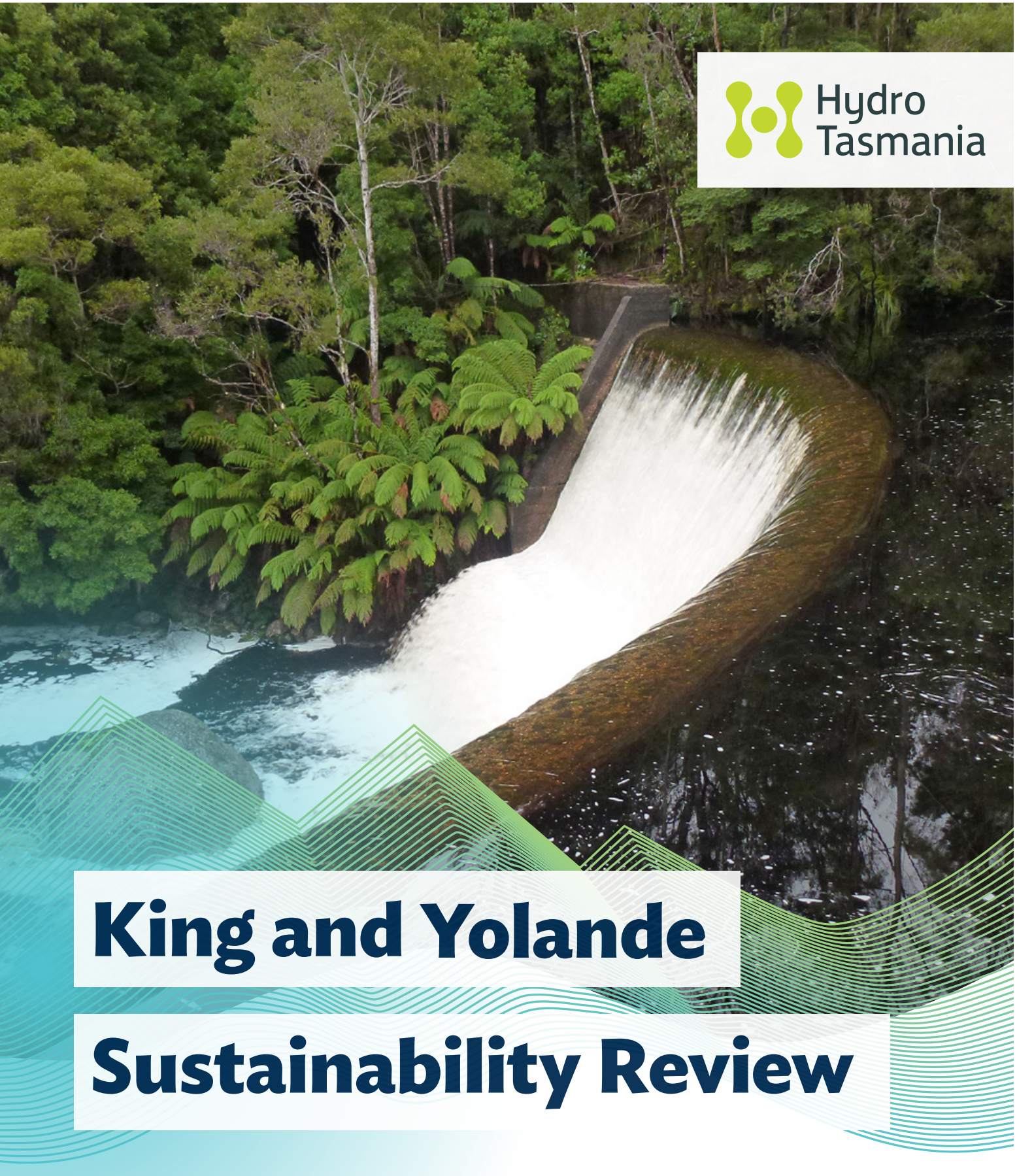

Hydro Tasmania

King and Yolande Sustainability Review

Information Review - September 2019

King and Yolande Sustainability Review team

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For further information on sustainability reviews and water management:

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Contents

1. Introduction

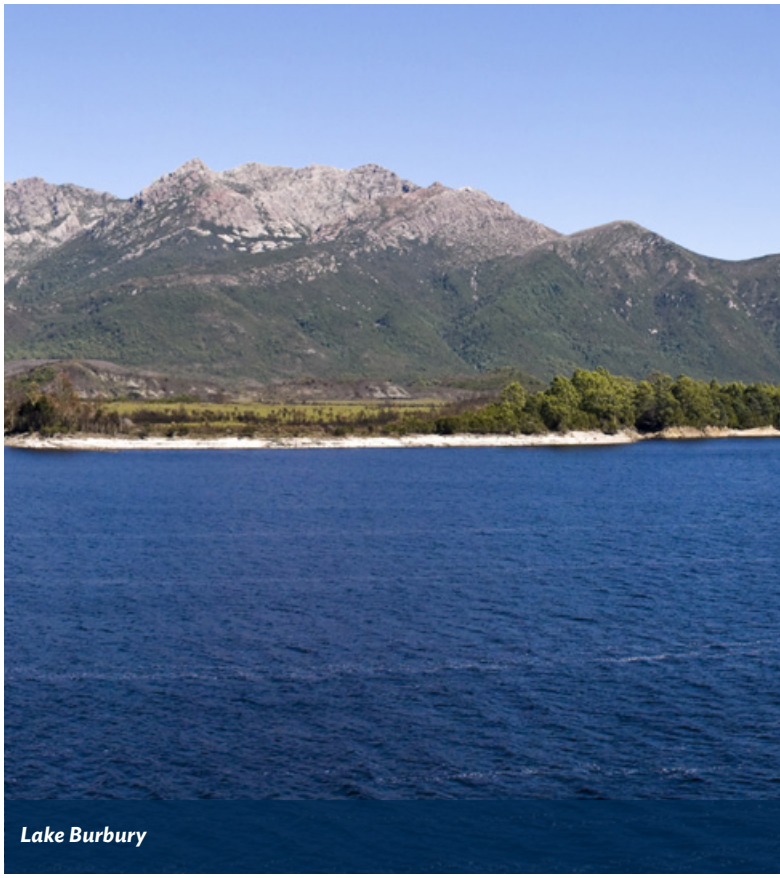
1.1 What is a sustainability review?

