Mt Buller and Mt Stirling Alpine Resort Management Board

Mt Buller Sustainable Water Security Project - Off-stream Storage

July 2014

Table of contents

Table index

Figure index

Appendices

1. Introduction

1.1 Background

The water requirements of the Mt Buller Resort are determined by the need to service the resident and visitor populations, and to maintain the amenity of the Resort during winter for skiing and snow-play. The Alpine Resorts Strategic Plan and the Master Plan in place for Mt Buller Mt Stirling Alpine Resort (the Resort) propose not only an increase in total visitor numbers, but also an increase in visitation outside the peak winter period..

The annual water demand for Mt Buller is influenced by climatic conditions and varies significantly from year to year. The Mt Buller Mt Stirling Resort Management (RMB) has an obligation to provide a secure and reliable water supply to the Resort and the RMB has established the Mt Buller Sustainable Water Security Project which encompasses a series of projects to meet the objectives of this strategy.

Based on a number of previous investigations and reviews, the RMB have determined that a 100 ML on mountain storage is required to meet future potable and snow making water demands. Investigations into water supply and potential water storage locations have been undertaken periodically by the RMB over the last decade and a range of options and sites for water supply storages have been assessed.

GHD were commissioned to advance the off stream storage project which includes:

- Finalising the siting and concept design of an appropriate storage dam and associated supply infrastructure.
- Compiling and submitting a planning permit application for the project.

1.2 Purpose of this report

This report: has been prepared by GHD for Mt Buller and Mt Stirling Alpine Resort Management Board and may only be used and relied on by Mt Buller and Mt Stirling Alpine Resort Management Board for the purpose agreed between GHD and the Mt Buller and Mt Stirling Alpine Resort Management Board as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Mt Buller and Mt Stirling Alpine Resort Management Board arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The purpose of the report is to:

- Review the water supply demand and water supply system at Mt Buller for the purposes of the off stream storage project.
- Prepare concept design options for delivery of raw water to a new off stream storage.

1.3 Objectives

The objectives of the concept design included:

Supply Demand

- Determine likely maximum volumes of potable water and snow -making water use in resort - reassess GHD 2013 assumptions and revised
- Provide additional information beyond that in the GHD report 2103 on the factors influencing snow making demand to better understand annual variability and future

demand volumes.- consult with management and operational staff from Ski Lift Pty Ltd, revised GHD 2013 estimates

- Review timing of future snow making infrastructure improvements to better inform decision making about scheduling of future water supply works - revise long term supply-demand balance and timing

Water Supply System

- Prepare report on condition and capacity of existing water off- take and raw water delivery infrastructure including all raw water storages e.g. Burnt Hut and underground tank.
- Review suitability of existing infrastructure for delivery of raw water to a new off- stream storage.
- Prepare report on condition and capacity of existing off - stream storage to reticulation system delivery infrastructure including disinfection and chlorine dosing facilities.
- Identify potential efficiencies of amalgamating existing multiple treatment facilities.
- Review capacity and suitability of existing infrastructure for delivery of treated water to the village potable reticulation system and snow making system.

1.4 Scope and limitations

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

GHD has prepared this report on the basis of information provided by Mt Buller and Mt Stirling Alpine Resort Management Board and others who provided information to GHD (including Buller Ski Lifts), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

2. The Mt Buller Water Supply System

2.1 Overview of the supply system

The water requirements of Mt Buller are determined by the need to service the resident population, the visitors to the Resort and maintaining the amenity of the Resort during winter for skiing and snow-play. The population of the Resort varies throughout the year. Mt Buller's resident population during summer is 100 – 150 people, increasing to approximately 1,600 residents during the ski season (RMB 2011). The resident and visitor population require a supply of potable water for domestic and commercial purposes. Water is also used at Mt Buller for snowmaking purposes to improve snow cover in lower lying or highly used areas. The annual demand is dependent on the climate conditions and varies substantially from year to year.

The Mt Buller water supply system receives water from two main sources; diversions from Boggy Creek (and its tributaries), and Class A recycled water from the Mt Buller Wastewater Treatment Plant. The streamflow diverted from Boggy Creek is used to supply potable water demands within the Resort, and any water in excess of these needs can be used for snowmaking. The Class A recycled water is used for snowmaking purposes only. A third source of supply is obtained from a diversion which occurs on a tributary of the Howqua River into Sun Valley Reservoir. This is a temporary diversion arrangement, with the infrastructure owned and operated by Ski Lifts Pty Ltd.

Water diverted from Boggy Creek is stored in Burnt Hut Reservoir prior to being distributed through the high and low level reticulation systems. Disinfection occurs for the High Level System after leaving Baldy Tank, and for the Low Level System as it leaves Burnt Hut Reservoir. Water that is in excess of the potable needs is transferred from Burnt Hut to Sun Valley Reservoir.

The Class A recycled water produced by the Mt Buller Wastewater Treatment Plant is transferred to Sun Valley Reservoir to supplement the snowmaking supply. For public health purposes the Class A recycled water cannot be used to supply potable demand and cannot be used on areas which fall within the potable water supply catchment area.

A schematic of the Mt Buller water supply system is shown in Figure 1.

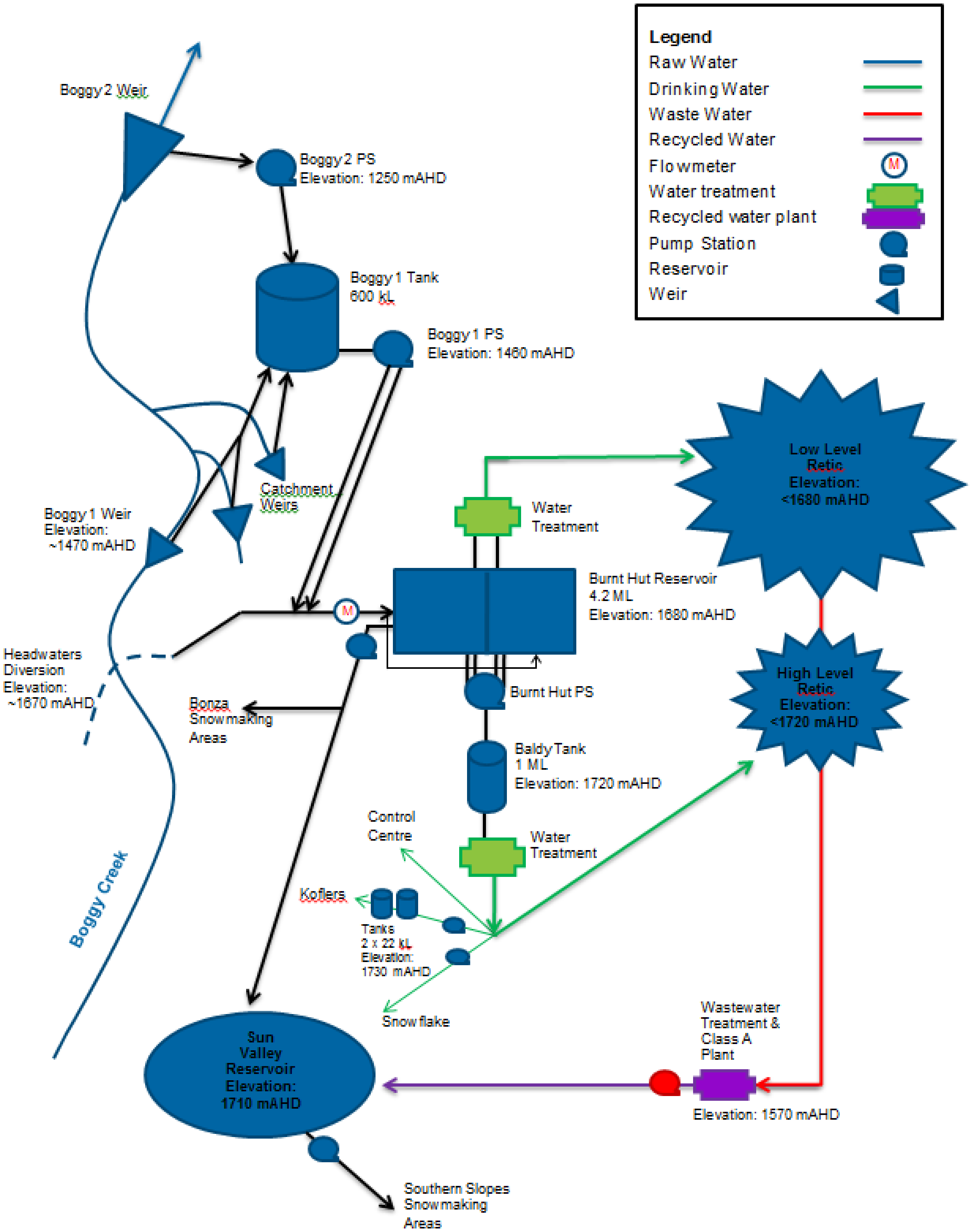


Figure 1 Mt Buller Water Supply System Schematic

2.1.1 Streamflow diversions

Water for the Mt Buller supply system is diverted from Boggy Creek (and its tributaries) at three separate locations. The diversions from Boggy Creek occur under a Section 51 Annual Diversion Licence which allows up to 700 ML to be diverted each year between the months of May to October (inclusive) at a maximum diversion rate of 4 ML/d. The following temporary arrangements have been established:

1. On (date), an exemption was obtained which permits diversions to meet summer potable demands to occur between November and April, until 2013.
2. A temporary transfer of 30 ML from the existing licence volume has been approved which enables water to be diverted from an existing diversion site located on an unnamed tributary of the Howqua River.

Boggy Creek forms part of the Delatite River catchment, which is a tributary of the Goulburn River. The Boggy Creek catchment is the northeast aspect of Mt Buller and is bounded by two spur lines running north. The catchment is above 1,250 m elevation and is mainly covered in snow during the winter period, mid-June to mid-September. The topography of the catchment is steep and vegetated, and lies in montane, sub alpine and alpine areas. The catchment is relatively inaccessible and is an area where vehicle access is controlled. In winter, the water sourced from the catchment is either snowmelt or spring fed streamflow. In summer the majority of the flow in the river is spring fed streamflow (RMB 2011).

Diversions from Boggy Creek catchment occur at three locations. These are:

- The Headwaters of Boggy Creek– a side hill trench across the northeast aspect of Mt Buller that collects water that has originated from alpine bogs. This water can be gravity fed into Burnt Hut Reservoir.
- Catchment Weirs – two weirs that collect water from a number of small gullies within the Boggy Creek catchment. This water is gravity fed into the Mt Buller system, and
- Boggy Creek Weirs - two weirs that divert water from Boggy Creek. One weir gravity feeds into Boggy 1 Tank and other requires the water to be pumped from the Creek into Boggy 1 Tank.

The three sources of supply are shown in Figure 1.

The Headwaters provide raw water at a higher elevation than Boggy Creek and can be used when appropriate to minimise pumping costs. If there is sufficient capacity and raw water quality, the Headwaters are used preferentially to Boggy Creek (RMB 2011), although it is noted that the diversion has not been used in recent years due to the relatively poor water quality.

Streamflow has not been gauged at any sites and therefore there are no long term flow records.

Diversions from Boggy Creek are currently metered through a Goulburn Murray Water owned meter which is located on the inflow pipe to Burnt Hut Reservoir. Diversions from the Howqua River are currently not metered.

2.1.2 Recycled water

The Mt Buller Water Recycle and Conservation Project was completed in 2008 and provides recycled water as a supplementary supply for snow making.

The recycled water supply for Mt Buller is sourced from the Mt Buller Wastewater Treatment Plant. This plant receives wastewater from the Resort and treats it using a combination of secondary treatment processes and ultrafiltration to produce Class A recycled water. Class A recycled water is of sufficient quality to be used for snowmaking purposes, but cannot be used for drinking. Class A water is not used on snowmaking areas which are located within the Boggy Creek water supply catchment.

The Class A recycled water is produced during the winter months and stored in Sun Valley Reservoir. This storage is separate from the potable water supply system to ensure that the potable water supply is not contaminated by Class A recycled water.

2.2 System constraints and limitations

The Water Supply Demand Strategy for Mt Buller, Mt Stirling and Mirimbah Water Supply Systems (GHD 2013) assessed the ability of the system to meet demands, now and into the future. The Strategy identified the following limitations with the existing system:

- There is no ability to store water over the summer period to meet potable demands, resulting in the continuation of long term historical practice of diverting water during summer months. This practice is currently undertaken as part of a temporary exemption to the existing winterfill period diversion licence condition.
- The reliability of existing system is low during low inflow years. This is particularly problematic if this coincides with years where natural snow coverage is also poor.
- Water use occurs at rates in excess of 10 ML/d. Diversions are only permitted up to 4 ML/d. The existing 70 ML of raw water constraints water use in peak snow making periods.

2.3 Options for improving system reliability

The Mt Buller Water Supply Demand Strategy (GHD 2013) identified a range of options for improving system reliability. The preliminary assessment undertaken identified that additional off stream storage was a priority supply option, considered to be the most effective means of balancing the large difference between water use rates and water supply rates.

As part of the concept design investigations, further consideration has been given to the various pumping and offstream storage options available to address the key supply constraint. The options identified include:

Option A – Above snowline offstream storage with current diversion arrangements

Option B – Existing system supplemented with a below snowline dam and new local diversion

Option C – Existing system supplemented with pumping from lower (downstream) reaches of the Howqua or Delatite Rivers (no additional offstream storage)

These options are evaluated in the table below. The peak demand during snowmaking (refer section 4.2.1) is high and will require large diameter pipework and significant energy use (pumping) if large static lifts are required. Therefore the key issues considered in the evaluation are:

- Minimising cost (i.e. reducing the size and amount of new infrastructure required)
- Minimising the impact of construction on flora and fauna (i.e. minimising the amount of large diameter pipework required)
- Minimising energy use (i.e. minimising the amount of pumping required)

Table 1 Option Assessment

Option	Advantages	Disadvantages
Option A – Above Snowline Storage	Storage site close to snow making locations (in distance and elevation) thereby minimising the amount of large diameter pipework and pumping required	Space is required above the snowline for siting of the storage
Option B – Below Snowline Storage	No footprint is required above the snowline for siting of the storage	Storage site away / below the snow making locations requiring long lengths of large diameter pipework and significant pumping
Option C – No Storage	No off-stream storage required	New diversion points away / below snow making locations requiring long lengths of large diameter pipework and significant pumping

Given the high peak demand during snowmaking the preferred option is to locate the off-stream storage above the snowline close to the snow making locations.

3. The Supply/Demand Balance

3.1 Current and future demands

3.1.1 Summary of estimated demands

The demand for water is characterised by significant seasonal (within year) and annual (across years) variability.

The highest demands occur during the winter period (considered to be May to October inclusive) which is attributable to an increased live-in population, high visitation numbers to the resort and high water requirements for snow making. In contrast, demand over the summer period (November to May inclusive) represents about 8% of the annual demand.

Variability in water demand from year to year is related to climatic conditions, particularly over the winter period. However, operational decisions regarding the area of snowmaking and depth of coverage, significantly affect annual water consumption volumes, thus water use can also be high in wet years where snow making areas and/or depths are increased.

Current and future demands estimates were developed as part of the Mt Buller Water Supply Demand Strategy (GHD 2013). These have been revised as part of these concept investigations to incorporate revised assumptions relating to snowmaking water use forecasts, as provided by Ski Lifts Pty Ltd. Table 2 provides a summary of the estimated demands at 2013, 2025 and 2035. The basis for these estimates is provided in the following sections.

Table 2 Current and estimated furture demand – medium growth (in ML)

Type and Season	2013 Estimate	2025 Estimate	2035 Estimate
Potable Demand			
May-October	134	161	161
November-April	33	44	44
Total	**167**	**205**	**205**
Snow Making Demand			
May-October	283	413	481
Total Demand (Winter + Summer)	**450**	**618**	**686**

Figure 2 illustrates the current and estimated future demands, based on expected low, medium and high growth rates.

