Mt Buller and Stirling Final IWM Plan

June 2025

Traditional Custodians

We acknowledge Taungurung as the Traditional Custodians of Country that includes Mt Buller and Mt Stirling Alpine Resorts.
Taungurung language, knowledge and concepts referenced in this document remain the cultural and intellectual property of Taungurung Peoples.

Document Management

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Disclaimer

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Cover image

Snowmaking at Mt Buller Resort. (Source: Mt Buller Resort, 2025. https://www.mtbuller.com.au/snow-weather/snowmaking) .

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Executive Summary

This Integrated Water Management (IWM) Plan establishes a framework for managing water and water systems at Mt Buller and Mt Stirling Alpine Resorts over the next 20 years. It has been prepared to inform water planning in support of the economic viability and ecological and cultural values of the resorts in a changing climate.

The plan considers water supply and demand (potable and snowmaking), stormwater management, wastewater treatment – all within the context of a Victorian alpine environment. It has been developed in consultation with ARV and resort stakeholders and informed by ARV's ongoing engagement with Traditional Owners/Custodians.

Resort Context

Mt Buller and Mt Stirling Alpine Resorts are situated on Taungurung Country (Yowung-illum-balluk clan). Mt Buller (elevation 1,805m) attracts about 400,000 visitors during the snow season, with daily peak visitation of up to 17,000 on weekends, the largest proportion of snow season visitors of all Victorian alpine resorts. Mt Stirling has no permanent population or accommodation, seeing around 8,000 visitors during the snow season for cross-country skiing and snow camping.

Water plays a critical role at both resorts. Mt Buller has an extensive water supply, storage, treatment and distribution systems with highly seasonal demands for potable water and snowmaking. Mt Stirling has a much smaller water system, with a primary focus on maintaining basic supply to remote facilities.

Water Context

Mt Buller and Mt Stirling are within the Upper Goulburn catchment. The resorts are located at the headwaters of river systems with high ecological values, with implications for water management and potential impacts on downstream ecosystems and communities.

Mt Buller's primary water source is Boggy Creek catchment, with water extracted from weirs and pumped to Burnt Hut Reservoir (4.2 ML), Boggy Creek Reservoir (100 ML), and Sun Valley Reservoir (70 ML). Water licenses allow up to 700 ML per year to be extracted across multiple locations, subject to licence conditions.

Drinking water and wastewater at both resorts is managed by Goulburn Valley Water. Mt Buller has two water reticulation systems (low and high level), with water treated via UV radiation and sodium hypochlorite. Mt Stirling's water supply comes from Falls Creek catchment and is treated via carbon and cartridge filters and sodium hypochlorite. Mt Buller previously operated a water recycling system for snowmaking but it was discontinued in 2019 due to operational challenges and cost-effectiveness.

Climate Context

Victoria's alpine resorts, including Mt Buller and Mt Stirling, face significant challenges from climate change, which is forecast to impact on a variety of environmental values, and the local and state economy. Key changes include:

- declining snowfall and natural snow depth
- decreasing annual precipitation
- rising temperatures
- reduced hours suitable for snowmaking using snow/fan guns
- increased reliance on snow factories
- increased risks of bushfires and extreme weather events.

Projected temperature increases would significantly alter the natural snow coverage, depth and overall visitor experience, reinforcing a transition to a hybrid use of natural snow, snowmaking with fan guns, and snow factories

Climate change is reducing natural snowfall and the effectiveness of snow guns, increasing reliance on snow factories. Effective water planning and management at Mt Buller is critical to the ongoing resort operation and visitor experience.

Cultural Context

Taungurung strategic documents, including the Taungurung Country Plan and Cultural Land Management Strategy, outline cultural values, responsibilities and aspirations related to Healthy Country. Taungurung Land and Waters Council (TLaWC) did not contribute to the development of this plan due to their current priorities and capacity. However, the IWM approach is informed by Taungurung knowledge and aspirations outlined in these documents and implementation actions should be informed by ARV's Traditional Owner Engagement and Self-Determination Strategy.

Water Management Options

The IWM plan evaluated 25 options across four water management categories. Stakeholder input and analysis was used to identify] 14 priority recommendations (13 for My Buller and 1 for Mt Stirling). These are listed below.

<u>Good Water Management</u>

1. Building cultural understanding and two-way knowledge sharing
2. Water metering
3. Systematic leak detection
4. Water efficiency
5. Snowmaking water efficiency
6. Maintenance
7. IWM Reporting

<u>Environmental Management</u>

8. Stormwater management (trial)

<u>Future Water Resilience</u>

9. New diversion licence and infrastructure (Chalet Creek) (business case)
10. Connect Sawmill Settlement water network to Boggy Creek Weir 2 (investigation/feasibility)
11. Rainwater harvesting
12. Stormwater harvesting (business case)
13. Storage cover (monitoring/investigation)
14. Potable water system - Mt Stirling (investigate decommissioning)

Strategic Alignment and Benefits

Recommendations align with ARV's strategic objectives (investment, environment, visitors, reform, progress, and people) and IWM outcomes. Benefits include:

- Enhanced water security and climate resilience
- Water infrastructure and services supporting visitor experience
- Support for Traditional Owner cultural values and self-determination
- More sustainable and efficient water use across resort operations

Implementation is contingent on ARV priorities, available resources (including grant funding), and stakeholder support.

Action Plan

Suggested actions based on priority recommendations are summarised below.

Immediate / Current

- Continue engaging with Taungurung Traditional Owners
- Identify opportunities to support Taungurung land and water initiatives

Short-term (1-3 years)

- Install sub-meters throughout resort to monitor water usage and detect leaks across all facilities
- Conduct systematic leak detection and improve water efficiency by upgrading appliances to maximum WELS ratings
- Develop water efficiency guidelines for accommodation dwellings over 3-year implementation period
- Maintain all water infrastructure assets and treatment plants to prevent leaks and ensure water quality
- Implement annual reporting system covering all water aspects (stormwater, wastewater, potable, snowmaking, efficiency)
- Install erosion control measures (logs, coir logs) in identified risk areas below car park edges
- Monitor effectiveness of stormwater interventions
- Investigate business case for additional diversion licence to supplement Boggy Creek Reservoir
- Study feasibility of extending Sawmill Settlement potable water network to Boggy Creek Weir 2
- Assess stormwater harvesting potential for snowmaking at multiple locations
- Evaluate rainwater tank installation for toilet flushing at high-usage areas

Medium-term (4-9 years)

- Trial measurement of evaporation losses from storage pond surfaces to inform possible cover of the storage pond(s)
- Investigate costs and benefits of covering storage ponds (Boggy Creek and Sun Valley Reservoirs) to reduce evaporation
- Assess transitioning Mt Stirling from potable to raw water system

Long-term (10+ years)

- Re-evaluate wastewater recycling and groundwater extraction for alternative water supplies

1 Introduction

1.1 Purpose of this plan

The purpose of this plan is to provide a comprehensive framework for managing water resources at Mt Buller and Mt Stirling Alpine Resorts (referred to in this report as Mt Buller and Mt Stirling) in a way that balances environmental sustainability, social needs, and economic considerations. By integrating diverse aspects of water use—supply, wastewater, stormwater, and environmental flows—the plan seeks to optimise the overall performance of water systems while addressing challenges like climate change, visitation growth, and resource scarcity. It promotes collaboration among stakeholders to align goals and actions. Ultimately, this plan aims to ensure the long-term availability and quality of water, protect ecosystems, enhance resilience, and support resort function in a coordinated and efficient manner over the next 20 years.

1.2 Overview of Mt Buller and Mt Stirling Alpine Resorts

Mt Buller and Mt Stirling Alpine Resorts are situated on Taungurung Country.

The Yowung-illam-balluk (stone dwelling people) are one of fifteen clans of the Taungurung. Yowung-illam-balluk have connections to the Goulburn River and its tributaries between the Great Dividing Range (including Mt Stirling and Mt Buller) in the East and Alexandra in the West. This includes the Howqua, Delatite, and Jamieson rivers.[1]

Taungurung people have lived on their country for more than a thousand generations. [They] had, and continue to maintain, a special relationship with all their lands, mountains and waters. The Goulburn River holds particularly important meanings.

Taungurung RSA (2020)

Taungurung connections to alpine landscapes, including Mt Buller and Mt Stirling, are described in *Integrated Water Management in Taungurung Biik*. [2]

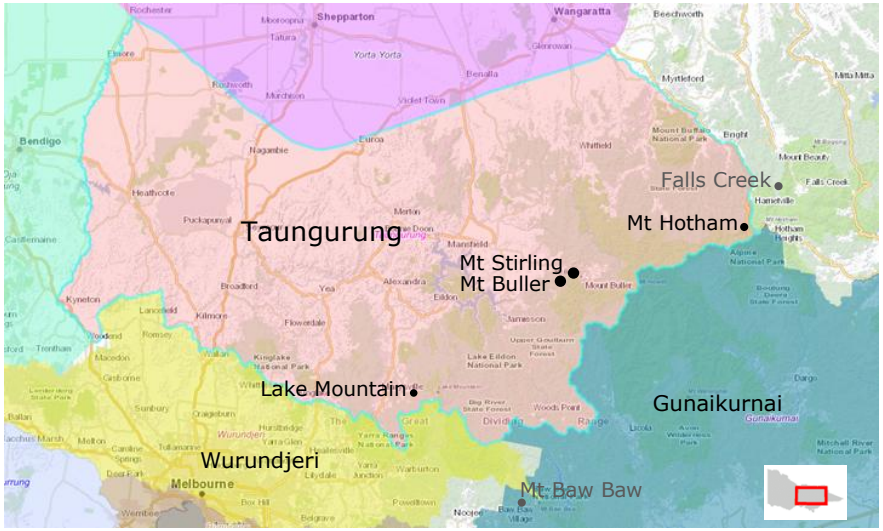


Figure 1. Taungurung Country and Victorian Alpine Resorts (Source: Victorian Aboriginal Heritage Register and Information System, annotated with Victorian Alpine Resorts)

[1] Darby (2008). *Mt Buller: The Story of a Mountain*, quoted in https://taungurung.com.au/significant-sites (accessed December 2024).

[2] Three Seeds (2025). *Integrated water Management in Taungurung Biik – Lake Mountain | Mt Buller | Mt Stirling | Mt Hotham*. Prepared by Three Seeds Agency for Alpine Resorts Victoria. January 2025.

Located about 220 km from Melbourne, Mt Buller sits at an elevation of 1,500m. During the snow season, it hosts a residential population of around 1,600 and attracts about 400,000 visitors, with daily peaks of up to 17,000 on weekends in July, August, and the Term 2 school holidays. Mt Buller comprises the largest proportion of snow season visitors of all the alpine resorts in Victoria.[3]

In the green season, the permanent population of Mt Buller drops to 40–50, with an additional 100–150 staff, including Mt Buller and lift company employees, hospitality workers, and construction crews. Events and activities drive off-season tourism, bringing in about 50,000 visitors. Mt Buller also has the most extensive mountain biking network in Victoria.[4]

Table 1. Mt Buller Profile

Statistics	***Values***
Winter Visitation (2024)	444,157 visitor days
Summer Visitation, number of visitors (2022)[5]	107,498 visitors
Resort Area	2,820 hectares
Resort Altitude (Summit)	1,805 m
Food establishments	31
Accommodation (number of beds)	8,000
Groomed trails (cross-country)	68
Snowmaking terrain	56 ha
Downhill skiable terrain	300 ha
Number of lifts	21
Road cycling*	16 km
Mountain biking*	100 km
Walking*	100 km

** including sections of road / trail beyond the resort*
Source: Urban Enterprise (2021)[6], ARV (2025)[7]

Figure 2. Mt Stirling café (Photo: Wave Consulting)

Mt Stirling Resort shares a boundary with Mt Buller along the Delatite River, with Mirimbah serving as the entry point for both. Unlike Mt Buller, Mt Stirling has no permanent population or accommodation. Facilities include a small ARV staff building, kids snow sports equipment hire and café, a storage shed, several shelters and toilet blocks, and three huts. The resort sees around 8,000 visitors during the snow season, primarily for cross-country skiing and snow camping, with frequent school groups. Outside of the winter months, about

[3] Urban Enterprise (2021). *Victorian Alpine Resorts Visitor Economy Development Plan*.
[4] Ibid.
[5] Mt Buller & Mt Stirling ARMB (2022). *2022 Annual Report.*
[6] Urban Enterprise (2021). *Victorian Alpine Resorts Visitor Economy Development Plan*.
[7] ARV (2025). *2024 weekly visitation*. https://www.alpineresorts.vic.gov.au/the-resorts/visitation-statistics/2024-weekly-visitation (accessed 14 March 2025).

30,000 people visit, especially from December to February, with many passing through to reach Craig's Hut. Camping is a common activity within the resort. It is also a popular horse-riding destination in summer.

Mt Stirling's management focus also includes threatened species reliant on high quality mountain streams – Barred Galaxias and Mt Stirling Stonefly, both critically endangered. There are significant populations of both these species within Mt Stirling including Falls Creek (adjacent to Telephone Box Junction).

Water plays a critical role at both Mt Buller and Mt Stirling, particularly in supporting the resorts' operations and environmental sustainability. However, the stark differences in the number of visitors and activities between the two resorts means Mt Stirling's water issues are more about maintaining basic supply to remote facilities, whereas Mt Buller's focus is on managing a much larger system under stress during peak periods. Mt Buller relies on water for snowmaking to enable reliable skiing conditions throughout the winter season.

Natural snow depth and coverage is declining in alpine regions due to climate change, with shorter and more variable winter conditions. Mt Buller piloted snowmaking systems in the 1970's, with permanent snowmaking infrastructure (water storage, pump stations, air compressors, and snow guns) implemented in 1994. Mt Buller continues to expand and evolve its snowmaking systems to support a quality winter experience for its visitors.[8] There is an increasing reliance on water and power for snowmaking to offset declining natural snow.

Historic visitation (2012-24) and projected visitation (2025-45) at Mt Buller under different future natural snow scenarios are shown in Figure 3. Projected visitation assumes that snowmaking will offset half of the natural snow depth lost due to changing climate.[9]

Visitation increased by approximately 20% between 2012 and 2019, representing an average annual increase of approximately 3%. Future visitation is forecast to continue growing under low, average and high natural snow conditions at Mt Buller. For Mt Stirling (no snowmaking), visitation is forecast to remain relatively stable under average and high natural snow scenarios and decrease under a low natural snow scenario.

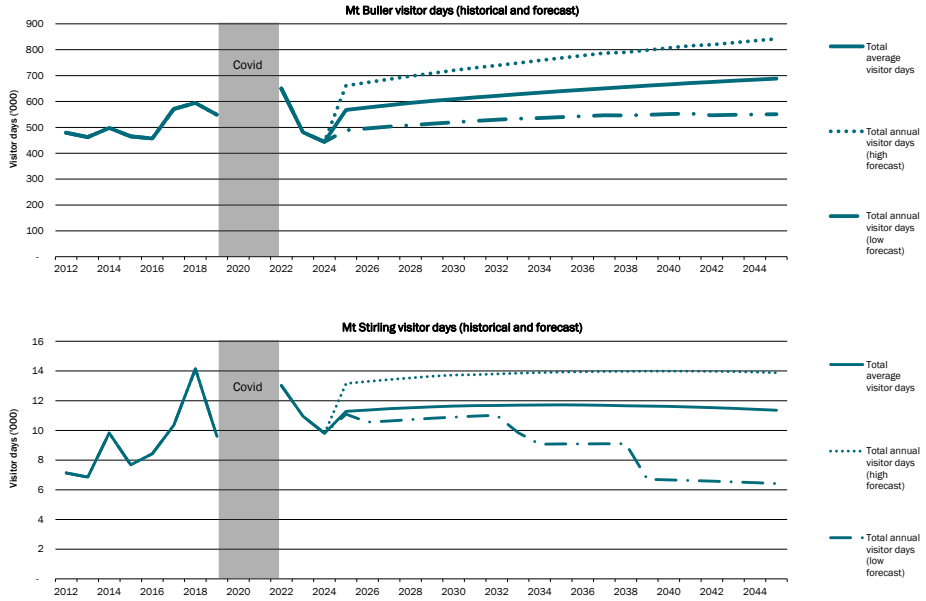


Figure 3. Historic and Projected Total Number of Visitor Days Under Different Snow Scenarios (data provided by Centre for International Economics, 2024).

[8] Mt Buller website: https://mtbuller.com.au/snow-weather/snowmaking (accessed 23 May 2025).

[9] Centre for International Economics (2024). *Carrying Capacity of Victorian Alpine Resorts: Preliminary Draft Report*.

Given the location in a sensitive alpine environment, Mt Buller and Mt Stirling must manage water resources carefully to minimise environmental impact. Effective water management is essential to protect local ecosystems, maintain water quality in surrounding rivers and streams, and ensure sustainable use, especially during peak seasons.

Alpine ecosystems have evolved with the mountain water cycle; melting snow and rainfall feed unique wetlands, streams, and forests. One such ecosystem is the alpine sphagnum bogs found on the northern side of Mt Buller's summit. These sphagnum bogs act as natural sponges, storing, filtering and slowly releasing water. They also provide habitat for specialised flora and fauna. The sphagnum bogs could be at risk from drying, especially with climate change and altered drainage. An environmental watering system has been implemented to mitigate the hydrologic impact of Boggy Creek Reservoir on downstream sphagnum bogs.[10]

[10] Mt Buller Mt Stirling Resort Management (2023). *Water Recycling & Storage Reservoir*. https://www.rmb.mtbuller.com.au/water-recycling-reservoir (accessed 17 March 2025).

1.3 History of snow depth at the resort

Snow depth data has been recorded since 1979 at the resort, on a daily basis, providing an excellent basis for considering changes in climate and their impact on water management. The chart below shows the natural snow depth for each season, and the long-term trend. It is rare to get more than 2 metres of natural snow depth on the mountain, and the depth will vary over the season and may be adversely affected by rain and warmer weather melting the snow.

This data reinforces the role of snowmaking in transitioning from a resort that relies mostly on natural snow depths to a hybrid situation.

