survey. Where discrepancies or changes had occurred amendments were made to a subset of the mapped product for this report only, as is reflected in the following figures, tables and discussion.

Mapped vegetation formations within the study area included units mapped as Sclerophyll (Wet and Dry) Rainforest, Native Remnant, Native Pioneers, Exotic, Plantation (includes horticulture), Forested Wetlands and Freshwater Wetlands (Table 2). These formations totalled 745 ha within 664 polygons throughout the study area. Sixteen contiguous vegetation patches within the study area are greater than 10 ha in size. Areas of derived grassland were not included within the mapping for this study. Riparian zones within the valley are generally very narrow and too small to delineate and therefore aren't mapped as a separate unit.

Additionally, certain portions of the study area were considered to be highly modified by agricultural (horticultural) or utilised for other purposes.

The mapping is categorised as a fine-scale vegetation product (Class 5) - for an area the size of the Bonville study area vegetation communities have been mapped to a fine level of detail.

4.1.1 Vegetation classes

Broad vegetation classes for the Bonville study area are depicted in Figure 5, with Table 2 providing the vegetation categories, area figures, forested vegetation percentage cover and percentage cover across the study area.

Table 2: Vegetation class areas

Class	Count (polygons)	Area (ha)	Forested vegetation cover (%)	Study area cover (%)
Dry Sclerophyll Forests	28	28.07	3.76	1.52
Exotic Vegetation	240	184.80	24.78	10.00
Forested Wetlands	25	36.11	4.84	1.95
Freshwater Wetlands	17	11.88	1.59	0.64
Native Pioneers	11	5.30	0.71	0.29
Native Remnant Vegetation	91	43.49	5.83	2.35
Plantation	72	99.72	13.37	5.39
Rainforest	2	1.79	0.24	0.10
Wet Sclerophyll Forests	178	334.70	44.87	18.10
Cleared / not mapped	NA	1103.00	NA	59.66
Total	**664**	**1848.87**	**100.00**	**100.00**

Table 2 indicates the majority of the study area is currently cleared (60%). When areas of non-native vegetation cover (plantation, exotic vegetation and horticulture) are considered the level of non-native

vegetation cover increases (>75%). This reflects changing landuses over time where relatively flat to undulating lands have been cleared for agricultural and horticultural purposes. These figures indicate how the landscape has regrown with exotic vegetation after the decline of the dairy, grazing and horticultural industries and following the increase of rural residential living.

4.1.2 Vegetation community data

The vegetation community table (Table 3) has been extracted from the Class 5 mapped vegetation layer (OEH 2012). Using this information 22 communities have been delineated within the study area, of which only 15 are recognised as supporting remnant native vegetation. The remainder were allocated to derived communities or non-natural vegetation states due to previous land uses, clearing and re-growth events or landform modifications. For example, the freshwater wetland community is largely comprised of derived communities resulting from clearing forested drainage lines and damming or creating impediments to drainage. These actions result in the formation of a water feature or artificial wetland community. Overtime these water features can become important areas for wildlife in the landscape such as water birds (e.g. water fowl and waders) and herpetofauna (e.g. frogs and reptiles) as well as providing water resources for domestic or rural uses.

More specific detail about each vegetation community can be found for each community in the summary and / or full mapping reports on the CHCC website (OEH 2012).

Table 3: Vegetation community areas

Class	Vegetation Code	Vegetation Community	Polygons	Area Ha
Dry Sclerophyll	(CH_DOF01)	Coast and Escarpment Blackbutt Dry Forest	27	24.30
Dry Sclerophyll	(CH_DOF05)	Foothills Grey Gum - Ironbark - Mahogany Dry Forest	1	3.77
Exotic Vegetation	(CH_EX02)	Camphor laurel	90	78.99
Exotic Vegetation	(CH_EX03)	Exotic vegetation	150	105.81
Forested Wetlands	(CH_FrW01)	Coastal Paperbark Swamp Oak Floodplain Forest	10	9.38
Forested Wetlands	(CH_FrW02)	Coastal Swamp Mahogany Forest	10	18.84
Forested Wetlands	(CH_FrW04)	Coastal Paperbark Sedgeland Dominated Forest	5	7.90
Freshwater Wetlands	(CH_FW08)	Coastal Freshwater Wetland	17	11.88
Native Pioneers	(CH_NP01)	Acacia pioneers	11	5.30
Native Remnant	(CH_NRV01)	Native remnant vegetation	91	43.49
Plantation	(CH_P01)	Plantation - native species	23	83.77
Plantation	(CH_P02)	Plantation - exotic/pine species	1	0.19
Plantation	(CH_P03)	Environmental plantings	48	15.76
Rainforest	(CH_RF11)	Escarpment and Lowland Bangalow - Carabeen - Black Booyong Palm Gully Rainforest	2	1.79
Wet Sclerophyll	(CH_WSF01)	Coast and Hinterland Riparian Flooded Gum Bangalow Wet Forest	65	92.87
Wet Sclerophyll	(CH_WSF02)	Hinterland Blackbutt - Bangalow - Turpentine Wet Shrubby Tall Forest	1	0.16

Wet Sclerophyll	(CH_WSF03)	Foothills and Escarpment Blue Gum Tallowwood - Turpentine Wet Shrubby Forest	18	41.52
Wet Sclerophyll	(CH_WSF05)	Foothills to Escarpment Brush Box - Tallowwood - Blackbutt Wet Forest	27	66.27
Wet Sclerophyll	(CH_WSF08)	Southern Foothills Blackbutt - Turpentine - Tallowwood Wet Ferny Forest	31	48.33
Wet Sclerophyll	(CH_WSF09)	Northern Escarpment Blackbutt - Apple Wet Ferny Forest	18	34.97
Wet Sclerophyll	(CH_WSF10)	Hinterland and Escarpment Tallowwood - Blackbutt - Blue Gum Wet Ferny Forest	16	45.56
Wet Sclerophyll	(CH_WSF17)	Foothills Turpentine - Grey Gum - Ironbark Moist Shrubby Forest	2	5.01

4.1.3 Vegetation communities

The following vegetation community descriptions provide an indication of forest structure, previous land use and disturbance regimes within the study area.

Wet Sclerophyll Types

The vegetation community data presented in Tables 2 and 3 (Figures 5 and 6) represents predominately wet sclerophyll types of which eight specific mapped units were delineated. The majority of these mapped units occur on the southern fall of the main northerly ridgeline of the study area. These vegetation types occupy the low coastal hills, gully riparian systems and lower slopes on floodplains of the coastal lowlands within the study area and the wider Coffs Harbour LGA.

These forest types are tall, occurring on moderately fertile soils in high rainfall areas and support a luxuriant understory of soft-leaved shrubs, ferns and herbs. Many of the understory plants are closely related to or are rainforest species and often represent a blend between rainforest and wet sclerophyll forest types.

These wet sclerophyll vegetation types are relatively common and do not represent any EECs listed under the NSW TSC Act. These vegetation units represent 334 ha of the total vegetation mapped within the study area (or 18% of total vegetation cover).

Rainforest

This class is represented by one community *Escarpment and Lowland Bangalow - Carabeen - Black Booyong Palm Gully Rainforest* which has been mapped in the north-westerly portion of the study area. This unit equates to less than two ha and appears to be in a disturbed / regenerative state. The canopy of this unit supports species such as *Sloanea woollsii* (Yellow Carabeen), *Heritiera actinophylla* (Black Booyong), *Geissois benthamiana* (Red Carabeen), *Caldcluvia paniculosa* (Soft Cordwood), *Sloanea australis* (Maiden's Blush), *Neolitsea dealbata* (Hairy-leaved Bollygum) and *Lophostemon australis* (Brush Box). These forest systems are highly diverse when in a static state but in a disturbed regenerative phase they may be missing some of the listed overstorey species and heavily disturbed by weeds.

Plantation

Approximately 100 ha of mapped plantation occur within the Bonville study area. This class includes native hardwood plantations established in the 1960's and 1970's on old dairy farms through to small areas identified as environmental plantings (e.g. adjacent to the Bonville Pacific Highway). The last remnants of hardwood plantation areas occur within the BIG club grounds and small areas on the western edge of the study area (bounded by North Bonville and Crossmaglen Roads). Harvesting continues in certain small plantation areas (as was noted during the current study) while other areas have been cleared after completion of the mapping product.

The small plantation holdings on private property have maintained their forest harvest guarantee under the PF Act and therefore are continuing to be harvested or cleared. Most of these areas have been converted back to open grassland or a mosaic of forest and grassland areas. Very little of these areas appear to have been utilised for their intended purpose of forestry resource production.

Plantations generally support lower ecological values as they are monoculture tree crops planted very close together to achieve a tall, straight growth form with minimal branching. Previously these areas have been characterised as secondary Koala habitat, yet it is unclear how important these areas have been for Koala habitat utilisation. Plantations play a role in maintaining forest cover, allow for ground and mid-storey species restoration, provide a range of fauna resources and potentially allow re-growth of more favourable Koala feed trees (e.g. Tallowwood). The BIG club lands are likely to provide forest cover and a less intensive land use, thus allowing wildlife movement through the area.

Native Remnants

This unit captures small to medium sized native-dominated remnants that cannot be assigned to a floristic community due to their size and history of disturbance and fragmentation. Their distribution is strongly linked to cleared urban and rural landscapes but also includes remnant tree lines within forest plantation areas (CHCC 2013).

Native Pioneers

This unit corresponds to Acacia re-growth predominated by two species *Acacia irrorata* (Green Wattle) and *A. melanoxylon* (Black Wattle). Areas within this class are represented by small mapped units found in the rural, urban and semi urban environments. They will generally support low ecological values but provide a stepping stone to longer-term regeneration and are an indicator of potential land use changes.

Freshwater Wetlands

This class is represented by one community *Coastal Freshwater Wetlands* and is predominately characterised by farm dams that have impeded flow along cleared drainage lines within the Bonville study area. Natural occurring freshwater wetlands may be attributed to the EEC *Freshwater Wetlands on coastal floodplains*. One area within the study area has been labelled a potential EEC from this mapped unit (Figure 8), however most represent man-made or derived occurrences.

Forested Wetlands

This category contains the majority of potential EECs within any class. Three vegetation communities within this class have been mapped within the study area: *Coastal Paperbark Swamp Oak Floodplain Forest, Coastal Swamp Mahogany Forest* and *Coastal Paperbark Sedgeland* dominated forest. All three vegetation communities are very closely aligned and subtle changes in elevation and or salinity can see abrupt changes to vegetation composition. These vegetation communities would align with three possible EECs:

- *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions;*
- *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions;* and
- *Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.*

These systems are found along the easterly edge of the study area adjacent to low-lying areas of Bonville and Pine Creeks and their tributaries (Figure 8). These vegetation communities are dominated by tree canopy species such as *Melaleuca quinquenervia* (Broad-leaved Paperbark), *E. robusta* (Swamp Mahogany), *Casuarina glauca* (Swamp Oak) and *Callistemon salignus* (Willow Bottle-brush). The majority of these species are primary Koala feed trees as listed under the CKPoM 2000 (Lunney et. al., 1999). These systems play a very important role in filtering run-off to coastal waterways and are potentially harmed by excessive nutrient and sediment loads as a potential consequence of poor farming practises and / or residential and rural subdivisions.

Exotic Vegetation

In excess of 180 ha of this class has been mapped within the study area and indicates re-growth of cleared drainage lines since the cessation of dairying and other intensive agricultural activities. This class is abundantly represented within the rural residential subdivisions already located in the study area. The majority of this class is represented by exotic planted vegetation with the propensity to spread as a garden escape, as observed during field surveys. Within the study area garden plants were found many hundreds of metres from the nearest known occurrence within rural residential areas.

The majority of this class is mapped as *Camphora laurina* (Camphor Laurel) which has become a dominant vegetation class in regenerative zones and has established within coastal remnant forest areas and along drainage lines. A number of native species (some of which are threatened species) may have benefited from the rise of Camphor Laurel as a foraging resource, notably Wompoo Fruit Dove (*Ptilinopus magnificus*), Rose-crowned Fruit Dove (*Ptilinopus regina*) and Purple-crowned Fruit Dove (*Ptilinopus superbus*). Large flocks of Top-knot Pigeon (*Lopholaimus antarcticus*) and White-headed Pigeon (*Columba leucomela*) were observed in the study area feeding on Camphor Laurel. During spot-lighting sessions Grey-headed Flying-fox (*Pteropus poliocephalus*) were observed feeding on Camphor Laurel fruit. Combined with highly mobile frugivorous pigeons feeding on this fruit Camphor Laurel seed can spread significant distances throughout the landscape.

Dry Sclerophyll

A relatively small area of dry sclerophyll forest occurs within the study which is dominated by Coast and *Escarpment Blackbutt Dry Forest*. This vegetation unit is dominated by *Eucalyptus pilularis* (Blackbutt) with other less dominant canopy species present such as *E. resinifera* (Red Mahogany), *Syncarpia glomulifera* (Turpentine), *Corymbia intermedia* (Pink Bloodwood) and *E. microcorys* (Tallowwood). This community is also considered likely to provide habitat foraging resources for Koalas.

This class generally occurs on slightly elevated areas of coastal floodplains and on taller coastal ridges within the study area. Several large Blackbutt trees were found within this vegetation community that were above two metres diameter-at-breast-height (DBH) and therefore are more likely to contain hollows. Hollow-bearing trees were found to be extremely rare within the study area. None of these forest types are considered likely to represent an EEC definition.

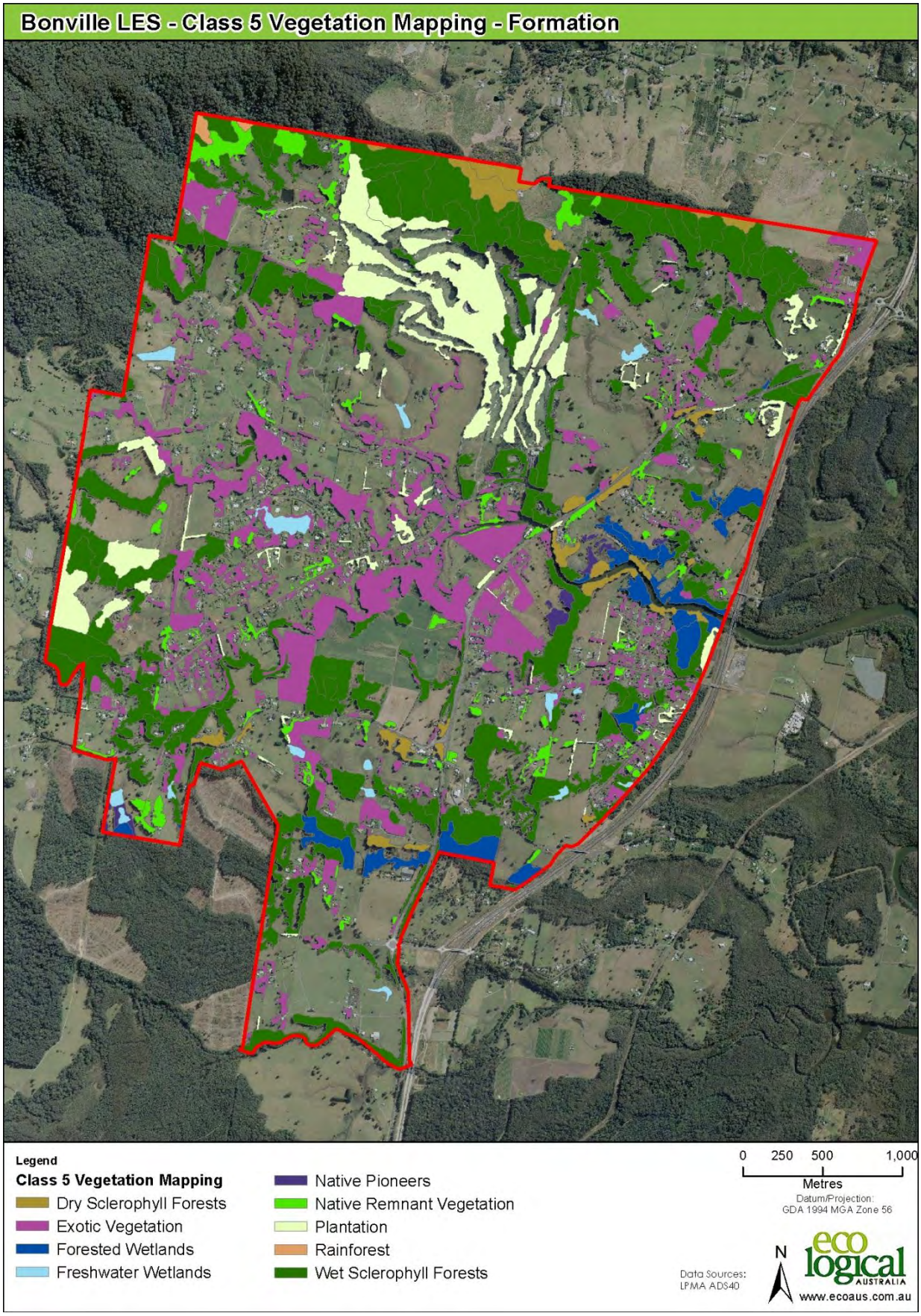

Figure 5: Vegetation formations

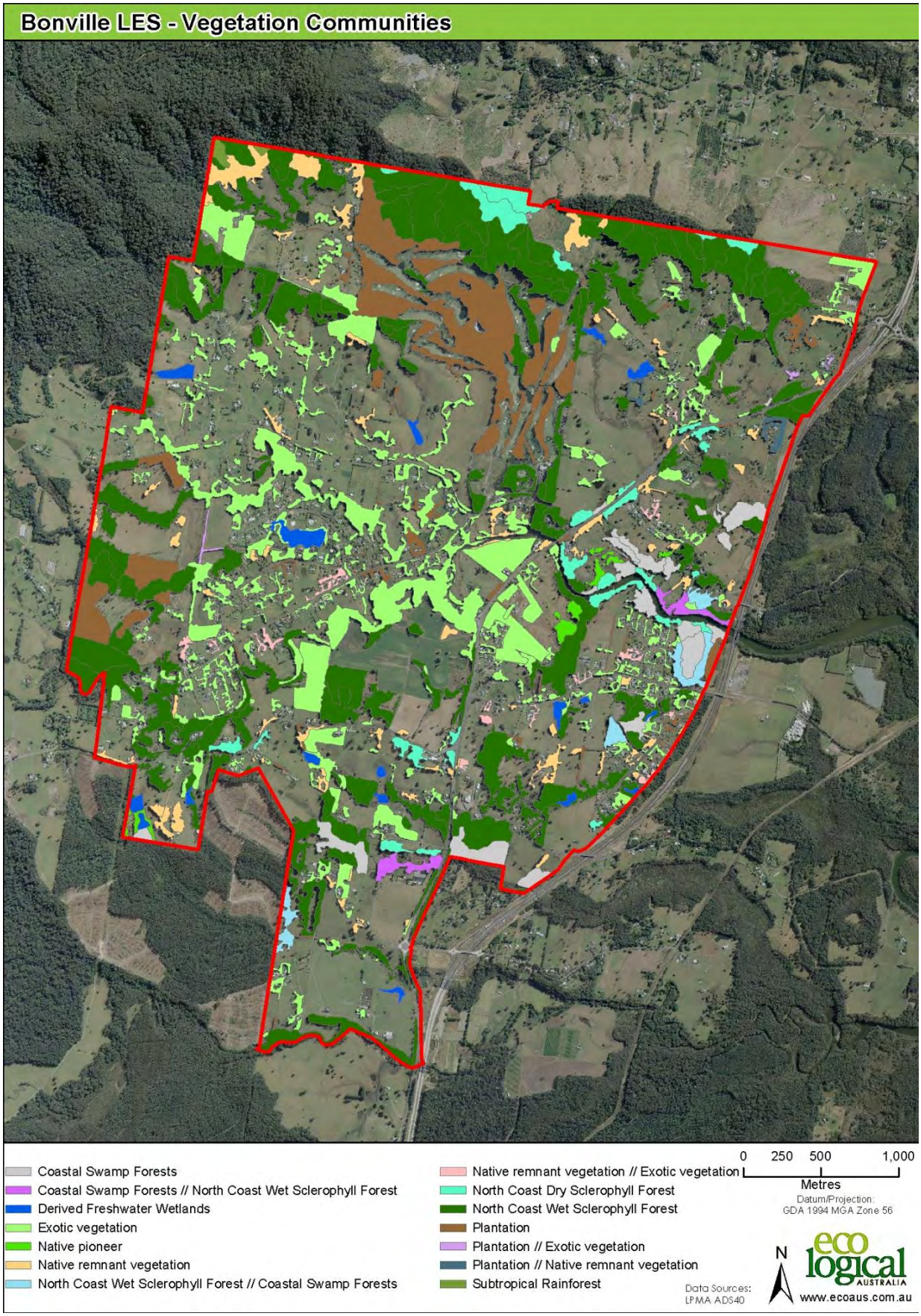

Figure 6: Vegetation communities

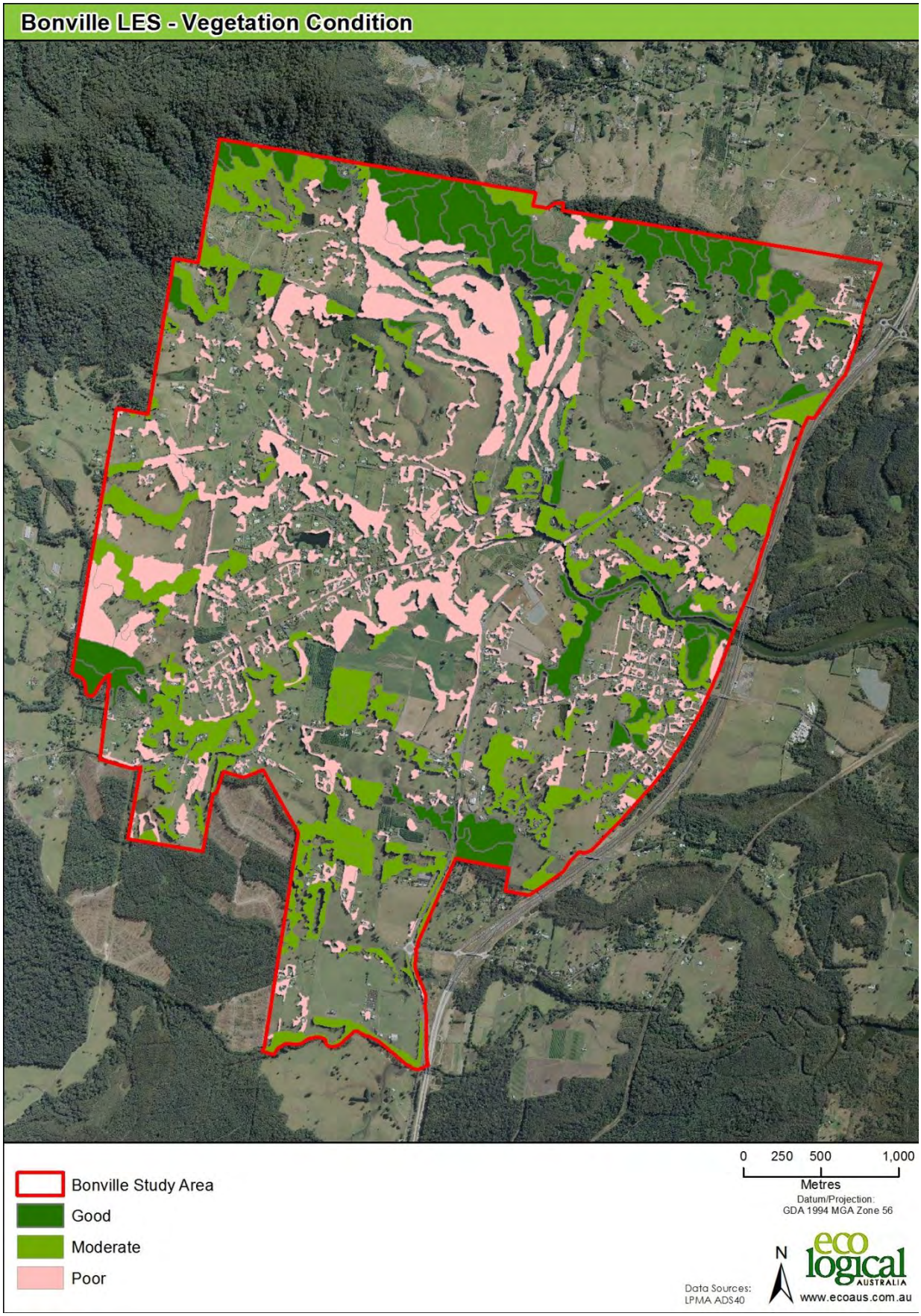

Figure 7: Vegetation condition

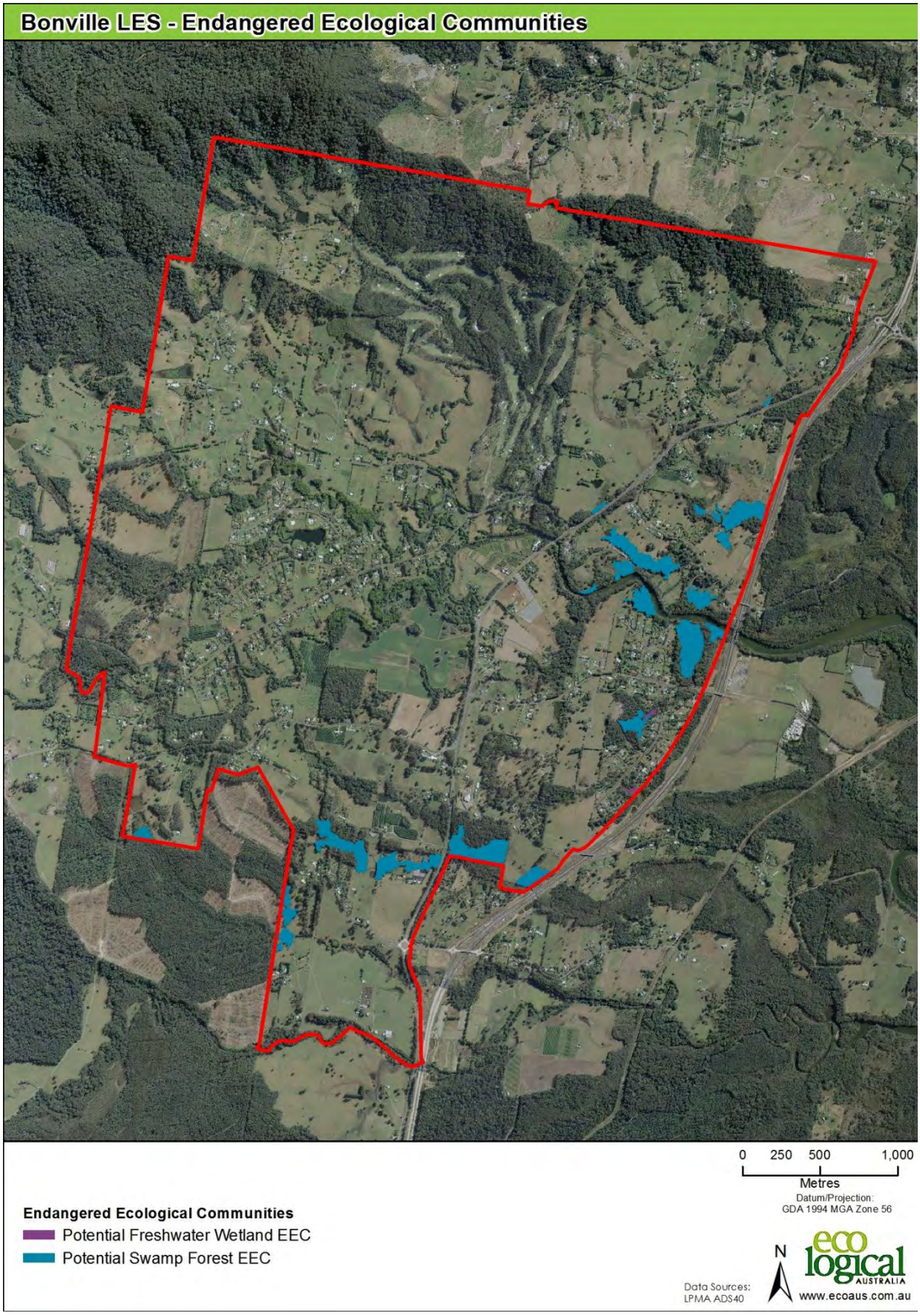

Figure 8: Endangered Ecological Communities

4.1.4 Vegetation condition

Vegetation community information described in Section 4.1.3 provides an indication of forest structure, previous land use and disturbance regimes over time. A native vegetation condition statement for each community can be developed, based on the ranking of null, good, moderate or poor condition categories.

This ranking system was used to categorise vegetation mapping and determine simple condition statements within the study area (Figure 7). This system was based on available information from the mapping project coupled with field assessment data.

The vegetation condition layer (Figure 7) will be combined with riparian buffers, potential EECs and landscape context (corridors) to create habitat significance and environmental constraints layers (Section 6).

Vegetation condition is a function of several interacting factors, including:

- previous disturbance / clearing regimes;
- subsequent re-growth of native and exotic species; and
- resilience of remnant vegetation communities.

This process attempts to sort vegetation cover into a ranked condition statement thereby determining the relative vegetation quality throughout the study area.

Four condition categories (rankings) were created by applying the following series of rule sets to the data. Table 4 provides a summary of the rankings and the area they cover within the study area.

- Data was excluded or given a *Null* rating for non-vegetated systems (e.g. farm dams or horticultural production areas).
- Areas dominated by weeds or native pioneers, small / fragmented native remnants and hardwood plantations were ranked as *Poor*.
- Areas of native vegetation categorised as specific vegetation community units and >0.25 ha were ranked as *Moderate*.
- Areas of native vegetation not connected to *Moderate* category areas and <0.25 ha were ranked as *Poor.*
- The ranking of *Medium* category vegetation patches was lowered / elevated based on field validation where forest structural components were observed to be present / absent (e.g. old-growth and hollow-bearing trees).
- The ranking of *Medium* categories was elevated to *Good* where they formed part of a large contiguous forest block (e.g. good connectivity).

Table 4: Vegetation condition rankings

Vegetation Condition	Polygons	Area (ha)
Null	36	67.97
Poor	398	285.34
Moderate	173	243.92
Good	57	148.64

A ranking of *Poor* does not necessarily indicate low conservation significance. Small regenerating and / or degraded patches of native vegetation may represent higher ecological values in a landscape

context. For example, these may represent an example of an EEC or have the potential to form part of a wildlife corridor.

4.1.5 Threats

A recent threat to certain native vegetation throughout areas of NSW and the Bonville area is the plant fungal disease Myrtle Rust (*Uredo rangelii*). This fungus attacks plants belonging to the family Myrtaceae. The disease has spread from the Central Coast of NSW through all NSW coastal LGA's into south-east Queensland and Victoria. It has been recorded on over 100 flora species within 27 genera of Myrtaceae (e.g. Eucalypt, Melaleuca, Callistemon and Angophora). The rust attacks and kills the new growth tips of the plant and is indicated by spots on leaves and stems which develop a mass of orange to yellow powdery spores. Myrtle Rust can kill young plants and severely stunt mature plants by affecting new growth over successive seasons. It was observed on *Rhodamnia rubescens* (Scrub Turpentine) within the study area (Photos 1 and 2).

Photo 1: Yellow spores of Myrtle Rust (*Uredo rangelii*) on Scrub Turpentine growth tips

Photo 2: Spotting on Scrub Turpentine leaves caused by Myrtle Rust

4.1.6 Species of plant

Within the study area 197 plant species have been recorded including 25 exotic species (13%) (Appendix B). This does not represent a comprehensive flora species list of the study area. This list is a combination of flora survey records and additional incidental sightings from the current field survey.

4.1.7 Significant flora

No significant flora (ROTAP or NSW TSC-listed species) were recorded during the survey effort for this study. A review of the OEH Atlas records for the study area highlighted *Marsdenia longiloba* (Slender Marsdenia) as a threatened species which occurs within the study area (Photo 3).

Photo 3: *Marsdenia longiloba*

Fig trees (*Ficus* spp.) are not listed as a threatened or rare species but are considered in this study to be significant as a foraging source for a range of threatened species (Figure 11).

Instances of isolated Figs were noted as stand-alone paddock trees or growing on eucalypt stumps during roadside assessment. These features should be retained in any future development area and locations will be provided as a point feature constraint.

4.2 FAUNA HABITATS

The vegetation communities described within the study area provide a range of fauna habitat resources. At a landscape scale the vegetation of the study area is a mosaic of remnant and regenerating forested patches, regenerating ephemeral drainage lines and riparian zones supporting a high density of planted and naturalised weed species.

Forested vegetation communities range from small areas of rainforest to extensive wet sclerophyll forests, isolated areas of dry sclerophyll forest and remnant swamp forest communities. These communities are largely dominated by eucalypts and support mesic or moist understoreys. Based on historic accounts of timber extraction activities and remnant vegetation patches it is likely that rainforest

and swamp forest communities may have been more widespread within the locality prior to European settlement.

Riparian zones and man-made wetlands also provide a range of resources for specific fauna guilds within the study area. Large areas within the valley have been extensively cleared of forest (60%) while regenerating and exotic vegetation accounts for a further 15% of the overall vegetation cover. Derived grasslands containing a mix of introduced and native grasses occur widely as a habitat type, and provide habitat resources for some native fauna.

The disturbance regimes applied to the Bonville area since the late 1800's have reduced the occurrence of a range of native faunal species while providing opportunities for certain other fauna species. A severely depleted habitat component throughout the study area is hollow-bearing trees. Large trees rarely occur and only a few significant trees containing a range of hollow sizes were recorded within the study area.

Eucalypts take many decades to mature and centuries to reach an age where hollows can develop. Blackbutt growth rates (measured in the Coffs Harbour area) were estimated at approximately 21 years to reach 25 cm (DBH), 52 years to 50 cm, 94 years to 75 cm, 144 years to 100 cm and 194 years to 125 cm (Mackowski 1984). The oldest trees produce the largest hollows which are a necessary requirement for certain fauna species such as the larger forest owls and glider species.

4.3 FAUNA SPECIES

The Bonville area provides a range of fauna habitats for a number of fauna species. Table 5 lists faunal groups and the number of native and exotic species recorded during field survey effort (including records from previous studies).

Table 5: Summary of fauna species

Terrestrial Fauna Groups	Native	Exotic	Total
Frogs	5	1	6
Reptiles	8	0	8
Mammals (excl. bats)	14	4	18
Bats	17	0	17
Birds	118	3	121
			170

A total of 170 vertebrate fauna species were recorded within the study area including good representation across all fauna guilds, with eight species recognised as exotic (approximately 5%). This is not a comprehensive fauna list with many more species likely to occur based on the available habitats of the study area. The full list of fauna species recorded during the current survey and previous studies is provided in Appendix A.

4.3.1 Ultrasonic microbat call identification

Analysis of ultrasonic echolocation bat calls via Anabat recorders identified 13 distinct species of microchiropteran bat within the study area (Table 6). Five of these species are listed as Vulnerable under Schedule 2 of the TSC Act. Full echolocation call results are provided in Appendix C. An additional three species were recorded during previous studies. All recorded bat species are listed in the fauna table (Appendix A).

Table 6: Summary of microbat species

Scientific Name	Common Name	Call Confidence	TSC Act	EPBC Act
Chalinolobus gouldii	Gould's wattled bat	D, Po	-	-
Miniopterus australis	Little Bentwing-bat	D, Pr, Po	Vulnerable	-
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	D, Pr, Po	Vulnerable	-
Mormopterus norfolkensis	East Coast Freetail-bat	D	Vulnerable	-
Mormopterus sp. 2	Eastern Freetail-bat	D, Po	-	-
Myotis macropus	Large-footed Myotis	D, Po	Vulnerable	-
Myotis macropus / Nyctophilus sp.		D	-	-
Nyctophilus sp.	Long-eared Bat	D	-	-
Rhinolophus megaphyllus	Eastern Horseshoe Bat	D	-	-
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	D	Vulnerable	-
Tadarida australis	White-striped Freetail Bat	D		
Vespadelus darlingtoni	Large Forest Bat	D		
Vespadelus pumilus	Eastern Forest Bat	Pr		
Vespadelus regulus	Southern Forest Bat	Pr		

D = Definite, Pr = Probable, Po = Possible call identification

4.3.2 Significant fauna

Eight threatened species listed as Vulnerable under the TSC Act were recorded during the current field survey:

Bird

- Square-tailed Kite (*Lophoictinia isura*)

Mammals

- East Coast Freetail-bat (*Mormopterus norfolkensis*)
- Eastern Bentwing (*Miniopterus schreibersii oceanensis*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*)
- Koala (*Phascolarctos cinereus*)
- Large-footed Myotis (*Myotis macropus*)
- Little Bentwing Bat (*Miniopterus australis*)
- Yellow-bellied Freetail Bat (*Saccolaimus flaviventris*)

Of these species three bats have not been previously recorded within the study area, namely the East Coast Freetail-bat, Large-footed Myotis and Yellow-bellied Freetail Bat.

OEH Atlas records show fourteen threatened species (including two insects) listed as Endangered under the TSC Act as previously recorded within the study area:

Birds

- Glossy Black-Cockatoo (*Calyptorhynchus lathami*) V
- Barred Cuckoo-shrike (*Coracina lineata*) V
- Black-necked Stork (*Ephippiorhynchus asiaticus*) E
- Little Lorikeet (*Glossopsitta pusilla*) V
- Black Bittern (*Ixobrychus flavicollis*) V
- Square-tailed Kite (*Lophoictinia isura*) V

- Eastern Osprey (Pandion cristatus) V
- Masked Owl (*Tyto novaehollandiae*) V
- Sooty Owl (*Tyto tenebricosa*) V

Mammals

- Little Bentwing-bat (*Miniopterus australis*) V
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) V
- Koala (*Phascolarctos cinereus*) V

Insects

- Black Grass-dart Butterfly (*Ocybadistes knightorum*) E
- Coastal Petaltail (*Petalura litorea*) E

A combined total of 18 threatened fauna species have been recorded within the study area during current and previous studies.

4.4 SPECIES, POPULATIONS AND COMMUNITIES OF CONSERVATION CONCERN

From the database searches 94 animals (Table 7) and 40 plants listed under the TSC Act or the EPBC Act are recorded within a one km search of the study area. Of these 46 animals and 13 plants are either likely or have the potential to occur within the study area based on available habitat. Eight EECs have been recorded within this search with only the 3 following likely to occur:

- *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions;*
- *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions;* and
- *Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.*

Table 7: Summary of threatened fauna

Faunal Group	No	Unlikely	Potential	Likely	Yes	Total
Frogs	0	5	3	1	0	9
Reptiles	0	0	3	0	0	3
Mammals (excl. bats)	2	5	6	0	2	15
Mammals(bats)	0	2	5	1	6	14
Birds	17	3	20	2	7	49
Fish	0	0	0	0	0	0
Insects	0	1	1	0	2	4
Total	**19**	**16**	**38**	**4**	**17**	**94**

4.5 LANDSCAPE LINKAGES

Several large remnant forested areas and potential corridor features are located adjacent to and traversing the study area. These areas include:

- Boambee State Forest to the north-west;
- Pine Creek State Forest to the south;
- links to the lowland habitats to the east (Bongil Bongil National Park);
- the ridgeline running east along the northern boundary of the study area; and
- surrounding private property areas.

Koala populations in particular have been documented as highly significant in the Pine Creek - Bongil Bongil areas in a state and national context (Scotts 2013). This area is bisected by the Bonville Pacific Highway upgrade and forms the easterly edge of the Bonville study area.

Overall a greater separation between wildlife and vehicle traffic now exists, although the road upgrade has reduced habitat in the area via clearing and potentially severed significant east to west wildlife movement. Death and injury to wildlife by cars on roadways (particularly in high speed areas) can cause significant impacts to local wildlife population dynamics. The upgrade may have reduced these potential impacts (after an initial disruption) by providing dedicated wildlife overpass, underpass and fencing along the roadway allowing fauna movement away from vehicle interaction. However Koala monitoring research for the Bonville Pacific Highway upgrade (2000 – 2009) reported a decline in Koala numbers. High levels of disease, a low breeding rate and vehicle strike were all implicated (AMBS 2012).

Six fauna underpasses are located directly adjacent to the Bonville study area. Most of these are located along drainage lines and one dedicated fauna overpass exists just south of the study area. These drainage line linkages under the roadway allow land and water movement to fauna species. These underpasses logically align with likely local corridors traversing the study area or adjoin State Forest or National Park tenure (Figure 9). The main underpass location linkages are listed (north to south):

- Titans – Herdegen Close;
- Bonville Creek (north and south bank);
- Northern Pine Creek tributary;
- Reedy Creek; and

- Pine Creek.

Several subregional corridors traverse the study area (Figure 9) and were mapped as part of the *Key Habitats and Corridors for Forest Fauna* project (Scotts 2003). Construction of the Bonville bypass has preserved the majority of these corridors except one which would probably follow a drainage line along a tributary of Pine Creek. Post highway construction, a review of corridor connections is required to examine functional connectivity regarding the new fauna underpasses, as at least one depicted corridor is misaligned.

The *Coffs Harbour City Council NSW 2009 Draft Priority Habitats and Corridors Strategy 2010 – 2030* maps local corridors within a regional framework across the Coffs Harbour LGA. These two corridor frameworks were overlayed with existing GIS datasets to highlight areas which would improve connectivity and wildlife movement.

Both datasets show plantation habitat was not considered as an ecological unit as part of these corridor assessments. Plantation forest cover provides certain habitat features to allow wildlife movement and comprises a significant part of the potential BIG club corridor. This corridor extends from the northerly portion of the study area in a southerly direction along the Bonville Creek riparian corridor and east to Bongil Bongil National Park. Habitat corridors are explored further in Section 6 of this report.

The most practical solution to wildlife corridors within existing zoned and occupied landscapes is to utilise drainage lines and their subsequent vegetation buffers applicable to the stream order definition.

Drainage lines are natural traverse zones for a range of species particularly highly mobile bird and bat species. Data from the microbat echolocation call data indicate that microbats utilise these natural conduits for their foraging requirements indicated by 12 species recorded included several threatened species.

Local corridor definition for this study area has naturally been focused on the riparian and their associated buffer areas with the potential limits to development around water front land. Protection and improvement through environmental management; weed removal and suppression of riparian zones will also improve the ability for the iconic koala to access fauna underpasses under the Pacific Highway bypass to significant koala habitat areas in the Bongil Bongil and Pine Creek locations. Riparian buffers form a significant component of the environmental constraints derivation in section 6 of this report.

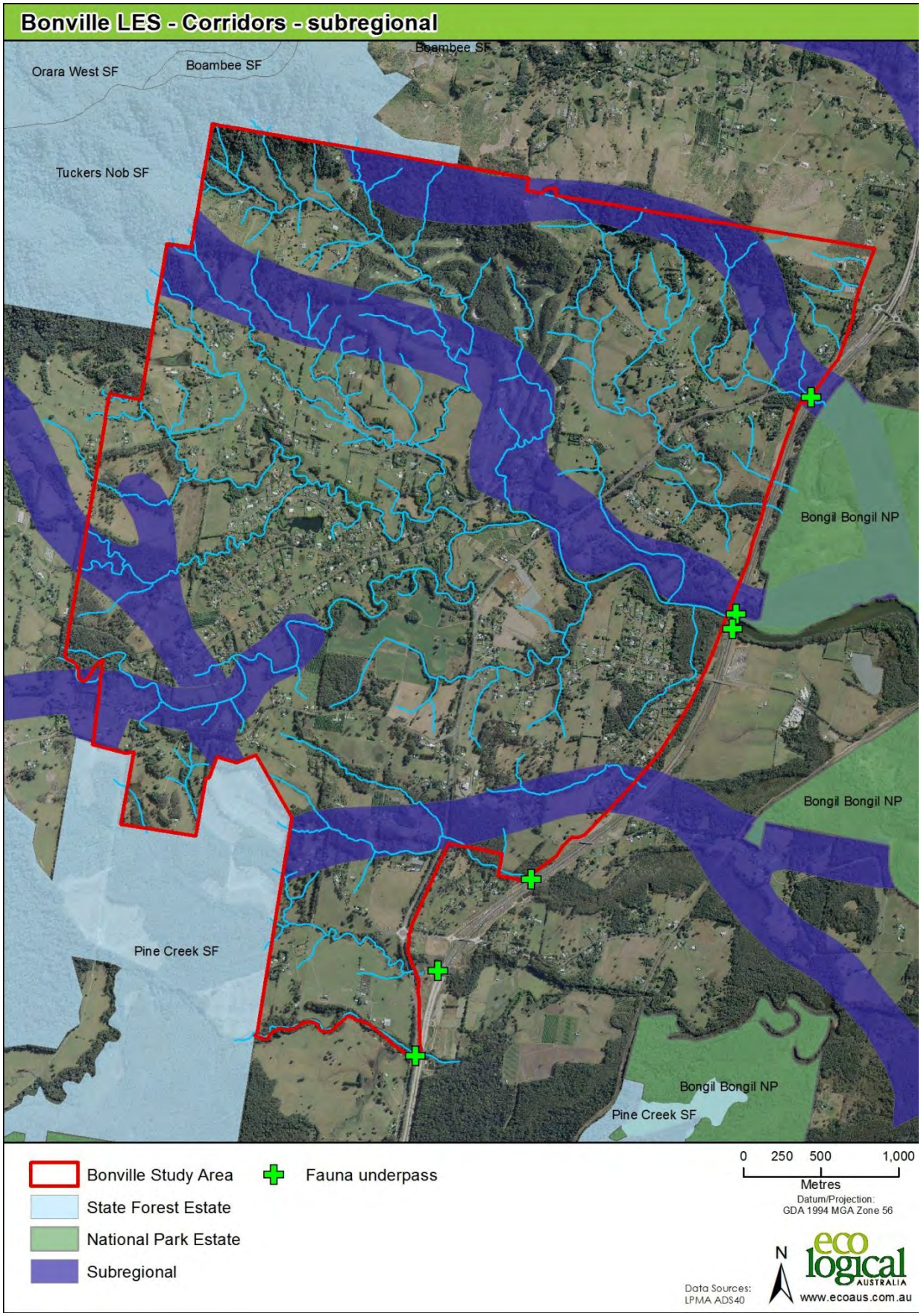

Figure 9: Regional corridors

5 Discussion

This study documents the environmental values of the Bonville study area, in the context of a planning initiative examining potential further rural residential land releases. Through the process of assessing vegetation cover and related fauna habitats throughout the study area it is apparent this area has undergone extensive clearing and modification via forestry and agricultural development. Local landuse has changed overtime as indicated by original industries which no longer persist in the area (e.g. dairying) and other discontinued industry projects (e.g. plantation products for paper manufacture). Agriculture landuse has shifted from grazing systems predominately to increased small-scale intensive horticulture developments. This area currently provides extensive rural landscape living opportunities.

Fine-scale vegetation mapping highlights that vegetation systems are fragmented overall, with steeper slopes retaining larger blocks of vegetation cover throughout the majority of the study area. Landuse changes can also be seen throughout extensive riparian zones which are mapped as primarily exotic vegetation. This fine-scale mapping also shows large areas of primary Koala habitat (mapped for CHCC LEP 2000) which support communities dominated by Camphor Laurel. This indicates a potential over-emphasis of functional Koala habitat extent in the study area.

