Thredbo Golf Course Development
Aquatic and Riparian Impact Assessment

Kosciuszko Thredbo Pty Ltd

ecological AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au

DOCUMENT TRACKING

Project Name	Thredbo Golf Course Development Aquatic and Riparian Impact Assessment
Project Number	22SYD-2528
Project Manager	Richard Cresswell
Prepared by	Ian Dixon and Erin Hodgkin
Reviewed by	Ian Dixon
Approved by	Richard Cresswell
Status	Draft
Version Number	V2
Last saved on	22 August 2023

This report should be cited as 'Eco Logical Australia 2023. Thredbo Golf Course Development: Aquatic and Riparian Impact Assessment. Prepared for Kosciuszko Thredbo Pty Ltd.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Kosciuszko Thredbo Pty Ltd.

Template 2.8.1

Contents

List of Figures

List of Tables

Abbreviations

Abbreviation	Description
BC Act	NSW *Biodiversity Conservation Act 2016*
DEWHA	Department of the Environment, Heritage, Water and the Arts
DPI	NSW Department of Primary Industries
DPE	NSW Department of Planning and Environment
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FM Act	NSW *Fisheries Management Act 1994*
KFH	Key fish habitat
KT	Kosciuszko Thredbo Pty Ltd
MNES	Matters of National and Environmental Significance
SEMP	Site Environmental Management Plan
SEPP	State Environmental Planning Policy
SRLEP	Snowy River Local Environmental Plan 2013
SWMP	Stormwater Management Plan
VRZ	Vegetated Riparian Zone
WM Act	NSW *Water Management Act 2000*
WM Regulations	NSW Water Management (General) Regulation 2018

Executive summary

Eco Logical Australia was engaged by Kosciuszko Thredbo Pty Ltd to prepare an Aquatic and Riparian Impact Assessment to support their Development Application relating to the subdivision and development of Thredbo Golf Course, located within Kosciuszko National Park. This assessment addresses threatened fish species, populations and communities, policies and guidelines, and development controls relevant to the area, especially:

- Matters of National Environmental Significance (MNES) listed under *the Environment Protection and Biodiversity Conservation Act* (EPBC Act)
- Riparian guidelines under the *Water Management Act 2000*
- Threatened species, populations and communities listed under the *Fisheries Management Act 1994* (FM Act), and consideration of the DPI Fisheries Policy and Guidelines for Fish Habitat Conservation and Management (2013 update)

An assessment of significance for *Austropetalia tonyana* (Alpine Redspot Dragonfly) and the Aquatic Ecological Community in the Catchment of the Snowy River in NSW concluded no significant impact would result from the proposed development. No other threatened fish species, populations or communities occur, or are likely to occur, in or adjacent to the site.

The proposed works do not involve instream works, dredging, reclamation or obstruction to fish passage, and therefore, do not require permits under Part 7 of the FM Act (outlets would be covered in a CAA). There would be no net loss of key fish habitat, as defined under the FM Act.

The proposed footprint encroaches the inner 50% vegetated riparian zone (VRZ) of the riparian corridor, however, will not degrade watercourse condition due to being on existing cleared land on the golf course. An integrated Development Application is required for a merit-based assessment by DPE Water for works within waterfront land.

In order to prevent any adverse effects to Thredbo River's water quality, the development must implement the mitigation measures outlined in the Stormwater Management Plan and Construction Environmental Management Plan.

1. Introduction

This report has been prepared by Eco Logical Austral Pty Ltd (ELA) for Kosciuszko Thredbo (KT) Pty Ltd. KT require an Aquatic and Riparian Impact Assessment for the proposed subdivision and development at Thredbo Golf Course, located in Kosciuszko National Park NSW. The existing golf course is located within the Thredbo Alpine Resort boundary, and the study area is shown in Figure 1.

Specific aims and objectives of this report are to:

- Identify riparian buffers triggered by the *Water Management Act 2000*
- Review existing literature and site data to determine the potential impacts of the development on the aquatic ecology of Thredbo River adjacent to the site
- Provide recommendations to mitigate impact during construction and operation.

Consideration has been given to DPE Riparian Guidelines for Works on Waterfront Land (DPE 2022) and DPI Fisheries' Policy and Guidelines for Fish Habitat Conservation and Management (2013 update, Fairfull 2013).

1.1 Proposed work

The total development area within the site is 4.46 ha, which includes 19 subdivided lots and the accompanying asset protection zones. The site would be accessed by a new 425 m long, 6.1 m wide public road from Crackenback Drive. An additional 48 visitor carparks would be positioned along the road network. Three stormwater retention devices would capture sediment and hydrocarbon pollutants from stormwater prior to discharge to Thredbo River. Development, landscape, stormwater and drainage concepts are shown in Appendix A.

Development would be comprised of:

- Bulk earthworks
- Stormwater drains and other ancillary services (electricity, sewer, gas, potable water, communications)
- Building, access road and carpark construction
- Landscaping and rehabilitation work.

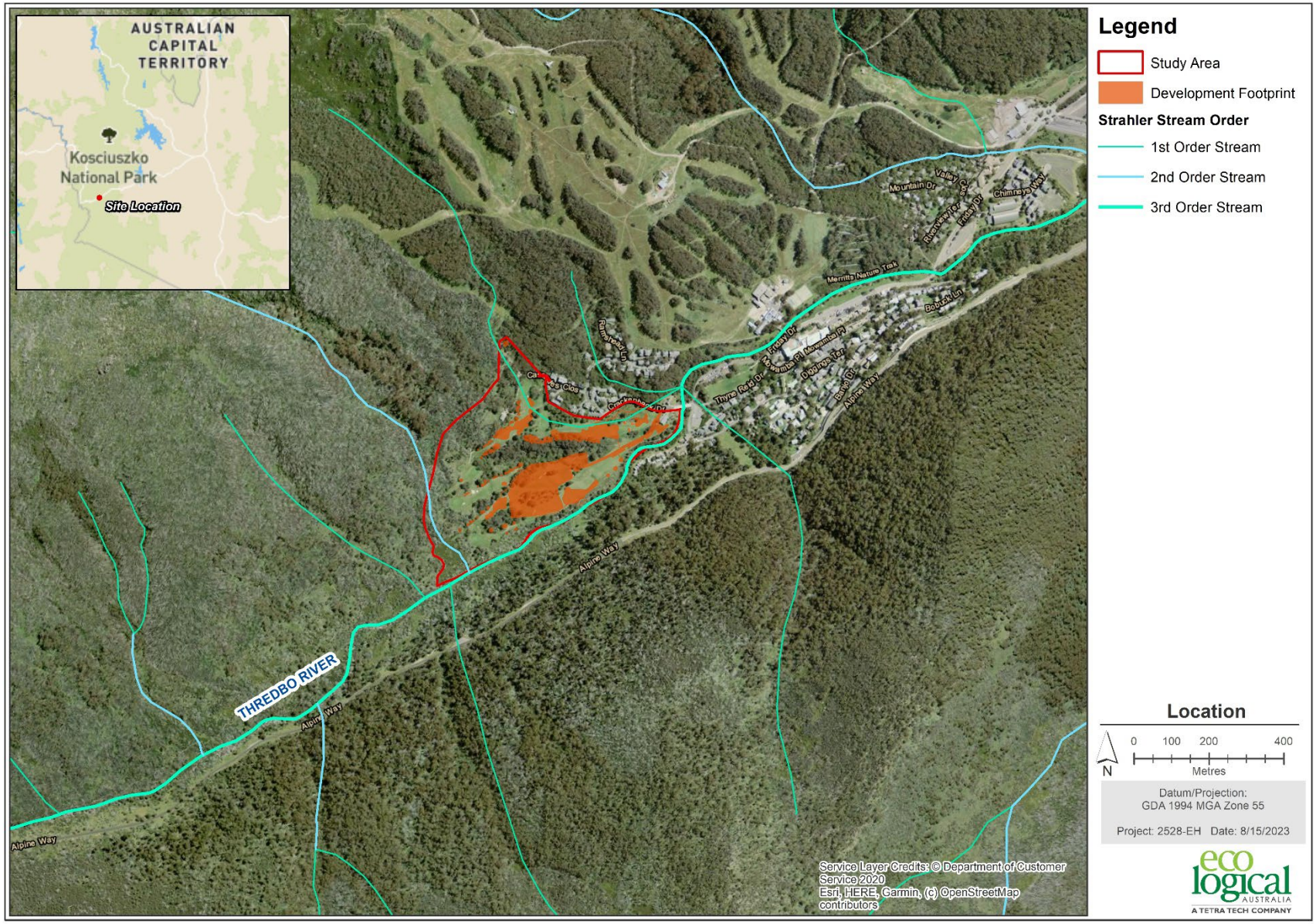


Figure 1: Location of the proposed development

2. Regulatory context

Various legislation, policies and guidelines apply to the assessment, planning and management of waterways and riparian land within the study area. Items reviewed include:

- *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act)
- *Water Management Act 2000* (WM Act)
- Wetlands Management Policy 2010
- *Fisheries Management Act 1994* (FM Act)
- Policy and guidelines for fish habitat conservation and management (Fairfull 2013)
- State of Environmental Planning Policy (Precincts – Regional) 2021 – Chapter 4 (Alpine SEPP)

2.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EBPC Act is the Australian Government's central piece of environmental legislation. Under the EPBC Act, the Commonwealth Environment Minister needs to approve any development that is likely to have a significant impact on Matters of National Environmental Significance (MNES). Should such an impact, as defined in the EPBC Act Policy Statement 1.1 – Significant Impact Guidelines (DEWHA 2009), be likely, the preparation and submission of a Referral is required.