Sustainability reviews are the process we use to consult with the community and review our operations in the catchments we use for generating hydropower. They allow us to increase our knowledge of the lakes and waterways in our catchments, and help us understand the ways in which people use and interact with them. We regularly conduct sustainability reviews to provide a way to identify issues and opportunities associated with our hydropower schemes.

The focus of this sustainability review is the King and Yolande catchments.

1.2 About this report

This report provides an overview of the environment, our operations and how people use the King and Yolande catchments.



Lake Burbury

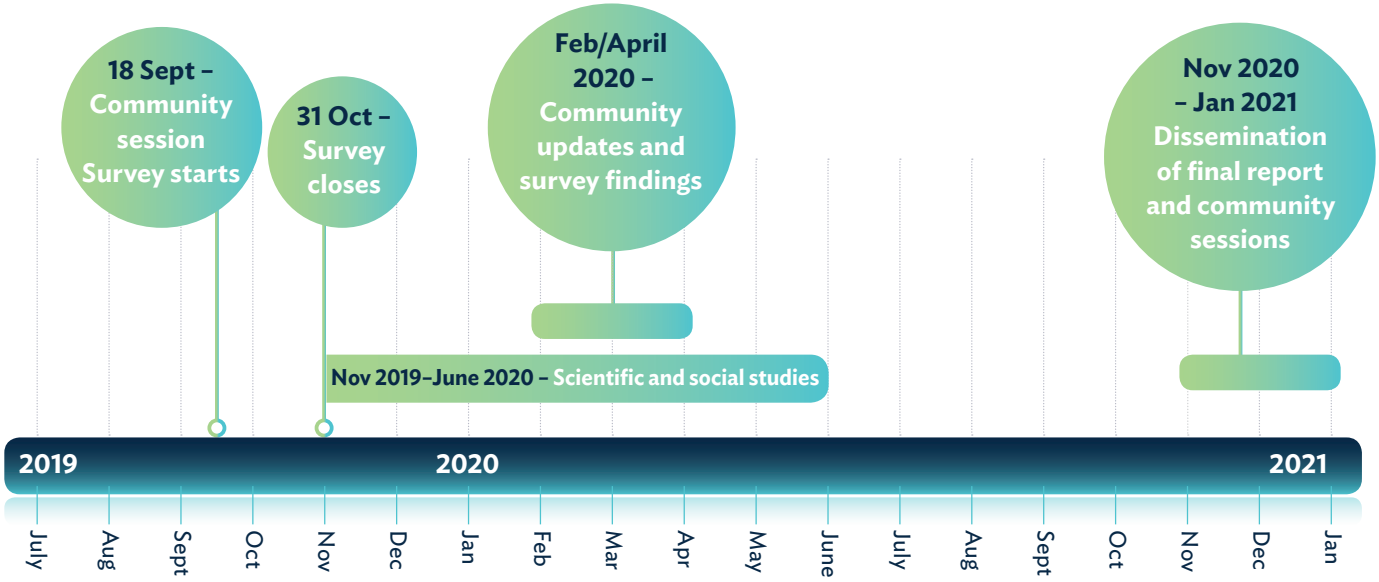
Sustainability review process

Information review: We publish information on social and environmental aspects of our operations within the King and Yolande catchments (this report).

Community consultation: We consult the community to improve our understanding of issues and opportunities relating to the catchments, including face-to-face meetings, a survey and follow-up discussions. The information and advice gained is used to identify particular issues where targeted studies are needed.

Targeted studies: We investigate issues and assess potential opportunities for improvement based on survey feedback.

Commitments: We improve management practices based on the findings of studies and evaluation of costs and benefits.