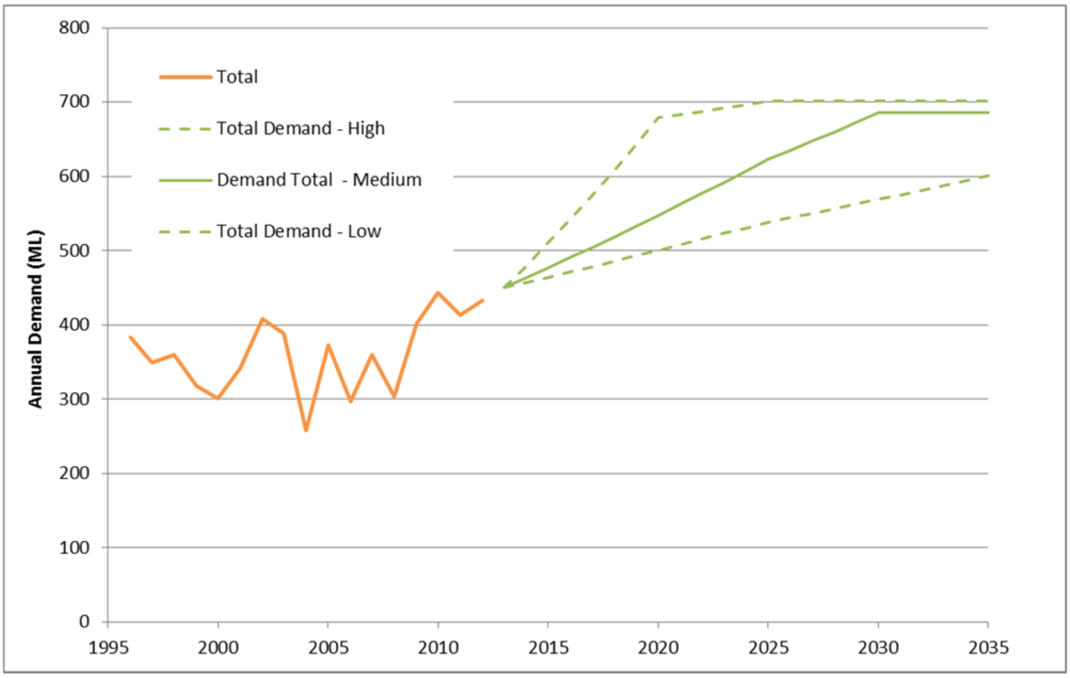


Figure 2 Current and estimated future total demands

3.1.2 Basis for potable demand estimates

Current potable water demand

The current annual average potable raw water demand at Mt Buller is 167 ML/yr. This demand is assumed to be inclusive of all consumptive use and non-consumptive uses such as losses.

The population of Mt Buller varies seasonally, with a large number of visitors to the resort during the ski season. Therefore the water demand for potable water use also varies seasonally, with high water demand during winter months and lower water demand during summer months, as shown by Figure 3.

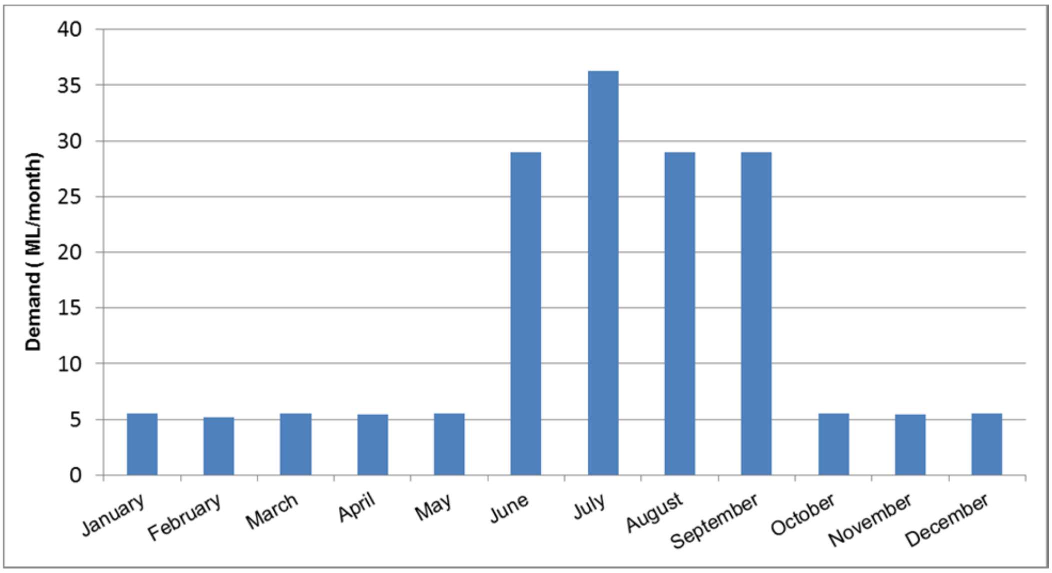


Figure 3 Current average monthly potable demand

There is currently limited information on the annual variability in potable demand. Annual demand is expected to be highly correlated to visitation numbers during the winter period, which is ultimately related to climatic conditions (ie snow coverage).

Future potable water demand

The estimated future potable demand has been estimated based on existing predictions of the growth in permanent population and visitors over the next 10 to 15 years (to say 2025). The details of this estimate are provided in Table 3. It is assumed that there will be no growth in potable demand beyond 2025.

Table 3 Estimated increase in demand (% from 2013/14)

Demand scenario	Summer period (November to April)	Winter period (May to October)
Low growth	20%	10%
Medium growth	32%	20%
High growth	40%	30%

3.1.3 Basis for snowmaking demand estimates

Current snowmaking demand

Snow making is used to supplement natural snow cover on heavily used or lower elevation ski runs and lift access areas. The volumes of water used for snowmaking is largely dependent on climatic conditions, with wind speed, temperature and humidity influencing the efficiency of snowmaking. However, operational decisions regarding the area of snowmaking and depth of coverage, significantly affect annual water consumption. Whilst wetter years may provide adequate snow coverage, increased water availability also provides the opportunity to expand or improve upon the overall amenity for skiing and snow play, thus water use may not necessarily be lower as could be expected. In recent years, the automation of snow making operations has resulted in the significant increase in snowmaking and resultant water use at Mt Buller.

The historical water use for snowmaking is illustrated in Figure 4. There is limited information on the snowmaking areas and depths relating to these years, however generally snowmaking has increased from 43 ha to 72 ha over this period.

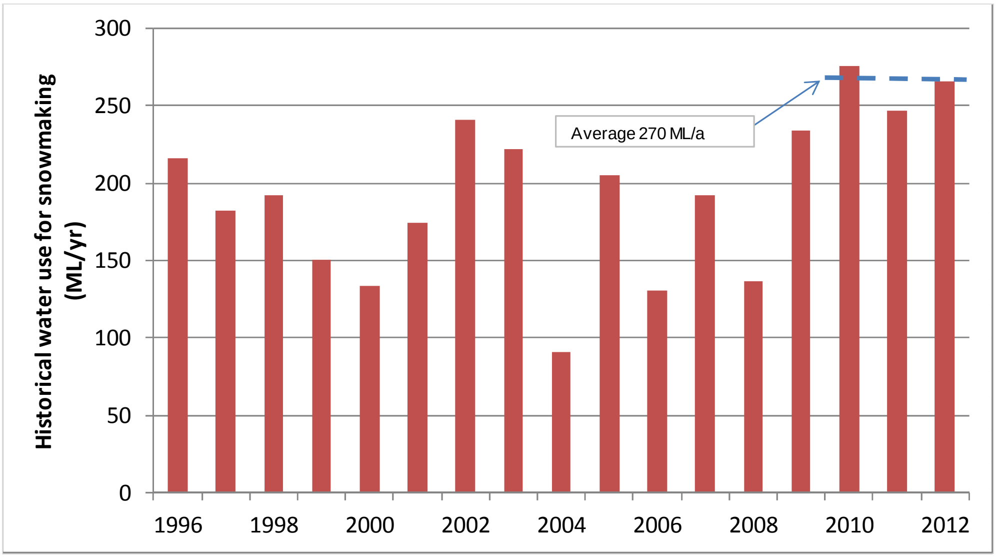


Figure 4 Historical Water Use for Snowmaking

The current average annual snowmaking demand at Mt Buller is estimated to be 270 ML/yr based on the average use over the last four years.

Water use throughout the year is influenced by (in priority order):

- Operational preferences to maximise snow coverage at the commencement of the ski season
- Suitable weather conditions for snowmaking
- The capacity of the snowmaking infrastructure, and
- Water availability

Figure 5 illustrates the historical weekly water use pattern and the patterns which have been adopted for use in a weekly water balance model.

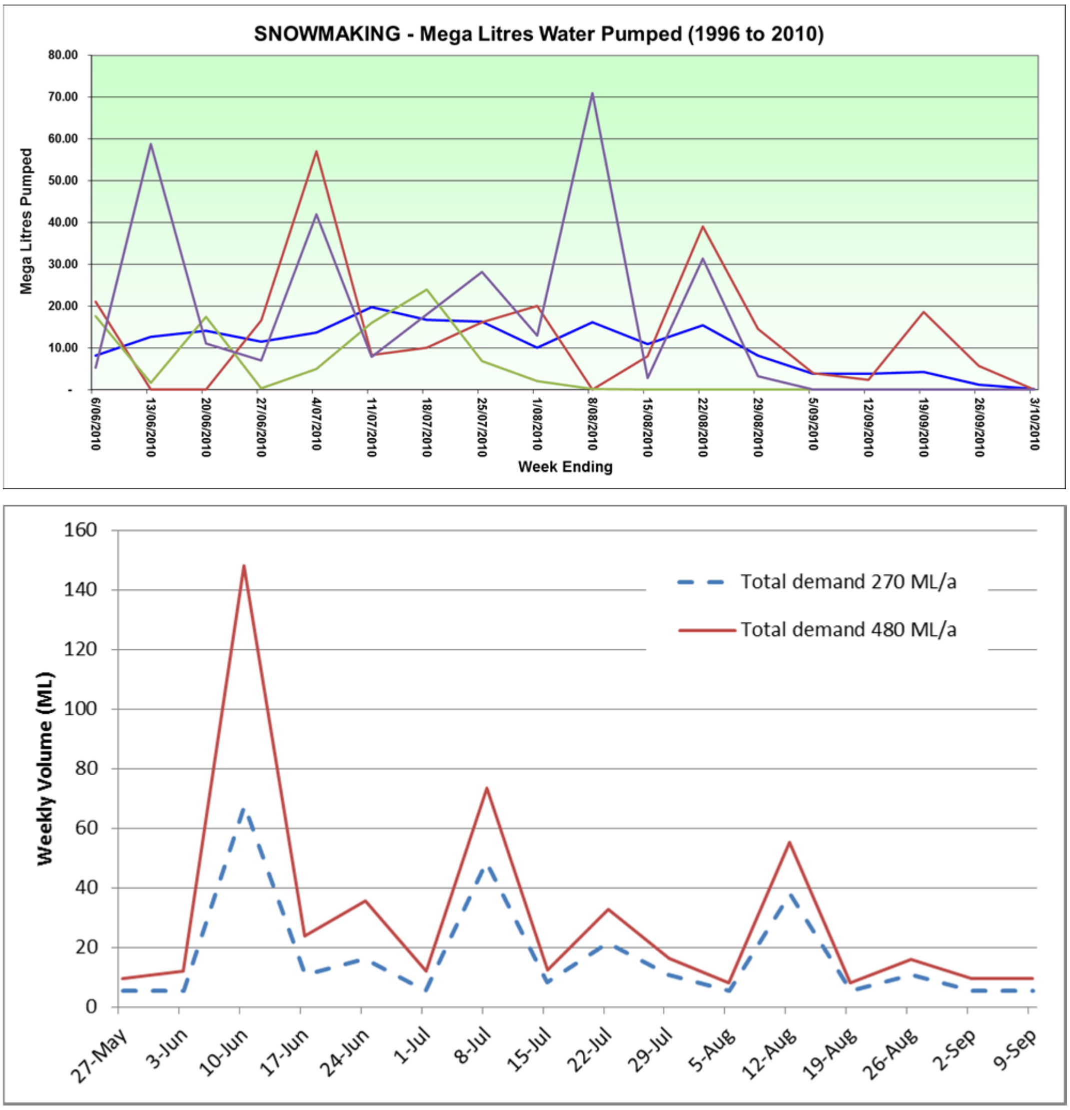


Figure 5 Snowmaking demand patterns

Future snowmaking demand

The snowmaking demand forecast prepared for the Mt Buller Water Supply Demand Strategy has been updated, incorporating more recent analysis of current and future demand completed by Ski Lift Pty Ltd.

The details of this estimate are provided in Table 4.

Table 4 Snowmaking demand growth assumptions

Assumption	Range	Comments
Water use per hectare of snowmaking area	3.75 ML/ha to 4.81 ML/ha	The water application rates will increase as investment continues to occur in automation and more extension coverage of spray heads.
Increase in snowmaking area	72 ha to 100 ha	Planned expansion of snow making areas

For the purposes of this study, three future snowmaking demand scenarios have been developed as follows, and illustrated in Figure 6:

- High demand estimate (upper range assumptions achieved by 2020)
- Medium demand estimate (upper range assumptions achieved by 2030)
- Low demand estimate (upper range assumptions achieved by 2040)

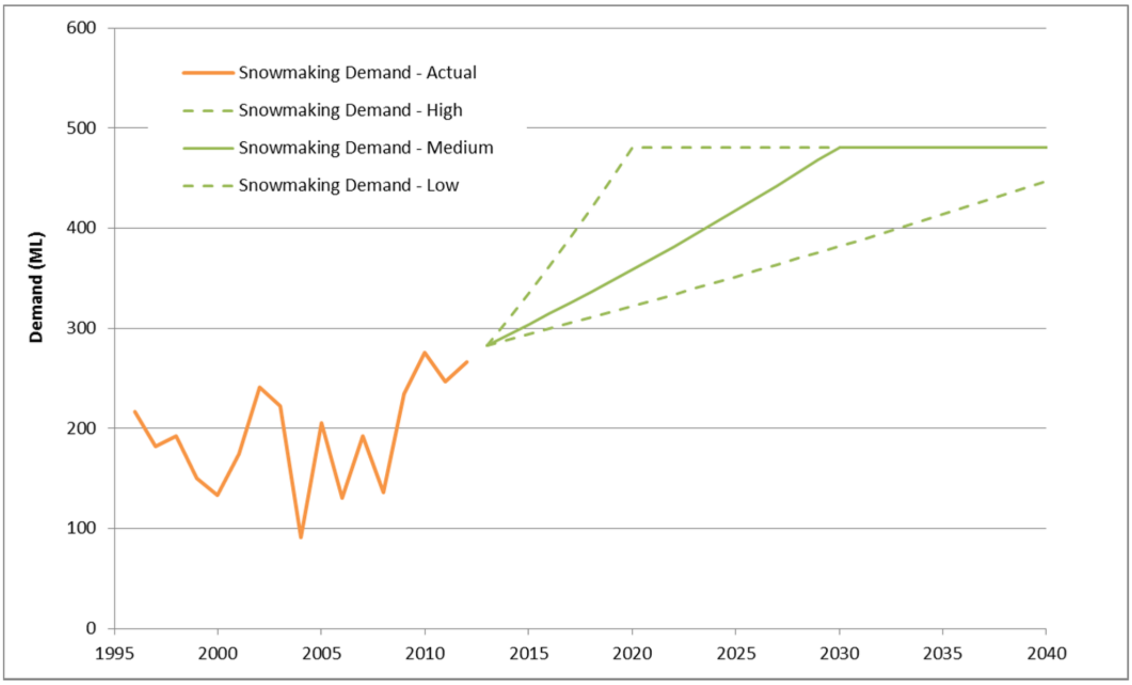


Figure 6 Snowmaking demand forecasts

3.1.4 Emergency Supplies

During the summer months, diversion licence conditions prevent the harvesting of water from Boggy Creek. Therefore, the Mt Buller Resort is reliant on water that is held in storage. This water must meet the potable demand over the summer period, but also meet any unexpected water demands such as firefighting requirements or water for other emergency situations. It is recommended that Mt Buller maintain a minimum volume of water within the supply system to allow for emergency events. This volume of water could be comprised of both recycled water and potable water. Class A recycled water can be used for firefighting purposes if sufficient treatment and precautions are taken. Refer to the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) (NRMMC, EPHC and AHMC, 2006) for more information regarding the use of recycled water for firefighting purposes.

It is assumed that a minimum of 10 ML of water (equivalent of 2 months of current summer demand) is maintained in storage at all times to allow for emergency purposes.

Therefore, the minimum raw water storage volume required to meet summer period potable is 44 ML (consumption) + 10 ML (emergency) + 6 ML (storage and treatment plant losses) = 60 ML.