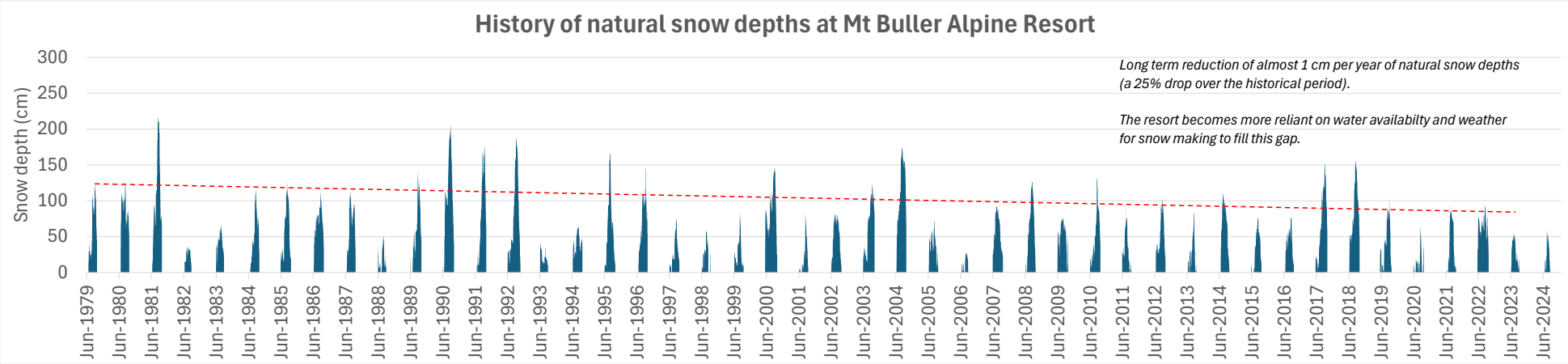


Figure 4. Snow depth at Mt Buller Alpine Resort since 1979.

1.4 Water planning approach

An iterative process was used to understand the resort context, water and environment context, identify potential opportunities, and evaluate options (see Figure 5). Wave Consulting worked with ARV and Mt Buller and Mt Stirling stakeholders (including Buller Ski Lifts, DEECA, Mansfield Shire Council, Goulburn Murray Water, Goulburn Valley Water) to understand the water context, challenges and aspirations associated with each resort.

Wave Consulting conducted informal interviews with resort stakeholders and visited the resorts with ARV staff to assess existing infrastructure and ground-truth potential opportunities. Two online stakeholder workshops were also undertaken. The first workshop focused on understanding the role of water, as well as constraints and opportunities for better water management at the resort. The second workshop identified and critiqued potential options. Inputs from both workshops informed the options presented in this plan. Appendix A and Appendix B contain summaries from each workshop. Resort stakeholders also had an opportunity to review the draft plan and provide feedback.

ARV engaged with Taungurung Land and Waters Council (TLaWC) as part of the development of ARV's Traditional Owner Engagement and Self-Determination Strategy. TLaWC have not been directly involved in water planning for Mt Buller and Mt Stirling due to their current organisational priorities and capacity. Cultural considerations and associated water-related opportunities based on current Taungurung plans and strategies are identified in *Integrated Water Management in Taungurung Biik*.[11]

Figure 5. Water planning approach

[11] Three Seeds (2025). *Integrated water Management in Taungurung Biik – Lake Mountain | Mt Buller | Mt Stirling | Mt Hotham*.

2 Water context

2.1 Waterway Catchments

Operating within an alpine catchment means that any water the resorts take, or release, has environmental consequences. Mt Buller and Mt Stirling are essentially at the headwaters of important river systems, so their water management can affect downstream ecosystems and communities.

Managing the impact of water extraction on natural stream flows is particularly important. Both resorts are only permitted to draw water during the winter-spring "high flow" period (Mt Buller's licence allows extraction between May and October (inclusive) and at Mt Stirling extraction can be diverted between July and October). This policy restricts water extraction during the drier months when rivers are most vulnerable. In the past, Mt Buller's limited storage forced the resort to seek exemptions to pump water in summer droughts to supply the village (ERM 2017). The Delatite River (which Boggy Creek feeds into) is already classified as a stressed waterway in summer.[12]

Mt Stirling, being largely undeveloped, has relatively little direct impact on water besides minor diversions from Falls Creek. Notably, the headwaters of the Howqua River originate on Mt Stirling and are classified as a Heritage River for their high conservation value.[13] This status reinforces strict protection – any water use must not compromise the natural state of those streams. In practice, Mt Stirling's tiny water usage has negligible effect on stream ecology, and its management focus is on preventing pollution (e.g. ensuring septic systems or horse-riding activities at Stirling do not contaminate waterways) and protecting riparian zones.

"Maintaining water quality is crucial to protecting both the environment and Indigenous cultural significance."

Workshop 1 participant

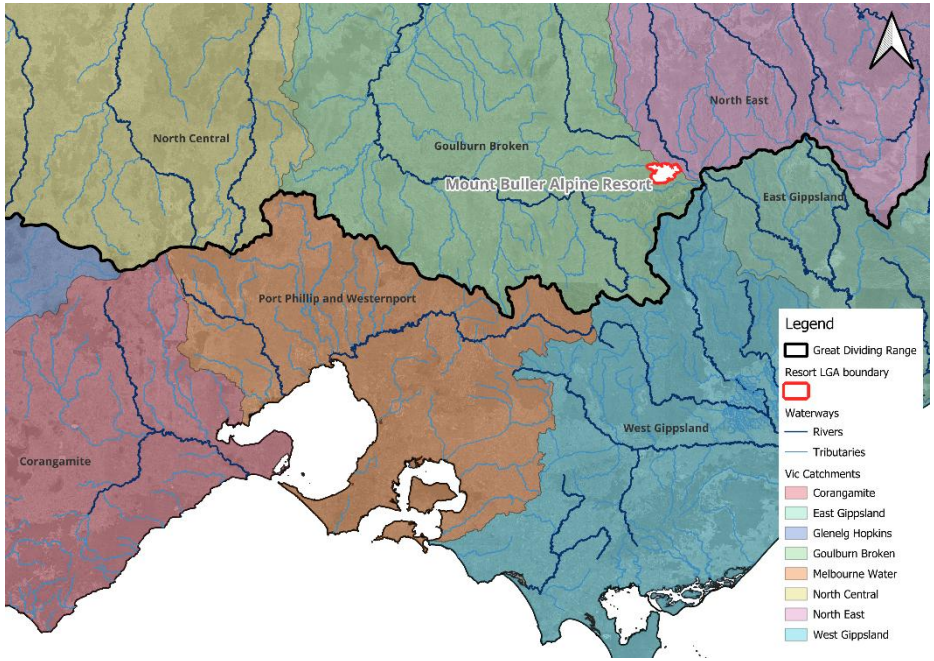


Figure 6. Mt Buller, Mt Stirling and surrounding catchments

[12] ERM (2017). *Mt Buller Sustainable Water Security Project – Off Stream Storage*. Report for Mt Buller and Mt Stirling Alpine Resort Management Board.

[13] Biosis Research (2012). *Mount Buller and Mount Stirling Environmental Management Plan*. Report for Mount Buller and Mount Stirling Alpine Resorts Management Board.

2.2 Water Infrastructure

2.2.1 Water Supply

Potable (drinking) water is supplied to Mirimbah, Mt Stirling and Mt Buller. Water is also supplied to Mt Buller for snowmaking. Water licenses (take and use) allow up to 700 ML per year to be extracted from Boggy Creek (665 ML / year), Howqua River (30 ML / year), Buller Creek at Mirimbah (3 ML / year) and Falls Creek at Telephone Box Junction (2 ML / year), subject to licence conditions.

Mt Stirling

Mt Stirling's water supply comes from the perennial and reliable Falls Creek catchment (including Baldy Creek). Water is pumped from Falls Creek at Telephone Box Junction to a settling tank, passed through carbon and cartridge filters, dosed with hypochlorite, pumped to a header tank, and then gravity fed through the reticulation system. This small, pumped supply provides water to the toilet block, ski patrol base, and café at Telephone Box Junction.[14]

Mt Buller

Mt Buller's primary water source is Boggy Creek catchment. With an elevation above 1,250m, the upper catchment is typically snow-covered from early June to late September and snowmelt supplements surface and sub-surface flows.[15] Water from the Howqua River tributary could be pumped to Sun Valley Reservoir via a temporary diversion under the current water licence but is not currently utilised. Mt Buller's water supply remains largely uncontaminated due to the pristine environment, alpine bogs, groundwater dependent ecosystems, and limited human or vehicle access within the water catchments.

Raw water is extracted from weirs on Boggy Creek and its tributaries and pumped to Burnt Hut Reservoir (4.2 ML, 1680m AHD) and Boggy Creek Reservoir (100 ML, 1741m AHD). Boggy Creek Reservoir, constructed in 2020, includes 30 ML capacity for potable water supply and 70 ML for snowmaking. Sun Valley Reservoir (70 ML) is used for snowmaking. It is supplied from Boggy Creek Reservoir and Burn Hut Reservoir via a pumped network, and the Howqua River tributary temporary diversion. [16]

Two water reticulation systems (low level and high level) are required to maintain water pressure below 1,000 Kpa as there is a 100m elevation difference across the village**.** Water from Burnt Hut Reservoir is treated before

[14] Alpine Resorts Victoria (2022). *Drinking Water Quality Annual Report, 2022 – 2023*.
[15] Ibid.
[16] Ibid.

being distributed via the low level reticulation system (1.3 ML/d) to the lower two-thirds of the village. Water from Boggy Creek Reservoir is pumped to the underground Baldy Reservoir (1 ML, 1700m AHD), treated and distributed to via the high level reticulation system (0.7 ML/d) to the upper third of the village, including the lift company workshop, public toilets, and Kofler's Hütte restaurant in the ski area. The workshops are served via a rising main, while Kofler's Hütte receives water through a rising main that feeds two storage tanks before gravity distribution to the premises. [17]

Drinking water in the low level and high level reticulation systems is treated via UV radiation and sodium hypochlorite.

Figure 7. The 100 ML Boggy Creek Reservoir water storage reservoir at Mt Buller (opened 2020).

Leakage from Boggy Creek Reservoir as a result of damage to the liner was identified in October 2024, with initial repair works attempted in early November 2024. The reservoir was subsequently drained so more substantial repairs to the liner could be undertaken in January 2025. A water licence exemption enabled the reservoir to be refilled outside the winter fill period.

Figure 8. Mt Buller UV filtration plant

[17] Ibid.

2.2.2 Wastewater

Goulburn Valley Water (GVW) operates and maintains sewer (and potable water) operations on behalf of the resorts.[18] GVW also has responsibility for all water and sewer operations at Sawmill Settlement located 3km from the resort entry (Mirimbah).

Mt Buller constructed a trial water recycling system for snowmaking in 2003/2004 and 2004/2005. It was operational intermittently and had several infrastructural upgrades from 2008 to 2018. The system was discontinued in 2019 as it was determined to not be cost-effective for the amount of water produced.[19] Reinstating the recycled water system to create more water for snowmaking is considered difficult and costly by the operators.[20]

2.2.3 Snowmaking

Mt Buller has an extensive snowmaking system with the majority of snowmaking assets owned, operated, and maintained by Buller Ski Lifts. There are five snow factories (including one owned by ARV) and over 300 snow guns, covering key ski runs and resort areas. These guns include both fan guns and lances, strategically positioned to maximise efficiency and snow coverage.

Figure 9. One of the Mt Buller snow factories (Photo: Wave Consulting).

[18] Alpine Resorts Victoria (2022). *Drinking Water Quality Annual Report, 2022 – 2023*.
[19] Mt Buller Mt Stirling Resort Management (2023). Water Recycling & Storage Reservoir.
[20] ARV, 2025. Pers. Comms. (stakeholder engagement workshops).

Water for snowmaking comes from Boggy Creek diversions, which are pumped to Boggy Creek Reservoir and the Burnt Hut Reservoir and transferred to the 70 ML capacity Sun Valley Reservoir. Snowmaking operations using snow guns are largely dependent on favourable temperature and humidity, requiring conditions below -2°C wet bulb temperature for efficient production. The system is partly automated, allowing for rapid deployment when conditions are favourable, with the capacity to pump up to 600 L/s.[21] The five snow factories use potable water and enable snow production regardless of air temperature.

The snowmaking network is powered by a high-pressure pumping system, delivering water through underground pipes to snow guns located across the resort. Compressed air is also supplied where needed, ensuring effective snow crystal formation.

The snow guns are also an important asset to help protect the resort from fire in the summer months. They can work as a giant sprinkler system pumping water across the mountain to prevent the spread of fire. However, without sufficient water in storage, these guns cannot operate in any season.

There is an ongoing movement in the industry to adapt and transition snowmaking infrastructure in response to climate change. The use of more efficient snow fan guns, more sensors to calibrate and target snow production, and the installation of snow factories is expected to continue. The future of snowmaking at Mt Buller may well include a hybrid mix of more efficient snow fan guns, operating at slightly higher wet bulb temperatures, and snow factories, where snow produced lasts longer on the ground.

2.3 Water Demand

An analysis of water demand patterns is based on metered data and driven by visitation and the operation of services and facilities and backed up by anecdotal evidence provided by resort staff. Flow data from the wastewater treatment plant provides a good reference point for estimating the seasonal and annual water demand.

Data provided by ARV was used to develop a calibrated water demand model that also included visitation figures to the resort, local rainfall records, nearby weather data (temperature, humidity, wet bulb, and wind direction and speed at an hourly interval), and river monitoring at a downstream station on the Delatite River. The water demand model was used to produce a demand profile for the two main uses of water:

- Potable water for all accommodation, toilets, buildings, administration and workshop
- Snowmaking production.

Annual water demand fluctuates based on weather, visitation rates, leakage in the system, and other climate variables. Potable water use occurs across the year while snowmaking is specific to the snow season. The figure below represents a typical year, noting the water demand pattern can vary significantly.

The analysis focuses on Mt Buller Alpine Resort, as the Mt Stirling Alpine Resort is a simple and small-scale operation not requiring the same level of analysis.

[21] Mt Buller 2025. Snowmaking.

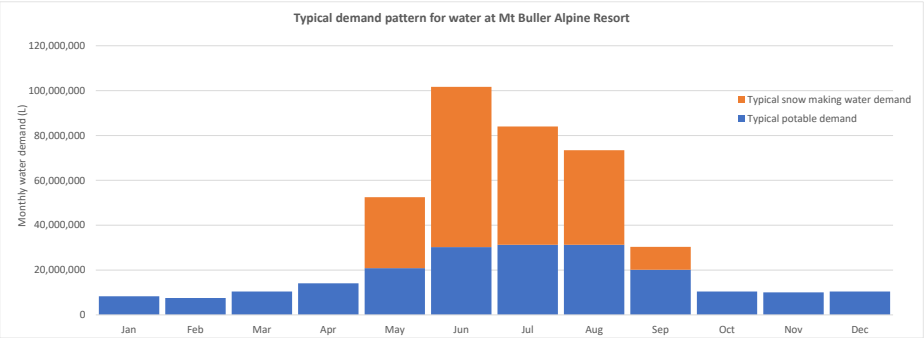


Figure 10. Average water demand at Mt Buller

A 2013 report on water demand and supply[22] notes the average potable demand was 163 ML / year, and the average snowmaking demand was 230 ML / year (forecast to rise to 700 ML / year)[23].

[22] GHD, 2013. Report on Water Supply Demand Strategy for Mt Buller, Stirling, and Mirimbah Water Supply Systems

[23] Buller Ski Lifts Pty Ltd, 2025. Pers comms via email.

2.4 Water Balance

A water balance represents the average flow of water through a geographic area, and highlights the complexity of the different water uses, diversions, runoff relationships, and end uses of all sources and discharges of water. A water balance for Mt Buller was calculated using a variety of models and data points to estimate water flows and uses associated with different resort activities.

Access to raw water (based on licence extraction limits and available storage) and weather conditions to support snowmaking are water-related constraints for the resort. Most of the water falling on the resort (rain and snow), on an average annual basis, is intercepted by vegetation and evapotranspires. Water diversion from Boggy Creek weir (a diversion licence of up to 665 ML / year with various seasonal and daily extraction limits) is a key part of the resort water balance. Snow melt evaporates, infiltrates or flows into Boggy Creek (northern slopes) or Howqua River (southern slopes).

Wastewater is treated to near Class A but is no longer recycled due to water quality and pipe distribution issues and is instead discharged to the Howqua River system. Impervious runoff from the several car parks and natural snow melt are relatively large discharges from the resort, compared to wastewater, but are distributed (i.e. the water is spread across a large area).

Water balance analysis focuses on Mt Buller Alpine Resort, as the Mt Stirling Alpine Resort is a simple and small-scale operation not requiring the same level of analysis. A variety of modelling methods was used to create this water balance as no one modelling platform look at all water inputs and outputs, with data inputs from ARV, DEECA, BOM and Buller Ski Lifts.

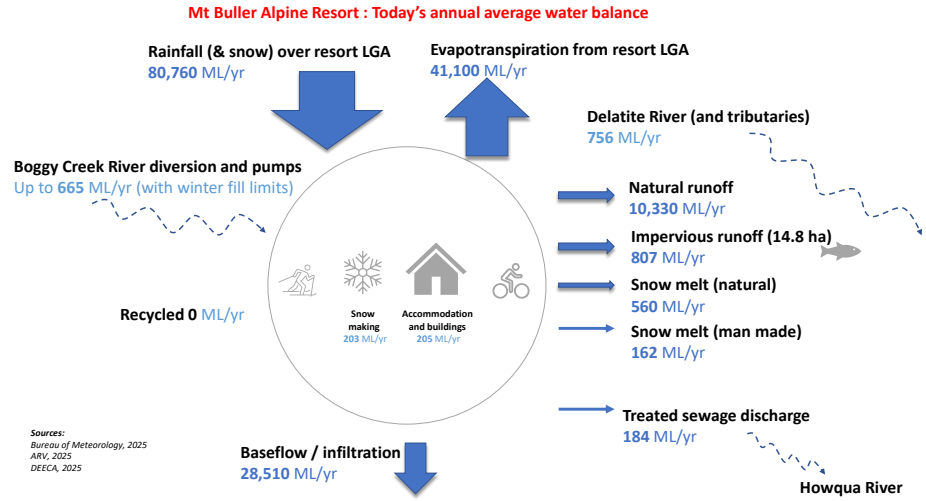


Figure 11. Mt Buller water balance.