1.3 About Hydro Tasmania

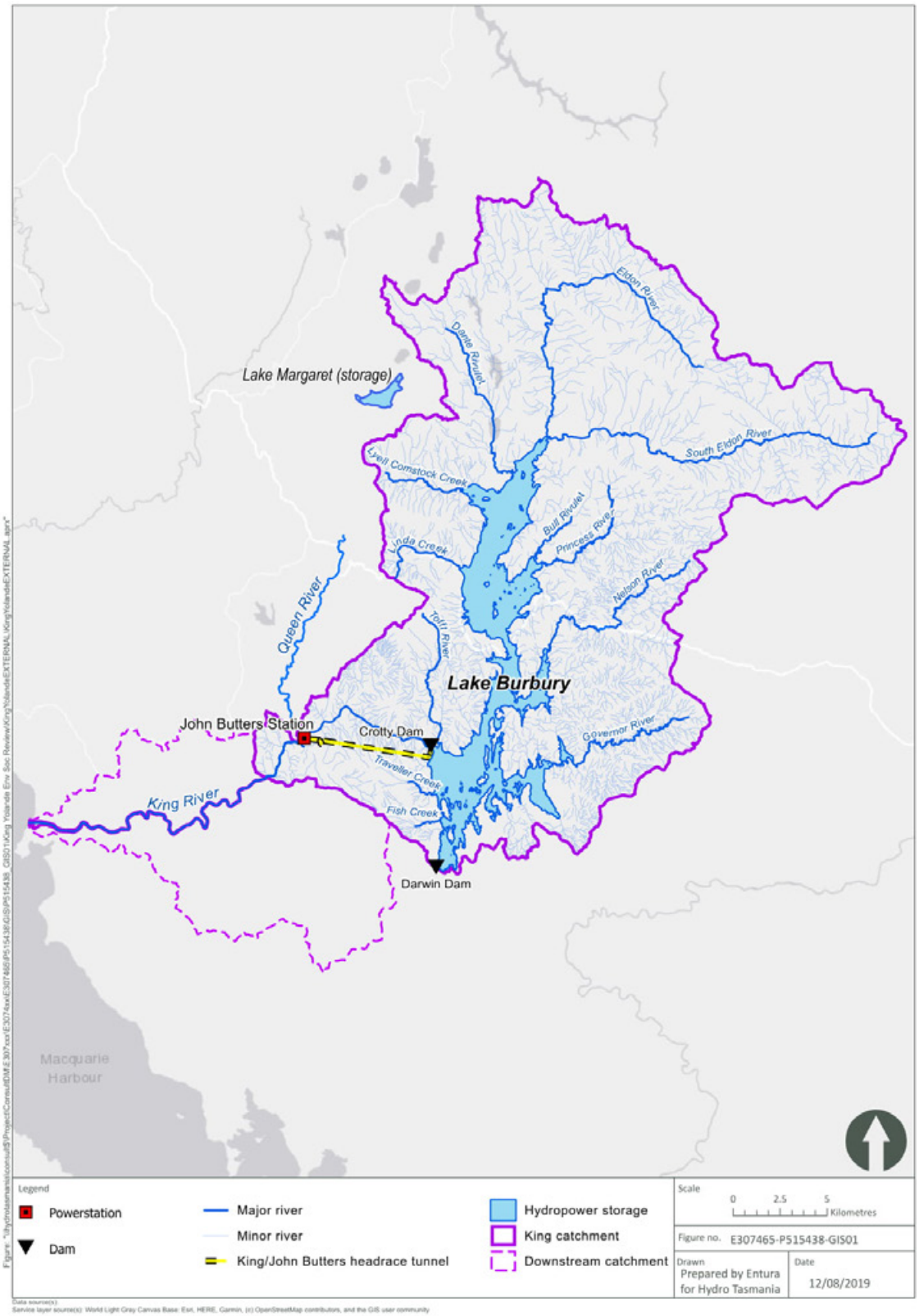
Hydro Tasmania is Australia's leading clean energy business and largest generator of renewable energy. We're champions for a sustainable future, as well as champions for Tasmania. We employ more than 1000 people locally, nationally and internationally, and manage $5 billion worth of energy generation and related assets. While providing clean, secure energy is our first priority, we also take pride in supporting recreational water users and irrigators and the activities that enrich Tasmanians' lives. Tasmanians are our most important customers, and the very people we were created to serve. As custodians of 60 per cent of the state's freshwater resources, we seek a clean, healthy and sustainable future for Tasmania and Australia and we're committed to reducing our environmental and social impacts wherever we can.

We operate in accordance with the *Government Business Enterprises Act 1995*, the *Hydro-Electric Corporation Act 1995*, and our Ministerial Charter. We have compliance obligations under a range of state and federal legislation. Our water licence is issued under the *Tasmanian Water Management Act 1999* and is regulated by the Department of Primary Industries, Parks, Water and Environment.

