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# Mount Buller Water Storage Project: Hydrological and Ecological Monitoring and Adaptive Management Program - Impact Year 4

30 October 2023

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## EXECUTIVE SUMMARY

### Background

From October 2019 to May 2020, the Mount Buller and Mount Stirling Alpine Resort Management Board (the RMB) constructed a 100-megalitre off-stream water storage and ancillary infrastructure (the project) on Mount Buller, within a 10.347-hectare Project Construction Footprint (PCF) between the summit and the Mount Buller Village. As part of the project, the RMB is implementing an ongoing Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP), with an objective of maintaining the extent and condition of Alpine Bogs that are within the Boggy Creek catchment, downslope of the water storage.

Two years of baseline hydrological and ecological monitoring data (Baseline Years 1 and 2 or BY1 and BY2) were collected as part of the HEMAMP in 2018 and 2019. This was followed by hydrological and ecological monitoring during construction in 2020 (Impact Year 1 or IY1) and post-construction ecological monitoring in 2021, 2022 and 2023 (Impact Years 2, 3 and 4 or IY2, IY3 and IY4). This report summarises the results of hydrological and ecological monitoring from Impact Year 4, compares the results with baseline data and provides an assessment of these results against the HEMAMP's performance criteria and ecological triggers for adaptive management.

### Performance Criteria

The HEMAMP's performance criteria are as follows:

- The 'extent' criterion – there will be no more than a 10% reduction in the total combined area of the impact sites, determined by on-ground or remote (aerial) monitoring and taking into account natural variation based on extent observations averaged across control sites.
- The 'composition' criterion – there will be no more than a 10% reduction in the total 'bog-dependent' native flora species richness of the impact sites, taking into account natural variation based on species richness observations averaged across control sites.
- The 'encroachment' criteria:
  1. Atypical species – there will be no more than a 10% increase in the cover of 'non-bog-dependent' species within the impact sites, taking into account natural variation based on observations averaged across control sites.
  2. Weeds – the total cover of weeds (naturalised exotic flora species) within the impact sites will not exceed 5%.
- The 'structure' criterion – there will be no more than a 10% reduction in the average cover of Peat Moss *Sphagnum* spp. within the impact sites, taking into account natural variation based on Peat Moss cover averaged across control sites.

Performance criteria are expressed in terms of all impact sites collectively, relative to all control sites collectively. All impact sites are at Mount Buller and are at least partially within the catchment area of the water storage. Control sites are split between Mount Buller (outside of the catchment area of the water storage) and Mount Stirling (approximately 6 kilometres north-east of Mount Buller). Mount Buller and Mount Stirling control sites have been analysed collectively and separately to better understand the potential causes of differences between impact sites and control sites.

## Adaptive Management Triggers

The HEMAMP's ecological triggers for adaptive management are related to the above performance criteria. Hydrological triggers have been set with reference to hydrological models for the Boggy Creek catchment, which are designed to provide an early warning system for pre-empting ecological change at the impact sites. The adaptive management trigger thresholds follow a 'traffic light' approach, where the level of management intervention is escalated as the risk of adverse impacts on the ecological values of the impact sites increases. Risks of adverse impacts increase as trigger levels move from green, to amber, to red.

Trigger	Parameter	'Green' Threshold	'Amber' Threshold	'Red' Threshold
<b>Alpine Bog Extent</b>	Reduction in area of Alpine Bogs at impact sites relative to control sites.	≤5%	>5% but ≤10%	>10%
<b>Alpine Bog Composition</b>	Reduction in bog-dependent species richness at impact sites relative to control sites.	≤5%	>5% but ≤10%	>10%
<b>Encroachment by Atypical Species</b>	Increase in cover of non-bog-dependent native flora at impact sites relative to control sites.	≤5%	>5% but ≤10%	>10%
<b>Encroachment by Weeds</b>	Increase in cover of weeds at impact sites.	≤2.5%	>2.5% but ≤5%	>5%
<b>Alpine Bog Structure</b>	Reduction in cover of Peat Moss at impact sites relative to control sites.	≤5%	>5% but ≤10%	>10%
<b>Surface Water Flows</b>	Reduction in mean annual surface water flows to Boggy Creek over two consecutive years, relative to model.	<10%	>10% but ≤50%	>50%
<b>Groundwater Levels</b>	Reduction in mean annual groundwater levels over two consecutive years, relative to model.	≤10%	>10% but ≤50%	>50%
<b>Surface Water Quality</b>	Change in various surface water quality parameters, relative to baseline.	<1.5 x IQR*	≥1.5 x IQR* and ≤3 x IQR*	>3 x IQR*

Trigger	Parameter	'Green' Threshold	'Amber' Threshold	'Red' Threshold
Groundwater Quality	Change in various groundwater quality parameters, relative to baseline.	<1.5 x IQR*	≥1.5 x IQR* and ≤3 x IQR*	>3 x IQR*

\*IQR = Interquartile Range

Alpine Bog Extent

Comparison	IY4 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	-6.6%	Yes	Yes	The true relative reduction in the area of impact sites is likely to be closer to -0.4%. Various factors, including the RMB's deer control works, are likely to have disproportionately benefited Mount Stirling control sites. Continued sediment/weed control and revegetation needed at impact sites.
Mount Buller Impact Sites v Mount Buller Control Sites	-0.4%	Yes	Yes	

Alpine Bog Composition

Comparison	IY4 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	0%	Yes	Yes	Silver Astelia was incidentally observed at impact sites again in IY4 (the first observation since IY1), although not along transects or in quadrats. Propagation of Silver Astelia commenced in 2023 (10 pups and approx. 120 seeds) with the aim of re-introducing the species in 2024 to areas of impact sites where it has previously been recorded.
Mount Buller Impact Sites v Mount Buller Control Sites	+4.8%	Yes	Yes	

Encroachment by Atypical Species

Comparison	IY4 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	+3.0%	Yes	No	No intervention required. Continue monitoring in IY5.
Mount Buller Impact Sites v Mount Buller Control Sites	-1.9%	Yes	No	

Encroachment by Weeds

Comparison	IY4 Result	Compliant?	Action Req'd?	Comments
Not applicable	7.8%	No	Yes	Weed cover was already non-compliant (5.4% and 6.3%) in baseline monitoring years. Intensive weed control was undertaken during and after IY3 monitoring, resulting in a 1.0% reduction in weed cover in IY4. Similar effort is needed in future years to bring weed cover to 5% or less.

Alpine Bog Structure

Comparison	IY4 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	+1.8%	Yes	No	No intervention required. Continue monitoring in IY5.
Mount Buller Impact Sites v Mount Buller Control Sites	+21.5%	Yes	No	

Surface Water Flows

No results are available for IY3 and IY4. It is a recommended action that the RMB monitor the Environmental Watering System (EWS) sump and redistribution network for the next 12 months. Triggers, and appropriate management responses for each level of risk would then be established based upon these monitoring results.

Comparison*	IY3 Result	IY4 Result	Action Req'd?	Comments
Boggy Creek Weir 1 Pickup 2 v Modelled Surface Water Flows	Unknown	Unknown	Yes	No surface water datasets were collected in IY3, meaning a comparison with modelled surface water flows was not possible. An incomplete surface water flow dataset was available for IY4. Known surface water flows in IY4 were slightly above expected flows, given the climatological conditions that were experienced. Goulburn Valley Water will be engaged to gather a complete surface water dataset for IY5.
Boggy Creek Weir 2 v Modelled Surface Water Flows	Unknown	Unknown	Yes	

\*As outlined in the HEMAMP protocol, no reliable comparison is currently possible between Boggy Creek Weir 1 Pickup 1 and modelled surface water flows, so it has been excluded from this table.

### Groundwater Levels

A hydrological model was created for comparison to recorded groundwater levels as described in the HEMAMP protocol. GHD did not contribute to the development of the hydrological model and has not reviewed or verified the model.

The recorded mean annual groundwater level for all bores in 2021 was approximately 2% higher than the annual mean predicted by the model. In contrast, the recorded mean annual groundwater level for all bores in 2022 was approximately 46% lower than the annual mean predicted by the model.

Comparison	IY3 Result	IY4 Result	Action Req'd?	Comments
All boreholes v Modelled Groundwater Levels	+2%	-46%	No	Groundwater levels did not depart considerably from expected levels in IY3 or IY4. Monitoring must continue but no further intervention is needed.

### Surface Water Quality

The concentrations of most parameters are very low, particularly for major ions (i.e. typically < Limit of Reporting (LOR) or <2 mg/L). Some parameters are therefore particularly sensitive to the Interquartile Range (IQR) as a measure for adaptive management.

The results for IY4 were predominantly within the green threshold range and therefore no adaptive management is triggered at this time. Chloride and sulfate concentrations were detected above the red threshold in April 2023, yet across the three monitoring events these were predominantly within the green threshold. Chloride and sulfate should be monitored in IY5 for concentrations within the amber or red threshold range.

Parameter	IY4 Result	Action Req'd?	Comments
Electrical Conductivity	No outliers detected.	No	Most results were within the green threshold range of <1.5 x IQR. No intervention required. Continue monitoring in IY5.
Total Dissolved Solids	Minor outliers detected at Boggy 1 p/u 1 and Boggy 2.	No	
pH	No outliers detected.	No	
Nutrients	Minor outliers detected.	No	
Major Ions	Minor outliers detected for chloride, calcium, sodium, sulfate.	No	
Turbidity	One minor outlier detected.	No	
Suspended Solids	No outliers detected.	No	

## Groundwater Quality

A baseline IQR was calculated for all groundwater bores and compared to IY4 monitoring results for each bore. Where an outlier was identified, this was compared to the baseline IQR for the individual bore reporting the outlier. Most results were within the IQR for all bores.

BH06 is the only bore which reported outliers in IY4. Nitrate as N was  $>3 \times$  IQR at BH06 when compared to data from all bores, however, when compared to the IQR from BH06 alone Nitrate as N was  $<1.5 \times$  IQR (within the green threshold range).

Parameter	IY4 Result	Action Req'd?	Comments
Temperature	No outliers detected.	No	No intervention required. Continue monitoring in IY5.
pH	No outliers detected.	No	
Dissolved Oxygen	No outliers detected.	No	
Oxidation Reduction Potential	No outliers detected.	No	
Electrical Conductivity	No outliers detected.	No	
Total Dissolved Solids	One outlier in the red threshold range at BH06.	No	
Suspended Solids	No outliers detected.	No	
Turbidity	No outliers detected.	No	
Nutrients	Two outliers detected at BH06 for nitrate.	No	
Major Ions	One outlier detected at BH06 for calcium (in the amber range).	No	

## Conclusions

All recommendations from the IY3 ecological report were implemented during IY4. Ten further recommendations are outlined within the IY4 ecological report.

Ecological results in IY4 indicate a trigger for adaptive management in response to a reduction in bog extent ('amber' threshold) and increase in weed cover ('red' threshold). In response to these adaptive management triggers, intensive weed control commenced in IY3 and will continue to be undertaken to reverse the increase in weed cover that has been observed at impact sites since construction of the water storage.

Assessment of IY4 results against the baseline IQR for surface water and groundwater did not indicate a trigger for adaptive management. Minor, isolated exceedances were reported for some parameters; however, these were not consistently recorded across the three monitoring events.

Groundwater levels deviated from the climatological model prediction by 46% in IY4, however, showed almost no deviation (2%) in IY3. Adaptive management is not triggered currently. A comparison of year-on-year data reflected the outcome of the model comparison.

No notable change was observed in groundwater levels at most locations. However, two bores directly down-gradient of the water storage (BH09 and BH17) have shown a change in water level behaviour. The strong seasonal water level trend identified historically, has been replaced with a more stable water level, albeit with a slight reduction in water level highs (refer to the hydrographs in the hydrological report). In response to this result, these bores will continue to be monitored and agreed recommendations implemented.



Mount Buller Water Storage Project  
Hydrological and Ecological Monitoring and  
Adaptive Management Program  
Impact Year 4 Monitoring

FINAL REPORT

Prepared for Mount Buller and Mount Stirling Alpine Resort Management Board

19 July 2023

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## Document control

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- Michael Goddard, Jane Kenny, Nick Lloyd, Georgie Zacks and Sarah Hilliar and Sally Mitchell (fieldwork, data analysis and/or reporting)
- Sally Mitchell (mapping)
- Jane Kenny (quality assurance)

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## Summary

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### Background

From October 2019 to May 2020, the Mount Buller and Mount Stirling Alpine Resort Management Board (the RMB) constructed a 100-megalitre off-stream water storage and ancillary infrastructure (the project) on Mount Buller, within a 10.347-hectare Project Construction Footprint (PCF) between the summit and the Mount Buller Village. As part of the project, the RMB is implementing an ongoing Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP), with an objective of maintaining the extent and condition of Alpine Bogs that are downslope of the water storage.

Two years of baseline ecological monitoring data (Baseline Years 1 and 2 or BY1 and BY2) were collected as part of the HEMAMP in 2018 and 2019. This was followed by ecological monitoring during construction in 2020 (Impact Year 1 or IY1) and post-construction ecological monitoring in 2021, 2022 and 2023 (Impact Years 2, 3 and 4 or IY2, IY3 and IY4). This report summarises the results of ecological monitoring from Impact Year 4, compares the results with baseline data and provides an assessment of these results against the HEMAMP's performance criteria and ecological triggers for adaptive management.

The HEMAMP's performance criteria are as follows:

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- The 'composition' criterion – there will be no more than a 10% reduction in the total 'bog-dependent' native flora species richness of the impact sites, taking into account natural variation based on species richness observations averaged across control sites.
- The 'encroachment' criteria:
  - Atypical species – there will be no more than a 10% increase in the cover of 'non-bog-dependent' species within the impact sites, taking into account natural variation based on observations averaged across control sites.
  - Weeds – the total cover of weeds (naturalised exotic flora species) within the impact sites will not exceed 5%.
- The 'structure' criterion – there will be no more than a 10% reduction in the average cover of Peat Moss *Sphagnum* spp. within the impact sites, taking into account natural variation based on Peat Moss cover averaged across control sites.

The HEMAMP's ecological triggers for adaptive management are directly related to the above performance criteria.

Results

Alpine Bog Extent

Comparison	Threshold	IY4 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	-10.0%	-6.6%	Yes	Yes	True relative reduction in area of impact sites is likely to be closer to 0.4%. Various factors, including the RMB's deer control works, are likely to have disproportionately benefitted Mount Stirling control sites. Continued sediment/weed control and revegetation needed at impact sites.
Mount Buller Impact Sites v Mount Buller Control Sites	-10.0%	-0.4%	Yes	Yes	

Alpine Bog Composition

Comparison	Threshold	IY4 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	-10.0%	0%	Yes	Yes	Silver Astelia was incidentally observed at impact sites again in IY4 (the first observation since IY1), although not along transects or in quadrats. Propagation of Silver Astelia commenced in 2023 (10 pups and approx. 120 seeds) with the aim of re-introducing the species in 2024 to areas of impact sites where it has previously been recorded.
Mount Buller Impact Sites v Mount Buller Control Sites	-10.0%	+4.8%	Yes	Yes	

Encroachment by Atypical Species

Comparison	Threshold	IY4 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	+10.0%	+3.0%	Yes	No	No intervention required. Continue monitoring in IY5.
Mount Buller Impact Sites v Mount Buller Control Sites	+10.0%	-1.9%	Yes	No	

## Encroachment by Weeds

Comparison	Threshold	IY4 Result	Compliant?	Action Req'd?	Comments
Not applicable	5%	7.8%	No	Yes	Weed cover was already non-compliant (5.4% and 6.3%) in baseline monitoring years. Intensive weed control was undertaken during and after IY3 monitoring, resulting in a 1.0% reduction in weed cover in IY4. Similar effort is needed in future years to bring weed cover to 5% or less.

## Alpine Bog Structure

Comparison	Threshold	IY4 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	-10.0%	+1.8%	Yes	No	No intervention required. Continue monitoring in IY5.
Mount Buller Impact Sites v Mount Buller Control Sites	-10.0%	+21.5%	Yes	No	

\*Note to tables: The result for cover of weeds is expressed as an absolute percentage cover. All other results are expressed as a relative change from the Baseline Mean (BM) to Impact Year 4 (IY4).

## Conclusion and recommendations

The following observations and conclusions were made from Impact Year 4 ecological monitoring:

- There was an exceptional effort from the RMB to undertake management actions that were recommended in previous monitoring reports and/or required by the Ecological Rehabilitation Plan Addendum and associated management plans. Management actions included:
  - Installation and maintenance of more than 500 metres of sediment socks and 20 metres of sediment fence.
  - 336 hours of weed control at Mount Buller, 256 hours of weed control at Mount Stirling and removal of over 3 tonnes of weed material.
  - Culling of 40 Sambar Deer from the Mount Buller and Mount Stirling resorts.
  - Planting of 875 tubestock in the Alpine Bogs.
  - Collection of approximately 120 seeds and 10 vegetative samples of Silver Astelia for propagation and re-introduction to impact sites in 2024.
- The effort involved to implement the above management actions should be commended. However, some management actions, such as deer control, are likely to have disproportionately benefitted control sites, rather than impact sites. This must be considered when interpreting monitoring results, particularly in relation to bog extent.

- Benefits of the above management actions and those undertaken in IY3 are already apparent at impact sites. Bare ground attributed to sedimentation has declined from 3.4% in IY2 and 1.1% in IY3 to 0.0% in IY4, indicating that the RMB has successfully contained the movement of sediment into impact sites from the Project Construction Footprint (PCF). Total weed cover at impact sites has reduced from 8.8% in IY3 to 7.8% in IY4. This can be mainly attributed to results of the concerted and increased weed control effort at Bog 6 in IY3.
- While benefits from IY3 management actions are already apparent at impact sites, it is too soon for the full range of expected benefits from continued management actions undertaken in IY4 to be reflected in monitoring results at impact sites. As was the case in IY3, management actions mostly took place during or after IY4 monitoring. Continued improvements are expected to materialise in future monitoring years.

The recommendations of this monitoring report are as follows:

1. Despite positive trends being observed at impact sites, adaptive management actions should continue to be implemented at these sites (particularly at Bog 6) to reverse construction-related impacts.
2. Now that the unintentional bulk discharge of water upslope of Mount Buller's eastern control sites has ceased, ecological monitoring should be alert to a potential decline in the area of these sites and adapt analysis of results accordingly.
3. The RMB should investigate the small discharge of water that is still occurring from Baldy Turret pump house and, if possible, consider stopping this discharge so as not to affect monitoring results at Mount Buller's eastern control sites.
4. Dieback locations must continue to be re-visited in future years to investigate possible causes, to track vegetation recovery or succession and to plan any necessary management interventions e.g. revegetation.
5. The RMB should further investigate whether the environmental watering system meets the original design specifications (by comparing endoscope footage with final design drawings) and what volumes of water are being discharged from the water storage drainage system to the environmental watering system.
6. Additional survey effort should be undertaken in IY5 to identify and map any new Alpine Bog vegetation within the Boggy Creek catchment (upslope of Bog 13) and to re-visit Alpine Bogs that were newly identified and mapped in BY2 (so-called 'other sites'). This will provide a broader picture of how Alpine Bog vegetation in the Boggy Creek catchment is responding to construction of the water storage.
7. In IY4, the RMB was again successful in preventing further movement of sediment into impact sites. The RMB must continue to implement the Ecological Rehabilitation Plan (Biosis 2020a) and its Addendum (Biosis 2022a) to continue to prevent movement of sediment from the PCF into Alpine Bogs.
8. The HEMAMP Protocol should be updated to indicate that bog composition considers species recorded along transects and incidentally. The monitoring procedure should be updated to specify that if any given bog-dependent species is not recorded along transects in a given year, a more detailed and thorough search should be undertaken for the missing species before further action is taken.
9. Despite the concerted weed control effort of IY3 resulting in a noticeable improvement in weed cover at impact sites in IY4, weed covers still sit at the 'red' trigger level for adaptive management. In accordance with the HEMAMP Protocol, weed management actions and effort will need to be scaled up and intensified further in IY5.

10. Update the HEMAMP Protocol to change the weed cover threshold from 5% to the relative baseline mean for both impact and control sites. Weed control efforts should not be reduced and must be scaled up and intensified in IY5.

# 1. Introduction

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## 1.1 Project background

Alpine Bogs are groundwater dependent ecosystems with a scattered distribution in alpine, sub-alpine and montane environments across the Australian Alps (DEWHA 2009; FFG Act Scientific Advisory Committee 2013). They are generally characterised by the presence of Peat Moss *Sphagnum* spp. and are particularly susceptible to climate change, given that they have a fragmented distribution and are already at their environmental tolerance limit (DEWHA 2009; Macdonald 2009). Approximately 3 hectares of Alpine Bog are known to exist at Mount Buller.

Alpine Bogs are listed as threatened ecological communities under Commonwealth and State legislation. The Alpine Sphagnum Bogs and Associated Fens (ASBAF) ecological community is listed as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Alpine Bog Community is listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act). Throughout this document, the term 'Alpine Bogs' refers to both ASBAF and the Alpine Bog Community.

In October 2019, the Mount Buller and Mount Stirling Alpine Resort Management Board (the RMB) started construction of a 100-megalitre off-stream water storage and ancillary infrastructure (the project) on Mount Buller between the summit and the Mount Buller Village. Construction of the project finished in May 2020, although there is ongoing rehabilitation of the Project Construction Footprint (PCF) and areas of unauthorised disturbance outside the PCF. The RMB continues to implement agreed compliance tasks to manage the impacts of the unauthorised disturbance outside the PCF, in consultation with and under supervision of the Victorian Government Department of Energy, Environment and Climate Action (DEECA), Victorian Government Department of Transport and Planning (DTP) and the Australian Government Department of Climate Change, Environment, Energy and Water (DCCEEW). Note that until 2023, the responsibilities of DEECA and DTP came under the former Victorian Government Department of Environment, Land, Water and Planning (DELWP).

Most of the known Alpine Bog community at Mount Buller is located downslope of the PCF and the project has the potential to affect the hydrology of these Alpine Bogs (Biosis and GHD 2016). In accordance with approvals for the project (EPBC Act Approval 2014/7303 and Planning Permit PA1600138), the RMB is implementing a Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP), with the objective of maintaining the extent and condition of Alpine Bogs that are downslope of the proposed water storage (Biosis 2019). Those Alpine Bogs with catchment areas affected by the water storage are known as impact sites and are monitored annually as part of the HEMAMP. The annual monitoring also includes control sites, which are Alpine Bogs with catchment areas that are unaffected by the water storage.

The HEMAMP aims to meet the following performance criteria:

- The 'extent' criterion – there will be no more than a 10% reduction in the total combined area of the impact sites, determined by on-ground or remote (aerial) monitoring and taking into account natural variation based on extent observations averaged across control sites.
- The 'composition' criterion – there will be no more than a 10% reduction in the total 'bog-dependent' native flora species richness of the impact sites, taking into account natural variation based on species richness observations averaged across control sites.

- The 'encroachment' criteria:
  - Atypical species – there will be no more than a 10% increase in the cover of 'non-bog-dependent' species within the impact sites, taking into account natural variation based on observations averaged across control sites.
  - Weeds – the total cover of weeds (naturalised exotic flora species) within the impact sites will not exceed 5%.
- The 'structure' criterion – there will be no more than a 10% reduction in the average cover of Peat Moss within the impact sites, taking into account natural variation based on Peat Moss cover averaged across control sites.

## 1.2 Scope of this report

The HEMAMP is a monitoring and management regime for selected Alpine Bogs on Mount Buller and Mount Stirling (Figure 1). The methods for this monitoring and management regime are outlined in the HEMAMP Protocol (Biosis 2022b). The Protocol is regularly updated and improved in consultation with DEECA and DCCEEW.

Between 2014 and 2018, the RMB, assisted by Biosis Pty Ltd (Biosis) and GHD Pty Ltd (GHD), established climatological and hydrological monitoring infrastructure and commenced collecting climate, groundwater and surface water observations as part of the HEMAMP. In January and February 2018, the RMB commissioned Biosis to establish the HEMAMP's ecological monitoring components and collect the first year of baseline ecological monitoring data. In total, two years of baseline (pre-construction) monitoring were undertaken (Baseline Years 1 and 2 or BY1 and BY2), one year of monitoring was completed during construction (Impact Year 1 or IY1) and three years of post-construction monitoring have been completed (Impact Years 2, 3 and 4 or IY2, IY3 and IY4).

This monitoring report:

- Provides a summary of the ecological monitoring data collected in IY4.
- Compares ecological data collected in IY4 with the baseline data collected over BY1 and BY2.
- Provides an assessment of these results against the HEMAMP's performance criteria and ecological triggers for adaptive management.
- Recommends appropriate management actions.

Throughout this report, recommendations are highlighted in text boxes as shown below.

### Recommendations

All recommendations arising from IY4 monitoring are highlighted in this fashion throughout this monitoring report.

## 2. Methods

Monitoring methods followed the HEMAMP Protocol (Biosis 2022b), except where explicitly noted. Mount Buller and Mount Stirling monitoring sites are shown on Figure 2 and Figure 3 respectively.

### 2.1 Monitoring effort, frequency and timing

HEMAMP monitoring years run from the start of June (winter) to the end of May (autumn) each year. The ecological monitoring components of the HEMAMP were established in January and February 2018 (BY1). Since 2018, Biosis has conducted ecological monitoring, with assistance from the RMB, at six impact sites and seven control sites (Table 1). Each year, transect monitoring has been undertaken from late January until mid-February, while mapping has been undertaken from late January until mid-March (Table 2). The timing and completeness of the ecological datasets are further outlined in Appendix 1.

Slight differences in timing of ecological monitoring (particularly the monitoring end date) are generally associated with weather conditions and the need to maintain consistency in the quality of the data (e.g. mapping under clear skies to maximise spatial accuracy). Slight differences in the timing of ecological monitoring from year to year are unlikely to affect an assessment against the performance criteria or ecological triggers for adaptive management.

**Table 1 Annual ecological monitoring effort as part of the HEMAMP**

Monitoring effort	Impact sites	Control sites (Mt Buller: Mt Stirling)	Total
<b>Number of sites* (Alpine Bogs)</b>	6	7 (4 : 3)	13
<b>Number of transects</b>	24	23 (14 : 9)	47
<b>Average length of transect (m)</b>	18.5	21.6 (22.3 : 20.4)	20
<b>Number of point intersections (20-cm intervals)</b>	2196	2457 (1546 : 911)	4653
<b>Number of quadrats</b>	87	101 (64 : 37)	188
<b>Number of photo points</b>	48	46 (28 : 18)	94

\*Note: The data presented in this table relate to the sites at which line and belt transects have been established. Additional sites are mapped but not subject to monitoring with line and belt transects.

**Table 2** Timing of ecological monitoring

Monitoring year	Transect monitoring period	Mapping period
Baseline Year 1	26 Jan 2018 to 9 Feb 2018	26 Jan 2018 to 9 Feb 2018
Baseline Year 2	29 Jan 2019 to 14 Feb 2019	29 Jan 2019 to 23 Feb 2019
Impact Year 1	28 Jan 2020 to 20 Feb 2020	30 Jan 2020 to 14 Mar 2020
Impact Year 2	25 Jan 2021 to 4 Feb 2021	2 Feb 2021 to 26 Feb 2021
Impact Year 3	31 Jan 2022 to 9 Feb 2022	2 Feb 2022 to 22 Feb 2022
Impact Year 4	23 Jan 2023 to 2 Feb 2023	20 Feb 2023 to 28 Feb 2023

## 2.2 Monitoring parameters and data collection

The HEMAMP Protocol (Biosis 2022b) requires that the following ecological parameters are monitored annually:

- Bog extent
- Bog composition
- Encroachment by weeds and other atypical species
- Bog structure.

These parameters allow for the current extent and condition of the Alpine Bogs to be directly assessed against the performance criteria and triggers for adaptive management. Data relating to these ecological parameters are collected using established line transects, belt transects, photo points and on-ground mapping techniques. These data collection methods are outlined in detail in the Standard Operating Procedure (SOP) for ecological monitoring, which is appended to the HEMAMP Protocol (Biosis 2022b).

### 2.2.1 Bog extent

Bog extent refers to the area of the Alpine Bogs, which is calculated by mapping the boundary of each Alpine Bog on foot using a Differential Global Positioning System (DGPS). Until IY3, boundaries were mapped using a Samsung Galaxy Tab A6, which was paired with a Trimble R1 Global Navigation Satellite System (GNSS) receiver to provide DGPS functionality. From IY3 onwards, boundaries have been mapped using newer DGPS technology, consisting of a tablet or mobile phone paired with an Emlid Reach RS2 or RS+ GNSS receiver.

Ongoing improvements to DGPS technology have allowed for more accurate mapping over the past 5 years. In BY1 and BY2, mapping was to an accuracy of 3 metres or better in most instances, but accuracy was reduced to up to 5 metres in some areas with an overhanging tree canopy, particularly at Mount Stirling. In IY1 and IY2, improvements to DGPS technology (e.g. satellite availability and satellite-delivered correction services) allowed for sub-2-metre accuracy in most instances (especially at Mount Buller sites) and generally no worse than 3-metre accuracy (e.g. at Mount Stirling sites with overhanging tree canopies). In IY3 and IY4, use of the Emlid Reach RS2 and RS+ GNSS receivers allowed for access to a greater number of satellites and sub-metre accuracy at all locations. DGPS accuracy was generally at 1 centimetre, but up to 15 centimetres below tree canopies at Mount Buller and up to 70 centimetres below tree canopies at Mount Stirling.

In addition to mapping the boundaries of Alpine Bogs, further analysis of bog extent is undertaken using data collected from the permanent monitoring transects. The dimensions of the Alpine Bogs are estimated by determining the start and end of Alpine Bog vegetation along the transects. The edge of the Alpine Bog

vegetation is taken to be the point at which bog-dependent flora species richness is equal to non-bog-dependent flora species richness (similar to the on-ground boundary mapping, which records the boundary of the Alpine Bog at the point where bog-dependent flora transition from at least 50% of vegetative cover to less than 50% of vegetative cover). In addition, the transects allow for the cover and cause of bare ground to be analysed, which informs management actions (e.g. revegetation or pest animal control) that may be required to maintain bog extent.

### **2.2.2 Bog composition**

Bog composition refers to the species richness of bog-dependent flora, which is determined using line transects (point intersection sampling) and belt transects (quadrat sampling) in accordance with the SOP for ecological monitoring (Biosis 2022b). The list of bog-dependent species is provided in Appendix 2 of this report and in the HEMAMP Protocol (Biosis 2022b).

The IY2 monitoring report documented the difficulty in distinguishing between Mountain *Baeckea baeckea utilis* s.s. and Subalpine *Baeckea baeckea latifolia*, which are two bog-dependent species that co-occur at Mount Buller and Mount Stirling and that are suspected of hybridising or forming intermediates (Biosis 2021). It is assumed that where one of these species has been recorded, both species and their intermediates are likely to exist. For this reason, while efforts were still made in the field to distinguish the two species, their records have been amalgamated for the purposes of assessing bog composition, in accordance with the HEMAMP Protocol (Biosis 2022b).

In addition to bog-dependent species richness, line transects also provide an estimate of the cover of bog-dependent flora. This analysis provides an indication of underlying trends in bog composition and allows for pre-emptive management actions to be taken, if needed.

### **2.2.3 Encroachment by weeds and other atypical species**

Encroachment is assessed by estimating the cover of weeds and other atypical species, using line transects (point intersection sampling) in accordance with the SOP for ecological monitoring (Biosis 2022b).

It is important to note that weed cover is assessed as an absolute cover. This is unlike all other ecological monitoring parameters, which are assessed at impact sites relative to control sites. As noted in previous monitoring reports (e.g. Biosis 2019), weed cover is estimated across the entire length of the monitoring transects, not only within the Alpine Bogs themselves. The permanent monitoring transects were set up to pass through the Alpine Bogs, starting and ending 1.5-4 metres outside of the Alpine Bog boundary (when first established in BY1). This means that some weed cover may be attributable to areas immediately outside the Alpine Bogs.

In an effort to scale up weed management, the RMB and Biosis conducted some weed control concurrently with monitoring in IY3 and IY4. Where we encountered isolated occurrences of a weed species, these isolated plants were removed by hand and placed in plastic bags for solarisation and disposal, immediately after recording any required monitoring data (e.g. point intersection or quadrat results). Where relevant, these plants will have contributed to weed cover results in IY3 and IY4 but will not contribute to results in future years, assuming the immediate weed control actions have been effective. As always, a concerted effort was made to identify and map any novel weed species in the Alpine Bogs, whether encountered during mapping or transect monitoring.

### **2.2.4 Bog structure**

Bog structure refers to the total cover of Peat Moss, whether dead or alive. The proportion of Peat Moss recorded as dead is also analysed to provide an indication of underlying trends in bog structure and pre-empt management actions that may be required (e.g. to avert the future loss of Peat Moss). The cover of Peat Moss,

both alive and dead, is estimated using line transects (point intersection sampling) in accordance with the SOP for ecological monitoring (Biosis 2022b).

### 2.2.5 Other data collection considerations

In accordance with the SOP for ecological monitoring (Biosis 2022b), standardised photos were taken from the permanent photo points at the start and end of transects. These photos provide a visual documentation of gross vegetation changes, when compared with the same photos from previous monitoring years.

In addition, on-ground mapping provided an opportunity to inspect the full extent of the Alpine Bogs and to note any management issues that may not have been detected by transect monitoring (e.g. sedimentation, weed invasion or deer activity). Mapping data and notes from previous years were made available in the field for comparison, so that the cause of any changes could be investigated on the ground and past observations re-visited.

## 2.3 Data management

The following ecological datasets are being maintained for monitoring consistency and repeatability in future years:

- Herbarium of plant samples.
- An electronic data collection spreadsheet for transect monitoring.
- A spreadsheet of all observations from all transect monitoring conducted to date.
- Spatial dataset of Alpine Bog boundaries from each year, photo point locations and transect locations.
- Database of all photo points taken to date.
- A collection of on-ground observations (e.g. potential management issues) made while walking the Alpine Bog boundaries.

As required by the HEMAMP Protocol (Biosis 2022b), the electronic datasets are stored on the RMB's servers and on a third-party cloud-based backup.

## 2.4 Data analysis

The ecological monitoring program follows a 'Beyond BACI' (Before-After-Control-Impact) design and data analysis has been set up accordingly (Underwood 1992 and 1994). Linear Mixed-effects Models (LMMs) and Analysis of Variance (ANOVA) were used to test the statistical significance of the effect of the period (before/after) and treatment (control/impact) on a given response variable (e.g. area of Alpine Bogs or cover of weeds).

LMMs were fitted using the 'lme4' package in the R statistical and graphical environment (R Development Core Team 2023) using the Restricted Maximum Likelihood (REML) method. The models were in the following form:

$$\text{Response} \sim \text{Period} * \text{Site Class} + (1|\text{Year}) + (1|\text{Sample})$$

The various components of the models are explained as follows:

- Response:
  - The response variable is the ecological monitoring parameter of interest, such as the area of Alpine Bogs or cover of weeds, non-bog-dependent flora, bog-dependent flora or Peat Moss.
  - We are interested in detecting whether or not there has been a statistically significant change in the response variable at impact sites relative to control sites in the period after the impact commenced.
- Period and Site Class:
  - Period refers to the time before (i.e. BY1 and BY2) or after (i.e. IY1 and IY2) the potential impact commenced (i.e. before or after construction of the water storage started).
  - Site Class refers to the 'treatment' that the Alpine Bogs have received. The Alpine Bogs belong to one of two Site Classes – control sites or impact sites.
  - Period and Site Class are the fixed effects in the model. They are the BACI effect that we are monitoring.
  - Where relevant, a third fixed effect is added to the model to investigate differences between responses at Mount Buller and Mount Stirling. This fixed effect is known as Site, as opposed to Site Class.
- 1|Year and 1|Sample:
  - The model also includes Year (BY1, BY2, IY1 etc.) and Sample (Bog 1, Bog 2, Bog 4.1/5/7 etc.) as random effects (i.e. random temporal and spatial variables).
  - The Sample-to-Sample variation represents localised spatial variability within each Site Class (e.g. the variation between Bog 1 and Bog 2 represents some of the random effect within Control sites).
  - The Year-to-Year variation represents temporal variability that applies to all Samples, regardless of Site Class (i.e. the random temporal effect that applies equally to Control and Impact sites, causing the same fluctuations at both Site Classes from year-to-year).

We are interested in determining whether or not there is a statistically significant interaction between Period and Site Class (sometimes called a BA\*CI interaction or BACI contrast). If the coefficient for the BA\*CI interaction (i.e. the estimate of the BACI contrast) is statistically significant, it suggests that there is a significant difference in the response of control and impact sites to the impact. In other words, there is a statistically significant difference between the control and impact sites after the impact, compared with the control and impact sites before the impact.

The statistical significance of the BA\*CI interaction (BACI contrast) was determined by two-way ANOVA using Type III Sums of Squares and the Kenward-Roger approximation for Degrees of Freedom (DF). Estimated Marginal Means (EMMs) provided an estimate of the BACI contrast and an indication of the variability or Standard Error (SE) in the dataset.

Examining SE is important and requires an ecological understanding of the dataset. If ANOVA suggests that the BA\*CI interaction is not statistically significant, this may be because construction of the water storage has genuinely had no detectable effect on impact sites or it may be because the datasets are too variable (SE is too high) for an effect to be detectable.

Statistical tests were undertaken in the R statistical and graphical environment (R Development Core Team 2023) with a 5% statistical significance threshold ( $\alpha = 0.05$ ). LMMs were fitted and ANOVA conducted using the 'lmerTest' package, while EMMs were computed and analysed using the 'emmeans' package.

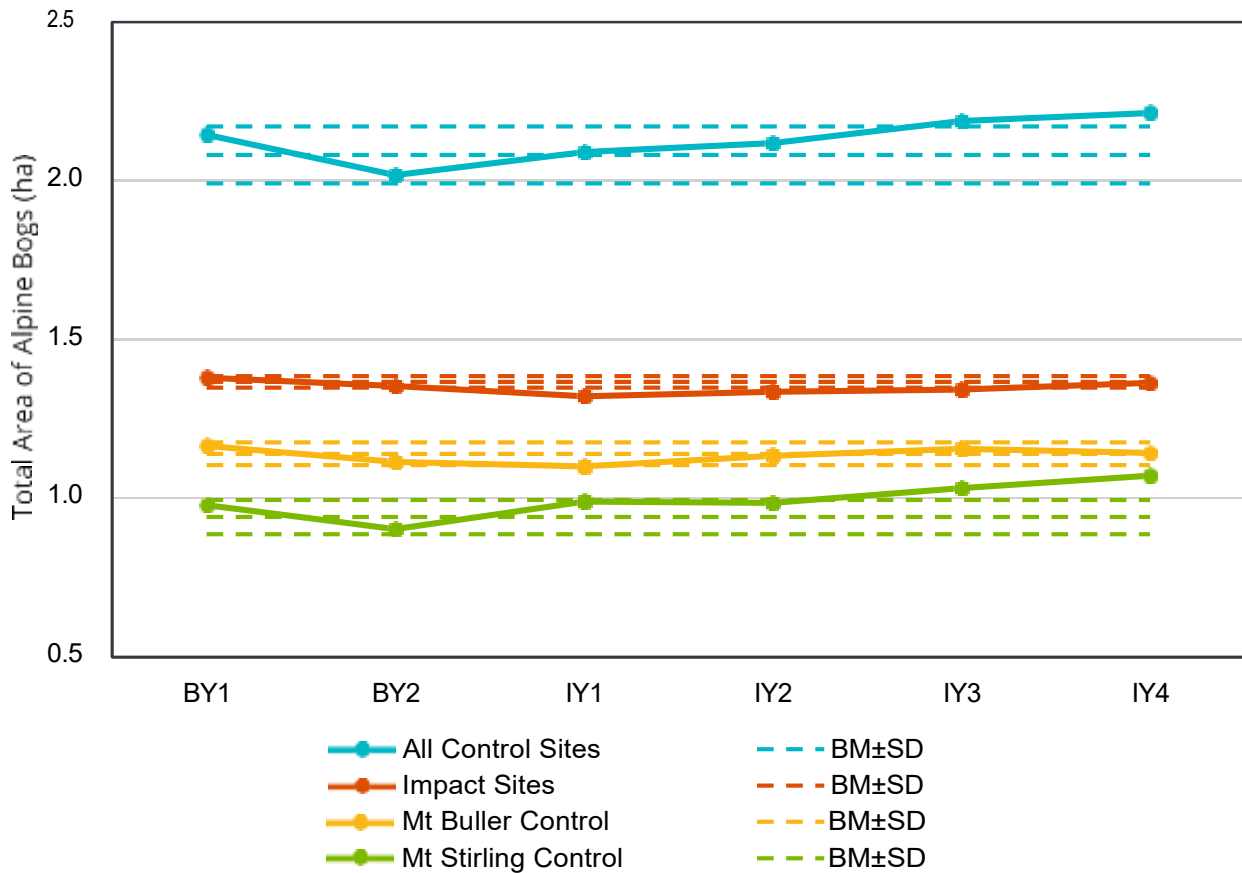
### 3. Results

Where results have reached the HEMAMP Protocol’s ‘amber’ or ‘red’ thresholds for adaptive management actions (Biosis 2022b), the results are presented here in greater detail by contrasting Mount Buller control sites and Mount Stirling control sites. This allows for more detailed investigation of potential causes and is consistent with the recommendations of previous monitoring reports (e.g. Biosis 2022c) and independent peer reviews (e.g. SE Botanical 2023).

#### 3.1 Bog extent

##### 3.1.1 Area of Alpine Bogs

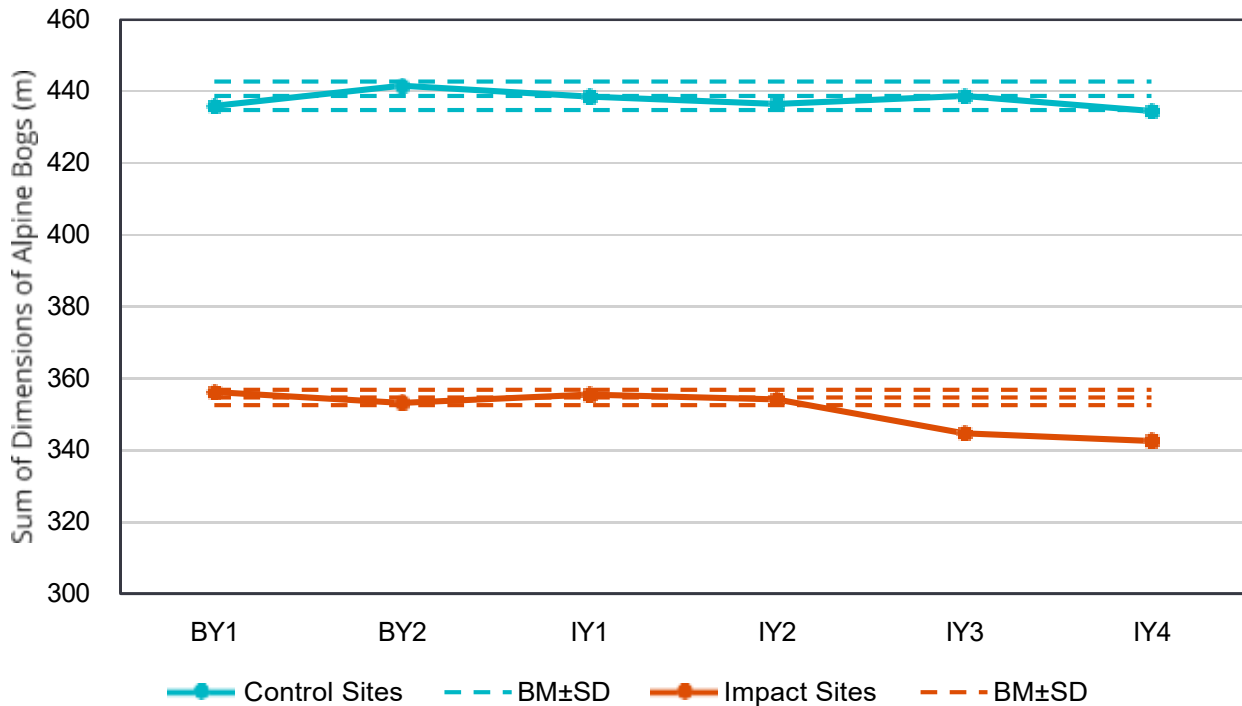
Alpine Bog areas were mapped using DGPS. The results of this mapping are summarised in Chart 1 and depicted in Figure 4 (raw results for each Alpine Bog are available in Appendix 5). The total combined area of all Alpine Bogs at impact sites was 1.3636 hectares in IY4, which is less than the baseline mean of 1.3666 hectares (a decrease of 0.0030 hectares or 0.2%). The total combined area of all Alpine Bogs at control sites was 2.2136 hectares in IY4, which is greater than the baseline mean of 2.0812 hectares (an increase of 0.1324 hectares or 6.4%, almost entirely at Mount Stirling control sites). The relative change in the area of impact sites in IY4 was therefore a decrease of 6.6%, although this change was not statistically significant (BACI contrast = 0.0145; SE = 0.0082; F-statistic = 3.1577; numerator DF = 1; denominator DF = 59; P = 0.0807).



**Chart 1 Total area (hectares) of Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)**

### 3.1.2 Dimensions of Alpine Bogs

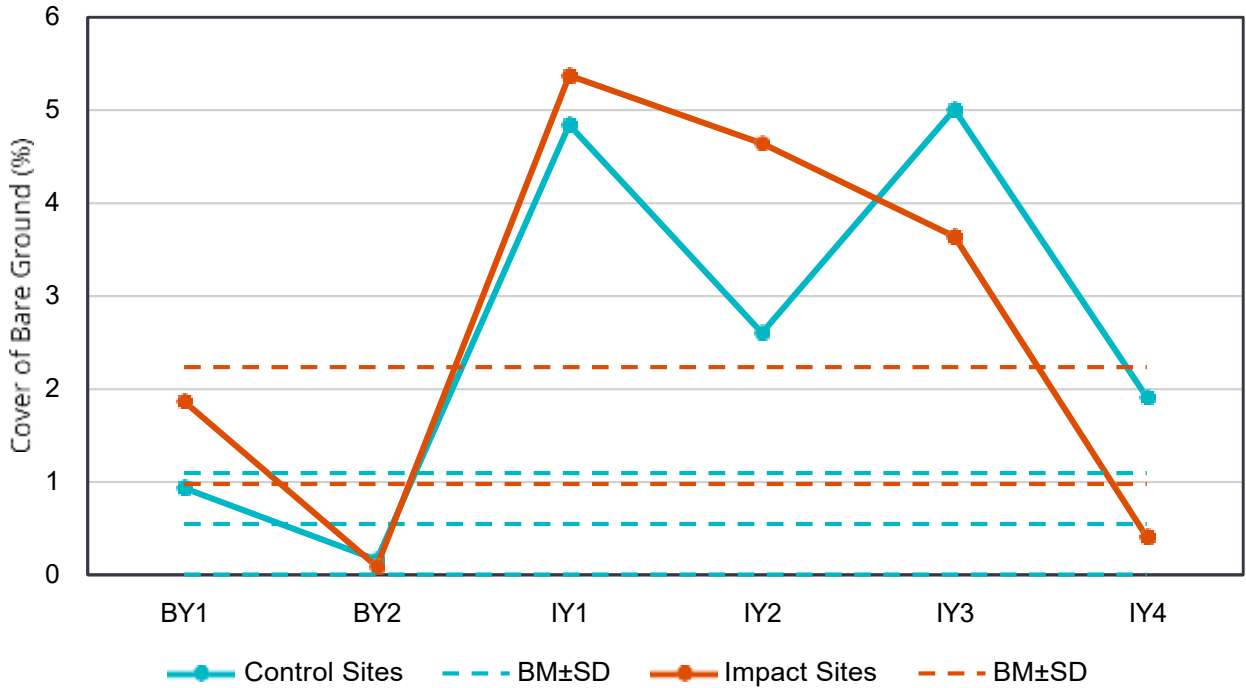
The dimensions of each Alpine Bog were estimated using line transects and the Diagnostic Key to Alpine Bogs (Appendix 3). The results of these estimates are presented in Chart 2 (raw results for each Alpine Bog are available in Appendix 5). The sum of dimensions at impact sites was 342.6 metres in IY4, which is less than the baseline mean of 354.7 metres (a decrease of 12.1 metres or 3.4%). The sum of dimensions at control sites was 434.6 metres in IY4, which is less than the baseline mean of 438.8 metres (a decrease of 4.2 metres or 1.0%). The relative change in the dimensions of the impact sites was therefore a decrease of 2.5%, although this change was not statistically significant (BACI contrast = 0.6640; SE = 0.6950; F-statistic = 0.9132; numerator DF = 1; denominator DF = 59; P = 0.3432).



**Chart 2 Sum of dimensions (metres) of Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)**

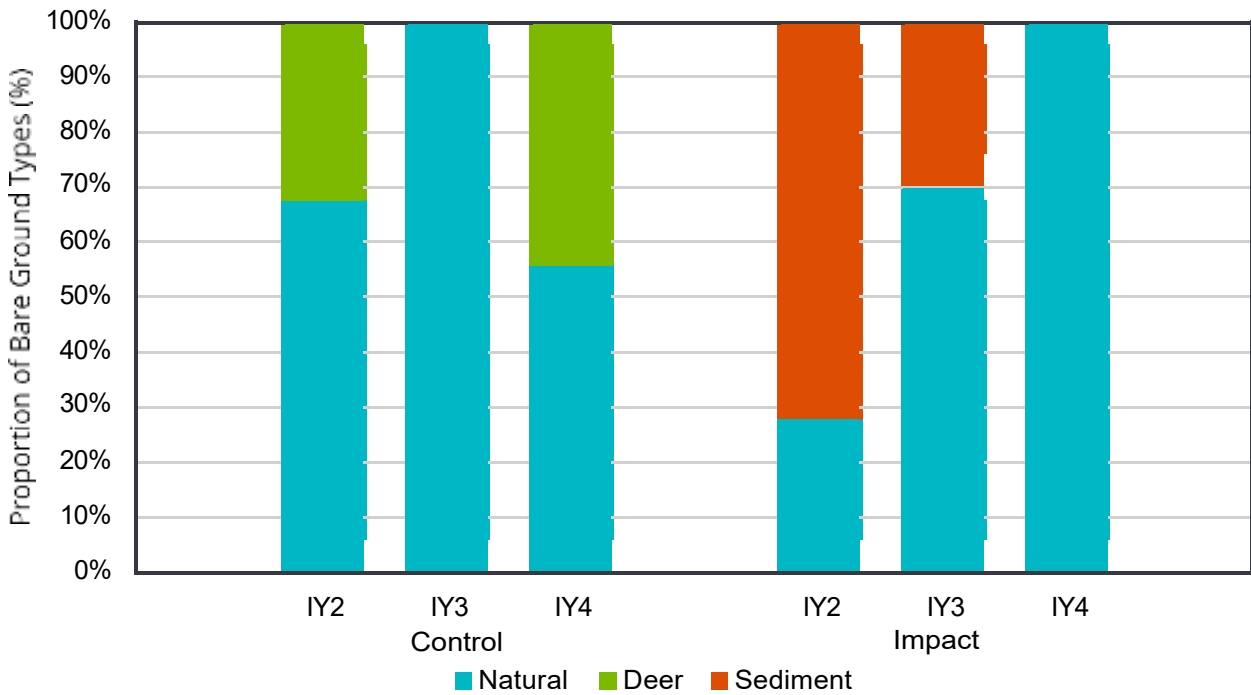
### 3.1.3 Bare ground

Line transects (point intersections) were also used to estimate the cover of bare ground. These estimates are displayed in Chart 3 (raw results for each Alpine Bog are available in Appendix 5). The cover of bare ground returned to baseline levels at impact sites and close to baseline levels at control sites in IY4, after three years of being relatively elevated at all sites. In IY4, the cover of bare ground was 0.4% at impact sites and 1.9% at control sites, compared with baseline mean covers of 1.0% and 0.5% respectively. The changes in bare ground at impact sites relative to control sites have not been statistically significant (BACI contrast = 0.0087; SE = 0.0135; F-statistic = 0.4119; numerator DF = 1; denominator DF = 59; P = 0.5235).



**Chart 3 Percentage cover of total bare ground at Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)**

The causes of bare ground differed at impact sites compared with control sites, as shown in Chart 4 (note that the cause or type of bare ground was not recorded prior to IY2). At impact sites, all bare ground was attributed to natural causes in IY4. This was an improvement from IY2 and IY3, when 72.5% and 30% of bare ground was attributed to sedimentation at Mount Buller. At control sites, 44.7% of bare ground was attributed to deer activity at Mount Stirling in IY4, which was an increase from IY3, when all bare ground was considered natural. The absolute cover of bare ground attributed to deer activity at control sites in IY4 was 0.9%, which was the same cover recorded in IY2 (although the overall decrease in bare ground cover at control sites in IY4 meant that deer activity contributed to a greater proportion of bare ground in IY4 than in IY2).

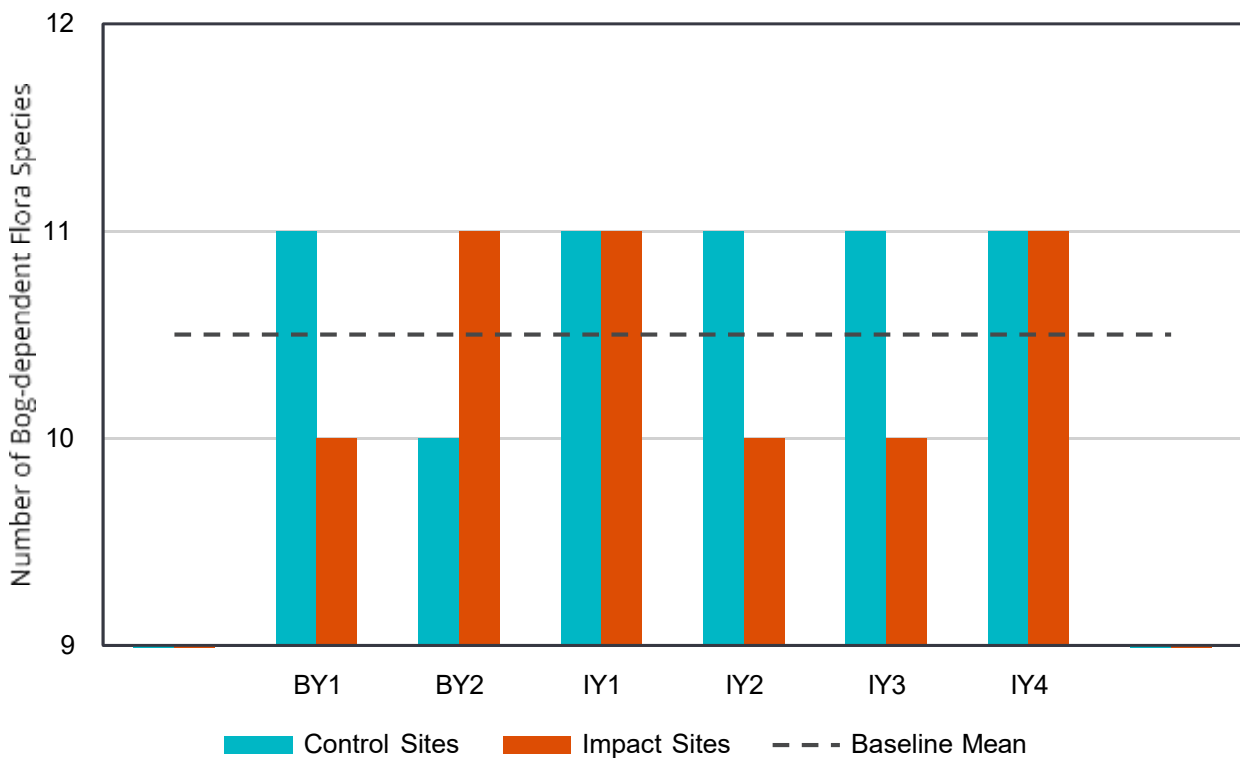


**Chart 4** Types of bare ground recorded at control and impact sites as a proportion of all bare ground recorded at those sites

### 3.2 Bog composition

#### 3.2.1 Species richness

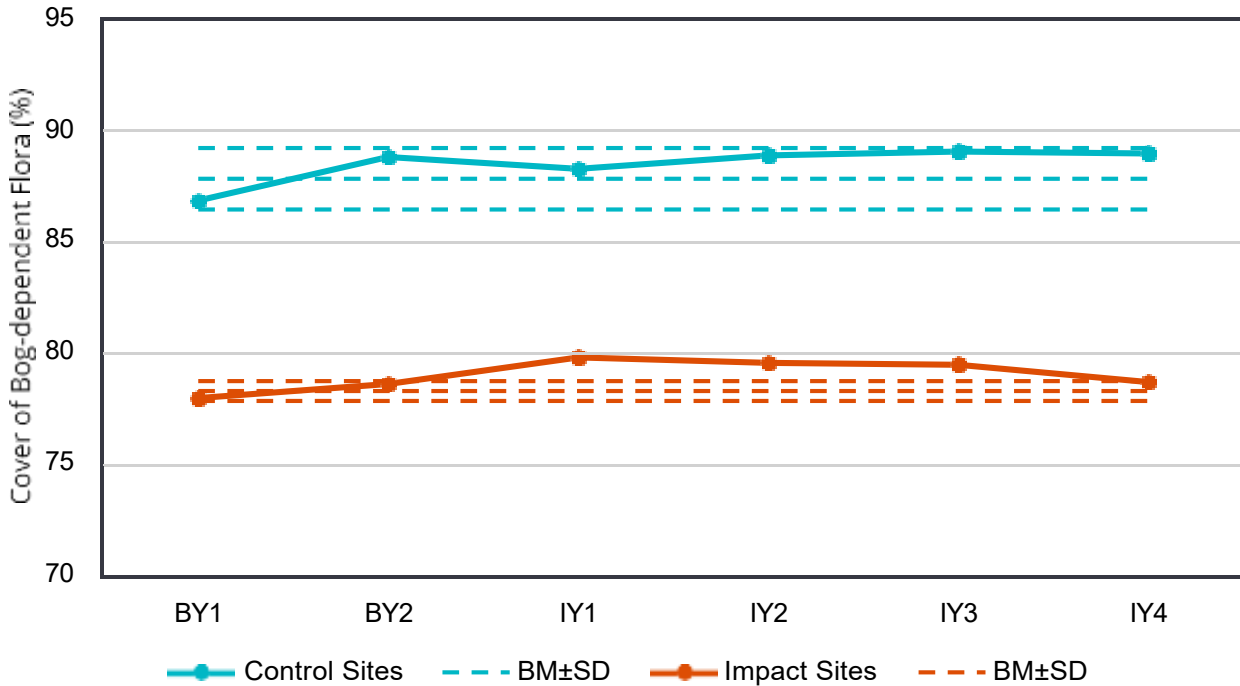
Using line transects (point intersections) and belt transects (quadrats), a total of twelve bog-dependent flora species have been recorded at impact and control sites since monitoring started (Appendix 2; Appendix 5). Baseline monitoring detected 10-11 bog-dependent species across all impact sites and 10-11 bog-dependent species across all control sites (Chart 5). This means that the baseline mean bog-dependent species richness at impact sites and control sites was 10.5. In IY4, 11 bog-dependent flora species were recorded at impact sites and control sites (a 4.8% increase in species richness at both impact sites and control sites when compared with the baseline mean). As a result, there was no relative change in species richness at impact sites relative to control sites in IY4 and the result was not statistically significant (BACI contrast = 0.1190; SE = 0.3850; F-statistic = 0.0957; numerator DF = 1; denominator DF = 59; P = 0.7581).



**Chart 5 Bog-dependent flora species richness at control and impact sites relative to the baseline mean**

**3.2.2 Cover of bog-dependent flora**

Line transects (point intersections) were also used to estimate the cover of bog-dependent flora species. Chart 6 shows these covers (raw results for each Alpine Bog are available in Appendix 5). The cover of bog-dependent flora species increased at impact sites from a baseline mean of 78.2% to 78.6% in IY4. The cover of bog-dependent flora species at control sites increased from a baseline mean of 87.2% to 88.6% in IY4. While the increase in cover of bog-dependent species is proportionally greater at control sites relative to impact sites, the increase is not statistically significant (BACI contrast = -0.0139; SE = 0.0102; F-statistic = 1.8515; numerator DF = 1; denominator DF = 59; P = 0.1788).



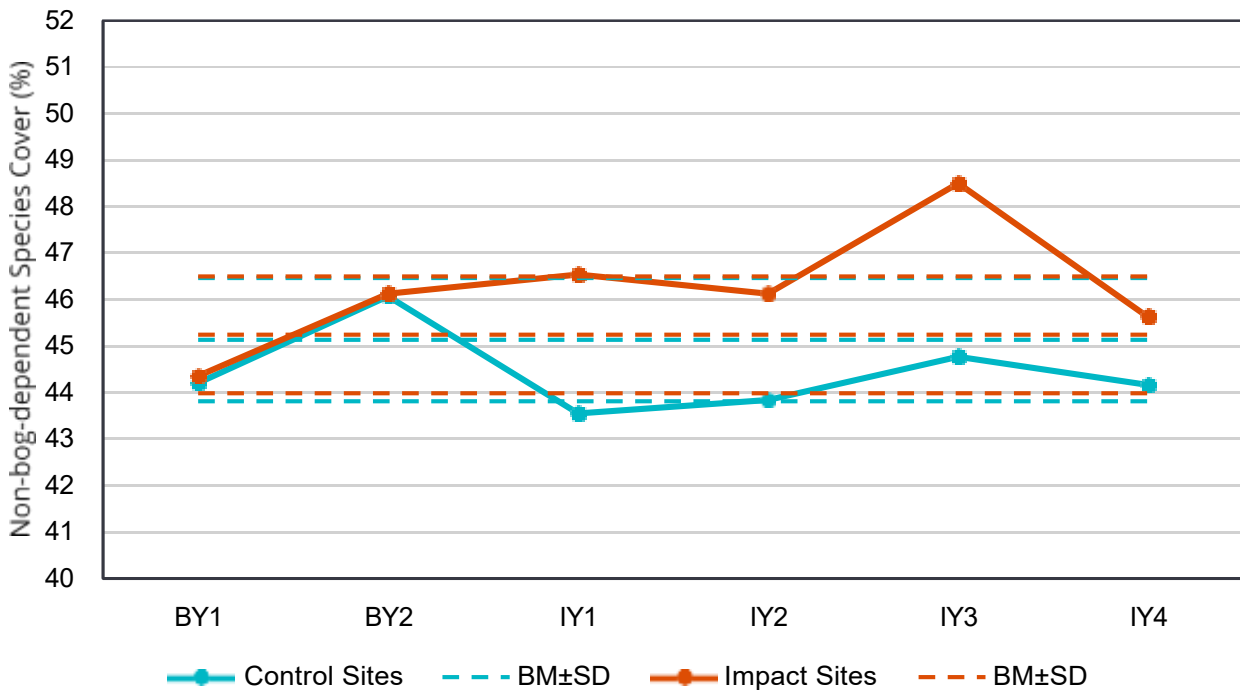
**Chart 6 Percentage cover of bog-dependent flora at Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)**

### 3.3 Encroachment by weeds and other atypical species

Line transects (point intersections) were used to estimate the covers of native non-bog-dependent flora species and introduced flora species (weeds) at each Alpine Bog (Appendix 5).

#### 3.3.1 Cover of native non-bog-dependent flora

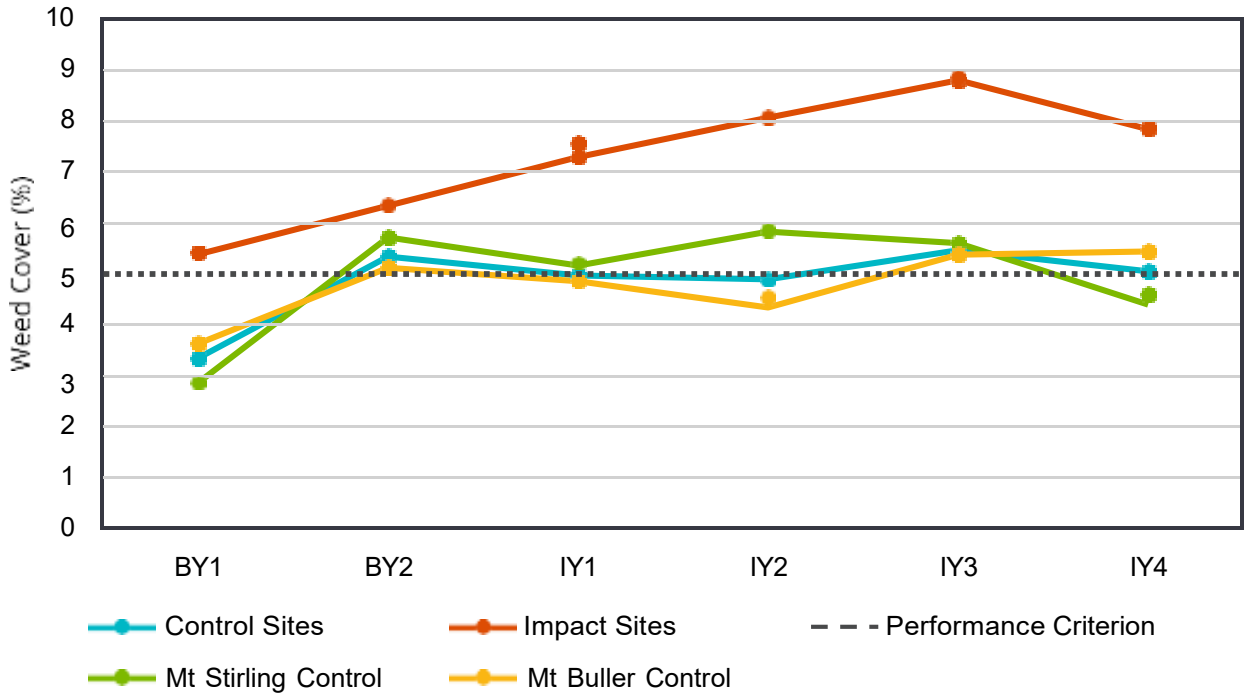
The cover of native non-bog-dependent flora species is shown in Chart 7. The cover of native non-bog-dependent flora increased at impact sites from a baseline mean of 45.2% to 45.6% in IY4 and decreased at control sites from a baseline mean of 45.1% to 44.2% in IY4. This represents a relative increase of 3.0% in the cover of native non-bog-dependent flora species at impact sites relative to control sites in IY4. The relative increase in cover of native non-bog-dependent flora at impact sites relative to control sites since construction of the water storage is statistically significant (BACI contrast = -0.0290; SE = 0.0124; F-statistic = 5.4803; numerator DF = 1; denominator DF = 59; P = 0.0226).



**Chart 7 Percentage cover of native non-bog-dependent flora at Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)**

**3.3.2 Cover of weeds**

The cover of weeds is shown in Chart 8. The cover of weeds increased at impact sites from a baseline mean of 5.9% to 7.8% in IY4 and increased at control sites from a baseline mean of 4.3% to 5.0% in IY4. As a result of a decrease in weed cover at impact sites from IY3 to IY4, the elevated weed cover at impact sites relative to control sites since construction of the water storage is no longer statistically significant (BACI contrast = -0.0167; SE = 0.0087; F-statistic = 3.7415; numerator DF = 1; denominator DF = 59; P = 0.0579). Nevertheless, weed cover continues to be elevated at impact sites compared with control sites, regardless of which group of control sites used for comparison (Mount Buller controls sites or Mount Stirling control sites).

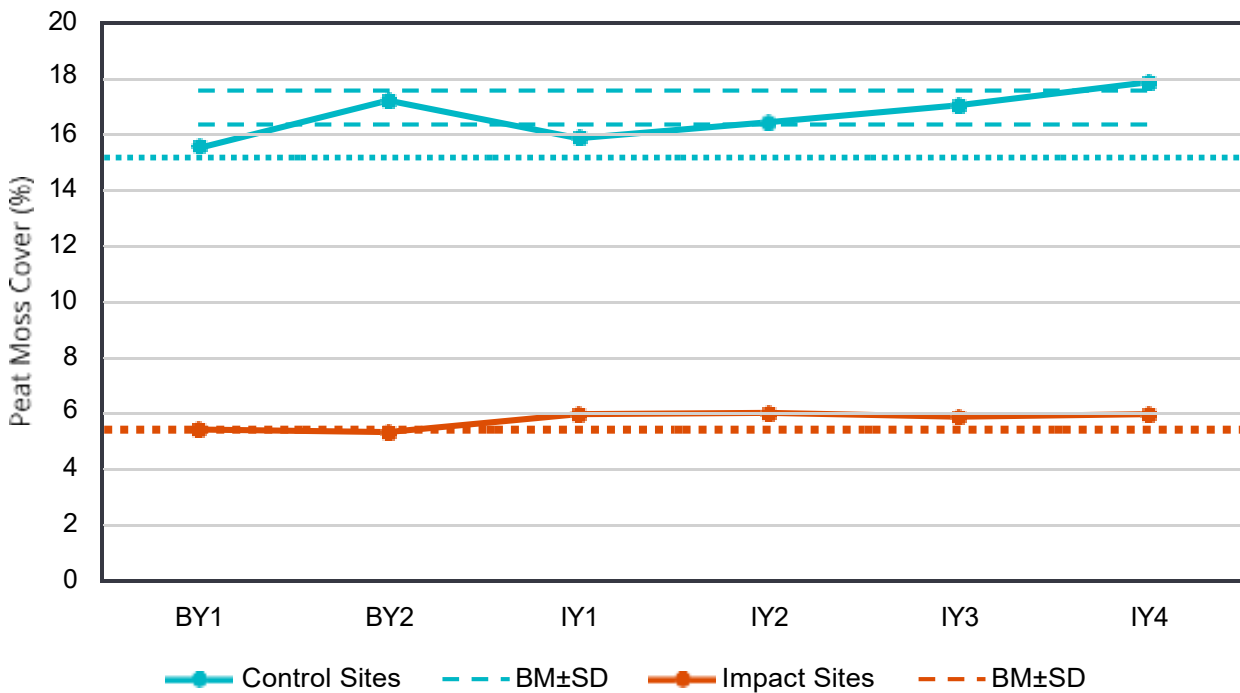


**Chart 8 Percentage weed cover at Alpine Bogs over time relative to the 5% performance criterion**

### 3.4 Bog structure

#### 3.4.1 Cover of Peat Moss

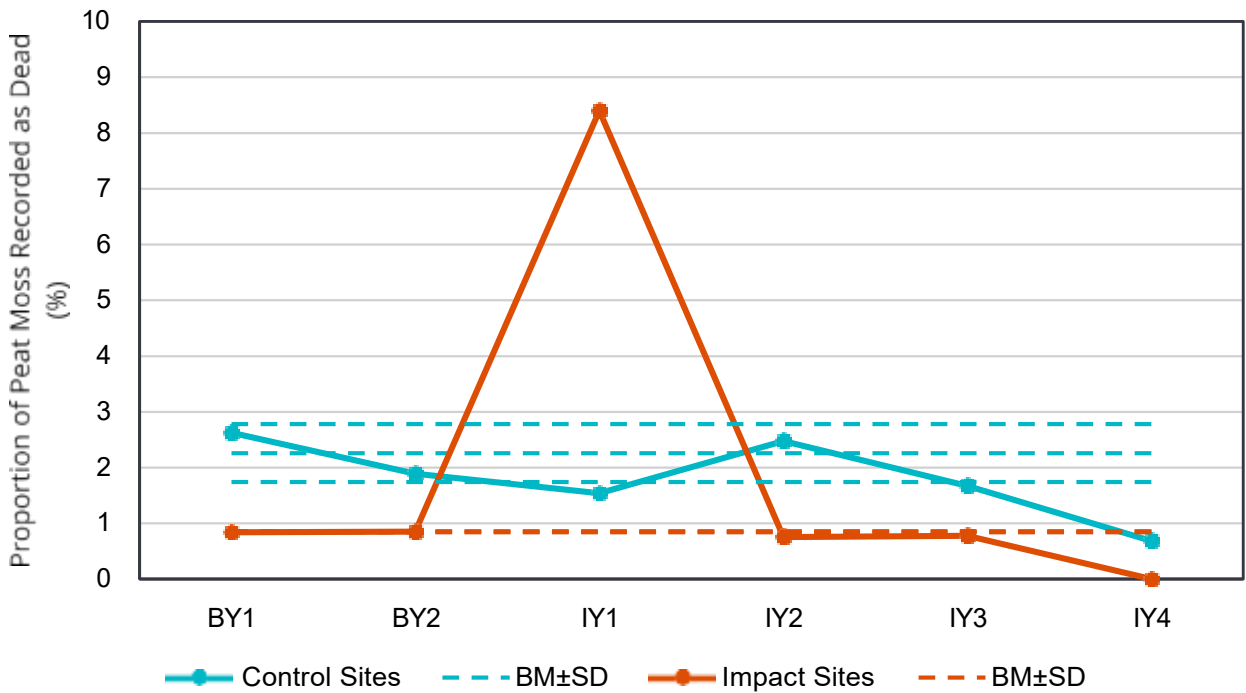
Line transects (point intersections) were used to estimate the cover of Peat Moss *Sphagnum* spp. at impact sites and control sites. These estimates are displayed in Chart 9 (raw results for each Alpine Bog are available in Appendix 5). At impact sites, the cover of Peat Moss increased from a baseline mean cover of 5.4% to a cover of 6.0% in IY4, which represents a 11.0% increase. At control sites, the cover of Peat Moss increased from a baseline mean cover of 16.4% to a cover of 17.9% in IY4, which represents a 9.2% increase. In real terms, this means that Peat Moss cover increased by 1.8% at impact sites relative to control sites. However, the relative increase in Peat Moss cover at impact sites compared with control sites is not statistically significant (BACI contrast = -0.0083; SE = 0.0087; F-statistic = 0.9230; numerator DF = 1; denominator DF = 59; P = 0.3406).