2.5 Climate Context

Victoria's alpine resorts, including Mt Buller and Mt Stirling, face significant challenges from climate change, which is forecast to impact on a variety of environmental values, and the local and state economy. Over the past 70 years, snowfall has decreased, with the snow season now starting later and ending earlier. By 2070-2099, under a high emissions scenario (RCP8.5), snowfall decline relative to 1961-1990 at both Mt Buller and Mt Stirling is projected to be around 74% (Nation Partners 2024). [24] Projections indicate Mount Stirling and Mount Buller may have the greatest contraction in natural season length compared to the other Victorian alpine resorts. However, projected visitation numbers at Mt Stirling were not significantly impacted by changes in snow depth.[25]

> "In 20 years, water scarcity might become a greater issue. Snowmaking temperatures may also become unsuitable."
>
> *Workshop 1 participant*

Snowmaking technology will be critical for sustaining winter tourism, but its effectiveness depends on future water availability and energy costs. An overall decline in Spring rainfall by 22% in 2040-2059 under high emissions scenarios in the Ovens-Murray region may limit water supply for snowmaking.[26] Earlier snowmelt could also reduce water storage capacity, affecting both ski operations and environmental water flows. While average rainfall may decline, there are large uncertainties in projected changes in heavy rainfall events; daily rainfall intensity for events with a 20-year recurrence interval is projected to decrease by up to 9% under a high emissions scenario but increase 3% under a medium emissions scenario.[27]

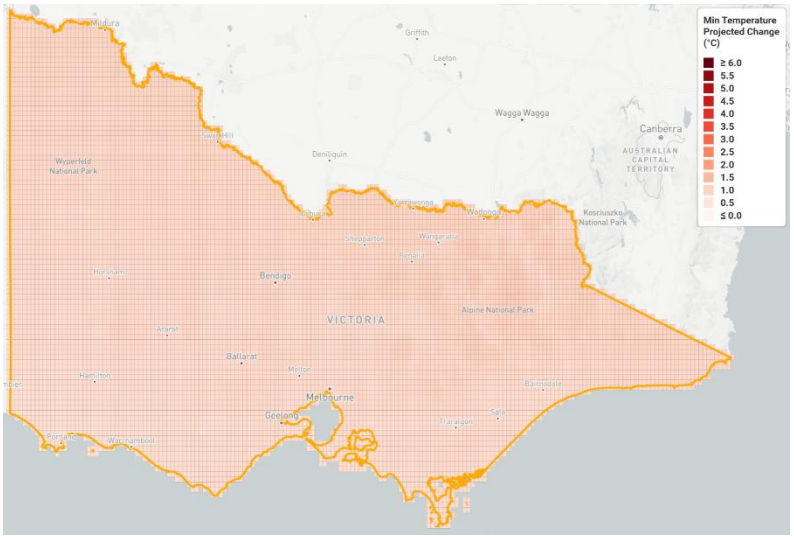
Under all emission scenarios, both Mt Buller and Mt Stirling are expected to experience an increase in the duration of extreme dry weather.[28] At the same time, average daily maximum temperatures for both summer and winter are projected to increase relative to the historic average. Winter minimum temperatures are modelled to increase by 1.2°C at Mt Buller and 1.4°C at Mt Stirling by 2050 under a high emissions scenario. Summer average daily maximum temperatures are expected to increase by 2.8°C at Mt Buller and 2.6°C at Mt Stirling.[29] This warming will accelerate snowmelt, shorten the snow season, reduce snowmaking efficiency, and increase bushfire risk.

[24] Nation Partners (2024). *Summary of Climate Change Science and Impacts*.
[25] Ibid.
[26] Ibid.
[27] Ibid.
[28] Ibid.
[29] Ibid.

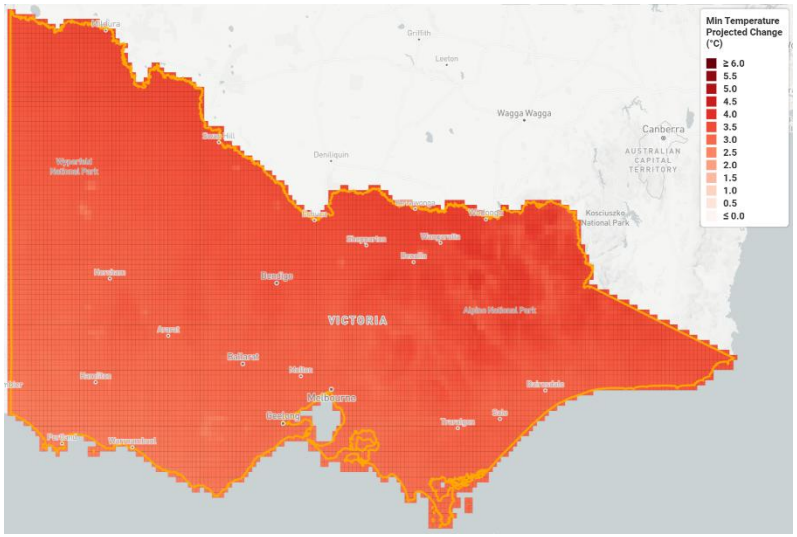
Figure 12. View from Mt Buller Alpine Resort

Climate change forecasts from the Department of Energy, Environment and Climate Action, through the Victoria Climate Future Tool for an RCP 8.5 emissions forecast (the highest emission scenario), are shown on the next page.[30] The figures illustrate how the climate is forecast to change, with a focus on minimum and maximum temperatures. Projected temperature increases would significantly alter the natural snow coverage, depth and overall visitor experience, reinforcing a transition to a hybrid use of natural snow, snowmaking with fan guns, and snow factories

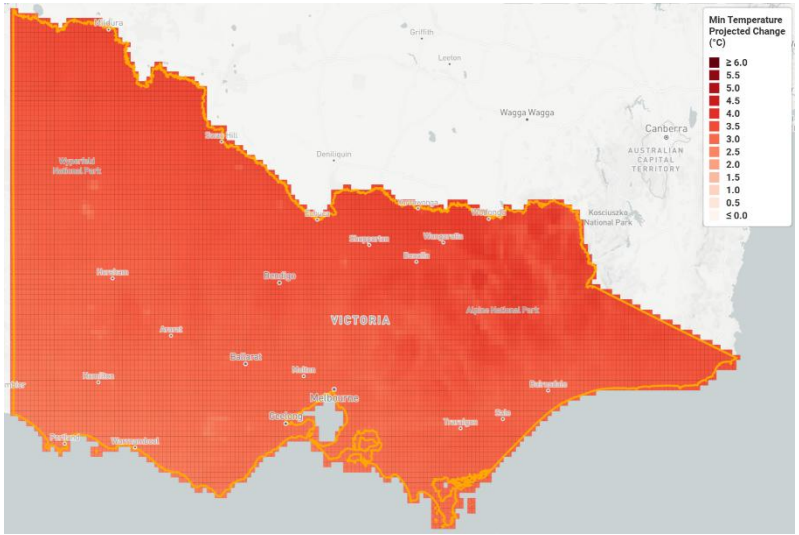
[30] Clarke JM, Grose M, Thatcher M, Hernaman V, Heady C, Round V, Rafter T, Trenham C & Wilson L. (2019). *Victorian Climate Projections 2019 Technical Report*. CSIRO, Melbourne Australia.



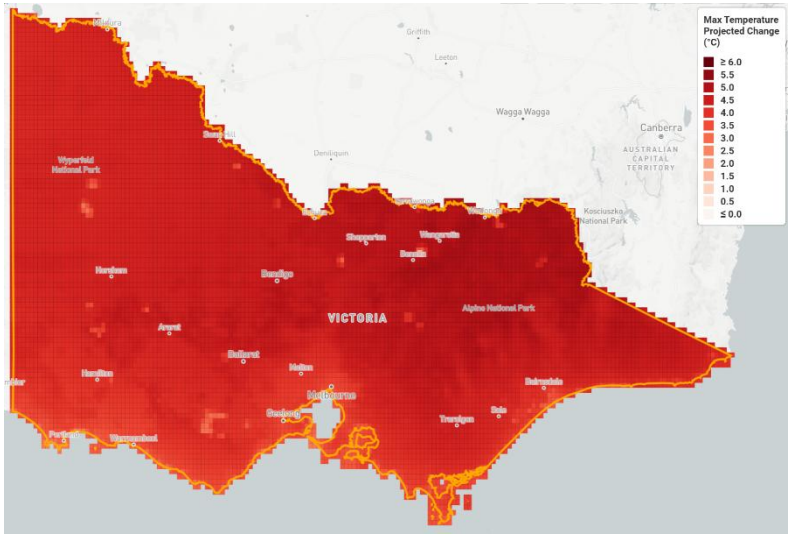
Climate change impact on minimum temperatures for 2020-2039



Climate change impact on maximum temperatures for 2020-2039



Climate change impact on minimum temperatures for 2080-2099



Climate change impact on maximum temperatures for 2080-2099

2.6 Managing Country

Taungurung responsibilities and aspirations related to Healthy Country are outlined in Taungurung Land and Waters Council (TLaWC) plans and guidance including:

- Taungurung buk dadbagi / Taungurung Country Plan[31]
- Taungurung Nation Statement - Water is Life[32]
- Taungurung Cultural Land Management Strategy[33]

These documents provide cultural context for water planning at alpine resorts in Taungurung Country.

Approaches for reading water country, assessing values, identifying important waterscapes and applying flow regimes to heal and strengthen cultural values will be developed by the Taungurung Cultural Water Program.[34] Reform of institutional and governance arrangements for water policy and programs was also identified as a crucial element of this work.

2.7 Partnering with Traditional Owners and Building Cultural Competency

ARV has obligations and aspirations to:

- build organisational cultural competence to engage with Traditional Owner groups with rights and interests in alpine resorts (Registered Aboriginal Parties and Traditional Owner groups without formal recognition)
- support Aboriginal self-determination and partner with Traditional Owners in the planning and management of alpine resorts.

ARV's *draft Traditional Owner Engagement and Self-Determination Strategy* identifies a series of actions 'to champion Aboriginal self-determination through genuine partnerships with Traditional Owners, ensuring their rights and interests in Alpine Country are understood, supported and upheld'. These actions relate to three key focus areas: governance and accountability, culture and Country, and economic opportunities. [35]

Integrated Water Management in Taungurung Biik informs this IWM plan and contributes to building ARV's water-related cultural knowledge and competence.[36]

[31] Taungurung Land and Waters Council (2016). *Taungurung Country Plan*.
[32] Taungurung Land and Waters Council (2022). *Taungurung Nation Statement – Water is Life*.
[33] Taungurung Land and Waters Council (2023). *Taungurung Cultural Land Management Strategy*.
[34] Ibid.
[35] ARV (2025). DRAFT *Traditional Owner Engagement and Self-Determination Strategy.*
[36] Three Seeds (2025). *Integrated water Management in Taungurung Biik – Lake Mountain | Mt Buller | Mt Stirling | Mt Hotham*. Prepared by Three Seeds Agency for Alpine Resorts Victoria. January 2025.

3 Integrated Water Management Planning in an Alpine Environment

Integrated Water Management (IWM) is a collaborative approach to managing water resources that considers the interconnectedness of water systems, including supply, demand, wastewater, stormwater, and environmental flows. In alpine environments, IWM is particularly important due to the region's unique ecological, hydrological, and climatic characteristics. These areas are critical sources of freshwater for downstream communities and ecosystems, yet they face increasing pressures from climate change, seasonal variability, tourism, and development.

Effective IWM in alpine environments ensures sustainable water use, protects fragile ecosystems, and enhances the resilience of water systems against extreme weather events like droughts, fires, and floods. By integrating perspectives across stakeholders, IWM helps balance the needs of people, industry, and nature while preserving the alpine environment for future generations.

As discussed previously, the options for IWM management considered in this plan were sourced from conversations with ARV staff and stakeholders during the two workshops, as well as interviews and the site visit. The ideas and opportunities generated from this engagement were then analysed using available data and also were evaluated based on their alignment with ARV strategic objectives and IWM outcomes. This alignment is important as it addresses how each option supports ARV's organisational goals, as well as the broader outcomes IWM seeks to support.

3.1 ARV Strategic Objectives, 2024 – 2027

Alpine Resorts Victoria (ARV) has six strategic objectives to guide activities between 2024 – 2027. These objectives were created to ensure ARV has clear direction to support sound decision-making. The alignment of these objectives with each individual IWM option will be discussed further later sections. The table below shows the connection between the ARV objectives and IWM planning.

Table 2. ARV Strategic Objectives

ARV Strategic Objective	Relevance to IWM planning
Investment: Enable investment that drives sustainable businesses	Supports IWM through financing water infrastructure improvements and ensuring water-related services are resilient and sustainable
Environment: Protect and enhance the alpine environment and adapt to climate change	Reducing water use and improving water security mitigates environmental impacts on alpine ecosystems
Visitors: Enhance the visitor experience	Ensures water services meet visitor demand, maintaining quality and accessibility
Reform: Implement practical policy and regulatory reform	Facilitates the adoption of updated water management practices and regulations
Progress: Enhance organisational excellence and sustainability	Effective IWM planning depends on robust governance, resource allocation, and continuous improvements.
People: Build constructive culture and leadership capabilities	Developing expertise in IWM among ARV staff ensures long-term sustainability and informed decision-making.

3.2 IWM outcomes and relevance to Mt Buller and Mt Stirling

There are generally eight strategic outcomes of an IWM approach; each outcome addresses a different aspect of the water system. However, it is important to recognise that most IWM plans (and outcomes) are focused on urban environments and communities that are quite different from a resort or alpine environment. The following table displays the IWM strategic outcomes and their relevance to Mt Buller and Mt Stirling.

Table 3. IWM objectives

System Aspect	Outcome	Relevance to Buller - Stirling
Water sources	1. Safe, secure and affordable supplies in an uncertain future	Increase the amount of water conserved or alternative water volume supplied to meet demand.
Wastewater	2. Effective and affordable wastewater systems	Ensure environmental and public health standards are met while maximising resource recovery.
Drainage, stormwater, and flooding risks	3. Effective stormwater management to manage flood risks	Minimise environmental impacts of stormwater; ensure resilience to existing and future flood risks.
Waterways	4. Healthy and valued waterways and waterbodies	Improved ecological health of riparian areas, hydrology, and water quality.
Water in urban landscapes	5. Healthy and valued landscapes	Maximise the connectivity, accessibility, aesthetic, and recreational values of landscapes.

System Aspect	Outcome	Relevance to Buller - Stirling
Traditional Owners	6. Traditional Owner values, opportunities, and inclusion	Ensure that Traditional Owner values and priorities are acknowledged, respected, and enhanced.
Community value of water	7. Community values reflected in place-based planning	Ensure that different communities are considered and included in planning and design. Consider how to increase water systems literacy of Mt Buller and Mt Stirling visitors.
Economic values	8. Jobs, economic opportunity and innovation	Recognition that water management is an integral part of sustainable business

3.3 Taungurung considerations

Cultural considerations informed by Taungurung knowledge, aspirations and land management principles presented in Taungurung strategic documents are identified below.

1. Recognise and respect Taungurung cultural rights and obligations

- The Taungurung are the first peoples of the rivers and mountains. Taungurung Country is bounded by the Great Dividing Range to the east and south, the Campaspe River to the west and by the Ovens River and a series of flats and wetlands in the North.
- Taungurung buk dadbagi / Taungurung Country Plan asserts Taungurung inherent rights as Traditional Owners of Country. These rights are captured in Aboriginal Law and remain with Taungurung despite the role successive governments have played in dispossessing and dispersing Taungurung People.

IWM Consideration: *Recognise and respect Taungurung connection to Country, and the associated strategic objective of applying Taungurung cultural knowledge and practice to heal Taungurung land and waters.*

2. Water is part of a cultural landscape; everything is connected

- Taungurung manage Country holistically to address multiple values and objectives, healing both Country and culture. Partnership arrangements and management objectives are tailored to each cultural landscape context
- Taungurung Country must be planned for and managed according to bio-cultural values and objectives.

IWM Consideration: *Understand and minimise potential adverse impacts of water management decisions within and beyond alpine resorts.*

3. Work Together to care for Country

- Taungurung Country includes waterways, land, plants and animals, and cultural sites. [Parks and reserves] contain extensive cultural heritage and abundant natural and cultural resources.
- Taungurung are working to establish ongoing support and investment for cultural mapping on Taungurung Country – from the tops of their mountains to their waterways and tributaries, including tangible and intangible heritage.

IWM Consideration: *Identify opportunities to support Taungurung caring for Country goals and aspirations through alpine water planning and management.*

4 Water resilience at Mt Buller

The resilience of Mt Buller's water systems is dependent on water supply and storage meeting potable water and snowmaking demands throughout the year. Licence conditions permit water extraction between May and October, subject to minimum passing flows and maximum daily (and annual) extraction limits to protect water-dependant ecosystems. Potable water and snowmaking demands area strongly seasonal, with water for early-season snowmaking required in April and May. This can lead to periods of water stress, impacting on resort operations and visitor experience.

An understanding of the relationship between water supply, storage and use (and its variability) informs the identification of water management options for the resort. Water supply and demand are summarised in sections 2.2 and 2.3. Mt Buller has a total storage capacity of 170 ML across Boggy Creek Reservoir (30 ML potable and 70 ML snowmaking) and Sun Valley Reservoir (70 ML snowmaking).

The volume of water in Boggy Creek Reservoir from November 2021 and August 2024 is presented in Figure 13. The stored water volume declines significantly from January to June, increasing from 1st May once diversions from Boggy Creek resume. Stored water volumes at the start of April (when snowmaking commences) were 30-50% of Boggy Creek Reservoir's capacity.

Figure 13 also shows (modelled) potential storage volume in Boggy Creek Reservoir, assuming improved water use efficiency and additional water supplies. Possible additional water sources include stormwater, recycled wastewater (previously implemented but discontinued), and new surface water extraction sites. Analysis of these options is presented in section 6, noting all options require to further investigation to confirm technical feasibility (including additional treatment requirements), environmental impacts, and benefits and costs.

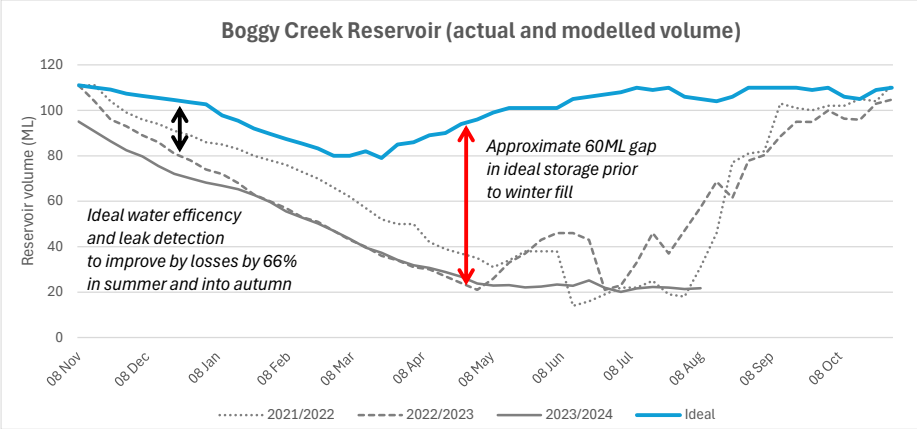


Figure 13. Boggy Creek Reservoir storage levels (actual and ideal)

A shortfall of approximately 60 ML is evident in May, consistent with recent experience following completion of Boggy Creek Reservoir in 2020.