3.2 System yield and reliability

3.2.1 Design objectives

The reliability of the existing water supply system is highly dependent on annual climatic conditions. If wetter conditions exist, then inflows are higher and the ability to meet full snowmaking water use requirements is high. Conversely, if dryer conditions exist, then inflows are low and the ability to meet full snowmaking water use requirements is low. Over the last 10-15 years, the annual reliability of the system has generally been low due to persistent low inflow conditions, combined with a steady increase in water use requirements from snow making.

The primary objectives for providing additional offstream storage at Mt Buller are:

- to provide storage of raw water which can be used to meet potable demands over the summer period, and
- to reduce the impacts from dry years (low inflow), such that there is less uncertainty around the water available for snow making during these periods.

3.2.2 Design basis

The Mt Buller system has been designed for a 3 year critical period, comprising two consecutive low inflow years followed by a recovery year with high inflows.

The "design condition" is based on a typical dry period. Uncertainty (or variability) has been represented as an "Extreme dry period" and a "Wet period".

The design conditions are illustrated in Table 5.

Table 5 Design inflow conditions for estimating system yield

Design Conditions	Year 1	Year 2	Year 3
Design conditions	**Ave. 2 ML/d inflow**	**Ave. 2 ML/d inflow**	**Ave. 4 ML/d inflow**
Extreme dry period	Ave. 1.6 ML/d inflow	Ave. 1.6 ML/d inflow	Ave. 4 ML/d inflow
Wet period	Ave. 4 ML/d inflow	Ave. 4 ML/d inflow	Ave. 4 ML/d inflow

The lack of long term hydrological data prevents the reliability of the system being quantified in terms of a conventional frequency assessment.

3.2.1 System yield

System yield is typically defined as the average annual demand that can be supplied from the water supply system subject to operating constraints and patterns of demand, at a given reliability of supply.

For the purposes of the Mt Buller system, yield has been expressed as the volume of snowmaking demand which can be supplied. The yield (and reliability) assessment inherently includes the supply requirements for potable demands. The assessment assumes that potable demands are met with 100% reliability, with the balance of the available supply available for snowmaking purposes.

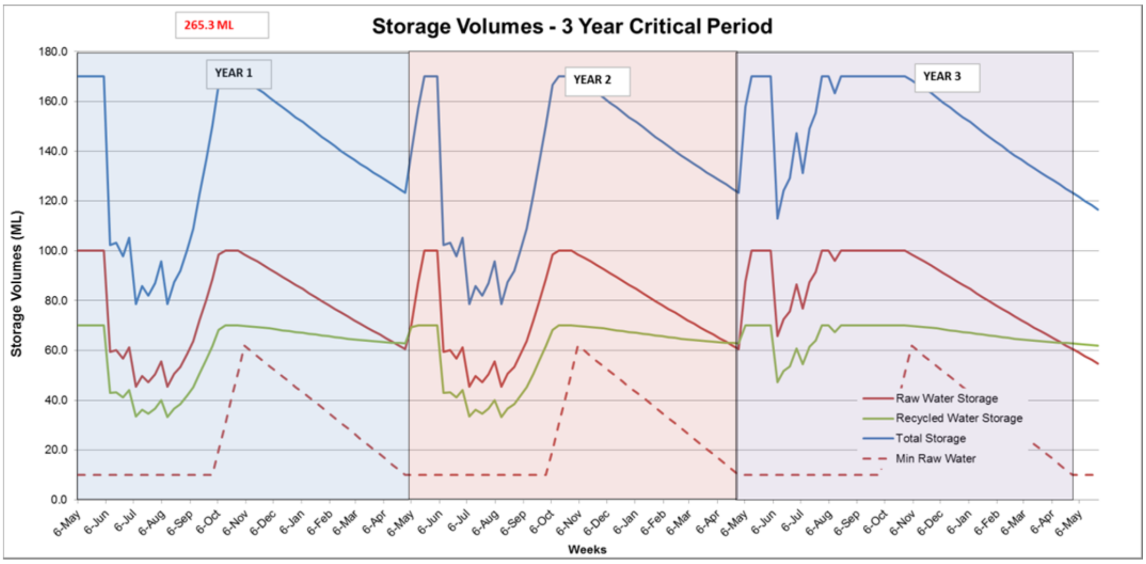


Figure 7 Simulated storage levels for 270 ML/a snowmaking demand under design inflow conditions

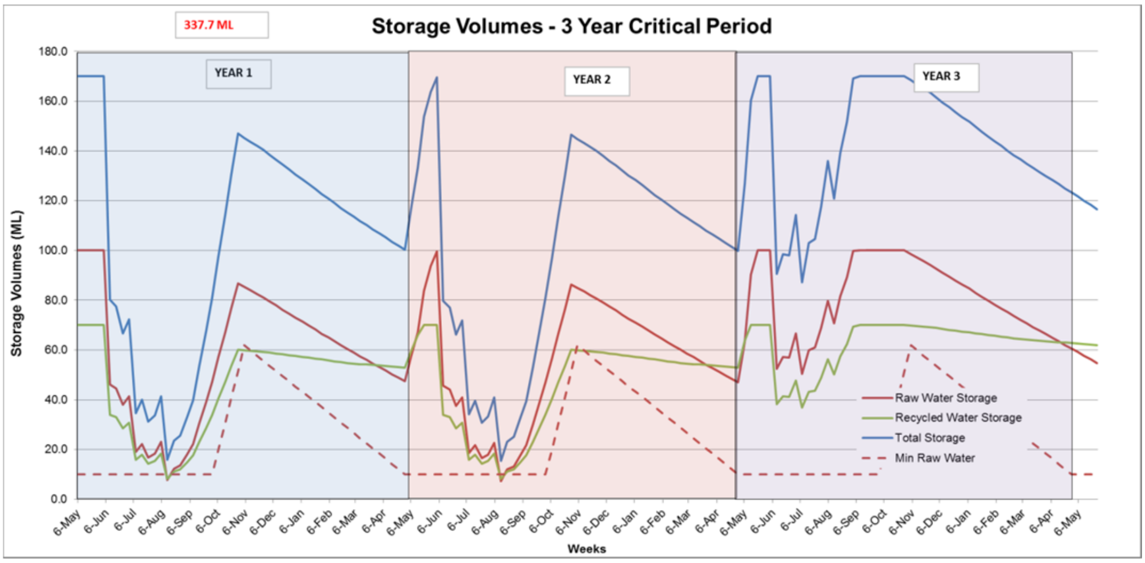


Figure 8 Simulated storage levels for 330 ML/a snowmaking demand under design inflow conditions

For operational purposes, a trigger curve has been established which quarantines a volume of water for potable demand purposes. Water for snowmaking cannot be provided from the proposed raw water storage, if water levels fall below this trigger level.

- Minimum total storage volume of 20 ML (in any year), and/or
- Total storage volume must be full at the end of the third year.

Using this approach, the yield of the system has been determined for the existing system and the proposed 100 ML capacity raw water storage. In addition, an assessment of 150 ML and 200 ML capacity storages was completed for comparative purposes.

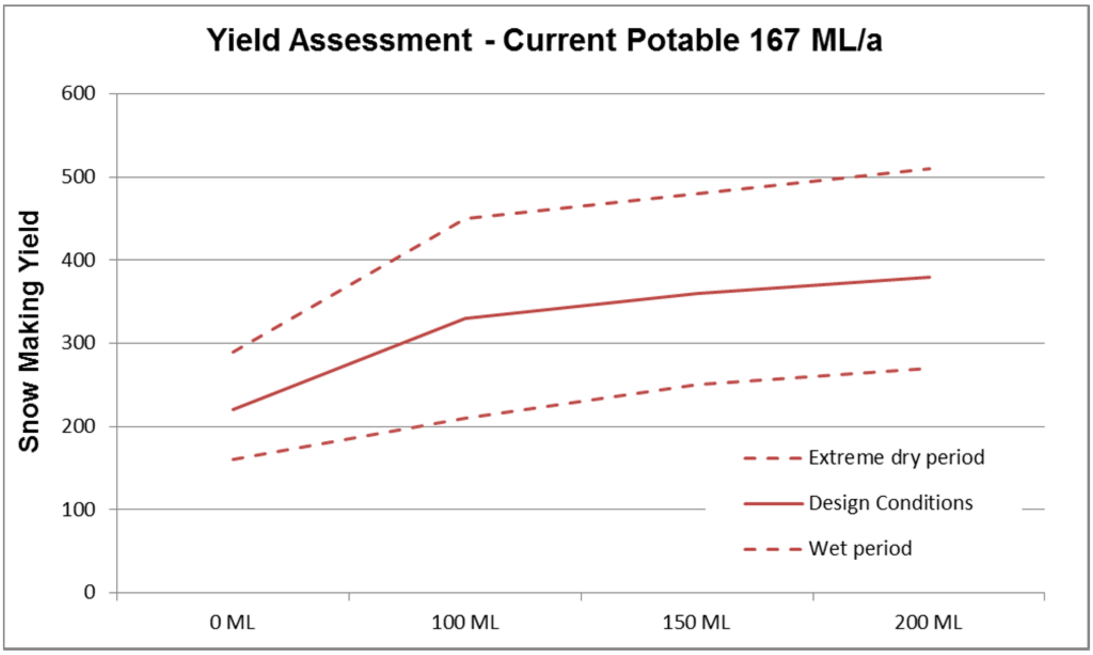


Figure 9 Mt Buller system yield assessment

The analysis shows that the snowmaking yield can be increased by about 0.5 ML for each additional megalitre of storage above 100 ML. For example, a 200 ML storage (i.e. 100 ML additional storage) would result in an additional 50 ML per annum of snowmaking demand over the critical period.

The analysis has revealed that the additional 100 ML of offstream is designed to supply 330 ML/a over a 3 year critical supply period, for the design inflow conditions, with an expected range of between 210 ML and 450 ML, in any given year.

Table 6 System yield estimates

Design Conditions	Existing system (ML/a)	Existing plus 100 ML storage (ML/a)
Extreme dry period	160	210
Design conditions	**220**	**330**
Wet period	290	450

It should be recognised that restrictions to the annual supply volumes would need to occur, when:

- Annual inflows are significantly lower than the “design” conditions, and storage levels are falling more rapidly than anticipated,
- Snow making water use is significantly higher than the “design” conditions, and storage levels are falling more rapidly than anticipated,
- Dry conditions persist beyond a consecutive 2-year period.

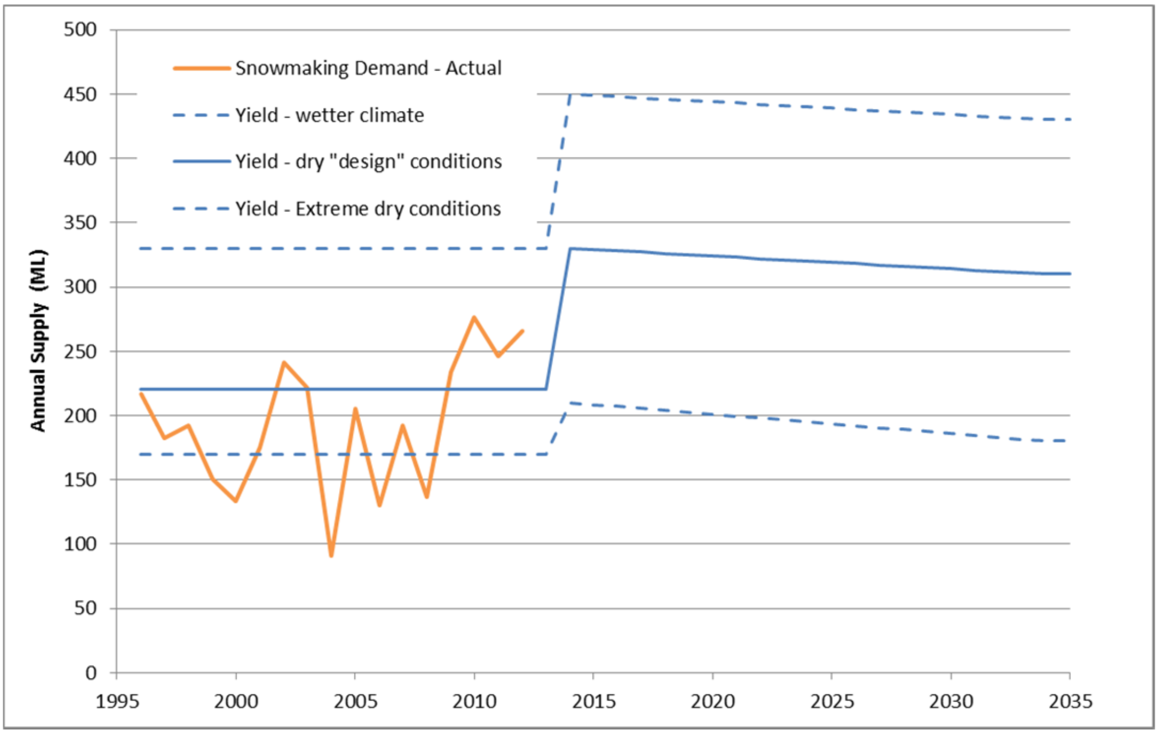


Figure 10 Mt Buller system yield forecasts

3.3 Supply and demand balance

The figure below shows the supply and demand balance over time, illustrating the benefits which will be achieved through augmentation via an additional 100 ML of off stream storage.

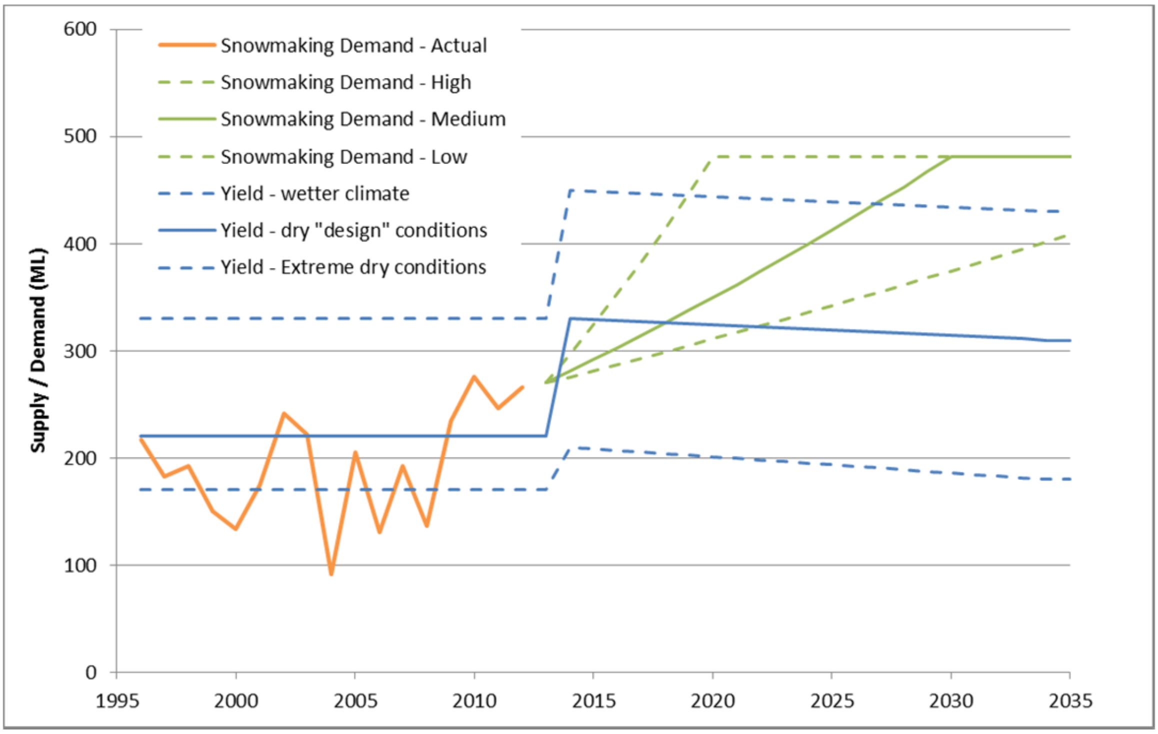


Figure 11 Mt Buller system supply and demand balance

3.3.1 Operational considerations

It is recommended that an operating plan be developed which documents operational arrangements and provides a framework in which operational decisions can be made throughout the year. The operational plan should be developed around the principles of resource allocation and water accounting used by Victoria storage and resource managers, such as:

- Forecasting water availability for the coming season (or other defined period) and communicating outcomes to water users and other stakeholders
- A water accounting process which provides operators with information about inflows, demands and water availability,
- Development of operational triggers to provide clarity to users about resource allocation and other water sharing arrangements
- In adopting this approach, the operational arrangements do not restrict the way in which users utilise their share the available water, throughout the year.