**Chart 9 Percentage cover of Peat Moss at Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)**

### 3.4.2 Dead Peat Moss

The proportion of dead Peat Moss at impact sites and control sites is shown in Chart 10. A substantial (albeit statistically insignificant) increase in dead Peat Moss was observed at impact sites in IY1, but the result has not been repeated since. At impact sites, the proportion of dead Peat Moss in IY4 was 0.0% and lower than the baseline mean of 0.8%. Changes in the proportion of dead Peat Moss at impact sites compared with control sites before and after construction have not been statistically significant (BACI contrast = -0.0013; SE = 0.0042; F-statistic = 0.0974; numerator DF = 1; denominator DF = 59; P = 0.7560).



**Chart 10 Proportion of Peat Moss recorded as dead relative to the baseline mean  $\pm$  one standard deviation (BM $\pm$ SD)**

### 3.5 Summary of ecological monitoring results

Table 3 summarises the results of the HEMAMP IY4 monitoring in terms of the four performance criteria.

**Table 3 Summary of ecological monitoring results in Impact Year 4**

Parameter	Site	Baseline Mean (BM) ±Standard Deviation	IY4	Change (BM to IY4)	% Change (BM to IY4)
<b>Extent</b>					
<b>Area (ha)</b>	Impact sites	1.3667 ±0.0185	1.3636	-0.0030	-0.2%
	Control sites	2.0812 ±0.0897	2.2136	+0.1324	+6.4%
<b>Sum of dimensions (m)</b>	Impact sites	354.7 ±2.1	342.6	-12.1	-3.4%
	Control sites	438.8 ±4.0	434.6	-4.2	-1.0%
<b>Cover of bare ground (%)</b>	Impact sites	1.0 ±1.3	0.4	-0.6	-58.1%
	Control sites	0.6 ±0.5	1.9	+1.4	+247.6%
<b>Composition</b>					
<b>Bog-dependent species richness</b>	Impact sites	10.5 ±0.7	11	+0.5	+4.8%
	Control sites	10.5 ±0.7	11	+0.5	+4.8%
<b>Cover of bog-dependent flora (%)</b>	Impact sites	78.2 ±0.4	78.6	+0.4	+0.5%
	Control sites	87.9 ±1.3	89.0	+1.1	+1.3%
<b>Encroachment</b>					
<b>Cover of non-bog-dependent native flora (%)</b>	Impact sites	45.2 ±1.2	45.6	+0.4	+0.9%
	Control sites	45.1 ±1.3	44.2	-0.9	-2.1%
<b>Cover of weeds (%)</b>	Impact sites	5.9 ±0.6	7.8	+2.0	+33.9%
	Control sites	4.3 ±1.4	5.0	+0.7	+16.4%
<b>Structure</b>					
<b>Cover of Peat Moss (%)</b>	Impact sites	5.4 ±0.1	6.0	+0.6	+11.0%
	Control sites	16.4 ±1.2	17.9	+1.5	+9.2%

## 4. Discussion

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Construction of the water storage project started in October 2019 (midway through IY1) and finished in May 2020 (at the end of IY1). Monitoring in IY1 and IY2 detected that construction of the water storage and ancillary infrastructure had caused noticeable impacts on several downslope Alpine Bogs at Mount Buller, particularly Bogs 4.2, 6, 11.2 and 12 (all impact sites). Impacts on Alpine Bogs were documented in the IY1 and IY2 monitoring reports (Biosis 2020b and Biosis 2021) and included:

- Movement of sediment, large rocks and boulders into and through Alpine Bogs from the Project Construction Footprint (PCF) located upslope.
- Direct removal of approximately 8 square metres of Bog 4.2 along approximately 16 metres of its south-eastern boundary.
- Proliferation of weeds as a result of the above impacts, but particularly in areas affected by sedimentation.

In response to these impacts, the RMB prepared an Addendum to the Ecological Rehabilitation Plan (ERP; Biosis 2022a). The ERP Addendum aims to rehabilitate the Alpine Bogs through sediment control, weed management, pest animal control and revegetation. It was officially endorsed by DELWP and DCCEEW in March 2022. However, with consent from DELWP and DCCEEW (and after consultation with both departments), the RMB began early implementation of parts of the ERP Addendum in December 2021.

A range of management actions started in IY3 and were documented in the IY3 monitoring report (Biosis 2022c). Most of these same management actions continued in IY4 as part of the ERP Addendum and/or associated management plans. In IY4, management actions included the following (L. Perrin, RMB, pers. comm., 29 March 2023 and 6 July 2023):

- Sediment control, involving:
  - Installation and maintenance of more than 500 metres of sediment socks.
  - Installation and maintenance of more than 20 metres of sediment fence, followed by disassembly before the declared snow season.
- Weed control, involving:
  - 336 hours of weed control at Mount Buller and 256 hours of weed control at Mount Stirling, with up to eight personnel from various organisations (RMB, Taungurung Biik, Biosis and Graduate Gardeners).
  - Mostly manual weed removal, but with isolated herbicide treatment (e.g. for woody weeds).
  - Continuation of ongoing trials using a combination of methods, including manual removal, heat treatment and smothering.
  - Removal of over 3 tonnes of weed material from Mount Buller and Mount Stirling.
- Pest animal control, including:
  - Authorised deer control (shooting) from November 2022 to May 2023, involving the culling of 40 Sambar Deer *Cervus unicolor*. Authority to Control or Destroy Game provided by the Game Management Authority under the *Wildlife Act 1975*; Authority Number GMS/2021/05 expiry 20 September 2024.

- Revegetation, involving:
  - Infill planting of 875 tubestock in April and May 2023, concentrating on areas previously affected by sedimentation. This planting occurred specifically within the Alpine Bogs, in addition to the 15000 tubestock planted annually for general site rehabilitation post construction.
  - Collection of approximately 120 seeds and 10 vegetative samples of Silver Astelia *Astelia alpina* var. *novae-hollandiae* on 5 April 2023 for propagation and re-introduction to impact sites in spring 2024.

No evidence of European Rabbit *Oryctolagus cuniculus* activity was observed during IY4, therefore no rabbit control or deterrence was undertaken.

Some of the positive effects of the above management actions are reflected in IY4 monitoring results and are discussed in the following sub-sections of this report.

## 4.1 Bog extent

### 4.1.1 Extent of impact sites relative to all control sites

The performance criterion related to bog extent requires that there be no more than a 10% reduction in the total combined area of impact sites, relative to control sites. Further to this, Condition 2b of EPBC Act Approval 2014/7303 requires that there is no more than a 0.0900-hectare reduction in the total combined area of 'indirectly affected areas of Alpine Bog', relative to baseline monitoring and control sites. The approval defines 'indirectly affected areas of Alpine Bog' as Bogs 4.2, 6, 8, 9, 10, 11.2 and 12 (i.e. all impact sites except Bog 13).

As at IY4, neither of the performance thresholds (10% or 0.0900-hectare reduction) have been reached. There has been a 6.6% reduction in the total combined area of impact sites relative to control sites and the total combined area of 'indirectly affected areas of Alpine Bog' is 0.0033 hectares lower than the baseline mean. While these results represent compliance with conditions of approval for the project, the 6.6% relative decline in area of impact sites meets the 'amber' trigger level threshold for adaptive management, as described in the HEMAMP Protocol (Biosis 2022b). The 'amber' threshold is met when there is more than a 5% reduction in the area of impact sites relative to control sites (Biosis 2022b).

The 'amber' threshold for bog extent was first reached in IY3, when a 6.9% relative decline in area of impact sites was recorded (Biosis 2022c). The 6.9% relative decline in IY3 was one of several triggers for implementation of the management actions that are listed above and documented in the IY3 monitoring report (Biosis 2022c). Results for bog extent in IY4 (a 6.6% relative decline) suggest that these management actions have started to reverse the decline in bog extent at impact sites.

### 4.1.2 Extent of impact sites relative to Mount Buller control sites

The relative decline in area of impact sites has been driven by an increase in the area of control sites, which has occurred almost entirely at Mount Stirling, in Bogs S2 and S3 (Chart 1; Appendix 5). Mount Stirling control sites were 0.1303 hectares (13.8%) larger in IY4 compared with their baseline mean. In contrast, the area of Mount Buller control sites has remained relatively stable, at only 0.0021 hectares (0.2%) greater in IY4 than the baseline mean. Similarly, the absolute area (as opposed to relative area) of impact sites in IY4 was only 0.0030 hectares (0.2%) less than its baseline mean (Table 4).

**Table 4 Change in Alpine Bog area from baseline mean to Impact Year 4**

Site	Area (ha)		
	Baseline Mean (BM) ±Standard Deviation	Impact Year 4	Change (BM to IY4)
<b>All Impact Sites</b>	<b>1.3666</b> <b>±0.0184</b>	<b>1.3636</b>	<b>-0.0030</b> <b>(-0.2%)</b>
<b>All Control Sites</b>	<b>2.0812</b> <b>±0.0896</b>	<b>2.2136</b>	<b>+0.1324</b> <b>(+6.4%)</b>
<b>Mount Buller Control Sites</b>	1.1403 ±0.0360	1.1424	+0.0021 (+0.2%)
<b>Mount Stirling Control Sites</b>	0.9410 ±0.0536	1.0712	+0.1303 (+13.8%)

For reasons outlined in the IY3 monitoring report (Biosis 2022c) and elaborated below, a comparison of impact sites and Mount Buller control sites is likely to be more appropriate for assessing bog extent than a comparison of impact sites with all control sites (Mount Buller and Mount Stirling). When compared with Mount Buller control sites, the relative reduction in the extent of impact sites is 0.0051 hectares or 0.4%. This result would be within the 'green' trigger level threshold for adaptive management (Biosis 2022b) and not necessitate the intensive management interventions that are currently occurring at impact sites. However, adaptive management actions should continue at impact sites for the following reasons:

- While effective rehabilitation actions have limited and started to reverse some of the construction-related impacts, the direct and indirect effects of construction (e.g. sedimentation and increased weed cover) are still evident at impact sites. The ERP Addendum requires that these impacts be rehabilitated (Biosis 2022a).
- Construction-related impacts may continue to materialise at impact sites in the coming years. For example, despite there now being effective control of sediment movement into Alpine Bogs, sediment that is already present continues to move through the Alpine Bogs, providing opportunities for weeds to colonise.
- The ecological integrity of impact sites has been compromised in some areas, making them more vulnerable to future impacts (whether construction-related or not). For example, Bog 6 now exists as eight patches, rather than the single patch that was mapped in baseline monitoring years. Fragmentation was initially caused by sedimentation and weed invasion but there was an increase in the number of patches (from four to eight) between IY3 and IY4 because successful weed control and revegetation had 're-established' some of the original areas of Bog 6. This progress towards full rehabilitation must continue.

#### Impact Year 4–Recommendation 1

Despite positive trends being observed at impact sites, adaptive management actions should continue to be implemented at these sites (particularly at Bog 6) to reverse construction-related impacts.

#### 4.1.3 Potential causes for the increased extent of Mount Stirling control sites

While the difference between Mount Buller and Mount Stirling control sites is not statistically significant (BACI contrast = -0.0281; SE = 0.0138; F-statistic = 4.1280; numerator DF = 1; denominator DF = 29; P = 0.0514), the

increase in area of Mount Stirling control sites in the previous two years is outside the range of variability recorded during baseline monitoring and therefore notable. Approximately two thirds of the increase in area of Mount Stirling control sites has been recorded since IY2, when intensive deer control at Mount Stirling started.

As detailed in the IY3 monitoring report (Biosis 2022c), Mount Stirling control sites have disproportionately benefitted from the RMB's successful deer control program, the RMB's weed management program and post-fire vegetation succession. Together with above average rainfall in IY4 (experienced at impact and control sites alike), these factors are likely to have contributed to the increase in bog extent at Mount Stirling control sites. Peat Moss, which is known to be sensitive to trampling by deer, weed invasion and fire, is likely to have been one beneficiary.

Vigorous and extensive growth of Peat Moss beyond former Alpine Bog boundaries was observed at Mount Stirling control sites during on-ground mapping in IY4 (Photo 1). These observations were supported by transect monitoring results, which suggested that the cover of Peat Moss at Mount Stirling control sites was 44.5% in IY4, compared with a baseline mean of 40% (i.e. 11.3% increase in cover). In contrast, the cover of Peat Moss at Mount Buller control sites was 2.2% in IY4, compared with a baseline mean of 2.5% (i.e. 10.5% decrease in cover).

#### 4.1.4 Further considerations when assessing bog extent

##### Artificial watering of control sites

In IY3, it was reported that Mount Buller's eastern control sites (Bogs 1, 2 and 11.1) may have benefitted from artificial watering due to accidental but regular discharge of drinking water from Baldy Turret tank, located upslope of these control sites. The eastern control sites increased in area in IY3, while the western control site (Bog 4.1/5/7) decreased in area (Biosis 2022c).

The regular bulk discharge of water from Baldy Turret tank ceased in November 2021, midway through IY3. A much smaller discharge of water (currently unquantified) was noted to be coming from Baldy Turret pump house, adjacent to the tank, during a site visit on 28 April 2023 (Photo 2). The reduction in artificial watering of Mount Buller's eastern control sites coincided with a stabilising of their areas in IY4. Bogs 1, 2 and 11.1 collectively increased in area by 0.0047 hectares from IY3 to IY4, compared with an increase of 0.0302 hectares from IY2 to IY3 (when artificial watering was occurring). It may be that Bogs 1, 2 and 11.1 will begin to decrease in area in coming years, now that artificially watering has largely ceased.

As noted in the IY3 monitoring report, Bog 4.1/5/7 would appear to be the most reliable control site for comparison with impact sites, due to a range of external factors that are likely to have disproportionately benefitted other control sites. This will potentially continue to be the case for several years, while Bogs 1, 2 and 11.1 continue to stabilise after cessation of artificial watering. Bog 4.1/5/7 was 0.0170 hectares (3.1%) smaller in IY4 compared with its baseline mean, continuing a declining trend that was first observed in IY3. If Bog 4.1/5/7 were used as the control against which impact sites were assessed, the relative change in area of impact sites from their baseline mean would be a 2.9% increase as at IY4.

#### Impact Year 4 – Recommendation 2

Now that the unintentional bulk discharge of water upslope of Mount Buller's eastern control sites has ceased, ecological monitoring should be alert to a potential decline in the area of these sites and adapt analysis of results accordingly.

### Impact Year 4–Recommendation 3

The RMB should investigate the small discharge of water that is still occurring from Baldy Turret pump house and, if possible, consider stopping this discharge so as not to affect monitoring results at Mount Buller's eastern control sites.

#### Localised hydrological changes and dieback

During IY2 monitoring, we observed localised mortality of small areas of Alpine Grassy Heathland downslope of the PCF, outside of Alpine Bogs but within 4 metres of Alpine Bog boundaries (Biosis 2021). Dieback of Alpine Rusty-pods *Hovea montana*, Alpine Leionema *Leionema phyllicifolium* and Dusty Daisy-bush *Olearia phlogopappa* subsp. *flavescens* (all non-bog-dependent species) was observed at two locations. Additional areas of similar dieback were mapped in IY3 and it was recommended that the RMB investigate the role that the environmental watering system may be playing (Biosis 2022c).

Areas of dieback were re-visited and mapped in IY4. The results of this mapping are summarised in Table 5 and shown in Figure 5. The RMB commissioned endoscope footage to be captured of the environmental watering system in May 2023. This endoscope footage suggested the following:

- The majority of the environmental watering system has been constructed with slotted or perforated pipe. This means that the environmental watering system is likely to be intercepting groundwater flows (i.e. groundwater that would otherwise be delivered elsewhere) and distributing groundwater to areas (or vegetation types) that would not have normally received significant amounts of groundwater.
- The environmental watering system has varying elevations and gradients along its length. The location of much of the dieback is directly downslope of parts of the environmental watering system that are at lower elevation and that therefore appear to be pooling (and presumably discharging) water.
- There appears to be a regular discharge of water from drainage system below the water storage to the environmental watering system. This highlights the need for effective monitoring of drainage discharge volumes, as required by the HEMAMP Protocol (Biosis 2022b).

Overall, initial observations suggest that the environmental watering system may lead to an expansion of some impact sites as bog-dependent flora colonise areas of dieback. In addition, the endoscope footage has confirmed that the environmental watering system will be able to deliver supplementary water to Alpine Bogs, if required.

### Impact Year 4–Recommendation 4

Dieback locations must continue to be re-visited in future years to investigate possible causes, to track vegetation recovery or succession and to plan any necessary management interventions e.g. revegetation.

### Impact Year 4–Recommendation 5

The RMB should further investigate whether the environmental watering system meets the original design specifications (by comparing endoscope footage with final design drawings) and what volumes of water are being discharged from the water storage drainage system to the environmental watering system.

**Table 5 Observations of dieback of non-bog-dependent species**

Location	Proximity	Approx. area in IY3 (sq. m)	Area in IY4 (sq. m)	Observations in IY4
<b>D1</b>	Bog 11.2 (impact site)	30	69	Area of dieback appears to be increasing. Potential future increase in area of Bog 11.2 (Photo 3 and Photo 4).
<b>D2</b>	Bog 10 (impact site)	6	6	Dieback of Alpine Leionema. Swamp Heath and Spreading Rope-rush <i>Empodisma minus</i> are persisting, resulting in an increase in the extent of Bog 10.
<b>D3 and D3.1</b>	Bog 10 (impact site)	20	52	Area denoted as D3.1 was new in IY4 and is in close proximity to D3, therefore assumed to have the same cause. Likely to join with D1 in future years.
<b>D4</b>	Bog 12 (impact site)	1	2	Dieback of Alpine Shaggy-pea. No immediate change to bog extent, but location of possible future increase in bog extent.
<b>D5</b>	Bog 11.1 (control site)	4	3	Dieback of non-bog dependent species, mainly Alpine Leionema. Alpine Baeckea <i>Baeckea gunniana</i> , Mountain Daisy-bush <i>Olearia algida</i> and Tall Sedge are now dominant, resulting in increased extent of Bog 11.1.
<b>D6.1 and D6.2</b>	Bog 11.1 (control site)	10	16	Dieback of Alpine Leionema and Alpine Shaggy-pea. Partly replaced by Subalpine Baeckea, resulting in increased area of Bog 11.1, but also by weeds, such as Soft Rush <i>Juncus effusus</i> and Monkey Musk <i>Erythranthe guttata</i> .
<b>D7</b>	Bog 11.1 (control site)	10	11	Dieback of Alpine Leionema and Alpine Shaggy-pea. Nothing yet filling void, meaning no change to bog extent.
<b>D8.1 and D8.2</b>	Bog 11.1 (control site)	3	9	Area denoted as D8.2 was new in IY4 and is in close proximity to D8.1, therefore assumed to have the same cause. Dieback of Alpine Leionema and Alpine Shaggy-pea. Alpine Baeckea and Carpet Sedge <i>Carex jackiana</i> filling void, resulting in increased extent of Bog 11.1.

Location	Proximity	Approx. area in IY3 (sq. m)	Area in IY4 (sq. m)	Observations in IY4
<b>D9</b>	Bog 11.1 (control site)	2	3	Dieback of Alpine Leionema and Alpine Shaggy-pea. Alpine Baeckea and Spreading Rope-rush filling void, resulting in increased extent of Bog 11.1.
<b>D10</b>	Bog 4.2 (impact site)	4	5	Dieback of Alpine Leionema. Baeckea <i>Baeckea</i> spp. and Swamp Heath are persisting, resulting in an increase in the extent of Bog 4.2.
<b>D11.1, D11.2 and D14</b>	Bog 4.2 (impact site)	27	48	Areas denoted as D11 and D14 in IY3 have merged in IY4. Dieback of Alpine Leionema and Alpine Pepper (Photo 5). Potential future increase in bog extent as Spreading Rope-rush and Candle Heath <i>Dracophyllum continentis</i> appear unaffected.
<b>D12</b>	Bog 4.2 (impact site)	6	8	Dieback of Alpine Leionema. Bog-dependent species now dominant, resulting in increased extent of Bog 4.2.
<b>D13.1 and D13.2</b>	Bog 4.2 (impact site)	3	16	Dieback of Alpine Leionema and Mountain Plum-pine <i>Podocarpus lawrencei</i> . Bog-dependent species appear unaffected, resulting in increased extent of Bog 4.2.
<b>D15</b>	Bog 4.2 (impact site)	15	14	Dieback of Alpine Pepper, Mountain Plum-pine and, to a lesser extent, Kerosene Bush <i>Ozothamnus cupressoides</i> . Associated with dieback of bog-dependent species from sedimentation and deer trampling/browsing.
<b>D16</b>	Bog 6 (impact site)	3	2	Dieback of Alpine Leionema and Mountain Plum-pine, associated with sedimentation, proliferation of weeds and decline in bog extent.
<b>D17.1, D17.2 and D17.3</b>	Bog 1 (control site)	NA	1	New dieback recorded in IY4 that was not present in IY3. Dieback of three small distinct shrubs, potentially associated with changed drainage due to summit trail path upgrade.
<b>D18</b>	Bog 11.1 (control site)	NA	3	New dieback recorded in IY4 that was not present in IY3.

## Regeneration of Alpine Bog vegetation on ski slopes

During BY2 monitoring, Biosis mapped a number of previously unrecorded Alpine Bogs on the mid-slopes of Mount Buller (Biosis 2019). These Alpine Bogs were given new numbers and became known as 'other sites', as opposed to 'impact sites' and 'control sites'. Some of these 'other sites' were 50-100 metres downslope of known impact sites (e.g. Bogs 8/9/10 and 11.1), meaning that they probably had catchment areas that were affected by the water storage and could plausibly be added to the monitoring as additional impact sites. However, these 'other sites' have not been monitored or mapped in detail since BY2.

During IY4, it was observed that Alpine Bog vegetation at some of the 'other sites' had undergone vigorous growth and had potentially expanded in area. Furthermore, up to 0.3 hectares of previously unidentified and unmapped Alpine Bog vegetation was recorded approximately 40 metres downslope and north-east of Bog 6, in an area that was not mapped as Alpine Bog vegetation in BY2. The precise area of this newly identified Alpine Bog vegetation has not yet been mapped with a DGPS, but its location suggests that it would have a catchment area affected by the water storage. A comparison of past aerial imagery suggests that vigorous regrowth of this Alpine Bog vegetation likely occurred between IY1 (2019) and IY4 (2022).

Regeneration of relatively large areas of Alpine Bog vegetation on the mid-slopes of Mount Buller, within the catchment area that has been affected by construction of the water storage, merits further investigation. It may point to a 'migration' of Alpine Bog vegetation to new areas because of changed hydrological conditions caused by the new water storage, similar to the expansion of Alpine Bog vegetation into areas of dieback. Alternatively, it may be part of a long-term trend of native vegetation regeneration on the northern ski slopes of Mount Buller, ever since Buller Ski Lifts began implementing a vegetation management plan across the Mount Buller ski field in 2011 (Biosis Research 2011).

### Impact Year 4–Recommendation 6

Additional survey effort should be undertaken in IY5 to identify and map any new Alpine Bog vegetation within the Bogy Creek catchment (upslope of Bog 13) and to re-visit Alpine Bogs that were newly identified and mapped in BY2 (so-called 'other sites'). This will provide a broader picture of how Alpine Bog vegetation in the Bogy Creek catchment is responding to construction of the water storage.

## Bare ground and sedimentation

There is no doubt that sedimentation is one of the construction-related impacts that contributed to a post-construction reduction in the extent of impact sites, relative to control sites. However, it appears that sedimentation has now been contained and sediment that is present within impact sites is being colonised by vegetation. Where the colonising vegetation is native, it is typically resulting in a recovery of bog extent at impact sites.

It is notable that the cover of bare ground attributable to sedimentation decreased from 3.4% in IY2 and 1.1% in IY3 to 0.0% in IY4. No sedimentation was recorded along transects in IY4. This result supports the following observations made during transect monitoring and on-ground mapping in IY4:

- The RMB has effectively contained the movement of sediment into impact sites from the PCF. Sediment control has been achieved with sediment socks, sediment fences, mulch, natural regeneration and revegetation.
- Some sediment has been covered by a new humus or peat layer. Unlike a layer of sediment, a layer of humus or peat is preferable because it appears to be less easily eroded and favours the re-establishment of bog-dependent flora rather than weeds.

- It is expected that sedimentation detected by transect monitoring may continue to fluctuate over coming years as some sediment that is already present within the impact sites continues to move downstream through the impact sites.

#### Impact Year 4–Recommendation 7

In IY4, the RMB was again successful in preventing further movement of sediment into impact sites. The RMB must continue to implement the Ecological Rehabilitation Plan (Biosis 2020a) and its Addendum (Biosis 2022a) to continue to prevent movement of sediment from the PCF into Alpine Bogs.

## 4.2 Bog composition

The performance criterion relating to the composition of the Alpine Bogs is expressed in terms of bog-dependent species richness (i.e. number of bog-dependent species). It requires that there be no more than a 10% reduction in the total bog-dependent native flora species richness of the impact sites, taking into account natural variation based on species richness observations averaged across control sites. The baseline mean bog-dependent species richness at impact sites and control sites was 10.5 species (10 to 11 bog-dependent species were recorded on average in the baseline monitoring years). This means that there would need to be a net loss of two bog-dependent species from impact sites relative to control sites for there to be greater than a 10% reduction in bog-dependent species richness.

In IY2 and IY3, 10 bog-dependent species were recorded at impact sites and 11 bog-dependent species were recorded at control sites (all bog-dependent species recorded at impact sites were also recorded at control sites). The relative decrease in species richness at impact sites compared with control sites was therefore one species or 9.6%, close to the 10% threshold for non-compliance as specified in the performance criteria. The single bog-dependent species that was not detected at impact sites in IY2 and IY3 was Silver Astelia *Astelia alpina* var. *novae-hollandiae*.

As explained in previous monitoring reports, Silver Astelia has had a highly localised distribution at impact sites since monitoring began. Its distribution is so localised that it has not been recorded at control sites. It has only been previously detected in Bogs 4.2, 6 and 12 (Figure 6). The failure of transect monitoring to detect Silver Astelia may have been due to natural vegetation succession, seasonal conditions or observer error. Alternatively, localised construction-related impacts, such as sedimentation, may have resulted in the loss of this species.

In IY4, a more concerted effort was made to document any incidental observations of Silver Astelia. As a result, Silver Astelia was observed at impact sites again in IY4 (the first observation since IY1), although it was not detected by transect or quadrat monitoring. This incidental observation has increased the number of observed bog-dependent species at impact sites from 10 to 11 i.e. equal to control sites. Propagation of Silver Astelia commenced in 2023 with the aim of re-introducing the species in 2024 to areas of impact sites where it has previously been recorded.

#### Impact Year 4–Recommendation 8

The HEMAMP Protocol should be updated to indicate that bog composition considers species recorded along transects and incidentally. The monitoring procedure should be updated to specify that if any given bog-dependent species is not recorded along transects in a given year, a more detailed and thorough search should be undertaken for the missing species before further action is taken.

## 4.3 Encroachment by weeds and other atypical species

### 4.3.1 Encroachment by weeds

In 2013/2014, Mount Buller's Alpine Bogs were recorded as having low (less than 5%) weed cover (Biosis and GHD 2016). As a result, the HEMAMP's performance criteria require that the total weed cover at impact sites does not exceed 5% (Biosis 2022b). The total weed cover at impact sites progressively increased from 5.4% in BY1 to a peak of 8.8% in IY3. Total weed cover at impact sites was 7.8% in IY4 (Chart 8). In contrast, after an initial increase from 3.3% in BY1 to 5.3% in BY2, total weed cover at control sites has remained relatively stable and was at 5.0% in IY4 (Chart 8).

It should be noted that the HEMAMP's performance criterion for weed cover has never been met at impact sites, even during baseline monitoring. Weed cover was non-compliant before the project started. However, the upward trend that was observed in weed cover at impact sites was concerning and triggered intensive weed management and revegetation actions that started in IY2. These management actions have been concentrated around Bog 6 because Bog 6 effectively accounted for most, if not all, of the increased weed cover recorded collectively across impact sites.

At Bog 6, weed cover increased from a baseline mean of 5.7%, to 7.8% in IY1, 9.7% in IY2 and 14.5% in IY3. As a result of the concerted and increased weed control effort at Bog 6 in IY3, weed cover at Bog 6 returned to 9.7% in IY4. Recovery of Alpine Bog vegetation was noted in some areas of Bog 6 during IY4 and resulted in localised increases in the extent of Bog 6. As a result, Bog 6 was mapped as eight discrete patches in IY4, up from four patches in IY3.

While improvements in weed cover were recorded at Bog 6 in IY4, weed cover results at Bog 6 and more broadly across all impact sites are still non-compliant with the HEMAMP's performance criterion for weed encroachment. The 'red' threshold for adaptive management is still being triggered. The HEMAMP Protocol (Biosis 2022b) requires that the following escalation procedure be enacted:

- If a threshold (e.g. weed cover threshold) is within the 'amber' trigger level, it should be expected that the threshold return to the 'green' trigger level within 3 years. If there is no return to the 'green' trigger level within 3 years, management actions and effort will need to be increased.
- If a threshold (e.g. weed cover threshold) is within the 'red' trigger level, it should be expected that those thresholds return to the 'amber' trigger level within 2 years. If there is no return to the 'amber' trigger level within 2 years, management actions and effort will need to be increased.

Intensive weed management and revegetation actions started in IY2. Since then, there have now been two consecutive years (IY3 and IY4) where the 'red' trigger level for weed cover has been met. Despite a noticeable improvement in weed cover in IY4, there has been no return to the 'amber' trigger level. As a result, in accordance with the HEMAMP Protocol, weed management actions and effort will need to be scaled up and intensified further in IY5.

#### Impact Year 4–Recommendation 9

Despite the concerted weed control effort of IY3 resulting in a noticeable improvement in weed cover at impact sites in IY4, weed covers still sit at the 'red' trigger level for adaptive management. In accordance with the HEMAMP Protocol, weed management actions and effort will need to be scaled up and intensified further in IY5.

### Impact Year 4–Recommendation 10

Update the HEMAMP Protocol to change the weed cover threshold from 5% to the relative baseline mean for both impact and control sites. Weed control efforts should not be reduced and must be scaled up and intensified in IY5.

#### 4.3.2 Encroachment by native non-bog-dependent species

The performance criterion for atypical species requires that there be no more than a 10% increase in the cover of non-bog-dependent species at impact sites, relative to control sites. A divergence of impact sites from control sites with respect to cover of non-bog-dependent species was detected in IY1 and persisted until IY3. In BY1, the cover of non-bog-dependent flora was 44.4% at impact sites and 44.2% at control sites. In BY2, the cover of non-bog-dependent flora was 46.1% at impact sites and control sites alike. During and after construction of the water storage, the cover of non-bog-dependent flora was consistently 2.3% to 3.7% higher at impact sites relative to control sites (Chart 7). This represented a statistically significant relative increase in the cover of non-bog-dependent species at impact sites compared with the baseline mean.

In IY4, the cover of non-bog-dependent flora was 1.4% higher at impact sites relative to control sites, suggesting that there is the beginning of a reversal of the divergence between impact sites and control sites that has been observed since IY1. As a result, this performance criterion returned to the 'green' trigger level in IY4. This observation is consistent with other positive trends that were observed at impact sites in IY4, including improvements to bog extent and reductions in weed cover.

#### 4.4 Bog structure

The structure criterion requires that there be no more than a 10% reduction in the average cover of Peat Moss at impact sites, relative to control sites. The cover of Peat Moss has remained relatively stable at impact and control sites across monitoring years (although note the difference observed between Mount Buller control sites and Mount Stirling control sites in IY4, as explained in Section 4.1.3 of this report). The baseline mean cover of Peat Moss at impact sites and control sites was 5.4% and 16.4% respectively. As at IY4, the cover of Peat Moss at impact sites and control sites is 6.0% and 17.9% respectively. While this represents a 1.8% increase in the cover of Peat Moss at impact sites relative to control sites, it is not statistically significant.

Importantly, after a peak in the proportion of dead Peat Moss recorded along transects at impact sites in IY1, the proportion of dead Peat Moss returned to baseline levels at impact sites in IY2, remained there in IY3 and declined even further (to below baseline levels) in IY4 (Chart 10). This observation suggests that Peat Moss has recovered at impact sites after a disturbance event in IY1 and is supported by observations from on-ground mapping. It appears that entry of new sediment into the Alpine Bogs has been controlled, allowing existing sediment to be washed out of Alpine Bogs and/or be covered by peat-forming species such as Peat Moss.

#### 4.5 Triggers for adaptive management

The HEMAMP Protocol uses a 'traffic light' approach to adaptive management triggers, where the level of management intervention is escalated as the risk of adverse impacts on the ecological values of the impact sites increases, from 'green' to 'amber' to 'red' (Biosis 2022b).

The following ecological trigger levels have been reached:

- 'Green' trigger level, on the basis of the following criterion:

- Bog composition – There has been no decrease in bog-dependent species richness at impact sites, relative to control sites, due to the incidental observation of Silver Astelia in IY4 at impact sites.
  - Encroachment by atypical species – There has been an 3.0% increase in the cover of non-bog-dependent species at impact sites, relative to control sites. No intervention is required at this stage to address this result, although HEMAMP monitoring, in-depth analysis and reporting must continue. Encroachment by atypical species would need to increase by more than 5% at impact sites relative to control sites for the 'amber' trigger level to apply.
  - Bog structure – There has been a 1.8% increase in Peat Moss cover at impact sites, relative to control sites. No management actions are required to address this result, although HEMAMP monitoring, in-depth analysis and reporting must continue. Peat Moss cover would need to decline by more than 5% at impact sites relative to control sites for the 'amber' trigger level to apply.
- 'Amber' trigger level, on the basis of the following criteria:
    - Bog extent – There has been a 6.6% decrease in the extent of impact sites, relative to control sites. However, as explained in Section 4.1.3 of this report, this relative decrease may have been inflated by Mount Stirling control sites disproportionately benefitting from deer control, weed control and post-fire vegetation succession and from certain Mount Buller control sites benefitting from unintended artificial watering. A relative decline in area of 0.4% is a more realistic assessment. In any case, management actions to address other criteria are likely to also reverse any decline in bog extent.
  - 'Red' trigger level, on the basis of the following criterion:
    - Encroachment by weeds – Weed cover at impact sites is currently at 7.8% and has been steadily increasing since monitoring started in BY1. It should be noted that baseline mean weed cover at impact sites was 5.9% and therefore already at the 'red' trigger level before construction started. Intensive weed control was undertaken in IY3, during and after ecological monitoring, which has resulted in a 1.0% reduction in weed cover in IY4. Similar effort and intensity of weed management in accordance with the ERP Addendum (Biosis 2022a) is needed in future years to further reduce weed cover. Deer control, rabbit control, sediment control and revegetation are ongoing and will assist weed control efforts.

In response to the above triggers, intensive management actions commenced in IY3. The management actions include sediment control, weed control, pest animal (deer and rabbit) control and revegetation. In accordance with the HEMAMP protocol (Biosis 2022b), if the criteria that are within the 'amber' trigger level do not return to the 'green' trigger level within 3 years (i.e. by IY6), management actions and effort will need to be increased. Similarly, if the weed criterion does not return to the 'amber' trigger level within 2 years (i.e. by IY5), weed control efforts will need to be increased further.

## 4.6 Key observations and required management actions at each monitoring site

Table 6 summarises the key observations made at each monitoring site in IY4 and recommended management actions.

**Table 6 Observations made at monitoring sites in IY4 and management priorities**

Bog	Observations in IY4	Priority
<b>Impact Sites</b>		
<b>Bog 4.2</b>	This impact site is showing signs of recovery from the effects of vegetation removal, sedimentation and rabbit activity, as a result of revegetation, sediment control and rabbit control that took place in IY2, IY3 and IY4. Dieback of native vegetation surrounding this impact site has occurred in six locations. Sediment control, weed control, rabbit control and revegetation must continue.	High priority for weed control, rabbit control and revegetation.
<b>Bog 6</b>	Less evidence of sedimentation within this site in IY4. Sediment becoming incorporated into or covered by a new humus or peat layer (Photo 6). Weeds continue to proliferate, resulting in further fragmentation of the Alpine Bog. Deer control, weed control and revegetation undertaken in IY4 is likely to result in future improvements, assuming management efforts are maintained. Similar deer control, weed control and revegetation efforts must therefore be made in IY5. Weed control should include a focus on tributaries that enter Bog 6.	High priority for weed control, deer control, revegetation and review of weed control techniques.
<b>Bog 8/9/10</b>	The area of this impact site has increased as bog-dependent species have filled the void left by the dieback of non-bog-dependent species, which has occurred at three locations. Conversely, the dimensions of this Alpine Bog complex along transects have decreased and the cover of weeds within the Alpine Bog complex has increased.	Moderate priority for weed control.
<b>Bog 11.2 and 12</b>	These bogs are immediately upslope/downslope of each other and have similar management issues. Bog 11.2 is showing signs of recovery from the effects of sedimentation, rocks and boulders, as a result of sediment control, weed control and revegetation. However, weeds continue to colonise sediment at both sites, including the area of Bog 11.2 damaged by a rock in IY1 (compare Photo 7, Photo 8, Photo 9 and Photo 10).	High priority for weed control.
<b>Bog 13</b>	<p>Since BY1, this bog has been surrounded by predominantly introduced vegetation, particularly weedy grasses (e.g. Brown-top Bent and Sweet Vernal-grass). As at IY4, weed cover at this Alpine Bog appears to have stabilised but is still elevated compared to the baseline mean. This is likely to be due to the very small size of the Alpine Bog and its isolation, rather than any impacts from construction.</p> <p>Earthworks have occurred directly upslope of this bog in IY4 (Photo 11). Follow up sediment and weed control is needed to avoid potential impacts to Bog 13.</p>	<p>Moderate priority for weed control.</p> <p>High priority for sediment control.</p>

Bog	Observations in IY4	Priority
<b>Control Sites</b>		
<b>Bog 1</b>	The south-eastern corner of Bog 1 has been subject to unintended artificial watering from Baldy Turret tank for an unknown period of time. Regular discharges of water ceased in November 2021. The site should be monitored for drying and consequent incursion of weeds and/or non-bog-dependent species. Soft Rush is present along the northern boundary of this site, along the edge of the Summer Nature Walk. These plants need to be removed or killed. Given the location's proximity to the walking trail and sensitivity to erosion, herbicide treatment followed by revegetation may be the most appropriate method. Soft Rush is also present near the southern extent of this site.	Moderate priority for weed control.
<b>Bog 2</b>	The eastern boundary of Bog 2, near Transect 2A, is subject to severe weed pressures due to historic disturbances to the east of this monitoring site. Targeted weed control along the eastern boundary will be required.	Moderate priority for weed control.
<b>Bog 4.1/5/7</b>	This Alpine Bog complex has been fragmented by weed proliferation along the aqueduct and north of the aqueduct. The main weeds of concern remain Sword Rush, Musk Monkey-flower and Soft Rush. Further weed control will be needed in IY5, particularly downstream of the aqueduct. Reduced deer activity was noted at this control site in IY4, presumably as a result of recent deer control.	High priority for weed, deer and rabbit control.
<b>Bog 11.1</b>	Deer activity appears to have reduced at this control site. As a result, vigorous growth of bog-dependent species and a further increase in the extent of this control site was noted in IY4. Dieback of non-bog-dependent species along the westernmost branch has occurred at four locations. This, along with possible artificial watering of the eastern side of Bog 11.1 from Baldy Turret tank, may have contributed to the increased area recorded in IY3 and IY4.	Moderate priority for weed and deer control.
<b>Bog S1</b>	The north-western end of this Alpine Bog (near Transect S1A) remains dry, perhaps due to water flow becoming channelised by past deer and horse activity. The impact of deer is still evident and impacts from horses are still present near Stirling Trail. Blocking of the main channel (e.g. with rice straw bales) may flood the dominant weeds and allow for recolonisation by bog-dependent species. Further treatment of weeds such as Musk Monkey-flower will be needed. Near the mid-point of this Alpine Bog, the southern boundary remains dynamic as Mountain Tea-tree continue to regenerate following the 2006-2007 fires. The removal of Grey Sallow <i>Salix cinerea</i> in 2022 has led to the recovery of bog extent on the western boundary of Bog S1. Strong growth of Peat Moss at multiple locations along the western boundary and at the southern end of the site has resulted in an increase to the area of Bog S1.	Moderate priority for weed control, deer control and flow management.

Bog	Observations in IY4	Priority
<b>Bog S2</b>	Deer activity has reduced in the Montane Riparian Thicket surrounding the Alpine Bog and post-fire vegetation succession and vigorous Peat Moss growth has resulted in recovery of Alpine Bog vegetation and an increase in the extent of this monitoring site.	Moderate priority for weed and deer control.
<b>Bog S3</b>	Peat Moss at this control site appears very healthy and has resulted in an increase in the extent of this site, especially along the western boundary. Continued presence of Musk Monkey-flower has resulted in a loss of extent at the north-east boundary of Bog S3. In IY4, recovery of native vegetation was observed at established deer wallow sites outside the northern boundary of Bog S3, however, recent deer activity was evident. The RMB's deer control efforts will need to be repeated to ensure that deer activity remains low.	Moderate priority for weed and deer control.
<b>Other Sites</b>		
<b>Bog 3</b>	Soft Rush and Musk Monkey-flower are still present in Bog 3, particularly along its western side, resulting in the current size of the Alpine Bog still being less than its baseline mean, and a reduction in the area of Bog 3 compared to IY3. Bog 3 is at the headwaters of drainage line that ultimately enters Bog 6, which is why Bog 3 was targeted for weed control in IY3 and IY4. Further weed control will be needed in IY5.	High priority for weed control.

## 5. Conclusion and recommendations

Six years of ecological monitoring, including two years of baseline monitoring, have now been completed. The monitoring results allow for an assessment against the HEMAMP's performance criteria. Table 7 presents the results of the compliance assessment as at IY4. It should be noted that there was a strong effort from the RMB to undertake management actions again in IY4 (e.g. weed, deer and sediment control). The benefits of IY3 management actions on impact sites are reflected in monitoring results in that construction-related impacts (e.g. sedimentation and weed cover) have stabilised or been reversed in some instances.

**Table 7 Compliance with the HEMAMP performance criteria**

Performance criterion	Compliant?	Action required?	Comments
<b>Extent</b>			
<b>No more than a 10% reduction in the total combined area of impact sites, relative to control sites.</b>	Yes	Yes	Potential for future non-compliance. Total combined area of impact sites, relative to control sites, has decreased by 6.6% (although true value is likely to be closer to 0.4%). Sediment/weed control and revegetation are still needed, especially at Bog 6.
<b>Composition</b>			
<b>No more than a 10% reduction in the total 'bog-dependent' native flora species richness of impact sites, relative to control sites.</b>	Yes	Yes	Silver Astelia was incidentally observed at impact sites again in IY4. Propagation of Silver Astelia commenced in 2023 and re-introduction to impact sites is planned for spring 2024.
<b>Encroachment</b>			
<b>No more than a 10% increase in the cover of 'non-bog-dependent' species within impact sites, relative to control sites.</b>	Yes	No	The cover of non-bog-dependent flora species has increased by 3.0% at impact sites relative to control sites. This result shows the reversal of the divergence between impact sites and control sites that has been observed since IY1.
<b>Weed cover not to exceed 5% (noting that baseline mean was already 5.9%).</b>	No	Yes	Weed cover at impact sites is 7.8%. Concerted IY3 weed control effort resulted in 1.0% reduction in weed cover in IY4. Continued need to control sediment, weeds and deer and revegetate.
<b>Structure</b>			
<b>No more than a 10% reduction in the average cover of Peat Moss within impact sites, relative to control sites.</b>	Yes	No	Peat Moss cover has increased by 1.8% at impact sites relative to control sites. Overall, Peat Moss cover and health is good.

The recommendations of this monitoring report are as follows:

1. Despite positive trends being observed at impact sites, adaptive management actions should continue to be implemented at these sites (particularly at Bog 6) to reverse construction-related impacts.
2. Now that the unintentional bulk discharge of water upslope of Mount Buller's eastern control sites has ceased, ecological monitoring should be alert to a potential decline in the area of these sites and adapt analysis of results accordingly.
3. The RMB should investigate the small discharge of water that is still occurring from Baldy Turret pump house and, if possible, consider stopping this discharge so as not to affect monitoring results at Mount Buller's eastern control sites.
4. Dieback locations must continue to be re-visited in future years to investigate possible causes, to track vegetation recovery or succession and to plan any necessary management interventions e.g. revegetation.
5. The RMB should further investigate whether the environmental watering system meets the original design specifications (by comparing endoscope footage with final design drawings) and what volumes of water are being discharged from the water storage drainage system to the environmental watering system.
6. Additional survey effort should be undertaken in IY5 to identify and map any new Alpine Bog vegetation within the Boggy Creek catchment (upslope of Bog 13) and to re-visit Alpine Bogs that were newly identified and mapped in BY2 (so-called 'other sites'). This will provide a broader picture of how Alpine Bog vegetation in the Boggy Creek catchment is responding to construction of the water storage.
7. In IY4, the RMB was again successful in preventing further movement of sediment into impact sites. The RMB must continue to implement the Ecological Rehabilitation Plan (Biosis 2020a) and its Addendum (Biosis 2022a) to continue to prevent movement of sediment from the PCF into Alpine Bogs.
8. The HEMAMP Protocol should be updated to indicate that bog composition considers species recorded along transects and incidentally. The monitoring procedure should be updated to specify that if any given bog-dependent species is not recorded along transects in a given year, a more detailed and thorough search should be undertaken for the missing species before further action is taken.
9. Despite the concerted weed control effort of IY3 resulting in a noticeable improvement in weed cover at impact sites in IY4, weed covers still sit at the 'red' trigger level for adaptive management. In accordance with the HEMAMP Protocol, weed management actions and effort will need to be scaled up and intensified further in IY5.
10. Update the HEMAMP Protocol to change the weed cover threshold from 5% to the relative baseline mean for both impact and control sites. Weed control efforts should not be reduced and must be scaled up and intensified in IY5.

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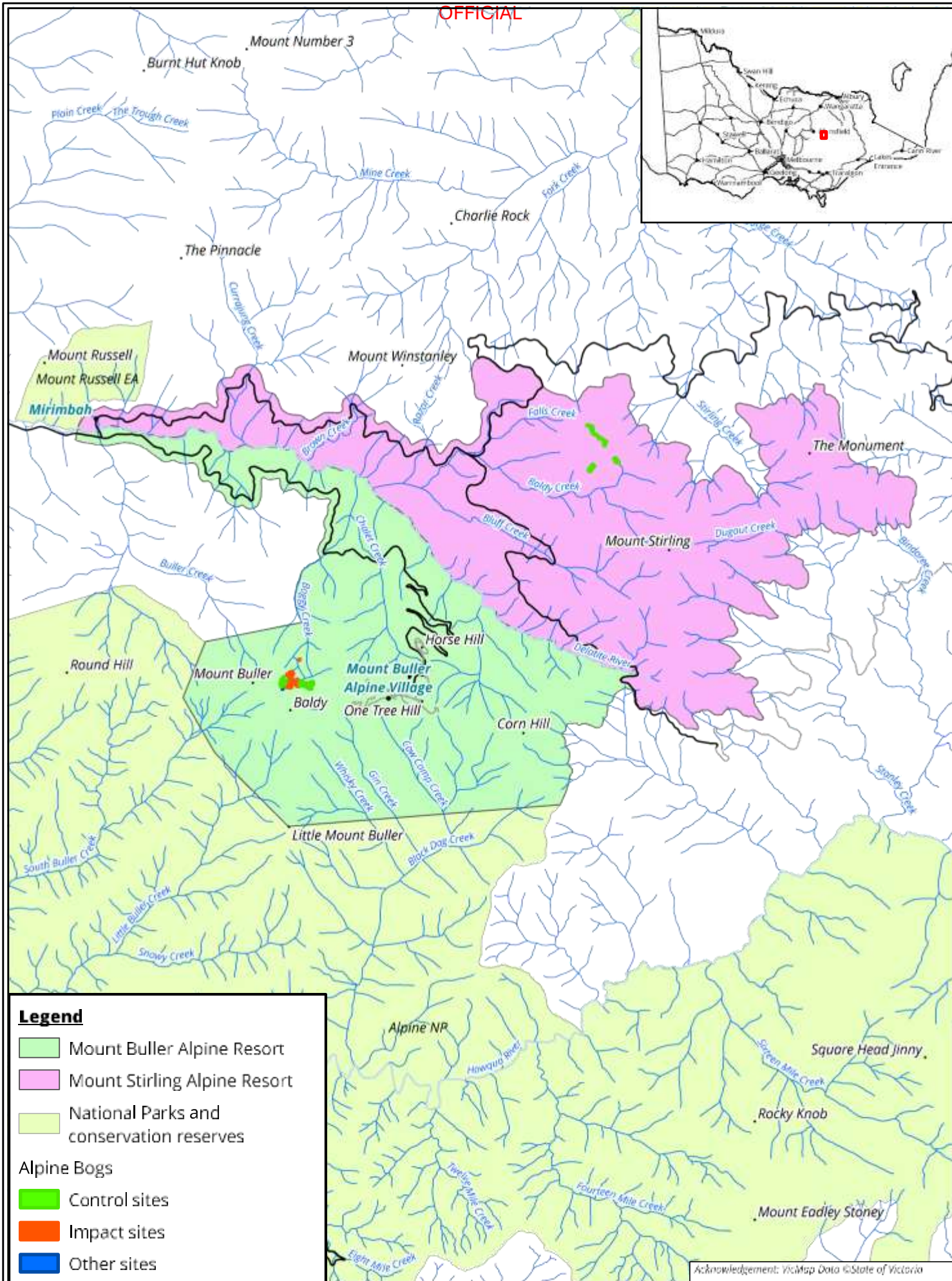
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## Figures

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**Legend**

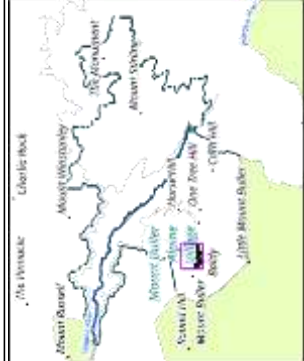
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- Mount Stirling Alpine Resort
- National Parks and conservation reserves
- Alpine Bogs
  - Control sites
  - Impact sites
  - Other sites

**Figure 1 Location of the Mount Buller and Mount Stirling Alpine Resorts, Victoria**

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 Date: 07 June 2023,  
 Prepared for: MG, Prepared by: SKM, Last edited by: smitchell  
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 Project: P:\38500s\38541\Mapping\38541\_Mt\_Buller\38541\_Mt\_Buller\_2023\Project\_Year4.aprx



Acknowledgement: VicMap Data ©State of Victoria



- Legend**
- Project Construction Footprint (PCF)
  - Ecological monitoring (Alpine Bogs)
    - Control site (2023)
    - Impact site (2023)
    - Other site (2023)
  - Climatological monitoring
    - Snow gauge
    - Weather station
  - Hydrological monitoring
    - Groundwater bore
    - Surface water monitoring location

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**Figure 2 Location of Alpine Bogs subject to monitoring at Mount Buller Alpine Resort**

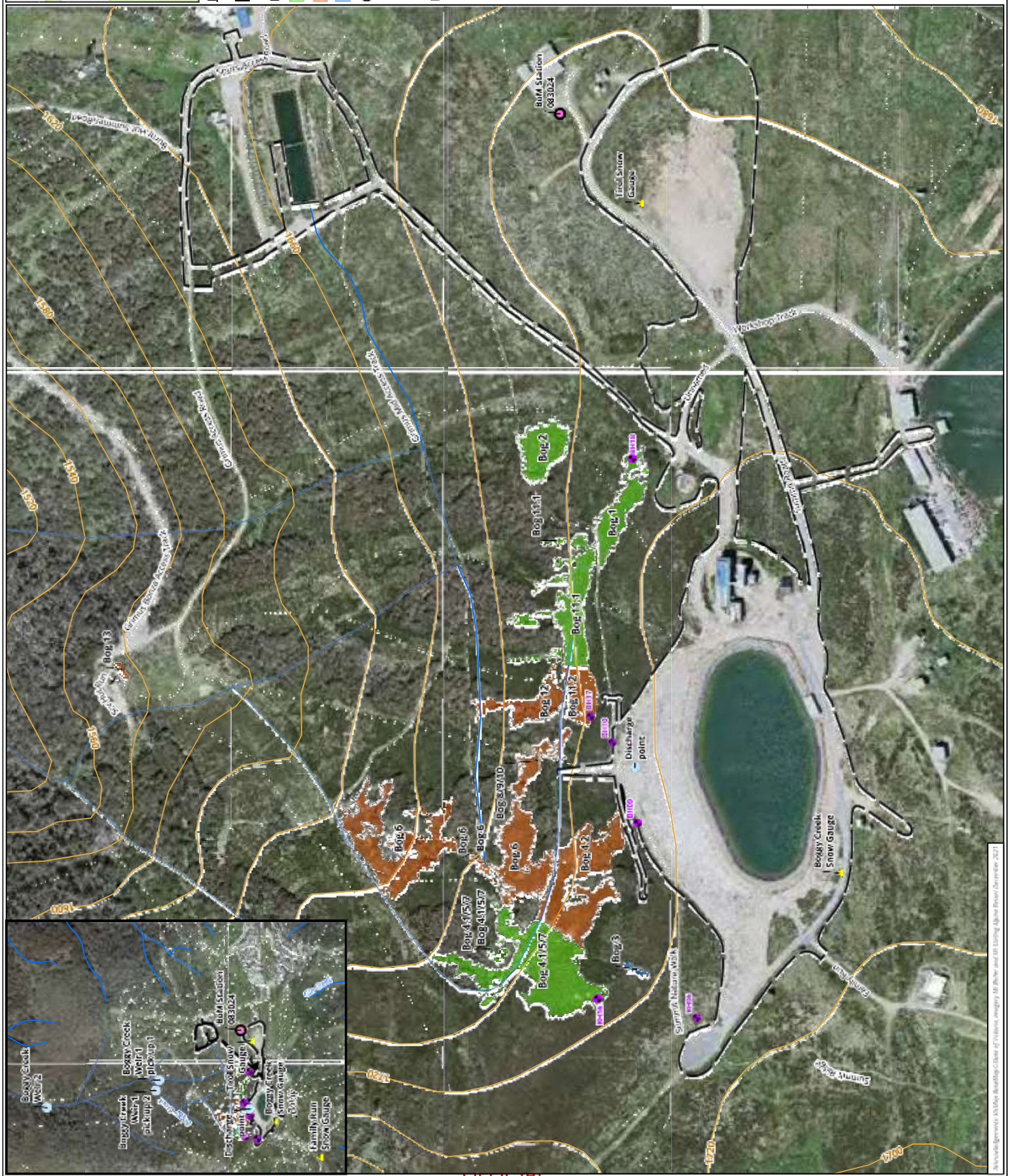
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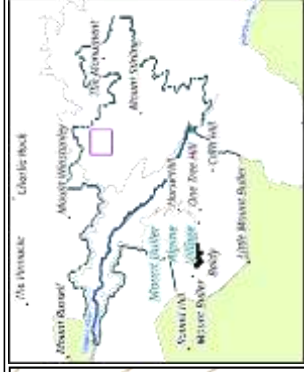
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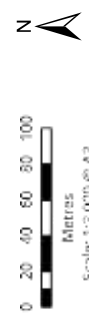
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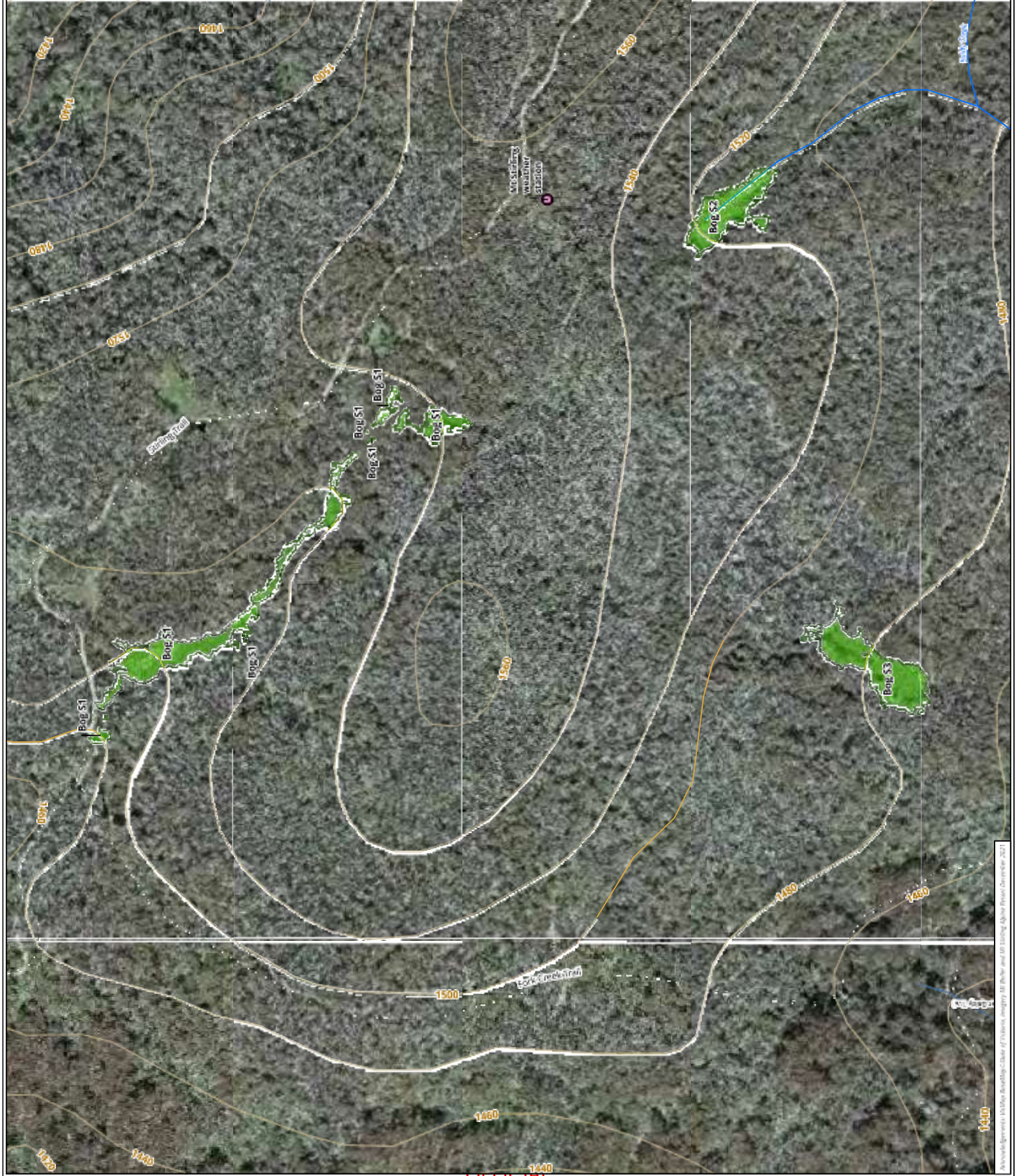
**Legend**  
 Alpine Bogs (Biosis 2023)  
 Control site (2023)  
 Climatological monitoring  
 Weather station



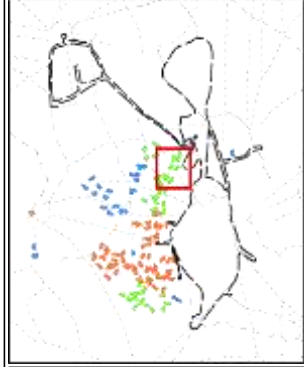
Scale: 1:50,000 @ A3  
 Coordinate System: GDA 1994 MGA Zone 55



Mount Stirling  
 2023-2024  
 Prepared by: Biosis  
 Project: Mount Stirling Alpine Bogs  
 Date: 2023-10-20

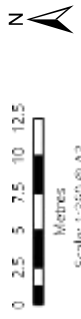


Mount Stirling Alpine Bogs  
 2023-2024  
 Prepared by: Biosis  
 Project: Mount Stirling Alpine Bogs  
 Date: 2023-10-20



**Legend**

- Project Construction Footprint
- Transects
- Quadrat
- Transect photo point
- Control site (2023)
- Baseline year 1
- Baseline year 2

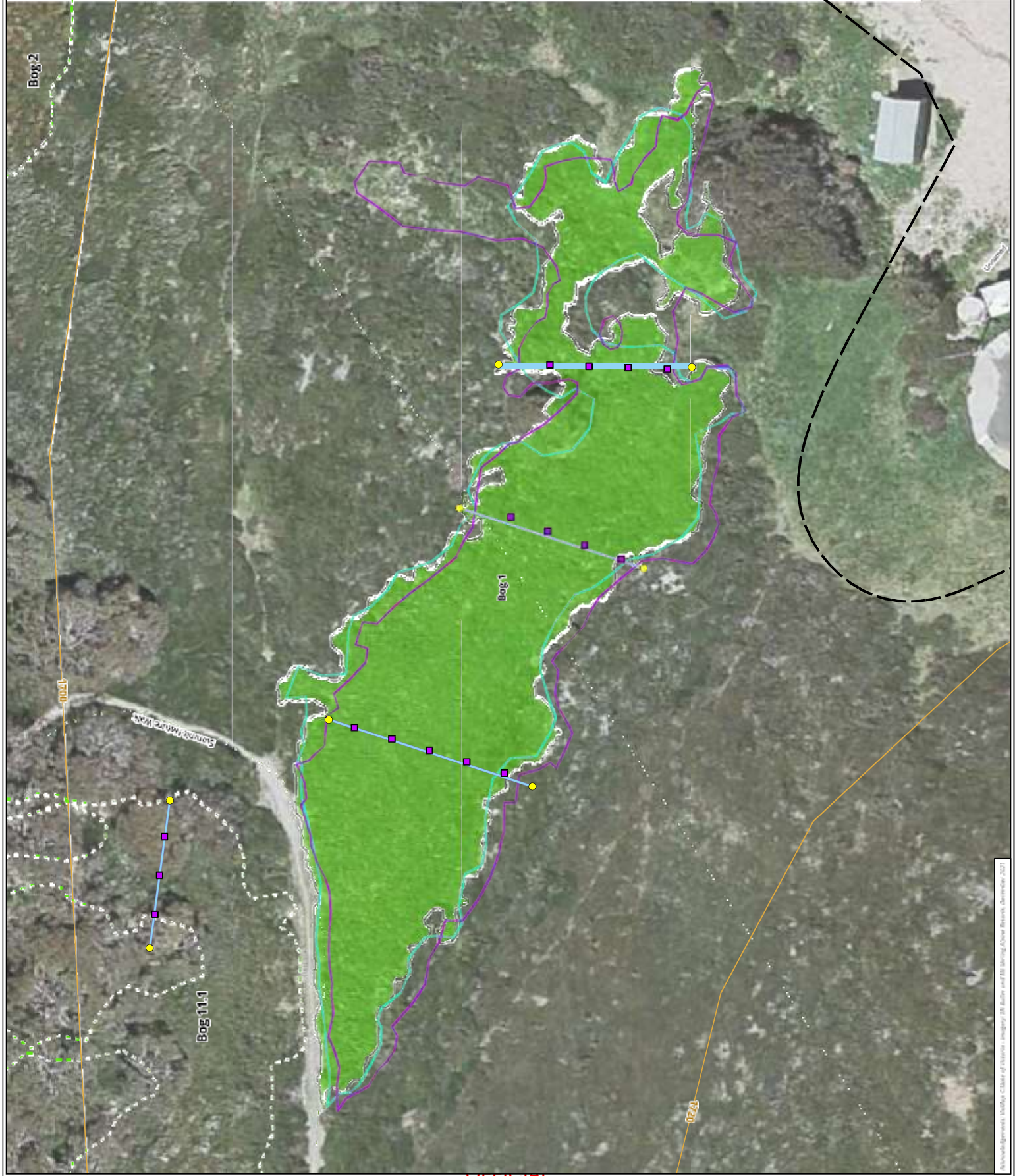


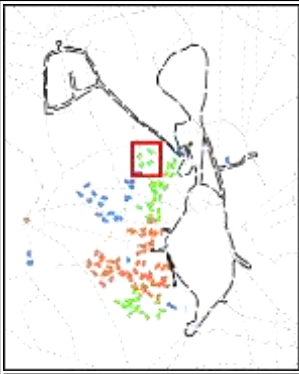
Scale: 1:500 @ A3  
 Coordinate System: GCS 1994 MGR Zone 55



Version: 25-01  
 Date: 10/12/2024  
 Author: [Name]  
 Project: [Name]  
 File: [Name]

**Figure 4a Bog 1 (control site)**

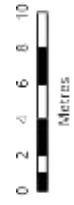




**Legend**

- Transects
- Quadrat
- Transect photo point
- Control site (2023)
- Baseline year 1
- Baseline year 2

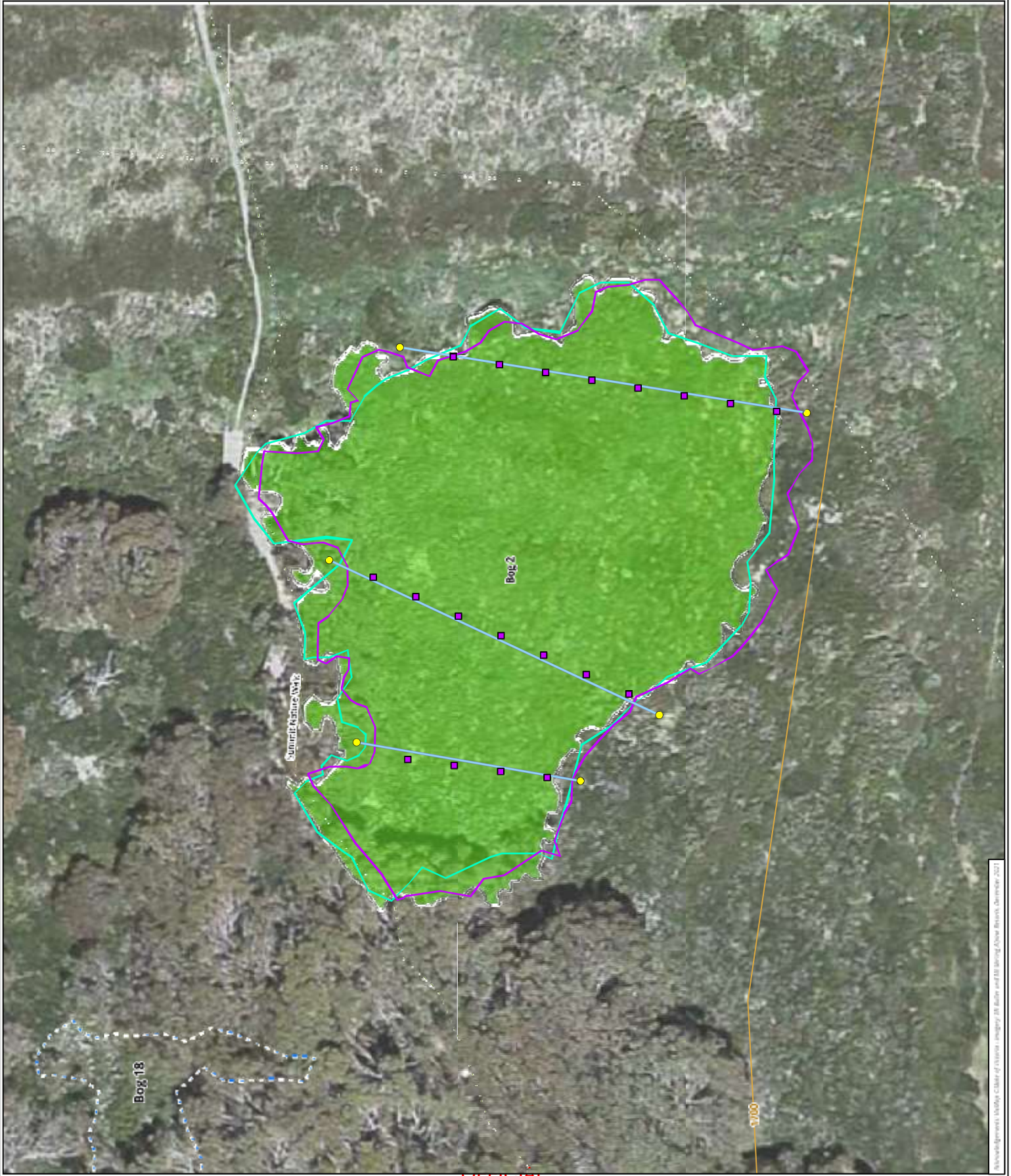
**Figure 4b Bog 2 (control site)**



Scale: 1:5000 @ A3  
Coordinate System: GCS: 1994 MGA Zone 55



Version: 25-01  
Date: 10/10/2023  
Author: [Name]  
Project: [Name]

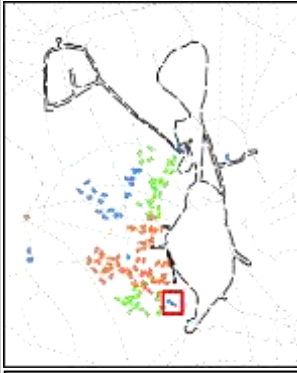




Scale: 1:200 @ A3  
Coordinate System: GCS: 1994 MGRS Zone 35



Project 23-01  
2411/2024/01  
2411/2024/01 - Support for...  
2411/2024/01 - Support for...  
2411/2024/01 - Support for...  
2411/2024/01 - Support for...



**Legend**




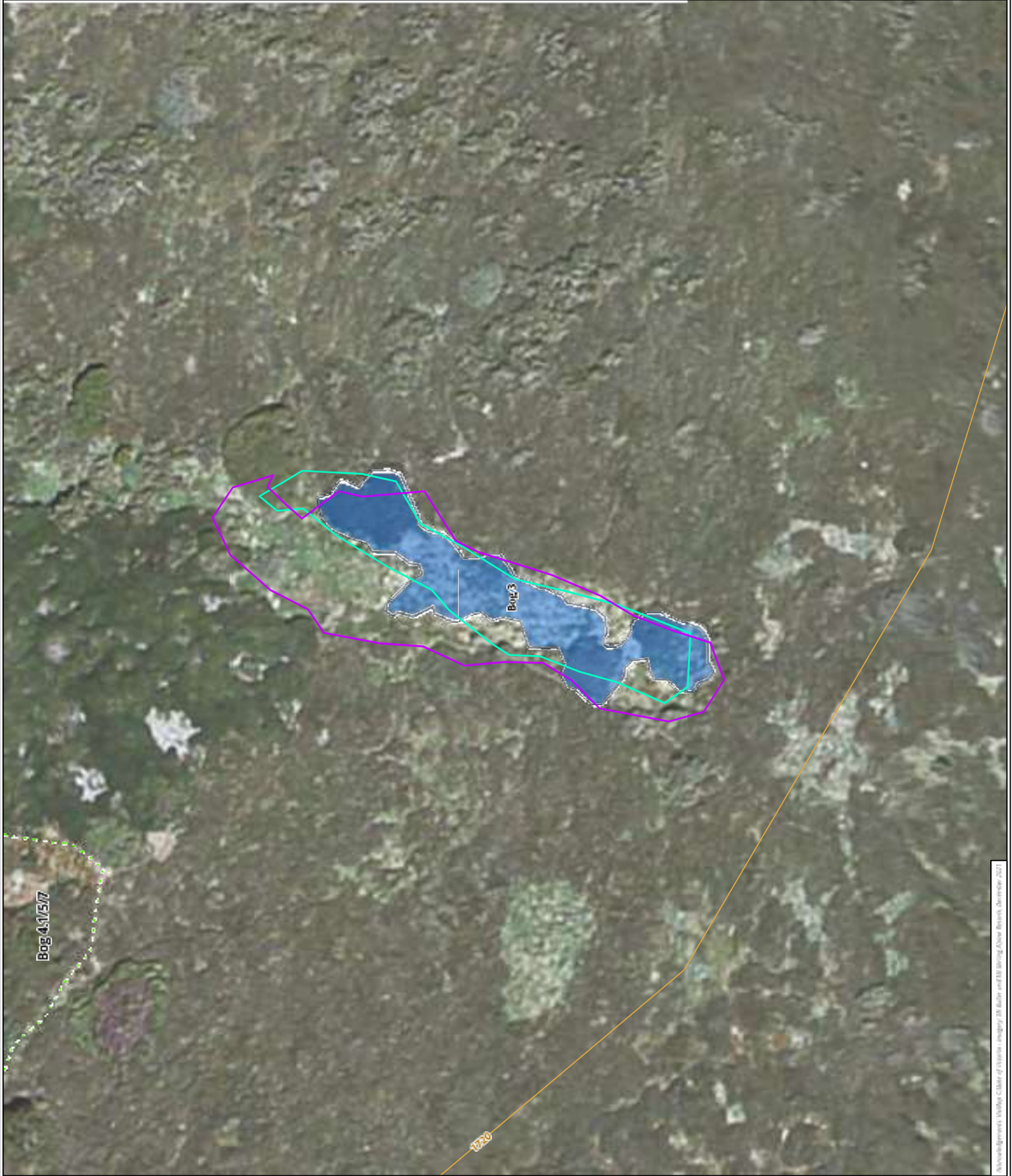
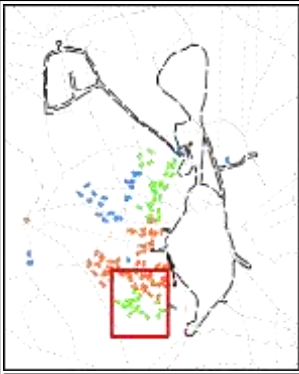
-  Other site (2023)
-  Baseline year 1
-  Baseline year 2

Figure 4c Bog 3 (other site)



Accession numbers: 2411/2024/01 - Support for... 2411/2024/01 - Support for... 2411/2024/01 - Support for... 2411/2024/01 - Support for...



