



# *Lake Mountain Final IWM Plan*

*May 2025*



*Three  
Seeds*



## Traditional Owners

We acknowledge Taungurung and Wurundjeri Woi-wurrung as the Traditional Owners and Custodians of Country that includes Lake Mountain Alpine Resort. Traditional Owner language, knowledge and concepts referenced in this document remain the cultural and intellectual property of those peoples.

## Document Management

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## Cover image

Lake Mountain Resort. Source: <https://www.mountainwatch.com/australia/lake-mountain-resort/>.

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## Executive Summary

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This Integrated Water Management (IWM) Plan for Lake Mountain Alpine Resort establishes a framework for managing water and water systems at the resort over the next 20 years. It has been prepared to support the economic viability and ecological and cultural values of the resort in a changing climate.

The plan addresses water supply (including snow making), stormwater management, wastewater treatment, and the downstream environment. It has been developed in consultation with resort stakeholders. ARV is engaging with Traditional Owners / Custodians on the *Traditional Owner Engagement and Self-Determination Strategy* (in development), and Taungurung and Wurundjeri Woi-wurrung water-related cultural considerations have informed this IWM plan.

### Resort Context

Lake Mountain Alpine Resort is predominantly located in Taungurung Country, with its southernmost extents in Wurundjeri Woi-wurrung Country. It is the closest alpine resort to Melbourne, covering 465 hectares with a summit elevation of 1,433 meters. The resort primarily caters to snow play, tobogganing, and cross-country skiing, with extensive day-visitor facilities but no on-mountain overnight accommodation.

Water plays a central role in the resort's operation and sustainability. It is critical for snowmaking to ensure consistent snow coverage during winter months, especially given the resort's relatively low elevation.

### Water Context

Lake Mountain Alpine Resort is located within the upper reaches of Goulburn-Broken catchment, with a small area of the resort within the Birrarung / Yarra River catchment. The resort accesses water from the Taggerty River, a pristine stream fed by the Echo Flat bog and heath catchment within the Yarra Ranges National Park.

The resort has licence to extract up to 0.25 ML of water per day (max. 88 ML per year) from the Taggerty River. Water is diverted via a small weir to three storage tanks (800 kL total capacity). The resort typically uses a small portion of the licenced allocation - approximately 1.7 ML per year for buildings and operations, and 1.7-2.8 ML per year for snowmaking. There is no potable (drinking) water system at the resort; water diverted from the Taggerty river is not treated to potable standard, so visitors must bring their own drinking water for the day.

Wastewater from the resort village is diverted into a septic tank and discharged via absorption trenches. Remote septic systems treat wastewater from individual toilet blocks (e.g. at the resort entrance gate).

Two snow factories and six fan guns are used to supplement natural snowfall.

### Climate Context

Current and projected future climate change impact water management and the viability of the resort. Changes include:

- declining snowfall and snow depth
- decreasing annual precipitation
- rising temperatures
- reduced hours suitable for snowmaking due to warming temperatures
- increased risks of bushfires and extreme weather events.

Climate change is reducing natural snowfall and the effectiveness of snow fan guns and increasing reliance on snow factories.

### Cultural Context

Taungurung and Wurundjeri strategies and plans provide a basis for understanding the cultural context of water in alpine environments and building relationships with Traditional Owners / Custodians. 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'.

### **Water Management Options**

The IWM plan evaluated 22 options across four categories, with stakeholder input and analysis refining these to 8 priority recommendations:

#### Good Water Management

1. Building cultural awareness of Taungurung and Wurundjeri Woiwurrung cultural values of water
2. Supporting Traditional Owner cultural land management opportunities
3. Introducing water metering for improved monitoring and leak detection
4. Implementing water efficiency measures throughout resort facilities
5. Continuing use of snow factories for reliable snow production

#### Environmental Management

6. Monitoring wastewater impacts to ensure minimal environmental effects
7. Implementing stormwater management and erosion control measures to reduce environmental impacts

#### Future Water Resilience

8. Design and build new rainwater harvesting systems at the remote buildings and gatehouse, to reduce reliance on river extractions and long piped diversions

9. Design and build a new rainwater harvesting system for potable use (connected to the administration and bistro buildings) to reduce reliance on the Taggerty River

Options not recommended included increasing snowmaking storage capacity and infrastructure, as analysis showed minimal benefits given climate trends. Instead, the plan recommends a hybrid approach with an increased focus on snow factory use, which is less dependent on weather conditions, alongside more efficient snow fan gun technology.

### **Action Plan, structured over four phases**

#### **Immediate (Current):**

- Continue engaging with Traditional Owners
- Maintain snow factory operations
- Monitor wastewater impacts

#### **Short-term (1-3 years):**

- Install water metering at key locations across the resort
- Implement water efficiency and leak detection measures
- Deploy erosion protection measures
- Install rainwater harvesting for remote buildings

#### **Medium-term (4-10 years):**

- Design and implement rainwater harvesting for potable water use

#### **Long-term (10+ years):**

- Revisit options for stormwater harvesting, wastewater recycling, and groundwater extraction
- Reassess snowmaking requirements and snow melt capture opportunities

**Benefits and Alignment**

The recommended options align with both ARV's strategic objectives (investment, environment, visitors, reform, progress, and people) and IWM outcomes. Key benefits include:

- Enhanced water security and reduced pressure on the Taggerty River
- Improved environmental outcomes through better wastewater and stormwater management
- Support for Traditional Owner cultural values and land management practices
- Increased visitor experience through reliable snow coverage and potable water availability
- Greater resilience to climate change impacts
- More sustainable and efficient water use

Implementation depends on available resources and potential grant funding to support ARV in transforming Lake Mountain into an integrated water management demonstration site while ensuring its continued viability as a key Victorian alpine tourism destination.

# 1 Introduction

## 1.1 Purpose of this plan

This plan documents a comprehensive framework for managing water resources at Lake Mountain Alpine Resort (referred to as Lake Mountain in this report) to balance environmental sustainability, social needs, and economic considerations. By integrating diverse aspects of water management—supply, wastewater, stormwater, and environmental flows—the plan seeks to optimise the overall performance of water systems while responding to climate change, visitation growth, and ecological context. 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 Lake Mountain Alpine Resort

Lake Mountain is predominantly in the Taungurung Country and part of the Waring / Goulburn River catchment. Taungurung connections to alpine landscapes, including Lake Mountain, are described in *Integrated Water Management in Taungurung Biik*.<sup>1</sup>

The southernmost extents of the resort are in Wurundjeri Woi-wurrung Country and part of the Birrarung / Yarra River catchment. Wurundjeri responsibilities and aspirations for Country (including water) are described in the *Wurundjeri Woi-wurrung Nation Statement - Water is Life*.<sup>2</sup>

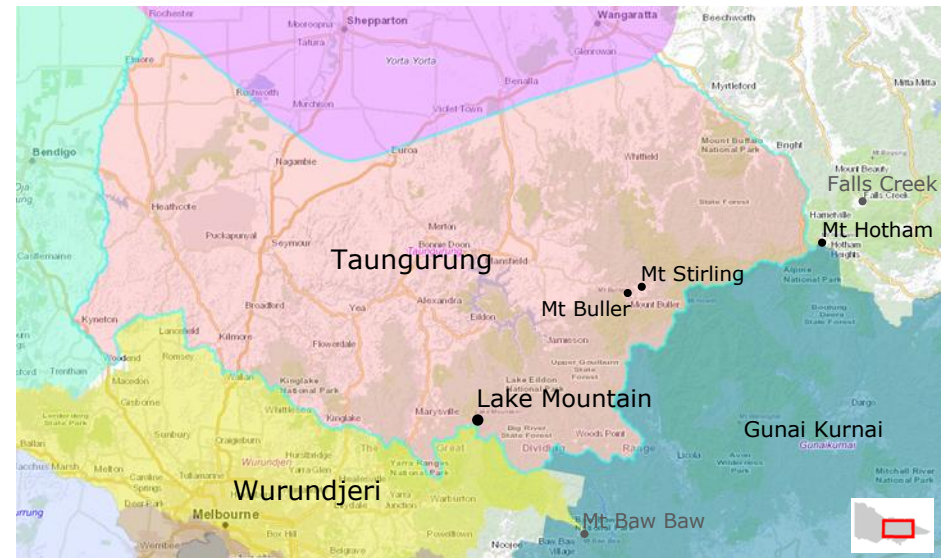


Figure 1. Lake Mountain - Taungurung and Wurundjeri Country (Source: Victorian Aboriginal Heritage Register and Information System, annotated with Victorian Alpine Resorts)

The Lake Mountain area contains at least 265 native and 19 introduced flora species.<sup>3</sup> Major vegetation communities include alpine or sub-alpine snow gum woodland, sub-alpine wetlands, and montane forest.

Lake Mountain is the closest alpine resort to Melbourne (approximately 118 km away) and is Victoria's premier family snow play destination. The resort spans 465 hectares with a summit elevation of 1,433 metres adjacent to Yarra Ranges National Park. Key facilities are situated at around 1,400 meters

<sup>1</sup> 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.

<sup>2</sup> WWC (2022). *Wurundjeri Woi-wurrung Nation Statement – Water is Life*.

<sup>3</sup> Southern Alpine Resort Management Board. (2020). *Environmental Management Plan 2020–24*. Marysville, VIC: State of Victoria, Southern Alpine Resort Management Board.

including toboggan slopes, cross-country ski trails, a visitor centre, and an administration building.

The resort primarily caters to snow play, tobogganing and cross-country skiing, with extensive car parking and day-visitor facilities (including two cafes) but no on-mountain public overnight accommodation. The resort represents about 4% of visitor expenditure for the sector (\$37 million in 2019).<sup>4</sup> As with the other alpine resorts in Victoria, the majority of Lake Mountain's visitation and economic activity occurs in the white season (winter).

Table 1. Lake Mountain Profile

<b>Statistics</b>	<b>Values</b>
Winter Visitation (2024)	93,142 visitors
Summer Visitation (2022)	48,507 visitors
Resort Size	466 ha
Resort Altitude (Summit)	1,433 m
Distance from Melbourne	118 km
Number of food establishments	2
Groomed trails (cross-country)	37 km (11 trails)
Snowmaking terrain	3 ha
Toboggan parks	4
Road cycling*	21 km
Mountain biking*	28 km
Walking*	25 km

\* including sections of road / trail beyond the resort  
Source: Urban Enterprise (2021) and SARMB (2022)

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<sup>4</sup> Urban Enterprise (2021). *Victorian Alpine Resorts Visitor Economy Development Plan*. Prepared for Tourism North East. Brunswick, VIC: Urban Enterprise Pty Ltd.

