Selwyn Snow Resort

STP Dilution Study

Selwyn Snow Resort Pty Ltd

10 February 2023

311012-01613

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PROJECT 311012-01613 -REP001: Selwyn Snow Resort STP Dilution Study

Rev	Description	Author	Review	Advisian approval	Revision date	Client approval	Approval date
A	Internal Review	M Priestley	J. Jiang	K. Newton	18 Nov 22	[Initial. Surname]	[App date]
B	Issued to Client	M Priestley		K. Newton	21 Nov 22		
C	Issued to Client	M Priestley		K. Newton	30 Jan 23	Josh Elliot	30 Jan 23
D	Revised after stakeholder meeting	M Priestley			10 Feb 23		

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Executive summary

Selwyn Snow Resort is a day snow resort located in Mount Kosciuszko National Park in New South Wales (NSW), Australia. The resort was burnt down during the 2020 bushfires and is in the process of rebuilding with an aim to reopen for the 2023 snow season. The rebuild includes a new Sewage Treatment Plant (STP) (which has been completed). Advisian was engaged by Selwyn Snow Pty Ltd to prepare a Dilution Study in support of an options assessment for effluent management to discharge into a waterway called Clear Creek, that intersects through the valley of the resort.

The purpose of this report is to select an effluent management option for the STP and undertake a dilution study to inform this selection. Two options have been considered in detail:

- Beneficial reuse of recycled waters for reticulation in resort snow production, following dilution with freshwaters from Clear Creek and storage in the former quarry dam.
- Direct Discharge into Clear Creek.

A high-level assessment was undertaken on the dilution capacity of Clear creek. The objective was to determine whether dilution would be sufficient to meet the Water Quality Objective, of 'no changes to ambient water quality' as a result of effluent management. Continuous flow monitoring undertaken at two potential discharge points within the creek between 17th September 2022 and 15th October 2022 shows variable flows in Clear Creek during this period that are dependent on the snow melt regime, as well as rainfall, extraction volumes, catchment inflows and creek bathymetry.

For the 'Direct discharge into Clear Creek' option, there are days when the dilution afforded by natural flows would not be sufficient to meet the high value water quality guidelines that are required to protect waterways of Mount Kosciusko National Park. This is because the water is locked up in snow and not flowing. This option was discounted on this basis and communication with NSW EPA.

For the 'Beneficial Reuse as reticulation and snowmaking' option, this is significantly more favorable in terms of the potential environmental impacts and Principles of Ecologically Sustainable Development (ESD). In comparison to the option to direct discharge into Clear Creek, the option to recycle water significantly reduces likelihood for environmental impacts as:

- Approximately half of recycled water is reused in the resort toilet facilities, further reducing the volumes discharged to environment.
- The recycled water is significantly diluted in a controlled manner within the Quarry Dam, then further on snow fields when combined with natural snow fall. Discharge into Clear Creek is during snow melt events and peak flow rates. Continuous flow monitoring (temperature and flow data) suggests the snow melt events are likely gradual, over days.
- Discharge into Clear Creek is diffuse rather than point source.
- Further reductions on pollutants will be achieved during detention in the Quarry Dam, snowmaking process and travel over land prior to eventual discharge into Clear Creek via the snow melt regime.

The estimated water quality within the snow making dam and the receiving Clear Creek shows that the recycled water option should not result in **changes to ambient water quality** beyond natural variability. This includes layers of conservatism and maximum inputs into a range of scenarios, including consideration of periods where snow making cannot occur for consecutive days (volume of recycled water storage in Quarry Dam for 1-10 days during peak visitation were considered).

Acronyms and abbreviations

Acronym/abbreviation	Definition
AGWR	Australian Guidelines for Water Recycling
ANZG	Australia and New Zealand Water Quality Guidelines
DEC	Department of Environment and Conservation
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence
MKNP	Mount Kosciusko National Park
NSW	New South Wales
NSW EPA	New South Wales Environmental Protection Authority
STP	Sewage Treatment Plant

1 Introduction

1.1 Background

Selwyn Snow Resort is a day snow resort located in Mount Kosciuszko National Park in New South Wales (NSW), Australia, which was burnt down during the 2020 bushfires. The resort is in the process of rebuilding with an aim to open for the 2023 snow season (beginning on the June long weekend). The rebuild includes a new Sewage Treatment Plant (STP) (which has been completed). Advisian was engaged by Selwyn Snow Pty Ltd to prepare a Dilution Study in support of an options assessment for effluent management to discharge into a local waterway called Clear Creek, that intersects through the valley of the resort (Figure 1-1). Images of the new facilities and resort are shown in Figure 1-2.

Selwyn Snow Resort is typically open during the snow season, between the June and September long weekends. It is a day resort with very limited accommodation (for staff purposes only). The STP is required to treat sewage and grey waters that are associated with the day resort facilities. Prior to the bushfires during 2020, pit toilets were the method for wastewater disposal.

Under the *Protection of the Environment Operations (POEO) Act 1997*, an Environment Protection License (EPL) is required to discharge into waterways. Part of the requirements of the NSW Environment Protection Authority (EPA) for the EPL approval includes the preparation of a receiving environment assessment. This includes a Dilution Study to estimate the mixing zones of the proposed treated effluent discharges into Clear Creek. Clear Creek is also used for the extraction of potable waters and freshwater for snow production (under an existing extraction license (Figure 1-3).

Figure 1-1 Selwyn Snow Resort and Clear Creek (shown by blue line) (Nearmap, 2022)

Figure 1-2 Selwyn Snow Resort with facilities (top) and ski run (bottom) (from: About - Selwyn Snow Resort)

Figure 1-3 Clear Creek Extraction Points for potable waters (left) and snowmaking (right).

1.2 Scope of Works

A dilution assessment was undertaken on the dilution capacity of the creek. The objective was to determine whether dilution would be sufficient to be able to discharge effluent into the creek and still meet the stringent water quality guidelines for Kosciusko National Park or otherwise have an acceptable mixing zone.

The scope included:

1. Review of the scope and EPA requirements.
2. Field visit and inspection, including collection of creek profile/bathymetric data for 12 locations
3. Assessment of the Clear Creek receiving environment in relation to the Australian and New Zealand guidelines for fresh and marine water quality (ANZG) (2018) and NSW EPA requirements for discharging into waterways in a high value ecosystem.
4. Collection of one-month of continuous flow monitoring data for two discharge location options.
5. Review of previous water quality data for Clear Creek collected from 29th July – 24th October 2022 by K2 Consulting.

1.3 Selwyn Snow Resort Sewage Treatment Plant

The treatment of wastewater is required for the treatment of wastewaters for an estimated population (EP) of 2,100 persons per day during the peak snow season between 1st June and 30th September. The wastewater is generated from the following sources:

- Main resort complex (up to 2,000 persons per day).
- Workshop (up to 50 persons per day).
- Staff accommodation (up to 50 persons per day).

The STP is designed to treat a maximum of 50 kL per day (40 kL per day ± 10%) in conjunction with two 50 kL balance tanks to cover the peak flows. The tertiary process consists of a Modified Ludzack-Ettinger (MLE) process with MBR polishing. The final disinfection is dependent on the effluent management option. If used for recycled waters, then disinfection would be a combination of ultraviolet light (UV) and liquid chlorine dosing to achieve sufficient pathogen log reduction to meet the recycled water guidelines. Chlorine would not be used in the scenario that the effluent is discharged to the creek due to its acute toxicity of total chlorine (sum of free chlorine and chloramines) at very low concentrations (Batley et al. 2021). A suitably sized grease trap will be installed upstream of the plant. Heating elements will be installed within the initial anoxic tank to ensure optimal temperatures for the nitrogen conversion by the anoxic bacteria, to account for the cold environment.

A Statement of Environment Effects (SEE) for the construction of the STP was approved by the Department of Planning and Environment (DP&E) in accordance with the State Environmental Planning Policy (Kosciuszko National Park – Alpine Resorts) under Part 4 of the *Environmental Planning and Assessment Act* 1979 (EP&A Act) in March 2022.

Refer to the SEE (2022) and design brief by Demem Akwa (2022) for further detailed information on the STP including the location of the STP and associated infrastructure. The STP was originally designed for the management option of beneficial reuse as recycled water. The recycled water quality is to be in accordance with the National Guidelines for Water Recycling, Managing Health and Environmental Risks, Phase 1 (AGWR) (2006).

The STP design effluent limits were based on communications with NSW EPA (DOC21/126763, see **Appendix A**), which specify the 90% accepted levels for discharges to inland waterways (Table 1-1). These limits are conservative and represent the worst-case scenario of concentrations in effluent discharges.

Table 1-1 Discharge limits for inland waterways

Parameter	Accepted levels achieved by modern technology for discharges to inland waterways
Biological oxygen demand	10 mg/L
Total nitrogen	10 mg/L
Total phosphorus	0.3 mg/L
Suspended solids	15 mg/L

Parameter	Accepted levels achieved by modern technology for discharges to inland waterways
Ammonia as N	2 mg/L
pH	6.5 – 8.5 pH units
Oil and grease	2 mg/L
Pathogens (measured using faecal coliforms as indicator)	200 colony forming units per 100mL

1.4 Other Relevant Information

Other relevant information that needs to be accounted for in the Dilution Study includes:

- The maximum peak effluent discharge volume is 50,000 L per day, based on STP capacity, although typical volumes will be lower. This corresponds to:
  - A rate of 34.7 L/min assuming continuous 24/7 discharges.
  - A rate of 104.1 L/ min, assuming a 16:8 scheme to assist with recycled water quality (water is extracted for 16 hours and effluent discharged for 8 hours).
- Extraction licenses:
  - Potable water extraction point, based on 20 kL per day.
  - Snow making water extraction point, based on a 40ML (40ML / 100 days during snow making season). This is a conservative assumption, as the full amount is rarely used (Pers. Comm Selwyn Snow Resort).

1.5 Snow Making Operations

Schematics of the snow making operations are shown in Figure 1-4 and Figure 1-5.

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Worley Group

Selwyn Snow Resort

Figure 1-4 Schematic of snowmaking operations at Selwyn Snow Resort

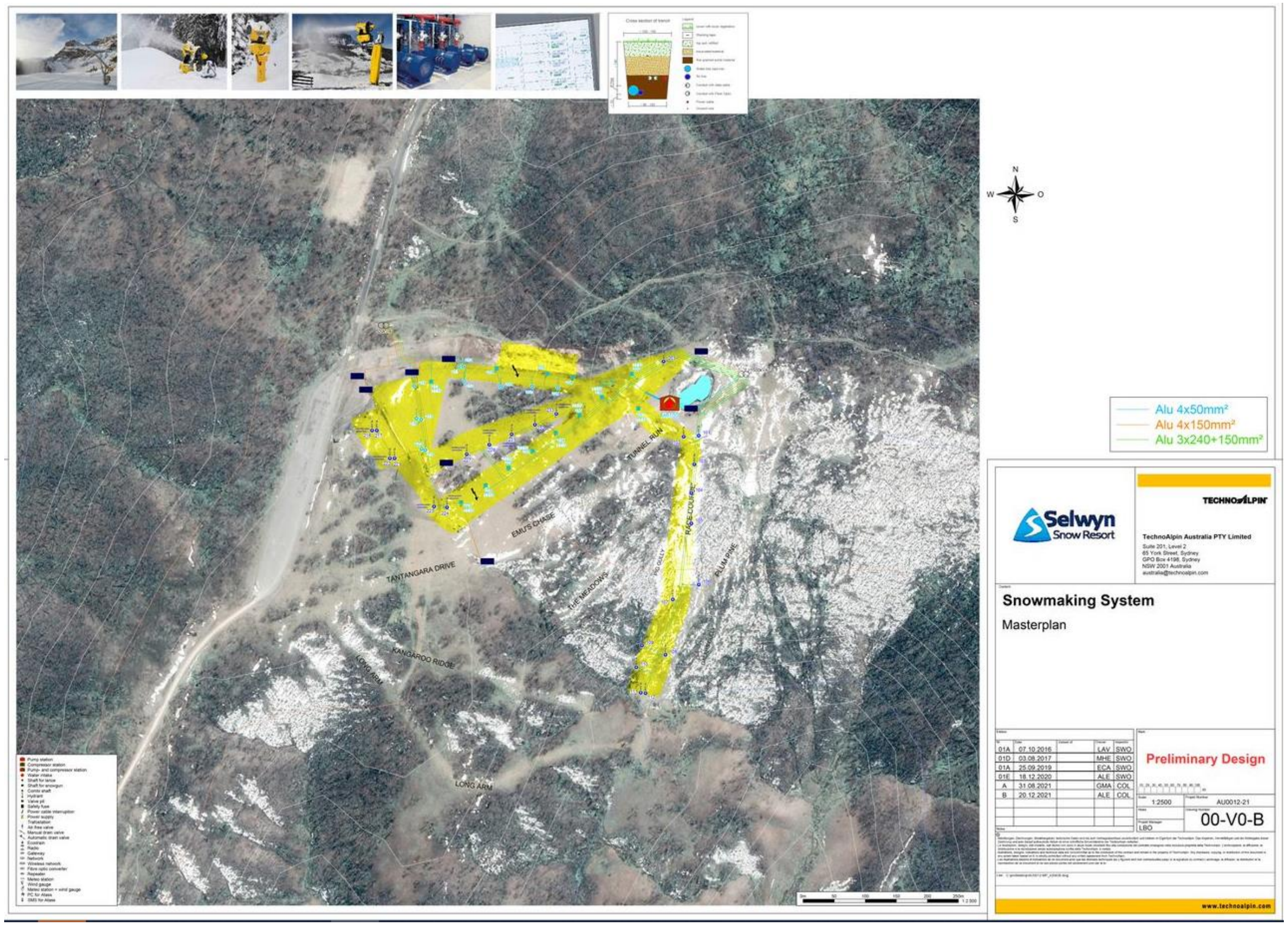


Figure 1-5 Detailed schematic of snowmaking operations at Selwyn Snow Resort

2 Stakeholder Consultation

A list of stakeholder correspondence that is relevant to the Dilution Study is provided in **Appendix A**. Table 2-1 provides a summary of the available stakeholder comments and responses.

Table 2-1 Comments on the Dilution Study (based on time of reporting)

No.	Comment	Response
NPWS (6-2-23)		
1	*1.2 Scope of work* – We note that the data informing the study is limited to one month of flow monitoring and water quality monitoring data for three months, late July to late October 2022. Any limitations of this small dataset should be accounted for in the study.	The water quality and flow dataset does not capture long term variation (e.g. year to year) noting that this would not be possible in the available timeframe. However, it is considered that the water quality dataset is not limited in terms of covering an extensive set of parameters (including many that do not have guidelines) across 6 sampling sites with fortnightly sampling. In addition, the flow monitoring was undertaken at two sites, with measurements every 15 minutes for one month. The data is considered to be sufficient as a representative timeframe for the modelling exercise. Noting that many layers of conservatism have been included in the calculations (see Section 5.3.1.1). In addition, refer to Section 8 for the following recommendation: • A modelling validation component is recommended as part of the first or second annual Water Quality Report. This study would reassess the calculations considering longer-term water quality dataset during operation.
2	*2.3 Guideline values* – We would like to see further evidence that default ANZG (2018) guideline values are appropriate for use in this situation. We would also like further details on what work is proposed to develop site specific guidelines (including sampling effort for long term dataset) and how these would be verified.	The default ANZG (2018) are proposed as interim approach. In addition, for all water quality parameters we have also compared to the available ambient median water quality concentrations. This is a similar approach to how site-specific guidelines would be derived but acknowledging a longer (2 year) dataset is required. Potentially, if suitable baseline reference water quality data can be sourced (for example, from the Snowy 2.0 project), then site specific guidelines could be derived earlier. We have attempted to source this data but do not have at the time of reporting. In addition, refer to Section 8 for the following recommendation: Site specific water quality guidelines should be derived for stressors (as a minimum for parameters of dissolved oxygen, pH, temperature, salinity, total nitrogen and total phosphorous) using a longer-term dataset of two years of baseline data with minimum monthly sampling at reference sites, during the winter and spring seasons. As the area is high conservation, it is considered that the objective will be to keep the water body at reference condition with 'no changes beyond natural variability'. The test site medians should be compared with the medians of long-term reference site dataset. As the resort and STP is not operational during summer or autumn, then it is not considered necessary to develop water quality guidelines for

No.	Comment	Response
		these seasons. Developing seasonal water quality guidelines is an accepted approach as part of the ANZG framework.
3	*4.2 Clear Creek* – Is Clear Creek the only waterway likely to be affected by recycled water snowmaking? What are the relevant watersheds and anticipated drift of artificial snow? Will there be certain weather condition parameters (e.g. for wind) around which snowmaking will / will not occur?	For Selwyn, as this is a small resort and snow making is energy and cost intensive it is in their best interest to only apply snow to recreational areas. The snowmaking guns are targeted at ski runs and the application procedure is very controlled. The ski runs where snow is applied are located on the sides of the valley of the Clear Creek catchment. Due to the topography of the valley and the ski runs, snow drift can be contained within the Clear Creek catchments. Also noting that the skis runs are nestled within the mountains, the wind speeds are much lower within the catchment and snow application areas. Refer to Figure 1-4 that shows the snowmaking application areas.
4	*4.3.1.1 Assumptions* – A2 appears to assume that snowmaking would not be possible on around 4 consecutive days during peak operations – Is this realistic given temperature parameters for skiable quality snowmaking at the resort and historical temperature data/ anticipated future temperature modelling? What is the effect of this assumption on storage for recycled water that SSR anticipates it will require, particularly for nitrogen (see further second bullet point in 4.3.1.3)?	These were based on selected scenarios that are representative of the historic snowmaking application requirements for Selwyn Snow Resort and the recycled water volumes during peak resort usage (2000 people per day). A 25 kL scenario was selected as a credible typical scenario of daily snow making. The 100kL scenario was selected as a credible longer scenario where there would be 4 consecutive days without snowmaking during peak visitation. It is acknowledged that the wording of 'maximum' may have been misleading. It is agreed that restrictions on maximum storage could be restrictive for Selwyn Snow Resort. While it is unlikely, there may be periods where the Quarry Dam is needed to store recycled water for longer periods. Such as in an uncharacteristic cold period with extended natural snow fall, they would not need to make snow. We have included a longer scenario (250kL, or 10 days consecutive storage during peak visitation). The dilution is still sufficient that discharges into Clear Creek would meet the adopted interim water quality guidelines. In addition, it is considered that the modelling is very conservative. Given that the STP is not operational yet, and the high value of the ecosystem this is appropriate. However, actual concentrations in both the Quarry Dam and discharges to Clear Creek are expected to be much lower than those modelled (the license limits and average recycled water concentrations from other plants in Australia). In addition, refer to Section 8 for the following recommendation of a Modelling Validation Study.
5	*4.3.1.1 Assumptions* – D1 and D2 are based on one month of flow monitoring in mid-late spring. Is this sufficient to inform the assumption around snow melt events? How would the absence of snow melt events result in higher	During the winter season, it is predicted that the snow melt events would be less frequent or partial melt events. With a longer duration between snow melt events this would result in more time for natural snow to accumulate on the ski slopes. During complete snow melt events, there would be larger volume of snow melting and entering Clear Creek resulting in higher dilution.

No.	Comment	Response
	dilution given there would be less flow?	By applying recycled water as snow, this means that the discharges into Clear Creek will mimic the natural snow melt regime and enter the creek during the highest flow periods.
6	*5 Review of effluent management options* – Is there data / calculations to support the assumption that required discharge will be reduced by approximately 50% where reuse in toilet facilities occurs?	The volumes required for reticulation are based on peak visitation (2,000 guests per day) to Selwyn Snow Resort. This corresponds to a peak volume of 25 kL per day that is required for the toilets based on the design of the STP. This is 50% of the estimated volume of recycled water (100kL) that will be produced during peak visitation.
7	*5.1 (Table)* – Incorrect categorisation of NPWS as consent authority for planning purposes. See comments above.	This has been amended.
8	Flora, Fauna and Groundwater: The dilution study was solely focused on Clear Creek. There are other, potentially significant, impacts on flora, fauna and groundwater. The dilution study states that there should be no "changes to ambient water quality beyond natural variability" in Clear Creek and this has been used to hypothesize that there will be no impacts on flora, fauna and groundwater. This hypothesis needs to be tested through mass balance calculations and an additional flora and fauna study that encompasses all the areas where snow making and snow push occurs as well as where any meltwaters can run.	It is agreed that the dilution study is focused on Clear Creek aquatic receiving environment. Further assessment has been undertaken to support the assessment of the potential impacts of the recycled water option on groundwater, terrestrial flora and terrestrial fauna. **Recycled Water Management Plan (Water Futures 2023)** Additional monitoring has been recommended by Advisian in the proposed environmental monitoring program. An annual soil testing program and assessment has been included to assess the potential long-term effects on soil, in line with the Australian Recycled Water Guidelines. This includes cumulative thresholds for salinity in soils for protection of Australian native species. The Quarry Dam has been included as a sampling site in the environmental monitoring program. Groundwater sampling has not been included in consideration of the safety concerns as the ski slopes and the bottom of valley are not accessible for a drill rig. There is a sampling point at the start of Clear Creek for the potable water supply that is fed by groundwater, but not considered to be impacted by the recycled water application. **Human Health Environmental Risk Assessment (Water Futures and Advisian, 2023)** An additional detailed Environmental Risk Assessment has been undertaken in line with the framework of the Australian Recycled Water Guidelines. This examines the potential pathways that could the recycled water application could impact on soils, groundwater, surface waters and terrestrial plants The focus is on the quality of the recycled water, and comparison to available established environmental thresholds for relevant parameters to soils, waters, grasses and/or plants. As the baseline terrestrial ecology survey was not available at the time of reporting, the most sensitive

<table>
<tr><th>No.</th><th>Comment</th><th>Response</th></tr>
<tr><td></td><td></td><td> criteria were applied. The HHERA did not identify any parameters that would be above the relevant thresholds for soils, plants and waters. Assessments of cumulative impacts of salinity, nitrates and phosphorus rely on testing soil extracts during operation and comparing to thresholds. Baseline Flora and Fauna Survey It is understood that Selwyn Snow Resort have organised for a Baseline Flora and Fauna Survey to cover the area of snowmaking, snow push and run off. This will be useful context for the ongoing assessment of recycled water impacts, as there are key thresholds for Australian native that can be applied to soil and water testing results (at present we have assumed most sensitive). It is considered that the Australian Recycled Water Guidelines provide the best framework for assessing the potential impacts of the recycled water application on terrestrial (and freshwater aquatic) biodiversity. This is through soil and water testing, with thresholds for assessing impacts on terrestrial Australian native species, non-natives and grasses. The AGWR framework does not consider ongoing terrestrial flora and fauna surveys (such as repeated transects) as part of the ongoing assessment approach. The value of ongoing flora and fauna to assess impacts of recycled water is challenged for the following reasons: Flora surveys can be useful to select relevant thresholds (for example, salinity and phosphorous thresholds for native species).
The terrestrial habitat is still in recovery mode from the extensive bushfire in 2020. It would not be practical to assess changes in ecology and try to attribute to impacts from recycled water application.
The AGWR provides an established framework for considering terrestrial ecology impacts, that can be undertaken using with the proposed environmental monitoring soil and water monitoring program.</td></tr>
<tr><td>9</td><td>We understand that DPE has corresponded with you separately about the Biodiversity Offsets Scheme under the Biodiversity Conservation Act 2016. Potential triggers for the Scheme and why they do or do not apply in the circumstances proposed should be included in the DA.</td><td> This comment is relevant to the preparation of the Statement of Environmental Effects (SEE). The Dilution Study shows that there is sufficient dilution within the Quarry Dam that there would be no changes to ambient water quality within freshwater Clear Creek as a result of the proposal. An additional detailed environmental risk assessment has been prepared as per response to comment #8. </td></tr>
</table>

3 Water Quality Objectives and Guideline Values

3.1 Framework

The following guidelines apply to this assessment:

- National Health and Medical Research Council (NHMRC) (2006). Australian Guidelines for Water Recycling and Managing Health and Environmental Risks (AQWR) (Phase 1). Available from: https://www.waterquality.gov.au/sites/default/files/documents/water-recycling-guidelines-full-21.pdf.

- Australian Wastewater Quality Management Guidelines (2022). Available (to WSAA members) from: https://www.wsaa.asn.au/search?keys=AGWR.

- NSW EPA (2022). Guidance on Water Pollution Discharge Assessments. Available from: https://www.epa.nsw.gov.au/your-environment/water/managing-water-pollution-in-nsw/environment-protection-licensing/water-pollution-discharge-assessments

- Department of Environment and Conservation (DEC) (2004). The Australian River Assessment Program: AusRivAS Physical Assessment Protocol. Available from: AUSRIVAS Australian River Assessment System (ewater.org.au).

- NHRMC (2008). Guidelines for Management Risks in Recreational Waters. Available from: https://www.nhmrc.gov.au/about-us/publications/guidelines-managing-risks-recreational-water. Note these guidelines were used for baseline assessment of pathogen indicators.

- ANZG (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality–Toxicant Default Guideline Values for 99% species protection. http://www.waterquality.gov.au/anz-guidelines.

- ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality–Guidelines for Physical and Chemical Stressors in Southeast Australia – VIC Alpine Regions. Available from: http://www.waterquality.gov.au/anz-guidelines.

3.2 Water Quality Objectives

The water quality objectives (WQO) that have been adopted for the Clear Creek receiving environment for this assessment are provided in Table 3-1.

Table 3-1 Adopted Water Quality Objectives

Water Quality Objective	Target	Guideline
Protection of Aquatic Ecosystems	Maintaining the level of high ecological protection No changes to receiving ambient waters beyond natural variability Meeting 99% protection for toxicants in receiving waters	ANZECC (2000) ANZG (2018)
Visual Amenity	Maintaining the aesthetic quality of the receiving waters	ANZECC (2000) ANZG (2018)

Water Quality Objective	Target	Guideline
Primary contact recreational	Maintain water quality for use in snow making for recreational activities of the snow resort, where there is a high probability of snow being swallowed.	NHMRC (2008)

3.3 Guideline Values

Guideline values to protect the identified WQOs are provided in Table 3-2.

Updated default ANZG (2018) guidelines values for inland waterways are under review and not yet available. The preferred approach is to develop site specific guidelines for stressors that are based on a long-term data (24 months) of reference sites data with minimum of monthly sampling.

Interim guidelines for the purpose of this assessment were based on the ANZECC (2000) default guidelines and available ANZG (2018) default toxicant guidelines for the protection of 99% of species in high value ecosystems.