4. Water supply infrastructure

4.1 Assessment of existing stream diversion, water treatment, water distribution and wastewater treatment infrastructure

The existing water supply infrastructure is shown schematically in Figure 12.

A list of the existing water supply assets is provided in tabular form in Appendix A. The assets can broadly be categorised as follows:

- Stream diversions and raw water storages
- Raw water transfer assets(Boggy Creek pumps, High Lift and Sun Valley Pump Stations; Raw Water Transfer Pipelines)
- Water treatment and potable water distribution assets (Hypochlorite Chemical Dosing Systems and UV Disinfection Units; Village high and low level reticulation systems)
- Wastewater treatment and recycling assets

In addition, Buller Ski Lifts Pty Ltd own and operate snowmaking assets comprising 180 no. machines of two types: high pressure water plus separate air pipe network and low pressure water plus power network for local compressors; annual cost $0.7m/year, $30m investment. The condition and capacity have not been reviewed as part of this study.

The key findings from the high level appraisal of the RMB's existing assets (which included a review of the recent report on Strategic Water Supply Monitoring – System Review and Upgrade, WaterGroup Pty Ltd, Sept 2013) are as follows:

- There is limited power supply at the Boggy 1 Pump Station
- The headwaters diversions should remain decommissioned. The poor water quality (and impacts for treatment) outweighs the potential cost savings resulting from reduced pumping.
- Over time sediment builds up in the bottom of the raw water storage tank at the Boggy 1 Pump Station.
- The existing Sun Valley pump and pipeline have a capacity limit of 2 ML/d
- The condition of Burnt Hut Reservoir is poor. Therefore concepts involving this storage being abandoned would be preferred.
- The existing treatment processes do not meet the requirements of the latest Australian Drinking Water Guidelines and industry best practice for potable water supplies.
- There is a potential risk that snow drift on the northern slopes may lead to some Class A recycled water entering the Boggy Creek water supply catchment.

These findings are discussed further in the following sections.

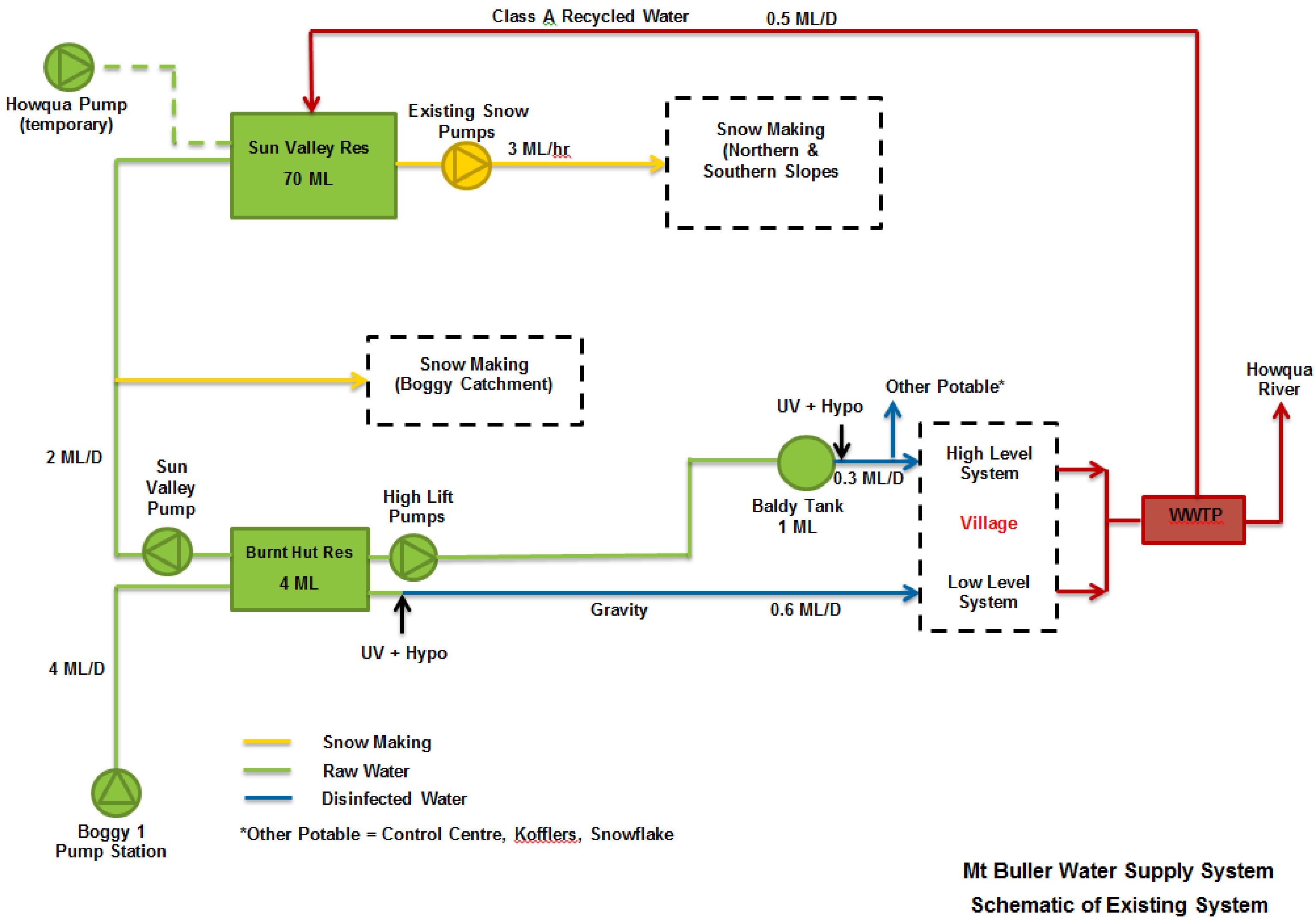


Figure 12 Existing Water Supply Infrastructure

Raw water transfer assets

Lack of raw water storage for potable use in summer leads to extraction during non-winter months from the catchment under a licence exemption.

It is understood that the raw water transfer infrastructure from Boggy 1 Tank to Burnt Hut Reservoir was designed for 4 ML/d to match the maximum allowable streamflow diversion rate.

However, the Boggy 1 Pump Station is constrained by a limited power supply i.e. the existing pumps draw all available power when they operate (at or close to 4 ML/d).

In addition the discharge pipework from the pumps need connection so that they both discharge into the 200mm transfer pipeline (i.e. so that the Pump 1 discharge is not choked by sections of 100mm and 150mm pipe as it is currently – this will improve the hydraulic performance of the pumps).

The tank at the Boggy 1 Pump Station accumulates sediment at the bottom over time and the current practice is to clean out the sludge by hand on an annual basis. This is costly, time consuming and requires personnel to enter the tank which is a confined space. Options such as adding a mixer to the tank (to prevent sediment settling on the bottom) or providing a system for flushing the tank from the outside via a scour drain should be considered as part of any future infrastructure works (for existing and any new tanks).

Burnt Hut Reservoir was constructed in 1965 and is in poor condition. Issues include:

- The concrete is deteriorating.
- There are concerns / suspicions that the reservoir is leaking and/or there is ingress of groundwater.
- Algal blooms have occurred in the last 4 years requiring the storage to be drained 2 to 3 times a year and cleaned / disinfected. It is understood from RMB that the algae have been tested and are not toxic.

We understand that the headwaters diversions (or “Race Line” pick up) has provided a supplementary supply into Burnt Hut Reservoir in the past but has not been used for 5 or 6 years due to poor water quality (e.g. contamination from wildlife). This is considered appropriate based on the risk management approach to water treatment which is discussed further in the next section.

Water treatment

The RMB has an obligation to provide the community it serves with safe water at all times. Safe water is defined as water that complies with the requirements of the Australian Drinking Water Guidelines (ADWG) and relevant statutory regulations, namely Victoria’s Safe Drinking Water Act 2003.

The Safe Drinking Water Act 2003 includes specific ADWG targets and requires water quality risks to be effectively managed. The ADWG provide a framework to identify appropriate “levels of service” across an entire water supply system (catchment, storage, treatment and reticulation). The framework is based on a multiple barrier risk management approach to water quality.

The latest version of the ADWG was released in 2011. The 2011 ADWG consider the use of turbidity as a measure of the ability of water treatment assets to remove pathogens (bacteria, protozoa such as Giardia and Cryptosporidium, viruses) on the basis that filtration is a significant barrier to protozoan pathogens against which chlorine disinfection is not effective.

The existing treatment of the raw water (downstream of Burnt Hut Reservoir and the Baldy Tank) by chlorination (with hypochlorite) and UV disinfection is unlikely to meet the requirements and intent of the 2011 ADWG with its emphasis on multiple barrier approaches to water treatment. Therefore it is recommended that a filtration process be adopted for treatment of the raw water to reliably supply safe drinking water to consumers in the Village. GHD also understands the Department of Health has requested that a filtration process step be provided.

Class A Recycled Water Use

Good practice would be to remove the potential risk of snow drift on the northern slopes leading to Class A recycled water entering the Boggy Creek water supply catchment.

This has been considered in the concepts for reconfiguring the water supply infrastructure with provision of the new off-stream storage.

4.2 Concepts for reconfiguring water supply infrastructure

4.2.1 Overall Performance Objectives

The following overall performance targets have been adopted for the reconfigured water supply system:

1. Water quantity: meeting consumer current and future demands
2. Water quality: providing potable water that meets treated water quality guidelines and provide water that meets the specific requirements for snow making
3. Minimising whole of life costs (e.g. utilise existing assets where possible, avoid duplication)
4. Providing systems with efficient operation and maintenance (e.g. removing redundant equipment, simplifying systems)
5. Managing contingencies (e.g. providing redundancy for critical equipment)
6. Meeting statutory and OHS requirements

The water quantity and quality objectives are outlined in more detail below.

Water Quantity: Meeting Current and Future Demands

Potable Water

It is typical for potable water treatment plants to be sized for peak day demands.

Based on the current peak monthly demand of 36 ML/month (refer section 3.1.2) the current peak day demand has been estimated at 1.5 ML/d (note this is based on an average day demand of 1.2 ML/day multiplied by a peaking factor because, for example, there will be more demand on a weekend than on a weekday).

The estimated future peak day demand for potable water has been based on a 30% increase to the current peak day demand as per section 3.1.2.

It is understood that the low level system in the Village uses around two thirds of the potable water demand, with the high level system using around one third – therefore the peak day demands in Table 7 have been apportioned accordingly.

Table 7 Potable Demand Assumptions for Concept Development

Demand Assumptions	Current	Future
Peak Day Demand - Total	1.5 ML/d	2.0 ML/d
Peak Day Demand – High Level System	0.5 ML/d	0.7 ML/d
Peak Day Demand – Low Level System	1.0 ML/d	1.3 ML/d

Snow Making

The Ski Lifts Pty Ltd has advised the following requirements for snow making water:

- The priority areas for snow making are Shakey Knees, Bourke St, Baldy and either Wombat, Skyline or Summit (this is based on the Lift Company needing to guarantee snow on a minimum of 5 no. runs to prevent refunding lift tickets to customers)
- Approximately $1m^3$ of water equates to $2m^3$ of snow
- Current water flows for snow making are up to 300 L/s (1.1 ML/hr)
- Future demands for snow making water could be up to 500 L/s (1.8 ML/hr)

In the future the Ski Lifts Pty Ltd plans to locate transfer pumps for snow making water at the new off-stream storage site in order to provide redundancy of equipment (the snow making water pumps at Sun Valley Reservoir will be retained) and minimise the snow making water transfer infrastructure required.

For concept development, a raw water demand of 7 ML/d has been adopted for the 70 ML Sun Valley Reservoir. This is based on being able to refill the storage over 10 days.

Water Quality

Potable Water Quality Targets

Potable water should be supplied in accordance with the Safe Drinking Water Act 2003 and the 2011 ADWG. Targets for some key parameters are shown in Table 8.

Table 8 Potable Water Quality Parameters

Parameter	Units	2011 ADWG
E.coli	org/100mL	Not detected
Total coliforms	org/100mL	Not detected
pH	units	6.5 – 8.5
Turbidity	NTU	<0.2 NTU is the target for effective filtration of Cryptosporidium and Giardia. <1 NTU is the target for effective disinfection.
True Colour	HU	15
Aluminium	mg/L	0.2[1] (<0.1 desirable)
Fluoride	mg/L	1.5
Iron, total	mg/L	0.3
Lead, total	mg/L	0.01
Manganese, total	mg/L	0.1
THMs	mg/L	<0.25[1]
Taste & Odour		Acceptable to most consumers
NOTES: (1) Safe Drinking Water Regulations- 2005;		

Snow Making Requirements

The following quality requirements for snow making water were advised by Ski Lifts Pty Ltd:

- The water cannot be coloured as coloured water causes the snow to melt (note: raw water is acceptable but stormwater, for example, would need to be clarified to reduce colour)
- The water needs to be cold (i.e. less than 2 degrees Celsius) and can be cooled by bubbling air through it.

4.2.2 Concept Development

Concept development for reconfiguring the water supply infrastructure has been based on the following:

- Raw Water System: Provision of a raw water system that allows for transfer of 4 ML/d from Boggy Creek.
- Treatment: Improved potable water quality to meet regulations via provision of a new (filtration based) water treatment plant with an appropriate level of automation, reliability/redundancy and water conservation where practicable.
- Potable Water Distribution System: Distribution of potable water for use in the Village and for firefighting without breaking pipes and allowing continuous plant operation.
- Storage Functionality:
  - New storage to contain raw water only and provide:
    - a potable water supply (via the new treatment plant) in summer when diversion from Boggy Creek is not permitted and;
    - a snow making supply in winter for the northern slopes.
  - Sun Valley Reservoir to contain raw water and Class A recycled water when available (as per the existing system) to provide a snow making supply to the southern slopes in winter. It is recommended that double isolation between the snow making supply pipework to the northern and southern slopes is provided (to prevent any class A water going to snow making locations on the northern slopes).

Review of Options

A number of options for reconfiguring the water supply infrastructure system have been identified and reviewed as follows:

- Review of options for each category of asset (i.e. raw water transfer options, treatment process and siting options, potable water transfer options)
- Development of overall concepts for reconfiguring the water supply infrastructure:

Full details of the review are provided in Appendix B which includes proposed system schematics and a comparative cost estimate.

The comparative cost estimate indicated similar costs ($7.5 to 8m) for all overall concepts.

4.2.3 Preferred Concept

The preferred concept for reconfiguring the water supply infrastructure is Concept 1A which involves siting the WTP at the new storage site and providing additional potable water storage at the Baldy Tank site.

The key reasons for adopting Concept 1A as the preferred concept are summarised in Table 9. For further details and discussion please refer to Appendix B.

Table 9 Preferred Concept

Asset Category	Need for Improvement	Preferred Option Justification
Raw water transfer to new storage	Around 50m additional lift required to transfer to new storage (versus current transfer to Burnt Hut)[1]	Upgrading the Boggy 1 P/S will require a power supply upgrade which is likely to be costly. Therefore new booster pumps just below Burnt Hut Reservoir are preferred. A Break Tank is recommended for the booster pumps (as in line pumping has a risk of pipeline breakage).
Raw water transfer to Sun Valley Storage	Existing pump and pipe from Burnt Hut can only transfer 2 ML/d	Increasing the existing transfer system from Burnt Hut to Sun Valley by installing a larger pump would be likely to cause a pipe breakage due to increased friction head in pipe i.e. new pumps and pipe would be required. Preferred option is to decrease amount of new infrastructure required. There is an opportunity to use the Lift Company's new (large) snow making pumps at the new storage and therefore the preferred option is for raw water transfer to Sun Valley to be via the new storage using the Lift Company's new pumps.
Water Treatment Plant	New filtration based plant required	Filtration based process required to supply potable water that meets ADWG (2011). The existing chlorination and UV systems will be required to remain in operation whilst the new plant is being constructed. Therefore a new plant is preferred. The preferred option for siting the new plant is at the new storage site (this reduces assets at Burnt Hut and there may be opportunity to share infrastructure such as the feed pump wet well and building structure with the Lift Company to reduce costs)
Potable Water transfer to Village	Potable water balance tank (clear water storage or CWS) required for diurnal balancing, contingency during plant outage/maintenance, firefighting supply)	The existing Baldy Tank and trunk transfer main to the high level system can be retained. However additional storage will be required for supply to the low level system. It is preferred to site this additional storage at Baldy Tank (rather than at Burnt Hut to reduce assets here). A new trunk main will be required from the new storage at Baldy to the low level system with a small break tank (can be underground) prior to the connection point to ensure pressures are not too high.