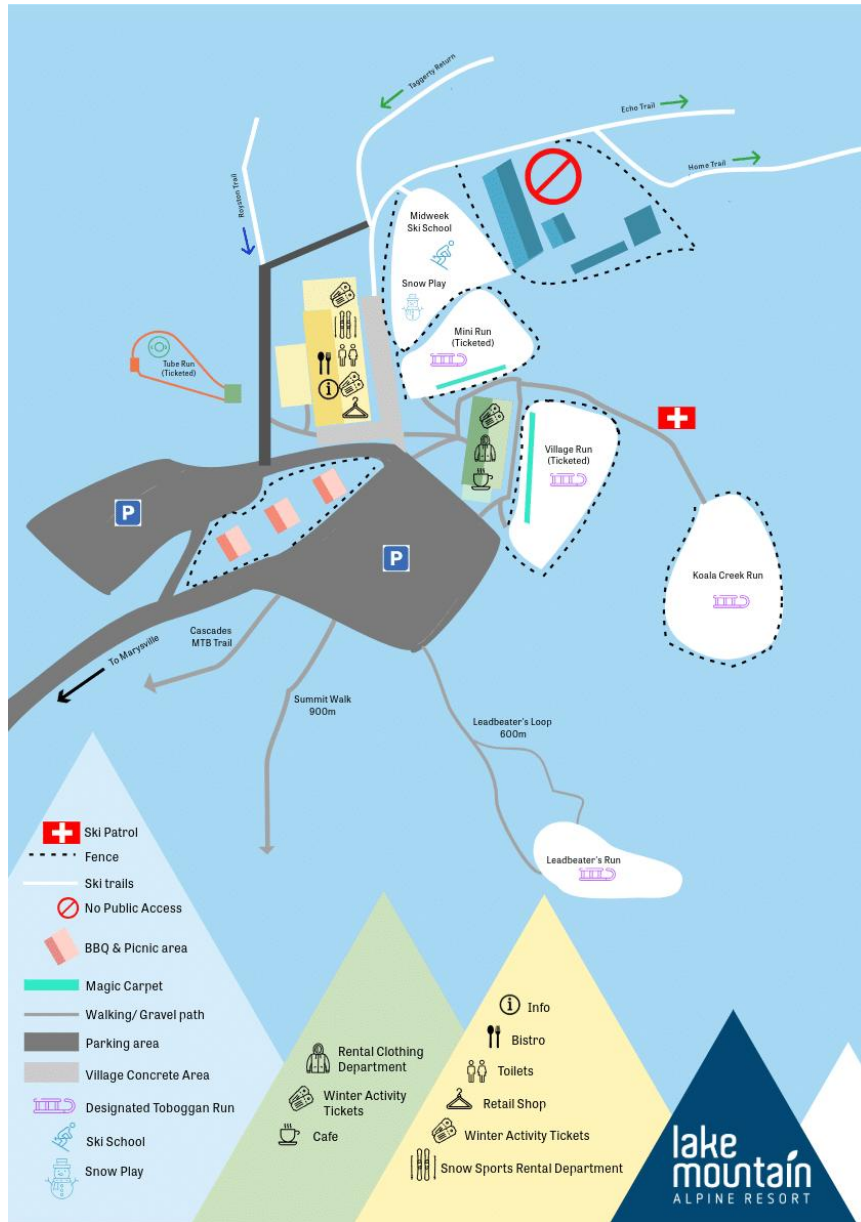


Figure 2. Lake Mountain resort facilities and runs (Source: Alpine Resorts Victoria)

During the green season (non-winter), Lake Mountain transforms into an event venue and hosts guided walking tours, mountain biking, road cycling and other nature-based adventure activities / competitions. It has also gained popularity among cyclists, particularly for the road climb from Marysville, one of the 7 Peaks climbs promoted across Alpine Resorts. Recent investment in mountain biking, including the Cascades Trail, has further boosted summer visitation.

Water plays a central role in the operation and sustainability of Lake Mountain. Water for snowmaking is critical to ensure consistent snow coverage during winter months, even though the resort does not have alpine skiing infrastructure. The relatively low elevation of the resort makes efficient snowmaking and water use even more crucial. Water also supports the resort’s eco-tourism focus, sustaining facilities for visitors while managing ecological impacts on the surrounding sensitive alpine environment.

The economic viability of Lake Mountain Alpine Resort is under pressure as a result of climate change and increasing climate variability. Without adaptation, shorter snow seasons and reduced winter visitation will likely impact revenue and make diversification and year-round operations increasingly important. At the same time, the resort must address infrastructure vulnerabilities and risks, while ensuring accessibility and safety for visitors. This includes the lack of treatment system infrastructure to provide potable water for current and anticipated future demand.

Figure 3 shows historic and projected visitor days under different scenarios (average year, low snow year, and high snow year), assuming an adaptation scenario where half of the natural snow reduction from climate change is

alleviated through snowmaking.<sup>5</sup> With snowmaking, visitor days may remain similar to historic numbers in an average snow scenario, decline somewhat in a low snow scenario, and grow in a high snow scenario. Visitation projections do not incorporate alternate snowmaking scenarios to reflect advances in snowmaking technology.

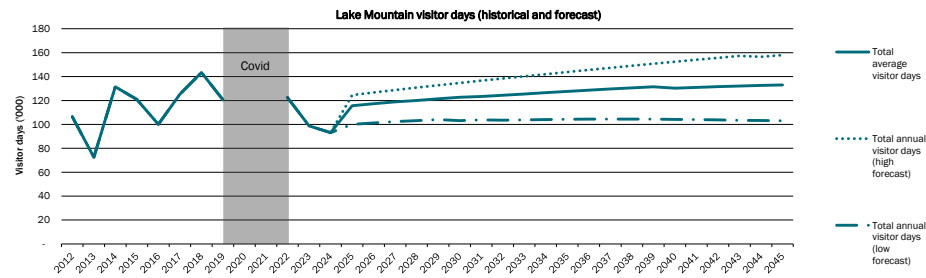


Figure 3. Historic and Projected Total Number of Visitor Days Under Different Snow Scenarios (data provided by Centre for International Economics, 2024).

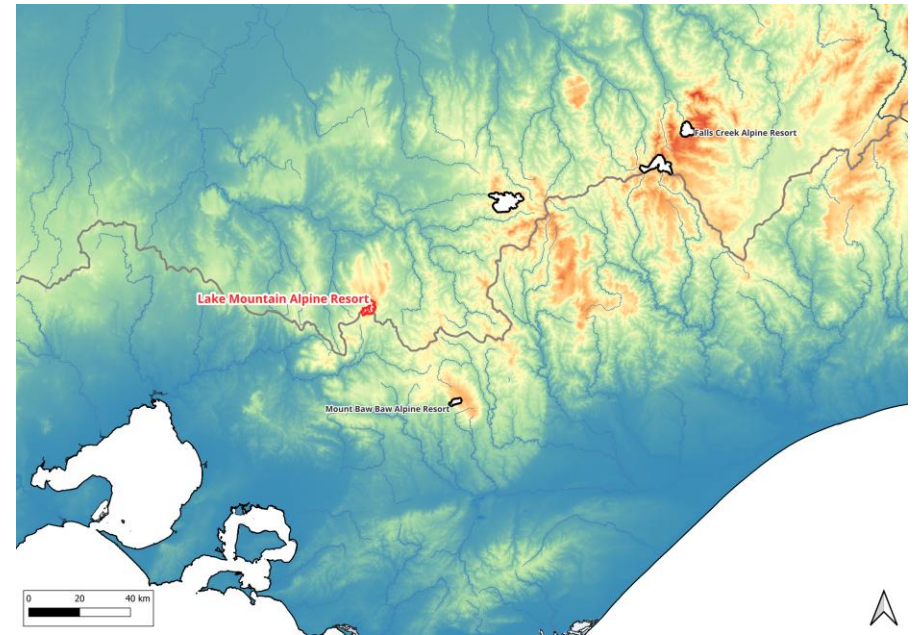


Figure 4. Resort boundary and surrounds

<sup>5</sup> Centre for International Economics (2024). *Carrying Capacity of Victorian Alpine Resorts: Preliminary Draft Report*. Prepared for Alpine Resorts Victoria, 30 September 2024. The Centre for International Economics.

### 1.3 History of snow depth at the resort

Snow depth data has been recorded since 1993 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 depth for each season, and the long-term trend. It is rare to get more than 1 metre of snow depth on the mountain, and it would normally only remain on the mountain for a few weeks or up to a month, due to rain and warmer weather melting the snow.

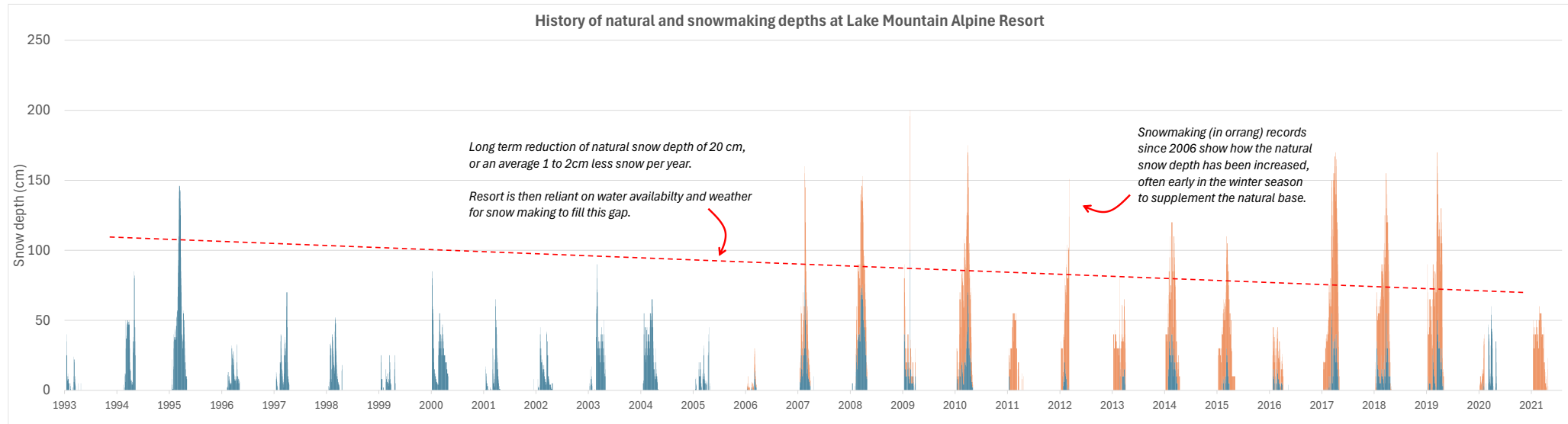


Figure 5. Snow depth (natural and snowmaking) at Lake Mountain since 1993.

The red line represents the linear trend of the whole record of natural snow falls, for the maximum depth experienced each season. Records were only available from 1993 to 2021.

## 1.4 Water planning approach

An iterative process was used to develop this plan and to understand the resort context, water and environment context, identify potential opportunities, and evaluate options (see figure to the right).

The consultant team worked with ARV and Lake Mountain stakeholders to understand and explore the resorts water-related context, aspirations and challenges through a series of informal interviews and two online workshops.

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 as well as critiqued potential options. Inputs from both workshops formed the basis of what options are presented in this plan. See the Appendix for summaries of the outcomes from each workshop.

Wave Consulting and Three Seeds also visited the resort with ARV staff to assess existing infrastructure and ground-truth potential opportunities.

ARV engaged with Taungurung Land and Waters Council (TLaWC) and Wurundjeri Woi-wurrung Cultural Heritage Aboriginal Corporation (Wurundjeri Corporation) as part of the development of ARV’s Traditional Owner Engagement and Self-Determination Strategy. However, TLaWC and Wurundjeri Corporation have not been directly involved in water planning for Lake Mountain. Three Seeds reviewed existing Taungurung and Wurundjeri strategic documents to understand their connections to this area and water-related considerations.

Lake Mountain stakeholders involved in water planning for the resort included:

- ARV
- Department of Energy, Environment and Climate Action (DEECA)
- Goulburn Valley Water (GVW)
- Goulburn-Murray Water (GMW).