The below approach is based on default interim guidelines, with the intent to develop site specific guidelines in the next 24 months once a long-term dataset has been collected.

Table 3-2 Adopted interim water quality guidelines for Clear Creek

Group	Parameter	Unit	Objective	Guideline Value	Reference
Physicochemistry	Temperature	°C	No change from natural conditions	-	EPA requirements[3] & ANZECC (2000)[1]
	pH	-		6.5 – 7.5	
	Dissolved oxygen	% Sat	-	90 - 110	ANZECC (2000)[1]
		mg/L			
	Conductivity	µS/cm	-	-	-
	Turbidity	NTU	-	2 - 25	ANZECC (2000)[1]
Physical quality	Biological Oxygen Demand (BOD)	mg/L	-	-	-
	Oil and grease	mg/L	No visual sheen	-	-
	Total dissolved solids (TDS)	mg/L	-	-	-
	Total suspended solids (TSS)	mg/L	-	-	-
Nutrients	Ammonia as N (NH)	mg/L	-	0.32	ANZG (2018)[2]
	Total nitrogen as N (TN)	mg/L	-	0.25	ANZECC (2000)[1]
	Total organic nitrogen as N (TON)	mg/L	-	-	-
	Total kjeldhal nitrogen (TKN)	mg/L	-	-	-
	Nitrates as N (NO_3)	mg/L	-	-	-
	Nitrites as N (NO_2)	mg/L	-	-	-

Group	Parameter	Unit	Objective	Guideline Value	Reference
	Nitrates + nitrites as N (NO_x)	mg/L	-	0.015	ANZECC (2000)[1]
	Total phosphorus as P (TP)	mg/L	-	0.02	ANZECC (2000)[1]
	Filterable reactive phosphorus as P (FRP)	mg/L	-	0.015	ANZECC (2000)[1]
Dissolved Metals and metalloids	Total Mercury (Hg)	mg/L	-	-	-
	Aluminium (Al)	µg/L	-	27 (pH>6.5)	-
	Arsenic ((As)	µg/L	-	1 (AS III)	ANZG (2018)[2]
	Barium (Ba)	µg/L	-	-	-
	Beryllium (Be)	µg/L	-	-	-
	Cadmium (Cd)	µg/L	-	0.06	ANZG (2018)[2]
	Chromium (Cr)	µg/L	-	-	-
	Copper (Cu)	µg/L	-	1	ANZG (2018)[2]
	Lead (Pb)	µg/L	-	1	ANZG (2018)[2]
	Iron (Fe)	µg/L	-	-	-
	Magnesium (Mg)	µg/L	-	-	-
	Nickel (Ni)	µg/L	-	8	ANZG (2018)[2]
	Vanadium (V)	µg/L	-	6	ANZG (2018)[2]
	Zinc (Zn)	µg/L	-	2.4	ANZG (2018)[2]
Total Metals and metalloids	Mercury (Hg)	mg/L	-	-	-
	Arsenic (As)	µg/L	-	-	-
	Barium (Ba)	µg/L	-	-	-
	Beryllium (Be)	µg/L	-	-	-
	Cadmium (Cd)	µg/L	-	-	-
	Chromium (Cr)	µg/L	-	-	-
	Cobalt (Co)	µg/L	-	-	-
	Copper (Cu)	µg/L	-	-	-
	Manganese (M)	µg/L	-	-	-
	Nickel (Ni)	µg/L	-	-	-
	Lead (Pb)	µg/L	-	-	-
	Vanadium (V)	µg/L	-	-	-
	Zinc (Zn)	µg/L	-	-	-

Group	Parameter	Unit	Objective	Guideline Value	Reference
Cations	Calcium (Ca)	mg/L	-	-	-
	Magnesium (Mg)	mg/L	-	-	-
	Sodium (Na)	mg/L	-	-	-
	Potassium (K)	mg/L	-	-	-
Pathogen indicators & microbiological	Faecal coliforms	CFU/100ml	-	200	NHMRC (2008)
	enterococci	CFU/100ml	-	40	NHMRC (2008)
	Heterotrophic Count (HPC) at 22°C	CFU/100ml	-	-	-
	Heterotrophic Count (HPC) at 36°C	CFU/100ml	-	-	-
	Thermotolerant coliforms	CFU/100ml	-	-	-
Algae indicator	Chlorophyll - *a*	mg/L	No algae blooms	-	-
Disinfectants	Total chlorine (sum of free chlorine and chloramines)	µg/L	-	3	ANZG (2018)[2]

1. ANZECC (2000) Default trigger values for physical and chemical stressors in south-east Australia and 2. ANZG (2018) 99% species protection for toxicants for high value ecosystems, 3. ANZECC (2000) Interim working guideline for iron based on the Canadian guideline level.

3.4 Key environmental risks of recycled water

The key environmental risks of recycled water are outlined in Table 4.2 of the ADWG (NHMRC 2006) as shown below.

Table 4.2 Key environmental hazards, environmental endpoints and common effects on the environment when using recycled water for agricultural, municipal, residential and fire-control purposes

Hazard	Environmental endpoint	Effect or impact on the environment
Boron	Accumulation in soil	Plant toxicity
Cadmium	A low risk with respect to cadmium concentrations in recycled water, but cadmium already in soils can be made more readily available to plants if chloride concentrations increase. Chloride can be measured indirectly, but reliably, as salinity (see the salinity section below).	
Chlorine disinfection residuals	Plants	Direct toxicity to plants
	Surface waters	Toxicity to aquatic biota
Hydraulic loading (water)	Soil	Waterlogging of plants
	Groundwaters	Waterlogging of plants
	Groundwaters	Soil salinity (secondary)
Nitrogen	Soils	Nutrient imbalance in plants
	Soils	Pest and disease in plants
	Soils	Eutrophication of soils and effects on terrestrial biota
	Surface waters	Eutrophication
	Groundwaters	Contamination
Phosphorus	Soils	Eutrophication of soils and toxic effects on phosphorus sensitive terrestrial biota (native plants)
	Surface waters	Eutrophication
Salinity	Infrastructure	Salinity may cause rising damp or corrosion of assets; this can also arise from excessive hydraulic load (secondary salinity)
	Soils	Plants stressed from osmotic affects of soil salinity
	Soils	Contamination of soils by increasing plant availability of cadmium that is already in the soil
	Surface water	Increasing the salinity of fresh groundwaters
	Groundwater	Increasing the salinity of fresh surface waters
Chloride	Plants	Direct toxicity to plants when sprayed on leaves
	Soils	Plant toxicity via uptake through the root
	Surface water	Toxicity to aquatic biota
Sodium	Plants	Direct toxicity to plants when sprayed on leaves
	Soils	Plant toxicity via uptake through the root
	Soils	Soil structure decline due to sodicity

4 Assessment Approach

An assessment was undertaken on the proposed Clear Creek receiving environment to gain an understanding of baseline water quality and the dilution capacity of the creek.

4.1 Baseline Water Quality Monitoring

A baseline water quality monitoring program was designed by K2 Consulting. The sampling was undertaken during September and October, which is representative of the late snow season. There were six sampling occasions undertaken weekly in July, August, September and October. During this period, there is no effluent being discharged into the creek as there is no operational STP.

The objective of the monitoring program was to assess baseline ambient water quality at the discharge location (Clear Creek), upstream and downstream and at reference sites.

Six monitoring sites were included in this program:

- SP1 – 20 m upstream of the preferred discharge location (Discharge option #1).
- SP2 – at Discharge option #1.
- SP3 – 300 m downstream of Discharge option #1 and just upstream of the snow making extraction point.
- SP4 - at the alternative discharge location (Discharge option #2).
- SP5 – 100 m downstream of the alternative discharge location (Discharge option #2).
- SP6 – reference site in nearby catchment of 3-mile creek.

A multi-parameter water quality meter was used to record physicochemistry on the day of sampling. Surface water samples were collected using a grab sampling method and decanted into laboratory provided sterile containers and then transported in chilled eskies via a chain of custody (COC) to a NATA accredited laboratory. All samples were received within the relevant holding times for the tests.

A suite of water quality parameters was measured in the baseline program to include physical and chemical stressors and toxicants that could potentially impact on water quality in the receiving environment. Selection of parameters was based on potential changes to ambient water quality due to the discharges.

A summary of the parameters and interim water quality guidelines are provided in Section 3.2.

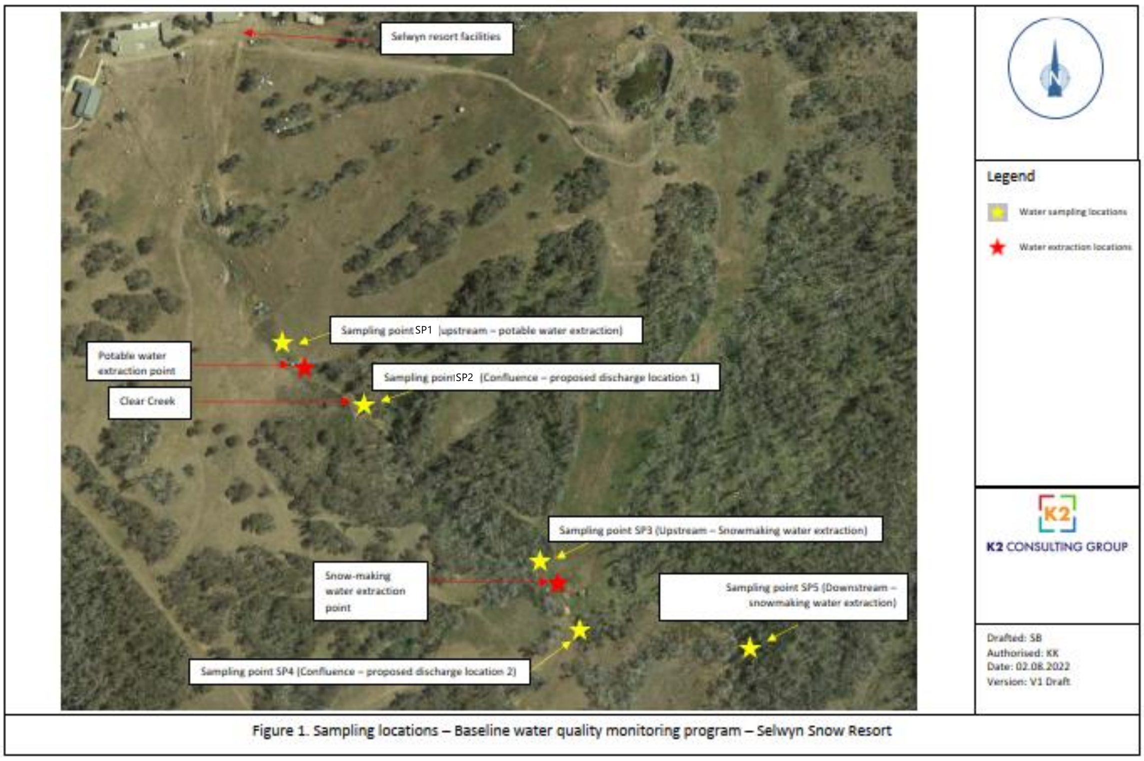


Figure 4-1 Baseline water sampling locations for Selwyn Snow Resort (K2 Consulting 2022)

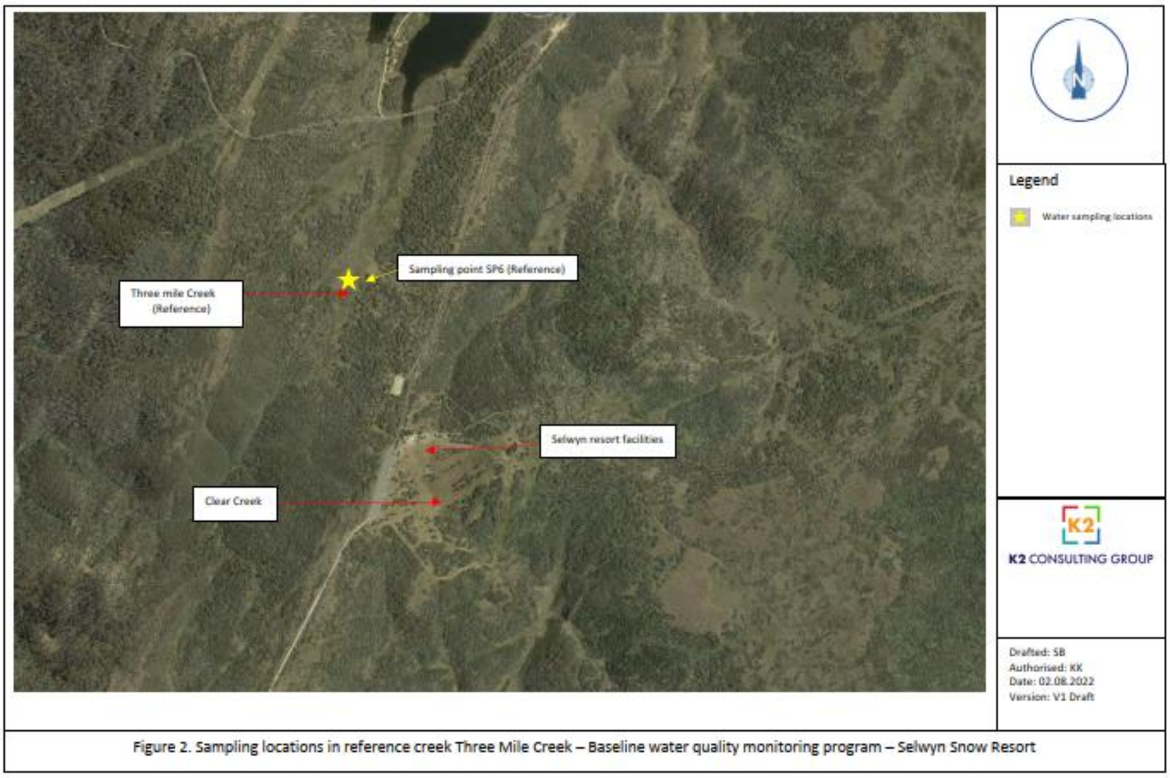


Figure 4-2 Baseline reference location for Selwyn Snow Resort (K2 Consulting 2022)

4.2 Clear Creek Field Survey

A survey was undertaken based on the DEC AusRivas Physical Assessment Protocol Manual (2002) for surveying inland waterways and the requirements to build a 2D dilution model to estimate flow volumes (and dilution) along the creek.

4.2.1 Sites

Twelve cross-section profiles were surveyed in Clear Creek, including sites that are upstream and downstream of proposed discharge options #1 and #2. The sites were selected to include a variety of stream types (riffle, run and pools) and to account for the heterogenous nature of the creek which is windy and not uniform in stream profile. Refer to Figure 4-4 for the sites that were surveyed.

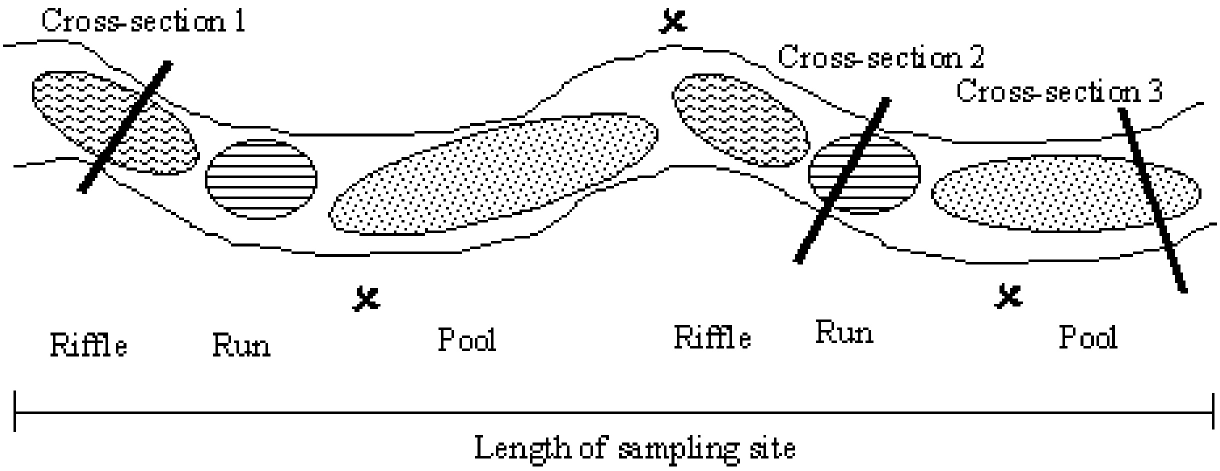


Figure 4-3 Example of the stream cross section and classifications (DEC 2002)

Figure 4-4 Monitoring sites for field survey. Discharge option #1 = 2/SP2, discharge option #2 = 8

4.2.2 Site Information

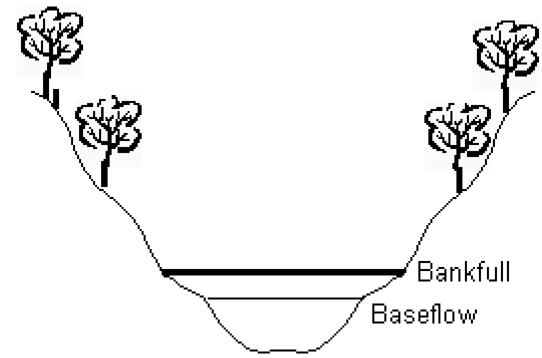
The date, time of survey, GPS coordinates, weather, recorders name and elevation above sea level were recorded at each site. Upstream and downstream photographs were taken at each site.

4.2.3 Stream Profiles

Three different types of stream profiles were observed based on classifications in DEC (2002):

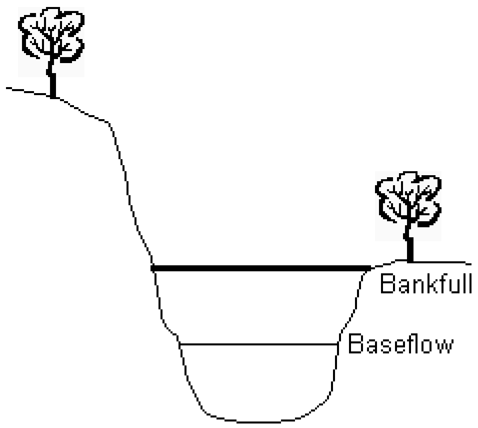
1. Confined upland.
2. One bank higher than the other.
3. Braided channels.

Refer to Figure 4-3.



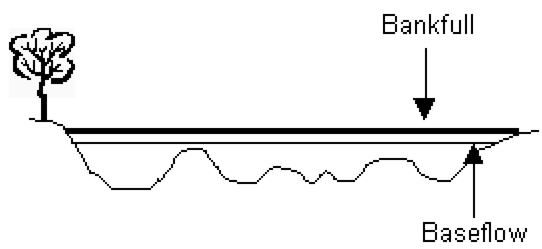
Confined upland
Confined channels have no floodplain development and are generally found in upland areas with steep valleys. Bank full width was usually not much larger than baseflow width.

E.g. sites: 1, 2, 7



One bank higher than the other
When one bank is higher than the other, bank full width was measured to the top of the lowest bank.

E.g. Sites: 5, 6, 10, 11, 12



Braided channels
Braided channels contain multiple channels that diverge and converge around many islands. These channels were very difficult to survey for the water level as had many streams were running under tussock grasses, wider and poorly defined banks.

E.g. Sites: 3, 4, 8, 9

4.2.4 Creek Bathymetry

The creek cross sections were measured using the following steps based on DEC (2002):

1. At the cross section, the creek was examined to locate the **bank full level**, **baseflow water mark** level and the **present water level**. For some sites this was a bit difficult but was determined by examining the vegetation and stream bank profile.

2. A string line was run across the cross section of the creek from one edge of the stream to the other at the baseflow water mark level and levelled with a leveling staff. The stream width was recorded at the water surface.

3. A staff member moved across the stream to record the **vertical present water depth** at 10 cm intervals using a weighted tape measure. The number of points measured should depend on the width and heterogeneity of the stream, so at least 10 measurements were taken.
4. The **bank height** and **bank width** were measured using a tape measure.
5. The **stream width at the water mark** was measured by two people using a tape measure.
6. Return to the starting bank and measure **bank height**, **bank width** and where necessary, **vertical distance between the water surface and the water mark**.

In summary, each cross-section included measurement of the following components:

- Stream width measured at the baseflow water mark level.
- Stream width measured at the water level at the time of sampling.
- Bank height for both banks.
- Bank width for both banks.
- Vertical distance between the water mark level and the water level at the time of sampling, for both banks.
- Between 5 and 15 water depth measurements taken at recorded intervals across the stream.
- Channel width measured at bank full level, which is a function of stream width at the water mark and left and right bank widths.

A summary of the channel cross section measurements is shown in Figure 4-5.

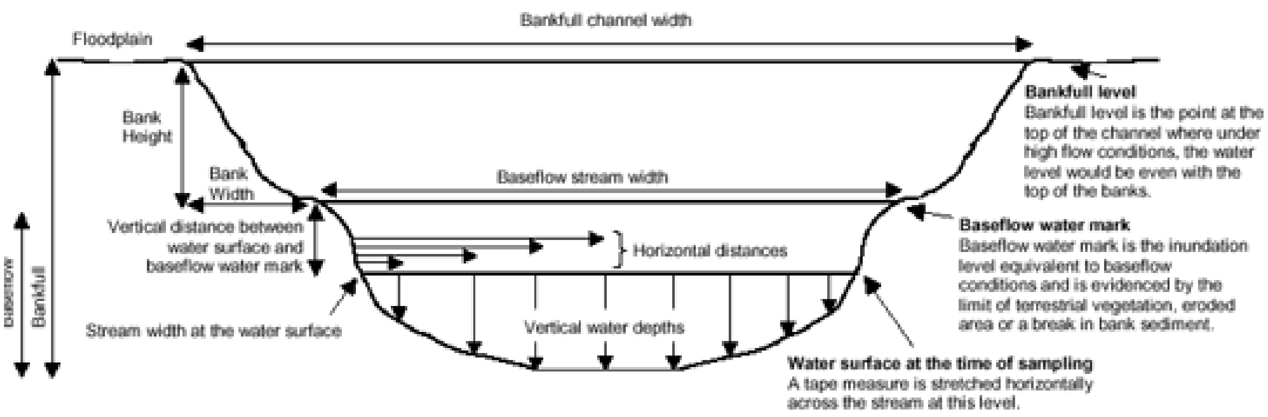


Figure 4-5 Summary of the channel cross section measurement

4.2.5 Bedform

The type of bedform (riffle, run, pool, cascade or other) was recorded at each site.

4.2.6 Vegetation

The percentage class of aquatic vegetation and debris was estimated at each site including filamentous algae, periphyton, moss and detritus.

4.2.7 Creek Substrate

The percentage class of substrate type was estimated at each site including bedrock, boulders (>256 mm), cobbles (64 - 256 mm), pebbles (16 – 64 mm), gravel (2 - 16 mm), sand (0.06 – 2 mm) and fine clay and silt (<0.06 mm).

4.3 Flow Monitoring

4.3.1 Event

Event flow monitoring was undertaken at the same six sites and during the same sampling events as the water quality sampling described in Section 4.2.1 using a handheld (dip and read) flow meter. This monitoring was undertaken to supplement the continuous flow data and cover all sites as it was not feasible to deploy continuous flow loggers at all sites.

4.3.2 Continuous

Continuous flow monitoring was undertaken using Sontek-IQ Plus loggers (Figure 4-6). This was undertaken for two sites (site 2/SP2 and site 6) that were being considered as potential discharge location options into Clear Creek (under the direct discharge to creek option).

The monitoring period was during the late snow season and occurred between the 17th September to 15th October 2022. The monitoring data was collected at 15-minute intervals for the following parameters:

- Water temperature (°C).
- Water level (m).
- Cross section area of water (m^2) - calculated internally by the software as a function of the channel bathymetry based on initial survey and depth of instrument.
- Mean flow velocity (m/s) - calculated internally based on four sensors which measure velocity along the sides and center of the stream to profile the whole stream.
- Flow rates (m^3/s) - calculated internally by the software as a function of the mean velocity multiplied by the area of water, adjusted to actual depth.
- Daily total flow volume (ML) – calculated using the daily total which is based actual flow rate for each 15 min interval.

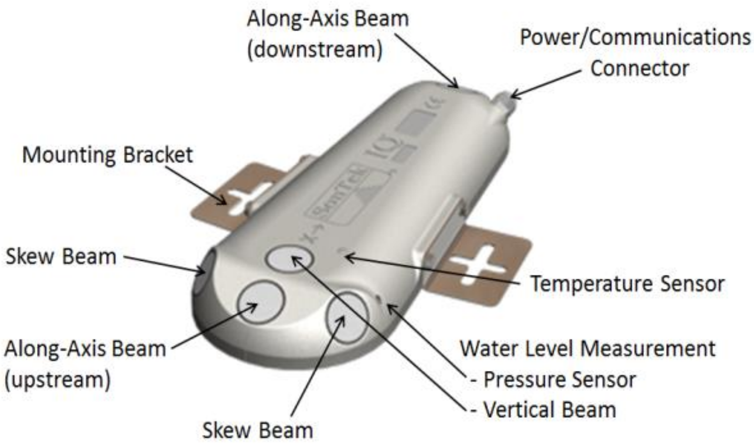


Figure 4-6 Sontek-IQ plus water quality loggers

4.4 Direct Discharge to Creek Dilution Estimates

The following formula was used to make dilution calculations:

$$Dilution\ factor = \frac{Daily\ Creek\ Volume\ (ML)}{Effluent\ Discharge\ (ML)}$$

Where:

Dilution factor = ratio of effluent to freshwater in Clear Creek at initial mixing point.

Volume = total calculated daily volume (ML) in Clear Creek at the discharge point, based on continuous (15 min) intervals of flow monitoring.

Discharge = maximum discharge volumes of effluent (ML) that could be discharged into Clear Creek due peak use period. Dilution factors were estimated for four scenarios summarised in Table 4-1.

Table 4-1 Summary of Discharge Scenarios

Discharge option	Discharge location	Effluent management Option	Discharge volume into Clear Creek	Discharge rate
1	Site 2/SP2	All effluent discharges to Clear Creek	40,000 L	27.8 L / min, assuming continuous discharges
1	Site 2/SP2	20,000 L discharged to Clear Creek, 20,000L beneficial reuse as grey waters	20,000 L	13.8 L/ min, assuming continuous discharges
2	Site 6/SP4	All effluent discharges to Clear Creek	40,000 L	27.8 L / min, assuming continuous discharges
2	Site 6/SP4	20,000 L discharged to Clear Creek, 20,000L beneficial reuse as grey waters	20,000 L	13.8 L/ min, assuming continuous discharges

It should be noted that this approach makes several assumptions to estimate dilution. For example, it does not consider the advection, dispersion or mixing within the creek, the full extent of surveyed bathymetry data or the complexity of this receiving environment. This is not considered necessary given the small scale of the creek environment.