2.2 Water Management Act 2000

The main objective of the WM Act is to manage NSW water in a sustainable and integrated manner that will benefit current generations without compromising future generations' ability to meet their needs. The WM Act is administered by the DPE and establishes an approval regime for activities within waterfront land, defined as the land 40 m from the highest bank of a river, lake or estuary.

The relevant objects and principles of the WM Act are set out clause 3 and 5 of the WM Act.

3 Objects

The objects of this Act are to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations and, in particular—

a. *to apply the principles of ecologically sustainable development, and*
b. *to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality*
c. *to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:*
    i. *benefits to the environment*
    ii. *benefits to urban communities, agriculture, fisheries, industry and recreation*
    iii. *benefits to culture and heritage*
    iv. *benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water*
d. *to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,*

e. to provide for the orderly, efficient and equitable sharing of water from water sources,
f. to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,
g. to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,
h. to encourage best practice in the management and use of water.

5 Water management principles
(2) Generally—
a. water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded, and
b. habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored, and
c. the water quality of all water sources should be protected and, wherever possible, enhanced, and
d. the cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised, and
e. geographical and other features of Aboriginal significance should be protected, and
f. geographical and other features of major cultural, heritage or spiritual significance should be protected, and
g. the social and economic benefits to the community should be maximised, and
h. the principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirements.

Under WM Act framework, activities and works proposed on waterfront land are regulated. These 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
- the deposition of material on land by landfill or otherwise
- any activity that affects the quantity or flow of water in a water source.

2.2.1 Guidelines for riparian corridors on waterfront land

The DPE Guidelines for Controlled Activities on waterfront land—Riparian corridors (DPE 2022) outlines the need for a Vegetated Riparian Zone (VRZ) adjacent to the channel to provide a transition zone between the terrestrial environment and watercourse. This vegetated zone helps maintain and improve the ecological functions of a watercourse whilst providing habitat for terrestrial flora and fauna. The VRZ plus the channel (bed and banks of the watercourse to the highest bank) constitute the 'riparian corridor' (Figure 2). To be consistent with the guidelines, VRZ widths should be based on watercourse order as classified under the Strahler system of ordering watercourses and using Hydroline Spatial Data which is published on the department's website (Table 1).

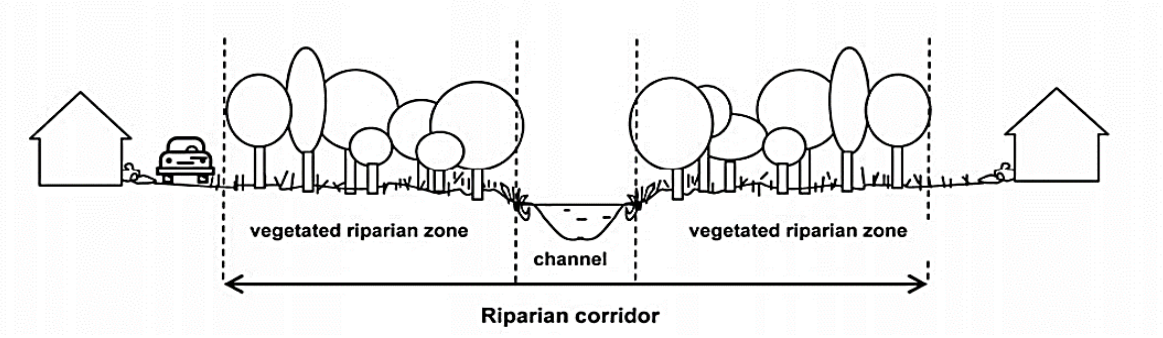


Figure 2: Vegetated riparian zone and watercourse channel comprising the riparian corridor (DPE 2022).

Table 1: Recommended riparian corridor widths relative to Strahler stream order (DPE 2022).

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

Certain works are permissible within the riparian zone if specific design criteria are met (Table 2 and key). Non-riparian uses in the outer 50% of the VRZ are permitted as long as compensation (1:1 offset) is achieved within the site using the 'averaging rule' (Figure 3).

Table 2: Riparian corridor (RC) matrix of permissible use with key (DPE 2022).

Stream order	Vegetated Riparian Zone (VRZ)	RC offsetting 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	10 m	●	●	●	●	●	●	●		
2nd	20 m	●	●	●	●	●		●		
3rd	30 m	●	●	●		●			●	●
4th +	40 m	●	●	●		●			●	●

Key to riparian corridor matrix

Stream order: The watercourse order as classified under the Strahler system based on Hydroline Spatial Data published on the Department's website[1]

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 bushfire Asset Protection Zones, roads and urban development are allowed within the outer 50% 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% of the VRZ.

Detention basins: Detention basins can be built in the outer 50% of the VRZ or online where indicated. 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.

Stream realignment: Indicates that a watercourse may be realigned.

Road crossings: Indicates permitted road crossing methods. Also refer to DPI Fisheries policy and guidelines for fish friendly waterway crossings (Fairfull 2013, discussed below in section 0).

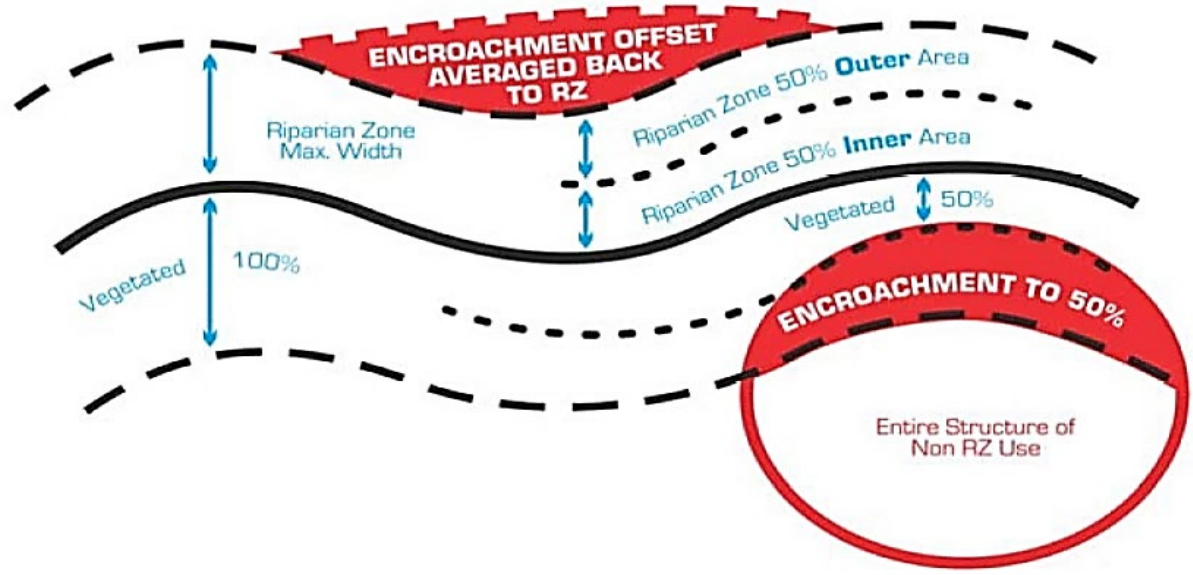


Figure 3: Riparian 'averaging rule' for offsetting encroachment into the outer 50% of the VRZ (DPE 2022)

Exemptions for obtaining Controlled Activity Approvals for works on waterfront land may apply under Part 2 of Schedule 4 of the Water Management (General) Regulation 2018 (WM Regulations).

[1] https://www.industry.nsw.gov.au/water/licensing-trade/hydroline-spatial-data

2.3 Wetlands Management Policy 2010

The NSW Wetlands Management Policy (DECCW 2010) aims to provide for the protection, ecologically sustainable use and management of NSW wetlands. Wetlands include lakes, lagoons, estuaries, rivers, floodplains, swamps, bogs, billabongs, marshes, coral reefs and seagrass beds. This policy provides 12 principles that guide the way in which wetlands should be looked after and preserved. Upland wetlands and rivers occur within the study area and are considered in this report and a Biodiversity Development Assessment Report (in preparation).

2.4 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) aims to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. The FM Act defines 'fish' as any marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history. This includes insects, molluscs (e.g. oysters), crustaceans, echinoderms, and aquatic polychaetes (e.g. beachworms), but does not include whales, mammals, reptiles, birds, amphibians or species specifically excluded (e.g. some dragonflies are protected under the Biodiversity Conservation Act (BC Act) 2016 instead of the FM Act). Under this Act, if any activity occurs on key fish habitat and will obstruct fish passage, involve dredging or reclamation of channel bed or banks or involve use of explosives in the waterway, then a permit under Part 7 of this Act will be required.