Flows in Boggy Creek at Weir 2 were modelled to understand the seasonal relationship between flow rates and water extraction potential under existing licence conditions (see Figure 14). Flows at Weir 2 were estimated based recorded historical flows for the Delatite River at Sawmill Settlement, downscaled by 98% to account for the smaller catchment. Potential water extractions were calculated using current licence conditions and assume suitable water quality and turbidity.

This analysis indicates the minimum passing flow rate (0.25 ML/day) limit early season potential extraction volumes (8 ML/day across Boggy Creek Weir 1A, 1B and 2) in seven of the ten years included in this analysis. Recommended monitoring of passing flows in Boggy Creek[37] would enable a more accurate assessment of water extraction potential, given different physical and hydro-geological characteristics of the reference catchment affect the reliability of flow downscaling.

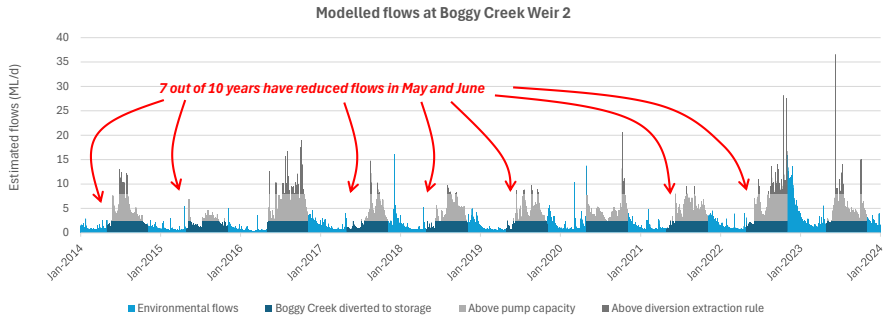


Figure 14. 10 years of flows and modelled availability showing 7 out or 10 years have limited flows in May and June, even when diversions can commence.

Options that could improve water use efficiency and increase supply volumes, while also protecting/enhancing ecological, social and environmental values are identified and investigated in the following sections.

[37] Streamology (2023). Boggy Creek Environmental Flow Assessment – Report for Mt Buller & Mt Stirling Alpine Resorts.

5 Water Management Options

IWM options are presented in this section, grouped into the following four categories.

- **Good water management**. These options relate to good asset management and sound management of water as a precious resource, which should be pursued irrespective of the long-term strategic plan for the resort. They include ensuring there is no leakage in the system, that the assets are maintained at appropriate frequencies and service levels, that the resort increases the partnerships and understanding with the Traditional Owners, and there is better reporting on water consumption, savings, end uses and discharges, for an overall increased water efficient resort.
- **Environmental values**. These options relate to the impact of surface water systems on the downstream and surrounding environment. Options specific to reducing the impact of stormwater from the impervious surfaces (in particular the car parks in and around the resort) are critical to these values. The options relate to reducing diffuse source pollution, and erosion, and in some instances wastewater discharges on the environment.
- **Integrated water and energy strategy**. Energy and water are both significant issues in running the alpine resorts. Options that increase opportunities for renewable energy production through the smart use of water storages and water discharges are identified.
- **Future water resilience**. These options relate to augmentation of the water supply, storage and infrastructure system that support moves to creating a more resilient water system that can cope with climate change and forecast visitation at the resort.

With only a small, pumped supply and comparably very low visitation, there are very few water issues and opportunities that are specific to Mt Stirling. Therefore, only one option (Option 4S) was identified and evaluated for this resort, which focused on the requirements to maintain a potable water system, and if this is an appropriate and fit for purpose water system, and related testing, management, and ongoing costs.

5.1 Refining options based on stakeholder feedback

Twenty-five diverse water management options addressing a range of IWM outcomes for Mt Buller and Mt Stirling were identified (see Figure 15). This IWM plan seeks to prioritises action and investment in a few key areas that support IWM and the ARV's strategic objectives, rather than present a long list of options.

The twenty-five options were assessed though an iterative approach based on stakeholder expertise and high-level analysis to determine feasibility and level of support. This included two workshops attended largely by the same stakeholder representatives, with options being reviewed and refined in the second workshop (see Appendix B). Some options were deemed not feasible and others were refined or adapted based on stakeholder insights. Fifteen options were selected for additional review and modelling – these are identified by bold text in Figure 15. Of these, eight relate to 'good water management' and were acknowledged as important irrespective of the longer-term vision and operation of the resort.

Figure 16 presents the progression of all options through the iterative IWM assessment process, identifying the stage and reasons for discontinuation of specific options.

Stakeholders also reviewed and provided feedback on the draft plan. A total of 108 comments were received from five stakeholders.

General feedback included a request for detailed cost-benefit analysis of options and/or identification of cost per unit of water supplied/saved ($/ML). Economic analysis will be required as part of feasibility assessment for many options; however, it is beyond the scope of this plan.

More detail on the quantity of additional water available for snowmaking under various options was requested by Buller Ski Lifts to understand the contribution toward their estimated future water demand of up to 700 ML / year (current water use for snowmaking varies between 100 and 300 ML / year). Buller Ski Lifts also suggested investment in water infrastructure and management should be considered within the context of the snow industries contribution to the Victoria economy, estimated to be $2.14 billion (Alpine Resorts Victoria, 2024)[38].

The previously decommissioned wastewater recycling plant was raised by two stakeholders. Buller Ski Lifts requested greater consideration of reinstating operation of the plant to provide Class A water for snowmaking. DEECA enquired about the potential for upgrading the wastewater treatment plant to improve the quality of discharges to the environment. Stakeholders collectively identified this option as a lower priority to progress than the options presented in Section 6.

Groundwater as a resource was mentioned by GM Water as an option that has proved to be successful in other resorts and would be supportive of further investigation of this option. Assessment of conditions including aquifer depth and any relationship with any groundwater dependent ecosystems will need to be considered if this option is progressed.

Treatment and reuse of greywater for toilet flushing was suggested by GM Water a potential option. This option was not part of the iterative assessment process is therefore not included in the plan.

[38] Alpine Resorts Victoria, 2024. We're a $2.14 billion+ industry! Accessed at https://www.alpineresorts.vic.gov.au/about-arv/publications/alpine-resorts-economic-significance-study

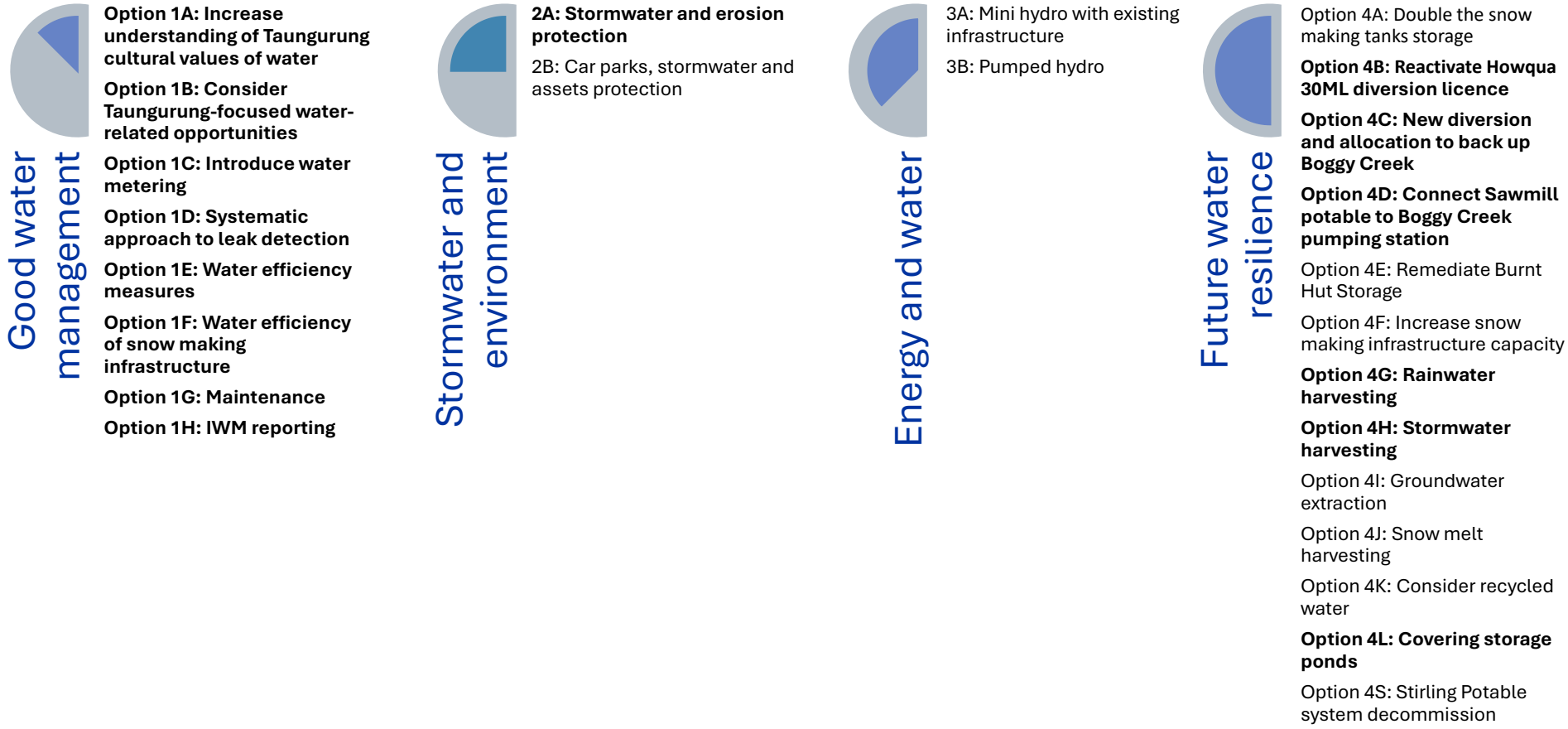


Figure 15. All IWM options for Buller and Stirling resorts

Options in **bold** were supported by stakeholders involved in the second workshop. Additional review and analysis was required for some options and is presented in section 6.2.

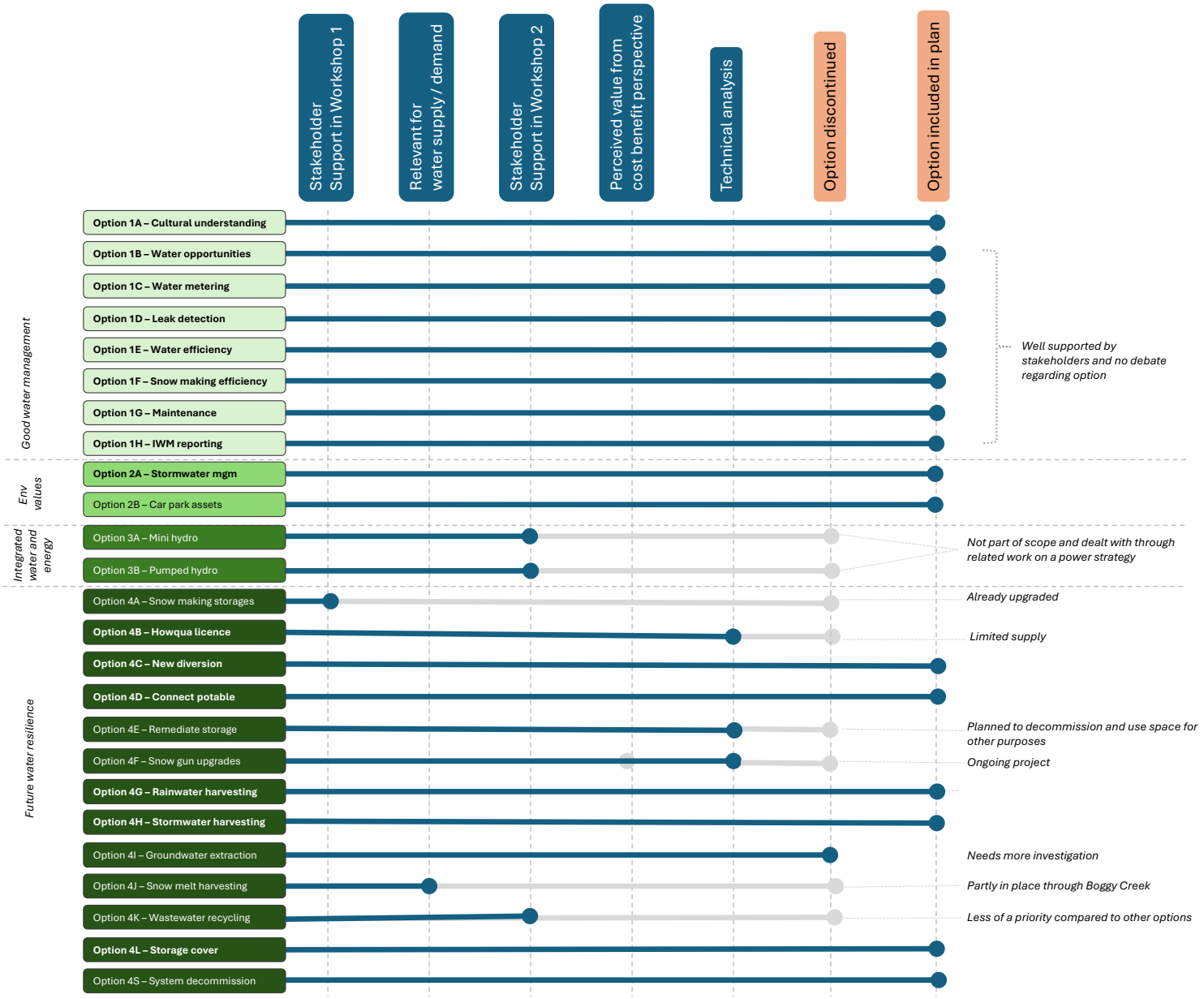


Figure 16. Refinement and prioritisation of IWM options with stakeholder feedback and analysis

6 Options Analysis

Water management options for Mt Buller have been modelled where possible to identify benefits, costs, uncertainties, and risks. Several recommended options were unable to be modelled due to lack of available data. Many of these options are still recommended and are discussed in Section 7.

6.1 Modelling method

To assess water options, the following method was used, and assumptions made:

- The resort uses 400 ML / year of water (205 ML / year of potable water for accommodation, buildings and operations, and 203 ML / year of non-potable water for the snowmaking).
- The resort has up to 17,000 people on the most visited day of the year.
- The resort creates snowmaking at the following locations:
    - Bourke Street
    - Baldy
    - Skyline
    - Magic Forest
    - Chamois
    - Northside Discovery Area
    - Burnt Hut
    - Koflers
    - Summit
    - Howqua
    - Howqua Extension
    - Family Run
    - The Chute
    - Little Buller Spur
    - Whiskey Creek Trail
    - Wombat
    - Shakey Knees
    - Access trails
    - Men's Downhill
    - Standard Run
    - Snowplay parks in the village and at Celia's (Horse Hill)
- Snowmaking covers an area of 56 hectares and uses between 100 ML and 350 ML of water (average of approximately 200 ML per year).
- Snowmaking requires 500 L of water to create 1 cubic metre of snow.
- Water is diverted from Boggy Creek into Boggy Creek Reservoir (total capacity of 100 ML), and then can be transferred by gravity to Sun Valley Reservoir
- Boggy Creek Weir 2 has an upstream area (largely alpine bog) of approximately 153 hectares. A flow monitoring station at Delatite River @ Sawmill Settlement (Station ID 405321), with a catchment area of 5,820 ha and 20+ years of recorded flows (15-minute interval), was used to estimate long term flows at Boggy Creek Weir 2.
- Modelled rainfall was based on daily rainfall records at Mt Buller. Mean annual rainfall for the period modelled was 1,574 mm / year.
- Hourly temperate, humidity, wind and wet bulb data for Mt Buller was used to model snowmaking conditions for snow guns and fan guns, using hourly data over up to 30 years. The BOM data set did not have wet bulb observations so a meteorological formula [39] based on temperature and humidity was used to calculate wet bulb temperature (see below).

[39] CalcTools, 2025. Wet bulb calculator. https://www.calctool.org/atmospheric-thermodynamics/wet-bulb

$$T_w = T \times \arctan[0.151977(RH\% + 8.313659)^{1/2}] + \arctan(T + RH\%) - \arctan(RH\% - 1.676331) + 0.00391838(RH\%)^{3/2}\arctan(0.023101RH\%) - 4.686035$$

where:

- T — Air temperature, in °C;
- $RH\%$ — relative humidity, expressed as a percentage; and
- T_w — Wetbulb temperature, in °C.

- Snowmaking (snow guns and fan guns) was modelled to occur every time the wet bulb temperature is less than '-2 degrees'.
- It is assumed that up to 150 cm of snow would be made if the weather were conducive, there was available water, and the volume of water did not exceed the pump capacity, in the peak of winter.
- Snow melt was modelled using a 'degree days' function, which varies with temperature (i.e. a higher Degree Days Factor for a higher temperature). The following function was used to determine the melting factor (and applied every time step): $y = 0.2415\ e^{.1004\,x}$ (where y = cm of snow melt, and x = temperature) (Muhammad Fraz Ismail, 2015).[40]

Figures relating the weather conditions are shown below, a key influence on visitation and snowmaking potential (snow guns and fan guns), and hence water storage and use.

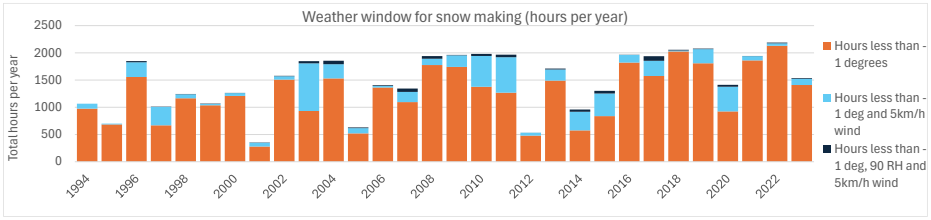


Figure 17. Hours of appropriate temperature, wind and humidity relevant to snow gun usage.

The trend of this weather data indicates a reduction in the ideal conditions for all parameters, but in practice it is far more complicated and site specific as to when and for how long the weather is conducive to snowmaking with snow guns and fan guns. Snowmaking using snow factories is much less weather dependant and is not included in this analysis.