Extraction volumes were not included in the dilution estimates for the following reasons:

- The majority of the extraction volumes would be for snow making. Although waters would be extracted for snow making, they will also return to the creek as the snow melts so the overall balance of water in the creek over the season will not change.
- The small volume (20 KL) of waters extracted for potable waters at site 1, are not considered to affect flow rate continuously as these will be collected via a weir.
- Extraction volumes cannot be subtracted from the daily creek using a high-level calculation as this would assume that volumes are never returned to creek. This would be incorrect, as the same volume would gradually flow back into creek as the snow melts (as shown in this study results).
- Extraction is not continuous and collected from a weir over short periods, and therefore flow rate would only be affected during the time that the weir takes to recharge.
- There are multiple layers of conservatism built into the assessment by adopting the maximum discharge and effluent limits.

5 Results

5.1 Water Quality Monitoring

Baseline water quality data was collected during six weekly events in July, August, September and October 2022. A suite of physiochemistry was measured using a multi-parameter water quality meter and grab samples were collected for NATA laboratory analysis of a suite of chemistry parameters.

Monitoring data was collected from six monitoring sites:

- SP1 – 20 m upstream of the preferred discharge location (Discharge option #1).
- SP2 – at Discharge option #1.
- SP3 – 300 m downstream of Discharge option #1 and just upstream of the snow making extraction point.
- SP4 - at the alternative discharge location (Discharge option #2).
- SP5 – 100 m downstream of the alternative discharge location (Discharge option #2).
- SP6 – reference site in 3-mile creek.

A summary of the baseline water quality monitoring data is provided in Appendix B and summarised in Table 5-1. The baseline water quality results show that the receiving waters are of high quality as would be expected considering that Clear Creek and Three-mile Creek (reference site) are first order streams and located in an undisturbed area of the catchment. However, the following exceedances were noted in relation to the proposed interim water quality guidelines (WQG):

- Concentrations of TON ranged from <0.005 to 0.43 mg/L and were sometimes above interim WQG of 0.015 mg/L in Clear Creek sites and the Three-mile Creek (reference site).
- Concentrations of TN ranged from 0.06 to 1.5 mg/L and most values were above interim WQG of 0.25 mg/L in Clear Creek sites and the Three-mile Creek (reference site).
- Concentrations of TP ranged from 0.01 to 1.4 mg/L and most values were above interim WQG of 0.02 mg/L in Clear Creek sites and the Three-mile Creek (reference site).
- Concentrations of aluminium ranged between 7 and 29 µg/L, and one value (SP2 in Clear Creek) was above the 99% Protection WQG of 27 µg/L.

This indicates that the ANZECC (2000) water quality guidelines for nutrients are not indicative of baseline water quality. Further assessments to develop site specific guidelines would be useful, based on a longer-term baseline water quality monitoring program or adopting guidelines developed from other reference sites in Mount Kosciusko National Park. For example, those used for Snowy 2.0 or from other reference sites in Mount Kosciusko National Park (if this information can be sourced).

Table 5-1 Summary of water quality statistics for baseline water quality program in September and October 2022.

Group	Site	Unit	WQGV	Mean	StDev	Median	Min	Max	N
Physicochemistry	Temperature	°C		8.31	2.88	7.93	5.15	19.25	6
	pH[1]		6.5 - 7.5	*5.47*	*1.21*	*5.76*	*2.91*	*7.41*	*6*
	Conductivity (EC)	µS/cm		12.72	2.53	13.00	7.70	20.00	6
	Total Dissolved Solids (TDS)	mg/L		4.77	4.90	0.50	<10	14.00	6
	Dissolved Oxygen (DO)	mg/L		11.95	2.86	10.97	8.65	20.37	6
	ORP			108.86	55.62	96.38	14.80	246.35	6
	Specific Conductance			11.40	6.00	13.55	0.01	17.10	6
	Turbidity	NTU		1.12	1.34	0.60	<0.5	5.00	6
Physical Quality	Biochemical Oxygen Demand (BOD5)	mg/L		2.57	0.42	2.50	2.50	5.00	6
	Total Suspended Solids	mg/L		3.53	3.29	2.50	2.50	19.00	6
Nutrients	Nitrate Nitrogen, NO3-N	mg/L		0.19	0.13	0.16	0.00	0.43	6
	Nitrite Nitrogen, NO2 as N	mg/L		0.00	0.00	0.00	<0.005	0.01	6
	Total Oxidized Nitrogen, Nox-N	mg/L	0.015	0.19	0.12	0.16	0.00	0.43	6
	Total Kjeldhal Nitrogen (TKN)	mg/L		0.22	0.24	0.15	0.03	1.40	6
	Organic Nitrogen	mg/L		0.19	0.20	0.13	0.03	1.20	6
	Total Nitrogen	mg/L	0.25	0.41	0.25	0.40	0.06	1.50	6
	Ammonia Nitrogen, NH3 as N	mg/L	0.32	0.03	0.04	0.02	0.01	0.24	6
	Total Phosphorus (Kjeldhal Digestion) as P	mg/L	0.02	0.07	0.25	0.01	0.01	1.40	6
	Filterable Reactive Phosphorus as P	mg/L	0.015	0.00	0.00	0.00	0.00	0.01	6
Cations	Calcium, Ca	mg/L		0.70	0.11	0.70	0.60	1.00	6
	Magnesium, Mg	mg/L		0.45	0.17	0.40	0.30	0.90	6
	Sodium, Na	mg/L		1.16	0.33	1.05	0.80	2.00	6
	Potassium, K	mg/L		0.22	0.10	0.20	<0.1	0.50	6
Dissolved metals and metalloids	Iron, Fe	µg/L		4.72	4.59	2.50	2.50	21.00	6

Group	Site	Unit	WQGV	Mean	StDev	Median	Min	Max	N
	Aluminium, Al	µg/L	27	13.17	7.99	10.00	7.00	29.00	6
	Arsenic, As	µg/L	1	<1	<1	<1	<1	<1	6
	Barium, Ba	µg/L		3.25	1.24	3.00	0.50	6.00	6
	Beryllium, Be	µg/L		<1	<1	<1	<1	<1	6
	Cadmium, Cd	µg/L	0.06	<0.1	<0.1	<0.1	<0.1	<0.1	6
	Chromium, Cr	µg/L		<1	<1	<1	<1	<1	6
	Cobalt, Co	µg/L		<1	<1	<1	<1	<1	6
	Copper, Cu	µg/L	1	0.81	0.57	0.50	<1	2.00	6
	Manganese, Mn	µg/L		5.81	5.89	3.00	<1	16.00	6
	Nickel, Ni	µg/L	8	0.64	0.23	0.50	<1	1.00	6
	Lead, Pb	µg/L	1	0.50	0.00	0.50	<1	0.50	6
	Vanadium, V	µg/L	6	0.50	0.00	0.50	<1	0.50	6
	Zinc, Zn	µg/L	204	7.00	5.32	5.00	<5	18.00	6
	Total Mercury	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	6
Total metals and metalloids and metalloids	Total Arsenic	µg/L		<1	<1	<1	<1	<1	6
	Total Barium	µg/L		5.20	3.60	4.00	2.00	23.00	6
	Total Beryllium	µg/L		<1	<1	<1	<1	<1	6
	Total Cadmium	µg/L		0.05	0.01	0.05	0.05	0.10	6
	Total Chromium	µg/L		<1	<1	<1	<1	<1	6
	Total Cobalt	µg/L		<1	<1	<1	<1	<1	6
	Total Copper	µg/L		0.73	0.52	0.50	<1	2.00	6
	Total Manganese	µg/L		9.02	6.11	9.00	<1	23.00	6
	Total Nickel	µg/L		0.72	0.41	0.50	<1	2.00	6
	Total Lead	µg/L		0.50	0.00	0.50	<1	0.50	6
	Total Vanadium	µg/L		0.50	0.00	0.50	0.50	0.50	6
	Total Zinc	µg/L		5.65	4.81	2.50	<5	20.00	6

Group	Site	Unit	WQGV	Mean	StDev	Median	Min	Max	N
	Total Mercury	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	0.00	6
Pathogen indicators & microbiological	Heterotrophic Count (HPC) at 22°C	CFU/100mL		4808.25	6713.98	1500.00	6.00	25000.00	6
	Heterotrophic Count (HPC) at 36°C	CFU/100mL		31.01	60.79	8.50	<1	300.00	6
	Thermotolerant Coliforms	CFU/100mL	200	1.47	1.99	0.50	<1	8.00	6
	E.Coli	CFU/100mL		1.11	1.44	0.50	<1	6.00	6
	Intestinal Enterococci	CFU/100mL	40	<1	<1	<1	<1	<1	6
Disinfectants	Total Chlorine	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1	6

1 pH data at all sites is likely associated with issue with sensor and should be discarded.

Where values were below the limit of reporting (LOR), half the LOR was used for calculations of summary statistics (mean, standard deviation and median).

The summary is based on all monitoring sites, please refer to **Appendix B – Water Quality Data** for the full results.

5.2 Clear Creek

A survey was undertaken on 15th September 2022 based on the DEC AusRivas Physical Assessment Protocol Manual (2002) for surveying inland waterways and the requirements to build a 2D dilution model to estimate flow volumes (and dilution) along the creek. In addition, one month of continuous flow monitoring was undertaken at two proposed discharge options.

The detailed field survey results are shown in Appendix Cand continuous flow monitoring data in Appendix D.

5.2.1 Stream Properties

Based on the field survey, the following characteristics are identified for Clear Creek:

- Clear Creek is a variable first order stream that begins at the potable water extraction point. The stream profile is very heterogenous across the study site, in terms of its shape and stream bank profiles. For some sites (i.e. sites 3, 4, 8 and 9), the stream is braided with multiple shallow channels that flow underneath tussock grasses. The stream is typically shallow with water depths of 10 – 20 cm at most sites measured during the September survey, and maximum water depths of 64 cm at site 10.
- There is a considerable drop in elevation between site 1 and site 12, site 1 being located at 1529.1 m and site 12 at 1464.48 m (above sea-level), with a total of approximately 64.6 m difference over 620 m.
- The total length of the creek that was surveyed was 620 m. Further downstream (after site 12), Clear Creek converges with four other streams that flow off Mount Selwyn so becomes much wider, deeper and has higher volumes. This is evident from review of aerial photography and knowledge of staff (pers. Comm. Selwyn Snow Resort). However, sites further downstream of site 12 could not be sampled or inspected due to the very steep terrain after this point.
- The flows in Clear Creek are highly variable and appear to be fed by groundwater and rainfall (catchment inflows). Both snow melt and rainfall highly influence the flow regime (see Section 5.2.2). The volume of the creek (and therefore dilution) approximately doubles between site 1 and site 6, as there are multiple inflows coming down the side of the northern steep catchment bank.
- The substrate composition of the stream bed varies between sites but was typically comprised of gravel, followed by sand, cobbles or pebbles (Figure 5-1). The percentage of fines (silt and clay) was very low at all sites.
- The stream bed aquatic vegetation was typically very low (<10%) with exceptions:
    - Some sites (3, 5 and 9) had filamentous algae covers (10 - 35%).
    - Some sites (2 and 5) had moss cover (10-35%).
    - Some sites (2, 3 and 5) had a high level of detritus (35 – 65%).

Figure 5-1 Percentage substrate classes at monitoring sites

5.2.2 Continuous Flow Monitoring

Continuous stream flow monitoring, temperature and high-level dilution estimates are provided in Figure 5-2 to Figure 5-7. The following observations are made for site 2 (preferred direct discharge location) and site 6 (alternative direct discharge location):

- The peak flows in the creek at both sites are likely related to snow melt events. Dips in the water temperature are seen on the dates of 18th September, 19th September and 6th October, which correspond to rainfall records for Kiandra (i.e. higher rainfall resulted in higher flow). A gradual increase in the flow is seen in the days following rainfall.
- Rainfall on the 14th and 15th October did not appear to fall as snow (based on water temperature data). The flow increased after these days but for a much shorter duration (spike) than was observed for the snow melt.
- The flows at site 6 are approximately double that of site 2, reflective of the additional inflows into the creek that occur between these sites.
- The flows were highly variable at both sites. There were 12 days where the flow rate was low with less than 0.01 m^3/s at site 2, and 0.02 m^3/s at site 6.

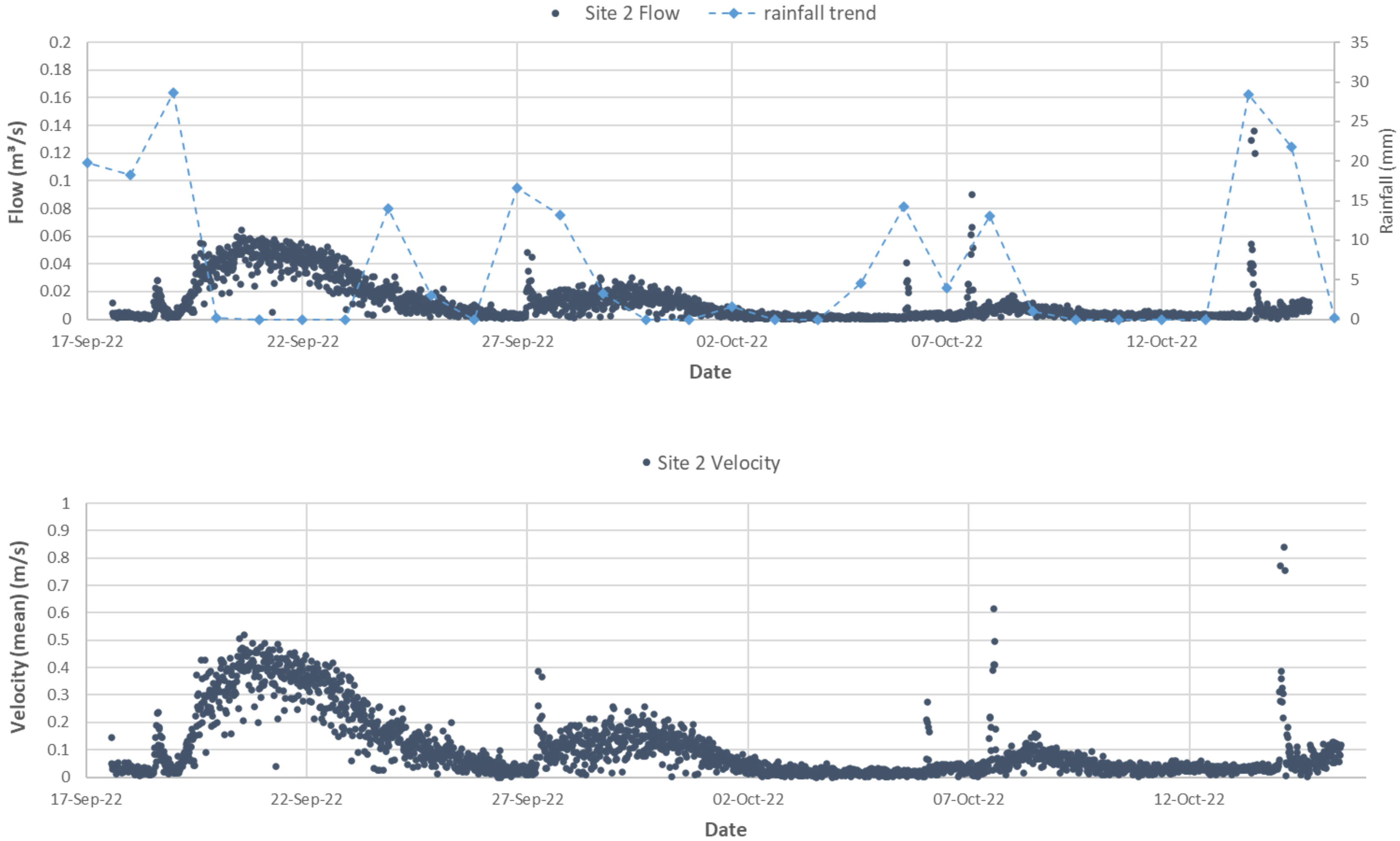
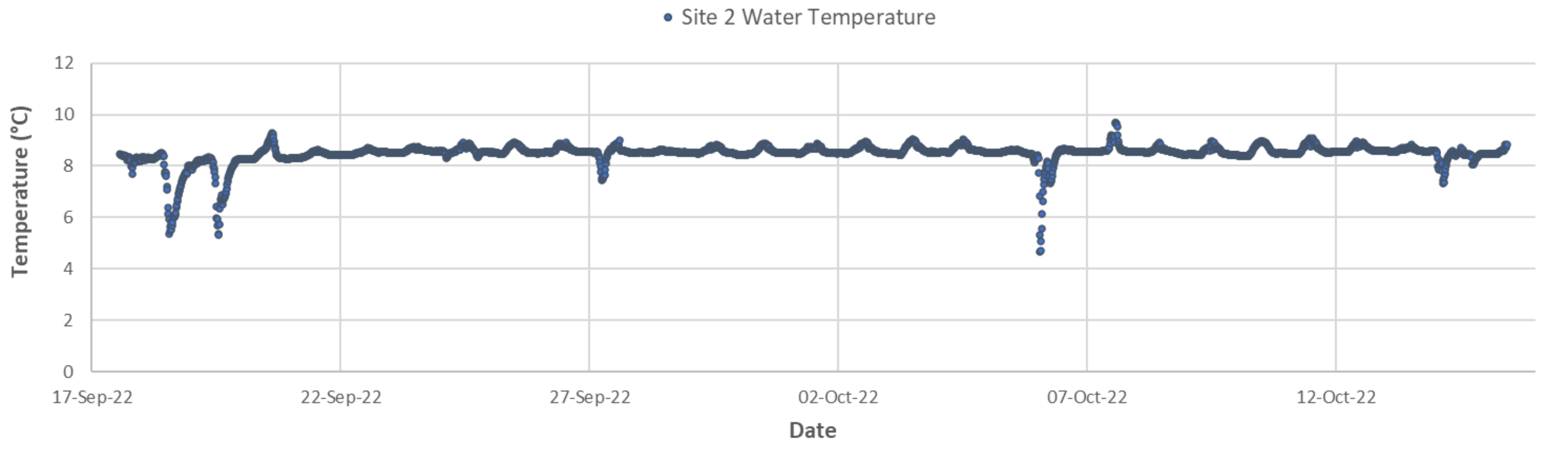


Figure 5-2 Rainfall (or snow), continuous flow (m^3/sec) and velocity (m/s) monitoring during 17 September to 15 October at site 2, preferred discharge to Creek option



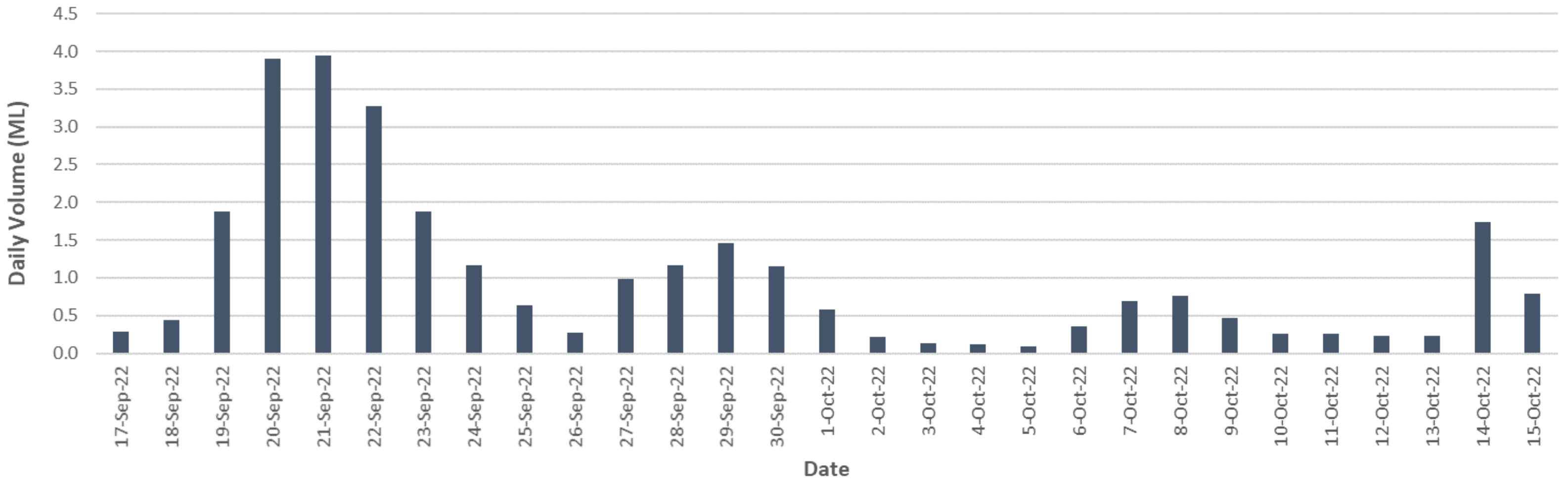
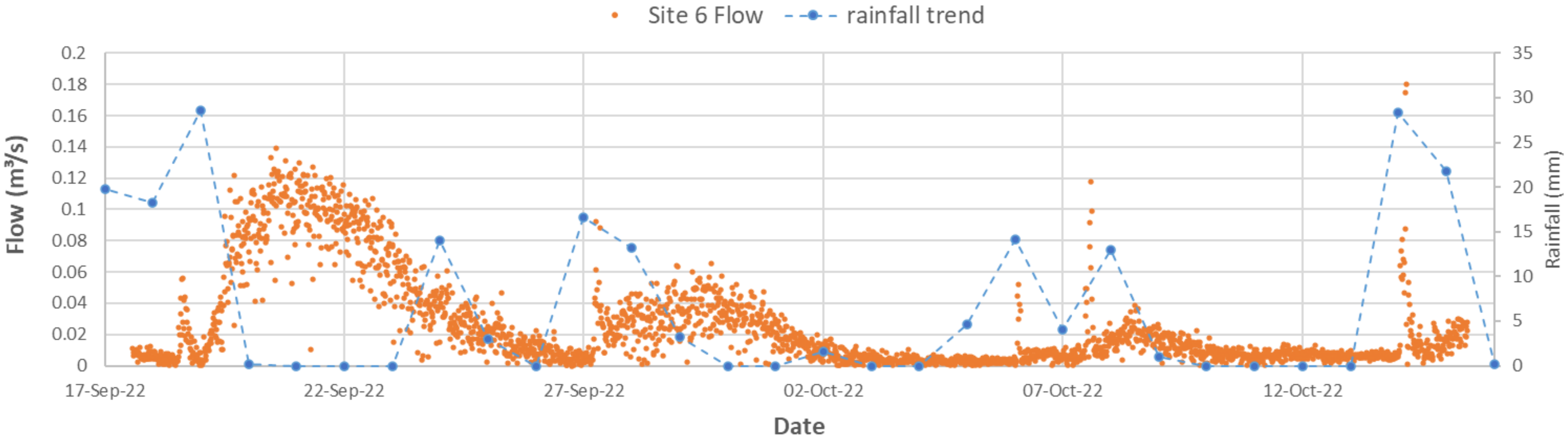


Figure 5-3 Water temperature (°C) and estimate total daily volume (ML) based on monitoring during 17 September to 15 October at site 2, preferred discharge to Creek location option.



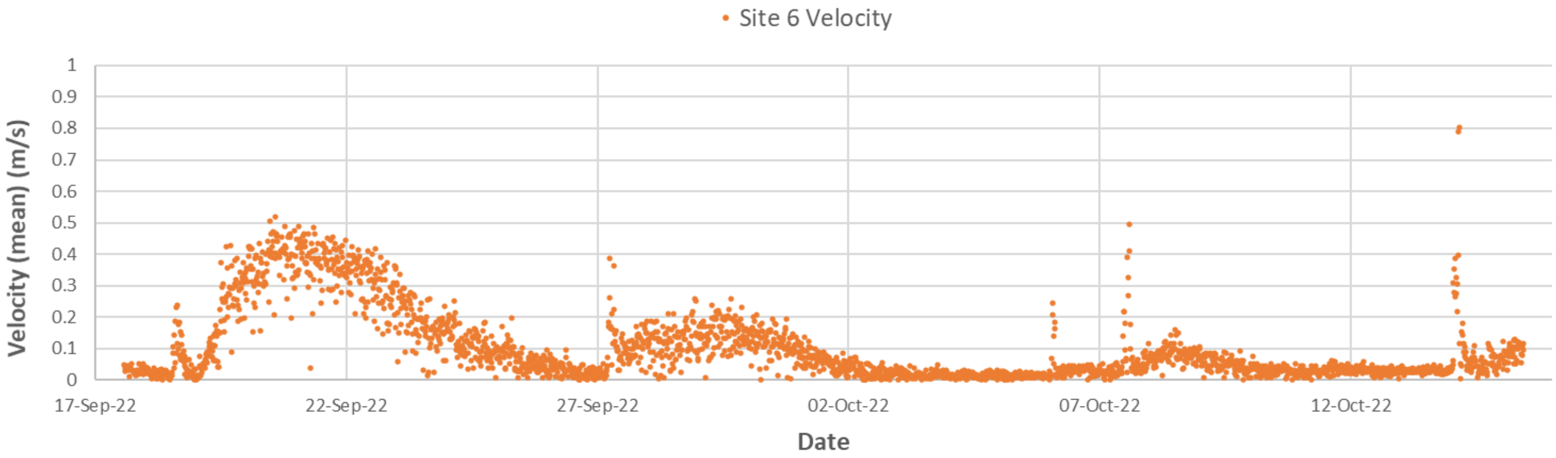
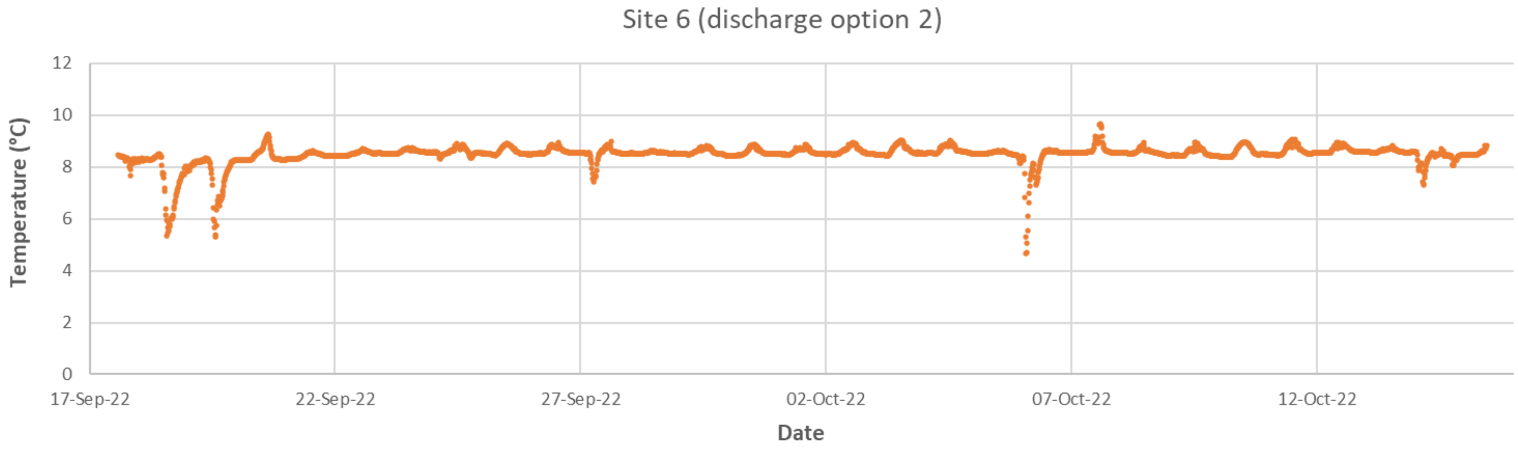


Figure 5-4 Rainfall (or snow), continuous flow (m^3/sec) and velocity (m/s) monitoring during 17 September to 15 October at site 6.