**Legend**

- Transects
- Quadrac
- Transect photo point
- Control site (2023)
- Baseline year 1
- Baseline year 2

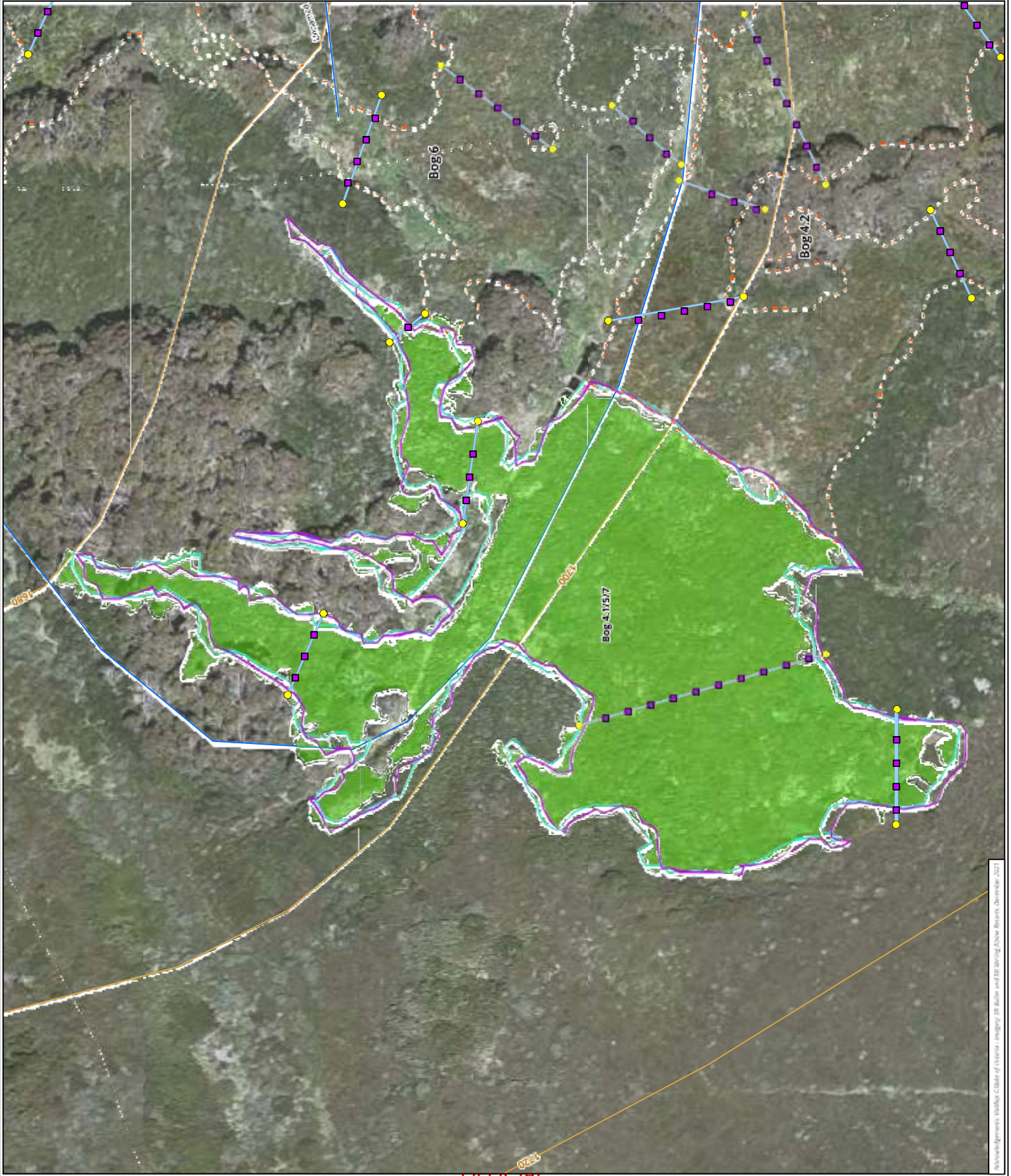
**Figure 4d Bog 4.1/5/7 (control site)**

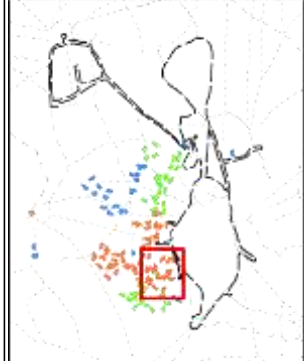


Metres  
Scale: 1:6000 @ A3  
Coordinate System: GCS 1994 MGRS Zone 35



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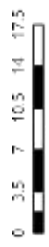




**Legend**

- Project Construction Footprint
- Tracks
- Quadrat
- Transect photo point
- Impact site (2023)
- Baseline year 1
- Baseline year 2

**Figure 4e Bog 4.2 (impact site)**



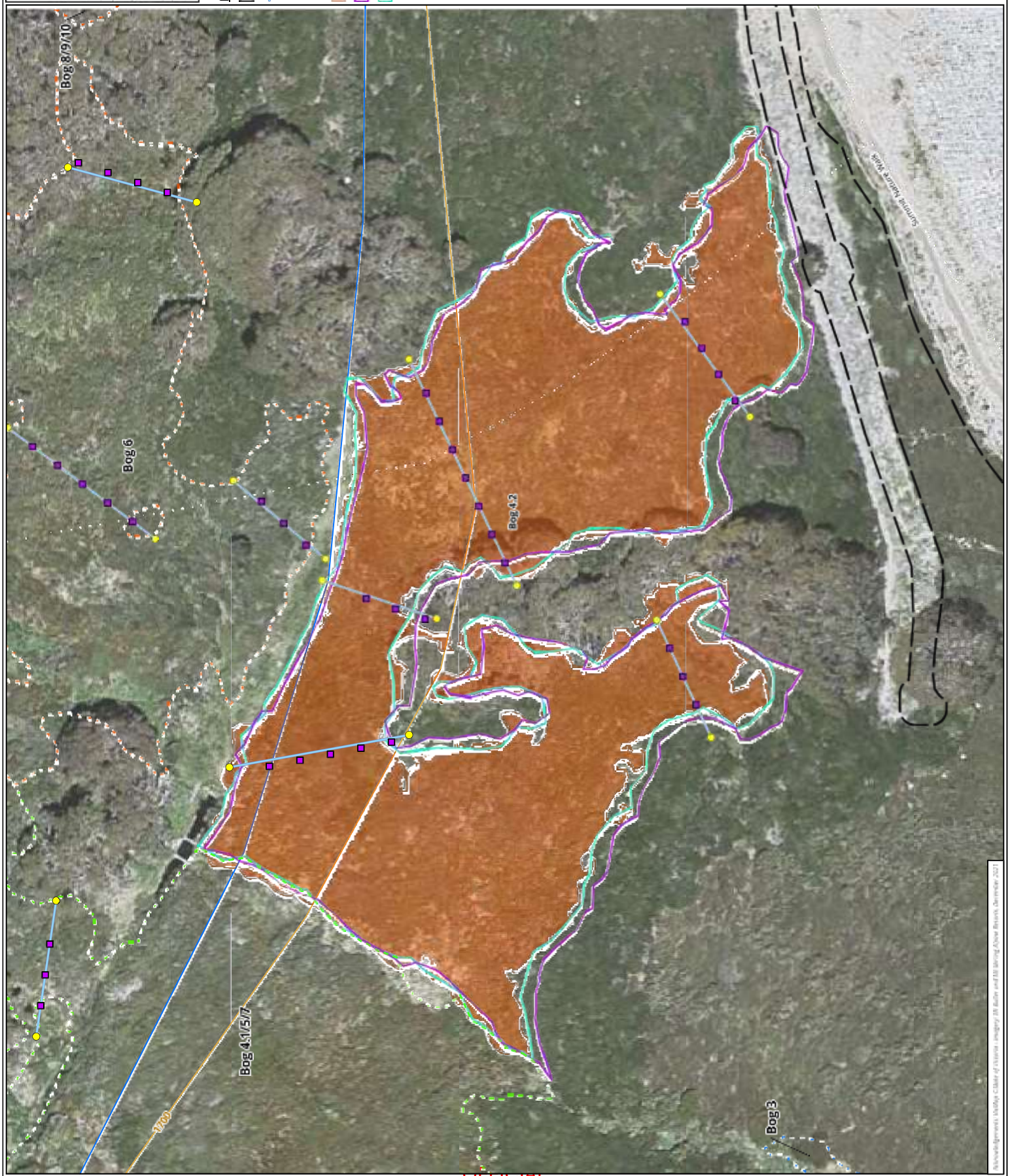
Metres

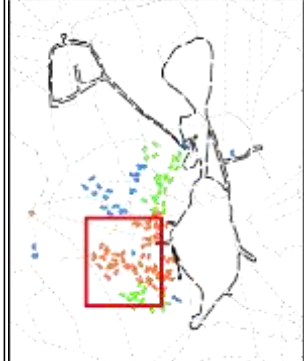
Scale: 1:430 @ A3

Coordinate System: GCS 1994 MGR Zone 55



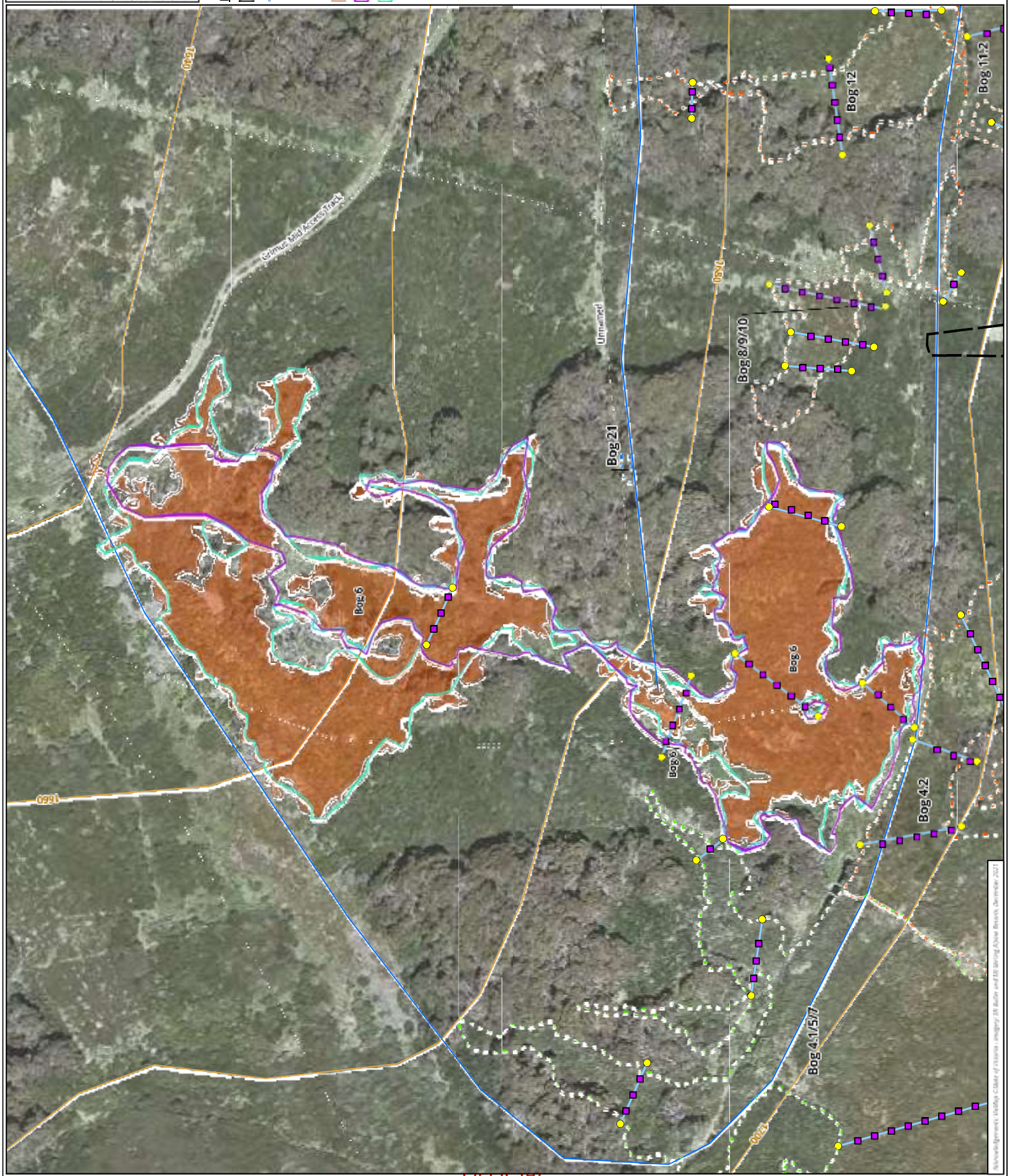
Project 25-01  
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 25/10/2023  
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 31/12/2023



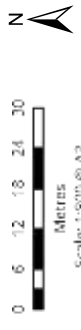


**Legend**

- Project Construction Footprint
- Transects
- Quadrat
- Transect photo point
- Impact site (2023)
- Baseline year 1
- Baseline year 2



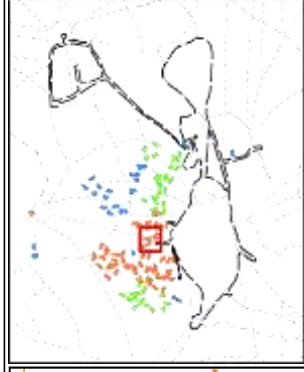
**Figure 4f Bog 6 (impact site)**



Scale: 1:800 @ A3  
 Coordinate System: GCS 1994 MGA Zone 55



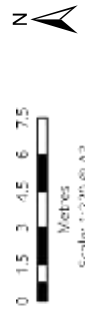
Version: 25-01  
 Date: 10/10/2023  
 Author: Biosis  
 Project: 2301 - Bog 6 Impact  
 File: 2301 - Bog 6 Impact - Figure 4f



**Legend**

- Project Construction Footprint
- Transects
- Quadrat
- Transect photo point
- Impact site (2023)
- Baseline year 1
- Baseline year 2

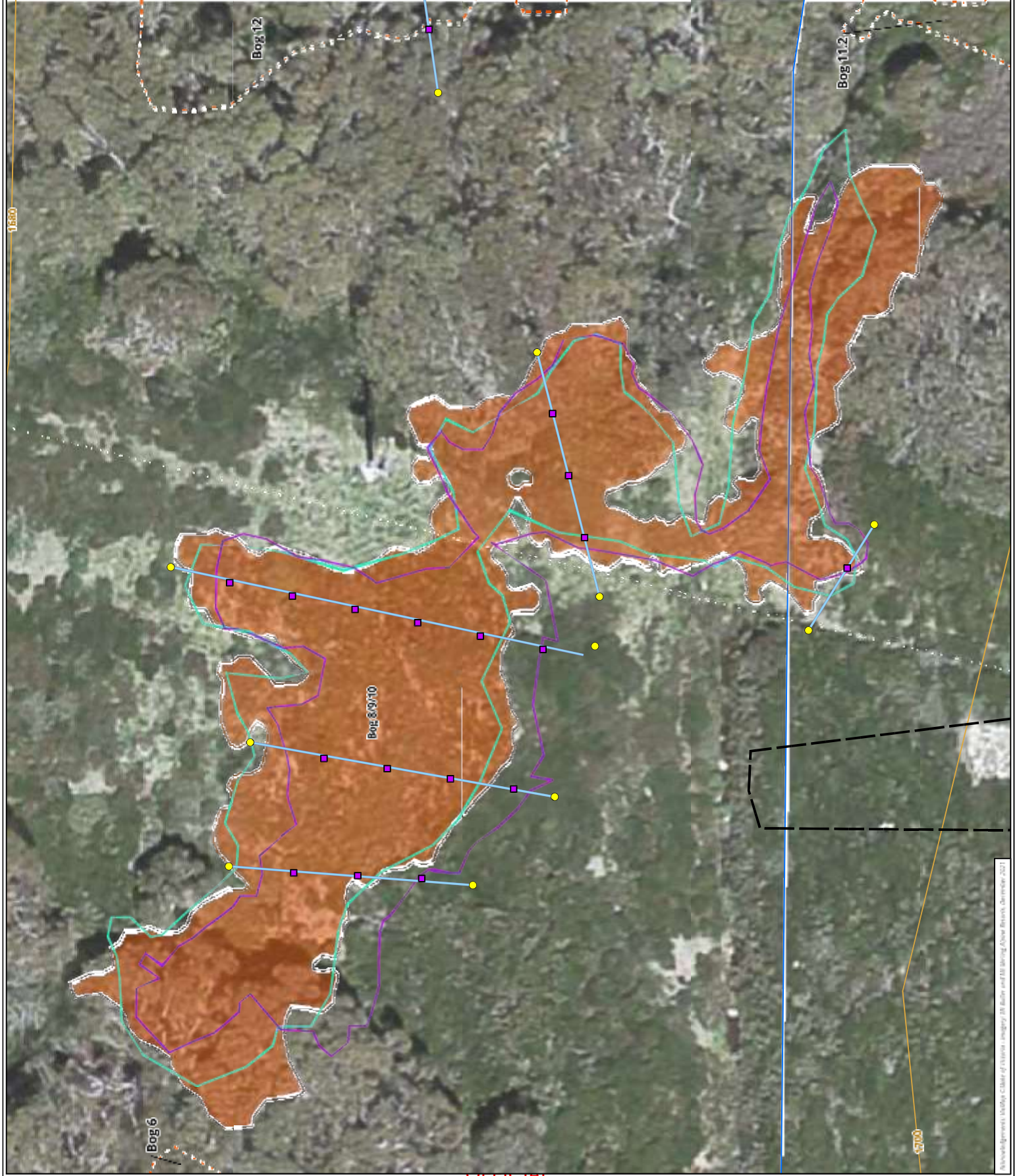
**Figure 4g Bog 8/9/10 (impact site)**



Scale: 1:220 @ A3  
 Coordinate System: GCS 1994 MGR Zone 35



Version: 25-01  
 Date: 10/12/2024  
 Author: [Name]  
 Project: [Name]  
 File: [Name]

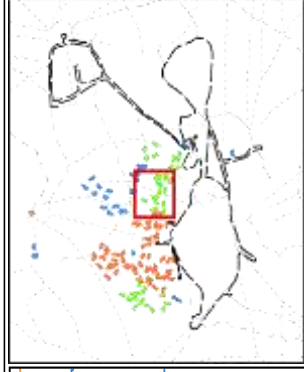




Scale: 1:420 @ A3  
Coordinate System: GCS 1994 MGA Zone 55

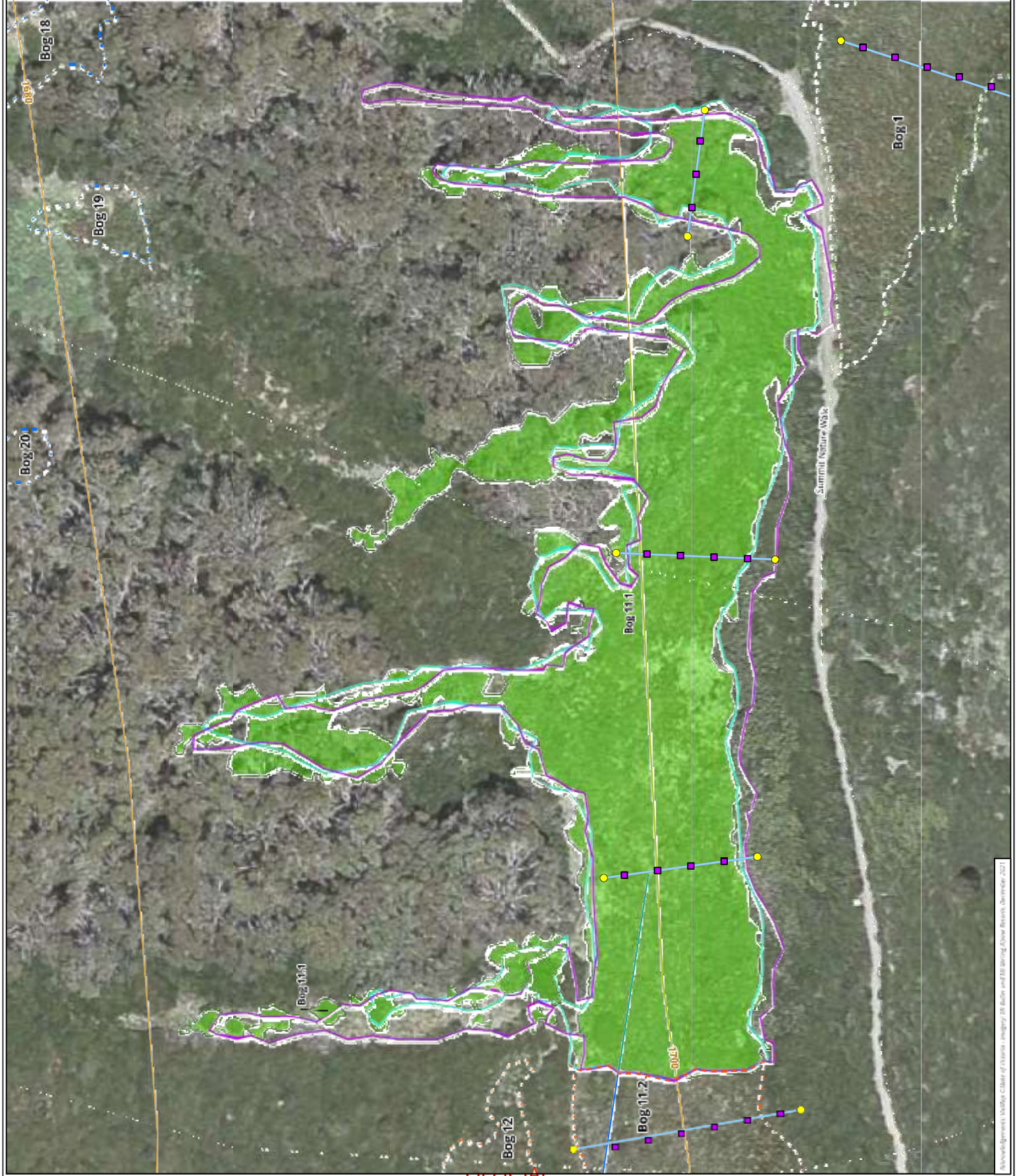


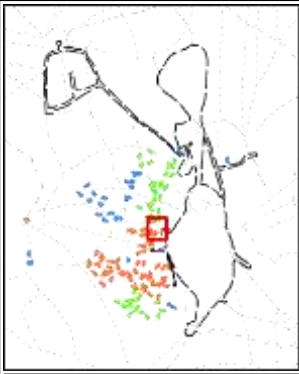
Project 25-01  
24/10/2023  
Prepared by: Biosis  
Approved by: [Name]  
Date: 24/10/2023



- Legend**
- Transects
  - Quadrat
  - Transect photo point
  - Control site (2023)
  - Baseline year 1
  - Baseline year 2

Figure 4h Bog 11.1 (control site)





**Legend**

- Project Construction Footprint
- Transects
- Quadrat
- Transect photo point
- Impact site (2023)
- Baseline year 1
- Baseline year 2

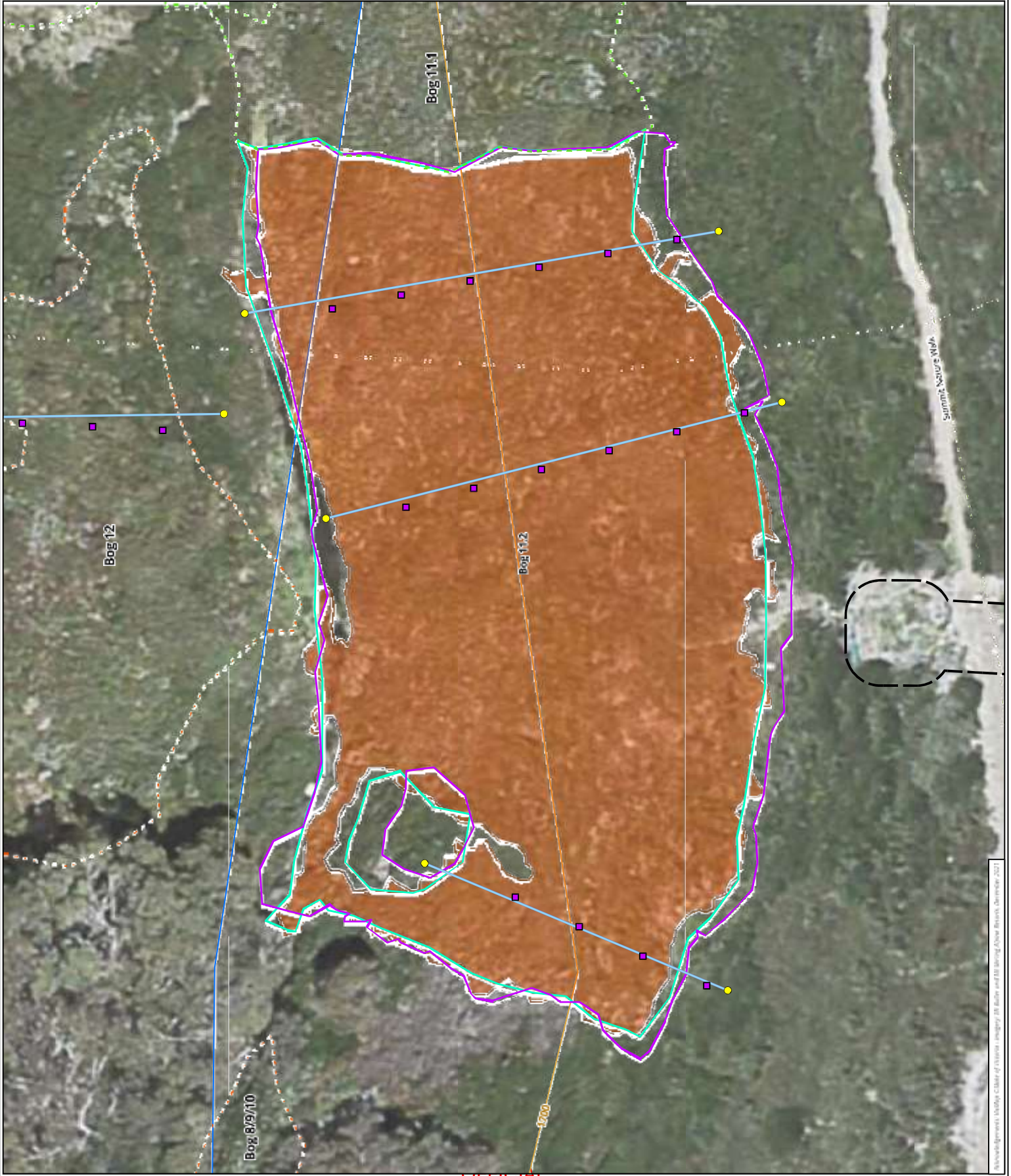
**Figure 4| Bog 11.2 (impact site)**

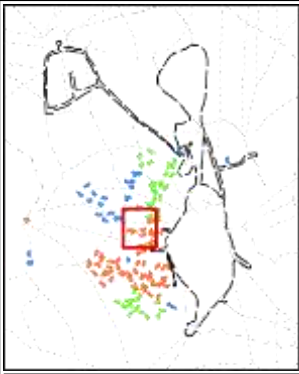


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 Coordinate System: GCS: NAD 1983 UTM Zone 18N



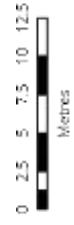
Summit 25-01  
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 2023-01-10  
 2023-01-10  
 2023-01-10





**Legend**

- Transects
- Quadrac
- Transect photo point
- Impact site (2023)
- Baseline year 1
- Baseline year 2

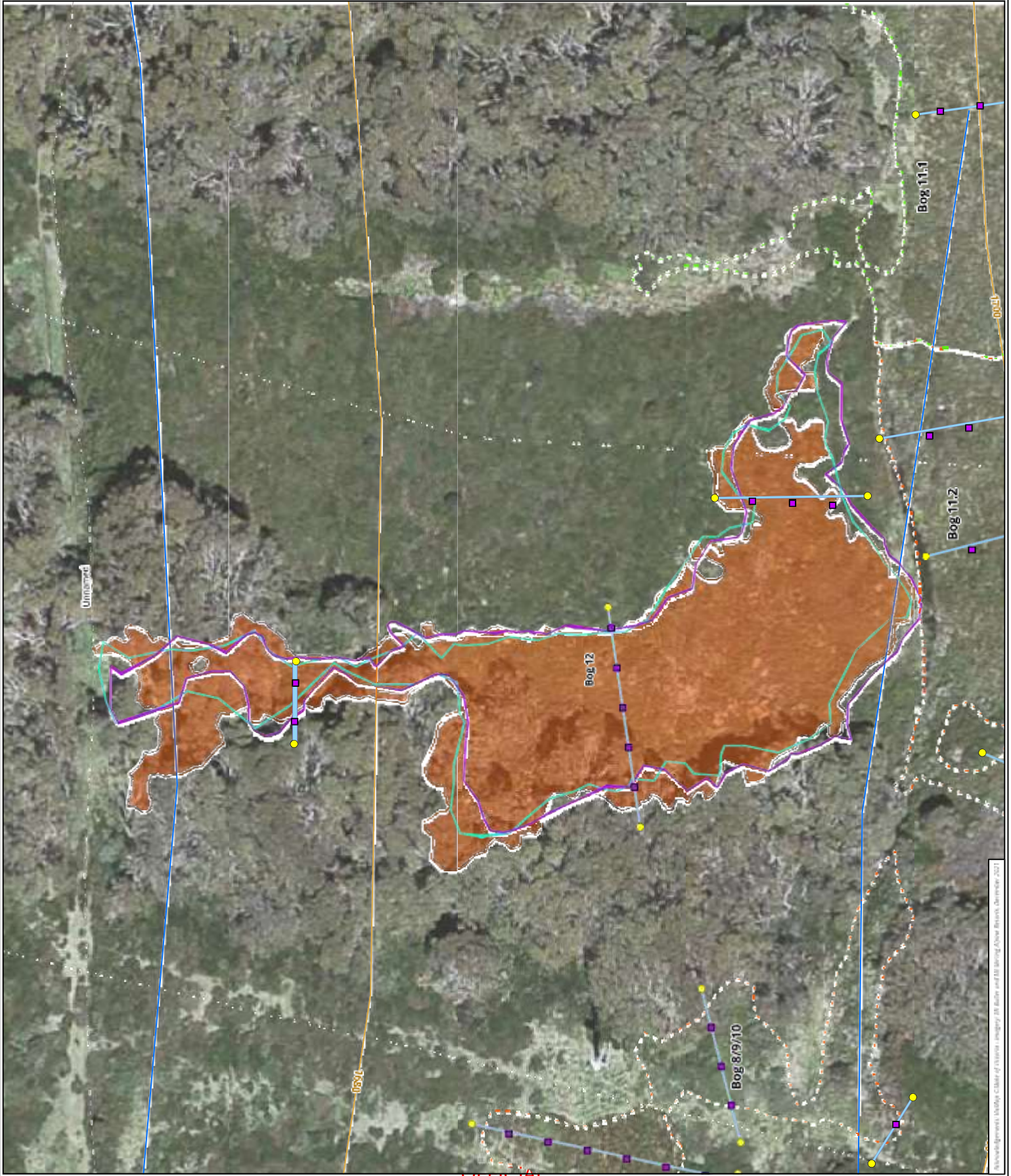


Scale: 1:500 @ A3  
 Coordinate System: GCS 1994 MGA Zone 55

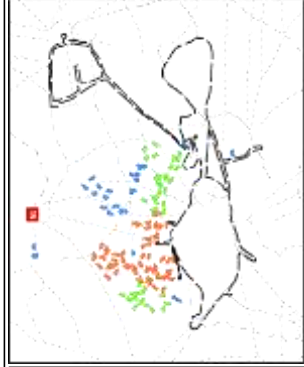


Project 25-01  
 24/11/2024  
 Prepared by: Biosis  
 Project 25-01, 25-02, 25-03, 25-04, 25-05, 25-06, 25-07, 25-08, 25-09, 25-10, 25-11, 25-12, 25-13, 25-14, 25-15, 25-16, 25-17, 25-18, 25-19, 25-20, 25-21, 25-22, 25-23, 25-24, 25-25, 25-26, 25-27, 25-28, 25-29, 25-30, 25-31, 25-32, 25-33, 25-34, 25-35, 25-36, 25-37, 25-38, 25-39, 25-40, 25-41, 25-42, 25-43, 25-44, 25-45, 25-46, 25-47, 25-48, 25-49, 25-50, 25-51, 25-52, 25-53, 25-54, 25-55, 25-56, 25-57, 25-58, 25-59, 25-60, 25-61, 25-62, 25-63, 25-64, 25-65, 25-66, 25-67, 25-68, 25-69, 25-70, 25-71, 25-72, 25-73, 25-74, 25-75, 25-76, 25-77, 25-78, 25-79, 25-80, 25-81, 25-82, 25-83, 25-84, 25-85, 25-86, 25-87, 25-88, 25-89, 25-90, 25-91, 25-92, 25-93, 25-94, 25-95, 25-96, 25-97, 25-98, 25-99, 25-100

**Figure 4j Bog 12 (impact site)**



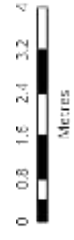
Management Plan for the Bog 12 and 11.1/11.2/11.3/11.4/11.5/11.6/11.7/11.8/11.9/11.10/11.11/11.12/11.13/11.14/11.15/11.16/11.17/11.18/11.19/11.20/11.21/11.22/11.23/11.24/11.25/11.26/11.27/11.28/11.29/11.30/11.31/11.32/11.33/11.34/11.35/11.36/11.37/11.38/11.39/11.40/11.41/11.42/11.43/11.44/11.45/11.46/11.47/11.48/11.49/11.50/11.51/11.52/11.53/11.54/11.55/11.56/11.57/11.58/11.59/11.60/11.61/11.62/11.63/11.64/11.65/11.66/11.67/11.68/11.69/11.70/11.71/11.72/11.73/11.74/11.75/11.76/11.77/11.78/11.79/11.80/11.81/11.82/11.83/11.84/11.85/11.86/11.87/11.88/11.89/11.90/11.91/11.92/11.93/11.94/11.95/11.96/11.97/11.98/11.99/12.00



**Legend**

- Transects
- Quadrat
- Transect photo point
- Impact site (2023)
- Baseline year 1
- Baseline year 2

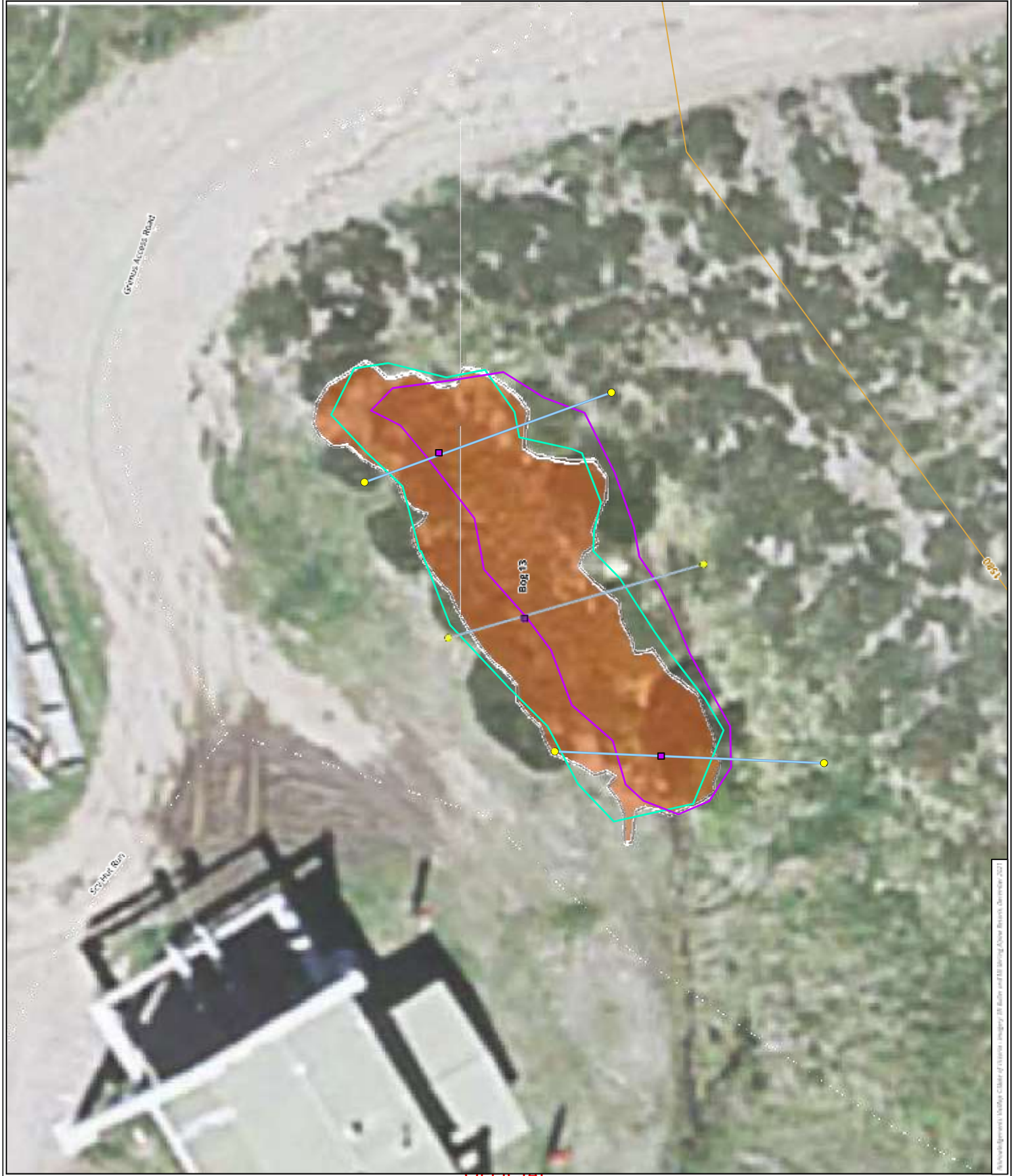
**Figure 4k Bog 13 (impact site)**

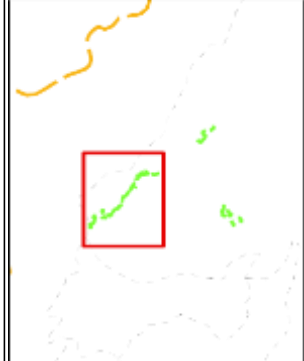


Scale: 1:100 @ A3  
 Coordinate System: GCS 1994 MGA Zone 55



Project 25-01  
 24/11/2024  
 Prepared by: Biosis Pty Ltd  
 Project 25-01, 25-02, 25-03, 25-04, 25-05, 25-06, 25-07, 25-08, 25-09, 25-10, 25-11, 25-12, 25-13, 25-14, 25-15, 25-16, 25-17, 25-18, 25-19, 25-20, 25-21, 25-22, 25-23, 25-24, 25-25, 25-26, 25-27, 25-28, 25-29, 25-30, 25-31, 25-32, 25-33, 25-34, 25-35, 25-36, 25-37, 25-38, 25-39, 25-40, 25-41, 25-42, 25-43, 25-44, 25-45, 25-46, 25-47, 25-48, 25-49, 25-50, 25-51, 25-52, 25-53, 25-54, 25-55, 25-56, 25-57, 25-58, 25-59, 25-60, 25-61, 25-62, 25-63, 25-64, 25-65, 25-66, 25-67, 25-68, 25-69, 25-70, 25-71, 25-72, 25-73, 25-74, 25-75, 25-76, 25-77, 25-78, 25-79, 25-80, 25-81, 25-82, 25-83, 25-84, 25-85, 25-86, 25-87, 25-88, 25-89, 25-90, 25-91, 25-92, 25-93, 25-94, 25-95, 25-96, 25-97, 25-98, 25-99, 25-100





**Legend**

-  Transects
-  Quadrat
-  Transect photo point
-  Control site (2023)
-  Baseline year 1
-  Baseline year 2

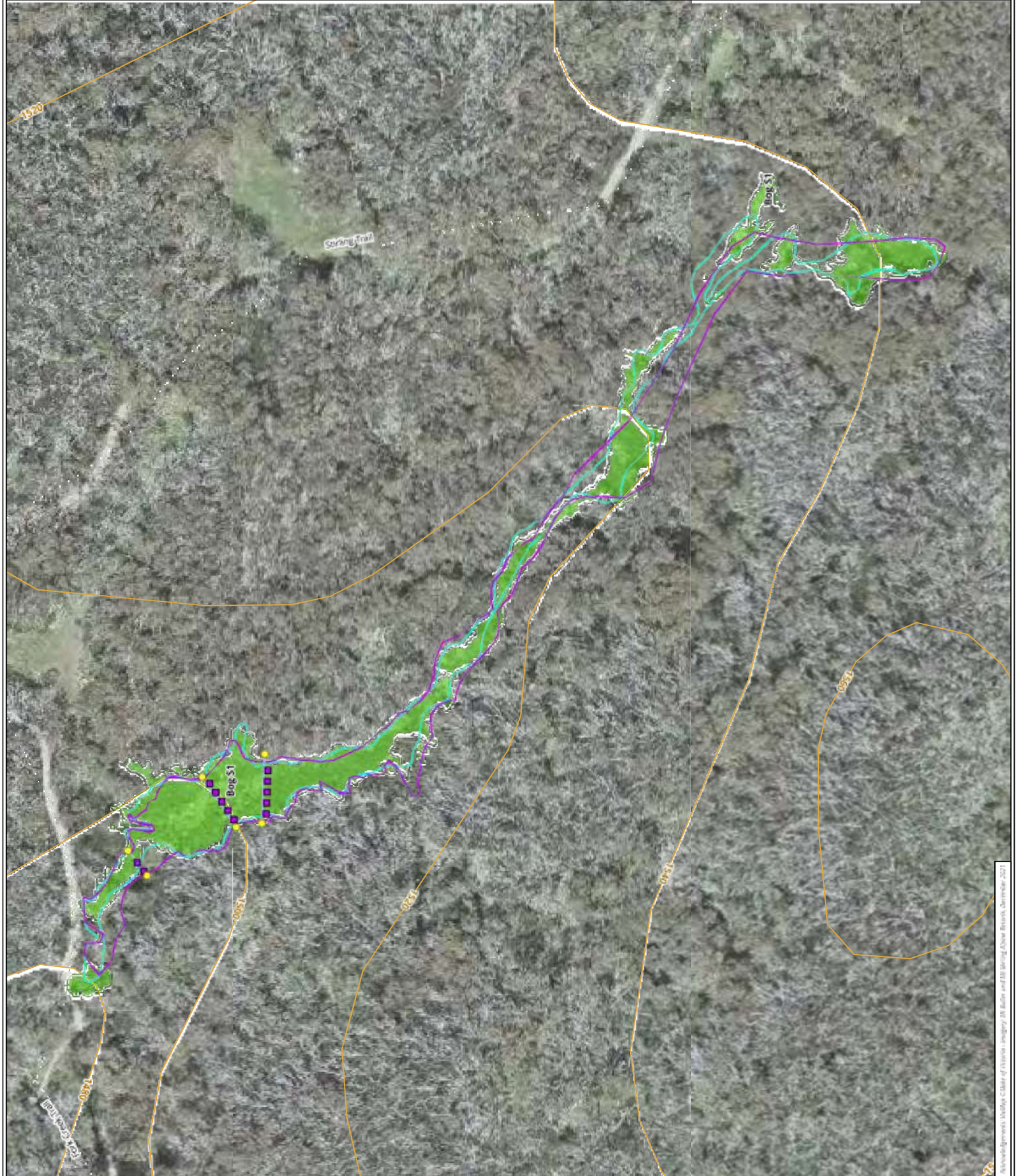
**Figure 4I Bog S1 (control site)**

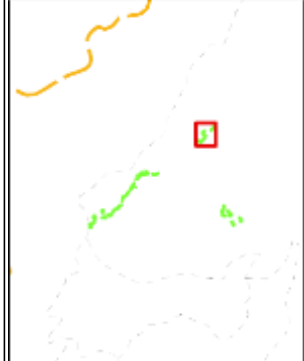


Scale: 1: 300 @ A3  
Coordinate System: UTM 1994 MGR Zone 35









Project 25-01  
24112019-2021  
Prepared by: Biosis  
2021 10/20/2021 10:00 AM  
www.biosis.com.au

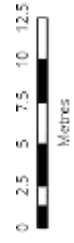




**Legend**

-  Transects
-  Quadrac
-  Transect photo point
-  Control site (2023)
-  Baseline year 1
-  Baseline year 2

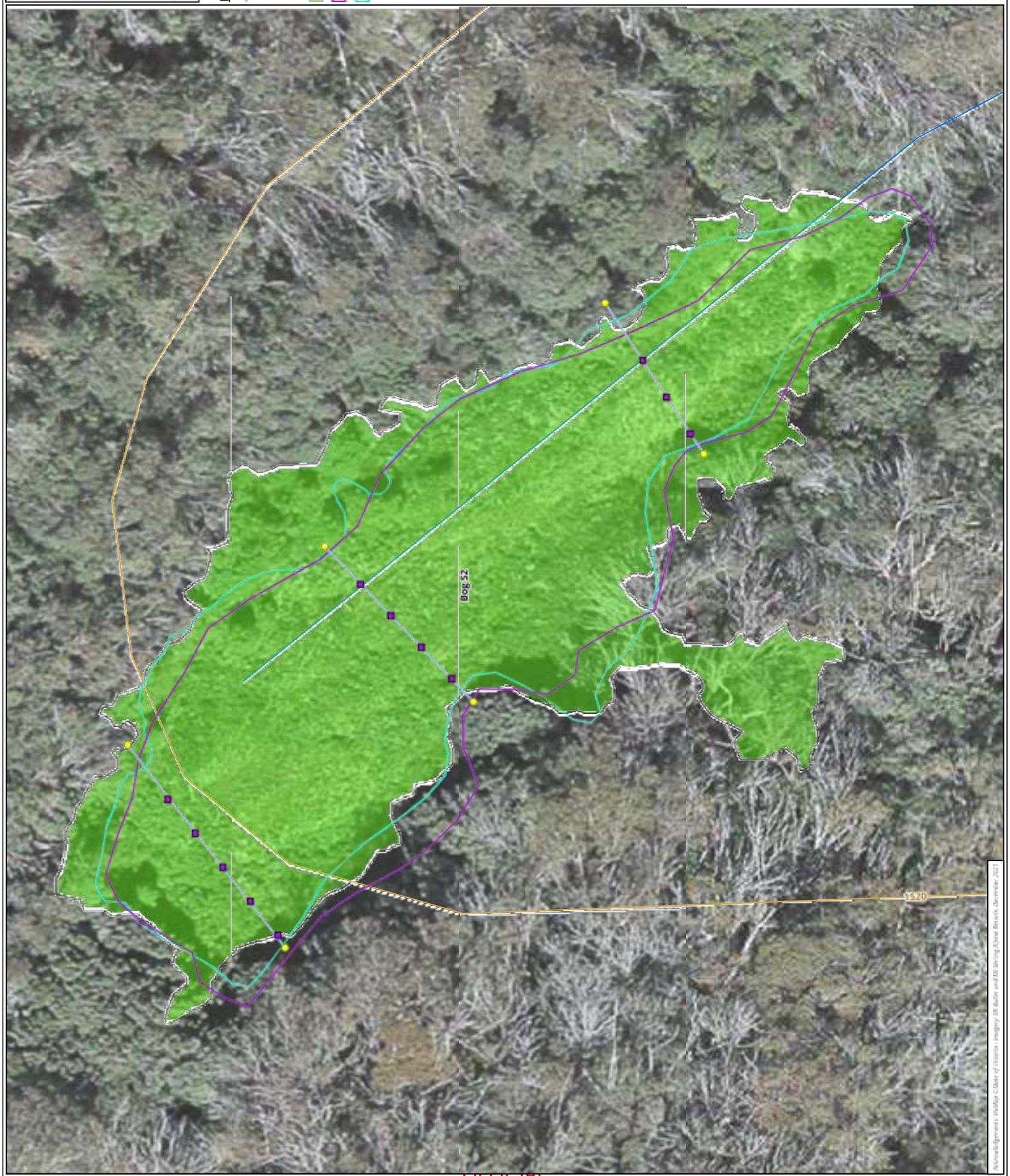
**Figure 4m Bog 52 (control site)**

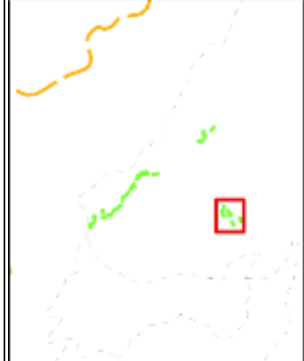


Scale: 1:6250 @ A3  
 Coordinate System: GCS 1994 MGA Zone 55



Project 25-01  
 24/11/2024  
 Prepared by: [Name]  
 Checked by: [Name]  
 Approved by: [Name]

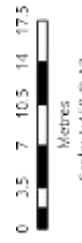




**Legend**

- Transects
- Quadrat
- Transect photo point
- Control site (2023)
- Baseline year 1
- Baseline year 2

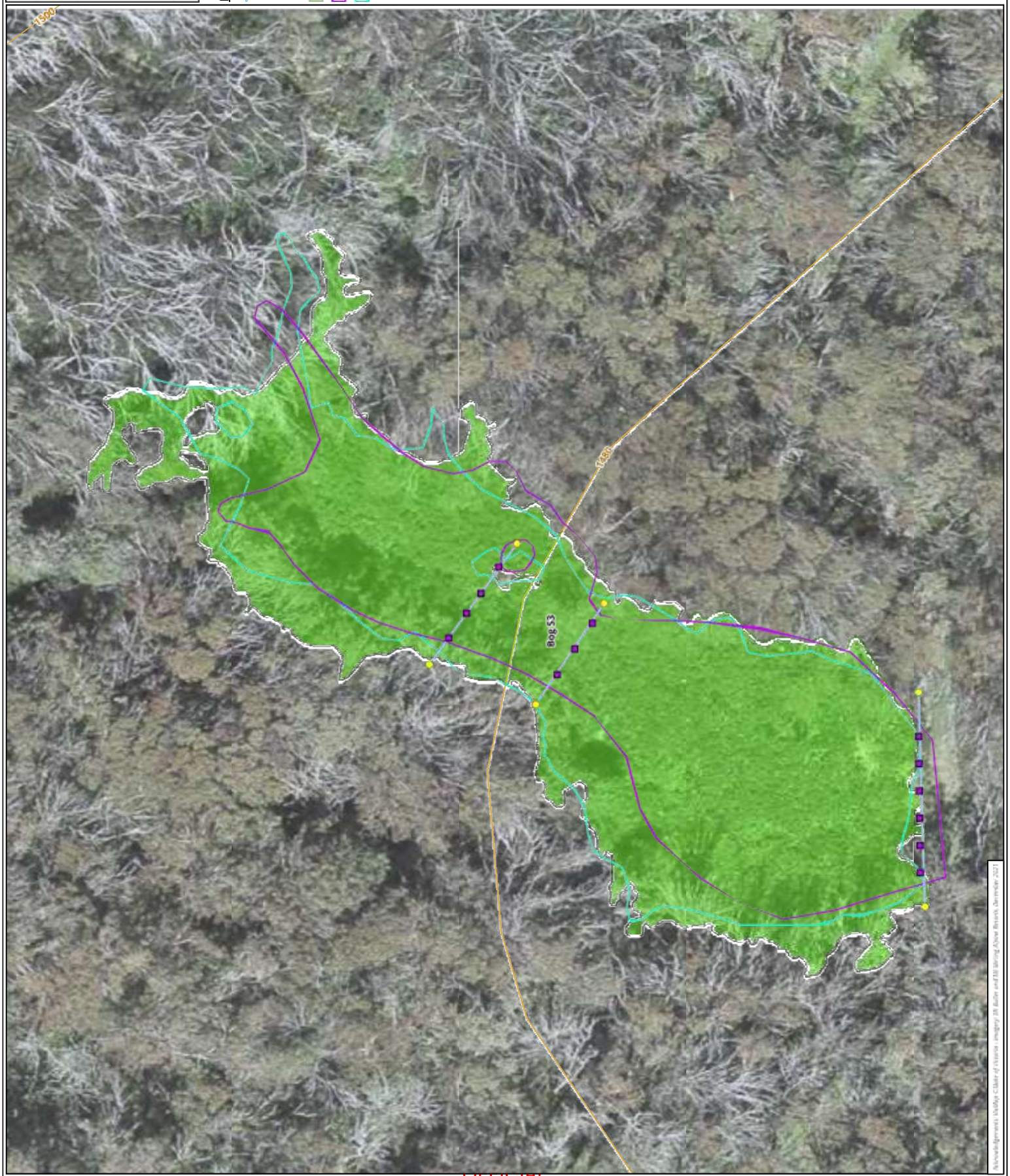
**Figure 4n Bog S3 (control site)**

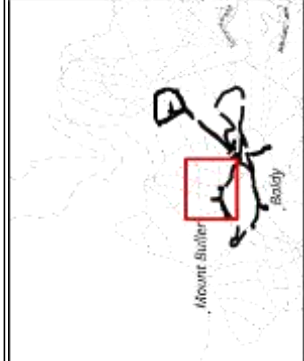


Scale: 1:4.50 @ A3  
Coordinate System: GCS: 1994 MGA Zone 55



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Project 25-01  
24-11-2024 10:41:03  
Project 25-01  
24-11-2024 10:41:03





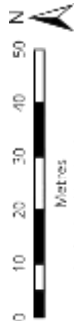
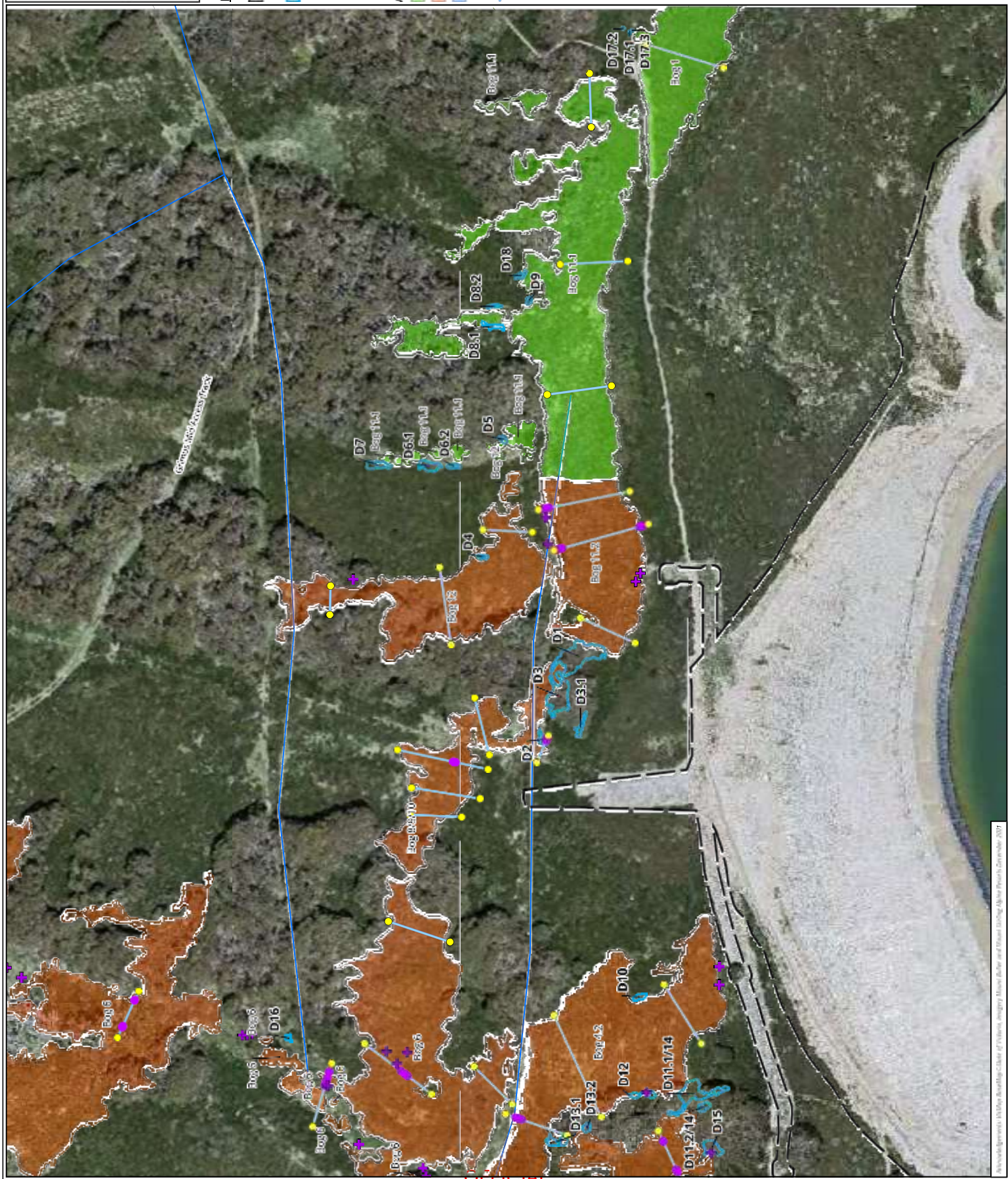
**Legend**

- Project Construction Footprint (PCF)
- Area of dieback of non-bog-dependent flora (2023)
- Sediment recorded by transect monitoring (2021)
- Sediment recorded during on-ground mapping (2021 to 2023)

**Alpine Bogs (Biosis 2023)**

- Control site (2023)
- Impact site (2023)
- Other site (2023)
- Transect photo point
- Transects

**Figure 5** Locations of dieback of Alpine Grassy Heathland and Sub-alpine Woodland (non-bog-dependent flora) surrounding Alpine Bog vegetation in Impact Year 4



Mount 2021  
 21/10/2021  
 Project: 155 - Mount 2021  
 Author: 155 - 2021  
 Date: 21/10/2021  
 File: 155 - 2021 - 2021



**Legend**

Silver Astella records from BY1 (2018) to IY4 (2023)

Recorded as an incidental observation

Recorded by transect monitoring

Project Construction Footprint (PCF)

Photo point

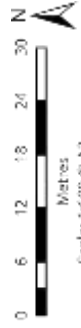
Transect

Alpine Bogs (Biosis 2023)

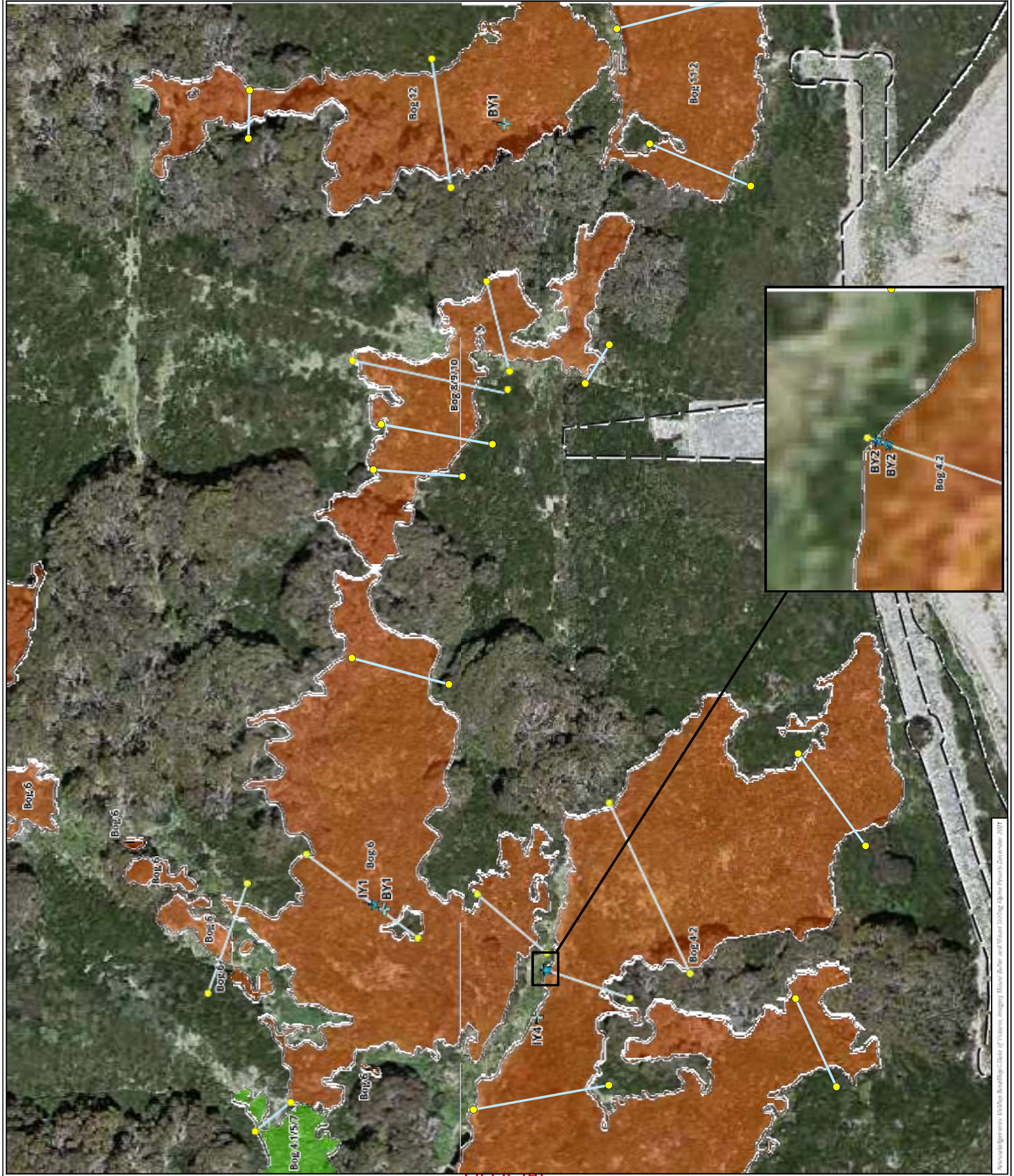
Control site (2023)

Impact site (2023)

**Figure 6 Locations of Silver Astella recorded from Baseline Year 1 (BY1) to Impact Year 4 (IY4)**



Mount Buller  
S.A.T. 13/10/2023  
Scale: 1:5000 GDA  
Coordinate System: GDA 1994 MGA Zone 55  
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Management of Silver Astella at Mount Buller and Mount Stirling - Mount Buller and Mount Stirling - Other Plans (December 2019)

## Photos

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**Photo 1** Peat Moss observed expanding beneath a canopy of Alpine Podolobium and Mountain Plum-pine (IY4; 27 February 2023)



**Photo 2 Discharge of water from Baldy Turrent pump house, upslope of Bog 1 (IY4; 28 April 2023)**



**Photo 3** Dieback of non-bog-dependent flora at western boundary of Bog 11.2 (Location D1; IY3; 1 February 2022; compare with Photo 4)



**Photo 4** Increased dieback of non-bog-dependent flora at western boundary of Bog 11.2 (Location D1; IY4; 21 February 2023; compare with Photo 3)



**Photo 5 Dieback of non-bog-dependent flora near southern boundary of Bog 4.2 (Location D11/D14; IY4; 28 February 2023)**



**Photo 6 Sediment becoming incorporated into humus layer midway down Bog 6 (IY4; 1 March 2023)**



**Photo 7** A rock that entered Bog 11.2 from the PCF in IY1 (IY2; 18 February 2020)



**Photo 8** The rock in Bog 11.2 in IY2, with death of surrounding vegetation (IY2; 24 February 2021)



**Photo 9** The rock in Bog 11.2 in IY3, with some recovery of bog-dependent flora but also colonisation by weeds (IY3; 17 February 2022)



**Photo 10** The rock in Bog 11.2 in IY4, with colonisation by weeds (IY4; 21 February 2023)



**Photo 11 Earthworks surrounding Bog 13 in IY4 (IY4; 25 May 2023)**

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## Appendices

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## Appendix 1 HEMAMP monitoring calendar

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Table A1.1 summarises the frequency and timing of the ecological monitoring and highlights where datasets may be incomplete. The following codes are used in Table A1.1:

<b>Code</b>	<b>Meaning</b>
Yes	Complete dataset for given month
Part	Partially complete dataset for given month
No	Missing dataset for given month

Table A1.1 Timing, frequency and completeness of the HEMAMP's ecological datasets

			Baseline Year 1											
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
			2017						2018					
<b>Ecology</b>	Transect monitoring	Control sites									Yes			
		Impact sites								Yes	Yes			
	Mapping	Control sites								Yes	Yes			
		Impact sites								Yes	Yes			

			Baseline Year 2											
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
			2018						2019					
<b>Ecology</b>	Transect monitoring	Control sites								Yes	Yes			
		Impact sites								Yes	Yes			
	Mapping	Control sites									Yes			
		Impact sites									Yes			

			Impact Year 1											
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
			2019						2020					
<b>Ecology</b>	Transect monitoring	Control sites								Yes	Yes			
		Impact sites									Yes			
	Mapping	Control sites								Yes	Yes	Yes		
		Impact sites								Yes	Yes	Yes		

			Impact Year 2											
			Jun	Jul	Aug	Sep 2020	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
									2021					
<b>Ecology</b>	<b>Transect monitoring</b>	<b>Control sites</b>								Yes	Yes			
		<b>Impact sites</b>								Yes	Yes			
	<b>Mapping</b>	<b>Control sites</b>									Yes			
		<b>Impact sites</b>									Yes			

			Impact Year 3											
			Jun	Jul	Aug	Sep 2021	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
									2022					
<b>Ecology</b>	<b>Transect monitoring</b>	<b>Control sites</b>								Yes	Yes			
		<b>Impact sites</b>								Yes	Yes			
	<b>Mapping</b>	<b>Control sites</b>									Yes			
		<b>Impact sites</b>									Yes			

			Impact Year 4											
			Jun	Jul	Aug	Sep 2022	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
									2023					
<b>Ecology</b>	<b>Transect monitoring</b>	<b>Control sites</b>								Yes	Yes			
		<b>Impact sites</b>								Yes	Yes			
	<b>Mapping</b>	<b>Control sites</b>									Yes			
		<b>Impact sites</b>									Yes			

## Appendix 2 Flora species lists

The following status codes are used in this Appendix:

Code	Meaning	Notes
<b>National significance</b>		
CR	Critically endangered	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act)
EN	Endangered	
VU	Vulnerable	
<b>State significance</b>		
cr	Critically endangered	Victorian <i>Flora and Fauna Guarantee Act 1988</i> (FFG Act)
e	Endangered	
v	Vulnerable	
P	Protected species (public land only)	
<b>Noxious weed status</b>		
SP	State prohibited species	Victorian <i>Catchment and Land Protection Act 1994</i> (CaLP Act) statuses within the Goulburn Broken/North East catchments
RP	Regionally prohibited species	
RC	Regionally controlled species	
R	Restricted species	
<b>Other</b>		
#	Native species outside its natural range	Assessed using VBA (DELWP 2021) and VicFlora (RBGV 2021)
^	Bog-dependent species	Refer to Diagnostic Key to Alpine Bogs (Appendix 3)

Table A2.1 Flora species list for all Alpine Bogs

Status	Scientific Name	Common Name
<b>Indigenous species</b>		
	<i>Acaena novae-zelandiae</i>	Bidgee-widgee
	<i>Achrophyllum dentatum</i>	Toothed Mitre-moss
e P	<i>Aciphylla glacialis</i>	Snow Aciphyll
e P	<i>Acrothamnus montanus</i>	Snow Beard-heath
	<i>Agrostis parviflora s.s.</i>	Hair Bent
	<i>Anthosachne scabra s.s.</i>	Common Wheat-grass
e P	<i>Argyrotegium poliochlorum</i>	Grey-green Cudweed
P	<i>Asperula conferta</i>	Common Woodruff
P	<i>Asperula gunnii</i>	Mountain Woodruff
^	<i>Astelia alpina var. novae-hollandiae</i>	Silver Astelia
P ^	<i>Baeckea gunniana</i>	Alpine Baeckea
e P ^	<i>Baeckea latifolia</i>	Subalpine Baeckea
P ^	<i>Baeckea utilis s.s.</i>	Mountain Baeckea
	<i>Bartramia robusta</i>	Common Apple-moss
P	<i>Blechnum penna-marina</i> subsp. <i>alpina</i>	Alpine Water-fern
P	<i>Brachyscome scapigera</i>	Tufted Daisy
P	<i>Brachyscome spathulata</i>	Spoon Daisy
	<i>Brachythecium paradoxum</i>	Feather Moss
	<i>Brachythecium rutabulum</i>	Rough-stalked Feather-moss
	<i>Brachythecium salebrosum</i>	Smooth-stalk Feather-moss
	<i>Brachythecium</i> spp.	Feather Moss
^	<i>Callistemon pityoides</i>	Alpine Bottlebrush
	<i>Campylopus introflexus</i>	Heath Star Moss
	<i>Carex appressa</i>	Tall Sedge
	<i>Carex breviculmis</i>	Common Grass-sedge
	<i>Carex flaccida</i> (syn. <i>Carex austroflaccida</i> )	Mountain Hook-sedge
	<i>Carex hebes</i>	Mountain Sedge
e ^	<i>Carex jackiana</i>	Carpet Sedge
	<i>Carex</i> spp.	Sedge
	<i>Catagonium nitens</i> subsp. <i>nitens</i>	Feather-tail Moss
e P	<i>Celmisia latifolia</i>	Victorian Snow-daisy
P	<i>Celmisia</i> spp.	Snow Daisy
v P	<i>Celmisia tomentella</i>	Silver Snow-daisy
P	<i>Chiloglottis cornuta</i>	Green Bird-orchid
P	<i>Chiloglottis</i> spp.	Bird Orchid
	<i>Chiloscyphus semiteres</i> var. <i>semiteres</i>	Common Crestwort
	<i>Chiloscyphus trialatus</i> (syn. <i>Chiloscyphus pallidus</i> )	Greasy Crestwort
	<i>Clematis aristata</i>	Mountain Clematis
P	<i>Coronidium monticola</i>	Mountain Everlasting
P	<i>Cotula alpina</i>	Alpine Cotula
e P	<i>Craspedia adenophora</i>	Sticky Billy-buttons
P	<i>Craspedia aurantia s.l.</i>	Orange/Green Billy-buttons

Status	Scientific Name	Common Name
eP	<i>Craspedia lamicola</i>	Bog Billy-buttons
P	<i>Craspedia</i> spp.	Billy Buttons
eP	<i>Craspedia sylvestris</i>	Mountain Forest Billy-buttons
P ^	<i>Dracophyllum continentis</i> (syn. <i>Richea continentis</i> )	Candle Heath
^	<i>Empodisma minus</i>	Spreading Rope-rush
P ^	<i>Epacris paludosa</i>	Swamp Heath
	<i>Epilobium billardioreanum</i> subsp. <i>billardioreanum</i>	Smooth Willow-herb
	<i>Epilobium billardioreanum</i> subsp. <i>hydrophilum</i>	Robust Willow-herb
v	<i>Epilobium sarmentaceum</i>	Mountain Willow-herb
	<i>Epilobium</i> spp.	Willow Herb
	<i>Eucalyptus pauciflora</i>	Snow Gum
P	<i>Euchiton involucratus</i> s.s.	Star Cudweed
P	<i>Euchiton sphaericus</i>	Annual Cudweed
P	<i>Euchiton</i> spp.	Cudweed
	<i>Exocarpos nanus</i>	Alpine Ballart
	<i>Gemmabryum sauteri</i>	Sauter's Thread-moss
	<i>Gentianella cunninghamii</i> subsp. <i>major</i>	Tall Snow-gentian
v	<i>Gentianella muelleriana</i> subsp. <i>willisiana</i>	Mt Buller Snow-gentian
	<i>Geranium potentilloides</i> var. 1	Soft Crane's-bill
	<i>Geranium</i> sp. 7	Alpine Swamp Crane's-bill
	<i>Gonocarpus micranthus</i>	Creeping Raspwort
	<i>Gonocarpus montanus</i>	Mat Raspwort
	<i>Gonocarpus tetragynus</i>	Common Raspwort
	<i>Goodenia hederacea</i>	Ivy Goodenia
P	<i>Grevillea australis</i>	Alpine Grevillea
	<i>Grimmia pulvinata</i> var. <i>africana</i>	Blunt-beak Grimmia
^	<i>Hierochloa redolens</i>	Sweet Holy-grass
	<i>Hovea montana</i>	Alpine Rusty-pods
eP	<i>Huperzia australiana</i>	Fir Clubmoss
	<i>Hydrocotyle hirta</i>	Hairy Pennywort
	<i>Hydrocotyle</i> spp.	Pennywort
	<i>Hygrolembidium acrocladum</i>	Fingerwort
	<i>Hymenodontopsis mnioides</i> (syn. <i>Pyrrhobryum mnioides</i> )	Woolly-stem Thyme-moss
	<i>Hypericum japonicum</i>	Matted St John's Wort
	<i>Isolepis aucklandica</i>	New Zealand Club-sedge
	<i>Isolepis habra</i>	Wispy Club-sedge
e	<i>Isolepis montivaga</i>	Fog Club-sedge
	<i>Isolepis</i> spp.	Club Sedge
	<i>Isolepis subtilissima</i>	Mountain Club-sedge
P	<i>Lagenophora montana</i>	Mountain Bottle-daisy
P	<i>Lagenophora stipitata</i> s.s.	Blue Bottle-daisy
	<i>Leionema phyllicifolium</i>	Alpine Leionema
	<i>Leptospermum grandifolium</i>	Mountain Tea-tree

Status	Scientific Name	Common Name
P cr P	<i>Libertia pulchella</i>	Pretty Grass-flag
	<i>Luzula modesta</i>	Southern Woodrush
	<i>Luzula</i> spp.	Woodrush
	<i>Lycopodium fastigiatum</i>	Mountain Clubmoss
	<i>Lycopodium scariosum</i>	Spreading Clubmoss
	<i>Marchantia berteroana</i>	Common Marchantia
	<i>Melicytus</i> sp. aff. <i>dentatus</i> (snowfields variant)	Alpine Shrub-violet
	<i>Mentha laxiflora</i>	Forest Mint
P	<i>Microseris lanceolata</i>	Alpine Yam-daisy
P ^	<i>Olearia algida</i>	Mountain Daisy-bush
e P	<i>Olearia phlogopappa</i> subsp. <i>flavescens</i>	Dusty Daisy-bush
	<i>Oreobolus distichus</i>	Fan Tuft-rush
	<i>Oreomyrrhis eriopoda</i>	Australian Caraway
	<i>Orites lancifolius</i>	Alpine Orites
	<i>Orthodontium lineare</i>	Cape Thread-moss
P	<i>Ozothamnus cupressoides</i>	Kerosene Bush
e	<i>Phebalium squamulosum</i> subsp. <i>alpinum</i>	Alpine Phebalium
P	<i>Picris angustifolia</i> subsp. <i>merxmulleri</i>	Highland Picris
	<i>Pimelea alpina</i>	Alpine Rice-flower
	<i>Pimelea ligustrina</i>	Tall Rice-flower
	<i>Pimelea</i> spp.	Rice Flower
	<i>Plantago euryphylla</i>	Broad Plantain
	<i>Poa costiniana</i>	Bog Snow-grass
	<i>Poa ensiformis</i>	Sword Tussock-grass
	<i>Poa fawcettiae</i>	Horny Snow-grass
	<i>Poa hiemata</i>	Soft Snow-grass
	<i>Poa hothamensis</i>	Ledge Grass
	<i>Poaceae</i> spp.	Grass
	<i>Podocarpus lawrencei</i>	Mountain Plum-pine
P	<i>Podolepis robusta</i>	Alpine Podolepis
P	<i>Podolepis</i> spp.	Podolepis
	<i>Podolobium alpestre</i>	Alpine Podolobium
P	<i>Polystichum proliferum</i>	Mother Shield-fern
	<i>Polytrichum commune</i>	Common Haircap
	<i>Polytrichum</i> spp.	Haircap
P	<i>Prasophyllum alpestre</i>	Mauve Leek-orchid
P	<i>Prasophyllum</i> spp.	Leek Orchid
	<i>Ptychostomum pseudotriquetrum</i>	Bog Bryum
	<i>Ranunculus graniticola</i>	Granite Buttercup
e	<i>Ranunculus gunnianus</i>	Gunn's Alpine Buttercup
	<i>Ranunculus lappaceus</i>	Australian Buttercup
	<i>Ranunculus pimpinellifolius</i>	Bog Buttercup
	<i>Ranunculus scapiger</i>	Hairy Buttercup
	<i>Ranunculus</i> spp.	Buttercup
	<i>Rhaphidorrhynchium amoenum</i>	Common Signal-moss

Status	Scientific Name	Common Name
	<i>Rosulabryum capillare</i>	Capillary Thread-moss
	<i>Rubus parvifolius</i>	Small-leaf Bramble
	<i>Rumex brownii</i>	Slender Dock
	<i>Rytidosperma nudiflorum</i>	Alpine Wallaby-grass
	<i>Rytidosperma penicillatum</i>	Weeping Wallaby-grass
	<i>Rytidosperma</i> spp.	Wallaby Grass
	<i>Sanionia uncinata</i>	Sickle-leaved Hook-moss
	<i>Schoenus calypttratus</i>	Alpine Bog-sedge
e	<i>Scleranthus brockiei</i>	Brock Knawel
P	<i>Senecio gunnii</i>	Mountain Fireweed
eP	<i>Senecio pinnatifolius</i> var. <i>alpinus</i>	Snowfield Groundsel
P ^	<i>Sphagnum cristatum</i>	Peat Moss
	<i>Stellaria pungens</i>	Prickly Starwort
P	<i>Stylidium armeria</i> subsp. <i>armeria</i>	Common Triggerplant
eP	<i>Stylidium montanum</i>	Alpine Triggerplant
P	<i>Stylidium</i> spp.	Trigger Plant
	<i>Tasmania xerophila</i> subsp. <i>xerophila</i>	Alpine Pepper
P	<i>Thelymitra</i> spp.	Sun Orchid
eP	<i>Trochocarpa clarkei</i>	Lilac Berry
	<i>Veronica serpyllifolia</i>	Thyme Speedwell
	<i>Viola betonicifolia</i>	Showy Violet
	<i>Wahlenbergia ceracea</i>	Waxy Bluebell
	<i>Wahlenbergia gloriosa</i>	Royal Bluebell
P	<i>Xerochrysum subundulatum</i>	Orange Everlasting
	<i>Zoopsis leitgebiana</i>	Glass Centipede
Introduced species		
	<i>Acetosella vulgaris</i>	Sheep Sorrel
	<i>Achillea millefolium</i>	Milfoil
	<i>Agrostis capillaris</i>	Brown-top Bent
	<i>Anthoxanthum odoratum</i>	Sweet Vernal-grass
	<i>Cerastium glomeratum</i> s.s.	Sticky Mouse-ear Chickweed
	<i>Cerastium</i> spp.	Mouse-ear Chickweed
	<i>Cerastium vulgare</i>	Common Mouse-ear Chickweed
R/RC	<i>Cirsium vulgare</i>	Spear Thistle
	<i>Dactylis glomerata</i>	Cocksfoot
	<i>Erythranthe guttata</i>	Monkey Musk
	<i>Erythranthe moschata</i>	Musk Monkey-flower
	<i>Festuca rubra</i> s.s.	Creeping Fescue
	<i>Glyceria declinata</i>	Manna Grass
	<i>Holcus lanatus</i>	Yorkshire Fog
	<i>Hypochaeris radicata</i>	Flatweed
	<i>Juncus articulatus</i> subsp. <i>articulatus</i>	Jointed Rush
	<i>Juncus effusus</i> subsp. <i>effusus</i>	Soft Rush
	<i>Juncus ensifolius</i>	Sword Rush

Status	Scientific Name	Common Name
	<i>Malus pumila</i>	Apple
	<i>Phleum pratense</i>	Timothy Grass
RC	<i>Ranunculus repens</i>	Creeping Buttercup
	<i>Rubus anglocandicans</i>	Common Blackberry
	<i>Rumex conglomeratus</i>	Clustered Dock
	<i>Sonchus asper s.s.</i>	Rough Sow-thistle
	<i>Taraxacum officinale</i> spp. agg.	Garden Dandelion
	<i>Trifolium repens</i> var. <i>repens</i>	White Clover
	<i>Viola arvensis</i>	Field Pansy

**Table A2.2 Bog-dependent flora species list**

Status	Scientific Name	Common Name
^	<i>Astelia alpina</i> var. <i>novae-hollandiae</i>	Silver Astelia
P ^	<i>Baeckea gunniana</i>	Alpine Baeckea
e P ^	<i>Baeckea latifolia</i>	Subalpine Baeckea
P ^	<i>Baeckea utilis</i> s.s.	Mountain Baeckea
^	<i>Callistemon ptyoides</i>	Alpine Bottlebrush
e ^	<i>Carex jackiana</i>	Carpet Sedge
P ^	<i>Dracophyllum continentis</i> (syn. <i>Richea continentis</i> )	Candle Heath
^	<i>Empodisma minus</i>	Spreading Rope-rush
P ^	<i>Epacris paludosa</i>	Swamp Heath
^	<i>Hierochloa redolens</i>	Sweet Holy-grass
P ^	<i>Olearia algida</i>	Mountain Daisy-bush
P ^	<i>Sphagnum cristatum</i>	Peat Moss

## Appendix 3 Diagnostic Key to Alpine Bogs

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This diagnostic key has been reproduced from the key to the EPBC Act listed Alpine Sphagnum Bogs and Associated Fens ecological community on the Australian mainland, prepared by the Australian Government Department of the Environment (DoE 2013). The key appeared in early draft versions of the National Recovery Plan but does not appear in the final version, although the final version does make reference to the key (DoE 2015; A. Tolsma, ARI, pers. comm., February 2019).