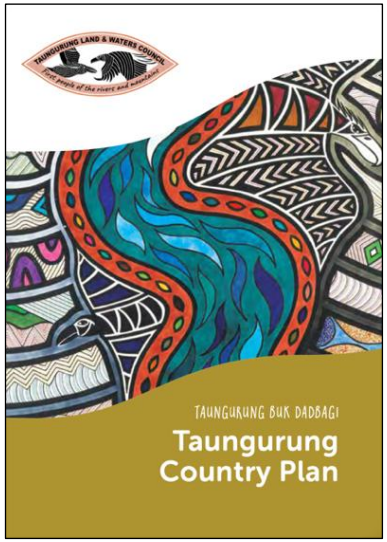
[40] Muhammad Fraz Ismail, H.-u.-R. W. (2015*). Degree day factor models for forecasting the snowmelt runoff for Naran watershed*. Science International Lahore, 1951-1959.

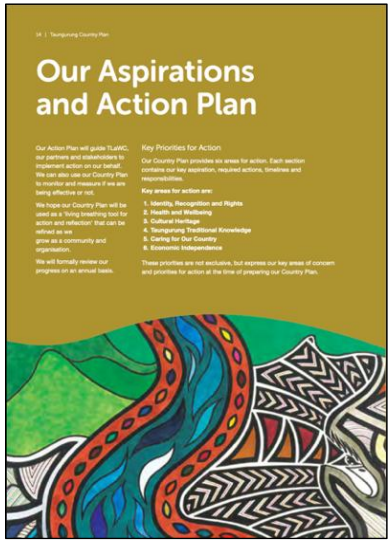
6.2 Options review

6.2.1 Option 1A: Building cultural awareness (increase understanding of Taungurung cultural values of water)

This option supports broader and deeper understanding of Taungurung cultural values of water in alpine landscapes, includes connections to Taungurung Country via the Delatite, Howqua, and Goulburn Rivers and to other First Peoples Country along the Goulburn and Murray Rivers. Initiatives should:

- focus on building the cultural awareness and competence of resort staff and visitors,
- align with ARV's Traditional Owner Self-Determination and Engagement Strategy (in-development), and
- be delivered in partnership with Taungurung Land and Waters Council – subject to Taungurung self-determined priorities and capacity.





Category: Good Water Management

Who benefits: ARV, resort visitors, Taungurung.

Costs: To be determined (dependent on the scope of specific initiatives and level of Taungurung involvement).

Alignment with IWM Outcomes and ARV Objectives:

Risks / Uncertainties:

- Taungurung involvement will be self-determined, informed by their priorities and capacity.

Summary:
Greater awareness of cultural values of water in alpine landscapes supports ARV obligations and aspirations to work in partnership with Traditional Custodians.

Stakeholder feedback
Broad support; GM Water noted other options may need to be reviewed as cultural understanding increases.

6.2.2 Option 1B: Supporting cultural land management (consider Taungurung-focused water-related opportunities)

This option relates to cultural land and water management opportunities within and connected to the resorts that support:

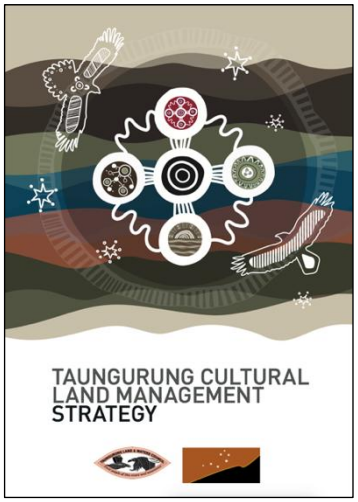
- implementation of the Taungurung Cultural Land Management Strategy (2023), and
- Taungurung and Victorian Government joint management of the Alpine National Park (as part of the Taungurung Recognition and Settlement Agreement 2018).

Opportunities may relate to Taungurung strategic goals of healing knowledge, healing country, managing country and governing with country. Specific initiatives should be identified and developed as part of an ongoing relationship with Taungurung and align with ARV's Traditional Owner Self-Determination and Engagement Strategy (in-development).

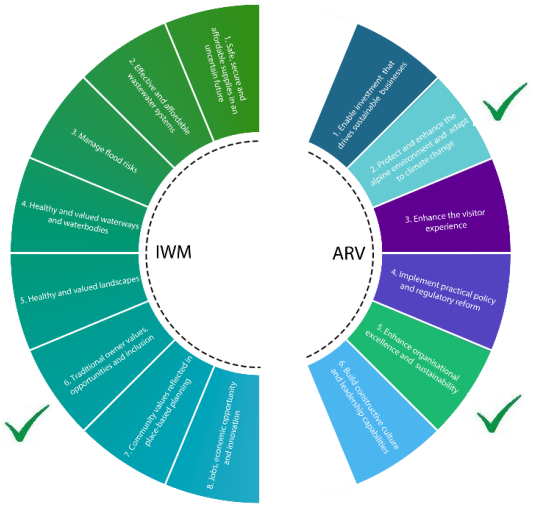
Category: Good Water Management

Who benefits: Taungurung, ARV, resort stakeholders.

Costs: To be determined (dependent on specific initiatives identified in consultation with Taungurung)



Alignment with IWM Outcomes and ARV Objectives:



Risks / Uncertainties:

- Taungurung involvement will be self-determined, informed by their priorities and capacity.
- Identification of specific initiatives was not possible at the time this plan was prepared.

Summary:

Working with Taungurung on cultural land management initiatives supports ARV obligations and aspirations to work in partnership with Traditional Custodians.

Stakeholder feedback

Broad support.

6.2.3 Option 1C to 1G: Good water management options

These options continue several basic water management actions necessary to ensure a robust, well maintained, and efficient water system. Water networks can lose between 3 and 15% of water through leaking and a lack of maintenance of pipes and valves[41], and there is an ongoing need to focus on water efficiency and water. While leaks in the potable system have previously been identified and reduced, more can be done. Ongoing maintenance and reporting is important to demonstrate the value of these actions as part of an integrated water management approach. In the summer of 2024/25, Buller Ski Lifts installed 5 isolation valves in the snowmaking network this summer to better manage water loss



Retrofitting water efficiency, monitoring, metering and leak detection can be difficult, but has the potential to offset or defer additional water supplies and/or infrastructure needs.

Risks / Uncertainties:

- Without a good metering and SCADA network it is difficult to gauge the scale of benefits (and costs) that a water efficiency and leak detection program would deliver.
- There is uncertainty as to the cost benefit of metering.

Summary:

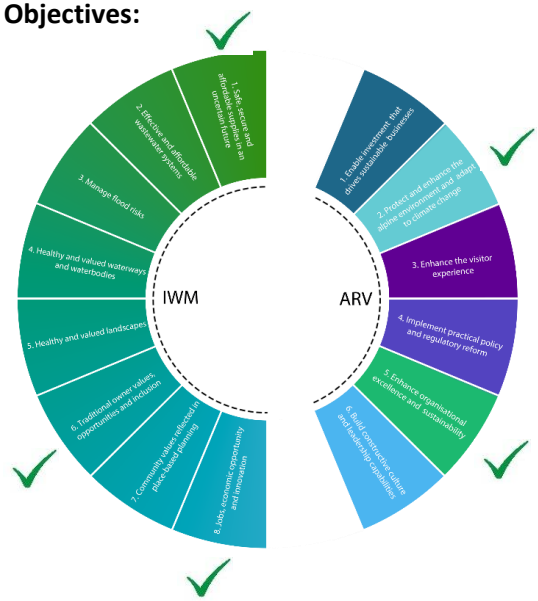
Ongoing works to ensure that good water management practices are in place are critical. Anecdotal reports suggests that there is a lot to be gained with a focus on leak management. Metering, leak detection, water efficiency works, maintenance and reporting are critical to the resort operation and should be delivered before any major water supply augmentations are considered.

Category: Good Water Management

Who benefits: ARV, Buller Ski Lifts and other resort stakeholders, Taungurung, Visitors

Costs: Dependent on scale of initiatives and return on investment.

Alignment with IWM Outcomes and ARV Objectives:



Stakeholder feedback

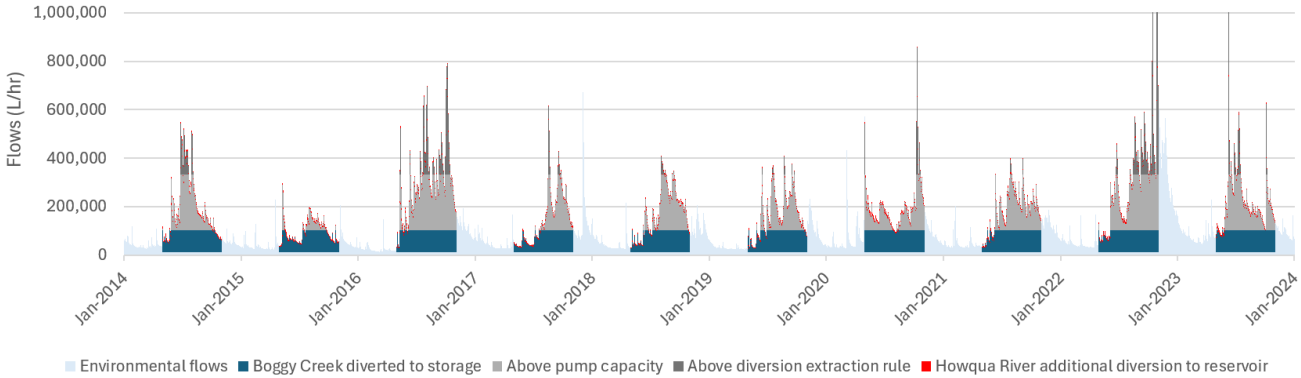
Broad support; BSL noted recent upgrades to monitor leaks; ARV noted lots to do to reduce leaking across the whole system.

[41] Bureau of Meteorology, 2024. Urban national performance report 2023-2024 raw dataset for small and medium sized utilities. Accessed at http://www.bom.gov.au/water/npr/index.shtml

6.2.4 Option 4B: New Infrastructure to operationalise Howqua River diversion licence

This option proposes the installation and operation of a diversion weir and pump station from the Howqua River. An existing licence (renewed in 2024) allows up to 30 ML per year (0.5 kl/day) of water to be extracted for industrial / commercial use between 1 July and 31 October. The short take period and daily extraction limit affects the ability of this option to supplement water supplies for early season snowmaking. The opportunity of revising the take period to 1 May – 31 October as for Boggy Creek should be explored if this option is pursued. Modelled flow as and water extraction under current licence conditions from Boggy Creek (8 ML/day limit) and Howqua River (0.5 ML/day limit) confirm that the contribution of the Howqua River diversion to overall water supplies is minor, adding less than 8 ML in early winter. By adding surface water extractions from a different catchment, this option may reduce potential environmental impact of surface water extractions in Boggy Creek.

Modelled impact of additional diversion from Howqua River to supplement Boggy Creek supply



Risks / Uncertainties:

- Quantity and quality uncertainty (how much water could be extracted at the right times, and additional treatment requirements)
- Accessibility and environmental impacts of weir and pipeline construction.

Summary:

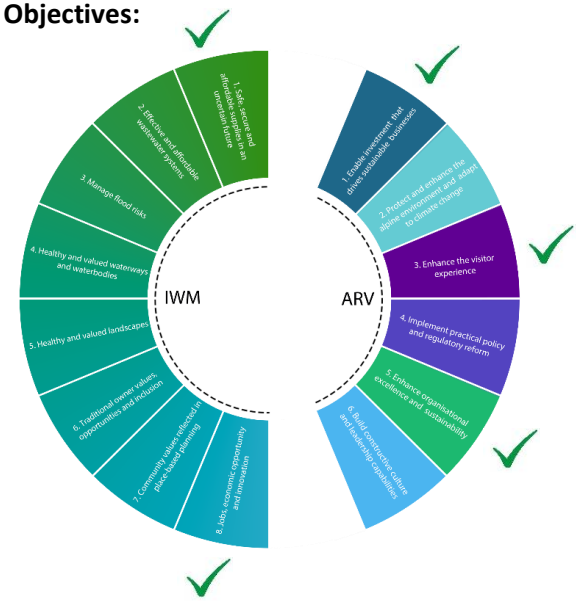
While an existing diversion licence is in place, there is limited value in using this licence to bolster supplies given the limitations of a winter fill take period.

Category: Future Water Resilience

Who benefits: ARV, Buller Ski Lifts and other resort stakeholders, visitors.

Costs: $300k to $500k for weir and pipe network. Possible additional costs for treatment.
Costs to engage with Taungurung on cultural considerations for this option.

Alignment with IWM Outcomes and ARV Objectives:

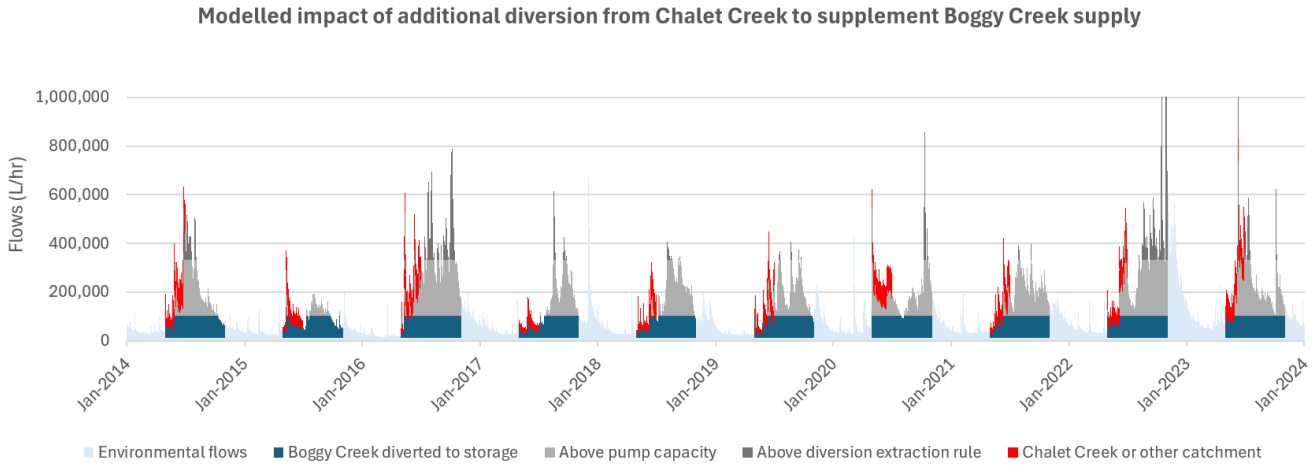


Stakeholder feedback

BSL supports use of this licence and provided revised cost estimate; DEECA noted environmental impact of wastewater discharge on Howqua River.

6.2.5 Option 4C: New diversion licence and infrastructure (Chalet Creek)

This option considers a new 1 May – 31 October diversion licence (subject to regulatory approval) in a local catchment to supplement Boggy Creek water extractions and support early season snowmaking. Challet Creek within the Mt Buller resort boundary is a possible location. With construction of a weir and pump station, modelling indicates this option could potentially supply 40 ML in May – June.
A Chalet Creek diversion was investigated in 1993 and 1997, with an estimated yield of 0.4-1.7 /ML per day depending on the season.[42] Buller Creek may be an alternate water diversion location, noting there is an existing diversion licence for Buller Creek at Mirimbah (3 ML / year) to supply Mirimbah demands.



Risks / Uncertainties:

- Ability to secure a diversion licence for industrial / commercial use.
- Impacts on cultural and ecological values (further investigation required)
- Modelling assumes hydrology (and potential yield) is similar to the Boggy Creek catchment. This would need to be confirmed.

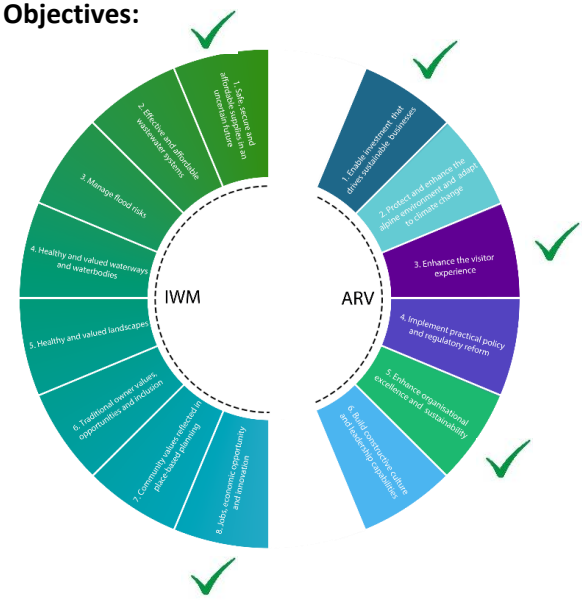
Summary:
This option could improve water resilience if identified considerations can be suitably addressed. Primary considerations include obtaining a water extraction licence and potential impacts on cultural and ecological values. Climatic conditions and take period constraints that apply to Boggy Creek also apply to this option.

Category: Future Water Resilience

Who benefits: ARV, Buller Ski Lifts and other resort stakeholders, visitors.

Costs: Indicative costs (approvals, design, construction): $1M+.
Consider allocating $50-100k for business case and concept design.

Alignment with IWM Outcomes and ARV Objectives:



Stakeholder feedback
GM Water noted the vulnerability of all surface water extractions in a changing climate, particularly those without extensive alpine bogs in the upper catchment to store and slowly release water.

[42] GMR (1997) Mt Buller Alpine Resort Water Supply Options (memo).

6.2.6 Option 4D: Connect Sawmill Settlement water network to Boggy Creek Weir 2

This option proposes construction of a 7km distribution pipeline and pumping stations (with a vertical life of 740 metres) to connect Boggy Creek Weir 2 to the Sawmill Settlement water treatment plant. Pumping raw water (rather than treated water) is preferred but would require a new/additional bulk water allocation.

This option would provide access to reliable early season water (February to May) when surface water extractions may be limited. Existing infrastructure would be used to deliver water from Boggy Creek Weir 2 to Burn Hut and Boggy Creek Reservoirs. Variable pumping could be deployed to take advantage of negative spot prices on the energy market.

Risks / Uncertainties:

- Impacts of pipeline construction on cultural and ecological values (and associated regulatory approvals)
- Obtaining a new/additional bulk water allocation at Sawmill Settlement (to supply raw water) or trading another licence needs careful consideration
- Community acceptance within the upper Delatite River catchment
- Pump station infrastructure upgrade requirements

Summary:
A relatively high cost / high reliability option to increases water supply by up to 90 ML / year, with more reliable access to early season water (February – May). Consider initiating engagement with GVW and undertaking a feasibility assessment to quantify benefits and costs.