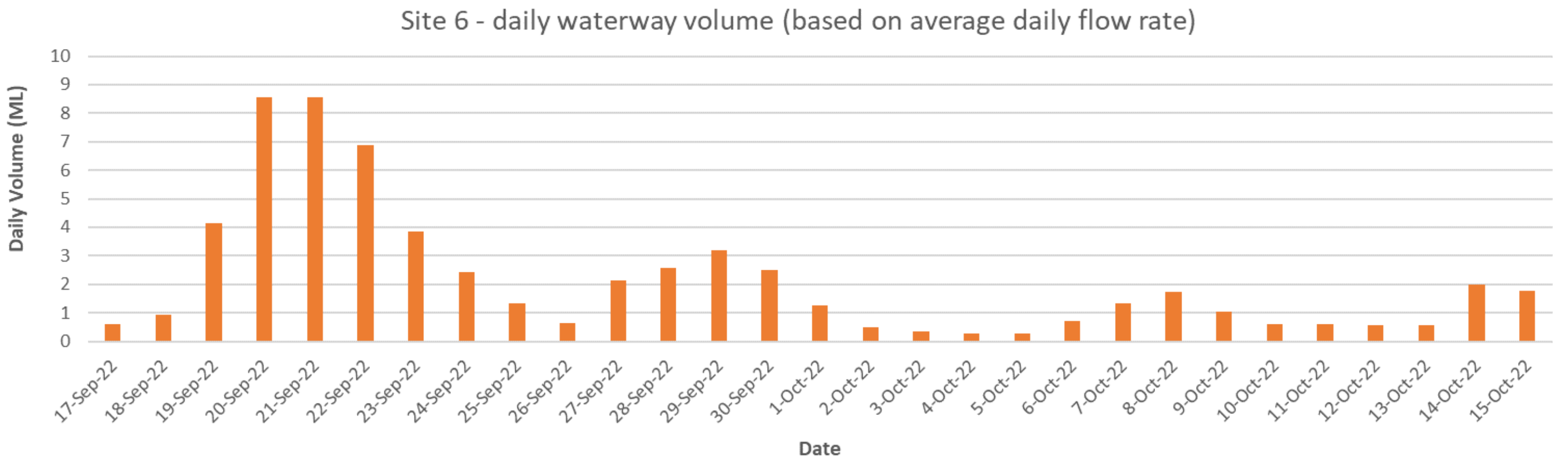


Figure 5-5 Water temperature (°C) and estimate total daily volume (ML) based on monitoring during 17 September to 15 October at site 2.

5.3 Effluent Management Options – Dilution Assessment

5.3.1 Hybrid Beneficial Reuse for Reticulation and Snowmaking (Preferred Discharge Option)

5.3.1.1 Assumptions

The assumptions for the dilution calculations for this option are shown in Table 5-2.

Table 5-2 Assumptions for Dilution Calculations

	Assumption	Volume	Unit
A1	Scenario 1 – 25 kL recycled water is used for snowmaking daily	25	kL/d
A2	Scenario 2 - 100kL recycled water (~4 days stored in dam without snowmaking during peak operation)	100	kL/ 4 d
A3	Scenario 3 - 250kL recycled water (~10 days stored in dam without snowmaking during peak operation)	250	kL/ 10 d
B	Quarry Dam Storage	2500	kL
C	Duration between snow melt events	10	D
D1	Minimum Clear Creek snow melt event volume	7590	kL
D2	Maximum Clear Creek snow melt event volume	10500	kL
DF	Dilution Factor	-	-

In addition,

- Flow monitoring (D1 and D2) are based on snow melt events undertaken using continuous flow monitoring between 16/9/2022 to 17/10/2022 (Advisian 2022). This is conservative as snow melt events would be more infrequent during colder months, with higher dilution.
- Ambient water quality is based on water quality data was collected during six weekly events in July, August, September and October 2022.
- A volume of 25 kL of recycled water per day is conservative as this is based on peak visitation.
- Recycled water quality is based on STP design effluent limits NSW EPA (DOC21/126763), which specify 90%ile accepted levels for discharges to inland waterways (Advisian 2022). This is conservative as concentrations are likely to be much lower than license limits.
- The AGWR provide a summary of average concentrations of other key parameters in recycled waters based on a review of 40 plants across Australia (NHMRC 2006). This is useful to estimate dilution of other important water quality parameters that are not licensed (i.e. salinity and heavy metals).
- Dilution in Quarry Dam is calculated by $snowmaking\ dam\ dilution = B/A$
- Minimum dilution in Clear Creek is calculated by $Min\ Clear\ Creek\ dilution = (D1/(A * C)) * Quarry\ dam\ DF)$. Only minimum dilution in Clear Creek was assumed.

5.3.1.2 Estimated Water Quality (based on license limits)

The water quality within the Quarry Dam and Clear Creek is estimated using the above dilution factors applied to STP design effluent limits as shown in Table 5-3.

In summary, these estimates suggest that:

- The estimated water quality within the snow making dam and the receiving Clear Creek shows that the recycled water option should not result in **changes to water quality beyond natural variability**.
- In the Quarry Dam, all parameters except nitrogen were estimated to be below the interim ANZG (2018) water quality guidelines. Nitrogen was estimated to be 0.4 mg/L for the 100 kL scenario and 1.0 mg/L for the 250 kL scenario. The ANZG (2018) however, apply to Clear Creek and not the Quarry Dam.
- In Clear Creek, all parameters were estimated to be below the ANZG (2018) interim water quality guidelines and similar concentrations to median values measured in Clear Creek during baseline surveys. Dilution is estimated to be sufficient that no changes expected to ambient water quality for these parameters.
- In the scenario that recycled water needs to be stored for much longer periods (> 10 days during peak period), the dilution is still sufficient that discharges into Clear Creek would meet the adopted interim ANZG (2018) quality guidelines for Clear Creek and be comparable to available median baseline water quality.
- Calculations are provided for total chlorine, assuming no degradation. This is a significant overestimation as no reduction for degradation is applied. In reality, the free chlorine will rapidly combine with organic matter to form combined forms (including chloramines and disinfection by products), which are subject to degradation by UV (sunlight) within the dam, snowmaking and then by transport over land processes. There is sufficient time and travel over land that total chlorine would be reduced to well below detection limits, and the water quality guideline prior to discharge into Clear Creek.

5.3.1.3 Estimated Water Quality (based on average recycled water quality)

The water quality within the Quarry Dam and Clear Creek is estimated using the above dilution factors applied to average concentrations of parameters in recycled waters (from NHMRC 2006, based on their review of 40 plants across Australia, with different sizes and treatment processes). This is shown in Table 5-5.

In summary these estimates suggest that:

- For all parameters, there is sufficient estimated dilution that the application of recycled water would result in no changes beyond natural variability within Clear Creek.
- For scenarios A1 (25kL) and A2 (100kL) storage in Quarry Dam, no changes to water quality in Clear Creek are predicted.
- For scenario A3 (250 kL), concentrations of total dissolved solids (TDS), sodium and magnesium in Clear Creek were estimated to be slightly higher compared to median values measured in baseline water quality monitoring. There are no ANZG (2018) guidelines for these parameters. This data is based on average concentrations in recycled water based on 40 plants within Australia. Considering that the STP at Selwyn Snow Resort is a smaller than average plant, actual values are likely to be much lower. Potential impacts on salinity in Clear Creek need to be considered in future assessments based on actual monitoring data.

The estimated water quality was also compared to available thresholds for recycled water for sensitive plants as below:

- Sodium and chloride in recycled water are well below the critical thresholds for plant exposures for chloride (<175 mg/L) and sodium (<115 mg/L). The risk of salinity and sodicity is much lower for sandy soils in comparison to heavy clay soils. There is high overland drainage at the site and previous testing at the site showed soil composition is typically characteristic of well drained soils (sandy gravel to silty sand) (ACT Geotechnical Engineers, 2021).
- Boron concentrations are below the critical threshold for sensitive plants (0.3 mg/L).

In the AGWR, there are thresholds for soil extracts (salinity, sodium, chloride, phosphorous, nitrogen, soil hydraulic loading) to assess long term cumulative impacts on soils and plants during recycled water application, along with recommended controls to correct issues. This cannot be accurately estimated or modelled at this stage, but annual soil testing and assessment should form part of the future environmental monitoring program.

Table 5-3 Estimated water quality parameters based on dilution estimates in the Quarry Dam and Clear Creek, based on 90% license limits

Parameter	Unit	Effluent concentration (90th%ile license limit)	Estimated dilution for Quarry Dam during scenarios			Estimated dilution for Clear Creek during scenarios			Clear Creek (baseline water quality)	ANZG (2018) Water Quality Guideline
			A1 (25kL RW) DF 100	A2 (100kL RW) DF 25	A3 (250kL RW) DF 10	A1 + D1 (25kL RW) DF 3030	A2 + D1 (100kL RW) DF 190	A3 + D1 (250kL RW) DF 30	Median	
Biological oxygen demand	mg/L	10	0.100	0.400	1.00	0.003	0.053	0.333	2.500	-
Total nitrogen	mg/L	10	0.100	0.400	1.00	0.003	0.053	0.333	0.400	0.25
Total phosphorus	mg/L	0.3	0.003	0.012	0.030	0.000	0.002	0.010	0.010	0.02
Suspended solids	mg/L	15	0.150	0.600	1.500	0.005	0.079	0.500	2.500	-
Ammonia as N	mg/L	2	0.020	0.080	0.200	0.001	0.011	0.067	0.020	0.32
pH	-	6.5 – 8.5	-	-	-	-	-	-	-	-
Oil and grease	mg/L	2	0.020	0.080	0.200	0.001	0.011	0.067	-	-
Faecal coliforms	CFU/100mL	200	2.000	8.000	20.00	0.066	1.053	6.67	0.500	-
Total chlorine*	mg/L	0.5	*<0.005**	*<0.020**	*<0.050**	*<0.000**	*<0.003**	*<0.017**	-	0.03

Estimated water quality in Clear Creek is higher than median baseline.

* With retention times and UV degradation, total chlorine (free + combined forms) would be expected to be well below the water quality guideline.

A= scenarios of recycled water storage in Quarry Dam, D = Clear Creek volumes during snow melt events, DF= dilution factor.

Table 5-4 Estimated water quality parameters based on dilution estimates in the Quarry Dam and Clear Creek, based on review average concentrations in recycled water from Australian plants (from Table 10.4 of NHMRC 2006)

Parameter	Unit	Average concentration from other Australian recycled water plants	Estimated recycled water contributions following dilution for Quarry Dam			Estimated recycled water contributions following dilution for Clear Creek			Median Clear Creek (baseline water quality)	ANZG (2018) Freshwater Waer	AGWR (NHRMC 2006)
			A1 25kL RW DF 100	A2 100kL RW DF 25	A3 250kL RW DF 10	A1 + D1 25kL RW DF 3030	A2 + D1 100kL RW DF 190	A3 + D1 250kL RW DF 30			
Ammonium	mg/L	8.4	0.084	0.336	0.840	0.003	0.044	0.280	-	-	
pH	-	7.9	-	-	-	-	-	-	-	6.5-7.5	
Total dissolved salts	mg/L	675	6.750	27.000	67.500	0.223	3.553	22.500	4.77	-	
Electrical conductivity	mg/L	1.3	0.013	0.052	0.130	0.000	0.007	0.043	13	-	
Sodium	mg/L	181	1.810	7.240	18.100	0.060	0.953	6.033	1.05	-	115[2]
Calcium	mg/L	35	0.350	1.400	3.500	0.012	0.184	1.167	0.7	-	
Magnesium	mg/L	19	0.190	0.760	1.900	0.006	0.100	0.633	0.4	-	
Chloride	mg/L	135	1.350	5.400	13.500	0.045	0.711	4.500	-	-	175[2]
Aluminium*	µg/L	227	2.270	9.080	22.700	0.075	1.195	7.567	10	27	
Arsenic	µg/L	1.9	0.019	0.076	0.190	0.001	0.010	0.063	<1	1	
Barium	µg/L	9.7	0.097	0.388	0.970	0.003	0.051	0.323	4	-	
Boron	µg/L	289	2.890	11.560	28.900	0.095	1.521	9.633	-	-	300[1]
Cadmium	µg/L	0.3	0.003	0.012	0.030	0.000	0.002	0.010	<0.1	0.06	
Chromium	µg/L	9.4	0.094	0.376	0.940	0.003	0.049	0.313	<1	-	

Parameter	Unit	Average concentration from other Australian recycled water plants	Estimated recycled water contributions following dilution for Quarry Dam			Estimated recycled water contributions following dilution for Clear Creek			Median Clear Creek (baseline water quality)	ANZG (2018) Freshwater Waer	AGWR (NHRMC 2006)
			A1 25kL RW DF 100	A2 100kL RW DF 25	A3 250kL RW DF 10	A1 + D1 25kL RW DF 3030	A2 + D1 100kL RW DF 190	A3 + D1 250kL RW DF 30			
Cobalt	µg/L	0.7	0.007	0.028	0.070	0.000	0.004	0.023	<1	-	
Copper	µg/L	23.5	0.235	0.940	2.350	0.008	0.124	0.783	0.5	1	
Cyanide	µg/L	<1.0	-	-	-	-	-	-	-	-	
Iron	µg/L	722	7.220	28.880	72.200	0.238	3.800	24.067	-	-	
Lead	µg/L	5.4	0.054	0.216	0.540	0.002	0.028	0.180	0.5	1	
Manganese	µg/L	35.2	0.352	1.408	3.520	0.012	0.185	1.173	9	-	
Mercury	µg/L	0.1	0.001	0.004	0.010	0.000	0.001	0.003	<0.0001	-	
Molybdenum	µg/L	9.8	0.098	0.392	0.980	0.003	0.052	0.327	-	-	
Nickel	µg/L	7	0.070	0.280	0.700	0.002	0.037	0.233	0.5	8	
Silver	µg/L	2.6	0.026	0.104	0.260	0.001	0.014	0.087	-	-	
Zinc	µg/L	48	0.480	1.920	4.800	0.016	0.253	1.600	2.5	2.4	
Anionic surfactants	µg/L	200	2.000	8.000	20.000	0.066	1.053	6.667	-	-	
Phenols	µg/L	4.6	0.046	0.184	0.460	0.002	0.024	0.153	-	-	
Key	Estimated water quality in Clear Creek is higher than median baseline.										

1= AGWR guideline for boron in recycled water for most sensitive plants. 2= AGWR guideline for sodium and chloride for most sensitive Australian native plants.

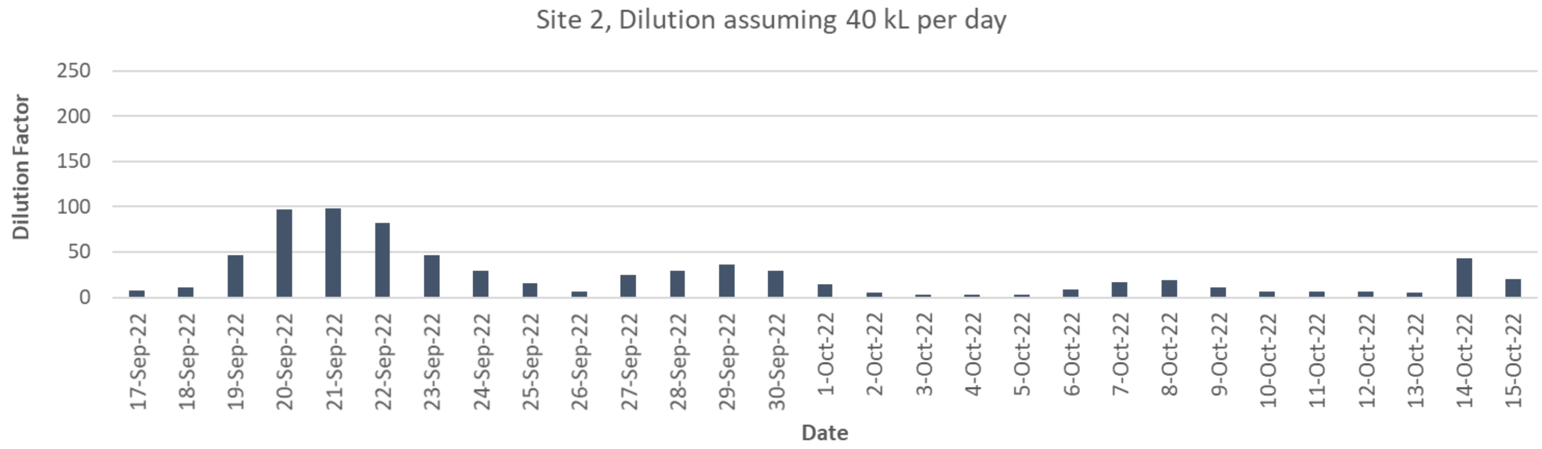
5.3.2 Direct Discharge into Clear Creek (Not Preferred)

A high-level dilution factor was calculated (see Section 4.4 for methods) for two scenarios (Table 5-5). This included scenarios assuming 20,000 L and 40,000 L for two direct discharges to creek location options.

- The number of days where the dilution factor is less than 50, ranges from 12 to 26 days depending on the scenario (discharge location and volume).
- The number of days where the dilution factor is less than 25, ranges from 2 to 19 days depending on the scenario (discharge location and volume).
- The flows are variable relating to the snow melt regime. High flows occur when the snow melts as evidenced by the drops in water temperature at the start of these events.

Table 5-5 Summary of dilution achieved for scenarios of discharge locations and volumes

Discharge option	Discharge location	Effluent management Option	Discharge volume into Clear Creek	Discharge rate	Days Dilution <100	Days Dilution <50	Days Dilution <25
1	Site 2/SP2	All effluent discharges to Clear Creek	40,000 L	27.8 L / min, assuming continuous discharges	29 days (100% of time)	26 days (89% of time)	19 days (65% of time)
1	Site 2/SP2	20,000 L discharged to Clear Creek, 20,000L beneficial reuse as grey waters	20,000 L	13.8 L/ min, assuming continuous discharges	26 days (90% of time)	19 days (65% of time)	13 days (44% of time)
2	Site 6/SP4	All effluent discharges to Clear Creek	40,000 L	27.8 L / min, assuming continuous discharges	25 days (86% of time)	19 days (65% of time)	7 days (25% of time)
2	Site 6/SP4	20,000 L discharged to Clear Creek, 20,000L beneficial reuse as grey waters	20,000 L	13.8 L/ min, assuming continuous discharges	19 days (65% of time)	12 days (41% of time)	2 days (7% of time)



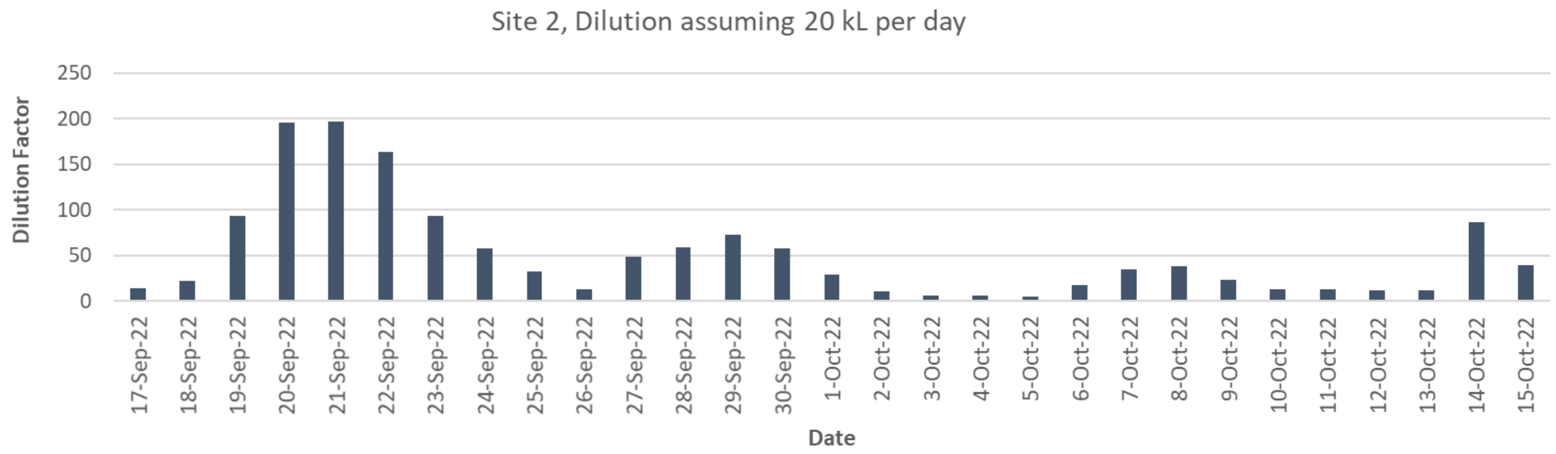
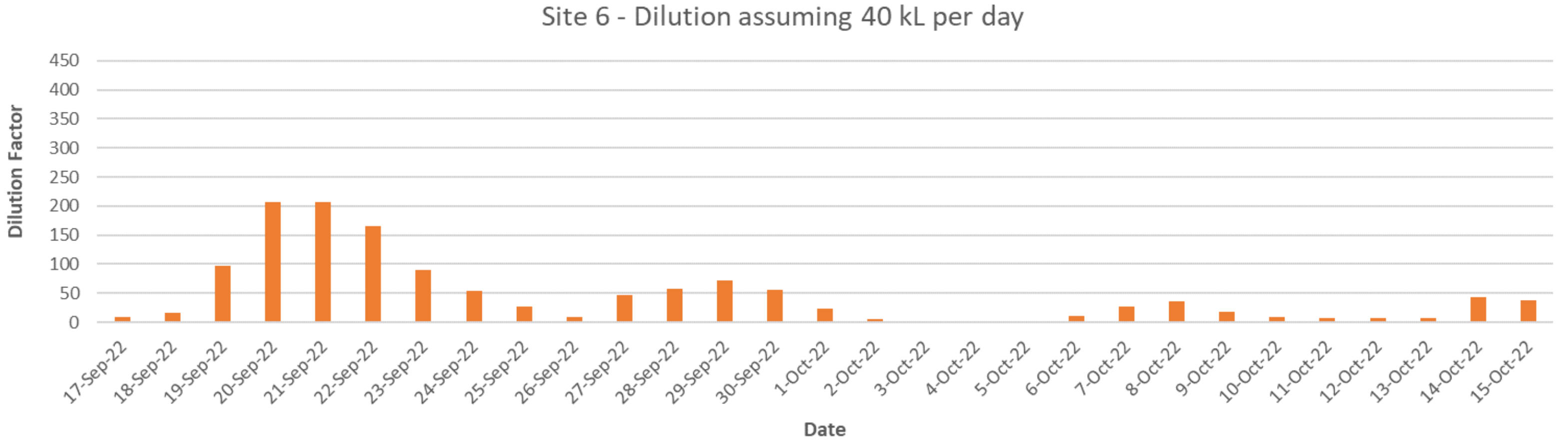


Figure 5-6 Estimated dilution for scenarios of 50 kL/d (top) and 20 kL/ d (bottom) effluent discharges based on based on flow monitoring during 17 September to 15 October at site 2, direct discharge to Creek option.



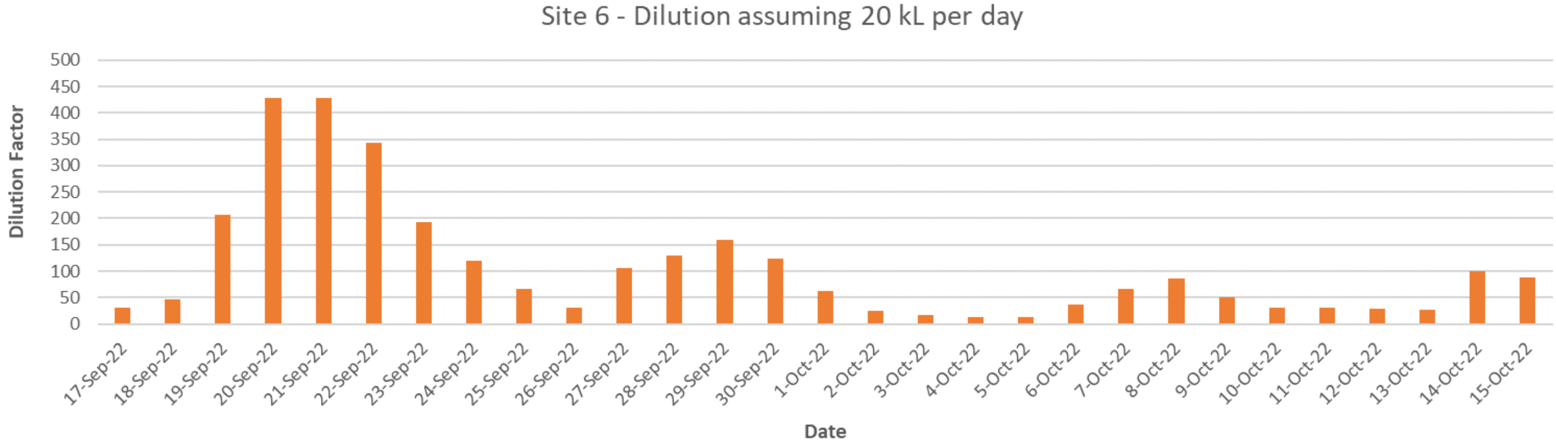


Figure 5-7 Estimated dilution for scenarios of 50 kL/d (top) and 20 kL/ d (bottom) effluent discharges based on based on flow monitoring during 17 September to 15 October at site 6, direct discharge to Creek option.