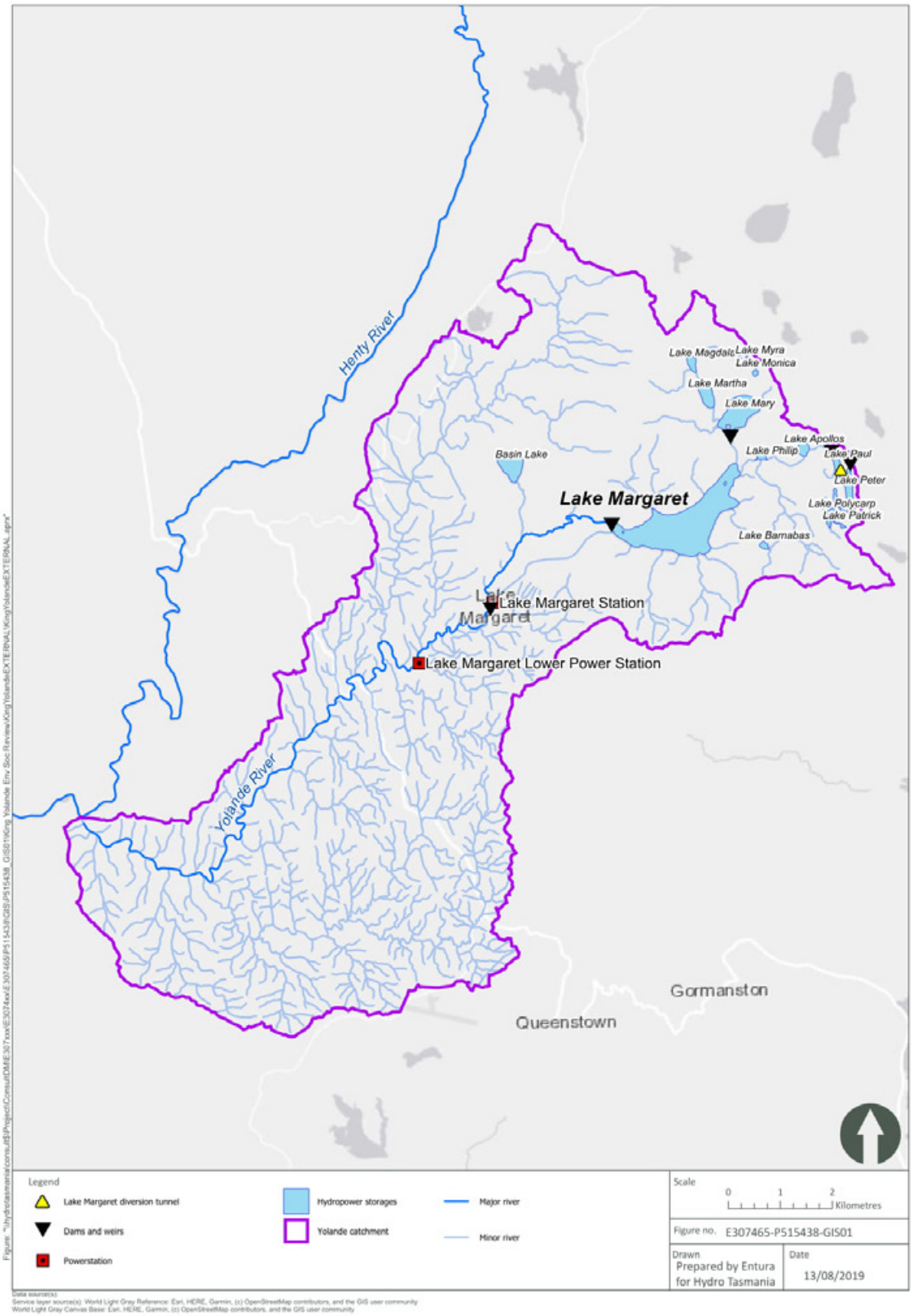
2.0 The King and Yolande catchments

2.1 Study area

The King catchment for this study (shown as purple outline) is defined as Lake Burbury and its catchment, and the King River from Crotty Dam to where it enters Macquarie Harbour.



The Yolande catchment (shown as purple outline) includes the Lake Margaret catchment and the Yolande River, above where it joins the Henty River.



Queenstown

2.1.1 Communities and local industries

The main communities within the King and Yolande catchments are Queenstown and Gormanston. Queenstown is the largest town on the West Coast with a population of 1,790 and Gormanston recorded a population of 17 in the 2016 Census. Both towns were built to support operations of the Mount Lyell Mining and Railway Company.

There are no permanent residents at Lake Margaret.

We have, under supervision of a Production Manager, a team of 16 staff are responsible for managing the Anthony Pieman, King and Yolande Schemes.

2.1.2 Land tenure and use

The King and Yolande catchments are located within the West Coast Council area.

The majority of the King catchment – 79 per cent – is Crown Land, including the downstream catchment, while Hydro Tasmania owns approximately nine per cent of the land, and nature conservation, tourism and recreation make up the bulk of land use in the catchment.

The land north and east of Lake Burbury is relatively pristine and includes national parks, conservation areas and regional reserves. Historically, the land west of Lake Burbury, near Linda and Comstock Creeks, has been used for mining.

The Crown owns 83 per cent of the Yolande catchment and Hydro Tasmania owns 15 per cent including the land around Lake Margaret. The primary land uses in the catchment are nature conservation and hydropower generation.

2.1.3 Climate

The King and Yolande catchments are subject to wet, cold winters, with drier, mild summers. The winter rainfall is almost double that of summer, and the average monthly rainfall is more than 100 millimetres. Snow typically falls in the highlands in winter, but can fall at any time of year.

Average rainfall for the King and Yolande catchments

Rainfall station and period of record	Lake Margaret Dam 1912-2019	South Queenstown 1996-2019	Darwin Dam* 1991-2019
Elevation (m above sea level)	665	129	258
Mean annual rainfall (mm)	3560	2404	3203

*Source: Australian Bureau of Meteorology (http://www.bom.gov.au/climate/data/); *Hydro Tasmania.*