## Key to the listed Alpine *Sphagnum* bogs and Associated Fens ecological community on the Australian mainland

The listed ecological community comprises two main components, *Sphagnum* bogs and their associated fens. Fens, or fen pools, are species-poor communities typically linked to bogs. They are dominated by sedges and frequently inundated. The bogs which surround or link to fens generally display greater species diversity, and it is this diversity which in part guides the following key.

1. Are you above 1000m in elevation and in the Australian Alps bioregion?

Yes - go to 2

No - Unlikely to be the listed community

2. Is live, hummock-forming *Sphagnum* present and abundant, or if burnt<sup>1</sup>, can abundant pre-fire *Sphagnum* be inferred from burnt remnants?

Yes - Is the listed community

No, *Sphagnum* is minor or absent - go to 3

3. Does the site have a peat substrate evident?

Yes, or unsure - go to 4

No - Unlikely to be the listed community

4. Is *Sphagnum* present? Yes-go to 5

No-go to 6

5. Is most of the non-*Sphagnum* vegetation cover composed of two or more of the diagnostic species listed below?

Yes - Is the listed community.

No - Not the listed community, but may be transitional or a degraded version<sup>2</sup>

6. Is most of the vegetation cover composed of 3 or more of the diagnostic species?

Yes - Is the listed community, possibly degraded.

No - Not the listed community, but may be transitional or a degraded version<sup>2</sup>

### Diagnostic species other than *Sphagnum*:

- *Empodisma minus*
- *Epacris* spp (usually *E. pa/udosa*, *E. g/acia/is*, *E. ce/ata* or *E. breviflora*)
- *Richea* spp (*R. continentis* or *R. victoriana*)
- *Baেকেea* spp (usually *B. gunniana*, *B. latifolia* or *B. utilis*)
- *Aste/ia alpina*
- *Carpha nivico/a*
- *Ba/oskion australe*
- *Carex gaudichaudiana*
- *Cal/istemon pityoides*
- *Hakea microcarpa*
- *Carex jackiana*<sup>3</sup>
- *Hierochloe redolens*<sup>3</sup>
- *O/earia algida*<sup>3</sup>

<sup>1</sup> If a site has been recently and severely burnt, *Sphagnum* and other key diagnostic species may be temporarily absent (live hummock-forming *Sphagnum* would normally comprise at least 20-30% cover). In this case, assessment of the site for the listed community should be delayed for at least 24 months. However, the presence of burnt hummocks over peat indicates the community is present.

<sup>2</sup> Clarification: no need to refer.

<sup>3</sup> This key originally appeared in a draft version of the National Recovery Plan for the Alpine *Sphagnum* Bogs and Associated Fens. The key has been left unchanged except for the addition of these three species and this footnote. These species have been added by Biosis for the purposes of monitoring Alpine Bogs at Mount Buller and Mount Stirling, Victoria. At these locations, *Carex jackiana*, *Hierochloe redolens* and *Olearia algida* are restricted to Alpine Bogs and are therefore amongst the diagnostic species.

## Appendix 4 Photo points

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**Bog 1 (Control Site), Photo Point 1AS**



Baseline Year 1, 9 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 31 January 2020



Impact Year 2, 2 February 2021



Impact Year 3, 31 January 2022



Impact Year 4, 2 February 2023

**Bog 1 (Control Site), Photo Point 1AE**



Baseline Year 1, 9 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 31 January 2020



Impact Year 2, 2 February 2021



Impact Year 3, 31 January 2022



Impact Year 4, 2 February 2023

**Bog 1 (Control Site), Photo Point 1BS**



Baseline Year 1, 9 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 31 January 2020



Impact Year 2, 2 February 2021



Impact Year 3, 31 January 2022



Impact Year 4, 23 January 2023

**Bog 1 (Control Site), Photo Point 1BE**



Baseline Year 1, 9 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 31 January 2020



Impact Year 2, 2 February 2021



Impact Year 3, 31 January 2022



Impact Year 4, 23 January 2023

**Bog 1 (Control Site), Photo Point 1CS**



Baseline Year 1, 9 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 31 January 2020



Impact Year 2, 2 February 2021



Impact Year 3, 31 January 2022



Impact Year 4, 23 January 2023

**Bog 1 (Control Site), Photo Point 1CE**



Baseline Year 1, 9 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 31 January 2020



Impact Year 2, 2 February 2021



Impact Year 3, 31 January 2022



Impact Year 4, 23 January 2023

**Bog 2 (Control Site), Photo Point 2AS**



Baseline Year 1, 9 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 3 February 2020



Impact Year 2, 26 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 26 January 2023

**Bog 2 (Control Site), Photo Point 2AE**



Baseline Year 1, 9 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 3 February 2020



Impact Year 2, 26 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 26 January 2023

**Bog 2 (Control Site), Photo Point 2BS**



Baseline Year 1, 9 February 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 3 February 2020



Impact Year 2, 25 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 26 January 2023

**Bog 2 (Control Site), Photo Point 2BE**



Baseline Year 1, 9 February 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 3 February 2020



Impact Year 2, 25 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 26 January 2023

**Bog 2 (Control Site), Photo Point 2CS**



Baseline Year 1, 9 February 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 3 February 2020



Impact Year 2, 25 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 2 February 2023

**Bog 2 (Control Site), Photo Point 2CE**



Baseline Year 1, 9 February 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 3 February 2020



Impact Year 2, 26 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 2 February 2023

**Bog 4.1/5/7 (Control Site), Photo Point 4.1AS**



Baseline Year 1, 8 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 2 February 2021



Impact Year 3, 9 February 2022



Impact Year 4, 2 February 2023

**Bog 4.1/5/7 (Control Site), Photo Point 4.1AE**



Baseline Year 1, 8 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 2 February 2021



Impact Year 3, 9 February 2022



Impact Year 4, 2 February 2023

**Bog 4.1/5/7 (Control Site), Photo Point 4.1BS**



Baseline Year 1, 8 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 1 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 25 January 2023

**Bog 4.1/5/7 (Control Site), Photo Point 4.1BE**



Baseline Year 1, 8 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 1 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 25 January 2023

**Bog 4.1/5/7 (Control Site), Photo Point 4.1CS**



Baseline Year 1, 8 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 8 February 2022



Impact Year 4, 25 January 2023

**Bog 4.1/5/7 (Control Site), Photo Point 4.1CE**



Baseline Year 1, 8 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 8 February 2022



Impact Year 4, 25 January 2023

**Bog 4.1/5/7 (Control Site), Photo Point 5AS**



Baseline Year 1, 8 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 6 February 2020



Impact Year 2, 1 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 2 February 2023

**Bog 4.1/5/7 (Control Site), Photo Point 6AE**



Baseline Year 1, 8 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 6 February 2020



Impact Year 2, 1 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 2 February 2023

**Bog 4.1/5/7 (Control Site), Photo Point 7AS**



Baseline Year 1, 1 February 2018



Baseline Year 2, 11 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 8 February 2022



Impact Year 4, 25 January 2023

**Bog 4.1/5/7 (Control Site), Photo Point 8AE**



Baseline Year 1, 1 February 2018



Baseline Year 2, 11 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 8 February 2022



Impact Year 4, 25 January 2023

**Bog 4.2 (Impact Site), Photo Point 4.2AS**



Baseline Year 1, 30 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 1 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 24 January 2023

**Bog 4.2 (Impact Site), Photo Point 4.2AE**



Baseline Year 1, 30 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 1 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 2 February 2023

**Bog 4.2 (Impact Site), Photo Point 4.2BS**



Baseline Year 1, 30 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 1 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 1 February 2023

**Bog 4.2 (Impact Site), Photo Point 4.2BE**



Baseline Year 1, 30 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 1 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 24 January 2023

**Bog 4.2 (Impact Site), Photo Point 4.2CS**



Baseline Year 1, 31 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 2 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 24 January 2023

**Bog 4.2 (Impact Site), Photo Point 4.2CE**



Baseline Year 1, 31 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 2 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 24 January 2023

**Bog 4.2 (Impact Site), Photo Point 4.2DS**



Baseline Year 1, 31 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 1 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 2 February 2023

**Bog 4.2 (Impact Site), Photo Point 4.2DE**



Baseline Year 1, 31 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 1 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 2 February 2023

**Bog 4.2 (Impact Site), Photo Point 4.2ES**



Baseline Year 1, 31 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 2 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 2 February 2023

**Bog 4.2 (Impact Site), Photo Point 4.2EE**



Baseline Year 1, 31 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 4 February 2020



Impact Year 2, 2 February 2021



Impact Year 3, 8 February 2022



Impact Year 4, 2 February 2023

**Bog 6 (Impact Site), Photo Point 6AS**



Baseline Year 1, 31 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 7 February 2022



Impact Year 4, 2 February 2023

**Bog 6 (Impact Site), Photo Point 6AE**



Baseline Year 1, 31 January 2018



Baseline Year 2, 1 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 7 February 2022



Impact Year 4, 2 February 2023

**Bog 6 (Impact Site), Photo Point 6BS**



Baseline Year 1, 31 January 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 7 February 2022



Impact Year 4, 25 January 2023

**Bog 6 (Impact Site), Photo Point 6BE**



Baseline Year 1, 31 January 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 7 February 2022



Impact Year 4, 25 January 2023

**Bog 6 (Impact Site), Photo Point 6CS**



Baseline Year 1, 1 February 2018



Baseline Year 2, 11 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 7 February 2022



Impact Year 4, 2 February 2023

**Bog 6 (Impact Site), Photo Point 6CE**



Baseline Year 1, 1 February 2018



Baseline Year 2, 11 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 7 February 2022



Impact Year 4, 2 February 2023

**Bog 6 (Impact Site), Photo Point 6DS**



Baseline Year 1, 1 February 2018



Baseline Year 2, 11 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 7 February 2022



Impact Year 4, 25 January 2023

**Bog 6 (Impact Site), Photo Point 6DE**



Baseline Year 1, 1 February 2018



Baseline Year 2, 11 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 7 February 2022



Impact Year 4, 25 January 2023

**Bog 6 (Impact Site), Photo Point 6ES**



Baseline Year 1, 1 February 2018



Baseline Year 2, 11 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 7 February 2022



Impact Year 4, 25 January 2023

**Bog 6 (Impact Site), Photo Point 6EE**



Baseline Year 1, 1 February 2018



Baseline Year 2, 11 February 2019



Impact Year 1, 5 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 7 February 2022



Impact Year 4, 25 January 2023

**Bog 8/9/10 (Impact Site), Photo Point 8AS**



Baseline Year 1, 26 January 2018



Baseline Year 2, 29 January 2019



Impact Year 1, 18 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 24 January 2023

**Bog 8/9/10 (Impact Site), Photo Point 8AE**



Baseline Year 1, 26 January 2018



Baseline Year 2, 29 January 2019



Impact Year 1, 18 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 24 January 2023

**Bog 8/9/10 (Impact Site), Photo Point 8BS**



Baseline Year 1, 26 January 2018



Baseline Year 2, 29 January 2019



Impact Year 1, 18 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 2 February 2023

**Bog 8/9/10 (Impact Site), Photo Point 8BE**



Baseline Year 1, 26 January 2018



Baseline Year 2, 29 January 2019



Impact Year 1, 18 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 2 February 2023

**Bog 8/9/10 (Impact Site), Photo Point 8CS**



Baseline Year 1, 26 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 20 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 3 February 2022



Impact Year 4, 24 January 2023

**Bog 8/9/10 (Impact Site), Photo Point 8CE**



Baseline Year 1, 26 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 20 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 3 February 2022



Impact Year 4, 24 January 2023

**Bog 8/9/10 (Impact Site), Photo Point 9AS**



Baseline Year 1, 27 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 7 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 24 January 2023

**Bog 8/9/10 (Impact Site), Photo Point 9AE**



Baseline Year 1, 27 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 7 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 24 January 2023

**Bog 8/9/10 (Impact Site), Photo Point 10AS**



Baseline Year 1, 27 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 7 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 3 February 2022



Impact Year 4, 24 January 2023

**Bog 8/9/10 (Impact Site), Photo Point 10AE**



Baseline Year 1, 27 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 7 February 2020



Impact Year 2, 28 January 2021



Impact Year 3, 3 February 2022



Impact Year 4, 24 January 2023

**Bog 11.1 (Control Site), Photo Point 11.1AS**



Baseline Year 1, 8 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 3 February 2020



Impact Year 2, 25 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 2 February 2023

**Bog 11.1 (Control Site), Photo Point 11.1AE**



Baseline Year 1, 8 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 3 February 2020



Impact Year 2, 25 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 2 February 2023

**Bog 11.1 (Control Site), Photo Point 11.1BS**



Baseline Year 1, 8 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 3 February 2020



Impact Year 2, 25 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 23 January 2023

**Bog 11.1 (Control Site), Photo Point 11.1BE**



Baseline Year 1, 8 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 3 February 2020



Impact Year 2, 25 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 23 January 2023

**Bog 11.1 (Control Site), Photo Point 11.1CS**



Baseline Year 1, 8 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 4 February 2020



Impact Year 2, 25 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 23 January 2023

**Bog 11.1 (Control Site), Photo Point 11.1CE**



Baseline Year 1, 8 February 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 4 February 2020



Impact Year 2, 25 January 2021



Impact Year 3, 31 January 2022



Impact Year 4, 23 January 2023

**Bog 11.2 (Impact Site), Photo Point 11.2AS**



Baseline Year 1, 28 January 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 7 February 2020



Impact Year 2, 26 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 24 January 2023

**Bog 11.2 (Impact Site), Photo Point 11.2AE**



Baseline Year 1, 28 January 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 7 February 2020



Impact Year 2, 26 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 2 February 2023

**Bog 11.2 (Impact Site), Photo Point 11.2BS**



Baseline Year 1, 28 January 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 20 February 2020



Impact Year 2, 26 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 23 January 2023

**Bog 11.2 (Impact Site), Photo Point 11.2BE**



Baseline Year 1, 28 January 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 20 February 2020



Impact Year 2, 26 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 23 January 2023

**Bog 11.2 (Impact Site), Photo Point 11.2CS**



Baseline Year 1, 28 January 2018



Baseline Year 2, 31 January 2019



Impact Year 1, 6 February 2020



Impact Year 2, 27 January 2021

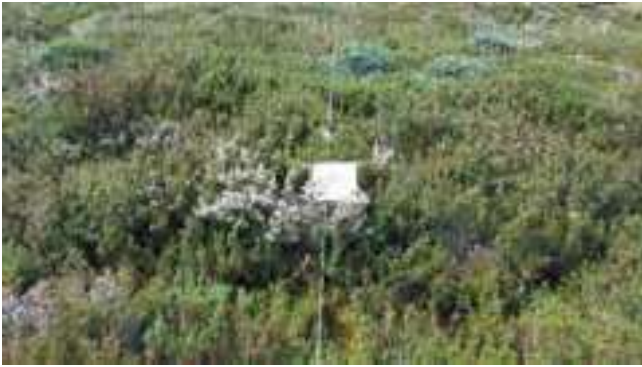


Impact Year 3, 1 February 2022



Impact Year 4, 2 February 2023

**Bog 11.2 (Impact Site), Photo Point 11.2CE**



Baseline Year 1, 28 January 2018



Baseline Year 2, 31 January 2019



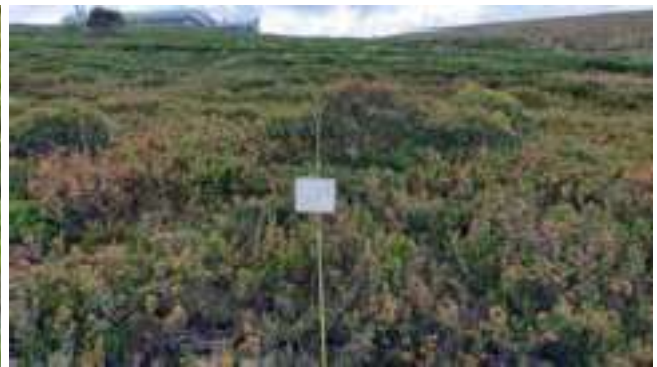
Impact Year 1, 6 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 2 February 2023

**Bog 12 (Impact Site), Photo Point 12AS**



Baseline Year 1, 27 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 7 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 3 February 2022



Impact Year 4, 24 January 2023

**Bog 12 (Impact Site), Photo Point 12AE**



Baseline Year 1, 27 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 7 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 3 February 2022



Impact Year 4, 24 January 2023

**Bog 12 (Impact Site), Photo Point 12BS**



Baseline Year 1, 29 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 6 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 2 February 2023

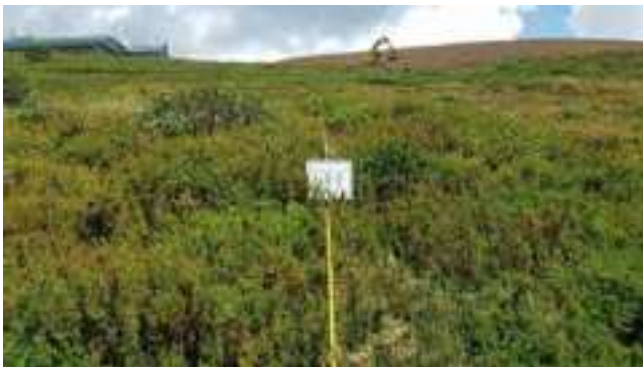
**Bog 12 (Impact Site), Photo Point 12BE**



Baseline Year 1, 29 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 6 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 1 February 2022



Impact Year 4, 2 February 2023

**Bog 12 (Impact Site), Photo Point 12CS**



Baseline Year 1, 29 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 7 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 3 February 2022



Impact Year 4, 24 January 2023

**Bog 12 (Impact Site), Photo Point 12CE**



Baseline Year 1, 29 January 2018



Baseline Year 2, 30 January 2019



Impact Year 1, 7 February 2020



Impact Year 2, 27 January 2021



Impact Year 3, 3 February 2022



Impact Year 4, 24 January 2023

**Bog 13 (Impact Site), Photo Point 13AS**



Baseline Year 1, 2 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 31 January 2020



Impact Year 2, 4 February 2021



Impact Year 3, 9 February 2022



Impact Year 4, 30 January 2023

**Bog 13 (Impact Site), Photo Point 13AE**



Baseline Year 1, 2 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 31 January 2020



Impact Year 2, 4 February 2021



Impact Year 3, 9 February 2022



Impact Year 4, 30 January 2023

**Bog 13 (Impact Site), Photo Point 13BS**



Baseline Year 1, 2 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 31 January 2020



Impact Year 2, 4 February 2021

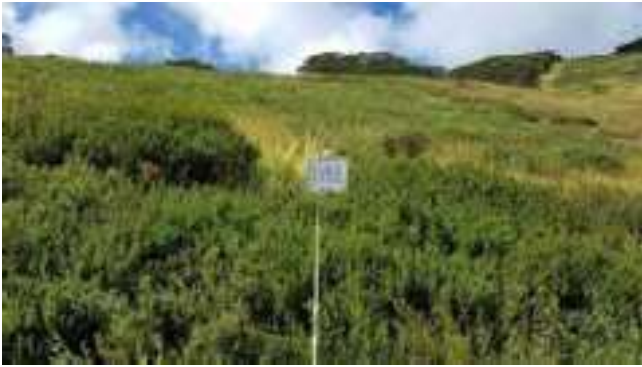


Impact Year 3, 9 February 2022



Impact Year 4, 30 January 2023

**Bog 13 (Impact Site), Photo Point 13BE**



Baseline Year 1, 2 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 31 January 2020



Impact Year 2, 4 February 2021



Impact Year 3, 9 February 2022



Impact Year 4, 30 January 2023

**Bog 13 (Impact Site), Photo Point 13CS**



Baseline Year 1, 2 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 31 January 2020



Impact Year 2, 4 February 2021



Impact Year 3, 9 February 2022



Impact Year 4, 30 January 2023

**Bog 13 (Impact Site), Photo Point 13CE**



Baseline Year 1, 2 February 2018



Baseline Year 2, 14 February 2019



Impact Year 1, 31 January 2020



Impact Year 2, 4 February 2021



Impact Year 3, 9 February 2022



Impact Year 4, 30 January 2023

**Bog S1 (Control Site), Photo Point S1AS**



Baseline Year 1, 6 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 28 January 2020



Impact Year 2, 4 February 2021



Impact Year 3, 2 February 2022



Impact Year 4, 2 February 2023

**Bog S1 (Control Site), Photo Point S1AE**



Baseline Year 1, 6 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 28 January 2020



Impact Year 2, 4 February 2021



Impact Year 3, 2 February 2022



Impact Year 4, 2 February 2023

**Bog S1 (Control Site), Photo Point S1BS**



Baseline Year 1, 6 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 28 January 2020



Impact Year 2, 4 February 2021



Impact Year 3, 2 February 2022



Impact Year 4, 31 January 2023

**Bog S1 (Control Site), Photo Point S1BE**



Baseline Year 1, 6 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 28 January 2020



Impact Year 2, 4 February 2021



Impact Year 3, 2 February 2022



Impact Year 4, 31 January 2023

**Bog S1 (Control Site), Photo Point S1CS**



Baseline Year 1, 6 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 28 January 2020



Impact Year 2, 4 February 2021



Impact Year 3, 2 February 2022



Impact Year 4, 31 January 2023

**Bog S1 (Control Site), Photo Point S1CE**



Baseline Year 1, 6 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 28 January 2020



Impact Year 2, 4 February 2021



Impact Year 3, 2 February 2022



Impact Year 4, 31 January 2023

**Bog S2 (Control Site), Photo Point S2AS**



Baseline Year 1, 6 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 29 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 3 February 2022



Impact Year 4, 31 January 2023

**Bog S2 (Control Site), Photo Point S2AE**



Baseline Year 1, 6 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 29 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 3 February 2022



Impact Year 4, 31 January 2023

**Bog S2 (Control Site), Photo Point S2BS**



Baseline Year 1, 7 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 29 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 3 February 2022



Impact Year 4, 31 January 2023

**Bog S2 (Control Site), Photo Point S2BE**



Baseline Year 1, 7 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 29 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 3 February 2022



Impact Year 4, 31 January 2023

**Bog S2 (Control Site), Photo Point S2CS**



Baseline Year 1, 7 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 30 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 3 February 2022



Impact Year 4, 2 February 2023

**Bog S2 (Control Site), Photo Point S2CE**



Baseline Year 1, 7 February 2018



Baseline Year 2, 13 February 2019



Impact Year 1, 30 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 3 February 2022



Impact Year 4, 2 February 2023

**Bog S3 (Control Site), Photo Point S3AS**



Baseline Year 1, 7 February 2018



Baseline Year 2, 12 February 2019



Impact Year 1, 29 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 3 February 2022



Impact Year 4, 31 January 2023

**Bog S3 (Control Site), Photo Point S3AE**



Baseline Year 1, 7 February 2018



Baseline Year 2, 12 February 2019



Impact Year 1, 29 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 3 February 2022



Impact Year 4, 31 January 2023

**Bog S3 (Control Site), Photo Point S3BS**



Baseline Year 1, 7 February 2018



Baseline Year 2, 12 February 2019



Impact Year 1, 29 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 3 February 2022



Impact Year 4, 2 February 2023

**Bog S3 (Control Site), Photo Point S3BE**



Baseline Year 1, 7 February 2018



Baseline Year 2, 12 February 2019



Impact Year 1, 29 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 3 February 2022



Impact Year 4, 2 February 2023

**Bog S3 (Control Site), Photo Point S3CS**



Baseline Year 1, 7 February 2018



Baseline Year 2, 12 February 2019



Impact Year 1, 29 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 2 February 2022



Impact Year 4, 31 January 2023

**Bog S3 (Control Site), Photo Point S3CE**



Baseline Year 1, 7 February 2018



Baseline Year 2, 12 February 2019



Impact Year 1, 29 January 2020



Impact Year 2, 3 February 2021



Impact Year 3, 2 February 2022



Impact Year 4, 31 January 2023

## Appendix 5 Ecology data

Table AS.1 Area of Alpine Bogs as determined by DGPS mapping

Site	Area (ha)										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	<b>1.3797*</b>	<b>1.3536</b>	<b>1.3666</b>	<b>1.3217</b>	<b>1.3353</b>	<b>1.3423</b>	<b>1.3636</b>				
<b>Bog4.2</b>	0.4014	0.3842	0.3928	0.3912	0.3823	0.3866	0.3882				
<b>Bog6</b>	0.4914*	0.6723	0.6723*	0.6380	0.6473	0.6359	0.6492				
<b>Bog 8/9/10</b>	0.0667	0.0718	0.0692	0.0704	0.0762	0.0798	0.0838				
<b>Bog 11.2</b>	0.1195	0.1120	0.1157	0.1094	0.1083	0.1094	0.1089				
<b>Bog12</b>	0.1145	0.1071	0.1108	0.1076	0.1157	0.1249	0.1275				
<b>Bog13</b>	0.0051	0.0063	0.0057	0.0051	0.0055	0.0058	0.0060				
<b>All control</b>	<b>2.1446</b>	<b>2.0178</b>	<b>2.0812</b>	<b>2.0902</b>	<b>2.1183</b>	<b>2.1875</b>	<b>2.2136</b>				
<b>Bog1</b>	0.1781	0.1620	0.1700	0.1491	0.1595	0.1626	0.1641				
<b>Bog2</b>	0.1516	0.1481	0.1499	0.1459	0.1464	0.1521	0.1519				
<b>Bog4.1/Sn</b>	0.5562	0.5457	0.5509	0.5480	0.5597	0.5519	0.5340				
<b>Bog 11.1</b>	0.2798	0.2590	0.2694	0.2571	0.2676	0.2890	0.2923				
<b>BogS1</b>	0.5712	0.4584	0.5148	0.5126	0.4992	0.5009	0.5145				
<b>BogS2</b>	0.1805	0.1778	0.1791	0.1785	0.1846	0.2108	0.2306				
<b>BogS3</b>	0.2271	0.2669	0.2470	0.2989	0.3013	0.3201	0.3261				

\*Note: As discussed in the IY1 monitoring report, mapping of Bog 6 in BY1 is unlikely to have captured the full extent of the Bog 6 entity as recognised in subsequent years and is therefore unreliable. The BY2 area for Bog 6 has therefore been used as the baseline mean and BY1 total for all impact sites.

Table AS.2 Dimensions of Alpine Bogs as estimated by line transects

Site	Sum of dimensions (m)										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	<b>356.2</b>	<b>353.2</b>	<b>354.7</b>	<b>355.6</b>	<b>354.2</b>	<b>344.8</b>	<b>342.6</b>				
<b>Bog4.2</b>	92.2	92.6	92.4	92.2	92.6	89.8	93				
<b>Bog6</b>	79.6	75.8	77.7	77.4	78.2	74.2	69.8				
<b>Bog 8/9/10</b>	66.4	67.8	67.1	65.2	65	61.4	60.8				
<b>Bog 11.2</b>	67.2	66.4	66.8	66.8	67.2	67.2	66				
<b>Bog12</b>	40.6	41.0	40.8	41.4	40.6	40.6	40.4				
<b>Bog13</b>	10.2	9.6	9.9	12.6	10.6	11.6	12.6				
<b>All control</b>	<b>436.0</b>	<b>441.6</b>	<b>438.8</b>	<b>438.6</b>	<b>436.6</b>	<b>438.8</b>	<b>434.6</b>				
<b>Bog1</b>	55.8	57.2	56.5	57.0	56.6	55.8	55				
<b>Bog2</b>	78.8	79.6	79.2	77.2	79	79.4	79.2				
<b>Bog4.1/Sn</b>	81.6	84.2	82.9	85.2	83.8	86	83.4				
<b>Bog 11.1</b>	48.6	48.4	48.5	48.0	47.4	47.6	48				
<b>BogS1</b>	52.6	52.4	52.5	52.0	51.2	50.8	51.2				
<b>BogS2</b>	57.4	58.2	57.8	58.2	57	57	57.8				
<b>BogS3</b>	61.2	61.6	61.4	61.0	61.6	62.2	60				

Table AS.3 Cover of all bare ground as estimated by line transects

Site	Cover of all bare ground										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	<b>1.9%</b>	<b>0.1%</b>	<b>1.0%</b>	<b>5.4%</b>	<b>4.6%*</b>	<b>3.6%*</b>	<b>0.4%*</b>				
<b>Bog4.2</b>	3.4%	0.0%	1.7%	5.8%	5.2%	1.9%	0.0%				
<b>Bog6</b>	3.8%	0.0%	1.9%	8.2%	5.3%	4.0%	1.5%				
<b>Bog 8/9/10</b>	0.7%	0.0%	0.3%	6.0%	3.7%	2.8%	0.5%				
<b>Bog 11.2</b>	0.0%	0.0%	0.0%	3.7%	8.0%	5.6%	0.0%				
<b>Bog12</b>	0.8%	0.8%	0.8%	3.1%	0.4%	5.4%	0.0%				
<b>Bog13</b>	0.0%	0.0%	0.0%	0.0%	1.7%	3.4%	0.0%				
<b>All control</b>	<b>0.9%</b>	<b>0.2%</b>	<b>0.5%</b>	<b>4.8%</b>	<b>2.6%*</b>	<b>5.0%*</b>	<b>1.9%*</b>				
<b>Bog1</b>	0.6%	0.0%	0.3%	3.5%	0.3%	1.9%	0.0%				
<b>Bog2</b>	1.1%	0.0%	0.6%	10.3%	0.7%	2.7%	0.0%				
<b>Bog4.1/Sn</b>	0.4%	0.0%	0.2%	0.8%	0.6%	0.6%	0.4%				
<b>Bog 11.1</b>	0.7%	0.4%	0.5%	3.6%	0.0%	3.2%	0.4%				
<b>BogS1</b>	3.0%	0.3%	1.7%	2.4%	7.1%	4.7%	6.4%				
<b>BogS2</b>	0.0%	0.0%	0.0%	5.7%	0.7%	1.0%	1.3%				
<b>BogS3</b>	0.9%	0.9%	0.8%	7.9%	10.7%	24.0%	6.6%				

\*Note: In IY2 and IY3, the type of bare ground was also recorded. Results presented here are for all bare ground, regardless of type.

Table AS.4 Cover of bare ground attributed to natural causes as estimated by line transects

Site	Cover of bare ground attributed to natural causes										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	-	-	-	-	1.3%	2.6%	0.4%				
<b>Bog4.2</b>					2.2%	1.7%	0.0%				
<b>Bog6</b>					1.1%	3.4%	1.5%				
<b>Bog 8/9/10</b>					1.1%	2.3%	0.5%				
<b>Bog 11.2</b>					0.8%	0.8%	0.0%				
<b>Bog12</b>					0.4%	5.4%	0.0%				
<b>Bog13</b>					1.7%	3.4%	0.0%				
<b>All control</b>	-	-	-	-	1.8%	5.0%	1.1%				
<b>Bog1</b>					0.3%	1.9%	0.0%				
<b>Bog2</b>					0.7%	2.7%	0.0%				
<b>Bog4.1/Sn</b>					0.0%	0.6%	0.4%				
<b>Bog 11.1</b>					0.0%	3.2%	0.4%				
<b>BogS1</b>					3.4%	4.7%	1.3%				
<b>BogS2</b>					0.7%	1.0%	1.3%				
<b>BogS3</b>					8.5%	24.0%	4.7%				

**Table AS.5 Cover of bare ground attributed to deer activity as estimated by line transects**

Site	Cover of bare ground attributed to deer activity										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	-	-	-	-	0.0%	0.0%	0.0%				
<b>Bog4.2</b>					0.0%	0.0%	0.0%				
<b>Bog6</b>					0.0%	0.0%	0.0%				
<b>Bog 8/9/10</b>					0.0%	0.0%	0.0%				
<b>Bog 11.2</b>					0.0%	0.0%	0.0%				
<b>Bog12</b>					0.0%	0.0%	0.0%				
<b>Bog13</b>					0.0%	0.0%	0.0%				
<b>All control</b>	-	-	-	-	0.9%	0.0%	0.9%				
<b>Bog1</b>					0.0%	0.0%	0.0%				
<b>Bog2</b>					0.0%	0.0%	0.0%				
<b>Bog4.1/Sn</b>					0.6%	0.0%	0.0%				
<b>Bog 11.1</b>					0.0%	0.0%	0.0%				
<b>BogS1</b>					3.7%	0.0%	5.1%				
<b>BogS2</b>					0.0%	0.0%	0.0%				
<b>BogS3</b>					2.2%	0.0%	1.9%				

**Table AS.6 Cover of bare ground attributed to sedimentation as estimated by line transects**

Site	Cover of bare ground attributed to sedimentation										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	-	-	-	-	3.4%	1.1%	0.0%				
<b>Bog4.2</b>					3.0%	0.2%	0.0%				
<b>Bog6</b>					4.2%	0.6%	0.0%				
<b>Bog 8/9/10</b>					2.5%	0.5%	0.0%				
<b>Bog 11.2</b>					7.2%	4.8%	0.0%				
<b>Bog12</b>					0.0%	0.0%	0.0%				
<b>Bog13</b>					0.0%	0.0%	0.0%				
<b>All control</b>	-	-	-	-	0.0%	0.0%	0.0%				
<b>Bog1</b>					0.0%	0.0%	0.0%				
<b>Bog2</b>					0.0%	0.0%	0.0%				
<b>Bog4.1/Sn</b>					0.0%	0.0%	0.0%				
<b>Bog 11.1</b>					0.0%	0.0%	0.0%				
<b>BogS1</b>					0.0%	0.0%	0.0%				
<b>BogS2</b>					0.0%	0.0%	0.0%				
<b>BogS3</b>					0.0%	0.0%	0.0%				

Table A5.7 Bog-dependent flora species richness as determined by line and belt transects

Site	Number of bog-dependent flora species										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	10	11	10.5	11	10	10	10*				
Bog 4.2	8	9	8.5	8	8	8	8*				
Bog 6	8	8	8	9	8	8	9				
Bog 8/9/10	9	5	7	8	7	7	7				
Bog 11.2	6	6	6	6	5	6	5				
Bog 12	7	7	7	6	6	6	6				
Bog 13	3	5	4	6	4	5	4				
<b>All control</b>	11	10	10.5	11	11	11	11				
Bog 1	5	5	5	5	6	6	5				
Bog 2	6	6	6	5	5	6	6				
Bog 4.1/5/7	8	8	8	7	9	8	9				
Bog 11.1	8	7	7.5	8	8	8	7				
Bog S1	6	6	6	7	7	6	7				
Bog S2	6	6	6	6	7	5	6				
Bog S3	7	8	7.5	9	8	8	8				

\*Note: While Silver Astelia was not recorded along line and belt transects at impact sites in IY4, it was incidentally recorded beside Transect 4.2B in Bog 4.2. The results presented here do not include this incidental record.

Table AS.8 Cover of bog-dependent flora species as estimated by line transects

Site	Cover of bog-dependent flora species										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	<b>77.9%</b>	<b>78.5%</b>	<b>78.2%</b>	<b>79.7%</b>	<b>79.5%</b>	<b>79.4%</b>	<b>78.6%</b>				
<b>Bog4.2</b>	87.5%	87.3%	87.4%	87.3%	87.7%	86.0%	87.9%				
<b>Bog6</b>	72.2%	72.4%	72.3%	72.6%	74.1%	74.3%	70.7%				
<b>Bog 8/9/10</b>	75.6%	75.6%	75.6%	77.5%	74.9%	77.5%	74.5%				
<b>Bog 11.2</b>	88.1%	90.5%	89.3%	91.0%	91.0%	88.9%	89.4%				
<b>Bog12</b>	72.8%	72.4%	72.6%	73.5%	75.1%	73.9%	73.2%				
<b>Bog13</b>	43.6%	48.7%	46.2%	59.0%	53.0%	58.1%	60.7%				
<b>All control</b>	<b>86.9%</b>	<b>88.8%</b>	<b>87.9%</b>	<b>88.3%</b>	<b>88.9%</b>	<b>89.1%</b>	<b>89.0%</b>				
<b>Bog1</b>	88.0%	90.5%	89.3%	90.2%	90.2%	88.6%	89.0%				
<b>Bog2</b>	89.0%	91.1%	90.0%	91.3%	90.4%	91.5%	91.5%				
<b>Bog4.1/Sn</b>	81.2%	83.9%	82.5%	83.7%	83.7%	81.7%	81.6%				
<b>Bog 11.1</b>	87.4%	87.7%	87.5%	88.1%	88.4%	88.4%	89.9%				
<b>BogS1</b>	84.8%	86.9%	85.9%	86.9%	89.2%	88.2%	89.2%				
<b>BogS2</b>	97.0%	99.3%	98.1%	98.0%	98.7%	98.3%	97.6%				
<b>BogS3</b>	84.2%	85.2%	84.7%	82.3%	85.2%	90.9%	88.6%				

Table AS.9 Cover of native non-bog-dependent flora species as estimated by line transects

Site	Cover of native non-bog-dependent flora species										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	44.4%	46.1%	45.2%	46.5%	46.1%	48.5%	45.6%				
<b>Bog4.2</b>	24.7%	26.9%	25.8%	27.1%	29.5%	27.5%	26.4%				
<b>Bog6</b>	62.5%	65.7%	64.1%	61.5%	65.7%	66.9%	66.7%				
<b>Bog 8/9/10</b>	49.4%	51.7%	50.6%	53.3%	50.6%	56.1%	50.1%				
<b>Bog 11.2</b>	24.9%	23.6%	24.3%	25.7%	24.7%	27.6%	25.7%				
<b>Bog12</b>	61.5%	61.5%	61.5%	63.4%	56.4%	62.6%	56.4%				
<b>Bog13</b>	66.7%	72.6%	69.7%	79.5%	72.6%	77.8%	71.8%				
<b>All control</b>	44.2%	46.1%	45.1%	43.5%	43.8%	44.8%	44.2%				
<b>Bog1</b>	42.9%	44.2%	43.5%	45.4%	44.8%	49.2%	51.1%				
<b>Bog2</b>	41.6%	41.4%	41.5%	41.2%	40.5%	42.1%	38.7%				
<b>Bog4.1/Sn</b>	39.2%	42.3%	40.8%	39.8%	39.0%	40.2%	41.4%				
<b>Bog 11.1</b>	41.2%	44.4%	42.8%	40.4%	43.0%	44.0%	44.0%				
<b>BogS1</b>	54.5%	57.9%	56.2%	46.8%	47.1%	44.4%	46.8%				
<b>BogS2</b>	32.3%	32.3%	32.3%	33.0%	34.7%	34.3%	33.3%				
<b>BogS3</b>	61.2%	63.7%	62.5%	60.6%	61.5%	62.1%	57.1%				

Table AS.10 Cover of weed species as estimated by line transects

Site	Cover of weed species										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	5.4%	6.3%	5.9%	7.3%	8.1%	8.8%	7.8%				
<b>Bog4.2</b>	4.5%	4.7%	4.6%	4.3%	4.5%	4.3%	4.7%				
<b>Bog6</b>	4.4%	6.9%	5.7%	7.8%	9.7%	14.5%	9.7%				
<b>Bog 8/9/10</b>	6.0%	9.0%	7.5%	11.0%	11.5%	10.3%	12.4%				
<b>Bog 11.2</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%				
<b>Bog12</b>	0.0%	0.4%	0.2%	0.8%	0.8%	1.6%	0.0%				
<b>Bog13</b>	40.2%	35.0%	37.6%	42.7%	47.0%	44.4%	37.6%				
<b>All control</b>	3.3%	5.3%	4.3%	5.0%	4.9%	5.5%	5.0%				
<b>Bog1</b>	3.2%	3.5%	3.3%	3.5%	3.8%	3.8%	3.8%				
<b>Bog2</b>	3.9%	4.6%	4.2%	5.5%	4.8%	7.8%	6.9%				
<b>Bog4.1/Sn</b>	4.9%	7.6%	6.2%	5.4%	5.0%	6.0%	7.4%				
<b>Bog 11.1</b>	1.4%	3.2%	2.3%	4.3%	2.9%	2.2%	1.4%				
<b>BogS1</b>	6.4%	7.4%	6.9%	6.7%	9.8%	6.7%	5.1%				
<b>BogS2</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				
<b>BogS3</b>	2.2%	9.5%	5.8%	8.5%	7.6%	9.8%	7.9%				

Table AS.11 Cover of Peat Moss *Sphagnum* spp. as estimated by line transects

Site	Cover of Peat Moss <i>Sphagnum</i> spp.										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	5.4%	5.3%	5.4%	6.0%	6.0%	5.9%	6.0%				
<b>Bog4.2</b>	15.9%	15.1%	15.5%	15.1%	16.8%	16.8%	15.3%				
<b>Bog6</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				
<b>Bog 8/9/10</b>	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	0.0%				
<b>Bog 11.2</b>	3.2%	2.7%	2.9%	2.1%	2.9%	2.1%	4.0%				
<b>Bog12</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				
<b>Bog13</b>	18.8%	22.2%	20.5%	28.2%	26.5%	26.5%	29.1%				
<b>All control</b>	15.5%	17.2%	16.4%	15.9%	16.4%	17.1%	17.9%				
<b>Bog1</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				
<b>Bog2</b>	3.4%	3.0%	3.2%	2.1%	3.4%	2.5%	3.7%				
<b>Bog4.1/Sn</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				
<b>Bog 11.1</b>	5.4%	11.9%	8.7%	7.6%	6.1%	4.7%	6.5%				
<b>BogS1</b>	33.7%	39.4%	36.5%	38.7%	37.7%	40.7%	43.4%				
<b>BogS2</b>	62.0%	65.0%	63.5%	59.3%	61.6%	65.0%	64.6%				
<b>BogS3</b>	21.1%	21.1%	21.1%	21.8%	24.3%	25.6%	26.5%				

Table AS.12 Proportion of Peat Moss *Sphagnum* spp. recorded as dead along line transects

Site	Proportion of Peat Moss <i>Sphagnum</i> spp. recorded as dead										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
<b>All impact sites</b>	<b>0.8%</b>	<b>0.9%</b>	<b>0.8%</b>	<b>8.4%</b>	<b>0.8%</b>	<b>0.8%</b>	<b>0.0%</b>				
<b>Bog4.2</b>	1.2%	1.2%	1.2%	2.5%	1.1%	1.1%	0.0%				
<b>Bog6</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				
<b>Bog 8/9/10</b>	0.0%	0.0%	0.0%	66.7%	0.0%	0.0%	0.0%				
<b>Bog 11.2</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				
<b>Bog12</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				
<b>Bog13</b>	0.0%	0.0%	0.0%	9.1%	0.0%	0.0%	0.0%				
<b>All control</b>	<b>2.6%</b>	<b>1.9%</b>	<b>2.2%</b>	<b>1.5%</b>	<b>2.5%</b>	<b>1.7%</b>	<b>0.7%</b>				
<b>Bog1</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				
<b>Bog2</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				
<b>Bog4.1/Sn</b>	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%				
<b>Bog 11.1</b>	0.0%	15.2%	10.4%	0.0%	0.0%	0.0%	0.0%				
<b>BogS1</b>	7.0%	0.0%	3.2%	1.7%	5.4%	0.8%	0.0%				
<b>BogS2</b>	1.6%	1.6%	1.6%	2.3%	0.5%	0.5%	1.6%				
<b>BogS3</b>	0.0%	0.0%	0.0%	0.0%	3.9%	6.2%	0.0%				



# **Mt Buller HEMAMP Groundwater and Surface Water Monitoring Review**

November 2022 -April 2023

Alpine Resorts Victoria

12 July 2023



The Power of Commitment


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# Executive summary

A 100 ML water storage dam was constructed on the Mt Buller summit, between October 2019 and May 2020, as part of the Mt Buller Sustainable Water Security Project. A Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP) was developed to enable monitoring of the condition of Alpine Sphagnum Bogs which are hydraulically down-gradient of the dam construction footprint.

The hydrological component of the HEMAMP involves bi-annual groundwater and surface water monitoring and sampling, undertaken by Mount Buller and Mount Stirling Resort Management Board (RMB). The annual monitoring period includes one monitoring event in spring (typically November) and one in late summer (typically February). Monitoring has been undertaken prior to dam construction (Baseline monitoring) and after dam construction (Impact monitoring).

Based upon the monitoring completed in late 2021 and early 2022, the following conclusions are made regarding the construction of the water storage dam:

No obvious hydrochemical differences in the surface water and groundwater, between the baseline and water storage construction periods

No major exceedances of the ANZG (2018) water quality objectives. The water quality objectives are met at all locations with the exception of minor exceedances at BH06 with regard to nitrate (as N)

Flow gauging stations have been installed by RMB, however, there is insufficient data at this point in time to draw any significant conclusions regarding changes in flows within the catchment

No obvious influence upon groundwater levels at most locations. However, two bores directly down-gradient of the water storage have shown a change in water level behaviour. The strong seasonal water level trend identified historically, has been replaced with a more stable water level, albeit with a slight reduction in water level highs

This change in water level response is in part due to changes in the upgradient groundwater catchment due to the footprint of the water storage and associated earthworks. It is noted, however, that groundwater seepage beneath the storage is captured via a drainage blanket, and redirected to Alpine bogs further downslope (north) via the Environmental Watering System (EWS).

This report recommends:

Continue to incorporate a third monitoring event in each annual monitoring period for the next 2 years

Incorporate flow monitoring of the EWS. It is understood that the flow meters in the EWS cannot be set up for automatic logging due to restricted Wi-Fi signal. Manual gauging should be incorporated monthly to include a meter reading and instantaneous flow measurement, with the exception of winter (June to September) to supplement the automatic data collection

Periodical inspection of the operation of the EWS is required to confirm that seepage waters from the storage are being redistributed to Alpine bog areas

RMB undertake regular inspection of the flow gauges installed at Boggy Creek 1 and 2 weirs to verify their operation and flow data capture. As part of the next annual review, surface water flow analysis from the catchment is to be included

Undertake maintenance of monitoring bores

- BH10 headworks should be repaired
- BH04 and BH04A should be decommissioned by a licenced driller

RMB began to consolidate all HEMAMP information into a database during this monitoring round. This database should continue to be updated and maintained

This report is subject to, and must be read in conjunction with, the limitations set out in section 1 and the assumptions and qualifications contained throughout the Report.

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# 1. Introduction

Mt Buller and Mt Stirling Resort Management Board (RMB), now incorporated into Alpine Resorts Victoria (ARV) determined the need for a 100 ML water storage as part of the Mt Buller Sustainable Water Security Project. This project aims to provide a reliable water supply to the resort, capable of meeting future demand. The water storage was constructed between October 2019 and May 2020 and had a 10.3 ha construction footprint. The footprint of the storage is adjacent to sensitive alpine ecosystems, particularly native vegetation and habitat for significant species, that are immediately down-gradient of the storage construction footprint.

A Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP) was developed to monitor the condition of the ecosystems, notably Alpine Sphagnum Bogs. The HEMAMP was implemented prior to the commencement of construction to obtain a baseline of information on surface water, groundwater and ecological conditions. Monitoring has continued post-construction. These pre-construction and post-construction monitoring periods have been referred to as *baseline* and *impact* periods in data reporting.

The hydrological component of the HEMAMP has involved bi-annual groundwater and surface water monitoring and sampling, undertaken by RMB. The annual monitoring period has included one monitoring event in spring (typically November) and one in late summer (typically February). In 2023, an additional monitoring round was added in April. This was added in response to a peer review of the monitoring program by Monash University as well as recommendations from the former Department of Environment, Land, Water and Planning (DELWP)<sup>1</sup>.

## 1.1 Purpose of this report

The purpose of this report is to present the data obtained from the annual groundwater and surface water monitoring at Mt Buller in the 2022-2023 hydrological monitoring period (i.e. November 2022, February 2023 and April 2023 monitoring events).

## 1.2 Scope and limitations

*This report: has been prepared by GHD for Alpine Resorts Victoria and may only be used and relied on by Alpine Resorts Victoria for the purpose agreed between GHD and Alpine Resorts Victoria as set out in section 1.1 of this report.*

*GHD otherwise disclaims responsibility to any person other than Alpine Resorts Victoria arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.*

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

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

*The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.*

*GHD has prepared this report on the basis of information provided by Alpine Resorts Victoria and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.*

*The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.*

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<sup>1</sup> Now the Department of Energy, Environment and Climate Action (DEECA)

*Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.*

*Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.*

## **1.3 Assumptions**

The following assumptions have been adopted to prepare this report:

GHD has relied upon data collected by the RMB, including climate (surface water flow and snow depth) data. This has been assumed as being accurate. GHD has not completed any independent verification of the data

## 2. Overview of monitoring program

### 2.1 Objectives

The objective of the water monitoring program is to identify potential implications on surface water and groundwater levels and quality caused by the construction and operation of the water storage.

### 2.2 Monitoring network

#### 2.2.1 Surface water

##### 2.2.1.1 Boggy Creek

Prior to 2018, there were two surface water sampling locations at weirs referred to as Boggy Creek 1 and Boggy Creek 2. Following a site inspection and sampling event in February 2018, a third location was added, at a weir downstream of the existing sampling locations.

The surface water sampling locations since 2018 include:

##### Boggy Creek 1

- Pick up Location 1, west of the shed and tank
- Pick up Location 2, south of the shed and tank

##### Boggy Creek 2

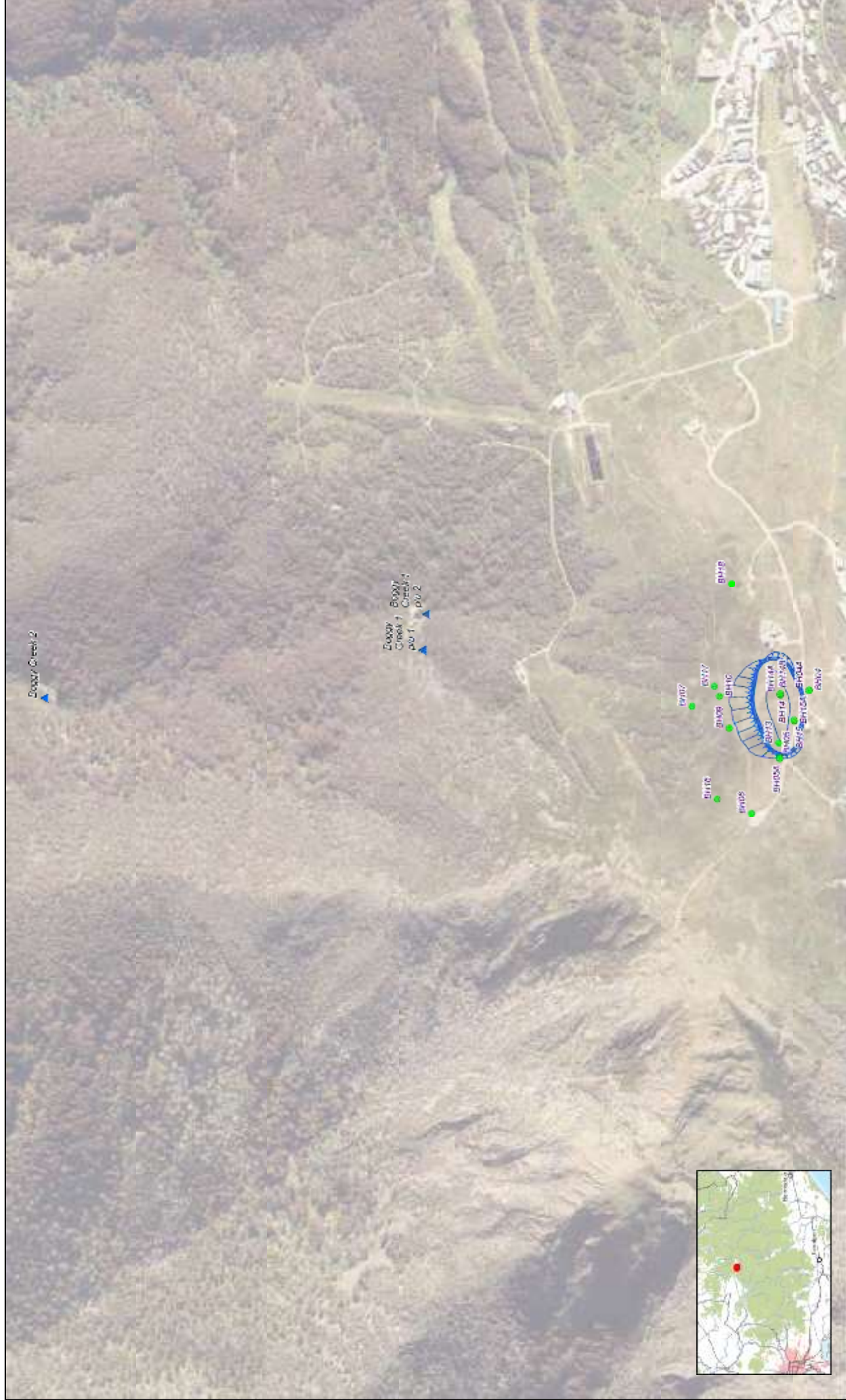
- At a weir downstream of the two Boggy Creek 1 sites

These three sampling sites are shown in Figure 1 and are summarised in Table 1.

**Table 1** Surface water monitoring network

Location Name	UTM zone 55 Coordinates		Location
	Easting	Northing	
Boggy Creek 1 p/u 1	449,781	5,889,496	Collection point is behind the shed off to the right up the hill, away from the tank pick up 1
Boggy Creek 1 p/u 2	449,857	5,889,488	Collection point is by the weir located on this hill behind the shed called Boggy Creek 1, pick up 2
Boggy Creek 2	449,678	5,890,310	Collection point is by the weir at Boggy Creek 2
Environmental Watering System (EWS)	449,656	5,888,881	Collection point is the western pipe of the EWS distribution pit, located on the northern wall of the dam. (western pipe is the groundwater collection drain, eastern pipe is the leakage collection drain)

It is noted that limited flow data has been provided for surface water. Therefore, surface water flow analysis is limited in this report. RMB installed new flow gauges at Boggy Creek weir 1 pickup 1 and pickup 2 in January and May 2022, which record flow rates at a daily frequency, although there are error periods in the new data. This data is included in Appendix B.



Mt Butler & Mt Stirling Resort Management  
 Surface and groundwater monitoring 2021-2022

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Figure 1 - Monitoring Network

LEGEND  
 ● Monitoring Bore Locations  
 ▲ Surface Water Monitoring  
 — Dam footprint



Paper Size A3  
 Metres  
 0 50 100 200 300 400  
 Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 55

### 2.2.1.2 Environmental watering system

The fourth sampling location is the Environmental Watering System located at the toe of the storage embankment.

To prevent excessive hydrostatic pressures on the storage lining system, the storage was constructed with an under-drainage system. The design drawings in Appendix A show the drainage system as comprising bedding sand with a network of DN100 collection pipes. The pipes terminate at central point beneath the storage, and then gravity feed to a 'distribution pit' located at the toe of the northern embankment. Groundwater collecting beneath the storage can then be directed to the north and discharged over the landscape. There are two (0.6 m deep) soakage trenches extending to the east (~58 m) and west (~107 m) of the distribution pit which spread the discharge across the northern slopes of Mount Buller. The pipe comprises both slotted and non-slotted intervals so that EWS water is mostly redirected to the Alpine Bog areas.

Sampling of the EWS is completed using the same methodology as that applied to the Boggy Creek locations. Flow meters are installed in the distribution pit, however due to difficulties obtaining WI-FI, the meters were not able to be incorporated into the existing SCADA network. Therefore, no gauging data is currently available.

## 2.2.2 Groundwater

### 2.2.2.1 Bore locations

The groundwater monitoring network originally comprised 14 bores which were installed as part of the initial geotechnical investigations. The original monitoring network is shown in Figure 1 and these bores were gauged multiple times during the preconstruction period to establish baseline conditions.

Additional bores were installed to target Alpine Bog areas e.g. BH16, BH17 and BH18. A review of the program by GHD (2018) recommended that water quality sampling continue at bores BH06, BH09, BH16, BH17 and BH18 during the construction period. The remaining bores (BH04, BH04A, BH07 and BH10) were to be manually gauged for the standing water level during sampling rounds (refer Table 2).

Table 2 Groundwater monitoring network

Bore ID	Automatic SWL data logger	Manual gauging	Groundwater sampling
BH04		✓	
BH04A		✓	
BH06	✓	✓	✓
BH07		✓	
BH09	✓	✓	✓
BH10		✓	
BH16	✓	✓	✓
BH17	✓	✓	✓
BH18	✓	✓	✓

Many of the original bores were located within the storage construction footprint and were destroyed in-situ during the construction program. During a site inspection by GHD in late 2021, bore BH09 could not be identified and was suspected as being hidden by fill material. Bore BH10 was sampled in place of the 'missing' bore BH09. Bore BH09 was subsequently identified using a metal detector in March 2022. The bore condition was reviewed and as it appeared to be sound and operational, it has been re-incorporated into the monitoring program.

### 2.2.2.2 Monitoring bore construction

The construction details for each groundwater monitoring bore are shown in Table 3. The bores which are no longer operational have been shaded grey.

Table 3 Groundwater monitoring bores construction details

Bore ID	Zone 55 Coordinates		Total Depth (m bgl)	Screen (m bgl)		
	Easting	Northing		Top	Bottom	Screened Lithology
BH04	449,692.8	5,888,663	15.68	8.68	14.68	Carbonaceous Mudstone
BH04A	449,692.6	5,888,663	2.56	1.56	2.56	Basalt
BH05	<b>449,547.4</b>	5,888,727	19.8	14	19.8	Granitic Soils
BH05A	449,546.6	5,888,727	2.5	1.5	2.5	Colluvium
BH06	449,429.0	5,888,787	9	6	9	Granite
BH07	449,658.3	5,888,915		0		Bog/Granitic Soil
BH09	449,611.8	5,888,835	6	3	6	Granite
BH10	449,679.9	5,888,856	9	6	9	Granite
BH13	449,580.0	5,888,729	9	6	9	Colluvium
BH14	449,683.5	5,888,724	19.5	16.5	19.5	Granite
BH14A	449,683.9	5,888,725	15	12	15	Granite
BH14B	449,684.4	5,888,725	9.5	6.5	9.5	Granitic Soils
BH15	449,626.7	5,888,695	23	20	23	Granitic Soils
BH15A	449,629.6	5,888,696	6	3	6	Colluvium
BH16	449,459	5,888,860	2.1	1.1	2.1	Granitic Soils
BH17	449,701	5,888,866	2.2		2.2	Granitic Soils
BH18	449,922	5,888,830	2.15	1.15	2.15	Granitic Soils

Note: grey shading denotes bores which are no longer operational

## 2.3 Sampling and analytical program

The monitoring is conducted tri-annually (previously bi-annually), in the months of February, November and April each year. The April monitoring round was introduced in 2023. The reporting period follows the financial year, i.e. this report documents results of the monitoring period November 2022 - April 2023.

### 2.3.1 Surface water

#### 2.3.1.1 Sampling method

A standard operating procedure (SOP) has been prepared for the hydrological monitoring program, to help to maintain consistency in the instance that a change in RMB staff should take place. Sampling for the 2022-2023 monitoring events was undertaken in accordance with this procedure.

Photographs of the sampling points are taken at each site and are attached in Appendix C. Samples are taken on the inside of the weir wall from the nearest access point at each weir:

the western corner at Boggy Creek 1 p/u 1 and Boggy Creek 2

the eastern corner at Boggy Creek 1 p/u 2

The western pipe within the EWS distribution pit

One duplicate and one split sample is required for each surface water monitoring event, as summarised in Table 4. This can be taken at either of the primary sample locations, making sure that the location of the duplicate sample is noted on the field sheet.

Table 4 Number of surface water samples required per monitoring event

Sample Type	Number
Primary sample	4
Primary laboratory duplicate (Duplicate) sample	
Inter-laboratory duplicate (Split) sample	

### 2.3.1.2 Analytical program

Table 5 lists the analytes requested for each surface water sample. Prior to taking a sample, a calibrated field water quality meter was used to measure in-field water quality parameters. The calibration certificate has been attached as Appendix C). The field and laboratory parameters are summarised in Table 5. In addition to the analytes in Table 5, metals were also analysed in November for comparison with metal results obtained in 2015. Incorporating metal results in April 2023 evens this to one impact year and one baseline year.

Table 5 Surface water analytes

Suite	Locations	Analytes
In-situ field measurements	Boggy Creek p/u 1 Boggy Creek p/u 2 Boggy Creek 2 EWS	Temperature pH Dissolved oxygen Oxidation - Reduction Potential (Redox) Electrical Conductivity (µSiem)
SW1 (laboratory analysis)	Boggy Creek p/u 1 Boggy Creek p/u 2 Boggy Creek 2 EWS	Electrical conductivity (EC) Total Dissolved Solids (TDS) pH (field) Nutrients (Total P, N), Total Kjeldahl Nitrogen (TKN) Major ions (Ca, Mg, Na, K, Cl, SO4, HCO3, CO3 and NO3) Turbidity Suspended Solids

## 2.3.2 Groundwater

### 2.3.2.1 Sampling method

A standard operating procedure (SOP) has been prepared for the hydrological monitoring program to help to maintain consistency in the instance that a change in field staff should take place. Sampling for the 2022-2023 monitoring period was undertaken in accordance with this procedure. The procedure is consistent with EPA Publication 669.1 (2022).

One duplicate and one split sample is required for each groundwater monitoring event, as shown in Table 6. This can be taken at either of the primary sample locations, making sure that the location of the duplicate sample is noted on the field sheet.

Table 6 Number of groundwater samples required per monitoring event

Sample Type	Number
Primary sample	5
Primary laboratory duplicate (Duplicate) sample	
Inter-laboratory duplicate (Split) sample	

Monitoring bores are purged of standing water (minimum three casing volumes, where possible) prior to sampling using a dedicated, disposable bailer to eliminate cross contamination. Field parameters are monitored throughout the purging process using a calibrated field water quality meter.

The bore is considered ready for sampling when the field indicators stabilise, in accordance with EPA Victoria (2022). Some bores are sampled without purging when there is insufficient recharge to purge three casing volumes of water or where recharge rates are very low.

The volume of water purged, and comments on observed characteristics of the water, are recorded on the field sheet for each bore (refer Appendix C).

### 2.3.2.2 Analytical program

Table 7 summarises the analytes requested for each groundwater sample, and the field measured water quality parameters. In addition to the analytes in Table 7, metals were also analysed in November for comparison with metal results obtained in 2015. Incorporating metal results in April 2023 evens this to one impact year and one baseline year.

Table 7 Groundwater analytes

Suite	Locations	Analytes
In-situ field measurements	BH06, BH09 (BH10*), BH16, BH17, BH18  *BH10 was monitored in place of BH09 in the 2021-2022 period	Temperature pH Dissolved oxygen Oxidation - Reduction Potential (Redox) Electrical Conductivity (µSiem)
GW1 (Laboratory analysis)	BH06, BH09 (BH10*), BH16, BH17, BH18  *BH10 was monitored in place of BH09 in the 2021-2022 period	Electrical conductivity, Total Dissolved Solids and pH Nitrate (as N), Nitrite (as N), Nitrogen (Total Oxidised) and Phosphorus (Total) Alkalinity (total) as CaCO <sub>3</sub> , Alkalinity (Bicarbonate as CaCO <sub>3</sub> ), Alkalinity (Carbonate as CaCO <sub>3</sub> ) Calcium, Magnesium, Potassium, Sodium, Chloride, sulphate

### 2.3.3 Laboratory

Samples are placed in an esky and chilled during the field sampling. Samples are stored in eskies on ice until they are ready for dispatch to the analytical laboratory with fresh ice.

The samples are submitted to ALS Environmental Laboratories Pty Ltd (ALS) as the primary laboratory and Eurofins MGT Pty Ltd (Eurofins) as the independent, secondary laboratory for QA/QC analysis.

A completed chain of custody form is submitted with the samples. Eurofins MGT and ALS are both registered with NATA<sup>2</sup> for the nominated analyses.

### 2.3.4 Water quality objectives

The *Environment Protection Act 2017* commenced on 1 July 2021 and specifies new objectives of the EPA and consequential amendments to the former act *Environment Protection Act 1970*. The Act changes Victoria's focus to a prevention based approach, rather than preventing waste and pollution impacts and managing these after they have occurred. Central to the Act is the general environmental duty (GED) which requires Victorians to reduce the risk of their activities potentially harming the environment or human health through waste and pollution.

The Act introduces two subordinate instruments:

- Environment Protection Regulations (EPR)
- Environment Reference Standard (ERS)

<sup>2</sup> NATA- National Association of Testing Authorities

Under section 93 of the new *Environment Protection Act 2017*, an Environmental Reference Standard (ERS) is used to assess and report on the environmental conditions throughout Victoria. The ERS:

- Identifies environmental values (human health and the environment) to be achieved or maintained in Victoria
- Specifies indicators and objectives used to measure, determine or assess whether those environmental values are being achieved, maintained, or threatened

The ERS is not meant to represent a compliance standard, but rather has a primary function to provide an environmental assessment and reporting benchmark. The ERS contains environmental values for each element of the environment in separate parts, i.e. air, land, water (surface and groundwater), however, the different elements of the environment can impact each other and the interactions between them need to be considered.

The ERS classifies the waters of Victoria (surface water and groundwater) into segments, with each segment having particular identified environmental values. For the surface and groundwater at the water storage, the protection of water dependent ecosystems and species is most relevant.