The Bonville Pacific Highway bypass has reduced traffic flow along the old permeable highway (now Pine Creek Way) with possible longer-term benefits to fauna. Additionally wildlife exclusion fencing and fauna over and underpasses assist in separating vehicle and wildlife interaction along the Bonville Pacific Highway upgrade route.

Increased residential development throughout the study area is expected via expanded residential development in the BIG club lands. Previous planning initiatives such as Koala habitat protection and changed rural enterprises have resulted in revegetation of certain areas and vegetation losses in other developed areas. Challenges continue in the implementation of planning initiatives regarding protection of significant lands, riparian vegetated buffers, wildlife corridors and linkages between existing remnant vegetation within and downstream of the study area.

5.1 KOALA ACTIVITY

Koalas are a unique and highly specialised native species, and their populations in Coffs Harbour are relatively well documented in comparison to many throughout NSW. Coffs Harbour was the first LGA in NSW to implement an LGA-wide Comprehensive Koala Plan of Management (CKPoM, Lunney et. al., 1999). Environmental protection zones were allocated to significant areas of the LGA through the CKPoM process. CHCC and OEH are currently undertaking a review of the CKPoM and further work is being done on a KPoM for the Bellingen and Nambucca coastal and valley LGAs by OEH staff. Consequently sites that were assessed for Koala activity for the CKPoM have been revisited, including four sites within the Bonville study area. The results have yet to be published but indications are that three of the four Bonville sites provided evidence of recent Koala activity (pers. comm., M. Fisher, OEH, 2013).

During this LES process Koala activity was confirmed from several locations within the study area:

- Pine Creek Way – Titans Close Koala crossing;
- Private property adjacent to BIG club lands;
- Private property in the Crossmaglen Road – Burgess Creek area;
- Reedy Creek; and

- Pine Creek drainage lines.

A recent study was undertaken on Koala population dynamics expressed as sub-populations, regional populations and meta-populations, for a consortium of local environmental groups in conjunction with OEH Wildlife Atlas data (Scotts 2013). The findings of this study state the North Coast Koala meta–population is of national significance. Additionally the Coffs Harbour and Bellingen LGAs and more specifically Pine Creek State Forest and Bongil Bongil National Park are noted as key areas of Koala habitat. However monitoring work for the Bonville Pacific Highway upgrade indicated a decline in Koala numbers between 2000 - 2009 (AMBS 2011).

The following information from Scotts 2013 report describes the Bonville Koala sub-population, which covers a slightly larger extent to the Bonville LES study area:

Location / Landform / Habitat

Southern Coffs Harbour LGA in Bonville district – east and west of the Pacific Highway; coastal foot hills; habitats as fragmented remnants.

Threats

Area of on-going and planned intensive urban and rural-residential development – habitat loss, fragmentation and degradation; dogs, vehicle strike, stress-induced diseases.

Tenure

Predominately private land

Prognosis

This sub-population is thought to have shrunken significantly. A broad estimate of 50 – 500 individuals is estimated but the upper limit may well be a drastic over-estimate. The functional viability of this sub-population is uncertain in the face of on-going and escalating threats; essentially a sink area for dispersing individuals from the sub-population 2A (2A = Pine Creek and Bongil Bongil area).

Recommendations

Severely impacted but retention and enhancement of habitat and corridor links wherever possible, along with koala-supportive management strategies as are possible over time will be of benefit; on-going public education regarding koala conservation, impacts of road collision and management of domestic dogs is required.

This synopsis of the Bonville Koala sub-population supports results from the current LES. Koala evidence and locations were determined from the periphery of the study area and are likely to have been populated by dispersing Koalas moving from Pine Creek State Forest and Bongil Bongil National Park which are adjacent into the study area. Corridors are highlighted as crucial components which allow Koalas to traverse remnant and regenerating habitats. A focus on maintaining and improving existing Koala habitat is required for the Bonville study area.

Photo 4: Koala detected during surveys along the Crossmaglen Road within the study area.

6 Conservation and Management

The study area covers approximately 1860 ha with mapped vegetation systems ranging from the flood plain EEC's in the low-lying easterly areas through to wet sclerophyll and rainforest systems on the elevated and south-facing slopes to the north. Significant riparian vegetation systems exist with a significant percentage found in a degraded state due to previous landuses, including some small riparian remnants heavily affected by environmental weeds (e.g. exotic vines).

Fauna habitats provide varied resources for a range of (mainly) highly mobile annual and seasonal migratory and resident species. These species include state and federally-listed species such as Grey-headed Flying-fox and Koala. Microbats in particular are a unique fauna guild which represent a large percentage of the threatened species detected during the current assessment, most of which were recorded along drainage lines.

6.1 ENVIRONMENTAL CONSTRAINT DERIVATION

An environmental constraint in a planning context indicates an environmental value (usually supported by legislation) highlighted for protection or consideration regarding proposed zoning changes and development.

The following criteria were used to build the constraints layer (Figure 11).

- Evaluate and protect existing high value vegetation.
- Protect existing Koala habitat.
- Establish corridor network to link existing vegetation to improve ecological function and catchment protection.
- Quantify statutory requirements for vegetation buffers around drainage lines for drainage line stabilisation and to improve water quality.

The following GIS layers were combined and intersected to create a single environmental constraints layer (Figure 11).

- Draft LEP 2013 – zones E2, W1 and W2.
- Class 5 Vegetation mapping.
    - EEC.
    - Vegetation significance.
    - Vegetation condition values.
    - Vegetation extent.
- Drainage lines, redefined and ordered.
    - Drainage buffers.
- Point significant field data.

The following projects and associated mapping were also considered as part of this process:

- Regional Corridors (Scotts 2003); and
- Draft Priority Corridors and Key Habitats (CHCC 2009).

GIS data layers have been presented in the results section of this report, and riparian buffers will be examined in more detail as part of the full constraint assessment process.

6.2 RIPARIAN BUFFERS

Riparian buffers are a major consideration of this planning process as they present a significant environmental constraint to proposed development.

The draft CHCC Biodiversity DCP (CHCC 2013) outlines the following objectives and guidelines regarding 'Riparian Lands'.

B8.4.1 Objectives

- *To improve water quality within waterways through sustainable design.*
- *To improve the stability of the bed and banks of waterways through the management of riparian vegetation.*
- *To improve the relationship between aquatic and terrestrial habitats associated with the riparian lands interface.*
- *To improve the ecological function of riparian areas within the landscape.*
- *To identify and protect scenic and cultural values.*

B8.4.2 Controls

Riparian Buffer Zones

i) Identified riparian buffer requirements are outlined in Appendix G.

ii) Where a riparian buffer is not designated within this Component of the DCP, the riparian buffer must be consistent with controlled activity guidelines for riparian corridors issued by the NSW Office of Water (NOW) for core riparian zones and

Vegetated Buffers

iii) Cleared buffer areas are to be revegetated.

iv) Buffer zones are not to be used for private infrastructure purposes, such as onsite effluent disposal, Asset Protection Zones (APZ) and the like.

Riparian Corridor Widths

NOW recommends a Vegetated Riparian Zone (VRZ) width based on watercourse order as classified under the Strahler System of ordering watercourses and using current 1:25 000 topographic maps (see Appendix G). *The width of the VRZ should be measured from the top of the highest bank on both sides of the watercourse.*

Table 8 shows how Vegetated Riparian Zone (VRZ) buffer distances were applied to all stream orders to create a drainage buffer layer, as detailed in Section 6.3.

Table 8: Stream order and buffer distances

Watercourse type	VRZ width (each side of watercourse)	Total riparian corridor width
1st Order	10 Metres	20 m + channel width
2nd Order	20 Metres	40 m + channel width
3rd order	30 Metres	60 m + channel width
4th Order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 Metres	80 m + channel width

6.3 DRAINAGE DATA AND DEFINITION

CHCC provided drainage data for this study area as part of a larger set of digital geographic data. Topographic drainage was captured at 1: 25000 scale by the NSW mapping agency for their original map production series. This dataset is too coarse for application to the drainage systems and buffered areas within the study area. Inaccuracies also exist within this dataset (e.g. certain drainage channels have changed course over time).

Initially the drainage alignment was re-mapped using high resolution imagery (ADS40 LPI) and LiDAR-derived metre-accurate contour information available for the study area. The re-defined drainage layer was utilised which contained stream order as categorised by Strahler (Appendix G). Buffer distances were then applied to all stream orders (Table 8) and a drainage buffer layer was produced (Figure 10).

Stream orders (as defined in Section 6.2) range from 1st order through to 6th order for the lower section of Bonville Creek. This created buffers on both sides of each drainage line ranging from 10 - 40 m. All stream orders require buffers to be created from the top of bank on each drainage line. This requires fine-scale delineation of the entire drainage network using differential GPS technology at the DA stage of the project. The buffers are designed for use in defining environmental constraints and/or potential LEP zones.

A crucial point within the NOW guidelines states that '*where a watercourse does not exhibit the features of a defined channel with bed and banks, the Office of Water may determine that the watercourse is not waterfront land for the purposes of the WM Act'*. Many of the 1st order streams within the study area may not display defined bed and channel definition as they have been cleared and grazed for many decades. Undefined and/or degraded 1st order drainage lines will require assessment by NOW at an early stage of the development process.

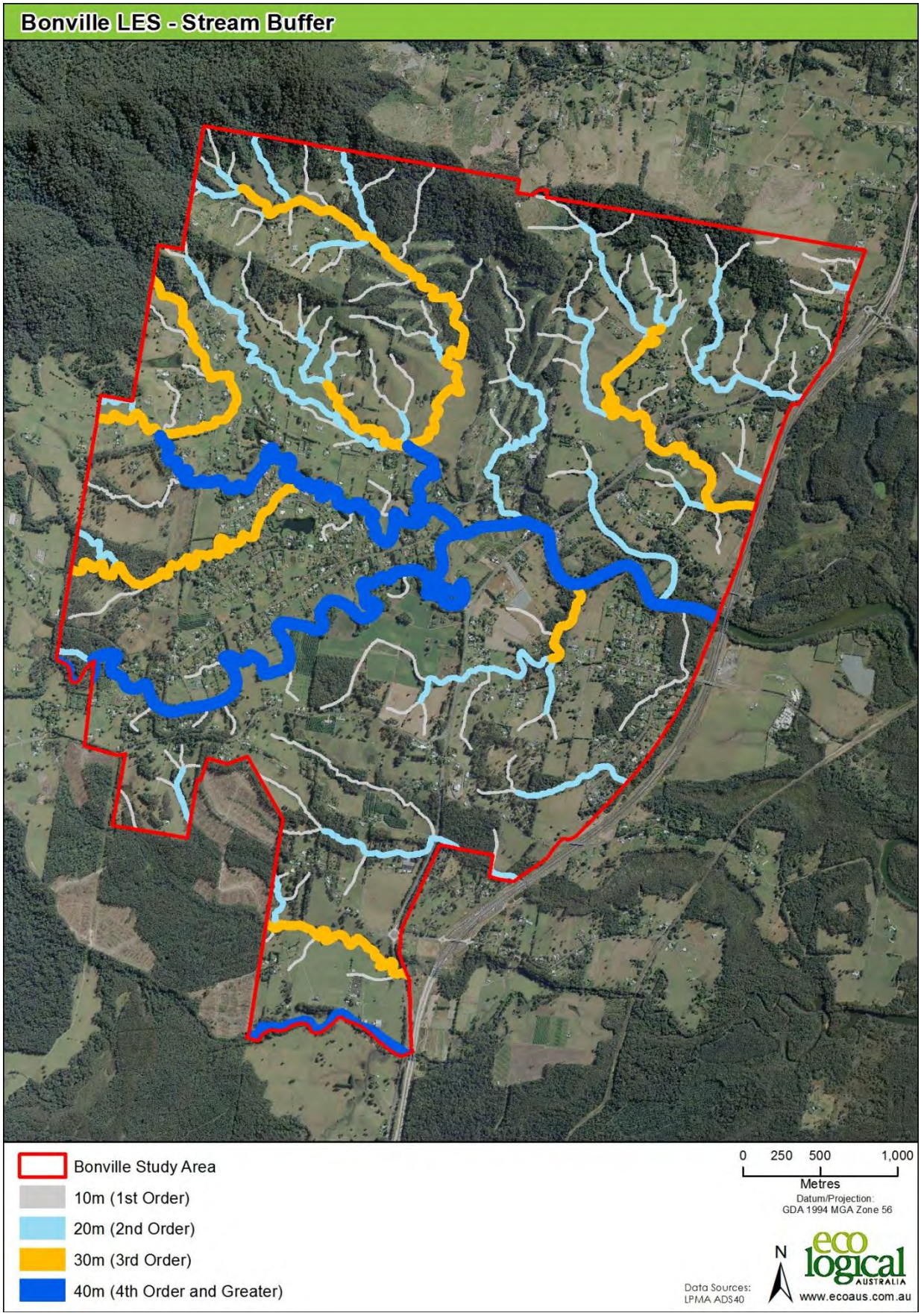

Figure 10: Drainage buffers

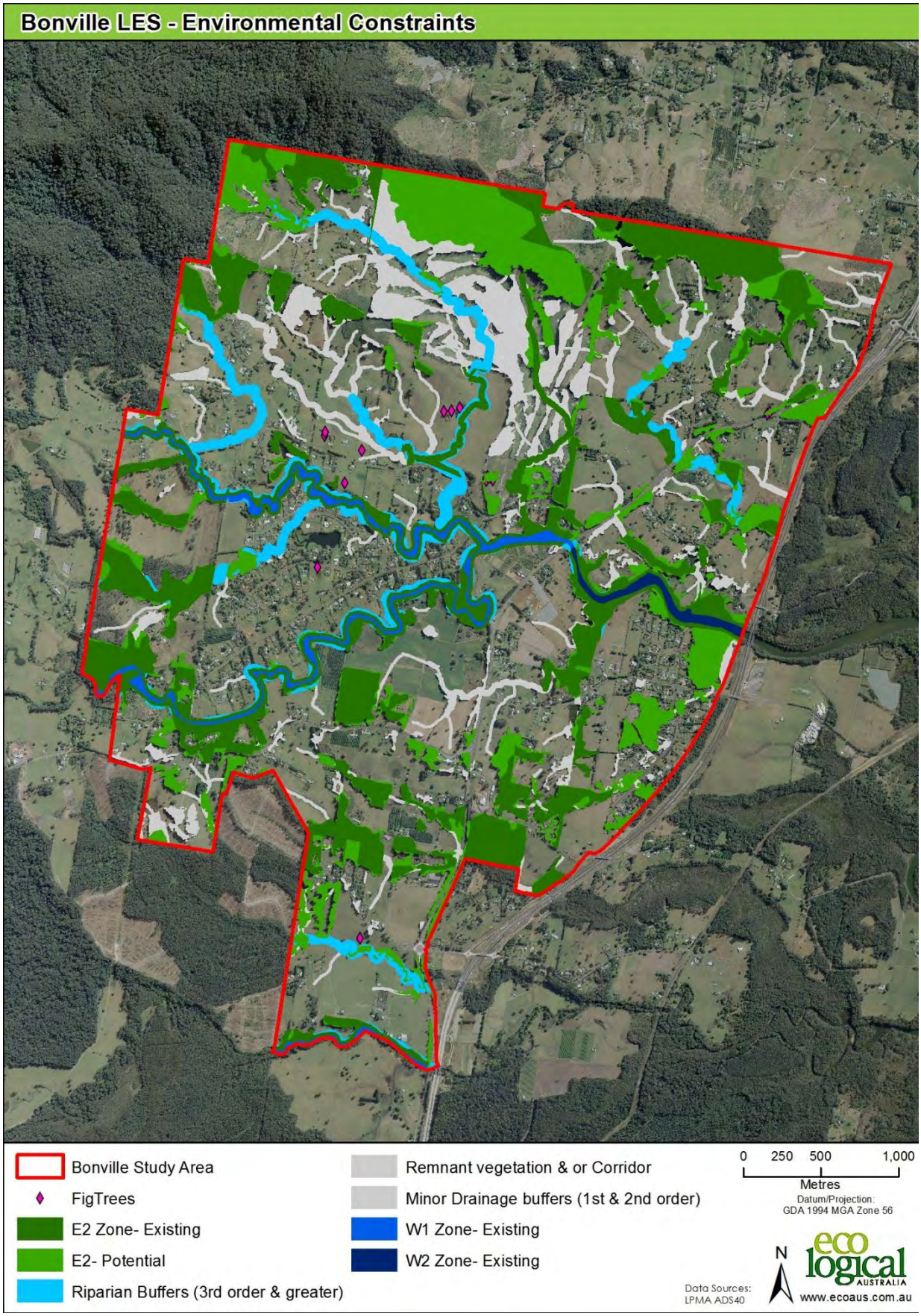

Figure 11: Environmental constraints

6.4 ENVIRONMENTAL CONSTRAINTS LAYER

The full extent of environmental constraints within the study area is depicted in Figure 11. A revision of the data layer was undertaken to remove slivers or edge effects from the GIS integration process. The final polygon layer has been reviewed and edited within each of the following categories to produce the final mapped output.

- E2 zone – Existing.
- E2 - Potential.
- Riparian buffers (3rd order and greater).
- Remnant vegetation and/or corridor.
- Minor drainage buffers (1st and 2nd order).
- W1 zone – Existing.
- W2 zone – Existing.

Table 9 shows the area covered by each environmental constraints category within the study area (Figure 11).

Table 9: Environmental constraints area

Environmental Constraint	Polygon Count	Area (ha)
E2 zone - existing	52	284.50
Minor drainage buffer (1st and 2nd order)	241	73.39
Remnant vegetation and/or corridor	130	98.52
Riparian buffers (3rd order and greater)	132	65.79
E2 - Potential	378	187.96
W1 zone - existing	2	24.11
W2 zone - existing	1	7.23
		741.50

The information provided in Figure 11 depicts the full extent of environmental variables for the Bonville study area, but is not intended as a recommendation for future environmental zones. This mapping layer will be provided to other consultants within the consortium to utilise during a full constraints analysis. This process may consider other potential constraints to land development (e.g. flooding and contaminated lands).

For inclusion to the planning process, the environmental constraints of the study area (Figure 11) will require logical assignment to relevant environmental zones. These existing categories (Table 9) have been assigned a zone (Figure 12) which could be applied to future rural or residential development areas.

It is likely that existing mapped environmental constraints (Figure 11) in areas deemed inappropriate for future development will retain their current zoning. Additional environmental zones are only likely to occur within areas identified for future development.

The Department of Planning and Infrastructure (DoPI) provided advice to CHCC regarding planning proposals using the new instrument zone categories. This advice suggested the 'E3 Environmental management' zone should not be used as part of any current planning processes.

'E2 Environmental conservation' provides a source zone to protect significant environmental values within the study area. Environmental constraints not considered for 'E2' zoning are displayed as a biodiversity overlay (Figure 12) for consideration during the full planning proposal process. These areas include minor drainage lines (e.g. stream orders 1 and 2) and some potential corridor areas for example through the BIG club lands.

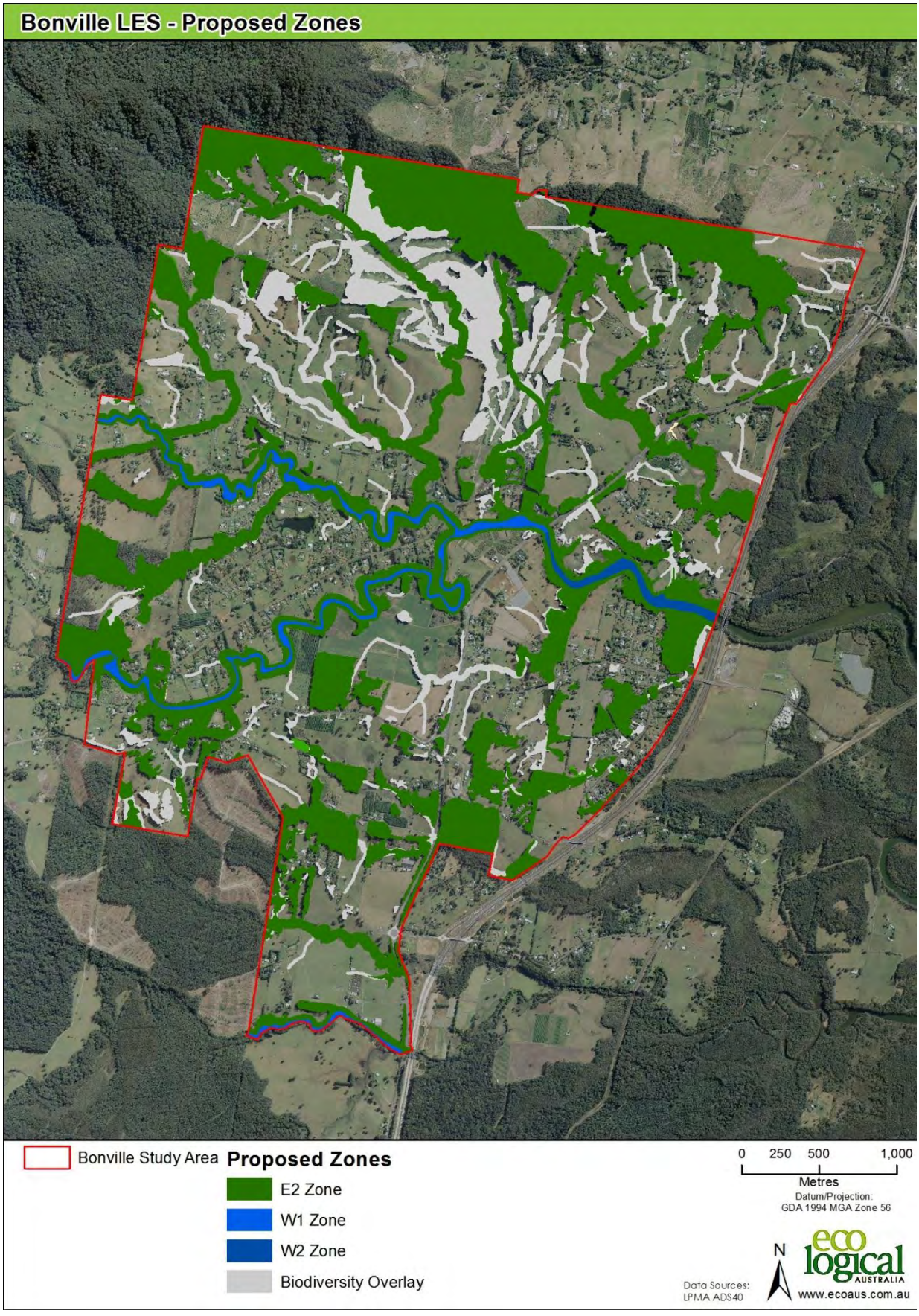

Figure 12: Proposed zones within potential development areas

7 Recommendations

For use during the full planning proposal process a workable constraints layer has been produced as part of this study (Figure 11). This layer was designed with the purpose of protecting and maintaining existing threatened species habitat, applying statutory requirements to riparian zones and applying the best available data when defining corridors. Figure 12 depicts likely allocations within the zoning scheme for any potential future rural or residential development area.

Recommendations for the Bonville study area developed during this study are as follows:

- Retain all high conservation habitats within E2 zoning (Figure 12).
- Absorb riparian buffer areas within E2 zoning as a statutory component (Figure 12).
- Remnant vegetation and / or corridor linkages should be retained as a biodiversity overlay (Figure 12).
- Provide 1st and 2nd order streams as a 'likely constraint' and displayed as a biodiversity overlay (Figure 12).
- Improve wildlife movement corridors under Pine Creek Way (formerly Old Pacific Highway) particularly at Reedy and Pine Creeks. This should allow a dry east – west access for fauna under the new Pacific Highway and Pine Creek Way road corridors.
- Encourage and establish a Bonville Landcare group to reduce NSW-listed weeds and environmental weed species, particularly along the Burgess, Crossmaglen and Bonville Creek drainage lines.
- Corridors within the BIG Club area must be maintained and improved to manage direct and indirect impacts of proposed development works.
- Encourage BIG club to develop a Flora and Fauna Plan of Management (PoM) for proposed housing development works and general management of environmentally significant lands under their control.

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Appendix A: Fauna species list

SPECIES NAME	COMMON NAME	Exotic	TSC Act	EPBC Act	Survey	
Amphibian					**LES**	**ATLAS**
Crinia signifera	Common Eastern Froglet				*	*
Limnodynastes peronii	Brown-striped Frog					*
Litoria fallax	Eastern Dwarf Tree Frog					*
Litoria tyleri	Tyler's Tree Frog					*
Pseudophryne coriacea	Red-backed Toadlet					*
Rhinella marina	Cane Toad	*				*
Reptiles						
Bellatorias major	Land Mullet					*
Cryptophis nigrescens	Eastern Small-eyed Snake					*
Demansia psammophis	Yellow-faced Whip Snake					*
Hemiaspis signata	Black-bellied Swamp Snake					*
Lampropholis delicata	Dark-flecked Garden Sunskink				*	*
Lialis burtonis	Burton's Snake-lizard					*
Ramphotyphlops nigrescens	Blackish Blind Snake					*
Ramphotyphlops sp.	Blind snake					*
Birds (Diurnal)						
Acanthiza lineata	Striated Thornbill					*
Acanthiza nana	Yellow Thornbill					*
Acanthiza pusilla	Brown Thornbill				*	*
Acanthorhynchus tenuirostris	Eastern Spinebill					*
Accipiter fasciatus	Brown Goshawk				*	
Accipiter novaehollandiae	Grey Goshawk				*	*
Acridotheres tristis	Indian Myna	*			*	
Ailuroedus crassirostris	Green Catbird				*	
Alisterus scapularis	Australian King-Parrot				*	*
Anas gracilis	Grey Teal				*	
Anas platyrhynchos	Mallard				*	
Anas superciliosa	Pacific Black Duck				*	*
Anthochaera chrysoptera	Little Wattlebird				*	*
Ardea ibis	Cattle Egret			Mi	*	*
Ardea intermedia	Intermediate Egret				*	
Ardea modesta	Great Egret				*	
Ardea pacifica	Pacific Heron				*	
Artamus leucorynchus	White-breasted Woodswallow					*
Aviceda subcristata	Pacific Baza				*	*
Aythya australis	Hardhead				*	

Cacatua galerita	Sulphur-crested Cockatoo				*	
Cacomantis flabelliformis	Fan-tailed Cuckoo				*	
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo				*	*
Calyptorhynchus lathami	Glossy Black-Cockatoo		V			*
Ceyx azureus	Azure Kingfisher				*	*
Chalcites basalis	Horsfield's Bronze-Cuckoo					*
Chenonetta jubata	Australian Wood Duck				*	*
Cisticola exilis	Golden Headed Cisticola				*	
Colluricincla harmonica	Grey Shrike-thrush				*	*
Columba leucomela	White-headed Pigeon				*	*
Coracina lineata	Barred Cuckoo-shrike		V			*
Coracina novaehollandiae	Black-faced Cuckoo-shrike				*	*
Coracina tenuirostris	Cicadabird					*
Corvus orru	Torresian Crow				*	*
Coturnix ypsilophora	Brown Quail				*	
Cracticus nigrogularis	Pied Butcherbird				*	*
Cracticus tibicen	Australian Magpie				*	*
Cracticus torquatus	Grey Butcherbird				*	*
Cygnus atratus	Black Swan					*
Dacelo novaeguineae	Laughing Kookaburra				*	*
Dicaeum hirundinaceum	Mistletoebird					*
Dicrurus bracteatus	Spangled Drongo					*
Egretta novaehollandiae	White-faced Heron				*	*
Elanus axillaris	Black-shouldered Kite				*	
Elseyornis melanops	Black-fronted Dotterel				*	
Entomyzon cyanotis	Blue-faced Honeyeater				*	*
Eolophus roseicapillus	Galah				*	*
Eopsaltria australis	Eastern Yellow Robin				*	*
Ephippiorhynchus asiaticus	Black-necked Stork		E			*
Eudynamys orientalis	Eastern Koel					*
Eurystomus orientalis	Dollarbird					*
Falco peregrinus	Peregrine Falcon					*
Fulica atra	Eurasian Coot				*	
Gallinula tenebrosa	Dusky Moorhen				*	
Gallirallus philippensis	Buff-banded Rail				*	*
Geopelia humeralis	Bar-shouldered Dove					*
Gerygone albogularis	White-throated Gerygone					*
Gerygone mouki	Brown Gerygone				*	*
Glossopsitta concinna	Musk Lorikeet				*	
Glossopsitta pusilla	Little Lorikeet		V			*
Grallina cyanoleuca	Magpie-lark				*	*
Haliaeetus leucogaster	White-bellied Sea Eagle			Mi	*	
Haliastur indus	Brahminy Kite				*	*
Haliastur sphenurus	Whistling Kite				*	

Hirundapus caudacutus	White-throated Needletail			Mi		*
Hirundo neoxena	Welcome Swallow			Mi	*	*
Ixobrychus flavicollis	Black Bittern		V			*
Lalage leucomela	Varied Triller				*	
Leucosarcia picata	Wonga Pigeon				*	*
Lonchura castaneothorax	Chestnut-breasted Mannikin					*
Lophoictinia isura	Square-tailed Kite		V		*	*
Lopholaimus antarcticus	Topknot Pigeon				*	*
Macropygia amboinensis	Brown Cuckoo-Dove				*	*
Malurus cyaneus	Superb Fairy-wren					*
Malurus lamberti	Variegated Fairy-wren					*
Manorina melanocephala	Noisy Miner				*	*
Megalurus gramineus	Little Grass Bird				*	
Meliphaga lewinii	Lewin's Honeyeater				*	*
Monarcha melanopsis	Black-faced Monarch					*
Myzomela sanguinolenta	Scarlet Honeyeater					
Neochmia temporalis	Red-browed Finch				*	*
Ocyphaps lophotes	Crested Pigeon				*	*
Oriolus sagittatus	Olive-backed Oriole				*	*
Orthonyx temminckii	Logrunner				*	*
Pachycephala pectoralis	Golden Whistler				*	*
Pachycephala rufiventris	Rufous Whistler					*
Pandion cristatus	Eastern Osprey		V		*	*
Pardalotus punctatus	Spotted Pardalote					*
Pardalotus striatus	Striated Pardalote				*	*
Petrochelidon ariel	Fairy Martin (nests)				*	
Petroica rosea	Rose Robin				*	
Phylidonyris niger	White-cheeked Honeyeater					*
Pitta versicolor	Noisy Pitta				*	
Platalea regia	Royal Spoonbill				*	
Platycercus eximius	Eastern Rosella				*	*
Porphyrio porphyrio	Purple Swamphen				*	*
Psophodes olivaceus	Eastern Whipbird				*	*
Ptilonorhynchus violaceus	Satin Bowerbird				*	*
Pycnonotus jocosus	Red-whiskered Bulbul	*				*
Rhipidura albiscapa	Grey Fantail				*	*
Rhipidura leucophrys	Willie Wagtail				*	*
Rhipidura rufifrons	Rufous Fantail					*
Sericornis citreogularis	Yellow-throated Scrubwren				*	
Sericornis frontalis	White-browed Scrubwren					*
Sericulus chrysocephalus	Regent Bowerbird				*	*
Sphecotheres vieilloti	Australasian Figbird				*	*
Strepera gaculina	Pied Currawong				*	
Streptopelia chinensis	Spotted Turtle Dove	*			*	

Symposiachrus trivirgatus	Spectacled Monarch					*
Tachybaptus novaehollandiae	Australasian Grebe				*	
Threskiornis molucca	Australian White Ibis				*	*
Threskiornis spinicollis	Straw-necked Ibis				*	
Todiramphus sanctus	Sacred Kingfisher					*
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet					*
Trichoglossus haematodus	Rainbow Lorikeet				*	*
Vanellus miles	Masked Lapwing				*	*
Zosterops lateralis	Silvereye				*	
Birds (Nocturnal)						
Podargus strigoides	Tawny Frogmouth				*	
Tyto alba delicatula	Eastern Barn Owl					*
Tyto novaehollandiae	Masked Owl		V			*
Tyto tenebricosa	Sooty Owl		V			*
Mammals (excluding bats)						
Acrobates pygmaeus	Feathertail Glider				*	
Antechinus stuartii	Brown Antechinus					*
Canis lupus	Dingo, domestic dog	*				*
Dasyurus maculatus	Spotted-tailed Quoll					*
Isoodon macrourus	Northern Brown Bandicoot					*
Lepus europaeus	Hare	*			*	*
Macropus rufogriseus	Red-necked Wallaby				*	
Ornithorhynchus anatinus	Platypus					*
Oryctolagus cuniculus	European rabbit	*			*	
Perameles nasuta	Long-nosed Bandicoot					*
Petaurus breviceps	Sugar Glider					*
Phascolarctos cinereus	Koala		V	V	*	*
Rattus fuscipes	Bush Rat					*
Rattus lutreolus	Swamp Rat					*
Tachyglossus aculeatus	Short-beaked Echidna					*
Trichosurus vulpecula	Brush-tailed Possum				*	*
Vulpes vulpes	Fox	*			*	*
Wallabia bicolor	Swamp Wallaby					*
Bats						
Chalinolobus gouldii	Gould's Wattled Bat				*	*
Chalinolobus morio	Chocolate Wattled Bat					*
Miniopterus australis	Little Bentwing-bat		V		*	*
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat		V		*	*
Mormopterus norfolkensis	East-coast Freetail Bat		V		*	
Mormopterus species 2	Eastern Freetail Bat				*	*
Myotis macropus	Large-footed Myotis		V		*	

Nyctophilus spp.	a long eared bat				*	
Pteropus poliocephalus	Grey-headed Flying Fox		V	V	*	
Rhinolophus megaphyllus	Eastern Horseshoe Bat				*	
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat		V		*	
Scoteanax rueppellii	Greater Broad-nosed Bat					*
Tadarida australis	White-striped Freetail Bat				*	
Vespadelus darlingtoni	Large Forest Bat				*	
Vespadelus pumilus	Eastern Forest Bat				*	*
Vespadelus regulus	Southern Forest Bat				*	
Vespadelus vulturnus	Little Forest Bat					*
Invertebrates						
Ocybadistes knightorum	Black Grass-dart Butterfly		E			*
Petalura litorea	Coastal Petaltail		E			*

Mi = Migratory species (EPBC Act)

V = Vulnerable (TSC and EPBC Acts)

E = Endangered (TSC and EPBC Acts)

Appendix B: Flora species list

Family	Scientific Name	Common Name	Exotic	TSC	EPBC
Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally			
Fabaceae (Mimosoideae)	*Acacia melanoxylon*	Blackwood			
Euphorbiaceae	*Acalypha nemorum*				
Polygonaceae	*Acetosa sagittata*	Rambling Dock	*		
Myrtaceae	*Acmena smithii*	Lilly Pilly			
Rutaceae	*Acronychia oblongifolia*	White Aspen			
Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair			
Adiantaceae	*Adiantum hispidulum*	Rough Maidenhair			
Adiantaceae	*Adiantum* spp.				
Asteraceae	*Ageratina adenophora*	Crofton Weed	*		
Asteraceae	*Ageratum houstonianum*		*		
Casuarinaceae	*Allocasuarina torulosa*	Forest Oak			
Rhamnaceae	*Alphitonia excelsa*	Red Ash			
Zingiberaceae	*Alpinia caerulea*	Native Ginger			
Poaceae	*Andropogon virginicus*	Whiskey Grass	*		
Myrtaceae	*Archirhodomyrtus beckleri*	Rose Myrtle			
Arecaceae	*Archontophoenix cunninghamiana*	Bangalow Palm			
Araliaceae	*Astrotricha latifolia*				
Poaceae	*Axonopus fissifolius*	Narrow-leafed Carpet Grass	*		

Asteraceae	*Baccharis halimifolia*	Groundsel Bush	*		
Myrtaceae	*Backhousia myrtifolia*	Grey Myrtle			
Asteraceae	*Bidens* spp.		*		
Pittosporaceae	*Billardiera scandens*	Hairy Apple Berry			
Blechnaceae	*Blechnum cartilagineum*	Gristle Fern			
Blechnaceae	*Blechnum indicum*	Swamp Water Fern			
Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush			
Arecaceae	*Calamus muelleri*	Southern Lawyer Cane			
Cunoniaceae	*Callicoma serratifolia*	Black Wattle			
Myrtaceae	*Callistemon salignus*	Willow Bottlebrush			
Dicksoniaceae	*Calochlaena dubia*	Rainbow Fern			
Poaceae	*Capillipedium spicigerum*	Scented-top Grass			
Vitaceae	*Cayratia clematidea*	Native Grape			
Apiaceae	*Centella asiatica*	Indian Pennywort			
Orchidaceae	*Chiloglottis sylvestris*				
Poaceae	*Chloris gayana*	Rhodes Grass	*		
Lauraceae	*Cinnamomum camphora*	Camphor Laurel	*		
Vitaceae	*Cissus hypoglauca*	Giant Water Vine			
Ranunculaceae	*Clematis aristata*	Old Man's Beard			
Ranunculaceae	*Clematis glycinoides*	Headache Vine			
Lamiaceae	*Clerodendrum floribundum* var. *floribundum*				
Lamiaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum			
Convolvulaceae	*Convolvulus erubescens*	Pink Bindweed			
Asteliaceae	*Cordyline petiolaris*	Broad-leaved Palm Lily			
Asteliaceae	*Cordyline stricta*	Narrow-leaved Palm Lily			
Asteraceae	*Coronidium elatum*				

Orchidaceae	*Corybas fimbriatus*	Fringed Helmet Orchid			
Myrtaceae	*Corymbia intermedia*	Pink Bloodwood			
Lauraceae	*Cryptocarya glaucescens*	Jackwood			
Lauraceae	*Cryptocarya microneura*	Murrogun			
Lauraceae	*Cryptocarya rigida*	Forest Maple			
Escalloniaceae	*Cuttsia viburnea*	Elderberry			
Cyatheaceae	*Cyathea australis*	Rough Treefern			
Rubiaceae	*Cyclophyllum longipetalum*	Coast Canthium			
Poaceae	*Cynodon dactylon*	Common Couch			
Cyperaceae	*Cyperus disjunctus*				
Davalliaceae	*Davallia solida* var. *pyxidata*	Hare's Foot Fern			
Orchidaceae	*Dendrobium aemulum*	Ironbark Orchid			
Urticaceae	*Dendrocnide excelsa*	Giant Stinging Tree			
Fabaceae (Faboideae)	*Desmodium gunnii*	Slender Tick-trefoil			
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*				
Phormiaceae	*Dianella caerulea*	Blue Flax-lily			
Phormiaceae	*Dianella* spp.				
Dioscoreaceae	*Dioscorea transversa*	Native Yam			
Ebenaceae	*Diospyros fasciculosa*	Grey Ebony			
Sapindaceae	*Diploglottis australis*	Native Tamarind			
Blechnaceae	*Doodia aspera*	Prickly Rasp Fern			
Solanaceae	*Duboisia myoporoides*	corkwood			
Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash			
Myrsinaceae	*Embelia australiana*				
Lauraceae	*Endiandra sieberi*	Hard Corkwood			
Poaceae	*Entolasia marginata*	Bordered Panic			

Poaceae	*Entolasia stricta*	Wiry Panic			
Poaceae	*Eragrostis elongata*	Clustered Lovegrass			
Myrtaceae	*Eucalyptus acmenoides*	White Mahogany			
Myrtaceae	*Eucalyptus biturbinata*	Grey Gum			
Myrtaceae	*Eucalyptus grandis*	Flooded Gum			
Myrtaceae	*Eucalyptus microcorys*	Tallowwood			
Myrtaceae	*Eucalyptus pilularis*	Blackbutt			
Myrtaceae	*Eucalyptus propinqua*	Small-fruited Grey Gum			
Myrtaceae	*Eucalyptus resinifera*	Red Mahogany			
Myrtaceae	*Eucalyptus robusta*	Swamp Mahogany			
Myrtaceae	*Eucalyptus saligna*	Sydney Blue Gum			
Myrtaceae	*Eucalyptus siderophloia*	Grey Ironbark			
Eupomatiaceae	*Eupomatia bennettii*	Small Bolwarra			
Anacardiaceae	*Euroschinus falcatus*	Ribbonwood			
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry			
Moraceae	*Ficus coronata*	Creek Sandpaper Fig			
Cyperaceae	*Gahnia clarkei*	Tall Saw-sedge			
Cyperaceae	*Gahnia sieberiana*	Red-fruit Saw-sedge			
Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily			
Gleicheniaceae	*Gleichenia dicarpa*	Pouched Coral Fern			
Phyllanthaceae	*Glochidion ferdinandi*	Cheese Tree			
Fabaceae (Faboideae)	*Glycine clandestina*	Twining Glycine			
Sapindaceae	*Guioa semiglauca*	Guioa			
Araceae	*Gymnostachys anceps*	Settler's Twine			
Dilleniaceae	*Hibbertia aspera*	Rough Guinea Flower			
Dilleniaceae	*Hibbertia dentata*	Twining Guinea Flower			

Dilleniaceae	*Hibbertia scandens*	Climbing Guinea Flower			
Malvaceae	*Hibiscus splendens*	Pink Hibiscus			
Dennstaedtiaceae	*Histiopteris incisa*	Bat's Wing Fern			
Euphorbiaceae	*Homalanthus populifolius*	Bleeding Heart			
Violaceae	*Hybanthus stellarioides*				
Asteraceae	*Hypochaeris radicata*	Catsear	*		
Dennstaedtiaceae	*Hypolepis muelleri*	Harsh Ground Fern			
Poaceae	*Imperata cylindrica*	Blady Grass			
Fabaceae (Faboideae)	*Indigofera australis*	Australian Indigo			
Cyperaceae	*Isolepis inundata*	Club-rush			
Bignoniaceae	*Jacaranda mimosifolia*	Jacaranda	*		
Sapindaceae	*Jagera pseudorhus* var. *pseudorhus*	Foambark Tree			
Fabaceae (Faboideae)	*Kennedia rubicunda*	Dusky Coral Pea			
Verbenaceae	*Lantana camara*	Lantana	*		
Sterculiaceae	*Lasiopetalum spp.*				
Dryopteridaceae	*Lastreopsis microsora* subsp. *microsora*	Creeping Shield Fern			
Dryopteridaceae	*Lastreopsis* spp.				
Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge			
Fabaceae (Faboideae)	*Lespedeza striata*	Japanese Clover	*		
Ericaceae	*Leucopogon lanceolatus*				
Oleaceae	*Ligustrum* spp.		*		
Arecaceae	*Livistona australis*	Cabbage Palm			
Lobeliaceae	*Lobelia trigonocaulis*	Forest Lobelia			
Lomandraceae	*Lomandra filiformis*	Wattle Matt-rush			
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush			
Proteaceae	*Lomatia silaifolia*	Crinkle Bush			

Myrtaceae	*Lophostemon confertus*	Brush Box			
Myrtaceae	*Lophostemon suaveolens*	Swamp Turpentine			
Apocynaceae	*Marsdenia longiloba*	Slender Marsdenia		E	V
Apocynaceae	*Marsdenia rostrata*	Milk Vine			
Myrtaceae	*Melaleuca alternifolia*				
Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark			
Myrtaceae	*Melaleuca quinquenervia*	Broad-leaved Paperbark			
Rubiaceae	*Morinda jasminoides*	Sweet Morinda			
Myrsinaceae	*Myrsine variabilis*				
Oleaceae	*Notelaea venosa*	Veined Mock-olive			
Asteraceae	*Olearia nernstii*				
Poaceae	*Oplismenus aemulus*				
Poaceae	*Oplismenus imbecillis*				
Poaceae	*Ottochloa gracillima*				
Fabaceae (Faboideae)	*Oxylobium robustum*	Tree Shaggy Pea			
Asteraceae	*Ozothamnus diosmifolius*	White Dogwood			
Apocynaceae	*Parsonsia straminea*	Common Silkpod			
Poaceae	*Paspalum mandiocanum*	Broadleaf Paspalum	*		
Passifloraceae	*Passiflora* spp.		*		
Passifloraceae	*Passiflora subpeltata*	White Passionflower	*		
Proteaceae	*Persoonia stradbrokensis*				
Rutaceae	*Phebalium squamulosum*	Scaly Phebalium			
Phyllanthaceae	*Phyllanthus gunnii*				
Myrtaceae	*Pilidiostigma glabrum*				
Pinaceae	*Pinus* spp.		*		
Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum			

Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum			
Polypodiaceae	*Platycerium bifurcatum*	Elkhorn Fern			
Poaceae	*Poa labillardierei* var. *labillardierei*	Tussock			
Araliaceae	*Polyscias murrayi*	Pencil Cedar			
Araliaceae	*Polyscias sambucifolia*	Elderberry Panax			
Rhamnaceae	*Pomaderris aspera*	Hazel Pomaderris			
Phyllanthaceae	*Poranthera microphylla*	Small Poranthera			
Lobeliaceae	*Pratia purpurascens*	Whiteroot			
Amygdalaceae	*Prunus* spp.		*		
Acanthaceae	*Pseuderanthemum variabile*	Pastel Flower			
Dennstaedtiaceae	*Pteridium esculentum*	Bracken			
Fabaceae (Faboideae)	*Pultenaea euchila*				
Myrtaceae	*Rhodamnia rubescens*	Scrub Turpentine			
Myrtaceae	*Rhodomyrtus psidioides*	Native Guava			
Ripogonaceae	*Ripogonum elseyanum*	Hairy Supplejack			
Ripogonaceae	*Ripogonum fawcettianum*	Small Supplejack			
Rosaceae	*Rubus moluccanus* var. *trilobus*	Molucca Bramble			
Rosaceae	*Rubus nebulosus*	Green-leaved Bramble			
Rosaceae	*Rubus parvifolius*	Native Raspberry			
Rosaceae	*Rubus* spp.		*		
Menispermaceae	*Sarcopetalum harveyanum*	Pearl Vine			
Araliaceae	*Schefflera actinophylla*	Umbrella Tree	*		
Cunoniaceae	*Schizomeria ovata*	Crabapple			
Cyperaceae	*Schoenus melanostachys*				
Fabaceae (Caesalpinioideae)	*Senna pendula* var. *glabrata*		*		
Sterculiaceae	*Seringia arborescens*				

Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	*		
Elaeocarpaceae	*Sloanea australis*	Maiden's blush			
Smilacaceae	*Smilax australis*	Lawyer Vine			
Smilacaceae	*Smilax glyciphylla*	Sweet Sarsaparilla			
Solanaceae	*Solanum mauritianum*	Wild Tobacco Bush	*		
Menispermaceae	*Stephania japonica*	Snake vine			
Menispermaceae	*Stephania japonica* var. *discolor*	Snake Vine			
Myrtaceae	*Syncarpia glomulifera*	Turpentine			
Meliaceae	*Synoum glandulosum* subsp. *glandulosum*	Scentless Rosewood			
Myrtaceae	*Syzygium oleosum*	Blue Lilly Pilly			
Apocynaceae	*Tabernaemontana pandacaqui*	Banana Bush			
Poaceae	*Themeda australis*	Kangaroo Grass			
Melastomataceae	*Tibouchina granulosa*	Tibouchina	*		
Ulmaceae	*Trema tomentosa* var. *aspera*	Native Peach			
Uvulariaceae	*Tripladenia cunninghamii*				
Myrtaceae	*Tristaniopsis laurina*	Kanooka			
Ericaceae	*Trochocarpa laurina*	Tree Heath			
Asteraceae	*Vernonia cinerea*				
Violaceae	*Viola hederacea*	Ivy-leaved Violet			
Monimiaceae	*Wilkiea huegeliana*	Veiny Wilkiea			
Rutaceae	*Zieria smithii*	Sandfly Zieria			
Rutaceae	*Zieria* spp.				