Additionally, the objects of this Act are to conserve threatened species, populations and ecological communities of fish and marine vegetation, which are determined as threatened by the Fisheries Scientific Committee. Vulnerable, endangered and critically endangered species, populations and ecological communities are at risk of extinction due to one or more of the following key threatening processes:

- Degradation of native riparian vegetation along New South Wales water courses
- Hook and line fishing in areas important for the survival of threatened fish species
- Human-caused climate change
- Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams
- Introduction of fish to waters within a river catchment outside their natural range
- Introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales
- Removal of large woody debris from New South Wales rivers and streams
- The current shark meshing program in New South Wales waters

Riches et al (2016) model vulnerable species *Austropetalia tonyana (*Alpine Redspot Dragonfly) as expected to occur within the study area. Additionally, the development is located within the Aquatic Ecological Community in the Catchment of the Snowy River.

2.4.1 Policy and guidelines for fish habitat conservation and management

The *Policy and guidelines for fish habitat conservation and management* (Fairfull 2013) is a supplementary document that outlines the requirements and obligations under the FM Act and the *Fisheries Management (General) Regulation 2010* and were developed to maintain and enhance fish habitat and assist in the protection of threatened species. The Policy provides a definition of key fish habitat and provides guidance for assigning a classification of waterways for fish passage, which informs the types of infrastructure suitable for the creekline (Table 3) and sensitivity of the key fish habitat present, which determines the potential disturbance and offsetting required for development (Table 4).

Table 3: Classification of waterways for fish passage and crossing type (Fairfull 2013)

Classification	Characteristics of waterway class and preferred crossing type
CLASS 1 Major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'. Bridge, arch structure or tunnel. Bridges are preferred to arch structures.
CLASS 2 Moderate key fish habitat	Non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pool or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present. Bridge, arch structure, culvert[1] or ford. Bridges are preferred to arch structures, box culverts and fords (in that order).
CLASS 3 Minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats. Culvert[2] or ford. Box culverts are preferred to fords and pipe culverts (in that order).
CLASS 4 Unlikely key fish habitat	Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or freestanding water or pools post rain events (e.g. dry gullies or shallow floodplain depressions with no aquatic flora present). Culvert[3], causeway or ford. Culverts and fords are preferred to causeways (in that order).

[1] High priority given to the 'High Flow Design' procedures presented for the design of these culverts—refer to the "Design Considerations" section of Fairfull and Witheridge 2003.

[2] Minimum culvert design using the 'Low Flow Design' procedures; however, 'High Flow Design' and 'Medium Flow Design' should be given priority where affordable—refer to the "Design Considerations" section of Fairfull and Witheridge (2003).

[3] Fish friendly waterway crossing designs possibly unwarranted. Fish passage requirements should be confirmed with NSW DPI.

As noted in Fairfull and Witheridge 2003, there are additional factors that must be taken into consideration by those involved in waterway crossing design and construction, including public safety, social and budgetary constraints. Each crossing is therefore assessed by NSW DPI on a case-by-case basis.

Table 4: Key fish habitat types (Fairfull 2013)

Key fish habitat and associated sensitivity classification scheme (for assessing potential impacts of certain activities and developments on key fish habitat types)
TYPE 1 – Highly sensitive key fish habitat:
Posidonia australis (strapweed)
Zostera, Heterozostera, Halophila and *Ruppia* species of seagrass beds >5 m^2 in area
Coastal saltmarsh >5 m^2 in area
Coral communities
Coastal lakes and lagoons that have a natural opening and closing regime (i.e. are not permanently open or artificially opened or are subject to one off unauthorised openings)
Marine park, an aquatic reserve or intertidal protected area
SEPP 14 coastal wetlands, wetlands recognised under international agreements (e.g. Ramsar, JAMBA, CAMBA, ROKAMBA wetlands), wetlands listed in the Directory of Important Wetlands of Australia
Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants
Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act
Mound springs
TYPE 2 – Moderately sensitive key fish habitat:
Zostera, Heterozostera, Halophila and *Ruppia* species of seagrass beds <5 m^2 in area
Mangroves
Coastal saltmarsh <5 m^2 in area
Marine macroalgae such as *Ecklonia* and *Sargassum* species
Estuarine and marine rocky reefs
Coastal lakes and lagoons that are permanently open or subject to artificial opening via agreed management arrangements (e.g. managed in line with an entrance management program)
Aquatic habitat within 100 m of a marine park, an aquatic reserve or intertidal protected area
Stable intertidal sand/mud flats, coastal and estuarine sandy beaches with large populations of in-fauna
Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1
Weir pools and dams up to full supply level where the weir or dam is across a natural waterway
TYPE 3 – Minimally sensitive key fish habitat may include:
Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no in-fauna
Coastal and freshwater habitats not included in TYPES 1 or 2
Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation

2.5 State of Environmental Planning Policy (Precincts – Regional) 2021 – Chapter 4 (Alpine SEPP)

Chapter 4 of the State Environmental Planning Policy (Precincts – Regional) 2021, is otherwise known as the Alpine SEPP and governs alpine resort development assessments. The aim of the SEPP is to protect the natural and cultural heritage of the land within alpine resorts. As outlined in Section 4.6 of the SEPP, this Chapter prevails the Snowy River Local Environmental Plan 2013.

Under this SEPP, all developments are subject to the assessment of environmental impacts and geotechnical and land stability issues. This SEPP requires all development proposals to be advertised, and those located within Kosciuszko National Park are to be referred to the NSW Office of Environment and Heritage for comment and to be authorised under the *National Parks and Wildlife Act 1974*.

In support of the WM Act, Part 4.3, clause 4.11 states:

(5) To be exempt or complying development, the development must not be carried out on waterfront land unless the development is carried out—

(a) under a controlled activity approval, or

(b) in accordance with an exemption from the requirement to have a controlled activity approval under the regulations under the Water Management Act 2000.

3. Methods

3.1 Literature review and desktop assessment

Online database searches were used to confirm the presence of watercourses and threatened species in the region. Results used to infer what may be present in the study area. Databases accessed include:

- 1:25,000 Hydroline (NSW government) mapping, and the corresponding stream order using the Strahler classification system
- EPBC Act – Protected Matters Search Tool (5 km radius)
- FM Act – Fisheries Portal, key fish habitat, listed protected and threatened species and populations, including species profiles, 'Primefact' publications and expected distribution maps (Riches et al 2016)
- Online Zoological Collections of Australian Museums (OZCAM) and Atlas of Living Australia (ALA) – individual species searches to determine likelihood of occurrence of threatened species (Thredbo River sub-catchment).

Additionally, previous studies provided by KT Pty Ltd were reviewed to determine past and recent aquatic conditions of Thredbo River, and the surrounding Snowy River Catchment.

3.2 Riparian assessment

A 'river', as termed in the WM Act, is a watercourse shown on the state hydroline map and one that has a defined bed, bank and evidence of geomorphic processes (erosion and deposition). A river may generally have some aquatic habitat features, either ephemeral or permanent, and may be discontinuous along its length. A watercourse may have portions of its length that do not display evidence of a river but if there are defining features upstream of that reach, then it must be classed as a river for its full length (as measured down from the uppermost part that has defining characteristics). Under the DPE riparian guidelines, should a watercourse not be defined as a river, then the downstream Strahler stream order cannot be altered. That is, the Strahler stream order is a fixed calculation from the state hydroline map, regardless of whether the river exists, or has been engineered, or is proposed to be engineered (i.e. piped or filled for development).

3.2.1 Top of bank mapping

Top of bank was initially mapped on ArcMap using 1 m lidar contours and high-resolution aerial photography. A brief, opportunistic, field survey was then conducted by Ian Dixon to verify the desktop mapping and confirm piping of one stream.

Once the field-validated top of bank linework was finalised, a riparian buffer (VRZ width) was applied to its corresponding stream order in accordance with the DPE riparian guidelines (Table 1), as well the SRLEP riparian land guidelines. The SRLEP riparian guidelines require a 40 m buffer from top of bank, which matches the 40 m waterfront land buffer required by the WM Act. Therefore, the SRLEP buffer has been absorbed by the waterfront land buffer as shown in Figure 4. A 50% VRZ line was added to show the limit of permitted encroachment if offsetting is possible, as per DPE's averaging rule (Figure 3).

4. Results

4.1 Literature review and database search

The study area intersects with the riparian corridors of two 1st order streams, one 2nd order stream, and one 3rd order stream (Thredbo River), forming part of the Snowy River Catchment. DPI Fisheries identify three types of KFH in their Policy and Guidelines for Fish Habitat Conservation and Management (Table 4). As a 3rd order stream, Thredbo River is mapped as key fish habitat by DPI Fisheries and can further be described as Type 1 – highly sensitive key fish habitat. Smaller streams can also be classed as KFH is they are known to support a threatened species, therefore the 2nd order stream along the western edge of the study area is defined as KFH (Figure 5).