Note 1: Power usage is determined by overall quantity of water transferred and the lift required which is the same for either option (i.e. upgrade Boggy 1 P/s OR construct new booster pump station)

The preferred Concept 1A is shown schematically in Figure 13.

The required scope of works is as follows:

- Raw Water System:
  - New Break Tank (0.15 ML) and Booster Pumps with VSDs (4 ML/d) located in a building below Burnt Hut
  - New 200mm diameter transfer pipe from the Break Tank to the New Storage (4 ML/d)
  - Use of the new snow making pumps at the New Storage to transfer raw water to Sun Valley Reservoir
  - New 250mm diameter transfer pipe from the New Storage to Sun Valley Reservoir (7ML/d)
- Water Treatment Plant:
  - New 2 ML/d WTP including raw water feed pumps, a filtration process, chemical systems and ancillary equipment, washwater and waste tanks, and general site works.
  - New washwater pumps to transfer washwater from the plant to Sun Valley Reservoir via the new raw water transfer main.
- Potable Water Distribution to the High Level System:
  - Treated water pumps and transfer pipe to transfer treated water from the plant to Baldy
  - Reuse of the existing Baldy Tank and trunk main to supply the high level reticulation system
- Potable Water Distribution to the Low Level System:
  - New CWS at Baldy (1ML)
  - New 200mm diameter trunk main to the low level reticulation with a small (say 10kL) underground break tank prior to connection to the reticulation so that the low level system is not over pressured

A plan indicating the potential location of the new infrastructure is provided in Appendix C. It should be noted that locations are indicative at this stage and have been selected for the purposes of providing corridor and/or footprint information for environmental and planning assessments. The specific locations are therefore subject to change as the design develops.

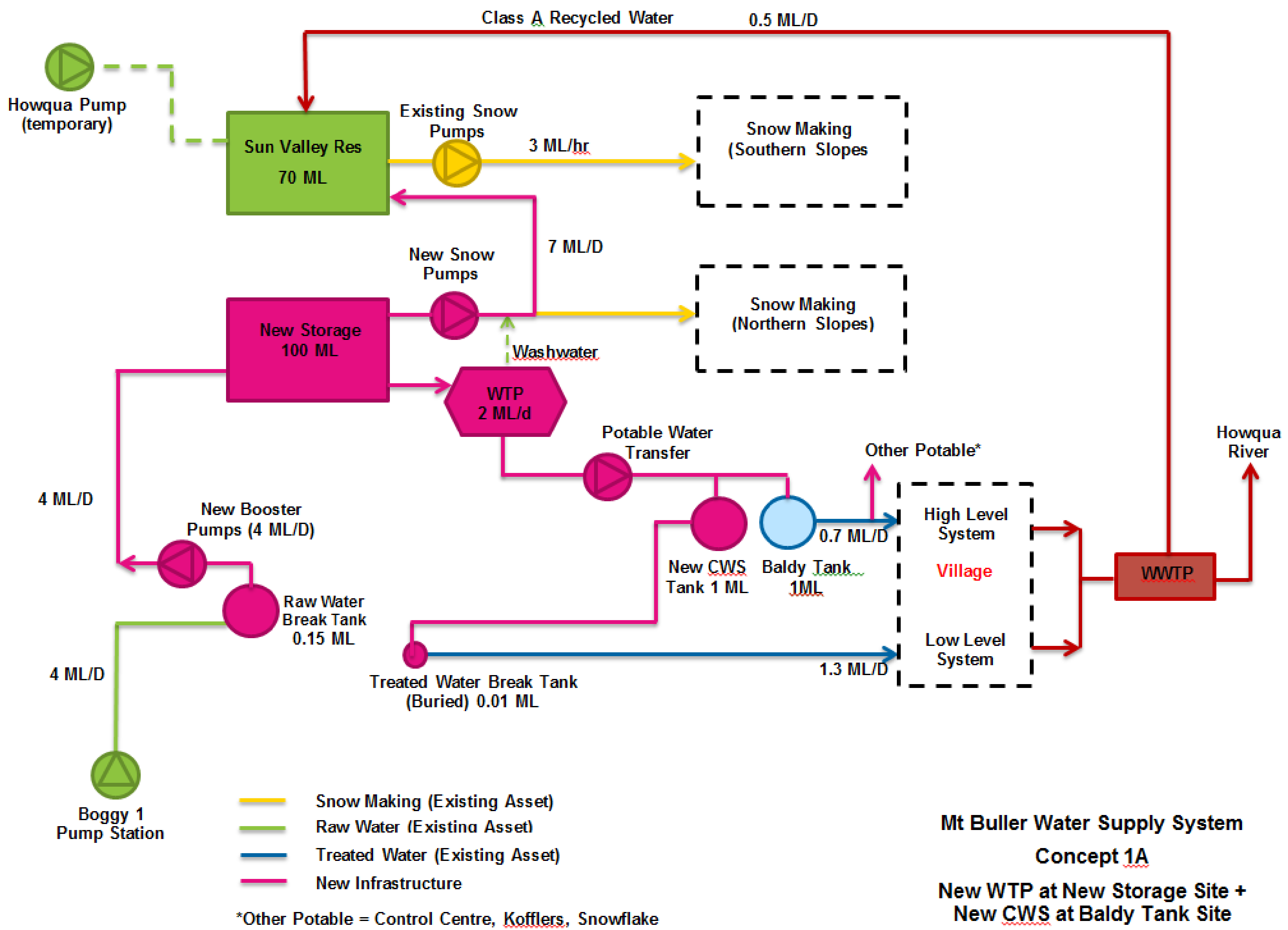


Figure 13 Water supply infrastructure – Preferred Concept 1A

4.2.4 Opportunities for Staging

The ability to stage the works will depend on the outcomes of the audit of the existing treatment facilities which RMB is currently undertaking under a separate project, however the following opportunities for staging of the works may exist:

Year 1 Works

Highest Priority Works: Given the poor condition of Burnt Hut Reservoir it is recommended that the new raw water transfer system to the new storage site is built as soon as possible to provide contingency in the case of a catastrophic failure of Burnt Hut Reservoir, as these works could be constructed in a way that allows the water to be directly transferred to Baldy Tank to provide some settling prior to disinfection via the existing hypo and UV systems as an interim solution.

Year 1 Works: Construction of:

- New raw water transfer system (break tank, booster pumps, transfer main to new storage) (highest priority)
- New raw water storage
- Transfer pipeline from new storage to Sun Valley Reservoir (this assumes the new Lift Company pumps can be used)
- Transfer pumps and pipeline from new storage to the existing Baldy Tank (these may be able to be reused after the treatment plant is built but more design development is needed to confirm this)
- Transfer pipeline from Baldy Tank to the low level reticulation via the existing hypochlorite and UV treatment systems at Burnt Hut (note that it is recommended this pipeline is constructed at the same time as the raw water transfer main to the new storage as they run in the same alignment)
- Underground Break Pressure Tank at Burnt Hut prior to the low level reticulation (given raw water will now be transferred from the higher level Baldy Tank)

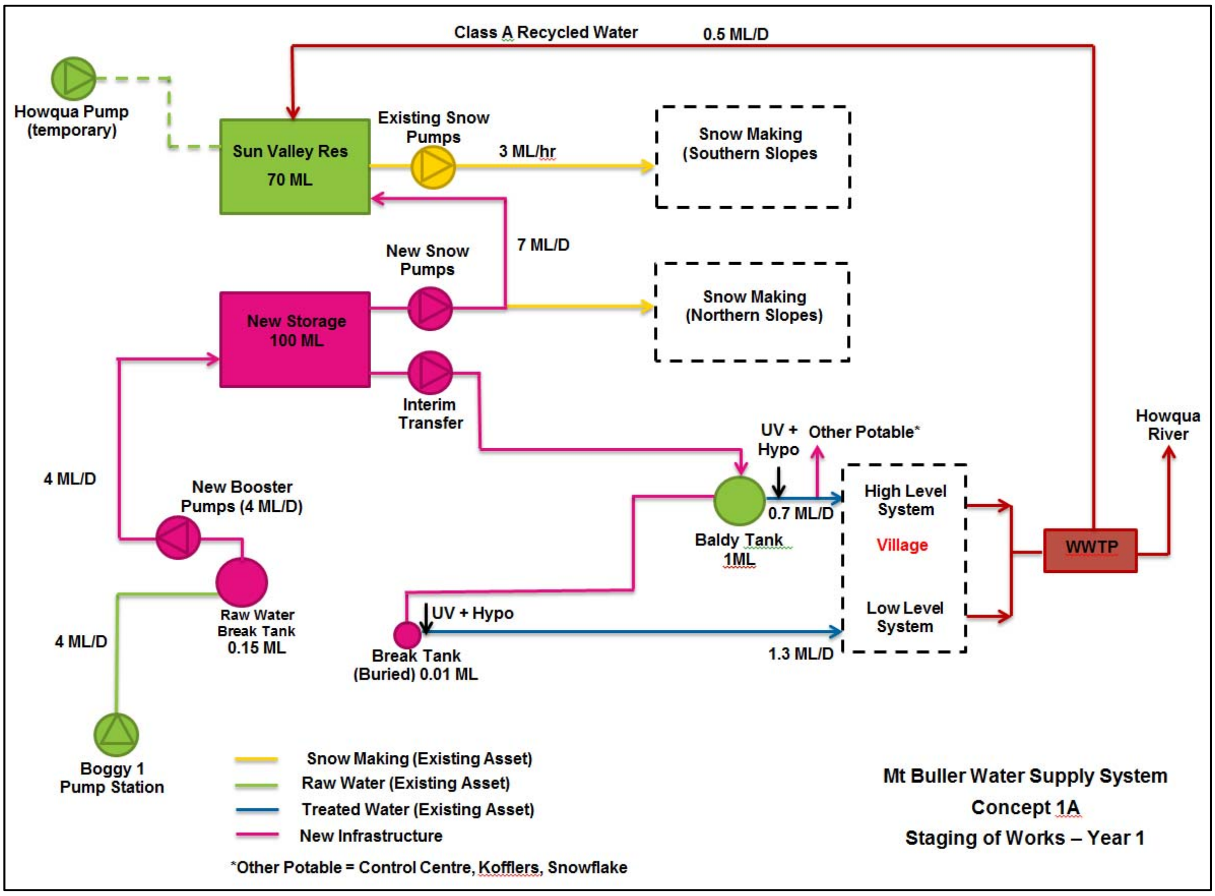
The ability to defer construction of the new WTP to the next stage will depend on the outcomes of the existing treatment facilities audit. It also assumes that the new raw water storage will provide effective settling of the water (i.e. lowering of the turbidity) prior to its treatment by the existing hypochlorite and UV systems (which require low turbidity water to be effective). This will require a plastic liner to be installed in the new raw water storage (as a clay liner is likely to increase turbidity of the water).

Year 2+ Works

Construction of:

- New water treatment plant inclusive of feed pumping (as/if required by membrane supplier's process), a washwater collection and transfer system, and a potable water transfer system to the Baldy Tank site (some of the Year 1 works may be reusable)
- New clear water storage tank at the Badly Tank site

This potential staging of the works is shown schematically on the following page.



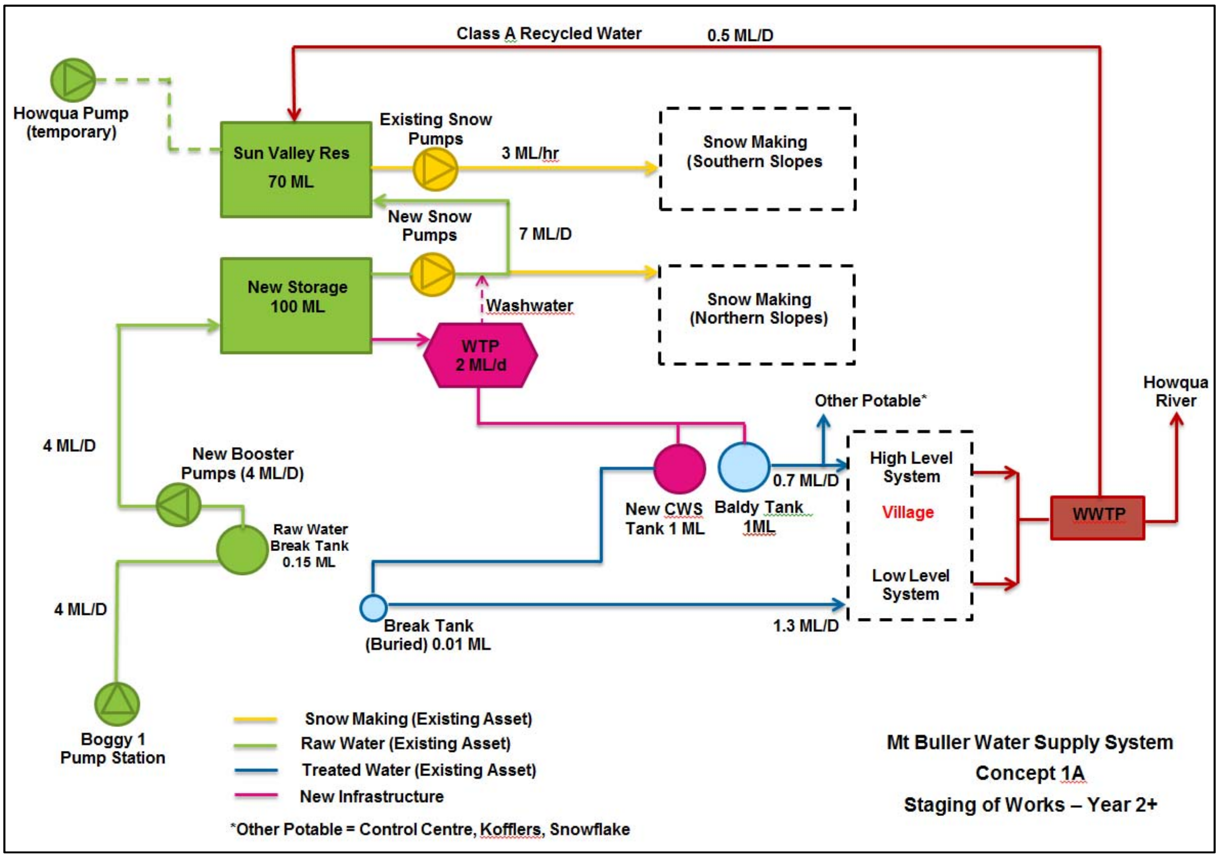


Figure 14 Potential Staging of the Works for Preferred Concept 1A

5. Conclusions and recommendations

5.1 Supply and demand balance

Current and future demands – increased water use for snow making will gradually reduce the reliability of the proposed system, until such time that further augmentation is undertaken. Demand analysis has shown that augmentation may not be required for at least 15 years if water use rates are at the lower end of the forecast range. This time period may be reduced below 10 years if the higher water use rates eventuate. Close monitoring of water use will be required to inform the timing for future augmentations.

System reliability and yield - analysis has shown that the augmented system combined with new operating rules, will significantly improve the ability to manage supply over critical dry periods, thus guaranteeing potable water supplies and improving the reliability of supply for snowmaking over these periods.

System yield and reliability estimates should be revisited when sufficient streamflow data is available to develop long term streamflow datasets and operational data is available to validate system water balance models.

Metering of streamflows – the lack of streamflow data creates uncertainty with system yield estimates, and in more general terms, limits the ability to understand the reliability of the water supply system. The collection of daily streamflow records will improve the accuracy of hydrological analyses which are undertaken in the future. It is therefore recommended that streamflow gauges are installed at the following locations (in priority order):

1. Boggy 2 Weir
2. Boggy 1 Weir
3. Howqua tributary flows

Given the lack of reliable streamflow data, a scenario based approach has been adopted to estimate the increase to yield and the improvement to system reliability which is achieved from the provision of additional off-stream storage capacity.