Appendix C: Microbat (Anabat) results

Anabat Results – Bonville Rural Residential LES, 14 Anabat nights, 14 - 19 May 2013.

Bat calls were analysed using the program AnalookW (Version 3.8 25 October 2012, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW. Available: (http://www.forest.nsw.gov.au/research/bats/default.asp).

Bat calls are analysed using species-specific parameters of the call profile such as call shape, characteristic frequency, initial slope and time between calls (Rinehold et al. 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et. al. 2006) were followed:

- Search phase calls were used in the analysis, rather than cruise phase calls or feeding buzzes (McKenzie et al. 2002)
- Recordings containing less than three pulses were not analysed and these sequences were labelled as short (Law et al. 1999)
- Four categories of confidence in species identification were used (Mills et al. 1996):
    - definite – identity not in doubt
    - probable – low probability of confusion with species of similar calls
    - possible – medium to high probability of confusion with species with similar calls
    - unidentifiable – calls made by bats which cannot be identified to even a species group.
- Nyctophilus spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al. 2004)
- Sequences not attributed to microbat echolocation calls were labelled as junk or non-bat calls and don't represent microbat activity at the site
- Sequences labelled as low were of poor quality and therefore not able to be identified to any microbat species, they can however be used as an indicator of microbat activity at the site

Over 5480 sequences were recorded from static Anabat detectors placed at four separate locations between 14 and 19 May 2013 within the Bonville study area. Approximately 79% of sequences submitted were able to be identified to species with the remainder being too short or of low quality preventing positive identification of species. General microbat activity was high at 2 locations on Bonville Creek; Pine Creek Way and at Crossmaglen Road with calls recorded more often than every two minutes throughout the evening. Activity was moderate at Burgess Creek at Crossmaglen, with calls recorded more often than every ten minutes but less often than every two minutes throughout the evening. Microbat activity on the northern Arm of Burgess Creek, North Bonville Rd was low with calls recorded less often than every ten minutes, perhaps reflecting the smaller order of stream and lower quality habitat surrounding the riparian area.

There were a minimum of 13 species identified including **five vulnerable** species listed under the NSW TSC Act 1987 (Tables 1 - 4). The most commonly recorded species were, Eastern Forest Bat (*Vespadelus pumilus*), **Little Bentwing Bat *(Miniopterus australis*) and Large-footed Myotis *(Myotis macropus*),** in that order which in total accounted for 63% of positively identified sequences. Eastern Forest Bat, Little Bentwing Bat and **Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*)** were found at every site surveyed. Feeding buzzes were often recorded.

Calls of the threatened **Eastern Bentwing Bat *(Miniopterus schreibersii oceanensis*)** overlap in frequency with those of the Large Forest Bat *(Vespadelus darlingtoni*) and Eastern Forest Bat (*V. regulus)*. Calls were identified as ***M.s.oceanensis*** when there was a down-sweeping tail, drop of more than 2 kHz in the pre-characteristic section, and the pulse shape and time between calls was variable.

Calls of the threatened **Large-footed Myotis** are very similar to all Nyctophilus species and it is often difficult to separate them. Calls were identified as *Nyctophilus spp*. when the time between calls (TBC) was higher than 95 ms and the initial slope (OPS) was lower than 300. Calls were identified as ***M. macropus*** when the TBC was lower than 75 ms and the OPS was greater than 400.

Calls of the **East-coast Freetail Bat (*Mormopterus norfolkensis*)** can be confused with those of the Eastern Freetail Bat (*Mormopterus species 2*). Positive identification of the East-coast Freetail Bat was assigned when there was alternation in frequency between pulses.

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Bonville Creek, Crossmaglen Rd	*Chalinolobus gouldii*	Gould's Wattled Bat	4	2		2
Bonville Creek, Crossmaglen Rd	*Miniopterus australis**	Little Bentwing Bat	48	48		
Bonville Creek, Crossmaglen Rd	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	86	81	4	1
Bonville Creek, Crossmaglen Rd	*Mormopterus* species 2	Eastern Freetail Bat	5	4	1	
Bonville Creek, Crossmaglen Rd	*Myotis macropus** / *Nyctophilus* spp.	Large-footed Myotis / a long eared bat	233			
Bonville Creek, Crossmaglen Rd	*Myotis macropus**	Large-footed Myotis	126	86	24	16
Bonville Creek, Crossmaglen Rd	*Nyctophilus* spp.	A long eared bat	16	16		
Bonville Creek, Crossmaglen Rd	*Saccolaimus flaviventris**	Yellow-bellied Sheathtail Bat	3	3		
Bonville Creek, Crossmaglen Rd	*Vespadelus darlingtoni*	Large Forest Bat	2	2		
Bonville Creek, Crossmaglen Rd	*Vespadelus pumilus*	Eastern Forest Bat	67	63	3	1
Bonville Creek, Crossmaglen Rd	*Vespadelus regulus*	Southern Forest Bat	1	1		
	Low		99			
	Short		182			
	Total sequences		872			

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Sth Trib. Burgess Ck	*Miniopterus australis**	Little Bentwing Bat	17	16		1
Sth Trib. Burgess Ck	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	47	47		
Sth Trib. Burgess Ck	*Mormopterus species 2*	Eastern Freetail Bat	3	3		
Sth Trib. Burgess Ck	*Myotis macropus* / Nyctophilus spp.*	Large-footed Myotis / a long eared bat	35			
Sth Trib. Burgess Ck	*Myotis macropus**	Large-footed Myotis	28	24	2	2
Sth Trib. Burgess Ck	*Rhinolophus megaphyllus*	Eastern Horseshoe Bat	1	1		
Sth Trib. Burgess Ck	*Vespadelus pumilus*	Eastern Forest Bat	815	814		1
	Low		4			
	Short		67			
	Total sequences		1017			

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Pine Creek, Pine Creek Way	*Chalinolobus gouldii*	Gould's Wattled Bat	5	4		1
Pine Creek, Pine Creek Way	*Miniopterus australis**	Little Bentwing Bat	764	763	1	
Pine Creek, Pine Creek Way	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	70	70		
Pine Creek, Pine Creek Way	*Mormopterus norfolkensis**	East-coast Freetail Bat	1	1		
Pine Creek, Pine Creek Way	*Mormopterus species 2*	Eastern Freetail Bat	12	11	1	
Pine Creek, Pine Creek Way	*Mormopterus species 2 / Mormopterus norfolkensis**	Eastern Freetail Bat / East-coast Freetail Bat	1			
Pine Creek, Pine Creek Way	*Myotis macropus* / Nyctophilus spp.*	Large-footed Myotis / a long eared bat	127			
Pine Creek, Pine Creek Way	*Myotis macropus**	Large-footed Myotis	118	75	33	10
Pine Creek, Pine Creek Way	*Nyctophilus spp.*	A long eared bat	7	5		2
Pine Creek, Pine Creek Way	*Rhinolophus megaphyllus*	Eastern Horseshoe Bat	1	1		
Pine Creek, Pine Creek Way	*Tadarida australis*	White-striped Freetail Bat	1	1		
Pine Creek, Pine Creek Way	*Vespadelus pumilus*	Eastern Forest Bat	971		3	
	Low		24			
	Short		337			
	Total sequences		2439			

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Bonville Creek, Pine Creek Way	*Chalinolobus gouldii*	Gould's Wattled Bat	7	4	1	2
Bonville Creek, Pine Creek Way	*Miniopterus australis**	Little Bentwing Bat	76	73		3
Bonville Creek, Pine Creek Way	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	64	60	3	1
Bonville Creek, Pine Creek Way	*Myotis macropus* / Nyctophilus spp.*	Large-footed Myotis / a long eared bat	117			
Bonville Creek, Pine Creek Way	*Myotis macropus**	Large-footed Myotis	82	61	15	6
Bonville Creek, Pine Creek Way	*Nyctophilus spp.*	a long eared bat	20	16	4	
Bonville Creek, Pine Creek Way	*Vespadelus pumilus*	Eastern Forest Bat	149	144	4	1
Bonville Creek, Pine Creek Way	*Vespadelus pumilus / Miniopterus australis*	Eastern Forest Bat / Little Bentwing Bat	1			
	Low		101			
	Short		242			
	Total sequences		859			

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Hand held - Spotlighting	*Miniopterus australis**	Little Bentwing Bat	1	1		
Hand held - Spotlighting	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	2	2		
Hand held - Spotlighting	*Vespadelus pumilus*	Eastern Forest Bat	1		1	
	Total sequences		4			

LOCATION	SPECIES NAME	COMMON NAME	NUMBER OF CALLS	DEFINITE	PROBABLE	POSSIBLE
Nth Trib. Burgess Ck	*Miniopterus australis**	Little Bentwing Bat	98	97		1
Nth Trib. Burgess Ck	*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat	7	7		
Nth Trib. Burgess Ck	*Myotis macropus**	Large-footed Myotis	1	1		
Nth Trib. Burgess Ck	*Vespadelus pumilus*	Eastern Forest Bat	70	69	1	
Nth Trib. Burgess Ck	*Vespadelus pumilus / Vespadelus vulturnus*	Eastern Forest Bat / Little Forest Bat	2			
	Low		15			
	Short		103			
	Total sequences		296			

* Listed threatened species

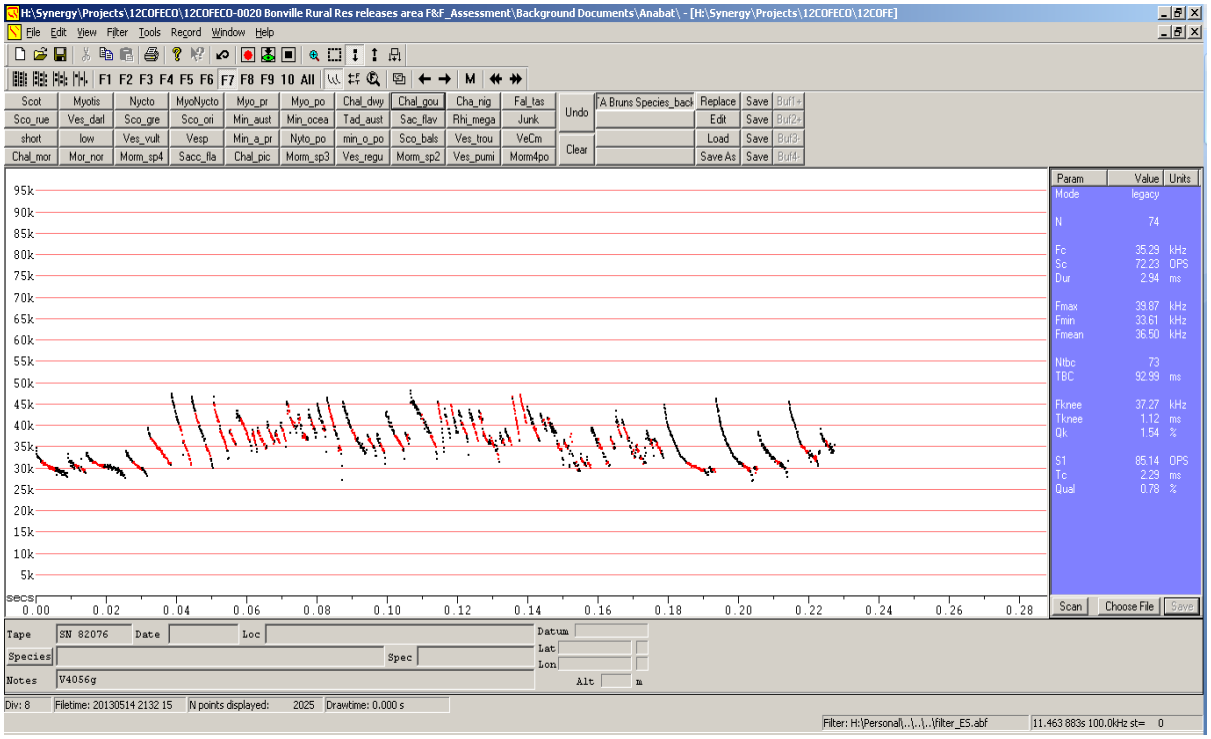

Figure 1: Call profile for *Chalinolobus gouldii* recorded along Bonville Creek, Pine Creek Way bridge at 21:32 on 14 May 2013.

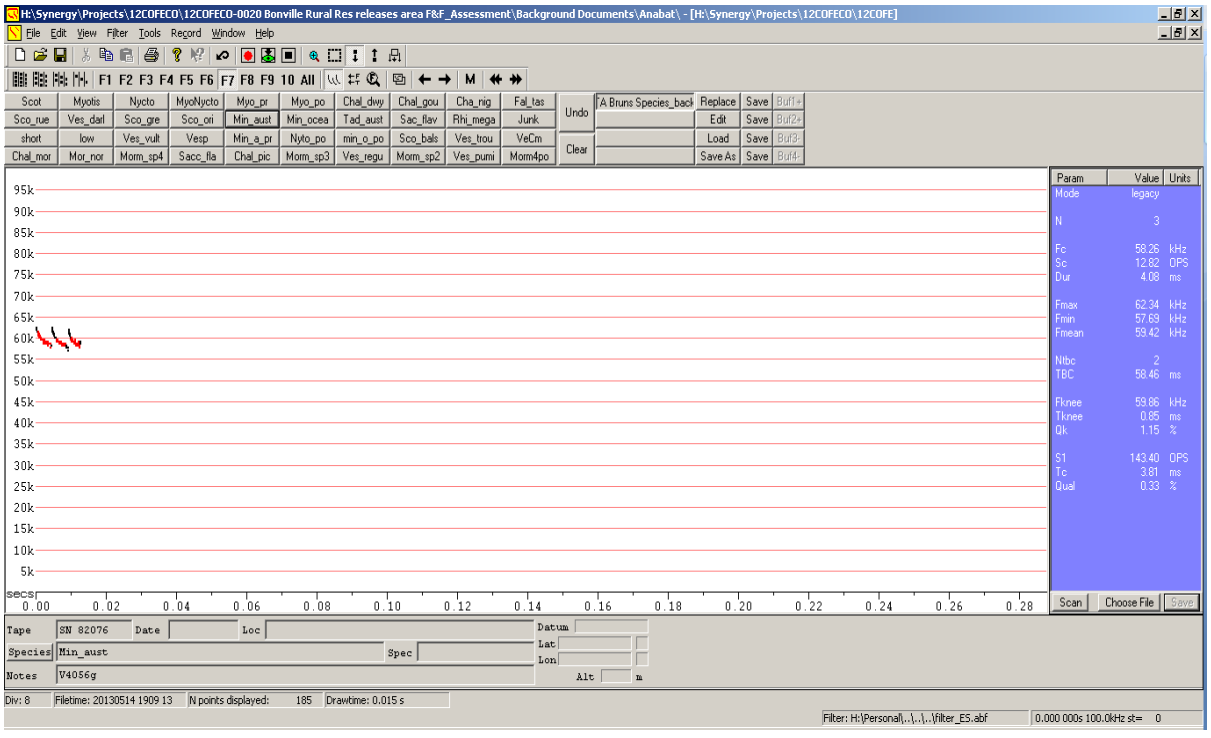

Figure 2: Call profile for *Miniopterus australis* recorded along Bonville Creek, Pine Creek Way bridge at 19:09 on 14 May 2013.

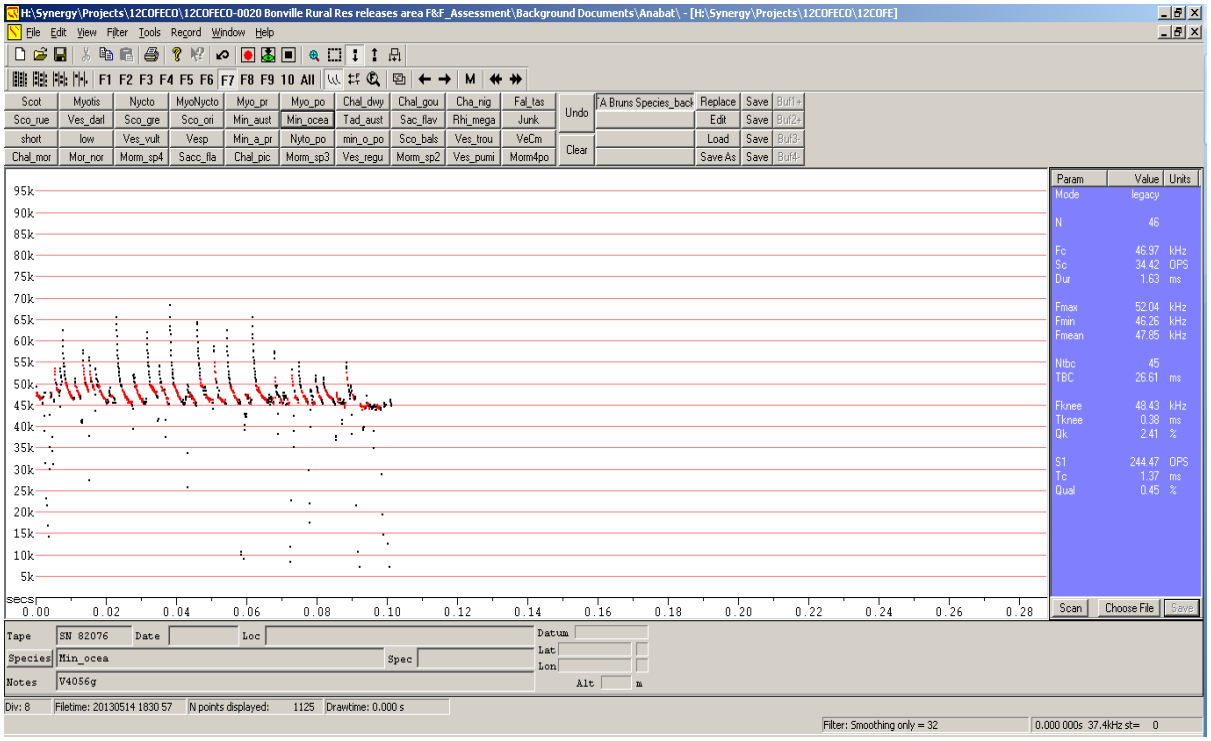

Figure 3: Call profile for *Miniopterus schreibersii oceanensis* recorded along Bonville Creek, Pine Creek Way Bridge at 18:30 on 14 May 2013.

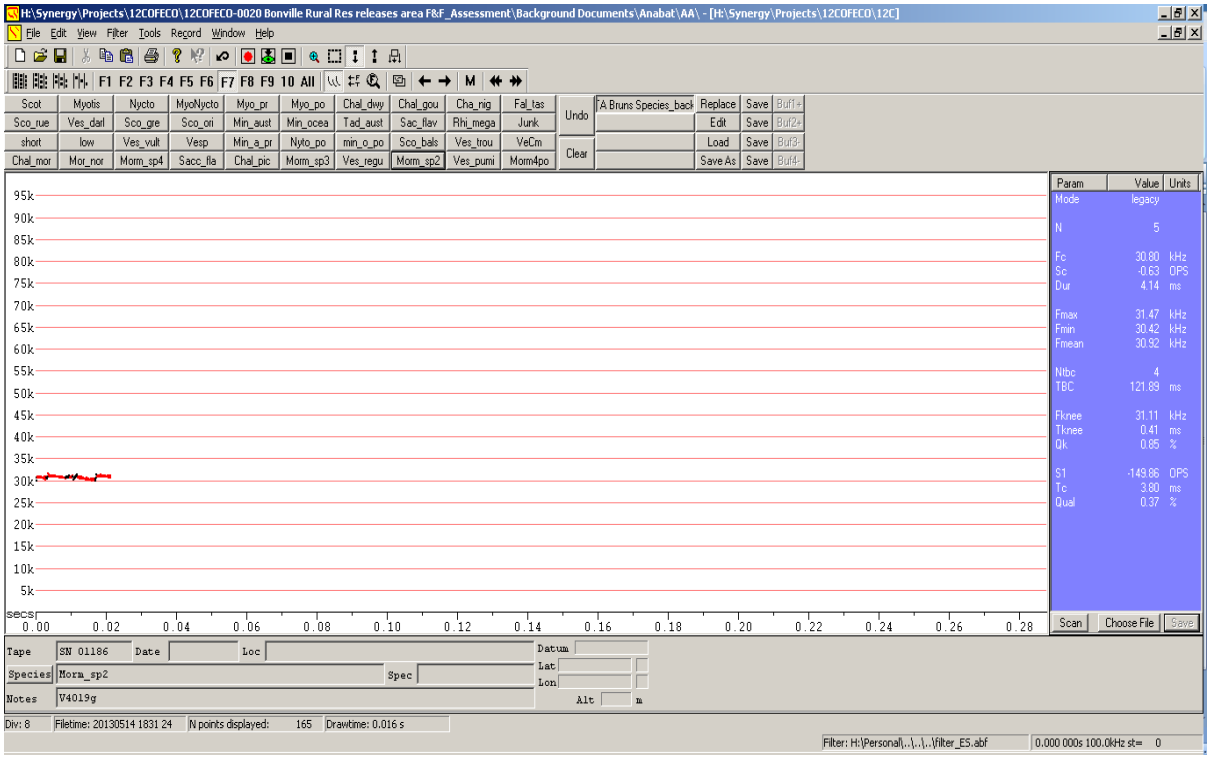

Figure 4: Call profile for *Mormopterus species 2* recorded at Bonville Creek at 21:39 on 14 May 2013.

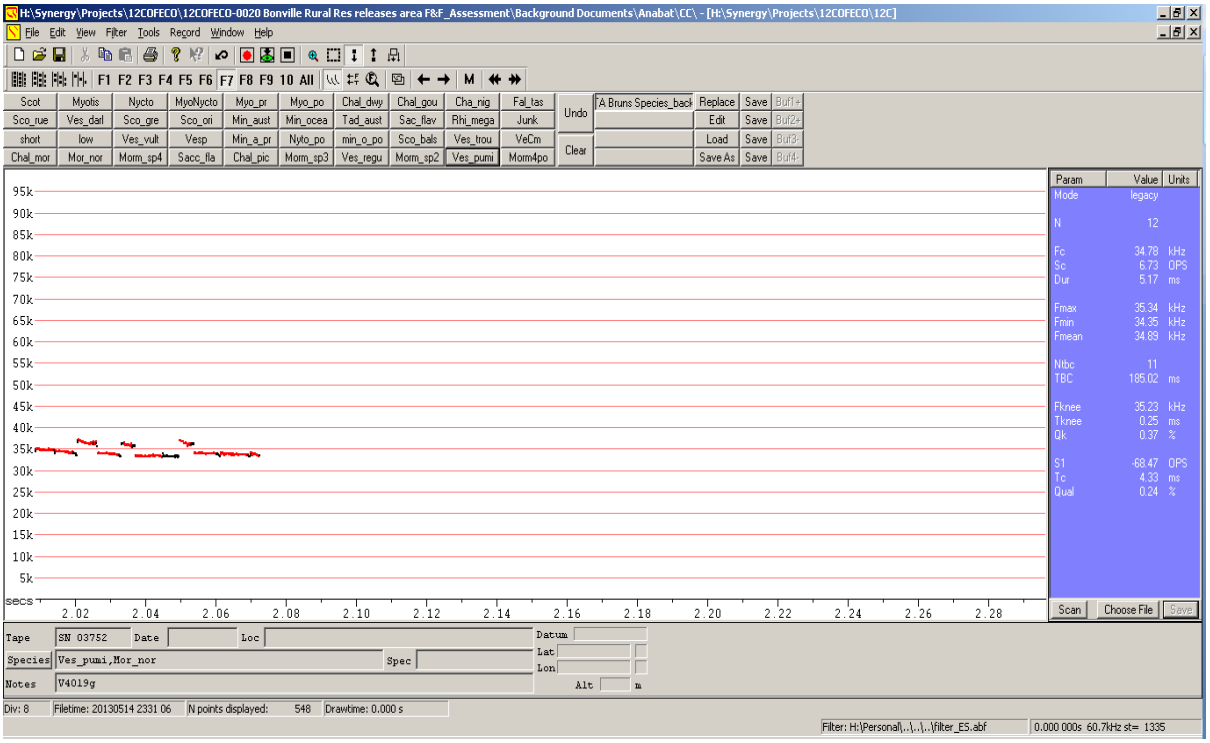

Figure 5: Call profile for *Mormopterus norfolkensis* recorded at Pine Creek, Bonville at 23:31 on 14 May 2013.

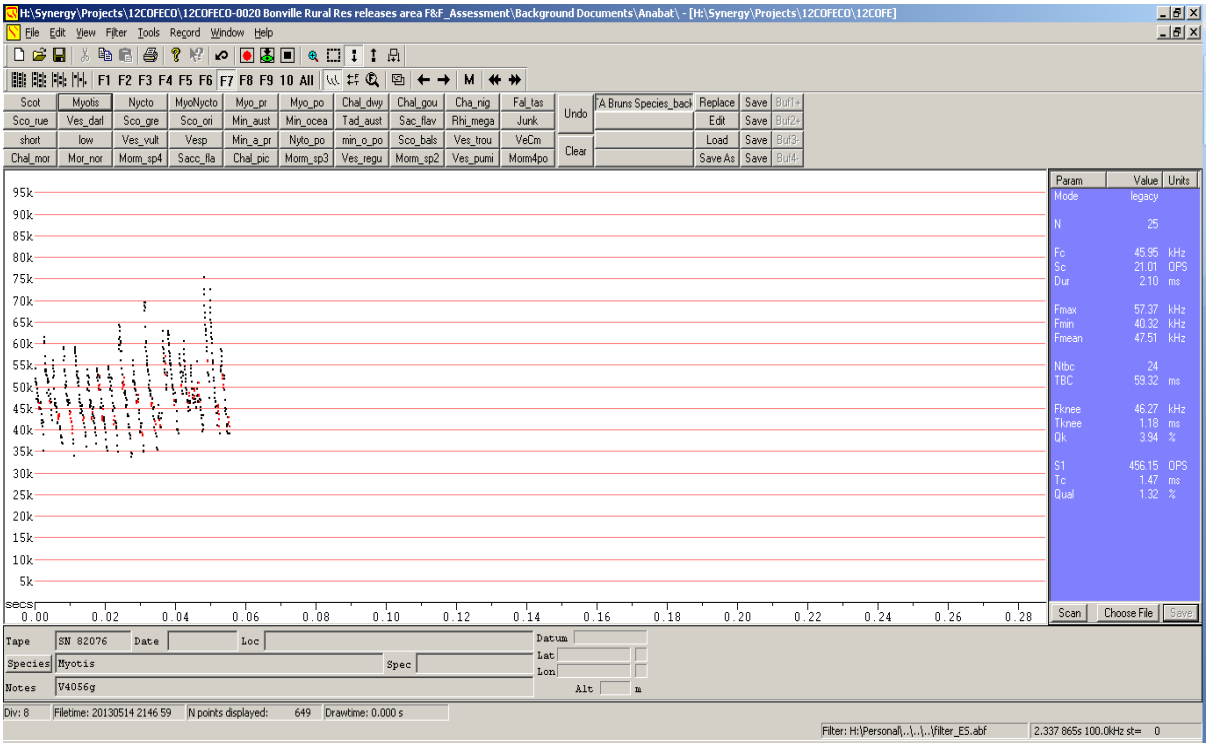

Figure 6: Call profile for *Myotis macropus* recorded along Bonville Creek, Pine Creek Way Bridge at 21:46 on 14 May 2013.

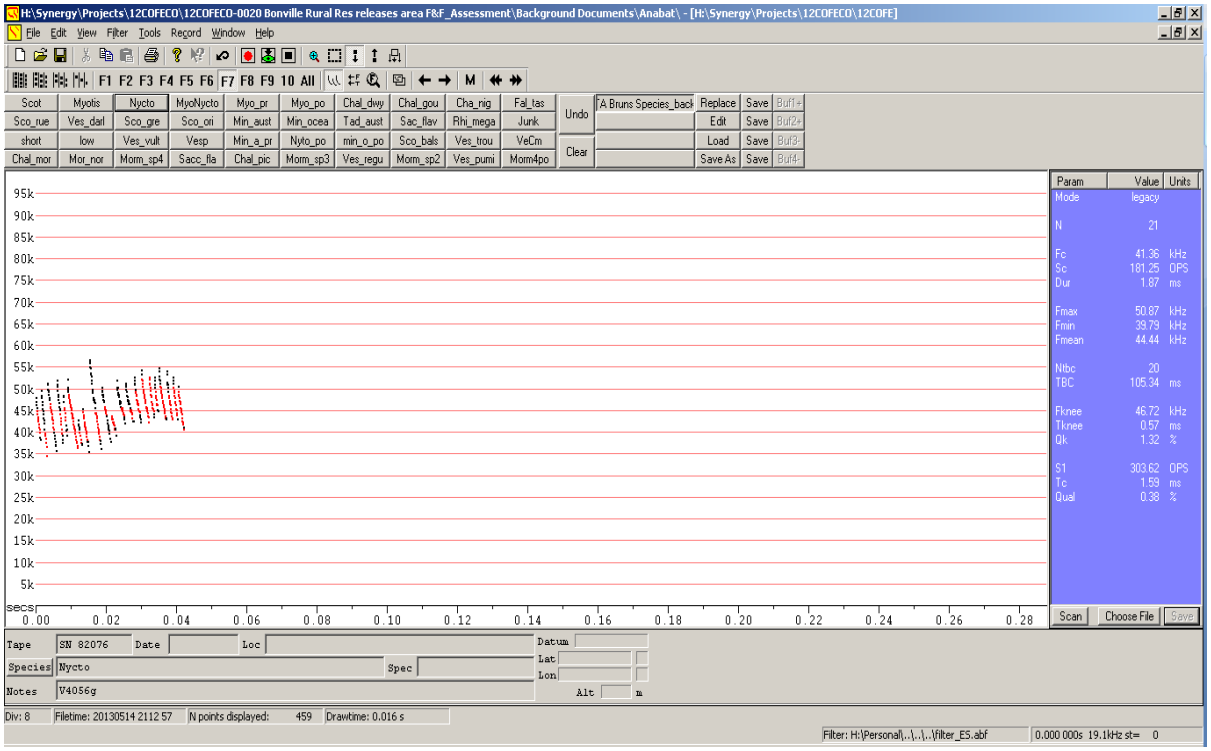

Figure 7: Call profile for *Nyctophilus sp.* recorded along Bonville Creek, Pine Creek Way Bridge at 21:12 on 14 May 2013.

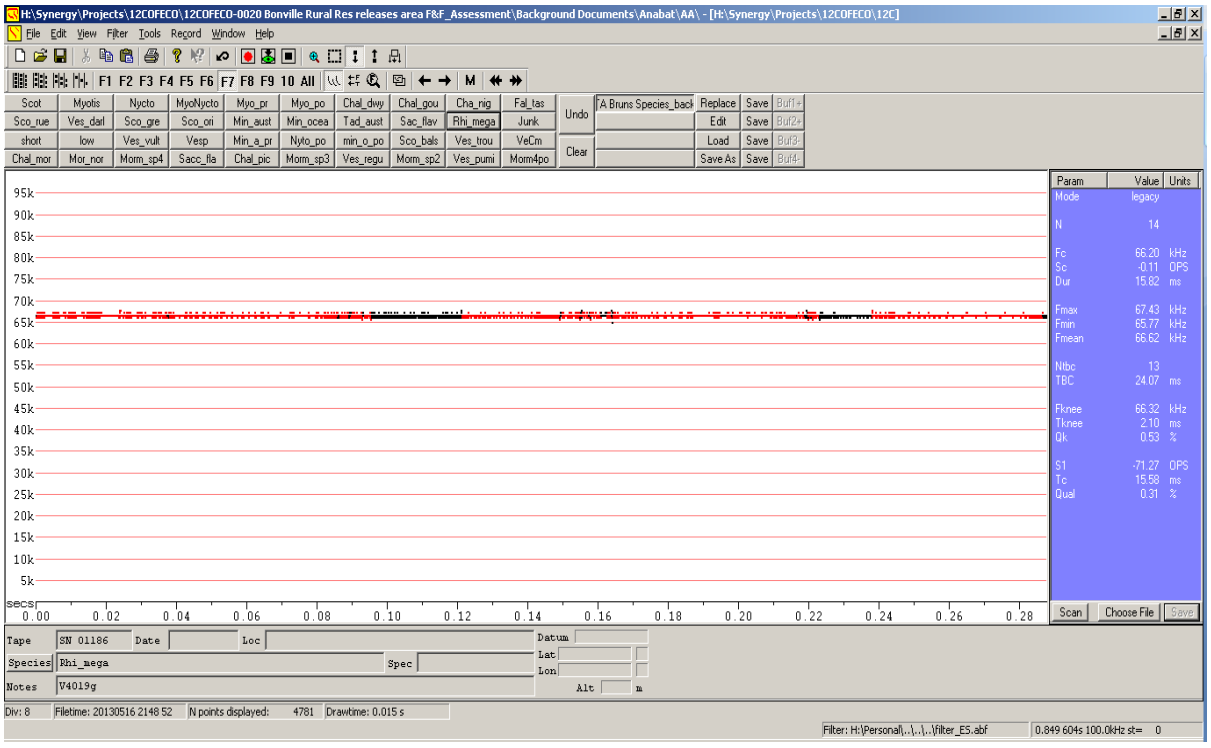

Figure 8: Call profile for *Rhinolophus megaphyllus* recorded at Crossmaglen at 21:48 on 16 May 2013.

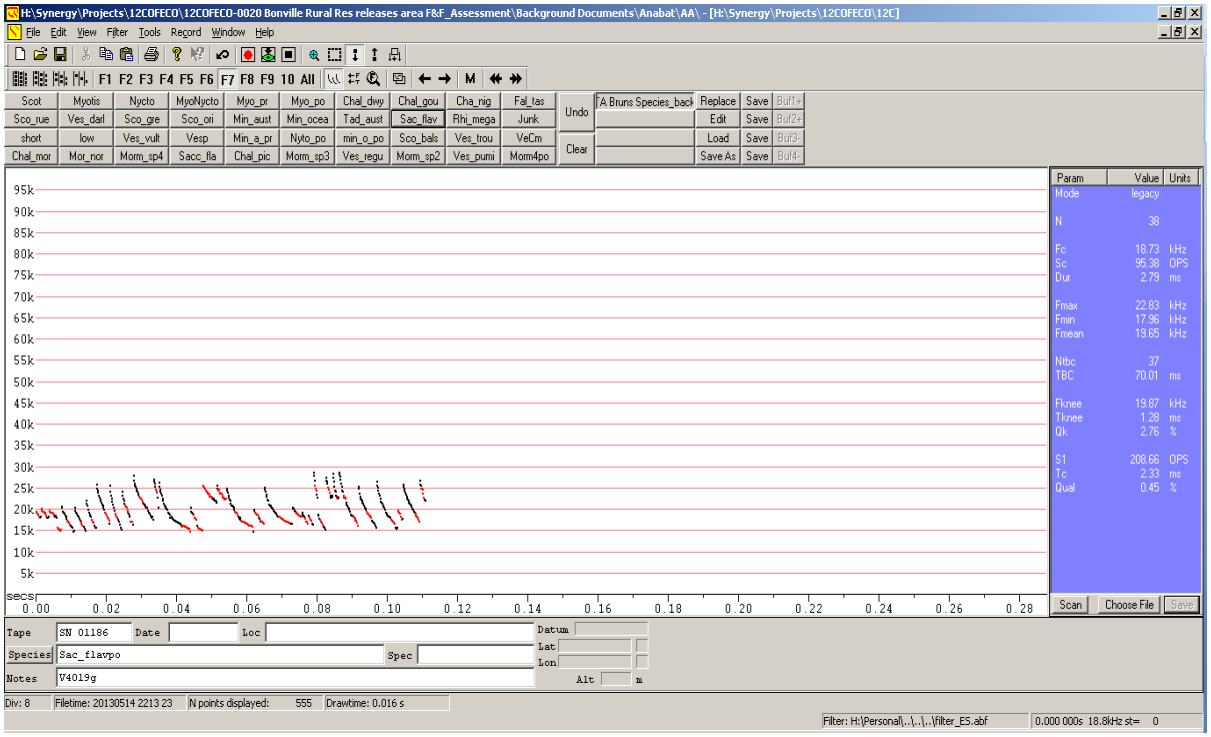

Figure 9: Call profile for *Saccolaimus flaviventris* recorded at Crossmaglen at 22:13 on 14 May 2013.

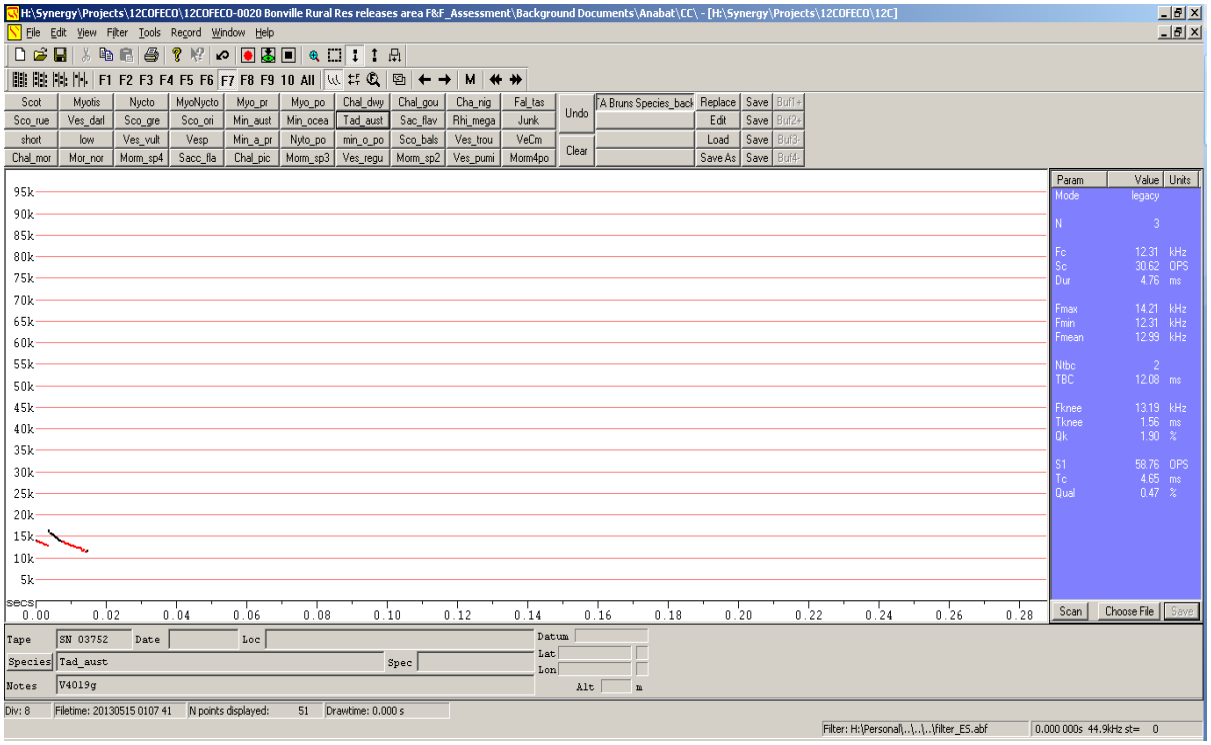

Figure 10: Call profile for *Tadarida australis* recorded at Pine Creek, Bonville at 01:07 on 15 May 2013.

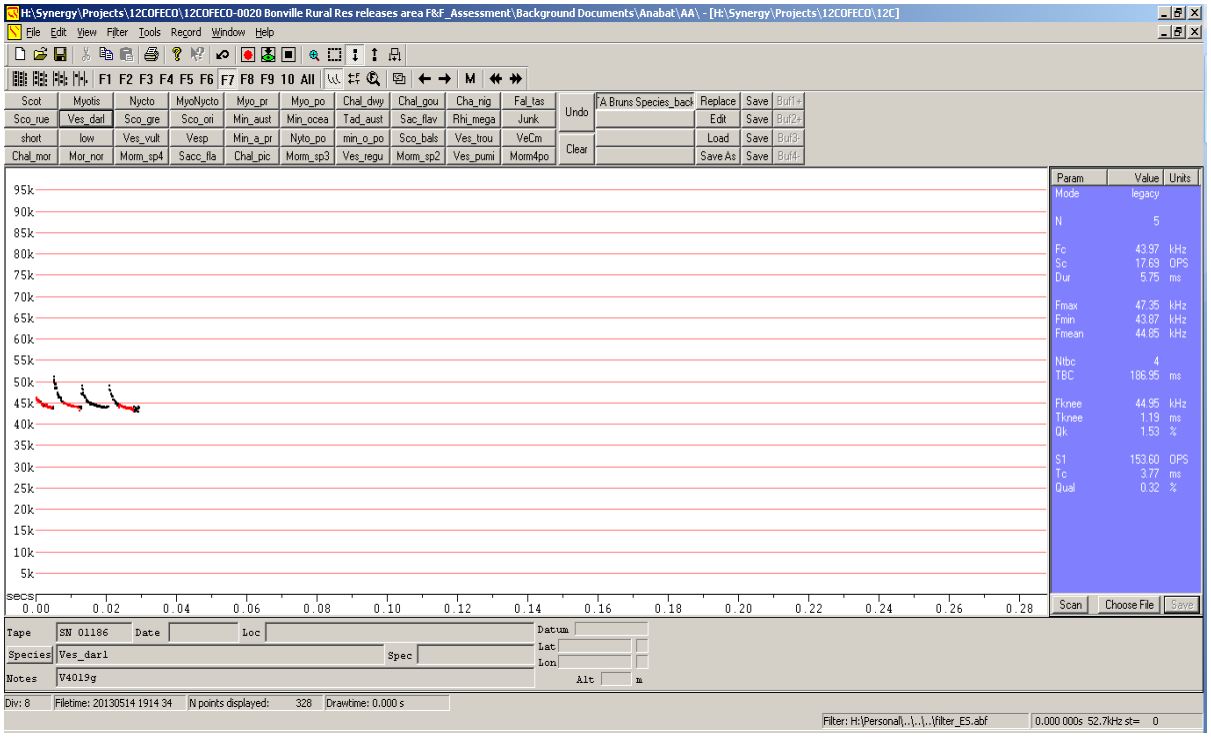

Figure 11: Call profile for *Vespadelus darlingtoni* recorded at Bonville Creek, Pine Creek Way Bridge at 19:14 on 14 May 2013.

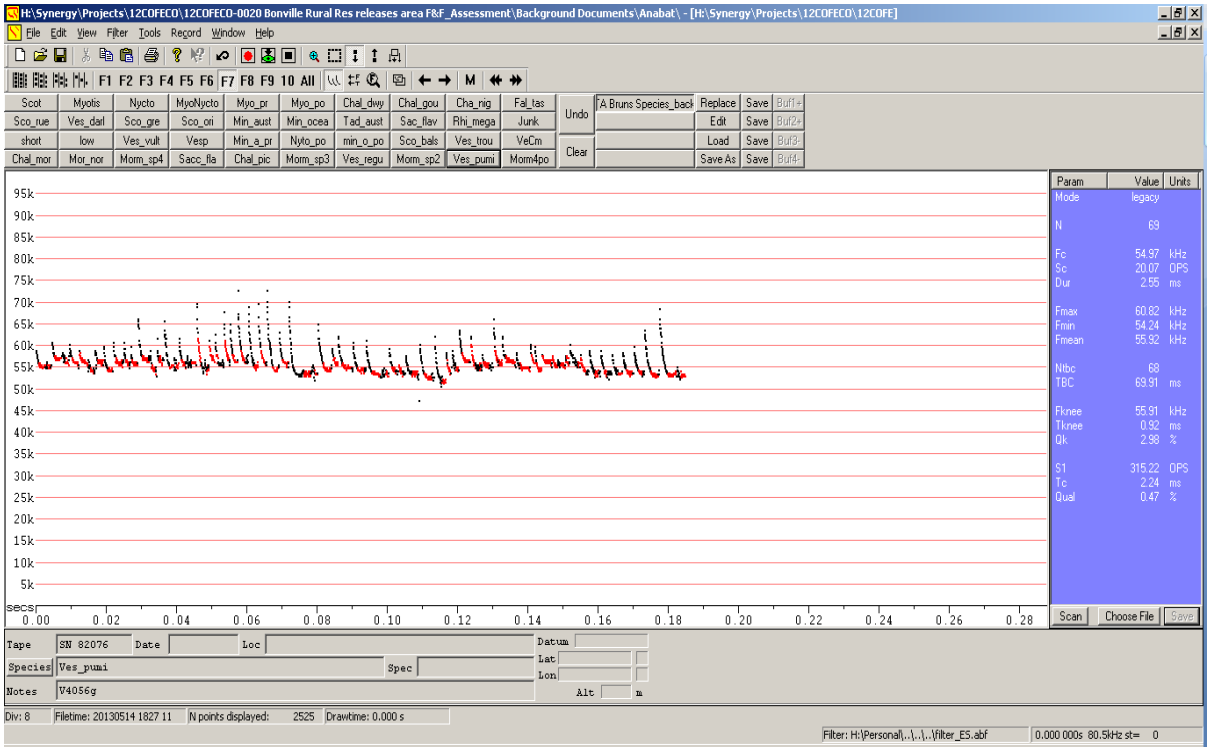

Figure 12: Call profile for *Vespadelus pumilus* recorded at Bonville Creek, Pine Creek Way Bridge at 18:27 on 14 May 2013.