Stakeholder feedback
BSL support this option given the potential to supply less climate-sensitive water, particularly for early season snowmaking; GM Water anticipate the cost-benefit will be unfavourable, and suggest the option be based on raw water rather than potable.

Category: Future Water Resilience

Who benefits: ARV, Buller Ski Lifts and other resort stakeholders, visitors.

Costs: Further investigation/feasibility assessment required to estimate costs (subsurface boring for the pipeline could cost $7M+ due to geology and access). Consider allocating $50-100k for an initial business case and concept design.

Alignment with IWM Outcomes and ARV Objectives:

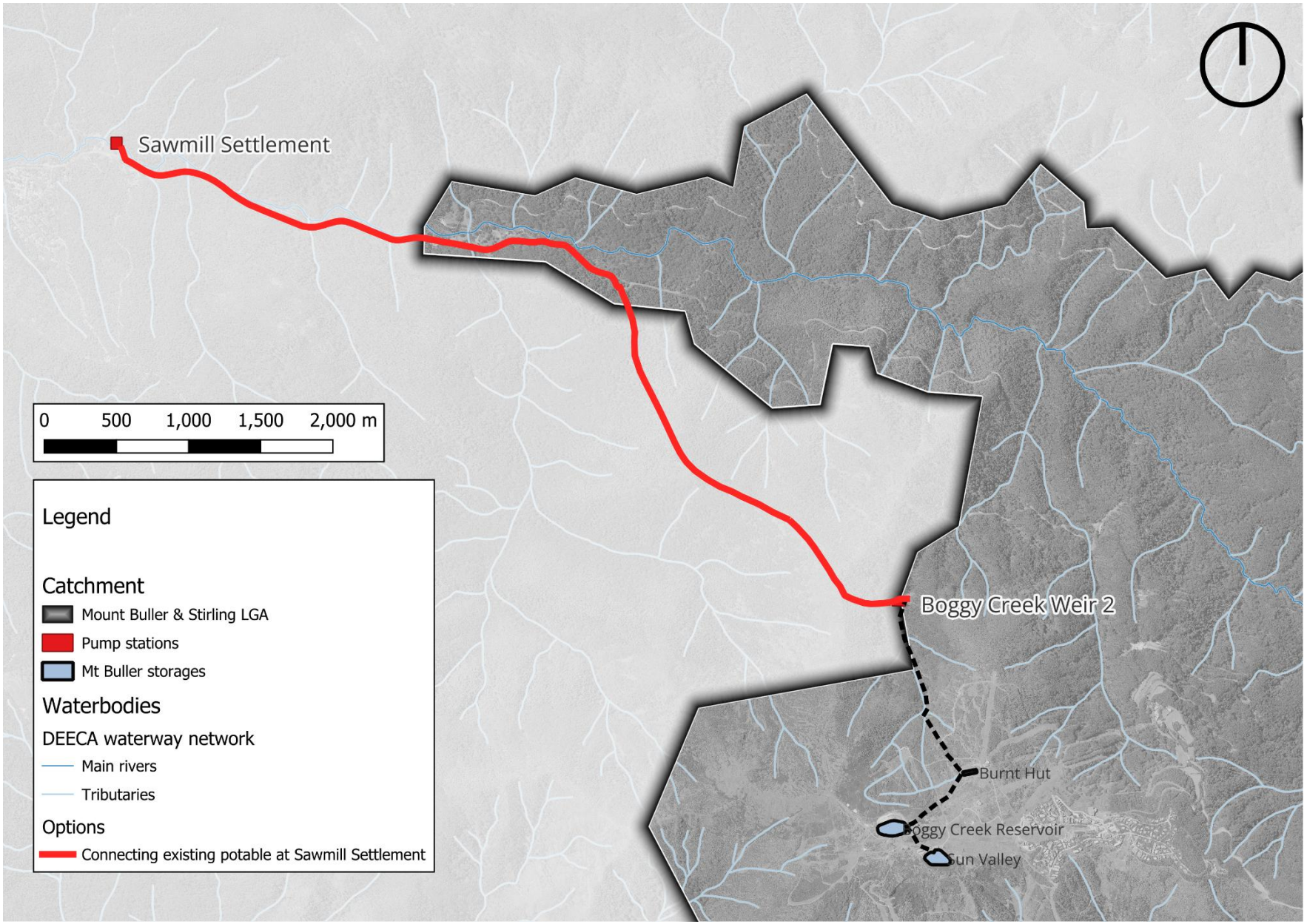
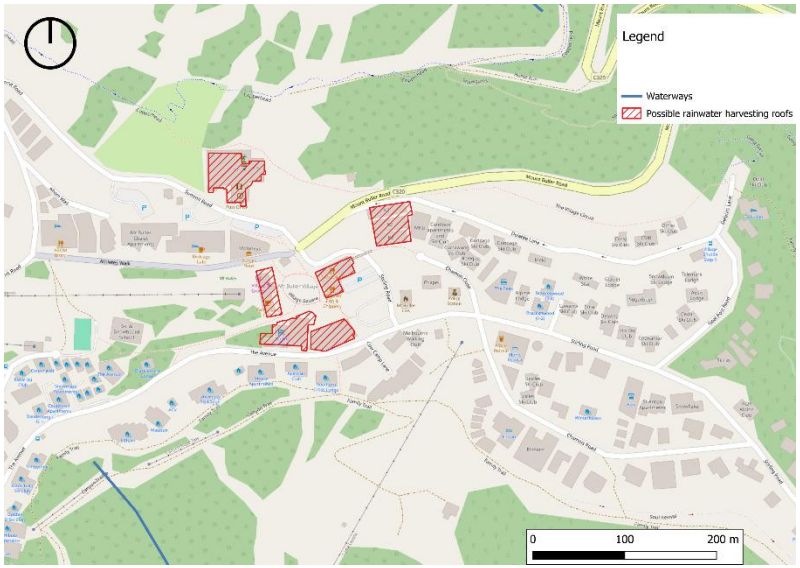
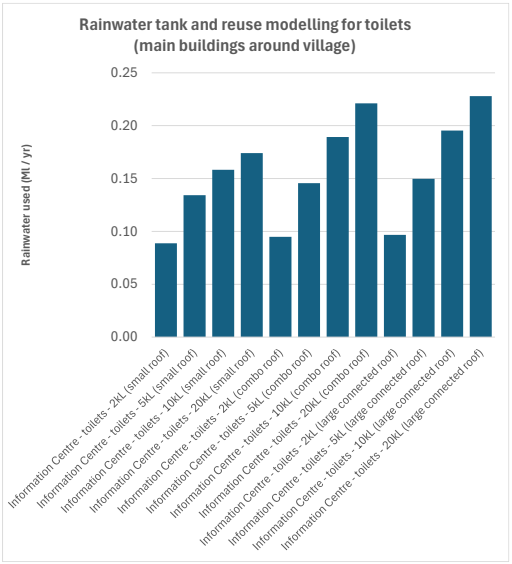


Figure 18. *Option 4D: Connect Sawmill Settlement water network to Boggy Creek Weir 2.*

6.2.7 Option 4G: Rainwater harvesting

This option includes various configurations of rainwater harvesting from one or multiple buildings to supply toilet flushing (with potable backup). Buildings would be retrofitted with gutters suitable to cope with rainwater and snowpack on roofs, and discrete units to supply toilets at one building or multiple buildings could be set up. Modelling over a ten-year period, accounting for initial loss and snow pack on roofs, indicates this option could supply 150 kL per year for a dwelling (60% reliability). If located at high visitation sites and toilet blocks, this option could reduce potable water use and decreases stormwater runoff and erosion risks.





Risks / Uncertainties:

- Designing, constructing and maintaining systems appropriate for alpine conditions
- Ability to scale-up the systems to substantially reduce potable water use.
- Funding and cost recovery
- Regulatory and administrative considerations (who owns and maintains systems)

Summary:

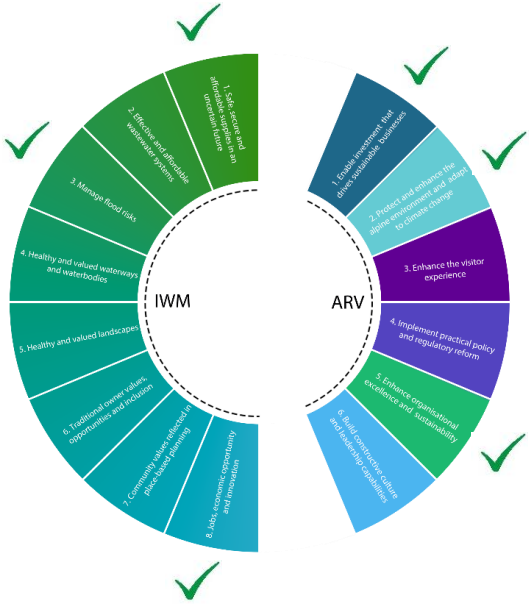
Rainwater harvesting is effective for reducing potable water use at the individual building level but has limited impact on overall water supply and demand when implemented at one or two buildings. Modelling indicates that widespread adoption could reduce potable water demand from Boggy Creek Reservoir by up to 25%.

Category: Future Water Resilience

Who benefits: ARV, resort visitors.

Costs: $50k per installation (depending on tank size, guttering solution, location and insulation).

Alignment with IWM Outcomes and ARV Objectives:



Stakeholder feedback

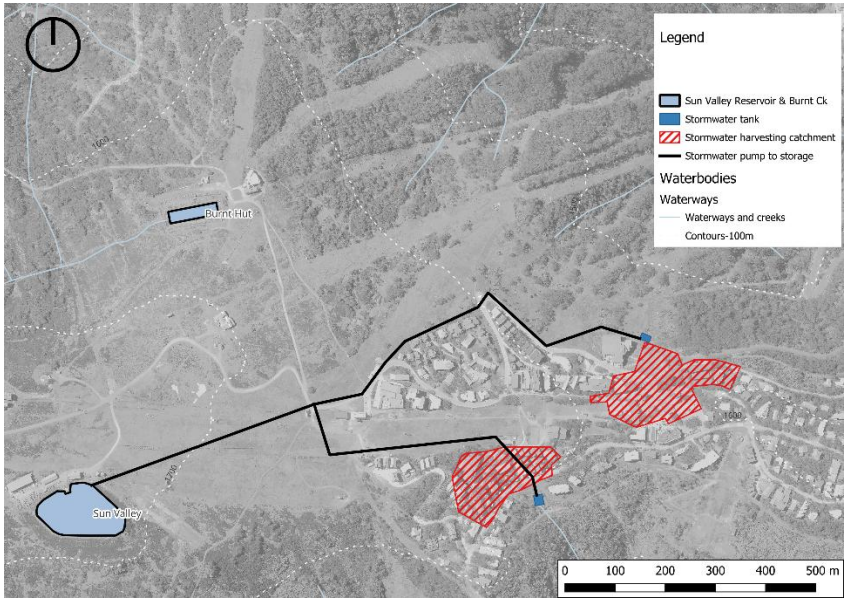
No specific feedback on this option from any stakeholders.

6.2.8 Option 4H: Stormwater harvesting for snowmaking

This option considers the introduction of a stormwater filtering and harvesting system at up to two locations to supplement snowmaking supply:

- Directly downstream of the admin building, with a catchment of 2.5 hectares.
- Head waters of Cow Camp Creek (below The Avenue), with a catchment of 2 hectares.

Stormwater harvesting requires construction of a treatment train and pump system from the identified stormwater outlet(s) to Sunny Valley Reservoir, where any harvested water collected throughout the year could top up the reservoir. Modelling over a 10-year period suggests that the two identified stormwater harvesting catchments could supply between 22 and 46 ML / year of stormwater. If only used in November to April, it would yield between 5 and 12 ML /yr. An all year round approach would provide more resilience.



Risks / Uncertainties:

- Several risks are relevant for this option, including complexity of infrastructure, distributed nature of drains and tanks, and overall water quality and treatment required.
- Locating storage tanks and maintaining filters to ensure good quality water is available for snowmaking is difficult.
- Pumping between 100 and 150 metres elevation from capture to reuse location.
- Possible need for extraction licence

Category: Future Water Resilience

Who benefits: ARV, Buller Ski Lifts, resort visitors.

Costs: Costs would be significant and would include maintenance costs and filtering costs. Consider allocation of $50k to 100k for business case and design.

Alignment with IWM Outcomes and ARV Objectives:

Stakeholder feedback

No specific feedback on this option from any stakeholders.

Summary:

An in-depth feasibility study is required to further assess this option and explore if more catchments could be harvested, as well as better understand the water quality from stormwater runoff.

6.2.9 Option 4L: Water storage cover

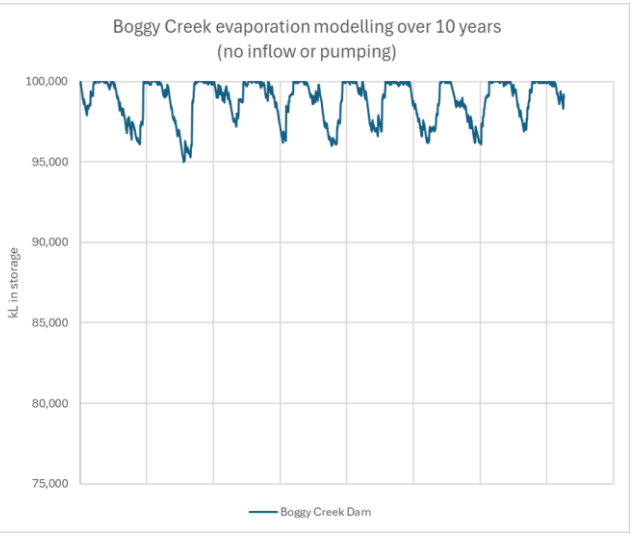
This option involves covering the surface of the storage ponds (both Boggy Creek Reservoir and Sun Valley Reservoir) to reduce evaporation.

It is recommended to first commence a field trial to monitor evaporation rates (or similar water temperature).

Category: Future Water Resilience

Who benefits: ARV, Buller Ski Lifts, resort visitors.

Costs: $500k + for cover and operational system to remove the cover in particular seasons.



Risks / Uncertainties:

- Maintaining integrity of the cover is risky.
- Potential impact on water quality through reduced UV and leaching of cover material into water.
- Maintenance of the cover is difficult and would need to be removed over winter.
- Costs are variable depending on the method and size

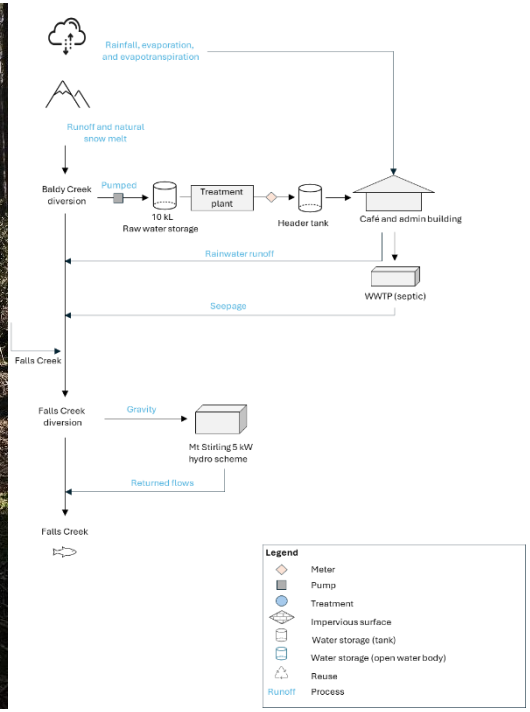
Summary:
8 to 10 ML of water saved from Boggy Creek Reservoir if all evaporation is reduced, and 3 to 4 ML / year of water saved from Sun Valley Reservoir with a new cover to reduce evaporation.

Alignment with IWM Outcomes and ARV Objectives:

Stakeholder feedback
No specific feedback on this option from any stakeholders other than ARV noting risk of increased costs.

6.2.10 Option 4S: Mt Stirling potable water arrangements

This option considers decommissioning the potable water infrastructure at Mt Stirling to avoid ongoing management, costs, and risks of this system. Under this option visitors would be required to bring in bottled water. There are a range of visitor, regulatory, and commercial considerations that should be included in this assessment.



Risks / Uncertainties:
This option decreases organisational risks but potentially increases public health risks.

Summary:
This option responds to operational and risk management issues.

Category: Future Water Resilience

Who benefits: ARV

Costs: $25k to $50k for investigation and risk assessment.

Alignment with IWM Outcomes and ARV Objectives:

Stakeholder feedback
ARV noted they had already looked into this option and believe that there is more complexity to this than original thought, so needs a thorough investigation before any commitments are made.

7 Recommendations

Through the engagement process and modelling of water issues and options, it has emerged that a suite of options are worthy of pursuing, though some require additional studies and investigations to ensure there is a sound business case for investment, by ARV or associated stakeholders. Note that options presented below but not shown in Section 5.2 were unable to be modelled due to lack of available data.

7.1 Recommended

These options are recommended as they will collectively meet the ARV and IWM objectives and align with the vision of an integrated water management approach at Mt Buller and Mt Stirling.

These are listed below in no particular order, other than the stakeholders were broadly in agreement that activities and options in the 'Good Water Management' were a good basis to start with.

Good Water Management

- **#1. Building cultural understanding and two-way knowledge sharing** [Option 1A & 1B]
  It is recommended that ARV, together with Mt Buller and Mt Stirling stakeholders, build cultural awareness (increased understanding of Taungurung cultural values of water in alpine environments) and identify opportunities to support Taungurung cultural land management initiatives within and connected to the resort.
- **#2. Water metering** [Option 1C]
  Scope and install real time metering for all major buildings and sites to improve the accountability of all water users and all end uses of water. For Mt Buller, this specifically refers to the metering of potable water consumed in all accommodation, restaurants, and administration and workshop buildings.
- **#3. Systematic leak detection** [Option 1D]
  Introduce a metering and alert system for leak detection and reporting, for snowmaking a potable water consumption, to improve the ability to identify leaks and reduce the associated water loss.
- **#4. Water efficiency** [Option 1E]
  It is recommended that all appliances within buildings be reviewed for their water efficiency, and upgrades progressively made. This might include placing timers on all taps and upgrading all showers and toilets to be at or near the maximum WELS rating.
- **#5. Snowmaking water efficiency** [Option 1F]
  It is recommended to continue to implement water efficiency measures to reduce water consumption in snowmaking systems.
- **#6. Maintenance** [Option 1G]
  Continued maintenance of all core infrastructure is recommended, such as inspection and maintenance of all tanks, pipes, drainage lines and potential blockages, algal build up. This is already happening but must continue to ensure existing infrastructure is actively maintained.
- **#7. IWM Reporting** [Option 1H]
  It is recommended to report on potable water consumption (both total and per visitor days), snowmaking water consumption, wastewater discharged, stormwater discharges, and rainwater estimates, each year. This is important to actively raise the profile of water as a finite resource in the alpine environment.