4.1.1 Presence or likelihood of threatened and protected species, populations and communities

The OZCAM database shows only a small number of records in the Thredbo River catchment: the native *Galaxias olidus* (Mountain Galaxias) and introduced *Salmo trutta* (Brown Trout). These species are common in alpine and subalpine streams of NSW, and are not listed as threatened.

Threatened fish species, populations or communities listed under the FM Act and EPBC Act that are known or expected to occur in the region are listed in Appendix B. Two are known or predicted to occur in the study area:

- *Austropetalia tonyana (*Alpine Redspot Dragonfly) is modelled to occur in Thredbo River and numerous tributaries, as seen in Figure 5 (Riches et al 2016). Alpine Redspot Dragonfly have an aquatic phase of their lifecycle, with extremely specific habitat requirements, in that they only occur amongst rocks, logs and moss within the splash zone of waterfalls or in the nearby stream edge. Their flight period is thought to occur between October and January. An assessment of significance under the FM Act is provided in Appendix C.
- Aquatic Ecological Community in the Catchment of the Snowy River in NSW is an endangered ecological community (EEC) that includes all native fish and aquatic invertebrates in all rivers, creeks and streams within the entire NSW portion of the Snowy River catchment. An assessment of significance for this EEC under the FM Act is provided in Appendix D.

4.2 Riparian assessment

The study area intersects with the riparian corridors of two 1st order streams, one 2nd order stream and one 3rd order stream (Thredbo River). All streams within the study area met the definition of a river under the WM Act, except for a 106 m piped section across the golf course (Reach 1B). Concrete-lined and piped sections are exempt from obtaining approvals for works on waterfront land (Clause 28 of Schedule 4 of the WM Regulations). Part of the development is separated from Reach 1A by an existing public road, therefore, that portion of land is also exempt (Clause 31 of Schedule 4 of the WM Regulations).

Final top of bank mapping and corresponding riparian corridors triggered by the riparian guidelines are shown in Figure 4.

4.2.1 Riparian and aquatic condition

The Snowy River catchment is typically the poorest in condition within the Southern Rivers CMA region and coastal catchments in NSW. Habitat degradation and modification, flow alteration due to the Snowy Mountains Hydro-electric Scheme (SMS) and climate change are all examples of factors that have led to the catchment's poor condition (DPI Fisheries 2011). Thredbo River, within the study area, remains upstream of the SMS and therefore remains in a relatively natural condition, with the exception of the migration barrier caused by Jindabyne Dam.

Quarterly water quality monitoring surveys have been carried out since 1989, as well as numerous studies, all carried out by the University of Canberra under various denominations, originally known as the Cooperative Research Centre for Freshwater Ecology. The current iteration, since 2016, known as Centre for Applied Water Science, undertake routine water quality monitoring and biological assessments of Thredbo River for KT Pty Ltd (Ugyen et al 2016 and 2022). Those studies aim to test effects of run-off from Thredbo Village, golf course and sewerage treatment plant by analysing macroinvertebrate assemblages. Between 2016 and 2022, all sites tested downstream of the golf course and Thredbo Village were, on average, given a band B score (significantly impaired), interpreted to mean that compared to the undisturbed reference site, there is potential impact on either water quality or habitat quality (or both) from development and run-off. For the proposed development to produce no adverse effects to the water quality of Thredbo River, sufficient erosion and sedimentation measures must be put into place, as well as water sensitive urban design measures to treat stormwater. Recommendations for these are outlined in the Stormwater Management Plan (SWMP) produced by ELA 2023.

All channels within the study area were assessed as poor to good condition, with representative photos shown in Figure 7.

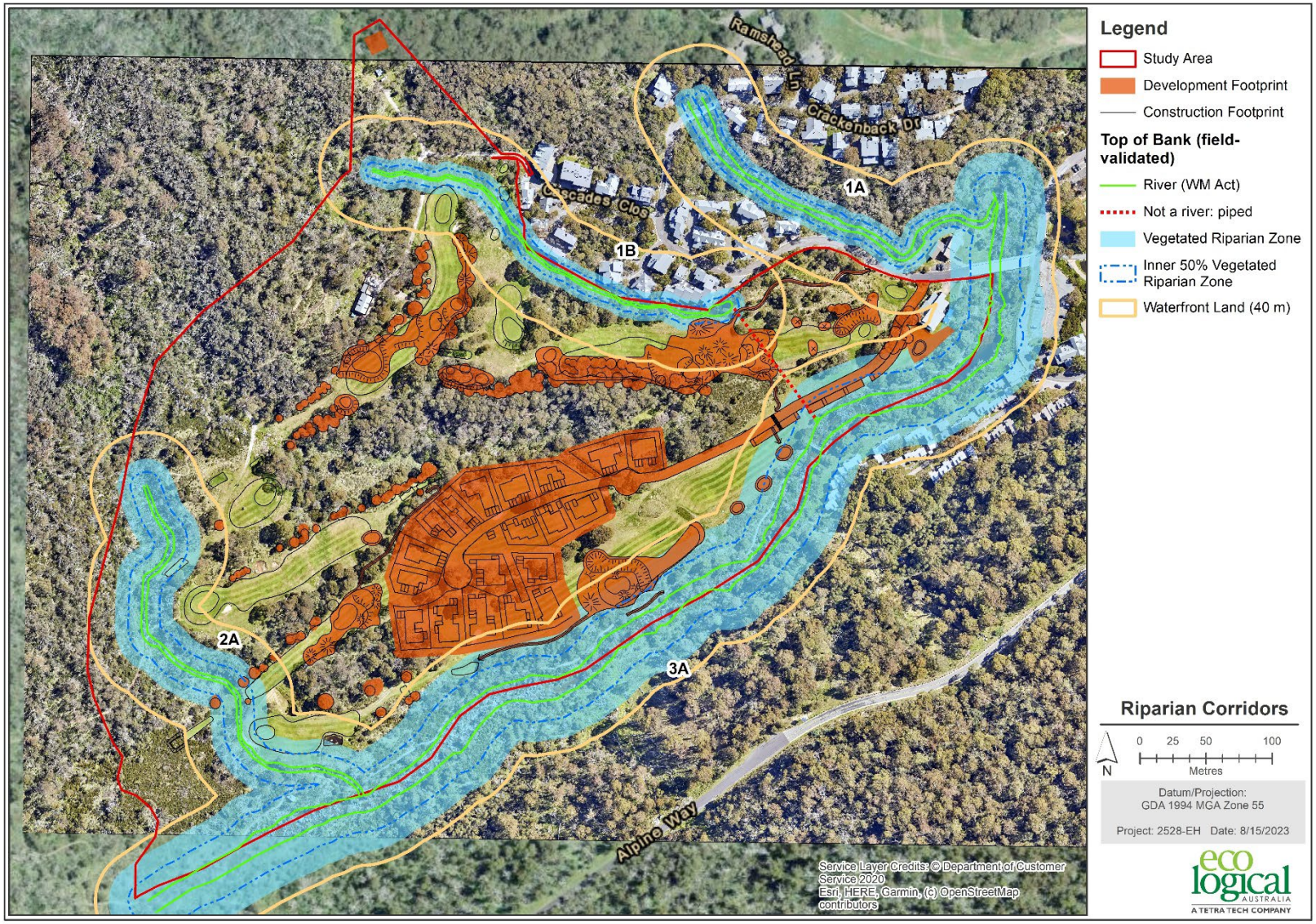


Figure 4: Field-validated top of bank mapping and vegetated riparian zones required under DPE riparian guidelines (2022)