The ERS also sets indicators and objectives for the environmental value of the water, which for water dependent ecosystem and species are the Australian and New Zealand Guidelines for Fresh and Marine Water quality (ANZG 2018, updated July 2021). The ANZG (2018) guideline allows for water quality objectives to be selected based on different levels of species protection sought.

The results of the 2022-2023 monitoring program have been compared to the criteria of ANZG (2018, updated July 2021) for 95% Freshwater species protection. Of the analytes included in the laboratory program, a water quality objective criterion exists for nitrate (2.4 mg/L as N).

### 3. Monitoring results - Climate

#### 3.1 Rainfall

The Bureau of Meteorology maintains an active climate station at Mt Buller (Station No. 083024). The automated station is located approximately 500 m from the water storage dam at Tirol flat and monitors temperature (highs and lows) and rainfall (amongst other climate parameters) at a daily frequency. The monthly rainfall for the 2022 - 2023 monitoring period has been summarised in Table 8.

Table 8 Monthly rainfall (mm) over the 2022-23 monitoring period

Month	Rainfall (mm)
March 2022	101
April 2022	166
May 2022	122
June 2022	202
July 2022	96
August 2022	260
September 2022	231
October 2022	490
November 2022	290
December 2022	127
January 2023	35
February 2023	64
March 2023	185
Year Total	<b>2,370</b>

Table 9 presents the monthly rainfall for the previous three years as well as the mean monthly rainfall during the baseline years and 1990 to 2018. From the table it can be seen that total rainfall over the recent years is higher than the historical range. The annual total for 2022 was 960.9 mm above the long term (1990-2018) average, and 586 mm above the mean recorded during the baseline years 2012-2018.

Rainfall trends are shown in Figure 2 for the years 2014 to 2023. To show the variability of the climate, the cumulative monthly rainfall deviation has also been included in Figure 2. This has been prepared to identify long term rainfall trends for the period 1990 to 2023 to characterise the influence of climate on groundwater levels. The absolute value of the residual mass curve is not important, but rather the slope:

- A positive slope indicates a wetter than average period.

- A negative slope indicates a drier than average period

- A section of both negative and positive indicates a period of generally average rainfall

- The grade of the slope indicates how much wetter or drier than average the climate is

Note that the cumulative deviation from mean monthly rainfall has been calculated from 1990 to present, and so on the graph starts at a negative value based on previous years of rainfall. The residual mass curve indicates that rainfall has been close to average between 2018 and the present.

Table 9 Monthly rainfall during impact years and historical mean rainfall

Month	Mean monthly rainfall		Monthly Rainfall		
	1990 - 2018	2012 - 2018	2020	2021	2022
January	75.7	101.5	114.4	122	136.6
February	75.1	84.6	95.6	76.6	19.4
March	76.9	107.8	108.8	134.4	100.8
April	97.1	100.7	358.2	51.8	165.6
May	125.1	184.6	136.6	142.4	122.0
June	146.1	166.3	179.2	180.0	202.0
July	163.6	213.0	74.6	148.4	96.4
August	167.0	215.7	129.4	98.0	260.4
September	148.5	143.9	118.0	0.0	231.4
October	108.4	111.2	270.8	92.0	490.0
November	109.1	91.2	44.6	136.8	290.0
December	95.1	134.6	69.0	75.2	126.6
<b>Year Total</b>	<b>1,280.3</b>	<b>1,655</b>	<b>1,422.6</b>	<b>1,699.2</b>	<b>2,241.2</b>

## 3.2 Snow depth

As the water storage and the associated groundwater monitoring bore network are above the snow line, they get inundated with snow during the winter period. Snow is another form of precipitation that can recharge the aquifers underlying the summit.

Mt Buller Ski Lifts (Ski Patrol) undertakes snow gauging at three (3) locations across the resort:

- Tirol flat
- Boggy Creek
- Family Run

These sites have been in use continuously since 1987 and are considered to be reasonably close to the study site to provide an indication of snow depths. Of the three sites, the Tirol and Boggy Creek gauges considered reflective of the conditions at the water storage site and are described below based on historical records:

### Tirol flat

The gauge is located near the BoM (Bureau of Meteorology) automated weather station (083024). The monitoring site is located above the tree line and generally receives the least amount of snow, has sunlight all day, is prone to scouring from wind effect and in spring will lose all its snow first, in line with the north side of the mountain. It is not unusual during a significant snowfall for the Tirol Gauge to have nothing on it due to wind. Although the Tirol Gauge has the least amount of snow due to exposure, all the gauges are well above the lowest skiable point of 1,375 m, therefore average depths are recorded and helps reflect snow across the whole resort

### Boggy Creek

The gauge is located at the top of the Boggy Creek T-Bar. The gauge is above the tree line and receives sunlight all day and has little or no wind affect. It receives considerably more snow than the Tirol Gauge

The snow depth information for the Tirol flat gauge has been shown in Figure 3. The graph has two snow depths reflecting the natural snow depth and that resulting from snow making activities. The graph indicates that natural snow depth was greater for a longer period of time in 2022-2023 compared with the previous two impact years. However, snow depth remained within the range of the baseline years.

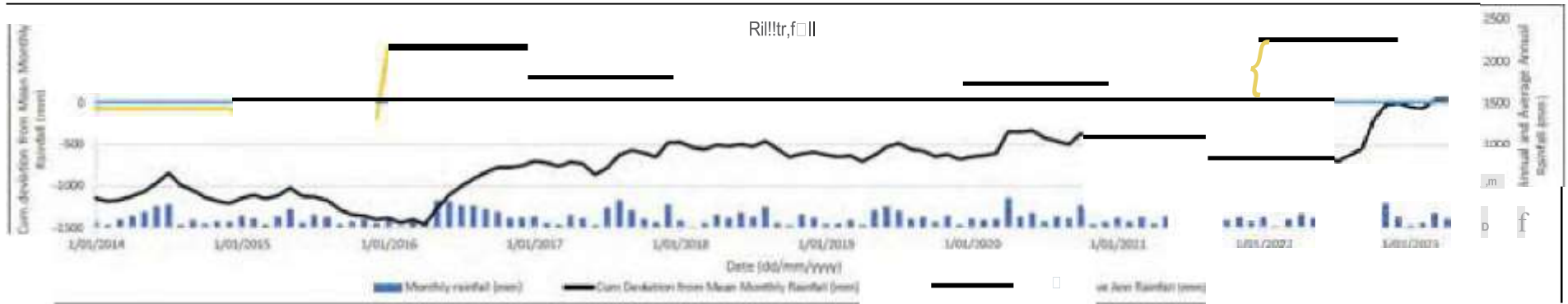


Figure 2 Rainfall trends January 2014 - June 2023

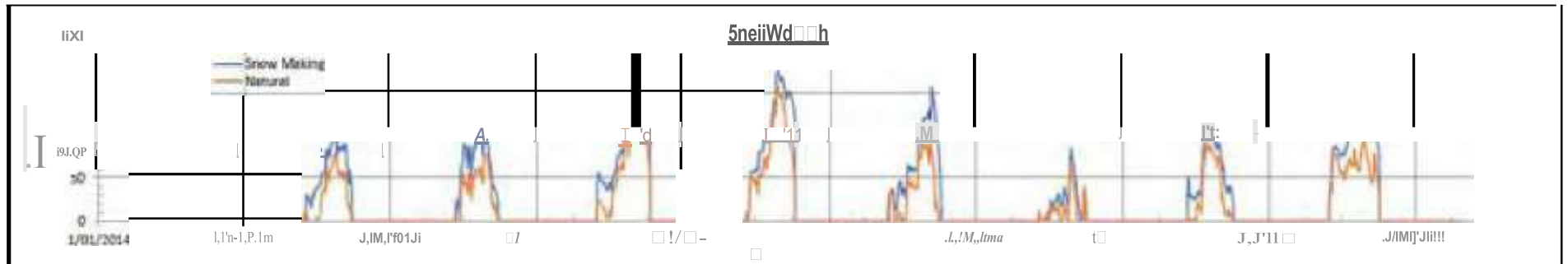


Figure 3 Snow depth data January 2014 - June 2023

## 4. Monitoring results - Network condition

### 4.1 Surface water

The surface water monitoring sites remain easily accessible for sampling. The weirs at each sampling site appeared to be in a similar condition to previous monitoring rounds.

### 4.2 Groundwater

All but two of the groundwater monitoring bores were in a sound condition i.e. there was no obvious damage to the casing or headworks, and they were secure and operational. Bores BH04 and BH10 were the exception, as both of their secure monuments had been damaged (refer Table 10). Bore BH04 was covered by realigned road works due to the dam construction in 2019-2020. Bore BH10 was not open over its full depth, however, access into the screen interval was possible.

All of the monitoring bores designated for sampling (BH06, BH09, BH16, BH17 and BH18) are in operable condition.

Table 10 Summary of monitoring bore condition

Bore ID	HEMAMP Water Quality Site	Status	Datalogger installed? (Y/N)	Condition
BH04	No	Identified	N	Headwork removed and PVC casing exposed. Casing was intact (and open) down to the constructed bore depth in the last monitoring round, however the well has been covered by road works during this monitoring round (Refer to Photographs in Appendix C).
BH04A	No	Identified	N	Headwork removed and PVC casing exposed. Casing was intact (and open) down to the constructed bore depth in the last monitoring round, however the well has been covered by road works during this monitoring round (Refer to Photographs in Appendix C).
BH06	Yes	Identified	Y	Operational and secure
BH07	No	Identified	N	Bore depth has reduced to 0.84 m from an original depth of 1.77 m. Bentonite is protruding at the top of the well around the J plug. Headworks are operational and secure
BH09	Yes	Identified	Y	Operational and secure
BH10	No	Identified	N	Headwork has been damaged and positioned loosely atop the well opening. The bore depth has reduced to 5.6 m from an original depth of 8.25 m.
BH16	Yes	Identified	Y	Operational and secure
BH17	Yes	Identified	Y	Operational and secure
BH18	Yes	Identified	Y	Operational and secure

## 5. Monitoring results - Surface flows

Flow meters were installed by RMB at Boggy Creek 1 and Boggy Creek 2 in January and May 2022. There is no flow gauging data for earlier impact periods. Six months of data was collected in 2022 from these locations, however further work is required to make sure that a continuous flow record is obtained moving forward. GHD have been provided with data from 2019 which is believed to be total flow for Boggy 1 only (this data is referred to as surface flow).

There is insufficient data to make a reasonable assessment as to whether a significant change has occurred as a result of the storage construction. It is understood that a flow gauge has been installed at the Boggy 1 and Boggy 2 weir and that this will be incorporated into the monitoring program and analysed in the next annual report.

## 6. Monitoring results - Groundwater levels

### 6.1 Data corrections

Automated water level dataloggers were installed in bores BH06, BH09, BH16, BH17 and BH18. The dataloggers (Insitu® LevelTROLL™) were non vented units and therefore barometric pressure datalogging was completed by installing an Insitu® BaroTROLL™ in bore BH06. The barometric logging enabled water level correction in the non-vented units. The dataloggers were removed, inspected, and downloaded during each monitoring round.

A manual measurement of the standing water level (SWL) is also taken for all monitoring bores (refer Appendix B) during each sampling round. For bores containing dataloggers, the SWL is manually taken before and after removing the datalogger. Standing water levels were manually measured using a hand held electronic water level probe. Manual SWL data is summarised in Appendix B.

There have been some issues identified with the water level logging data in terms of reference datums being incorrectly set and loggers switched in boreholes. This has required GHD to undertake some post processing of data, and the manual correction of barometric response. In some cases there are data gaps in the time series monitoring record.

### 6.2 Hydrographs

Hydrographs for each monitoring bore are presented in Appendix B. The following is noted regarding the format of the hydrographs:

The approximate construction period of the water storage has been indicated on the SWL graph

Snow depth and rainfall has been appended to each graph

A rainfall cumulative deviation has been included in the rainfall chart. It is based upon rainfall data since 1990

#### 6.2.1 Evidence of bore failure

Anomalous water levels can be taken as circumstantial evidence of bore failure. Anomalous water levels were not identified in any of the monitoring bores.

#### 6.2.2 Summary

Interpretations of the hydrographs for each monitoring bore are included in Table 11. Bores which are manually gauged have also been included in this table.

There is no groundwater abstraction occurring at Mount Buller and therefore the water level response in the monitoring bores is strongly dependent upon the prevailing climate. From the review of the hydrographs, the monitoring bores BH06, BH16 and BH18 exhibit similar responses to rainfall during the water storage construction period compared to the preconstruction or baseline monitoring period.

BH09 and BH17 exhibit changes in SWL trends following the water storage construction period. This indicates that there may be impacts occurring from the water storage at BH17 and BH09. Both of these bores are located on the northern side of the dam, close to the path of the summit nature trail.

Interpretation of the water level response in the manually monitored bores is more uncertain owing to the frequency of the water level gauging.

Table 11 Summary of hydrograph and other water level data responses

Bore ID	Aquifer	Monitoring method	Comment
BH04	Carbonaceous Mudstone	Manual only	Works were occurring at the location of BH04 and BH04A on the day of monitoring in April 2023. This bore has only manual gauging data. There is no obvious change in the water level response in this bore since the construction of the storage.
BH04A	Basalt/residual soils	Manual only	Works were occurring at the location of BH04 and BH04A on the day of monitoring in April 2023. BH04A has been dry, i.e. contains no water, over most of its monitoring record (water levels greater than 2.5 m below the surface). This suggests that the residual soils overlying the basalt are unsaturated.
BH06	Granite (weathered)	Datalogger + Manual	Bore BH06 is upgradient of mapped bogs near BH16. The hydrograph is responsive to rainfall and shows a strong seasonal trend. The SWL patterns are similar for 2015 and 2019; both following periods of below average rainfall. The SWL during 2022-2023 following above-average annual rainfall in 2022, resembles the trend in 2016-2017 following above-average rainfall in 2016. These trends suggest that the bore is behaving in the same way as it was prior to the water storage construction, i.e. no obvious impact from the water storage is apparent at this bore. Water levels are generally greater than 5 m below the surface, however during the snow season and spring, water can be within 2 m of the surface. After recharge during the Winter and Spring periods, water levels exhibit a slow decline over the Summer, i.e. the aquifer storage is filled, and then slowly drains over summer, providing water flows to down-gradient springs. Declines in some cases have continued below the base of the logger (9 m). Water levels recovery following in late Autumn is relatively rapid.
BH07	Granitic soil (bog)	Manual only (Datalogger prior to 2018)	The limited results of manual gauging during the impact period indicate that the SWL is continuing to respond to seasonal trends and remains within the baseline range. This is a shallow bore (1.0 m depth) which reacts to rainfall events. It is located within a mapped bog area immediately north of the water storage dam. In late Summer water levels can fall below the base of the monitoring bore. The bore indicates that for the majority of the year, water levels are within 1 m of the surface or shallower, however, there are small periods in the late Summer through Autumn where water levels become deeper than 1 m.
BH09	Granite (sandy clay/clayey sands)	Datalogger + Manual	There is an obvious change in the water level response in this monitoring bore since the construction of the storage. During the baseline period, the hydrograph exhibits a strong seasonality, with water level lows typically between 2.5 m and 3 m. Water levels can become artesian in late Winter and Spring. Prior to storage construction water levels would decline over the Summer period as water drains from aquifer storage, resulting in a pronounced seasonal response. Towards the end of the construction period the water level response changed, noting that this bore is directly down-gradient of the storage. Water levels no longer become artesian (a reduction in aquifer storage), and the seasonal drainage has stopped, with rapid water levels frequently responding between 1 m and 2.5 m. The groundwater catchment supplying water to the zone monitored by this bore has been disturbed by the storage construction. There is additional storage of infiltrating rainfall into the embankment materials (immediately north of the bore), and changes in recharge due to the storage itself. The bore is located marginally up-gradient of the western arm of the EWS. In short the bore is indicating that the water table is getting more frequent recharge events, but the total volume of recharge is not as much.

Bore ID	Aquifer	Monitoring method	Comment
BH10	Granite (extremely weathered-moderately weathered)	Manual only Datalogger prior to 2019)	<p>The response of monitoring bore BH10 was similar to bore BH09 in the baseline period monitoring. Manual gauging results indicate that the SWL is continuing to respond to seasonal trends and remains within the baseline range.</p> <p>The hydrograph exhibits a strong seasonality, with water levels typically deeper than 2 m, but become within 0.5 m of the surface in the peak of the snow season. Water levels exhibit a steady decline over the Summer period, and fall to around 6 m below the surface. Water level recovery is rapidly, rising over 5 m with rainfall and the commencement of the snow season. Smaller rainfall events in early Autumn do not seem to have a significant influence in terms of arresting the rate of water decline during the Summer/Autumn period. The significant variation in water levels, and slow drainage from the Winter/Spring highs potentially suggests that storage in the granites may form a significant contribution to down-gradient seeps and spring flows.</p>
BH16	Clayey gravelly SAND and Silty GRAVEL	Datalogger + Manual	<p>Bore BH16 is located cross slope from the storage, and within the margins of a bog.</p> <p>Water levels exhibit a strong seasonality and decline during the Summer and late Autumn periods. At times during Winter water levels can become artesian. As per other monitoring bores, there is a gradual decline in water levels following winter as groundwater drains from storage, however, water level recovery can be rapid. Larger rainfall events are, however, evident in the water level monitoring response. In this bog, there seems to be tendency for water levels to remain more stable (generally within 1 m variation between seasons), with groundwater storage taking more time to deplete, and recharge.</p> <p>The hydrograph shows no obvious changes between the pre- and post water storage behaviour.</p>
BH17	Clayey SAND	Datalogger + Manual	<p>BH17 is a shallow bore located within the margins of a bog. In the baseline years the bore shows similar features to that of bore BH16, i.e. an obvious seasonal response. At times the groundwater level has been artesian, and in some cases water levels remained artesian throughout the year.</p> <p>Since the construction of the storage the seasonal response of the water level has not been as pronounced.</p> <p>This bore is located directly down-gradient of the storage and it would seem that the construction of the storage has modified aquifer recharge in this area. It is noted that groundwater levels are tending to remain more stable (generally within 0.5 m of the ground surface, and 0.5 m variation between seasons), with groundwater storage taking more time to deplete, and recharge. The bog in this area is receiving water from the EWS.</p>
BH18	Clayey SAND	Datalogger + Manual	<p>This bore is located further to the east of the water storage. Bore BH18 appears to be experiencing similar trends and ranges in SWL in the impact years and baseline years. This indicates that the bore is not being impacted by the water storage.</p> <p>Water levels exhibit a strong seasonality and decline during the Summer and late Autumn periods. Water levels are reactive to rainfall events. At times during late Summer/Autumn water levels can fall below the base of the bore, however, they can quickly respond following a rainfall event.</p>

## 7. Monitoring results - Water quality

### 7.1 Surface water

#### 7.1.1 Field parameters

Table 12 summarises the field monitoring data (obtained immediately prior to sampling) for the 2022-2023 events. Field monitoring sheets have been attached in Appendix C. The stabilised field readings are displayed in both graph and table form alongside previous years in Appendix D, to allow comparison between the baseline and impact periods.

Table 12 and Appendix D show that the field parameters appear to remain within the same range between the baseline and impact periods at each location. No obvious change in Temperature, pH or Dissolved Oxygen has been identified from the field water quality parameter monitoring. Changes in Oxidation-Reduction Potential and Electrical Conductivity were noted in the 2022-2023 monitoring round as described below.

Typically, the field parameter results demonstrate:

Temperature averages are approximately 8°C to 9°C at each location

At all locations, pH typically ranges from slightly acidic to neutral. Boggy Creek 1 recorded a pH of 9 to 10 in 2015, but this is not considered to be significant to the baseline-impact analysis

Dissolved Oxygen values in the creek typically range between 7 mg/l and 12 mg/l with the exception of a low reading of 0.5 mg/l in January 2014 at Boggy Creek 1 plu 1

Oxidation Reduction Potential (ORP) is the most variable field parameter in all monitoring locations. The ORP averages are slightly less oxidising during the impact period at all locations yet remain within the range of the baseline monitoring period

Negative ORP results indicated reducing conditions in the November 2022 monitoring round at all locations. This was an anomaly to the previous and subsequent monitoring rounds and may have been an instrument error

Electrical conductivity (EC) has reduced at each Boggy Creek location during the 2022-2023 monitoring period but remains within the historical range.

The Boggy Creek sampling locations averaged 14.0 µSiem in the 2022-2023 monitoring period, compared to an average of 25.3 µSiem over the previous impact years. The overall averages remain similar between the baseline and impact years.

**Table 12** Surface water field measurements for November 2022 to April 2023

Location	Field Parameter	Nov 2022	Feb 2023	Apr 2023
Boggy Creek 1 (p/u 1)	Temperature (°C)	5.1	9.2	7.5
	pH (pH units)	8.15	7.57	7.7
	Dissolved Oxygen (mg/L)	11	10.4	11.73
	Oxidation - Reduction Potential (mV)	-70.8	66.3	116.2
	Electrical Conductivity (µSiem)	9.3	19.5	15.2

Location	Field Parameter	Nov 2022	Feb 2023	Apr 2023
Boggy Creek 1 (plu 2)	Temperature (°C)	5	8.2	7
	pH (pH units)	7.3	7.14	7.59
	Dissolved Oxygen (mg/l)	10.92	9.93	11.34
	Oxidation - Reduction Potential (mV)	-42.6	98.6	84.4
	Electrical Conductivity (µSiem)	7.6	15	12.8
Boggy Creek 2	Temperature (°C)	5.6	9.6	7.6
	pH (pH units)	7.19	7.47	8.27
	Dissolved Oxygen (mg/l)	10.97	9.8	12.43
	Oxidation - Reduction Potential (mV)	-11.1	81.4	9.3
	Electrical Conductivity (µSiem)	10.8	19.1	17.1

## 7.1.2 Analytical results

Analytical results are presented in summary tables in Appendix E. The certified laboratory reports are attached in Appendix F. The discussion below focuses on differences between the baseline and impact periods.

### Physico-chemical

For all monitoring locations, laboratory measurements of pH and EC are typically within the same range during both the baseline and impact monitoring periods. These parameters are typically within the same range as the field measurements. The pH range is typically slightly acidic to neutral.

New TDS maximums were recorded for Boggy 1 p/u 1 and Boggy 2 in the 2022-2023 monitoring round, however the overall trends remain similar. Boggy 1 p/u 1 saw spikes in TDS in November 2022 and April 2023, however February 2023 was within the previous range.

### Acidity and Alkalinity

At all locations, carbonate alkalinity is not identified above the limits of laboratory reporting (LOR) throughout the available monitoring record (as pH is generally well below 8.3). Concentrations of bicarbonate alkalinity are similar between the baseline and impact periods. Bicarbonate concentrations lowered slightly in November 2022 across all creek locations but increased again over the following two sampling rounds.

### Major Ions

At all locations, major ions such as calcium, magnesium and potassium ions are all within a similar range across the monitoring record, noting that the concentrations are very low; i.e. sodium and calcium <3 mg/L, magnesium and potassium <1 mg/L and chloride approximately 1 mg/L. Many of the major ion concentrations have been reported below the LOR in the baseline and impact periods.

### Nutrients

At all locations, total oxidised nitrogen and Total Kjeldahl Nitrogen (TKN) are within a similar range across all monitoring periods, and in many instances, below the LOR. Nitrate ranges are similar in all wells and showed a mild decrease in the start of the impact period, before increasing in the 2022-2023 monitoring period. Concentrations of phosphorus (Total) are low and are also below the LOR in many instances.

## 7.1.3 Summary table

Results are summarised in Table 13.

Table 13 Key analyte results for surface water

Key analyte	Boggy Creek 1 p/u 1	Boggy Creek 1 p/u 2	Boggy Creek 2
pH	Appears to be consistent between baseline and impact periods. Typically slightly acidic to neutral.		
Electrical conductivity	Appears to be consistent between baseline and impact periods. Concentration ranges from 20 to 50 $\mu$ Siem		
Turbidity	Slightly lower in the impact period (average of 0.4 NTU compared to 1.3 NTU in baseline period). Typically <2 NTU	Appears to be consistent between baseline and impact periods. Typically <1 NTU	
Bicarbonate	Appears to be largely consistent between baseline and impact periods with the exception of February 2022. Concentrations ranges from 12-15 mg/L except for Feb 2022 at 37 mg/L.	Appears to be consistent between baseline and impact periods. Concentrations ranges from 10-15 mg/L.	
Carbonate	Consistent between baseline and impact periods. Concentration below detection limit.		
Calcium, Magnesium, Potassium, Sodium, Chloride	Appears to be consistent between baseline and impact periods. Ion concentrations typically <2.6 mg/L.		
Nitrogen and nitrate	Appears to be consistent between baseline and impact periods. Typically <1 mg/L.		
Phosphorus and phosphate	Appears to be consistent between baseline and impact periods. Typically <1 mg/L.		

## 7.2 Groundwater

### 7.2.1 Field parameters

Table 14 shows the measurements taken in the field immediately prior to sampling for each site for November and February. These are displayed in both graph and table form alongside previous years in Appendix D, to allow comparison between baseline and impact periods.

From Appendix D, the field parameters appear to remain within the same range between baseline and impact periods at each groundwater monitoring location. This indicates that water quality has not obviously changed, with the exception of minor changes in ORP and EC. Typically, the field parameter results demonstrate:

Temperature averages between approximately 6°C to 10°C at each location, with bore BH18 exhibiting the widest variation in temperature

At all locations, pH ranges from acidic to neutral

DO values are generally similar among all bores. Note that DO measurements are less reliable than other parameters due to the sampling method (bailer). Average DO remains similar between the baseline and impact years. The EWS DO value is within the range of the bores

ORP in February 2023 and April 2023 was within the typical range for each bore. ORP was significantly lower in the November 2022 event (including negative values which have not been historically recorded at some locations). The November ORP results may be related equipment error. The EWS ORP concentration are consistent with that identified in the bores

EC remains reasonably consistent at each location between the baseline and impact periods. The EWS discharge has a similar EC

Table 14 Groundwater field measurements November 2022- April 2023

Borehole ID	Field Parameter	Nov 2022	Feb 2023	Apr 2023
BH06	Temperature (°C)	<b>4.1</b>	5.8	5.4
	pH (pH units)	3.85	5.07	5.7
	Dissolved Oxygen (mgll)	9.92	9.06	9.18
	Oxidation - Reduction Potential (mV)	8.7	199.9	146.9
	Electrical Conductivity (µSiem)	19.1	38.2	37.2
BH09	Temperature (°C)	4.8	6.4	8.4
	pH (pH units)	4.68	5.28	<b>5.54</b>
	Dissolved Oxygen (mgll)	6.83	8	8.53
	Oxidation - Reduction Potential (mV)	-40.4	184.5	190.5
	Electrical Conductivity (µSiem)	8.2	15.8	14.8
BH16	Temperature (°C)	5	6.3	6.2
	pH (pH units)	<b>4.24</b>	5.26	5.63
	Dissolved Oxygen (mgll)	9.34	8.3	6.76
	Oxidation - Reduction Potential (mV)	-4.5	187.5	203.1
	Electrical Conductivity (µSiem)	12.4	12.7	12.4
BH17	Temperature (°C)	4.8	9.4	6.6
	pH (pH units)	5.54	6.16	6.49
	Dissolved Oxygen (mgll)	8.5	8.85	8.41
	Oxidation - Reduction Potential (mV)	-59	168.1	164.3
	Electrical Conductivity (µSiem)	25.3	26.8	27.6
BH18	Temperature (°C)	5.7	9.5	7.3
	pH (pH units)	4.94	5.96	5.78
	Dissolved Oxygen (mgll)	2.7	3.32	2.38
	Oxidation - Reduction Potential (mV)	-37.8	77.9	182.6
	Electrical Conductivity (µSiem)	14.95	49	20.1
EWS	Temperature (°C)	6.8	11.6	7.9
	pH (pH units)	5.61	6.27	6.55
	Dissolved Oxygen (mgll)	5.59	<b>4.45</b>	7.45
	Oxidation - Reduction Potential (mV)	-59.2	76.4	127.5
	Electrical Conductivity (µSiem)	17.5	26.6	28.6

## 7.2.2 Analytical results

Analytical results are included in Appendix E. The following summary relates to the monitoring bores BH06, BH09, BH16, BH17 and BH18.

### Physico-Chemical

For all monitoring locations, laboratory measurements of pH and EC are typically within the same range during both the baseline and impact monitoring periods. The EC remains low, typically < 50  $\mu$ Siem. Bore BH06 is typically highest in EC, recording a maximum of 57  $\mu$ Siem.

For all locations, the groundwater salinity has similar concentrations between the baseline and impact monitoring periods. The salinity remains low, typically < 100 mg/L TDS, however, TDS values were marginally higher in all wells in April 2023 compared to previous records (ranging from 42 to 80 mg/L TDS).

### Acidity and Alkalinity

At all locations, the carbonate alkalinity has not been above the LOR.

Bicarbonate has been consistent between the baseline and impact periods in all bores prior to this monitoring round. In 2022-2023, bicarbonate concentrations were lower in bores BH06, BH09 and BH16 compared to recent monitoring periods. Note, however, that the laboratory limit of reporting (LOR) for bicarbonate has reduced from 20 mg/L to 1 to 2 mg/L, so values below the LOR, which have been assessed at half the LOR as per common practice, are biased to appear higher in the baseline period.

Bores BH17 and BH18 have the highest concentrations of bicarbonate (maximums of 26 mg/L and 16 mg/L respectively). The remaining bores typically have concentrations of bicarbonate <10 mg/L.

### Major Ions

Major ions (calcium, magnesium, potassium and sodium) are generally within a similar range between the baseline and impact periods for all bores. Bores BH06, BH10, BH16 and BH17 all typically average < 3 mg/L for calcium, magnesium and potassium. Chloride is relatively consistent for all bores in both baseline and impact periods, at approximately 1 mg/L to 2 mg/L.

Sulfate has remained fairly consistent since 2018.

### Nutrients

Nitrogen (as total N, total oxidised N and TKN) and nitrate are reasonably consistent across all locations, during both baseline and impact periods. Nitrate concentrations in bore BH18 are typically an order of magnitude lower than the other monitoring wells.

Bore BH06 shows the most variability in nitrogen (and nitrate) compared to other monitoring bores. The concentrations exhibit a degree of seasonality for bore BH06 yet appears consistent between baseline and construction periods.

Phosphate and phosphorus are typically below the LOR or very low (< 1 mg/L) at all locations in both baseline and impact periods, with the exception of bore BH16 in 2022 which has a total phosphorus concentration of 3.6 mg/L.

## 7.2.3 Summary table

Results are summarised in Table 15.

Table 15 Key analyte results for groundwater

Key analyte	BH06	BH09	BH16	BH17	BH18
pH	Appears to be consistent between baseline and impact periods. Typically slightly acidic to neutral.				
Electrical conductivity	Appears to be consistent between baseline and impact periods. Typically < 50 $\mu$ Siem.				
Bicarbonate	Appears to be consistent between baseline and impact periods. Range typically < 20 mg/L.				
Carbonate	Appears to be consistent between baseline and impact periods. Concentrations below detection limit.				
Calcium, Magnesium, Potassium, Sodium, Chloride	Appears to be consistent between baseline and impact periods. Typically < 10 mg/L.				
Nitrogen and nitrate	Appears to be consistent between baseline and impact periods. Typically < 10 mg/L.				
Phosphorus and phosphate	Appears to be consistent between baseline and impact periods. Typically < 1 mg/L.				

## 7.3 QAQC program

A quality assurance/quality control (QA/QC) program was implemented based on relevant Australian Standards (Standards Australia 2005) and industry common practice. The QA/QC program undertaken for the ongoing water monitoring program included the following:

- Minimising cross-contamination between sample points through the use of new bailers and rinsing the water quality meter between locations
- Preservation of samples with ice during transport from the field to the laboratory
- Transportation of samples with accompanying COC documentation
- Collection of quality control samples and calculated review of Relative Percent Difference (RPDs)
- Comparison of field and analytical data
- Review of laboratory QA/QC analysis including laboratory duplicates

Quality control samples provide information that discounts or potentially identifies any errors due to possible sources of cross contamination, inconsistencies in sampling, and analytical techniques used. The quality control program for the 2021-2022 monitoring period comprised the collection and analysis of the following types of samples:

**Field duplicates:** Coded duplicate samples submitted to the primary laboratory for analysis as individual samples without any indication to the laboratory that they have been duplicated

**Field splits:** Duplicate samples with one sample being sent to a secondary laboratory for analysis. The same parameters are analysed utilising similar analytical techniques

Additional quality control samples to be considered for the program, where appropriate, are:

**Rinsate:** A sample of deionised water collected from equipment used during sampling to indicate whether cross contamination occurred from equipment. Equipment to take the rinsate off would include a bailer or the bucket used to collect the EWS water

## 7.3.1 Duplicate and split overview

### Frequency

EPA Publication 669.1 states that the number of duplicate samples taken depends on the desired level of certainty in the analysis. Typically, one duplicate for every 10 samples (a duplicate frequency of 10%) is considered an appropriate frequency<sup>3</sup>.

### Relative percentage difference

A quantitative measure of the accuracy of the duplicate analyses results and QAQC sample results were made using calculated relative percentage difference (RPO) values. The RPO values were calculated using the following equation.

$$RPD (\%) = \frac{(C_o - C_s)}{\left(\frac{C_o + C_s}{2}\right)} \times 100$$

Where  $C_o$  = concentration obtained from the original sample

$C_s$  = concentration obtained from the duplicate/QAQC sample

The RPO was used to normalise each pair of results, allowing data interpretation and reliability. An RPO range of 30% to 50% is generally considered acceptable based on AS4482.1 (2005). For duplicate results near the detection limit, RPO values as high as 80% may still be acceptable. RPO percentages >50% have been highlighted in Appendix E for the 2021-2022 monitoring period.

## 7.3.2 Sampling program QA/QC

### 7.3.2.1 Compliance with recommended holding times

All samples were analysed within the recommended holding times in the 2022-2023 monitoring period, with minor exceptions as included in the laboratory reports in Appendix F.

### 7.3.2.2 Surface water field duplicate and split duplicate frequency

A total of 12 primary surface water samples were collected in the 2022-2023 monitoring period. One duplicate and one split surface water sample was analysed each sampling round (a total of 3 duplicates and 3 splits), for a sample duplicate frequency of 25%. This frequency complies with the target minimum frequency of 10%.

In November 2022, field duplicate sample SW-O1 and split sample SW-O2 were collected from monitoring site Boggy Creek 1, p/u 1. Tabulated surface water analytical results with RPO results are provided in Appendix E.

In February 2023, field duplicate sample SW-O1 and split sample SW-O2 were collected from monitoring site Boggy Creek 2. Tabulated surface water analytical results with RPO results are provided in Appendix E.

In April 2023, field duplicate sample SW-O1 and split sample SW-O2 were collected from monitoring site Boggy Creek 2. Tabulated surface water analytical results with RPO results are provided in Appendix E.

### 7.3.2.3 Groundwater field duplicate and split duplicate frequency

A total of 15 primary groundwater samples were collected during the 2022-2023 monitoring period. One duplicate and one split groundwater sample was analysed each sampling round (a total of 3 duplicates and 3 splits), for a sample duplicate frequency of 20%. This frequency complies with the target minimum frequency of 10%.

In November 2022, field duplicate sample GW-O1 and split duplicate GW-O2 was collected from monitoring well BH06. Tabulated surface water analytical results with RPO results are provided in Appendix E.

In February 2023, field duplicate sample GW-O1 and split duplicate GW-O2 were collected from monitoring well BH06. Tabulated groundwater analytical results with RPO results are provided in Appendix E.

<sup>3</sup> QLD Government, 2018. *Sampling design and preparation: Quality control for water and sediment sampling*

In April 2023, field duplicate sample GW-O1 and split duplicate GW-O2 were collected from monitoring well BH16. Tabulated groundwater analytical results with RPO results are provided in Appendix E.

#### **7.3.2.4 Rinsate frequency.**

One rinsate sample (R1) was taken from an unused bailer in the April 2023 monitoring round.

#### **7.3.2.5 Surface water and groundwater results**

Of the available results, there were six RPO results exceeding 50% in November 2022, nine RPO results exceeding 50% in February 2023 and 12 RPO results exceeding 50% in November 2023. The RPO results did not indicate consistent differences in the results for particular analytes or between the primary and secondary laboratory.

### **7.3.3 Laboratory internal QA/QC results**

#### **Laboratory duplicates**

The primary laboratory reported no outliers for the November 2022, February 2023 or April 2023 laboratory duplicates.

The secondary laboratory reported one outlier for November 2022 (Phosphate total as P). The secondary laboratory reported one outlier for February 2022 (Total Kjeldahl Nitrogen).

#### **Matrix spike outliers**

The primary laboratory reported no outliers for the November 2022, February 2023 or April 2023 laboratory matrix spike tests.

The secondary laboratory reported no outliers for November 2022. The secondary laboratory reported no outliers for the February 2023 laboratory matrix spike tests.

#### **Method blanks**

The primary laboratory reported no outliers for the November 2022, February 2023 or April 2023 laboratory method blank tests.

The secondary laboratory reported no outliers for the November 2022 laboratory method blank tests.

#### **Laboratory control sample (LCS) spike recoveries**

No LCS outliers were reported by the primary laboratory in November 2022, February 2023 or April 2023.

The secondary laboratory reported no outliers for the November 2022 laboratory LCS tests.

#### **Regular sample surrogate**

No regular sample surrogate outliers were reported by the primary laboratory in November 2022, February 2023 or April 2023.

The secondary laboratory reported no outliers for the February 2023 laboratory surrogate tests.

#### **Laboratory control sample frequency outliers**

No regular sample surrogate outliers were reported by the primary laboratory in November 2022, February 2023 or April 2023.

The secondary laboratory reported no outliers for the February 2023 laboratory LCS frequency tests.

#### **Holding time**

Holding times were exceeded by one to two days for pH and nitrate.

### **7.3.4 Outcome**

Review of the QAQC program indicated that the quality of sampling data in the 2022-2023 monitoring period is of adequate accuracy for the purpose of the report.

## 8. Discussion of results

### 8.1 Comparison with water quality objectives

Of the analytes included in the laboratory program, a water quality objective exists for nitrate (2.4 mg/L as **N**).

Bore BH06 recorded two exceedances of the nitrate (**N**) criteria during the baseline period and two exceedances of the nitrate (**N**) criteria during the impact period. Nitrate levels have been relatively high throughout the 2022-2023 monitoring period compared to the previous impact years.

The results suggest that the water quality objectives are met at all locations with the exception of some exceedances at BH06 with regard to nitrate (as **N**), which are variable and have been similar between baseline and impact years.

All bores showed a decline in nitrate during the earlier impact years (2020-2022) and have shown an increase in the recent impact year (2022-2023). It is understood that the Class A recycling plant is offline indefinitely and has not been operating for some years. Snow making is produced from raw water, therefore snow making is unlikely to be contributing to nutrient concentrations.

### 8.2 Statistical identification of trends

Mann-Kendall analysis was performed to assess if there was a statistical trend in the data that was monotonic, i.e. either increasing or decreasing.

The Mann-Kendall results for the surface water and groundwater samples are summarised in Table 16 and Table 17 respectively. The data set is too small to complete an analysis on the EWS discharge. Based upon the available data, most of the analytes assessed in either surface water or groundwater have either a stable or no trend in concentrations.

Whilst some analytes are noted as having a potential increasing or decreasing trend, there is not great confidence, i.e. there is either significant variability in concentrations over time, or little change in concentrations over time (with the latter seemingly more plausible).

Table 16 Mann-Kendall trend outputs - surface water

Analyte	Boggy 1 p/u 1	Boggy 1 p/u 2	Boggy 2
pH	Stable	Stable	Stable
EC	Stable	Stable	<b>Probably Decreasing</b>
TDS	No Trend	Stable	No Trend
Alkalinity (Bicarbonate as CaCO <sub>3</sub> )	Stable	Stable	Stable
Calcium	<b>Probably Decreasing</b>	<b>Probably Decreasing</b>	Stable
Chloride	No Trend	Stable	No Trend
Magnesium	Stable	<b>Decreasing</b>	No Trend
Potassium	Stable	No Trend	No Trend
Sodium	Stable	<b>Probably Decreasing</b>	No Trend

Analyte	Boggy 1 p/u 1	Boggy 1 p/u 2	Boggy 2
Sulfate	No Trend	Stable	No Trend
Nitrate	<b>Probably Increasing</b>	Stable	<b>Probably Increasing</b>

Note:

The difference between stable and no trend is based upon the ratio of the standard deviation to the mean. When the standard deviation is far greater than the mean, the variability in the data is considered to be high and the dataset deemed to have 'no trend'.

The Mann Kendall 'S' statistic is an indicator of the strength of the trend. A very high positive value of S is an indicator of an increasing trend and a very low negative value indicates a decreasing trend.

Table 17 Mann-Kendall trend outputs - groundwater

Analyte	BH06	BH09	BH16	BH17	BH18
pH	Stable	Stable	No Trend	Stable	No Trend
EC	No Trend	Stable	<b>Probably Decreasing</b>	Stable	No Trend
TDS	No Trend	Stable	No Trend	No Trend	<b>Increasing</b>
Alkalinity (Bicarbonate as CaCO <sub>3</sub> )	<b>Decreasing<sup>1</sup></b>	<b>Decreasing<sup>1</sup></b>	<b>Decreasing<sup>1</sup></b>	<b>Probably Increasing</b>	No Trend
Calcium	<b>Probability Increasing</b>	Stable	<b>Decreasing</b>	Stable	Stable
Chloride	No Trend	Stable	Stable	No Trend	Stable
Magnesium	No Trend	No Trend	No Trend	Stable	No Trend
Potassium	No Trend	Stable	No Trend	No Trend	No Trend
Sodium	<b>Decreasing</b>	<b>Probably Decreasing</b>	Stable	No Trend	<b>Decreasing</b>
Sulfate	No Trend	Stable	Stable	<b>Probably Decreasing</b>	<b>Decreasing</b>
Nitrate	No Trend	No Trend	Stable	Stable	No Trend

<sup>1</sup>Trend is likely to be skewed by the LOR in the data and is not considered to be accurate.

## 8.3 Summary of potential storage construction impacts

### 8.3.1 Surface water

Field results indicate that water quality parameters (temperature, pH, DO, ORP and EC) during the baseline and impact monitoring periods are similar. A summary of the review of the analytical results is presented in Table 18 which suggests that there is no obvious, gross change in the water quality between the baseline and impact periods.

Table 18 Surface water: Differences in key analytes between baseline and impact monitoring periods

Key analyte	Notable difference in construction period compared to baseline years?		
	Boggy Creek 1 p/u 1	Boggy Creek 1 p/u 1	Boggy Creek 2
pH	No	No	No
Electrical conductivity	No	No	No

Key analyte	Notable difference in construction period compared to baseline years?		
	Boggy Creek 1 p/u 1	Boggy Creek 1 p/u 1	Boggy Creek 2
Turbidity	No Slightly lower in the construction phase period (average of 0.4 NTU compared to 1.3 NTU in baseline period).	No	No
Bicarbonate	No	No	No
Carbonate	No	No	No
Major ions	No	No	No
Nitrogen and nitrate	No	No	No
Phosphorus and phosphate	No	No	No

It is perhaps reasonable that earthworks and construction may have mobilised more sediments in the catchment, however, turbidity actually decreased at Boggy Creek 1 p/u 1. It is suspected that turbidity is possibly linked to flow rates in the waterway, which may not have been identified from the event based sampling.

There is insufficient information to assess whether the storage has resulted in a significant change to surface water flows.

### 8.3.2 Groundwater

Salinity remains low throughout baseline and impact years, indicating an ongoing strong connection with infiltrating rainfall and snow melt. The low salinity also suggests short residence times of water in each aquifer throughout baseline and construction periods. A summary of the key differences is provided in Table 19.

Table 19 Groundwater: Differences in key analytes between baseline and impact monitoring periods

Key analyte	Notable difference in construction period compared to baseline years?				
	BH06	BH10	BH16	BH17	BH18
pH	No	No	No	No	No
Electrical conductivity	No	No	No	No	No
Bicarbonate	No	No	No	No	No
Carbonate	No	No	No	No	No
Major ions	No	No	No	No	<b>Possible Marginal changes in calcium, sodium, sulphate</b>
Nitrogen and nitrate	<b>Possible Increasing trend in 2022-2023.</b>	No	No	No	No
Phosphorus and phosphate	No	No	No	No	No

Groundwater analytical results are within similar ranges between the baseline and impact monitoring periods. Data is unable to be collected during the snow season due to ski field operation, and as such the monitoring data is limited to spring, summer and autumn events. It is noted that possible changes have occurred at two monitoring bores, however both of these bores are cross-gradient from the water storage. Bores that are down-gradient are expected to be most likely impacted yet these show no obvious change.

In either case, gross changes in groundwater quality were not predicted to occur as a result of the construction, and such have not been identified in the monitoring since construction.

The hydrographs of some monitoring bores have changed form, which is not unexpected given that footprint of the water storage construction and the earthworks undertaken. These earthworks may have changed local groundwater flow systems by removing (and or redistributing) parts of the unsaturated zone and aquifer materials. However, to compensate for the loss of recharge occurring within the footprint, the water storage had a drainage blanket installed under its lining system that captures groundwater seepage (and potentially links or enhances groundwater connectivity upgradient of Alpine bog areas). The strong seasonal water level response at some locations has been replaced with a more continuous supply of water, which may in part be due to the EWS which re-directs captured groundwater seepage to down-gradient bog systems. The EWS and associated monitoring bores should continue to be monitored to assess the efficacy of this system in maintaining the Alpine bogs that are local to it.

As a result of the implied changes in groundwater level behaviour and the observations associated with the EWS and growth of the Alpine Bog areas, consideration should be given to reviewing the dam safety and related geotechnical hazards based on the final dam design and corresponding geotechnical risk assessments. In particular, the concept design stage GHD Geotechnical Risk Assessment for the water storage (GHD 2016, report reference #233153) outlined possible geotechnical hazards associated with slope instability from the environmental watering system that was provided at that stage of design.

As outlined in the GHD planning stage water storage concept design summary report (GHD 2016, report reference 253326), the concept design for the project incorporated:

Storage drainage - a discharge drainage pipeline which extends down the hillside north of the Summit Nature Walk Track and connects to the existing aqueduct

Environmental Water System (EWS) - the design of an environmental watering system downslope of the storage would allow water from the storage and/or internal storage drainage water (noting the concept was based on water from the storage being used and controlled ) to be distributed across the contour above the Alpine bog community in response to a need to artificially water these communities as and when required in accordance with a project specific Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP). The system is designed to gravity feed water via a series of regulating pits (1 m x 1 m) connected via a network of underground and above ground distribution pipes

The GHD geotechnical risk assessment (GHD 2016, report reference #233153), identified the following hazards and recommended control measures associated with the EWS:

Hazard: Slope instability due to environmental water system construction and operation

Control Measures:

- Water inflow volumes into the bog areas should not exceed the water flow entering the areas prior to construction. Careful management of the of the water flow will be required
- Include water stop barriers at regular intervals along pipeline alignment section spacing to be determined

Residual risk rating: remains a moderate risk for slope instability

As outlined in section 2.2.1.2, GHD has subsequently been provided with detailed design drawings in relation to the water storage. However, detailed drawings associated with the flow meter pit and associated distribution pit for operational considerations (drawing C111) or any updated geotechnical risk assessments based on the detailed design changes has not been provided or reviewed by GHD. The key changes include the provision of an environmental soakage trench rather than distribution pits which would potentially allow uncontrolled and unpredictable infiltration into the slope. Any dam safety or related geotechnical risks as they relate to observations from groundwater behaviour are not within the scope of this report. Any dam safety and/or related geotechnical risks related to this change of design and observations of groundwater behaviour post-construction are not within the scope of this report.

## 9. Conclusions

### 9.1 Monitoring program

Monitoring data is being captured for both surface water and groundwater since the construction of the water storage. Whilst a number of issues have been identified in some aspects of the monitoring program, the data obtained is considered reasonable upon which to base an assessment of impacts. A number of recommendations have been made to improve the monitoring undertaken.

### 9.2 Surface water

Surface water flow data is limited and therefore gross changes in the catchment as a result of the water storage construction are difficult to quantify. From the limited analysis in Section 5, it appears that Boggy Creek flows are continuing to respond to rainfall in a similar way between the baseline and impact years.

No obvious change in surface water quality has been identified by the monitoring program.

### 9.3 Groundwater

No obvious change in groundwater quality has been identified by the monitoring program. A watching brief should be maintained on nitrate concentrations.

Monitoring bores have generally shown a strong seasonal groundwater response prior to the construction of the water storage, characterised by slow declines in water level during the Summer periods, and a rapid recovery in Autumn corresponding to increased rainfall. This water level decline is considered to reflect the slow drainage from the aquifer, as water emerges as spring flow and a source to maintain Alpine bog condition during periods of rainfall deficit.

Two monitoring bores have shown a change in water level behaviour. The seasonal response has changed to one where a more consistent supply of water is being noted, i.e., water levels appear to be more constant, but possibly slightly lower in maximum (water level high) magnitude. This possibly reflects the changes in the groundwater catchment within the footprint of the water storage, but also the under-drainage system and associated distribution across the down-gradient slope through the EWS. The EWS is capturing groundwater and redirecting it to identified Alpine bogs which require a good supply of groundwater. Due to this change in water level behaviour, ongoing monitoring is required to assess the health of Alpine bogs immediately down-gradient of the water storage.

As a result of the implied changes in groundwater level behaviour and the observations associated with the EWS and growth of the Alpine Bog areas, consideration should be given to reviewing the dam safety and related geotechnical hazards based on the final dam design and corresponding geotechnical risk assessments. In particular, the concept design stage GHD Geotechnical Risk Assessment for the water storage (GHD 2016, report reference #233153) outlined possible geotechnical hazards associated with slope instability from the environmental watering system that was provided at that stage of design.

## 10. Recommendations

This report makes the following recommendations:

Continue to incorporate a third monitoring event in each annual monitoring period for the next 2 years.

Incorporate flow monitoring of the EWS. It is understood that the flow meters in the EWS cannot be set up for automatic logging due to restricted Wi-Fi signal. Manual gauging should be incorporated monthly to include a meter reading and instantaneous flow measurement, with the exception of winter (June to September) to supplement the automatic data collection

Periodical inspection of the operation of the EWS is required to confirm that seepage waters from the storage are being redistributed to Alpine bog areas

RMB undertake regular inspection of the flow gauges installed at Boggy Creek 1 and 2 weirs to verify their operation and flow data capture. As part of the next annual review, surface water flow analysis from the catchment is to be included

Undertake maintenance of monitoring bores:

- BH10 headworks should be repaired
- BH04 and BH04A should be decommissioned by a licenced driller

RMB began to consolidate all HEMAMP information into a database during this monitoring round. This database should continue to be updated and maintained

RMB to consider a review of dam safety and associated geotechnical hazards associated with the change in groundwater behaviour and the design and operational arrangements of the EWS

# 11. References

Australian and New Zealand Environment Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), 2000: '*National Water Quality Management Strategy. Australian and New Zealand Guidelines for Fresh and Marine Water Quality*'

ANZG 2018. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at [www.waterquality.gov.au/anz-guidelines](http://www.waterquality.gov.au/anz-guidelines)

Bureau of Meteorology 2022, *Monthly Rainfall, Mount Buller*, Australian Government, accessed 6/8/2022, Monthly Rainfall - 083024 - Bureau of Meteorology (born.gov.au)

EPA Victoria, 2022: *Groundwater sampling guidelines*. Publication 669.1

EPA Victoria, 2022: *Environment Reference Standard*. No.S245 Gazette 26 May 2021

GHD, 2018. *Mt Buller Water Storage 2015-2018 Monitoring Report*, document reference 313073318

Biosis, 2021. *Mount Buller Water Storage Project: Hydrological and Ecological Monitoring and Adaptive Management Program; Impact Year 2 Monitoring*. 25 August 2021. Reference 34410

# Appendices

# Appendix A

## Design drawings

WATER STORAGE VOLUME VS DEPTH

WATER LEVEL (MRL)	VOLUME (ML)
1724.4	0.2
1724.8	0.7
1725.0	0.8
1726.0	6.2
1727.0	12.8
1728.0	20.2
1729.0	28.6
1730.0	37.9
1731.0	48.2
1732.0	59.6
1733.0	72.1
1734.0	85.6
1735.0	102.7

WATER STORAGE KEY DETAILS:

LINER EXTENT OF COVERAGE 18779.31m<sup>2</sup>  
 (TKL) TOP WATER LEVEL 1735.0mRL  
 (TKL) BOTTOM WATER LEVEL 1724.8 mRL  
 MINIMUM CREST LEVEL 1735.50mRL  
 APPROXIMATE USABLE VOLUME 1879L  
 FREEBOARD 500mm

NOTES ON LINER EXTENT:

1. LINER EXTENT IS APPROXIMATE ONLY AND DOES NOT ALLOW FOR OVERLAPS, JOINT DETAILS, PENETRATIONS OR ADDITIONAL LENGTH REQUIRED FOR ANCHOR TRENCH

NOTES:

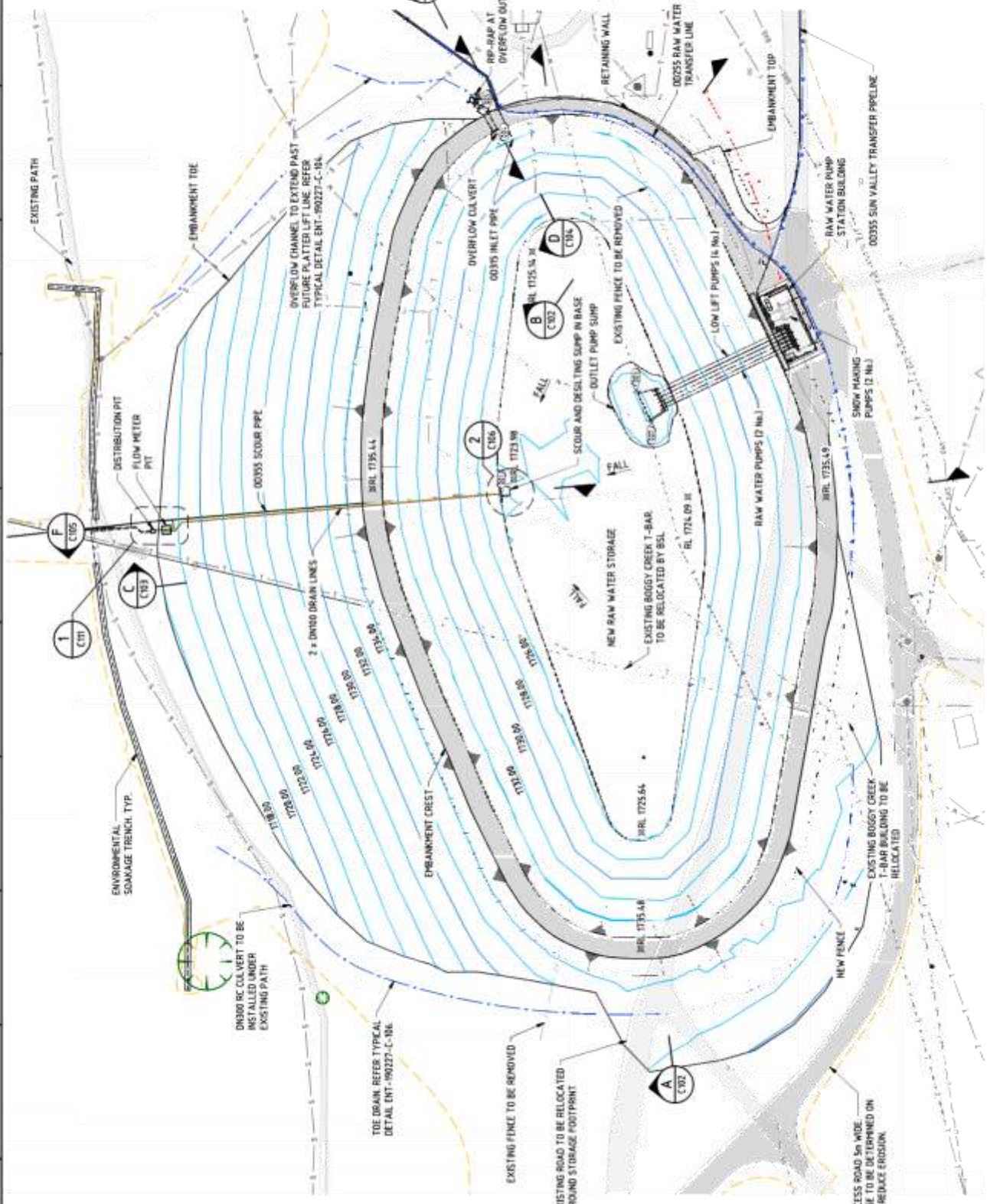
1. ALL COORDINATES ARE TO MGA
2. ALL LEVELS IN METRES TO AHD
3. ALL DIMENSIONS IN MM UNLESS NOTED OTHERWISE
4. REFER TO ENT-190227-C-002 FOR LEGEND
5. REFER TO ENT-190227-C-007 FOR CUT FILL VOLUMES
6. REFER TO ENT-190227-C-006 FOR SET OUT POINTS



**WARNING**  
 ALL UTILITIES AND OBSTRUCTIONS ARE APPROXIMATE ONLY EXERCISE CARE TO BE CONFIRMED ON SITE BY CONTRACTOR PRIOR TO COMMENCEMENT OF ANY WORKS

AS CONSTRUCTED

DO NOT SCALE	AS SHOWN
SCALE	DRAWING NUMBER
	ENT-190227-C-100
	SUBSIDIARY
	1
	REV.



RAW WATER STORAGE PLAN SCALE 1:500

AS CONSTRUCTED DETAILS BASED ON INFORMATION PROVIDED BY ENTRACON PTY LTD

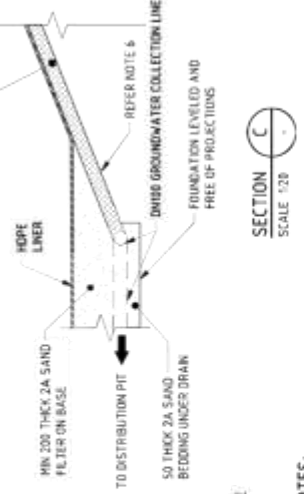
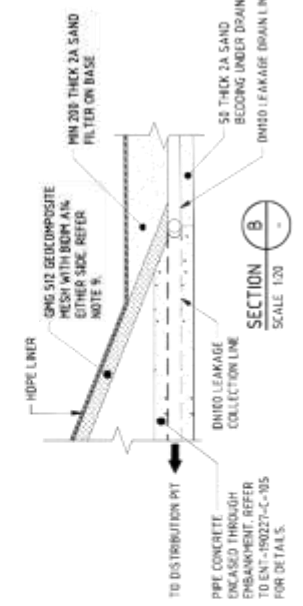
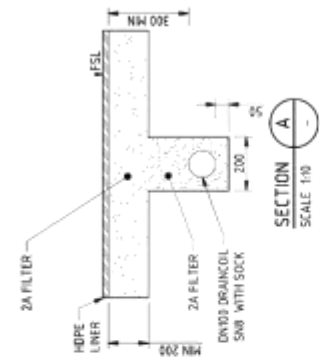
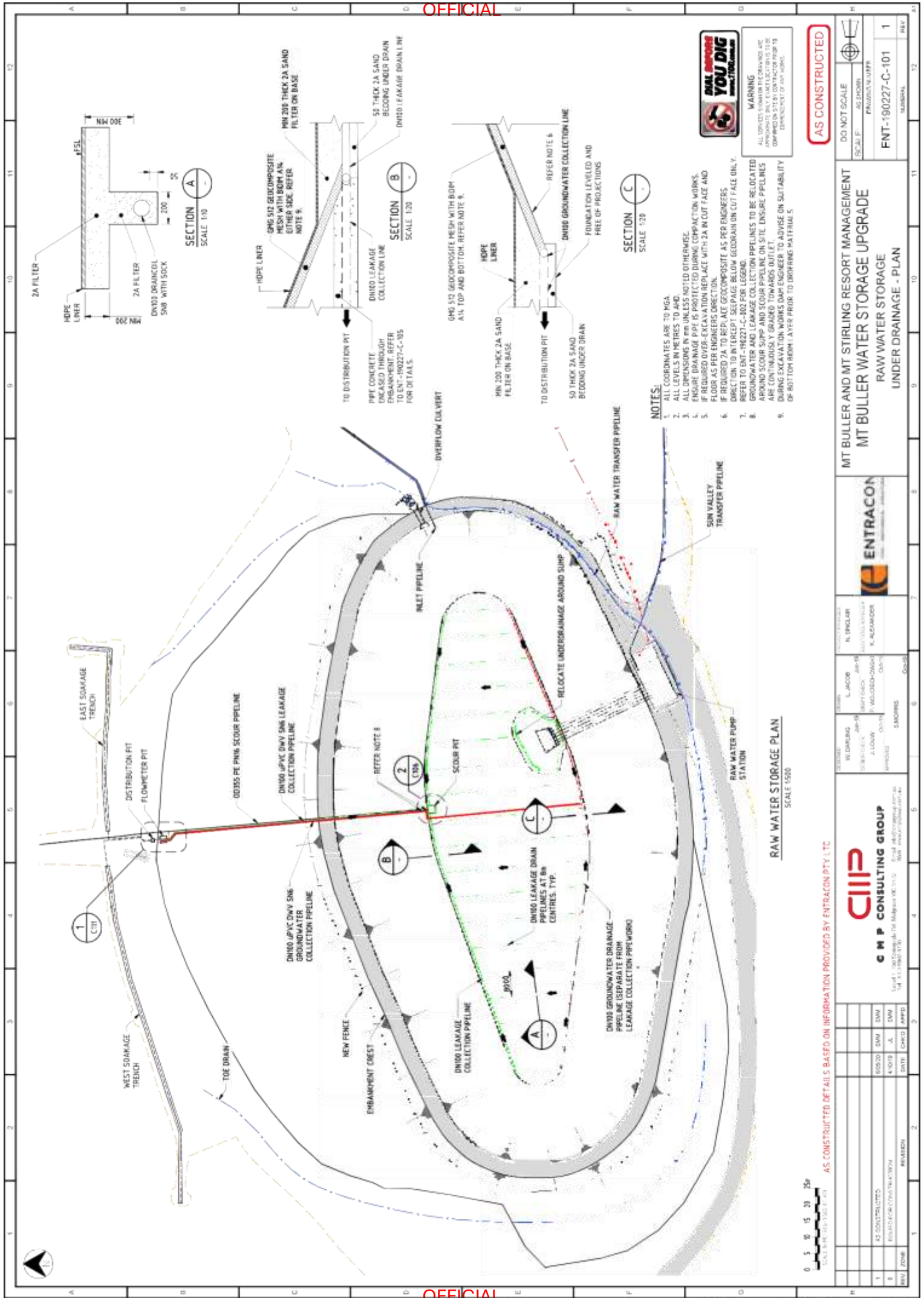
MT BULLER AND MT STIRLING RESORT MANAGEMENT  
 MT BULLER WATER STORAGE UPGRADE  
 RAW WATER STORAGE  
 GENERAL ARRANGEMENT - PLAN



DESIGNED	DRAWN	CHECKED	PROJECT ENGINEER
M. LARLING	L. JACOB	N. SPILLER	L. JACOB
G. BROWN	P. WOODROOPE	K. ALEXANDER	K. ALEXANDER
A. LOW	O. HIR	O. HIR	O. HIR
APPROVED	S. BARRIS	O. HIR	O. HIR

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REV.	DATE	CHKD	APPD	REVISION
1	6/05/20	DMW	DMW	AS CONSTRUCTED
2	3/10/19	JL	DMW	ISSUED FOR CONSTRUCTION



- NOTES:**
- ALL COORDINATES ARE TO MGA.
  - ALL LEVELS IN METRES TO AHD.
  - ALL DIMENSIONS IN MM UNLESS NOTED OTHERWISE.
  - ENGINE DRAINAGE PIPE IS PROTECTED DURING CONSTRUCTION WORKS.
  - IF REQUIRED OVER-EXCAVATION REPLACE WITH 2A IN CUT FACE AND FLOOR AS PER ENGINEERS DIRECTON.
  - IF REQUIRED 2A TO REPLACE GEOCOMPOSITE AS PER ENGINEERS DIRECTON TO INTERCEPT SEEPAGE BELOW UNDERDRAIN ON CUT FACE ONLY.
  - REFER TO ENT-190227-C-101 FOR LEGEND.
  - GROUNDWATER AND LEAKAGE COLLECTION PIPELINES TO BE RELOCATED AROUND SCOUR PUMP AND SCOUR PIPELINE ON SITE. ENSURE PIPELINES ARE CONTINUOUSLY GRADED TOWARDS OUTLET.
  - DURING EXCAVATION WORKS DRAFT ENGINEER TO ADVISE ON SUITABILITY OF BOTTOM BENT AFTER PRIOR TO DRIPPING MATERIALS.



**WARNING**  
 ALL UNTESTED EXCAVATIONS ARE APPROVED ONLY BY CONTRACTOR PREPARED DRAWINGS AND APPROVED BY A REGISTERED PROFESSIONAL ENGINEER OF ANY WORKS.

**AS CONSTRUCTED**

DO NOT SCALE		AS SHOWN	
SCALE: 1:10		PROWESSA LOTTOR	
ENT-190227-C-101		SUBSERRIAL	
1		1	

**MT BULLER AND MT STIRLING RESORT MANAGEMENT  
 MT BULLER WATER STORAGE UPGRADE  
 RAW WATER STORAGE  
 UNDER DRAINAGE - PLAN**

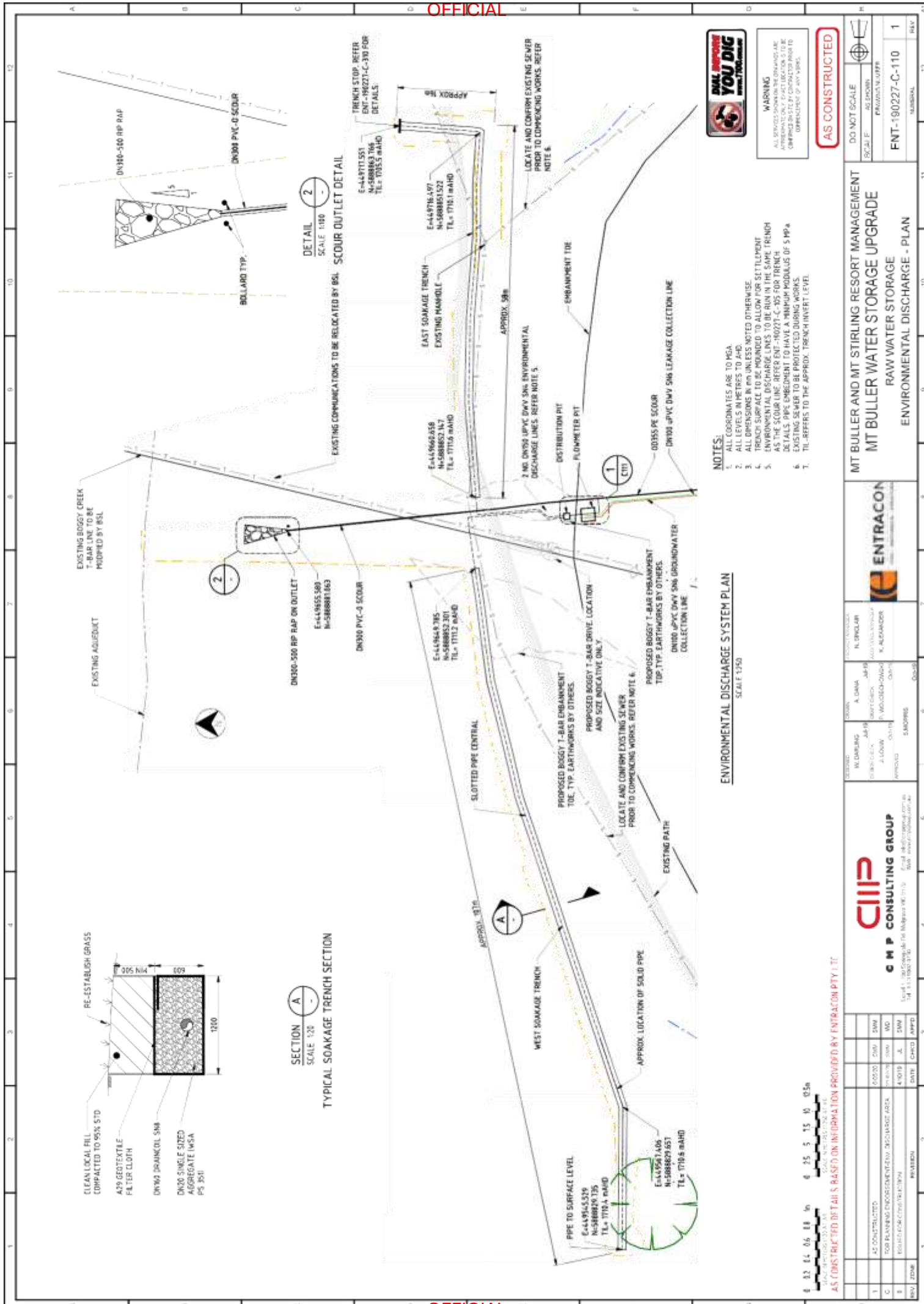


DESIGNED	REVISED	DRAWN	CHECKED	APPROVED	DATE
M. L. JACOB	A. L. GARDNER	A. L. GARDNER	A. L. GARDNER	A. L. GARDNER	20/07/2022
PROJECT ENGINEER M. L. JACOB					
SUPERVISOR K. KILGOUR					

**CIIP  
 C M P CONSULTING GROUP**

Level 1, 380 Springvale Rd, Melbourne VIC 3047  
 Tel: 03 9354 4477 Fax: 03 9354 4478 Email: info@cmipgroup.com.au  
 Web: www.cmipgroup.com.au

REV	DATE	CHANGED BY	REASON
1	08/05/2022	JM	FOR CONSTRUCTION
2	04/07/2022	JL	FOR CONSTRUCTION
3	04/07/2022	MM	FOR CONSTRUCTION
4	04/07/2022	MM	FOR CONSTRUCTION



**WARNING**  
ALL SERVICES SHOWN ON THE DRAWINGS ARE  
APPROXIMATE ONLY. EXACT LOCATIONS TO BE  
CONFIRMED IN-SITU BY CONTRACTOR PRIOR TO  
COMMENCEMENT OF ANY WORKS.

**AS CONSTRUCTED**

- NOTES:**
1. ALL COORDINATES ARE TO MGA
  2. ALL LEVELS IN METRES TO AHD
  3. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE
  4. TRENCH SURFACE TO BE INDICATED TO ALLOW FOR SETTLEMENT
  5. ENVIRONMENTAL DISCHARGE LINES TO BE RUN IN THE SAME TRENCH AS THE SCOUR LINE. REFER ENT-190227-C-335 FOR TRENCH DETAILS. PIPE EMBEUREMENT TO HAVE A MINIMUM MODULUS OF 5 MPa
  6. EXISTING SEWER TO BE PROTECTED DURING WORKS.
  7. TL - REFERS TO THE APPROX. TRENCH INVERT LEVEL.