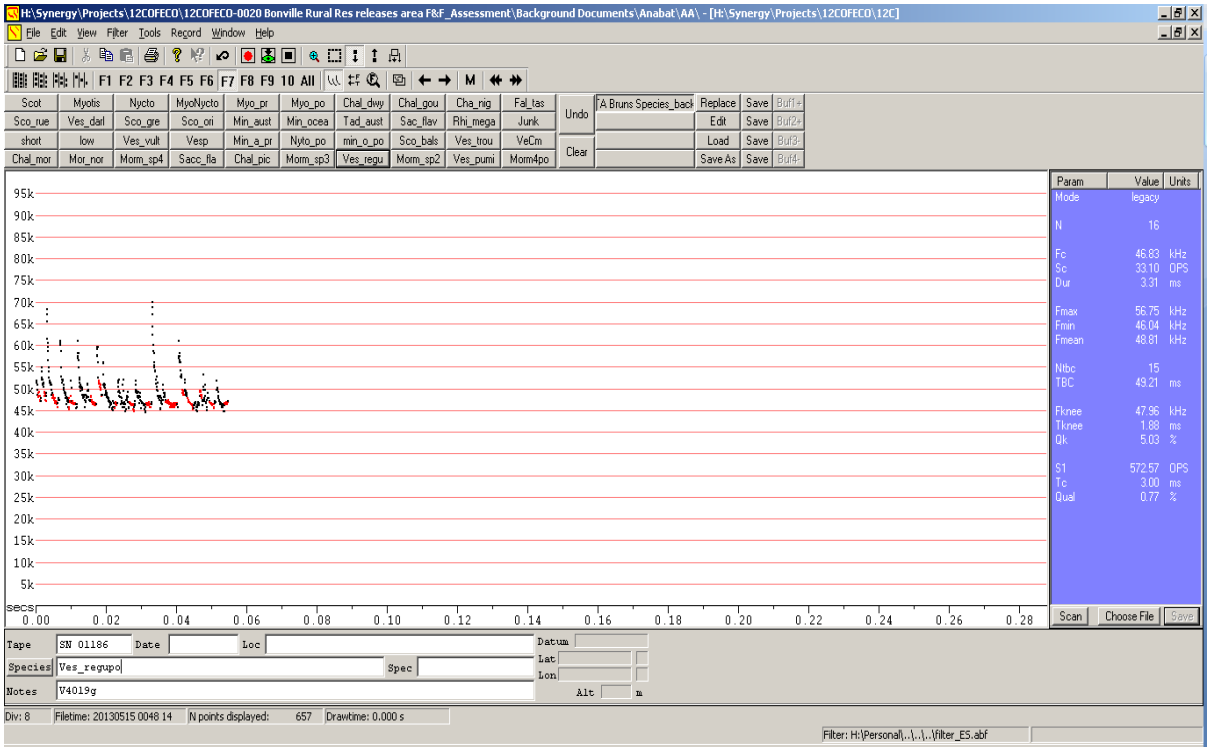

Figure 13: Possible call profile for *Vespadelus regulus* recorded at Crossmaglen at 00:48 on 15 May 2013.

Appendix D: Threatened fauna likelihood tables

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	NSW TSC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Amphibia					
Assa darlingtoni	Pouched Frog	—	V	Pouched Frog occurs mainly in the coolest, most moist sites within subtropical, warm temperate and cool temperate rainforests and wet sclerophyll forests (DECC 2009; Ehmann 1997). It favours the highlands and uplands of the eastern Great Dividing Range (300 to 1180 MASL) (Ehmann 1997).	Unlikely
Crinia tinnula	Wallum Froglet	—	V	The Wallum Frog is restricted to the Wallum swamps and associated low land meandering watercourses on coastal plains (Ehmann 1997). Occurs in elevations up to around 50m and is closely related to freshwater habitats in the coastal zone (DECC 2007). Found most commonly in wallum wetlands characterised by low nutrients, highly acidic, tannin-stained waters that are typically dominated by paperbarks and tea-trees. Also found in sedgeland and wet heathland (DECC 2007)	Potential

Litoria aurea	Green and Golden Bell Frog	V	E1	This species has been observed utilising a variety of natural and man-made waterbodies (Pyke & White 1996; Pyke and White 1996) such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands and billabongs, stormwater detention basins, farm dams, bunded areas, drains, ditches and any other structure capable of storing water (DECC 2009). Fast flowing streams are not utilised for breeding purposes by this species (Mahony 1999). Preferable habitat for this species includes attributes such as shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading (DEC 2005). Large permanent swamps and ponds exhibiting well-established fringing vegetation (especially bulrushes–*Typha* sp. and spikerushes–*Eleocharis* sp.) adjacent to open grassland areas for foraging are preferable (Ehmann 1997; Robinson 2004). Ponds that are typically inhabited tend to be free from predatory fish such as Mosquito Fish (*Gambusia holbrooki*) (DEC 2005; NPWS 2003). Formerly distributed from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extends into east Gippsland. Records from west to Bathurst, Tumut and the ACT region. Since 1990 there have been approximately 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range; however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands. Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.).	Potential
Litoria booroolongensis	Booroolong Frog	E1	E1	Typically inhabits rocky western-flowing creeks and their headwaters, although a small number of animals have also been recorded in eastern-flowing streams (NSW Scientific Committee 1998).	Unlikely

Litoria brevipalmata	Green Thighed Frog	—	V	Wet sclerophyll forest along the northern coast of NSW to Ourimbah (Anstis 2002). Also in a variety of habitats including dry to wet sclerophyll forest, rainforests and shrubland with a healthy understorey (DECC 2007). Breeding aggregations occur in still water habitats such as grassy temporary to semi-permanent ponds and flooded ditches in late spring and summer (Cogger 2000; Anstis 2002; DECC 2007).	Potential
Litoria olongburensis	Wallum Sedge Frog	V	V	Wallum, woodlands and sedgelands on coastal swamps dominated by *Melaleuca quinquenervia* with an understorey of the sedge Lepironia articulata are typical habitat (DECC 2007). Suitable wallum swamps are characterised by low nutrients, highly acidic, tannin-stained waters occurring on Pleistocene coastal sand deposits (DECC 2007).	Unlikely
Litoria subglandulosa	Glandular Frog	-	V	Predominately in the headwaters of coastal rivers in a narrow band along the eastern edge of the escarpment north from the Barrington Tops area to north of the Queensland border with occasional records just to the west of the Great Divide. Glandular Frogs may be found along streams in rainforest, moist and dry eucalypt forest or in subalpine swamps.	Unlikely
Mixophyes balbus	Stuttering Frog	V	E1	A variety of forest habitats from rainforest through wet and moist sclerophyll forest to riparian habitat in dry sclerophyll forest (DECC 2007) that are generally characterised by deep leaf litter or thick cover from understorey vegetation (Ehmann 1997). Breeding habitats are streams and occasionally springs. Not known from streams disturbed by humans (Ehmann 1997) or still water environments (NSW Scientific Committee 2002).	Unlikely
Mixophyes iteratus	Giant Barred Frog	E1	E1	Found on forested slopes of the escarpment and adjacent ranges in riparian vegetation, subtropical and dry rainforest, wet sclerophyll forests and swamp sclerophyll forest (DECC 2007; Ehmann 1997). This species is associated with flowing streams with high water quality, though habitats may contain weed species (Ehmann 1997). This species is not known from riparian vegetation disturbed by humans (NSW Scientific Committee 1999). During breeding eggs are kicked up onto an overhanging bank or the streams edge (DECC 2007).	Likely

Philoria sphagnicolus	Sphagnum Frog	—	V	Recorded between 640 to 1470 MASL in rainforest and wet sclerophyll forest with more than 1500mm annual rainfall (Ehmann 1997). Preferred habitat is sphagnum moss bogs in or adjacent to wet forest (DECC 2007). It occurs in the headwaters of small creeks and soaks associated with steep rocky cliffs or scree slopes (DECC 2007)	No
Reptilia					
Cacophis harriettae	White-crowned Snake	-	V	Typically found in coastal and near coastal areas (DECC 2007), usually in wet sclerophyll forests and rainforests (Swan 1999).	Potential
Hoplocephalus bitorquatus	Pale Headed Snake	—	V	Wide range of habitats from rain or wet sclerophyll forest to drier eucalypt forests (Cogger 1996).	Potential
Hoplocephalus stephensii	Stephen's Banded Snake	—	V	Found in a variety of habitats from rainforest through wet and moist sclerophyll forests to dry sclerophyll forests (DECC 2007). However it is most commonly found in wet to moist forests with rocky outcrops, cliffs or ridges and tends to favour ecotones between wet and dry forests (DECC 2007). It most frequently uses gaps in the peeling bark of large senescent or dead trees for daytime shelter (DECC 2007). However it can use hollow trunks, limbs, epiphytes, vine thickets, rock crevices or rock slabs (DECC 2007).	Potential
Aves (Diurnal Birds)					
Amaurornis moluccana	Pale-vented Bush-hen		V	Inhabits tall dense understorey or ground layer vegetation on the margins of freshwater streams and natural or artificial wetlands, usually within or bordering rainforest, rainforest remnants or forests. Also occurs in secondary forest growth, rank grass or reeds, thickets of weeds and pastures, crops or farmland where it borders forest, streams or wetlands. Requires dense undergrowth 2 to 4 m tall within 300m of water.	Potential

Anthochaera phrygia	Regent Honeyeater	E1, Mi	CE	Regent Honeyeaters mostly occur in dry box-ironbark eucalypt woodland and dry sclerophyll forest associations, wherein they prefer the most fertile sites available, e.g. along creek flats, or in broad river valleys and foothills. In NSW, riparian forests containing *Casuarina cunninghamiana* (River Oak), and with *Amyema cambagei* (Needle-leaf Mistletoe), are also important for feeding and breeding. At times of food shortage (e.g. when flowering fails in preferred habitats); Honeyeaters also use other woodland types and wet lowland coastal forest dominated by *Eucalyptus robusta* (Swamp Mahogany) or *E. maculata* (Spotted Gum) (Franklin et al. 1989; Geering & French 1998; Ley & Williams 1992; Oliver et al. 1999; Webster & Menkhorst 1992). Regent Honeyeaters sometimes occur in coastal forest, especially in stands dominated by Swamp Mahogany and Spotted Gum, but also in those with Southern Mahogany *E. botryoides*, and in those on sandstone ranges with banksias Banksia in the understorey (Franklin et al. 1989; Higgins et al. 2001; Menkhorst 1997c). They have been recorded in open forest including forest edges, wooded farmland and urban areas with mature eucalypts (Garnett 1993). The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar (Environment Australia 2000).	Potential
Atrichornis rufescens	Rufous Scrub-bird		V	Rainforest and adjacent eucalypt forest where undergrowth is particularly thick (Blakers et al. 1984).	No
Botaurus poiciloptilus	Australasian Bittern	E1	E1	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats (Marchant & Higgins 1990). Found along the east coast and in the Murray-Darling Basin, notably in floodplain wetlands of the Murrumbidgee, Lachlan, Macquarie and Gwydir Rivers (Marchant & Higgins 1990; NPWS 1990). Reedbeds, swamps, streams, estuaries (Simpson & Day 1999). Favours permanent shallow waters, edges of pools and waterways, with tall, dense vegetation such as sedges, rushes and reeds on muddy or peaty substrate. Also occurs in Lignum *Muehlenbeckia florulenta* and Canegrass *Eragrostis australasica* on inland wetlands (NSW Scientific Committee, 2010).	Potential

Burhinus grallarius	Bush Stone-curlew	—	E1	Associated with dry open woodland with grassy areas, dune scrubs, in savannah areas, the fringes of mangroves, golf courses and open forest / farmland (Pittwater Council 2000; Marchant & Higgins 1993). Forages in areas with fallen timber, leaf litter, little undergrowth and where the grass is short and patchy (Environment Australia 2000; Marchant & Higgins 1993). Is thought to require large tracts of habitat to support breeding, in which there is a preference for relatively undisturbed in lightly disturbed.	Unlikely
Calidris alba	Sanderling	—	V	Occur in coastal areas on low beaches, near reefs and inlets along tidal mudflats and bare open coastal lagoons (DECC 2007). Rarely seen in near-coastal wetlands such as lagoons, hypersaline lakes, saltponds and samphire flats (DECC 2007)	No
Calidris ferruginea	Curlew Sandpiper	Mi	E1	Intertidal mudflats of estuaries, lagoons, mangrove channels; around lakes, dams, floodwaters, flooded saltbush surrounds of inland lakes (Morcombe, 2004).	No
Calidris tenuirostris	Great Knot	—	V	Sheltered coastal habitats containing large intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons (DECC 2007). Often recorded on sandy beaches with mudflats nearby, sandy spits and inlets, or exposed reefs or rock platforms (Morris 1989; Higgins & Davies 1996).	No
Calyptorhynchus lathami	**Glossy Black-Cockatoo**	**—**	**V**	**Associated with a variety of forest types containing Allocasuarina species, usually reflecting the poor nutrient status of underlying soils (Environment Australia 2000; NPWS 1997; DECC 2007). Intact drier forest types with less rugged landscapes are preferred (DECC 2007). Nests in large trees with large hollows (Environment Australia 2000).**	**Yes**
Charadrius leschenaultii	Greater Sand Plover	—	V	Entirely coastal in NSW, foraging on intertidal sand and mudflats in estuaries, roosting during high tide on sandy beaches or rocky shores (DECC 2007)	No
Charadrius mongolus	Lesser Sand Plover	Ma	V	Favours coastal areas including beaches, mudflats and mangroves where they forage (DECC 2007). They may be seen roosting during high tide on sandy beaches or rocky shores (DECC 2007).	No

Circus assimilis	Spotted Harrier	—	V	The Spotted Harrier is found in mainland Australia and Indonesia. It is widespread but sparsely distributed. The Spotted Harrier is found in open wooded country in tropical and temperate Australia, particularly in arid and semi-arid areas (BIB, 2006).	Likely
Climacteris picumnus Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	—	V	Distributed through central NSW on the western side of the Great Dividing Range and sparsely scattered to the east of the Divide in drier areas such as the Cumberland Plain of Western Sydney, and in parts of the Hunter, Clarence, Richmond and Snowy River valleys. The Brown Treecreeper occupies eucalypt woodlands, particularly open woodland lacking a dense understorey. It is sedentary and nests in tree hollows within permanent territories. (NSW Scientific Committee 2001).	No
Coracina lineata	Barred Cuckoo-shrike	—	V	It is associated with subtropical, dry and littoral rainforests and is restricted to below 500m elevation (DECC 2007).	Potential
Daphoenositta chrysoptera	Varied Sittella	—	V	Varied Sittellas are endemic and widespread in mainland Australia. Varied Sittellas are found in eucalypt woodlands and forests throughout their range. They prefer rough-barked trees like stringybarks and ironbark's or mature trees with hollows or dead branches (BIB, 2006)	Potential
Dromaius novaehollandiae	Emu population of the NSW North Coast Bioregion and Port Stephens LGA	—	E2	Occupies a range of mainly open habitats including plains, grasslands, woodlands, shrubs and occasionally forest (NSW Scientific Committee 2002). Not found in rainforest (Simpson & Day 1999).	No
Ephippiorhynchus asiaticus	**Black-necked Stork**	**—**	**E1**	**Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains (Marchant & Higgins 1993). Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant & Higgins 1993; DECC 2007).**	**Yes**

Esacus neglectus	Beach Stone-curlew	-	CE	Beaches, mudflats, reefs and especially islands (Blakers et al. 1984). Open undisturbed beaches, islands, reefs, intertidal sand and mudflats, preferably with estuaries or mangroves nearby (DECC 2007).	No
Glossopsitta pusilla	**Little Lorikeet**	**—**	**V**	**In New South Wales Little Lorikeets are distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Little Lorikeets mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes.**	**Yes**
Grus rubicundus	Brolga	—	V	During breeding season mostly near shallow freshwater marshes or freshwater meadows (Marchant and Higgins 1993). During non-breeding seasons congregates near deep, permanent freshwater marshes, mostly foraging in nearby field, pastures and fallow fields and occasionally foraging in littoral zones of marshes (Marchant and Higgins 1993).	Potential
Haematopus fuliginosus	Sooty Oystercatcher	—	V	A coastal species that inhabits rock coastlines, coral cays, reefs and occasionally sandy beaches and Marchant & Higgins 1993; Simpson & Day 1999).	No
Haematopus longirostris	Pied Oystercatcher	—	E1	Roosts and forages on sandy beaches, sand banks, mudflats and estuaries (Marchant & Higgins 1993, Simpson & Day 1999).	No
Hieraaetus morphnoides	Little Eagle	—	V	The Little Eagle is widespread in mainland Australia, central and eastern New Guinea. The Little Eagle is seen over woodland, forested lands and open country, extending into the arid zone. It tends to avoid rainforest and heavy forest (BIB, 2006).The population of Little Eagle in NSW is considered to be a single population (DECCW 2010). This species was recently listed as vulnerable due to a moderate reduction in population size based on geographic distribution and habitat quality (NSWSC 2010).	Potential

Irediparra gallinacea	Comb-crested Jacana	—	V	Freshwater wetlands, such as lagoons, billabongs, swamps, lakes and reservoirs, generally with abundant floating aquatic vegetation (Marchant and Higgins 1999).	Potential
Ixobrychus flavicollis	**Black Bittern**	**—**	**V**	**Occurs in both terrestrial and estuarine wetlands generally in areas of permanent water and dense vegetation (DECC 2007). In areas with permanent water it may occur in flooded grassland, forest, woodland, rainforest and mangroves (DECC 2007)**	**Yes**
Lathamus discolor	Swift Parrot	E1, Ma	E	Breeds in Tasmania between September and January. Feeds mostly on nectar, mainly from eucalypts, but also eats psyllid insects and lerps, seeds and fruit. Migrates to mainland in autumn, where it forages on profuse flowering Eucalypts. Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*C. gummifera*), Mugga Ironbark (*E. sideroxylon*), White Box (*E. albens*) and Forest Red Gum (*E. tereticornis*) (DECC 2007). Box-ironbark habitat in drainage lines and coastal forest in NSW is thought to provide critical food resources during periods of drought or low food abundance elsewhere (MacNally et al. 2000).	Potential
Lichenostomus fasciogularis	Mangrove Honeyeater	—	V	Lives in mangroves, frequently visiting flowering shrubs in towns adjacent to mangroves. Spends some of its' time feeding close to the mud in mangroves (Blakers et al. 1984; DECC 2007).	No

Limicola falcinellus	Broad-billed Sandpiper	Mi	V	The eastern form of the Broad-billed Sandpiper breeds in northern Siberia before migrating southwards in winter to Australia (DECC 2007). In Australia, Broad-billed Sandpipers over-winter on the northern coast, particularly in the north-west, with birds located occasionally on the southern coast (DECC 2007). In NSW, the main site for the species is the Hunter River estuary, with birds occasionally reaching the Shoalhaven estuary (DECC 2007). There are few records for inland NSW (DECC 2007). Broad-billed Sandpipers favour sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayment's, lagoons, saltmarshes and reefs as feeding and roosting habitat (DECC 2007). Occasionally, individuals may be recorded in sewage farms or within shallow freshwater lagoons (DECC 2007). Broad-billed Sandpipers roost on banks on sheltered sand, shell or shingle beaches.	No
Limosa limosa	Black-tailed Godwit	—	V	Primarily found along the coast on sandspits, lagoons and mudflats (DECC 2007). The species has also been found to occur inland on mudflats or shallow receding waters of portions of large muddy swamps or lakes (Pizzey and Knight 1997; Higgins & Davies 1996).	No
Lophoictinia isura	**Square-tailed Kite**	**—**	**V**	**In coastal areas associated tropical and temperate forests and woodlands on fertile soils with an abundance of passerine birds (Marchant & Higgins 1993, DECC 2007). May be recorded inland along timbered watercourses (DECC 2007). In NSW it is commonly associated with ridge or gully forests dominated by Woollybutt (*Eucalyptus longiflora*), Spotted Gum (*E. maculata*), or Peppermint Gum (*E. elata, E. smithii*) (DECC 2007).**	**Yes**

Oxyura australis	Blue-billed Duck	—	V	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation (DECC 2007). The species is completely aquatic, swimming low in the water along the edge of dense cover (DECC 2007). It will fly if disturbed, but prefers to dive if approached (DECC 2007). Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and over-wintering lakes with some long-distance dispersal to breed during spring and early summer (DECC 2007). Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes (DECC 2007).	Potential
Pachycephala olivacea	Olive Whistler		V	Elevated (>500 MASL), cool temperate rainforest and moist eucalypt forest in the northern part of their range. This species appears to favour large tracts of undisturbed and densely vegetated forest (SFNSW 1995).	No
Pandion haliaetus	**Eastern Osprey**	**—**	**V**	**Associated with waterbodies including coastal waters, inlets, lakes, estuaries, beaches, offshore islands and sometimes along inland rivers (Schodde and Tidemann 1986; Clancy 1991; Olsen 1995). Osprey may nest on the ground, on sea cliffs or in trees (Olsen 1995). Osprey generally prefers emergent trees, often dead or partly dead with a broken off crown (Olsen 1995).**	**Yes**
Petroica boodang	Scarlet Robin	—	V	The Scarlet Robin is found in south-eastern and south-western Australia, as well as on Norfolk Island. In Australia, it is found south of latitude 25°S, from south-eastern Queensland along the coast of New South Wales (and inland to western slopes of Great Dividing Range) to Victoria and Tasmania, and west to Eyre Peninsula, South Australia; it is also found in south-west Western Australia. The Scarlet Robin lives in open forests and woodlands in Australia, while it prefers rainforest habitats on Norfolk Island. During winter, it will visit more open habitats such as grasslands and will be seen in farmland and urban parks and gardens at this time (BIB, 2006).	Potential

Petroica phoenicea	Flame Robin	—	V	Flame Robins are found in a broad coastal band around the south-east corner of the Australian mainland, from southern Queensland to just west of the South Australian border. The species is also found in Tasmania. Flame Robins prefer forests and woodlands up to about 1800 m above sea level.	Potential
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	—	V	Open woodlands dominated by mature eucalypts with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs (NSW Scientific Committee 2001). This species avoids very wet areas (Blakers et al. 1984).	Unlikely
Ptilinopus magnificus	Wompoo Fruit-Dove	—	V	Associated with large, undisturbed patches of tall tropical or subtropical rainforest, at all altitudes, preferably with a diversity of fruit (Marchant and Higgins 1999; DECC 2007). Occasionally located in patches of monsoon rainforest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest (Marchant and Higgins 1999; DECC 2007).	Potential
Ptilinopus regina	Rose-crowned Fruit-Dove	—	V	Tall tropical and subtropical, evergreen or semi-deciduous rainforests, especially with a dense growth of vines trees (Marchant and Higgins 1999). Also located in closed wet sclerophyll forest, gallery forests or sclerophyll woodlands with abundant fruiting trees, near or next to rainforest (DECC 2007). Is thought to prefer large areas of vegetation, but has been located in patches and occasionally in parks and gardens with fruiting trees (Marchant and Higgins 1999).	Potential
Ptilinopus superbus	Superb Fruit-Dove	—	V	Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms (DECC 2007). It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees (*ibid.*). Part of the population is migratory or nomadic (*ibid.*). At least some of the population, particularly young birds, moves south through Sydney, especially in autumn (*ibid.*). Breeding takes place from September to January (*ibid.*). Will feed in adjacent mangroves or eucalypt forests (Blakers et al. 1984).	Likely

Rostratula benghalensis australis	Painted Snipe (Australian subspecies)	E1	E1	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber (DECC 2007). Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds (*ibid.*). Breeding is often in response to local conditions; generally occurs from September to December (DECC 2007). Roosts during the day in dense vegetation (NSW Scientific Committee 2004). Forages nocturnally on mud-flats and in shallow water (DECC 2007). Feeds on worms, molluscs, insects and some plant-matter (*ibid.*).	Potential
Stagonopleura guttata	Diamond Firetail	—	V	Typically found in grassy eucalypt woodlands, but also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities (DECC 2007). It is often found in riparian areas and sometimes in lightly wooded farmland (DECC 2007). Appears to be sedentary, though some populations move locally, especially those in the south (DECC 2007).	Unlikely
Sterna albifrons	Little Tern	—	E	Almost exclusively coastal, preferring sheltered areas (DECC 2007), however may occur several kilometres inland in harbours, inlets and rivers (Smith 1990). Australian birds breed on sandy beaches and sand spits (Simpson & Day 1999).	No
Stictonetta naevosa	Freckled Duck	—	V	Associated with a variety of plankton-rich wetlands, such as heavily vegetated, large open lakes and their shores, creeks, farm dams, sewerage ponds and floodwaters (DECC 2007).	Potential
Xenus cinereus	Terek Sandpiper	Mi	V	A rare migrant to the eastern and southern Australian coasts, being most common in northern Australia, and extending its distribution south to the NSW coast in the east (DECC 2007). The two main sites for the species in NSW are the Richmond River estuary and the Hunter River estuary (DECC 2007). In Australia, has been recorded on coastal mudflats, lagoons, creeks and estuaries (DECC 2007). Favours mudbanks and sandbanks located near mangroves, but may also be observed on rocky pools and reefs, and occasionally up to 10 km inland around brackish pools (DECC 2007). Generally roosts communally amongst mangroves on dead trees, often with related wader species (DECC 2007).	No

Aves (Nocturnal birds)					
Ninox connivens	Barking Owl	—	V	Associated with a variety of habitats such as savannah woodland, open eucalypt forests, wetland and riverine forest. The habitat is typically dominated by Eucalypts (often Redgum species), however often dominated by Melaleuca species in the tropics (DECC 2007). It usually roosts in dense foliage in large trees such as River She-oak (*Allocasuarina cunninghamiana*), other Casuarina and Allocasuarina, eucalypts, Angophora, Acacia and rainforest species from streamside gallery forests (NPWS 2003). It usually nests near watercourses or wetlands (NPWS 2003) in large tree hollows with entrances averaging 2-29 metres above ground, depending on the forest or woodland structure and the canopy height (Debus 1997).	Potential
Ninox strenua	Powerful Owl		V	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes (Environment Australia 2000, Debus & Chafer 1994). Large trees with hollows at least 0.5m deep are required for shelter and breeding (Environment Australia 2000).	Potential
Tyto capensis	Grass Owl	—	V	Reported habitats include tall grass, swampy, sometimes tidal areas, mangrove fringes, grassy plains, coastal heaths, grassy woodland, cane grass, lignum, sedges, cumbungi, cane fields and grain stubble (Pizzey and Knight, 1997). The Grass Owl nests on the ground within dense tall grass, sedges, reeds and even sugarcane plantations (Pizzey and Knight, 1997). The Grass Owl primarily feeds on rodents, hunting on the wing over heathland, grassland and sedgeland, as well as along the edge of sugar cane, crops and pastureland (Pizzey and Knight, 1997).	Potential
Tyto novaehollandiae	**Masked Owl**	**—**	**V**	**Associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland (DECC 2007) and especially the ecotone between wet and dry forest, and non-forest habitat (Environment Australia 2000). Known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh & Peake 1993).**	**Yes**

Tyto tenebricosa	**Sooty Owl**	**—**	**V**	**Sooty Owls are associated with tall wet old growth forest on fertile soil with a dense understorey and emergent tall Eucalyptus species (Environment Australia 2000, Debus 1994). Pairs roost in the daytime amongst dense vegetation, in tree hollows and sometimes in caves. The Sooty Owl is typically associated with an abundant and diverse supply of prey items and a selection of large tree hollows (Debus 1994, Garnett 1993, Hyem 1979).**	**Yes**
Mammalia - terrestrial (excluding bats)					
Aepyprymnus rufescens	Rufous Bettong	—	V	The Rufous Bettong prefer forests with a grassy to sparse understorey including coastal forest, tall wet sclerophyll forest and dry forests west of GDR (DECC 2007). It is most commonly found on sites derived from sedimentary rock and in north eastern NSW in forests characterised by Spotted Gum (*Corymbia maculata and C. henryi)* (DECC 2007). It has been known to feed on introduced pasture species (DECC 2007).	No
Cercartetus nanus	Eastern Pygmy-possum	—	V	The Eastern Pygmy Possum occurs in wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath (Menkhorst & Knight 2004). Pygmy-Possums feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit (Turner & Ward 1995). The presence of *Banksia* sp. and *Leptospermum* sp. are an important habitat feature (DECC 2007). Small tree hollows are favoured as day nesting sites, but nests have also been found under bark, in old birds' nests and in the branch forks of tea-trees (Turner & Ward 1995).	Unlikely

***Dasyurus maculatus Dasyurus maculatus maculatus* (SE Mainland population)**	**Spotted-tailed Quoll**	**E1**	**V**	**The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests (Mansergh 1984; DECC 2007j), more frequently recorded near the ecotones of closed and open forest and in NSW within 200km of the coast. Preferred habitat is mature wet forest (Belcher 2000b; Green & Scarborough 1990; Watt 1993), especially in areas with rainfall 600 mm/year (Edgar & Belcher 2008; Mansergh 1984). Unlogged forest or forest that has been less disturbed by timber harvesting is also preferable (Catling et al. 1998, 2000). This species requires habitat features such as maternal den sites, an abundance of food (birds and small mammals) and large areas of relatively intact vegetation to forage in (DECC 2007). Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000).**	**Yes**
Macropus parma	Parma Wallaby	—	V	Preferred habitat is moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas, rainforest margins and occasionally drier eucalypt forest (DECC 2007).	Potential
Petaurus australis	Yellow-bellied Glider	—	V	This species is restricted to tall mature forests, preferring productive tall open sclerophyll forests with a mosaic of tree species including some that flower in winter (Environment Australia 2000, Braithwaite 1984, Davey 1984, Kavanagh 1984; DECC 2007). Large hollows within mature trees are required for shelter, nesting and breeding (Henry and Craig 1984; DECC 2007).	Potential
Petaurus norfolcensis	Squirrel Glider	—	V	Associated with dry hardwood forest and woodlands (Menkhorst et al. 1988; Quin 1995). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al. 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quin 1995).	Potential
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (Strahan 1995).	No
Phascogale tapoatafa	Brush-tailed Phascogale	—	V	The Brush-tailed Phascogale preferred habitat is Dry Open forest with a sparse open understorey, however, has been located in heath, swamps and rainforest and wet sclerophyll forest (DECC 2007).	Potential

Phascolarctos cinereus Phascolarctos cinereus **(combined populations of Qld, NSW and ACT)**	**Koala**	**V**	**V**	**Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70% (Reed et al. 1990), with acceptable Eucalypt food trees. Some preferred Eucalyptus species are: *Eucalyptus tereticornis, E. punctata, E. cypellocarpa, E. viminalis***	**Yes**
Planigale maculata	Common Planigale	—	V	Subtropical to dry rainforest, dry sclerophyll forest, heathland and grassland up to 400m elevation (DECC 2007; Strahan 1998). Habitat selection is dependent on surface cover (DECC 2007).	Potential
Potorous tridactylus Potorous tridactylus tridactylus (SE Mainland)	Long-nosed Potoroo	V	V	Associated with dry coastal heath and dry and wet sclerophyll forests (Strahan 1998) with dense cover for shelter and adjacent more open areas for foraging (Menkhorst & Knight 2004).	Unlikely
Pseudomys gracilicaudatus	Eastern Chestnut Mouse		V	In NSW the Eastern Chestnut Mouse is mostly found, in low numbers, in heathland and is most common in dense, wet heath and swamps (DECC 2007). Optimal habitat appears to be in vigorously regenerating heathland burnt from 18 months to four years previously (DECC 2007). By the time the heath is mature, the larger Swamp Rat becomes dominant, and Eastern Chestnut Mouse numbers drop again (DECC 2007).	Unlikely
Pseudomys novaehollandiae	New Holland Mouse	V		This species has been recorded from Queensland to Tasmania, though with a sporadic and patchy distribution. Most records are coastal. However, populations have been recently recorded up to 400km inland. The species includes heathlands, woodands, open forest and paperbark swamps and on sandy, loamy or rocky soils (Kemper and Wilson 2008). In coastal populations the species seems to have a preference for sandy substrates, a heathy understorey of legumes less than one metre high and sparse ground litter. This species is generally recorded in regenerating burnt areas occurs that are one or two years post fire and rehabilitated sand-mined areas that are four to five years post-mining (Kemper and Wilson 2008).	Unlikely

Pseudomys oralis	Hastings River Mouse	E1	E1	The Hasting River Mouse prefers areas with an open canopy and shrub layer appear to be the major predictive habitat features of this species (Read & Tweedie 1996). Open forest or woodland with a grassy sedge rush or heath understorey that is about 10-75cm above the ground (DECC 2007). Ground cover may vary from almost no cover to a dense, rank cover of grasses, herbs and sedges (DECC 2007). Sedges, particularly *Carex, Juncus* and *Cyperus* spp. are common to most sites (DEH 2006a). This habitat occurs beside creeks (permanent and ephemeral) and soakages, but is also found on ridges and grassy Plains (DEH 2006a). Shelter areas such as rock piles, hollow logs, yabby burrows or cavities in the butts of large old trees are also required to be present (DECC 2007).	Potential
Thylogale stigmatica	Red-legged Pademelon		V	Predominantly a rainforest species, also in wet sclerophyll forest and deciduous vine thickets. Requires a dense understorey for cover (SFNSW 1995).	Unlikely
Mammalia - terrestrial (Bats)					
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 1998; DECC 2007). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill 1998; DECC 2007).	Potential
Chalinolobus nigrogriseus	Hoary Wattled Bat	—	V	The preferred habitat of this species appears to be variable, with dry open forest, woodland, vine thickets, coastal scrub, sand dunes, grasslands and floodplains recorded (Churchill 1998). This species often forages along watercourses, swampy areas and over farm dams. In NSW, this species has been recorded in Spotted Gum (*Corymbia maculata*), Grey Box (*Eucalyptus moluccana*) and Northern Ironbark (*E. siderophloia*) and woodland characterised by Scribbly Gums (*E. signata*) and Pink Bloodwood (*C. intermedia*) and sites dominated by the Blackbutt (*E. pilularis*) (Churchill 1998). Roost sites have been identified as tree hollows, rock crevices and the roofs of buildings (Churchill 1998).	Potential

Falsistrellus tasmaniensis	Eastern False Pipistrelle	—	V	Prefers moist habitats with trees taller than 20m (DECC 2007). Roosts in tree hollows but has also been found roosting in buildings or under loose bark (DECC 2007).	Likely
Kerivoula papuensis	Golden-tipped Bat	—	V	The most favoured habitat for this species is moist closed forests often with a rainforest influence; however, some captures have been made in dry forests some distance from any rainforest (Lunney et. al. 1986; Parnaby and Mills, 1994). It has been suggested that the amount of vines and complex tree layers allows for increased numbers of spiders and webs and such areas are sought by the Golden-tipped Bat (Schulz & Eyre 2000). Often caught over streams within rainforest. Known to frequently roost within the pendulous nests of Yellow-throated and Large-billed Scrub Wrens and Brown Gerygone in rainforest areas (Schulz & Eyre 2000).	Potential
Miniopterus australis	**Little Bent-wing Bat**	**—**	**V**	**Prefers well-timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests (Churchill 1998). This species shelter in a range of structures including culverts, drains, mines and caves (Environment Australia 2000). Relatively large areas of dense vegetation of wet sclerophyll forest, rainforest or dense coastal Banksia scrub are usually found adjacent to caves in which this species is found (DECC 2007). Breeding occurs in caves, usually in association with M. schreibersii (Environment Australia 2000, DECC 2007).**	**Yes**
Miniopterus schreibersii oceanensis	**Eastern Bent-wing Bat**	**—**	**V**	**Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). It forages above and below the tree canopy on small insects (AMBS 1995, Dwyer 1995, Dwyer 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1995).**	**Yes**

Mormopterus norfolkensis	**Eastern Freetail-bat**	**—**	**V**	**Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Environment Australia 2000; Allison & Hoye 1998). Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (Environment Australia 2000; Allison & Hoye 1998).**	**Yes**
Myotis adversus	**Southern Myotis, Large-footed Myotis**	**—**	**V**	**Will occupy most habitat types such as mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland, and as long as they are close to water (Churchill 1998). While roosting is most commonly associated with caves, this species has been observed to roost in tree hollows, amongst vegetation, in clumps of Pandanus, under bridges, in mines, tunnels and stormwater drains (Churchill 1998). However the species apparently has specific roost requirements, and only a small percentage of available caves, mines, tunnels and culverts are used (Richards 1998).**	**Yes**
Nyctophilus bifax	Eastern Long-eared Bat	—	V	This species prefers wetter habitats, ranging from rainforest and monsoon forest to riverine forests of paperbark, but may be found in open woodland, tall open forest and dry sclerophyll woodland (Churchill 1998).These forest bats have been recorded roosting under peeling bark, among epiphytes, in tree hollows and in foliage (Churchill 1998). Individuals are likely to change roost sites nightly (DECC 2007).	Potential
Pteropus poliocephalus	**Grey-headed Flying-Fox**	**V**	**V**	**Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998, Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998).**	**Yes**

Saccolaimus flaviventris	**Yellow-bellied Sheathtail-bat**	**—**	**V**	**Found in almost all habitats, from wet and dry sclerophyll forest, open woodland (Churchill 1998), open country, mallee, rainforests, heathland and waterbodies (SFNSW 1995). Roosts in tree hollows; may also use caves; has also been recorded in a tree hollow in a paddock (Environment Australia 2000) and in abandoned sugar glider nests (Churchill 1998). The Yellow-bellied Sheathtail-bat is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats (Environment Australia 2000).**	**Yes**
Scoteanax rueppellii	Greater Broad-nosed Bat	—	V	Associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill, 1998), tending to be more frequently located in more productive forests (Hoye & Richards 1998). Within denser vegetation type's use is made of natural and manmade openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 1998).	Potential
Syconycteris australis	Common Blossom-bat	—	V	The combination of heathland and coastal rainforest is essential for this species (Churchill 1998). Breeding and sheltering habitats are in subtropical and littoral rainforests and a diverse range of nectar producing plant communities are required year round; it will occasionally eat some rainforest fruits (Churchill 1998; Environment Australia 2000).	Unlikely
Vespadelus troughtoni	Eastern Cave Bat	—	V	Inhabit tropical mixed woodland and wet sclerophyll forest on the coast and the dividing range but extend into the drier forest of the western slopes and inland areas (Churchill 1998). Has been found roosting in sandstone overhand caves, boulder piles, mine tunnels and occasionally in buildings (Churchill 1998).	Unlikely

Invertebrata					
Argyreus hyperbius	Laced Fritillary or Australian Fritillary	-	E1	Coastal areas of north-east NSW and south-east Queensland, and also New Guinea, south-east Asia and India. Australian population now restricted to a few widely separated localities from Port Macquarie north to Gympie. The Laced Fritillary has only been recorded from the Port Macquarie and Billinudgel/Byron Bay areas in NSW in recent times. Laced Fritillary is found in open swampy coastal habitat. Many former sites have been destroyed and records now only occur from a few widely separated sites.	Unlikely
Ocybadistes knightorum	**Black Grass-dart Butterfly**	**-**	**E1**	**The Black Grass-dart is found on the Mid North Coast between Digger's Headland and Warrell Creek (just south of Macksville). The main occurrence is just south of Coffs Harbour. It is restricted to areas where its sole food plant, Alexfloydia repens (Floyd's Grass), occurs. Floyd's Grass is also listed as an Endangered species in NSW.**	**Yes**
Petalura litorea	**Coastal Petaltail**	**-**	**E1**	**In NSW known populations are restricted to coastal and near coastal lowlands between Coffs Harbour and Ballina. Live in permanent swamps and bogs with some free water and open vegetation (DEC 2005).**	**Yes**
Phyllodes imperalis (Southern subspecies)	Pink Underwing Moth	E1	E1	Lower montane rainforests from QLD to NSW, where larvae appear to be dependent on the vine Carronia multisepalea (NSW Scientific Committee 2004). Breeding habitat is considered to be restricted to undisturbed old growth subtropical rainforest below 600m altitude (NSW Scientific Committee 2004)	Potential

Appendix E: Threatened flora likelihood table

SCIENTIFIC NAME	COMMON NAME	NSW TSC ACT	EPBC ACT	HABITAT ASSOCIATIONS	LIKELIHOOD OF OCCURRENCE
Acacia chrysotricha	Newry Golden Wattle	E1		*Acacia chrysotricha* occurs in a restricted area of the Kalang Valley south of Bellingen, on the NSW Mid North Coast. It is an understorey species on rainforest edges and in wet or dry eucalypt forest on quartzite soils. The round, yellow flower heads are present from July-August (DEC 2005).	No
Acronychia littoralis	Scented Acronychia	E1	E	Acronychia littoralis is found between Cooloola in south east Queensland and Port Macquarie on the North Coast of NSW. It occurs in littoral rainforest or in wet sclerophyll forest on the sandy coastal plain (Floyd 2008).	No
Aldrovanda vesiculosa	Waterwheel Plant	E1		Aldrovanda vesiculosa has only been recorded in NSW from lagoons in the Moruya area on the South Coast, from the Evans Head area on the North Coast and from north of Guyra on the New England Tablelands, where it is found free-floating in near-coastal shallow freshwater lagoons that are rich in organic matter (DEC 2005).	No

Alexfloydia repens	Floyd's Grass	E1		*Alexfloydia repens* is restricted to the area between Coffs Harbour and Macksville on the NSW Mid North Coast. It usually occurs in stands of Swamp Oak or paperbark in peat-like soil edging the upper tidal areas of mangroves and on the banks of estuarine creeks but has also been recorded in damp areas on headlands.	Potential
Allocasuarina defungens	Dwarf Heath Casuarina	E1	E	*Allocasuarina defungens* is found only in NSW from the Nabiac area, north-west of Forster, to Byron Bay on the North Coast. It is a straggly shrub about 2m high with blue-green foliage found in heath on sand (sometimes clay and sandstone soils), and swamp sclerophyll forest margins, and also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains (DEC 2005).	Unlikely
Ancistrachne maidenii		V		*Ancistrachne maidenii* is known from two disjunct areas in NSW - northern Sydney (e.g. Berowra Waters, Brooklyn and Wisemans Ferry), and the Grafton district. Surveys have indicated that the species may have specific habitat requirements, with populations occurring in distinct bands in areas associated with a transitional geology between Hawkesbury and Watagan soil landscapes (NSW SC, 1999). The northern Grafton populations also occur on sandstone.	No
Arthraxon hispidus	Hairy Jointgrass	V	V	*Arthraxon hispidus* is known from a number of locations on the North Coast and Northern Tablelands. It is a moisture and shade-loving grass, found in or on the edges of rainforest, in wet eucalypt forest and in or near creeks or swamps.	Potential

Asperula asthenes	Trailing Woodruff	V	V	*Asperula asthenes* occurs only in NSW, in scattered locations from Bulahdelah north to near Kempsey, with several records from the Port Stephens/Wallis Lakes area (DEC 2005). It grows in damp sites often along river banks (Harden 1993).	No
Astrotricha cordata	Heart-leaved Star Hair	E1		*Astrotricha cordata* is known from Mt Belmore State Forest and Mount Neville Nature Reserve on the NSW North Coast. Grows in dry eucalypt forest on exposed rocky summits, cliff edges and rocky slopes (DEC 2005).	No
Bertya sp. (Chambigne NR, M. Fatemi 24)	Chambigne Bertya	E1		Currently known from a single population near Shannon Creek Dam south of Grafton. Plants grow in shrubby woodland and heath in shallow sandy soils over sandstone.	No
Boronia hapalophylla	Shannon Creek Boronia	E1		Known from a several areas in the Grafton district. Plants grow in shrubby woodland on sandstone.	No
Boronia umbellata	Orara Boronia	V	V	*Boronia umbellata* is found at only a few locations between Glenreagh and Lower Bucca, north of Coffs Harbour, but it is locally common in the restricted area where it occurs (DEC 2005). It grows as an understorey shrub in and around gullies in wet open forest (DEC 2005). It appears to regenerate well after disturbance, but it is not known whether prolonged or repeated disturbance affects long-term persistence (DEC 2005).	Unlikely
Chamaesyce psammogeton	Sand Spurge	E1		*Chamaesyce psammogeton* is known from coastal sites north from near Jervis Bay as well as on Lord Howe Island. It is a prostrate perennial herb, which grows on foredunes and exposed sites on headlands often with Spinifex (DEC 2005).	No

Cynanchum elegans	White-flowered Wax Plant	E1	E	*Cynanchum elegans* is a climber or twiner with a variable form, and flowers between August and May, peaking in November (DEC 2005). It occurs in dry rainforest gullies, scrub and scree slopes, and prefers the ecotone between dry subtropical rainforest and sclerophyll woodland/forest (NPWS 1997). The species has also been found in littoral rainforest; Leptospermum laevigatum – Banksia integrifolia subsp. integrifolia coastal scrub; Eucalyptus tereticornis open forest/ woodland; Corymbia maculata open forest/woodland; and Melaleuca armillaris scrub to open scrub (DEC 2005).	Potential
Cyperus aquatilis	Water Nutgrass	E1		In NSW, *Cyperus aquatilis* is known only from a few sites north from Grafton, where it grows in ephemerally wet sites, such as roadside ditches and seepage areas from small cliffs, in sandstone areas (DEC 2005).	No
Dendrobium melaleucaphilum	Spider orchid	E1		Occurs from the lower Blue Mountains north to the Queensland border. Mostly grows on the bark of *Melaleuca stypheliodes* in paperbark swamps but also occasionally on rainforest trees and rarely as a lithophyte on rocks.	Potential
Diuris venosa	Veined Doubletail	V	V	Widespread in sub-alpine areas on Barrington Tops, known from Nowendoc and Brackendale, possibly southern parts of New England Tableland. Grows in moist tussock grassland or open shrubland around margins of subalpine swamps.	No

Eleocharis tetraquetra	Square-stemmed Spike-rush	E1		*Eleocharis tetraquetra* was thought to be extinct in NSW until it was rediscovered in 1997 at Boambee near Coffs Harbour, and has since been found in other north coast localities near Grafton and Murwillumbah (DEC 2005). It is found in damp locations on stream edges and in and on the margins of freshwater swamps (DEC 2005).	Potential
Lindsaea incisa	Slender Screw Fern	E1		In NSW, *Lindsaea incisa* is known only from a few locations on the North Coast such as the Woombah, Coffs Harbour, Grafton and Bungawalbyn districts. It grows in a range of woodland and open forest types, usually in waterlogged or poorly drained sites along creeks, where ferns, sedges and shrubs grow thickly (DEC 2005).	Potential
Marsdenia longiloba	**Slender Marsdenia**	**E1**	**V**	***Marsdenia longiloba* occurs on the NSW North Coast north from Barrington Tops. It occurs in subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops (DEC 2005). Preferred habitat seems to be moist open forest with a fern-grass understorey and occasional small rainforest trees, often on hillslopes adjacent to gully rainforest (Ecos Environmental Pty Ltd 2005).**	**Yes**
Neoastelia spectabilis	Silver Sword Lily	V	V	Known only from New England and Bellinger River National Parks where it is highly restricted and relatively uncommon. Grows in moist rocky areas near creeklines in rainforest and wet sclerophyll forest.	No

Niemeyera whitei	Rusty Plum, Plum Boxwood	V		*Niemeyera whitei* occurs north from the Macleay River in low to mid altitude coastal hills and ranges. It usually occurs in gully rainforest or wet sclerophyll forest with a well-developed rainforest understorey growing on medium fertility soils formed on metasediment or rhyolite (Floyd 2008).	Potential
Oberonia complanata	Yellow-flowered King of the Fairies	E1		Although historic records exist for this species from Coffs Harbour, Lismore and Byron Bay, Oberonia complanata is now known with certainty in NSW only from the Woodburn district. Plants grow as epiphytes on the bark of trees such as Prickly Paperbark (*Melaleuca styphelioides*) in moist swampy, areas at sea level.	Potential
Oberonia titania	Red-flowered King of the Fairies	V		Known from several populations on the North Coast north from the Port Macquarie district. Grows either as an epiphyte on rainforest trees (e.g. Grey Myrtle *Backhousia myrtifolia* and Bangalow Palm *Archontophoenix cunninghamiana*) or occasionally as a lithophyte on rocks.	
Parsonsia dorrigoensis	Milky Silkpod	V	E	*Parsonsia dorrigoensis* occurs as scattered populations in the Mid North Coast of NSW between Kendall and Woolgoolga (DEC 2005). Found in subtropical and warm-temperature rainforest, on rainforest margins, and in moist eucalypt forest up to 800 m, on brown clay soils. Flowers in summer (DEC 2005).	Potential
Peristeranthus hillii	Brown Fairy-chain Orchid	V		Known from coastal areas north from Port Macquarie. Grows as an epiphyte on rainforest trees and large climbers. Most records are from very close to the ocean in littoral rainforest.	No

Phaius australis	Southern Swamp Orchid	E1	E	Known from coastal areas north from about Port Macquarie with older records from as far south as Bulahdelah. Grows in moist swampy grassland and paperbark swamps and on the margins of rainforest.	Potential
Phaius tancarvilleae	Lady Tankerville's Swamp Orchid	E1	E	Found in swampy grassland or swampy forest, including rainforest, eucalypt and paperbark forest.	No
Pomaderris queenslandica	Scant Pomaderris	E1		Pomaderris queenslandica is widely scattered but not common in north-east NSW and in Queensland. It is only known from a few locations on the New England Tablelands and North Western Slopes, including near Torrington and Coolatai, and also from several locations on the NSW North Coast. It grows in moist eucalypt forest or sheltered woodlands with a shrubby understorey, occasionally along creeks (DEC 2005).	Potential
Pultenaea maritima	Coast Headland Pea	V		In NSW, *Pultenaea maritima* has been recorded from Newcastle north to Byron Bay on 16 headlands. It occurs in grasslands, shrublands and heath on exposed coastal headlands (DEC 2005).	No
Quassia sp. Moonee Creek	Moonee Quassia	E1	E	*Quassia sp. Moonee Creek* occurs between Moonee Creek near Coffs Harbour and the coast range north east of Grafton. It grows in either wet sclerophyll forest, dominated by species such as *Eucalyptus microcorys, Lophostemon confertus* and *Syncarpia glomulifera* or in dry open eucalypt forests with a well-developed shrub layer (DEC 2005).	No

Senna acclinis	Rainforest Cassia	E1		In NSW, *Senna acclinis* occurs in coastal districts and adjacent tablelands north from the Illawarra. It grows in or on the edges of subtropical, littoral and dry rainforest and in open eucalypt forest (DEC 2005).	Potential
Sophora tomentosa	Silverbush	E1		*Sophora tomentosa* occurs in coastal areas in Queensland and northern NSW. It was previously common north from Port Stephens but is now uncommon and found only north of Old Bar, near Taree. It grows on coastal dunes (DEC 2005).	No
Thesium australe	Austral Toadflax	V	V	Widespread throughout the eastern third of NSW but most common on the North Western Slopes, Northern Tablelands and North Coast. Occurs in grassland or grassy woodland. Often found in damp sites in association with Kangaroo Grass (*Themeda australis*) (DEC 2005). The preferred soil type is a fertile loam derived from basalt although it occasionally occurs on metasediments and granite.	Potential
Tinospora smilacina	Tinospora Vine	E1		North from the Coffs Harbour district on the North Coast of NSW, but chiefly further north again e.g. Lismore district. Mostly found in dry rainforest and in the ecotone between rainforest and dry eucalypt forest (DEC 2005).	Potential
Tylophora woollsii	Cryptic Forest Twiner	E1	E	Widespread but uncommon on the Northern Tablelands and North Coast of NSW. Known localities include the Ebor, Gibraltar Range, Nymboida and Tenterfield districts. Plants grow in moist eucalypt forest and on the margins of rainforest.	Unlikely

Typhonium sp. aff. brownii	Stinky Lily	E1		Only known from several locations in the ranges west of Coffs Harbour and Woolgoolga including Kangaroo River, Bruxner Park, Bindarri National Park and Upper Corindi (DEC 2005). Occurs on reasonably fertile soils, in moist eucalypt forest and the moist eucalypt forest-subtropical rainforest interface (DEC 2005).	Potential
Zieria prostrata	Headland Zieria	E1	E	*Zieria prostrata* is restricted to four coastal headlands in the Coffs Harbour area of north-east NSW. It grows in low grassy heath on exposed sites and wind-pruned open to sparse shrubland on more sheltered aspects (DEC 2005).	No

Appendix F: Threatened community likelihood table

ECOLOGICAL COMMUNITY	NSW TSC ACT	EPBC ACT	LIKELIHOOD OF OCCURRENCE
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3		No
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	**E3**		**Yes**
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3	CE	No
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	E3	CE	Potential
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	E3	CE	Unlikely
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	E3	E	No
Sub-tropical Coastal Floodplain Forest of the NSW North Coast bioregion	E3		Unlikely
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3		Potential
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	**E3**		**Yes**
Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions	E3		No

Appendix G - Riparian buffer guide

Department of Primary Industries
Office of Water

CONTROLLED ACTIVITIES ON WATERFRONT LAND

Guidelines for riparian corridors on waterfront land

Controlled activities carried out in, on or under waterfront land are regulated by the *Water Management Act 2000* (WM Act). The NSW Office of Water administers the WM Act and is required to assess the impact of any proposed controlled activity to ensure that no more than minimal harm will be done to waterfront land as a consequence of carrying out the controlled activity.

Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 metres of the highest bank of the river, lake or estuary.

This means that a controlled activity approval must be obtained from the Office of Water before commencing the controlled activity.

What is a riparian corridor?

A riparian corridor (RC) forms a transition zone between the land, also known as the terrestrial environment, and the river or watercourse or aquatic environment. Riparian corridors perform a range of important environmental functions such as:

- providing bed and bank stability and reducing bank and channel erosion
- protecting water quality by trapping sediment, nutrients and other contaminants
- providing diversity of habitat for terrestrial, riparian and aquatic plants (flora) and animals (fauna)
- providing connectivity between wildlife habitats
- conveying flood flows and controlling the direction of flood flows
- providing an interface or buffer between developments and waterways
- providing passive recreational uses.

The protection, restoration or rehabilitation of vegetated riparian corridors is important for maintaining or improving the shape, stability (or geomorphic form) and ecological functions of a watercourse.

Changes to controlled activities within riparian corridors

On 1 July 2012 new rules commenced regarding controlled activities within riparian corridors. The new rules amend the riparian corridor widths that apply to watercourses, providing more flexibility in how riparian corridors can be used and making it easier for applicants to determine the Office of Water controlled activity approval requirements. Key aspects of the changes include:

- Provision of greater flexibility in the allowable uses and works permitted within riparian corridors.
- The core riparian zone and vegetated buffer have been combined into a single vegetated riparian zone (VRZ).
- The width of the VRZ within the riparian corridor has been pre-determined and standardised for first, second, third and fourth order and greater watercourses.
- Where suitable, applicants may undertake non-riparian corridor works or development within the outer 50 per cent of a VRZ, as long as they offset this activity by connecting an equivalent area to the RC within the development site.
- A new 'riparian corridors matrix' enables applicants to determine what activities can be considered in riparian corridors.

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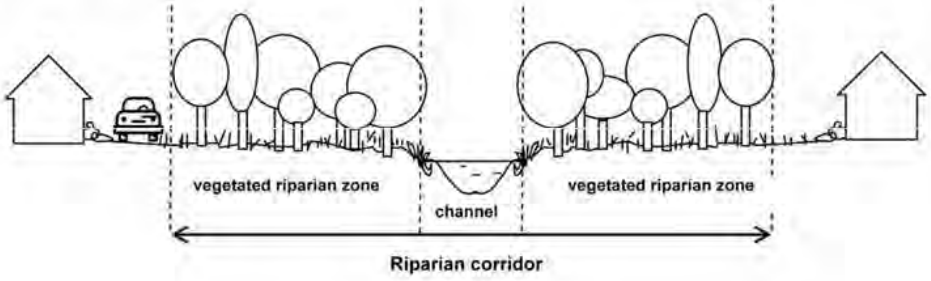
These changes will simplify the controlled activities application and assessment process, provide greater flexibility, help make more land available for housing, support floodplain, stormwater and bush fire management, and allow riparian corridors to be used for public amenity whilst continuing to deliver environmental outcomes required under the WM Act.

The riparian corridor consists of:

- the channel which comprises the bed and banks of the watercourse (to the highest bank) and
- the vegetated riparian zone (VRZ) adjoining the channel.

Figure 1. The riparian corridor



Riparian corridor widths

The Officer of Water recommends a VRZ width based on watercourse order as classified under the Strahler System of ordering watercourses and using current 1:25 000 topographic maps (see Figure 2 and Table 1). The width of the VRZ should be measured from the top of the highest bank on both sides of the watercourse.

Figure 2. The Strahler System

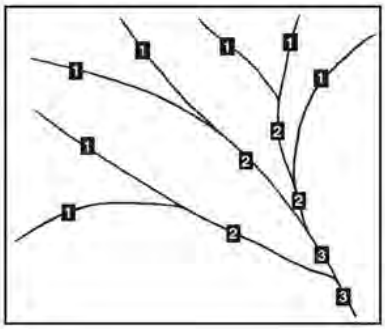


Table 1. Recommended riparian corridor (RC) widths

Watercourse type	VRZ width (each side of watercourse)	Total RC width
1st order	10 metres	20 m + channel width
2nd order	20 metres	40 m + channel width
3rd order	30 metres	60 m + channel width
4th order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 metres	80 m + channel width

Note: where a watercourse does not exhibit the features of a defined channel with bed and banks, the Office of Water may determine that the watercourse is not waterfront land for the purposes of the WM Act

Objectives for riparian corridor management

The overarching objective of the controlled activities provisions of the WM Act is to establish and preserve the integrity of riparian corridors.

Ideally the environmental functions of riparian corridors should be maintained or rehabilitated by applying the following principles:

- Identify whether or not there is a watercourse present and determine its order in accordance with the Strahler System.
- If a watercourse is present, define the RC/VRZ on a map in accordance with Table 1.
- Seek to maintain or rehabilitate a RC/VRZ with fully structured native vegetation in accordance with Table 1.
- Seek to minimise disturbance and harm to the recommended RC/VRZ.
- Minimise the number of creek crossings and provide perimeter road separating development from the RC/VRZ.
- Locate services and infrastructure outside of the RC/VRZ. Within the RC/VRZ provide multiple service easements and/or utilise road crossings where possible.
- Treat stormwater run-off before discharging into the RC/VRZ.

The Office of Water however, does allow for a range of works and activities on waterfront land and in riparian corridors to better meet the needs of the community, so long as they cause minimal harm as outlined in the riparian corridor matrix below.

Riparian corridor matrix

The riparian corridor matrix enables applicants to identify certain works and activities that can occur on waterfront land and in riparian corridors. Applicants should note that the matrix relates to controlled activity approvals under the WM Act only. They are still required to comply with other relevant government legislation, such as threatened species, flood planning levels and fisheries guidelines.

Table 2. Riparian corridor matrix

Stream order	Vegetated Riparian Zone (VRZ)	RC off-setting for non RC uses	Cycleways and paths	Detention basins		Stormwater outlet structures and essential services	Stream realignment	Road crossings		
				Only within 50% outer VRZ	Online			Any	Culvert	Bridge
1st	10m	•	•	•	•	•	•	•		
2nd	20m	•	•	•	•	•		•		
3rd	30m	•	•	•		•			•	•
4th +	40m	•	•	•		•			•	•

Key

Stream order: The watercourse order as classified under the Strahler System based on 1:25,000, 1:50,000 or 1:100,000 topographic maps whichever is the smallest scale available. A full list is provided at Part 2, Schedule 2 of the Water Management (General) Regulation 2011.

Vegetated riparian zone (VRZ): The required width of the VRZ measured from the top of the high bank on each side of the watercourse.

Riparian corridor (RC) off-setting for non RC uses: Non-riparian uses, such as Asset Protection Zones are allowed within the outer 50 per cent of the VRZ, so long as offsets are provided in accordance with the averaging rule as seen in Figure 3.

Cycleways and paths: Cycleways or paths no wider than four metres total disturbance footprint can be built in the outer 50 per cent of the VRZ.

Detention basins: Detention basins can be built in the outer 50 per cent of the VRZ or online where indicated. Refer to the Office of Water's *Controlled activities. Guidelines for outlet structures* and *Controlled activities. Guidelines for instream works*. Online basins must:

- be dry and vegetated
- be for temporary flood detention only with no permanent water holding
- have an equivalent VRZ for the corresponding watercourse order
- not be used for water quality treatment purposes.

Stormwater outlet structures and essential services: Stormwater outlets or essential services are allowed in the RC. Works for essential services on a fourth order or greater stream are to be undertaken by directional drilling or tied to existing crossings. Refer to the Office of Water's *Controlled activities. Guidelines for laying pipes and cables in watercourses* and *Controlled activities. Guidelines for outlet structures*.

Stream realignment: Indicates that a watercourse may be realigned. Refer to the Office of Water's *Controlled activities. Guidelines for instream works.*

Road crossings: Indicates permitted road crossing methods. Refer to the Office of Water's *Controlled activities. Guidelines for watercourse crossings* and NSW DPI policy and guidelines for fish friendly waterway crossings for Class 1 and 2 waterways.

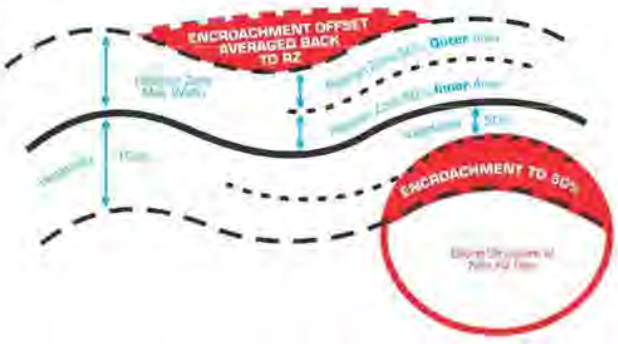
What is the averaging rule?

Non riparian corridor works and activities can be authorised within the outer riparian corridor, so long as the average width of the vegetated riparian zone can be achieved over the length of the watercourse within the development site. That is, where appropriate 50 per cent of the outer vegetated riparian zone width may be used for non-riparian uses including asset protection zones, recreational areas, roads, development lots and infrastructure. However, an equivalent area connected to the riparian corridor must be offset on the site (see Figure 3) and the inner 50 per cent of the vegetated riparian zone must be fully protected and vegetated with native endemic riparian plant species.

Bridges, cycleways, paths, stormwater oulets and other essential services do not need to be offset, but must comply with the requirements set out in the riparian corridor matrix (Table 2) and other relevant Office of Water controlled activities guidelines. Offline detention basins do not need to be offset so long as there is an equivalent VRZ for the corresponding watercourse and they are built in compliance with the Office of Water's *Controlled activities: Guidelines for watercourse crossings* and *Controlled activities: Guidelines for in-stream works*. If a proposed basin will not have an equivalent VRZ for the corresponding watercourse, it may still be built in the outer 50 per cent of the VRZ but must be offset.

The averaging rule should generally be applied to cleared waterfront land. Development proposals involving waterfront lands that contain existing native vegetation should seek to preserve that riparian vegetation in accordance with the minimum riparian corridor requirements outlined in Table 1.

Figure 3. Averaging rule



Applications for controlled activity approvals

Applications for controlled activities approvals should be informed by the riparian corridor matrix shown in Table 2 and prepared using the *Application for a Controlled Activity Approval for works on waterfront land* form and the *Guideline for completing an application for a Controlled Activity Approval*.

Other controlled activity guidelines are available on the Office of Water website and outline relevant considerations for applicants when proposing activities and works on waterfront lands.

Streamlined assessment

Where applications are presented in accordance with the riparian corridor matrix (Table 2) and other Office of Water controlled activity guidelines, they will be assessed under a streamlined process. This may decrease the amount of time it takes the Office of Water to make a determination, saving applicants time and money.

Applications that do not conform to the matrix and/or relevant Office of Water controlled activity guidelines will continue to be subject to merit assessment to ensure that the proposals meet the requirements of the WM Act. All applications will still need to demonstrate that minimal harm will occur to waterfront land before a controlled activity approval will be issued.

Where do I go for additional information?

Find out more about controlled activities at the Office of Water website www.water.nsw.gov.au.

Contact us

Contact a water regulatory officer as listed on the Office of Water website www.water.nsw.gov.au, free call the licensing information on 1800 353 104 or email information@water.nsw.gov.au.

Published by the Department of Primary Industries, a division of NSW Department of Trade and Investment, Regional Infrastructure and Services.

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APPENDIX 6 - BUSHFIRE ASSESSMENT

Bonville Rural Residential

Local Environmental Study – Bushfire Assessment

Prepared for
Coffs Harbour City Council

25 October 2013

DOCUMENT TRACKING

ITEM	DETAIL
Project Name	Bonville Rural Residential Local Environmental Study Bushfire Assessment
Project Number	12COFECO-0020
Project Manager	Peter Knock Ph: 02 8081 2762 35 Orlando Street, Coffs Harbour Jetty NSW 2450
Prepared by	David Peterson
Approved by	Peter Knock
Status	Final
Version Number	1
Last saved on	25 October 2013

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd.

Contents

Figures

Tables

1 Introduction

1.1 BACKGROUND

This report was commissioned by Coffs Harbour City Council (CHCC) as part of a local consortium of consultants headed by Geoff Smyth Consulting and de Groot & Benson Pty Ltd in preparation for an amendment to the Draft Coffs Harbour Local Environment Plan 2013 (DLEP 2013) for a future rural residential release area for Bonville.

Bonville has been identified as a priority release area under the Rural Residential Study 2009. This technical report is prepared to inform a Planning Proposal to rezone the study area to further residential development.

1.2 LOCATION AND DESCRIPTION OF BONVILLE RELEASE AREA

The Bonville study area is located approximately 13 km south of the Coffs Harbour Central Business District on the western side of the Bonville extension to the Pacific Highway on the North Coast of NSW (**Figure 1**). The study area covers approximately 1860 ha (**Figure 2**).

The current land uses in the Bonville locality consist of existing rural residential subdivisions and agriculture including intensive horticulture cropping lands, private recreation in the form of Bonville Golf Resort and small rural allotments. The study area is bounded by Boambee and Pine Creek State Forests to the north, west and south and Bongil Bongil National Park to the east. The Pacific Highway forms the eastern boundary of the study area, with the old Pacific Highway (now Pine Creek Way) being the main access road running north-south through the study area. From north to south, the main roads that provide access to the upper and lower Bonville Valley from Pine Creek Way are, Titans Close, Irvines Road, Williams Rd, North Bonville Road (linking to Cassidy's Rd and Bradford Dr), Bonville Station Rd, Glennifer Road (linking to Crossmaglen Rd) / East Bonville Rd and Butlers Rd.

1.3 AIMS AND OBJECTIVES OF BUSHFIRE ASSESSMENT

The aim of this study is to investigate the capability and general suitability of the site for future residential subdivision and other land uses with the appropriate bushfire protection measures as guided by the relevant legislation and policy into bushfire planning and design of new development in NSW. The findings and recommendations are to inform a Planning Proposal to appropriately rezone the site.

The objectives of this study are therefore to:

1. Provide statements as to the capability of the site to achieve the required minimum bushfire protection measures for future development, namely subdivision and the construction of dwellings;
2. Satisfy the legislative requirements for assessment of rezoning bushfire prone land for residential purposes under the *Environmental Planning and Assessment Act 1979*;
3. Investigate the application of Asset Protection Zone (APZ) building setbacks to vegetation/bushland and report on the location and dimensions of any required APZ;

4. Provide guidance on the access and egress requirements for residential development in bushfire prone land; and

5. Provide guidance on other bushfire protection measures such as the provision of utilities.

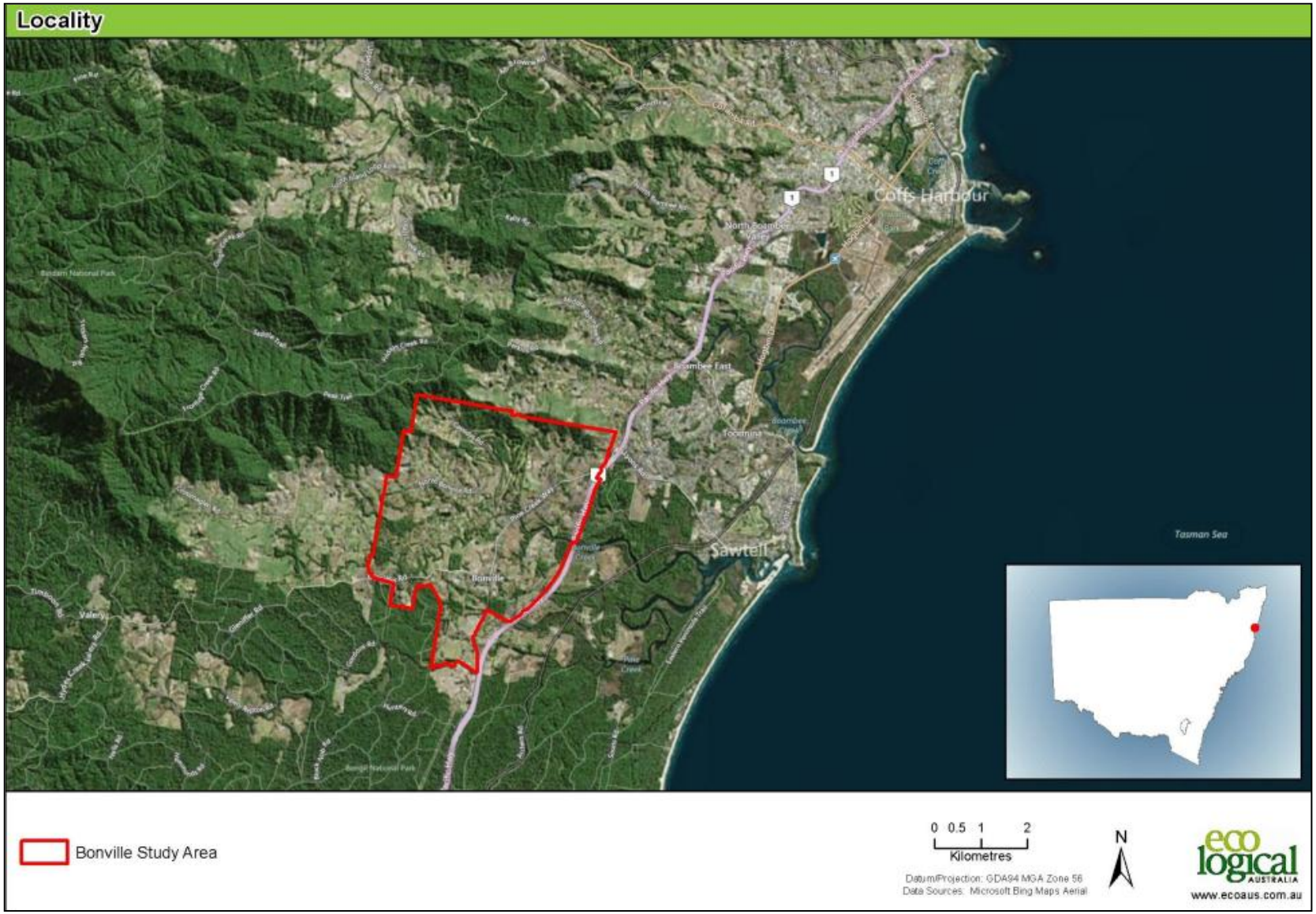

Figure 1: Location of Bonville Release Area

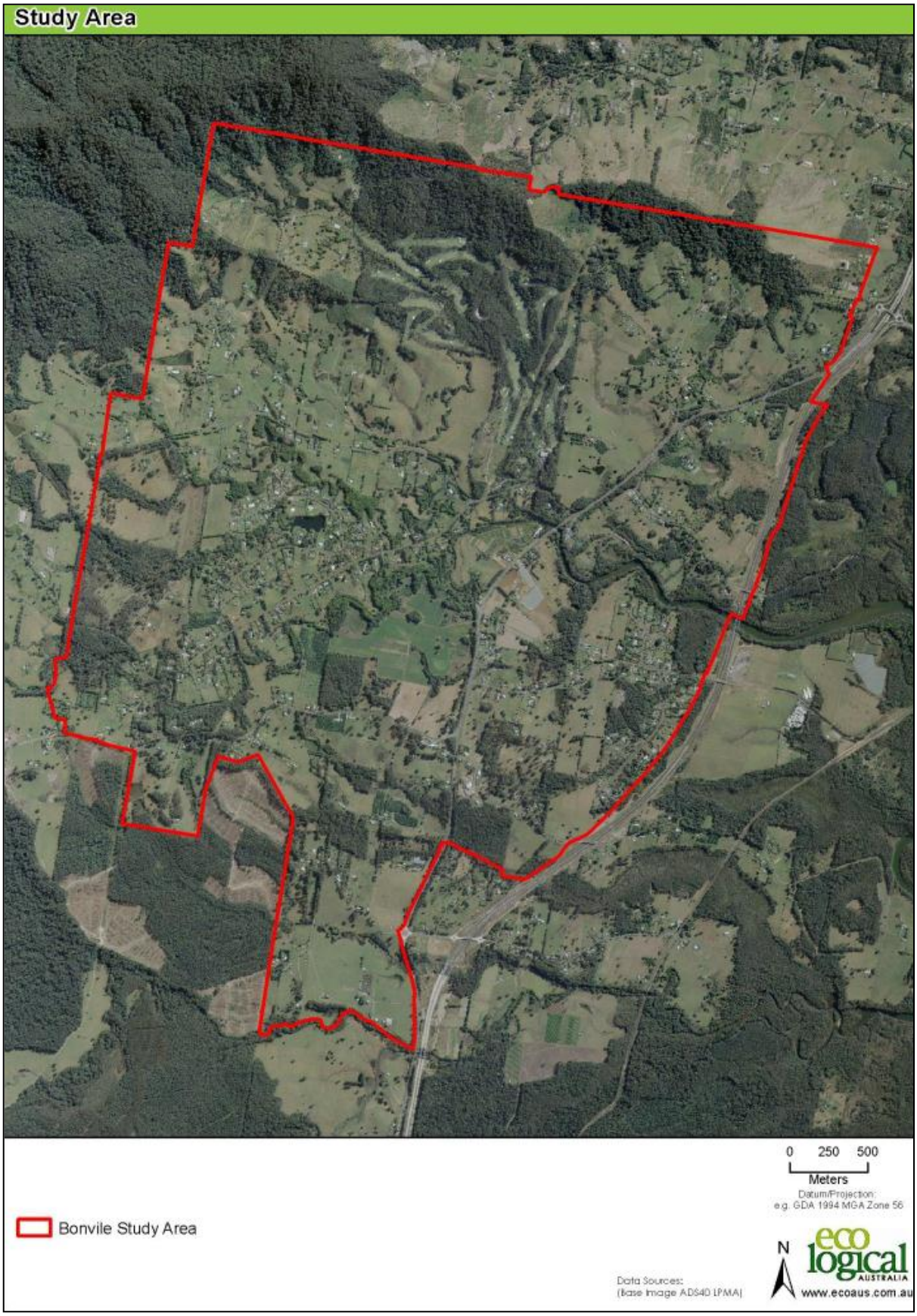

Figure 2: Bonville study area

2 Assessment Requirements

The study area has been identified as containing bushfire prone land as mapped by Coffs Harbour City Council and certified by the NSW Rural Fire Service (RFS) under a requirement of the *Rural Fires Act 1997*. In NSW, bushfire prone lands are those identified that could support a bushfire or are potentially likely to be subject to bushfire attack and are generally lands that contain or are within 100 m of significant stands of bushland.

When investigating the capability of bushfire prone land to be rezoned for residential purposes, local councils must have regard to s.117 (2) Direction 4.4 – 'Planning for Bush Fire Protection' of the *Environmental Planning and Assessment Act 1979*. The objectives of Direction 4.4 are:

- *To protect life, property and the environment from bushfire hazards, by discouraging the establishment of incompatible land uses in bushfire prone areas; and*
- *To encourage sound management of bushfire prone areas.*

Direction 4.4 instructs councils on the bushfire matters which need to be addressed when drafting LEPs. This includes:

- Consultation with the Commissioner of the RFS under s.62 of the EPA Act, and take into account any comments so made;
- Draft LEPs shall have regard to *Planning for Bushfire Protection 2006* (PBP)*;* and
- Compliance with numerous bushfire protection provisions where development is proposed.

After the rezoning stage, future subdivision of land and the construction of buildings also require an assessment against PBP. These assessments are based on a final development application for these uses.

3 Methods and Approach

This bushfire assessment followed the methods and approach outlined in **Table 1** below.

Table 1: Methods and Approach

Method and Approach	Task	Considerations
Review	A literature review of relevant reports and studies occurred.	Coffs Harbour Bush Fire Prone Land Map; Mid North Coast Bushfire Risk Management Plan.
Desk top analysis	Review and analysis of all available mapping layers in GIS relevant to bushfire hazard.	GIS layers include: satellite imagery; vegetation mapping; topographical data (e.g. contours).
Site inspection	An inspection of the study area occurred in June 2013.	The inspection ground-truthed the results of the desk-top analysis, particularly in regards to vegetation classification and slopes that influence the overall bushfire hazard and APZ calculations. The inspection took place with the consulting ecologist (ELA) so that discussions could take place on the likely retention and enhancement of remnant bushland for the protection and maintenance of biodiversity (e.g. Koala habitat and movement) including riparian treatments and buffers.
Ecological consultation	Consultation with ecologist to enable integrated design	Workshop sessions occurred with the consulting ecologist to refine the bushfire protection measures. The biodiversity constraints were first presented on which to base the required APZs (i.e. the vegetation to be retained due to conservation values forms the bushfire hazard to be assessed and the overall development footprint).
Assessment	Determine all relevant bushfire protection measures.	Assessment in accordance with PBP methodology, Direction 4.4 of EP&A Act and RFS requirements.
Reporting	Preparation of bushfire assessment.	Carry out all necessary reporting required for rezoning and Planning Proposals for development of bushfire prone land.

4 Bushfire Hazard

An assessment of the bushfire hazard is necessary to determine the application of bushfire protection measures such as Asset Protection Zone location and dimension. The following sub-sections provide a detailed account of the vegetation communities (bushfire fuels) and the topography (effective slope) that combine to create the bushfire hazard that may affect bushfire behaviour at the site.

This assessment is based on the possible future vegetation coverage as determined by ELA (2013) ecological assessment for the LES. The future vegetation is discussed in Section 4.1 below. Some of the current bushland areas will contribute to the future bushfire hazard, however this hazard will be significantly added to, particularly in the way of connectivity between remnants and along drainage lines to achieve biodiversity and riparian environmental objectives. The increase in hazard is not significant enough to preclude development or pose a future hazard that cannot be addressed by typical bushfire protection planning precautions as outlined within PBP.

Following on from above, the concept of bushfire risk as influenced by fire history and current and past bushfire issues has little bearing on the determination of bushfire protection strategies for rezoning and future development at this site. This is due to a different future vegetation layer and the fact that PBP assesses bushfire protection based purely on vegetation and slope (i.e. hazard and not risk), making the assumption that a fire may occur in any patch of bushland at a worst-case scenario (based on a set design fire).

Notwithstanding this, the *Mid North Coast Bushfire Risk Management Plan* was reviewed to gain a greater understanding of the bushfire environment, hazard and risk issues that affect the study area. The only impact the plan has specifically on the study area is the requirement to conduct hazard reduction within the forest plantations adjacent the southwest boundary of the study area. This complementary management offsite does not affect the bushfire protection measures required for future development within the study area.

4.1 VEGETATION COMMUNITIES INFLUENCING BUSHFIRE

The ‘predominant vegetation’ influencing fire behaviour approaching future developable areas has been assessed strictly in accordance with the methodology specified within PBP.

Comprehensive and site specific vegetation assessment and mapping has occurred as part of the ecological assessment (Eco Logical Australia 2013). A map displaying the current coverage of vegetation is provided in **Figure 3**. The bushland throughout and adjoining the site

Mapped vegetation formations within the study area include units mapped as Sclerophyll (Wet and Dry) Rainforest, Native Remnant, Native Pioneers, Exotic, and Plantation.

The primary hazard is predominantly Tall Open Forest of varying conditions with floristics, particularly within the understorey, changing from the wetter lowland areas such as along the drainage lines to the higher slopes.

Figure 3 shows the recommended future coverage of vegetation based on environmental objectives and constraints. It is this layer that the bushfire assessment is based on. The total constraints layer

consists of the existing E2 zone, significant vegetation, remnant vegetation, riparian and minor drainage buffers and existing W1 and W2 zones.

The PBP predominant vegetation classification of all future vegetation for the study area is 'forest', with the exception of small remnants (less than 1 ha) and narrow corridors (less than 50 m in width) which are able to be classified as 'low hazard' due to the limited fire behaviour in small areas of vegetation.

The presence and potential for rainforest throughout the site has been carefully assessed. Although some gullies, sheltered slopes and riparian areas provide habitat for mesic components, these areas are relatively small and maintain (or likely to present) a Eucalypt dominant overstorey such that they cannot be classified as 'rainforest' in accordance with PBP methodology and RFS policy. Areas of true rainforest do exist, such as within the gullies on the southern aspects of the range that forms the northern boundary of the study area, however these areas are located away from the boundary and relatively small within the context of the total (predominant) hazard.

4.2 SLOPES INFLUENCING BUSHFIRE

The 'effective slope' influencing fire behaviour approaching the developable area has been assessed strictly in accordance with the methodology specified within PBP. This is conducted by measuring the worst-case scenario slope where the vegetation occurs over a 100 m transect measured outwards from the development boundary. The slope classes are listed in **Table 2** below.

All slope classes are represented within the study area, from the floodplains within the valley floor, to the gentle and undulating hills between the major drainage lines, to the steep slopes leading up the ridgelines and spurs in the north of the study area. The slopes across the study area can be appreciated from the digital terrain model presented in **Figure 5**.

Table 2: PBP slope classes

Upslope or Downslope	PBP Slope Class
Upslope / Flat Land	Flat land and all upslope land leading away from the development
Downslope	>0-5 degrees downslope leading away from the development
	>5-10 degrees downslope leading away from the development
	>10-15 degrees downslope leading away from the development
	>15-18 degrees downslope leading away from the development

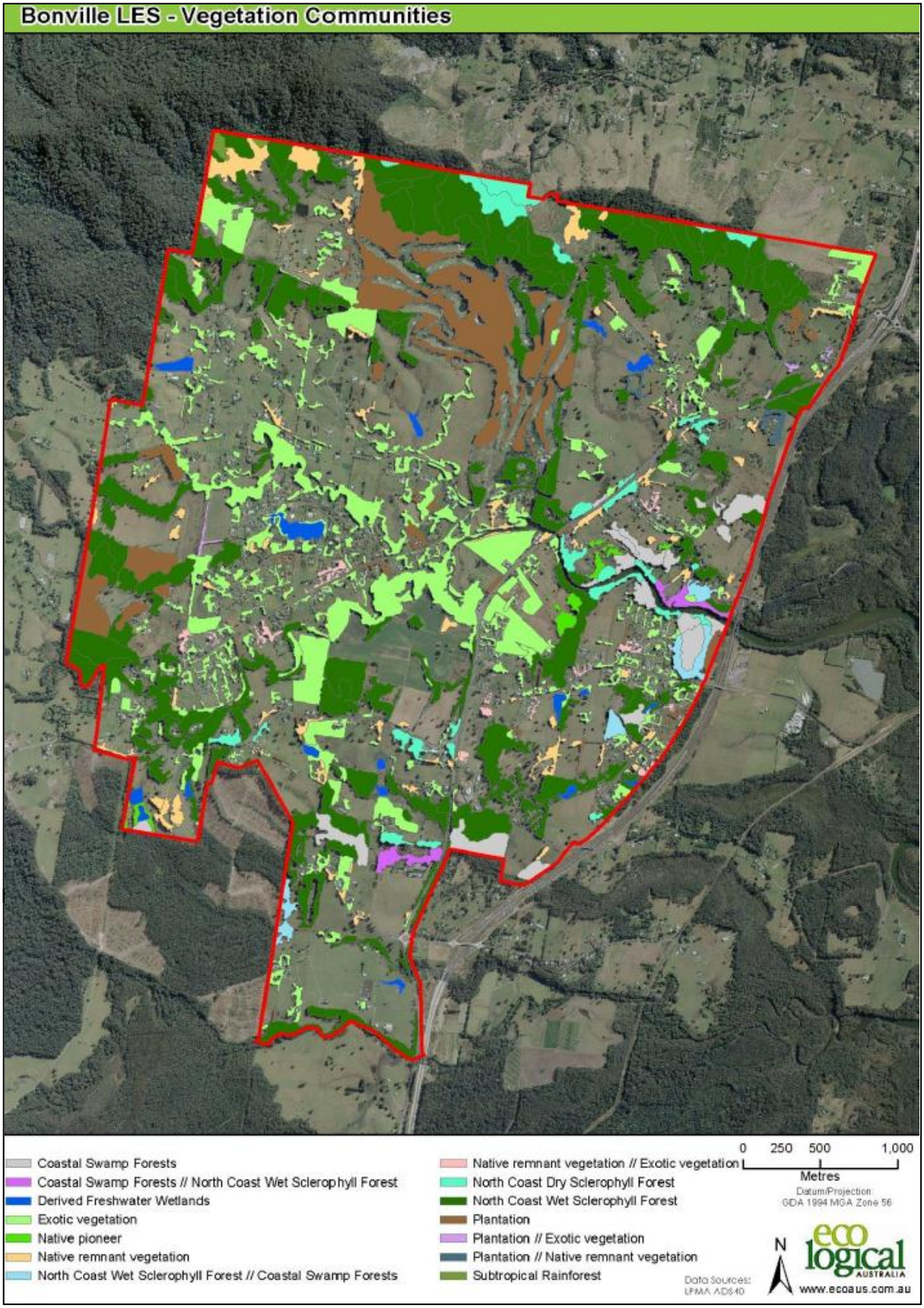

Figure 3: Current vegetation communities

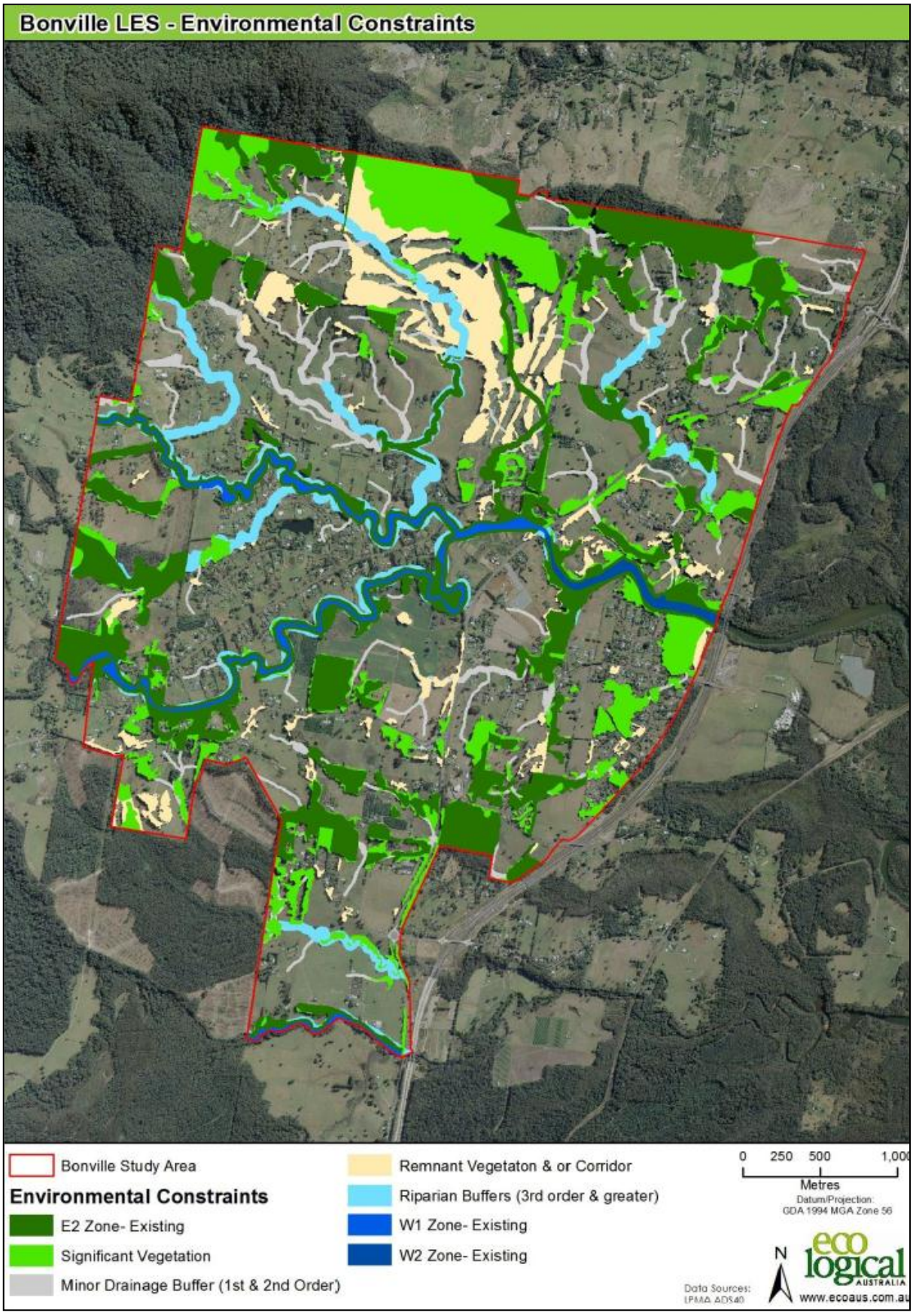

Figure 4: Future vegetation coverage

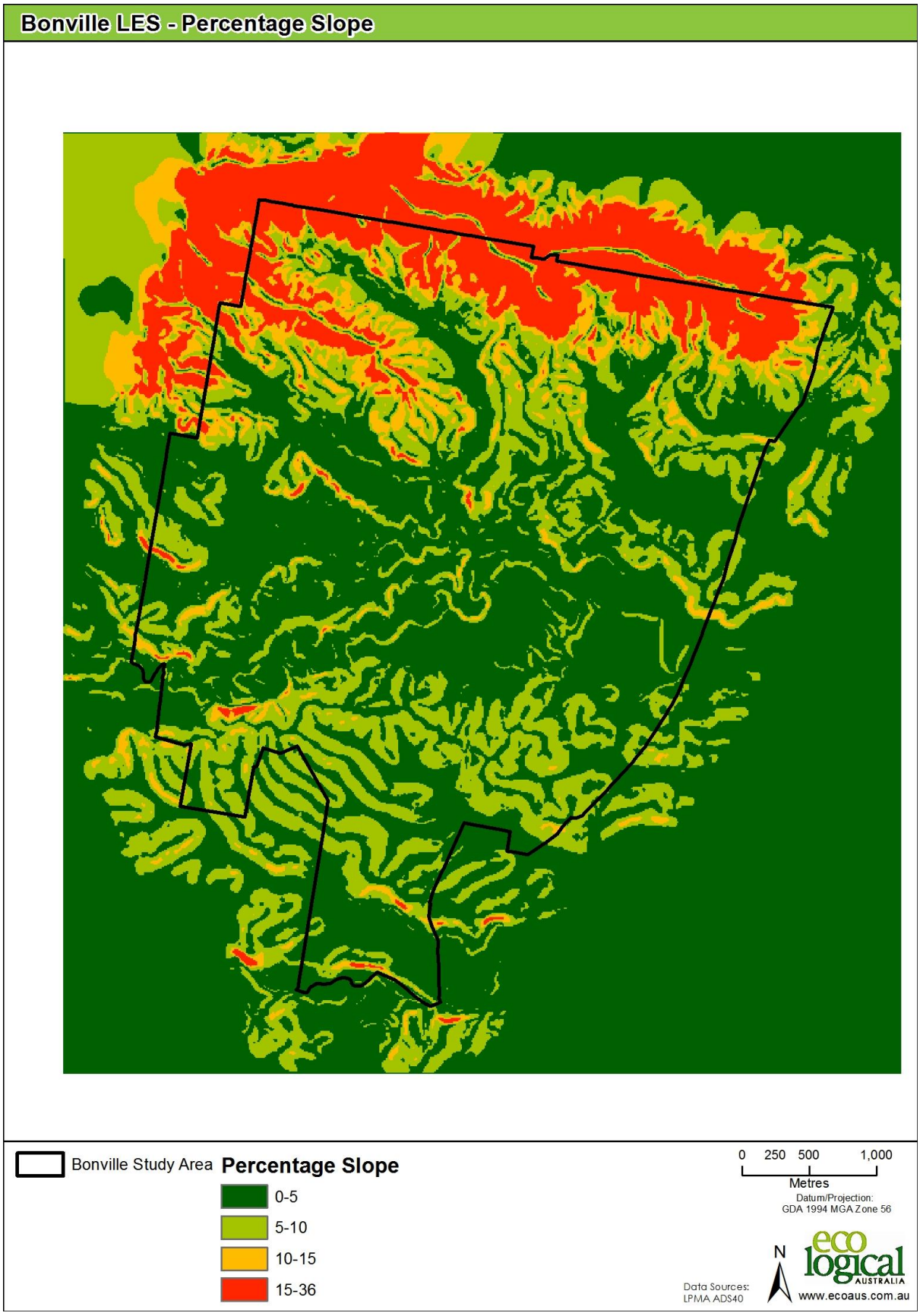

Figure 5: Planning for Bushfire Protection 2006 slope class distribution

5 Bushfire Protection Measures

PBP requires the assessment of a suite of bushfire protection measures that in total afford an adequate level of protection. The measures required to be assessed for rezoning are listed in **Table 3** below and are discussed in detail in the remainder of this section. This section demonstrates that the study area can accommodate the required bushfire protection measures and achieve the Direction 4.4 objectives and RFS requirements.

Table 3: PBP bushfire protection measures

Bushfire Protection Measure	Considerations
Asset Protection Zones (APZ)	Location and dimension of APZ setbacks from vegetation including prescriptions of vegetation management within the APZ.
Access	Assessment to include access and egress in and out of a developable area such as alternate access, operational response and evacuation options. APZ perimeter access to be considered as is design standards of public roads and any fire trails.
Water supply and other utilities	List requirements for reticulated water supply and hydrant provisions, and any static water supplies for fire fighting.
Building construction standards	Provide a guide on the application of construction standards for future buildings.

5.1 ASSET PROTECTION ZONES

5.1.1 APZ Location and Dimension

Using the vegetation and slope data discussed in Section 4, APZs suitable for residential subdivision around all environmentally constrained lands have been calculated. These have been mapped and identified on **Figure 6** and described in **Table 4**.

A second APZ dimension for Special Fire Protection Purposes (SFPP) is also listed in **Table 4**. These SFPP APZs are for schools, child care centres, accommodation, retirement villages and other uses listed under s100B (6) *Rural Fires Act 1997*.

It is recommended that development associated with employment lands, such as commercial and industrial development, be treated as residential development for the purpose of the rezoning analysis. Non-habitable development of this kind has the opportunity to have an APZ less than that required for residential subdivision. This flexibility relies on the known use of the building, its design and construction standard, and can be determined at the subdivision application stage.

It is currently considered best practice to provide an APZ dimension that achieves a building construction standard under *AS 3959-2009 Construction of buildings in bushfire-prone areas* (Standards Australia 2009) of Bushfire Attack Level (BAL)-29 at the maximum. The current accepted minimum APZ dimension allows for a BAL-40 standard. The increase in APZ provides a higher level of bushfire protection and ensures that future home owners are not impacted by the additional costs associated with construction of a dwelling at BAL-40. **Table 4** lists the current minimum APZ and best practice APZ related to BAL-29 (refer to Section 5.4 for more information on AS 3959-2009).