Figure 6. Water planning approach

## 2 Water context

### 2.1 Water Catchments

The majority of Lake Mountain is located within the Upper Goulburn catchment, which is part of the larger Goulburn-Broken Catchment. The Goulburn River is a major tributary of the Murray River, and the catchment plays a significant role in the water supply and ecosystem health for the region. A small part (about 5%) of the resort is located within the Yarra River Upper Catchment.

The main water source for Lake Mountain is the Taggerty River, a minor inland perennial river of the catchment. The headwaters of the Taggerty River rise on the north-western slopes below Lake Mountain and descend to flow into the Steavenson River near Marysville.

*“Lake Mountain acts as a gateway to winter and summer (Yarra Ranges) National Park recreation activities (cross country skiing, mountain biking). This means that managing water at the resort needs to consider the landscape scale (beyond the resort).”*

*Workshop 1 participant*

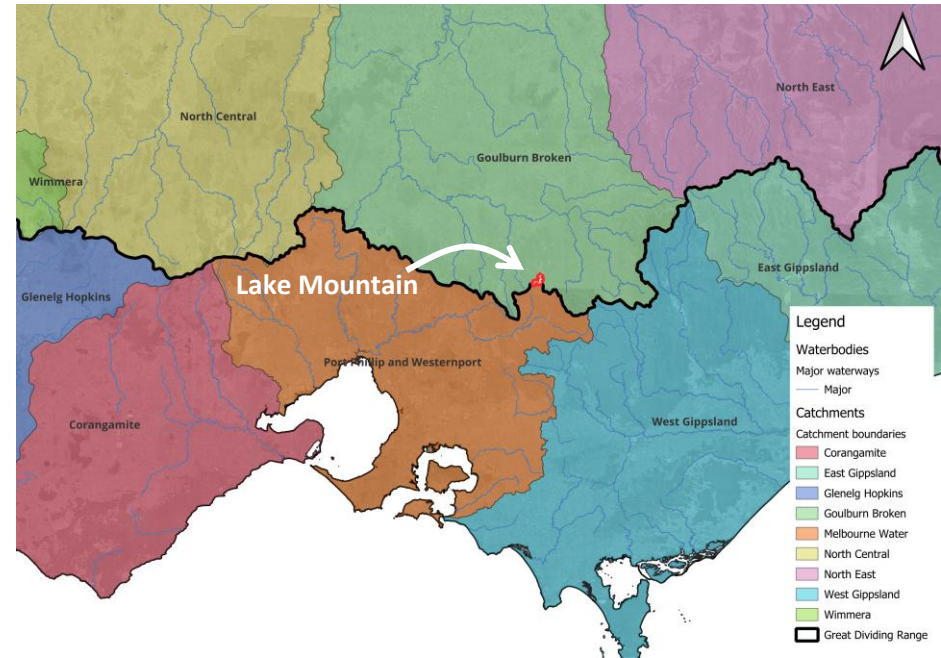


Figure 7. Lake Mountain Alpine Resort and catchment context.

## 2.2 Existing Infrastructure

### 2.2.1 Water source, storage and distribution

Lake Mountain accesses regulated, non-potable water from the headwaters of the Taggerty River, which forms part of the Goulburn Valley water catchment. Lake Mountain is unique in that it is a Regulated Water System as defined under the *Safe Drinking Water Act 2003* ('the Act'). The storage and supply of water to the Resort is untreated as declared and gazetted by the Minister for Health on the 23rd of October 2005. 'Regulated Water' is defined in Section 6 of the Act as, water that is not intended for drinking but could be reasonably mistaken as drinking water.

There is no treatment applied to the water supply at Lake Mountain. Alpine Resorts Victoria is minimising the possibility of potential health risks by raising public awareness through the placement of "Do Not Drink" signage above all resort water outlets, advising resort visitors that the water is not treated, nor is it suitable for consumption. Water that feeds into the food preparation outlets is filtered through multiple 20-micron and 5-micron cartridge units; testing occurs offsite by ALS Water on a fortnightly basis to analyse turbidity, E.coli, Coliforms and Plate Counts.<sup>6</sup>

#### Gerraty's Village Centre

Gerraty's is the resort's village centre, with water sourced from the Upper Taggerty River, a pristine stream fed by the Echo Flat bog and heath catchment within the Yarra Ranges National Park. The catchment area experiences minimal human contact, limited to bordering cross-country ski trails and occasional camping.

Water is collected via a small concrete weir and transported through a series of 50mm poly pipes using a gravity/siphon system to three enclosed concrete storage tanks with a combined capacity of 800 kL. These tanks supply water to resort facilities through a 100mm ductile iron pipe.

The water extraction licence is for 88 ML annually from Taggerty River.



Figure 8. Photo of tank water outlets in public toilets

<sup>6</sup> Southern Alpine Resort Management Board. (2021). *2020–21 Water Supply Annual Report*. Marysville, VIC: State of Victoria, Southern Alpine Resort Management Board.

**Snowy Hill**

Water for Snowy Hill amenities is supplied from Gerraty's storage system. The delivery line uses a 50mm poly pipe operating on a gravity/siphon process.

**Arnold Gap**

Water is sourced from a small tributary and stored in a 1,000L poly tank. The supply and delivery lines use a 50mm polythene pipe under a gravity/siphon system to provide water to the amenities building at Arnold Gap.

**Resort Entry**

Water for amenities at the resort entry is sourced from another small tributary and stored in a 2,270L poly tank. The system relies on gravity/siphon delivery via 50mm polythene pipes. Additionally, a rainwater collection tank installed in 2020 now services the staff toilet.



Figure 9. Photo of tank at resort entry

### 2.2.2 Wastewater

Wastewater is managed through absorption pits below the resort administration building.

A septic tank collects sludge, and then wastewater is transferred to two pits for absorption, and another six pits in peak season to cope with additional peaks of wastewater.

There are also remote septic treatment plants that manage sewage from individual toilet blocks, like the one near the resort entrance gate.



Figure 10. Photo of public toilets

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<sup>7</sup> Southern Alpine Resort Management Board (2020). *Environmental Management Plan 2020–24*.

### 2.2.3 Snowmaking

There are two snow factories, which can produce up to four tonnes of snow per hour.<sup>7</sup> Six fan guns are also in operation at resort, some of which have inbuilt weather sensors to optimise the operation of the snow gun, which focus on snow coverage on the two main toboggan areas.

There is an ongoing movement in the industry to adapt and transition snow making 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 will continue to deal with a changing climate and a more consistent coverage of snow.

The future of snow making at Lake Mountain will continue to 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.



Figure 11. Lake Mountain Snow Factory



Figure 12. Snow making guns directed to the Village Run toboggan area.

### 2.3 Water Demand

An analysis of water demand patterns is difficult without metering of supply and use. Logs of visitation 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 Taggerty River was used to input into a demand model to create a demand profile for the two main uses of water:

- Non-drinking water in the buildings and workshop
- Snow making production

Year to year the water demand fluctuates based on weather, on visitation rates, leakage in the system, and other climate variables. The figure below represents a typical year, noting the pattern can vary significantly.

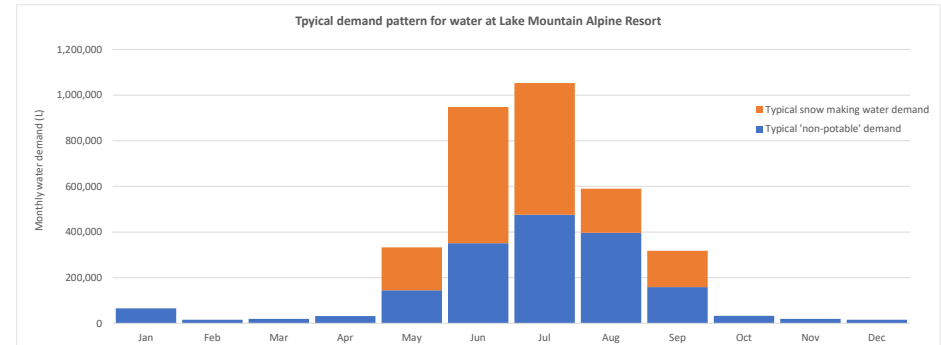


Figure 13. Monthly water demand pattern

### 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. The Lake Mountain resort water balance was calculated using a variety of models and data points to create the best estimate of how much water is associated with different resort areas and activities (refer Figure 14).

Most of the water falling on the resort (as rain and snow) is intercepted by vegetation and returns to the atmosphere via evapotranspiration. Infiltration of water into the soil is the next largest component of the water balance, followed by runoff from the two village centre car parks and natural snow melt. Total water use at the resort is relatively small. However, access to a licenced water diverted from the Taggerty River (up to 88 ML / year, restricted to 0.25 ML / day) is an important part of the resort water balance. Wastewater (currently treated in absorption trenches) is a relatively small component of the resort water balance.

The resort is not constrained in terms of access to raw water but is constrained in terms of storage sizes and weather conditions to support snow making, and the fact that raw water is not treated to potable standard.

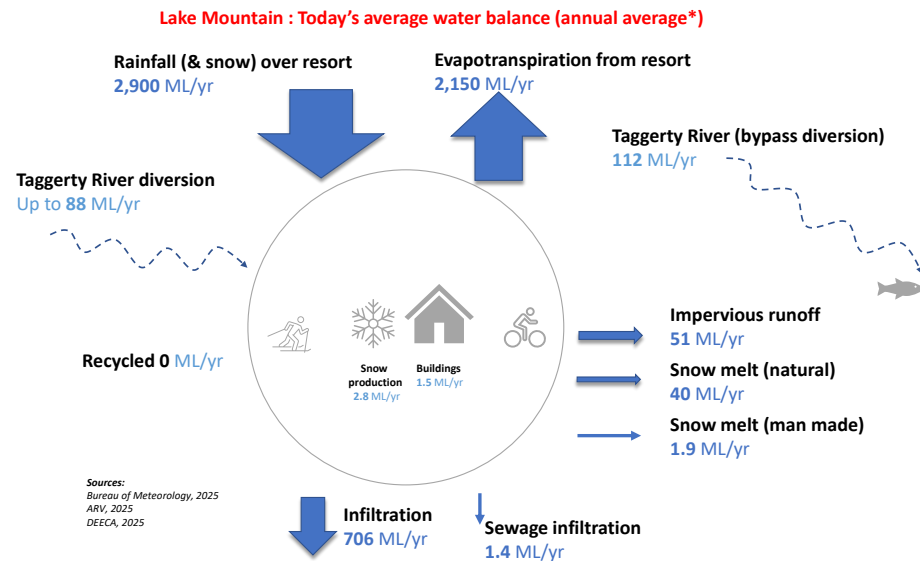


Figure 14. Water balance for the resort

## 2.5 Climate Context

Victoria’s alpine resorts, including Lake Mountain Alpine Resort, face significant challenges from climate change, which is altering key environmental and economic conditions. One of the primary challenges is the steady decline in snowfall and snow depth, trends that are projected to continue, leading to shorter snow seasons. Lake Mountain, at a lower elevation, is particularly vulnerable and may experience significant reductions

in snowfall. Projections indicate that by 2071–2100, mean annual snow cover days in the Australian Alps could decline by 75% under high emissions scenarios and 28% under low emissions scenarios (compared to 1981–2011 levels), underscoring the substantial impacts on natural snow availability.<sup>8</sup>

Rainfall patterns are also shifting, with overall annual precipitation expected to decrease by up to 19% in the Gippsland region by the late 2050s in the spring months under high emissions scenarios.<sup>9</sup> While average rainfall will decline, heavy rainfall events may increase in intensity, with projections suggesting a rise in daily rainfall intensity of up to 12% for events with a 20-year recurrence interval. These changes heighten risks of erosion, landslides, and infrastructure damage.