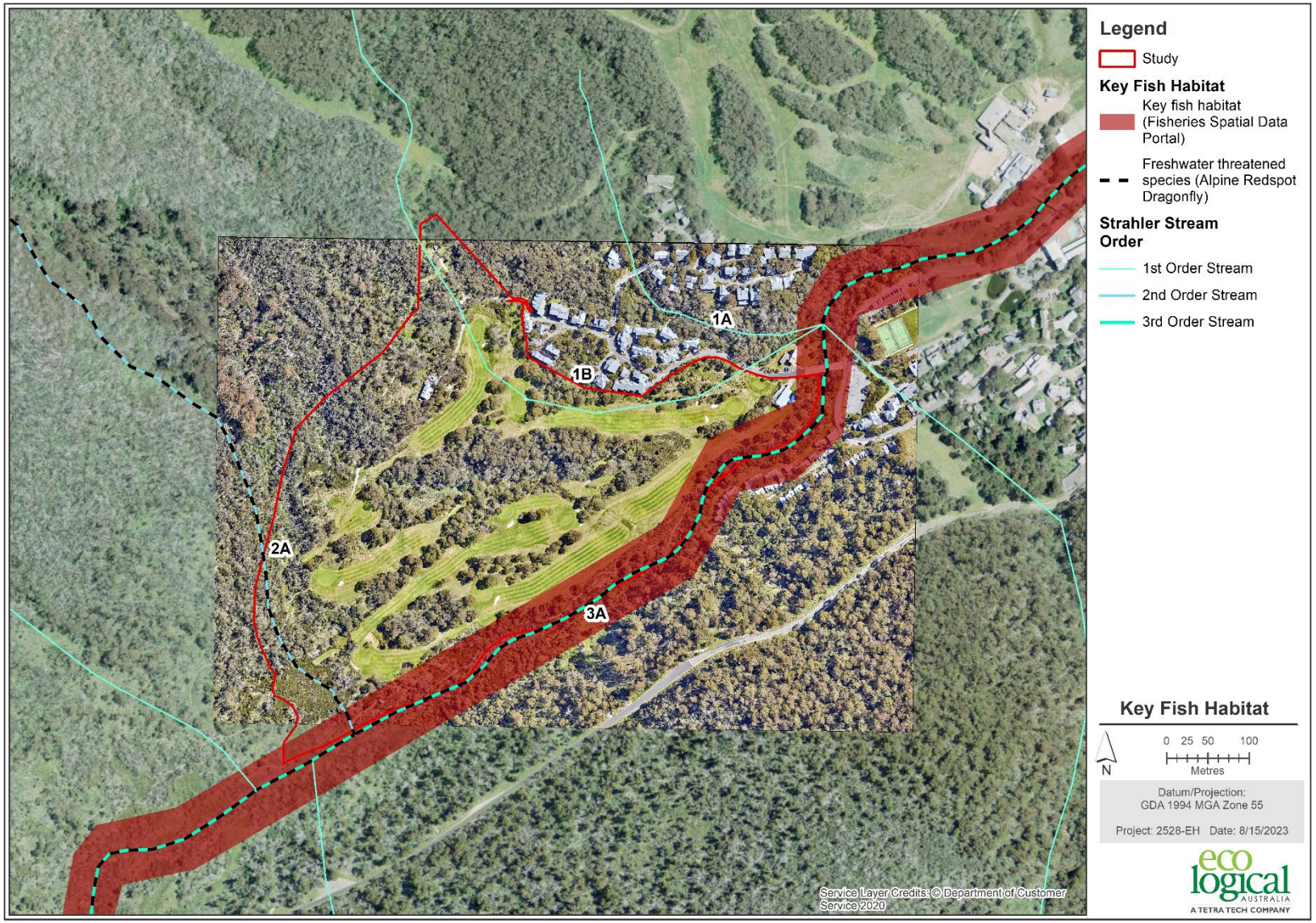


Figure 5: Key fish habitat, as identified by key fish habitat mapping and threatened species modelling (DPI Fisheries Spatial Portal)

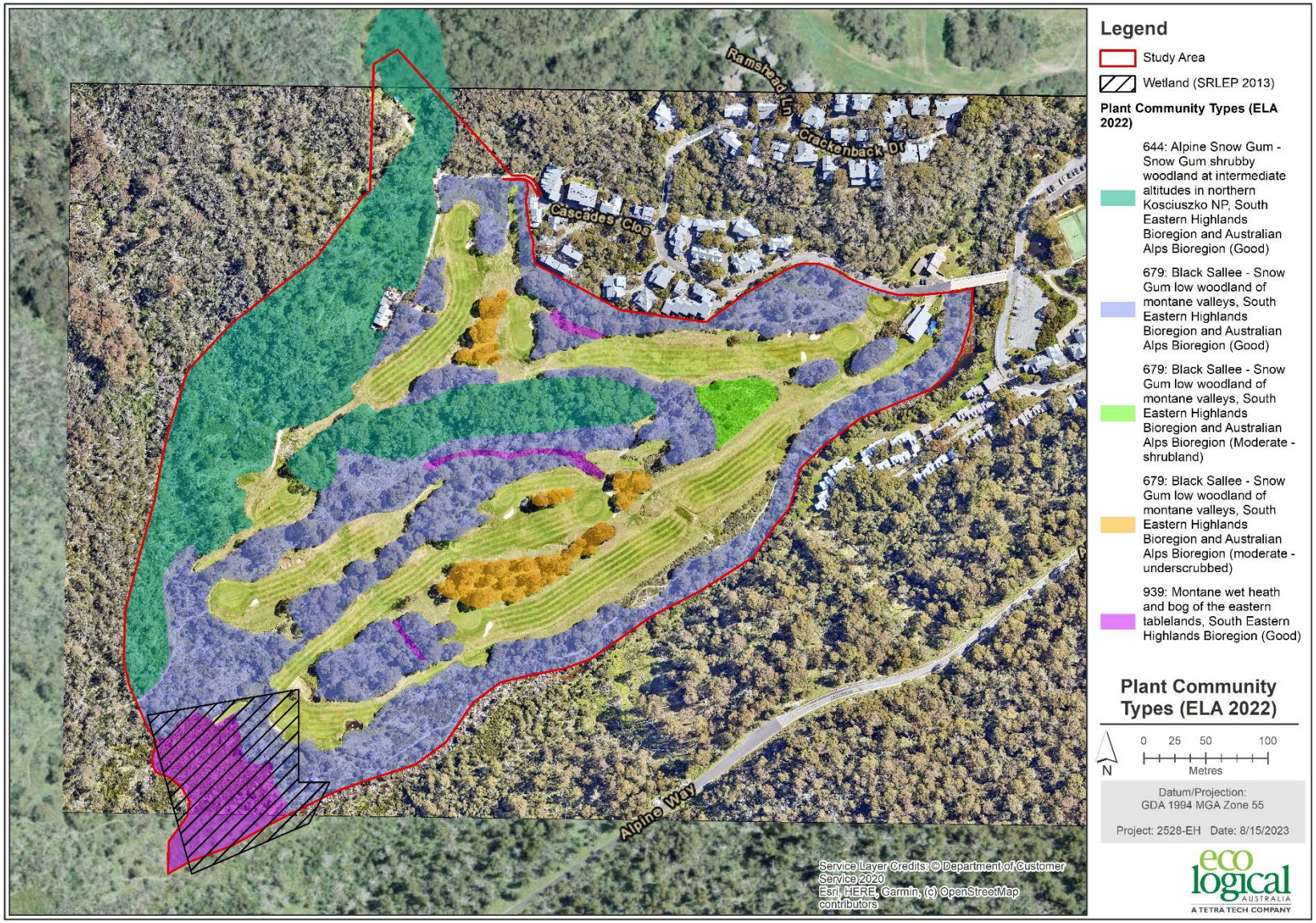


Figure 6: Plant Community Types (ELA 2022) and wetlands as mapped by the 2013 SRLEP


Reach 1B: Left – facing downstream from fire trail; Right – facing upstream near existing housing.


Reach 2A: Left – facing downstream from fairway footbridge; Right – facing upstream near confluence with Thredbo River.

Reach 3A (Thredbo River): Top left – facing upstream looking across to golf course; Top right – facing downstream from footbridge (gully and small bridge on left is pipe outlet from Reach 1B); Bottom left – typical riparian zone facing downstream; Bottom right – existing walking track (mixed boardwalk and gravel).

Figure 7: Representative photos of reaches

5. Impact assessment and mitigation

This section considers the impact of the proposed development described in Section 1.1.

5.1 Threatened species impact assessment

A likelihood of occurrence assessment is provided in Appendix B. Of the species gathered in database searches, the Vulnerable species *Austropetalia tonyana (*Alpine Redspot Dragonfly) and the Aquatic Ecological Community in the Catchment of the Snowy River in NSW trigger further assessment of significance under the FM Act. No other fishes listed under the EPBC Act have the potential to occur in the study area, and therefore, do not trigger further assessment. Given the proposed development is mainly situated on existing cleared and managed land, and does not include in stream works, the main concern are indirect impacts from factors, such as run-off during construction and operation.

The tests, conducted in Appendix C and Appendix D, conclude no significant impacts to either species or EEC. In summary, Alpine Redspot Dragonfly is currently threatened due to habitat degradation caused by climate change, natural disasters, reduced stream flow associated with forestry development and the capture of dragonflies by humans. The proposal sees no direct or indirect links to any of these factors, and given no instream works are proposed, there will be no modification or removal of habitat, particularly splash zones of waterfalls, or equivalent habitat around large boulder riffles. The Aquatic Ecological Community in the Catchment of the Snowy River in NSW is currently threatened due to the indirect impacts to biological cues (spawning, migration etc), largely caused by the SMS. Erection of the SMS reduced flows, affecting water quality, thermal pollution and fish barriers in the form of dam and weirs. The proposal sees no direct impact to the EEC, and with sufficient mitigation measures in place to minimise factors such as construction run-off and stormwater filtration, indirect impacts will also not modify or degrade the existing condition of the habitat supporting the aquatic community. As per the SWMP (ELA 2023), stormwater infrastructure is proposed to manage runoff surrounding impervious areas including the subdivided lots, buildings and access road. The drainage infrastructure will be connected to three stormwater retention devices (e.g. Puraceptor brand or similar) to treat stormwater prior to discharge to Thredbo River. If effective and adequately maintained, the treatment system would mitigate indirect impacts to the river.