It is important to note that the APZ calculations quoted in this assessment are indicative only and have been determined at a landscape scale. This level of detail is suitable for a rezoning assessment whereby the aim is to demonstrate whether a parcel of land can accommodate the bushfire hazard, the expected APZ and future development. The final APZ dimensions for any future subdivision or development depends on the accuracy of a slope assessment undertaken at a site-specific level. The APZ dimensions quoted in this assessment should not be relied on to approve a future subdivision; they may be used as a guide only.

Table 4: Asset Protection Zone (APZ) calculation

Predominant Vegetation	Effective Slope	APZ width	APZ colour Figure 6	SFPP APZ width	BAL-29 APZ
Forest	Upslope/Flat	20 m (10 m OPA)		60 m (20 m OPA)	21 m
Forest	>0-5º downslope	20 m (5 m OPA)		70 m (20 m OPA)	27 m
Forest	>5-10º downslope	30 m (15 m OPA)		85 m (25 m OPA)	33 m
Forest	>10-15º downslope	40 m 20 m OPA)		100 m (30 m OPA)	42 m
Forest	>15-18º downslope	45 m (20 m OPA)		100 m (25 m OPA)	52 m
Low hazard	Upslope/Flat	10 m		30 m	9 m
Low hazard	>0-5º downslope	10 m		40 m	11 m
Low hazard	>5-10º downslope	15 m		50 m	15 m
Low hazard	>10-15º downslope	15 m		60 m	19 m

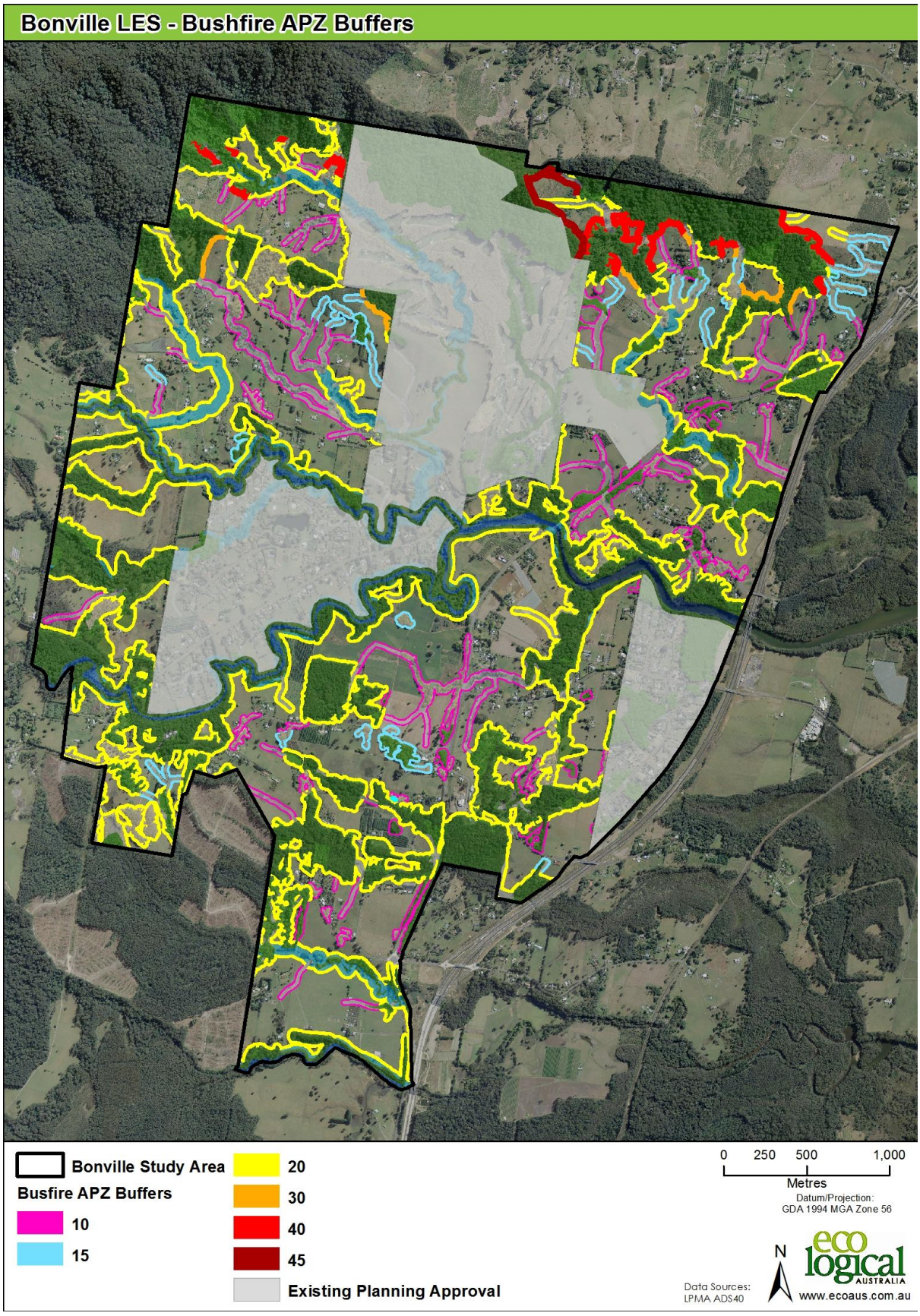

Figure 6: Asset Protection Zone (APZ)

5.1.2 Vegetation Management within APZ

The management of vegetation within the APZ is to achieve the specifications of an Inner Protection Area (IPA) and Outer Protection Area (OPA) as described by PBP. As such, the future APZ should be managed as follows:

- No tree or tree canopy is to occur within 2 - 5 m of future dwelling rooflines;
- The presence of a few shrubs or trees in the APZ is acceptable provided that they are well spread out, do not form a continuous canopy, and are located far enough away from future buildings so that they will not ignite the buildings by direct flame contact or radiant heat emission;
- Any landscaping or plantings should preferably be low flammability species such as local rainforest species;
- In the IPA, the ground fuel is to be maintained to less than 4 tonnes per hectare of fine fuel (4 t/ha is equivalent to a 1 cm thick layer of leaf litter and fine fuel means any dead or living vegetation of less than 6 mm in diameter, e.g. twigs less than a pencil in thickness); and
- In the OPA, the ground fuel may have up to 8 tonnes per hectare of fine fuel.

5.1.3 Perimeter Access within APZ

An APZ may require a perimeter road depending on the significance of the bushfire threat. The assessment of perimeter access is provided in the following Section 5.2.

5.2 ACCESS

PBP requires an access design that enables safe evacuation away from an area whilst facilitating adequate emergency and operational response to the area requiring protection. The following sections present the bushfire planning requirements for access in bushfire prone land.

5.2.1 Safe Access and Egress

All bushfire prone areas should have an alternate access or egress option. This is usually achieved by providing more than one public road into and out of a precinct. The need for an alternative road and its location depends on the bushfire risk, the density of the development, and the chances of the road being cut by fire. All precincts within the site should allow for an alternative public access road.

5.2.2 Perimeter Roads

Depending on the bushfire risk, all bushland interface areas containing an APZ for a significant bushfire hazard should feature a perimeter public road within the APZ. It is acceptable for some areas not to have a perimeter road or have a perimeter trail instead. These include areas of lower bushfire risk (such as adjoining low hazard areas), rural residential areas with large lot sizes whereby perimeter access can be provided within each lot, or areas where it may not be feasible to provide a continuous road due to the shape of the interface or the terrain. These areas should have some other access strategy such as trails or regular access points including access to a hydrant network.

The design details (PBP acceptable solutions) of public perimeter roads and fire trails are listed in Section 5.2.3 below.

5.2.3 Road Design and Construction Standards

Public roads and perimeter fire trails are to comply with the PBP acceptable solution design standards as listed in **Table 5** and **Table 6** respectively. Future residential subdivision within the site will be able to comply with these standards.

Table 5: Design and construction for public roads (RFS 2006; pg 21)

Performance Criteria	Acceptable Solutions
• *Firefighters are provided with safe all weather access to structures (thus allowing more efficient use of firefighting resources)*	• *Public roads are two-wheel drive, all weather roads*
• *Public road widths and design that allows safe access for firefighters while residents are evacuating an area*	• *Urban perimeter roads are two-way, that is, at least two traffic lane widths (carriageway 8 metres minimum kerb to kerb), allowing traffic to pass in opposite directions. Non perimeter roads comply with PBP Table 4.1 – Road widths for Category 1 Tanker (Medium Rigid Vehicle)* • *The perimeter road is linked to the internal road system at an interval of no greater than 500 metres in urban areas* • *Traffic management devices are constructed to facilitate access by emergency services vehicles* • *Public roads are through roads. Dead end roads are not recommended, but if unavoidable, dead ends are not more than 200 metres in length, incorporate a minimum 12 metres outer radius turning circle, and are clearly sign posted as a dead end and direct traffic away from the hazard* • *Curves of roads (other than perimeter roads) are a minimum inner radius of six metres* • *Maximum grades for sealed roads do not exceed 15 degrees and an average grade of not more than 10 degrees or other gradient specified by road design standards, whichever is the lesser gradient* • *There is a minimum vertical clearance to a height of four metres above the road at all times*
• *The capacity of road surfaces and bridges is sufficient to carry fully loaded firefighting vehicles*	• *The capacity of road surfaces and bridges is sufficient to carry fully loaded firefighting vehicles (approximately 15 tonnes for areas with reticulated water, 28 tonnes or 9 tonnes per axle for all other areas). Bridges clearly indicated load rating*
• *Roads that are clearly sign posted (with easy distinguishable names) and buildings / properties that are clearly numbered*	• *Public roads greater than 6.5 metres wide to locate hydrants outside of parking reserves to ensure accessibility to reticulated water for fire suppression* • *Public roads between 6.5 metres and 8 metres wide are No Parking on one side with the services (hydrants) located on this side to ensure accessibility to reticulated water for fire suppression*
• *There is clear access to reticulated water supply*	• *Public roads up to 6.5 metres wide provide parking within parking bays and located services outside of the parking bays to ensure accessibility to reticulated water for fire suppression* • *One way only public access roads are no less than 3.5 metres wide and provide parking within parking bays and located services outside of the parking bays to ensure accessibility to reticulated water for fire suppression*
• *Parking does not obstruct the minimum paved width*	• *Parking bays are a minimum of 2.6 metres wide from kerb to kerb edge to road pavement. No services or hydrants are located within the parking bays* • *Public roads directly interfacing the bush fire hazard vegetation provide roll top kerbing to the hazard side of the road*

Table 6: Design and construction for fire trails (RFS 2006; pg 25)

Performance Criteria	Acceptable Solutions
• *The width and design of the fire trails enables safe and ready access for firefighting vehicles*	• *A minimum carriageway width of four metres with an additional one metre wide strip on each side of the trail (clear of bushes and long grass is provided* • *The trail is a maximum grade of 15 degrees if sealed and not more than 10 degrees if unsealed* • *A minimum vertical clearance of four metres to any overhanging obstructions, including tree branches is provided* • *The crossfall of the trail is not more than 10 degrees* • *The trail has the capacity for passing by:* *- Reversing bays using the access to properties to reverse fire tankers, which are six metres wide and eight metres deep to any gates, with an inner minimum turning radius of six metres and outer minimum radius of 12 metres; and / or* *- A passing bay every 200 meters, 20 metres long by tree metres wide, making a minimum trafficable width of seven metres at the passing bay* *Note: Some short construction in the access may be accepted where they are not less than the minimum (3.5m) and extend for no more than 30m and where obstruction cannot be reasonably avoided or removed*
• *Fire trails are trafficable under all weather conditions. Where the fire trail joins a public road, access shall be controlled to prevent use by non authorised persons*	• *The fire service is accessible to firefighters and maintained in a serviceable condition by the owner of the land* • *Appropriate drainage and erosion controls are provided* • *The fire trail system is connected to the property access road and / or to the through road system at frequent intervals of 200 metres or less* • *Fire trails do not traverse a wetlands or other land potentially subject to periodic inundation (other than a flood or storm surge)* • *Gates for fire trails are provided and locked with a key / lock system authorized by the local RFS*
• *Fire trails designed to prevent ween infestation, soil erosion and other land degradation*	• *Fire trail does not adversely impact on natural hydrological flows* • *Fire trail design acts as an effective barrier to the spread of weeds and nutrients* • *Fire trail construction does not expose acid-sulphate soils*

5.3 WATER SUPPLY AND OTHER UTILITIES

5.3.1 Water Supply and Hydrants

Future lots are to be serviced by reticulated water infrastructure suitable for fire fighting purposes. With the exception of rural residential subdivision, the furthest point from any future dwellings to a hydrant is to be less than 90 m (with a tanker parked in-line) in accordance with *AS 2419.1 – 2005 Fire Hydrant Installations - System Design, Installation and Commissioning* (Standards Australia 2005). The reticulated water supply is to comply with the following acceptable solutions within Section 4.1.3 of PBP:

- Reticulated water supply to use a ring main system for areas with perimeter roads;
- Fire hydrant spacing, sizing and pressures comply with AS 2419.1 – 2005;
- Hydrants are not located within any road carriageway;
- All above ground water and gas service pipes external to the building are metal, including and up to any taps; and

- The PBP provisions of parking on public roads are met.

Future dwellings on rural residential lots will require a static water supply at time of development application as the dwellings will be beyond the hydrant distance quoted above.

5.3.2 Electrical and Gas Supplies

In accordance with PBP, electricity should be underground wherever practicable. Where overhead electrical transmission lines are installed:

- Lines are to be installed with short pole spacing, unless crossing gullies, and
- No part of a tree should be closer to a powerline than the distance specified in *Vegetation Safety Clearances* issued by Energy Australia (NS179, April 2002).

Any gas services are to be installed and maintained in accordance with *AS/NZS 1596-2008 The storage and handling of LP gas* (Standards Australia 2008).

5.4 BUILDING CONSTRUCTION STANDARDS

The application of building construction standards for bushfire protection under *AS 3959-2009 Construction of buildings in bushfire-prone areas* (Standards Australia 2009) is to be considered at the development application stage for individual dwellings and buildings. An assessment under AS 3959-2009 is not required at the rezoning or subdivision stages. The following is a brief introduction on AS 3959-2009.

AS 3959-2009 contains six Bushfire Attack Levels (BAL) each with a prescribed suite of design and construction specifications aimed at preventing ignition during the passing of a bushfire front. The BALs are introduced below:

- BAL-Low: The threat does not warrant application of construction standards. Developments with BAL-Low are generally not within bushfire prone land (greater than 100 m from bushland);
- BAL-12.5: Addresses background radiant heat at lower levels and ember attack;
- BAL-19: Addresses mid-range radiant heat and ember attack;
- BAL-29: Addresses high range radiant heat and ember attack;
- BAL-40: Addresses extreme range of radiant heat and potential flame contact and ember attack; and
- BAL-FZ: Addresses construction within the flame zone. New subdivided lots are not permitted within the flame zone in NSW.

NSW has a minor variation to AS 3959-2009 which requires consideration in future development applications. The variation is contained within the document ‘PBP Appendix 3 Addendum’ (RFS 2010).

6 Conclusion

6.1 STATEMENT OF CAPABILITY

This bushfire assessment demonstrates that the study area is capable of accommodating future subdivision and land development with the appropriate bushfire protection measures.

6.2 RECOMMENDATIONS AND CONCLUSION

The recommendations of this bushfire assessment are located within Section 5 – Bushfire Protection Measures. They include the provision of Asset Protection Zones, adequate access, water supply for fire fighting, the safe installation of utilities, and building construction standards for future dwellings.

This bushfire assessment demonstrates that the subject land is capable of accommodating future residential subdivision and associated land use with the appropriate bushfire protection measures and bushfire planning requirements prescribed by s.117 (2) Direction 4.4 – 'Planning for Bush Fire Protection' (EP&A Act) and *Planning for Bushfire Protection* (RFS 2006).

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APPENDIX 6 - BUSHFIRE ASSESSMENT

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Bonville Rural Residential

Flood Mapping

Draft

December 2013

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DOCUMENT CONTROL STATUS

Issue	Rev.	Issued To	Qty	Date	Reviewed	Approved
CHCC	D1	CHCC	PDF	20-03-2014	RDG	RDG

Revision Comments.

D1 Preliminary Draft

Printed:	20 March, 2014 11:20 AM
Last Saved:	20 March 2014 8:34 AM
File Name:	S:\13\13039 Bonville Rural Residential Investigation Area\WP\13039 Flood Mapping 2013-12-04.docx
Project Manager:	Rob de Groot
Name of Organisation:	CHCC
Name of Project:	Bonville Rural Residential
Name of Document:	Flood Mapping
Job Number:	13039

EXECUTIVE SUMMARY

This flood mapping has been prepared as part of a Local Environment Study of the Bonville Rural Residential Investigation Area. The study area encompasses some 1,858 Ha of mostly rural and rural residential land, west of the Pacific Highway at Bonville, some 10 km south of Coffs Harbour on the NSW mid north coast.

This study is limited to the mapping of land affected by main stream flooding. Such mapping forms a key input into the Local Environment Study. No determination of existing floodplain damages or further analysis of floodplain management options were undertaken.

In order to determine the extent of land affected by flooding, hydrologic and hydraulic computer flood modelling was undertaken. Key aspects were:

- A WBNM hydrologic computer model of the entire Bonville and Pine Creek catchments were prepared, extending to the ocean.

- The WBNM model included a rainfall elevation gradient consistent with recent Coffs Harbour flood studies.

- A Tuflow hydraulic computer model was constructed. The study area was modelled by a 4m two-dimensional grid. A one-dimensional model was extended from the study area to the ocean.

- The flood events modelled were:
  - 100-year ARI (1% AEP) flood under existing conditions. Temporal patterns from ARR87 (ref 4) were modelled for events of 30 min to 12 hour duration. Events of 2 hours (minor creeks) and 9 hours (Bonville and Pine Creeks) were generally found to be critical.
  - 100-year ARI with predicted effects of climate change by the year 2050 (0.5m rise in sea level and 10% increase in flows)
  - 500-year ARI under existing conditions.
  - The probable maximum flood (PMF).

- A sensitivity test was undertaken which found that flood level predictions within the study area are not sensitive to the ocean level assumption.

- The models were not calibrated due to an absence of data. However, the results were compared to what limited previous flood studies and historic flood level data is available. The comparison against previous studies was mixed, but was better against the limited historic flood data. The modelling for this study is considered superior to any previous investigations.

The results of the modelling are shown of Maps 1 to 7. These show the flood extends and contours for the 100-year ARI flood under existing conditions. The additional extents for the larger events are also shown.

1 INTRODUCTION

This investigation has been prepared as part of a Local Environment Study of the Bonville Rural Residential Investigation Area. The study area is shown in Figure 1 and covers some 1,858 Ha of existing rural, forest, recreational and rural residential land west of the Pacific Highway.

This study used computer flood modelling to determine and map flood levels and extents. Four flood events were considered:

- The 100-year average recurrence interval (ARI) flood under existing conditions;
- The 100-year ARI flood under climate change (2050 horizon);
- The 500-year ARI flood under existing conditions;
- The Probable Maximum Flood (PMF) under existing conditions.

The mapping prepared shows the main stream flood extents, flood depths and flood contours.

2 DATA SET

Three previous studies of relevance were reviewed:

- Bonville Creek Flood Study, (ref 1);
- Bonville International Golf Resort – Flood Study, (ref 2);
- Burgess Creek Flood Study, (ref 3).

The Bonville Creek flood study utilised RORB for the hydrology and EXTRAN for the channel hydraulics. The EXTRAN Hydraulic model extended from the ocean up to the then Pacific Highway (now Pine Creek Way). As such the hydraulic model only extended a short way into this study area. Regardless, this is the most expansive of the past studies and gives a basis to construct a downstream boundary for this study.

Ref 2 is confined to only a small part of the study area, being three minor creeks in and around the Bonville International Golf Resort. The study was undertaken using the steady state one dimensional HEC-RAS hydraulic model.

Ref 3 is also confined to only a small part of the study area along Burgess Creek. This is an old study using the one dimensional steady state HEC-II hydraulic model.

Council were also able to supply some historic flood level information from the November 1996 and March 2009 events.

3 HYDROLOGY

None of the hydrologic or hydraulic models used in the previous studies were readily available. Nor would they entirely meet the needs of this investigation. Fresh hydrologic modelling was undertaken using the WBNM computer model. WBNM was selected as it is well recognised in the industry, is freely downloadable and is EXCEL spreadsheet based. This makes it easily portable and gives the flexibility of a spreadsheet to manipulate the output data into a form compatible with the selected hydraulic model TUFLOW.

The WBNM model was set up with fairly course sub-catchment division of the main creeks upstream and downstream of the study area. However, the division of sub-catchments within the study area was much finer. This allowed the many small tributaries throughout the study area to be modelled. The sub-catchment division is shown in Figure 1a & 1b. Key aspects of the model are:

- Total catchment area of Bonville and Pine Creeks (excluding Middle Creek) at the estuary is 108.7 sq.km. The catchment was divided into 156 sub-catchments of which 121 were within the study area;

- A rainfall gradient was introduced that used the same elevation relationship adopted in recent flood studies of Coffs Creek and Newports Creek by WMA;

- The percentage imperviousness for existing conditions was set at 1% throughout.

- The model's prediction of peak 1% AEP flow at the estuary (1,440 m^3/s for the 9 hr event) was compared with the reported 1,295 m^3/s in from the RORB model used in Ref 1. The 11% increase in flows was considered reasonable given the inclusion of the rainfall gradient which accounted for a 13% increase in rainfall intensity, but biased to the upper reaches.

- Model parameters were typically set to the default as recommended by WBNM, specifically:
  - Catchment lag = 1.6;
  - Impervious lag = 0.1;
  - Initial loss = 0 mm (a wet catchment);
  - Pervious continuing loss = 3.5mm;

The WBNM model was used to prepare hydrographs for input into a TUFLOW hydraulic computer model of the study area. The following ARR87 design events were modelled:

- 1% AEP (100-yr ARI) events (0.5 to 12hr duration);
- 0.2% AEP (500-yr ARI) events (2 & 9 hr);
- Probably Maximum Flood (PMF) events (2 & 6hr).

Hydrographs for a 1% AEP event with climate change (year 2050 prediction) were also prepared. These were the existing condition 1% AEP hydrographs scaled up by 10%, plus the downstream ocean stage hydrograph was increased by 0.5m.

4 HYDRAULICS

Hydraulic modelling of the flood behaviour through the study area was undertaken using the computer program TUFLOW. TUFLOW is a un-steady state two dimensional hydraulic model that reliably accounts for the two dimensional flow distribution of flood waters across a floodplain plus the attenuation effect of floodplain storage.

In this instance the key aspects of the TUFLOW model are:

- The extent of the model is shown in Figure 2. The study area was modelled in 2D. In addition, the model was extended downstream to the estuary using TUFLOW's 1D routines.

- A digital elevation model (DEM) of the existing topography through the study area was generated from Council's aerial laser survey (ALS) data with modifications along the creek channels. The ALS data is most reliable across cleared ground where individual point accuracy is generally within plus or minus 0.2m. However, it is less reliable through thick vegetation, which in this case, is often along the creek lines. In areas of thick vegetation the ALS data tended to miss the narrow creek inverts. Using civil design software (12D and Autocad Civil 3D) long sections were plotted along all the modelled creek lines. Creek channels were then 'burnt' into the DEM by stringing the low points together, creating a channel that continuously fell towards the outlet. The width of these channels was varied based on close inspection of aerial photography and field observations. The approaches and exits from culverts were also burnt into the DEM to ensure they were below the field measurements of the culvert inverts.

  The ALS data also predates the recent Pacific Highway upgrade. The DEM was adjusted to approximate the motorway's embankments.

- A 4 by 4 metre modelling grid was adopted. This size was a compromise between run time of the model and accuracy. While a 4 metre grid is a little course to accurately model some of the smaller creeks, a finer resolution was unworkable. Due to some of the fairly step reaches, a short time step of 1 sec was needed for stability. The 4 m grid at 1 sec required approximately 12 hours of run time to model a 9 hour event. Halving the grid would increase the run time by a factor of eight, which was considered unworkable.

- Manning's n value of hydraulic roughness was assigned the regions based on experience and the aerial photography. The values adopted were:
  - Pavement = 0.02;
  - Open pasture = 0.03;
  - Sparse vegetation = 0.05;
  - Medium vegetation = 0.08;
  - Buildings = 3.0;

  Most of the creek channels were modelled at 0.08.

- Dams were essentially modelled as full.

- 51 culvert crossings were included. Their size and levels were measured in the field. Their levels were generally measured relative to the road centreline. This in turn was determined with reasonable accuracy from the ALS data. The ALS data being far more accurate along the clear road way than along the creek lines. Note, on some of the minor creeks driveway culverts were ignored as were some of the structures within the Bonville Golf Course.

Some of the bridges (such as Pine Creek Way and the Pacific Highway Motorway over Bonville and Pine Creeks) were not modelled using TUFLOW's bridge or culvert routines. In these cases, the bridge decks were determined to be comfortably above the flood surface. As such, their modelling was reliably achieved by accurately modelling the road embankments and bridge abutments in the 2D DEM. Any effect of bridge piers was ignored.

- To provide a reliable basis for the downstream boundary, the model was extended from the study area to the ocean. This extension was modelled using the simpler and faster one dimensional (1d) routines. The 1d model was constructed using the cross sections and channel arrangement from the Bonville Creek Flood Study (Ref 1), although some of these were modified as discussed in the comparison below.

  Extending the model brought all the creeks together to just one downstream boundary. Setting at the ocean allowed the use of long standing and accepted ocean level assumptions. The long extension of the model also ensures that any error in the ocean level assumption has reduced affect within the study area. That is, the flood levels modelled in the study area are not sensitive to the ocean level assumption.

  At the ocean a stage hydrograph with the same AEP as the rainfall event was adopted, with its peak coinciding with peak flow. This is a very conservative, but often used assumption. The peak ocean levels adopted were:

  – 2.5 mAHD for 1% AEP (100-year ARI) under existing conditions;
  – 3.0 mAHD for 1% AEP under year 2050 climate change conditions;
  – 2.7 mAHD for 0.2% AEP (500-year ARI) under existing conditions;
  – 3.0 mAHD for the PMF under existing conditions;

  The merits of this conservative assumption are somewhat irrelevant as the study area is sufficiently upstream to greatly mitigate any effects of the adopted assumption. To demonstrate this a sensitivity test with a normal ocean level (peak of RL 1.0 mAHD) was undertaken as discussed latter.

4.1 Comparison with Past Studies and Historic Flood Levels

Calibration of the WMNM hydrologic and TUFLOW hydraulic models was not attempted. The results were however compared against previous studies and the little historic flood level information available, as summarised in Table 4.1. For the 1% AEP event under existing conditions, this found:

Bonville Creek Flood Study (Ref 1)

Good agreement was found along Bonville Creek from the new highway to Pine Creek Way (the upstream limit of Ref 1). However, there is significant disagreement for Pine Creek, particularly at the downstream limit of the 2d modelling. Here TUFLOW predicts a 1% AEP flood level more than 1 metre below Ref 1. It is noted that this study's peak flow predictions were also lower than in ref 1 (472 vs 536 m^3/s) at Pine Creek Way, which may explain some of the difference but is unlikely to account for all of it.

The difference was surprising as both models initially used the same cross sections. Further investigations revealed that the cross sections from Ref 1 were not modelling the full extent of

floodplain storage or the Railway embankment and bridge. The TUFLOW cross sections were adjusted to better account for these effects, although the resulting TUFLOW flood level predictions within the study area, as summarised in Table 4.1a, were still substantially below those in Ref 1.

Table 4.1a – Comparison of Model Results Against Ref 1 (Peak 1% AEP Levels).

Location	Tuflow Model (mAHD)	Bonville Creek Flood Study (mAHD)
Bonville Creek at Pacific Highway	d/s Bon 1 = 4.39 u/s Bon 2 = 4.46	Stn 85 = 4.31
Bonville Creek u/s Pine Creek Way	Bon 5 = 5.34	Stn BONU/S = 5.26
Ocean	2.50	Stn OCEAN = 2.40
Pine Creek at confluence with Bonville Ck	B112 = 3.82	Stn BON-PINE = 3.38
Pine Creek at d/s boundary of 2d model	Pine 1 = 5.95	Stn 135 = 7.05
Pine Creek u/s Pine Creek Way	Pine 4 = 6.49	Stn PINU/S = 7.68

Bonville International Golf Resort – Flood Study (Ref 2)

The comparison with Ref 2 was mixed. There were significant differences at the downstream limits of Ref 2. Here Ref 2 had to assume 'starting water levels' and those assumptions were generally higher than TUFLOW's calculated levels. Further upstream the agreement was better. The notable exceptions is that TUFLOW predicts greater depth over North Bonville Road.

Table 4.1b – Comparison of Model Results Against Ref 2 (Peak 1% AEP Levels).

Location	Tuflow Model (mAHD)	BIG Flood Study (mAHD)
Cassidys Ck, 250m d/s of North Bonville Rd	Cas 1 = 6.34	Westmain 20 (d/s limit) = 7.46
Confluence of Cassidys & Yarraman Ck, 150m u/s of North Bonville Rd	Cas 4 = 9.32	WestSub1 2.5 = 8.53
Cassidys Rd over creek (Golf Course)	Cas 8 = 19.16	Westmain 1640 = 19.11
Middle Ck (BIG) d/s of North Bonville Rd	BIG 1 = 6.07	Middle Creek 71.96 = 5.80
BIG Club house	6.07	Middle Creek 640 = 5.83
Irvines Ck, d/s of Pine Ck Way	Irv 6 = 5.74	Eastmain 86.08 = 6.70
Irvines Ck, u/s of Pine Ck Way	Irv 7 = 6.81	Eastmain 110.63 = 7.28
Irvines Ck, 300m u/s of Pine Ck Way	Irv 9 = 7.62	Eastsub 20 = 7.67

Burgess Creek Flood Study (Ref 3)

The TUFLOW predictions are substantially higher than Ref 3. The difference is greatest at the Braford Drive bridge over Burgess Creek, which was the downstream boundary of the Burgess Creek Flood Study. Here TUFLOW predicts a flood level nearly 2 metres higher that the Burgess Creek Flood Study. A review of the Burgess Creek Flood Study found no discussion as to its downstream boundary assumption and it is difficult to see how the authors could justify such a low level.

The TUFLOW model predictions are considered more accurate than Ref 3.

Table 4.1c – Comparison of Model Results Against Ref 3 (Peak 1% AEP Levels).

Location	Tuflow Model (mAHD)	Burgess Creek Flood Study (mAHD)
Burgess Ck at:		**Burgess Creek Flood Study (Ref 2)**
Braford Drive	u/s (Bur 2) = 6.21	XS 1 = 4.26
Confluence of dam overflow trib	Bur 5 = 7.16	XS 3 = 6.25
Confluence of dam outlet	Bur 7 = 9.02	XS 4 = 7.69
Dam u/s of Bakker Dr	Bur Dam = 12.19	XS 11 = 11.76

Historic flood levels.

The historic flood levels were supplied from Council's GIS for the November 1996 and March 2009 events. In some instances the exact location of the recorded flood level was not clear from the description and some error in the comparison is possible.

Further, the historic flood levels are not directly comparable with the design 1% AEP TUFLOW levels as the actual probability of the historic events is not known. It is known that these were major rainfall events in the order of 100-year ARI. They were however not major ocean events.

Even though they are not directly comparable, they can be used as a gross check for consistency. In this case, the TUFLOW 1% AEP predictions generally appear a little higher, but more importantly, are reasonably consistent with the historic levels.

Table 4.1d – Comparison of Model Results Against Historic (Peak 1% AEP Levels).

Location	Tuflow Model (mAHD)	Historic Flood Levels (mAHD)
		November 1996 Historic Flood
Pine Creek Way over Bonville Creek	5.20	4.60
7 Braford Park Dr	6.15	5.52
North Bonville Rd, east Bridge	Cas 3 = 7.32	7.46
North Bonville Rd, west Bridge	NB 6 = 18.64	18.85
Pine Ck Way Culvert, 200m South Irvines	Irv 7 = 6.72	6.69
Pine Ck Way Culvert, near Titan Close	Irv D5 = 6.69	6.62
		March 2009 Historic Flood
257 Pine Ck Way (d/s of Bonville Ck bridge	4.90	5.07
Pine Ck Way bridge over Bonville Ck	4.82	4.99
282 Pine Ck Way (u/s of Bonville Ck bridge	5.72	5.48
7 Braford Park Dr	6.15	5.98 & 6.03
20 Bakker Drive (d/s of dam overflow)	Bur C1 = 7.47	7.59
62 Bakker Dr	Approx 9.5	9.99
173 Braford Dr	Approx 14.8	15.20

4.2 Sensitivity to Downstream Boundary

A sensitivity test was undertaken to test the impacts of the ocean level assumptions. The critical 1% AEP event (9hr duration) was modelled with a normal tidal ocean level, (peaking at RL 1.0 mAHD) and with the adopted 1% AEP ocean level (peaking at 2.5 mAHD). The results are summarised in Table 4.2

Table 4.2 - Ocean level sensitivity

Peak flood level at:	Normal high tide ocean (mAHD)	Adopted 1% ocean level (mAHD)
Ocean Level.	1.00	2.50
Confluence of Bonville and Pine Creeks. (XS112)	3.71	3.82
Bonville Creek at the downstream boundary of study area. (Bon 2)	4.39	4.45
Bonville Creek, just upstream of Pine Creek Way. (Bon 5)	5.28	5.33
Pine Creek at the downstream boundary of the study area. (Pine 3)	6.20	6.21

The results found that the ocean level assumption little influence of the modelled flood levels within the study area, being a maximum of 60mm along Bonville Creek at the downstream boundary of the study area.

5 FLOOD MAPPING

Design rainfall temporal patterns from Australian Rainfall and Runoff (ref 3) were adopted. Events ranging in duration from 30 minutes to 12 hours were modelled. The event causing the greatest flood level varied throughout the study area. As expected short duration events caused the greatest flood in the upper reaches of minor creeks, where as longer duration events caused the greatest flood level in the major creeks. The 9 hour event was found to be critical for Bonville and Pine Creeks. In all, the 2 hour and 9 hour events caused the greatest flood level over 75% of the study area.

The existing conditions 1% AEP flood extents and flood contours are shown on Maps 1 to 7. Note, these are the maximum levels from all the durations modelled.

Maps 1 to 7 also show:

- The additional flood extents for the 1% AEP flood with predicted climate change by the year 2050. Being 10% greater flows and the ocean level increased by 0.5 m;
- The additional extents of the 0.2% AEP (500-year ARI) flood under existing conditions; and;
- The extents of the probable maximum flood (PMF) under existing conditions.

Note, for clarity the flood contours are only shown for the 1% AEP flood under existing conditions. Also note that the flood extents up minor creeks is limited to the discrete locations of the modelled inflow.

6 REFERENCES

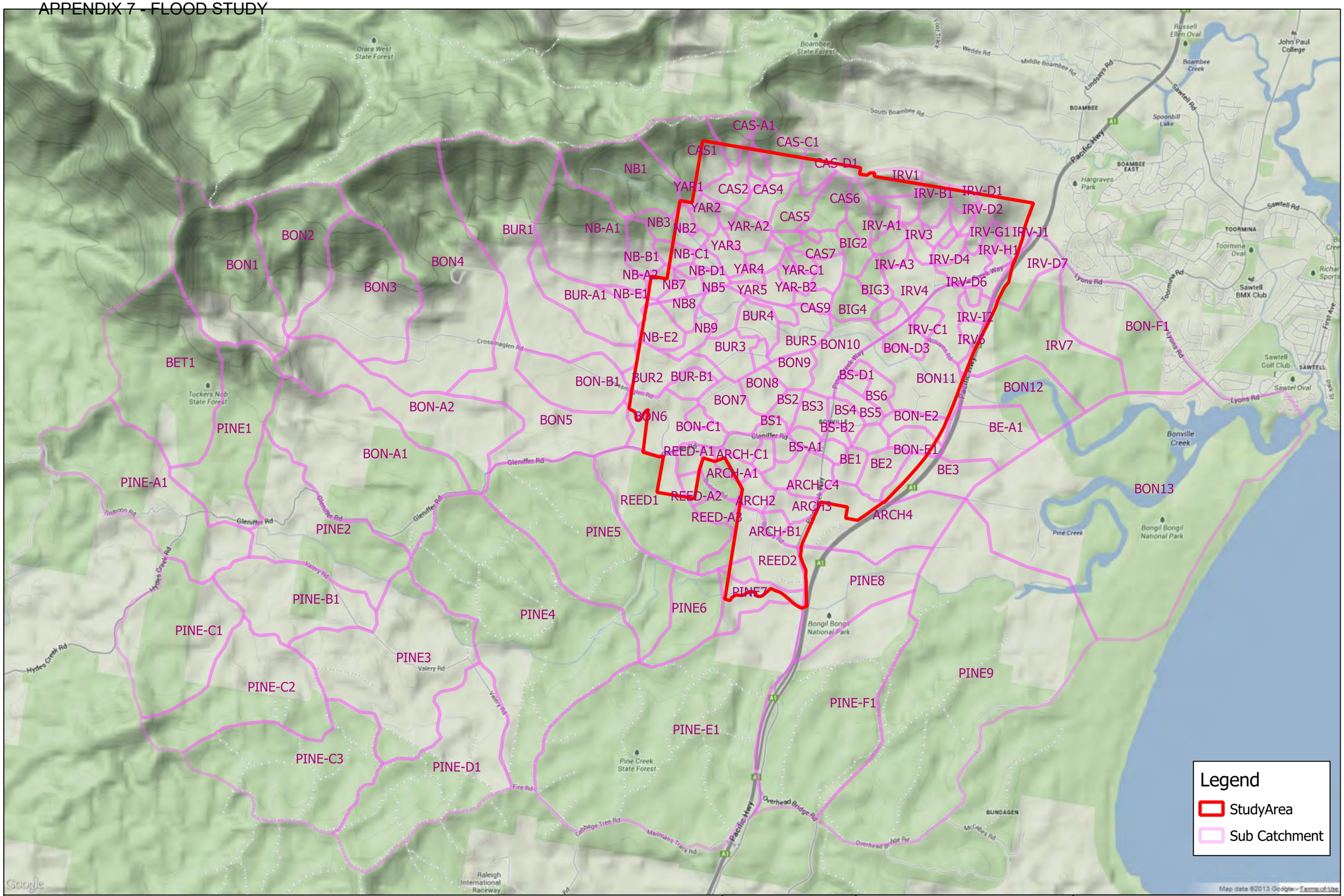
1. Bonville Creek Flood Study, (Slattery de Groot & Partners P/L & Bewsher Consulting P/L, October 1995).

2. Bonville International Golf Resort – Flood Study, Issue C, (Worley Parsons, 4th April 2011).

3. Burgess Creek Flood Study, (GHD 1989).

4. Australian Rainfall and Runoff, (Institute of Engineers, Australia, 1987)

MAPS


CAS-A1
CAS-C1
CAS1
CAS-D1
IRV1
IRV-B1
IRV-D1
NB1
YAR1
CAS2
CAS4
CAS6
YAR2
CAS5
IRV-A1
IRV3
IRV-G1
IRV-J1
IRV-D2
BON2
BUR1
NB-A1
NB3
NB2
YAR-A2
BIG2
IRV-H1
YAR3
CAS7
BON1
BON4
NB-B1
NB-C1
IRV-A3
IRV-D4
IRV-D7
NB-A2
NB-D1
YAR4
YAR-C1
BON3
NB7
NB5
YAR5
YAR-B2
BIG3
IRV4
IRV-D6
BUR-A1
NB-E1
NB8
CAS9
BIG4
BUR4
IRV-I2
NB9
IRV-C1
BON-F1
NB-E2
BUR3
BUR5
BON10
IRV5
BON-D3
IRV7
BET1
BON9
BON-B1
BUR2
BUR-B1
BON8
BS-D1
BON11
BON12
BON7
BS2
BS6
BS3
BS4
BS5
BON-E2
BON-A2
BON5
BON6
BON-C1
BS1
BS-B2
BE-A1
PINE1
REED-A1
ARCH-C1
BS-A1
BON-E1
BE1
BE2
BE3
BON-A1
ARCH-A1
PINE-A1
ARCH-C4
BON13
REED-A2
ARCH2
REED1
ARCH3
REED-A3
ARCH4
PINE2
PINE5
ARCH-B1
REED2
PINE8
PINE7
PINE-B1
PINE6
PINE4
PINE-C1
PINE9
PINE3
PINE-C2
PINE-F1
PINE-E1
PINE-C3
PINE-D1
Legend
StudyArea
Sub Catchment
1 0 1 2 3 4 km
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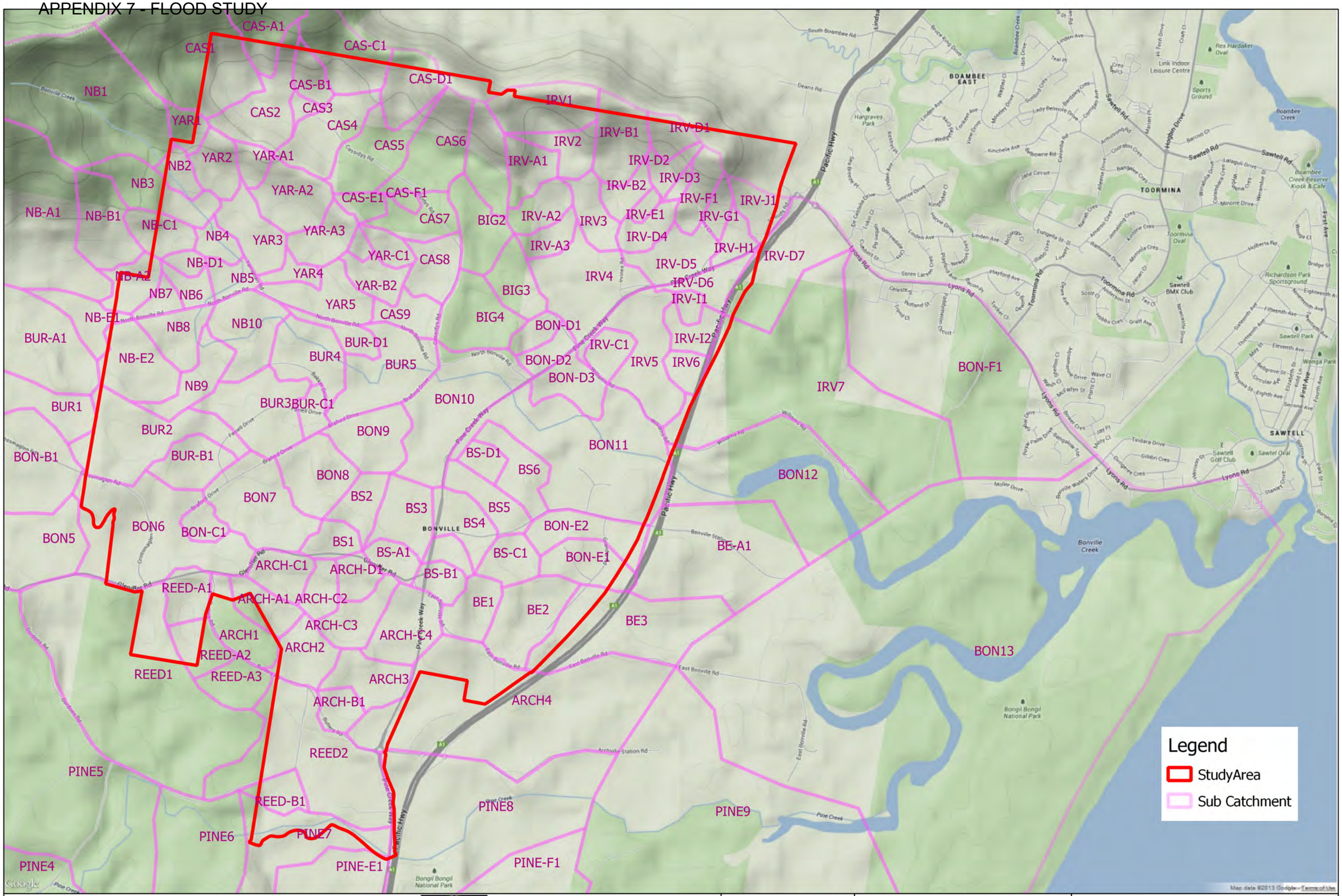
Consulting Engineers & Planners
Bonville Rural Residential Flood Study
Catchment Plan
Fig 1a



0.5 0 0.5 1 1.5 2 km

Scale 1:50,000 @ A3

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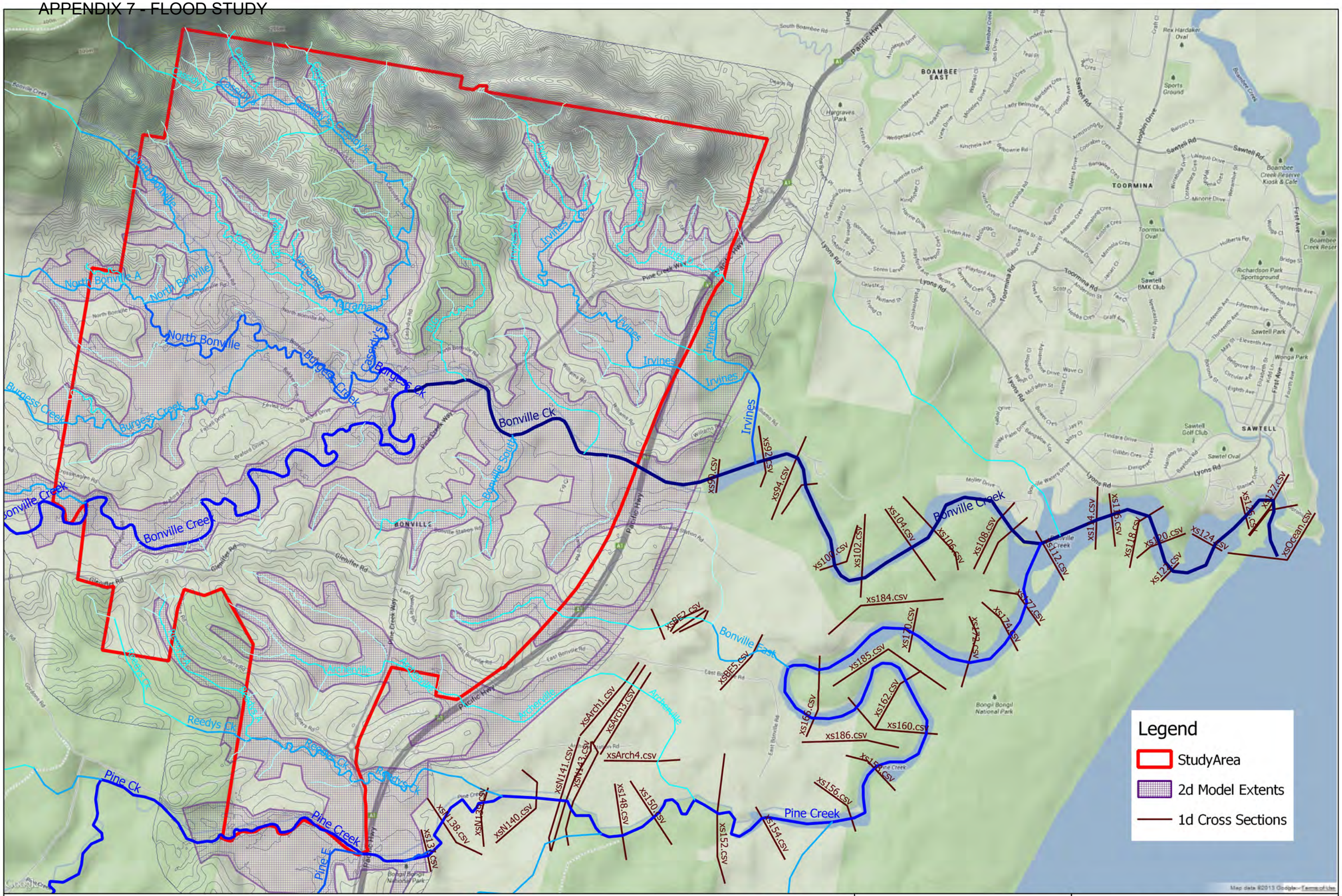
Catchment Plan