6 Review of Effluent Management Options

A review of effluent management options is shown in Table 6-1.

In comparison to the previous assessment of the option to direct discharge into Clear Creek (Advisian 2022), the option to recycle water significantly reduces likelihood for environmental impacts as:

a. Approximately half of recycled water is reused in the resort toilet facilities.

b. The recycled water is significantly diluted in a controlled manner within the Snowmaking Dam, then further on snow fields when combined with natural snow fall.

c. Discharge into Clear Creek is during snow melt events and peak flow rates. Continuous flow monitoring (temperature and flow data) suggests the snow melt events are likely gradual, over days. Note, that the assessment of the option to discharge into Clear Creek identified periods when flows were insufficient for dilution, as water is 'locked up' in snow.

d. Discharge into Clear Creek is diffuse rather than point source.

e. Further reductions on pollutants will be achieved during detention in the Snowmaking Dam and during the snow making process.

f. Free chlorine will rapidly combine with organic matter to form combined forms (including chloramines and disinfection by products), which are subject to degradation by UV (sunlight) and transport over land processes. There is sufficient time and travel over land that total chlorine would be reduced to below detection limits prior to discharge into Clear Creek.

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Selwyn Snow Resort

Table 6-1 Review of Effluent Management Options

Effluent Management Option	Feasibility	Legislation and agencies involved	Main Agencies involved	Detailed Assessments required	Potential Environmental and Biodiversity Impacts	Possible Mitigation Measures	Capability of the STP and its ability to deliver the results required
1. Manufacturing snow using treated effluent	**Alternate Option** The STP was originally designed for use as Class A recycled waters for snow production in line with the Australian Guidelines for Water Recycling (AGWR) (NHMRC 2006) and the existing pipework infrastructure is in place to support this option. Similar concept to the recycled water application to sporting fields.	Planning – Development Application (DA) approval *Protection of Environment Operations Act* (1997) *Public and Environmental Health Act* (2011)	NSW Health – advice on recycled water use in public or non-public areas. Review of Human Health Risk Assessment (HHERA for recycled water use in public areas. DP&E (NSW EPA) – advice on environmental impacts Workshop with planning agencies to run through the identified hazards, as input to the HHERA HHERA to demonstrate that the risk of ingestion of snow will not have any significant health implications, above the level of risk for natural snow (which is also subject to contamination by animals, vehicles and other skiers)	HHERA Recycled Water Management Plan In line with: Australian Guidelines for Water Recycling: Phase 1 (NHMRC 2006)	Beneficial reuse as recycled water would increase snow production, while decreasing the extraction volumes from Clear Creek. The STP is designed to improve the quality of run off that enters the surrounding area and water ways. The main potential environmental hazards in recycled water are metals (boron, cadmium), chlorine disinfection residuals, water flows, nutrients (nitrogen and phosphorous), salinity (chloride and sodium) (NHMRC 2006). The HHERA would consider in further detail, however potential impacts on environment and biodiversity are expected to be low: • The recycled water would be significantly diluted prior to application as snow (in the quarry dam). • Natural snow falls on the resort would also dilute significantly prior to snow melt. • There is sufficient dilution and timeframe for the degradation of residual free chlorine used for disinfection. • Entry of potential pollutants into waterways (either groundwater or Clear Creek) would be diffuse which reduces impacts on waterways in	The HHERA would consider in detail however, possible mitigation measures are outlined below. Training of staff to optimize recycled water performance including: • Onsite STP manager. • Annual human health specialist inspections and ongoing management. • Adequate monitoring and reporting including preparation of a Recycled Water Management Plan. Recycled water (maximum 50kL daily) would be deposited into a reservoir with significant dilution (2.5 ML) prior to use for snow making. Snow guns not used in public areas during operational hours. STP can be artificially fed during summer. Startup prior to resort operational hours (during March). Measures to account for variable effluent quality during start up (e.g. feed flows back into STP during start up if required for better quality). Continuous online STP monitoring, including chlorine residual. Capacity to cease operations (if required) to eliminate the possibility of partially treated or	The MBR plant including the type, discharge quality, volumes, and location are included within the Statement of Environmental Effects (SEE). The tertiary treatment Membrane Bioreactor (MBR) sewage treatment plant (STP) has been designed to achieve Class A quality effluent. Class A is the highest achievable standard for recycled water. This includes • STP has been designed for treatment and log reduction of pathogens in accordance with the Recycled Water Guidelines (Table 3.7) for use in firefighting (most stringent category of use) and for use in dual reticulation (Table 3.8). The target log reductions are 5.3 for bacteria, 5.1 for protozoa and 6.5 for viruses. • Both UV and chlorine for disinfection • Online monitoring • Heat lamps to optimise MBR nitrogen removal for cold climate • Small discharge volumes (50kL/day)

Effluent Management Option	Feasibility	Legislation and agencies involved	Main Agencies involved	Detailed Assessments required	Potential Environmental and Biodiversity Impacts	Possible Mitigation Measures	Capability of the STP and its ability to deliver the results required
					comparison to point discharges. • Drainage would be gradual towards Clear Creek or groundwater and dependent on the snow melt regime. Representative flow monitoring (15-9-22 to 14-10-22) shows that flows related to snow melt are more gradual. No threatened flora or habitat was identified in the dam embankment or associated asset protection zone (APZ) as part of the biodiversity assessment undertaken for the SEE.	untreated water entering the snowmaking dam. Communication and education on the use as recycled water. Capacity to truck untreated or insufficient quality effluent offsite to a licensed facility in event of an emergency.	• Pipework infrastructure in place for the reticulation use in resort facilities Pipework infrastructure for the transfer to the Quarry Dam, subject to planning approval
2. A hybrid option a. Beneficial reuse for reticulation resort facilities (toilets) b. manufacturing snow using treated effluent	**Preferred Option** This is considered suitable combining the beneficial reuse options for use as snow and resort waters (toilets). The STP was originally designed for use as Class A recycled waters for snow production in line with the Australian Guidelines for Water Recycling (AGWR) (NHMRC 2006) and the existing pipework infrastructure is in place to support these options Similar concept to the recycled water application to sporting fields.	*Protection of Environment Operations Act* (1997) *Public and Environmental Health Act* (2011)	NPWS – Development Application (DA) approval. NSW Health – advice on recycled water use in public and non-public areas. Review of HHERA for recycled water use in public areas. DP&E (NSW EPA) – advice on environmental impacts. Review of HHERA. Workshop with planning agencies to run through the identified hazards, as input to the HHERA HHERA to demonstrate that the risk of ingestion of snow will not have	HHERA Recycled Water Management Plan Ongoing management	The potential environmental and biodiversity impacts would be similar as outlined for Option 4, but of lower magnitude due to reduced volumes of recycled water used for snow (applied to land). The amount of recycled water used would be approximately halved with this option (maximum volumes of 30 kL for snow and 20 kL for reticulation). Beneficial reuse as recycled water for snow and reticulation would decrease the extraction volumes from Clear Creek. The STP is designed to improve the quality of run off that enters the surrounding area and water ways. The HHERA would consider in further detail, however the potential impacts on	The HHERA would consider in detail however, possible mitigation measures are outlined below. Training of staff to optimize recycled water performance including: • Onsite STP manager. • Annual human health specialist inspections and ongoing management. • Adequate monitoring and reporting including preparation of a Recycled Water Management Plan. Recycled water (maximum 50kL daily) would be deposited into a reservoir with significant dilution (2.5 ML) prior to use for snow making. Snow guns not used in public areas during operational hours.	The MBR plant including the type, discharge quality, volumes, and location are included within the Statement of Environmental Effects (SEE). The tertiary treatment Membrane Bioreactor (MBR) sewage treatment plant (STP) has been designed to achieve Class A quality effluent. Class A is the highest achievable standard for recycled water. This includes • Pipe network is in place for reticulation for resort. • STP has been designed for treatment and log reduction of pathogens in accordance with the Recycled Water Guidelines (Table 3.7) for use in firefighting

Effluent Management Option	Feasibility	Legislation and agencies involved	Main Agencies involved	Detailed Assessments required	Potential Environmental and Biodiversity Impacts	Possible Mitigation Measures	Capability of the STP and its ability to deliver the results required
			any significant health implications, above the level of risk for natural snow (which is also subject to contamination by animals, vehicles and other skiers).		environment and biodiversity are expected to be low: • No environmental impacts are expected to be associated with reticulation. • Low volumes of recycled water (maximum 25 kL/day) would be significantly diluted prior to application as snow (in the quarry dam). • Natural snow falls on the resort would also dilute significantly prior to snow melt. • There is sufficient dilution and timeframe for the degradation of residual free chlorine used for disinfection. • Entry of potential pollutants into waterways (either groundwater or Clear Creek) would be diffuse which reduces impacts on waterways in comparison to point discharges. • Drainage would be gradual towards Clear Creek or groundwater and dependent on the snow melt regime. Representative flow monitoring (15-9-22 to 14-10-22) shows that flows related to snow melt are more gradual. No threatened flora or habitat was identified in the dam embankment or associated asset protection zone (APZ) as part of the	STP can be artificially fed during summer. Startup prior to resort operational hours (during March). Measures to account for variable effluent quality during start up (e.g. feed flows back into STP during start up if required for better quality). Continuous online STP monitoring, including chlorine residual. Capacity to cease operations (if required) to eliminate the possibility of partially treated or untreated water entering the Quarry Dam. Communication and education on the use as recycled water. Capacity to truck untreated or insufficient quality effluent offsite to a licensed facility in event of an emergency. **Reticulation Controls (in addition to option 1)** Consideration in HHERA specifically for recycled water use in resort (toilets) as well as snow making. Strengthened cross-connection controls and ongoing education of resort users and plumbers. Adequate signage in place in resort on use of recycled water in toilets.	(most stringent category of use) and for use in dual reticulation (Table 3.8). The target log reductions are 5.3 for bacteria, 5.1 for protozoa and 6.5 for viruses. • Both UV and chlorine for disinfection • Online chlorine monitoring • Heat lamps to optimise MBR nitrogen removal for cold climate • Small discharge volumes (50kL/day) • Pipework infrastructure in place for the reticulation use in resort facilities Pipework infrastructure in place for the transfer to the Quarry Dam.

Effluent Management Option	Feasibility	Legislation and agencies involved	Main Agencies involved	Detailed Assessments required	Potential Environmental and Biodiversity Impacts	Possible Mitigation Measures	Capability of the STP and its ability to deliver the results required
					biodiversity assessment undertaken for the SEE.		
3. Trucking effluent offsite to a facility that can lawfully accept it	**Not feasible** There would be considerable greenhouse gas emissions associated with this option. Multiple truck visits would be required on a daily basis to and from Canberra (6-hour return). There are safety and traffic considerations associated with the passageway of additional trucks on the Snowy Mountain Highway during the ski season, which experiences high volumes of traffic and at times icy conditions. There are unacceptable cost implications of this option as a base scenario.	State Environmental Planning Policy (Kosciuszko National Park – Alpine Resorts (2007) *Protection of Environment Operations Act* (1997)	NPWS – Development Application (DA) approval Transport for NSW – Roads DP&E (NSW EPA)	Emissions Assessment Road Safety Assessment	Greenhouse Gas emissions from multiple truck movements each day	Transport outside of peak hours	Not relevant
4. Storing all of part of treated effluent over ski season and then irrigating on ski slopes during summer	**Not feasible** The practicality of constructing a suitable sized tank for storage of all or part of the effluent generated over the ski season are considered unacceptable. A 5ML tank would be required (based on 50kL per day, over 100 days of ski season).	State Environmental Planning Policy (Kosciuszko National Park – Alpine Resorts (2007) *Protection of Environment Operations Act* (1997)	DP&E (NSW EPA)	Not relevant	Not relevant	Not relevant	Not relevant
5. Direct Discharge into Clear Creek	**Not preferred** Based on the Dilution Study this would not be recommended as	State Environmental Planning Policy (Kosciuszko National	DP&E (NSW EPA) - Environment Protection Licence (EPL) for the	Receiving Environment Assessment and Dilution Modelling Study	Potential impacts on water quality values and uses within Clear Creek associated with point discharge.	Onsite STP manager Discharge regime to maximise dilution.	The Membrane Bioreactor (MBR) sewage treatment plant (STP) has been

Effluent Management Option	Feasibility	Legislation and agencies involved	Main Agencies involved	Detailed Assessments required	Potential Environmental and Biodiversity Impacts	Possible Mitigation Measures	Capability of the STP and its ability to deliver the results required
	preferred option due to the variable dilution capacity of the Clear Creek. Mount Kosciuszko is located within high value ecosystem and as such discharges would need to comply with no changes to ambient quality.	Park – Alpine Resorts (2007) *Protection of Environment Operations Act* (1997)	miscellaneous licensed discharge to waters (at any time)	In line with: NSW EPA (2022). Guidance on Water Pollution Discharges. • ANZG (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality– http://www.waterquality.gov.au/anz-guidelines.	Clear Creek is a first order stream with variable flows. The flow regime is dependent on snow melt and rainfall/snow fall. Based on initial Dilution Study assessment, this option is not considered acceptable in terms of potential environmental impacts.	Alternative discharge point (downstream of snowmaking extraction point) to achieve higher dilution. Water and flow quality monitoring program including effluent, receiving waters (multiple downstream and reference site). Measures to account for variable effluent quality during start up (e.g. feed flows back into STP during start up).	designed to achieve Class A quality effluent: • UV for disinfection (chlorine would not be used for this option). • Heat lamps to optimise nitrogen removal in cold climate. • Small discharge volumes (maximum volume of 50kL/day) The MBR plant including the type, discharge quality, volumes, and location are included within the Statement of Environmental Effects (SEE).
6. Beneficial reuse in resort facilities	**Not feasible** as standalone – refer to Option 7. This option would utilize approximately. half of the volumes of recycled water. Could be used in hybrid with another suitable option.	Refer to Option 2.	Refer to Option 2.	Refer to Option 2.	Refer to Option 2.	Refer to Option 2.	Refer to Option 2.
7. Evaporation using evaporation cannons or natural evaporation	**Not preferred** Evaporation methods are not considered suitable due to associated energy costs and the alpine nature of this area. Evaporation during summer would involve storage of large volumes over snow season.	*Protection of Environment Operations Act* (1997). *Public and Environmental Health Act* (2011).	NSW Health – advice on recycled water use in public areas. DP&E (NSW EPA) – advice on environmental impacts.	Recycled Water Management Plan	Associated energy costs and not in line with the alpine nature of this area. No beneficial reuse of effluent, not good use of resources	Not relevant	Refer to Option 2.

7 Discussion

7.1 Dilution Assessment

A dilution assessment was undertaken on the Quarry Dam and Clear Creek to assist with the selection of an effluent management option for Selwyn Snow Resort. Based on the findings of this dilution study, a hybrid effluent management approach has been selected to use recycled water for reticulation in resort, and to manufacture as snow following significant dilution in a former Quarry Dam. It is considered that this option is the most preferrable in line with the Principles of Ecologically Sustainable Development (ESD). The STP was originally designed for use as Class A recycled waters for snow production in line with the Australian Guidelines for Water Recycling (AGWR) (NHMRC 2006) and the existing pipework infrastructure for reticulation is in place to support these options. Details of the proposed STP (location, infrastructure, treatment processes, disinfection methodology, discharge quality and volumes) are outlined in the Statement of Environment Effects for the resort approved by DP&E (SEE, March 2022).

In comparison to the option to direct discharge into Clear Creek, the option to recycle water significantly reduces likelihood for environmental impacts as:

- Approximately half of recycled water is reused in the resort toilet facilities.
- The recycled water is significantly diluted in a controlled manner within the Quarry Dam, then further on snow fields when combined with natural snow fall.
- Discharge into Clear Creek is during snow melt events and peak flow rates. Continuous flow monitoring (temperature and flow data) suggests the snow melt events are likely gradual, over days. Note, that the assessment of the option to discharge into Clear Creek identified periods when flows were insufficient for dilution, as water is 'locked up' in snow.
- Discharge into Clear Creek is diffuse rather than point source.
- Further reductions on pollutants will be achieved during detention in the Quarry Dam and during the snow making process.

The estimated water quality within the snow making dam and the receiving Clear Creek shows that the recycled water option should not result in **changes to ambient water quality** beyond natural variability. This includes layers of conservatism and maximum inputs into a range of scenarios, including consideration of periods where snow making cannot occur for consecutive days (1-10 days during peak visitation).

7.2 Recommendations

The following recommendations are made for further assessment:

- A modelling validation component is recommended as part of the first or second annual Water Quality Report. This study would reassess the calculations considering longer-term water quality dataset during operation.
- Site specific water quality guidelines should be derived:
    - For stressors (as a minimum for parameters of dissolved oxygen, pH, temperature, salinity, total nitrogen and total phosphorous) using a longer-term dataset of two

  - years of baseline data with minimum monthly sampling at reference sites, during the winter and spring seasons.
  - As the area is high conservation, it is considered that the objective will be to keep the water body at reference condition with 'no changes beyond natural variability'. The test site medians should be compared with the medians of long-term reference site dataset.
  - As the resort and STP is not operational during summer or autumn, then it is not considered necessary to develop water quality guidelines for these seasons. Developing seasonal water quality guidelines is an accepted approach as part of the ANZG framework.
- The receiving environment monitoring program should include:
  - Annual monitoring of soils in line with the AGWR (NHRMC 2006). A minimum of three sampling sites in recycled water application areas, and a reference site.
  - Monthly monitoring of surface waters during the snowmaking and/or recycled water application months in the Quarry Dam at the snowmaking extraction point, in comparison to the ANZG (2018).
  - Monthly monitoring of surface waters during the snowmaking and/or recycled water application months in Clear Creek in comparison to ANZG (2018) as an interim approach, and then to site specific guidelines when available. Sampling sites should include upstream and downstream of the potable water extraction point and the snowmaking water extraction point. A reference site should be included in the program (three-mile creek).
  - No recycled water application will occur during summer or autumn. As the resort and STP is not operational during summer or autumn, it is not considered necessary to undertake monitoring in this time. This data would not be useful as a control for comparison, due to the anticipated seasonal variation in water quality.
- It is considered that the AGWR provides the best framework for assessing the potential impacts of the recycled water application on terrestrial (and freshwater aquatic) biodiversity. This is through soil and water testing, with thresholds for assessing impacts on plants.
- In the AGWR, there are thresholds for soil paste extracts (salinity, sodium, chloride, phosphorous, nitrogen, soil hydraulic loading) to assess long term cumulative impacts on soils and plants during recycled water application, along with recommended controls to correct issues. Long term cumulative concentrations in soils cannot be accurately estimated or modelled at this stage, but annual soil testing and assessment should form part of the future environmental monitoring program.

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Appendix A
Stakeholder Correspondence

DOC21/126763

Stuart Schramm
Director, Property and Commercial
Department of Planning, Industry and Environment
NSW National Parks and Wildlife Service
Locked Bag 5022
PARRAMATTA, NSW, 2124

22 February 2021

Dear Mr Schramm

Selwyn Snow Resort Rebuild - Sewage Treatment Plant specifications

I refer to a meeting held on 18 February 2021 between Department of Planning, Industry and Environment (DPIE Planning), National Parks and Wildlife Service (NPWS), Department of Primary Industries (DPI), Department of Health (Health), and the Environment Protection Authority (EPA) to discuss the Selwyn Snow Resort Sewage Treatment Plant rebuild following the 2020 bushfires.

The EPA understands that the proponent is currently considering the options for the discharge of the treated effluent. These options include, but may not be limited to:

1) beneficial reuse of the treated effluent; and
2) discharge of treated effluent into Clear Creek

To assist the proponent in determining whether its proposed sewage treatment infrastructure will be appropriate and likely to meet modern environmental requirements for the discharge of effluent into an inland river, the EPA provides the following comments and advice.

Modern performance standards for a sewage treatment plant

The EPA acknowledges the financial constraints on sewage treatment technology selection. However, where there is a proposal to undertake a significant upgrade or replacement of sewage treatment infrastructure, the EPA considers that the infrastructure should be robust and generally capable of reliably delivering effluent that meets or is better than modern technology performance standards outlined in the table below.

Parameter	**Accepted levels achieved by modern technology (for discharge to inland waters) – 90th%ile limits**
Biological Oxygen Demand	10mg/L

Total Nitrogen	10mg/L
Total Phosphorus	0.3mg/L
Suspended Solids	15mg/L
Ammonia – nitrogen	2mg/L
pH	6.5-8.5 pH units
Oil and Grease	2mg/L
Pathogens (measured as faecal coliforms)	200 colony forming units/100mL

Discharge to Waters: Environmental values and Water Quality Objectives of Clear Creek

If treated effluent is discharged to waters, the proponent will need to consider the potential impacts of effluent on the receiving waters in order to select the most appropriate technology for the STP. The NSW Water Quality Objectives (NSW WQOs) and Australian and New Zealand Guidelines for Fresh and Marine Water Quality (the ANZECC Guidelines) provide the general framework to assess the potential impacts of a discharge on the environmental values of receiving waters, including Clear Creek. Where possible, the proponent should utilise existing water quality data to refine any trigger values to determine the environmental values of the receiving waters.

If the proposed discharge quality will not meet the relevant trigger values to meet the WQOs, the proponent may also consider a site specific assessment and dilution study to confirm the potential size of the mixing zone. This assessment should include consideration of a range of flow conditions to determine the edge of the mixing zone where the NSW WQO will be met.

The EPA reiterates that if treated effluent is discharged to waters, the proponent will need to apply for an Environment Protection Licence for the *miscellaneous licensed discharge to waters (at any time)*. The EPA's general water quality assessment requirements for a discharge to waters are provided in **Attachment 1** of this letter.

Thank you for discussing this matter with the EPA. If you have any queries or wish to discuss this matter further, please contact Carlie Armstrong or myself on (02) 6229 7002 or at Queanbeyan@epa.nsw.gov.au.

Yours Sincerely,

Nigel Sargent
Manager Regulatory Operations - Regional South

ATTACHMENT 1 – Water Quality Assessment Requirements for a Discharge to Waters

1. Describe existing surface and groundwater quality. An assessment needs to be undertaken for any water resource likely to be affected by the proposal.
2. State the ambient WQOs and environmental values for the receiving waters relevant to the proposal. These refer to the community's agreed environmental values and human uses endorsed by the NSW Government as goals for ambient waters. Where groundwater may be impacted the assessment should identify appropriate groundwater values.
3. State the indicators and associated trigger values or criteria for the identified environmental values. This information should be sourced from the ANZECC Guidelines for Fresh and Marine Water Quality. Indicators that are relevant to the issues in the waterway should be selected, as well as potential pollutants from the activity.

   Where site-specific studies are proposed to tailor the trigger values to reflect local conditions, and the results are to be used for regulatory purposes (e.g. to assess whether a licensed discharge impacts on environmental values), then prior agreement from the EPA on the approach and study design must be obtained.
4. Describe the current state of the waterway (e.g. whether WQOs and River Flow Objectives (RFOs) are being achieved, lake or estuary flushing characteristics and other environmental considerations, such as specific human uses (e.g. exact location of drinking water offtake), sensitive ecosystems or species conservation values);
5. State any locally specific objectives, criteria or targets which have been endorsed by the NSW Government.

Describe Proposal

6. Describe the proposal including position of any intakes and discharges, volumes and water quality of all discharge streams.
7. Identify and estimate the quality and quantity of all pollutants that may be introduced into the water cycle by source and discharge point, including residual discharges after mitigation measures are implemented. This should be undertaken for construction and operation.
8. The assessment should demonstrate that all practical options to avoid discharge have been assessed and mitigation measures employed to minimise environmental impact where discharge is necessary.

Impact Assessment - predict impacts and environmental outcomes

9. Describe the nature and degree of impact that any proposed discharges will have on the receiving environment.

10. Assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes. Demonstrate how the proposal will be designed and operated to:

    - protect the WQOs for receiving waters where they are currently being achieved; and
    - contribute towards achievement of the WQOs over time where they are not currently being achieved.

11. The proposal should demonstrate how the wastewater discharged to waterways will meet the relevant trigger values for chemical and non-chemical parameters at the edge of the initial mixing zone of the discharge, and that any impacts in the initial mixing zone are demonstrated to be reversible. The proposal should also avoid direct discharge impacts on ecologically significant areas and sensitive ecosystems.

12. If a mixing zone is proposed, the EPA must be consulted early in the development of any mixing zone proposal. The EPA will advise the applicant under what conditions a mixing zone will and will not be acceptable, as well as the information and modelling requirements for assessment.

13. EPA recommends the project demonstrates that the area within the mixing zone will not contain:

    - contaminants in concentrations that cause acute toxicity to aquatic life;
    - substances that can bio-accumulate;
    - contaminants in concentrations that settle *to* form harmful deposits (also in the far field);
    - substances in concentrations that produce problematic colour, odour, turbidity or undesirable aesthetic impacts (also in the far field); and
    - substances in concentrations which encourage undesirable aquatic life or result in the dominance of nuisance species.

14. The proposal should provide a rationale, along with relevant calculations, modelling or monitoring, (depending on the nature and scale of the proposal) supporting the predicted outcomes. The degree of investigation should reflect the risk presented by the activity.

15. Assess impacts on groundwater and groundwater dependent ecosystems.

16. Outline how total water cycle considerations are to be addressed showing total water balances for the development (with the objective of minimising demands and impacts on water resources). Include water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options.

Management and Mitigation Measures

17. Provide rationale as to why the proposed discharge method represents the best environmental outcome and what measures can be taken to reduce the environmental impact.
18. Describe how stormwater will be managed both during construction and operation.
19. Describe wastewater treatment measures that are appropriate to the type and volume of wastewater and are based on a hierarchy of avoiding generation of wastewater; capturing all contaminated water (including stormwater) on the site; reusing/recycling wastewater; and treating any unavoidable discharge from the site to meet specified water quality requirements.