Annual average temperatures in the region have already risen by 1.4°C since 1950, and further increases are expected.<sup>10</sup> Improvements to snowmaking technologies are leading to efficiencies at higher temperatures, however increasing temperatures impact the longevity of either natural or manufactured snow and creates challenges to snow holding. This warming ultimately accelerates snowmelt, shortens the snow season, and reduces snowmaking efficiency. The snow season in Victoria is projected to contract by 65–90% by 2070–2099 (relative to 2000–2010). Additionally, warmer

*“A bushfire would have significant impacts on the water quality of the Taggerty River and would mean the diversion is taken offline, and therefore there is no raw water supply for the resort.”*

*Workshop 1 participant*

<sup>8</sup> Nation Partners (2024). *Summary of Climate Change Science and Impacts*. Prepared for Alpine Resorts Victoria. Version 3.0, 11 July 2024. Melbourne, VIC.

<sup>9</sup> Ibid.

<sup>10</sup> Ibid.

conditions increase bushfire risks and the number of days exceeding the "Very High" fire danger threshold could rise.<sup>11</sup>

While climate change poses challenges to winter tourism, it also presents opportunities for green season activities. As the summer season lengthens, Lake Mountain has the potential to expand walking and mountain biking offerings, attracting visitors seeking refuge in cooler alpine conditions. However, developing green season tourism will require investment in infrastructure and careful planning to ensure biodiversity and ecosystem health are protected, as well as considerations for water management.

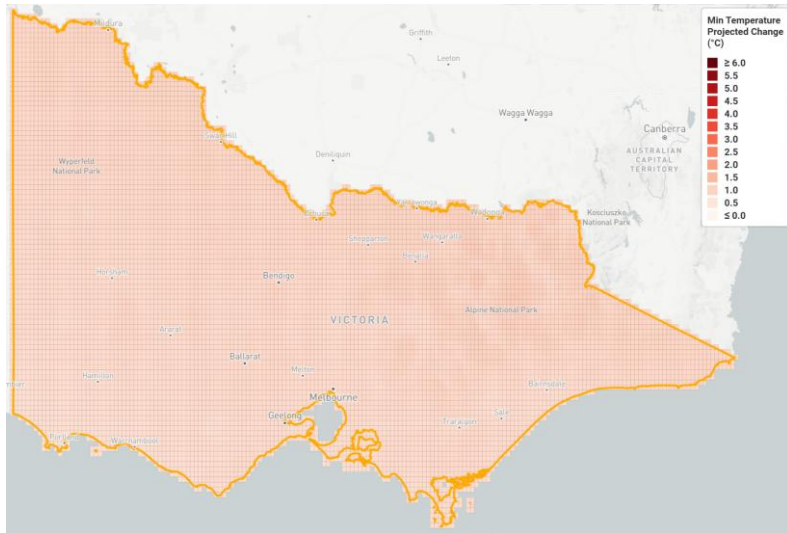
The figures on the following page illustrate how the climate is forecast to change with a focus on minimum and maximum temperatures. often with more change in the alpine area than other areas of the state. A temperature increase of 5 or 6 degrees would significantly alter the snow coverage, depth and overall visitor experience.

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.<sup>12</sup>

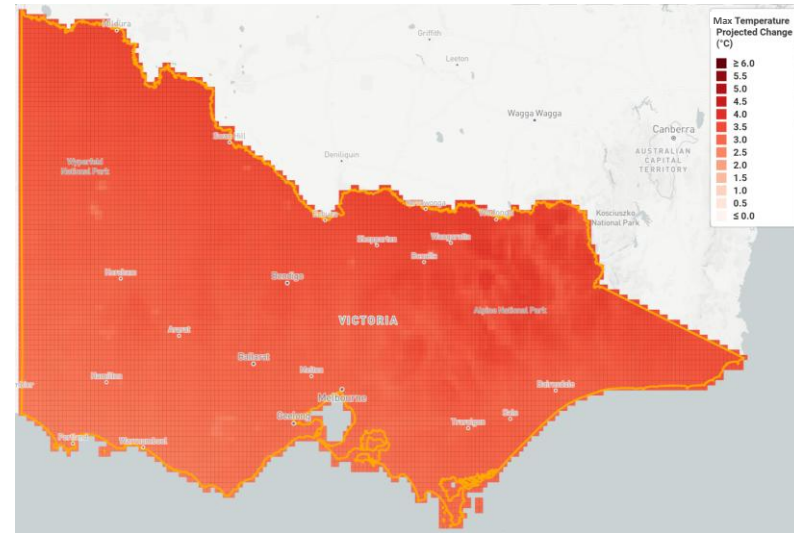
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<sup>11</sup> Ibid.

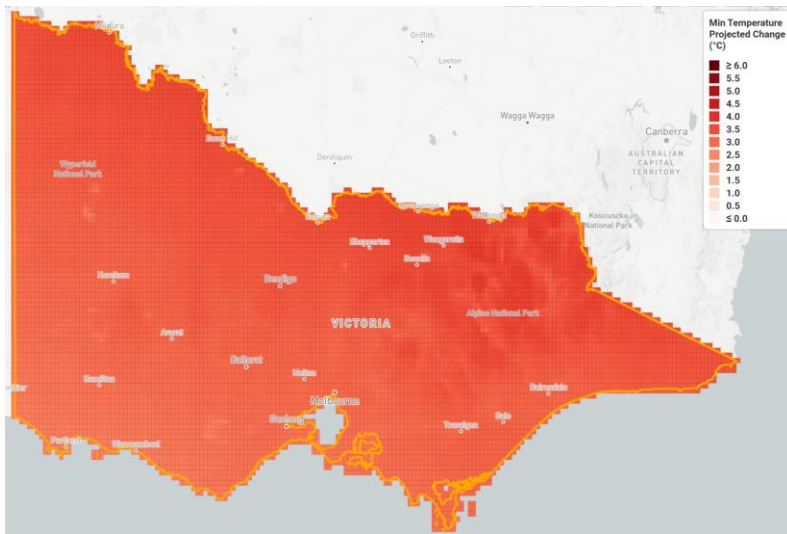
<sup>12</sup> Clarke JM, Grose M, Thatcher M, Hernaman V, Heady C, Round V, Rafter T, Trenham C & Wilson L. (2019). *Victorian Climate Projections 2019 Technical Report*. CSIRO, Melbourne Australia.



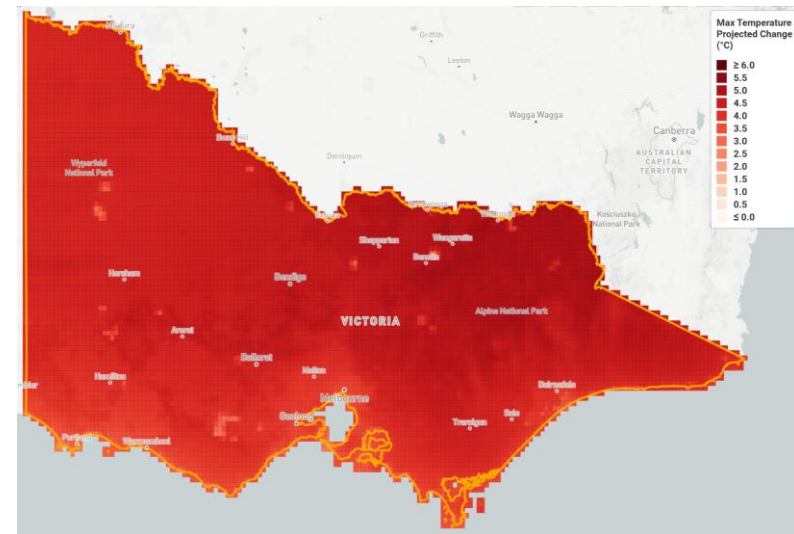
Climate change impact on minimum temperatures for 2020-2039



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 Cultural Context

Taungurung responsibilities and aspirations related to Healthy Country are outlined in Taungurung Land and Waters Council (TLaWC) plans and guidance including the Taungurung buk dadbagi / Taungurung Country Plan<sup>13</sup> and Taungurung Cultural Land Management Strategy<sup>14</sup>.

The Taungurung Cultural Land Management Strategy identified that approaches to reading water country, assessing values, identifying important waterscapes and applying flow regimes to heal and strengthen cultural values would be developed by the Taungurung Cultural Water Program. Reform of institutional and governance arrangements for water policy and programs was also identified as a crucial element of this work.

*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)*

Wurundjeri Woi-wurrung responsibilities and aspirations for Country (including water) are described in the *Wurundjeri Woi-wurrung Nation Statement - Water is Life*<sup>15</sup>. *Nhanbu narrun bu ngargunin twarn Birrurung / Ancient Spirit and Lore of the Yarra*<sup>16</sup>, developed to inform *Burndap birrarung burndap umarkoo / Yarra Strategic Plan*, also provides cultural context for managing water in Wurundjeri Woi-wurrung Country.

<sup>13</sup> TLaWC (2016). *Taungurung Country Plan*.

<sup>14</sup> TLaWC (2023). *Taungurung Cultural Land Management Strategy*.

<sup>15</sup> WWC (2022). *Wurundjeri Woi-wurrung Nation Statement – Water is Life*.

These documents provide a basis for understanding the cultural context of water in alpine environments and building relationships with Traditional Owners / Custodians.

*Wurundjeri invites all people to see water through our eyes, to talk with us to understand our values, and to partner with us to re-energise caring for water as we fulfill our cultural duty in bringing all water on Wurundjeri Woi-wurrung Country back to health.*

*Wurundjeri Woi-wurrung Nation Statement – Water is Life (2020)*

## 2.7 Partnering with Traditional Owners

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.<sup>17</sup>

<sup>16</sup> WWC (nd.). *Nhanbu narrun bu ngargunin twarn Birrurung / Ancient Spirit and Lore of the Yarra*.

<sup>17</sup> ARV (2025). *DRAFT Traditional Owner Engagement and Self-Determination Strategy*.



*Figure 15. Taggerty River weir diversion for use in the resort for potable and snow making uses.*

## 4 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.



Figure 16. Strategic framework for IWM at Lake Mountain Alpine Resort

### 4.1 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 in Sections 7 – 9. The table below shows the connection between the ARV objectives and IWM planning.

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

### 4.2 IWM outcomes and relevance to Lake Mountain

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 Lake Mountain.

System Aspect	Outcome	Relevance to Lake Mountain
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	Improve ecological health of riparian areas; improve 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 Lake Mountain
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 Lake Mountain visitors.
Economic values	8. Jobs, economic opportunity and innovation	Recognition that water management is an integral part of sustainable business

### 4.3 Traditional Owner considerations

As an interim step toward understanding and respecting Traditional Owner values of alpine water systems, water-related cultural considerations were identified with reference to documented Taungurung knowledge, aspirations and cultural land management principles. These cultural considerations informed the development of water management options and opportunities.