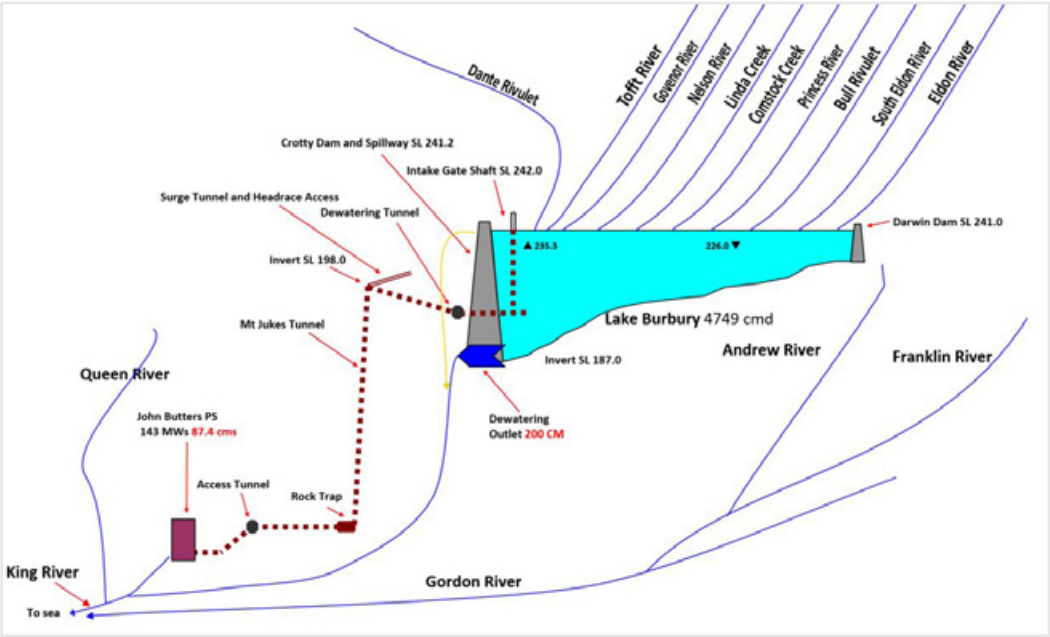
2.2 Hydropower schemes and assets

The King and Yolande hydropower schemes provide a highly valued and reliable source of electricity. The total water storage in the combined catchments is 1,097 gigalitres (nearly twice the volume of Sydney Harbour), although only around half of this amount is available for hydropower generation. The average annual power generation is a combined 597 gigawatt hours or 6.4 per cent of our entire hydropower system. Both Lake Burbury (King River) and Lake Margaret (Yolande River) were created when the King and Yolande hydropower schemes were built.

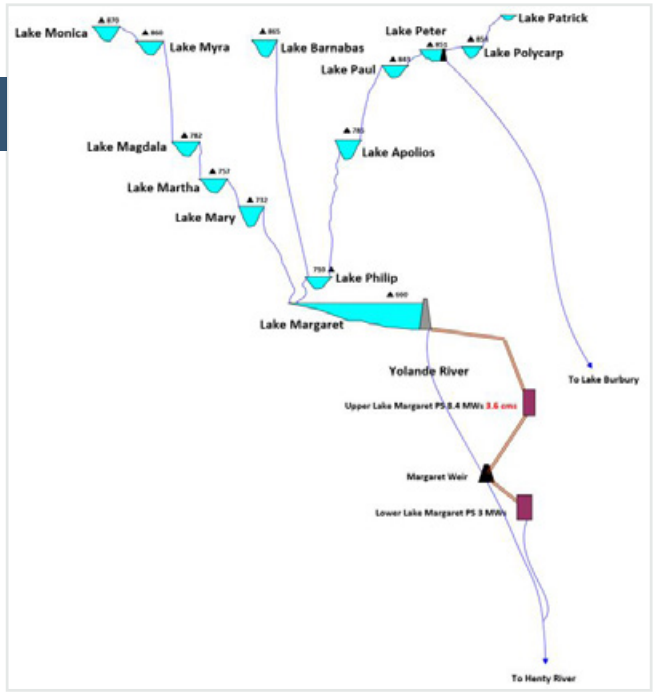
The King hydropower scheme is one of the most recently built in Tasmania and is ranked sixth in terms of contribution to our total power generation.

We acquired the Yolande scheme in 1985 from the Mount Lyell Mining and Railway Company. The scheme was built in 1914 to provide electricity for the company's mines and associated townships, including Queenstown, and continued to be leased by the company until 1994. It has been part of the statewide electricity system since then.

King Scheme



Yolande Scheme



Inside John Butters Power Station

2.2.1 Power stations

We manage a complex hydropower system across Tasmania, with water released to meet power generation needs over the short and long term. Power output for any given year varies according to rainfall, station outages, electricity demand and transmission constraints. Within the King and Yolande catchments, three power stations generate electricity: John Butters, Upper Lake Margaret and Lower Lake Margaret.

John Butters Power Station is the only power station within the King scheme and was commissioned in 1992. It is located on the King River, approximately one kilometre above the junction with the Queen River and eight kilometres downstream of Crotty Dam. Water is carried from Lake Burbury to John Butters Power Station through a seven kilometre tunnel below Mt Jukes.

The other two power stations are in the Yolande scheme.

Upper Lake Margaret Power Station is approximately 10 kilometres north of Queenstown, on the Yolande River. It was commissioned in 1925 – 1930 and uses water from Lake Margaret.

The Lower Lake Margaret Power Station is located on the Yolande River approximately 2.5 kilometres downstream from the Upper Lake Margaret Power Station. It is a mini-hydro scheme, originally commissioned in 1931. The Lower Power Station was taken out of operation in 1995, but reopened in 2010, when a new pipeline, penstock and mini-hydro station were commissioned.

Power station summary information

Power development	Stream	Reservoir	Power station	Annual average generation	Generation contribution
King River	King	Lake Burbury	John Butters	545 GWh	5.8%
Lake Margaret	Yolande	Lake Margaret	Upper Lake Margaret	40 GWh	0.5%
			Lower Lake Margaret	12 GWh	0.1%

Note: GWh = gigawatt hours.

2.2.2 Dams and lakes

Two main storages are associated with the King and Yolande schemes: Lake Burbury and Lake Margaret.

Lake Burbury has a surface area of 52.62 square kilometres at full supply level (FSL) and was created in 1991 after the construction of two dams, Crotty and Darwin. Crotty Dam controls flow to the King River and Darwin Dam prevents the lake spilling into the Andrew River. The main outflow of water from Lake Burbury is through the John Butters Power Station intake on the western side of the lake, near Crotty Dam.