DOC22/478433

The Proper Officer
The Blyton Group
PO Box 35
Jindabyne NSW 2627

Attention: Lucy Blyton

General Manager – Projects and Implementation

17 June 2022

Dear Ms Blyton,

Selwyn Snow Resort Rebuild – Sewage Treatment Plant

Thank you for providing the NSW Environment Protection Authority (EPA) with the opportunity to comment on the development of a Discharge Water Quality Impact Assessment for the proposed Selwyn sewage treatment plant (the Project).

The EPA previously advised you of the minimum performance standards for sewage treatment plants as well as the water quality assessment requirements for a proposal to discharge to waters. The EPA understands that the Blyton Group are currently developing a monitoring program to describe existing surface and groundwater quality of the proposed receiving waters (the monitoring program). In that regard, the EPA provides further advice below:

Performance standards for a sewage treatment plant

The EPA's previous correspondence included guidance on the minimum performance standard expected from any new sewage treatment plant. However, the EPA reminds you that the final effluent quality (and hence a decision about sewerage treatment technology) must also consider the environmental values of the receiving waters. The proposed sewage treatment plant for Selwyn Snow Resort will be in the high conservation value environment of Kosciuszko National Park. In that regard, the water quality guidelines will likely require a higher treated effluent discharge standard. The discharge water quality impact assessment will inform the Blyton Group and the EPA of any parameters that may require tighter treatment limits.

Parameters of the monitoring program

If the Blyton Group proposes to discharge to waters, you will need to demonstrate that the proposed discharge will:

1. maintain the environmental values of the receiving waterway where they are currently being achieved or
2. contribute to restoring the environmental values where they are not currently being achieved.

For proposed discharges occurring in high conservation value areas such as Kosciuszko National Park, an appropriate and robust baseline dataset is expected to support the proposal and to describe existing water quality. The EPA advises that the monitoring program must be representative of existing surface water and groundwater of the proposed receiving waters. Specifically,

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(from outside NSW) NSW 2124 Australia NSW 2150 Australia

1. the frequency, timing and duration of monitoring must be representative of the natural variability of the receiving waters. In that regard, samples should be taken during a range of seasonal and flow conditions
2. Monitoring should continue for long enough to gather data appropriate for establishing baseline conditions; and
3. Sampling locations should reflect the proposed discharge location, and appropriate upstream and downstream locations

The EPA recommends that you engage a suitably qualified person/s to establish the monitoring program and invites you to provide a draft of the monitoring program to the EPA for comment.

The EPA reminds you that the important and sensitive environmental values of Kosciuszko National Park require a high level of protection from activities associated with the Selwyn Snow Resort.

If you have any questions regarding this matter, please contact me on (02) 6229 7002 or via info@epa.nsw.gov.au .

Yours sincerely,

Nigel Sargent

Manager - Regulatory Operations Regional

DOC22/694398

The Proper Officer
The Blyton Group
PO Box 35
Jindabyne NSW 2627

Attention: Josh Elliot

Chief Operating Officer

10 August 2022

Dear Mr Elliot,

Selwyn Snow Resort STP Rebuild

Proposed Baseline Water Monitoring Program

Thank you for providing the NSW Environment Protection Authority (EPA) with the opportunity to provide comment on the Baseline Water Quality Monitoring Program (the Program) prepared by K2 Consulting Group for the proposed Selwyn Snow Resort STP discharge to waters (the Project).

The EPA previously recommended that the Blyton Group develop the Program to appropriately characterise the baseline water quality of the receiving waterways. The EPA has reviewed the Program and provides the following comments:

Appropriate protection value

Selwyn Snow Resort is located within Kosciuszko National Park. The important and sensitive environmental values of Kosciuszko National Park require a high level of protection from activities associated with the Project. Consistent with the ANZG (2018) guidelines the appropriate guideline values are '*no change in water quality beyond natural variability'* for physical chemical stressors, and the 99% species protection level for toxicants. This is also consistent with similar sewage treatment plants recently constructed for the nearby Snowy 2.0 project.

Discharge options

The EPA understands that the Blyton Group are currently exploring 3 discharge options for treated effluent from the STP.

Option A: discharge to waters via Clear Creek at the bottom of the ski slope

Option B: discharge to waters north of the resort

Option C: discharge via snow to the north of the resort

The Program has been updated to include fortnightly monitoring at representative locations upstream and downstream of Option A and Option B in Clear Creek. The EPA understands that the Blyton Group are considering a different testing methodology for the land application option (Option C). The EPA recommends that monitoring is undertaken in representative locations upstream and downstream of the land application area for Option C in Bullocks Head Creek as the receiving waters of any snow melt generated via this option. These sites could act as a reference site if these options are not pursued.

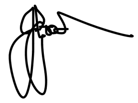
Flow monitoring

Satellite imagery indicates that there is a limited upstream catchment area, and limited channel definition at each of the 3 proposed discharge points. It is unclear how much available water will be present to sample throughout the year, and how far the mixing zone is likely to extend during periods of low flow (including flow that is trapped as snow).

The EPA recommends that the Blyton Group collects data that will assist in the identification of the mixing zone for each discharge option (such as flow monitoring). Flow monitoring may need to occur at an increased frequency (preferably continuously) due to the flow variability on site following rain and snow fall.

If you have any questions regarding this matter, please contact Carlie Armstrong on (02) 6229 7002 or via info@epa.nsw.gov.au .

Yours sincerely,



Janine Goodwin

Unit Head - Regulatory Operations Regional

Our ref: DOC22/780243-1

7/10/2022

Josh Elliot - Chief Operating Officer
Blyton Group
PO Box 35
JINDABYNE NSW 2627

Dear Mr Elliott,

Selwyn Snow Resort Rebuild
Sewage Treatment Plant Receiving Environment Assessment
Proposed Dilution Modelling Study

Thank you for providing the NSW Environment Protection Authority (EPA) with the opportunity to consult on the proposed dilution modelling study (the proposed study) for the Selwyn Snow Resort's (SSR) proposed Sewage Treatment Plant (STP) discharge to waters, provided to the EPA on 2 September 2022.

The EPA has reviewed the proposed study and understands that it aims to identify the extent of the mixing zone for proposed discharges from the STP into Clear Creek within Kosciuszko National Park (KNP). The EPA considers that the proposed study is unlikely to satisfy the level of information required to inform a licensing decision regarding a potential discharge to waters in accordance with section 45 of the *Protection of the Environment Operations Act 1997* (The POEO Act). Detailed comments on the proposed study are included in **Appendix A**.

The EPA is concerned about the suitability of discharging treated effluent to receiving waters in KNP. Specifically, the EPA is concerned that the STP may not be able to treat effluent to the high standard that would be required to protect the high conservation value of the receiving environment. The EPA understands that Clear Creek is a first order ephemeral creek with characteristically low flows. SSR must ensure that the significant environmental values of KNP receive a high level of protection from activities undertaken at the premises, including protection of the NSW Water Quality Objectives.

Given the current uncertainty about being able to lawfully discharge into the sensitive waters of Clear Creek, the EPA strongly encourages SSR to explore alternative options for managing the treated effluent. The EPA understands that preliminary exploration of alternative options has occurred, but detailed assessments and investigations are yet to occur. The EPA recommends SSR develop a comprehensive options assessment which explores all reasonable and feasible options for the management of treated effluent. This may include, but need not be limited to:

1. Trucking treated effluent offsite to a facility that can lawfully receive it
2. Storing all or part of the treated effluent over the ski season and irrigating on ski slopes over warmer months
3. Manufacturing snow using treated effluent (including treated effluent diluted with snow intake water)
4. Evaporating treated effluent using evaporation cannons or natural evaporation

5. A ‘hybrid’ option using a combination of treated effluent management options

Please note, the options assessment should include consultation with relevant agencies and consideration of impacts to the environment and human health. The EPA understands that NSW Health may require a human health impact assessment to support a proposal to use treated effluent for snow making and encourages you to engage with this agency directly.

The EPA is available to continue to consult with SSR, their consultants and other relevant agencies on the development and progression of this options assessment. However, in order for the EPA to provide definitive advice on the proposed operation of the STP and the regulation of its environmental impacts, it requires details of:

1. The type of STP to be installed at SSR, including the methodology used for disinfection and any chemical dosing utilised in the plant
2. The discharge quality that the STP can operationally treat to. This information is required for pH, biological oxygen demand, total suspended solids, total nitrogen, total phosphorus, ammonia, faecal coliforms and oil and grease
3. The expected daily volumes of treated effluent that would need to be managed over a 12 month period, and the maximum daily volumes of treated effluent
4. The location of the STP and associated infrastructure such as pipework for discharge, effluent transfer, including a scaled map

If you have any further questions or would like to discuss the matter further, please contact me on 02 6229 7002 or at info@pa.nsw.gov.au

Yours sincerely,

Carlie Armstrong

A/Manager
Regulatory Operations Regional South

APPENDIX A – Detail Comments on the Proposed Study

Water Quality Parameters

The proposed study identifies that detailed modelling will be undertaken for three water quality parameters however it is unclear which parameters will be selected. The EPA acknowledges that following discussions the proposed study has been amended to include total nitrogen and total phosphorous. However, the EPA advises that modelling should be include all pollutants which may be present at non-trivial concentrations, including salinity and temperature. Modelling should also account for pollutant loads and eutrophication risks to downstream receiving environments, including Tumut Pond.

Appropriate Water Quality Standards

The proposed study references 90th%ile effluent quality limits and notes that the 99% ANZG species protection guidelines apply for toxicants and the NHMRC (2008) guidelines for primary recreation (human health).

The EPA reiterates that its policy position is for '*no change beyond natural variability*' for physical and chemical stressors. This is consistent with the National Water Quality Management Strategy and national water quality guidelines that all States and Territories have adopted for managing water quality.

'Ramp Up' periods

The proposed study will need to account for the expected discharge water quality during the "ramp-up" phase each year when the discharge quality may be highly variable. SSR may need to consider alternative methods such as capture and re-treatment of treated effluent during seasonal commissioning.

Flow Conditions

The proposed study identifies that "one or two flow conditions (50th %ile and 95th %ile)" will be modelled. It is recommended that a wide range of representative flow conditions are considered, including low flow through to high flow conditions.

Modelling scenarios will also need to account for different extraction scenarios for snow making (i.e. low through to high flow conditions). It is recommended that the study considers the variability of flow due to water trapped as snow, changes to groundwater baseflow and changes in ambient air temperatures affecting snow melt.

Assessment Uncertainties

It is likely that there will be a high level of uncertainty associated with the mixing zone modelling due to the limited water quality data collected and difficulties in determining flow variability due to snow melt and groundwater baseflow. The EPA notes that higher-than-average rainfall that has been occurring in the region for the past two years is likely to have resulted in increased groundwater baseflow.

Flow and water quality data for reference sites from alternative sources (such as Snowy Hydro) should be considered to reduce the level of uncertainty.

Appendix B
Water Quality Data

K2 CONSULTING GROUP

			Flow		Nitrogen							Phosphorus					Trace Metals (Dissolved)															Ca	
			Min	Max	Nitrate Nitrogen, NO_3-N	Nitrite Nitrogen, NO_2 as N	Total Oxidised Nitrogen, NO_x-N	Total Kjedahl Nitrogen (TKN)	Organic Nitrogen	Total Nitrogen	Ammonia Nitrogen, NH_3 as N	Total Phosphorus (Kjedahl Digestion) as P	Filterable Reactive Phosphorus as P	Biochemical Oxygen Demand (BOD_5)	Total Suspended Solids	Total Chlorine	Iron, Fe	Aluminium, Al	Arsenic, As	Barium, Ba	Beryllium, Be	Cadmium, Cd	Chromium, Cr	Cobalt, Co	Copper, Cu	Manganese, Mn	Nickel, Ni	Lead, Pb	Vanadium, V	Zinc, Zn	Total Mercury	Calcium, Ca	Magnesium, Mg
		Adopted Water Quality Guidelines					0.015			0.25	0.32	0.02	0.015			0.03		27	1			0.06			1		8	1	6	2.4			
Sample ID	Monitoring Event	LOR	--	--	0.005	0.005	0.005	0.05	0.05	0.05	0.01	0.02	0.005	5	5	0.1	5	5	1	1	1	0.1	1	1	1	1	1	1	1	5	0.0001	0.2	0.1
		Sampled Date	m/s	m/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L
ST-01-1505-MON1-SP1	1	29/07/2022	0.10	0.10	0.39	<0.005	0.39	0.05	<0.05	0.44	<0.01	0.02	<0.005	<5	<5	<0.1	<5	7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.6	0.4
ST-01-1505-MON1-SP2		29/07/2022	0.10	0.10	0.36	<0.005	0.36	0.07	<0.05	0.43	0.03	0.02	<0.005	<5	<5	<0.1	<5	29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.6	0.4
ST-01-1505-MON1-SP3		29/07/2022	0.30	0.40	0.2	<0.005	0.20	0.11	0.1	0.31	0.01	0.02	<0.005	<5	<5	<0.1	<5	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.6	0.4
ST-01-1505-MON1-SP4		29/07/2022	0.30	0.40	0.2	<0.005	0.20	0.09	0.08	0.29	0.02	0.03	<0.005	<5	<5	<0.1	<5	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.6	0.4
ST-01-1505-MON1-SP5		29/07/2022	0.20	0.10	0.17	<0.005	0.18	0.14	0.12	0.31	0.01	0.06	<0.005	<5	11	<0.1	<5	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.7	0.4
ST-01-1505-MON1-SP6		29/07/2022	0.40	0.10	0.01	<0.005	0.012	0.10	0.08	0.12	0.02	0.03	<0.005	<5	<5	<0.1	<5	13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.6	0.9
ST-01-1505-MON2-SP1	2	22/08/2022	0.10	0.20	0.022	<0.005	0.025	0.32	0.31	0.35	<0.01	0.03	<0.005	<5	<5	<0.1	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.8	0.8
ST-01-1505-MON2-SP2		22/08/2022	0.10	0.30	0.27	<0.005	0.27	0.20	0.19	0.47	<0.01	<0.02	<0.005	<5	<5	<0.1	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.6	0.3
ST-01-1505-MON2-SP3		22/08/2022	0.30	0.40	0.27	<0.005	0.27	0.14	0.12	0.41	0.01	<0.02	<0.005	<5	<5	<0.1	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.6	0.3
ST-01-1505-MON2-SP4		22/08/2022	0.50	0.60	0.15	<0.005	0.15	0.14	0.13	0.29	<0.01	1.4	<0.005	<5	<5	<0.1	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.6	0.3
ST-01-1505-MON2-SP5		22/08/2022	0.60	0.70	0.13	0.006	0.14	0.14	0.13	0.28	0.01	0.55	<0.005	<5	<5	<0.1	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.6	0.4
ST-01-1505-MON2-SP6		22/08/2022	--	--	0.12	0.005	0.13	0.14	0.13	0.27	0.01	<0.02	<0.005	<5	<5	<0.1	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.7	0.4
ST-01-1505-MON3-SP1	3	29/08/2022	--	--	0.35	<0.005	0.36	0.07	0.06	0.42	<0.01	<0.02	0.006	<5	9	<0.1	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.7	0.4
ST-01-1505-MON3-SP2		29/08/2022	--	--	0.36	<0.005	0.36	<0.05	<0.05	0.36	<0.01	<0.02	0.006	<5	<5	<0.1	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.6	0.4
ST-01-1505-MON3-SP3		29/08/2022	--	--	0.16	<0.005	0.16	0.06	0.05	0.22	<0.01	<0.02	<0.005	<5	<5	<0.1	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.6	0.3
ST-01-1505-MON3-SP4		29/08/2022	--	--	0.15	<0.005	0.16	<0.05	<0.05	0.16	<0.01	<0.02	0.005	<5	<5	<0.1	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.7	0.4
ST-01-1505-MON3-SP5		29/08/2022	--	--	0.13	<0.005	0.13	<0.05	<0.05	0.13	<0.01	<0.02	<0.005	<5	<5	<0.1	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.8	0.4
ST-01-1505-MON3-SP6		29/08/2022	--	--	0.007	<0.005	0.01	0.07	0.06	0.06	<0.01	<0.02	<0.005	<5	<5	<0.1	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.0001	0.8	0.8
ST-01-1505-MON4-SP1	4	12/09/2022	0.10	0.40	0.35	<0.005	0.35	0.23	0.21	0.58	0.03	0.04	<0.005	<5	<5	<0.1	21	NA	<1	4	<1	<0.1	<1	<1	2	16	1	<1	<1	18	<0.0001	0.8	0.4
ST-01-1505-MON4-SP2		12/09/2022	0.30	0.40	0.34	<0.005	0.35	0.34	0.30	0.69	0.04	<0.02	<0.005	<5	<5	<0.1	19	NA	<1	4	<1	<0.1	<1	<1	2	14	1	<1	<1	14	<0.0001	0.7	0.4
ST-01-1505-MON4-SP3		12/09/2022	0.30	0.50	0.13	<0.005	0.13	1.4	1.2	1.5	0.24	<0.02	<0.005	<5	<5	<0.1	<5	NA	<1	3	<1	<0.1	<1	<1	<1	3	1	<1	<1	<5	<0.0001	0.7	0.4
ST-01-1505-MON4-SP4		12/09/2022	0.60	0.80	0.11	<0.005	0.12	0.31	0.26	0.43	0.05	<0.02	<0.005	<5	<5	<0.1	12	NA	<1	4	<1	<0.1	<1	<1	<1	3	1	<1	<1	9	<0.0001	0.8	0.4
ST-01-1505-MON4-SP5		12/09/2022	0.40	0.50	0.092	<0.005	0.093	0.33	0.31	0.43	0.03	<0.02	<0.005	<5	8	<0.1	11	NA	<1	4	<1	<0.1	<1	<1	1	3	<1	<1	<1	10	<0.0001	1	0.5
ST-01-1505-MON4-SP6		12/09/2022	--	--	<0.005	<0.005	<0.005	0.26	0.26	0.26	<0.01	<0.02	<0.005	5	19	<0.1	8	NA	<1	<1	<1	<0.1	<1	<1	<1	1	1	<1	<1	<5	<0.0001	0.9	0.9
ST-01-1505-MON5-SP1	5	26/09/2022	--	--	0.36	<0.005	0.36	0.35	0.30	0.71	0.06	<0.02	0.007	<5	<5	<0.1	<5	NA	<1	4	<1	<0.1	<1	<1	1	12	<1	<1	<1	12	<0.0001	0.7	0.4
ST-01-1505-MON5-SP2		26/09/2022	--	--	0.43	<0.005	0.43	0.17	0.13	0.60	0.04	<0.02	0.007	<5	<5	<0.1	<5	NA	<1	4	<1	<0.1	<1	<1	<1	13	<1	<1	<1	<5	<0.0001	0.7	0.4
ST-01-1505-MON5-SP3		26/09/2022	--	--	0.16	<0.005	0.16	0.15	0.12	0.31	0.04	0.04	<0.005	<5	<5	<0.1	<5	NA	<1	3	<1	<0.1	<1	<1	<1	2	<1	<1	<1	9	<0.0001	0.6	0.3
ST-01-1505-MON5-SP4		26/09/2022	--	--	0.16	<0.005	0.16	0.34	0.26	0.50	0.08	<0.02	<0.005	<5	<5	<0.1	7	NA	<1	3	<1	<0.1	<1	<1	<1	<1	<1	<1	<1	5	<0.0001	0.6	0.3
ST-01-1505-MON5-SP5		26/09/2022	--	--	0.11	<0.005	0.12	0.50	0.38	0.61	0.12	<0.02	<0.005	<5	<5	<0.1	10	NA	<1	6	<1	<0.1	<1	<1	2	<1	<1	<1	<1	17	<0.0001	0.9	0.4
ST-01-1505-MON5-SP6		26/09/2022	--	--	<0.005	<0.005	<0.005	0.11	0.09	0.11	0.02	<0.02	<0.005	<5	<5	<0.1	<5	NA	<1	1	<1	<0.1	<1	<1	<1	<1	<1	<1	<1	<5	<0.0001	0.7	0.7
ST-01-1505-MON6-SP1	6	10/10/2022	0.20	0.30	0.3	<0.005	0.30	0.19	0.17	0.49	0.03	<0.02	0.006	<5	<5	<0.1	<5	NA	<1	3	<1	<0.1	<1	<1	<1	11	<1	<1	<1	5	<0.0001	0.6	0.4
ST-01-1505-MON6-SP2		10/10/2022	0.20	0.40	0.33	<0.005	0.33	0.24	0.20	0.57	0.03	<0.02	0.006	<5	<5	<0.1	<5	NA	<1	4	<1	<0.1	<1	<1	<1	16	<1	<1	<1	7	<0.0001	0.7	0.4
ST-01-1505-MON6-SP3		10/10/2022	0.80	0.30	0.11	<0.005	0.11	0.27	0.23	0.38	0.04	<0.02	<0.005	<5	<5	<0.1	<5	NA	<1	3	<1	<0.1	<1	<1	<1	2	<1	<1	<1	<5	<0.0001	0.6	0.3
ST-01-1505-MON6-SP4		10/10/2022	0.30	0.50	0.11	<0.005	0.11	0.39	0.34	0.5	0.05	<0.02	<0.005	<5	<5	<0.1	5	NA	<1	3	<1	<0.1	<1	<1	<1	3	<1	<1	<1	<5	<0.0001	0.7	0.4
ST-01-1505-MON6-SP5		10/10/2022	0.40	0.50	0.094	<0.005	0.10	0.37	0.32	0.46	0.05	<0.02	<0.005	<5	<5	<0.1	<5	NA	<1	3	<1	<0.1	<1	<1	<1	2	<1	<1	<1	<5	<0.0001	0.8	0.4
ST-01-1505-MON6-SP6		10/10/2022	0.00	0.00	0.069	<0.005	0.07	0.08	0.08	0.15	<0.01	<0.02	<0.005	<5	<5	<0.1	7	NA	<1	2	<1	<0.1	<1	<1	<1	2	<1	<1	<1	<5	<0.0001	0.8	0.7
ST-01-1505-MON7-SP1	7	24/10/2022	0.30	0.50	0.32	<0.005	0.32	0.19	0.16	0.52	0.03	<0.02	0	<5	<5	<0.1	<5	21	<1	4	<1	<0.1	<1	<1	<1	11	<1	<1	<1	<5	<0.0001	0.6	0.3
ST-01-1505-MON7-SP2		24/10/2022	0.20	0.40	0.33	<0.005	0.33	0.28	0.23	0.62	0.06	0.03	0	<5	<5	<0.1	<5	25	<1	4	<1	<0.1	<1	<1	<1	12	<1	<1	<1	7	<0.0001	0.6	0.3
ST-01-1505-MON7-SP3		24/10/2022	0.30	0.60	0.13	<0.005	0.13	0.21	0.18	0.33	0.03	<0.02	<0.005	<5	<5	<0.1	<5	13	<1	3	<1	<0.1	<1	<1	<1	3	<1	<1	<1	<5	<0.0001	0.6	0.3
ST-01-1505-MON7-SP4		24/10/2022	0.30	0.60	0.13	<0.005	0.13	0.25	0.21	0.38	0.04	<0.02	<0.005	<5	<5	<0.1	8	14	<1	3	<1	<0.1	<1	<1	<1	3	<1	<1	<1	6	<0.0001	0.6	0.3
ST-01-1505-MON7-SP5		24/10/2022	0.20	0.60	0.11	<0.005	0.11	0.31	0.26	0.42	0.05	0.11	<0.005	<5	<5	<0.1	8	15	<1	4	<1	<0.1	<1	<1	2	3	<1	<1	<1	16	<0.0001	0.8	0.4
ST-01-1505-MON7-SP6		24/10/2022	0.00	0.00	<0.005	<0.005	<0.005	0.09	0.08	0.09	<0.01	0.02	<0.005	<5	<5	<0.1	11	9	<1	3	<1	<0.1	<1	<1	<1	<1	<1	<1	<1	<5	<0.0001	1	0.9