Water-related cultural considerations were subsequently updated to also reflect Wurundjeri Woi-wurrung knowledge and aspirations. Ongoing development and implementation of ARV’s Traditional Owner Engagement and Self-Determination Strategy may provide opportunities to review and refine water management options and opportunities to support both

<sup>18</sup> TLWC (2023). Taungurung Cultural Land Management Strategy.

<sup>19</sup> TLWC (2016). Taungurung Country Plan.

Taungurung and Wurundjeri Woi-wurrung cultural rights, responsibilities, and aspirations.

1. Recognise and respect cultural rights and obligations

#### Taungurung

- 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.<sup>18</sup>
- Taungurung have 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.<sup>19</sup>

#### Wurundjeri Woi-wurrung

- Wurundjeri Woi-wurrung people are the Traditional Owners of Country from the east past the upper reaches of the Birrarung to Lake Mountain, North to the Great Dividing Range, South to Mordialloc Creek and West to the Werribee Reiver.<sup>20</sup>
- Wurundjeri Woi-wurrung have inherited a sovereign responsibility to care for and manage their Country. These rights and responsibilities extent to the cultural, environmental, social, and economic uses of water and persist throughout time and cannot be forfeited.<sup>20</sup>

*IWM Consideration: Recognise and respect Taungurung and Wurundjeri Woi-wurrung connection to Country and their rights and responsibilities to care for and manage lands and waters.*

<sup>20</sup> WWC (2022). *Wurundjeri Woi-wurrung Nation Statement – Water is Life.*

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

### Taungurung

- 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 Country must be planned for and managed according to bio-cultural values and objectives.<sup>18</sup>

### Wurundjeri Woi-wurrung

- Water, which has sustained Wurundjeri Woi-wurrung for thousands of years, forms part of Wurundjeri Woi-wurrung dreaming.<sup>20</sup>
- For Wurundjeri Woi-wurrung, the natural world is also a cultural space. The significance of the cultural landscape is rooted in the investment of meaning by the Wurundjeri Woi-wurrung people.<sup>21</sup>
- Healthy water means healthy Country and healthy people.<sup>20</sup>

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

- 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.<sup>18</sup>
- Taungurung are working to establish ongoing support and investment for cultural mapping on Taungurung Country – from the tops of our

mountains to our waterways and tributaries, including tangible and intangible heritage.

### Wurundjeri Woi-wurrung

- Wurundjeri Woi-wurrung aspire to be structurally involved in each level of government regarding the decision-making and management of our lands and waterways – and for this to become standard practice, not the exception.<sup>22</sup>
- *Burndap Birrarung Burndap Umarkoo: Engagement Framework*<sup>23</sup>, developed as a guide for Yarra Strategic Plan partners, provides direction on engaging and partnering with Wurundjeri Woi-wurrung.

IWM Consideration: *Identify opportunities to support and work with Taungurung and Wurundjeri Woi-wurrung to care for Country through alpine water planning and management initiatives.*

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<sup>21</sup> WWC (circa 2019). Towards cultural and environmental renewal of the Birrarung – Bulleen-Banyule Flats Cultural Values Study (Overview Document).

<sup>22</sup> WWC (2022). *Wurundjeri Woi-wurrung Nation Statement – Water is Life.*

<sup>23</sup> WWC (nd.). *Burndap Birrarung Burndap Umarkoo: Engagement Framework*

## 5 Water Management Options

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The options presented in this plan have been grouped into four categories.

- **Good water management.** These set of options relate to good asset management and sound management of water as a precious resource, that 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 set of 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 instance wastewater discharges on the environment.
- **Integrated water and energy strategy.** Energy and water are both significant issues in running the alpine resorts, and options that relate to increasing the opportunities for renewable energy production through the smart use of water storages and water discharges are noted in these set of options.
- **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.

The options under these themes are shown below in Figure 17.

### 5.1 Refining options based on stakeholder feedback

Figure 17 has 22 unique options across a wide range of IWM issues and strategies. A useful IWM plan is one that is clear and prioritises action and investment in a few key areas that will support IWM and the resort's vision, rather than a long list of options.

To refine the 22 options and leverage stakeholder expertise, the project conducted multiple iterations to stress test feasibility and support levels. Two stakeholder workshops, attended largely by the same representatives, played a key role in this process. In particular, the second workshop provided an opportunity for ARV staff and stakeholders to critique and refine options (see Appendix B). Through this process, some options were deemed infeasible, while others were refined or improved based on stakeholder insights.

This resulted in a priority set of 12 options deemed worthy of additional review and modelling, shown in bold. Of the 12, one of the options (increased water storage for snow making) did not pass the technical feasibility task and is not included in the action plan. Also, of the 12 options, six of these are in the category of 'good water management', which were agreed to be sound pieces of work to do at the resort, irrespective of the longer-term vision and operation of the resort.

To further expand on some of the reasoning and issues that were discussed in the workshops, Figure 18 captures how far each option got in terms of meeting various criteria that was raised and discussed in the workshops.

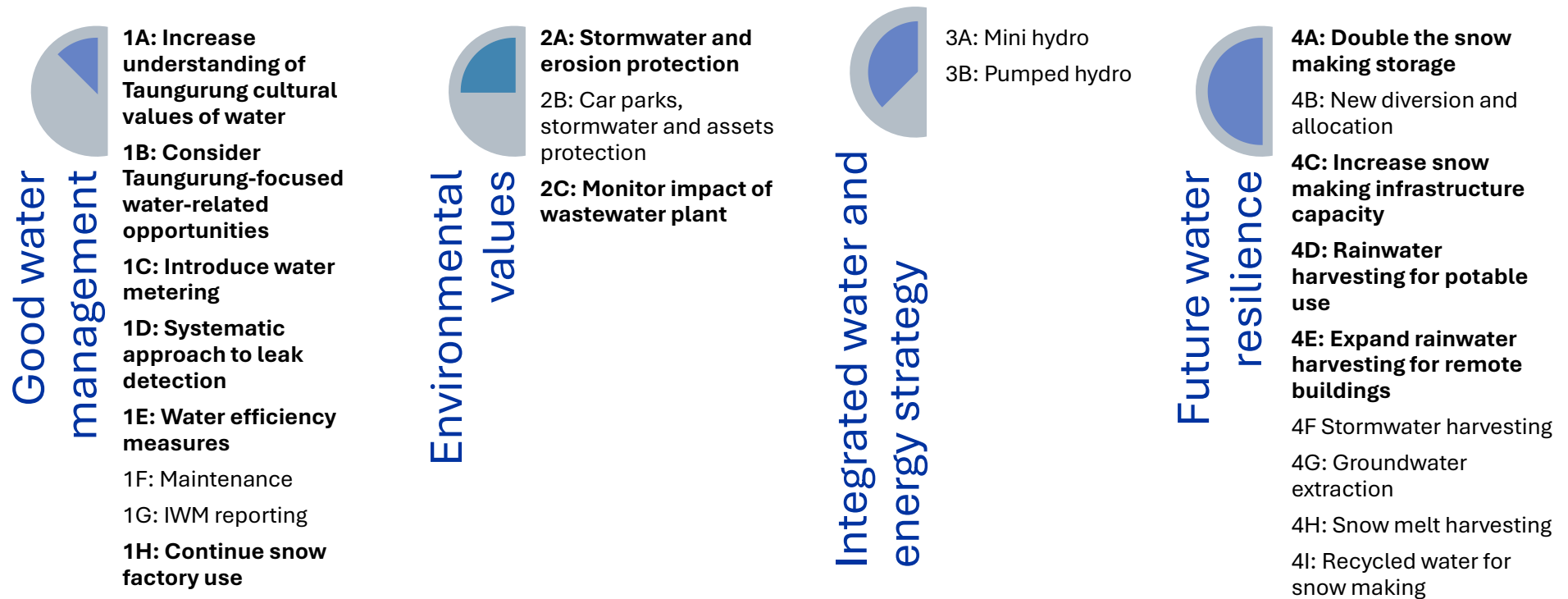


Figure 17. List of all IWM options

Options in **bold** in were supported by stakeholders involved in the second workshop and (where required) were subject to additional review and modelling. Option 4A was determined to not be technically feasible.

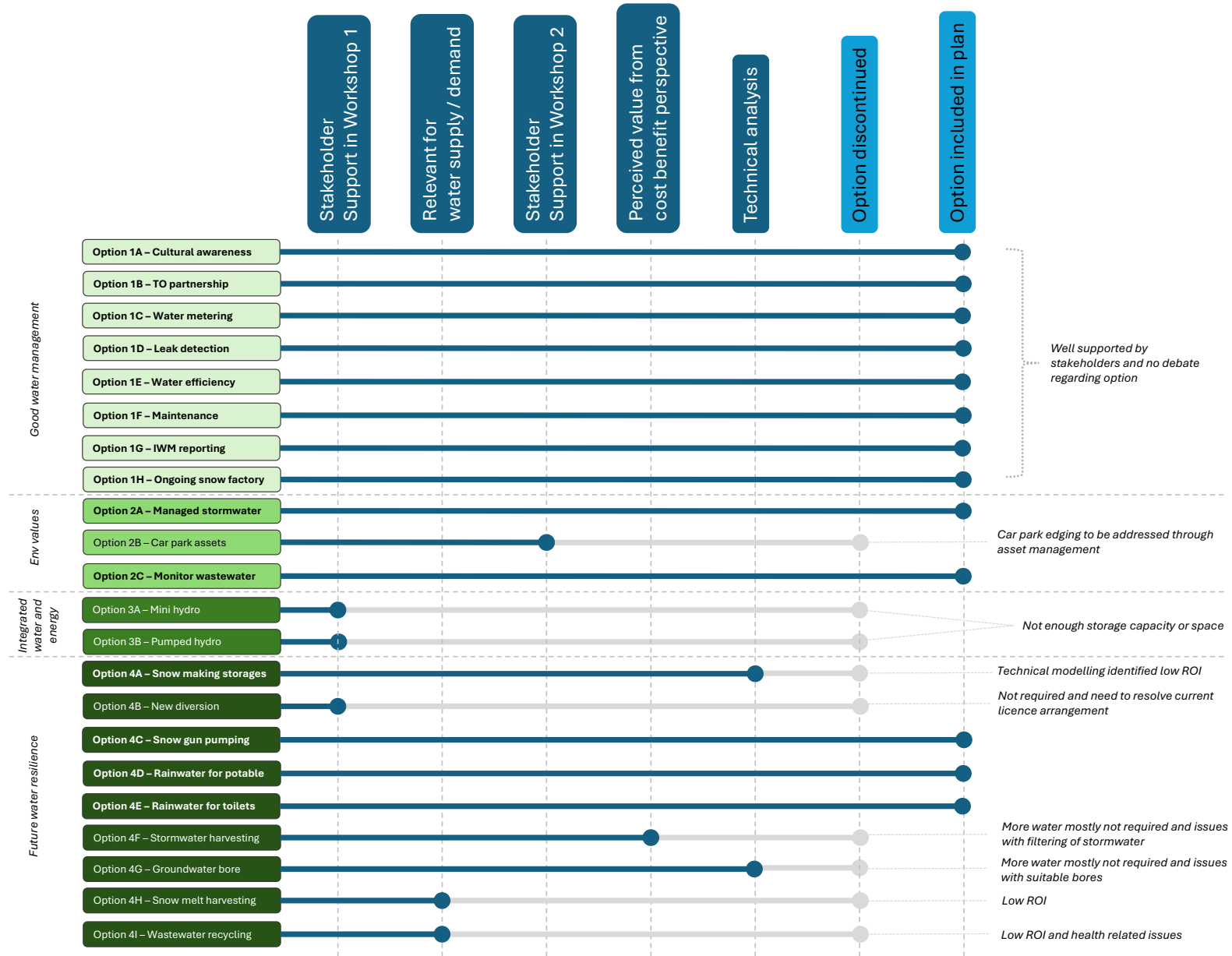


Figure 18. Summary of support for options

Water management options supported by ARV and resort stakeholders, perceived to represent value (from a cost-benefit perspective), and considered technically viable are presented in Section 6.2. Options that were initially considered but not pursued are listed below (Table 1).