Environmental Management

- **#8. Stormwater management** [Option 2A]
  Design and build a car park stormwater retention/filtering trial (whole area or ~1,000 m^2) to reduce the stormwater volume and associated pollutants entering Chalet Creek (to the north) and Cow Camp Creek (to the south). This trial should be monitored and assessed to inform future stormwater-related environmental initiatives and could support two-way knowledge sharing partnerships with Traditional Owners. Simple

erosion control and sediment / litter management techniques (such as the placement of old logs or coir logs, plantings, rock protection or other WSUD options) could be trialled on the edge of the car parks to reduce the impact of runoff and pollution of local streams and waterways, in specific catchments where this was identified as a risk. This is also important to reduce the risk of asphalt breaking up and migrating into waterways.

Future Water Resilience

All options that explore a variety of new water sources need to consider the TO and environmental values in this process.

- **#9. New diversion (Chalet Creek)** [Option 4C]
  It is recommended to explore a business case for a stream diversion licence from Chalet Creek or downstream near Mirimbah Store, as well as associated pumping, to increase the reliability of available water (and snowmaking capacity) and connect that diversion to the Boggy Creek Weir 2 pumping station.
- **#10. Connect potable** [Option 4D]
  It is recommended to further explore a business case for connecting the potable mains system at Sawmill Settlement to the Boggy Creek Weir 2 pumping station to increase the reliability of available water (and increase snowmaking capacity) and connect that diversion to the Boggy Creek Weir 2 pumping station.
- **#11. Rainwater harvesting** [Option 4G]
  It is recommended to retrofit buildings with significant roof areas (or whole blocks of buildings) to create a rainwater harvesting system for reuse within the buildings for flushing toilets (and occasional irrigation) to support a reduction in potable water consumption. This could be done in centralised manner to reduce the number of rainwater filter and pumps.
- **#12. Stormwater harvesting** [Option 4H]
  It is recommended to further explore a business case for harvesting stormwater from the main drain that discharges near the admin building, with filtering of pollutants, to create an alternative water supply for snowmaking. A business case for progressing this option is needed given filtering, storing, and distributing treated stormwater will be difficult and no clear end use and seasonal demand yet identified.
- **#13. Storage cover** [Option 4L]
  It is recommended to further explore the need to cover storage ponds to reduce evaporation. The first step would be to conduct a field trial to monitor evaporation rates and investigate the costs and benefits of this specific option.
- **#14. System decommission [Option 4S (Mt Stirling)]**
  This is the only recommendation for Mt Stirling. It is recommended to explore the option of decommissioning the potable water source and reduce testing and reporting requirements for this system and understand the costs and benefits of this option. Visitors would instead be required to bring in bottled water.

7.2 Not recommended

Option 4B (Howqua licence) is not recommended as there is too much uncertainty as to cost and available volume of water. Any water allocation would not be available until 1st May each year.

Option 4A (increase storage capacity) was not considered as storage capacity has recently been increased. Analysis shows the timing of supply was a bigger issue than total storage size.

8 Action plan

The delivery of this plan is contingent on available resources and grant funding to support ARV to upgrade the resort and create an integrated water management demonstration site.

The following table lays out the broad set of tasks and staging of projects that is recommended to meet the IWM and ARV objectives of the site.

Table 4. Action plan and staging of projects

Timing	Name / Option	Task(s)	Link to objectives	Theme	Indicative cost	Lead	Water savings (ML / year)
Immediate	Option 1A – cultural understanding	• Continue engaging with Taungurung to broaden and deepen understanding of cultural values of water in alpine landscapes. • Continue building cultural awareness and competence of resort staff and visitors.	Cultural and community values	Good water management	TBC	ARV	NA
Immediate	Option 1B – cultural land management	• Identify, through an ongoing relationship with Taungurung, opportunities to support cultural land and water management initiatives within and connected to the resort.	Cultural and community values	Good water management	TBC	ARV	NA
Short term (1 to 3 years)	Option 1C - metering	• Add at a network of sub meters to better understand usage, and leaking, across the whole resort. An investigation into the metering of every dwelling should completed, alongside a discussion regarding utility bills and the link with water savings.	Water efficiency and sustainable asset management	Good water management	$500 to $1,000 per meter installed, rolled out after review of business case.	ARV	NA

Timing	Name / Option	Task(s)	Link to objectives	Theme	Indicative cost	Lead	Water savings (ML / year)
Short term (1 to 3 years)	Option 1D, 1E & 1F – water efficiency and leaks	• Efficiency and leak detection. Ongoing work to continue to monitor for and systematically review network to identify leaks (from the potable supply network and snowmaking network) and opportunities to improve the WELS rating of all appliances. • Consider creating guidelines for all accommodation dwellings to maximise water efficiency over a 3-year period.	Water efficiency and sustainable asset management	Good water management	$10,000 for investigation	ARV, Buller Ski Lifts	Leaks typically account for 5% to 15% of usage.
Short term (1 to 3 years)	Option 1G - maintenance	• Ongoing maintenance of all water infrastructure assets and treatment plants is essential to reduce risk of water leaks, reduce risk of health impacts, and maintain appropriate water quality for all end uses.	Water efficiency and sustainable asset management	Good water management	Ongoing opex	ARV	~ 10-20ML per year based on typical water network leak rates.
Short term (1 to 3 years)	Option 1H – IWM reporting	• Annual reporting on all water issues (stormwater, rainwater, wastewater, environmental flows, potable water, snowmaking, water efficiency and leak detection.	Water efficiency and sustainable asset management	Good water management	Ongoing opex	ARV	NA

Timing	Name / Option	Task(s)	Link to objectives	Theme	Indicative cost	Lead	Water savings (ML / year)
Short term (1 to 3 years)	Option 2A – Erosion protection	• Identify specific areas (within the identified erosion risk catchments -see "Appendix F. Stormwater modelling") where the placement of old logs or coir logs would be useful to retain sediment and leaf litter and reduce erosion risk. Locations must be below the edge of the asphalt, to ensure winter machinery is not impacted when clearing snow from the car park. • Monitor effectiveness of these stormwater interventions.	Environmental management and sustainable asset management	Environmental management	$10,000 for trial	Goulburn Broken CMA, ARV	NA
Short term (1 to 3 years)	Option 4C – new diversion	• Investigate the concept and business case for securing an additional diversion licence to supplement Boggy Creek Reservoir diversion	Safe, secure, affordable water supplies	Future water resilience	$50k to 100k for business case and design	ARV	40 ML / year
Short term (1 to 3 years)	Option 4D – connect potable to pumping station	• Investigate the concept and business case for extending the existing GV potable water network at Sawmill Settlement to the Boggy Creek Weir 2 system.	Safe, secure, affordable water supplies	Future water resilience	$50k to 100k for business case and design	ARV	90 ML to 120 ML / year
Short term (1 to 3 years)	Option 4H – Stormwater harvesting	• Investigate the concept and business case for stormwater harvesting, at two or more locations, to harvest water and reuse for snowmaking.	Safe, secure, affordable water supplies AND Healthy and valued waterways	Future water resilience	$50k to 100k for business case and design	ARV and Buller Ski Lifts	22 ML to 46 ML / year
Short term (1 to 3 years)	Option 4G – Remote rainwater harvesting	• Investigate the concept and business case for delivery of a few rainwater tank storages near high usage areas for the replacement of potable water for toilet flushing.	Safe, secure, affordable water supplies	Future water resilience	$25,000	ARV	0.1 ML / year

Timing	Name / Option	Task(s)	Link to objectives	Theme	Indicative cost	Lead	Water savings (ML / year)
Medium term (4 to 9 years)	Option 4L – water storage	• Conduct a trial to measure the scale of evaporation losses from the surface of the storage ponds. • Investigate the concept and business case for covering the surface of the storage ponds (Boggy Creek Reservoir and Sun Valley Reservoir) to reduce evaporation losses.	Safe, secure, affordable water supplies	Future water resilience	$500,000 or more, to include the cover and mechanism to remove in particular seasonal periods	ARV	8 - 10ML / year from Boggy Creek Reservoir 3 – 4 ML / year from Sun Valley Reservoir
Short term (1 to 3 years)	Option 4S – Regulated supply at Mt Stirling	• Investigate the costs and benefits of scaling back water system from potable to raw water regulated system at Mt Stirling.	Safe, secure, affordable water supplies	Future water resilience	$25,000 to $50,000 for investigation and regulatory review	ARV	NA
Long term (10+ years)	-	• Revisit the option for wastewater recycling, and groundwater bores to create alternative supplies for potable and snowmaking demands.	Safe, secure, affordable water supplies	Future water resilience	NA	NA	NA

9 References

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Appendix A. Workshop 1 summary report

Appendix B. Workshop 2 summary report

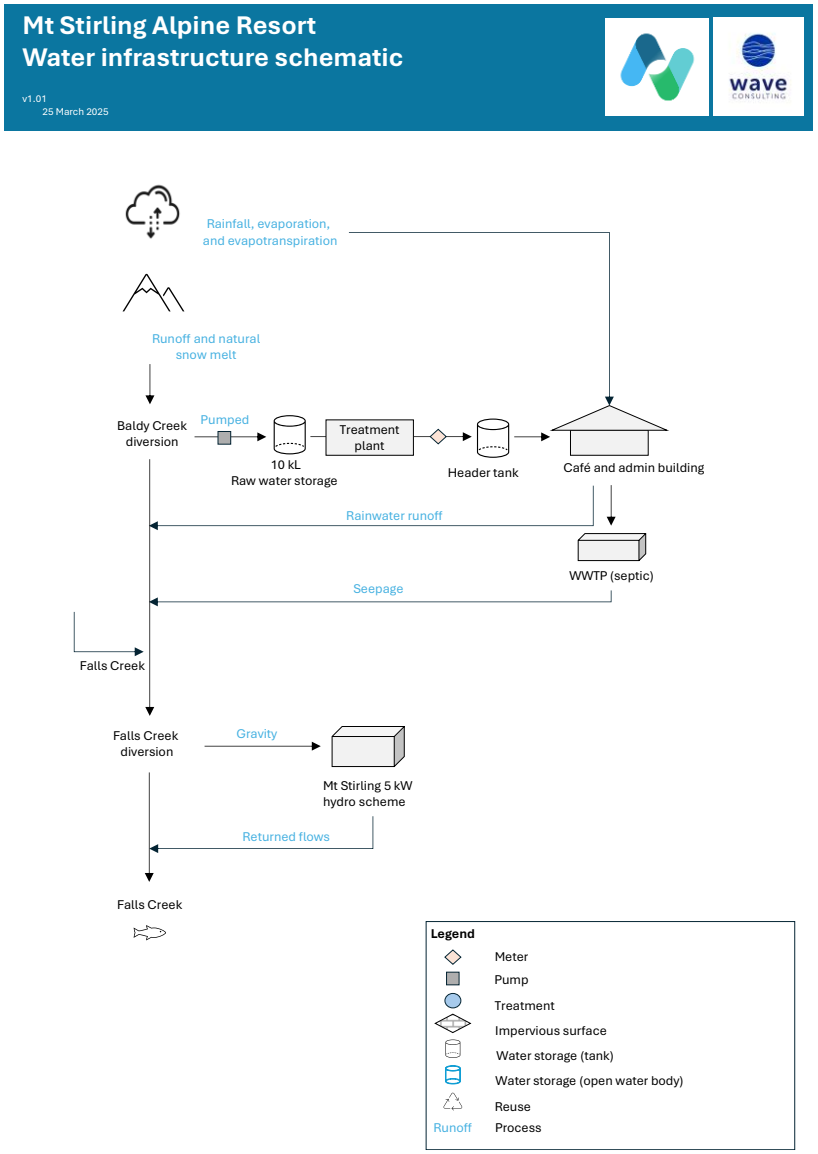
Appendix C. Available data

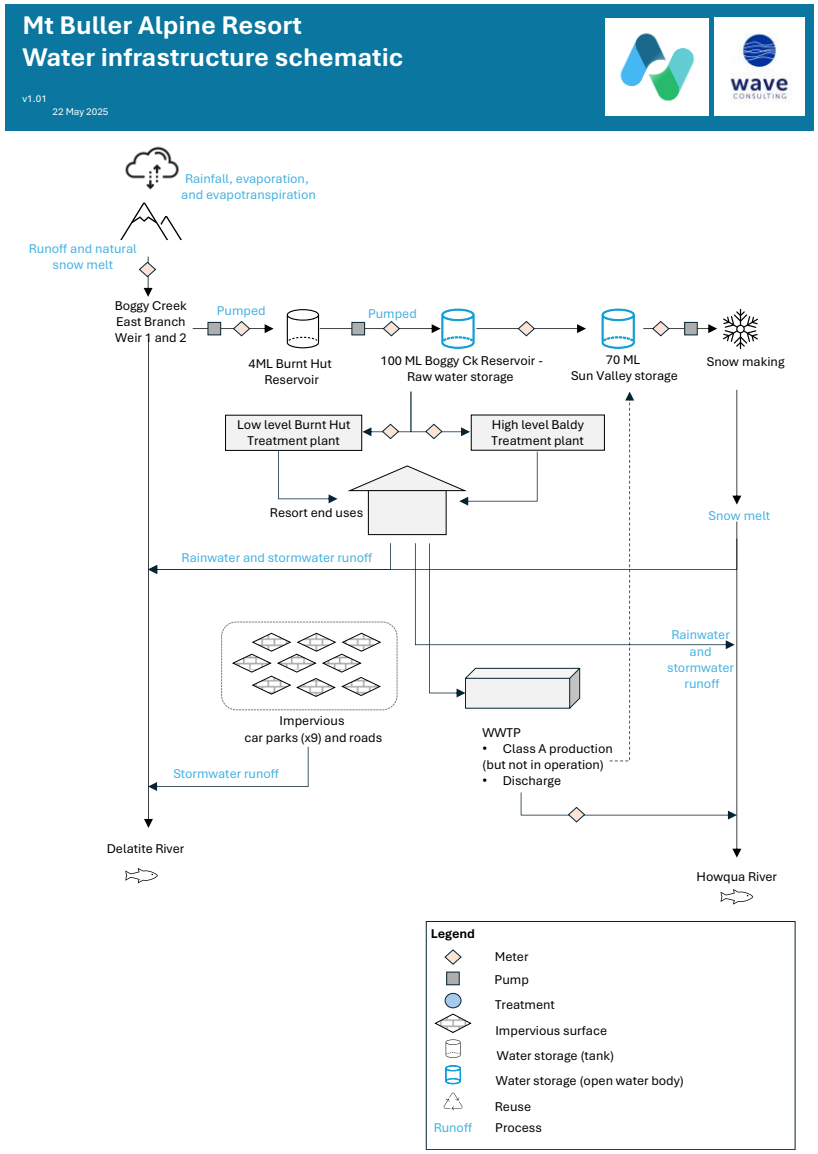
Data for this project came from a variety of sources. These are listed below, with reference to the time period that the data covers.

Table 5. Data sources and records

Variable	Source	Start	End
Snow (natural)	Mt Buller 79_23_DailySnowDepths_240606	1979	2024
Snow (making)	Mt Buller_SnowDepths_2015_2023	2015	2024
	SM Consumption 04_13_ProjectedPlus	2004	2013
Potable consumption	Water & Wastewater data 2024.xls	2023	2024
Recycled water	NA		
WWTP discharge	Water & Wastewater data 2024.xls	2022	2024
Rainfall	Mount Buller - 83024	1904	2024
River levels	DELATITE R SAWMILL	1973	2024
Temperature (min and max)	BOM – Mt Buller AWS - 083024	1994	2024
Temperature (hourly)	BOM – Mt Buller AWS - 083024	1994	2024
Humidity (hourly)	BOM – Mt Buller AWS - 083024	1994	2024
Wind (hourly)	BOM – Mt Buller AWS - 083024	1994	2024
Visitor days - winter	ARCC_Annual_Winter_VisitorDays_ Historical_Records_from_1985.csv	1985	2024
Visitor days - summer	ARCC-Summer-18.19-vis-nos-and-vehicle-countB.csv	2007	2024
Assets - tanks etc	ARV geospatial data	-	-
Assets - stormwater	ARV geospatial data	-	-
Assets - impervious	ARV geospatial data	-	-

Appendix D. Water schematic





Appendix E. Traditional Owner summary

Appendix F. Stormwater modelling

9.1.1 Review of assets and subcatchments

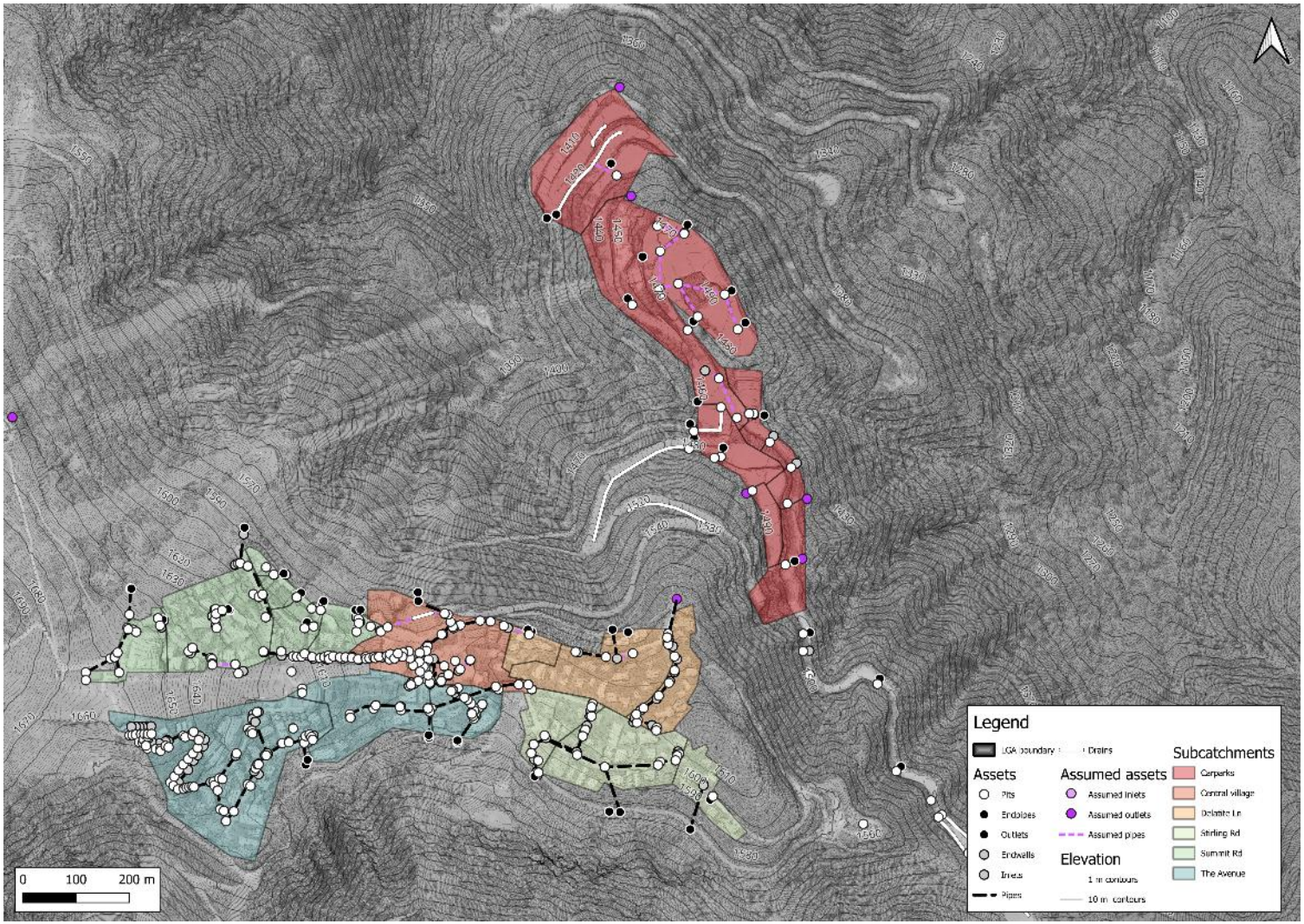


Figure 19. Mt Buller stormwater assets.