5.2 Riparian impact assessment

The proposed development encroaches the inner 50% of the vegetated riparian zone. Encroachment of Reaches 1A and 2A are limited to minor tree/shrub removal and reconfiguration of the golf course layout within existing cleared areas. Encroachment of Reach 3A (Thredbo River) is similar in nature plus the addition of the main access road and car parking, located on an existing cleared fairway. All areas of encroachment, besides a small section of walking trail realignment adjacent to Thredbo River, are within cleared areas or areas currently managed as a functional golf course.

No riparian offsetting using the averaging rule is proposed. It is argued that riparian averaging is not possible, due to ongoing existing use and limited space provided by this golf course. It is also argued that surrounding portions of Thredbo River have their inner 50% vegetated riparian zone encroached by previous village development. An example of this is seen in Figure 8, where immediately downstream of the study area, Friday Drive lies between 5-10 metres from the top of bank of Thredbo River in several areas. This distance is well under the 15 m inner 50% width recommended by DPE riparian guidelines (2022), and these distances are similar to the encroachments proposed by the golf course subdivision. Another example is on the opposite bank of Thredbo River, where clearing around the accommodation structures is 7-10 m from top of bank. With such development along the immediate reach, it is highly unlikely the proposed encroachment on existing cleared land would reduce the current riparian functions and value.

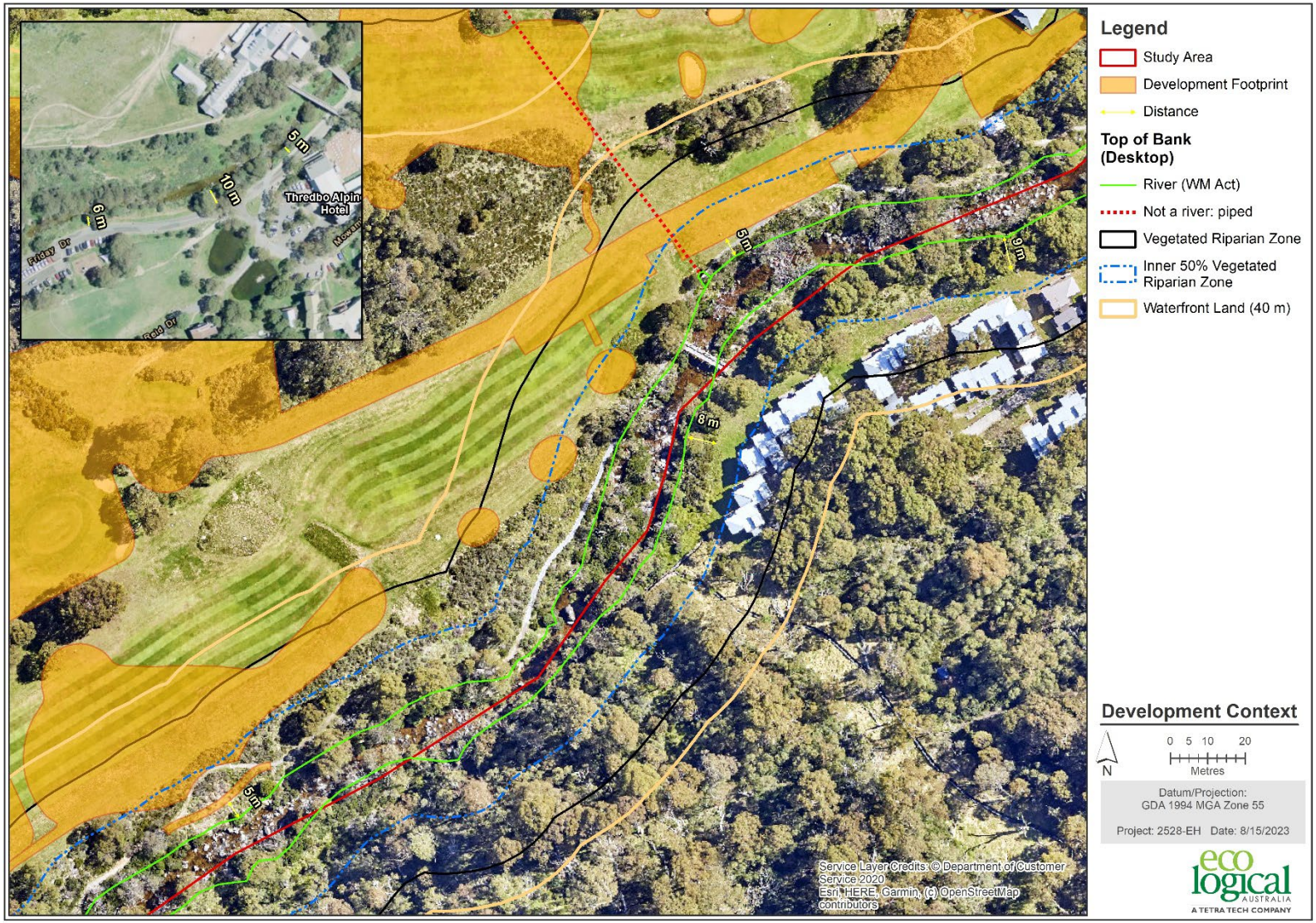


Figure 8: Riparian encroachments in context with past developments along Thredbo River

5.3 Recommendations

The following mitigation measures are recommended to minimise the risk of impact during construction and operation. At a minimum, KT Pty Ltd should:

- Develop a Site Environmental Management Plan (SEMP) to address pollution, contamination and unnecessary disturbance which could arise during construction, such as:
  - Erosion and Sediment Control Plan
  - oil/fuel/chemical storage and spill management
  - machinery and engine maintenance schedule to reduce oil/fuel leakage
  - biological hygiene (e.g. prevent spread of noxious flora species on and off the site)
  - other measures outlined in the SWMP (ELA 2023)
- Seek the following:
  - Merit-based assessment by DPE-Water when lodging an Integrated Development Application. A merit-based assessment is required because the proposal does not meet the DPE Riparian Guidelines 2022 (i.e. encroachment of the inner 50% VRZ and no application of the averaging rule). If DPE issue General Terms of Approval, this will lead to an application for a Controlled Activity Approval (CAA) for works on waterfront land (40 m from top of bank)
- The CAA will likely require development of a Vegetation Management Plan (VMP) to protect and enhance riparian vegetation using native riparian species endemic to the area. If required, the VMP should form part of the Rehabilitation and Landscape Plan, to be prepared during detailed design.
- Under the VMP, urban plantings should avoid using deciduous trees within 40 m of a watercourse, or in areas where excessive leaf drop cannot be contained from stormwater runoff.

6. Conclusion

This riparian and aquatic ecology assessment concludes that the proposed subdivision and construction work and golf course reconfiguration would:

- not have a significant impact on any threatened fish species or aquatic communities listed under the FM Act or EPBC Act
- not trigger the need for a Species Impact Statement nor referral to a Commonwealth body in relation to fish
- require an Integrated Development Application for assessment by DPE-Water for works on waterfront land
- not require dredging, reclamation, obstruction of fish passage or permits under Part 7 of the FM Act (outlets would be covered under a CAA)
- not degrade watercourse condition by proposed VRZ encroachments, due to existing cleared use
- require the implementation of mitigation measures as outlined in the SWMP to prevent adverse effects to Thredbo River's water quality
- meet environmental protection requirements of Chapter 7.3 – Snowy River LEP 2013
- require detailed designs of outlets to meet DPE standards.

7. References

ALA 2023. *Atlas of Living Australia*, accessed April 2023: https://spatial.ala.org.au/?q=lsid:urn:lsid:biodiversity.org.au:afd.taxon:6b53ca61-282b-4ec7-9028-10c384ff0a47&qc=data_hub_uid:dh1

Creese, R.G., Glasby, T.M., West, G. and Galen, C. 2009. *Mapping the habitats of NSW estuaries. Industry & Investment NSW Fisheries Final Report Series 113*. Port Stephens, NSW, Australia.

Department of Planning and Environment 2022. *Controlled activities – Guidelines for riparian corridors on waterfront land*. Department of Planning and Environment.

Eco Logical Australia 20222023. *Thredbo Golf Course Stormwater Management Plan.* Prepared for Kosciuszko Thredbo Pty Ltd.