Table 1. Options not pursued

Option Name	Description	Reason not pursued
Wastewater recycling	Option to filter and reuse treated wastewater for snow making.	There are adequate supplies for snowmaking, other more feasible options are preferred, and this option requires significant capital expenditure and ongoing maintenance and cost.
Mains water connection	Option to extend the potable water network (from Marysville) to Lake Mountain and therefore provide a potable water source to the resort, for drinking, buildings and snow making.	This is a 24 km route by road, and this is a particularly expensive option, with other options preferred over this.
Stormwater harvesting	Harvesting of stormwater from the two main car parks for reuse in toilet flushing and/or snow making	Rainwater harvesting for potable use was considered to be a better option, but in the future stormwater harvesting could be explored with the potential of between 5 and 50 ML / year of available water (with appropriate treatment and a location to store collected stormwater).

## 6 Options analysis

### 6.1 Modelling method

Water management options for Lake Mountain 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. These options are discussed in Section 7.

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

- The resort uses a total of 3 - 4 ML of water per year (1.7 ML / year of non-potable water for buildings and operations; 1.7 - 2.8 ML / year of non-potable water for snow making).
- Maximum (peak) visitation is 5,000 people per day
- The resort manufactures snow at Village Run and Mini-Run (a total area of 3,800 m<sup>2</sup>).
- The resort could make snow to cover Koala Creek, Snow Play and/or Toboggan area, an additional area of 3,450 m<sup>2</sup>.
- 500 L of water is required to manufacture one cubic metre of snow.
- Water is diverted from a 54-hectare forested catchment via the Taggerty River into three storage tanks (800 kL total capacity).
- Rainfall records at Marysville (the closest rainfall station with daily data) were used to model rainwater use patterns; mean annual rainfall at Marysville for the modelled period was 1,548 mm.
- Hourly temperature, humidity, wind, and wet bulb data for Coldstream (the closest station with hourly data) were used to model snow making conditions. There is a significant distance from the site to this weather station, but it still provides a good basis to identify appropriate weather conditions for snow making and melting.

- Snow making via snow guns was modelled to occur when the wet bulb temperature at Coldstream was less than -2 or -1 degrees (assumed to equate to -3 degrees at Lake Mountain given the higher elevation).
- Snow making via the Snow Factories can occur at any temperature up to around 25 degrees.
- It is assumed that up to 100 cm of snow would be made under ideal conditions (conducive weather conditions in mid-winter, available water volume and pump rate are equal to or greater than the demand).
- Snow melt was modelled using a 'degree days' function that varies with temperature (i.e. a higher Degree Days Factor for a higher temperature). Snow melt function (applied at every time step):  $y = 0.2415 e^{-.1004x}$  (where  $y$  = cm of snow melt, and  $x$  = temperature).<sup>24</sup>

The modelling method enables an assessment of how water is currently managed, and how climate change may impact future water management – including water storage and water demand, to support visitation and the visitor experience. The figure below illustrates the reducing frequency of cold nights (a key factor for the use of snow guns for snowmaking operations).

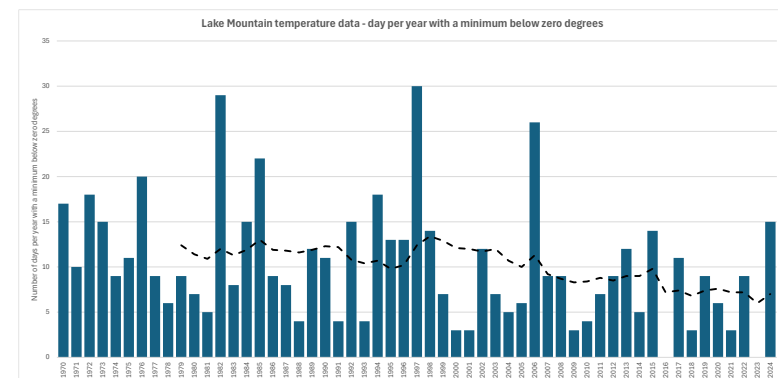


Figure 19. Lake Mountain minimum temperatures (the dotted line is the running average over 10 years, showing a reduction in the number of cold nights)

<sup>24</sup> 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 cultural values of water)

This option supports broader and deeper awareness of Taungurung and Wurundjeri Woi-wurrung cultural values of water in alpine landscapes, as well as connections to Country via the Goulburn River and Birrarung / Yarra River. 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 Traditional Owners / Custodians, subject to their self-determined priorities and capacity.

**Category:** Good Water Management

**Who benefits:** ARV, resort visitors, Taungurung, Wurundjeri Woi-wurrung

**Costs:** To be determined (dependent on the scope of specific initiatives and level of Traditional Owner / Custodian involvement)

**Alignment with IWM Outcomes and ARV Objectives:**



**Risks / Uncertainties:**

- Taungurung and Wurundjeri Woi-wurrung 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 Owners.

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

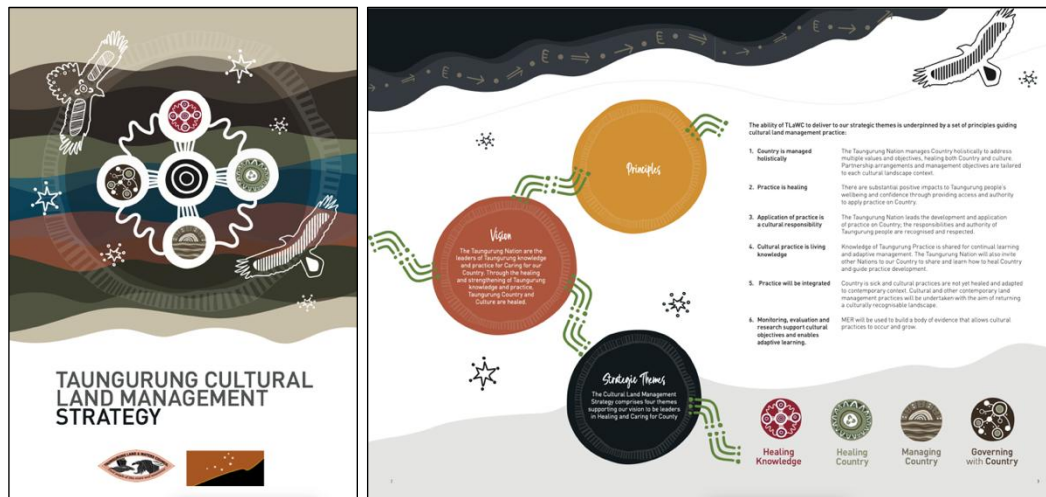
Consider, in partnership with Taungurung and Wurundjeri Woi-wurrung, resort-based water management initiatives that support implementation of relevant Traditional Owner/Custodian strategies. For example, opportunities identified in the Taungurung Cultural Land Management Strategy (2023) include reading water country, assessing values, identifying important waterscapes and applying flow regimes to heal and strengthen cultural values.

Initiatives should align with ARV's Traditional Owner Self-Determination and Engagement Strategy (in-development).

**Category:** Good Water Management

**Who benefits:** ARV, Taungurung, Wurundjeri Woi-wurrung

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



**Alignment with IWM Outcomes and ARV Objectives:**



**Risks / Uncertainties:**

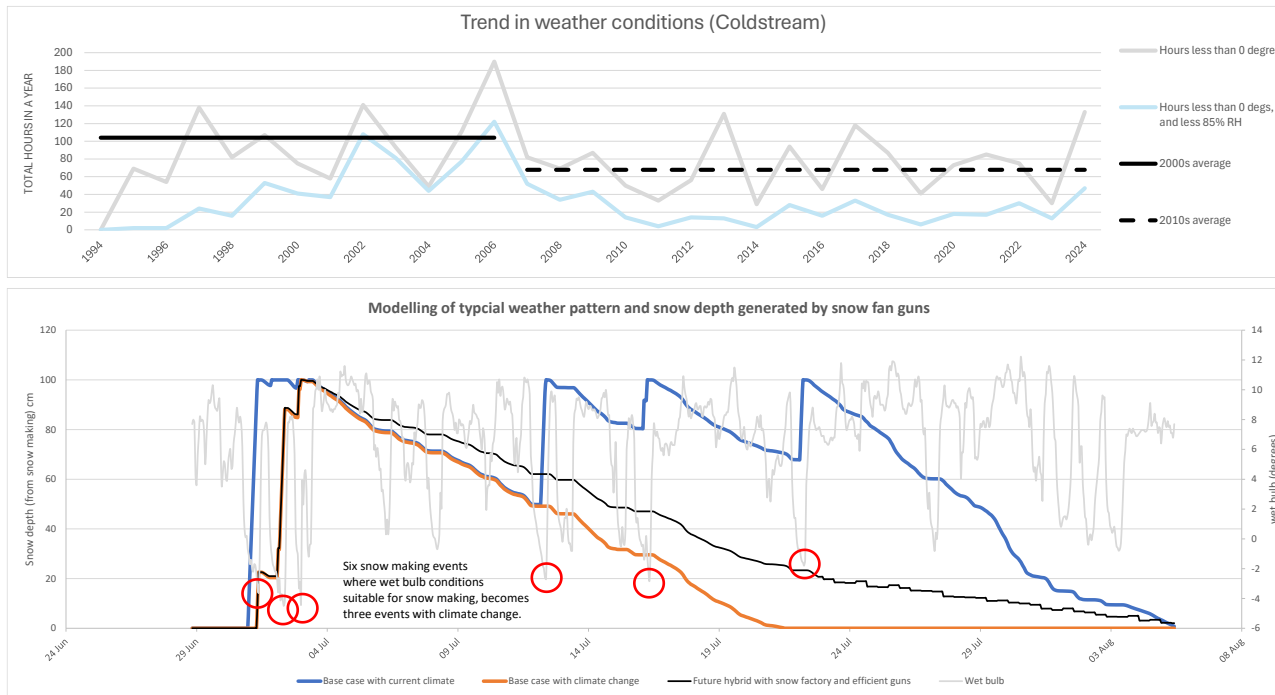
- Taungurung and Wurundjeri Woi-wurrung involvement will be self-determined, informed by their priorities and capacity.
- Identification of specific initiatives was not possible at the time this plan was prepared.

**Summary:**

Working with Taungurung and Wurundjeri Woi-wurrung on cultural land management initiatives supports ARV obligations and aspirations to work in partnership with Traditional Owners.

### 6.2.3 Option 4A: New storage for snow making

This option adds a new storage tank to double the capacity of water available for snow fan guns, considering the reduced number of hours per year suitable for snowmaking. This assumes that weather conditions will reduce the hours available for snow making, and that the Taggerty River diversion can support the filling of additional storage. Note that the use of snow factories are not constrained by these weather and climate factors.