**ENVIRONMENTAL DISCHARGE SYSTEM PLAN**  
SCALE 1:50

DO NOT SCALE	AS SHOWN
SCALE	PROVISIONAL OFFER
ENT-190227-C-110	
REVISION	SUBMITTAL
1	1

**MT BULLER AND MT STIRLING RESORT MANAGEMENT**  
**MT BULLER WATER STORAGE UPGRADE**  
**RAW WATER STORAGE**  
**ENVIRONMENTAL DISCHARGE - PLAN**



DESIGNED	REVISED	DATE	BY
IN CHARGE	BY		
APPROVED	APPROVED		
PROJECT ENGINEER	PROJECT ENGINEER		
N. SPILLER	N. SPILLER		
A. DUNA	A. DUNA		
J. WOOD	J. WOOD		
S. BARRIS	S. BARRIS		
06/03/20	06/03/20		

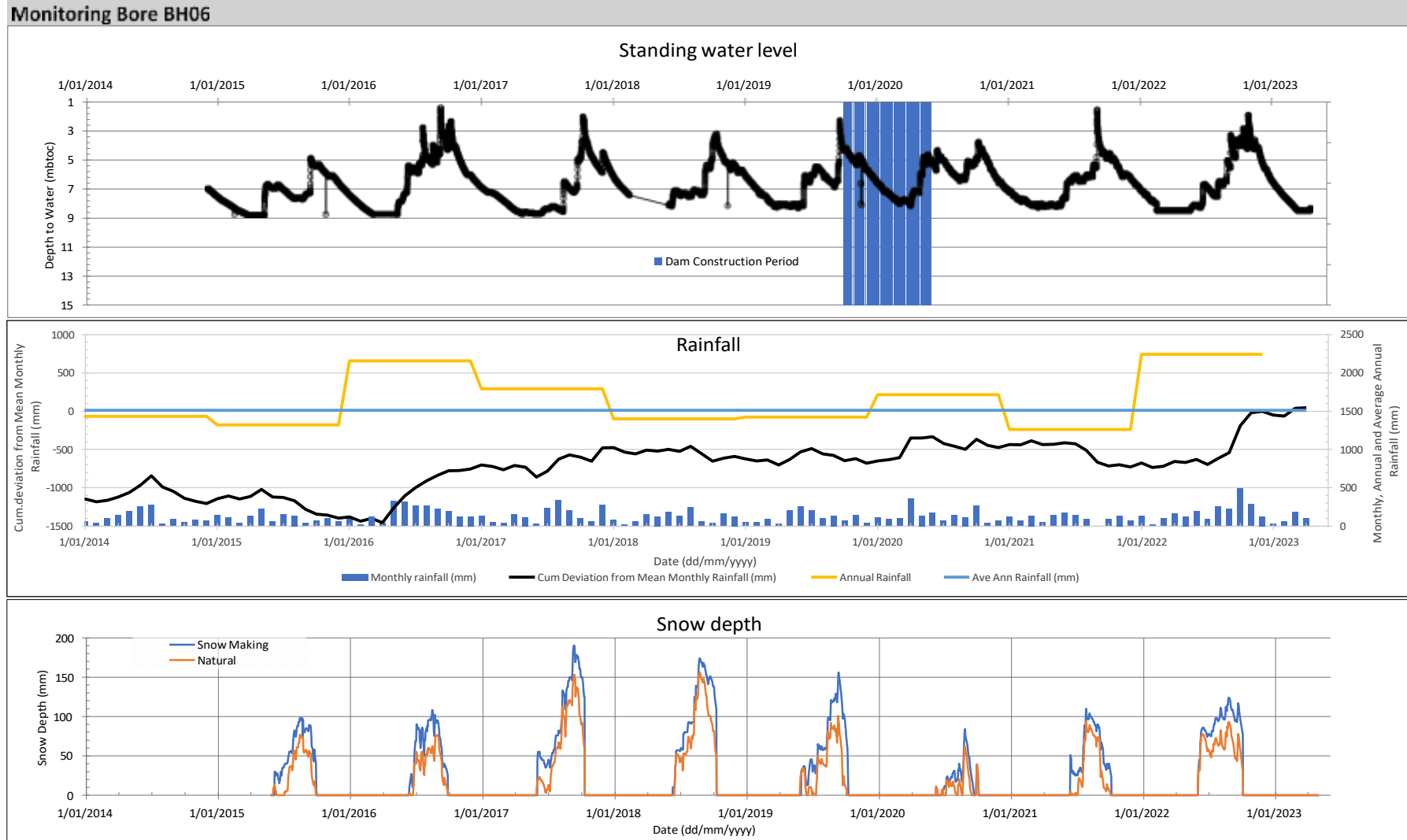


NO.	DATE	BY	CHKD	APPD
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3	FOR PLANNING INFORMATION ONLY - DISCHARGE AREA			
4	FOR PLANNING INFORMATION ONLY - DISCHARGE AREA			

AS CONSTRUCTED DETAIL IS BASED ON INFORMATION PROVIDED BY ENTRACON PTY LTD

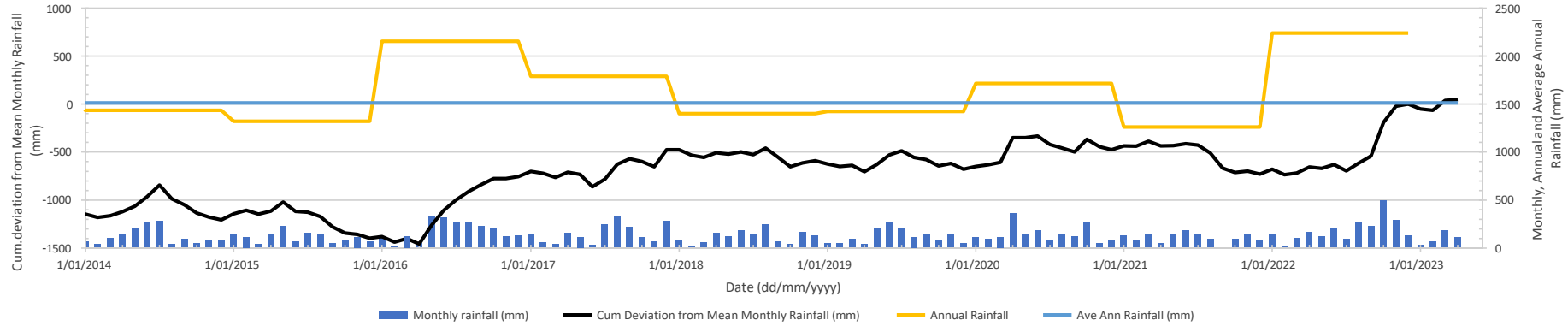
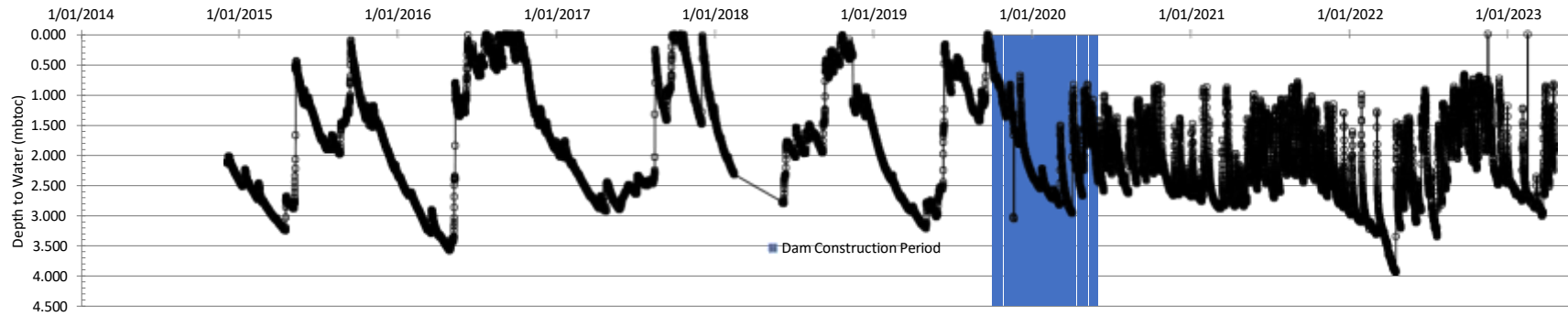
# Appendix B

Hydrographs, gauging record and surface flow

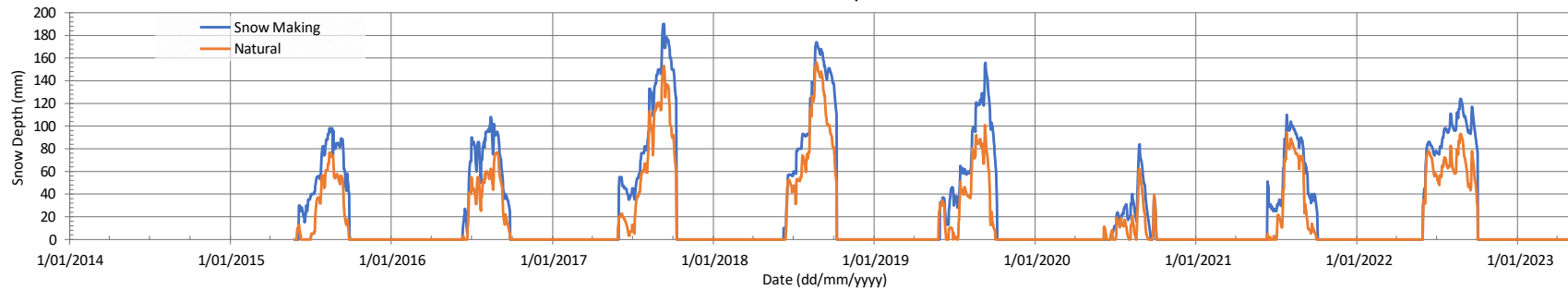


Monitoring Bore BH09

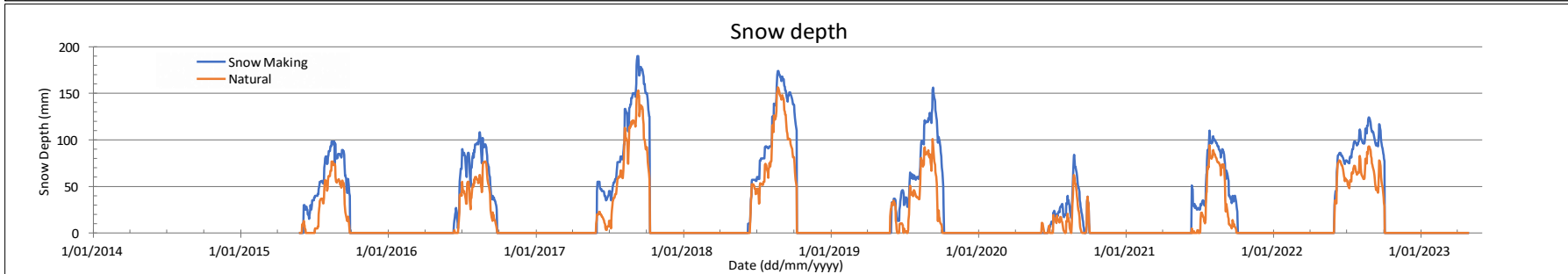
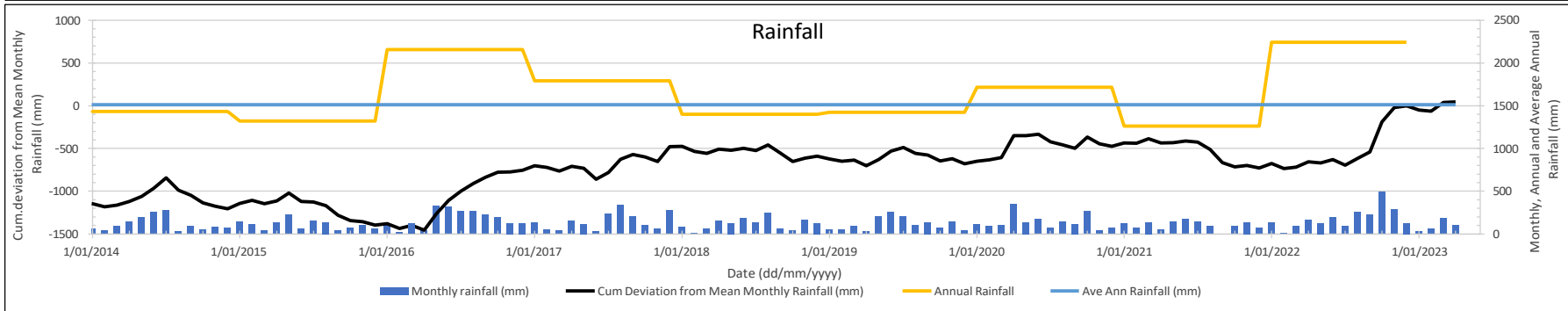
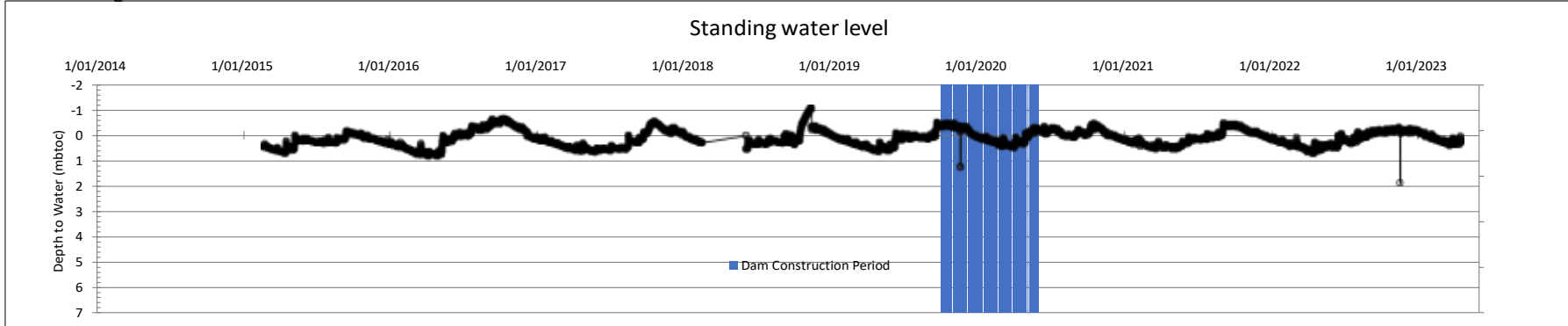
Standing water level



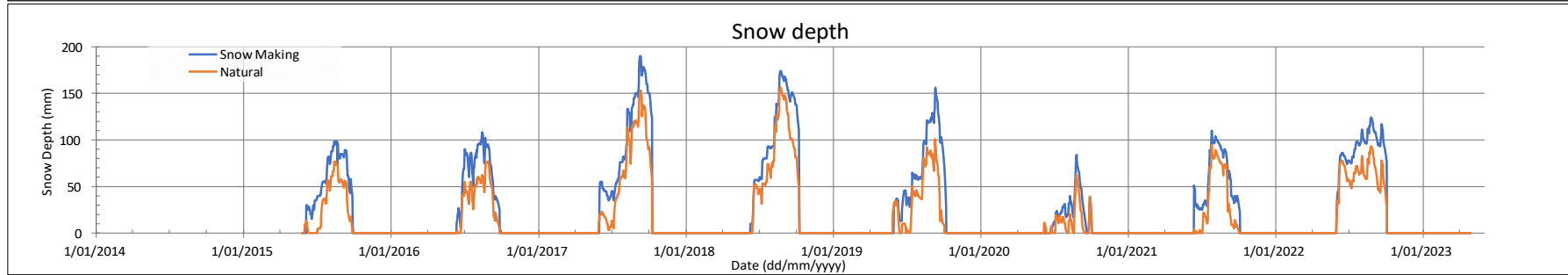
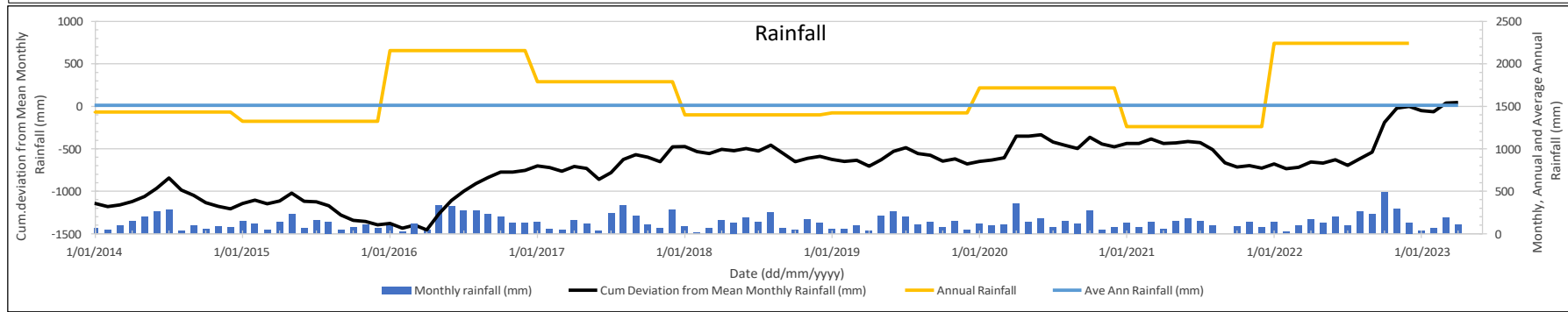
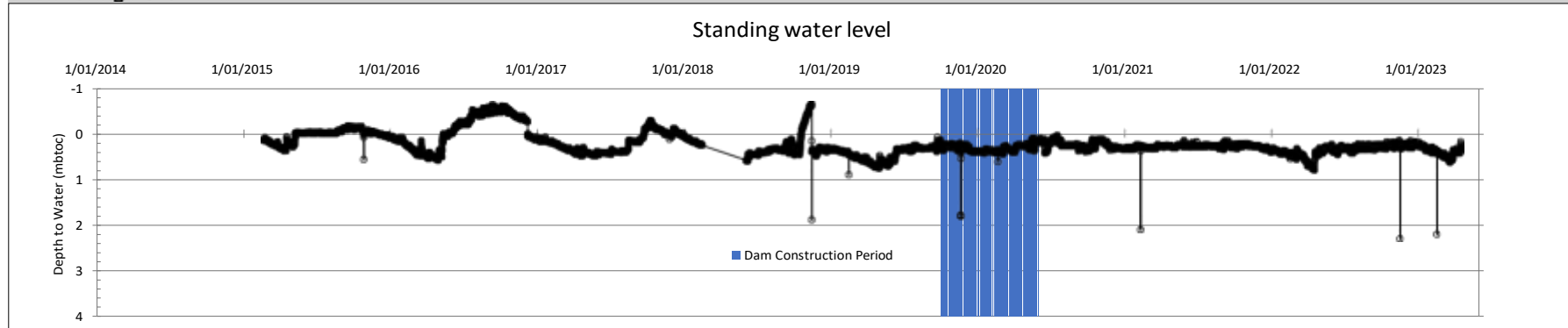
Snow depth



### Monitoring Bore BH16

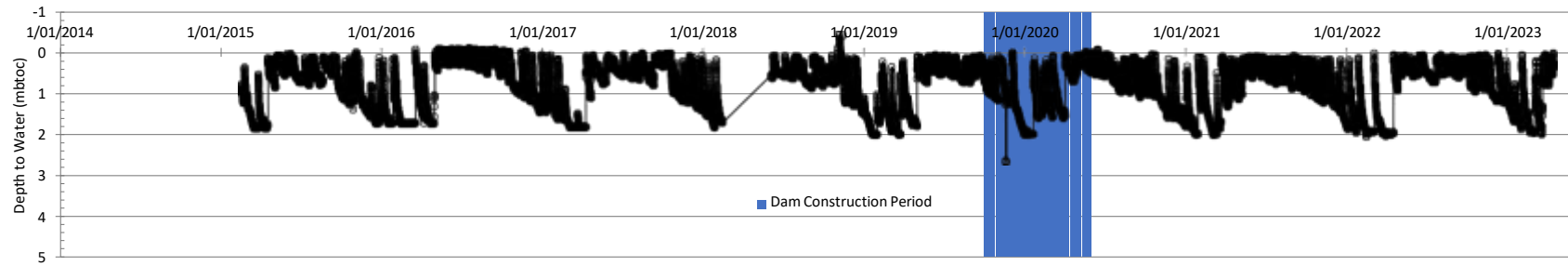


### Monitoring Bore BH17

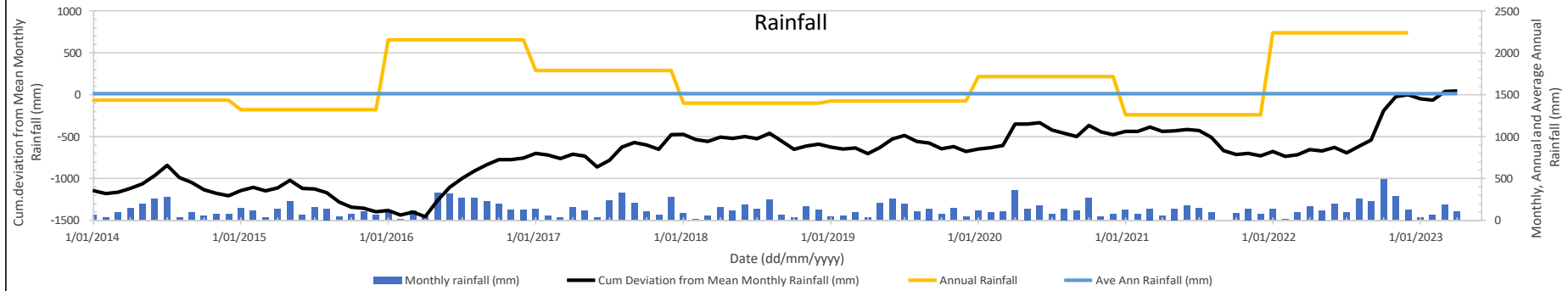


### Monitoring Bore BH18

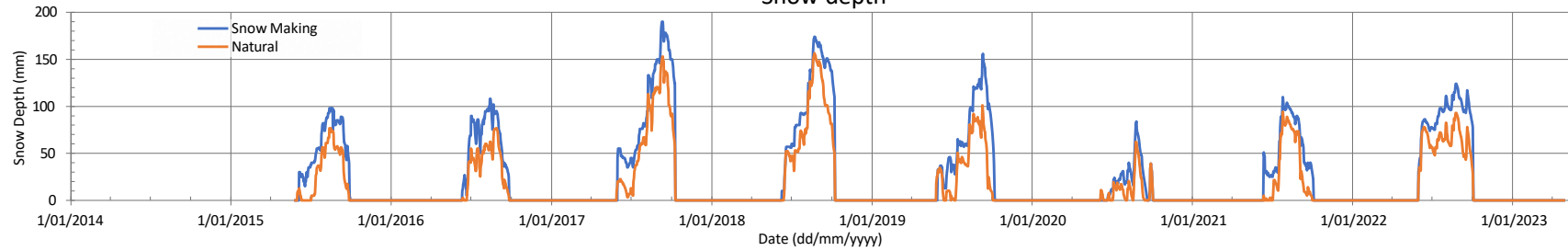
#### Standing water level



#### Rainfall



#### Snow depth



**Mount Buller HEMAMP  
Manual Water Level Gaugings**

Bore	Geology Sequence	RLNS (LIDAR)	Measured Bore Depth (m btoc)	Stick up (m bgl)	Feb-14		May-14		4/12/2014		5/12/2014		16/02/2015		17/02/2015		21/02/2015
					SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)
BH04	Carbonaceous Mudstone	1735	15.58	-0.1	6.97	1728	5.48	1728	6.5	1728	6.5	1728	6.6	1728	6.6	1728	
BH04A	Basalt (sandy days, cobbles)	1735	2.38	-0.07	DRY	DRY	1.71	1733	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	
BH05	Granitic Soils	1733	19.67	-0.1	17.96	1718	13.8	1718	14.38	1718	14.38	1718	15.5	1718	15.5	1718	
BH05A	Colluvium (clayey sand, cobbles)	1733	2.33	-0.12	DRY	DRY	0.3	1733	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	
BH06	Granite, weathered with clay bands	1727	9.02	-0.1	7.67	1718			6.9	1720	7.0	1720	8.3	1718	8.3	1718	8.3
BH07	Bog/Granitic Soil	1695	1.77	-0.09	DRY	DRY	0	1698	0.0	1698	0.5	1698	0.5	1698	0.6	1698	0.67
BH09	Granite (sandy clay / clayey sands)	1714	5.82	-0.1	2.72	1711	0.57	1713	1.98	1713	2.1	1713	2.5	1713	2.6	1713	2.72
BH10	Granite (EW-MW)	1712	8.825	-0.09	4.15	1708	2.61	1708	3.6	1708	3.6	1708	4.6	1708	4.6	1708	4.6
BH13	Colluvium (sand, cobbles)	1733	8.87	-0.09	5.32	1727	2.18	1730	4.52	1728	4.5	1728	3.9	1728	3.9	1728	4.07
BH14	Granite (EW-MW)	1733	19.35	-0.11	12.52	1720	13.17	1720	11.8	1721	11.9	1721	13.8	1719	13.8	1719	
BH14A	Granite (EW) to soils	1733	14.98	-0.09	12.61	1720	13.6	1719	11.4	1721	11.5	1721	13.6	1719	13.6	1719	13.77
BH14B	Granitic Soils	1733	9.44	-0.09	9.03	1724	8.38	1724	7.42	1726	7.4	1726	8.5	1724	8.4	1724	8.43
BH15	Granitic Soils	1734	18.29	-0.11	13.06	1721	13.45	1721	12.8	1721	12.8	1721	13.4	1721	13.4	1721	
BH15A	Colluvium	1734	5.5	-0.12	4.03	1730	1.75	1733	3.7	1730	3.7	1730	3.1	1733	3.2	1733	
BH16	Clayey gravelly SAND and Silty GRAVEL	1715															0.4
BH17	Clayey SAND	1707															0.1
BH18	Clayey SAND	1711															1.11

Mount Buller HEMAMP  
Manual Water Level Gaugings

Bore	Geology Sequence	RLNS (LIDAR)	Measured Bore Depth (m btoc)	Stick up (m bg)	12/01/2015	17/04/2015		17/04/2015		22/10/2015		26/10/2015		7/04/2016		7/12/2016		
					RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	
BH04	Carbonaceous Mudstone	1735	15.58	-0.1		7.42	1727	5.74	1725	5.74	1725	5.74	1725	8.04	1725	5.74	1725	
BH04A	Basalt (sandy clays, cobbles)	1735	2.38	-0.07		DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	
BH05	Granitic Soils	1733	19.67	-0.1		16.11	1717	13.05	1720	13.05	1720	13.81	1719	16.51	1716	13.31	1720	
BH05A	Colluvium (clayey sand, cobbles)	1733	2.33	-0.12		2.34	1731	0.55	1730	0.55	1730			2.21	1730	1.31	1730	
BH06	Granite, weathered with clay bands	1727	9.02	-0.1		1718	DRY	DRY	5.73	1721	5.73	1721	6.0 (est)	1721	DRY	DRY	6.11	1721
BH07	Bog/Granitic Soil	1695	1.77	-0.09		1695	0.1	1695	0.4	1695	0.4	1695	0.51	1695	DRY	DRY	0.51	DRY
BH09	Granite (sandy clay / clayey sands)	1714	5.82	-0.1		1711	3.21	1711	1.2	1713	1.2	1713	1.75 (est)	1712	3.31	1711	1.6	1711
BH10	Granite (EW-MW)	1712	8.825	-0.09		1707	5.31	1707	2.65	1705	2.65	1705	3.27 (est)	1705	5.61	1705	2.7	1705
BH13	Colluvium (sand, cobbles)	1733	8.87	-0.09		1728	5.65	1727	3.05	1730	3.05	1730	8.41	1724	6.91	1728	3.51	1728
BH14	Granite (EW-MW)	1733	19.35	-0.11		1733	14.95	1718	10.34	1721	10.35	1721	10.61	1721	15.11	1718	10.1	1721
BH14A	Granite (EW) to soils	1733	14.98	-0.09		1715	14.81	1718	9.85	1723	9.85	1723	10.11	1723	DRY	DRY	9.81	1723
BH14B	Granitic Soils	1733	9.44	-0.09		1725	DRY	DRY	6.05	1727	6.05	1727	6.11	1727	DRY	DRY	6.11	1727
BH15	Granitic Soils	1734	18.29	-0.11			14.15	1720	12.25	1722	12.25	1722	12.31	1722	14.51	1715	11.51	1722
BH15A	Colluvium	1734	5.5	-0.12			4.01	1730	2.7	1731	2.7	1731	2.21	1731	3.81	1730	2.9	1731
BH16	Clayey gravelly SAND and Silty GRAVEL	1715				1715	0.61	1714	+0.01	1715	0.01	1715	+0.02 (est) artesian	1715	0.7	1714	0.01	1715
BH17	Clayey SAND	1707				1707	0.41	1707	+0.05	1707	+0.05	1707	+0.02 (est) artesian	1707	0.1	1707	0.01	1707
BH18	Clayey SAND	1711				1710	1.71	1705	0.2	1711	0.2	1711	1.11	1710	0.51	1710	1.1	1710

**Mount Buller HEMAMP  
Manual Water Level Gaugings**

Bore	Geology Sequence	RLNS (LIDAR)	Measured Bore Depth (m btoc)	Stick up (m bg)	13/02/2018		4/06/2018		23/11/2021		16/02/2022		16/11/2022		23/02/2022	
					SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT
BH04	Carbonaceous Mudstone	1735	15.58	-0.1	7.11	1728	6.04	1728	N/A		N/A		6.2		Inaccessible	
BH04A	Basalt (sandy clays, cobbles)	1735	2.38	-0.07	DRY	DRY	DRY	DRY	DRY	DRY	Inaccessible		1.96		Inaccessible	
BH05	Granitic Soils	1733	19.67	-0.1	15.92	1717	15.6	1717	N/A		N/A				N/A	
BH05A	Colluvium (clayey sand, cobbles)	1733	2.33	-0.12	DRY	DRY	0.5	1733	N/A		N/A				N/A	
BH06	Granite, weathered with clay bands	1727	9.02	-0.1	7.46	1719	8.5	1718	6.3	1720	8.36	1718	3.67	1723	7.74	1719
BH07	Bog/Granitic Soil	1695	1.77	-0.09	0.76	DRY	0.45	1714	0.37	1695	N/A		0.28	1695	0.7	1695
BH09	Granite (sandy clay / clayey sands)	1714	5.82	-0.1	2.36	1712	2.55	1712	N/A		N/A		1.76	1713	3.723	1710
BH10	Granite (EW-MW)	1712	8.825	-0.09	3.95	1708	4.55	1707	2.64	1705	4.75	1707	1.76	1707	4.362	1708
BH13	Colluvium (sand, cobbles)	1733	8.87	-0.09	5.72	1727	2.9	1730	N/A		N/A		N/A		N/A	
BH14	Granite (EW-MW)	1733	19.35	-0.11	12.41	1720	14.66	1718	N/A		N/A		N/A		N/A	
BH14A	Granite (EW) to soils	1733	14.98	-0.09	11.9	1721	DRY	DRY	N/A		N/A		N/A		N/A	
BH14B	Granitic Soils	1733	9.44	-0.09	8.105	1725	DRY	DRY	N/A		N/A		N/A		N/A	
BH15	Granitic Soils	1734	18.29	-0.11	12.56	1721	13.45	1720	N/A		N/A		N/A		N/A	
BH15A	Colluvium	1734	5.5	-0.12	4.04	1730	2.72	1731	N/A		N/A		N/A		N/A	
BH16	Clayey gravelly SAND and Silty GRAVEL	1715			0.23	1715	0.4	1715		1715	0.4	1715	0	1715	0.2	1715
BH17	Clayey SAND	1707			0.05	1707	0.1	1707	Not found			0.1	1707	0.06	1707	0.2
BH18	Clayey SAND	1711			1.75	1709	0.28	1711	2.02	1709	1.94	1709	0.33	1711	1.705	1709

**Mount Buller HEMAMP**  
**Manual Water Level Gaugings**

Bore	Geology Sequence	RLNS (LIDAR)	Measured Bore Depth (m btoc)	Stick up (m bg)	16/04/2023	
					SWL (m btoc)	RLWT
BH04	Carbonaceous Mudstone	1735	15.58	-0.1	Inaccessible	
BH04A	Basalt (sandy clays, cobbles)	1735	2.38	-0.07	Inaccessible	
BH05	Granitic Soils	1733	19.67	-0.1	N/A	
BH05A	Colluvium (clayey sand, cobbles)	1733	2.33	-0.12	N/A	
BH06	Granite, weathered with clay bands	1727	9.02	-0.1	8.205	1719
BH07	Bog/Granitic Soil	1695	1.77	-0.09	0.23	1695
BH09	Granite (sandy clay / clayey sands)	1714	5.82	-0.1	2.11	1712
BH10	Granite (EW-MW)	1712	8.825	-0.09	2.4	1710
BH13	Colluvium (sand, cobbles)	1733	8.87	-0.09	N/A	
BH14	Granite (EW-MW)	1733	19.35	-0.11	N/A	
BH14A	Granite (EW) to soils	1733	14.98	-0.09	N/A	
BH14B	Granitic Soils	1733	9.44	-0.09	N/A	
BH15	Granitic Soils	1734	18.29	-0.11	N/A	
BH15A	Colluvium	1734	5.5	-0.12	N/A	
BH16	Clayey gravelly SAND and Silty GRAVEL	1715			0.28	1715
BH17	Clayey SAND	1707			0.04	1707
BH18	Clayey SAND	1711			0.44	1711

# Appendix C

## Field sheets



Figure 1 Boggy Creek 1 PU 1 location



Figure 2 Location of Boggy Creek 1 PU 1 - follow grassed path past the overhead PVC pipe behind the tank



Figure 3 *Boggy Creek 1 PU 2 location*



Figure 4 *Location of Boggy Creek 1 PU 2- follow the path to the right behind the tank*



Figure 5 *Boggy Creek 2*



Figure 6 *Depth for WQM measurements*



Figure 7 BH04 and BH04A



Figure 8 Location of BH04 and BH04A



Figure 9 BH06



Figure 10 BH06 is located on the eastern side of the carpark beneath the summit walk (pictured)



Figure 11 BH07



Figure 12 View from BH07 indicating location



Figure 13 BH09



Figure 14 View from BH09 indicating location



Figure 15 BH10



Figure 16 Location of BH10



Figure 17 BH16



Figure 18 View from BH16 indicating location



Figure 19 BH17



Figure 20 View from BH17 indicating location



Figure 21 BH18



Figure 22 Location of BH18

'i'-1.07 = 5.33

€k Bore ID: B. 7.5



Purging and Sampling Record

Site: tripl.ell!  
 DitG: V / 102  
 Round: 3

Purging Information  
 Purge Method: ...  
 Sample Method: ...  
 WQ Meter Type: ...  
 Flow Cell: Y / N Pump Depth: ...m  
 WLevel Meter Type: Dip / Fox / Int. Fox / Gge  
 Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Logic Ch  
 Screen: From: ... to: ... 1111  
 Chee!: ...  
 el.datum: ...  
 Bore Depth: ...m

Time	Volume (L)	Temp (°C)	pH (pH units)	Elec. Cond (µS/cm)	Dis. Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m TOC)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged
Stable when (3 consecutive readings)								
9:50	10		6.85	25.35	9.35	97.8	3.71 @ 11L	Clear, no sheen, no turb / sed
9:55	13	3.8	6.03	24.05	9.97	-77.3	3.75 @ 14L	" low turbidity
10:00	16	3.9	5.80	24.05	9.28	-67.0	3.71	" "
10:05	19	3.9	5.26	22.75	9.47	-57.9	3.71	" "
Bailer in Well								
<del>Resume</del> Resume 17th								
8:45	0						3.85	
8:50	3	3.4	8.02	19.7	9.95	-75.5	3.90	Clear, no sheen, odourless, no sediment
8:53	6	3.8	5.90	19.7	10.01	-8.7	3.91	"
8:57	9	4.0	4.32	20.9	9.36	13.0	3.88	"
9:02	12	4.0	3.87	19.9	10.0	13.8	3.89	"
9:06	15	4.1	3.85	19.1	9.92	8.7	3.91	Sample @ 15L

Field QA Checks:  
 Air bubbles in vials? Y / N Any violent reaction? Y / N  
 Decontamination as per GHD procedure? Y / N  
 Was sampling equipment pre-cleaned? Y / N  
 CDC updated? Y / N

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc.  
 Retrieve logger; 9:45 - 1pm | 17th: Logger out: 8:30 - 9:30

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (Lit of casing)	2.0	7.9	17.7

\*Double for gravel pack



OFFICIAL

Purging and Sampling 11g iff, ec, or

"2:f.2.□\*□;-: r"l..

Bore ID B/116

Job Information rCJfInt .til <u>2.116</u> RM Pwjacl □ Pnl. No. <u>11</u> C.e. <u>COO</u> Sil1111pl <u>MT</u> ii)ate <u>J.6</u> f.J.1.1 / <u>Nov 22</u> Round <u>Nov 22</u>		Sampling Information Purge Method: <u>PI</u> <u>Bailer</u> Sample Method: <u>Hand</u> WQ Meter type □ Flow Cram: <u>Y1N</u>   P\Imp Ooi; i1h: □ WLevel Meter Type: <u>Dip / Fox / Int.Fce / Gge</u> Field Filtered? <u>Y / N</u> (filter vessel, disposable filter/syringe)		ffo, w □ □ S'Wii.(mbTOC); <u>P.□□?</u> m Lc□le ctu; i;k: □ Sc□ettl from □.J.□.□ ...1.0.□; □.□ m \$1k>k U;p □ m 'l. tCIHJc.'lt; □ Bore Clilm.; □ mm R,e,f.daw11111: □   Bore Depth: □ m Wit□. <u>Cap Secure? X</u> <u>(Plug raised)</u>	
--	--	---	--	--	--

Time (.....)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (.....)	Dis.Oxygen (.....)	Ox-Red Pt. (± mV)	SWL (m TOC)	Comment: Colour, turbidity, sediment load, sneen, odour, flow rate, pur r, Q16d dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable	
10:52	3	5.3	5.69	12.8	9.74	-64.3	0.0	Low turbidity, no odour, no
10:58	6	5.0	4.89	12.3	10.28	-34.5	0.0	sheen, trace sediments (orange)
11:00	9	5.0	4.41	12.6	9.55	-13.2	0.0	" " bits of vegetation
11:03	12	5.0	4.24	12.4	9.34	-4.5	0.0	" "
								Sample @ 1L-

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N

Decontamination as per GHD procedure? Y / N

Was sampling equipment pre-cleaned? Y / N

COC updated? Y / N

Parameters	DTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.
Preservatives									

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

1.1. ogger cut □ \0□it.\0- □; /□

Upwelling water, quick recharge

Purge Volumes			
g Int. Dia (mm)	50	100	150
L/m of casing	2.0	7.9	17.7
*Double for gravel pack			

OFFICIAL

Boag  
C...

IB|or,e|D: ..... p./t:t ...,2:.\_J

EtIm :j

Purg1ing a.nd Sampling Record

Cuc-111m: .. M:..: "B... J! (., ---'-'  
 11! r:ojei:rt: .....  
 Proj. s o, JZ " .. fi fu fi / ..  
 Sflmp1QR ..... t! :C? .. -7 ..  
 Da-m: .. 15"/ .. L .., .. Z ..  
 Rownd! ... t: !P.. V. -- ..  
 Time Valumn "V'Qmll! pH! Ele: Jicm Dis: Oqjil, C-ll 01: -Rt-dPL SWI: fll: t: of o; uir ltunkr t't, y, 1-uillmem lo, til, Q4 p, gr, I mill, PW'Qiull #i 2

U: . "Y] \_ --- '5,1 i | .1C, . . i l. 0 - ;, 0 ;, --!'-===== r [ ] VD [ ] { . . . : - | [ ] l''i? rlfk.rr-

mM QA Chl!dlr; .  
 bubllVe: !, if11'ifll!ii? V / N lu: JI Mi'dan n: , iac; Cli; irg? y [ ] N  
 tfftIOM. llll'Ilm'lan a pe, - GIll: !'pt'DCcdJi. JnJ? [ ] / N  
 'N= nm piing aqulpm. nt pt9, ... Cia; an: Q"d1 YI , ..  
 C [ ] i; idllted? - VI ti, c  
 Ci; imm): 11 [ ] D! @lcatll i 111 mr; ii IH: coilectid., biliiH u: mcl, ic CH. 11, [ ] 'ffid' . . . eifl, 1, lit: c: J  
 " ; ; . \ . , J - 0 l I b . J . . D " 1 , , J , - r L , [ ] v " Q v . - [ ] 11 i J .  
 c: 11, 1 [ ] ilnL IDiti 1, mm : . O 100 , 511  
 j Ligmi c: im: ! " 1 ) , 2 , £ 1 U 1 ? J I  
 oobfJi rar 'li. liqt pedt

Boag

Cl.!!!inl. <b>tfr...</b> Prnecj:! Proj: <b>JISi5.i i.1..-'..</b> Silmpler: Dile: <b>J./U.</b> R_oumd: <b>N</b>	<b>Purg</b> Som13teM e. m: WO: <b>r1Y1CI</b> low Coll <b>YI IN</b> P plh m \NUV(!I Mlct or ilvrl\$: tFoo: <b>Uni.Foo 161111</b>	Som Informa... SWUmbTOCJ lliAPIL C !lpJ(C, --R.f.datum' Bori!!!e;pth
---	--	--

iiiiiii	1/all	romp	p3-1	Dis...0:711m	-0...R.ed PL	SWI...	Cerhro...:t
l...,...!	r'Cl	pH WII	...	(-J TIN)	[mfOCJ	f...)	c1011r, turbid III, 11:Ddl'!!!f}I Ind, IIIWIMI. . . . . at., JjUrgod cfr:t?
Si: '.....,f(J	-	#-0,fl!JJ,-l-t	+/-S9'	-+/- IM'	...f. OmV	!!tablii	
U:;,-;-	o.t)	o.!o	":JC.,	U)- 2	-1-2-1		a r(:) .-reJr, r yje , ...

Held a V.A.k Inr s. in't!ill5>? VIN Any ¥ilkint re-acclom't' Y' N Ck11: n. In,lnaiJM1, H-per •GHD, Pf r111 7 / i Wn !!!Tipli:m13 1 Jqu.lpmi.trit IN?? YHCOC IIPdalNi; Y N	<table border="1"> <tr> <td>PM</td> <td>DTIX</td> <td>"I111</td> <td>'AI11</td> <td>C1C</td> <td>r, eo</td> <td>(Jij)</td> <td>OPP</td> <td>'lrat. om</td> <td>(Iof,</td> </tr> <tr> <td>Jileieliella"lilieS</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	PM	DTIX	"I111	'AI11	C1C	r, eo	(Jij)	OPP	'lrat. om	(Iof,	Jileieliella"lilieS									
PM	DTIX	"I111	'AI11	C1C	r, eo	(Jij)	OPP	'lrat. om	(Iof,												
Jileieliella"lilieS																					

C0i1i1m1Bn.t: Clui;!!Jubi NP'npf,!!! youtY	eapng V£U'ilil n!!) .t.01 'r.9] 1:fJ' .:Doll!!!.lli- or QJ"ll"lli pck
---	---



### Purging and Sampling Record

0.353 w / l ---  orie D: 8H I'S  
 0.33 Bore Information

<b>Job Information</b> Client: <u>W. J. T. ...</u> Project: <u>...</u> IP#aj. NID: <u>Jz. 5/6. 5. 9. ...</u> S.111M)Jte.: <u>r. 1.3. ...</u> Did: <u>16 1. ...</u> Round: <u>...</u>		<b>Sampling Information</b> Purge Method: <u>Boiler</u> Sample Method: <u>Boiler</u> WQ Meter Type: <u>...</u> Flow Cell: <u>Y / N</u> Pump Depth: <u>...</u> m WLevel Meter Type: <u>Dip / Fox / Int. Fce / Gge</u> Field Filtered? <u>Y / N</u> (filter vessel, disposable filter/syringe)		<b>Bore Information</b> SWL (mbToc;): <u>0.33</u> Semen <input type="checkbox"/> From <u>J. ...</u> to <u>J. ...</u> m NAPL Check: <u>...</u> Ref. datum: <u>...</u> Bore Depth: <u>...</u> m	
--	--	--	--	--	--

Time	Volume (L)	Temp (°C)	pH (pH units)	Elec. Cond	Dis. Oxygen	Ox-Red Pt. (± mV)	SWL (m TOC)	Comm
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable	Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry r
12:29	3.5	6.0	6.04	17.3	2.95	-71.5	0.48	Clear, becoming low turbidity at 3L, no sheen, no colour, no sediment low turbid / some sed
12:33	8	5.8	5.26	15.60	2.29	-45	0.71	
12:37	12	5.7	4.94	14.95	2.70	-37.8	0.34	
								Sampled @ 12L

<b>Field QA Checks:</b> Air bubbles in vials? Y / N Any violent reactions? Y / N Decontamination as per GHD procedure? Y / N Was sampling equipment pre-cleaned? Y / N COC updated? Y / N		Parameters: BYTEX TPI PAH leuc r'al COC OPP Preservatives:	Tot. Metal	Biol.				
---	--	---	------------	-------	--	--	--	--

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc  
Loggers Ren. ... - 11:30

Purge Volumes		
Casing Int. Dia (mm)	50	100
Vol (L/m of casing)	2.0	7.9
*Double for gravel pack		



# Purging and Sampling Record

5x2=101

Core ID: Bff01

<b>Job Information</b> Client: <u>Ballin DMR</u> Project: <u>0</u> P/OJ.No.: <u>JZ\$, £it1ij</u> Sample: <u>17/11</u> Round: <u>Nov 22</u>		<b>Sampling Information</b> Purg: <input type="checkbox"/> Litho <input checked="" type="checkbox"/> Maffiod Sample: <u>Boiler</u> WQ Me: <u>f</u> <input type="checkbox"/> F19 Flow Cell: <u>Y / N</u> Plum <input type="checkbox"/> Cep. 'lh; WLevel Meter Type: <u>Dip / Fox / Int.Fce / Gge</u> Field Filtered? <u>Y / N</u> (filter vessel, disposable filter/syringe)		SWL (m TOC): <u>1.0</u> Z Scrib: <u>m, f-2</u> £ NAPL Che: <u>-</u> R,r.f.cf.(ium): Bore Depi.h:	
---	--	---	--	--	--

Time (.....)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (.....)	Dis.Oxygen (.....)	Ox-Red Pt. (± mV)	SWL (m TOC)	Notes
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable	
2:10	5	5.6	5.60	8.6	6.63	-53.4	1.47	Clear, no sediment, no sheen, no odour low turbidity, some fine trace sediments (trace) " "
2:15	10	4.7	4.37	8.3	6.49	-16.8	1.63	
2:20	15	4.7	4.23	8.2	6.76	-15.8	1.27	
2:25	20	4.7	4.38	8.2	6.50	-25.7	1.31	
2:30	25	4.8	4.50	8.2	6.66	-29.9	1.26	
2:35	30	4.8	4.68	8.2	6.83	-40.4	1.40	
								Sample @ 30

<b>Field QA Checks:</b> All bubbles in vials? Y / N Any violent reactions? Y / N Decontamination as per GHD procedure? Y / N W...s sampling equipment pre-cleaned? Y / N COC updated? Y / N		<table border="1"> <tr> <th>Parameters</th> <th>DTEX</th> <th>TPH</th> <th>PAH</th> <th>C,K: I F"CU</th> <th>CP</th> <th>OPP</th> <th>Tot.Metal</th> <th>Bio4</th> </tr> <tr> <td>Preservatives</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	Parameters	DTEX	TPH	PAH	C,K: I F"CU	CP	OPP	Tot.Metal	Bio4	Preservatives								
Parameters	DTEX	TPH	PAH	C,K: I F"CU	CP	OPP	Tot.Metal	Bio4												
Preservatives																				

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc. 2:05 - Logger out - 4:00

Purge Volumes	
Casing Int. Dia (mm)	50 100
Vol (L/m of casing)	2.0 7.9
*Double for gravel pack	

2... = 4

Bori1 ID: BHi



# Purging and Sampling ReGolid

Client: 1 Lit. Information: [ ] rwi: [ ]

Sample Method: Bailer

Sample Method: Bailer

WILMCI

Level Meter Type: [ ] / [ ] / [ ] / [ ]

Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Round: Nov 22

SWL (m TOC): 0.06

Bore Depth: [ ] m

Bore ID: [ ] mm

Time	Volume (L)	Temp (°C)	pH (pH units)	Elec. Cond	Dis. Oxygen	Ox-Red Pt. (± mV)	SWL (m TOC)	
3:04	4	4.8	5.54	25.3	8.50	-59.0	1.74	Colorless low turbidity, some orange sediment, odorless, no sheen
								Sampled @ 5' StoWI recharge
								Slow recharge, bailer getting stuck in well, and trouble pulling up.

Field QA Checks:

Air bubbles in [ ] Y / N Any violent reactions? Y / N

Earl tamimnhm \* p1r GHD procedure? Y / N

ent pre-cleaned? Y / N

Parameters	BTEX	TPH	PAH	CIC	PCB	Tot. Metal	Biol.
Preservatives							

Comment: Duplicate sam Ju □ ci: ., r, bt: ilms III Hd. .11: □ con dition of headworks III! c.

Logger CAt

50-814-10

Purge Volumes  
Casing Int. Dia (mm) 50 100  
Vol (L/m of casing) 2.0 7.9  
\*Double for gravel pack

Purgifllg and Sampling Record

Boe ID: *rl-/k*

Cfienl: <i>1.0t... 8.0000t... 1?(/g</i> Pm)lCl: <i>7,, r6 q.g</i> rm.. o SampJo,r: <i>r1T</i> □ ate: :: □ <i>i?.)</i> }1.../2. :: □ Ollnd . . . . . □ <i>3::</i> □ .....	Pul19 <i>l'Od' ;, . . . . . y □ . . . . .</i> !NO: <i>rT</i> low C4iln: <i>Y J N</i> Pump Dr:iptfi: <i>...m</i> □ 01 <i>M'O'c'i' iliy..pe:</i> <i>Dip □ Fo Jii UFCll &lt; Og □ □</i> Bora lll1>p.th: ..... m ff!l9ldlFih1roo'!V N j!':i!lcr vcS\$el, 4J;\$pos3ble (1l □ rls vnngel	SWL(.mtiTOCt □ ..... m L,og'ic Cl'ieclii: ..... Sti'ton: Ftt:irn: ..... 11:0 ..... m Siick Up: ..... m B-o □ !;)(girn: ..... <i>7</i> mm w-e-11CilJII Sa;urU,.....
---	--	---

Temp re	Elo;c.Cbilill	Di...mfil	4% mV	[m TOC}	Comm1;11111:
	{-----}	<i>1--</i> □	<i>4% mV</i>		Coliruf: <i>It'J'lii(fitJ. Hdll'IlillT: l'Old, lMi2fli. □ tr, inbw r,11111!, p111r11111d dry?</i>
<i>0":cO</i>	<i>&gt;. 36</i>	<i>oi, 10%</i>	<i>+J., OMV</i>	<i>C--l</i>	<i>c..lH: □ □ □ c: JI: mA.r{eg; nc: □ n</i>

A.lr bi;ii, bli'!& 1:n ;&b?y □ NI Any '!'l'OJimt nm.e:L □ t 'l" □ 'li likieo! □ ffinalio. 11H ip: Dr Ottl lll'Clcand 1.1Ni? 'l' □ N WIIS. iHmplmgi itlQUI □ mlmi lIFi1'-cilaMlll? 'l' / N OOC ir.pd'.a'tm? Y □ NI	□ <i>ti'EC</i> □ <i>J l PA.11</i> □ <i>Cl</i> □ <i>ep</i> □ <i>OP</i> □ <i>Tot..!Mct4il</i> □ <i>ks,</i> □ <i>Go,--</i>
--	--

CVTTTl!:" □ t □ <i>Lie. I □ . mmpm kllJac. lll □ . □ lllH. mnd; □ □ □ □ □ W</i> + 0 <i>feu.J</i> <i>vet □ ,t.../e- □ □</i> <i>s □ p1,e</i> <i>c_of(.ec □ -eR</i> <i>,r-1 □</i> <i>□ k.e4</i> <i>6 □</i> <i>t-e</i> <i>&gt;</i>	fl. irtgtt 101671111H (Hnlil...I. Di!! frn □ □ 'IDD 1,SO 'l'oli □ .In ofC'illmill Z.D, ... l? □ 'l' ' □ 11U1JL11rof ar, 11H
--	--



purging and Sampling Record

OFFICIAL

50334  
Bore ID: P:!!!

fi'ifo-J,an1 CH(-1!!!) Mt !-Y.l...-r... 'A , P.r<iJeet: K E.tl... P.,..m" P... IIA I,,,,, ,t4f.ct; " . . . "	s.ampil1Jl ,ntbtma'Ni11 urge Methcd; ..... mple M&ttiotJ; 1, .. W Q filete.rT:yJJe; ..... Filow Cell: Y Pump ! )pu, .....m Wic:Ye Mecer 1 ing; :! - . . . - Filted Fil Tir,ed/ #7 N (filter YOool. d,sr..... Filtel'a umJJel	_1,1,0 i'io.il SWUrn'.1110C : 111m u-r' ..... m LngJc c:t,m;k; ..... Sc:nacn: f,Ctt'I...ta ..... m INAPL Chrctn,, ..... Ref.datum; ..... Bore depth! ..... m 11Cat1 Si11cur.e? .....
---	---	--

Yarumil; Temp 11N J..... UI,J Sill pBI' 13:co.;-;,"" P'NI.ncm: J\:%	re, - g';J.	(pH unca) -t, 0.115 pH i-lif	..... -+/-Sl,g ,S.O	..... "I- 1of, q.,	(-tmV) Jm TOC} S.Sbr61	t..... Colour: Hlbcff.tv. HdImorr led:!!SIGi:11, α&11-r. Jll:lw rati;t d cllJ?
						LI c...3/4' dola...tl...S> t-la J /-oi ot- ;;, aS iJ lo , /J} ""1

M QA Ch'G; bubb'.11:i:ihtht? V/ N li;rr,j vii;iklnl Dt!conlnnallon iii, PII-f GHD pRCDdIDB? y / NI iWH 1, amplirgt .P11Luipmen1pr,e-clsamtd1 Y f OOC upldii'h!!d7 YIN	IP Pn:M'Ncive!;i	Illnl Trqi PAH <CIIC' IPD OU' CPI' Tm. Md.Ill Dil:11; C'U'bl1t tut-tj,-VCI plil
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Comment: H c,aliacred. i.1141, ee.m.s, c;,m:lIdan oa hdi'WJHIOIOCI  
CHIPISJ Int. j1111) 50, 100 1  
'11"n.rm at iii 1.0 'T.'11 i,;r,i'  
C'U'bl1t tut-tj,-VCI plil

OFFICIAL





OFFICIAL

Boogey '2.

Purgh1g and Sampili Record

IBo, e ID

Ckt .t1to !:W, / A... tyj}...  
 Proic...  
 r o j... : t 1 r... f...  
 sampl'g... fl... 15/s:2f...  
 Ro-1:ID-d...

Ssample M th-cl  
 WQ Mete:rTypar:J' ?J... Jf... P IQ...  
 flow Cell: Yl IPt!!mp Oe;pU1:..... \*iti  
 WL.c.vel Mlet"Ql liypo: D P-I IFIOI rtii G J sore D ph... r.n  
 field FIUar.cd? Y / N (fil "ese.e1, dispo:sabla filLerJ'syrino:o)

SYIL(1111:ifOC):...  
 Scm en F em... lo... m  
 Lo,gk: Cheek... m  
 Stle,;> iup:... m  
 NAPL Chac:t:...  
 Rc.itd lum...  
 Wct11 Cap SCm  
 aero OllllH!:... mm

'll'jr,ic	Vor. lufull	Imp (Cl)	i, III (pH, un.1)	Ehc.C.omi	Dt&Xb,yg	ox em Pt t±mV,	iWL tmTOC)	CGii'Im!!lrt:
			la.t)SpH	+1-:ffl	t.10%	... Jii,m	!	colgtu-, hlihdily, s!!ldt'Mnt 110:all, sfeltn, odour. {low rwte,. li!!J)JDd lirry
1 00		1	"1.1fl	JCf I	9.g	., i-		d'41 od" , ; it:c ill'JJ.J .sr...v(. .,J,
								"l-C.ir./ , d
								v

FJ.N.J.H QA Chech;  
 !Alrbubbls.m...Jal5? Y f Ni Ar,1"iolaitt. fil"ictloll"i5!? Y N  
 Dll11gnU,tii'i&viUIIn H ?Qr GHO pi'Ooedur81'r' V I  
 wH 11mpl1n;1r1Jqv.'ipr"llln1.J,NH;leamtd? if f  
 COC. l111)61al:Gdi" ff I m

Piiim'ISifiiH: ll"IE( TPU P.N | CIIC I"CD K.1P OPP TQ1. | lliol..  
 Pvf"!!!fftah'8:5

icommcm Duprka1111  
 W-D I (D-Jp) -- J2 (-splid-)  
 OFFICIAL  
 PMSa WWWW.NN  
 Cfttint J(iL 0-. (mm) 50 1ofl 1lf1  
 Vol [l.Irnotcmlngl 2.0 i',9 W,7  
 \*)Qllbl... Jgit QfiVlll:1:111:;

Client: JQB 1.11RI!Pill'Kln  
 P'Qjaa: Mb. t...  
 Proj. No": 1...  
 S n,p o ----iD"&...  
 Pa...  
 ftoy!!,(l ... r-...-3 .....

Pur,ge M.'C'lh'od...  
 S;111t,pl0 Mtffiodl: ...  
 WO Moh rr Typo: ... QI Q...  
 Flow Cell: Ylt-1 IPuffJ:i IJ...lh...m  
 WL!!wl Mletar T)'pe; Dto1Fox fl Fci GH  
 Fte: i d'FIH:arecll1-y t N (rill.el' t,!,.\$.Sd, di bl'ClI li.L lsyirtDili'

SW,l'(m-bro-C\*)... J...41... m  
 5c:Inian: From:,,6...to...7... m  
 INAPL Clun;;k;...  
 Ref.di111UII1...  
 Elarilil Uoplh; ...!..L:\... m

logic Check; .....  
 Slk:k Up... m  
 Sara Diem.©... min  
 We-JI Cap Sa cure? \_Y.,\_

J1mDJ	/lo]ume	Tilitip	BI	E Coid	Dls."0:qgan	Ox*ll(Qdpt	SWi.	C(IffIDInC
C.....	CU	"C	JPH Lin	(-----I	t--	UmVJ,	(mTOC)	r...J
SjnJla M/NI f.JCDII...\$,'11			f-1 Q'if,H	+I,3%	?/-11)%	-i-10rn',I	!!t'lid.'&	Coac1.11r, ludlid.IJy, iHliittml lo&d, 1!1:l'loni.cd:our, 'flow ,f"li. !!iLlrQcll d!Y!
!	\	5	5 c	1,J	\0 -1,0	1.,0,l. 5.		r-ro -k.,bJ.-li
\.. \	'-	t,, I	C: ,1	l..?i '2.	'6 .''''14'	191 .4		f1 f,
n.'i	q	t;	o,	'1 2-	q (?c..	iQ.q.9		
								ik... !',,: S?
								tJup\ -e (C..W-Dt 4 0...,,,"1
								... + rc. W O ,

Ri'itl QA .!i:

l' r' lbubbl'M In 'ihl1i!i? V t1N An.1violem r-qlg'J.li"j'V / li,l  
 Deer;,n,a!Tlln:!!HO'! ; pqr GHD procotrur-ili'? 'if I INI  
 M ilBfflj:lfing !leju(pm\*n1 11<l-d011!!"d? '(IH  
 COC UJ)!iatadi' YIN

... tPu POH cue | -1 OPP |

# Purging and Sampling Record

Bore ID: .... It>

<b>Job Information</b> Client: Mt Buller Project: HEMAMP PmNo: 256 59 89 Date: BL / SI / 23		<b>Sampling Information</b> Well ID: k, f, < M'et: i.s. } r k, ot WO Mt: Flow Cell: Y (N) Pump Depth: .....m WLevel Meter Type: Dip / Fox / Int. Fox / Gge Field Filtered? (Y) N (filter vessel, disposable filter)		<b>Information</b> SWL (m): ..... Suen; Frocm: L W J NAPL C'hecit: ..... Bore Delth: 9. \$ .....m	
---	--	---	--	---	--

Time	Volume (L)	Temp (°C)	pH (pH units)	Elec. Cond	Dis. Oxygen	Ox-Red Pt. (± mV)	SWL (m TOC)	Comment: (-, □) CO <sub>2</sub> , turbidity, sediment load, sheen, odour, flow rate, purge
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable	
3:46	1.5	9.1	7.60	19.1	6.25	55.1	clear, no sediment, no odour	
3:50	3.5	6.7	5.53	13.2	7.95	175.1	brown tinge, mod turbidity, fine sediment	
							mild odour (earthy)	
3:54	5.5	6.8	5.46	13.2	8.20	180.3	"	
<del>3:54</del>	<del>7.5</del>	6.4	5.54	12.8	8.60	175.8	"	
4:00	9.5	6.4	5.36	12.7	8.15	184.7	"	
4:03	11.5	6.3	5.26	12.7	8.30	187.5	"	
4:05							sample at 12 L	

**Field QA Checks**

Air decontamination as per GHD procedure? Y/N

Was sampling equipment pre-cleaned? Y/N

COC updated? Y/N

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

cul, @., i : q-0

if: 2\_5

Purge Volumes	
Casing Int. Dia (mm)	50 100
Vol (Lit of casing)	2.0 7.9
*Double for gravel pack	



# Purging and Sampling Record

OFFICIAL

Bore ID: gr { Z ..... }

<p>Client: ..... 1. (tlt, u... s. Ltr. ....)</p> <p>Pm\$set: ... f: . 1, .....</p> <p>oJ. o.o.: \ - Z . 1 . t . . . . . m . . . . .</p> <p>sample MF: . . . . .</p> <p>Dato: . . . . . p// Jla/, . . . . . 2. 4. " Z " . . . . .</p> <p>Round ..... 13/ti . l. l . . . . .</p>	<p>Sarr_pJng lrtlommJ</p> <p>PI!!IQ.C <b>McUtod</b> . . . . . Jf.t; 1 J-t . . . . .</p> <p>Sample Mt . . . . . 1'1'pd: . . . . . J. o. ufaf . . . . .</p> <p>WaP oot for Ty. H . . . . . S . . . . .</p> <p>Raw CeJI: Y Plump <input type="checkbox"/> th . . . . . m</p> <p>WLevel MaJor Ivii!C: Dip, J:gle / lrd.Ft&gt;a / Gg!!</p> <p>Field FrJhmid? <b>Y I N</b> ((tlLer" e <input type="checkbox"/> , dls:posablll! liltersyiinge,</p>	<p>wa l.tif()J:mlr'OiT</p> <p>SWL .-(m'b10C): . . . . . m Log;lc <input type="checkbox"/> heck <input type="checkbox"/> . . . . .</p> <p>Scraon: Freiff: ..... 1 . . . . . lo.it. <input type="checkbox"/> m Stlek Up! . . . . . u" " m</p> <p>INAPL <input type="checkbox"/> ha ck; <input type="checkbox"/> . . . . . Bare Diam. = . . . . . r" mm</p> <p>Ref. dalam . . . . . Well Cap Smc.u,e? . . . . . J <input type="checkbox"/> . . . . .</p> <p>Elorn lil'e.pti: ..... J . . . . . J? . . . . . r . . . . . 11'11</p>
--	---	--

Time	Vol'mnlli IU	TillmJll	Il'li (iillHuln:ltijJ	IEtHLCon-d	Dili..Oq;,Q:fl	O;fb; d Pt. (± rri'il)	:SWIL <input type="checkbox"/> rnTO-C.	:J	C.omm!!lt:
Sra.ra			"¥•0,05 pH	-t-/lSti	-+/- l'ffl	--t, WmV	slllbJl		C'o'our, h.litilidly, il:!ldlr!Wim load, silMn, odour, i'k1w rwt11 EUr.fl;4ld idr,i'
iL• t9	3.0	t,3	>S	31.5"	,is	(38.1			!ti ,cl/cu , <input type="checkbox"/> <input type="checkbox"/> L 4 . . . . . fD od..t:kt'
1•S.2	.S; .0	JO•S	t, <input type="checkbox"/>	3.1•1	,d,Z	H/3 . 2-			J."8J . . . . . f"1 e' . . . . . 0 . . . . . n   fv . . . . .
rl 4'7	,S	ei(.;	b 1c 11.4 i	S, S	li"•S•f				<input type="checkbox"/> . . . . . i L <input type="checkbox"/> l111..J rL . . . . . A.i.H <input type="checkbox"/> C deb-r !,IQ <input type="checkbox"/>

t:rl'rlQA C'uiwQ

'Air pubbl. es In vi□□' Y □ N An!J'! 'ldgn' r!':at:JOM' ' ' ' / Di!IC<111-□ml1eltcn H i>K=r GHD piece.dure'! YI M Wil!11 Hm116ng !?-qu.ij!!i'Mlll pr.11,-eleanod? Y / N C.OC !!J \_edtrleedr? '( / NI

IPw	EH	w11	A11	enc	ro	OOP	WP	Inrt.□□-1	mo1.

<p>CBmment: 0110 tti:Jll ft 11□1; bott1</p> <p> </p>	<p>Id, •eoflll, c.cmdlton of l'MlahAinr;a.</p> <p>hiJqt"J □ m fd,•</p>	<p>Pw-sil*Vlt,vm</p> <p>ICUllllJi □- CW [fflmJ i5l&gt; 10D 1,ti</p> <p>Vdi iJJ'n:ulicnJng• UI 7□□ 11</p> <p>Dttukiht rM li1Ni#11 pai;k</p>
--	--	--

OFFICIAL

Purging and SilmpHng Record

Bo(i ID: "r" 17

C:ll:e-nl P't0leel: B, Jj f: Proj No: 11.469 :s:all ilpru=... D:ste Rou'ld	51,fil,,Y,,g Pi:1-gb .hio,111 S'Impte Me01.o.dl: WQ or Y,')f y to2\G"9.  l=fow Coll! Y / N Pump Oeoth 'M.eul M!l'h:1" T)'li'B; F'ietid inU'roo? V IN litter vassel'di'.spossb Je lite:ry'niije)	S'l.1'l,L[mtiilOC-): 0.-1: Scr, nr. Frijm, \, , , kil, .h L4ii';lie C k: "" Slic:t IlJp: ..... ml NAP.IJi Cheel,i: Ref.diiiiim: li:(t,l'l'te: E:leptl\l El.ere Diam, mm WeU P. s?t,t:ur,c-l, Y,....
---	---	---

...	U!	p O!!-l t11:1\$)	IEI C:oi@	Chi)R1;1P(1t1 (i mV)	sw11. (lm Tac.	C-----l	C'oirilfili'dl: C'clour; lwrlil)lii).', s,stimilHlt lc,e_d;:ltloon. Ollo'ilil, flit1w ml 111.10 \$d dliY?
		O; pH				0.00	kf+n "-"...-\-
) .01	7/1 ¥	G J	l b l q-	"21.7	(,),(, j	1-"l-i. DI	I . G '1 i CJo - - h-4 5-0 (;
'7' iS	6;	h	G:fft	2"1 t6	l' 4-1	f:n, "7	;-151 u t v l -4-4::J
							Pear o£.
							QD¥, IO "?, '3,

Air bt.Jbb in iib:7Y.tN Anr viol:ini reatl n! ? y / !!  
 Dooeom.wmnrnl:lon p,r-r GI-IC p-soccdltt-c-?&)t 111  
 twa samplfn;i rsimiant rirN:!!>J 14  
 COC i:ijld;!!ltil?fl' ) l

Pt:Kft	WII	NUI	CHC	CD	00'	0	Tot.							
--------	-----	-----	-----	----	-----	---	------	--	--	--	--	--	--	--

C'(li'fii!'Ae!fllt: IJj',Pllcaf.e: umpit::SJ ool[oJd, bot!IH IIM'II, .,;Uj; .c,n,5;1,;Jj !!I ti o'! o'-'-o  
 \$,I.I( t -\n D...t '..¥f)r  
 r,i,il'li'i.Uf:>tMI  
 CairJil fol; Dill Cmm) :!1(1. ;oo iiII)  
 Vi.ii •LJm DI •CHfn:ui 2'.o J9 17,  
 -!AI!, ro.r .grawi tr.:h:

11!9

OFFICIAL

2-!.-:n ( 0 o D &.f.rJf .....

# Purging and Sampling Record

Client: Job: V?  
 Project No.: V-11-12  
 Sampler: J  
 Date: V.1.12  
 Round: 1

Purge Method: Y, a  
 Sample Method: z  
 Flow Cell: Y/N  
 Pump Depth: 6.7  
 W Level Meter: 0  
 Field Filtered? Y

SWL (mb TOC): 1  
 Screen From 0 to 2  
 Borehole Diam: 1  
 Ret. Datum: -  
 Well Cap Sure? X  
 Borehole Depth: q.2

Time	Volume (L)	Temp (°C)	pH	Elec. Cond (µmS/cm)	Dis. O <sub>2</sub> (mg/l)	OX-Rtd Pt. (mV)	SWL (m TOC)	Comment
11:00		12.7	7.6	7.2				Cl. ar -

*Field OACheck:*

Airtightness in vials? Y / W/ "10 min 1 r/c" Y / N

Oceonami Ntl On M per GHD proteuroi (\$ > 1 N)

Wn sampli 119 \iptncnt J) ff: <lea.r, d? { } N

COC updated? N

Comm: u, : 50

CO	OCI	Tot. Col	O <sub>2</sub>	...

CHng Jn L (lq (mrn) > S. 100 150  
 VOi (L) ft or CHitlg. 2.0 1.9 11.1  
 Ooubt. t □ !!'a'fil! Hilk

OFFICIAL

m

Purging and SampHng Record

B,ore ID:  1...1...-----

Cifon! .....  
 Project .....  
 Propri N .....  
 S.amrikt. M.....  
 F't.cun! 1 .....

Purge Meth oll: .....  
 s:irn P'ci M.t Qd.....  
 WQ Mwwr Tyn, :. L ..t JQ.&.: 6...  
 Jo,w Cell: Y. N PIW'lp Daplr .....  
 W:Lti'OI MI icr fypc: Dip: J F'v-li / Gf ti

SWL(mbTiOC. --'2:·?·f·L: f? m 'L'ic C'ho, .....  
 su,i,oliJ, Fr.r.if'l, t...:l...to m Sifck IJp.....  
 r,i A,PI Cihecll:..... [8(fCi IO!!!, ..... mm  
 RI'f,d3tu:m: Welll C'lp :S! iirJi? L....  
 B.ccre Cwllh .....

tJeki Ffill:e1ij!!d?YI N (Citer ile.Ssel, (ispasablo filtm-lyringo,))

Tim	ft/mr:i	pttl	Elc:u:1.Ct r.d	DJ...Olt'!!!m	O:t-RI!!! Pit.	!5Wl.	(... ..)	t.<MJmfit.
.....	rc1	p.H un-i8'	C-----I	(... ..)	(-t,n'YI	(!!! lot)	(... ..)	Colalir, du'ililfi; ilitid1moot lon_d,11M1em, ,o:llo1r., llow rr.aQ., r:uirge!J lii
		-IF-O:OSfiH	'''3'''		-+AWm-V	la		LJrthc /
02	G.7	5:11	\-.: Z..	7ro	lso .2.	:'!://		L... ..
t:-0	G	G.2-15 6&1	1 .6	16.67'	t7S,5	D+70		-G nf.J
								[st
								Jrit,e . L 2- lfs

Pl.eta O.A Ch&ers:  
 A.ilr bubb!H.ill rial"!!? YI IN Any ..... YJi  
 DiirHRIJUTJ;a;D'rii :o 'l.itil' Gttb P'.ifOOIHilln?@I iN  
 wa .....  
 coc !!.li)dauili1"1,'N

P----- IGlf 'NI I PAJ!!! | coc || PCD | f)CP | Of'ri' 1 ||,at. a, | Di.o'l.  
 1Pn:Mi!!M:!Etf

Con:111,nmt; ![,;lp! 'H colI:Hled'. !la'l'hlll! !DN, .....  
 a.tt: [ , , 'n ,l.. .f'  
 O V .w-O, , ?p/w ¼ vJ OL  
 n.Vlllt 'MJUm  
 C.-ll'njjl In Olli.ir.m'!Ji ,o, .lS!  
 ¥1>1 (LJ'n;! ,,,RR.IT'Ig t:(l 7.t fl.1  
 "Double iar 11a-nl

# Purging and Sampling Record

Bore ID: 8 tff

ellun:U .....  
 r: aA.f.WII  
 P(ro)gt. ....  
 ?roj. Nm: .....  
 S:fillp11Dr: .....  
 Date: .....  
 Rou111 .....

LP U' -9 IM .....  
 Sample Method: .....  
 WQ MttJii fyipo .Y; ..  
 FJa, w CII"II Y / N  
 P-1rmp-Oepilni: .....  
 Field Fil tch: d / NI (fltm' .....

kiformn:o' .....  
 j7 Q ... L:€ "<  
 "T" ou j: . A-t: .....  
 S c tcn', FtoIn, .....  
 NAPI Clilec:k: .....  
 ft!!UUihm'lr: .....  
 Bore Cie;pU11: ..... m

BII"i' lml;my11c'11  
 G' m .....  
 SI:c'kUp; .....  
 80 ..... mm  
 Wall CilJil Se re? .....

Temp	pH	...	...	...	...	...
r'ct	units	t	f.i	(m	fOCI	...
...	...	...	...	...	...	...
-z-'b	T	-n..tf	?	-1	(CY--1 q	Z,"2.2
Z.	e	!13_	S	IS	G	g: 0
1.1.i	1-	i"	IS	J.. 4-	-.	-n
2. t+J	q<:"	q.l.f	l	Su.	/l,,-9	'S-q)

**Field Q:4** IC'IsC:Fr:sl  
 Air 'lru1JliJtes .....  
 D,c,tont.Bminlti.1n Mi-pc-r G'-1:0. pr9;li;dIM'i?'a).f INI  
 Wes :s.am11DIISI .....  
 c.ac u11ft'tei:1? toH

CHIC	PrCIJ	OCP	00'	'll'Qt.Meli	D>'l,				
------	-------	-----	-----	-------------	-------	--	--	--	--

Comment; D.up&u1il .....  
 2:55  
 CH!nti l'M.Dia,(mm) \$:fl too H'D  
 vo1,1um,11e1HIn .....  
 'Dolib.l.fq sim'lil1iaclol

.l'lf/ foo  
 M...S  
 P...rJ...t?b.t.U? ...  
 S...n1p'ler  
 A!!...2  
 IF M F1 redftJ N (filte.r , lfo, posabtefiUer ng)

Tims, v oc- T'allVP p.H £ona Dr\$ \_afil i:b:ru:d li"t. swi1. comnu:nt  
 (...m--J U "C) 4EJH11111W) L fil: G (fmV) IY1111'0QL f. Golot.ir, tfillitlity, i:ed lm:-nt li:ild, 1101;111- odt.ur, ITow filtc, IUIII d'y?  
 sr;t:ilo,lifMIJ J  
 1 q n 2 7. i G.ac UJ. tn 2. S7 TL. 't 0 16 5  
 1 : 5f 4 5.W iq. 2"1:2- ?A--9 0, cl  
 11. ; 1 6 T. :2 5-B t!. \$ 4.- f 9 !\$\$, :- D q -  
 io'i' 1' 10. ; 0..7 t W ...0 c;177 1'16.6 o q1  
 to c,9 \0 7.1-. ,t,;-Jq lq J:t. 2.:1 ff l'tt7, B \, lc,f-  
 LO "L \:-L 7.1> \$ \_; ,f, 1.0. \ 2 11', 2. 1 \.31;

Clec<.,...c u. n-, / /.1..\*rG'lrfu.  
 \nr... (.(i; c:Jou.r./... : : 7M  
 vYI pJ-t  
 r,.; j  
 hic. \ " n t-u r  
 IJ:ah +u'<hlJ 'J.u  
 t,/, p + lcJ IS

R!NI. OA Oh Ft11:  
 Jribull11:5 ln,vl;J? / NI Amylio.'liHl re-a,ct10111:57 "i' f  
 DP!;Corremiriollon iir. l}tlr GHD pt\*g.ca:-lihml"l Y.,Ml  
 WD!S :liffiJ.)ling 41q11,1FIJm@n! p lnmlid? YIH  
 CO@pilla;t,11d? YIN

PtiF DIDC, TN' fAIII OIC P'tO OCP i'ot.ML(al Dillil.  
 ifrn::5,au

Co11mF1;ant: lrpklf;iah 'llmp't-i o!o;:1;1 bl:lilt 111hnl .acall!515, 1;,,,11filoo,;l h#1,t;,,llie  
 QJ.,t CJ " /i.r-  
 ] ' "V

C-11; In! Dia (mm). 1-0.D. 1,0  
 V ju. i aleu:In;J il.D ?.,ll, 17.7  
 \*c,,,uw. ifw IIN!