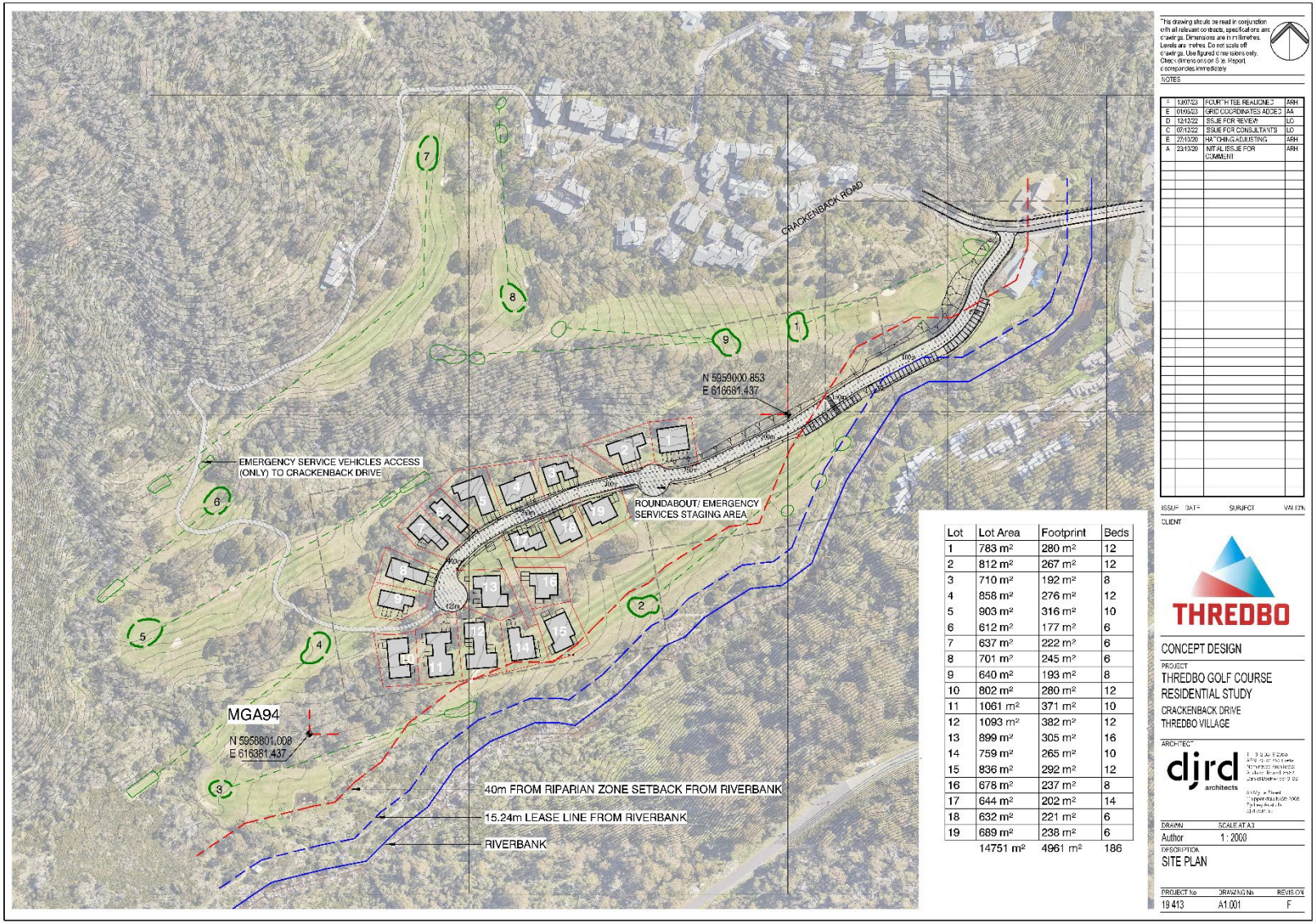
Fairfull, S. 2013. *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update).* NSW Department of Primary Industries.

Fisheries Scientific Committee 2011. *Final Determination: Aquatic Ecological Community in the Catchment of the Snowy River in NSW (April 2011)*. NSW Department of Primary Industries.

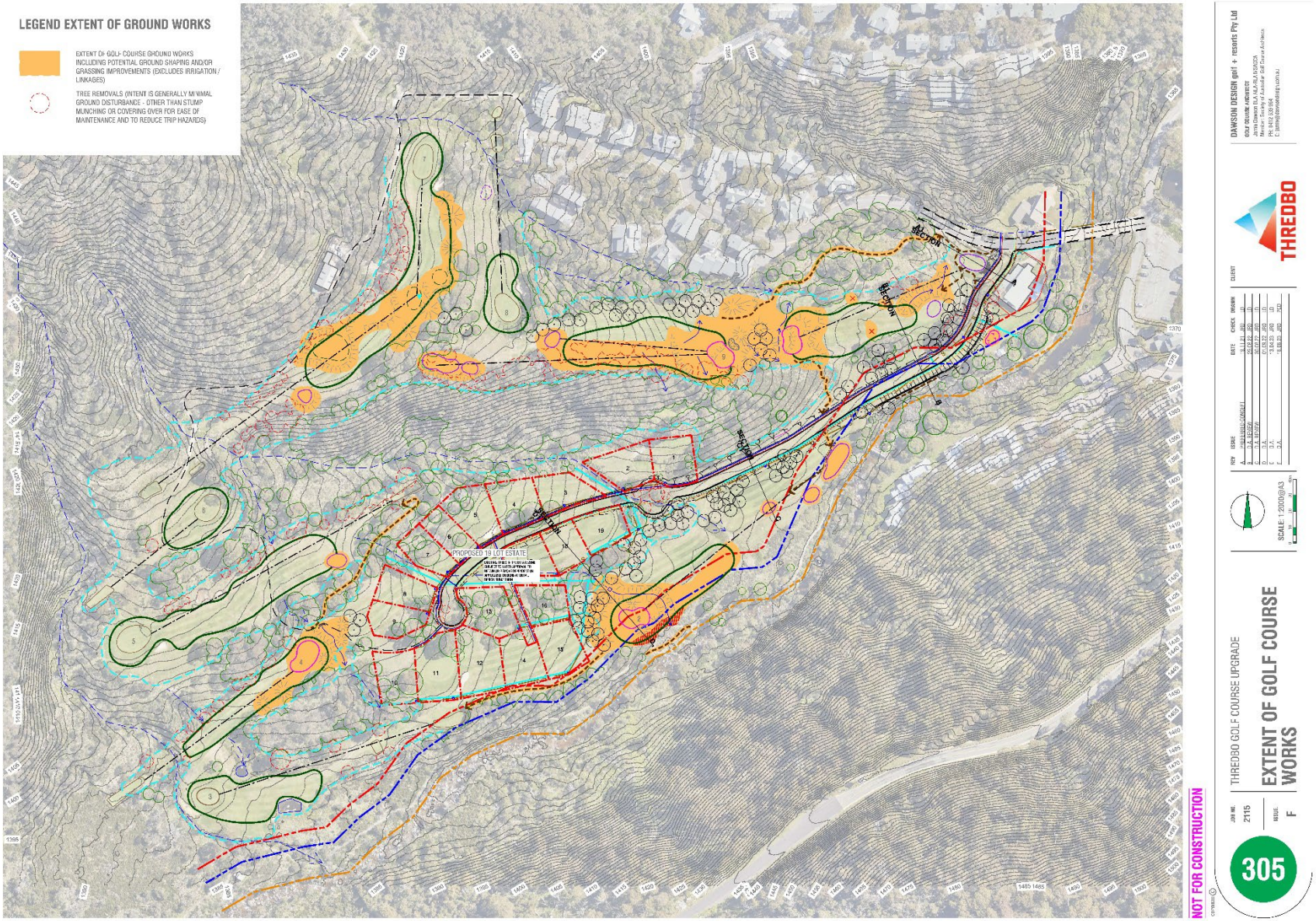
Ugyen, L., Broadhurst, B., and Clear, R. 2019. *Biological Assessment of the Thredbo River (February 2022)*. Centre for Applied Water Science – Institute for Applied Ecology. University of Canberra.

Ugyen, L., Broadhurst, B., and Clear, R. 2022. *Biological Assessment of the Thredbo River (Summary report November 2016 – August 2019)*. Centre for Applied Water Science – Institute for Applied Ecology. University of Canberra.

Appendix A – Concept Design



Lot	Lot Area	Footprint	Beds
1	783 m²	280 m²	12
2	812 m²	267 m²	12
3	710 m²	192 m²	8
4	858 m²	276 m²	12
5	903 m²	316 m²	10
6	612 m²	177 m²	6
7	637 m²	222 m²	6
8	701 m²	245 m²	6
9	640 m²	193 m²	8
10	802 m²	280 m²	12
11	1061 m²	371 m²	10
12	1093 m²	382 m²	12
13	899 m²	305 m²	16
14	759 m²	265 m²	10
15	836 m²	292 m²	12
16	678 m²	237 m²	8
17	644 m²	202 m²	14
18	632 m²	221 m²	6
19	689 m²	238 m²	6
	14751 m²	4961 m²	186


LEGEND EXTENT OF GROUND WORKS
EXTENT OF GOLF COURSE GROUND WORKS INCLUDING POTENTIAL GROUND SHAPING AND/OR GRASSING IMPROVEMENTS (EXCLUDES IRRIGATION / LINKAGES)
TREE REMOVALS (INTENT IS GENERALLY MINIMAL GROUND DISTURBANCE - OTHER THAN STUMP MUNCHING OR COVERING OVER FOR EASE OF MAINTENANCE AND TO REDUCE TRIP HAZARDS)
PROPOSED 19 LOT ESTATE
SECTION
SECTION
SECTION
NOT FOR CONSTRUCTION
DAWSON DESIGN golf + resorts Pty Ltd
THREDBO
THREDBO GOLF COURSE UPGRADE
EXTENT OF GOLF COURSE WORKS
JOB NO. 2115
ISSUE F
305

Appendix B – Threatened species likelihood of occurrence and impact

If a species has suitable habitat present on site **AND** is likely to use this habitat **AND** the species or its habitat would be directly or indirect impacted, **THEN** an Assessment of Significance is required. Such species, if any, are highlighted yellow in the table below and are assessed further in Appendix C and Appendix D.