Fig 1b



0.5 0 0.5 1 1.5 2 km

Scale 1:50.000 @ A3

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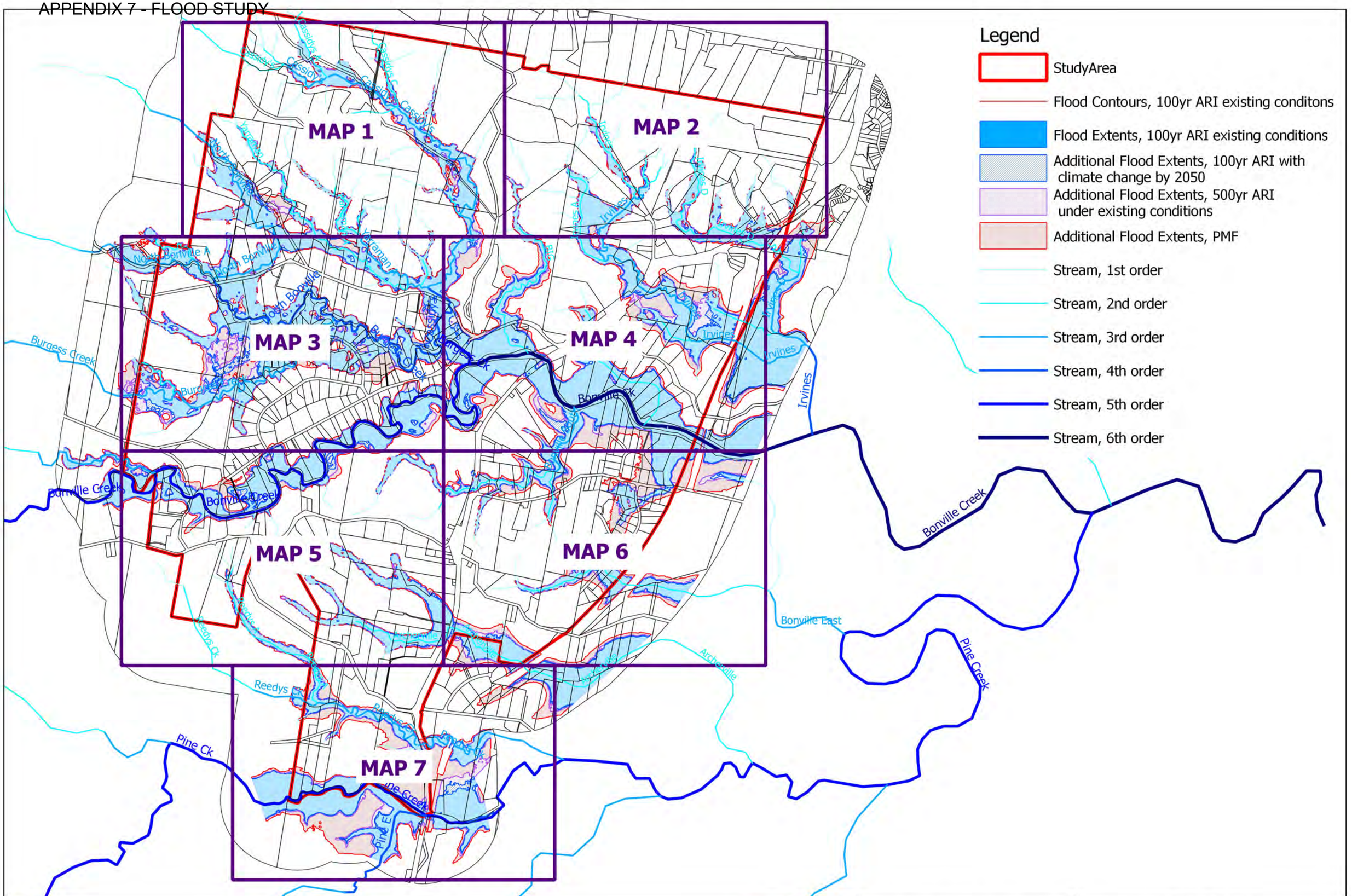
TUFLOW Model

Fig 2



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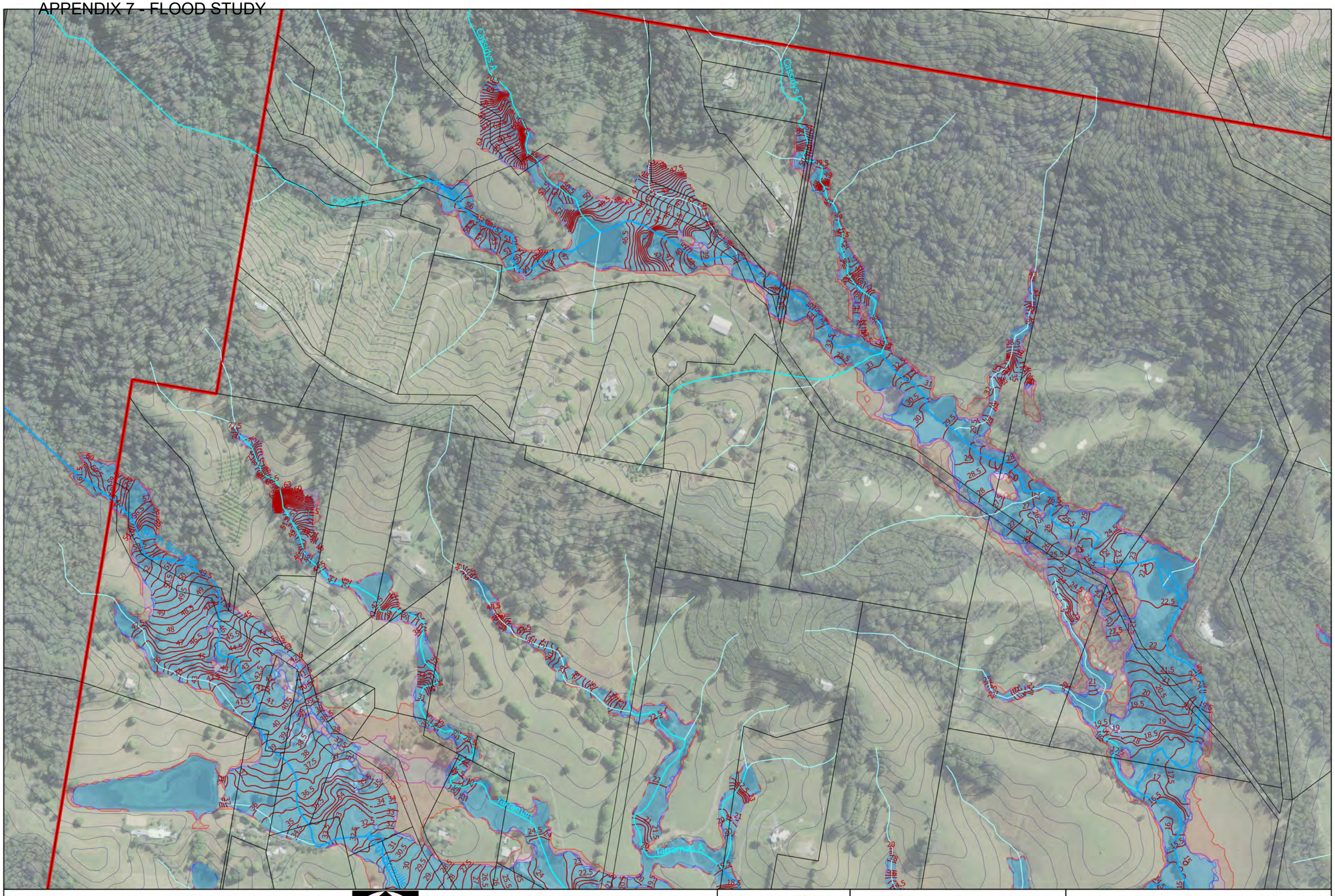
Flood Extents

Map Index & Legend



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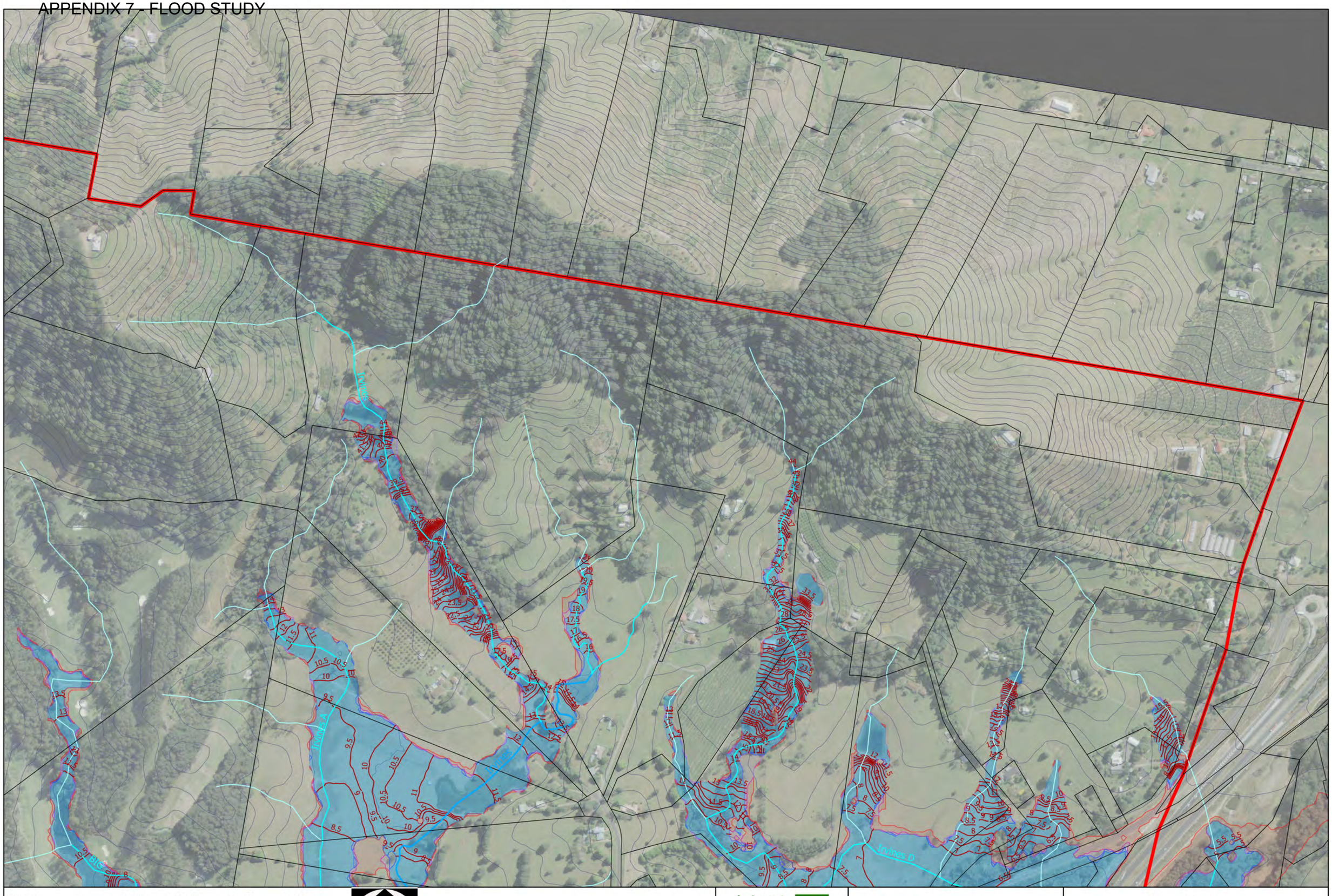
Flood Extents

Map 1



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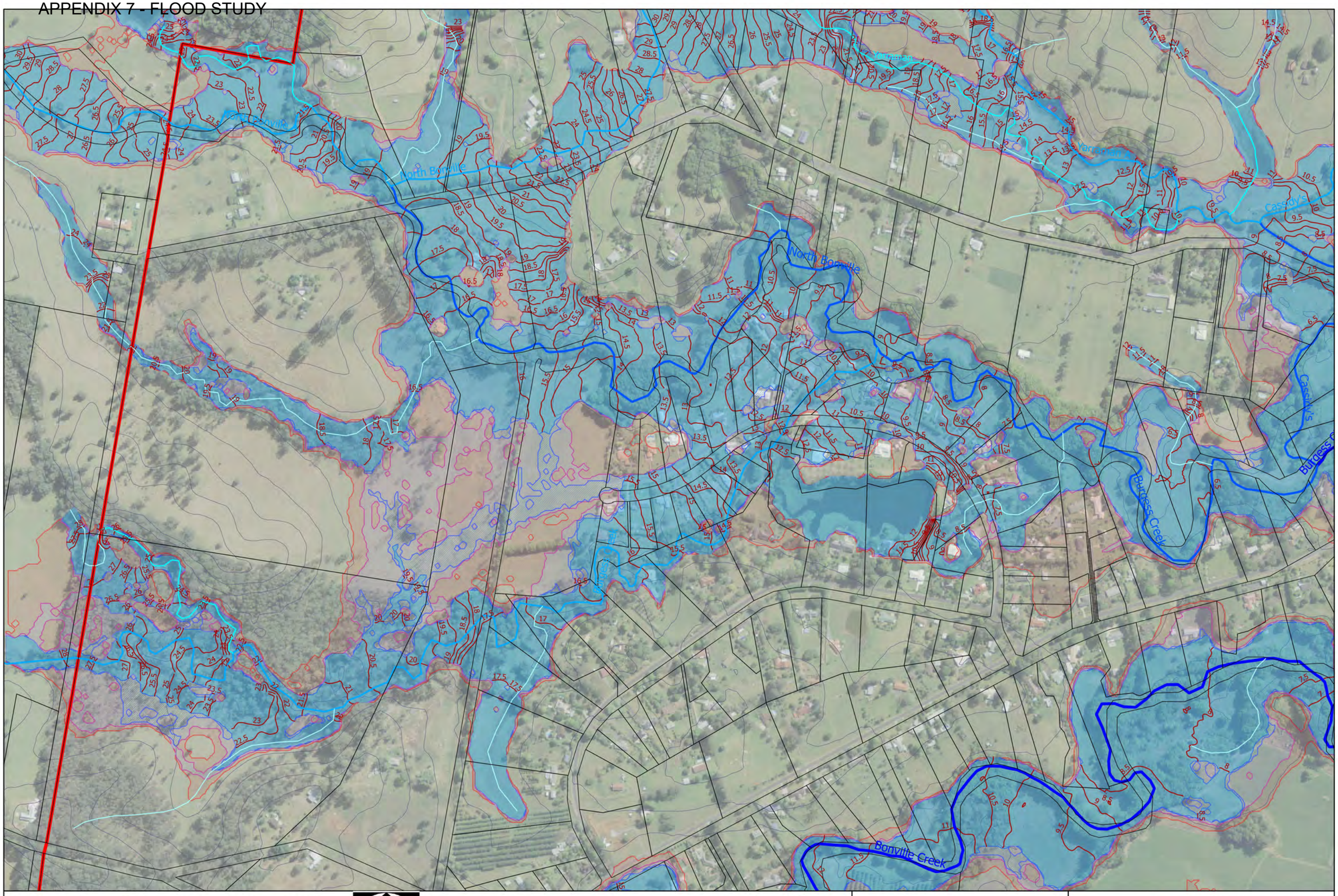
Flood Extents

Map 2



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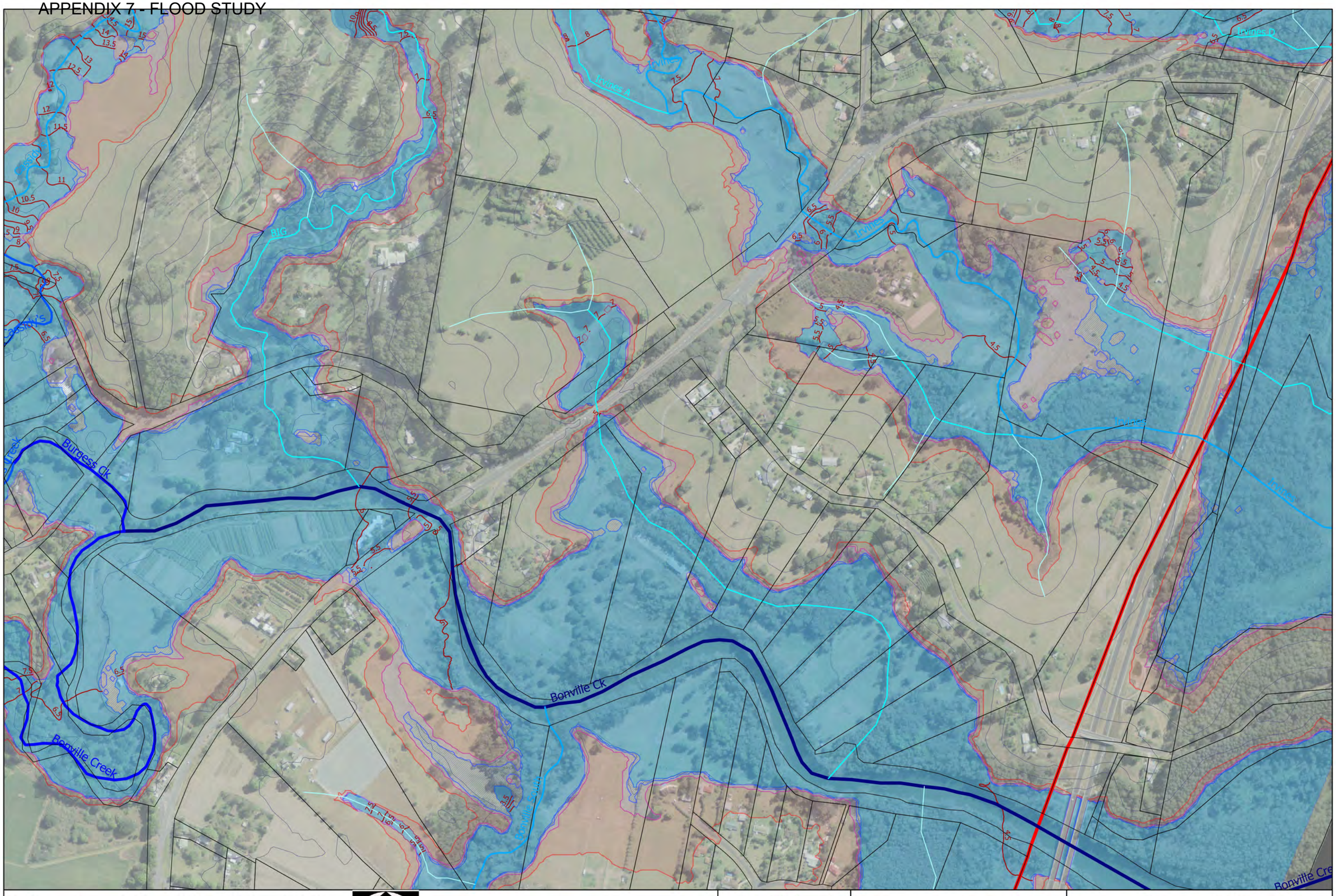
Bonville Rural Residential Flood Study

Flood Extents

Map 3



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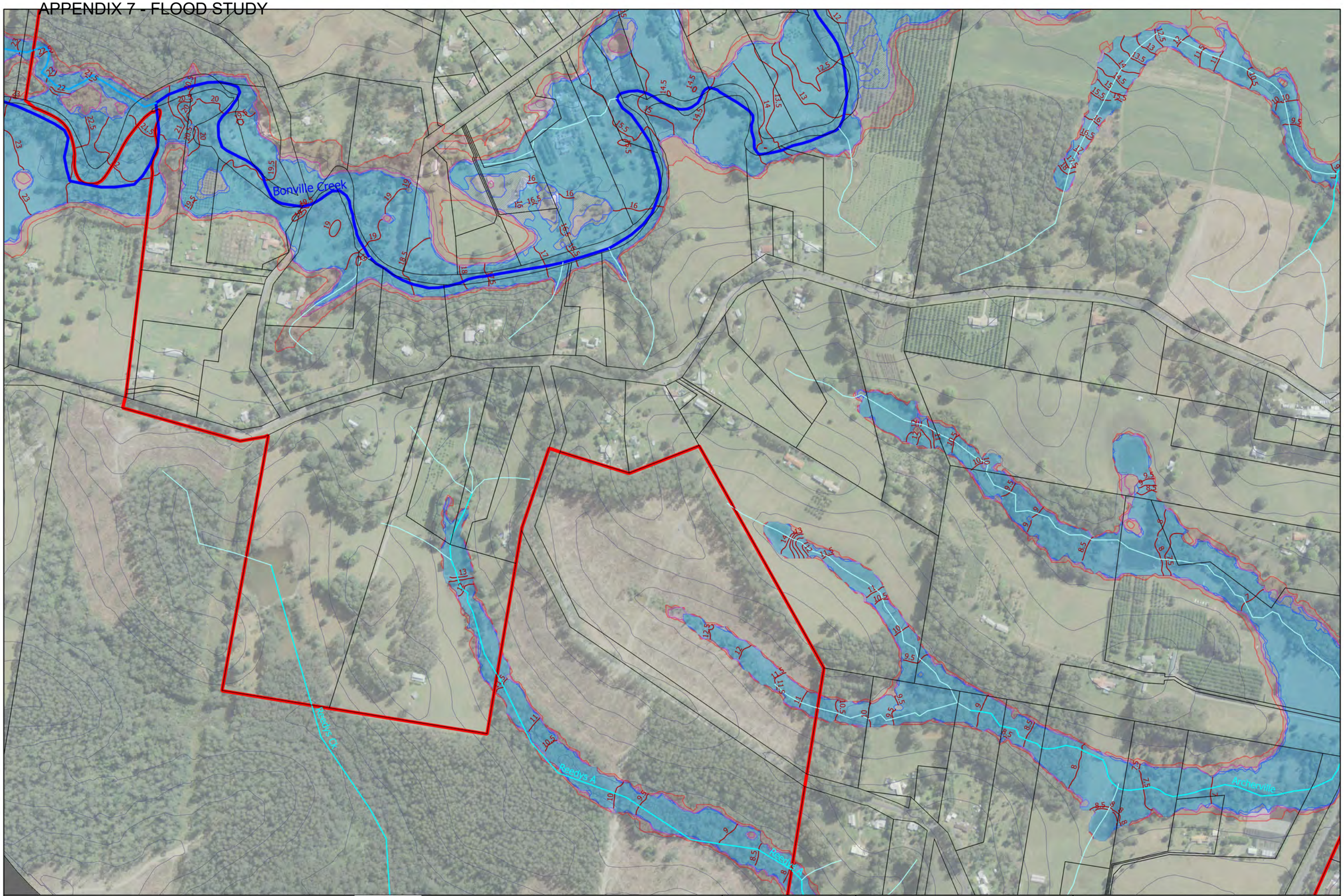
Bonville Rural Residential Flood Study

Flood Extents

Map 4



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Flood Extents

Map 5

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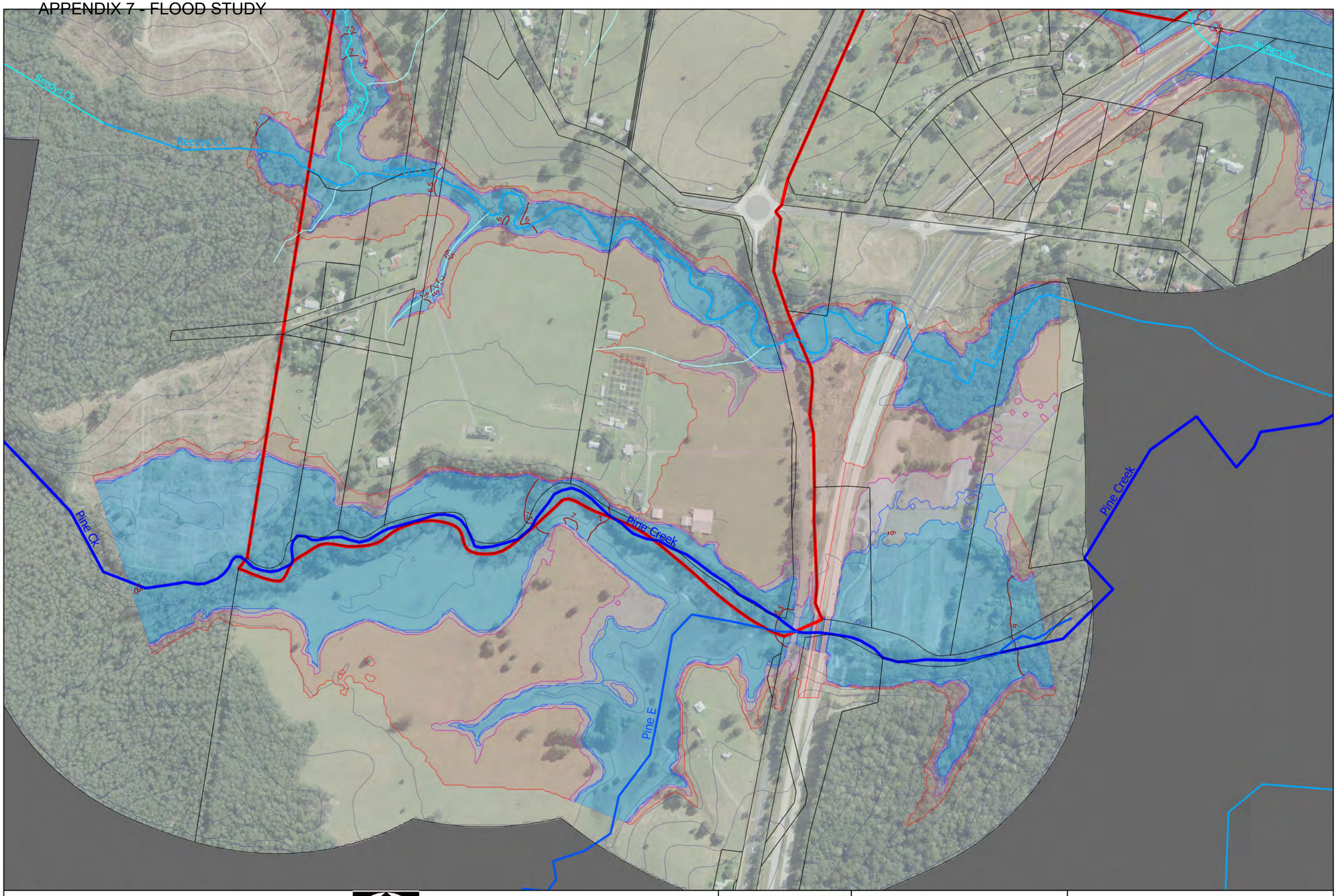
Bonville Rural Residential Flood Study

Flood Extents

Map 6



100 0 100 200 300 400 m

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Bonville Rural Residential Flood Study

Flood Extents

Map 7

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Bonville Local Environment Study

Wastewater Assessment

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Document Control Sheet

Document and Project Details	
Document Title:	Bonville Local Environment Study – Wastewater Assessment
Authors:	Shann Mitchell & Jasmin Kable
Project Manager:	Strider Duerinckx
Date of Issue:	21 November 2013
Job Reference:	1098
Synopsis:	Assess the limitations for wastewater management and the potential for rural residential subdivision in the township of Bonville

Client Details	
Client:	Coffs Harbour City Council
Primary Contact:	Harpreet Jenkins

Document Distribution

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Disclaimer

The information contained in this report is based on independent research undertaken by Shann Mitchell and Jasmin Kable of Whitehead & Associates Environmental Consultants Pty Ltd. To our knowledge, it does not contain any false, misleading or incomplete information. Recommendations are based on an honest appraisal of the site's opportunities and constraints, subject to the limited scope and resources available for this project, and follow relevant best practice standards and guidelines where applicable, including:

- AS/NZS 1547: *On-site Domestic Wastewater Management* (Standards Australia / Standards New Zealand, 2012);
- NSW Department of Local Government (1998) *Environment & Health Protection Guidelines: Onsite Sewage Management for Single Households*; and

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Table of Contents

1. Introduction

Bonville was identified as a priority release area for the Coffs Harbour Rural Residential Strategy (RRS) (2009) to allow rezoning of land for rural residential subdivision. This report forms part of a broad Local Environment Study for the preparation of a planning proposal to form an amendment to the Coffs Harbour City Local Environment Plan (LEP) 2000 and draft Coffs Harbour LEP 2012.

This Wastewater Assessment provides a hazard assessment of the study area in relation to site and soil limitations which can affect on-site wastewater management and the potential for subdivision. The report also provides a minimum lot size analysis and modelling to determine maximum lot density for subdivision.

1.1. The Study Area

Bonville is located on the Mid North Coast of New South Wales; approximately 13km south of Coffs Harbour to both the east and west of the Pacific Highway. Bonville was selected as a preferred area for rural residential subdivision because of its proximity to other town centres. It is proposed that approximately 420 hectares of land will be released in the area for rural residential/large lot residential subdivision. Preliminary assessments undertaken have determined the most suitable areas, with 17 Candidate Areas identified (CA1-17) for subdivision as shown in Figure 1.

W&A identified an average candidate area based on slopes, soil types and lot sizes upon which to undertake minimum lot size analysis upon. Candidate Area 2 (CA2) was adopted for these purposes. Ten lots were identified within this Candidate Area and minimum lot size analysis undertaken.

2. Site & Soil Assessment

2.1. Slope

Table K1 of *AS/NZS 1547:2012* (Standards Australia 2012) details a range of factors likely to limit the selection and applicability of land application systems; with slope/gradient identified as one critical factor. Steep slopes (>10-15%), particularly when combined with shallow or poorly drained soils, can lead to surface breakout of effluent downslope of the land application area. Conventional On-site Sewage Management (OSSM) systems will most likely be unsuitable and these lots will require a detailed site assessment and site specific design to enable a sustainable outcome. Steeply sloping sites are generally unsuitable for trenches and beds and can also be problematic for surface irrigation systems. Conversely, flat and gently sloping sites are less likely to experience such problems and are considered lower risk.

2.2. Soils

Soils and associated landform elements play a vital role in the design, operation and performance of OSSM systems. Key soil properties can be evaluated to assess a soil's capacity for absorption of wastewater, including soil texture, structure, permeability, drainage characteristics, total depth, and depth to limiting layers, such as bedrock, hardpans or water tables.

There are approximately sixteen (16) mapped soil landscapes within the Bonville Study Area; of which ten (10) soil landscapes fall within the Candidate Areas identified for potential subdivision. Most of the soil landscapes in the Candidate Areas are

characterised by a similar limiting subsoil horizon of light clay. No detailed soil investigations have been undertaken for this project but interpretation based on the Coffs Harbour 1:100,000 soil landscape series (Milford, 1999). Indicates a limiting soil of light clay at approximately 300–400mm depth. Table 1 summarises the soil landscapes within the adopted Candidate Area 2 and provides an overview of the limiting soil horizons. Figure 2 shows the distribution of soil landscapes throughout the study area.

Table 1: Summary of Soil Landscapes (Milford 1999)

Soil Landscape Name	Landscape	Slopes	Vegetation	Soils
Coffs Creek	level to gently undulating floodplains	0-5%	Completely cleared tall open forest	Loamy sand to sandy loam
				Loam
				Clay loam to light clay
				Clay loam to light clay
				Light to medium clay
Megan	Rolling low hills	5-20%	Partially cleared tall open forest and tall closed forest	Loam
				Clay loam
				Light clay
				Clay loam to light clay
Promised Land	Undulating to rolling low hills	3-15%	Extensively cleared tall open forest	Loam
				Clay loam to silty clay loam
				Light clay
				Light clay
				Light to medium clay
Ulong	Undulating to low rolling hills	5-20%	Partially cleared tall open forest and tall closed forest	Loam to silty loam with fine sand
				Clay loam to silty clay loam
				Light to medium clay
				Light to medium clay

The predominant and most limiting soil landscapes in the Candidate Area 2 are the Promised Land and Megan Soil Landscapes. The Megan and Promised Land Soil Landscapes are similarly characterised by dark reddish brown pedal loam to clay loam, moderately structured topsoil (up to 300mm thick) underlain by reddish brown pedal light clay moderately pedal subsoil (to 3.5m depth depending on location). Bedrock is typically greater than 1.5m depth.

Light clay is considered the most limiting soil for effluent application with a Design Loading Rate (DLR) of 5mm/day for trenches and a Design Irrigation Rate (DIR) of 3mm/day for secondary treatment with subsurface irrigation recommended by *AS/NZS 1547:2012.*

2.3. Climate

The nearest Bureau of Metrology (BoM) weather station to Bonville is Coffs Harbour (BoM number 059040). Coffs Harbour experiences a mean annual rainfall of 1,647mm, with a monthly high of 232mm in March and monthly low of 68.2mm in September. Coffs Harbour experiences mean annual pan evaporation of 1,602mm, with a monthly high of 192mm in January and a monthly low of 69mm in June.

Mean rainfall data was conservatively utilised for the modelling of effluent application at this broad scale of study. Selection of the appropriate rainfall data for site specific modelling will be dependent on the size of the development and risk assessment, and may be reduced to "median" rainfall, or increased to 70-90th percentile.

2.4. Water & Nutrient Balance

2.4.1 Primary Treatment with Trenches/Beds

Water balance modelling was undertaken to determine sustainable effluent application rates, and from this estimate the necessary size of the Effluent Management Area (EMA) required for effluent to be applied from a primary treatment system to trench or beds. The procedures used in the water balance generally follow the *AS/NZS 1547:2012* standard and DLG (1998) guideline. The water balance used is a monthly nominated area model. These calculations determined minimum EMAs for given effluent loads for each month of the year. The water balance can be expressed by the following equation:

Precipitation + Effluent Applied = Evapotranspiration + Percolation + Storage

Mean monthly rainfall data was conservatively utilised in the modelling. Mean data has a higher rainfall than median data typically adopted for domestic wastewater investigations. The water balance conservatively assumes a retained rainfall coefficient of 0.8; that is, generally 80% of rainfall will percolate into the soil and 20% will run off. Given the moderate slopes and good groundcover in Candidate Area 2, this is considered a conservative value. The rainfall hydraulic load is incorporated into the water balance to ensure that runoff from the EMA will not occur under typical (design) climate conditions.

Water balance modelling has been based on a four bedroom home on tank water in accordance with *AS/NZS 1547:2012* with a rate of 120L/p/day. The input data and results for the trench water balance are presented in Table 2, and calculation sheets in Appendix A.

A conservative nutrient balance was also undertaken, which calculates the minimum buffer around a trench to enable nutrients to be assimilated by the soils and vegetation. The nutrient balance used here is based on the simplistic DLG (1998) methodology, but improves this by more accurately accounting for natural nutrient cycles and processes. It acknowledges that a proportion of nitrogen will be retained in the soil through processes such as ammonification (the conversion of organic nitrogen to ammonia) and a certain amount will be lost by denitrification, microbial digestion and volatilisation (Patterson, 2003). Patterson (2002) estimates that these processes may account for up to 40% of total nitrogen loss from soil. In this case, a more conservative estimate of

20% is adopted for the nitrogen losses due to soil processes. A summary of the nutrient balance is provided in Table 3..

Table 2: Inputs for and Results of Hydraulic Modelling

Data Parameter	Units	Value	Comments
Hydraulic load	L/day	720	6 persons
Precipitation	mm/month	Coffs Harbour	BoM, mean monthly
Pan Evaporation	mm/month	Coffs Harbour	BoM, mean monthly
Retained rainfall	unitless	0.8	Proportion of rainfall that remains onsite and infiltrates the soil, allowing for 10% runoff.
Crop Factor	unitless	0.7-0.8	Expected annual range for vegetation based on monthly values.
Design Loading Rate (DLR)	mm/day	5	Maximum rate for design purposes, based on light clay subsoils.
Minimum trench basal area for hydraulic load (m^2)			**272m^2**

Table 3: Inputs for and Results of Nutrient Balance Modelling

Data Parameter	Units	Value	Comments
Effluent total nitrogen concentration	mg/L	60	Target effluent quality for primary treatment systems.
Nitrogen lost to soil processes (denitrification and volatilisation)	annual percentage	20	Patterson (2002).
Effluent total phosphorus concentration	mg/L	30	Target effluent quality for primary treatment systems.
Soil phosphorus sorption capacity	mg/kg	702	Value based on reported data for soil landscape.
Nitrogen uptake rate by plants	kg/Ha/yr	130	Conservative estimated value.
Phosphorus uptake rate by plants	kg/Ha/yr	25	Conservative estimated value.
Design life of system (for nutrient management)	years	50	Reasonable minimum service life for system.
Minimum irrigation area for total phosphorus load, without off-site export			**970m^2**
Minimum irrigation area for total nitrogen load, without off-site export			**761m^2**

2.4.2 Secondary Treatment with Irrigation

Water and nutrient balance modelling was also undertaken to determine sustainable sizing of irrigation EMAs. The procedures for this generally follow the DLG (1998) guidelines.

The water balance used is a monthly model adapted from the "Nominated Area Method" described in DLG (1998). These calculations determined minimum EMA sizes for given effluent loads for each month of the year. The water balance can be expressed by the following equation:

Precipitation + Effluent Applied = Evapotranspiration + Percolation + Storage

Irrigation areas are calculated to achieve no net excess of water and hence zero storage for all months.

A conservative nutrient balance has also been undertaken. The water and nutrient balances were modelled using the estimated average daily effluent load of 720L/day based on a four bedroom dwelling on tank water. Table 4 and Table 5 below contain the input data and results of the water and nutrient balances.

Table 4: Inputs for and Results of Water Balance Modelling

Data Parameter	Units	Value	Comments
Average effluent load	L/day	720	Design dwelling 4 bedrooms, 120 L/person/day.
Precipitation	mm/month	Coffs Harbour	BoM, mean Monthly
Pan Evaporation	mm/month	Coffs Harbour	BoM, mean Monthly
Retained rainfall	unitless	0.8	Proportion of rainfall that remains onsite and infiltrates the soil, allowing for 20% runoff.
Crop Factor	unitless	0.7-0.8	Expected annual range for vegetation based on monthly values.
Design Irrigation Rate (DIR)	mm/day	3	Maximum rate for design purposes, based on light clay subsoils.
Minimum irrigation area for hydraulic load, without wet weather storage (m^2)		**1,043**	Assuming zero wet weather storage.

Table 5: Inputs for and Results of Nutrient Balance Modelling

Data Parameter	Units	Value	Comments
Effluent total nitrogen concentration	mg/L	30	Target effluent quality for secondary treatment systems.
Nitrogen lost to soil processes (denitrification and volatilisation)	annual percentage	20	Patterson (2002).
Effluent total phosphorus concentration	mg/L	15	Target effluent quality for secondary treatment systems.

Data Parameter	Units	Value	Comments
Soil phosphorus sorption capacity	mg/kg	702	Value based on reported data for soil landscape.
Nitrogen uptake rate by plants	kg/Ha/yr	130	Conservative estimated value.
Phosphorus uptake rate by plants	kg/Ha/yr	25	Conservative estimated value.
Design life of system (for nutrient management)	years	50	Reasonable minimum service life for system.
Minimum irrigation area for total phosphorus load, without off-site export			**381m^2**
Minimum irrigation area for total nitrogen load, without off-site export			**486m^2**

As a result of the two water and nutrient balances undertaken for absorption trenches and irrigation areas, the most limiting balance has been used in calculating lot density in Section 4 below (Table 6). Based on the modelling, a minimum EMA of 1,043m^2 required for secondary treatment with subsurface irrigation has been adopted.

Table 6: Minimum Land Application Area Required

LAA system	Area Required
Trench/Bed Absorption System	970m^2
Subsurface Irrigation	1,043m^2

2.5. Buffer Distances

Buffer distances from EMAs are typically enforced to minimise risk to public health, maintain public amenity and protect sensitive environments. Generally, adopted environmental buffers for subsurface irrigation based on DLG (1998), are:

- 250m from domestic groundwater bores;
- 100m from permanent watercourses;
- 40m from downslope intermittent watercourses and dams;
- 12m from property boundaries; and
- 6m if area up-gradient and 3m if area down-gradient of buildings.

These buffer distances have been applied to our Minimum Lot Size Analysis for all future OSSM systems in the assessed Candidate Area. Figure 3 highlights the buffers to watercourses within the Bonville LES study area.

3. Minimum Lot Size Analysis

3.1. Methodology

When considering the suitability for a lot to sustainably manage wastewater on-site, we typically refer to 'adequate available area'. This broadly refers to available areas (i.e. not built out or used for a conflicting purpose) where OSSM will not be unduly constrained by underlying site and soil characteristics. Available area on a developed (or potentially developable) lot is determined by the following factors:

- total building area (including dwellings, sheds, pools etc.);
- driveways and paths (impervious areas), and gardens/vegetated areas unsuitable for effluent reuse;
- dams, intermittent and permanent watercourses running through lots; and
- maintenance of appropriate setback distances from property boundaries, buildings, driveways and paths, dams and watercourses.

Available areas may also be unsuitable or constrained for OSSM, due to other factors, including (but not limited to):

- excessive slope;
- excessively shallow soils;
- heavy (clay) soils with low permeability;
- excessively poor drainage and/or stormwater run-on; and
- excessive shading by vegetation.

Ten (10) representative lots were selected that have already been subdivided to ~1ha or less lot sizes (zoned R5) from the Bonville LES study area associated with Grandis Road and Faviell Drive (Figure 4). Selected lots typically included a dwelling, garage/shed, pool, trees and shrubs and impervious surfaces (driveways, tanks etc). It is assumed that this existing development style will be similar to that proposed for the Candidate Areas and therefore minimum lot size and development potential should be consistent.

The residual areas (areas not otherwise occupied by improvements, buffers or conservation vegetation) were then calculated for the selected lots (eg. Figure 5), and the results recorded. A percentage of the total lot area that is available for effluent disposal was then determined and the lowest percentage of available area to lot size was then used to conservatively determine the minimum lot size.

3.2. Results

Table 7 shows the assessment of available area for each lot. As is evident the variability of lot sizes and on-lot improvements of developed lots in the study area makes selection of a "typical" lot difficult, however, we have adopted a conservative approach to define minimum sustainable lot size as many lots are affected by watercourses which were not always evident within the 10 lots assessed.

From the sample selection of lots investigated the minimum percentage of the lot available for effluent disposal is 27%. The corresponding minimum lot size (for sustainable irrigation of secondary effluent) is 3,863m^2. Thus, a conservative minimum lot size for subdivision in the study area would be ~4,000m^2. This lot size allows for development of the site with a four bedroom (or smaller) dwelling together with

associated driveways, sheds, paths and pool, whilst still providing sufficient area for secondary wastewater treatment and sustainable land application.

The selection of 4,000m^2 as the minimum lot size presents a conservative approach that is similar in comparison to lot sizes that have been calculated for other catchments that have been assessed on the mid north coast. As can be seen by the variability in results, some lots may be capable of being developed to a smaller lot size. In addition, we assumed secondary treatment without full nutrient reduction capabilities, and use of mean rainfall rather than median rainfall which has resulted in larger required EMAs than could be achieved with site specific assessment and design.

Table 7: Minimum Lot Size Assessment Results

Lot	Lot Area (m^2)	Developed Area (m^2)	Available Area (m^2)	Percentage of Lot Available for Eff. Disp. (%)	Area required for Secondary Treatment (m^2)	Minimum Lot Size (m^2)
1	20,106	14,257	5,849	30	1,043	3,585
2	19,051	11,392	7,659	40	1,043	2,594
3	6,842	4,858	1,984	29	1,043	3,597
4	7,018	3,727	3,291	47	1,043	2,224
5	4,387	3,088	1,299	30	1,043	3,522
6	10,591	6,844	3,747	35	1,043	2,948
7	4,407	3,227	1,180	27	1,043	3,895
8	4,387	3,151	1,236	28	1,043	3,702
9	20,077	4,154	15,923	80	1,043	1,315
10	13,122	5,460	7,662	58	1043	1,786

4. Maximum Lot Density

The maximum number of 4,000m^2 lots was assessed for each of the lots within Candidate Area 2 (CA2) based on the lesser of the amount derived from total lot size or the amount derived following an aerial photograph review of available area. CA2 was selected due to its large variety of lot sizes, large total area and number of surface water features which may affect future development.

Table 8 provides the results of this assessment. In total, for the about 1,191.7ha CA2, 373 lots could be sustainably generated at a rate of 1.94lots/ha.

Table 8: Maximum Lot Density Assessment

Lot Number *	Total Lot Area m^2	Available Area m^2	Max No. Lots Using Lot size	Max No. Lots Using Min OSSM	Maximum Subdivision Potential for Lot
1	115,222	26,690	28.81	25.42	25
2	8,398	5,909	2.10	5.63	2
3	15,552	199	3.89	0.19	0
4	8,972	2,597	2.24	2.47	2
5	50,336	5,545	12.58	5.28	5
6	43,406	3,952	10.85	3.76	4
7	16,557	11,067	4.14	10.54	4
8	29,123	11,628	7.28	11.07	7
9	4,138	791	1.03	0.75	1
10	3,753	909	0.94	0.87	1
11	16,767	11,111	4.19	10.58	4
12	29,238	14,845	7.31	14.14	7
13	20,608	11,540	5.15	10.99	5
14	2,004	2,004	0.50	1.91	1
15	16,954	16,401	4.24	15.62	4
16	22,974	22,974	5.74	21.88	6
17	20,944	20,944	5.24	19.95	5
18	52,751	37,198	13.19	35.43	13
19	50,100	36,851	12.53	35.10	13
20	41,021	17,111	10.26	16.30	10
21	38,711	26,221	9.68	24.97	10
22	40,337	23,813	10.08	22.68	10
23	4,098	4,098	1.02	3.90	1
24	40,782	7,383	10.20	7.03	7
25	40,160	8,973	10.04	8.55	9
26	3,700	1,932	0.93	1.84	1
27	22,486	9,612	5.62	9.15	6
28	24,480	16,555	6.12	15.77	6
29	3,865	3,865	0.97	3.68	4
30	14,973	13,603	3.74	12.96	4
31	4,165	4,165	1.04	3.97	1
32	3,693	1,303	0.92	1.24	1
33	21,233	19,637	5.31	18.70	5
34	197,360	24,029	49.34	22.88	23
35	70,776	6,079	17.69	5.79	6
36	44,391	34,811	11.10	33.15	11
37	280,275	45,368	70.07	43.21	43
38	283,211	79,769	70.80	75.97	71
39	54,207	2,926	13.55	2.79	3
40	156,183	34,233	39.05	32.60	33

Note:
* Lot numbers are an identifier for assessment purposes only. They are not actual Lot/DP numbers.