Operational arrangements – An operating plan should be developed to document operational arrangements and provide an objective basis which informs operational decisions. The operational plan should be developed around the principles of resource allocation and water accounting used by Victorian Water Storage and Resource Managers, such as:

- Forecasting water availability for the coming season (or other defined period) and communicating outcomes to water users and other stakeholders
- A monitoring program and reporting system which provides operators with up-to-date information about inflows, demands and water availability,
- A water accounting process which supports regulatory reporting obligations as well as future water resource planning,
- Development of operational triggers to provide clarity to users about resource allocation and other water sharing arrangements

In adopting this approach, the operational arrangements do not restrict the way in which users utilise their share the available water, throughout the year.

5.2 Water supply infrastructure

The concept investigations completed to date have achieved the following:

- Confirmed limitations within the existing infrastructure, particularly related to the inadequate capacity of the existing raw water transfer from Burnt Hut Reservoir to Sun Valley Reservoir. To achieve the required yield and reliability, it is critical that the raw water transfer capacity is 4 ML/d.
- Investigations identified the need to locate snow making pump infrastructure at the new storage and the potential benefits which can be achieved through integrating operations and infrastructure for water supply and snow making purposes.

The preferred option for reconfiguring the water supply infrastructure involves siting a new water treatment plant at the new raw water storage site and providing additional potable water storage at the Badly Tank site.

To transfer raw water from the Boggy Pump Station 1 to the new storage (around 50 metres higher than Burnt Hut Reservoir) additional pumping will be required, with a new Break Tank and booster pumps located below Burnt Hut being the preferred option.

A new trunk main will be required to transfer potable water from the Baldy site to the low level reticulation with a small underground break pressure tank provided to ensure the system is not over pressured.

6. References

GHD (2013) Water Supply Demand Strategy for Mt Buller, Mt Stirling and Mirimbah Water Supply Systems, Prepared for Mt Buller & Mt Stirling Alpine Resorts Management Board, Revision 0, May.

RMB - Mt Buller & Mt Stirling Alpine Resorts Management Board (2011) Drinking Water Supply Annual Report 2010-2011.

WaterGroup Pty Ltd (2013) Strategic Water Supply Monitoring – System Review and Upgrade, September)

Appendices

Appendix A –Existing Assets

www.ghd.com.au
Tel. (03) 8687 8000 Fax. (03) 8687 8111
180 Lonsdale Street Melbourne Vic 3000

Mt Buller Water Supply System
High level appraisal of existing instructure

Existing works	Comments	Actions
Diversions and raw water storages		
Boggy Creek Diversions: Catchment Weir 1 Boggy 2 Weir Catchment Weir 2	All diversion sites not listed on existing Section51 licence No documentation of requirement for passing fllows	Discuss implications with licensing authority (GMW)
Boggy 2 Weir	Advised that all streamflow can be passed through the defined sill of the existing broad crested weir. Sharp crested weir plate as recommended by Water Group Pty Ltd, is appropriate	Install flow gauge on existing weir structure and commence flow gauging program to provide an improved understanding of streamflow variability and water availability Refer action below re Data Management
Headwaters diversion	Not used over last 5 years due to poor water quality	Do not reinstate due to poor water quaility and risk management approach to water treatment as per the Australian Drinking Water Guidelines
Howqua diversions (tributary of Howqua River)	Works owned and operated by Ski Lifts. Diversions occur under temporary licence, which expires in 2023. Max volume 30 ML @ 0.5 ML/d. No metering of flows	Install flow meter to meter diversions Consider securing long term licence, and install flow gauged to improve understanding of streamflow variability
GMW flow meter	Installation problems have been identified (Water Group, 2013) with concerns over accuracy	Report to GMW
Boggy 1 Tank (1 ML) and Burnt Hut Tank (4 ML)	Little data on inflows, outflows and levels	Improved monitoring and data management of inflows, outflows and water levels
Sun Valley Reservoir (70 ML)	Storage lined with HDPE. Reservoir also used to store receuycled water (not suitable for drinking water supply)	None
Inflows from recycled water treatment plant	High flow plant, can't provide flows during summer (when water use is low)	None
Raw Water Transfer		
Boggy 2 Pumps	Power supply limited. Isolated and no back-up power. Switchboard replaced around 4 years ago. Pumps OK	None
Boggy Tank	No comments. Useful balancing storage.	None
Boggy 1 Pumps	Power supply limited which limits maximum flow rate of pumps to around 42 L/s (or 4 ML/d); Pump 1 discharge pipework includes 100mm and 150mm diameter pipe prior to connection to the new 200mm transfer main; Switchboards were replaced last year. Pumps OK.	Connect discharge pipework of pump 1 and pump 2 so that sections of 100mm and 150mm pipework are avoided and hydraulic performance is improved.
Burnt Hut Reservoir	Poor condition - concrete wearing, potential leakage and/or ingress of groundwater Raw water enters the east end and is pumped out from the west end (to try to provide some settling in the storage). Algal problems have been experienced in the past 4 or so years requiring cleaning/disinfecting of the storage 2 - 3 times per year Little data on inflows, outflows and levels - transfer to Sun Valley Res stops when the water level in Burnt Hut drops 5% below top water level	Refurbishment required within next 5 years if to be retained. Concept development is based on Burnt Hut Res being abandoned/demolished
Sun Valley Reservoir	Little data on inflows, outflows and levels	
Sun Valley Pump (and pipeline)	Designed for 35 L/s but can only achive 24 L/s (or 2 ML/d) because...... Operates 24/7 over winter to maintain the level in Sun Valley Reservoir. When the snow making guns at the bottom of the Bonza Chair are turned on the water is diverted here, with flow resuming to	Requires upgrade to allow 4ML/d diversion rate from Boggy Creek
High level pumps (to Baldy tank)	Pumps ok.	None
Baldy Tank	1 ML undergournd concrete tank with 2 no. pressure pumps (one pumps to Kofflers Tank and is float operated, the other pumps to the accommodation and workshop at Sun Valley and is pressure operated).	None
Generator	Large new generator	None
Water treatment & distribution		
Chlorination systems	Maintained by supplier (C-tec). Around 5 years old. Turbidity of 1 NTU recorded on day of GHD site visit which is on limit for effective disinfection.	Water treatment process requires upgrading to include a filtration process step in line with latest ADWG.
UV Systems	Lots of maintenance issues reported by RMB operator who maintains the units. Lamps are replaced annually. Only measure lamp %. When it drops the operator takes the unit apart and cleans the sleeve to boost % again.	
Trunk main to high level retic		
Trunk main to high level retic		
High and low level reticulation	Comprises 100mm and 150mm DICL pipework which has been installed over the last 12 years.	
Wastewater treatment and recycling plant		
Sewerage treatment plant		
Recycled water		
Sewer mains		

Appendix B – Concept Development

B1 Concept Development

B2 Overall Concepts

B3 Comparative Cost Estimate

B1 Concept Development

General

Development of concepts for the water supply infrastructure has been based on the following:

- Raw Water System: Provision of a raw water system that allows for transfer of 4 ML/d from Boggy Creek.
- Treatment: Improved potable water quality to meet regulations via provision of a new (filtration based) water treatment plant with an appropriate level of automation, reliability/redundancy and water conservation where practicable.
- Potable Water Distribution System: Distribution of potable water for use in the Village and for firefighting without breaking pipes and allowing continuous plant operation.
- Storage Functionality:
  - New storage to contain raw water only and provide:
    - a potable water supply (via the new treatment plant) in summer when diversion from Boggy Creek is not permitted and;
    - a snow making supply in winter for the northern slopes.
  - Sun Valley Reservoir to contain raw water and Class A recycled water when available (as per the existing system) to provide a snow making supply to the southern slopes in winter. It is recommended that double isolation between the snow making supply pipework to the northern and southern slopes is provided (to prevent any class A water going to snow making locations on the northern slopes).

Raw Water Transfer System Concepts

<u>Raw Water Transfer to the New Storage</u>

PUMPS: The existing Boggy 1 Pumps will not be able to transfer 4 ML/d to the new storage as increasing the size of the pump impellor to achieve the additional static lift required (around 50 metres) would draw more power which is not available. Therefore a Break Tank and additional booster pumps will be required at or near the existing Burnt Hut Reservoir. It has been assumed that this new infrastructure would cost less than upgrading the power supply at the Boggy 1 Pump Station. Note also that an additional pump station will not increase the power usage as the overall water quantity and lift required to the new storage is the same.

A Break Tank with booster pumps is preferred over inline booster pumps because of the risk of pipeline breakage associated with the latter. The Break Tank can also provide raw water balancing should the new treatment plant be located at Burnt Hut.

New infrastructure has been assumed rather than reuse of the existing given that:

- Refurbishment of Burnt Hut Reservoir is likely to provide limited savings compared with a new tank; and
- Burnt Hut Reservoir and the high lift pump station will need to remain in operation during construction of the new works to maintain a supply for potable use and firefighting. (Note: As the reservoir is in poor condition the central wall may not be able to support one side of the basin being drained whilst the other side remains in operation).

PIPES: The existing 200mm DICL diameter pipeline from the Boggy 1 Pumps to Burnt Hut Reservoir is sufficient to transfer 4 ML/d (velocity = 1.5 m/s) and can be retained.

However, the existing 150mm DICL pipeline from Burnt Hut Reservoir to Baldy Tank is too small to transfer 4 ML/d (velocity = 2.6 m/s) and can be reused under some concepts (refer Section

B2) for potable water distribution. It is recommended that a new 200mm diameter pipeline be constructed from the new Break Tank to the new storage for transfer of raw water.

Note that a direct pipeline route from the Boggy 1 Pump Station to the new storage is not preferred as it would require disruption of highly sensitive areas and would not take advantage of the opportunity to reuse the existing 200mm pipeline between Boggy Creek and Burnt Hut. Also the power supply at Boggy 1 Pump Station is insufficient for a direct transfer.

Raw Water Transfer to the Existing Sun Valley Storage

The existing Sun Valley Pump and 150mm PVC pipe from Burnt Hut Reservoir to Sun Valley Reservoir can currently only transfer 2 ML/d (and increasing the transfer to say 4 ML/d by installing a larger pump would be likely to cause a pipe breakage due to increased friction in the pipe). Based on the assumption that a transfer rate of 7 ML/d is desirable (for 10 day storage refill) it is recommended that:

- Transfer of raw water to Sun Valley Reservoir be via the new storage
- The new snow making pumps proposed by the Lift Company at the new storage are used to transfer the water
- A new transfer pipe from the new storage to Sun Valley Reservoir be constructed

Treatment Plant Concepts

General

A new 2 ML/d net output filtration based treatment plant is required. The preference is for one plant to supply all the potable water for simplification of the system and efficiency of operation and maintenance. It is typical for water treatment plants to comprise multiple treatment trains and duty/standby for all critical equipment so that adequate redundancy/reliability is provided.

It is recommended that the plant be fully automatic and capable of periods of unattended operation – this should include automatic recovery following a power supply failure without the need for operator intervention.

The existing chlorination and UV systems will be required to remain in operation whilst the new plant is being constructed so that the potable supply to existing customers can be maintained. Therefore they would not be reused in the new plant. Their reuse is also not preferred as in their current condition it would be difficult to get water treatment contractors to guarantee their performance as part of a new plant.

A conventional or membrane based filtration plant could be adopted. A membrane plant may be preferable because it can provide reliable filtered water quality and may prevent the need for a coagulation process step (however this needs to be confirmed at the functional design stage – no process design has been undertaken at this stage). Chlorination will be required for disinfection and to maintain a residual in the reticulation system.

The plant will need to be housed in a building with appropriate acoustic protection and access for chemical deliveries. Heating is likely to be required to prevent freezing of chemical dosing lines and membranes.

An approximate footprint based on other small plants is 25m x 35m for the plant and chemical delivery area. An access road with adequate turning circle for trucks will also be required.

Wastes

The plant will have a wastewater stream from backwashing of the filtration process. For a membrane plant this is typically 15% of the flow so in this case around 0.3 ML/d. Options for disposal of this washwater stream include:

- Discharge Option A: Discharge to sewer
- Discharge Option B: Discharge to the New Storage
- Discharge Option C: Discharge to Sun Valley Reservoir

Option A is not preferred as it may overload the waste water treatment plant. For Options B and C it is assumed that dilution of the washwater (which will contain organics/colour) within the storages will be sufficient for the water to meet snow making requirements (i.e. not coloured). Option C is preferred over Option B given that water from Sun Valley Reservoir is not used for potable purposes and existing pipework can be utilised for transfer.

A washwater holding tank may be required at the WTP, as well as a neutralisation tank for storing washwater from backwashes after a CIP clean (see below).

The membrane plant will also produce chemical wastes from chemical (clean in place) CIP cleans of the membranes. These could be stored in a waste tank with removal off site. The waste tank will need to be sized to cater for storage over the peak winter months when the site is inaccessible due to snow coverage (i.e. say 5 months storage). Note that the required volume of the waste tank will be dependent on the volume of CIP wastes generated and this will vary for different membrane suppliers.

<u>Plant Location</u>

The following options have been identified for location of the new treatment plant:

- Plant Location Option A: At the New Storage site
- Plant Location Option B: At the Burnt Hut Reservoir site

These options have been compared in the table below.

Table 10 Water Treatment Plant Site – Options Comparison

Criteria	New Storage Site	Burnt Hut Reservoir Site
Power available	existing	existing
Pipeline length (raw water, treated water, wastewater)	✓	✓✓
Operator access	✓	✓✓
Requirement for new tanks	similar	similar
Land Use	✓	× Lift Company has expressed a desire to use the land at Burnt Hut for snow activities if possible
Other	✓ There is an opportunity to co-locate the water treatment plant in a building with the Lift Company's new snow making equipment and to use the wet well that will be required for their snow making water pumps for the water treatment plant raw water feed pumps	×

Potable Water Distribution System

A potable water balance tank (typically called a clear water storage) will be required downstream of the water treatment plant for:

- Diurnal balancing;
- Contingency supply in the case of a plant break down or planned outage for maintenance; and
- Firefighting supply.

The capacity should be at least two thirds of the peak day demand (noting that balancing storage equivalent to the peak day demand is typical).

How balancing storage is best provided needs consideration of how distribution of potable water to the high and low level systems in the Village will occur and this depends on the location of the treatment plant – a suitable scope of works has been developed for each overall concept in the next section of this report.

In all cases the Baldy Tank and trunk transfer main to the high level system can be retained. Additional storage will be required for supply to the low level system however.

Reuse of the Control Tank has not been pursued as it is located away from other assets and its size and condition are currently unknown.

B2 Overall Concepts

Three concepts for reconfiguring the water supply infrastructure are shown schematically in Figures 15 – 17. In addition, plans illustrating the potential location of new infrastructure are provided in Appendix C, noting that the indicative locations have been selected to inform environmental planning assessments, and are subject to change.

Concepts 1a and 1b are based on locating a new water treatment plant (WTP) at the new storage site. The sub-options for Concept 1 are based on how potable water transfer to the Village low level reticulation would occur.

Concept 2 is based on locating a new WTP at the Burnt Hut Reservoir site.

The scope of works required for each concept is outlined below.

Concept 1A: WTP at New Storage Site; CWS at Baldy Tank Site with New Pipe and Break Tank

The required scope of works is as follows:

- Raw Water System:
  - New Break Tank (0.15 ML) and Booster Pumps with VSDs (4 ML/d) located in a building near or at Burnt Hut
  - New 200mm diameter transfer pipe from the Break Tank to the New Storage (4 ML/d)
  - Use of the new snow making pumps at the New Storage to transfer raw water to Sun Valley Reservoir
  - New 600mm diameter transfer pipe from the New Storage to Sun Valley Reservoir (7ML/d)
- Water Treatment Plant:
  - New 2 ML/d WTP including raw water feed pumps, a membrane filtration process, chemical systems and ancillary equipment, washwater and waste tanks, and general site works.
  - Plant potentially co-located in building with new snow making pumps (separate rooms could be provided to provide clear separation between RMB and Lift Company assets)
  - New washwater pumps to transfer washwater from the plant to Sun Valley Reservoir via the new raw water transfer main.
- Potable Water Distribution to the High Level System:
  - Treated water pumps and transfer pipe to transfer treated water from the plant to Baldy
  - Reuse of the existing Baldy Tank and trunk main to supply the high level reticulation system
- Potable Water Distribution to the Low Level System:
  - New CWS at Baldy (1ML)
  - New 200mm diameter trunk main to the low level reticulation with a small (say 10kL) break tank prior to connection to the reticulation

Concept 1B: WTP at New Storage Site; CWS at Burnt Hut with Reused Pipe

The required scope of works is as follows:

- Raw Water System: As per Concept 1A
- Water Treatment Plant: As per Concept 1A
- Potable Water Distribution to the High Level System: As per Concept 1A
- Potable Water Distribution to the Low Level System:
  - Reuse of the existing 150mm diameter pipe to transfer water from Baldy Tank to Burnt Hut (i.e. reverse operation to existing system) with connection to a new CWS at Burnt Hut (1.5ML) to feed the existing trunk main to the low level reticulation system.