Lake Margaret has a surface area of 1.54 square kilometres at FSL. It was constructed in 1914 and has been raised several times since. The dam controls flow to the Yolande River and water is delivered through a pipeline to the Upper Lake Margaret Power Station. The Lower Lake Margaret Weir was constructed on the Yolande River in 1934. It forms the Margaret Pond into which the upper Lake Margaret Power Station discharges water. It has a pipeline to take water to the Lower Lake Margaret Power Station, along with small dams, a diversion and associated infrastructure on Lake Peter.

2.2.3 Water levels and operations

Water levels in Lake Burbury and Lake Margaret range between their FSL and the normal minimum operating level (NMOL). Sometimes lakes can be drawn below NWOL for reasons such as maintenance of dams and power stations, or unusually low rainfall periods. Conversely, lakes can also exceed their FSL during times of high rainfall or power station outages, which is referred to as the lake being on 'spill.'

Lakes Burbury and Margaret are primarily used as storages for power generation. Lake Burbury is usually drawn down over summer and autumn when inflows decline, while water levels generally increase in winter and spring as inflows increase. The lake typically spills every four to five years. In general, annual variation in Lake Burbury ranges from FSL to 10 metres from full.

Water levels in Lake Margaret typically range from FSL to eleven metres below FSL. The power station generally runs continuously throughout the year, only reducing for outages or after prolonged dry periods. Water levels in Lake Margaret exceed FSL in most years, usually during winter and spring.

Dimensions and operational characteristics of lakes

Storage	Surface area at FSL (km^2)	Reservoir storage capacity ($x106m^3$)	Approx. max depth at dam (m)	Operating range (m)	Storage energy conversion factor ($GWh/106\ m^3$)	FSL (MASL)	NMOL (MASL)
Lake Burbury	52.62	1081.42	82	10.3	0.458	235.3	225
Lake Margaret	1.54	16	17	~11 m	0.722	662.42	650.89

Note: MASL – metres above sea level; FSL – full supply level; Gwh – gigawatt hours.

At each lake, water management for power generation may affect other uses. For example, at Lake Burbury, management also includes water releases for tourism activities and notifications to the community about boat ramp access during low lake levels. At Lake Margaret we provide water releases for the mining industry.

2.2.4 Flows

Hydropower development has led to changes in the natural flow regime of rivers in the King and Yolande catchments.

For example, since John Butters Power Station was built maximum flows in the King River have decreased, with flood events being partially captured in Lake Burbury. Tributary inflows make up the flow in the King River for short periods when the John Butters Power Station isn't operating.

For 70 per cent of the time, flow is relatively consistent in the 12.5 kilometre section of the Yolande River between Lower Lake Margaret Power Station and the junction of the Yolande and Henty Rivers. While some variability is provided by spills at Lake Margaret, the constant flow of water below the power station lacks natural, seasonal and short-term variability. However, the impacts of this are likely reduced by the distance downstream and catchment inflows, which help restore a more natural flow regime.

2.2.5 Other facilities

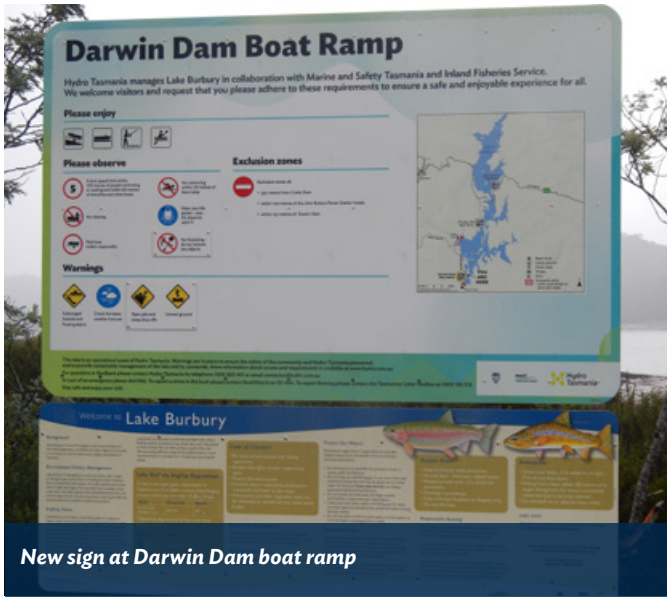
While the main function of our storages is power generation, we also manage public facilities such as boat ramps, roads, day use and camping areas.

This includes three boat ramps on Lake Burbury that we manage with Marine and Safety Tasmania (MAST) and the Inland Fisheries Service (IFS): Lake Burbury boat ramp on the eastern shore, and Thureau Hills and Darwin Dam boat ramps on the western shore. There is a basic campground at Darwin Dam and a day-use site at the beginning of the Harris Reward Trail. The campgrounds at Thureau Hills and Lake Burbury are managed by West Coast Council.

We also own and manage sections of Mt Jukes Road, a Lyell Highway deviation and other access ways, as well as Newall and Bradshaw Bridges. Two scenic lookouts are provided on Mt Jukes Road, with parking and a lookout on Mt Huxley Hill. Our roads often enable public access to otherwise hard-to-reach, scenic places on the wild West Coast.

Lake Margaret Power Station is closed to the public unless on an organised tour. There are no formal boat ramps, walking trails or campsites within the Yolande catchment.

Campers at Darwin Dam



New sign at Darwin Dam boat ramp

3.0 Social values and issues

As part of our operation of the King and Yolande schemes, we manage a number of social values, issues and opportunities, relating to public safety, water levels, recreational use and cultural heritage.