Type	Scientific name	Common name	FM Act Status	EPBC Act Status	Use of site	Is an impact assessment required?
Fish	*Galaxias supremus*	Kosciuszko Galaxias		CE	Only known to occur in small area in an adjacent catchment to the north	No
	Galaxias terenasus	Roundsnout Galaxias		E	Not known to occur upstream of Jindabyne Dam	No
	Maccullochella peelii	Murray Cod		V	Only known to occur in an adjacent catchment flowing west to the Murray River	No
	Macquaria australasica	Macquarie Perch	E	E	Only known to occur in an adjacent catchment flowing west to the Murray River	No
	Prototroctes maraena	Australian Grayling	E	V	Jindabyne Dam prohibits connectivity to its preferred adult habitat that connects to the ocean where larvae migrate.	No
	Austropetalia tonyana	Alpine Redspot Dragonfly	V		Suitable habitat is within splash zones of waterfalls and rocks, logs and moss within these areas or nearby stream edges. None were observed during field survey, however, may still frequent the site or follow the river. No preferred habitat would be removed, modified or fragmented as a result of development.	Yes
	Aquatic Ecological Community in the Catchment of the Snowy River in NSW	Snowy River Endangered Ecological Community (EEC)	E		This EEC comprises all fish and aquatic invertebrates within the Snowy River catchment. This EEC is typically in poor condition, and with appropriate mitigation measures in place, the development would not exacerbate the factors causing this community to be endangered.	Yes

FM Act: E = Endangered, V = Vulnerable
EPBC Act: CE = Critically Endangered, E = Endangered, V = Vulnerable

Appendix C – Assessment of Significance: Alpine Redspot Dragonfly

An Assessment of Significance for *Austropetalia tonyana* (Alpine Redspot Dragonfly) has been conducted below against criteria listed in Section 221ZV of the FM Act (C1).

***Austropetalia tonyana* (Alpine Redspot Dragonfly)**

November 2014, Primefact 1356, First edition, DPI Fisheries – Aquatic Ecosystems Unit

The Alpine Redspot Dragonfly is a moderate-sized dragonfly. The larvae grow to 32-35 mm long and adults grow to 70-80 mm long. Restricted to mountainous regions below 35°S that reach above 600-1,800 metres above sea level, the species has extremely specific habitat requirements. Nymphs are only known to occur among rocks, logs and moss in the spray zone of waterfalls, while adults are found to perch in a territorial area within the waterfall splash zone. Their flight period is thought to occur between October and January. The species is listed as threatened as they are highly sensitive to habitat disturbance, climate change and reduced stream flow. Although no waterfalls occur within or near the study area, the watercourse provide similar habitat in the form of large boulder riffles and spray.

C1 *Fisheries Management Act 1994* Assessment of Significance

***Austropetalia tonyana* (Alpine Redspot Dragonfly) – Vulnerable Species (FM Act)**

FM Act	Question	Response
221ZV a)	In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.	The majority of the proposed works are to occur on existing cleared and managed land within the golf course. Minor areas of proposed landscaping works are within the northern VRZ of Thredbo River, but there would no-instream works. Water quality would be protected by mitigation measures during construction and operation. No modification to flow is expected. Therefore, the development is unlikely to have an impact on the habitat that this species uses during its aquatic life cycle phase, and there is negligible risk to its viability.
221ZV b)	In the case of an endangered population, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.	Not applicable
221ZV c)	In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or (ii) Is likely to substantially and adversely modify the composition of the ecological community such	Not applicable

FM Act	Question	Response
	that its local occurrence is likely to be placed at risk of extinction.	
221ZV d)	In relation to the habitat of a threatened species, population or ecological community: (i) The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality.	(i) No in-stream works or modification to flows are proposed, therefore, no habitat will be removed or modified. (ii) Alpine Redspot Dragonflies live in waterfall splash zones, which will not be fragmented by the proposed development. (iii) Not applicable, no habitat to be modified or removed.
221ZV e)	Whether the proposed development or activity is likely to have an adverse effect on any critical habitat (either directly or indirectly).	The site is not declared critical habitat.
221ZV f)	Whether the proposed development or activity is consistent with a Priorities Action Statement.	Consultation with DPI Fisheries is consistent with the High Priority action for DPI to: *Provide information on the distribution of the Alpine Redspot Dragonfly to local councils and determining authorities to ensure appropriate consideration during development assessment processes.*
221ZV g)	Whether the proposed development constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.	The proposal does not meet the definition of any of the eight key threatening processes: https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/key-threatening-processes
Conclusion	**Is there likely to be a significant impact?**	**No, because no habitat would be directly or indirectly modified**

Appendix D – Assessment of Significance: Aquatic Ecological Community in the Catchment of the Snowy River in NSW

An Assessment of Significance for the Aquatic Ecological Community in the Catchment of the Snowy River in NSW has been conducted below against criteria listed in Section 221ZV of the FM Act (D1).

Aquatic Ecological Community in the Catchment of the Snowy River in NSW

May 2012, Primefact 1204, First edition, DPI Fisheries – Fisheries Ecosystems Unit

Located in the Australian Alps in south eastern NSW, the Snowy River is known for its snowmelt and flood flows during Spring, and other features such as deep channels, pools and cascades. The aquatic ecological community of the Snowy River catchment has been listed as an endangered ecological community, as the community is likely to become extinct unless threatening factors cease to hinder evolutionary development. The community includes all native fish and aquatic invertebrates within all rivers, creeks and streams, and includes 19 native fish species and hundreds of native invertebrate species.

Processes threatening this community vary depending on the position of the waterway within the catchment. Within the NSW portion of the catchment, 44% of watercourses are located within national parks and reserves, although due to the connected nature of the catchment, these waterways are affected by factors outside of these areas. The largest key threatening process affecting the community is reduced/altered flow caused by the construction of major dams, as well as adverse effects such as thermal pollution and in stream structure barriers. Additionally, introduced fish species such as Eastern Gambusia and Brown Trout, and clearing of riparian vegetation have a range of detrimental impacts to the community.

D1 Fisheries Management Act 1994 Assessment of Significance

Aquatic Ecological Community in the Catchment of the Snowy River in NSW – Endangered Ecological Community (FM Act)

FM Act	Question	Response
221ZV a)	In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.	Not applicable
221ZV b)	In the case of an endangered population, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.	Not applicable
221ZV c)	In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity: (i) Is likely to have an adverse effect on the extent of the ecological community such that its local	(i) The majority of the proposed works are to occur on existing cleared and managed land within the golf course. Minor areas of proposed landscaping works encroaching VRZs (no-instream works) will be mitigated with sufficient erosion and sediment control measures in order to prevent pollution or debris run off. Indirect impacts such as run-off will be accounted for by the

FM Act	Question	Response
	occurrence is likely to be placed at risk of extinction, or (ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.	stormwater drainage design, and three Puraceptors will treat any stormwater prior to discharge to Thredbo River. Therefore, the extent of the community will not be placed at risk of extinction by the proposed works. (ii) As above, the majority of the proposed works are to occur on existing cleared and land managed as a golf course. The composition of the ecological community would not be modified by the proposed works as no fringing or aquatic vegetation would be being removed and no aquatic fauna would be added or removed as a part of the development.
221ZV d)	In relation to the habitat of a threatened species, population or ecological community: (i) The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and (ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and (iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality.	(i) No in-stream works are proposed, therefore, no habitat would be removed or modified. (ii) The proposed works would not remove, realign or modify habitat and, therefore, would not become fragmented. (iii) Not applicable, as no habitat would be modified or removed.
221ZV e)	Whether the proposed development or activity is likely to have an adverse effect on any critical habitat (either directly or indirectly).	The site is not declared critical habitat
221ZV f)	Whether the proposed development or activity is consistent with a Priorities Action Statement.	Consultation with DPI Fisheries is consistent with the Medium Priority action for DPI to: *Provide local councils, government agencies and Local Land Service's with resource materials and training regarding habitat protection and threatened species provisions of the NSW Fisheries Management Act 1994 to support planning, determination, impact assessment and concurrence decision making processes. This may include impact assessment guidelines, mitigating prescriptions, offsets, and generic consent conditions.*
221ZV g)	Whether the proposed development constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.	The proposal does not meet the definition of any of the eight key threatening processes: https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/key-threatening-processes
Conclusion	**Is there likely to be a significant impact?**	**No, because no habitat would be modified, and the works would not exacerbate the factors causing this community to be endangered.**

ecological AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au