GH1c:

~ount Buller

Groundwater Level Gauging Form

Reference: t1T



ENGINEERING  
 ENVIRONMENT

Method: Scl □ □ s \-

File: \_\_\_\_\_ rccpylo:

Bore Id	Date	Time	SWL (m)	Previous SWL	Comment Repairs Required, condition etc	Construction Depth (m)
<del>BH04</del>						15.68
<del>BH04A</del>						2.58
<del>BH05</del>						1el.a
<del>UMHA</del>						2.15
EIHO&	19/4/23	11:00	S,W			9
EIHG,?	19/4/23	4:10 pm	0.2"5:..		Depth 0.84	1
BH09	19/4/23	2:25 pm	2.14			G
BH"110	19/4/23	3:50 pm	2.40			9
<del>8H1.3</del>						9
<del>BH14</del>						19□5
<del>BH14A</del>						15
<del>BH14B</del>						9.5
<del>8H45</del>						23
<del>BH15A</del>						is
BH16	19/4/23	12:00 pm	0.28			2.1
BH17	19/4/23	3:00 pm	0.06			2.2
BH18	19/4/23	9:40	0.44			2.1:5

# PuqJng aq d SaImpHng Record

liore ID: ..E.□Jr:!.9,..---

**Purge f.let** | **bn.Acrw-** | SW(1L Off'bfOC) | **m** | Logle.Cllc:l(: , .....

Project = **Z+** | mpte | Ma\*1r1od... | Screen; Fron1; | **m** | Stick Up: ID

Pf6 j. N s | **s** | 11.26 ¥f,⊗ | WQ Mcti:rT!,'□□.'t□.t.1□- . □ □ g □ □ ?...NAPII..Cbdc... m,.....m\*.. | sore DI:1rn,; ..... mm

S:llilt,P□□ **rt'** | Frow ce11:i::a11\1 | P111mpDCli:tlb:..- . " -m | !Rel.datum□ | We.ll Cap :Sec.uni?.....

D:rc:..... **1\$./:..(□□ 3** | **WLe-ve!! Meter** Tvoe: | Dilll, fox hnt r□ d | **B.o:re!Jieri-i;h;** ..... m

Round □. "A? (..□..... :?.-:!) | Fic.1dl fiHol[Cdt y) N, (fill.er va□.I. disposable ilij]LerlsylllgO]

Time	Temp (C)	pH	Conductivity (μS/cm)	Dissolved Oxygen (%)	ORP (mV)	SWL (cm)	Color
12:15	7.5	tr	1.1	1	-17mV	S.S. ill	

**Fii** 0-A tCPeeh, | **le 1wu** | IP14 || me | P'COI | KP | 'IM" | Tot.M:il.d | ilcL

**M"t** Yto=rrt'I' | Ilorn: ? Y | **abzsi**

M:O.iW!limi'13Ji\_on M 01 GfID.t ip□oo811U | /P1

!!i11t1pfvig,!!'qcu;fiiii!!!f pti,dNiru | IN

CIKI'rneiiU: DY□ :Nrfl.P'fi □. bed1fH LIHCl,..acc.'fiU., it<indilhm of □ 11i.

CP11IQI tlit.DI,1.(rmm• &o. 'IDil i:i:11  
 Vall ti.l'mi;ip CHil:ilJ J..Cl 7.t 11.1  
 'Dqab'la 1or □ pa a:



n-4  
QJr  
5 a

# Purging and Sampling Record

Bore ID: B□, □It'..1,..r.□k\_n

Client: tk. □. B. -...-----''''-----  
 P□!e;it. ... J. C" JVA:40  
 Flow.Cilill: Y/ N      P.ump De:plh;.....m1  
 Well Cap :Set:uire1.....

Elit...Co1ld	Dis.OXJ[lllll	□R,r;dfPL	swl.	C01nmr;11.1:
35				c□o-w-: lurtlrilil), i1iNI1m11il !!:Kild, \$hlliin, oIf our, llcw rateJ purgod dry?
1,50				LLC.□□ fr C..tl"-''''' LVL t...i&Lt... , l t;.lc:t''''--Lf''□

Mr In!bbJgs 111 vll!t? Tr □ fjJ An)w J;..lw□ie□. I!1115? T / \_  
 D□i.int.im1111ih:11i H [Pii!r' GHD p.roe,ed1.lre . j N  
 Wu iS!1mtJt11g l:Nripn;mt □eealUtilil .|.|IH  
 COO llfJ>Qhd□(N

P.□ □	Tfil	IPAl	CLIC-	l'QIL	OCF	OPJi	'fat.Metr.1	...01:*
-------	------	------	-------	-------	-----	------	-------------	---------

Co:mment.; ll)upfnalO 8J.w1p111 ;o'l1C!te<i, lboillr:s. 11,11!!!1d. □. «-iiii<in iil' i'iN,dw,ork.1

Com□Int.Ola f,nmil :SO 'ICiO 1sri  
 'TqJ (!.Im Oil e.ulingJ :it:D 1.9' 11''!  
 •0.;ub4• for □r,filp1iek.



-g1in,g and Sa111pH111.g Record

IBoRe ID: .. - - ..

Client: ..... at 8,4

Projcc1: #. ..... Sampl:C,a1clhod: !!!I I }r

P,,o.J. INft: "¥.' i... .21.Eft

Smitelr: ... }::J. ... flow Cell/ N Pu

Diilte: J ( h: ..

81:lro lJJ m. m

Ref da j) 11111111: W.111111:al1 Secm?

!!!O!!! lDeph: .. . 1tn

U.J	Temp (C)	ptl (CPIrl Wllb)	Blit Comp (m)	DRXI	LI	sw1..	Cammaat.
							Onllrt.ir Ly, MK!ffiiJli,load, :so n, o,dQ!ur. flim purac:d dYI
	-G						Low -11A:O-"I" r.4 \$; id:
				49.3			

QA Clt<-f

DRXI

Fbl.1141Jll I.n... Y{JY Aiiyv1or.ft'N1 JyicfJ

11teC'Gll'lattmliidiFl :a,pii" Gtlll !W{lcedll / IN

Wu,&llll1J" i'f'gi. ulpi'llini pra, Cflca'llll . M

OOC: u di m; u; I Y INI

m!MM: lielit 1" 1P c,oll -bo-- s

u7& W

ciSIRU.j InL [Cl.ta IYIYIJ .so ,ao 1151:i

CL/ l'f'IOI Uii!lll 2.11 1.1 n 7

ltoubJe kir-1jrl#111 [P.ik

(Sw-OL) (s.w-nz.)



# Pulging and Sampling Record

OFFICIAL

18-pr, e 10 en

IDJ: 'Uo,n c11enm: <b>mr</b> 114-t Proj: <b>lf &amp; t: 1.P</b> PllOj. No.: <b>J2-</b> Sa mp. 1: rit, m Eat U: <b>lkj</b> Round:	Pu rge Mli-lhodlr S; llnple <b>M e thialid</b> WQ Meler Type: <b>f(J; t=; lQ.9.. \.</b> fiow Cell <b>V lffi</b> Pump Depth ..... rn WLeval IMc-trc Tumo.: Dip / Fm .nt.Foc / Bga, AoI'd Altci' CdI7 Y / N If IJter vessel disposable faterlsyngGt	aM .a-11Q>1 Sreen rem: I.J.? ...10. 1.Ci m St ick Up: ..... m NA.PI ChecK..... Ref.d\Irtum: ..... Bore Di.am.; ..... mm Well Cap, Ser;ure l.....
--	--	---

Tiffie,	Vc'lUnMI (lb)	Tj:tmp re	pH fp'H l.mrIs	Elle.ColId 1-----	Eill1-(h:rgan t---)	O;a;RI.ldPit. mVJ	5WL (m 1'tOCl <---	Cio@nMmt Cotour. lurbkl. fDdim m ID.il.d. 5h;x1111;1d'o1.1r. ffmW ra.p.pry?
			-1-0. fJSpH	1-a	+1-flm	-ti- WFTlll	.sljtJ.'O	
	<b>C-r</b>							/.;:IJJ.. _fe'd... J- fco..d ;Jl'i or.f- r{
i .S".o	<b>0'-</b>							.S, /J 7-J..J J... eid 7Jrb J...f_ "
	<b>c7</b>							
S' '55	st							l IttlI IL''''
1.57	<b>D.g</b>	<b>-S</b>	<b>S,</b>	<b>4-i-O</b>	<b>,3-31-</b>	<b>17.0</b>		
'6. )	<b>V</b>							J,c...IV . L, j, il k . Sf... I't, j; . d e.
9.05"								r ... J .c( J: i .
<b>-1-1   1-11 . -1</b>								

Air , pulritl'es.1111 'li:1 V / N <b>Ai"lfvr: 1lent rm&lt;lr; itj1; 1n" Y / N</b> O:H:1;1ri,!:;lmuVjL1!!!ff1111, pll!<r GHD pnrii; 111r!?' Y' f NI WJi nmpUr, g pr: nanl pm, , clHned? YIN COC IIIJId; id'?'f IN C,om.m!!!!, t=Dupl.lGal' is; ampln con-ct, i, i in; ad <b>al' Cf' t, condJllow llll hudwmiks llle</b> Lo jO' - - - i .<' ... 9, 6 <b>OFFICIAL</b>	p, a, CHC PCD OPP       CHIQU l'fii'. 11: lli Grm) SI! 1i; li; 1 vqiUIJIII Ci ei; ipitR J 1.111: r: s, ru "DIINblll   R lJIn'ill p.11cj,a
--	---



PuF1g1ing and Sampling Record

OFFICIAL

B-Ofe 10: ...00... ..

Cl]ent: ...nir.....,i f...  
14e...t1b...mL

Pur□Me1i!lodl: ...  
5:.,-ip/111g \..J□'. J1'on1

SWI□m.tiTiOCj, ...  
3.7ZY. /2 3.723--  
Ser□lin: From:17.....Jo .b.....m

IP roq.ct.....  
Pr□t & lo: .t□□Jl.□.□L.....

5.emple Melhad: ,.....  
WQ Meier Type: .IS.....lf...□.□Q.□□i□□.□- -

NA:PL Check;.....  
Slildc Up□.....m  
81111□o□t□m.□...5\_0...m

5#- mp□-or m.r  
i:1:j:r...  
oatc..  
Round 6...r oq

Flowc Cell.; Y /@ Pump [[lh;ipl.h\*:.....m  
Wll..Cvell Mgterhoo□ DIP / Fox /□/ Gin,  
Ft-e'lel F"Jlteinelfl y f N (F.,ter "teSiS.of, d□□t,le, ratter,syonge)

Ref..d.alum□□...  
Bore Deplh□...5.,,\_□f?-□.....,... m  
Will E.ail) S Ccuro? Y... ..

TIIM	Vq1urni,	"T,i!ffip	JllH	6lgr!.,C1:md	Di:11.0.!!.:y(Jrlll	Ole-fl:i3d //	SWL	Ci.immant□
□.....□.. □.I	□.□	□,;q	[pH u11llilj	□-- .)	•- - - - -)	(i:m\J	(m1"llOCI	{ - , - , - }
□ -IMWI-(1□□'1"1'	□ □ □ □	-	¥,0,(t;:i□	-;- .13%	□□_ faff	+1- rom11	!(.lltA&	
r:r! 2.S	2.0							C //A. E .ne. cu-l r:1,./
□c 1:9	3, ,o	1.:',	s-1s	17. L	g.. 2.i	/1S.□		" /< tA/ ,,, S, clvriw Jo.,,J "l..JL□□ r&_i.,fu
10-JZ	□ 0	l '=□t	15-!d	f b,S	i" .JG1:	17g.3g		...
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OFFICIAL



**a1rme**

Air-Met Scientific - ty Ltd  
1300137 067

**Multi Parameter Water Meter**

Instrument YSI Quatr Pro Plu  
Serf I Ne- 15K101(1B11)

Comm nts.

II 1M	Test	
eatt-ery	□ Cooiooi	✓
	Fu&.e1i	✓
	C r;ir;	✓
Sw tcl1□k yp;ad		✓
0 plly		✓
		✓
	(segment-s)	
Grill m□r	Oondltion	✓
	Se	✓
<b>PCB</b>	Coru:lltk:il'i	
Co:mn φlo'	C(indltion	
Se_rnsor	LpH	✓
	2.. niV	✓
	□ FC	
	D.O	✓
	6 T ifi	✓
· Lem1!!!	Beeper	
	Settings	
<b>Software</b>	Version	
<b>Data logger</b>	Operation	
<b>Download</b>	Operation	
<b>Other tests:</b>		

**Certiffc,ate of Calibra·tion**

TI I □ Co rriff , a the ilbo'18 h11slrumen• has, bee11 calibrated to th illoing specifications:

Sensor	Seri.111 no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0		377403	0 ppm
2. Conductivity		2itOuS		385047	:2700uS
3. pH7		pH 7.00		386487	PH 7.00
4. pH4		pH 4.00		384826	PH 1-14.00
5. ORP mV		234		371983 / 387511	234
6. Temp °C		2.0		163377	:20

**Calibrated by:**

**Frank Team**

**Calibration date:**

7- Nov-22

**Next calil.matfon daa:**

**6-May-23**

Oil / Water Interface Meter



a11rmet

Air-Met Scientific Pty Ltd  
1300 137 067

Instrument Solirn .• Interf o. Meter (SOM)  
Serial Nlo. 312 1):

Item	T	Comments
Battery	<input type="checkbox"/> am_Aaf I Capacity above 7.9	✓ ✓
Probe	Cleaned/Decon. Operation	✓
Connectors	Condition	
Temp. Cn_ec	Cl" .inod	✓
Conno □ 1:1 &	Chu, ud i;ir □ult	✓
ID 6trum □ n t To. t	!;(Urf.w □ ol	cl'

### Cerlifkate, of Calibration

This ID 03riify that the abo\la ffl me11) h befl'I cleaffed Bllld tested.

**Calibrated by:** \_\_\_\_\_ **nk Team**

**Calibration date:** **07-Nov-22**

**Next. c; "bra-tfM dlti :** **06-May-23**


**airmet**

 Air-Met Scientific Pty Ltd  
 1300 137 067

 Instrument YSI Quatro Pro Plus  
 Serial No. **22G103276**

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad Display	Operation	✓	
	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB Connectors	Condition	✓	
	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. 0.0	✓	
	5. Temp	✓	
Alarms			
Software Data logger	Beeper Settings		
	Version		
Download	Operation		
Other tests:	Operation		

### Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0 ppm		391223	0 oom
2. Conductivity		2760uS		385789	2760uS
3. oH7		pH 7.00		399304	pH 7.00
4. oH4		pH 4.00		389384	pH 4.00
5. ORP mV		230.92		381475 / 387511	230.92
6. Temp °C		21.4		163377	21.4

Calibrated by: \_\_\_\_\_ Herman Chau

Calibration date: 8-Feb-23

Next calibration due: 7-Aug-23

Oil / Water Interface Meter  
Multi Parameter Water Meter



Instrument      Interface Meter (30M)  
Serial No.      288048

Air-Met Scientific Pty Ltd  
1300 137 067

Item	Test	Pass	Comments
<b>Battery</b>	Compartment Capacity	✓	
	above 7.9V	✓	
<b>Probe</b>	Cleaned/Decon.	✓	
	Operation	✓	
<b>Connectors</b>	Condition	✓	
<b>Tape Check</b>	Cleaned	✓	
<b>Connectors</b>	Checked for cuts	✓	
<b>Instrument Test</b>	At surface level	✓	

**Certificate of Calibration**

This is to certify that the above instrument has been cleaned and tested.

Tested by: \_\_\_\_\_ Tom Turvey

**Test date:** 9/02/2023

**Next Test due:** 8/08/2023



Air-Met Scientific Pty Ltd  
1300 137 067

**Instrument** YSI Quatro Pro Plus  
**Serial No.** 21G102167

Item	Test	Pass	Comments
<b>Battery</b>	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
<b>Switch/keypad</b>	Operation	✓	
	<b>Display</b>	Intensity	✓
Operation (segments)		✓	
<b>Grill Filter</b>	Condition	✓	
	Seal	✓	
<b>PCB</b>	Condition	✓	
<b>Connectors</b>	Condition	✓	
<b>Sensor</b>	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
<b>Alarms</b>	Beeper		
	Settings		
<b>Software</b>	Version		
<b>Data logger</b>	Operation		
<b>Download</b>	Operation		
<b>Other tests:</b>			

**Certificate of Calibration**

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0 onm		391223	0ppm
2. Conductivity		2760uS		396172	2760uS
3. pH?		pH 7.00		398134	pH 7.00
4. pH4		pH 4.00		399527	pH 4.00
5. ORP mV		236.64		393379 / 387511	236.64
6. Temo °C		18.8		163377	18.8

Calibrated by: \_\_\_\_\_ Harrison Meers

*Calibration date:* 12-Apr-23

*Next calibration due:* 9- Oct-23

Oil / Water Interface Meter

**Multi Parameter Water Meter**  
**Instrument**        **Interface Meter (30M)**  
**Serial No.**         **288141**

**airmet**

Air-Met Scientific Pty Ltd  
1300137067

<b>Item</b>	<b>Test</b>	<b>Pass</b>	<b>Comments</b>
<b>Battery</b>	1 Compartment	✓	
	1 Capacity	✓	
	1 above 7.9V	✓	
<b>Probe</b>	1 Cleaned/Decon.	✓	
	1 Operation	✓	
<b>Connectors</b>	1 Condition	✓	
		✓	
<b>IC/Pe Check Connectors</b>	Cleaned	✓	
	Checked for cuts	✓	
<b>Instrument Test</b>	At surface level	✓	
			1 Serviced

**Certificate of Calibration**

This is to certify that the above instrument has been cleaned and tested.

Tested by: \_\_\_\_\_ Tom Turvey

*Test date:* 4/04/2023

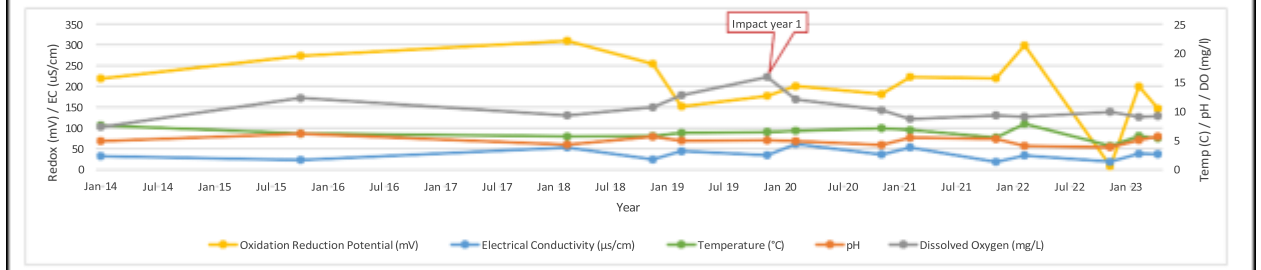
*Next Test due:* 1/10/2023

# Appendix D

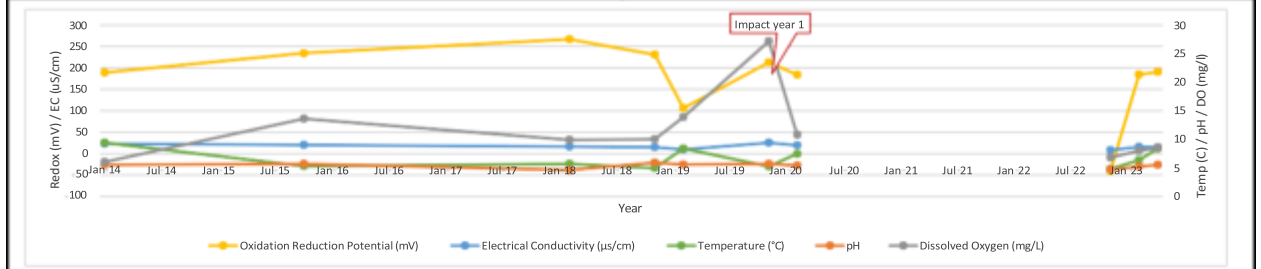
## Field parameter data

**OFFICIAL**  
Appendix D  
Purging Field Parameters

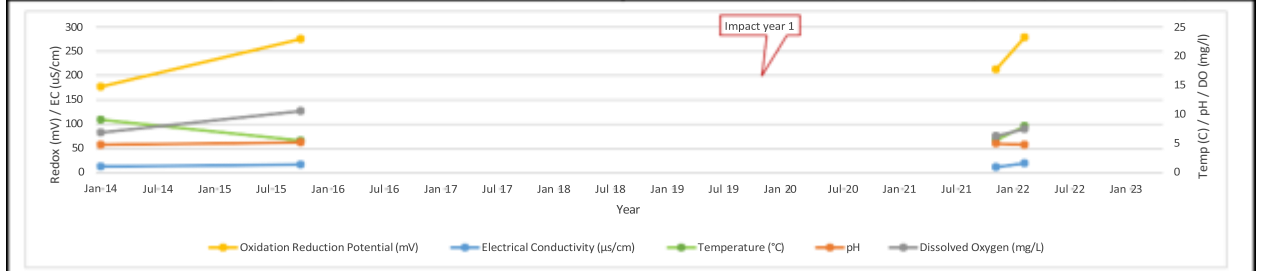
	Baseline					Impact									
	Jan-14	Oct-15	Feb-18	Nov-18	Feb-19	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23	
<b>BH06</b>															
Temperature (°C)	7.6	6.2	5.7	5.8	6.3	6.43	6.67	7.1	6.8	5.5	7.9	4.1	5.8	5.4	
pH	4.92	6.2	4.32	5.65	4.97	5.04	4.9	4.24	5.48	5.26	4.09	3.85	5.07	5.7	
Dissolved Oxygen (mg/L)	7.31	12.31	9.29	10.7	<b>12.76</b>	<b>15.9</b>	<b>12.05</b>	10.21	8.71	9.3	9.09	9.92	9.06	9.18	
Oxidation Reduction Potential (mV)	219	273.4	310	254	152	177.37	200.67	181.5	222.73	219.5	298.4	8.7	199.9	145.9	
Electrical Conductivity (µs/cm)	32.3	23	53.3	24.4	44.4	34.97	61.63	35.53	53.23	18.5	34.2	19.1	38.2	37.2	



<b>BH09</b>														
Temperature (°C)	9.4	5.3	5.7	5	8.4	5.23	7.47					4.8	6.4	8.4
pH	5.52	5.72	4.63	5.94	5.61	5.71	5.42					4.68	5.28	5.54
Dissolved Oxygen (mg/L)	6.03	13.62	9.89	10	<b>13.9</b>	<b>27.2</b>	10.78					6.83	8	8.53
Oxidation Reduction Potential (mV)	189	234.3	267	231	106	213.33	184.2					-40.4	184.5	190.5
Electrical Conductivity (µs/cm)	23	20	16.1	15	9.8	25.07	19.47					8.2	15.8	14.8



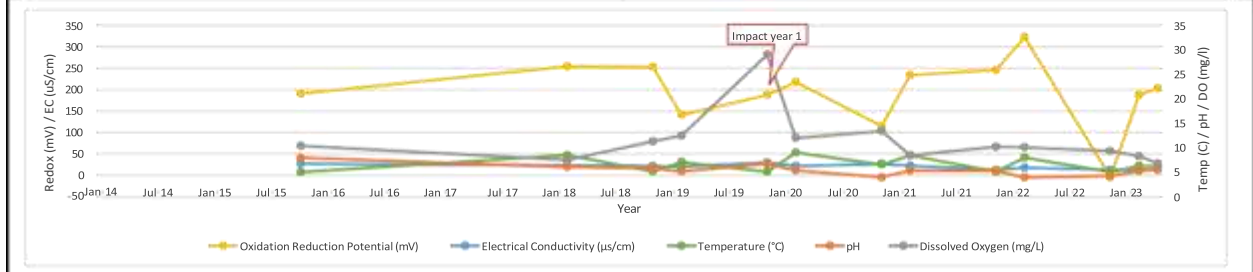
<b>BH10</b>														
Temperature (°C)	9.1	5.5							5.6	8				
pH	4.79	5.18							5	4.81				
Dissolved Oxygen (mg/L)	6.91	10.59							6.3	7.48				
Oxidation Reduction Potential (mV)	177	275.5							212.7	278.9				
Electrical Conductivity (µs/cm)	12.6	17							11.5	19.6				



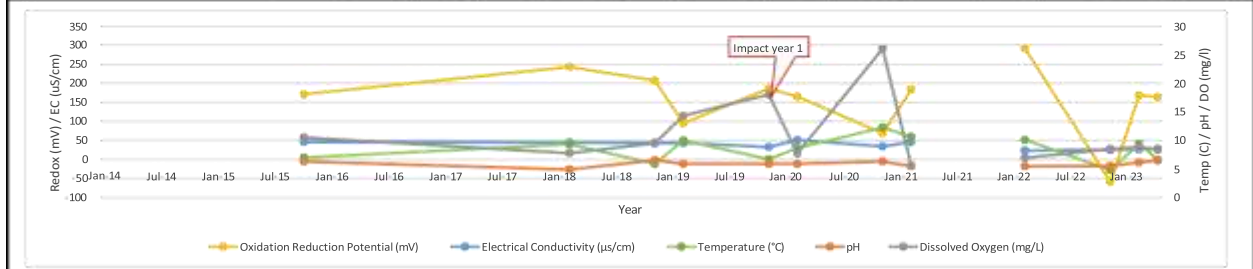
Note - Bold indicates value converted from ppm to mg/L.

**OFFICIAL**  
Appendix D  
Purging Field Parameters

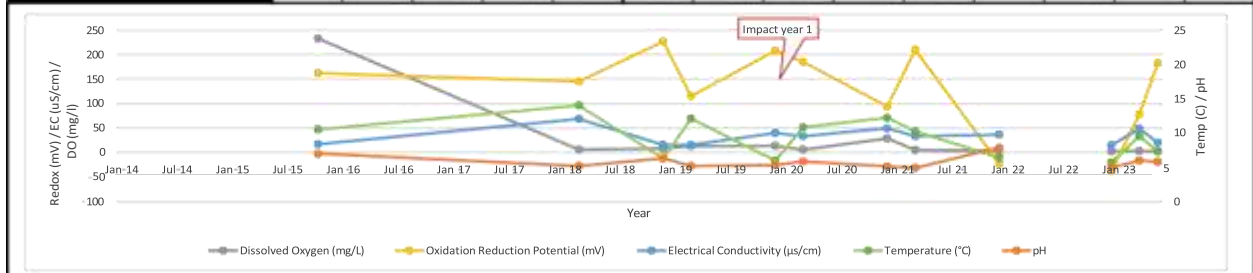
	Baseline					Impact									
	Jan-14	Oct-15	Feb-18	Nov-18	Feb-19	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23	
<b>BH16</b>															
Temperature (°C)		6	8.5	5.2	7.1	5.13	9	6.57	8.46	5.1	8	5	6.3	6.2	
pH		7.93	6.09	5.83	5.19	6.73	5.38	3.95	5.37	5.3	3.96	4.24	5.26	5.63	
Dissolved Oxygen (mg/L)		10.38	7.5	11.3	<b>12.5</b>	<b>29</b>	<b>12</b>	13.45	8.44	10.2	10.11	9.34	8.3	6.76	
Oxidation Reduction Potential (mV)		191	254	253	141	187.67	217.6	114.97	234.13	246	322.1	-4.5	187.5	203.1	
Electrical Conductivity (µs/cm)		27	23.1	21.6	20.1	29.97	21.5	26.67	22.56	12.4	18.1	12.4	12.7	12.4	



<b>BH17</b>														
Temperature (°C)		7	9.3	5.9	10	6.7	8.67	12.27	10.63		10.1	4.8	9.4	6.6
pH		6.3	4.91	6.57	5.89	5.9	5.9	6.3	5.48		5.46	5.54	6.16	6.49
Dissolved Oxygen (mg/L)		10.52	7.76	9.47	<b>14.3</b>	<b>18</b>	7.73	26.06	5.58		6.93	8.5	8.85	8.41
Oxidation Reduction Potential (mV)		171	243	207	95	186	165.07	68.67	182.86		291.5	-56	168.1	164.3
Electrical Conductivity (µs/cm)		46	44.4	43.3	43.1	32.7	51.3	34.23	45.46		23.6	25.3	26.8	27.6



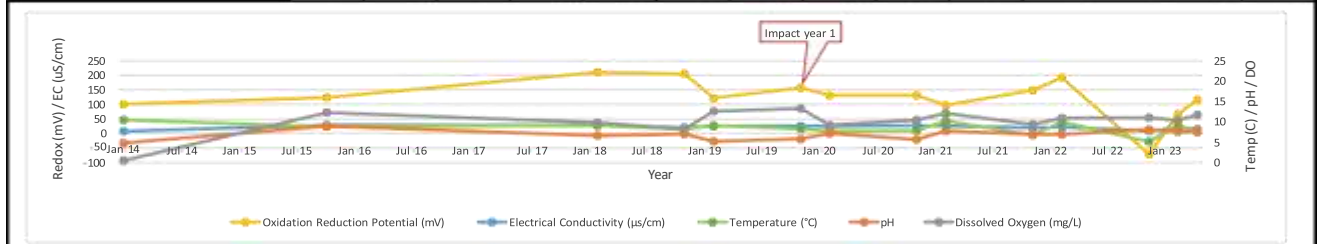
<b>BH18</b>														
Temperature (°C)		10.5	14	6.3	12.1	5.97	10.83	12.2	10.2	6.4		5.7	9.5	7.3
pH		6.97	5.16	6.3	5.18	5.3	5.81	5.1	4.9	7.86		4.94	5.96	5.78
Dissolved Oxygen (mg/L)		233.1	5.99	<b>8.6</b>	<b>13.1</b>	<b>13.6</b>	5.76	28.6	4.97	3.51		2.7	3.32	2.38
Oxidation Reduction Potential (mV)		161.9	145	227	115	207.67	184.9	93.7	209.7	-23.1		-37.8	77.9	182.6
Electrical Conductivity (µs/cm)		17	68.8	15.4	15.3	39.67	33.07	49.3	33	36.4		14.95	49	20.1



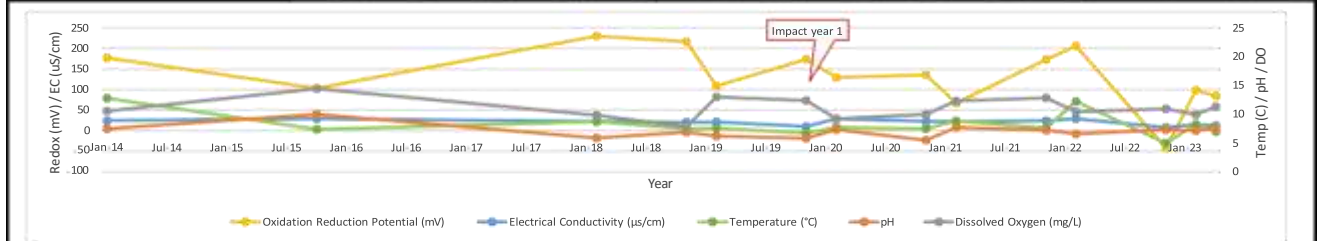
Note - Bold indicates value converted from ppm to mg/L.

**OFFICIAL**  
Appendix C  
Surface Water  
Field Parameters

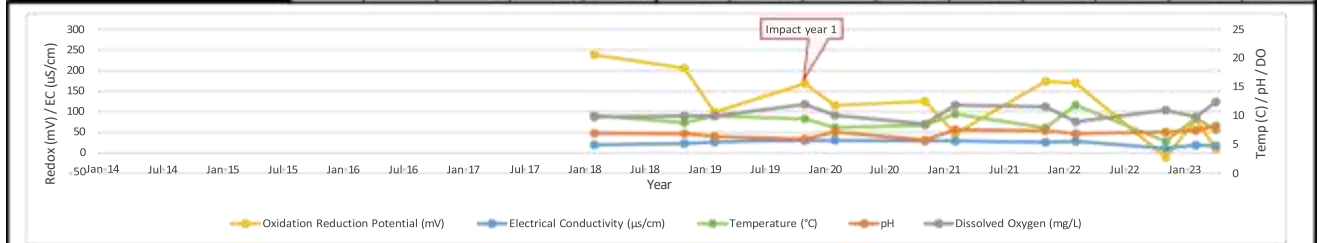
	Baseline					Impact								
	Jan-14	Oct-15	Feb-18	Nov-18	Feb-18	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23
<b>Boggy Creek 1 p/u 1</b>														
Temperature (°C)	10.5	8.8	9.1	8.2	9.1	8.3	7.7	7.9	10.2	6.8	10	5.1	9.2	7.5
pH	4.79	9	6.6	7	5.2	5.8	7.2	5.7	7.8	6.9	6.92	6.15	7.57	7.7
Dissolved Oxygen (mg/L)	0.51	12.24	9.8	8.2	12.6	13.3	9.2	10.5	12.1	9.37	10.93	11	10.4	11.73
Oxidation Reduction Potential (mV)	101	123.8	210	204.5	121.8	156.3	130.5	131.2	96.7	149	192	-70.8	66.3	116.2
Electrical Conductivity (µs/cm)	8.5	29	26.3	20.6	25.8	26.3	24.6	27.5	25.9	20.2	22.8	9.3	19.5	15.2



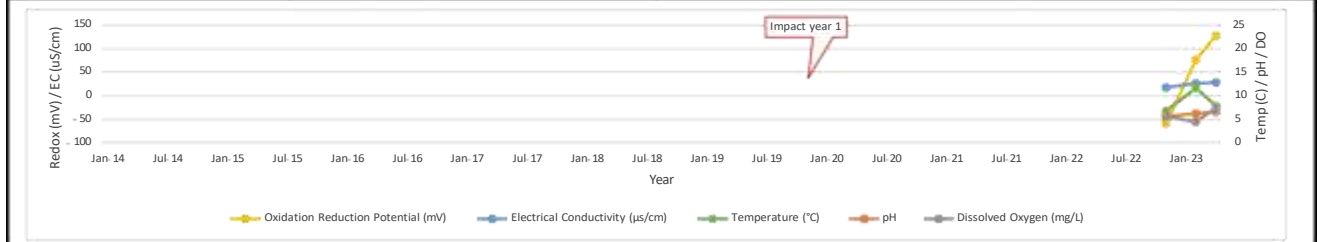
<b>Boggy Creek 1 p/u 2</b>														
Temperature (°C)	12.8	7.4	8.7	7.5	7.6	6.7	7.7	7.5	8.8	7.8	12.2	5	8.2	7
pH	7.47	9.97	5.9	6.9	6.2	5.8	7.3	5.5	7.7	7.2	6.62	7.3	7.14	7.59
Dissolved Oxygen (mg/L)	10.57	14.45	9.8	7.8	13	12.4	9.2	10	12.3	12.81	10.42	10.92	9.93	11.34
Oxidation Reduction Potential (mV)	177	102.8	230	216.6	108.1	173.7	129.4	135.4	66.8	173	206	-42.6	98.6	84.4
Electrical Conductivity (µs/cm)	24.7	29	22.4	20.5	21	10.1	28.6	22.5	21.7	24.1	28.7	7.6	15	12.8



<b>Boggy Creek 2</b>														
Temperature (°C)			10.1	8.8	10	9.5	8	8.4	10.3	7.9	11.9	5.6	9.6	7.6
pH			7	6.9	6.4	6	7.2	5.8	7.6	7.4	6.9	7.19	7.47	8.27
Dissolved Oxygen (mg/L)			9.8	10	10	12	10.1	8.6	11.9	11.6	8.99	10.97	9.8	12.43
Oxidation Reduction Potential (mV)			238.6	205.5	99.1	168.7	115.4	125.4	47	174	170.2	-11.1	81.4	9.3
Electrical Conductivity (µs/cm)			20	23	26.4	29.6	30.6	28.9	28.7	25.9	28.5	10.8	19.1	17.1



<b>EWS</b>														
Temperature (°C)												6.8	11.6	7.9
pH												5.61	6.27	6.55
Dissolved Oxygen (mg/L)												5.59	4.45	7.45
Oxidation Reduction Potential (mV)												-59.2	76.4	127.5
Electrical Conductivity (µs/cm)												17.5	26.6	28.6



Note - Bold indicates value converted from ppm to mg/L.

# Appendix E

## Summary laboratory results



OFFICIAL  
Appendix E  
Table 1  
Analytical Results

Mt Buller RMB

Field ID	Baseline/Impact year	Date	Baseline				Baseline				Baseline				
			13Feb2014	27Oct2015	27Oct2015	14Feb2016	13Feb2014	27Oct2015	27Oct2015	15Feb2016	12Feb2014	27Oct2015	27Oct2015	15Feb2016	
Lab Report Number	Doc#	Doc#	EM1401293	477470	479595	1519277	EM1401293	477470	479595	1508442	EM1401293	477470	479595	1508444	
Field ID	Doc#	Doc#	ANZG (2018) FW 10% (updated 26 July 2021)	ANZG (2018) FW 10% (updated 26 July 2021)	ANZG (2018) FW 10% (updated 26 July 2021)	ANZG (2018) FW 10% (updated 26 July 2021)	ANZG (2018) FW 10% (updated 26 July 2021)	ANZG (2018) FW 10% (updated 26 July 2021)	ANZG (2018) FW 10% (updated 26 July 2021)	ANZG (2018) FW 10% (updated 26 July 2021)	ANZG (2018) FW 10% (updated 26 July 2021)	ANZG (2018) FW 10% (updated 26 July 2021)	ANZG (2018) FW 10% (updated 26 July 2021)	ANZG (2018) FW 10% (updated 26 July 2021)	
Field Parameters	pH (lab)														
H	Dissolved Oxygen	mg/L													
	Nitrite as N (NH2) (lab)	mg/L													
	Phosphorus reactive (SRP)	µg/L													
Unassigned	Phosphorus total (P <sub>tot</sub> )	µg/L													
	Temperature	°C													
Ecology	pH (Lab)	pH units	0.01												
	pH (Field)	pH units	0.01												
	Secchi disc visibility (lab)	m													
	DO (min 5cm depth) (lab)	mg/L													
	Res. (Lab)	mg/L													
Total Dissolved Solids	Temperature	°C													
	Turbidity	NTU	1												
	Total Dissolved Solids (lab)	mg/L	5												
	Total Dissolved Solids (field)	mg/L	0												
Cyanide	Total Dissolved Solids @ 100°C	mg/L	0												
	Total Suspended Solids	mg/L													
Acidity/Alkalinity	Cyanide (total)	mg/L	0.007 <sup>#</sup>												
	Acidity (Carbonate as CaCO <sub>3</sub> )	mg/L													
	Alkalinity (Bicarbonate as CaCO <sub>3</sub> )	mg/L													
	Acidity (Phosphate as CaCO <sub>3</sub> )	mg/L													
	Alkalinity (Total as CaCO <sub>3</sub> )	mg/L													
	Total Hardness as CaCO <sub>3</sub>	mg/L													
	Metals	Calcium	mg/L	0 <sub>u</sub>											
		Calcium (filtered)	mg/L	0 <sub>u</sub>											
		Magnesium	mg/L	0 <sub>u</sub>											
		Magnesium (filtered)	mg/L	0 <sub>u</sub>											
Manganese		mg/L	0 <sub>u</sub>												
Total Iron (filtered)		mg/L	0 <sub>u</sub>												
Cadmium		µg/L	0 <sub>u</sub>												
Sodium (filtered)		mg/L	0 <sub>u</sub>												
Copper		µg/L	0 <sub>u</sub>												
Sulphate		Sulphate (filtered)	mg/L	0 <sub>u</sub>											
	Sulphate	mg/L	0 <sub>u</sub>												
Cations	Cations Total	mg/L	0.01												
	Anions Total	mg/L	0.01												
Anions	Conductance	µS	0.01												
	Bicarbonate ion (HCO <sub>3</sub> <sup>-</sup> )	mg/L													
Nitrate	Carbonate ion	mg/L													
	Nitrate (as N)	mg/L	0.01												
Nitrite	Nitrite (as N)	mg/L	0.01												
	Nitrogen (total dissolved) (as N)	mg/L	0.01												
Nitrogen	Nitrogen (total)	mg/L	0 <sub>u</sub>												
	Reactive Nitrogen (total)	mg/L	0 <sub>u</sub>												
Nitrate	Nitrate (as NO <sub>3</sub> <sup>-</sup> )	mg/L	0.2												
	Nitrogen (filtered)	mg/L	0.05												
Phosphorus	Phosphorus (total)	mg/L													
	Phosphorus (filtered)	mg/L													
Arsenic	Arsenic (filtered)	mg/L	0.001	0.013 <sup>#</sup>											
	Chromium (filtered)	mg/L	0.0001	0.0002											
Chromium	Chromium (VI+VI <sub>3</sub> ) (filtered)	mg/L	0.001	0.001 <sup>#</sup>											
	Chromium (hexavalent)	mg/L	0.001	0.001											
Copper	Copper (filtered)	mg/L	0.001	0.0014											
	Copper (total)	mg/L	0.05												
Lead	Lead (filtered)	mg/L	0.001	0.0034											
	Lead (total)	mg/L	0.001	0.0034											
Mercury	Mercury (filtered)	µg/L	0.001	0.0000											
	Mercury (total)	µg/L	0.005												
Nickel	Nickel (filtered)	mg/L	0.001	0.011											
	Nickel (total)	mg/L	0.001	0.011											
Selenium	Selenium (filtered)	mg/L	0.001	0.011											
	Selenium (total)	mg/L	0.005	0.0005											
Silver	Silver (filtered)	mg/L	0.005	0.0005											
	Silver (total)	mg/L	0.005	0.0005											
Zinc	Zinc (filtered)	mg/L	0.001	0.0002											
	Zinc (total)	mg/L	0.001	0.0002											

Comments  
 #1 Cyanide as un-ionised HCN, measured as (CN).  
 #2 Measured as NH<sub>3</sub>-N at pH 8  
 #3 Values taken from 'Updating nitrate toxicity effects on freshwater aquatic species, 2013'  
 #4 In absence of total As guideline, As (V) guideline has been adopted.  
 #5 In absence of total Cr guideline, Cr (VI) guideline has been adopted.  
 #6 Free Cyanide trigger level  
 #7 Trigger corrected Sep 2002. <https://www.mfe.govt.nz/sites/default/files/lanzeccc-trate-correction-sep02.pdf>  
 #8 As (V) used as conservative value  
 #9 Chromium VI value has been used as indicator

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 Department of Agriculture and Water Resources, 2018 updated July 2021, ANZG (2018).FW. 95% (updated 26 July 2021)



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Analytical Results

Mt Buller RMB

Parameter	Unit	Impact						BSEB016						Impact	
		23 Nov 2021		09 Feb 2021		23 Nov 2021		23 Nov 2021		27 Oct 2015		14 Feb 2016		16 Nov 2022	16 Nov 2023
		8/11/26	8/8/14	3/3/15	9/6/24	1/1/22/28	2/3/19/6	18/9/23	23/11/07	13/11/15	4/9/16	18/11/15	16/2/22/28	2/3/16/00	18/9/23
<b>Field Parameters</b>															
pH (FAS)	pH units														
Dissolved Oxygen	mg/L														
Nitrate as N (P20)	mg/L														
Phosphate as P (P20)	mg/L														
<b>Unassigned</b>															
<b>Organics</b>															
pH (Lab)	pH units					6.02						6.22			
pH (Sec)	pH units											5.90			
Spectrophotometry (60)	mg/L	31.2	10.0	3.2											
Dissolved Nitrate (Lab) (filtered)	mg/L	8.72	9.3	9.09											
Residual Ammonia (Lab)	mg/L	225.1	219.5	238.4								2.00			
Temperature	°C	0.5	3.9	7.9											
Turbidity	NTU				27			5.90							
Total Dissolved Solids	mg/L														
Total Dissolved Solids (Filtered)	mg/L														
Total Dissolved Solids @ 180 °C	mg/L														
Total Suspended Solids	mg/L														
Cyanide	mg/L					5.7								1	
<b>Acidity/Alkalinity</b>															
Acidity (Carbonates/CaCO3)	mg/L														
Alkalinity (Carbonates/CaCO3)	mg/L														
Acidity (Phosphates/CaCO3)	mg/L														
Alkalinity (Phosphates/CaCO3)	mg/L														
Total Hardness (CaCO3)	mg/L														
<b>Major Ions</b>															
Calcium	mg/L														
Calcium (Filtered)	mg/L														
Magnesium	mg/L														
Magnesium (Filtered)	mg/L														
Potassium	mg/L														
Potassium (Filtered)	mg/L														
Sodium	mg/L														
Sodium (Filtered)	mg/L														
Sulfate	mg/L														
Sulfate (Filtered)	mg/L														
Sulfate as S	mg/L														
Fluoride	mg/L														
Calcium, total	mg/L				0.19		0.39		0.27				0.08		0.09
Aluminum, total	mg/L				0.07		0.20		0.01				0.08		0.09
Iron, total	mg/L														
<b>Microions</b>															
Bicarbonate Ion (HCO3-)	mg/L														
Carbonate Ion	mg/L														
<b>Nitrate</b>															
Nitrate (as N)	mg/L														
Nitrite (as N)	mg/L														
Nitrogen (total) (as NO3)	mg/L	2.5	0.3	0.2	0.6	0.8			0.27		0.57	0.7	0.2		0.9
Nitrate as NO3-	mg/L														
Nitrogen (Organic)	mg/L														
Phosphate (as P)	mg/L														
Phosphorus (total)	mg/L														
<b>Trace</b>															
Arsenic (Filtered)	mg/L														
Cadmium (Filtered)	mg/L														
Chromium (VI) (Filtered)	mg/L														
Chromium (hexavalent)	mg/L														
Copper (Filtered)	mg/L														
Cobalt (Filtered)	mg/L														
Cadmium (Filtered)	mg/L														
Mercury (Filtered)	mg/L														
Manganese (Filtered)	mg/L														
Nickel (Filtered)	mg/L														
Selenium (Filtered)	mg/L														
Silver (Filtered)	mg/L														
Vanadium (Filtered)	mg/L														
Zinc (Filtered)	mg/L														

Comments  
 #1 Cyanide as un-ionised HCN, measured as (CN)  
 #2 Measured as NH3-NatpH8  
 #3 Values taken from "Updating nitrate toxicity eff  
 #4 In absence of total As guideline, As(V) guideline  
 #5 In absence of total Cr guideline, Cr(VI) guideline  
 #6 Free Cyanide trigger level  
 #7 Trigger corrected Sep 2002. <https://www.mie.>  
 #8 As(V) used as conservative value  
 #9 Chromium VI value has been used as indicator

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Analytical Results

Mt Buller RMB

Parameters	Units	Baseline				pact				Baseline				Baseline					
		12Feb2014	27Oct2015	27Oct2015	18Feb2018	23Nov2021	15Feb2022	13Feb2014	27Oct2015	27Oct2015	15Feb2018	11Feb2014	27Oct2015	27Oct2015	15Feb2018	12Feb2014	27Oct2015	27Oct2015	15Feb2018
		EM1401293	477470	479595	18-08453	93350	86624	EM1401293	477470	479595	18-08442	EM1401293	477470	479595	18-08442	EM1401293	477470	479595	18-08455
<b>PHYSICAL</b>																			
Dissolved Oxygen	mg/L																		
Nitrate as N (N-NO3-N)	mg/L																		
Phosphate as P (P-PO4-P)	mg/L																		
<b>CHEMICAL</b>																			
Ammonia as N (N-NH4-N)	mg/L																		
Calcium	mg/L																		
Magnesium	mg/L																		
Potassium	mg/L																		
Sodium	mg/L																		
Total Dissolved Solids (TDS)	mg/L																		
Total Suspended Solids (TSS)	mg/L																		
<b>TRACE ELEMENTS</b>																			
Aluminum	mg/L																		
Barium	mg/L																		
Boron	mg/L																		
Cadmium	mg/L																		
Cobalt	mg/L																		
Copper	mg/L																		
Iron	mg/L																		
Manganese	mg/L																		
Nickel	mg/L																		
Silver	mg/L																		
Zinc	mg/L																		

Comments  
 #1 Cyanide as un-ionised HCN, measured as (CN)<sub>2</sub>  
 #2 Measured as NH<sub>3</sub>-NapH8  
 #3 Values taken from "Updating nitrate toxicity eff  
 #4 1nabsenceoftotalAsguideline.As(V)guidelir  
 #5 1nabsenceoftotalCrguideline.Cr(V)guidelir  
 #6 FreeCyanidetriggerlevel  
 #7 Trigger corrected Sep 2002. <https://www.mie.vic.gov.au/usedasconservativevalue>  
 #8 As(V)usedasconservativevalue  
 #9 Chromium VI value has been used as indicator

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	Baseline				Baseline				Baseline				Baseline				Impact					
	13Feb2014	27Oct2015	27Oct2015	13Feb2015	13Feb2014	27Oct2015	27Oct2015	13Feb2015	13Feb2014	27Oct2015	27Oct2015	13Feb2015	27Nov2021	13Feb2022	23Nov2021	13Feb2022	17Nov2022					
	EMTRU235	477470	479393	1803660	ELT140235	477470	479393	7	ELT140235	477470	479393	1803660	477470	479393	1803660	870535	893700	333360	156222	ELT1222893		
Field Parameters																						
pH (Field)																						
Dissolved Oxygen																						
Nitrate as NO <sub>3</sub> -P																						
Phosphate as PO <sub>4</sub> -P																						
Unassigned																						
Phosphorus total (P <sub>tot</sub> )																						
Organics																						
pH (Lab)																						0.8
pH (Sec)																						2.55
Spectrophotometry (lab)																						22
Discovet M18 (lab) (filtered)																						
Rec(Lab)																						
Temperature																						
Conductivity																						
Total Dissolved Solids																						
Total Dissolved Solids (filtered)																						
Total Dissolved Solids @ 180°C																						
Total suspended solids																						
Cyanide																						
Cyanide (total)																						
Alkalinity (Calcium)																						
Alkalinity (Carbonate)																						
Alkalinity (Total)																						
Hardness (Calcium)																						
Hardness (Total)																						
Major Ions																						
Calcium																						
Calcium (filtered)																						
Magnesium																						
Magnesium (filtered)																						
Potassium																						
Potassium (filtered)																						
Sodium																						
Sodium (filtered)																						
Cyanide																						
Sulfate																						
Sulfate (filtered)																						
Sulfate (total)																						
Fluoride																						
Chloride																						
Chloride (total)																						
Acidity (total)																						
Acidity (total)																						
Microions																						
Bicarbonate (HCO <sub>3</sub> <sup>-</sup> )																						
Carbonate																						
Nitrate (as N)																						
Nitrate (as N)																						
Nitrogen (as NO <sub>3</sub> -) (as N)																						
Nitrogen (total) (as N)																						
Arsenic (total)																						
Nitrate (as NO <sub>3</sub> -)																						
Nitrogen (as N)																						
Phosphate (as P)																						
Phosphorus (total)																						
Lead																						
Arsenic (filtered)																						
Cadmium (filtered)																						
Chromium (VI) (filtered)																						
Chromium (total)																						
Copper (filtered)																						
Iron (filtered)																						
Lead (filtered)																						
Mercury (filtered)																						
Nickel (filtered)																						
Selenium (filtered)																						
Silver (filtered)																						
Zinc (filtered)																						

Comments  
 #1 Cyanide as un-ionised HCN, measured as (CN)<sub>2</sub>  
 #2 Measured as NH<sub>3</sub>-N at pH 8  
 #3 Values taken from "Updating nitrate toxicity eff  
 #4 In absence of total As guideline, As (V) guideline  
 #5 In absence of total Cr guideline, Cr (VI) guideline  
 #6 Free Cyanide trigger level  
 #7 Trigger corrected Sep 2002. <https://www.mie.gov.au>  
 #8 As (V) used as conservative value  
 #9 Chromium VI value has been used as indicator

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Parameter	Unit	Baseline					Impact					Baseline					Impact				
		18F02023	18Apr2023	27Oct2013	27Oct2013	18F02019	25Nov2020	08F02021	18F02022	18Nov2022	18F02023	18Apr2023	27Oct2013	27Oct2013	18F02019	25Nov2020	08F02021	18F02022	18Nov2022	18F02023	18Apr2023
<b>Field Parameters</b>																					
pH(Field)	pH																				
Dissolved Oxygen	mg/L																				
Nitrate as Nitrogen (NO3-N)	mg/L																				
Phosphate as Phosphorus (PO4-P)	mg/L																				
Unassigned Phosphate as Phosphorus (P205)	mg/L																				
<b>Inorganics</b>																					
pH(Lab)	pH																				
Ammonia	mg/L																				
Ammonium	mg/L																				
Sulfate as Sulfur (SO4-S)	mg/L																				
Dissolved Manganese (Mn)	mg/L																				
Reactive Phosphorus	mg/L																				
Temperature	°C																				
Turbidity	NTU																				
Total Dissolved Solids (TDS)	mg/L																				
Total Dissolved Solids (Filtered)	mg/L																				
Total Dissolved Solids @ 180°C	mg/L																				
Total Suspended Solids	mg/L																				
<b>Cyanide</b>																					
Cyanide (Total)	mg/L	0.7								0.8										0.2	
<b>Heavy Metals</b>																					
Aluminum (Al)	mg/L																				
Barium (Ba)	mg/L																				
Cadmium (Cd)	mg/L																				
Chromium (Cr)	mg/L																				
Copper (Cu)	mg/L																				
Lead (Pb)	mg/L																				
Manganese (Mn)	mg/L																				
Mercury (Hg)	mg/L																				
Nickel (Ni)	mg/L																				
Selenium (Se)	mg/L																				
Zinc (Zn)	mg/L																				
<b>Major Ions</b>																					
Calcium	mg/L																				
Chloride (Cl)	mg/L																				
Magnesium	mg/L																				
Potassium	mg/L																				
Sodium	mg/L																				
Sulfate	mg/L																				
Total Hardness	mg/L																				
Calcium Chloride	mg/L																				
Calcium Sulfate	mg/L																				
Calcium Nitrate	mg/L																				
Calcium Bicarbonate	mg/L																				
Calcium Chloride	mg/L																				
Calcium Sulfate	mg/L																				
Calcium Nitrate	mg/L																				
Calcium Bicarbonate	mg/L																				
<b>Minor Ions</b>																					
Bicarbonate Ion (HCO3-)	mg/L																				
Carbonate Ion	mg/L																				
Nitrate (as N)	mg/L																				
Nitrite (as N)	mg/L																				
Nitrogen (as Nitrate)	mg/L																				
Nitrogen (Total)	mg/L																				
Nitrate as Nitrogen (NO3-N)	mg/L																				
Nitrite as Nitrogen (NO2-N)	mg/L																				
Nitrogen (Ammonia)	mg/L																				
Phosphate (Total)	mg/L																				
<b>Trace</b>																					
Antimony	mg/L																				
Barium	mg/L																				
Chromium (VI)	mg/L																				
Chromium (Total)	mg/L																				
Copper	mg/L																				
Iron	mg/L																				
Lead	mg/L																				
Mercury	mg/L																				
Manganese	mg/L																				
Nickel	mg/L																				
Selenium	mg/L																				
Silver	mg/L																				
Zinc	mg/L																				

Comments  
 #1 Cyanide as un-ionised HCN, measured as (CN)  
 #2 Measured as NH3-NatpH8  
 #3 Values taken from "Updating nitrate toxicity eff  
 #4 In absence of total As guideline, As(V) guideline  
 #5 In absence of total Cr guideline, Cr(VI) guideline  
 #6 Free Cyanide trigger level  
 #7 Trigger corrected Sep 2002. <https://www.mie.qld.gov.au/used-as-conservative-value>  
 #8 As(V) used as conservative value  
 #9 Chromium VI value has been used as indicator

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Parameters	Boggy 1P:01										Boggy 1P:02									
	Baseline		20Nov2018		20Nov2018		20Nov2018		20Nov2018		Baseline		20Nov2018		20Nov2018		20Nov2018		20Nov2018	
	260-12015	471470	18-09-219	670279	683806	933587	956223	EM2222893	23-11-006	ET-1230697	ET-11401293	471470	18-09-219	670279	683806	933587	956223	EM2222893	23-11-006	
Field Parameters																				
pH(Field)																				
Dissolved Oxygen																				
Nitrate as Nitrogen (NO3-N)																				
Phosphate as Phosphorus (PO4-P)																				
Unassigned																				
Phosphate as Phosphorus (P205)																				
Acidity																				
Alkalinity (as CaCO3)																				
Calcium																				
Magnesium																				
Sulfate																				
Chloride																				
Total Dissolved Solids (TDS)																				
Total Suspended Solids (TSS)																				
Cyanide (Total)																				
Cyanide (Total)																				
Major Ions																				
Calcium																				
Magnesium																				
Sulfate																				
Chloride																				
Carbonate																				
Bicarbonate																				
Nitrate																				
Nitrite																				
Ammonia																				
Ammonium																				
Fluoride																				
Calcium Total																				
Aluminum Total																				
Iron																				
Carbonate Ion (HCO3-)																				
Carbonate Ion																				
Nitrate (as N)																				
Nitrite (as N)																				
Nitrogen (as Nitrate) (NO3-N)																				
Nitrogen (Total)																				
Nitrogen (as Ammonia) (NH4-N)																				
Nitrate (as NO3-)																				
Nitrogen (as Ammonia)																				
Phosphate (as P)																				
Phosphorus (Total)																				
Vanadium																				
Asenic (Filtered)																				
Cadmium (Filtered)																				
Chromium (VI) (Filtered)																				
Chromium (Total)																				
Copper (Filtered)																				
Iron (Filtered)																				
Lead (Filtered)																				
Mercury (Filtered)																				
Nickel (Filtered)																				
Selenium (Filtered)																				
Silver (Filtered)																				
Zinc (Filtered)																				

Comments  
 #1 Cyanide as un-ionised HCN, measured as (CN)  
 #2 Measured as NH3-NatpH8  
 #3 Values taken from "Updating nitrate toxicity eff  
 #4 In absence of total As guideline, As(V) guideline  
 #5 In absence of total Cr guideline, Cr(VI) guideline  
 #6 Free Cyanide trigger level  
 #7 Trigger corrected Sep 2002. <https://www.mie.qld.gov.au/usedas/conservativevalue>  
 #8 As(V) used as conservative value  
 #9 Chromium VI value has been used as indicator

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Analytical Results

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Field Parameters	Units	Results									
		Baseline 14 Feb 2018 18-09131	25 Nov 2020 870279	09 Feb 2021 893908	23 Nov 2021 933587	19 Feb 2022 966223	19 Nov 2022 EL12222863	19 Feb 2023 23-14906	18 Apr 2023 EL12309967	17 Nov 2023 EM2222863	18 Apr 2023 EM2309967
*Dissolved Oxygen	mg/L										
*Nitrate as N (NO3-N)	mg/L										
*Phosphate as Phosphorus (P)	mg/L										
Unassigned											
*Phosphate as Phosphorus (P) (lab)	mg/L										
pH (lab)	pH										
pH (field)	pH										
*Electrical Conductivity (lab)	µS/cm	29			269	206	299				
*Dissolved Manganese (lab) (filtered)	mg/L	8.52		11.91	11.5	8.59					
Residual Chlorine	mg/L				47.1	11.1	1.02				
Temperature	°C			18.4	10.3	7.9	11.9				
Turbidity	NTU	0.4	0.4	0.4	0.3	0.4					
Total Dissolved Solids	mg/L	27									
Total Dissolved Solids (filtered)	mg/L										
Total Dissolved Solids @ 180°C	mg/L										
Total Suspended Solids	mg/L										
Cyanide (total)	mg/L								0.2		
Acidity (as CaCO3)	mg/L										
*Acidity (Bicarbonate as CaCO3)	mg/L										
*Acidity (Total as CaCO3)	mg/L										
*Acidity (Total as CaCO3)	mg/L										
*Acidity (Total as CaCO3)	mg/L										
Major Ions											
*Calcium	mg/L										
*Calcium (filtered)	mg/L										
*Magnesium	mg/L										
*Magnesium (filtered)	mg/L										
*Potassium	mg/L										
*Potassium (filtered)	mg/L										
*Sodium	mg/L										
*Sodium (filtered)	mg/L										
*Chloride	mg/L										
*Sulfate	mg/L										
*Sulfate (filtered)	mg/L										
*Sulfate (as SO4)	mg/L										
*Fluoride	mg/L										
*Calcium, total	mg/L	0.19					0.44		0.19	0.14	0.37
*Anions, total	mg/L	0.24					0.75		0.36	0.22	0.60
Trace Ions											
*Bicarbonate Ion (HCO3-)	mg/L										
*Carbonate Ion	mg/L										
*Nitrate (as N)	mg/L								<0.01	0.20	<0.01
*Nitrite (as N)	mg/L								0.22	0.20	0.41
*Nitrogen (as N) (total) (as N)	mg/L	0.17	0.09	0.09	0.4	0.4	0.14	0.14	0.17	0.17	0.17
*Nitrogen (total) (as N)	mg/L	0.4	0.2	0.2	0.3	0.3	0.4	0.4	0.2	0.4	0.4
*Ammonia Nitrogen (total)	mg/L	0.3		0.1	0.2	0.4	0.1	0.2			
*Nitrate (as NO3-)	mg/L		0.07			0.09					
*Nitrogen (organic)	mg/L										
*Phosphate (as P)	mg/L										
*Phosphorus (total)	mg/L										
Trace Metals											
*Arsenic (filtered)	mg/L								<0.001		
*Cadmium (filtered)	mg/L								<0.001		
*Chromium (VI) (filtered)	mg/L								<0.001		
*Cromium (hexavalent)	mg/L										
*Copper (filtered)	mg/L										
*Iron (filtered)	mg/L										
*Lead (filtered)	mg/L	<0.001							<0.001		<0.001
*Mercury (filtered)	mg/L	<0.001							<0.001		<0.001
*Manganese (filtered)	mg/L										
*Nickel (filtered)	mg/L										
*Selenium (filtered)	mg/L										
*Silver (filtered)	mg/L										
*Zinc (filtered)	mg/L										

Comments  
 #1 Cyanide as un-ionised HCN, measured as (CN)  
 #2 Measured as NH3-N at pH 8  
 #3 Values taken from "Updating nitrate toxicity eff  
 #4 In absence of total As guideline, As(V) guideline  
 #5 In absence of total Cr guideline, Cr(VI) guideline  
 #6 Free Cyanide trigger level  
 #7 Trigger corrected Sep 2002. <https://www.mie.>  
 #8 As(V) used as conservative value  
 #9 Chromium VI value has been used as indicator

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Table 2  
RPO Results

Location Code		SW1.1 (Boggy 1 pu 1)		SW_D1	SW1.1 (Boggy 1 pu 1)		SW_D2	BH06		BH06	BH06		GW_D2	BH06	
Field ID	Date	SW1.1 (Boggy 1 pu 1)	SW_D1	SW1.1 (Boggy 1 pu 1)	SW_D2	BH06	GW_D1	BH06	GW_D2	BH06	GW_D2	BH06	GW_D2	BH06	GW_D2
	15 Nov 2022	15 Nov 2022	15 Nov 2022	21 Nov 2022	21 Nov 2022	17 Nov 2022	17 Nov 2022	17 Nov 2022	17 Nov 2022	17 Nov 2022	21 Nov 2022	17 Nov 2022	21 Nov 2022	17 Nov 2022	21 Nov 2022
	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
	Normal	Field D	Normal	Interim D	Normal	Field D	Normal	Field D	Normal	Field D	Normal	Field D	Normal	Interim D	
Lab Report Number	EM2222893	EM2222893	EM2222893	943114	EM2222893	943114	EM2222893	EM2222893	EM2222893	EM2222893	943114	EM2222893	943114	EM2222893	943114
			RPD			RPD									RPD
Field Parameters	Unit	EQL													
pH (Field)	pH units														
Redox (Field)	mv	1						200						410	
NA															
Dissolved Oxygen	mg/L	0.01	9.7	10.2	5	9.7	9.2	5	10.4	10.2	2	10.4	9.0	14	
Nitrate as Nin ASLP 5.0	mg/L														
Phosphorus reactive (as P)	MG/L	0.01													
Unassigned															
Phosphorus total (P2O5)	µg/L														
Inorganics															
pH (Lab)	pH units	0.01	6.58	6.58	0	6.58	6.8	3	6.02	5.04	18	6.02	6.4	6	
pH Redox	pH units	0.01	6.89	6.93	1	6.89			5.79	5.55	4	5.79			
Electrical conductivity (lab)	µSiem	1	18	17	6	18	18	0	32	32	0	32	31		
Dissolved Oxygen (Lab) (filtered)	mg/L														
Redox (Lab)	mV	0.1	224	239	6	224			256	295	14	256			
Temperature															
Turbidity	NTU	0.1	3.7	4.8	26	3.7			7.9	5.2	41	7.9			
Total Dissolved Solids	mg/L	5	36	35	3	36	32	12	27	27	0	27	46	52	
Total Dissolved Solids (filtered)	mg/L	5													
Total Dissolved Solids@ 180°C	mg/L														
Total Suspended Solids	mg/L														
Cyanide															
Cyanide (Total)	mg/L														
Acidity & Alkalinity															
Alkalinity (Carbonate as CaCO3)	mg/L	1	<1	<1	0	<1	<10	0	<1	<1	0	<1	<10		
Alkalinity (Bicarbonate as CaCO3)	mg/L	1	5	5	0	5	<20	0	2	<1	67	2	<20		
Alkalinity (Bicarbonate)	mg/L														
Alkalinity (Hydroxide as CaCO3)	mg/L	1	<1	<1	0	<1	<20	0	<1	<1	0	<1	<20		
Alkalinity (total as CaCO3)	mg/L	1	5	5	0	5	<20	0	2	<1	67	2	<20		
Hardness as CaCO3	mg/L														
Major Ions															
Calcium	mg/L	0.1					0.7						1.6		
Calcium (filtered)	mg/L	0.1	1	<1	0	1			2	2	0	2			
Magnesium	mg/L	0.1					<0.5						0.6		
Magnesium (filtered)	mg/L	0.1	<1	<1	0	<1			<1	<1	0	<1			
Potassium	mg/L	0.1					<0.5						<0.5		
Potassium (filtered)	mg/L	0.1	<1	<1	0	<1			<1	<1	0	<1			
Sodium	mg/L	0.1					1.1						1.4		
Sodium (filtered)	mg/L	0.1	2	2	0	2			2	2	0	2			
Chloride	mg/L	1	1	<1	0	1	<1	0	1	1	0	1	<1		
Sulfate	mg/L	1					<5						<5		
Sulfate (filtered)	mg/L	1	<1	<1	0	<1			<1	<1	0	<1			
Sulfate ass	mg/L	5													
Cations Total	meq/L	0.01	0.14	0.09	43	0.14			0.19	0.19	0	0.19			
Anions Total	meq/L	0.01	0.13	0.10	26	0.13			0.07	0.03	80	0.07			
Tonic Balance	%	0.01													
Minor Ions															
Bicarbonate ion (HCO3-)	mg/L														
Carbonate ion	mg/L														
Nutrients															
Ammonia as N	mg/L	0.01													
Nitrate (as N)	mg/L	0.01	0.22	0.22	0	0.22			2.13	2.13	0	2.13			
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	0	<0.01			<0.01	<0.01	0	<0.01			
Nitrogen (Total Oxidised) (as N)	mg/L	0.01	0.22	0.22	0	0.22			2.13	2.13	0	2.13			
Nitrogen (Total)	mg/L	0.1	0.2	0.3	40	0.2	0.4	67	2.9	2.5	15	2.9	2.1	32	
Kjeldahl Nitrogen Total	mg/L	0.1	<0.1	0.1	0	<0.1			0.8	0.4	67	0.8			
Nitrate (as NO3-)	mg/L														
Nitrogen (Organic)	mg/L	0.2													
Phosphate total (P)	mg/L	0.05													
Phosphorus (Total)	mg/L	0.01	<0.01	<0.01	0	<0.01	<0.01	0	<0.01	<0.01	0	<0.01	<0.01		
Metals															
Arsenic (filtered)	mg/L	0.001													
Cadmium (filtered)	mg/L	0.0001													
Chromium (III+VI) (filtered)	mg/L	0.001													
Copper (filtered)	mg/L	0.001													
Iron (filtered)	mg/L	0.05													
Lead (filtered)	mg/L	0.001													
Mercury (filtered)	mg/L	0.0001													
Molybdenum (filtered)	mg/L	0.001													

**OFFICIAL**  
**Appendix E**  
**Table 2**  
**RPO Results**

Mt Buller RMB

Location Code		SW1.1 (Boggy 1 pu 1)		SW1.1 (Boggy 1 pu 1)		BH06		BH06	
Field ID	SW_D1	SW_D1	SW-D2	SW-D2	BH06	GW_D1	BH06	GW-D2	
Date	15 Nov 2022	15 Nov 2022	15 Nov 2022	21 Nov 2022	17 Nov 2022	17 Nov 2022	17 Nov 2022	21 Nov 2022	
Matrix Type	Water	Water	Water	Water	Water	Water	Water	Water	
Sample Type	Normal	Field D	Normal	Interl D	Normal	Field D	Normal	Interl D	
Lab Report Number	EM2222893	EM2222893	EM2222893	943114	EM2222893	EM2222893	EM2222893	943114	
	Unit	EQL							
Nickel (filtered)	mg/L	0.001							
Selenium (filtered)	mg/L	0.01							
Silver (filtered)	mg/L	0.001							
Tin (filtered)	mg/L	0.005							

OFFICIAL  
Appendix E  
Table 2  
RPO Results

Mt Buller RMB

	Unit	Boggy 2		RPD	Boggy 2		RPD	BH06		RPD	BH06		RPD	Boggy 2		RPD
		SW-D1	SW-D1		SW-D2	SW-D2		GW-D1	GW-D1		GW-D2	GW-D2		SW-D1	SW-D1	
		15 Feb 2023	15 Feb 2023		15 Feb 2023	15 Feb 2023		16 Feb 2023	16 Feb 2023		16 Feb 2023	16 Feb 2023		18 Apr 2023	18 Apr 2023	
		Water	Water		Water	Water		Water	Water		Water	Water		Water	Water	
		23-14906	23-14906		23-14906	966000		23-14906	23-14906		23-14906	966000		EM2306987	EM2306987	
Field Parameters																
pH (Field)	pH units															
Redox (Field)	mv															
NA																
Dissolved Oxygen	mg/L															
Nitrate as Nin ASLP 5.0	mg/L															
Phosphorus reactive (as P)	MG/L													<0.01	0.01	
Unassigned																
Phosphorus total (P2O5)	µg/L	80	80	0	80			<50	60	18	<50					
Inorganics																
pH (Lab)	pH units													6.35	6.30	
pH Redox	pH units															
Electrical conductivity (lab)	µSiem	26	26	0	26	27	4	57	54	5	57	54	5	25	25	
Dissolved Oxygen (Lab) (filtered)	mg/L															
Redox (Lab)	mv															
Temperature																
Turbidity	NTU	<0.1	<0.1	0	<0.1	<1	0	29	27	7	29	11	90	19	17	11
Total Dissolved Solids	mg/L					28						42				
Total Dissolved Solids (filtered)	mg/L															
Total Dissolved Solids@ 180°C	mg/L	12	15	22	12			35	32	9	35					
Total Suspended Solids	mg/L													<5	<5	
Cyanide																
Cyanide (Total)	mg/L	<0.1	<0.1	0	<0.1			5.7	6	5	5.7					
Acidity & Alkalinity																
Alkalinity (Carbonate as CaCO3)	mg/L	<2	<2	0	<2	<10	0	<2	<2	0	<2	<10	0	<1	<1	
Alkalinity (Bicarbonate as CaCO3)	mg/L	10	9	11	10	140	173	<2	<2	0	<2	88	191	14	26	60
Alkalinity (Bicarbonate)	mg/L															
Alkalinity (Hydroxide as CaCO3)	mg/L	<2	<2	0	<2			<2	<2	0	<2			<1	<1	
Alkalinity (total as CaCO3)	mg/L	10	9	11	10			<2	<2	0	<2			14	26	60
Hardness as CaCO3	mg/L							<2	<2	0	<2			5	5	0
Major Ions																
Calcium	mg/L	1.3	1.2	8	1.3	1.8	32	2.1	2.1	0	2.1	3.0	35			
Calcium (filtered)	mg/L															
Magnesium	mg/L	0.4	0.4	0	0.4	0.7	55	0.8	0.9	12	0.8	1.4	55			
Magnesium (filtered)	mg/L															
Potassium	mg/L	0.1	0.1	0	0.1	<0.5	0	0.4	0.5	22	0.4	0.8	40	<1	<1	
Potassium (filtered)	mg/L															
Sodium	mg/L	1.5	1.5	0	1.5	2.1	33	1.5	1.6	6	1.5	2.3	42	<1	<1	
Sodium (filtered)	mg/L															
Chloride	mg/L	2	1	67	2	<1	67	2	2	0	2	<1	67			67
Sulfate	mg/L	<1	<1	0	<1	<5	0	<1	<1	0	<1	<5	0			
Sulfate (filtered)	mg/L															
Sulfate ass	mg/L															
Cations Total	meq/L													0.19	0.19	0
Anions Total	meq/L													0.35	0.59	48
Tonic Balance	%															
Minor Ions																
Bicarbonate ion (HCO3-)	mg/L															
Carbonate ion	mg/L															
Nutrients																
Ammonia as N	mg/L					<0.01						<0.01		<0.01	<0.01	0
Nitrate (as N)	mg/L	0.09	0.09	0	0.09	0.04	77	5.1	5.4	6	5.1	3.6	34	0.22	0.21	5
Nitrite (as N)	mg/L					<0.02						<0.02		<0.01	0.01	0
Nitrogen (Total Oxidised) (as N)	mg/L	0.1	0.1	0	0.1	0.05	67	5.1	5.4	6	5.1	3.6	34	0.22	0.22	0
Nitrogen (Total)	mg/L					0.55						6.4		0.4	0.3	29
Kjeldahl Nitrogen Total	mg/L	<0.1	<0.1	0	<0.1	0.5	133	0.6	0.7	15	0.6	2.8	129	0.2	0.1	67
Nitrate (as NO3-)	mg/L															
Nitrogen (Organic)	mg/L											2.8				
Phosphate total (P)	mg/L															
Phosphorus (Total)	mg/L					<0.01						<0.01		0.01	0.02	67
Metals																
Arsenic (filtered)	mg/L													<0.001	<0.001	
Cadmium (filtered)	mg/L													<0.0001	<0.0001	
Chromium (III+VI) (filtered)	mg/L													<0.001	<0.001	
Copper (filtered)	mg/L													<0.001	<0.001	
Iron (filtered)	mg/L													<0.001	<0.001	
Lead (filtered)	mg/L													<0.001	<0.001	
Mercury (filtered)	mg/L													<0.0001	<0.0001	
Molybdenum (filtered)	mg/L													<0.0001	<0.0001	