3.1 Cultural heritage

We manage Aboriginal and historic cultural heritage values in accordance with our heritage management procedure and Tasmanian legislation.

3.1.1 Aboriginal heritage

Aboriginal cultural heritage relates to the places, activities and traditions of Aboriginal people. Recent studies indicate Aboriginal presence in the region within the past 1000 years, although the details are unclear. Sites identified in the King catchment include cave sites and artefact scatters. Whilst no Aboriginal heritage sites have been identified in the Yolande catchment, this may reflect a lack of surveys rather than a lack of Aboriginal activity in the area. It's also important to note that the King and Yolande catchments may hold other cultural heritage values of significance to the Aboriginal community, such as Aboriginal landscapes or traditional practices, which can't be identified by scientific studies.

Upper Lake Margaret power station

3.1.2 Historic heritage

Historic heritage reflects the period between early European settlement and the present day. European history of the catchments is primarily linked to mining from the 1890s onwards. Sites of historic cultural heritage include the Linda-Kelly Basin Railway, various flux quarries, logging tramways and sawmills. Two other historic sites – the North Lyell (Crotty) smelter site and Crotty township – are now submerged by Lake Burbury.

The Lake Margaret Power Scheme is also a site of heritage significance. The power station, associated operating infrastructure, and abandoned village are listed on the Tasmanian Heritage Register and are highly valued by the West Coast community. We maintain the Lake Margaret village to protect and interpret heritage values.

3.2 Recreation and tourism

Recreation and tourism in the King and Yolande catchments are increasingly important to the local West Coast economy. While fishing is the main recreational activity in the King catchment, there is also four wheel driving, hiking and kayaking. Lake Burbury is managed as a Premium Wild Trout Fishery and is open to fishing all year round, attracting locals, as well as visitors from abroad. Commercial tourism operators provide jet boating and white water rafting in the King River.

Lake Margaret village and power station have been featured in a number of documentaries and tourism promotions; however, visitor access is only possible via commercial tours, which are run through a licensed local tour operator. There are no other official tourist or recreational activities within the Yolande catchment, although the area is used informally by bushwalkers. Lake Margaret is closed to the public and there is generally no recreational use of the lake.

We are involved in a variety of tourism and cultural activities in the King and Yolande catchments, including the Unconformity Festival, recreational fishing on Lake Burbury, rafting, and tours of Lake Margaret. These activities help to support the West Coast community and the local economy.

4.0 Environmental values and issues

Lake Peter Dam

As part of our operation of the King and Yolande schemes, we manage a number of environmental values, issues and opportunities relating to geomorphology, water quality, flora and fauna, and climate change.

4.1 Geomorphology

Geomorphology describes the shape and form of rivers and lakes. The King catchment is known for the deep river gorges downstream of the Crotty Dam, while the Yolande catchment has notable glacial features. The western Tasmania blanket bogs (peatlands) that are found in both catchments are the most extensive in the southern hemisphere. They are easily destroyed by fire, underlining the need for effective fire management in these areas.

Observational monitoring of the shoreline at Lake Burbury has shown low erosion at low water levels. The operation of the John Butters Power Station has influenced sediment movement in the lower King River and the river continues to adjust to flow regulation.

There has been no erosion found on the shorelines of Lake Margaret and no known, broader sediment issues in the Yolande River in relation to our hydropower operations.

4.2 Water quality

General surface water quality in the catchments is good. Salinity is low, nutrients are low, pH is slightly acidic, and oxygen in the water is at levels that support aquatic life. The tannin-stained waters contain large amounts of organic matter and are characteristic of the West Coast.

In the King and Yolande catchments, hydropower can affect water quality through processes such as thermal stratification (separation of warm and cold layers of water in a lake). The water quality can also be affected by other land uses, such as inflows of metals.

4.2.1 Thermal stratification

Thermal stratification limits mixing between surface and bottom waters and can lead to low oxygen in the bottom of lakes. Thermal stratification occurs each year in Lakes Burbury and Margaret from late spring to early autumn, along with a reduction in oxygen in the deeper parts of the lakes. This is more severe at Lake Burbury than Lake Margaret, but is considered a low risk to the lake health overall.

4.2.2 Heavy metals

Copper and aluminium make up the bulk of metals that flow into Lake Burbury. The dark, tannin-stained waters of the West Coast help to bind these metals, reducing their threat to the environment. Metals at Crotty Dam have remained stable and the lake continues to support a recreational fishery.

The drainage from legacy mining activities have resulted in poor water quality in the Queen River and lower King River. The headwaters of Comstock and Linda Creeks drain water from the mine site and flow into Lake Burbury. These waterways were diverted around Lake Burbury to the Queen River in the 1990s to protect the water quality in Lake Burbury.

Queen River near its confluence with the King River

Water from Lake Burbury dilutes metals entering the King River from the Queen River. There has been an improvement in the water quality in the King River below the Queen River and in Macquarie Harbour since 2014.

Metal concentrations in Lake Margaret are typically low, with the exception of aluminium, but there is little threat to the environment due to the binding of metals to organic matter in the lake.

4.3 River health

River health monitoring in the King River between the power station and junction with the Queen River has found variation in the river condition, from poor to very good. However, the poor rating related to in-stream works, which resulted in the removal of bed material from the river. In subsequent years, river health recovered to be rated as very good.

River health monitoring in the Yolande catchment is limited to one site on the Yolande River at the Zeehan Highway, last sampled in the mid-1990s. At that time, river health was very good.

River health in the King and Yolande Rivers will continue to be routinely monitored as part of our baseline river monitoring program.