Concept 2: WTP and CWS at Burnt Hut Site

The required scope of works is as follows:

- Raw Water System: As per Concept 1A with the following additions:
  - New Break Tank also used for balancing raw water flows prior to entering new WTP – hence renamed Break/Balance Tank and increased in size to 0.2 ML.
  - Summer Return Pumps to transfer raw water from the New Storage back to the Break/Balance Tank (using new transfer pipeline in reverse) during summer when supply from Boggy Creek is restricted.
- Water Treatment Plant:
  - New 2 ML/d WTP including raw water feed pumps, a membrane filtration process, chemical systems and ancillary equipment, washwater and waste tanks, and general site works.
  - Plant located in a new building
  - New washwater pumps to transfer washwater from the plant to Sun Valley Reservoir via the existing 150mm PVC pipe from Burnt Hut to Sun Valley Reservoir.
- Potable Water Distribution to the High Level System:
  - New relift pumps and reuse of the existing 150mm diameter pipe to transfer treated water to Baldy Tank.
  - Reuse of the existing Baldy Tank and trunk main to supply the high level reticulation system
- Potable Water Distribution to the Low Level System:
  - New CWS at Baldy (1.5 ML) with connection to the existing trunk main to the low level reticulation.

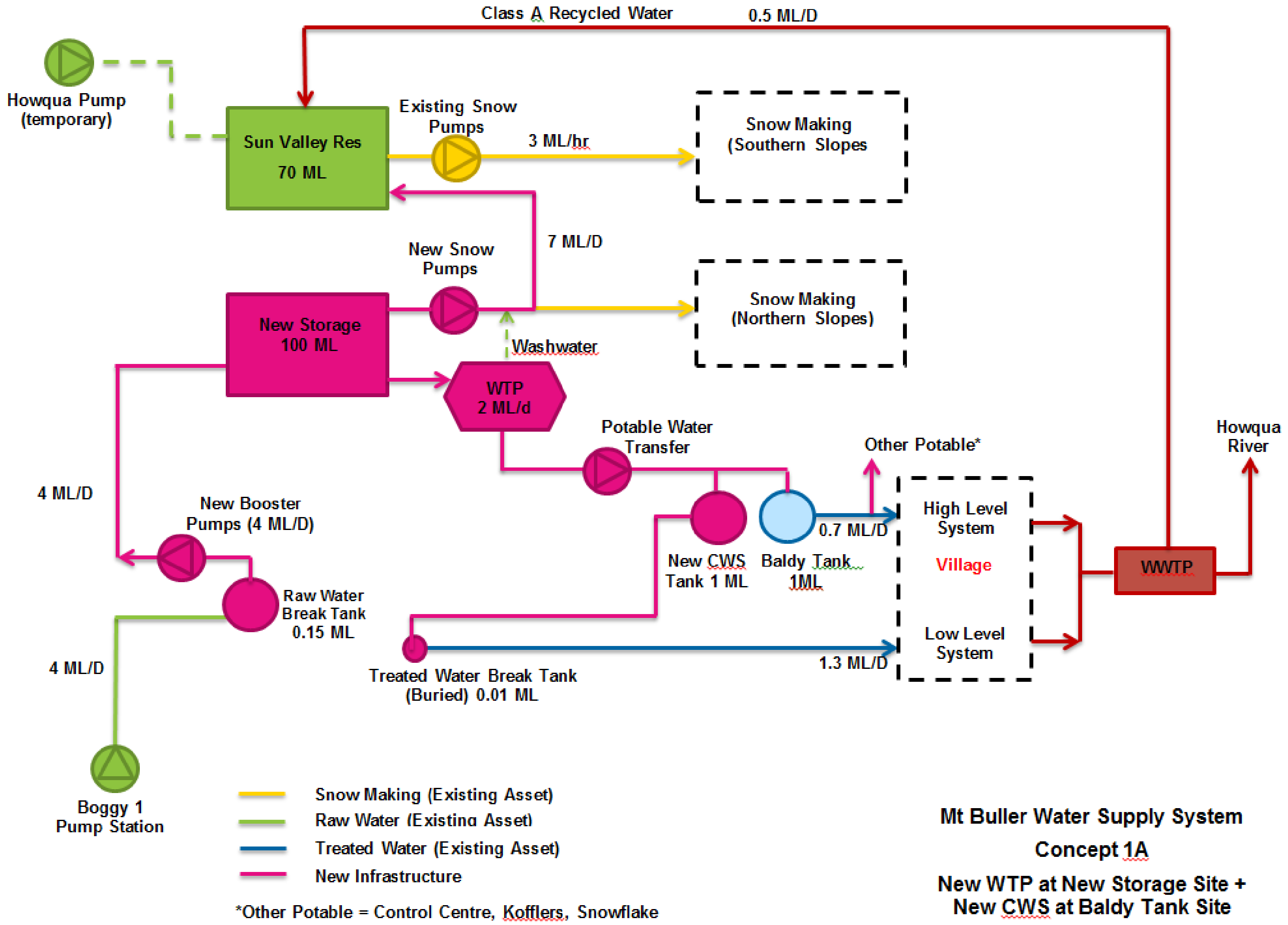


Figure 15 Water supply infrastructure – Concept 1A

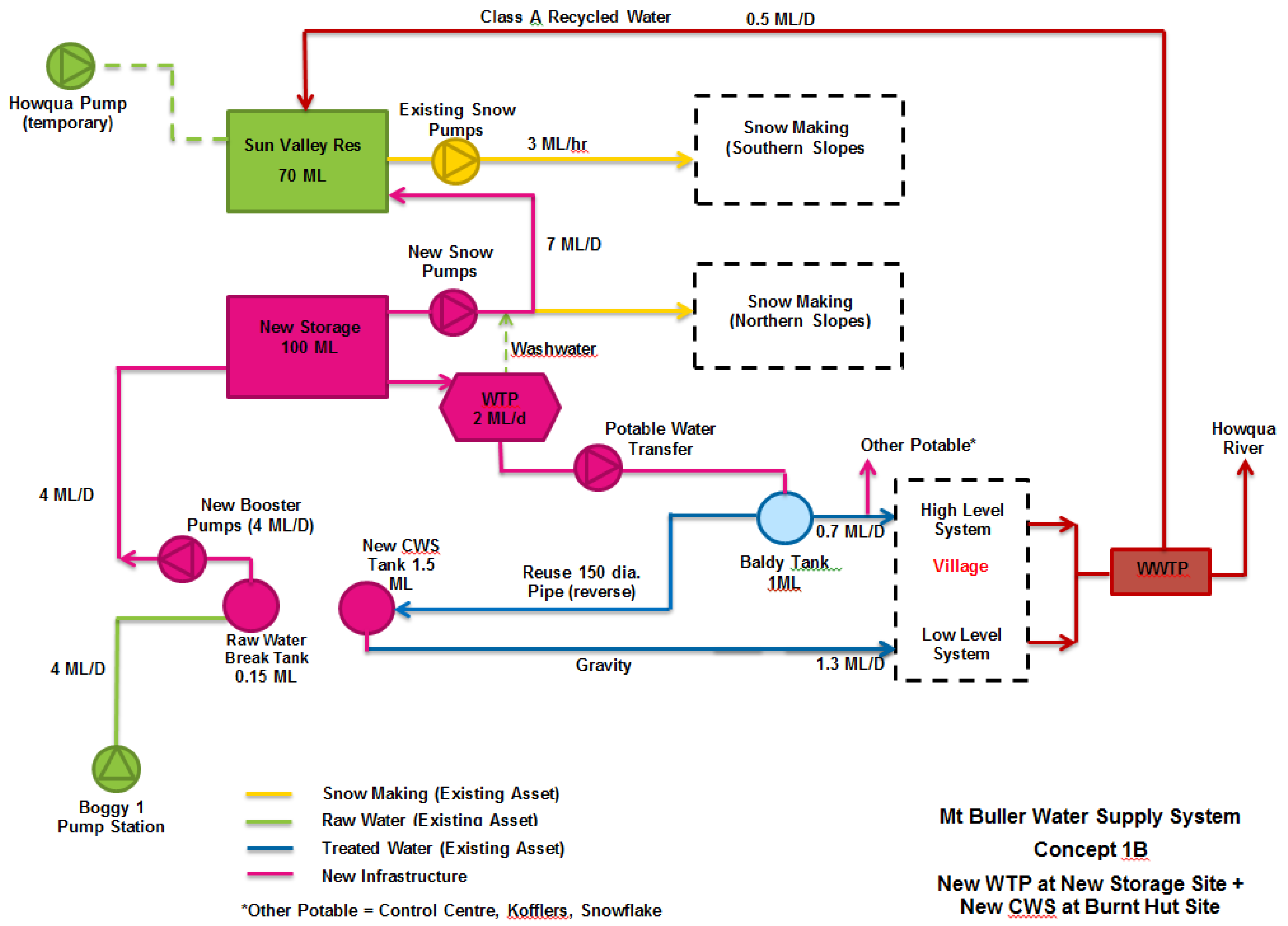


Figure 16 Water supply infrastructure – Concept 1B

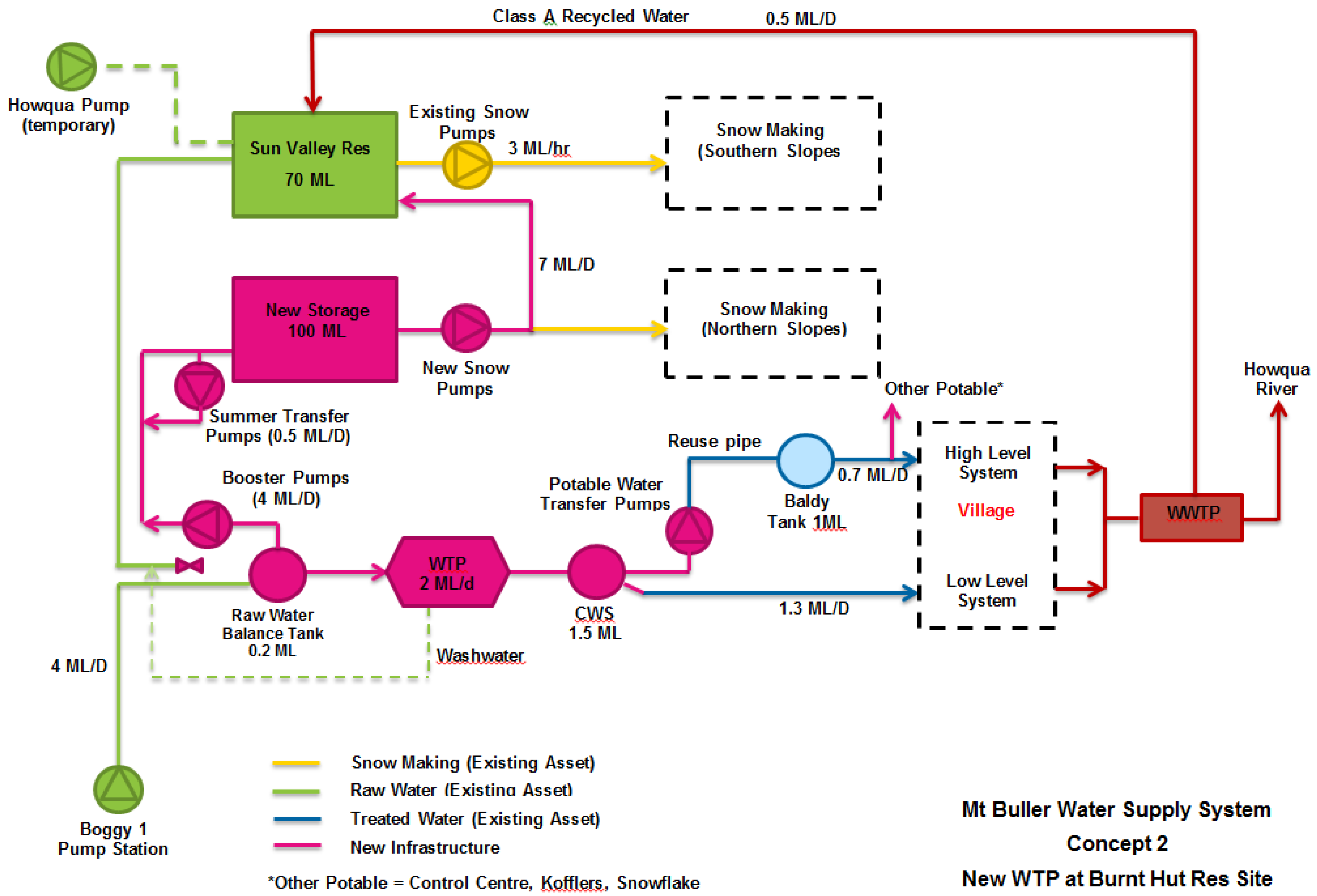


Figure 17 Water supply infrastructure – Concept 2

B3 Comparative Cost Estimate

A high level comparative capital cost estimate has been prepared for the overall concepts. This estimate is summarised below with the full estimate provided in Appendix D.

Table 11 Comparative capital cost estimate of overall concepts

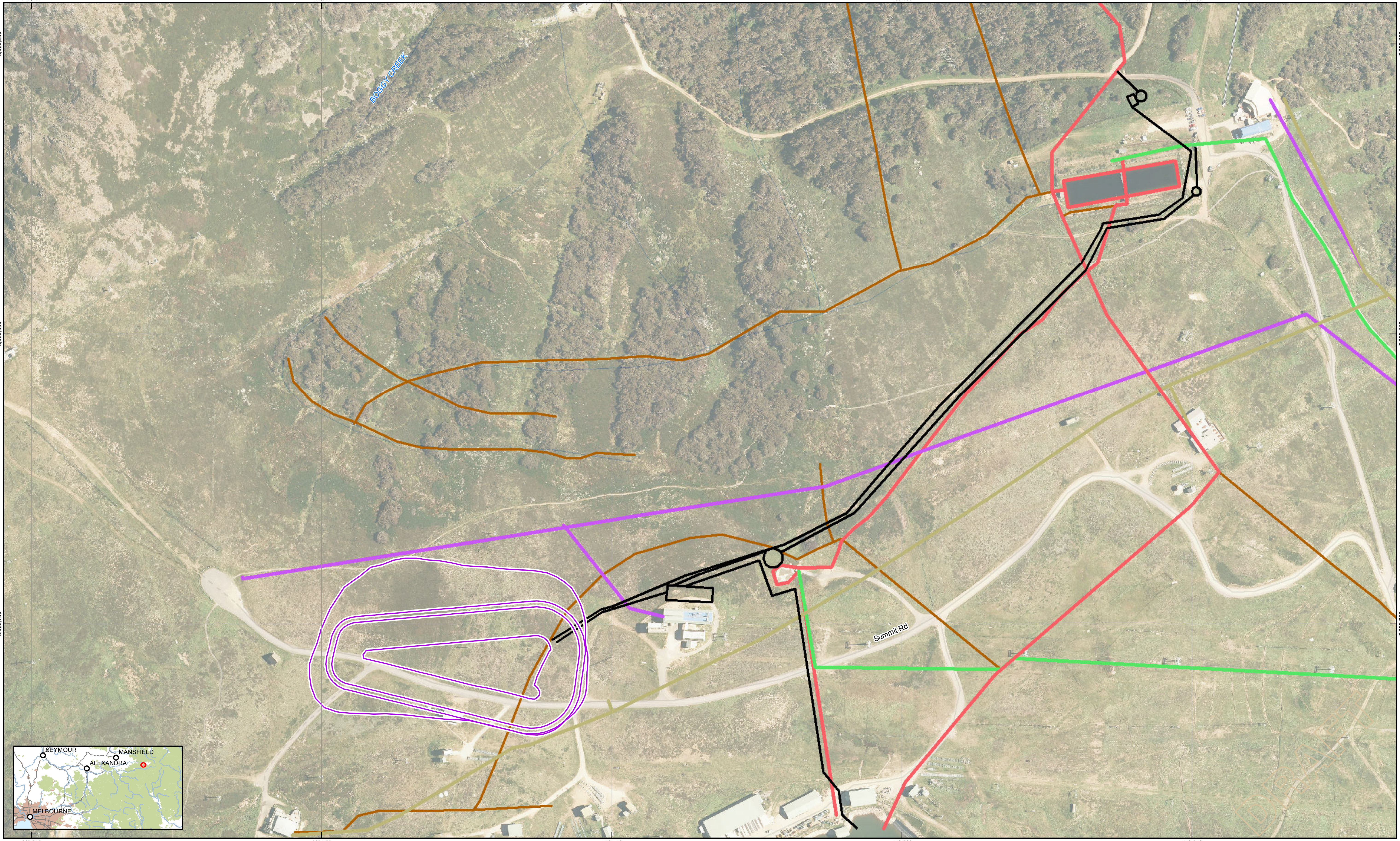
	Concept 1A	Concept 1B	Concept 2
Raw Water Transfer System Works	$1m	$1m	$1m
Treatment Plant Works	$3.5m	$3.5m	$3.5m
Potable Transfer to High Level Reticulation	$0.1m	$0.1m	$0.05m
Potable Transfer to Low Level Reticulation	$1.15m	$0.8m	$0.8m
Subtotal	**$5.75m**	**$5.4m**	**$5.35**
Engineering & Contingencies (40%)	$2.3m	$2.15m	$2.15m
Total	**$8.05m** **Say $8m**	**$7.55m** **Say $7.5m**	**$7.5m** **Say $7.5m**

It can be seen from the table that all the concepts have similar cost within the accuracy of the cost estimates developed at this concept level stage.