5. Cumulative Impact Assessment

5.1. Rationale and Methodology

We assessed the sustainability of the lot density for application of wastewater on the local receiving environment from OSSM systems. Desktop data was used to model OSSM operation and pollutant discharge to groundwater and sensitive surface receptors for CA2 using the Decentralised Sewer Model (DSM) as described below.

5.2. Decentralised Sewerage Model

The DSM is a GIS based tool designed to compare a range of wastewater servicing options and has the ability to assess long term environmental and human health performance of wastewater systems.

The DSM was developed by W&A for the purpose of providing a rapid-assessment tool to predict the performance of on-site and decentralised wastewater management systems under varying environmental conditions. It does this by simulating the movement of pollutants (nitrogen, phosphorus and pathogens) within the effluent load as it travels from the point source (on-site or community-scale systems) down the catchment as surface or subsurface flows. The model simulates a 72 year period and is designed to provide conservative estimates of OSSM system performance CA2.

The DSM has five modules, an on-lot performance module, a particle tracking module, a node-link module, a central management components module and a costing module.

It is important to note that the OLPM makes the conservative assumption that the entire, non-attenuated pollutant load is transported down the catchment and that no dilution occurs within the receiving waters. The key model inputs are provided in Table 9 below. The raw data as used in the DSM has been included in Appendix B as well as the raw outputs.

Table 9: Input Data Summary for DSM

Input Parameter	Unit	On-site Scenario
Average Wastewater Flow per system	L/day (m^3/day)	720 (0.72)
Total Average Wastewater Flow per system	ML/year	0.02628
EMA Type	-	Future Development - SSI 325 systems Existing Development - Trenches 43 systems not upgraded
Application Type	-	No storage with fixed rate
Storage Type	-	No storage
Effluent Total Nitrogen Concentration	mg/L	SSI - 30 Trench - 60
Effluent Total Phosphorus Concentration	mg/L	15
Effluent Virus Concentration[1]	MPN/100mL	SSI – 100 Trench – 10,000,000
Average Annual Rainfall	mm	1,647
Average Annual Evaporation	mm	1,602

Input Parameter	Unit	On-site Scenario
Average Air Temperature (in lieu of ground temperature)	ºC	21.8
Crop Factor [2]	unitless	0.7-0.8 grass
Buffer From Dam/Intermittent Waterway	m	40
Buffer From Property Boundaries	m	12
Buffer From Driveways	m	6
Slope	%	5-20
Required Effluent Application Area	m^2	SSI - 1043 Trench - 272
Soil Phosphorus Adsorption (P-sorb) Capacity	mg/kg	702
Soil Depth for P-sorb	mm	800
Fixed Application Rate	Mm/day	SSI - 3 Trench - 5
Crop Nitrogen Uptake [3]	kg/ha/year	130
Crop Phosphorus Uptake [3]	kg/ha/year	25
Attenuation Rate for Total Phosphorus	%	94
Attenuation Rate for Total Nitrogen	%	93
Attenuation Rate for Viruses	%	97
Attenuation for Surface Flow	%	0.6

5.3. DSM Results

The predicted deep drainage of nutrients and viruses from the developed CA2 that reaches Bonville Creek was compared to expected background deep drainage from an agricultural catchment. Figure 6 provides an overview of the layout of the DSM model for CA2. A summary of the results of the DSM is provided in Table 10 below.

The results from the DSM modelling indicated that mean annual nutrient concentrations in deep drainage represented less than a 1% increase on existing background pollutant levels, and there were no net increase in nutrients in surface runoff. The DSM modelling also indicates that virus surface runoff would not occur at the applied loading rate and that virus deep drainage is very low.

Based on this, by improving the level of treatment and land application of OSSM an increase in lot density is predicted to have negligible effect on nutrient and virus export from the catchments and that the predicted maximum lot density is sustainable.

Table 10: Average Daily Modelled Deep Drainage

(For Candidate Area 2)	TP kg/day	TN kg/day	Virus MPN/m^2/day
Background Pollutants (Fletcher, 2004)	1.27	5.39	-
W&A DSM Model Deep Drainage	$3.7x10^{-5}$	$2.3x10^{-4}$	0.03
% increase from background levels	0.0029	0.0043	-
W&A DSM Model Surface Discharge	0	0	0
% increase from background levels	0	0	0

* All percentages are relative to the total background load generated annually (Fletcher et al., 2004)

5.4. Discussion

Whilst the DSM modelling undertaken has shown that one system per 4,000m^2 is sustainable, the limitations of this study should be noted. This study has been undertaken and based on a desktop analysis of site and soil data, there were no provisions for soil sampling and confirmation of site conditions throughout the study area and therefore individual site conditions may vary. As a consequence conservative modelling was undertaken using assumed soil and climate parameters to overestimate the minimum areas and maximum lot densities achievable.

Therefore is would still be necessary to undertake detailed land capability assessments for each lot prior to subdivision to ensure that there is sufficient available area OSSM land application plus improvements for each lot within a proposed subdivision which meets Council requirements.

6. Conclusions

This report provides a desktop hazard assessment of the study area in relation to site and soil limitations which can effect on-site wastewater management and the potential for subdivision.

The recommended minimum lot size for future subdivision is 4,000m^2 and DSM modelling indicates that lot density for subdivision allows one onsite wastewater management system per 4,000m^2. Due to the unique locality and minimum available area for effluent management identified within the CA2 we recommend that all future subdivision require a detailed land capability assessment for onsite wastewater management to ensure any proposed subdivision can be sustainable.

7. References

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Coffs Harbour City Council (2006) *Onsite Sewage Management Strategy*, Coffs Harbour.

Department of Local Government et al. (1998). *Environment & Health Protection Guidelines: On-site Sewage Management for Single Households*.

Fletcher, T., Duncan, H., Poelsma, P. & Lloyd, S. *Stormwater Flow and Quality, and the effectiveness of non-proprietary stormwater treatment measures – a review and gap analysis* Technical Report 04/8 December 2004, Cooperative Research Centre for Catchment Hydrology.

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Patterson, R.A. (2003). *Nitrogen in Wastewater and its Role in Constraining On-Site Planning*. In Patterson & Jones (Eds.) Proceedings of On-site '03 Conference: *Future Directions for On-site Systems: Best Management Practice*. Lanfax Laboratories, Armidale.

Standards Australia / Standards New Zealand (2012*). AS/NZS 1547:2012 On-site Domestic-wastewater Management*.

FIGURES

Figure 1:
Existing Planning Scheme Zones Map Showing Selected Candidate Area and Lots for Assessment

CHCC Planning Zones (2009)

- R5
- R1
- Wetlands
- National Parks
- Roads
- Creeks
- RU2
- W2
- Forests
- W1
- SP2
- RU3
- R2
- E2
- E1
- RE1

- Bonville Study Area
- Candidate Areas 1-17
- Selected Candidate Areas and Lots for Assessment

Project: Bonville LES- Wastewater Assessment
Drawn: Jasmin Kable
Date: 17 July 2013
Scale: Not to Scale

N

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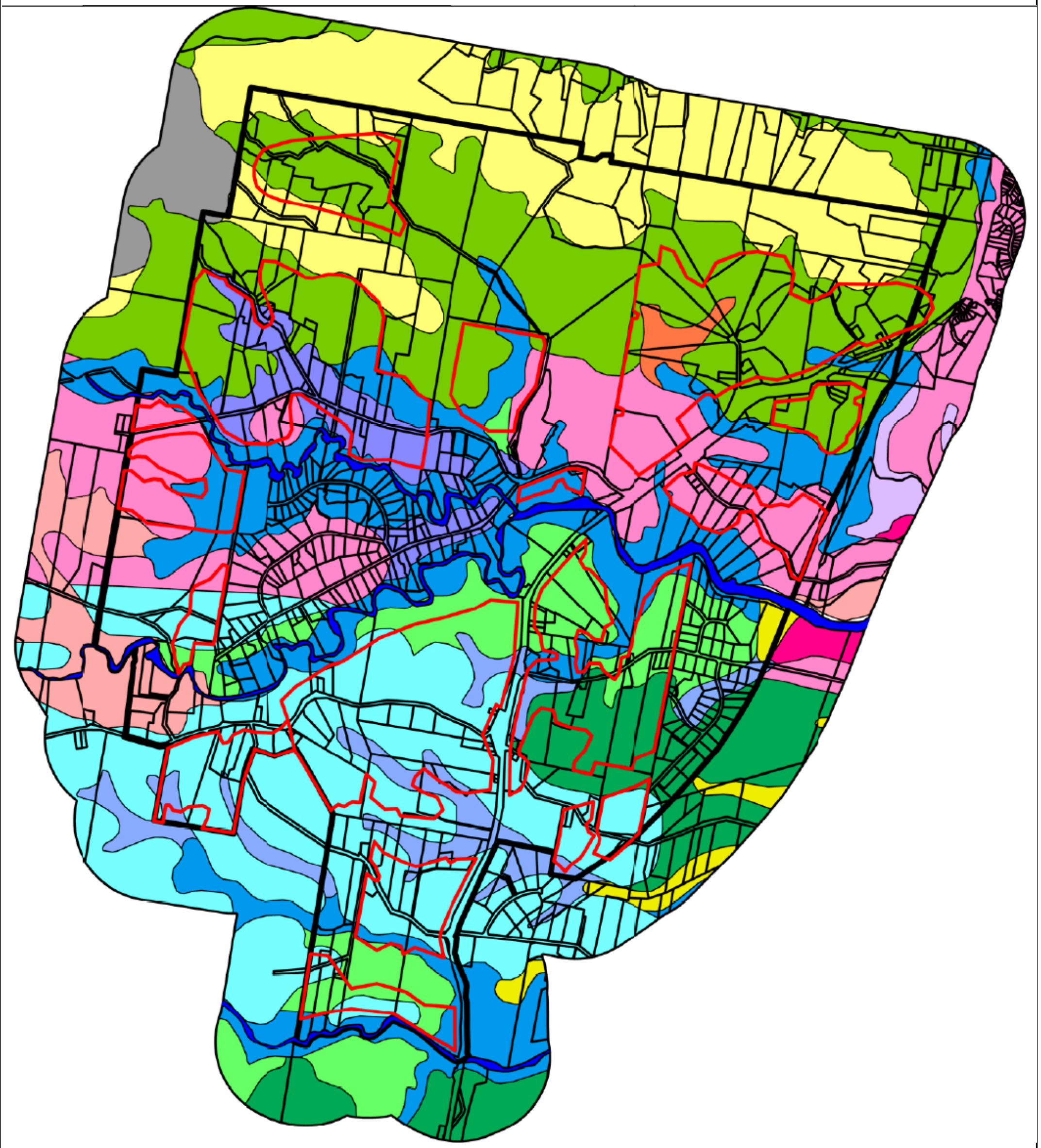

Figure 2:
Soil Landscape Map of Bonville

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Drawn: Jasmin Kable
Date: 17 July 2013
Scale: Not to Scale

N

Whitehead & Associates Environmental Consultants Pty Ltd

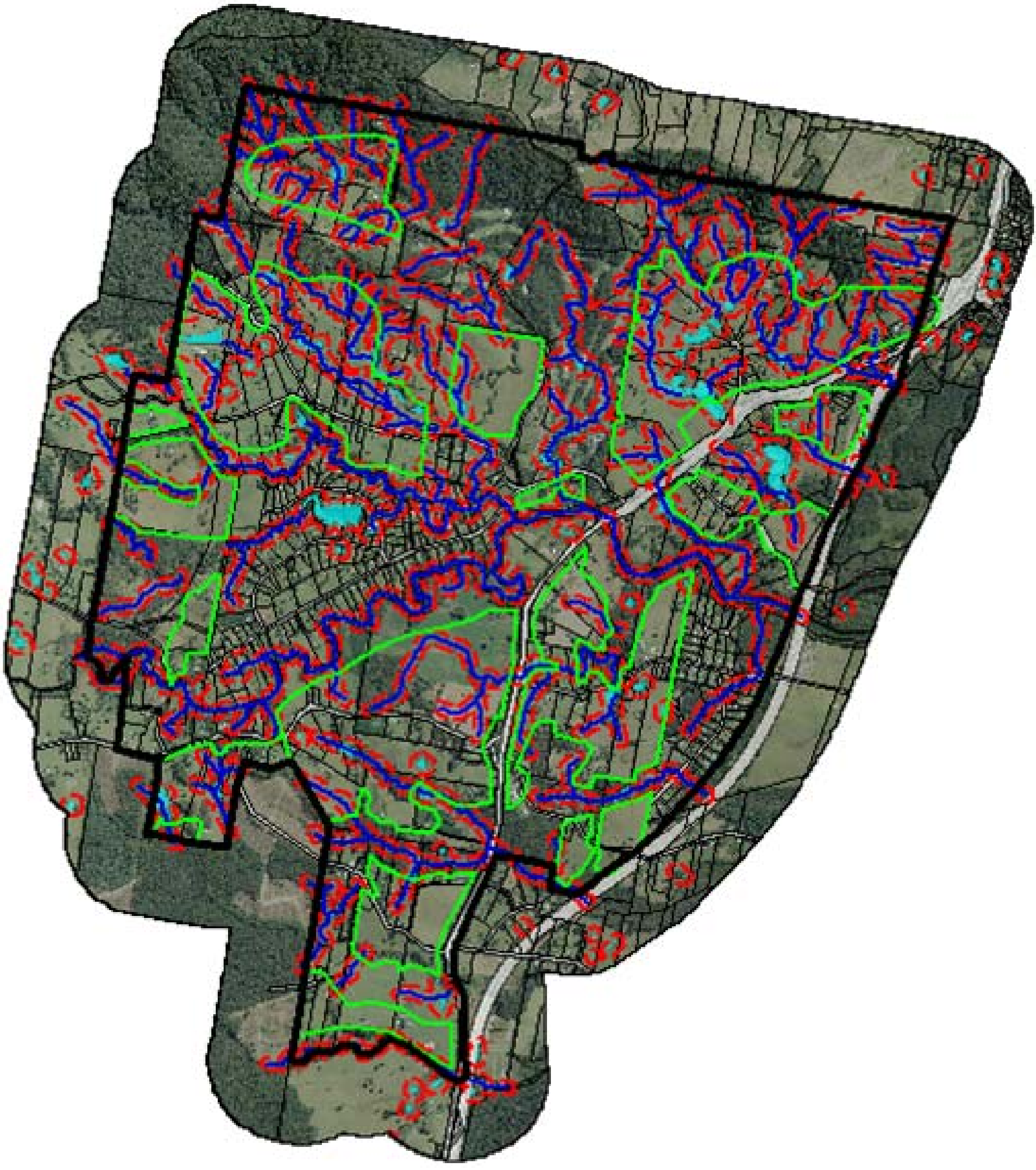

Figure 3:
Buffer Analysis of Bonville Showing Available Areas for OSSM

Bonville Study Area
Candidate Areas
Buffers
Cadastre
Creeks
Surface Water Features

Project: Bonville LES- Wastewater Assessment
Drawn: Jasmin Kable
Date: 17 July 2013
Scale: Not to Scale

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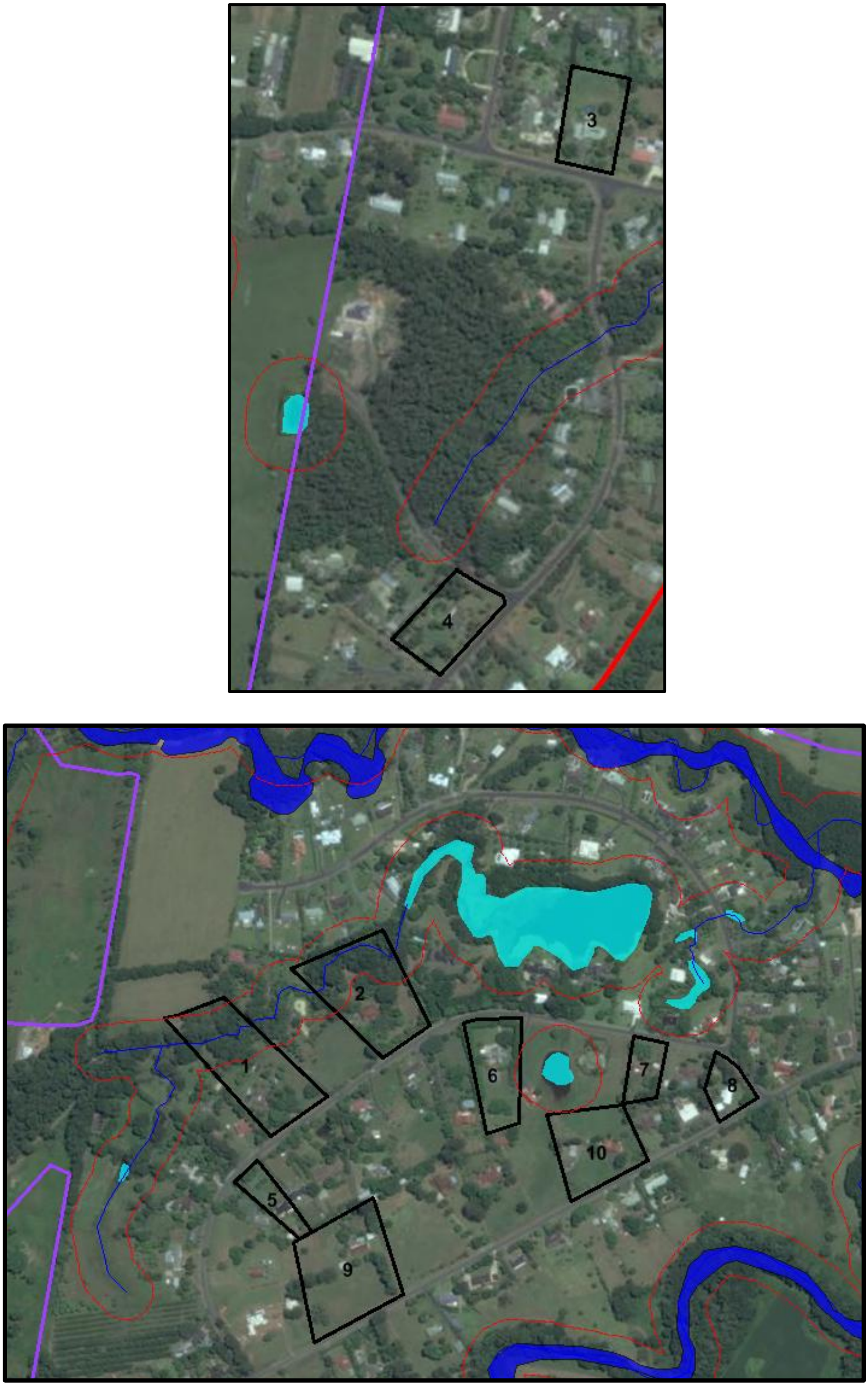

Figure 4:
Overview of Minimum Lot Size Analysis

Candidate Area Boundary
Lot Boundary
Buffers
Creeks
Surface Water Features

Project: Bonville LES- Wastewater Assessment
Drawn: Jasmin Kable
Date: 17 July 2013
Scale: Not to Scale

N

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Figure 5:
Minimum Lot Size Analysis- Lot 1

Lot Boundary
Buffers
Available Area for OSSM
Creeks
Surface Water Features

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Drawn: Jasmin Kable
Date: 17 July 2013
Scale: Not to Scale

N

Figure 6: Decentralised Sewage Model, Bonville

Selected Candidate Area
Buffers
Cadastre
Creeks
Surface Water Features
*Soil Landscapes as labelled

Link
Receiving Node
Site Point (Individual OSSM systems)

*Digital Elevation Model underlay (red is highest elevation and dark blue is the lowest elevation)

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Date: 17 July 2013
Scale: Not to Scale

N

APPENDIX A

Water & Nutrient Balances

APPENDIX 8 - WASTEWATER ASSESSMENT

Nominated Area Water Balance & Storage Calculations - Trench/Bed Design

Whitehead & Associates
Environmental Consultants Pty Ltd

Site Address: **Bonville Subdivision**

INPUT DATA

Design Wastewater Flow	Q	720	L/day	Estimated daily flow from residence with tank water
Daily DLR		5.0	mm/day	Litres per sq.m. per day - recommended max loading rate based on AS/NZS 1547:2012 for primary effluent
Nominated Land Application Area	L	272	m sq	Used for iterative purposes to determine storage requirements based on nominated trench/bed bottom area
Crop Factor	C	0.7	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type
Retained Rainfall	RR	0.8	untiless	Proportion of rainfall that remains onsite and infiltrates; function of slope/cover, allowing for any runoff
Void Space Ratio	V	0.3	unitless	Proportion of bed/trench that is available for storage
Rainfall Data		BOM Coffs Harbour		Mean Monthly data
Evaporation Data		BOM Coffs Harbour		Mean Monthly data

WW Flow Allowance	120	L/p/d
No. of Bedrooms	4	Bdrm
Occupancy	1.5	p/Bdrm

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	31	28	31	30	31	30	**365.0**
Rainfall	R	\	mm/month	169.3	207	232	189	138.4	129.9	93.9	81.3	68.2	95.7	104.4	136.8	169.3	207.0	232.0	189.0	138.4	129.9	**1,647**
Evaporation	E	\	mm/month	192.2	156.8	148.8	117	86.8	69	77.5	102	139.5	161.2	171	192.2	192.2	156.8	148.8	117.0	86.8	69.0	**1,602**
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	0.80	0.80	0.80	0.70	0.70	0.70	
OUTPUTS (LOSSES)																						
Evapotranspiration	ET	ExC	mm/month	154	125	119	82	61	48	54	71	98	129	137	154	154	125	119	82	61	48	**1,232.0**
Percolation	B	(DLR)xD	mm/month	155.0	140.0	155.0	150.0	155.0	150.0	155.0	155.0	150.0	155.0	150.0	155.0	155.0	140.0	155.0	150.0	155.0	150.0	**1,825.0**
Outputs		ET+B	mm/month	308.8	265.4	274.0	231.9	215.8	198.3	209.3	226.4	247.7	284.0	286.8	308.8	308.8	265.4	274.0	231.9	215.8	198.3	**3,057.0**
INPUTS (GAINS)																						
Retained Rainfall	Re	R*RR	mm/month	135.4	165.6	185.6	151.2	110.7	103.9	75.1	65.0	54.6	76.6	83.5	109.4	135.4	165.6	185.6	151.2	110.7	103.9	**1,316.7**
Applied Effluent	W	(QxD)/L	mm/month	82.1	74.1	82.1	79.4	82.1	79.4	82.1	82.1	79.4	82.1	79.4	82.1	82.1	74.1	82.1	79.4	82.1	79.4	**966.2**
Inputs		Re+W	mm/month	217.5	239.7	267.7	230.6	192.8	183.3	157.2	147.1	134.0	158.6	162.9	191.5	217.5	239.7	267.7	230.6	192.8	183.3	**2,282.9**
STORAGE CALCULATION (Δ)																						
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(Re+W)-(ET+B))^	mm/month	-304.2	-85.7	-21.3	-4.3	-76.6	-49.9	-173.6	-264.3	-378.9	-417.8	-412.9	-390.9	-304.2	-85.7	-21.3	-4.3	-76.6	-49.9	**-2,580.4**
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Maximum Storage Depth for Nominated Area	N		mm	**0.0**																		
Maximum Storage Vol. for Nominated Area	V	NxL	L	**0**																		
BOTTOM AREA REQUIRED FOR ZERO STORAGE			m^2	129	202	252	268	212	229	166	138	112	108	106	112	129	202	252	268	212	229	

MINIMUM BOTTOM AREA REQUIRED FOR ZERO STORAGE: **267.7** m^2

Value is based on the worst month of the year, so the balance overestimates the storage requirement for all other months. Assumes zero effluent depth (storage) in trench/bed. Model is run for 18-months to ensure trench/bed empties at least once per cycle.

Nutrient Balance

Site Address: **Bonville**

Whitehead & Associates
Environmental Consultants Pty Ltd

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = **970 m^2**

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	720	L/Day	Crop N Uptake	130	kg/ha/yr	which equals	36	$mg/m^2/day$
Effluent N Concentration	60	mg/L	Crop P Uptake	25	kg/ha/yr	which equals	7	$mg/m^2/day$
% Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal	**Phosphorus Sorption**					
Total N Loss to Soil	8,640	mg/day	P-sorption result	702	mg/kg	which equals	7,862	kg/ha
Remaining N Load after soil loss	34,560	mg/day	Bulk Density	1.4	g/cm3			
Effluent P Concentration	30	mg/L	Depth of Soil	0.8	m			
Design Life of System	50	yrs	% of Predicted P-sorp. [2]	0.5	Decimal			

METHOD 1: NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer		
Nitrogen	970.34	m^2
Phosphorus	760.83	m^2

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nominated LAA Size	1,044.00	m^2
Predicted N Export from LAA	-0.96	kg/year
Predicted P Export from LAA	-2.93	kg/year
Phosphorus Longevity for LAA	78	Years
Minimum Buffer Required for excess nutrient	0	m^2

PHOSPHORUS BALANCE
STEP 1: Using the nominated LAA Size

Nominated LAA Size	1,044	m^2				
Daily P Load	0.0216	kg/day	→	Phosphorus generated over life of system	394.2	kg
Daily Uptake	0.007151	kg/day	→	Phosphorus vegetative uptake for life of system	0.125	kg/m^2
Measured p-sorption capacity	0.78624	kg/m^2				
Assumed p-sorption capacity	0.393	kg/m^2	→	Phosphorus adsorbed in 50 years	0.393	kg/m^2
Site P-sorption capacity	410.42	kg	→	Desired Annual P Application Rate	10.818	kg/year
				which equals	0.02964	kg/day
P-load to be sorbed	5.27	kg/year				

NOTES

Nominated Area Water Balance & Storage Calculations

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Site Address: Bonville

INPUT DATA

Design Wastewater Flow	Q	720	L/day	
Design Percolation Rate	DIPR	21	mm/week	
Daily DPR		3.0	mm/day	Litres per sq.m. per day - based on Table M1 AS/NZS 1547:2012 for secondary effluent
Nominated Land Application Area	L	1044	m sq	
Crop Factor	C	0.7-0.8	unitless	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type
Runoff Coefficient		0.8	untiless	Proportion of rainfall that remains onsite and infiltrates; function of slope/cover, allowing for any runoff
Rainfall Data		Coffs Harbour		Mean Monthly Data
Evaporation Data		Coffs Harbour		Mean Monthly Data

Flow Allowance	120	L/p/d
No. of bedrooms	4	
Occup Rate	1.5	

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	**365**
Rainfall	R	\	mm/month	169.3	207	232	189	138.4	129.9	93.9	81.3	68.2	95.7	104.4	136.8	**1,647**
Evaporation	E	\	mm/month	192.2	156.8	148.8	117	86.8	69	77.5	102	139.5	161.2	171	192.2	**1,602**
Daily Evaporation				6.2	5.6	4.8	3.9	2.8	2.3	2.5	3.3	4.7	5.2	5.7	6.2	
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	154	125	119	82	61	48	54	71	98	129	137	154	**1232.0**
Percolation	B	(DPR/7)xD	mm/month	93.0	84	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	**1095.0**
Outputs		ET+B	mm/month	246.8	209.44	212.0	171.9	153.8	138.3	147.3	164.4	187.7	222.0	226.8	246.8	**2327.0**
INPUTS																
Retained Rainfall	RR	R*runoff coef	mm/month	135.44	165.6	185.6	151.2	110.72	103.92	75.12	65.04	54.56	76.56	83.52	109.44	**1316.7**
Effluent Irrigation	W	(QxD)/L	mm/month	21.4	19.3	21.4	20.7	21.4	20.7	21.4	21.4	20.7	21.4	20.7	21.4	**251.7**
Inputs		RR+W	mm/month	156.8	184.9	207.0	171.9	132.1	124.6	96.5	86.4	75.2	97.9	104.2	130.8	**1568.4**
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-89.9	-24.5	-5.1	0.0	-21.7	-13.7	-50.8	-78.0	-112.4	-124.0	-122.6	-115.9	**-193.7**
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Maximum Storage for Nominated Area	N		mm	**0.00**												
	V	NxL	L	**0**												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	201	460	844	1043	519	628	309	225	162	154	151	163	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: **1,043** m^2

Nutrient Balance

Site Address: **Bonville**

Whitehead & Associates
Environmental Consultants Pty Ltd

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = **485 m^2**

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake					
Hydraulic Load	720	L/Day	Crop N Uptake	130	kg/ha/yr	which equals	36	$mg/m^2/day$
Effluent N Concentration	30	mg/L	Crop P Uptake	25	kg/ha/yr	which equals	7	$mg/m^2/day$
% Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal	**Phosphorus Sorption**					
Total N Loss to Soil	4,320	mg/day	P-sorption result	702	mg/kg	which equals	7,862	kg/ha
Remaining N Load after soil loss	17,280	mg/day	Bulk Density	1.4	g/cm3			
Effluent P Concentration	15	mg/L	Depth of Soil	0.8	m			
Design Life of System	50	yrs	% of Predicted P-sorp. [2]	0.5	Decimal			

METHOD 1: NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer		
Nitrogen	485.17	m^2
Phosphorus	380.41	m^2

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nominated LAA Size	1,044.00	m^2
Predicted N Export from LAA	-7.26	kg/year
Predicted P Export from LAA	-6.88	kg/year
Phosphorus Longevity for LAA	308	Years
Minimum Buffer Required for excess nutrient	0	m^2

PHOSPHORUS BALANCE
STEP 1: Using the nominated LAA Size

Nominated LAA Size	1,044	m^2				
Daily P Load	0.0108	kg/day	→	Phosphorus generated over life of system	197.1	kg
Daily Uptake	0.007151	kg/day	→	Phosphorus vegetative uptake for life of system	0.125	kg/m^2
Measured p-sorption capacity	0.78624	kg/m^2				
Assumed p-sorption capacity	0.393	kg/m^2	→	Phosphorus adsorbed in 50 years	0.393	kg/m^2
Site P-sorption capacity	410.42	kg	→	Desired Annual P Application Rate	10.818	kg/year
				which equals	0.02964	kg/day
P-load to be sorbed	1.33	kg/year				

NOTES

APPENDIX B

DSM Model Inputs and Outputs

APPENDIX 8 - WASTEWATER ASSESSMENT

Project Dir = C:\Users\JasminKable\Desktop\
Output Dir = C:\Users\JasminKable\Desktop\Outputs\
Table Dir = C:\Users\JasminKable\Desktop\Tables\
MU Filenames =
MU1.csv
RN Filenames =
receiving node creek.csv
nUnits = 1
nNodes = 1
nSites = 368
nLinks = 1
nSoils = 8
nCrops = 1
nData = 26664
StartDate = 1/01/1940
EndDate = ########

SiteID	X_coord	Y_coord	LAA	WWF	WWF_File	TN	TP	Virus	StorageTy	LAAType	AppMethod	SC	SD	SKsat	FAD	SWT	AAD	CropN	CropP	CropFactor
1	501577.9	6641069	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
2	501543.6	6641043	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
3	501771.9	6640978	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
4	501753.6	6641131	1043	0.72		30	15	100	1	2	1	0	0	0	5	0	0	130	25	Grass
5	501676	6641109	1043	0.72		30	15	100	1	2	1	0	0	0	5	0	0	130	25	Grass
6	501762	6641065	1043	0.72		30	15	100	1	2	1	0	0	0	5	0	0	130	25	Grass
7	501683.1	6641056	1043	0.72		30	15	100	1	2	1	0	0	0	5	0	0	130	25	Grass
8	501693	6640985	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	DEFAULT
9	501828.7	6641028	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
10	501877.1	6641140	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
11	501823.5	6641163	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
12	501832.5	6641098	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
13	501881.3	6640981	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
14	501907.2	6641048	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
15	501893.1	6641200	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
16	501942.9	6641112	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
17	501946.2	6641196	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
18	502136.4	6641179	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
19	502183.4	6641137	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
20	502290.5	6641080	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
21	502334.2	6641098	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
22	502360	6641033	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
23	502359.1	6640966	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
24	502339.8	6640917	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
25	502407.5	6641030	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
26	502501.9	6640991	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
27	502559.7	6640990	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
28	502444.6	6641018	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
29	502555	6640924	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
30	502493.4	6640939	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
31	502438	6640952	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
32	502432.4	6640893	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
33	502510.3	6640877	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
34	502622.6	6640833	272	0.72		60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
35	502600.5	6640875	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
36	502609.5	6640928	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
37	502617	6640990	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
38	502674.8	6640984	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
39	502666.8	6640918	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
40	502661.1	6640862	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
41	502712.8	6641047	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
42	502737.7	6640954	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
43	502724.1	6640880	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
44	502632.5	6641078	272	0.72		60	15	10000000	1	1	1	0	0	0	0	0	0	130	25	Grass
45	501631	6641067	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
46	501639.4	6641018	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
47	501579.7	6641099	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
48	501534.2	6641092	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
49	501616.4	6640991	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
50	501605.1	6641084	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
51	501716.5	6641116	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
52	501725.4	6641060	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass

APPENDIX 8 - WASTEWATER ASSESSMENT

53	501732	6640983	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
54	501817.9	6640960	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
55	501869.1	6641070	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
56	501846.1	6641131	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
57	501801	6641140	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
58	501804.8	6641079	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
59	501900.6	6641067	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
60	501925	6641064	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
61	501954.6	6641056	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
62	501939.1	6641036	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
63	501923.6	6640998	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
64	501914.7	6641025	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
65	502114.8	6641196	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
66	502075.8	6641221	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
67	501932.5	6641143	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
68	501954.6	6641219	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
69	501988.9	6641248	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
70	502043.9	6641239	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
71	502221.9	6641113	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
72	502273.1	6641116	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
73	502330	6641071	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
74	502327.1	6641040	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
75	502545.6	6640892	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
76	502469.9	6640910	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
77	502456.8	6641046	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
78	502650.8	6641342	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
79	502552.6	6641139	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
80	502583.6	6641134	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
81	502678.5	6641046	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
82	502734	6641040	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
83	502764.5	6641029	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
84	502771.5	6640979	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
85	502762.1	6640938	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
86	502757.9	6640901	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
87	502742.4	6640983	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
88	502734	6640919	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
89	502720.3	6640859	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
90	502712.3	6640820	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
91	502741.9	6640808	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
92	502707.2	6640993	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
93	502703.9	6640968	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
94	502697.8	6640937	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
95	502692.6	6640901	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
96	502689.8	6640873	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
97	502686.5	6640845	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
98	502684.6	6640822	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
99	502651.7	6641002	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
100	502643.8	6640967	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
101	502639.1	6640935	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
102	502634.8	6640905	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
103	502627.8	6640881	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
104	502625.9	6640863	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
105	502653.6	6640833	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
106	502615.6	6640955	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
107	502628.7	6641009	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
108	502583.2	6640856	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
109	502545.1	6641320	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
110	502497.2	6641166	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
111	502524	6641157	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
112	502486.4	6641124	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
113	502519.7	6641121	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
114	502426.7	6641164	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
115	502390.1	6641236	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
116	502465.2	6641153	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
117	502460.5	6641129	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
118	502415.5	6641129	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
119	502442.2	6641139	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
120	502453.5	6641108	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
121	502435.7	6641426	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass

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122	502438	6641401	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
123	502401.4	6641418	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
124	502368.9	6641413	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
125	502340.3	6641413	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
126	502310.7	6641455	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
127	502452.1	6641577	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
128	502452.6	6641607	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
129	502467.6	6641636	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
130	502485.5	6641662	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
131	502492.5	6641701	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
132	502352	6641688	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
133	502409.3	6641816	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
134	502419.7	6641837	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
135	502427.7	6641852	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
136	502297.5	6641238	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
137	502353	6641249	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
138	502339.8	6641199	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
139	502335.6	6641163	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
140	502305.5	6641190	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
141	502275	6641203	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
142	502400.9	6641192	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
143	502198.9	6641267	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
144	502218.1	6641222	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
145	502240.2	6641349	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
146	502181.5	6641365	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
147	502207.1	6641317	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
148	502099.7	6641349	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
149	502136.8	6641378	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
150	502096.7	6641390	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
151	502102.5	6641446	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
152	501992.2	6641558	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
153	502023.5	6641518	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
154	502003.2	6641488	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
155	502046.1	6641501	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
156	502026.4	6641465	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
157	502061.8	6641471	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
158	502050.8	6641411	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
159	502088.6	6641678	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
160	501886.8	6641724	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
161	501948	6641670	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
162	501939.3	6641635	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
163	501952.6	6641588	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
164	502064.7	6641289	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
165	502001.7	6641322	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
166	501913.7	6641504	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
167	501935.2	6641452	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
168	501957.8	6641407	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
169	501982.2	6641364	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
170	501840.4	6641450	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
171	501867.2	6641488	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
172	501905.6	6641365	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
173	501867.2	6641332	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
174	501906.1	6641294	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
175	501692.4	6641484	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
176	501745.2	6641180	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
177	501798.1	6641211	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
178	501850.4	6641236	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
179	501738.2	6641248	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
180	501784.7	6641266	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
181	501838.2	6641288	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
182	501716.8	6641313	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
183	501763.8	6641325	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
184	501825.4	6641340	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
185	501709.2	6641376	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
186	501778.9	6641373	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
187	501810.9	6641443	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
188	501667.3	6641316	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
189	501632.5	6641481	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
190	501611.6	6641441	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass

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191	501649.9	6641445	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
192	501601.7	6641392	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
193	501666.8	6641397	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
194	501644.7	6641355	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
195	501703.4	6641200	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
196	501577.9	6641223	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
197	501547.7	6641149	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
198	501639.5	6641167	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
199	501640.6	6641220	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
200	501357.7	6641354	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25 Grass
201	501359.5	6641368	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
202	501374	6641342	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
203	501363	6641337	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
204	501379.2	6641323	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
205	501374.6	6641317	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
206	501382.7	6641305	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
207	501380.4	6641292	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
208	501392	6641276	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
209	501394.9	6641260	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
210	501400.1	6641249	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
211	501408.9	6641238	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
212	501413.5	6641228	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
213	501429.8	6641559	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25 Grass
214	501492.5	6641134	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
215	501329.8	6641469	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
216	501363.5	6641469	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
217	501405.4	6641468	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
218	501329.8	6641446	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
219	501365.9	6641446	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
220	501414.7	6641448	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
221	501341.5	6641415	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
222	501375.7	6641418	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
223	501419.3	6641422	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
224	501356	6641389	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
225	501400.7	6641390	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
226	501457.1	6641397	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
227	501395.5	6641351	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
228	501435.6	6641360	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
229	501484.4	6641374	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
230	501394.9	6641317	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
231	501442.5	6641327	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
232	501475.7	6641333	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
233	501398.4	6641287	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
234	501443.1	6641297	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
235	501412.9	6641258	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
236	501448.9	6641268	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
237	501437.3	6641247	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
238	501381	6641371	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
239	501348.4	6641785	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
240	501382.7	6641772	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
241	501416.4	6641759	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
242	501336.8	6641734	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
243	501367.6	6641748	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
244	501450.1	6641756	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
245	501374.9	6641831	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25 Grass
246	501641.8	6641793	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
247	501649.4	6641816	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
248	501658.1	6641842	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
249	501629	6641856	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
250	501618	6641831	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
251	501608.1	6641875	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
252	501595.9	6641848	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
253	501587.8	6641886	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
254	501571.5	6641861	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
255	501557	6641902	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
256	501532	6641878	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
257	501534.9	6641943	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
258	501512.8	6641924	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass
259	501494.3	6641896	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25 Grass

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260	501487.3	6641946	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
261	501462.9	6641971	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
262	501425.7	6641994	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
263	501360.6	6641867	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
264	501390.8	6641856	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
265	501354.8	6641840	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
266	501346.7	6641814	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
267	501439.6	6641794	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
268	501461.1	6641777	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
269	501393.8	6641805	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
270	501684.3	6641776	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
271	501687.7	6641726	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
272	501649.6	6641561	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
273	501719.6	6641683	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
274	501753.4	6641649	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
275	501726	6641580	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
276	501712.7	6641632	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
277	501781.5	6641613	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
278	501765.6	6641577	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
279	501879.4	6641622	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
280	501905.6	6641564	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
281	501823.6	6641508	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
282	501842.8	6641771	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
283	501836.3	6641798	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
284	501849.3	6641844	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
285	501872.7	6641875	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
286	501902.1	6641847	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
287	501863.4	6641817	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
288	501897.7	6641892	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
289	501881.7	6641795	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
290	501982.2	6641975	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
291	501944.2	6642003	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
292	501948	6641981	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
293	501814.1	6641887	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
294	501792.6	6641935	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
295	501853.6	6642052	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
296	501806.2	6642054	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
297	501811.4	6641913	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
298	501784.4	6641898	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
299	502236	6641444	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
300	502108	6641487	272	0.72	60	15	10000000	1	1	1	0	0	0	5	0	0	130	25	Grass
301	502267.2	6641486	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
302	502274.2	6641526	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
303	502280	6641569	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
304	502286.9	6641618	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
305	502296.8	6641669	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
306	502300.3	6641704	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
307	502266	6641713	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
308	502255	6641654	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
309	502253.2	6641603	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
310	502244.5	6641551	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
311	502236.4	6641517	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
312	502240.5	6641738	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
313	502234.1	6641695	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
314	502219.5	6641655	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
315	502214.3	6641619	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
316	502208.5	6641758	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
317	502205	6641727	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
318	502191.7	6641693	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
319	502181.2	6641658	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
320	502141.7	6641640	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
321	502153.3	6641676	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
322	502162.6	6641709	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
323	502166.7	6641734	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
324	502176	6641770	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
325	502160.9	6641804	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
326	502148.7	6641770	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
327	502143.4	6641748	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
328	502137.1	6641716	1043	0.72	30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass

APPENDIX 8 - WASTEWATER ASSESSMENT

329	502131.8	6641693	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
330	502127.2	6641660	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
331	502110.9	6641696	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
332	502120.2	6641734	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
333	502131.8	6641774	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
334	502137.6	6641801	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
335	502144.6	6641825	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
336	502092.9	6641709	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
337	502098.1	6641732	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
338	502102.8	6641759	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
339	502107.4	6641784	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
340	502117.3	6641820	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
341	502098.1	6641846	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
342	502088.3	6641822	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
343	502080.1	6641784	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
344	502067.3	6641752	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
345	502038.3	6641766	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
346	502048.8	6641789	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
347	502058.6	6641819	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
348	502065.6	6641845	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
349	502074.3	6641870	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
350	502017.4	6641777	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
351	502028.4	6641840	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
352	502041.8	6641879	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
353	502013.3	6641878	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
354	502023.8	6641915	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
355	502002.3	6641905	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
356	502008.1	6641955	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
357	502145.8	6641959	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
358	502186.4	6641966	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
359	502226.5	6641970	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
360	502272.4	6641964	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
361	502170.2	6641934	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
362	502205.6	6641940	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
363	502248	6641942	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
364	502270.7	6641920	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
365	502234.1	6641905	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
366	502275.3	6641888	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
367	502255.6	6641872	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass
368	502279.4	6641841	1043	0.72		30	15	100	1	2	1	0	0	0	3	0	0	130	25	Grass

LinkID	k_Flow_ov	k_TN_over	k_TP_over	k_Virus_ov	k_Flow_sui	k_TN_surf	k_TP_surf	k_Virus_su	k_Flc	k_TN_dd	k_TP_dd	k_Virus_dd
1	0.6	0.93	0.94	0.97	0.6	0.93	0.94	0.97	0.6	0.93	0.94	0.97

Date	R	ET	E	T								
26664	26664	26664	26664	26664				325				
1/01/1940	0	5.3	6.2	23				43				
2/01/1940	1.6	4.8	6.4	20.8								
3/01/1940	0	4.8	6.4	23.5								
4/01/1940	0	6	6.4	25.2								
5/01/1940	0.8	4.6	6.4	22.8								
6/01/1940	0	4.5	6.4	23.2								
7/01/1940	0	4.3	6.4	21.5								
8/01/1940	8.9	5.3	6.4	21.5								
9/01/1940	1.1	4.8	6.4	22								
10/01/1940	0	4.4	6.4	23.5								
11/01/1940	0	4.3	6.2	24								
12/01/1940	0	5	6.2	25								
13/01/1940	0	4.8	6.2	23.2								
14/01/1940	0.9	4.1	6	22.5								
15/01/1940	0.5	6.4	6.2	25.5								
16/01/1940	46.5	4.8	6.2	27								
17/01/1940	1.4	5.7	6.2	27.8								
18/01/1940	0.6	5.3	6	25.5								
19/01/1940	7.2	5.8	6.2	25.2								
20/01/1940	8.6	5.4	6.4	24.5								
21/01/1940	0	4.3	6.4	25.5								
22/01/1940	0.7	7.2	6.4	28								
23/01/1940	0	7.1	6.4	24.5								
24/01/1940	0	7.7	6.4	27.2								
25/01/1940	0	6.8	6.2	29								

DSM Soil Data Inputs

Data Input	Code	Value	Unit	Typical Source of Information
Bio-physical Data				
Soil water at effective saturation	SAT	mm	352-437	saturated capacity. need to represent a trench media if trench, but soil if irrig area. porosity *0.9 or 0.95
Field capacity	FC		130-240	field capacity. point at which soil stops draining. See Interp Soil Test Results (Hazelton 2007) table 2.5
Permanent Wilting Point	PWP		16-25	permanent wilting point. Point at which plants cannot obtain enough water. See Interp Soil Test Results (Hazelton 2007) table 2.5
Saturated hydraulic conductivity	SHC	mm/day	60-380	rate of percolation through the saturated soil profile. Use limiting layer
Soil depth for phosphorus sorption	SDP	mm	350-1500	soil depth for p sorp. Use limiting layer
Bulk density	BD	kg/m^3	1400-1600	bulk density. Average value based on soil depth
Initial depression storage	DS	mm	6	depression storage. Initial loss before infiltration
Dry soil infiltration rate	INF	mm/day	60-120	infiltration rate of water
Infiltration exponent	EXP1	dimensionless	5698	exponent 1. how slowly ifiltration decreases once soil gets wet.
Freundlich adsorption coefficient	A1	g/L	259	A1 is exp10 of intercept of isotherm with y axis
Freundlich adsorption exponent	B1	dimensionless	0.99	B1 is slope of log normal line
Freundlich desorption exponent	B2		0.495	B2 is half of B1

DSM Output Summary

DSM Outputs	**Receiving Node**
Mean Annual Surface Runoff (m3) =	0.00
Mean Annual Surface N (g) =	0.00
Mean Annual Surface P (g) =	0.00
Mean Annual Surface V (MPN) =	0.00
Mean Annual Deep Drainage (m3) =	315.45
Mean Annual Deep Drainage N (g) =	84.52
Mean Annual Deep Drainage P (g) =	13.61
Mean Annual Deep Drainage V (MPN) =	170921296.00

N: Total Nitrogen
P: Total Phosphorus
V: viruses (Most Probable Number).