Aerial view of landscape around Queenstown

4.4 Flora

4.4.1 Vegetation communities

The King and Yolande catchments support a diverse range of vegetation communities, which have been shaped by historic land use and fire, including wet and dry eucalypt forest, non-eucalypt forest, rainforest, scrub and moorland communities. The condition of vegetation communities around Lakes Burbury and Margaret is generally good, although a large area on the northeastern side of Lake Burbury was impacted by bushfire in January 2014.

4.4.2 Threatened species and communities

The catchments contain two threatened plant species – toothed orites and narrowleaf geebung. Threatened vegetation communities include king billy and pencil pine communities upstream of Lakes Margaret and Burbury. These threatened species and communities are not affected by our operations as they are associated with land and occur upstream of our lakes.

4.4.3 Weeds and pathogens

A number of weeds have been recorded in the King and Yolande catchments. We manage these in accordance with our *West Coast 10 Year Weed Action Plan*, which outlines how we prioritise, manage and monitor weeds in our West Coast catchments. To date, action has been taken on weeds such as Blackberry, Pampas, Spanish heath, as well as Foxglove and Elisha's tears.

The disease, 'root rot' has been recorded in both catchments.

4.5 Fauna

4.5.1 Native non-threatened fish

Native fish found in the lower King River, as well as Lake Burbury and the Yolande River include short-finned eel, spotted galaxias and climbing galaxias. Jollytail, pouched lamprey, and tupong have also been recorded at the junction of the Yolande and Henty Rivers.

The Inland Fisheries Service has stocked short-finned eel in Lake Burbury since 2010 - 2011 to reduce the impact of Crotty Dam on movement upstream. There is currently no stocking of Lake Margaret.

It is unclear whether fish can consistently move up the King River because of the poor water quality. Records suggest that upstream migration is possible at some times. High flows from the John Butters Power Station and low flows in the Queen River may combine to improve the water quality to allow this to occur. If fish can move up the King River, the Crotty Dam is a significant physical barrier, which would prevent them from moving further into the catchment.

Our current operations are likely to have only a minimal impact on native fish within the King and Yolande catchments. It is also likely that the damming of Lake Margaret and changes to flows in the Yolande River have had a low impact on native fish, as only the upper part of the Yolande and Henty catchment has been affected.

4.5.2 Introduced fish

Brown trout and rainbow trout have been stocked since the early 1900s and are now widespread within the King catchment, above the junction with the Queen River. Lake Burbury and its inflowing waterways also support resident populations of these trout. Brown trout also occur in Lake Margaret and the Yolande River and there are records of brook trout from the Langdon River, which joins the Yolande River, approximately one kilometre downstream of the Lower Lake Margaret Power Station.

4.5.3 Threatened species

The Tasmanian devil, spotted-tailed quoll and wedge-tailed eagle have been recorded in both catchments. The eastern quoll, grey goshawk and Bubs Hill cave spider have also been recorded in the King catchment. It is unlikely that our operations impact on these land-based animals.

There are no records of threatened species in Lake Burbury or the King River; however, there are some records of freshwater crayfish dating back to before the flooding of the King River. This crayfish is not listed as threatened at a national or state level, but its current presence and status in uncertain. The creation of Lake Burbury in the early 1990s is likely to have caused historical impacts on this species.

The Australian grayling, listed nationally as vulnerable, has been recorded in some West Coast rivers, including the Yolande and Henty Rivers. Impacts on this species from hydropower generation are considered low as only the upper part of the Yolande and Henty catchment has been largely affected by flow regulation.

4.6 Climate change

The main climate change risks to our rivers and streams in these catchments include increased water temperatures and reduced oxygen in the water due to higher temperatures. In addition, altered rainfall and runoff may lead to changes in flow, and increased extreme rainfall events may cause more frequent flooding, potentially causing erosion and sediment movement in our rivers and streams.

Seasonal runoff into our King and Yolande catchments is expected to increase in winter but decrease in summer and autumn. A predicted increase in the number of wet days in winter and early spring, along with an increase in winter runoff, may change stream flow and, therefore, inflows to our hydropower schemes.

We have helped lead studies into climate change and impacts on hydropower schemes through our involvement in Climate Futures for Tasmania. We also established a climate change research program in 2017 to better understand potential impacts on our electricity generation system and activities. We will continue to investigate the best ways to deal with climate risks in the aquatic and land environments we manage.

5.0 What happens next?

As an integral part of our sustainability review process, we want the community's input into our activities in the King and Yolande catchments. We are keen to know more about the benefits to you or your business, as well as any opportunities or concerns you may have as a result of our operations in the region.

Please see the section below on how to become involved and feel free to use this report as background information when providing feedback.

How to be involved

It's important for us to hear from people who live in, work in and visit the King and Yolande catchments, to help us understand current issues and opportunities for our operations.

If you have feedback you would like to share, you can do this a number of ways:

- Listen to 7XS and look for notices in *The Advocate* for more information on how and when our staff will be in your local area and for information on further studies
- Complete our community survey - available from **18 September 2019** at **www.hydro.com.au** or call us on **1300 360 441** to obtain a copy
- Email us engagement@hydro.com.au
- Contact us to arrange to meet up.

Contact details:

King and Yolande Sustainability Review team

Post: GPO Box 355, Hobart, Tasmania 7001, Australia

Email: engagement@hydro.com.au

Call: **1300 360 441** (Local call cost Australia-wide)

For further information on sustainability reviews and water management:

www.hydro.com.au

Image: King and Yolande catchment region

Hydro Tasmania