Cost estimate qualification

The cost estimates presented in this section have been developed for the purposes of comparing options and may be used for preliminary budgeting. However, the scope and quality of the works has not been fully defined. These estimates are typically developed based on cost curves, extrapolation of recent similar project pricing and GHD experience. The accuracy of the estimates is not expected to be better than about ± 35% for the items described in this report. A functional design is recommended for budget setting purposes.

Appendix C – Concept Layout Plans



Paper Size A3

0 15 30 60 90 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Concept 1A

- Proposed Pipeline Alignment

Underground Services

- Gas Main
- Sewer Pipe
- Water Infrastructure
- Water Pipe
- Storage Dam Footprint
- Water Pipeline
- Stream
- Unsealed road
- Track and bike path

Mt Buller & Mt Stirling Resort Management
Mt Buller Sustainable Water Security Project

Job Number	31-30733
Revision	A
Date	20 Dec 2013

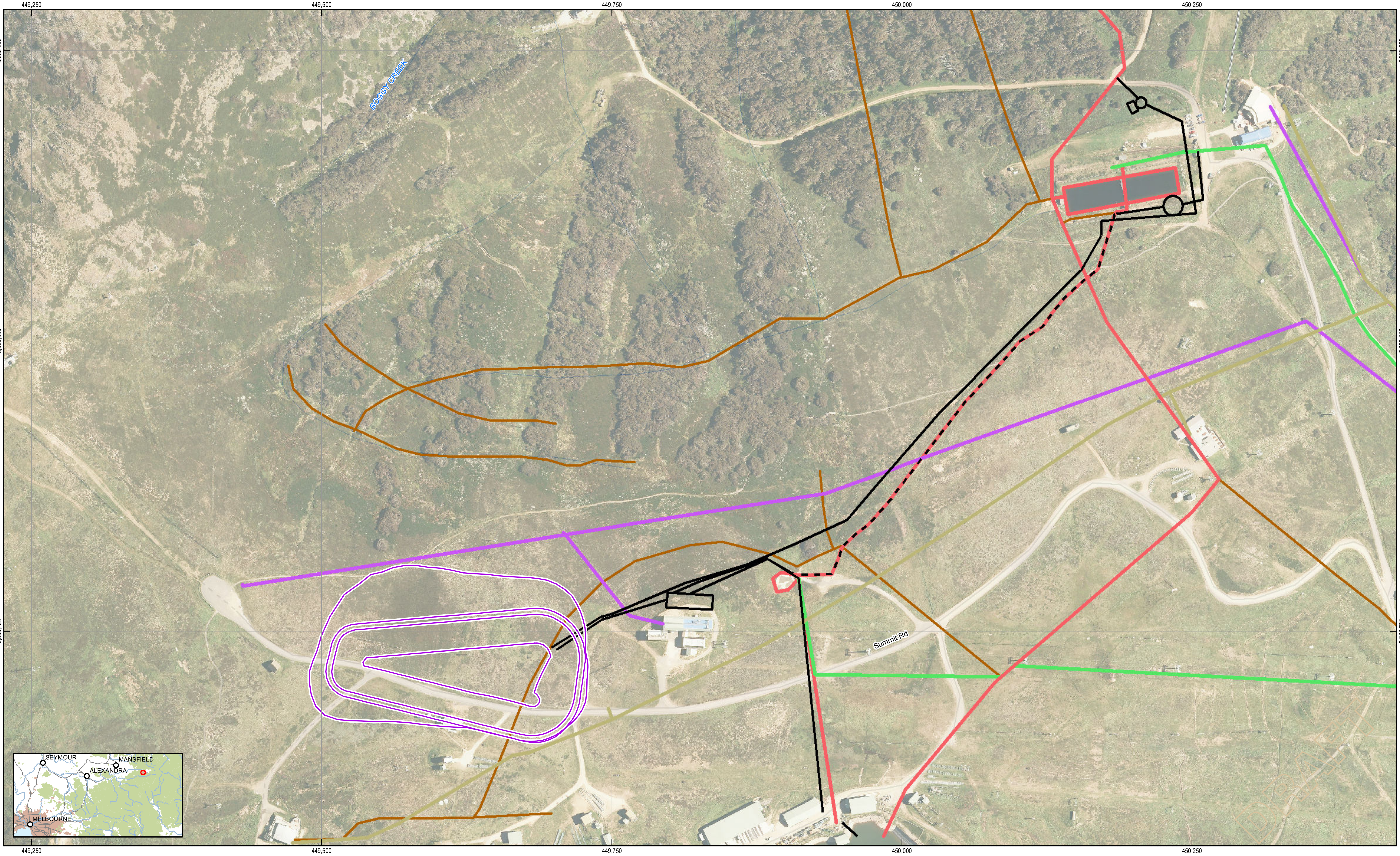
GHD

Pipeline Alignment
Concept 1A

G:\31\30733\GIS\Maps\Working\31-30733_KBM_Template.mxd

Data Source: DSE: Vicmap - 2013; GHD - 2013; DEPI - 2013. Created by: mjahanshahi

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A3

0 15 30 60 90 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Id
- Proposed Pipeline Alignment
- Connection to Exisitng Infrastructure
- Storage Dam Footprint

Underground Services
- Gas Main
- Sewer Pipe
- Water Infrastructure
- Water Pipe
- Water Pipeline
- Stream
- Unsealed road
- Track and bike path

GHD

Mt Buller & Mt Stirling Resort Management
Mt Buller Sustainable Water Security Project

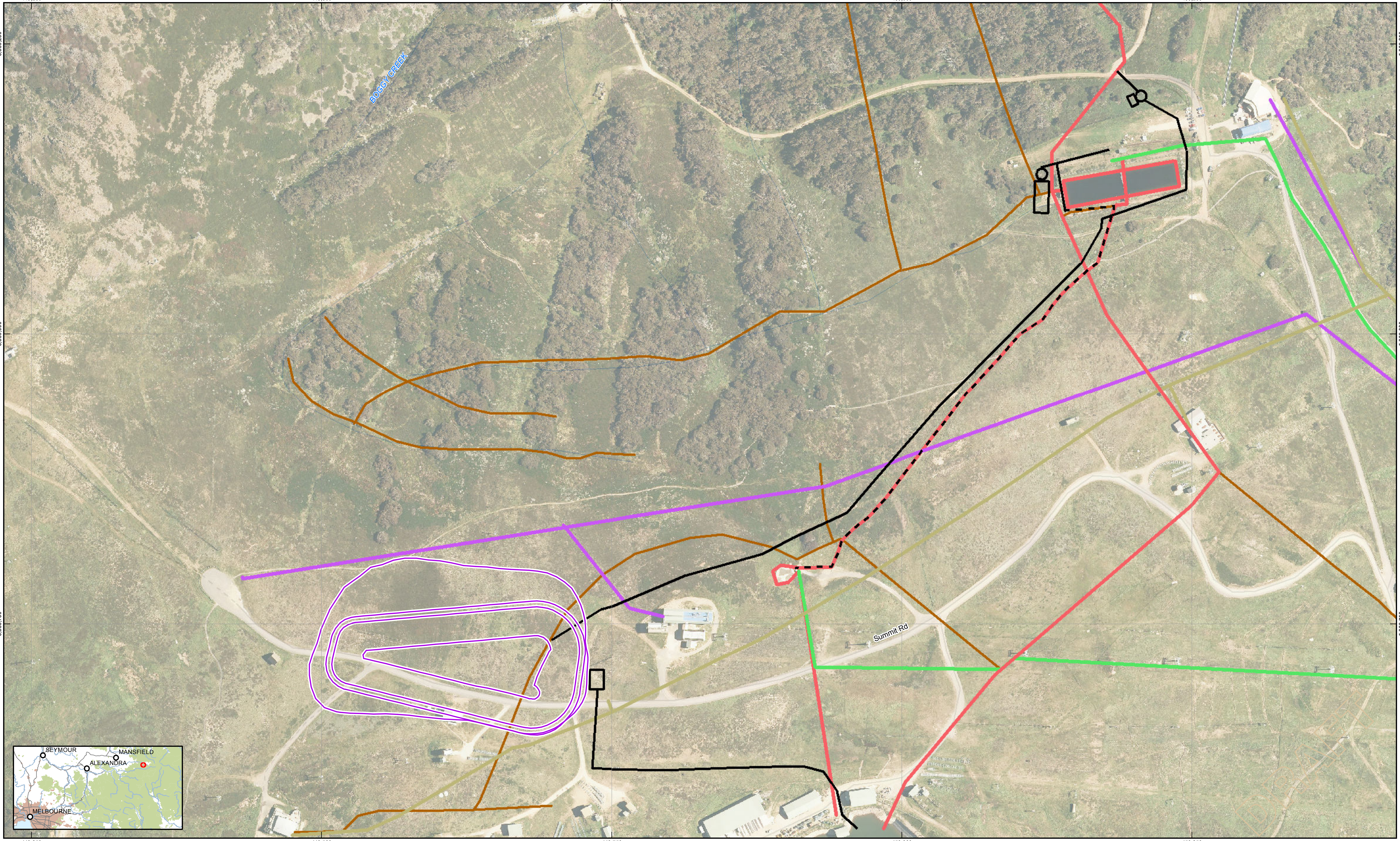
Job Number	31-30733
Revision	A
Date	20 Dec 2013

Pipeline Alignment
Concept 1B

G:\31\30733\GIS\Maps\Working\31-30733_KBM_Template.mxd

Data Source: DSE: Vicmap - 2013; GHD - 2013; DEPI - 2013. Created by: mjahanshahi

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com



Paper Size A3

0 15 30 60 90 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Id

- Proposed Pipeline Alignment
- Connection to Exisiting Infrastructure
- Storage Dam Footprint

Underground Services

- Gas Main
- Sewer Pipe
- Water Infrastructure
- Water Pipe
- Water Pipeline
- Stream
- Unsealed road
- Track and bike path

Mt Buller & Mt Stirling Resort Management
Mt Buller Sustainable Water Security Project

Job Number	31-30733
Revision	A
Date	20 Dec 2013

GHD

Pipeline Alignment
Concept 2

G:\31\30733\GIS\Maps\Working\31-30733_KBM_Template.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data Source: DSE: Vicmap - 2013; GHD - 2013; DEPI - 2013. Created by: mjahanshahi

Appendix D – Cost Estimates

Option	Concept 1 - New WTP Located at New Storage Site		Concept 2 - New WTP Located at Burnt Hut Site	Comment
Potable Water Transfer to Low Level System Sub-Option	*1A: CWS at Baldy with new pipe and Break Tank*	*1B: Reuse Pipe to new CWS at Burnt Hut*		
Raw Water Transfer System				
Demolition Works at Burnt Hut	$100	$100	$100	Repair of Burnt Hut difficult as need to maintain supply during construction
New Break Tank at Burnt Hut (0.15 ML)	$150	$150		
New Break/Balance Tank at Burnt Hut (0.2 ML)			$200	If plant located at Burnt Hut will need some balancing raw water storage (rather than just a break tank)
New Booster Pumps with VSDs (4 ML/d)	$150	$150	$150	Reuse of high lift pumps difficult as need to maintain potable and fire fighting supply during construction
New Building for new Booster Pumps	$150	$150	-	For Concept 2 the Booster Pumps can be located in the new WTP building
New Pipe from Break Tank to New Storage (4 ML/d)	$250	$250	$250	Existing pipe too small to transfer 4 ML/d (and is reused in Concept 1B and 2 for potable water transfer)
Summer Return Pumps for transfer from new storage back to Raw Water Balance Tank (0.5ML/d)	-	-	$100	
Raw water transfer pipe from New Storage to Sun Valley (7 ML/d)	$150	$150	$150	This will also act as a bypass to allow transfer of raw water direct to Sun Valley if required
Raw Water transfer pumps from New Storage to Sun Valley (7 ML/d)	-	-	-	It has been assumed that the new snow making pumps can be used
Raw Water System Subtotal	$950	$950	$950	
Treatment Plant				
New 2 ML/d Plant including raw water feed pumps, heated plant building and waste tanks	$3,500	$3,500	$3,500	Concept 1 assumes that the plant can be co-located in the snow making pumps building. Plant costs uncertain given location at top of mountain and cold temperatures. Project Budget for Class A MBR plant was $3.5 million
Power	-	-	-	It has been assumed the existing power supply can be used.
Washwater transfer pipe to Sun Valley Reservoir (dilution assumed ok)	$50	$50	$50	Concept 1 assumes use of the 7ML/d transfer pipe, concept 2 assumes resue of the existing pipe from Burnt Hut to Sun Valley
Treatment Plant Subtotal	$3,550	$3,550	$3,550	
High Level Potable Reticulation				
Potable Water Transfer Pumps to Baldy Tank	$50	$50	$50	
Potable Water Transfer Pipe to Baldy Tank	$50	$50	-	For Concept 2 the existing pipe from Burnt Hut to Baldy Tank can be reused
Reuse Baldy Tank and trunk main to high level reticulation	-	-	-	
High Level Subtotal	$100	$100	$50	
Low Level Potable Reticulation				
New Clear Water Storage (CWS) at Baldy Tank (1ML)	$600		-	
New Clear Water Storage (CWS) at Burnt Hut (1.5ML)		$800	$800	Repair and roofing of Burnt Hut Reservoir may provide minor savings but difficult to maintain supply & fire fighting during construction
New trunk main from Baldy Tank to low level reticulation (200dia, 1km approx)	$500	-	-	Concept 1B: reuse existing pipe between Baldy and Burnt Hut to transfer potable water to new CWS at Burnt Hut
Break Tank prior to connection to low level reticulation (say 10kL)	$50	-	-	
Low Level Subtotal	$1,150	$800	$800	
Subtotal	$5,750	$5,400	$5,350	
Engineering & Contingencies (40%)	$2,300	$2,160	$2,140	
Total	$8,050	$7,560	$7,490	
	say $8m	say $7.5m	say $7.5m	

GHD

180 Lonsdale Street
Melbourne, Victoria 3000
T: (03) 8687 8000   F: (03) 8687 8111   E: melmail@ghd.com.au

G:\31\3073311\WP\227530.docx

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft A	S Roach K van Lieshout	S Roach N Johnston		G Jones		20/12/2013
0	S Roach K van Lieshout	K van Lieshout G Jones		G Jones		03/07/2014

www.ghd.com