#### Risks / Uncertainties:

- More space may be required (and planning approval), and there may be adverse impact on the local environment for storages. Possible to reuse existing storage tank, if a new rainwater harvesting system is introduced as per option 4D.
- Power consumption may significantly increase during snow making periods.

#### Summary:

- Additional storage provides more water for snow making but has no material benefit for snow making in the figure due to modelled impact of climate change. Additional water storage will be beneficial in extreme dry conditions as a firefighting resource.
- Investment makes minimal difference, so there is virtually no benefit to pursuing this option.

**Category:** Future Water Resilience

**Who benefits:** With no benefit to increasing the storage capacity, there are no benefactors.

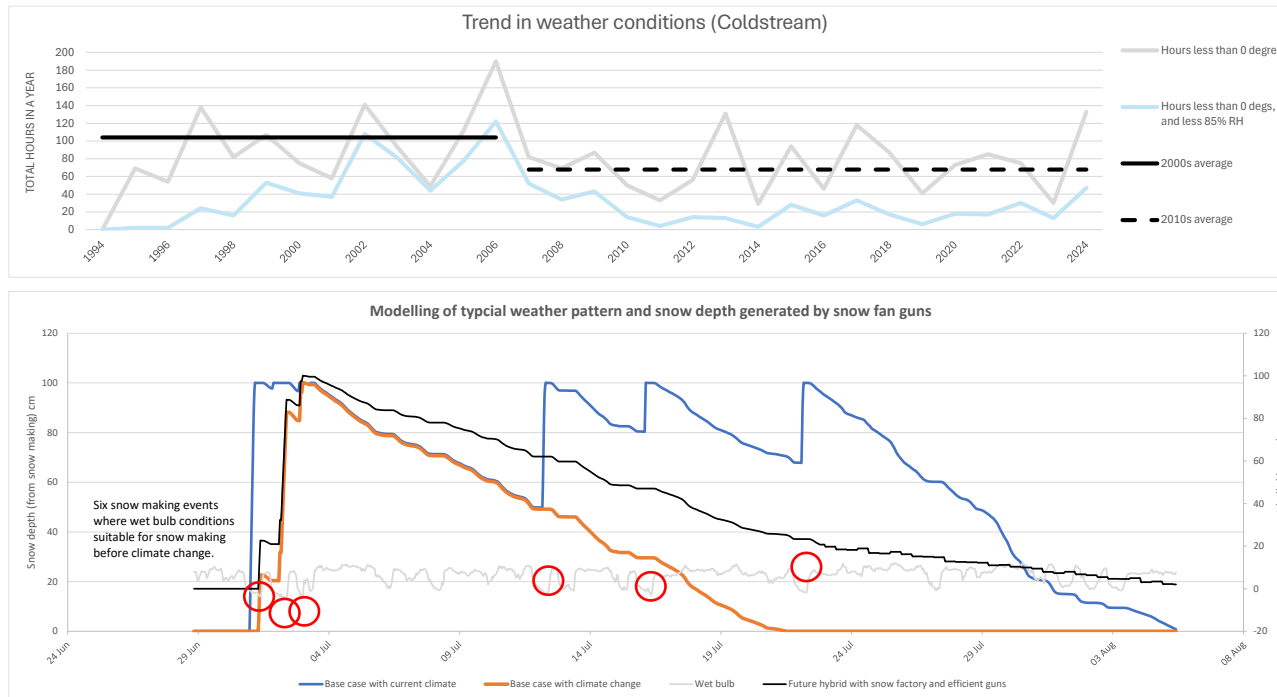
**Costs:** \$250k+

**Alignment with IWM Outcomes and ARV Objectives:**



### 6.2.4 Option 4C: New pump and distribution infrastructure for snow making

This option adds new pumps, snow guns, and distribution lines to allow for more snow production in a shorter period, in the context of a reduced number of hours per year to make snow. This assumes that weather conditions will reduce the hours available for snow making and that the Taggerty River diversion can support using more water in a shorter period. The result is that snow making, and snow coverage changes increase by around 1%, and climate change has the biggest impact on the ability to make snow (similar to the previous option on new storage for snow making).



#### Risks / Uncertainties:

- Significant infrastructure upgrades are needed (and increased power consumption) but is risky in terms of investment that explicitly acknowledges less time for snow making.
- Planning approval will be needed if any disturbance of the landscape is required for new trenches and snow guns.

#### Summary:

Additional pumping creates more snow through the snow fan gun network, in a shorter period and will allow more snow to cover areas such as Koala Creek, but is mostly affected by the variability in snow making conditions (just as the option above on water storage was). The resort would be best to look at this hybrid approach that relies on snow factory all season, and efficient snow guns.

**Category:** Future Water Resilience

**Who benefits:** Marginal increased coverage and depth of snow, with the visitors being the main benefactors.

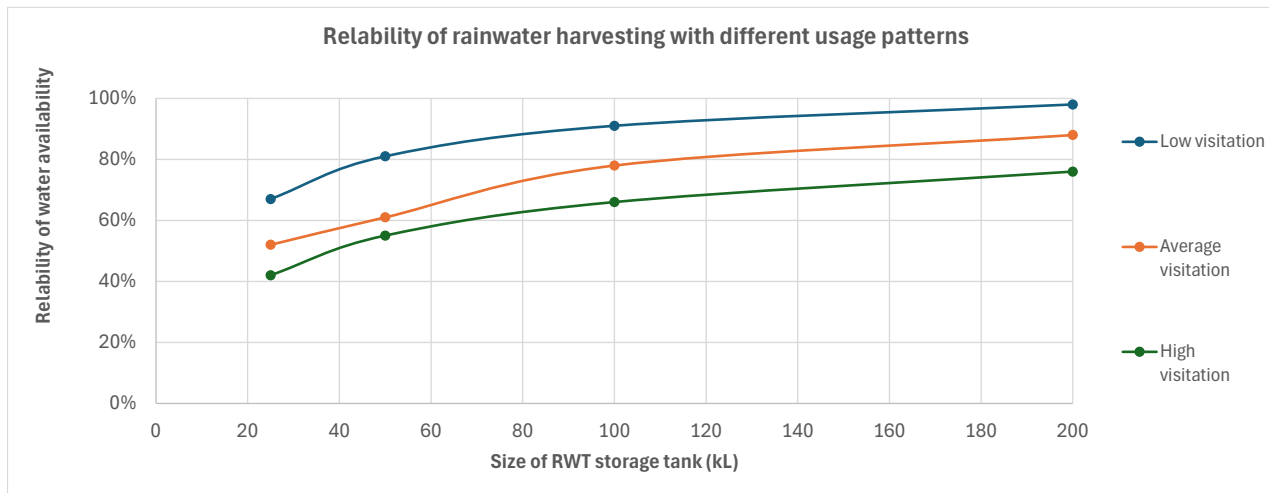
**Costs:** \$500k+

**Alignment with IWM Outcomes and ARV Objectives:**



### 6.2.5 Option 4D: Rainwater harvesting for potable drinking water source use

This option is to build a new rainwater harvesting system that collects water from both resort buildings (administration and bistro), into a 200 kL partly underground tank, located on the low side of the bistro adjacent to the tube ride area), and treat this water to potable standard and reduce the reliance on the Taggerty River offtake water. A larger tank would ensure that treated rainwater is available for most peak seasons, but there is a point when increasing the tank capacity will not deliver additional benefits. On average this could yield 1.3 ML (of a total 1.7 ML / year demand for potable and workshop needs).



#### Risks / Uncertainties:

- Risk of introducing more cost and work related to potable treatment plant maintenance
- Assumes that Taggerty River can continue to supply back up water when rainwater is insufficient for peak season demands.
- Assume that there is available space to introduce a new rainwater tank adjacent to the car park and the tube run.
- Requires engineering solution for rainwater capture that is not impacted by snow shed (already used in Mt Stirling so this risk should be managed)

#### Summary:

This option creates an alternative water supply and will reduce pressure on the use of the extraction from the Taggerty River for potable use by 85%, while increasing options for water use for snow making and reducing stormwater runoff.

**Category:** Future Water Resilience

**Who Benefits:** ARV, resort visitors, and downstream environmental users through additional flows in Taggerty River.

**Costs:** \$500k for tank + \$100k for guttering and pipe work + 150k for treatment plant

Noted (Depends on tank location, geology, above or underground tank, guttering, and type of treatment system).

#### Alignment with IWM Outcomes and ARV Objectives:

##### Objectives:



### 6.2.6 Option 4E: Expand the rainwater tanks for remote buildings

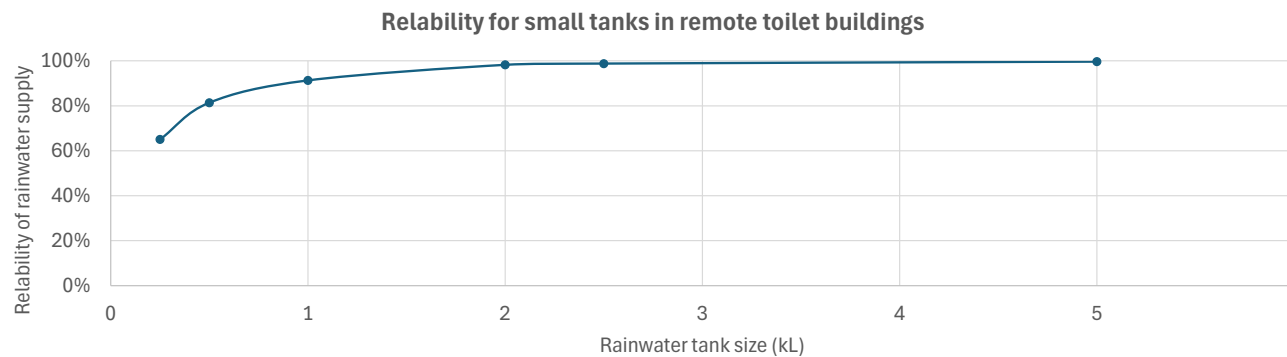
This option is to supply toilets at the Resort entry and other remote buildings with rainwater tank systems, to replace the diversions and piping network that is used to currently flush toilets at these buildings. The option modelled the benefit of a 2kL to 8kL rainwater tank, collecting water from the roof of the toilet block itself, to flush toilets, on the basis that it would deliver 95% plus reliability of supply (with little impact from increasing the size of the tank). A 5-kL tank would be worth adopting for this use.

**Category:** Future Water Resilience

**Who Benefits:** ARV, resort visitors, and downstream environmental users.

**Costs:** \$15 - \$35k

**Alignment with IWM Outcomes and ARV Objectives:**



**Risks / Uncertainties:**

- Little risk to this option due to the adoption of a well-known strategy to manage water locally.
- Requires access to electricity for the pump

**Summary:**

This option would yield 10 to 20 kL a year and will reduce pressure on the use of the extraction from the Taggerty River, while avoiding the maintenance of the existing pipe network and other operations issues (e.g., freezing, impact from treefall).

## 7 Recommendations

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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. 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 ARV and IWM objectives and align with the vision of an integrated water management approach at Lake Mountain.

These are listed below priority order, based on stakeholder discussions in the workshop, to ensure the most cost effective and impactful actions are addressed first.