K2 CONSULTING GROUP

			tions		Microbiological					Trace Metals (Total)													Physical parameters							
			Sodium, Na	Potassium, K	Heterotrophic Count (HPC) at 22°c	Heterotrophic Count (HPC) at 36°c	Thermotolerant Coliforms	E.Coli	Intestinal Enterococci	Total Arsenic	Total Barium	Total Beryllium	Total Cadmium	Total Chromium	Total Cobalt	Total Copper	Total Manganese	Total Nickel	Total Lead	Total Vanadium	Total Zinc	Total Mercury	Temperature	pH	Conductivity (EC)	Total Dissolved Solids (TDS)	Dissolved Oxygen (DO)	ORP	Specific Conductance	Turbidity
		Adopted Water Quality Guidelines					200		40	94			0.4	6		1.8	2500	13	5.6		15	1.9		6.5 - 7.5			90-110			2-25
Sample ID	Monitoring Event	LOR	0.5	0.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	5.0	0.0001			2.00	10.00				0.50
		Sampled Date	mg/L	mg/L	CFU/mL	CFU/mL	CFU/100 mL	CFU/100 mL	CFU/100 mL	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	°C	-	µs/cm	mg/L	mg/L	mV	-	NTU
ST-01-1505-MON1-SP1	1	29/07/2022	1.2	0.2	500	8	<1	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.8	5.8	9.3	0	9.55	214.85	0.014	0
ST-01-1505-MON1-SP2		29/07/2022	1.2	0.2	500	<1	<1	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8	5.48	10.6	0	8.95	150.2	0.016	0
ST-01-1505-MON1-SP3		29/07/2022	1	0.2	700	7	<1	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6.2	7.2	7.7	0	10.35	97.65	0.012	0.05
ST-01-1505-MON1-SP4		29/07/2022	1	0.2	2000	38	<1	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.7	7.41	8.55	0	10.35	107.7	0.01	0
ST-01-1505-MON1-SP5		29/07/2022	1	0.2	2000	40	<1	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.65	7.35	10.5	0	9.85	159.1	0.015	0
ST-01-1505-MON1-SP6		29/07/2022	1.3	0.1	4000	18	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.85	6.68	10.85	0	10.1	159.85	0.016	0
ST-01-1505-MON2-SP1	2	22/08/2022	1.0	0.1	500	10	<1	<1	NA	<1	2	<1	<0.1	<1	<1	<1	<1	<1	<1	<1	<5	NA	NA	NA	NA	<10	NA	NA	NA	<0.5
ST-01-1505-MON2-SP2		22/08/2022	0.9	0.2	41	2	<1	<1	NA	<1	4	<1	<0.1	<1	<1	<1	10	<1	<1	<1	<5	NA	NA	NA	NA	<10	NA	NA	NA	<0.5
ST-01-1505-MON2-SP3		22/08/2022	0.9	0.2	110	6	<1	<1	NA	<1	4	<1	<0.1	<1	<1	<1	8	<1	<1	<1	<5	NA	NA	NA	NA	<10	NA	NA	NA	1.5
ST-01-1505-MON2-SP4		22/08/2022	0.8	0.2	160	6	<1	<1	NA	<1	4	<1	<0.1	<1	<1	<1	3	<1	<1	<1	<5	NA	NA	NA	NA	14	NA	NA	NA	0.6
ST-01-1505-MON2-SP5		22/08/2022	0.8	0.2	170	9	<1	<1	NA	<1	4	<1	<0.1	<1	<1	<1	3	<1	<1	<1	<5	NA	NA	NA	NA	<10	NA	NA	NA	0.9
ST-01-1505-MON2-SP6		22/08/2022	0.8	0.2	150	10	<1	<1	NA	<1	4	<1	<0.1	<1	<1	<1	2	<1	<1	<1	<5	NA	NA	NA	NA	12	NA	NA	NA	1.2
ST-01-1505-MON3-SP1	3	29/08/2022	1.1	0.2	1000	10	2	2	<1	<1	6	<1	<0.1	<1	<1	<1	21	1	<1	<1	<5	<0.0001	8.1	5.38	14	<10	12.58	99.45	14.65	5
ST-01-1505-MON3-SP2		29/08/2022	1.1	0.2	6	<1	<1	<1	<1	<1	4	<1	<0.1	<1	<1	<1	13	1	<1	<1	<5	<0.0001	8.2	5.2	14	<10	12.27	95.1	15.8	<0.5
ST-01-1505-MON3-SP3		29/08/2022	1	0.2	950	2	6	6	<1	<1	4	<1	<0.1	<1	<1	<1	4	<1	<1	<1	<5	<0.0001	7.1	6.19	11	<10	12.8	89.65	12.2	0.5
ST-01-1505-MON3-SP4		29/08/2022	0.9	0.2	260	<1	5	5	<1	<1	4	<1	<0.1	<1	<1	<1	4	1	<1	<1	<5	<0.0001	6.9	6.05	10	<10	14.56	90.3	13.15	<0.5
ST-01-1505-MON3-SP5		29/08/2022	0.9	0.2	1300	7	3	3	<1	<1	4	<1	<0.1	<1	<1	<1	4	1	<1	<1	<5	<0.0001	6.5	6.03	11	<10	13.82	91.45	16.4	0.6
ST-01-1505-MON3-SP6		29/08/2022	1	<0.1	3000	1	<1	<1	<1	<1	2	<1	<0.1	<1	<1	<1	4	<1	<1	<1	<5	<0.0001	5.7	5.88	14	10	15.17	100.3	15.55	1.1
ST-01-1505-MON4-SP1	4	12/09/2022	1.9	0.4	17000	90	8	<1	<1	<1	5	<1	<0.1	<1	<1	2	16	1	<1	<1	18	<0.0001	7.3	5.72	13	<10	15.33	81	14.75	2.7
ST-01-1505-MON4-SP2		12/09/2022	1.2	0.4	13000	18	6	<1	<1	<1	5	<1	<0.1	<1	<1	2	15	2	<1	<1	13	<0.0001	7.25	5.5	15	10.72	13.27	76.9	16.4	3.2
ST-01-1505-MON4-SP3		12/09/2022	0.9	0.2	17000	60	<1	<1	<1	<1	4	<1	<0.1	<1	<1	<1	2	1	<1	<1	<5	<0.0001	5.55	6.74	20	<10	10.71	40.7	12.6	2.9
ST-01-1505-MON4-SP4		12/09/2022	1	0.2	16000	1	<1	<1	<1	<1	4	<1	<0.1	<1	<1	1	3	1	<1	<1	8	<0.0001	5.5	6.65	13	<10	15.15	49.3	12.95	2.4
ST-01-1505-MON4-SP5		12/09/2022	1	0.3	25000	2	<1	<1	<1	<1	5	<1	<0.1	<1	<1	1	11	<1	<1	<1	10	<0.0001	5.15	5.89	13	<10	13.26	57.35	14.15	4
ST-01-1505-MON4-SP6		12/09/2022	1.1	<0.1	1700	6	<1	<1	<1	<1	23	<1	<0.1	<1	<1	<1	14	<1	<1	<1	<5	<0.0001	6.25	6.43	15	11.05	17.73	75.6	16.95	4.6
ST-01-1505-MON5-SP1	5	26/09/2022	2	0.4	380	4	<1	<1	<1	<1	5	<1	<0.1	<1	<1	2	15	<1	<1	<1	12	<0.0001	9.1	3.78	17	9.1	20.37	80.15	14.45	0.8
ST-01-1505-MON5-SP2		26/09/2022	1.9	0.3	16	<1	<1	<1	<1	<1	5	<1	0.1	<1	<1	<1	13	<1	<1	<1	5	<0.0001	8.85	3.69	14	11.05	9.52	59.55	17.1	<0.5
ST-01-1505-MON5-SP3		26/09/2022	1.6	0.3	10000	31	3	3	<1	<1	4	<1	<0.1	<1	<1	<1	4	<1	<1	<1	9	<0.0001	8.85	3.62	12	7.16	9.92	124	11.6	0.6
ST-01-1505-MON5-SP4		26/09/2022	1.5	0.2	10000	26	1	1	<1	<1	4	<1	<0.1	<1	<1	<1	4	<1	<1	<1	5	<0.0001	8.75	3.84	12	7.47	10.25	123	11.7	1
ST-01-1505-MON5-SP5		26/09/2022	1.9	0.5	10000	170	5	5	<1	<1	8	<1	0.1	<1	<1	2	10	<1	<1	<1	20	<0.0001	8.45	4.21	13	8.12	10.05	66.25	12.45	1.5
ST-01-1505-MON5-SP6		26/09/2022	1.5	0.1	2000	9	<1	<1	<1	<1	3	<1	<0.1	<1	<1	<1	6	<1	<1	<1	<5	<0.0001	15.45	5.84	14	9.42	8.65	35.55	14.4	0.5
ST-01-1505-MON6-SP1	6	10/10/2022	1.1	0.2	54	<1	<1	<1	<1	<1	6	<1	<0.1	<1	<1	<1	16	<1	<1	<1	<5	<0.0001	8.5	3.72	13	9.1	9.29	132.65	14.45	<0.5
ST-01-1505-MON6-SP2		10/10/2022	1.2	0.3	100	6	<1	<1	<1	<1	7	<1	<0.1	<1	<1	<1	23	<1	<1	<1	9	<0.0001	8.85	2.91	14	10.4	11.22	172.7	16.25	<0.5
ST-01-1505-MON6-SP3		10/10/2022	1	0.2	6400	31	<1	<1	<1	<1	5	<1	<0.1	<1	<1	<1	5	<1	<1	<1	5	<0.0001	10.15	6.01	12	7.8	12.69	246.35	11.7	1
ST-01-1505-MON6-SP4		10/10/2022	1	0.2	5100	160	<1	<1	<1	<1	6	<1	<0.1	<1	<1	<1	10	<1	<1	<1	6	<0.0001	10.1	5.29	12	8.12	13.13	166.15	12.4	0.9
ST-01-1505-MON6-SP5		10/10/2022	1.1	0.3	19000	300	<1	<1	<1	<1	6	<1	<0.1	<1	<1	<1	11	2	<1	<1	7	<0.0001	10.15	5.33	12	9.42	8.84	14.8	13.95	0.8
ST-01-1505-MON6-SP6		10/10/2022	1.1	0.1	3000	26	<1	<1	<1	<1	5	<1	<0.1	<1	<1	<1	16	<1	<1	<1	<5	<0.0001	19.25	4.41	16	10.39	8.71	208.05	15.8	<0.5
ST-01-1505-MON7-SP1	7	24/10/2022	0.9	0.2	2100	360	<1	<1	<1	<1	4	<1	<0.1	<1	<1	<1	12	<1	<1	<1	<5	<0.0001	8.3	5.18	13	9.42	7.54	79.1	14.5	1
ST-01-1505-MON7-SP2		24/10/2022	0.9	0.2	900	17	<1	1	1	<1	5	<1	<0.1	<1	<1	<1	13	<1	<1	<1	7	<0.0001	8.65	4.82	15	10.4	7.61	75.65	16.2	2.1
ST-01-1505-MON7-SP3		24/10/2022	0.8	0.1	4000	9	<1	6	4	<1	4	<1	<0.1	<1	<1	<1	4	<1	<1	<1	5	<0.0001	9.05	6.15	11	7.95	6.88	57	11.79	1.6
ST-01-1505-MON7-SP4		24/10/2022	0.8	0.2	6100	1900	<1	33	2	<1	4	<1	<0.1	<1	<1	1	4	<1	<1	<1	6	<0.0001	9.05	5.88	11	8.45	6.31	55.75	13.05	1.1
ST-01-1505-MON7-SP5		24/10/2022	0.9	0.2	8000	1300	<1	30	1	<1	5	<1	<0.1	<1	<1	2	4	<1	<1	<1	17	<0.0001	9.9	7	13	8.77	5.91	27.85	13.45	1.1
ST-01-1505-MON7-SP6		24/10/2022	0.9	<0.1	3000	5	<1	<1	<1	<1	4	<1	<0.1	<1	<1	<1	16	<1	<1	<1	<5	<0.0001	13.25	6.16	17	11.37	6.28	85.6	16.95	<0.5

Appendix C
Field Assessment Data

Site 1

Table 6-1 Site 1 (potable extraction water weir) information.

Project Name		Selwyn
Season		Snow season (October 2022)
Site		1
Date		15-10-2022
Time		12:03
Stream Type		Pool
GPS Coordinates		-35.908864, 148.451359
Elevation (m above sea level)		1529.1
Notes		Potable water extraction point/weir. Potable water extraction volumes will need to be accounted for in the modelling.
Substrate (%)	Bedrock	10%
	Boulder (>256mm)	20%
	Cobble (64-256mm)	0
	Pebble (16-64mm)	0
	Gravel	20%
	Sand (2-16mm)	50%
	Fines (0-2mm)	0
Waterway profile (m)	Bank full channel width (m)	11.6
	Baseflow stream width (m)	3.5
	Baseflow maximum water depth (m)	0.21
	L Bank Height (m)	1
	L Bank Width (m)	4.4
	R Bank Height (m)	1.2
	L Bank Width (m)	3.7

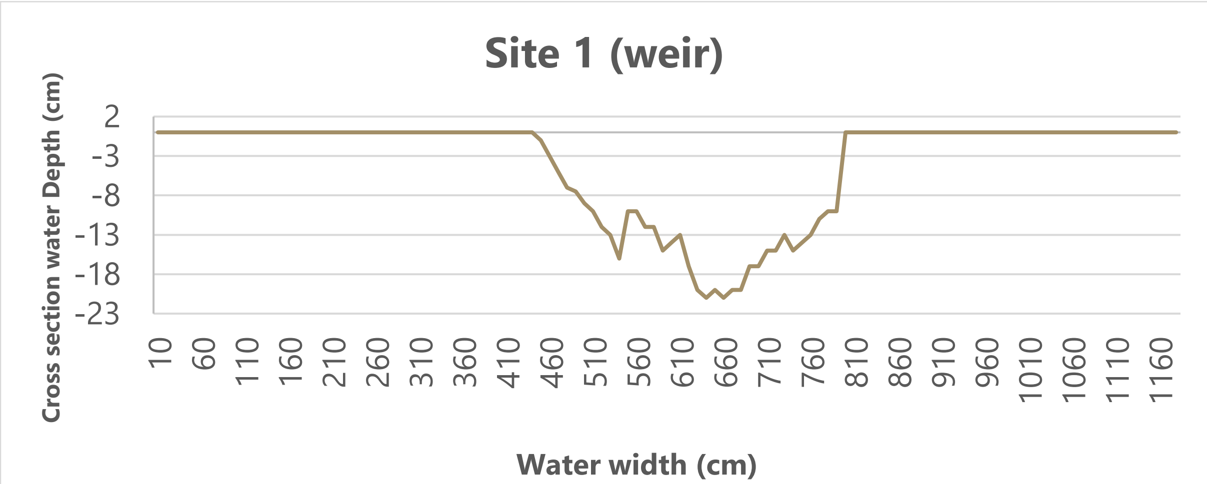
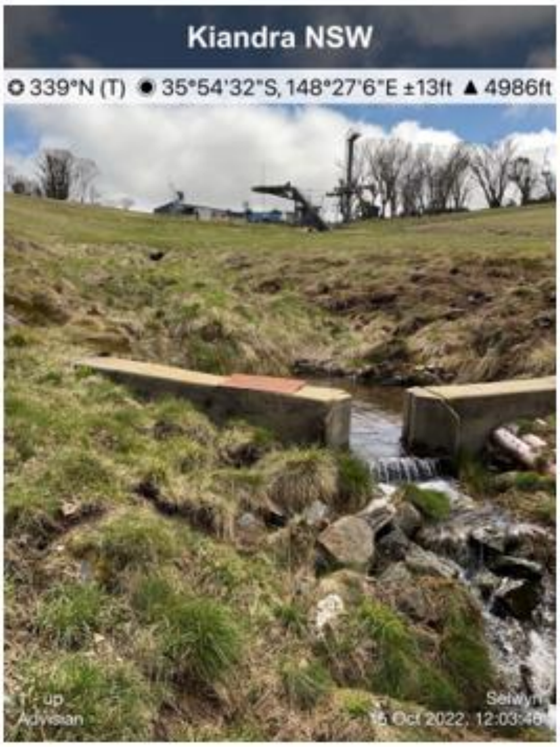


Figure 6-1 Site 1 present stream water depth cross section profile (15 October 2022) (banks not shown).



View upstream

View downstream

Site 2

Table 6-2 Site 2 (Discharge option # 1) information.

Project Name		Selwyn
Season		Snow season (September 2022)
Site		2
Date		16/09/2022
Time		13:00
Stream Type		Run
GPS Coordinates		-35.908993, 148.451573
Elevation (m above sea level)		1521.78
Notes		Proposed Discharge Location 1. Just downstream of the potable extraction weird. Flow logger 1 (File name = Selwyn SP2) installed. L and R when facing downstream. Very fast flowing on both sampling days. Site covered in tussock grasses. Multiple streams flowing underneath the grasses that could not be surveyed.
Substrate (%)	Bedrock	0
	Boulder (>256mm)	0
	Cobble (64-256mm)	10
	Pebble (16-64mm)	20
	Gravel	70
	Sand (2-16mm)	0
	Fines (0-2mm)	0
Waterway profile (m)	Bank full stream width	3.6
	Baseflow stream width (m)	1.4
	Baseflow maximum water depth (m)	0.14
	L Bank Height (m)	0.6
	L Bank Width (m)	1.2
	R Bank Height (m)	0.4
	L Bank Width (m)	1

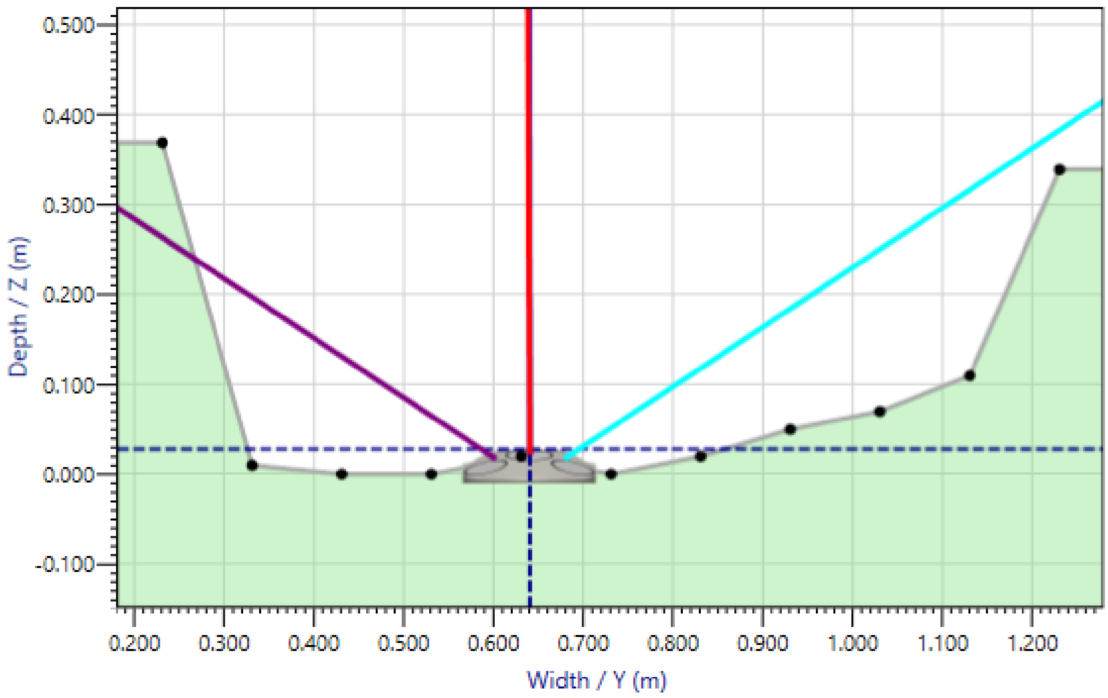


Figure 6-2 Site 2 stream water depth cross section profile (16 September 2022).

Flow logger and view downstream

Flow logger and view immediately upstream

Figure 6-3 Site 2 images (16 September 2022).

Site 3

Table 6-3 Site 3 information.

Project Name		Selwyn
Season		Snow season (September 2022)
Site		4
Date		17/09/2022
Time		12:24
Stream Type		Riffle
GPS Coordinates		-35.909892, 148.452717
Elevation (m above sea level)		1516.99
Notes		L and R when facing downstream. Covered in tussock grass and very wide. A lot of water flowing under grasses that could not be measured in stream width. Riparian zone is snow gums, mosses and ferns.
Substrate (%)	Bedrock	10
	Boulder (>256mm)	0
	Cobble (64-256mm)	20
	Pebble (16-64mm)	0
	Gravel	50
	Sand (2-16mm)	10
	Fines (0-2mm)	10
Waterway profile (m)	Bank full stream width	12.5
	Baseflow stream width (m)	12.3
	Baseflow maximum water depth (m)	0.13
	L Bank Height (m)	0.35
	L Bank Width (m)	0.1
	R Bank Height (m)	0.2
	L Bank Width (m)	0.1

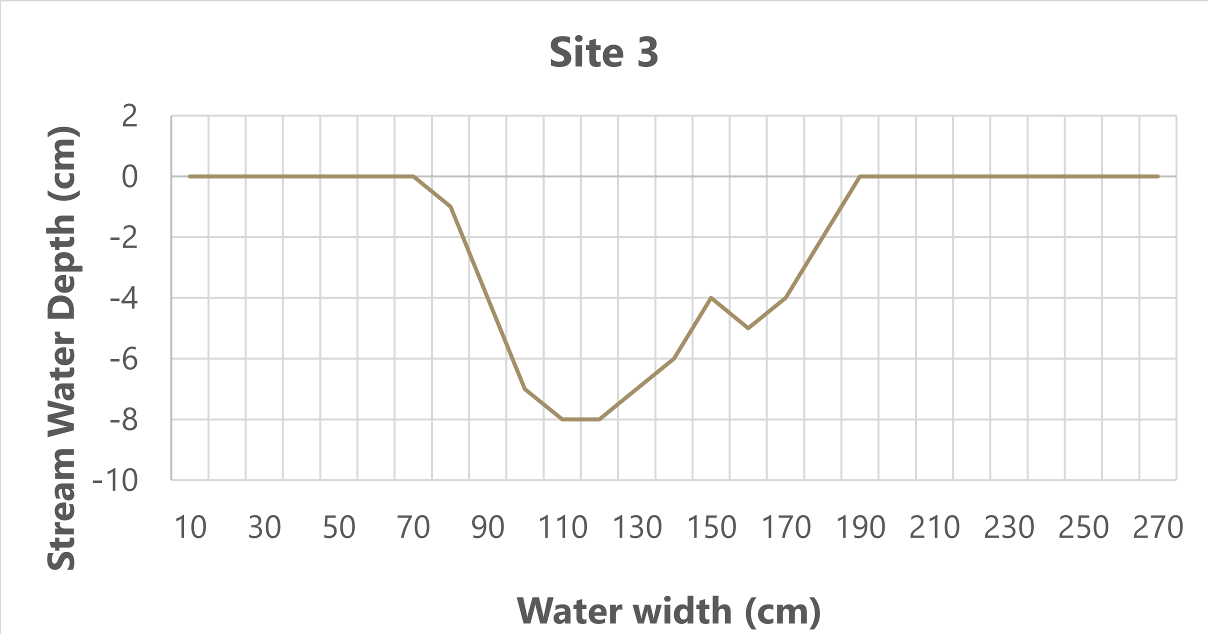


Figure 6-4 Site 3 stream water depth cross section profile (16 September 2022) (banks not shown).

Stream cross section area

View upstream

View downstream

Figure 6-5 Site 3 images (16 September 2022).

Site 4

Table 6-4 Site 4 information.

Project Name		Selwyn
Season		Snow season (September 2022)
Site		4
Date		16/09/2022
Time		12:41
Stream Type		Run
GPS Coordinates		-35.909396, 148.452299
Elevation (m above sea level)		1506.85
Notes		L and R when facing downstream. Site covered in tussock grasses and multiple streams underneath flowing underneath grasses - only mainstream is surveyed.
Substrate (%)	Bedrock	10
	Boulder (>256mm)	0
	Cobble (64-256mm)	0
	Pebble (16-64mm)	10
	Gravel	40
	Sand (2-16mm)	20
	Fines (0-2mm)	20
Waterway profile (m)	Bank full stream width (m)	4.5
	Baseflow stream width (m)	3.95
	Baseflow maximum water depth (m)	0.08
	L Bank Height (m)	0.4
	L Bank Width (m)	0.4
	R Bank Height (m)	0.5
	L Bank Width (m)	0.15

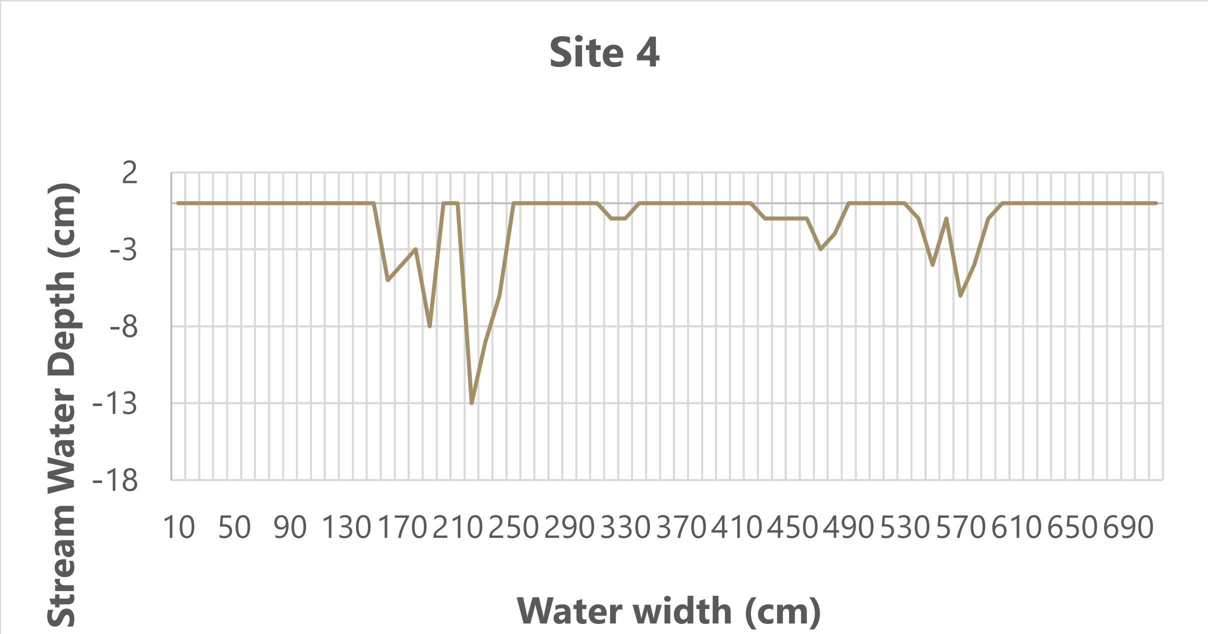


Figure 6-6 Site 4 stream water depth cross section profile (16 September 2022) (banks not shown).

Stream cross section area

View upstream View downstream

Figure 6-7 Site 4 images (16 September 2022).

Site 5

Table 6-5 Site 5 information.