Figure 19 shows the way catchments have been grouped and set up, based on geospatial stormwater infrastructure data and the 1 metre contour dataset, as well as the extensive network of stormwater infrastructure that is evenly distributed on the north and south side of the resort. There is a large number of pits that collect runoff and snow melt on the north side of the Bourke St Express.

9.1.2 Review of stormwater capacity and pipe network

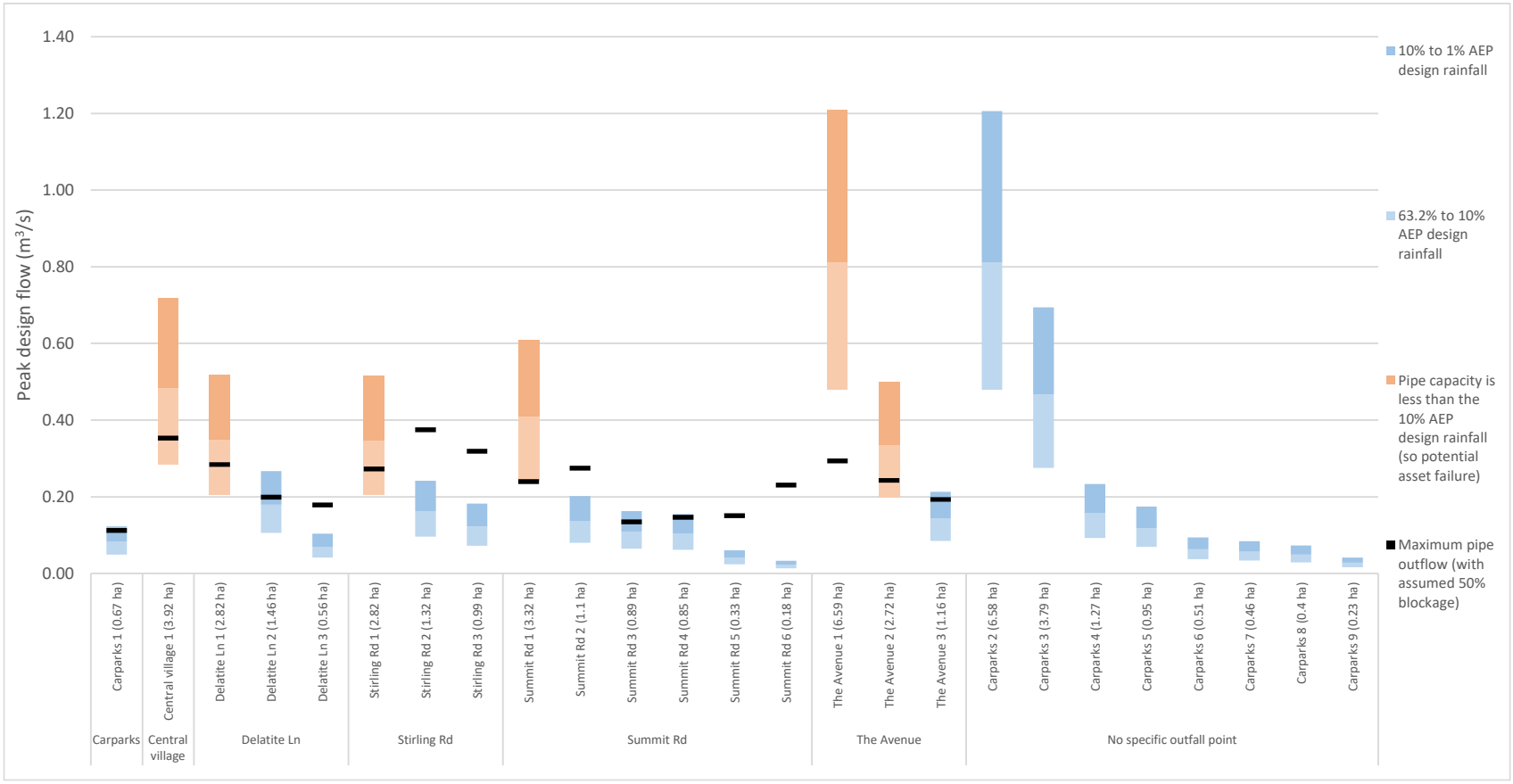


Figure 20. Stormwater capacity issues highlighted across Mt Buller resort.

Figure 20 is a presentation of all the modelling of peak flows across all stormwater subcatchments. The orange colours are the ones of interest as they indicate that these pipes are not able to cope with the 10% AEP storm and should be investigated for potential infrastructure upgrades.

9.1.3 Review of stormwater capacity and pipe network with climate change

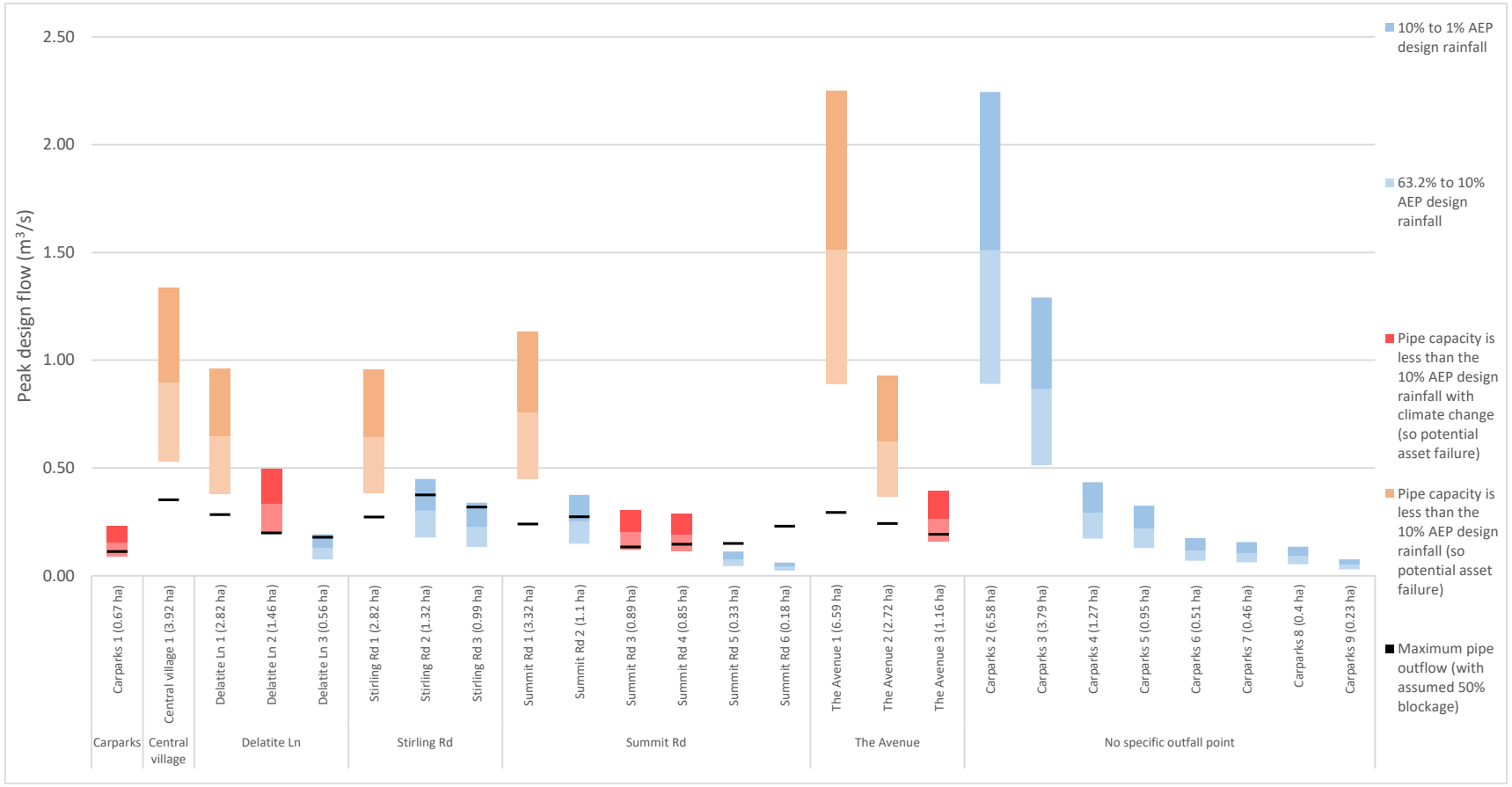


Figure 21. Stormwater capacity issues highlighted across Mt Buller resort with the projected impact of climate change.

When climate change is considered and the potential to have more intense storms (but less rainfall overall), we find that there are five more catchments and outlet pipes that may not cope with a 10% AEP storm, and should also be considered for upgrades, noting that these forecasts relate to 2100 climate change forecasts.

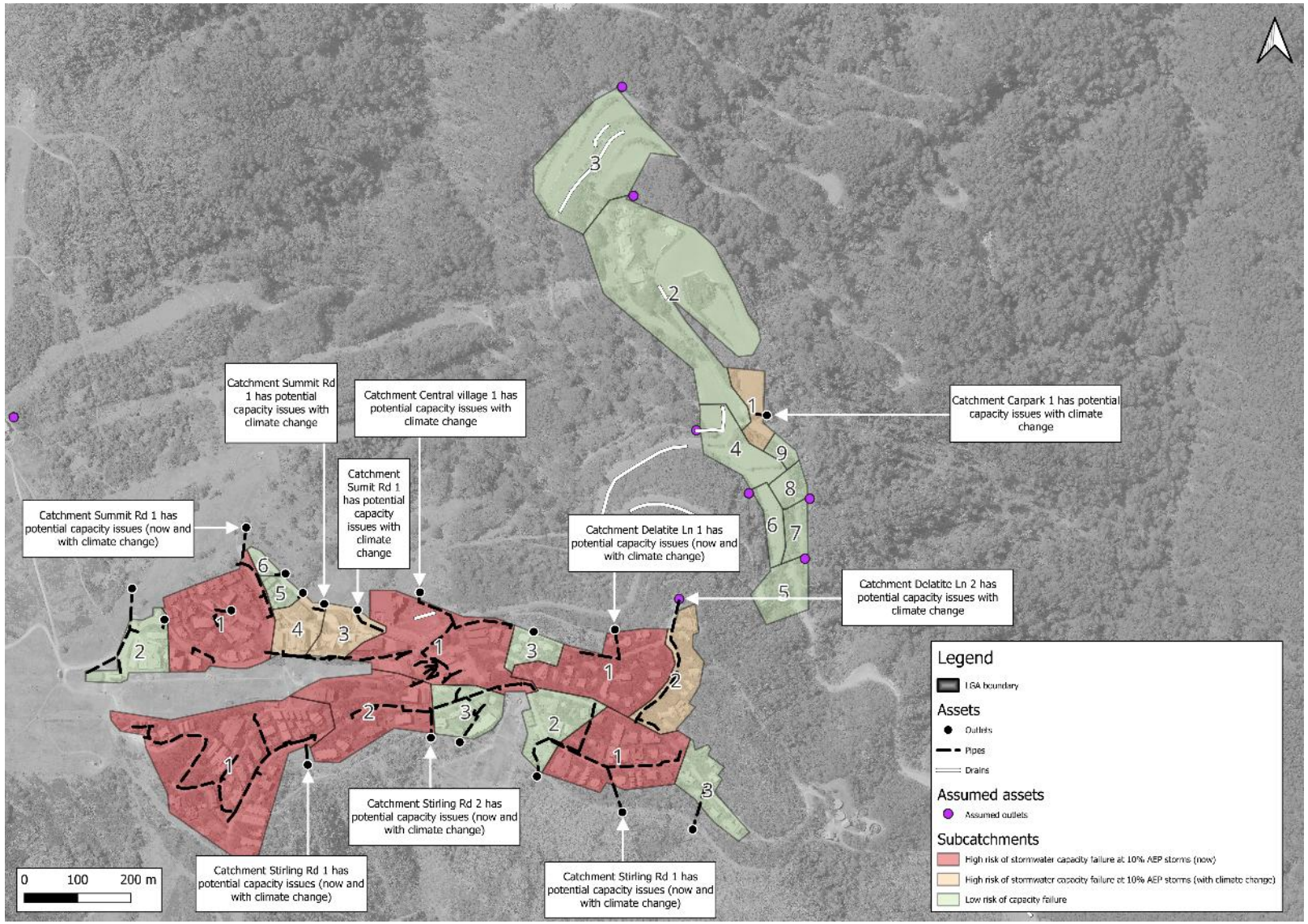


Figure 22. Erosion risk across all catchments in Mt Buller Alpine Resort.

9.1.4 Identifying erosion risks at outlets

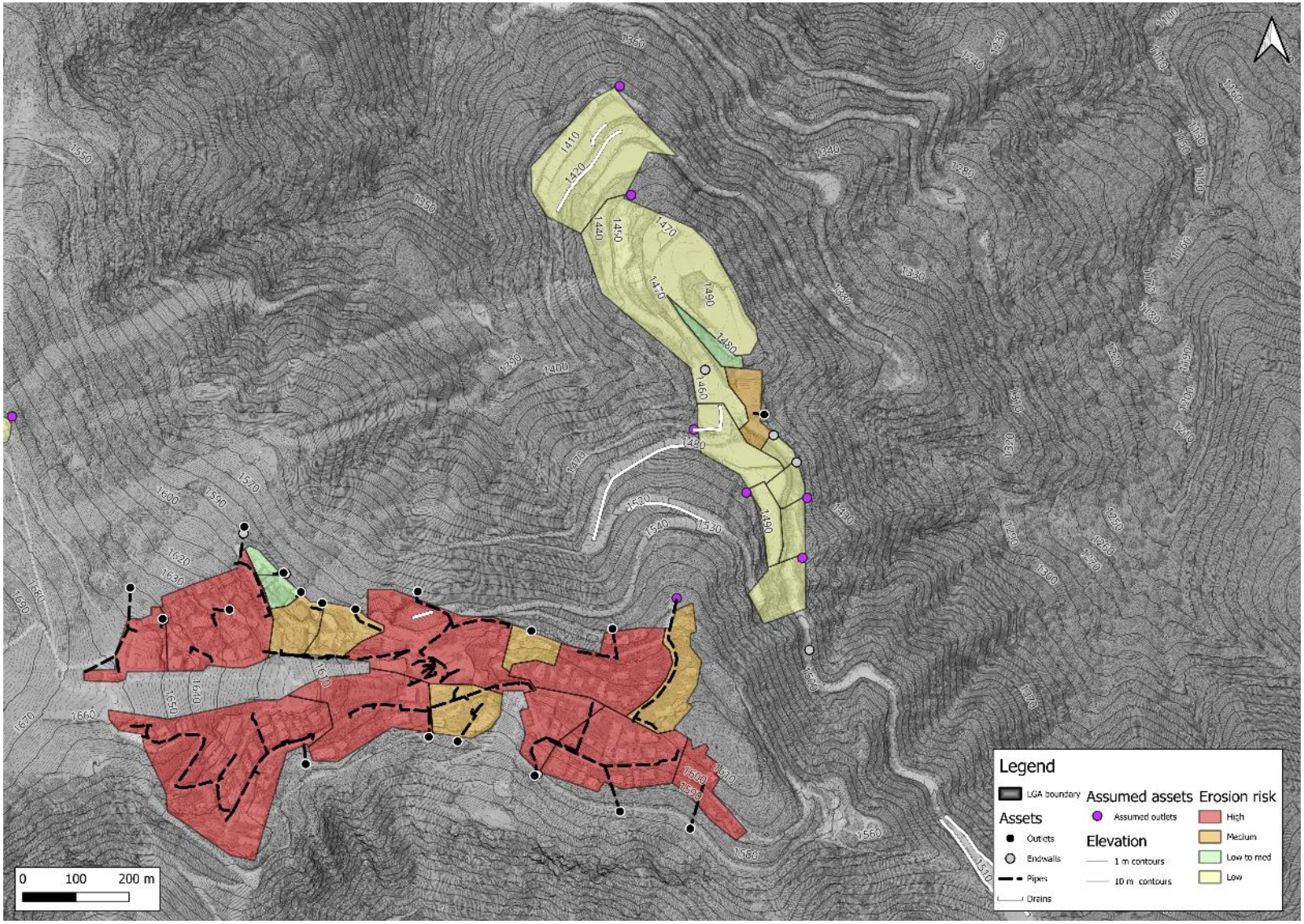


Figure 23. Erosion risk across all catchments in Mount Buller

The figure shows that due to the nature of the size of catchments, and slope, there are several areas that have a high risk of erosion where the stormwater enters the downstream alpine environment. Based on the semi-quantitative analysis in Figure 23, it may be worth considering a more detailed assessment of the local environment and risk of erosion, and how to mitigate this risk (thinking of actions within the catchment and at the outlet).