#### Good Water Management

- **#1. Building cultural understanding and two-way knowledge sharing** [Option 1A & 1B]  
It is recommended that ARV and Lake Mountain representatives work closely on the partnership with the Taungurung traditional owners to build on the understanding of cultural values and water related opportunities.
- **#2. Water metering** [Option 1C]  
It is recommended that real time metering be deployed from the storage tank, and into the two buildings and workshop, with the ability for alerts to detect leaks.
- **#3. Water efficiency** [Option 1D]  
It is recommended that all appliances within the building be reviewed for their water efficiency, and upgrades be progressively made. An ongoing focus on the efficiency and technology of snow fan guns that

can produce the same volume of snow with less water use is important for the visitor experience and good water management.

- **#4. Snow factory use** [Option 1H]  
It is recommended to increase the use of the snow factory to enable snowpack on days when snow guns will not operate, noting that maintenance of the snow factory is complex. The increased use of the snow factory must factor in the impact on power consumption, and be delivered using a hybrid approach of snow factory and snow fan guns.

#### Future Water Resilience and Environmental Management

- **#5. Rainwater tanks (RWT) for remote buildings** [Option 4E]  
It is recommended that small rainwater tanks (approx. 5 kL) be designed and installed for toilet flushing at the gate house, as a reliable water source (with the usual treatment and pumps) that would replace the existing 1 km diversion pipe that supplies water for this site.
- **#6. Monitoring of wastewater impacts** [Option 2C]  
Beyond a simple compliance approach, it is recommended that the impact of the current wastewater be closely monitored to ensure there is minimal impact on the downstream environment.
- **#7. Rainwater tank to potable** [Option 4D]  
Undertake a retrofit rainwater harvesting project to collect rainwater off the two main buildings, to treat to potable standard and reuse for all potable water uses. This will involve at least a 50 kL tank. The project must liaise with the regulators prior to the pilot to ensure that this option is the most suitable for potable and all risks understood and managed. This will create a potable water source for the resort and reduce the need for visitors to bring water to the resort and reduce the diversion from the Taggerty River, and reduce stormwater pollution.
- **#8. Stormwater management** [Option 2A]  
Design and build a car park stormwater retention/filtering asset (for the northern car park) to reduce the stormwater volume and associated pollutants entering local creeks. 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 [Option 1B]. This will protect local car park assets as well. Additional planting and the strategic use of rock in gullies and in areas experiencing a headcut near alpine assets, are also options to reduce the risk of erosion.

## 7.2 Not recommended

Options to create more snow through the six or more snow guns, by either adding more water storage or upgrading infrastructure, has little or no benefit to the ability to create snow at this altitude and with the modelled climate pattern. **Therefore Options 4A (doubling snowmaking tank capacity) and Option 4C (expanding snowmaking infrastructure capacity) are not recommended.** Instead, a focus on the use of the snow factory is appropriate that may only cover a smaller area but is climate independent. Water supply modelling indicates that the Taggerty River allocation is sufficient for all uses, so options like stormwater harvesting, wastewater recycling, and groundwater diversions are not currently recommended. However, these may require future consideration as visitation and climate patterns evolve.

## 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 2. 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 - TO	<ul style="list-style-type: none"> <li>Continue to explore how to engage with the Taungurung.</li> </ul>	Cultural and community values	Good water management	Not determined	ARV	NA
Immediate	Option 1H – snow factory	<ul style="list-style-type: none"> <li>Continue use of the snow factory, and explore options for more automated running of the snow factory to reduce down time and maintenance burden</li> </ul>	Sustainable asset management	Good water management	Ongoing opex.	ARV	NA
Immediate	Option 2C – wastewater monitoring	<ul style="list-style-type: none"> <li>Once a permit is approved, undertake appropriate monitoring of the absorption pits and visual inspection (and photography) of downstream waterways for algal growth, near the wastewater treatment plant.</li> </ul>	Environmental management	Environmental management	Ongoing opex.	ARV	NA
Short term (1 to 3 years)	Option 1C - metering	<ul style="list-style-type: none"> <li>Add at least four water meters (one from the tank, and three individual sub meters into the bistro, admin and workshop buildings), and meter the snow fan guns, snow factory, and sewage volumes and store that data in a log for daily or weekly recording of meter readings.</li> </ul>	Water efficiency	Good water management	\$5,000	ARV	NA
Short term (1 to 3 years)	Option 1D & 1E - metering	<ul style="list-style-type: none"> <li>Efficiency and leak detection. Systematically review every tap, toilet, hose and water outlet to ensure all units maximise water efficiency (as per minimum WELS rating of 4 stars) and</li> </ul>	Water efficiency and sustainable asset management	Good water management	\$5,000	ARV	0.17 ML / year

Timing	Name / Option	Task(s)	Link to objectives	Theme	Indicative cost	Lead	Water savings (ML / year)
		water efficient flow restrictors in place, over a 3-year period.					
Short term (1 to 3 years)	Option 2A – Erosion protection	<ul style="list-style-type: none"> <li>Identify specific areas where the placement of old logs or coir logs would be useful to retain sediment and leaf litter and reduce erosion risk and sedimentation from carpark 1 and 2. Locations must be below the edge of the asphalt, to ensure winter machinery is not impacted when clearing snow from the car park.</li> <li>Monitor effectiveness of these stormwater interventions.</li> </ul>	Environmental management and sustainable asset management	Environmental management	\$10,000	Goulburn Broken CMA, ARV	NA
Short term (1 to 3 years)	Option 4E – Remote rainwater harvesting	<ul style="list-style-type: none"> <li>Design and install rainwater harvesting tanks at resort entry</li> <li>Use qualified plumber for compliant installation</li> </ul>	Safe, secure, affordable water supplies	Future water resilience	\$25,000	ARV	0.1 ML / year
Medium term (4 to 10 years)	Option 4D – Rainwater harvesting for potable	<ul style="list-style-type: none"> <li>Undertake detailed design of tank and treatment plant (as well as distribution lines and guttering) to create a detailed plan for costing.</li> <li>Review cost benefit of proposed detailed design</li> </ul>	Safe, secure, affordable water supplies	Future water resilience	\$750,000	ARV, GM Water, DEECA, Dept of Health	1.3 ML / year
Long term (10+ years)	-	<ul style="list-style-type: none"> <li>Revisit the option for stormwater harvesting, wastewater recycling, and groundwater bores to create alternative supplies for potable and snow making demands.</li> </ul>	Safe, secure, affordable water supplies	Future water resilience	NA	NA	NA
Long term (10+ years)	-	<ul style="list-style-type: none"> <li>Revisit the need for increased snow making at the resort, and if the capture of snow melt could support increased snow making.</li> </ul>	Safe, secure, affordable water supplies	Future water resilience	NA	NA	NA

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## Appendix A. Workshop 1 summary report

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## Appendix B. Workshop 2 summary report

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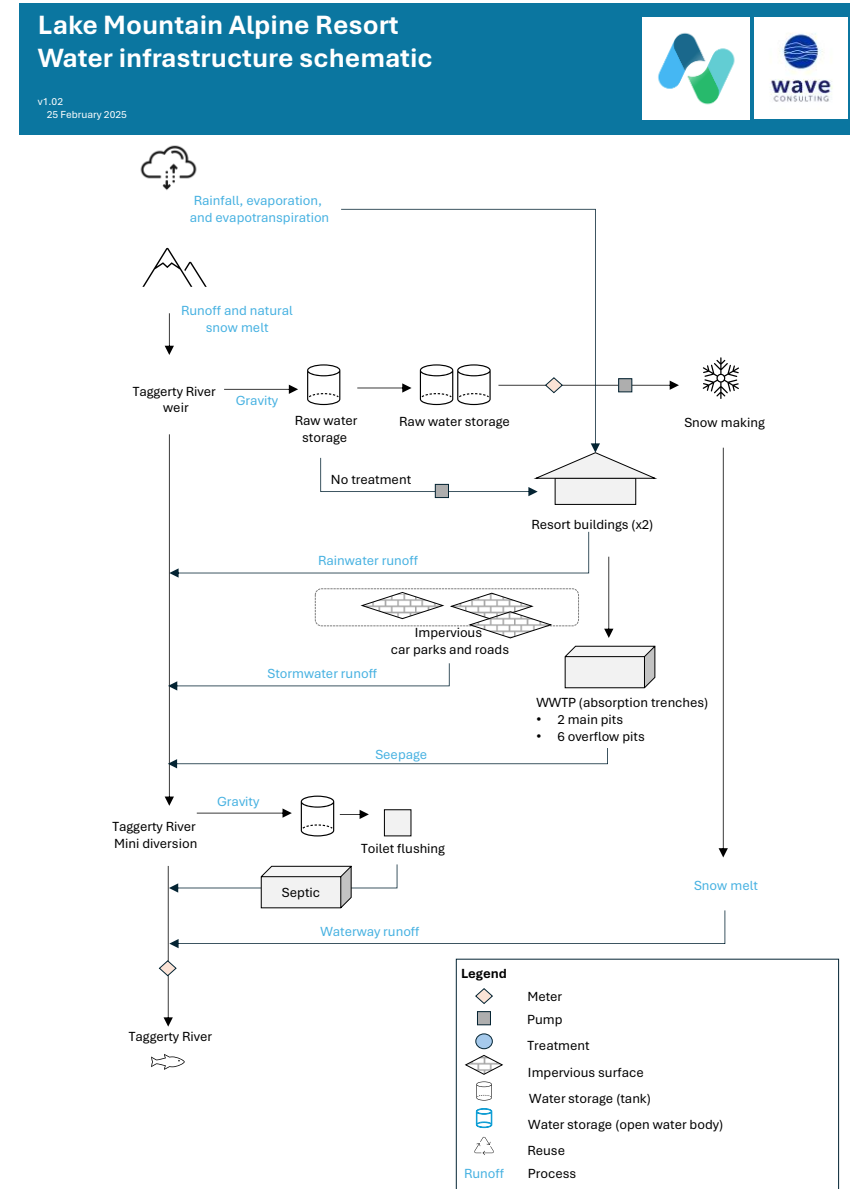
## Appendix C. Available data

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 3. Data sources and records

Variable	Source	Start	End
<b>Snow (natural)</b>	ARV - Lake Mountain Snow Depths & Visitor Numbers.xls	1993	2017
<b>Snow (making)</b>	Lake Mountain Snow Depths & Visitor Numbers.xls	2016	2017
<b>Potable consumption</b>	Not provided	-	-
<b>Recycled water</b>	Not applicable	-	-
<b>WWTP discharge</b>	Not metered	-	-
<b>Rainfall</b>	BOM - Marysville station 88044	1904	2024
<b>River levels</b>	Vic Govt Water Warehouse - ACHERON @ TAGGERTY	1973	2024
<b>Temperature (min and max)</b>	BOM - Lake Eildon – 88023 & BOM - Coldstream - 086383	1970	2024
<b>Temperature (hourly)</b>	BOM - Coldstream - 086383	1994	2024
<b>Humidity (hourly)</b>	BOM - Coldstream - 086383	1994	2024
<b>Wind (hourly)</b>	BOM - Coldstream - 086383	1994	2024
<b>Visitor days - winter</b>	ARCC_Annual_Winter_VisitorDays_Historical_Records_from_1985.csv	1985	2024
<b>Visitor days - summer</b>	ARCC-Summer-18.19-vis-nos-and-vehicle-countB.csv	2007	2024
<b>Assets - tanks etc</b>	ARV geospatial data	-	-
<b>Assets - stormwater</b>	ARV geospatial data	-	-
<b>Assets - impervious</b>	ARV geospatial data	-	-

## Appendix D. Water schematic



## Appendix E. Traditional owner's summary

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