Project Name		Selwyn
Season		Snow season (September 2022)
Site		5
Date		17/09/2022
Time		12:11
Stream Type		Run
GPS Coordinates		-35.910417, 148.453322
Elevation (m above sea level)		1500.14
Notes		L and R when facing downstream. Very fast flows, flowing into a pool. A lot of fallen trees between sites 4 &5, inaccessible.
Substrate (%)	Bedrock	10
	Boulder (>256mm)	10
	Cobble (64-256mm)	10
	Pebble (16-64mm)	20
	Gravel	30
	Sand (2-16mm)	0
	Fines (0-2mm)	10
Waterway profile (m)	Bank full stream width (m)	7.5
	Baseflow stream width (m)	7.05
	Baseflow maximum water depth (m)	0.26
	L Bank Height (m)	0.4
	L Bank Width (m)	0.2
	R Bank Height (m)	0.65
	L Bank Width (m)	0.25

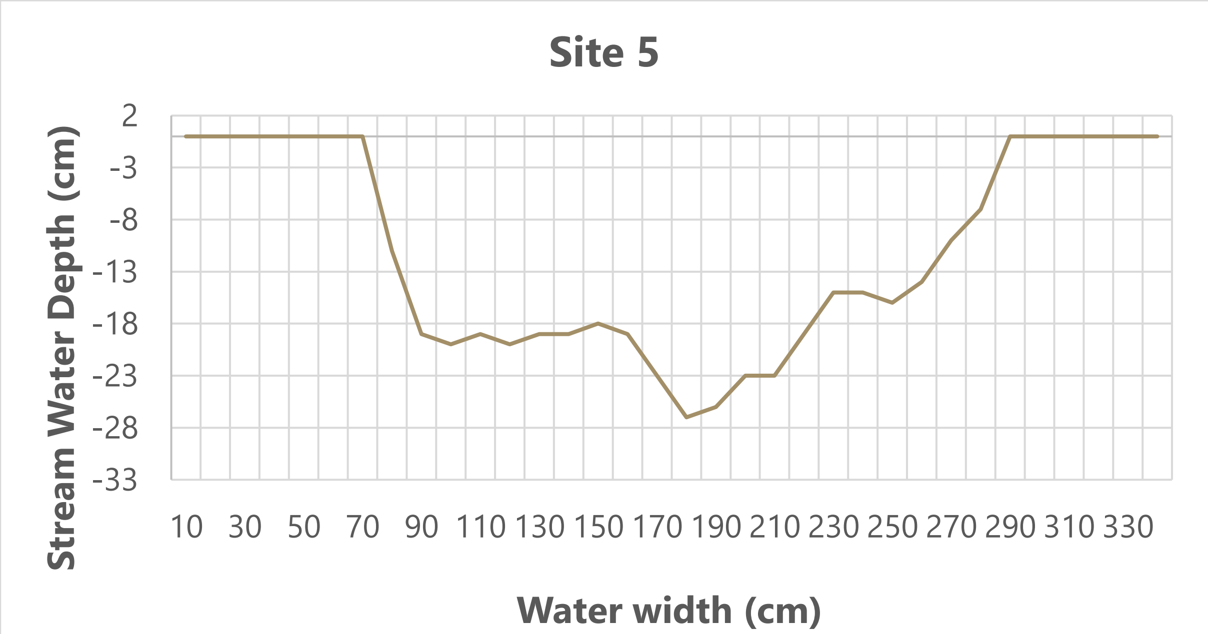


Figure 6-8 Site 5 stream water depth cross section profile (16 September 2022) (banks not shown).

Stream cross section area

View upstream

View downstream

Figure 6-9 Site 5 images (16 September 2022).

Site 6

Table 6-6 Site 6 (Discharge option # 2) information.

Project Name		Selwyn
Season		Snow season (September 2022)
Site		6
Date		16/09/2022
Time		15:51
Stream Type		pool
GPS Coordinates		-35.91086, 148.45419
Elevation (m above sea level)		1486.42
Notes		Flow logger 2 (File name = Selwyn2) installed - not possible to install at proposed discharge location. L and R when facing downstream. Just upstream of snow making extraction point. Snow making extraction waters will need be to be considered in the modelling study
Substrate (%)	Bedrock	0
	Boulder (>256mm)	5
	Cobble (64-256mm)	20
	Pebble (16-64mm)	50
	Gravel	25
	Sand (2-16mm)	0
	Fines (0-2mm)	0
Waterway profile (m)	Bank full stream width (m)	1.2
	Baseflow stream width (m)	0.84
	Baseflow maximum water depth (m)	0.27
	L Bank Height (m)	0.45
	L Bank Width (m)	0.16
	R Bank Height (m)	0.45
	L Bank Width (m)	0.2

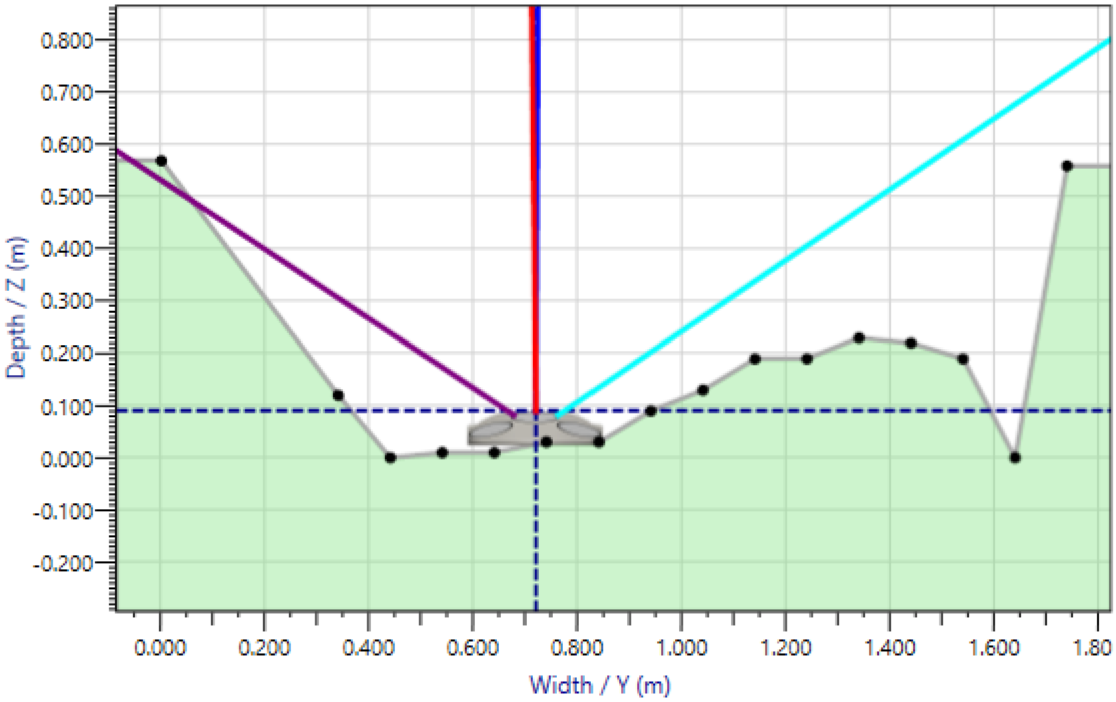


Figure 6-10 Site 6 stream water depth cross section profile (16 September 2022).

View upstream

View downstream

Figure 6-11 Site 6 images (16 September 2022).

Site 7

Table 6-7 Site 7 information.

Project Name		Selwyn
Season		Snow season (September 2022)
Site		7
Date		17/09/2022
Time		11:01
Stream Type		Riffle/pool
GPS Coordinates		-35.911054, 148.454328
Elevation (m above sea level)		1485.81
Notes		L and R when facing downstream. Proposed discharge location 2. Just downstream of snow making extraction point.
Substrate (%)	Bedrock	0
	Boulder (>256mm)	0
	Cobble (64-256mm)	15
	Pebble (16-64mm)	80
	Gravel	0
	Sand (2-16mm)	5
	Fines (0-2mm)	0
Waterway profile (m)	Bank full stream width (m)	1.1
	Baseflow stream width (m)	0.99
	Baseflow maximum water depth (m)	0.29
	L Bank Height (m)	0.5
	L Bank Width (m)	0.08
	R Bank Height (m)	0.5
	L Bank Width (m)	0.03

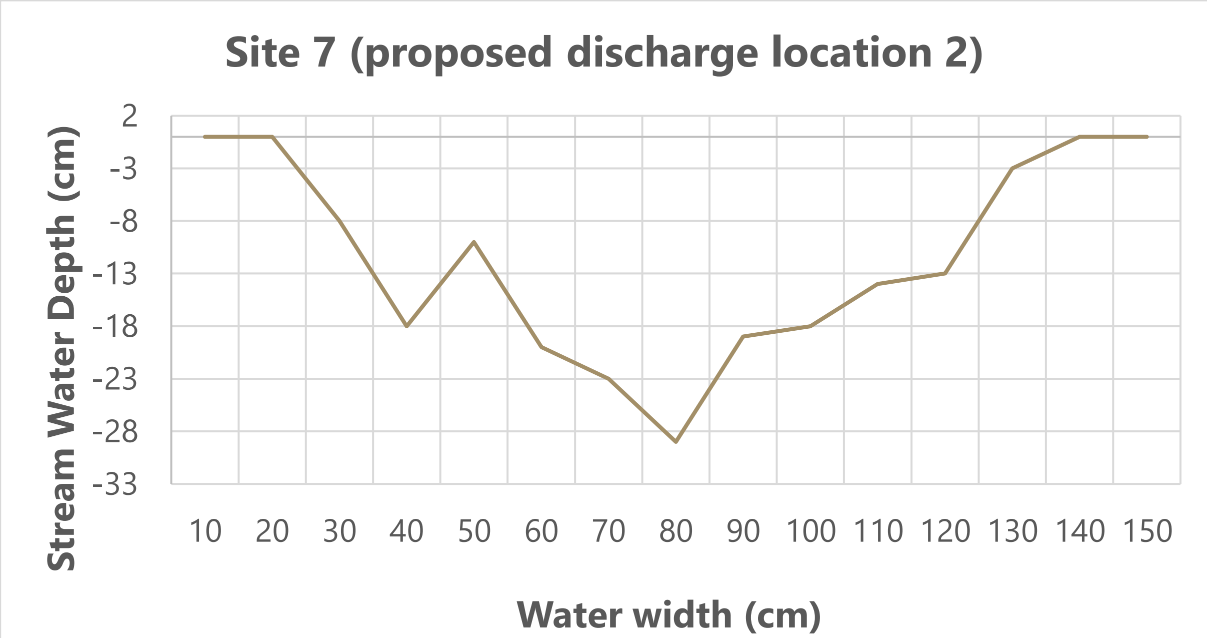


Figure 6-12 Site 7 stream water depth cross section profile (16 September 2022) (banks not shown).

View upstream

View downstream

Logger location and cross section area

Figure 6-13 Site 7 images (16 September 2022).

Site 8

Table 6-8 Site 8 information.

Project Name		Selwyn
Season		Snow season (September 2022)
Site		8
Date		17/09/2022
Time		11:04
Stream Type		Run
GPS Coordinates		-35.911155, 148.454768
Elevation (m above sea level)		1484.9
Notes		L and R when facing downstream. Very fast flowing. Survey is of main stream. Lots of tussock grasses and multiple other streams that could not be surveyed. Downstream of snow making extraction point.
Substrate (%)	Bedrock	0
	Boulder (>256mm)	0
	Cobble (64-256mm)	10
	Pebble (16-64mm)	0
	Gravel	80
	Sand (2-16mm)	0
	Fines (0-2mm)	10
Waterway profile (m)	Bank full stream width (m)	7
	Baseflow stream width (m)	6.2
	Baseflow maximum water depth (m)	0.17
	L Bank Height (m)	0.4
	L Bank Width (m)	0.4
	R Bank Height (m)	0.4
	L Bank Width (m)	0.4

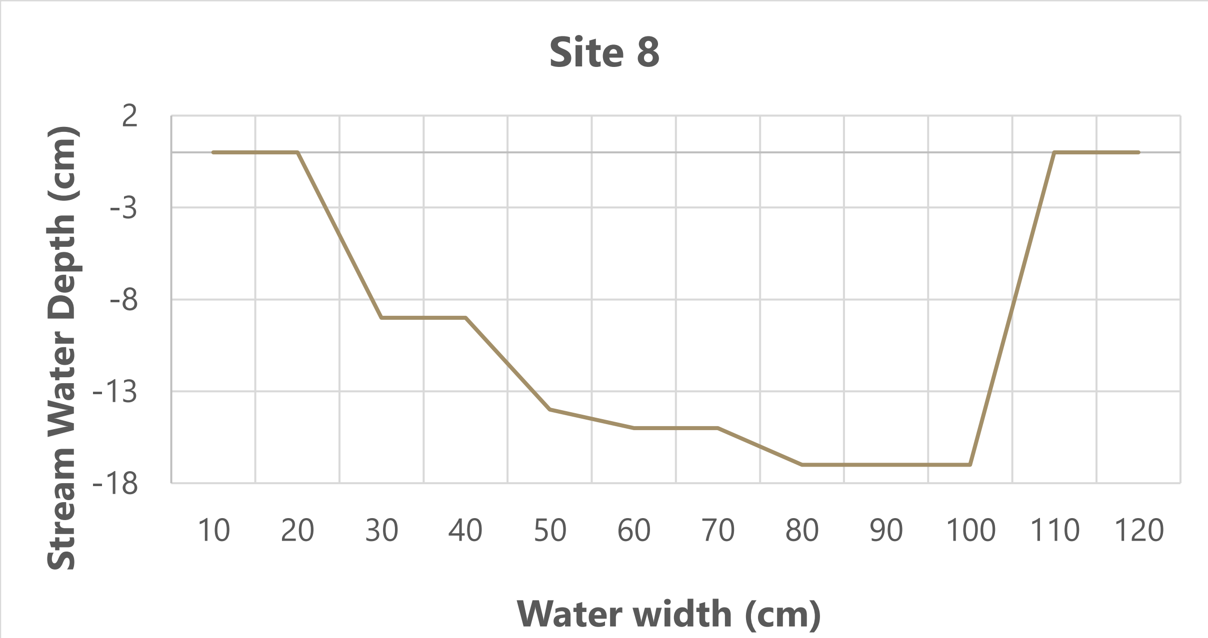


Figure 6-14 Site 8 stream water depth cross section profile (16 September 2022) (banks not shown).

Cross section area

View upstream

View downstream

Figure 6-15 Site 8 images (16 September 2022).

Site 9

Table 6-9 Site 9 information.

Project Name		Selwyn
Season		Snow season (September 2022)
Site		9
Date		17/09/2022
Time		11:12
Stream Type		Run
GPS Coordinates		-35.91097, 148.455353
Elevation (m above sea level)		1479.11
Notes		L and R when facing downstream. Lots of ferns and very fast flow. Downstream of snow making extraction point.
Substrate (%)	Bedrock	10
	Boulder (>256mm)	0
	Cobble (64-256mm)	20
	Pebble (16-64mm)	10
	Gravel	50
	Sand (2-16mm)	0
	Fines (0-2mm)	10
Waterway profile (m)	Bank full stream width (m)	2.8
	Baseflow stream width (m)	1.7
	Baseflow maximum water depth (m)	0.15
	L Bank Height (m)	0.6
	L Bank Width (m)	0.4
	R Bank Height (m)	0.7
	L Bank Width (m)	0.7

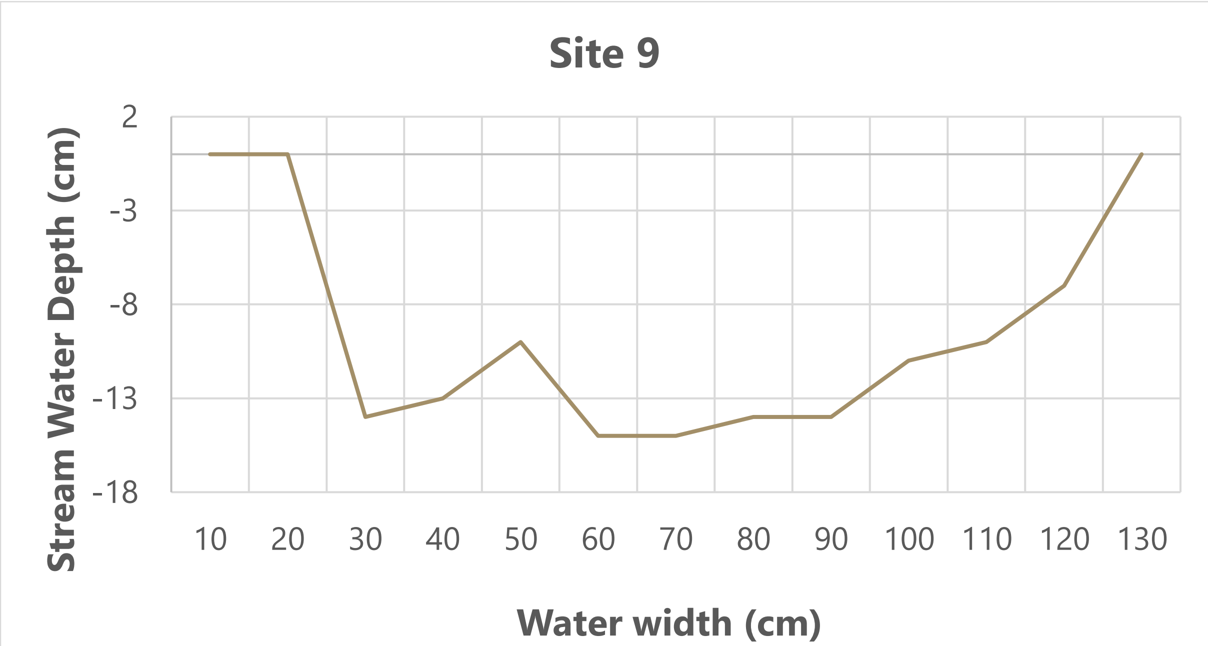


Figure 6-16 Site 9 stream water depth cross section profile (16 September 2022) (banks not shown).

Stream cross section area

View upstream View downstream

Figure 6-17 Site 9 images (16 September 2022).

Site 10

Table 6-10 Site 10 information.

Project Name		Selwyn
Season		Snow season (September 2022)
Site		10
Date		17/09/2022
Time		11:24
Stream Type		Pool
GPS Coordinates		-35.911131, 148.455972
Elevation (m above sea level)		1476.06
Notes		L and R when facing downstream. Profile is just before a cascade. Downstream of snow making extraction point. River is covered in tussocks.
Substrate (%)	Bedrock	0
	Boulder (>256mm)	5
	Cobble (64-256mm)	30
	Pebble (16-64mm)	30
	Gravel	0
	Sand (2-16mm)	30
	Fines (0-2mm)	5
Waterway profile (m)	Bank full stream width (m)	3.2
	Baseflow stream width (m)	2.7
	Baseflow maximum water depth (m)	0.64
	L Bank Height (m)	0.8
	L Bank Width (m)	0.25
	R Bank Height (m)	0.8
	L Bank Width (m)	0.25

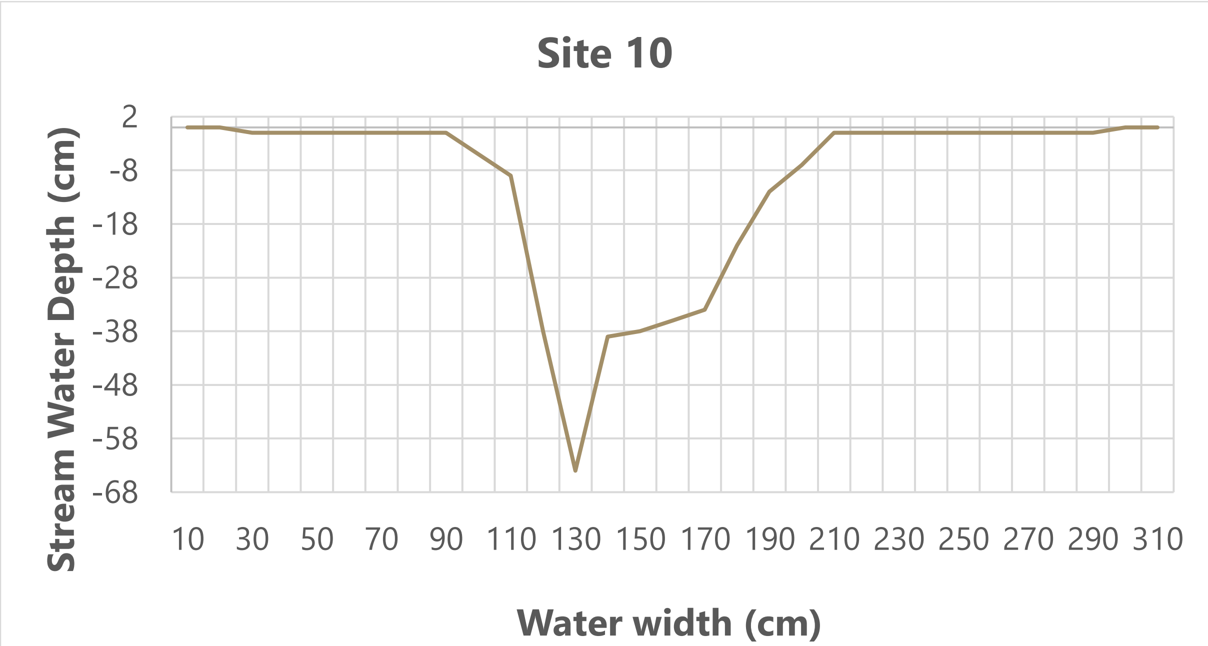


Figure 6-18 Site 10 stream water depth cross section profile (16 September 2022) (banks not shown)

Cross section area

View downstream

View downstream

Figure 6-19 Site 10 images (16 September 2022).

Site 11

Table 6-11 Site 11 information.

Project Name		Selwyn
Season		Snow season (September 2022)
Site		11
Date		17/09/2022
Time		11:38
Stream Type		pool
GPS Coordinates		-35.911508, 148.456288
Elevation (m above sea level)		1475.15
Notes		L and R when facing downstream. Downstream of snow making extraction point. Heavy snow at time of sampling.
Substrate (%)	Bedrock	0
	Boulder (>256mm)	0
	Cobble (64-256mm)	0
	Pebble (16-64mm)	0
	Gravel	80
	Sand (2-16mm)	10
	Fines (0-2mm)	10
Waterway profile (m)	Bank full stream width (m)	4.4
	Baseflow stream width (m)	2.8
	Baseflow maximum water depth (m)	0.33
	L Bank Height (m)	1
	L Bank Width (m)	0.4
	R Bank Height (m)	1
	L Bank Width (m)	1.2

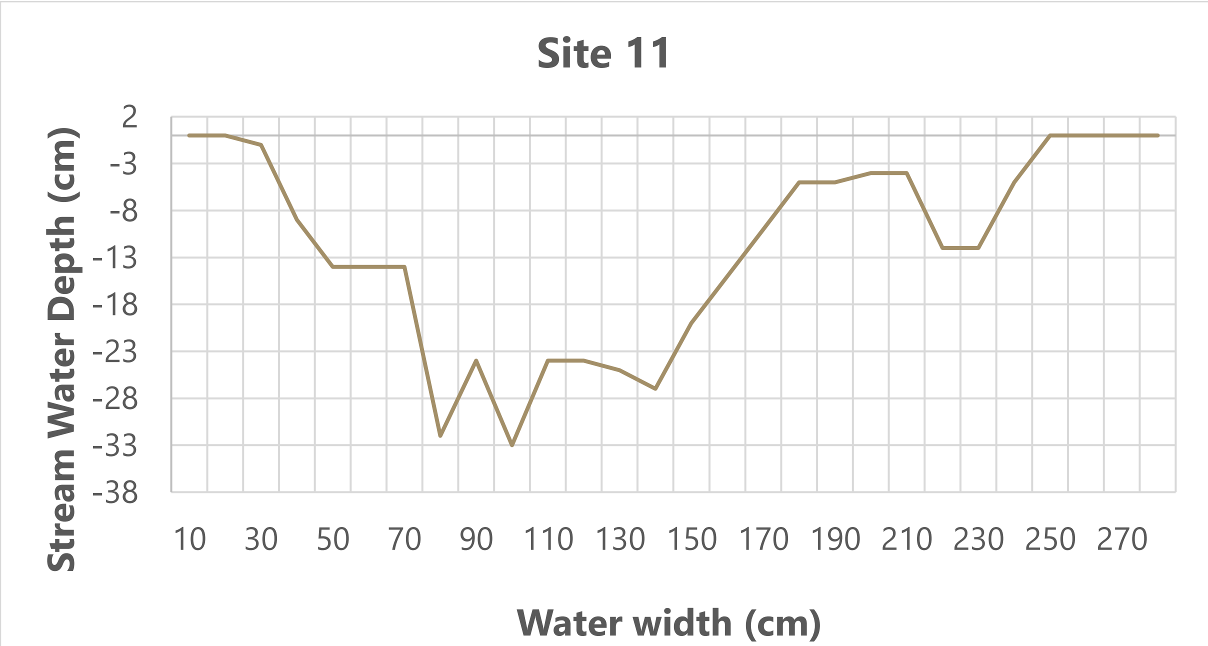


Figure 6-20 Site 11 stream water depth cross section profile (16 September 2022) (bank not shown).

Stream cross section area

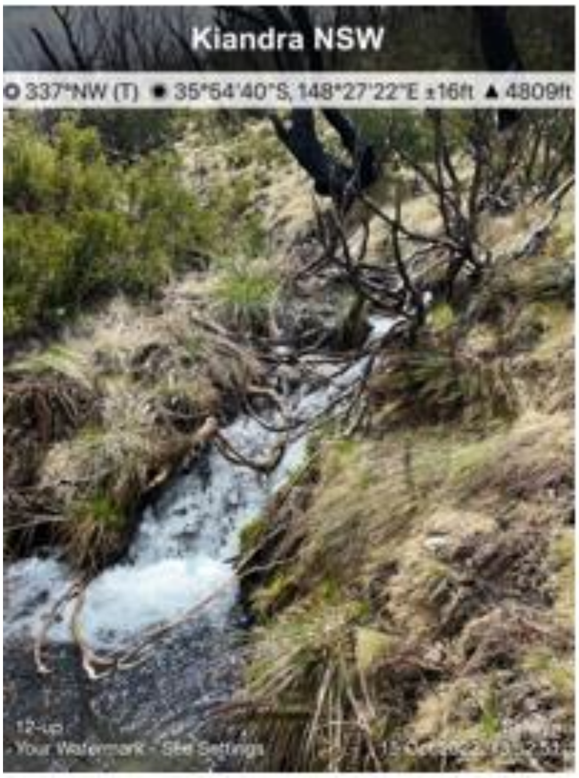

View upstream View downstream

Figure 6-21 Site 11 photos (16 September 2022).

Site 12

Table 6-12 Site 12 information.

Project Name		Selwyn
Season		Snow season (October 2022)
Site		12
Date		15/10/2022
Time		14:00
Stream Type		run
GPS Coordinates		-35.91184, 148.456431
Elevation (m above sea level)		1464.48
Notes		L and R when facing downstream. Most SE site - very challenging to survey further downstream due to site constraints.
Substrate (%)	Bedrock	0
	Boulder (>256mm)	0
	Cobble (64-256mm)	0
	Pebble (16-64mm)	20
	Gravel	60
	Sand (2-16mm)	20
	Fines (0-2mm)	0
Waterway profile (m)	Bank full stream width (m)	4.9
	Baseflow stream width (m)	3.8
	Baseflow maximum water depth (m)	0.3
	L Bank Height (m)	0.5
	L Bank Width (m)	0.5
	R Bank Height (m)	0.6
	L Bank Width (m)	0.6



View upstream View downstream

Figure 6-22 Site 12 photos (15 October 2022).

Appendix D
Continuous Flow Monitoring Data

Continuous flow monitoring data is saved in the excel object below:

Microsoft Excel
Worksheet