**OFFICIAL**  
Appendix E  
Table 2  
RPO Results

Mt Buller RMB

Boggy 2	SW-D1		Boggy 2			BH06	GW-D1		BH06	BH06		Boggy 2	SW-D1	
Boggy 2	SW-D1		Boggy 2	SW-D2		BH06	GW-D1		BH06	GW-D2		Boggy 2	SW-D1	
15 Feb 2023	15 Feb 2023		15 Feb 2023	15 Feb 2023		16 Feb 2023	16 Feb 2023		16 Feb 2023	16 Feb 2023		18 Apr 2023	18 Apr 2023	
Water	Water		Water	Water		Water	Water		Water	Water		Water	Water	
Normal	Field D		Normal	Interlig D		Normal	Field D		Normal	Interlig D		Normal	Field D	
23-14906	23-14906	RPD	23-14906	966000	RPD	23-14906	23-14906	RPD	23-14906	966000	RPD	EM2306987	EM2306987	RPD

Unit														
Nickel (filtered)	mg/L												<0.001	<0.001
Selenium (filtered)	mg/L													
Silver (filtered)	mg/L													
Tin (filtered)														
Zinc (filtered)	mg/L												<0.005	<0.005

**OFFICIAL**  
Appendix E  
**Table 2**  
**RPO Results**

Mt Buller RMB

	Unit	Boggy 2			BH16			BH16		
		SW-D2		RPD	GW-D1		RPD	GW-D2		
		18 Apr 2023			19 Apr 2023			19 Apr 2023		
		Water			Water			Water		
Normal		Normal		Normal		Normal				
		Interla <sub>3</sub> D		EM2306987	Field D		EM2306987	Interla <sub>3</sub> D		
		983641		EM2306987	EM2306987		EM2306987	983641		
Field Parameters										
pH (Field)	pH units									
Redox (Field)	mv									
NA										
Dissolved Oxygen	mg/L									
Nitrate as Nin ASLP 5.0	mg/L									
Phosphorus reactive (as P)	MG/L	<0.01	<0.01	0	0.01	<0.01	0	0.01	0.01	
Unassigned										
Phosphorus total (P2O5)	µg/L									
Inorganics										
pH (Lab)	pH units	6.36	7.4	15	6.00	6.03	0	6.00	7.0	15
pH Redox	pH units									
Electrical conductivity (lab)	µSiem	25	25	0	17	17	0	17	19	11
Dissolved Oxygen (Lab) (filtered)	mg/L									
Redox (Lab)	mv									
Temperature										
Turbidity	NTU									
Total Dissolved Solids	mg/L	19	46	83	42	30	33	42	34	21
Total Dissolved Solids (filtered)	mg/L									
Total Dissolved Solids@ 180°C	mg/L									
Total Suspended Solids	mg/L	<5	<5	0	61	54	12	61	86	34
Cyanide										
Cyanide (Total)	mg/L									
Acidity & Alkalinity										
Alkalinity (Carbonate as CaCO3)	mg/L	<1			<1	<1	0	<1		
Alkalinity (Bicarbonate as CaCO3)	mg/L	14			3	4	29	3		
Alkalinity (Bicarbonate)	mg/L									
Alkalinity (Hydroxide as CaCO3)	mg/L	<1			<1	<1	0	<1		
Alkalinity (total as CaCO3)	mg/L	14	<20	0	3	4	29	3	23	154
Hardness as CaCO3	mg/L	5	7.3	37	<1	<1	0	<1	<5	0
Major Ions										
Calcium	mg/L		1.8						0.9	
Calcium (filtered)	mg/L	2			<1	<1	0	<1		
Magnesium	mg/L		0.7						<0.5	
Magnesium (filtered)	mg/L	<1			<1	<1	0	<1		
Potassium	mg/L		<0.5						<0.5	
Potassium (filtered)	mg/L	<1			<1	<1	0	<1		
Sodium	mg/L		1.6						1.7	
Sodium (filtered)	mg/L	2			2	2	0	2		
Chloride	mg/L	2	<1	67	1	<1	0	1	<1	
Sulfate	mg/L		<5						<5	
Sulfate (filtered)	mg/L	1			<1	1	0	<1		
Sulfate ass	mg/L									
Cations Total	meq/L	0.19			0.09	0.09	0	0.09		
Anions Total	meq/L	0.36			0.09	0.10	11	0.09		
Tonic Balance	%				0.66			0.66		
Minor Ions										
Bicarbonate ion (HCO3-)	mg/L									
Carbonate ion	mg/L									
Nutrients										
Ammonia as N	mg/L	<0.01			0.10	0.08	22	0.10		
Nitrate (as N)	mg/L	0.22	0.20	10	0.74	0.72	3	0.74	0.77	4
Nitrite (as N)	mg/L	<0.01	<0.02	0	<0.01	<0.01	0	<0.01	<0.02	0
Nitrogen (Total Oxidised) (as N)	mg/L	0.22			0.74	0.72	3	0.74		
Nitrogen (Total)	mg/L	0.4			0.9	0.9	0	0.9		
Kjeldahl Nitrogen Total	mg/L	0.2	<0.2	0	0.2	0.2	0	0.2	<0.2	
Nitrate (as NO3-)	mg/L									
Nitrogen (Organic)	mg/L									
Phosphate total (P)	mg/L									
Phosphorus (Total)	mg/L	0.01	0.02	67	0.08	0.10	22	0.08	0.02	120
Metals										
Arsenic (filtered)	mg/L	<0.001	<0.001	0	<0.001	<0.001	0	<0.001	<0.001	
Cadmium (filtered)	mg/L	<0.0001	<0.0002	0	<0.0001	<0.0001	0	<0.0001	<0.0002	
Chromium (III+VI) (filtered)	mg/L	<0.001	<0.001	0	<0.001	<0.001	0	<0.001	<0.001	
Copper (filtered)	mg/L	<0.001	<0.001	0	0.010	0.008	22	0.010	0.006	50
Iron (filtered)	mg/L									
Lead (filtered)	mg/L	<0.001	<0.001	0	<0.001	<0.001	0	<0.001	<0.001	
Mercury (filtered)	mg/L	<0.0001	<0.0001	0	<0.0001	<0.0001	0	<0.0001	<0.0001	
Molybdenum (filtered)	mg/L									



Appendix E  
Table 2  
RPD Results

MI Euler RMB

	Biosyn 2		SH16		SH16		SH16		SH16	
	18 Apr 2023	18 Apr 2023	19 Apr 2023	19 Apr 2023	19 Apr 2023	19 Apr 2023	19 Apr 2023	19 Apr 2023	19 Apr 2023	19 Apr 2023
	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
	Normal	Interface, D	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Interface, D
	E/M2206987	883641	E/M2206987	E/M2206987	E/M2206987	E/M2206987	E/M2206987	E/M2206987	E/M2206987	883641
	RPD	RPD	RPD	RPD	RPD	RPD	RPD	RPD	RPD	RPD
	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (Filtered)	mg/L									
Selenium (Filtered)	mg/L									
Silver (Filtered)	mg/L									
Tin (Filtered)	mg/L									
Zinc (Filtered)	mg/L									
		<0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
		0	0	0	0	0	0	0	0	0

# Appendix F

## Laboratory Reports

**Eurofins Environment Testing Australia Pty Ltd**

ABN: 50 005 085 521

<b>Melbourne</b> 6 Monterey Road Dandenong South VIC 3175 Tel: +61 3 8564 5000 NATA# 1261 Site# 1254	<b>Geelong</b> 19/8 Lewalan Street Grovedale VIC 3216 Tel: +61 3 8564 5000 NATA# 1261 Site# 1254	<b>Sydney</b> 179 Magowar Road Girraween NSW2145 Tel: +61 2 9900 8400 NATA# 1261 Site# 18217
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<b>Canberra</b> Unit 1.2 Dacre Street Mitchell ACT 2911 Tel: +61261138091	<b>Brisbane</b> 1/21 Smallwood Place Murarrie QLD 4172 Tel: +61739024600 NATA# 1261 Site# 20794	<b>Newcastle</b> 4/52 Industrial Drive Mayfield East NSW 2304 PO Box 60 Wickham 2293 Tel: +61249688448 NATA# 1261 Site# 25079
---	--	--

**Eurofins ARL Pty Ltd**

ABN: 91 05 0159 898

<b>Perth</b> 46-48 Banksia Road Welshpool WA6106 Tel: +61 8 6253 4444 NATA# 2377 Site# 2370
--

**Eurofins Environment Testing NZ Ltd**

NZBN: 9429046024954

<b>Auckland</b> 35 O'Rorke Road Penrose, Auckland 1061 Tel: +64 9 526 45 51 IANZ# 1327	<b>Christchurch</b> 43 Detroit Drive Rolleston, Christchurch 7675 Tel: 0800 856 450 IANZ# 1290
---	---

## Sample Receipt Advice

<b>Company name:</b>	GHD Pty Ltd VIC
<b>Contact name:</b>	Meg Turner
<b>Project name:</b>	Not provided
<b>Project ID:</b>	12565989
<b>Turnaround time:</b>	5 Day
<b>Date/Time received</b>	Nov 21, 2022 2:20 PM
<b>Eurofins reference</b>	943114

## Sample Information

- / A detailed list of analytes logged into our LIMS, is included in the attached summary table.
- / All samples have been received as described on the above COC.
- / COC has been completed correctly.
- / Attempt to chill was evident.
- / Appropriately preserved sample containers have been used.
- / All samples were received in good condition.
- / Samples have been provided with adequate time to commence analysis in accordance with the relevant holding times.
- / Appropriate sample containers have been used.
- / Sample containers for volatile analysis received with zero headspace.
- X Split sample sent to requested external lab.
- X Some samples have been subcontracted.
- N/A Custody Seals intact (if used).

## Notes

## Contact

If you have any questions with respect to these samples, please contact your Analytical Services Manager:

**Harry Bacalis on phone : or by email: [HarryBacalis@eurofins.com](mailto:HarryBacalis@eurofins.com)**

Results will be delivered electronically via email to Meg Turner - [meg.turner@ghd.com](mailto:meg.turner@ghd.com).

*Note: A copy of these results will also be delivered to the general GHD Pty Ltd VIC email address.*





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NSW 2145
Tel: +61 2 9900 8400
NATA# 1261 Site# 18217

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Murarrie
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NATA# 1261 Site# 20794

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Penrose,
Auckland 1061
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IANZ# 1327

Christchurch
43 Detroit Drive
Rolleston,
Christchurch 7675
Tel: 0800 856 450
IANZ# 1290

Company Name: GHD Ply Ltd VIC
Address: Level 8, 180 Lonsdale St
Melbourne
VIC 3000

Order No.: 12565989
Report#: 943114
Phone: 8687 8000
Fax: 8687 8111

Received: Nov 21, 2022 2:20 PM
Due: Nov 28, 2022
Priority: 5 Day
Contact Name: Meg Turner

Project Name:
Project ID: 12565989

Eurofins Analytical Services Manager : Harry Bacalis

Table with columns for Sample ID, Sample Date, Sampling Time, Matrix, LABID and Test Counts. Includes a large 'Sample Detail' section and a 'Test Counts' section at the bottom.

GHD Melbourne  
 Level 8, 180 Lonsdale St  
 Melbourne  
 VIC 3000



NATA Accredited  
 Accreditation Number 1261  
 Site Number 1254

Accredited for compliance with ISO/IEC 17025 - Testing  
 NATA is a signatory to the ILAC Mutual Recognition  
 Arrangement for the mutual recognition of the  
 equivalence of testing, medical testing, calibration,  
 inspection, proficiency testing scheme providers and  
 reference materials producers reports and certificates.

Attention: Meg Turner

Report 943114-W  
 Project name  
 Project ID 12565989  
 Received Date Nov 21, 2022

Client Sample ID			SW-D2	GW-D2
Sample Matrix			Water	Water
Eurofins Sample No.			M22- No0050257	M22- No0050258
Date Sampled			Nov 21, 2022	Nov 21, 2022
TesUReference	LOR	Unit		
Chloride		mg/L	< 1	< 1
Conductivity (at 25 °C)	10	uS/cm	18	31
Dissolved Oxygen	0.01	mg/L	9.2	9.0
pH (at 25 °C)	0.1	pH Units	6.8	6.4
Phosphate total (as P)	0.01	mg/L	< 0.01	< 0.01
Redox Potential mV (relative to Ag/AgCl)	1	mV	200	410
Sulphate (as SO4)	5	mg/L	<5	<5
Total Dissolved Solids Dried at 180 °C ± 2 °C	10	mg/L	32	46
Total Nitrogen (as N)	0.2	mg/L	0.4	2.1
<b>Alkalinity (speciated)</b>				
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	< 20	< 20
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	< 20	< 20
<b>Alkali Metals</b>				
Calcium	0.5	mg/L	0.7	1.6
Magnesium	0.5	mg/L	< 0.5	0.6
Potassium	0.5	mg/L	< 0.5	< 0.5
Sodium	0.5	mg/L	1.1	1.4

**Sample History**

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
<b>Eurofins Suite B11E: Cl/SO4/Alkalinity</b>			
<b>Chloride</b> - Method: LTM-INO-4090 Chloride by Discrete Analyser	Melbourne	Nov 22, 2022	28 Days
<b>Sulphate (as SO4)</b> - Method: LTM-INO-4110 Sulfate by Discrete Analyser	Melbourne	Nov 22, 2022	28 Days
<b>Alkalinity (speciated)</b> - Method: LTM-INO-4250 Alkalinity by Electrometric Titration	Melbourne	Nov 22, 2022	14 Days
<b>Conductivity (at 25 °C)</b> - Method: LTM-INO-4030 Conductivity	Melbourne	Nov 22, 2022	28 Days
<b>Dissolved Oxygen</b> - Method: APHA 4500-0 B, C, G using Dissolved Oxygen analyser	Melbourne	Nov 23, 2022	28 Days
<b>pH (at 25 °C)</b> - Method: LTM-GEN-7090 pH in water by ISE	Melbourne	Nov 22, 2022	0 Hours
<b>Phosphate total (as P)</b> - Method: LTM-INO-4040 Phosphate by CFA	Melbourne	Nov 22, 2022	28 Days
<b>Redox Potential mV (relative to Ag/AgCl)</b> - Method: APHA 2580B Redox Potential	Melbourne	Nov 23, 2022	5 Days
<b>Total Nitrogen (as N)</b> - Method: LTM-INO-4040 Phosphate and Nitrogen in waters	Melbourne	Nov 22, 2022	7 Days
<b>Eurofins Suite B11C: Na/K/Ca/Mg</b> - Method: LTM-MET-3010 Alkali Metals by ICP-AES	Melbourne	Nov 22, 2022	180 Days
<b>Total Dissolved Solids Dried at 180 °C ± 2 °C</b> - Method: LTM-INO-4170 Total Dissolved Solids in Water	Melbourne	Nov 22, 2022	28 Days



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Tel: 0800 856 450  
IANZ# 1290

**Company Name:** GHD Ply Ltd VIC  
**Address:** Level 8, 180 Lonsdale St  
Melbourne  
VIC 3000

**Order No.:** 12565989  
**Report#:** 943114  
**Phone:** 8687 8000  
**Fax:** 8687 8111

**Received:** Nov 21, 2022 2:20 PM  
**Due:** Nov 28, 2022  
**Priority:** 5 Day  
**Contact Name:** Meg Turner

**Project Name:**  
**Project ID:** 12565989

Eurofins Analytical Services Manager : Harry Bacalis

Sample Detail					Asbestos	Lead	Mercury	PCDD/F	PCB	PAH	PFAS	Other
Melbourne Laboratory - NATA# 1261 Site# 1254					X	X	X	X	X	X	X	X
External Laboratory					X	X	X	X	X	X	X	X
SampleID	Sample Date	Sampling Time	Matrix	LABID								
SW-D2	Nov 21, 2022		Water	M22-No0050257	X	X	X	X	X	X	X	X
GW-D2	Nov 21, 2022		Water	M22-No0050258	X	X	X	X	X	X	X	X
Test Counts					2	2						

## Internal Quality Control Review and Glossary

### General

- Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
- All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
- All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
- Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
- Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
- SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
- Samples were analysed on an 'as received' basis.**
- Information identified on this report with blue colour, indicates data provided by customer that may have an impact on the results.
- This report replaces any interim results previously issued.

### Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

### Units

<b>mg/kg:</b> milligrams per kilogram	<b>mg/L:</b> milligrams per litre	<b>µg/L:</b> micrograms per litre
<b>ppm:</b> parts per million	<b>ppb:</b> parts per billion	<b>%: Percentage</b>
<b>org/100 ml:</b> Organisms per 100 millilitres	<b>NTU:</b> Nephelometric Turbidity Units	<b>MPN/100 ml:</b> Most Probable Number of organisms per 100 millilitres

### Terms

<b>APHA</b>	American Public Health Association
<b>COC</b>	Chain of Custody
<b>CP</b>	Client Parent - QC was performed on samples pertaining to this report
<b>CRM</b>	Certified Reference Material (ISO17034)- reported as percent recovery.
<b>Dry</b>	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
<b>Duplicate</b>	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
<b>LOR</b>	Limit of Reporting.
<b>LCS</b>	Laboratory Control Sample - reported as percent recovery.
<b>Method Blank</b>	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
<b>NCP</b>	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
<b>RPD</b>	Relative Percent Difference between two Duplicate pieces of analysis.
<b>SPIKE</b>	Addition of the analyte to the sample and reported as percentage recovery.
<b>SRA</b>	Sample Receipt Advice
<b>Surr - Surrogate</b>	The addition of a like compound to the analyte target and reported as percentage recovery.
<b>TBTO</b>	Tributyltin oxide (bis-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment however free tributyltin was measured and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
<b>TCLP</b>	Toxicity Characteristic Leaching Procedure
<b>TEQ</b>	Toxic Equivalency Quotient or Total Equivalence
<b>QSM</b>	US Department of Defense Quality Systems Manual Version 5.4
<b>US EPA</b>	United States Environmental Protection Agency
<b>WADWER</b>	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

### QC - Acceptance Criteria

The acceptance criteria should be used as a guide only and may be different when site specific Sampling Analysis and Quality Plan (SAQP) have been implemented

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR: No Limit

Results between 10-20 times the LOR: RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.4 where no positive PFAS results have been reported have been reviewed and no data was affected.

### QC Data General Comments

- Where a result is reported as a less than(<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
- Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
- pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
- Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery the term "INT" appears against that analyte.
- For Matrix Spikes and LCS results a dash "-" in the report means that the specific analyte was not added to the QC sample.
- Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code	
<b>Method Blank</b>								
Chloride	mg/L	< 1				Pass		
Conductivity (at 25 °C)	uS/cm	< 10			10	Pass		
Phosphate total (as P)	mg/L	< 0.01			0.01	Pass		
Sulphate (as SO4)	mg/L	<5			5	Pass		
Total Dissolved Solids Dried at 180 °C ± 2 °C	mg/L	< 10			10	Pass		
Total Nitrogen (as N)	mg/L	< 0.2			0.2	Pass		
<b>Method Blank</b>								
<b>Alkalinity (speciated)</b>								
Bicarbonate Alkalinity (as CaCO3)	mg/L	< 20			20	Pass		
Carbonate Alkalinity (as CaCO3)	mg/L	< 10			10	Pass		
Hydroxide Alkalinity (as CaCO3)	mg/L	< 20			20	Pass		
Total Alkalinity (as CaCO3)	mg/L	< 20			20	Pass		
<b>Method Blank</b>								
<b>Alkali Metals</b>								
Calcium	mg/L	< 0.5			0.5	Pass		
Magnesium	mg/L	< 0.5			0.5	Pass		
Potassium	mg/L	< 0.5			0.5	Pass		
Sodium	mg/L	< 0.5			0.5	Pass		
<b>LCS - % Recovery</b>								
Chloride	%	99			70-130	Pass		
Conductivity (at 25 °C)	%	102			70-130	Pass		
Phosphate total (as P)	%	96			70-130	Pass		
Sulphate (as SO4)	%	84			70-130	Pass		
Total Dissolved Solids Dried at 180 °C ± 2 °C	%	97			70-130	Pass		
Total Nitrogen (as N)	%	85			70-130	Pass		
<b>LCS - % Recovery</b>								
<b>Alkalinity (speciated)</b>								
Carbonate Alkalinity (as CaCO3)	%	100			70-130	Pass		
Total Alkalinity (as CaCO3)	%	101			70-130	Pass		
<b>LCS - % Recovery</b>								
<b>Alkali Metals</b>								
Calcium	%	85			80-120	Pass		
Magnesium	%	83			80-120	Pass		
Potassium	%	86			80-120	Pass		
Sodium	%	93			80-120	Pass		
Test	Lab Sample ID	QA Source	Units	Result 1		Acceptance Limits	Pass Limits	Qualifying Code
<b>Spike - % Recovery</b>								
<b>Alkali Metals</b>								
Calcium	M22-No00524 76	NCP	%	96		75-125	Pass	
Magnesium	M22-No00524 76	NCP	%	118		75-125	Pass	
Potassium	M22-No00524 76	NCP	%	104		75-125	Pass	
Sodium	M22-No00524 76	NCP	%	105		75-125	Pass	
Test	Lab Sample ID	Source	Units	Result 1		Acceptance Limits	Pass Limits	Qualifying Code
<b>Duplicate</b>								
				Result 1	Result 2	RPO		
Chloride	M22-No0050124	NCP	mg/L	3000	2900	1.4	30%	Pass
Conductivity (at 25 °C)	B22-No0051468	NCP	uS/cm	860	850	<1	30%	Pass
Dissolved Oxygen	M22-No0053682	NCP	mg/L	9.0	9.2	1.5	30%	Pass
pH (at 25 °C)	B22-No0051468	NCP	pH Units	8.1	8.1	pass	30%	Pass

Test	Lab Sample ID	Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
<b>Duplicate</b>									
				Result 1	Result 2	RPO			
Phosphate total (as P)	S22-No0044084	NCP	mg/L	0.04	0.02	45	30%	Fail	015
Redox Potential mV (relative to Ag/AgCl)	M22-No0053682	NCP	mV	350	340	<1	30%		
Total Dissolved Solids Dried at 180 °C ± 2 °C	M22-No0046484	NCP	mg/L	800	750	6.2	30%		
<b>Duplicate</b>									
<b>Alkalinity (speciated)</b>				Result 1	Result 2	RPO			
Bicarbonate Alkalinity (as CaCO <sub>3</sub> )	B22-No0051468	NCP	mg/L	500	440	12	30%	Pass	
Carbonate Alkalinity (as CaCO <sub>3</sub> )	B22-No0051468	NCP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO <sub>3</sub> )	B22-No0051468	NCP	mg/L	< 20	< 20	<1	30%	Pass	
Total Alkalinity (as CaCO <sub>3</sub> )	B22-No0051468	NCP	mg/L	500	440	12	30%	Pass	
<b>Duplicate</b>									
<b>Alkali Metals</b>				Result 1	Result 2	RPO			
Calcium	B22-No0046030	NCP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
Magnesium	B22-No0046030	NCP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
Potassium	B22-No0046030	NCP	mg/L	0.5	0.5	5.6	30%	Pass	
Sodium	B22-No0046030	NCP	mg/L	0.8	0.8	9.4	30%	Pass	

**Comments**

**Sample Integrity**

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
<b>Sample containers for volatile analysis received with minimal headspace</b>	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

**Qualifier Codes/Comments**

Code	Description
015	The RPO reported passes Eurofins Environment Testing's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

**Authorised by:**

Catherine Wilson	Analytical Services Manager
Mary Makarios	Senior Analyst-Inorganic
Mary Makarios	Senior Analyst-Metal



**Glenn Jackson**  
**General Manager**

Final Report - this report replaces any previously issued Report

- Indicates Not Requested
- Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please [click here](#).

Eurofins shall not be liable for loss, cost, damages or expenses incurred by the client, or any other person or company, resulting from the use of any information or interpretation given in this report. In no case shall Eurofins be liable for consequential damages including, but not limited to, lost profits, damages for failure to meet deadlines and lost production arising from this report. This document shall not be reproduced except in full and relates only to the items tested. Unless indicated otherwise, the tests were performed on the samples as received.



Environmental Testing Report

Client Name	Project Name	Test Item	Test Method
Address	Location	Quantity	Standard
Contact Person	Inspector	Sampling Method	Reference
Company Name	Sampling Date	Storage Method	Remarks
Site Name	Sampling Time	Test Result	
Inspector Name	Inspector Signature	Client Signature	
Company Name	Address	Contact Number	
Test Item	Test Method	Test Result	
Test Item	Test Method	Test Result	
Test Item	Test Method	Test Result	
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Environmental Test Report Form

Client Name: [ ]

Project Name: [ ]

Test Item: [ ]

Test Method: [ ]

Quantity: [ ]

Standard: [ ]

Reference: [ ]

Remarks: [ ]

Test Item	Test Method	Test Result
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Main table with 4 columns: Test Name, Reference, Result, and Remarks. Includes accreditation logos for ilac-MRA and NATA.

Notes section containing three bullet points regarding test results and procedures.

Footer section with additional fields and a signature line.







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# FREIGH

CHAIN OF CUSTODY  
Wekir Re-scu Gro'U:p

ABN: 64 170170170  
Page... \. | aLZ... |

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PO Box 1469  
Traralgon VIC 3644  
Phone: 03 5176 4170  
Fax: 03 5176 4473  
Email: traralgon@freigh.com.au

Client: GHD		Office use only									
Contact: (results) Meg Turner		Lab Work Order No:									
(invoice) Meg Turner		LIMS Program Code:									
Address: 105 Hume St Wodonga. 3690		TESTS REQUIRED <b>See</b>									
Phone: +61 3 8787 8862		Fax:		Special Instructions							
Email: Meg.Turner@ghd.com											
P/O No.: 12565989		Quote No.:									
T/A Time:		Sampler: MT									
Job/Proj Ref: 12565989											
Lab Sample ID	Sample Description	No of Containers	Date Sampled	Time sampled	Matrix	Cation	Nutrient	Field	Conduct	Send	
1 SW1.1	Surface Water	2	15/11/22		Water	X	X	X	X		
2 SW1.2	"	2	15/11/22		"	X	X	X	X		
3 SW2	"	2	15/11/22		"	X	X	X	X		
4 SW-01	"	2	15/11/22		"	X	X	X	X		
	SW-02	2	15/11/22		"	X	X	X	X	X	
Special Instructions:		Cations / Anions = ALS Suite NT-1, NT-2		Conductivity, TDS, turbidity = ALS suite WA010, WA015, WA045							
		Nutrients = ALS Suite NT-11, EK059GV		Field parameters = DO, EC, pH, Redox, Temp (ALS Suite EN67.2)							
Relinquished By:	Company:	Date:	Time:	Received By:	Company:	Date:	Time:				
Meg. Turner	GHD	17/11/22	4:30 pm	JW	ALS	18/11	10:40				
This form is for recording of sample data after prior consultation with an analyst regarding sampling procedures and does not over-ride pricing agreements, CH3 requirements and our terms and conditions.						LAB USE ONLY		Sample condition:		Samples received undamaged (Yes/No)	
As an Occupational Health and Safety consideration, it is a requirement of ALS Water Resources Group that all samples received be undamaged and prior advice given in writing of any potential health risks.								Samples adequately preserved (Yes/No)		Samples transported at appropriate temperature (Yes/No)	

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Telephone : + 61-3-8519 9800



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ho,n| Peter Rp""  
S□nilt: IF• d□y. 1S No. m'be.r 2022 2.'06 'M  
To.: roe M 1bicn.Je  
Subj&t: GHD COC □ Water Samples REC'D IODA'I' 8/11 • UR.GENT ,KO DING TIMES  
A rtntt. roe-

follow Up Flag□ Follow LI,P  
ifilag Statu□ Frag ed


Categories: COC for incoming samples

Hi Team

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Springvale Vic 3171  
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[www.alsglobal.com](http://www.alsglobal.com)

Late in 2022 ALS Springval a will bl;! a a .-•elephony services to a different provider. During this time you may notice that the number r at l/re cal ,s, nocton.sistent with the details listed above. All of our existing numbers are being routed t . 9h tern | . nng this time and will remain active for the entire process. Please continue to contact s; ad above, we would recommend not saving the temporary numbers to your o ds ;□ lh Once the transition is complete.

IFn:im,•Meg lili <M12g.Tu er@□hd..a;im>  
- |t; |Firdlav, ll3 N,a,vemb.er. 0.°2 1=43 PiM

To: Peter Ravlic <peter.ravlic@alsglobal.com>  
Subject: (E) Re: NLI - W te- mp s

CAUTION: This email originates from the QJRM OUIS of the Victorian Government. Do not click links or open attachments unless you recognize the sender.

Hi Peter,

Please see COC attached.

Glad to hear the 'made in Victoria' theme.

Kind regards,

Meg Turner (she/her)

81 Little Sci  
Level 11, 111 E Street - Victoria Environmental Management

GHD

Proudly employed - owned | [ghd.com](http://ghd.com)

105 Hume Street, Wodonga, VIC 3690 Australia

Phone: +61 3 377 8862 M +61 477 513 431 E [meg.turner@ghd.com](mailto:meg.turner@ghd.com)

→ The Power of Commitment

11111 m

Please consider the environment before printing this email

From: Peter Ravlic <peter.ravlic@alsglobal.com>  
Date: 18 November 2022 11:58 AM  
Subject: NLI - W te- mp s

Hi Meg

Are you able to email through a COC for the water samples we rec'd this morning

Thanks

ai tot Ra"li:c=

Client Service - Victoria

Enviromn nta!



CERTIFICATE OF ANALYSIS

Batch No: 23-14906

Page 1 of 4

Final Report 71901

Laboratory

Scoresby Laboratory  
Caribbean Business Park,  
22 Dalmore Drive,  
Scoresby,  
VIC 3179  
03 8756 8000  
03 9763 1862

Client: GHD Pty Ltd

Address  
Phone  
Fax

Contact: Accounts

Address: Level8  
180 Lonsdale Street  
MELBOURNE  
VIC  
3000  
AUSTRALIA

Contact:

Brad Snibson  
Client Manager  
Brad.Snibson@alsglobal.com

Client Program Ref- 12565989-Mt Buller

ALS Program Ref- GHDWSG

Date Sampled:

15-Feb-2023 - 16-Feb-2023

Date Samples Received:

21-Feb-2023

PO No: Not Available

Date Issued:

27-Feb-2023

The hash (#) below indicates methods not covered by NATA accreditation in the performance of this service.

Analysis	Method	Laboratory	Analysis	Method	Laboratory	Analysis	Method	Laboratory
Alkalinity	WD037	Scoresby	Chloride	WD045G	Scoresby			
EC	WA010	Scoresby	TCN	WK062	Scoresby			
NO3-N	EK058GV	Scoresby	NOXas N	EK058V & 059GV	Scoresby			
OES Scan	WG005A( Si not NATA); EA 065-69	Scoresby	TDS at 180°C +/- 5°C	WA015	Scoresby			
SO4DA	WD041G	Scoresby	TKN/TP (HL)	WK061A	Scoresby			
Turbidity	WA045	Scoresby						

Measurement Uncertainties values for your compliance results are available at this link

Signatories

<i>Name</i>	<i>Title</i>	<i>Name</i>	<i>Title</i>
<b>Alan Chung</b>	<b>Team Leader Metals</b>	<b>Brad Snibson</b>	<b>Client Manager</b>
<b>Chatura Perera</b>	<b>Team Leader Nutrients</b>	<b>Hoa Nguyen</b>	<b>Analyst</b>
<b>Joseph De Alwis</b>	<b>Analyst</b>		



Batch No: 23-14906  
 Report Number: 71901  
 Client: GHD Pty Ltd  
 Client Program Ref- 12565989-Mt Buller

Chemistry			Analysis:	rns at 1a0°C+/- S°C	EC	Turbidity	Chloride	SO4DA	Alkalinity	Alkalinity	Alkalinity
Sample	Sampled Date	Your Ref	Component: Units: Sample Type	TDS_180 mg/L	EC uS/cm	TURBIDITY NTU	W-CHLORIDE(DA) mg/L	W-SO4-DA mg/L	HCO3 AS CaCO3 mg CaCO3 /L	CO3AS CaCO3 mg CaCO3 /L	OH AS CaCO3 mg CaCO3 /L
8320917	15-02-23	NONE Boggy 1.1	WATER	15	27	0.3	1	<1	9	<2	<2
8320918	15-02-23	NONE Boggy 1.2	WATER	12	21	<0.1	1	<1	7	<2	<2
8320919	15-02-23	NONE Boggy 2	WATER	12	26	<0.1	2	<1	10	<2	<2
8320920	15-02-23	NONE SW-D1	WATER	15	26	<0.1	1	<1	9	<2	<2
8320922	15-02-23	NONEEWS	WATER	18	34	2.3	1	1	11	<2	<2
8321065	16-02-23	NONE GW-D1	WATER	32	54	27	2	<1	<2	<2	<2
8321066	16-02-23	NONE BH06	WATER	35	57	29	2	<1	<2	<2	<2
8321067	16-02-23	NONE BH09	WATER	12	23	53	1	<1	4	<2	<2
8321068	16-02-23	NONE BH16	WATER	10	18	36	1	<1	3	<2	<2
8321069	16-02-23	NONEBH17	WATER	22	44	21	2	<1	16	<2	<2
8321070	16-02-23	NONE BH18	WATER	22	38	190	2	<1	16	<2	<2

Chemistry			Analysis:	Alkalinity
Sample	Sampled Date	Your Ref	Component: Units: Sample Type	ALKALINITYAS CaCO3 mg CaCO3 /L
8320917	15-02-23	NONE Boggy 1.1	WATER	9
8320918	15-02-23	NONE Boggy 1.2	WATER	7
8320919	15-02-23	NONE Boggy 2	WATER	10
8320920	15-02-23	NONE SW-D1	WATER	9
8320922	15-02-23	NONEEWS	WATER	11
8321065	16-02-23	NONE GW-D1	WATER	<2
8321066	16-02-23	NONE BH06	WATER	<2
8321067	16-02-23	NONE BH09	WATER	4
8321068	16-02-23	NONE BH16	WATER	3
8321069	16-02-23	NONE BH17	WATER	16
8321070	16-02-23	NONE BH18	WATER	16

Samples not collected by ALS and are tested as received.



Batch No: 23-14906  
 Report Number: 71901  
 Client: GHD Pty Ltd  
 Client Program Ref- 12565989-Mt Buller

Nutrients			Analysis:	TKN/TP (HL)	TKN/TP (HL)	TCN	NOX as N	N03-N
				TKN_HL mg N /L	TOTAL P_HL mg P /L	TCN mg/L	NOX_HL mg N /L	W-N03-N mg N /L
Sample	Sampled Date	Your Ref	Component: Units: Sample Type					
8320917	15-02-23	NONE Boggy 1.1	WATER	<0.1	<0.05	0.2	0.19	0.18
8320918	15-02-23	NONE Boggy 1.2	WATER	<0.1	0.06	0.1	0.13	0.13
8320919	15-02-23	NONE Boggy 2	WATER	<0.1	0.08	<0.1	0.10	0.09
8320920	15-02-23	NONE SW-D1	WATER	<0.1	0.08	<0.1	0.10	0.09
8320922	15-02-23	NONEEWS	WATER	<0.1	<0.05	0.2	0.23	0.23
8321065	16-02-23	NONE GW-D1	WATER	0.7	0.06	6.0	5.4	5.4
8321066	16-02-23	NONE BH06	WATER	0.6	<0.05	5.7	5.1	5.1
8321067	16-02-23	NONE BH09	WATER	0.2	0.05	1.0	0.84	0.84
8321068	16-02-23	NONE BH16	WATER	<0.1	0.07	0.7	0.73	0.72
8321069	16-02-23	NONEBH17	WATER	0.1	0.10	0.8	0.65	0.64
8321070	16-02-23	NONE BH18	WATER	0.2	0.06	0.2	0.02	0.01

Metals			Analysis:	OES Scan	OES Scan	OES Scan	OES Scan
				CA mg/L	MG mg/L	K mg/L	NA mg/L
Sample	Sampled Date	Your Ref	Component: Units: Sample Type				
8320917	15-02-23	NONE Boggy 1.1	WATER	1.9	0.6	0.2	2.7
8320918	15-02-23	NONE Boggy 1.2	WATER	0.9	0.3	<0.1	1.3
8320919	15-02-23	NONE Boggy 2	WATER	1.3	0.4	0.1	1.5
8320920	15-02-23	NONE SW-D1	WATER	1.2	0.4	0.1	1.5
8320922	15-02-23	NONEEWS	WATER	1.8	0.6	0.4	1.0
8321065	16-02-23	NONE GW-D1	WATER	2.1	0.9	0.5	1.6
8321066	16-02-23	NONE BH06	WATER	2.1	0.8	0.4	1.5
8321067	16-02-23	NONE BH09	WATER	0.9	0.4	0.1	0.8
8321068	16-02-23	NONE BH16	WATER	0.5	0.2	<0.1	1.3
8321069	16-02-23	NONE BH17	WATER	3.1	1.1	0.5	3.8
8321070	16-02-23	NONE BH18	WATER	1.6	0.6	0.2	2.4

Samples not collected by ALS and are tested as received.



## QA/QC Compliance Assessment and Control Data

<b>Work Order</b>	=GHDWSG	<b>Page</b>	: 1 of 18
<b>Client</b>	:GHD	<b>Laboratory</b>	: Scoresby Laboratory
<b>Contact</b>		<b>Telephone</b>	03 8756 8000
<b>Project</b>	=23-14906	<b>Date Samples Received</b>	: 21-February-2023
<b>Site</b>		<b>Issue Date</b>	: 27-February-2023
<b>Sampler</b>		<b>No. Samples Received</b>	12
<b>Order Number</b>		<b>No. Samples Analysed</b>	11

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal and external review. Many components of this report contribute to the overall Quality assessment.

Brief method summaries and references are also provided to assist in traceability.

### Summary of QC Outliers

#### Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- Number of Method Blank value outliers :
- Number of Duplicate outliers : 0
- Number of Laboratory Control outliers : 0
- Number of Matrix Spike outliers : 0
- For all regular sample matrices,  
Number of surrogate recovery outliers : 0

**Analysis Holding Time Compliance**

*Holding times may vary depending on test and preservation used.*

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS Water recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

	<i>Sampled Date</i>	<i>Date analysed</i>	<i>Due for analysis</i>	<i>Evaluation</i>	
<b>Sample Number:</b> 8320917					
<b>Sampling Point:</b> NONE Boggy 1.1					
<b>Matrix:</b> WATER					
<b>EK058V &amp; 059GV : NOX as N</b>					
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	15-Mar-2023	✓	
<b>WG005A (Si not NATA); EA065-69: OES</b>					
150ml Plastic (RED label - metals acidified)	15-Feb-2023	23-Feb-2023	14-Aug-2023	✓	
<b>WA015: TDS AT 180C</b>					
Plastic - 500ml	15-Feb-2023	22-Feb-2023	22-Feb-2023	x	
<b>WK061A: TKN/TP (HL)</b>					
Plastic - 60ml - H2SO4 (COD & Nutrients)	15-Feb-2023	23-Feb-2023	15-Mar-2023	✓	
<b>WK062 : Total N Cale</b>					
Field or Client container bottle	15-Feb-2023		15-Feb-2023	N/A	
<b>WA045 : TURBIDITY NTU</b>					
Plastic - 250ml for General Chem.	15-Feb-2023	21-Feb-2023	17-Feb-2023	x	
<b>WD037 : W-ALK</b>					
Plastic - 250ml for General Chem.	15-Feb-2023	22-Feb-2023	01-Mar-2023	✓	
<b>WD045G : W-Chloride(DA)</b>					
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	15-Mar-2023	✓	
<b>WA010: W-EC</b>					
Plastic - 250ml for General Chem.	15-Feb-2023	21-Feb-2023	15-Mar-2023	✓	
<b>EK058GV : W-NO3-N</b>					
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	17-Feb-2023	x	
<b>WD041G: W-5O4-Da</b>					
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	15-Mar-2023	✓	

	Sampled Date	Date analysed	Due for analysis	Evaluation
<b>Sample Number: 8320918</b>				
<b>Sampling Point: NONE Boggy 1.2</b>				
<b>Matrix: WATER</b>				
<b>EK058V &amp; 059GV : NOX as N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	15-Mar-2023	✓
<b>WG005A (SI not NATA); EA065-69 : OES</b>				
150ml Plastic (RED label - metals acidified)	15-Feb-2023	23-Feb-2023	14-Aug-2023	✓
<b>WA015: TDS AT 180C</b>				
Plastic - 500ml	15-Feb-2023	22-Feb-2023	22-Feb-2023	jc
<b>WK061A: TKN/TP (HL)</b>				
Plastic - 60ml - H2SO4 (COD & Nutrients)	15-Feb-2023	23-Feb-2023	15-Mar-2023	✓
<b>WK062 : Total N Cale</b>				
Field or Client container bottle	15-Feb-2023		15-Feb-2023	N/A
<b>WA045 : TURBIDITY NTU</b>				
Plastic - 250ml for General Chem.	15-Feb-2023	21-Feb-2023	17-Feb-2023	jc
<b>WD037 : W-ALK</b>				
Plastic - 250ml for General Chem.	15-Feb-2023	22-Feb-2023	01-Mar-2023	✓
<b>WD045G : W-Chloride(DA)</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	15-Mar-2023	✓
<b>WA010: W-EC</b>				
Plastic - 250ml for General Chem.	15-Feb-2023	21-Feb-2023	15-Mar-2023	✓
<b>EK058GV : W-NO3-N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	17-Feb-2023	jc
<b>WD041G: W-SO4-Da</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	15-Mar-2023	✓

	Sampled Date	Date analysed	Due for analysis	Evaluation
<b>Sample Number: 8320919</b>				
<b>Sampling Point: NONE Boggy 2</b>				
<b>Matrix: WATER</b>				
<b>EK058V &amp; 059GV : NOX as N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	15-Mar-2023	✓
<b>WG005A (SI not NATA); EA065-69 : OES</b>				
150ml Plastic (RED label - metals acidified)	15-Feb-2023	23-Feb-2023	14-Aug-2023	✓
<b>WA015: TDS AT 180C</b>				
Plastic - 500ml	15-Feb-2023	22-Feb-2023	22-Feb-2023	jc
<b>WK061A: TKN/TP (HL)</b>				
Plastic - 60ml - H2SO4 (COD & Nutrients)	15-Feb-2023	23-Feb-2023	15-Mar-2023	✓
<b>WK062 : Total N Cale</b>				
Field or Client container bottle	15-Feb-2023		15-Feb-2023	N/A
<b>WA045 : TURBIDITY NTU</b>				
Plastic - 250ml for General Chem.	15-Feb-2023	21-Feb-2023	17-Feb-2023	jc
<b>WD037 : W-ALK</b>				
Plastic - 250ml for General Chem.	15-Feb-2023	22-Feb-2023	01-Mar-2023	✓
<b>WD045G : W-Chloride(DA)</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	15-Mar-2023	✓
<b>WA010: W-EC</b>				
Plastic - 250ml for General Chem.	15-Feb-2023	21-Feb-2023	15-Mar-2023	✓
<b>EK058GV : W-NO3-N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	17-Feb-2023	jc
<b>WD041G: W-SO4-Da</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	15-Feb-2023	22-Feb-2023	15-Mar-2023	✓

		Sampled Date	Date analysed	Due for analysis	Evaluation
<b>Sample Number: 8320920</b>					
<b>Sampling Point: NONE SW-D1</b>					
<b>Matrix: WATER</b>					
<b>EK058V &amp; 059GV : NOX as N</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		15-Feb-2023	22-Feb-2023	15-Mar-2023	✓
<b>WG005A (SI not NATA); EA065-69 : OES</b>					
150ml Plastic (RED label - metals acidified)		15-Feb-2023	23-Feb-2023	14-Aug-2023	✓
<b>WA015: TDS AT 180C</b>					
Plastic - 500ml		15-Feb-2023	22-Feb-2023	22-Feb-2023	jc
<b>WK061A: TKN/TP (HL)</b>					
Plastic - 60ml - H2SO4 (COD & Nutrients)		15-Feb-2023	23-Feb-2023	15-Mar-2023	✓
<b>WK062 : Total N Cale</b>					
Field or Client container bottle		15-Feb-2023		15-Feb-2023	N/A
<b>WA045 : TURBIDITY NTU</b>					
Plastic - 250ml for General Chem.		15-Feb-2023	21-Feb-2023	17-Feb-2023	jc
<b>WD037 : W-ALK</b>					
Plastic - 250ml for General Chem.		15-Feb-2023	22-Feb-2023	01-Mar-2023	✓
<b>WD045G : W-Chloride(DA)</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		15-Feb-2023	22-Feb-2023	15-Mar-2023	✓
<b>WA010: W-EC</b>					
Plastic - 250ml for General Chem.		15-Feb-2023	21-Feb-2023	15-Mar-2023	✓
<b>EK058GV : W-NO3-N</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		15-Feb-2023	22-Feb-2023	17-Feb-2023	jc
<b>WD041G: W-5O4-Da</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		15-Feb-2023	22-Feb-2023	15-Mar-2023	✓

		Sampled Date	Date analysed	Due for analysis	Evaluation
<b>Sample Number: 8320922</b>					
<b>Sampling Point: NONE EWS</b>					
<b>Matrix: WATER</b>					
<b>EK058V &amp; 059GV : NOX as N</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		15-Feb-2023	22-Feb-2023	15-Mar-2023	✓
<b>WG005A (SI not NATA); EA065-69 : OES</b>					
150ml Plastic (RED label - metals acidified)		15-Feb-2023	23-Feb-2023	14-Aug-2023	✓
<b>WA015: TDS AT 180C</b>					
Plastic - 500ml		15-Feb-2023	22-Feb-2023	22-Feb-2023	jc
<b>WK061A: TKN/TP (HL)</b>					
Plastic - 60ml - H2SO4 (COD & Nutrients)		15-Feb-2023	23-Feb-2023	15-Mar-2023	✓
<b>WK062 : Total N Cale</b>					
Field or Client container bottle		15-Feb-2023		15-Feb-2023	N/A
<b>WA045 : TURBIDITY NTU</b>					
Plastic - 250ml for General Chem.		15-Feb-2023	21-Feb-2023	17-Feb-2023	jc
<b>WD037 : W-ALK</b>					
Plastic - 250ml for General Chem.		15-Feb-2023	22-Feb-2023	01-Mar-2023	✓
<b>WD045G : W-Chloride(DA)</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		15-Feb-2023	22-Feb-2023	15-Mar-2023	✓
<b>WA010: W-EC</b>					
Plastic - 250ml for General Chem.		15-Feb-2023	21-Feb-2023	15-Mar-2023	✓
<b>EK058GV : W-NO3-N</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		15-Feb-2023	22-Feb-2023	17-Feb-2023	jc
<b>WD041G: W-SO4-Da</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		15-Feb-2023	22-Feb-2023	15-Mar-2023	✓

	Sampled Date	Date analysed	Due for analysis	Evaluation
<b>Sample Number: 8321065</b>				
<b>Sampling Point: NONE GW-D1</b>				
<b>Matrix: WATER</b>				
<b>EK058V &amp; 059GV : NOX as N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WG005A (SI not NATA); EA065-69 : OES</b>				
150ml Plastic (RED label - metals acidified)	16-Feb-2023	23-Feb-2023	15-Aug-2023	✓
<b>WA015: TDS AT 180C</b>				
Plastic - 500ml	16-Feb-2023	22-Feb-2023	23-Feb-2023	✓
<b>WK061A: TKN/TP (HL)</b>				
Plastic - 60ml - H2SO4 (COD & Nutrients)	16-Feb-2023	23-Feb-2023	16-Mar-2023	✓
<b>WK062 : Total N Cale</b>				
Field or Client container bottle	16-Feb-2023		16-Feb-2023	N/A
<b>WA045 : TURBIDITY NTU</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	21-Feb-2023	18-Feb-2023	x
<b>WD037 : W-ALK</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	22-Feb-2023	02-Mar-2023	✓
<b>WD045G : W-Chloride(DA)</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WA010: W-EC</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	21-Feb-2023	16-Mar-2023	✓
<b>EK058GV : W-NO3-N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	18-Feb-2023	x
<b>WD041G: W-5O4-Da</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓

	Sampled Date	Date analysed	Due for analysis	Evaluation
<b>Sample Number: 8321066</b>				
<b>Sampling Point: NONE BH06</b>				
<b>Matrix: WATER</b>				
<b>EK058V &amp; 059GV : NOX as N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WG005A (SI not NATA); EA065-69 : OES</b>				
150ml Plastic (RED label - metals acidified)	16-Feb-2023	23-Feb-2023	15-Aug-2023	✓
<b>WA015: TDS AT 180C</b>				
Plastic - 500ml	16-Feb-2023	22-Feb-2023	23-Feb-2023	✓
<b>WK061A: TKN/TP (HL)</b>				
Plastic - 60ml - H2SO4 (COD & Nutrients)	16-Feb-2023	23-Feb-2023	16-Mar-2023	✓
<b>WK062 : Total N Cale</b>				
Field or Client container bottle	16-Feb-2023		16-Feb-2023	N/A
<b>WA045 : TURBIDITY NTU</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	21-Feb-2023	18-Feb-2023	x
<b>WD037 : W-ALK</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	22-Feb-2023	02-Mar-2023	✓
<b>WD045G : W-Chloride(DA)</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WA010: W-EC</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	21-Feb-2023	16-Mar-2023	✓
<b>EK058GV : W-NO3-N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	18-Feb-2023	x
<b>WD041G: W-SO4-Da</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓

	Sampled Date	Date analysed	Due for analysis	Evaluation
<b>Sample Number: 8321067</b>				
<b>Sampling Point: NONE BH09</b>				
<b>Matrix: WATER</b>				
<b>EK058V &amp; 059GV : NOX as N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WG005A (SI not NATA); EA065-69 : OES</b>				
150ml Plastic (RED label - metals acidified)	16-Feb-2023	23-Feb-2023	15-Aug-2023	✓
<b>WA015: TDS AT 180C</b>				
Plastic - 500ml	16-Feb-2023	22-Feb-2023	23-Feb-2023	✓
<b>WK061A: TKN/TP (HL)</b>				
Plastic - 60ml - H2SO4 (COD & Nutrients)	16-Feb-2023	23-Feb-2023	16-Mar-2023	✓
<b>WK062 : Total N Cale</b>				
Field or Client container bottle	16-Feb-2023		16-Feb-2023	N/A
<b>WA045 : TURBIDITY NTU</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	21-Feb-2023	18-Feb-2023	x
<b>WD037 : W-ALK</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	22-Feb-2023	02-Mar-2023	✓
<b>WD045G : W-Chloride(DA)</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WA010: W-EC</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	21-Feb-2023	16-Mar-2023	✓
<b>EK058GV : W-NO3-N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	18-Feb-2023	x
<b>WD041G: W-SO4-Da</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓

	Sampled Date	Date analysed	Due for analysis	Evaluation
<b>Sample Number: 8321068</b>				
<b>Sampling Point: NONE BH16</b>				
<b>Matrix: WATER</b>				
<b>EK058V &amp; 059GV : NOX as N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WG005A (SI not NATA); EA065-69 : OES</b>				
150ml Plastic (RED label - metals acidified)	16-Feb-2023	23-Feb-2023	15-Aug-2023	✓
<b>WA015: TDS AT 180C</b>				
Plastic - 500ml	16-Feb-2023	22-Feb-2023	23-Feb-2023	✓
<b>WK061A: TKN/TP (HL)</b>				
Plastic - 60ml - H2SO4 (COD & Nutrients)	16-Feb-2023	23-Feb-2023	16-Mar-2023	✓
<b>WK062 : Total N Cale</b>				
Field or Client container bottle	16-Feb-2023		16-Feb-2023	N/A
<b>WA045 : TURBIDITY NTU</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	21-Feb-2023	18-Feb-2023	x
<b>WD037 : W-ALK</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	22-Feb-2023	02-Mar-2023	✓
<b>WD045G : W-Chloride(DA)</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WA010: W-EC</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	21-Feb-2023	16-Mar-2023	✓
<b>EK058GV : W-NO3-N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	18-Feb-2023	x
<b>WD041G: W-5O4-Da</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓

	Sampled Date	Date analysed	Due for analysis	Evaluation
<b>Sample Number: 8321069</b>				
<b>Sampling Point: NONE BH17</b>				
<b>Matrix: WATER</b>				
<b>EK058V &amp; 059GV : NOX as N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WG005A (SI not NATA); EA065-69 : OES</b>				
150ml Plastic (RED label - metals acidified)	16-Feb-2023	23-Feb-2023	15-Aug-2023	✓
<b>WA015: TDS AT 180C</b>				
Plastic - 500ml	16-Feb-2023	22-Feb-2023	23-Feb-2023	✓
<b>WK061A: TKN/TP (HL)</b>				
Plastic - 60ml - H2SO4 (COD & Nutrients)	16-Feb-2023	23-Feb-2023	16-Mar-2023	✓
<b>WK062 : Total N Cale</b>				
Field or Client container bottle	16-Feb-2023		16-Feb-2023	N/A
<b>WA045 : TURBIDITY NTU</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	21-Feb-2023	18-Feb-2023	x
<b>WD037 : W-ALK</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	22-Feb-2023	02-Mar-2023	✓
<b>WD045G : W-Chloride(DA)</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WA010: W-EC</b>				
Plastic - 250ml for General Chem.	16-Feb-2023	21-Feb-2023	16-Mar-2023	✓
<b>EK058GV : W-NO3-N</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	18-Feb-2023	x
<b>WD041G: W-5O4-Da</b>				
Plastic - 60ml (DA Analysis SO4, Cl)	16-Feb-2023	22-Feb-2023	16-Mar-2023	✓

		Sampled Date	Date analysed	Due for analysis	Evaluation
<b>Sample Number: 8321070</b>					
<b>Sampling Point: NONE BH18</b>					
<b>Matrix: WATER</b>					
<b>EK058V &amp; 059GV : NOX as N</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WG005A (SI not NATA); EA065-69 : OES</b>					
150ml Plastic (RED label - metals acidified)		16-Feb-2023	23-Feb-2023	15-Aug-2023	✓
<b>WA015: TDS AT 180C</b>					
Plastic - 500ml		16-Feb-2023	22-Feb-2023	23-Feb-2023	✓
<b>WK061A: TKN/TP (HL)</b>					
Plastic - 60ml - H2SO4 (COD & Nutrients)		16-Feb-2023	23-Feb-2023	16-Mar-2023	✓
<b>WK062 : Total N Calc</b>					
Field or Client container bottle		16-Feb-2023		16-Feb-2023	N/A
<b>WA045 : TURBIDITY NTU</b>					
Plastic - 250ml for General Chem.		16-Feb-2023	21-Feb-2023	18-Feb-2023	x
<b>WD037 : W-ALK</b>					
Plastic - 250ml for General Chem.		16-Feb-2023	22-Feb-2023	02-Mar-2023	✓
<b>WD045G : W-Chloride(DA)</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		16-Feb-2023	22-Feb-2023	16-Mar-2023	✓
<b>WA010: W-EC</b>					
Plastic - 250ml for General Chem.		16-Feb-2023	21-Feb-2023	16-Mar-2023	✓
<b>EK058GV : W-NO3-N</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		16-Feb-2023	22-Feb-2023	18-Feb-2023	x
<b>WD041G: W-5O4-Da</b>					
Plastic - 60ml (DA Analysis SO4, Cl)		16-Feb-2023	22-Feb-2023	16-Mar-2023	✓

**Brief Method Summaries**

The analytical procedures used by the Water Business have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at client request. The following table provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
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QUALITY CONTROL - BLANKS

Lab Sample ID	Client Sample ID	Analysis	Analyte	Units	LOR	Pass/Fail	Sample Value
8333405	QC- Blank	OES Scan	Aluminium		mg/L	<0.1 PASS	<0.1
			Antimony		mg/L	<0.5 PASS	<0.5
			Arsenic		mg/L	<0.1 PASS	<0.1
			Barium		mg/L	<0.01 PASS	<0.01
			Beryllium		mg/L	<0.01 PASS	<0.01
			Boron		mg/L	<0.05 PASS	<0.05
			Cadmium		mg/L	<0.01 PASS	<0.01
			Calcium		mg/L	<0.1 PASS	<0.1
			Cerium		mg/L	<0.1 PASS	<0.1
			Chromium		mg/L	<0.01 PASS	<0.01
			Cobalt		mg/L	<0.1 PASS	<0.1
			Copper		mg/L	<0.01 PASS	<0.01
			Iron		mg/L	<0.05 PASS	<0.05
			Lead		mg/L	<0.05 PASS	<0.05
			Lithium		mg/L	<0.02 PASS	<0.02
			Magnesium		mg/L	<0.1 PASS	<0.1
			Manganese		mg/L	<0.01 PASS	<0.01
			Mercury		mg/L	<0.1 PASS	<0.1
			Molybdenum		mg/L	<0.1 PASS	<0.1
			Nickel		mg/L	<0.01 PASS	<0.01
			Phosphorus		mg P/L	<0.1 PASS	<0.1
			Potassium		mg/L	<0.1 PASS	<0.1
			Selenium		mg/L	<0.1 PASS	<0.1
			Silicon		mg/L	<0.1 PASS	<0.1
			Silver		mg/L	<0.01 PASS	<0.01
			Sodium		mg/L	<0.1 PASS	<0.1
			Strontium		mg/L	<0.01 PASS	<0.01
			Sulphur		mg/L	<0.1 PASS	<0.1
			Thallium		mg/L	<0.1 PASS	<0.1
			Tin		mg/L	<0.1 PASS	<0.1
Titanium		mg/L	<0.01 PASS	<0.01			
Vanadium		mg/L	<0.1 PASS	<0.1			
Zinc		mg/L	<0.01 PASS	<0.01			
Lab Sample ID	Client Sample ID	Analysis	Analyte	Units	LOR	Pass/Fail	Sample Value
8333328	QC- Blank	OES Scan	Aluminium		mg/L	<0.1 PASS	<0.1
			Antimony		mg/L	<0.5 PASS	<0.5
			Arsenic		mg/L	<0.1 PASS	<0.1
			Barium		mg/L	<0.01 PASS	<0.01
			Beryllium		mg/L	<0.01 PASS	<0.01
			Boron		mg/L	<0.05 PASS	<0.05
			Cadmium		mg/L	<0.01 PASS	<0.01
			Calcium		mg/L	<0.1 PASS	<0.1
			Cerium		mg/L	<0.1 PASS	<0.1

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						Sample Value	
8333328	QC- Blank	OES Scan	Chromium	mg/L	<0.01	PASS	<0.01
			Cobalt	mg/L	<0.1	PASS	<0.1
			Copper	mg/L	<0.01	PASS	<0.01
			Iron	mg/L	<0.05	PASS	<0.05
			Lead	mg/L	<0.05	PASS	<0.05
			Lithium	mg/L	<0.02	PASS	<0.02
			Magnesium	mg/L	<0.1	PASS	<0.1
			Manganese	mg/L	<0.01	PASS	<0.01
			Mercury	mg/L	<0.1	PASS	<0.1
			Molybdenum	mg/L	<0.1	PASS	<0.1
			Nickel	mg/L	<0.01	PASS	<0.01
			Phosphorus	mg P/L	<0.1	PASS	<0.1
			Potassium	mg/L	<0.1	PASS	<0.1
			Selenium	mg/L	<0.1	PASS	<0.1
			Silicon	mg/L	<0.1	PASS	<0.1
			Silver	mg/L	<0.01	PASS	<0.01
			Sodium	mg/L	<0.1	PASS	<0.1
			Strontium	mg/L	<0.01	PASS	<0.01
			Sulphur	mg/L	<0.1	PASS	<0.1
			Thallium	mg/L	<0.1	PASS	<0.1
Tin	mg/L	<0.1	PASS	<0.1			
Titanium	mg/L	<0.01	PASS	<0.01			
Vanadium	mg/L	<0.1	PASS	<0.1			
Zinc	mg/L	<0.01	PASS	<0.01			

QUALITY CONTROL- DUPLICATES

Lab Sample ID	Client Sample ID	Analysis	Analyte	Units	LOR	Pass/Fail	%RPD	Duplicate Value	Expected Value	Sample Value
8326243	EWS	TDS at 180°C +/- 5 oc				PASS	2.7	37		36
				g		PASS	0.1	34.1842		34.1495
				ml		PASS	0.0	40.0		40.0
			Total Dissolved Solids	mg/L	<5	PASS	0.0	18		18
8329746	NCP	Alkalinity		ml		PASS	0.9		185.1	183.4
				Units		PASS	0.0		7.2	7.2
		Bicarbonate Alkalinity as CaCO3		mg CaCO3	<2	PASS	0.9		190	180
		Bicarbonate, as Bicarbonate		mg/L	<2	PASS	0.9		230	220
		Carbonate Alkalinity as CaCO3		mg CaCO3	<2	PASS	0		<2	<2
		Carbonate, as Carbonate		mg/L	<2	PASS	0		<2	<2
		Hydroxide Alkalinity as CaCO3		mg CaCO3	<2	PASS	0		<2	<2
		Hydroxide, as Hydroxide		mg/L	<2	PASS	0		<2	<2
		Total Alkalinity as CaCO3		mg CaCO3	<2	PASS	0.9		190	180
8326583	NCP	EC	Electrical Conductivity @ 25C	uS/cm	<2	PASS	0.2		1800	1800
		pH	pH, units	Units		PASS	0.0		7.0	7.0
8326624	NCP	Turbidity	Turbidity, NTU	NTU	<0.1	PASS	0		<0.1	<0.1
8326661	NCP	EC	Electrical Conductivity @ 25C	uS/cm	<2	PASS	0		<2	<2
		pH	pH, units	Units		PASS	1.9		5.7	5.8
8328587	Boggy 1.2	Chloride	Chloride, as Cl	mg/L	<1	PASS	1.6		1	1
		SO4DA	Sulphate, as SO4	mg/L	<1	PASS	0		<1	<1
8328583	NCP	Reactive P (HL)	Phosphorus, reactive as P	mg P/L	<0.01	PASS	0.7		15	15
8328585	NCP	NO2-N	Nitrite, as N	mg N /L	<0.01	PASS	1.1		0.18	0.18
8326327	NCP	TKN/TP (HL)	Phosphorus, total as P	mg P/L	<0.05	PASS	1.2		9.3	9.2
			Total Kjeldahl Nitrogen as N	mg N /L	<0.1	PASS	0.0		70	70
8328587	Boggy 1.2	NO3-N	Nitrate, as N	mg N /L	<0.01	PASS	3.2		0.12	0.13
		NOX as N	Nitrate + Nitrite, as N	mg N /L	<0.01	PASS	3.1		0.13	0.13
8333326	NCP	OES Scan	Acid soluble Si, as SiO2	mg/L	<0.5	PASS	5.6		5.1	5.4
			Aluminium	mg/L	<0.1	PASS	0		<0.1	<0.1
			Antimony	mg/L	<0.5	PASS	0		<0.5	<0.5
			Arsenic	mg/L	<0.1	PASS	0		<0.1	<0.1
			Barium	mg/L	<0.01	PASS	8.0		0.01	0.01
			Beryllium	mg/L	<0.01	PASS	0		<0.01	<0.01
			Boron	mg/L	<0.05	PASS	0		<0.05	<0.05
			Cadmium	mg/L	<0.01	PASS	0		<0.01	<0.01
			Calcium	mg/L	<0.1	PASS	5.4		5.3	5.6
			Calcium Hardness, as CaCO3	mg/L	<0.5	PASS	5.4		13	14
			Cerium	mg/L	<0.1	PASS	0		<0.1	<0.1
			Chromium	mg/L	<0.01	PASS	0		<0.01	<0.01
			Cobalt	mg/L	<0.1	PASS	0		<0.1	<0.1
			Copper	mg/L	<0.01	PASS	0		<0.01	<0.01

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8333326	NCP	OES Scan				%RPD	Duplicate Value	Expected Value	Sample Value	
			Hardness, as CaCO3	mg/L	<1	PASS	<b>5.4</b>		<b>19</b>	<b>20</b>
			Iron	mg/L	<0.05	PASS	<b>NA</b>		<b>&lt;0.05</b>	<b>0.06</b>
			Lead	mg/L	<0.05	PASS	<b>0</b>		<b>&lt;0.05</b>	<b>&lt;0.05</b>
			Lithium	mg/L	<0.02	PASS	<b>0</b>		<b>&lt;0.02</b>	<b>&lt;0.02</b>
			Magnesium	mg/L	<0.1	PASS	<b>5.5</b>		<b>1.4</b>	<b>1.5</b>
			Magnesium Hardness, as CaCO3	mg/L	<0.5	PASS	<b>5.5</b>		<b>5.9</b>	<b>6.2</b>
			Manganese	mg/L	<0.01	PASS	<b>0</b>		<b>&lt;0.01</b>	<b>&lt;0.01</b>
			Mercury	mg/L	<0.1	PASS	<b>0</b>		<b>&lt;0.1</b>	<b>&lt;0.1</b>
			Molybdenum	mg/L	<0.1	PASS	<b>0</b>		<b>&lt;0.1</b>	<b>&lt;0.1</b>
			Nickel	mg/L	<0.01	PASS	<b>0</b>		<b>&lt;0.01</b>	<b>&lt;0.01</b>
			Phosphorus	mg P/L	<0.1	PASS	<b>0</b>		<b>&lt;0.1</b>	<b>&lt;0.1</b>
			Potassium	mg/L	<0.1	PASS	<b>3.8</b>		<b>0.7</b>	<b>0.7</b>
			Selenium	mg/L	<0.1	PASS	<b>0</b>		<b>&lt;0.1</b>	<b>&lt;0.1</b>
			Silicon	mg/L	<0.1	PASS	<b>5.6</b>		<b>2.4</b>	<b>2.5</b>
			Silver	mg/L	<0.01	PASS	<b>0</b>		<b>&lt;0.01</b>	<b>&lt;0.01</b>
			Sodium	mg/L	<0.1	PASS	<b>4.5</b>		<b>7.7</b>	<b>8.0</b>
			Strontium	mg/L	<0.01	PASS	<b>4.4</b>		<b>0.02</b>	<b>0.02</b>
			Sulphur	mg/L	<0.1	PASS	<b>6.7</b>		<b>0.6</b>	<b>0.7</b>
			Sulphur, as Sulphate	mg/L	<0.5	PASS	<b>6.7</b>		<b>1.9</b>	<b>2.0</b>
			Thallium	mg/L	<0.1	PASS	<b>0</b>		<b>&lt;0.1</b>	<b>&lt;0.1</b>
			Tin	mg/L	<0.1	PASS	<b>0</b>		<b>&lt;0.1</b>	<b>&lt;0.1</b>
			Titanium	mg/L	<0.01	PASS	<b>0</b>		<b>&lt;0.01</b>	<b>&lt;0.01</b>
			Vanadium	mg/L	<0.1	PASS	<b>0</b>		<b>&lt;0.1</b>	<b>&lt;0.1</b>
			Zinc	mg/L	<0.01	PASS	<b>0</b>		<b>&lt;0.01</b>	<b>&lt;0.01</b>

QUALITY CONTROL - SPIKES

Lab Sample ID	Client Sample ID	Analysis	Analyte	Units	LOR	Pass/Fail	% Recovery	Expected Value	Sample Value	
8328579	Boggy 1.1	Chloride	Chloride, as Cl		mg/L	<1	PASS	110	200	1
		SO4DA	Sulphate, as SO4		mg/L	<1	PASS	103	200	<1
Lab Sample ID	Client Sample ID	Analysis	Analyte	Units	LOR	Pass/Fail				
8328577	NCP	Reactive P (HL)	Phosphorus, reactive as P		mg P/L	<0.01	PASS	110	18	16
8328578	NCP	NO2-N	Nitrite, as N		mg N /L	<0.01	PASS	122	2.2	0.18
8326310	NCP	TKNfTP (HL)	Phosphorus, total as P		mg P/L	<0.05	PASS	83.7	29	9.2
			Total Kjeldahl Nitrogen as N		mg N /L	<0.1	PASS	99.5	90	70
8328579	Boggy 1.1	NO3-N	Nitrate, as N		mg N /L	<0.01	PASS	101	8.2	0.18
		NOX as N	Nitrate + Nitrite, as N		mg N /L	<0.01	PASS	102	10	0.19
Lab Sample ID	Client Sample ID	Analysis	Analyte	Units	LOR	Pass/Fail				
8333327	NCP	OES Scan	Aluminium		mg/L	<0.1	PASS	112	1.0	<0.1
			Antimony		mg/L	<0.5	PASS	114	1.0	<0.5
			Arsenic		mg/L	<0.1	PASS	104	N/A	<0.1
			Barium		mg/L	<0.01	PASS	111	0.21	0.01
			Beryllium		mg/L	<0.01	PASS	115	0.20	<0.01
			Boron		mg/L	<0.05	PASS	109	1.0	<0.05
			Cadmium		mg/L	<0.01	PASS	106	1.0	<0.01
			Calcium		mg/L	<0.1	PASS	118	7.6	5.6
			Cerium		mg/L	<0.1	PASS	108	0.50	<0.1
			Chromium		mg/L	<0.01	PASS	106	1.0	<0.01
			Cobalt		mg/L	<0.1	PASS	110	1.0	<0.1
			Copper		mg/L	<0.01	PASS	107	1.0	<0.01
			Iron		mg/L	<0.05	PASS	104	1.1	0.06
			Lead		mg/L	<0.05	PASS	106	1.0	<0.05
			Lithium		mg/L	<0.02	PASS	119	2.0	<0.02
			Magnesium		mg/L	<0.1	PASS	114	3.5	1.5
			Manganese		mg/L	<0.01	PASS	106	1.0	<0.01
			Mercury		mg/L	<0.1	PASS	87.0	N/A	<0.1
			Molybdenum		mg/L	<0.1	PASS	92.7	1.0	<0.1
			Nickel		mg/L	<0.01	PASS	108	1.0	<0.01
			Phosphorus		mg P/L	<0.1	PASS	113	2.0	<0.1
			Potassium		mg/L	<0.1	PASS	104	2.7	0.7
			Selenium		mg/L	<0.1	PASS	120	0.98	<0.1
			Silicon		mg/L	<0.1	PASS	112	4.5	2.5
			Silver		mg/L	<0.01	PASS	106	0.10	<0.01
			Sodium		mg/L	<0.1	PASS	105	10	8.0
			Strontium		mg/L	<0.01	PASS	109	0.52	0.02
			Sulphur		mg/L	<0.1	PASS	113	2.7	0.7
			Thallium		mg/L	<0.1	PASS	101	1.0	<0.1
			Tin		mg/L	<0.1	PASS	103	1.0	<0.1
			Titanium		mg/L	<0.01	PASS	113	1.0	<0.01
			Vanadium		mg/L	<0.1	PASS	104	1.0	<0.1
Zinc		mg/L	<0.01	PASS	113	1.0	<0.01			

**Measurement of Uncertainty.**

When any measurement is made there are a number of factors that affect how accurate the result is. Every step undertaken in the analysis of a sample is subject to some (small) level of error. Estimates of measurement uncertainty provide information about the relative size of the error. As such, MU is an important aspect of any result. Refer to Enviromail™ 53 - What is Measurement Uncertainty for more information.

Analysis	Method Code	Component	Location
			MEL
W-EC	WA010	EC	5%
W-SLDTDS	WA015	TDS_180	10%
W-TURBID	WA045	TURBIDITY	15%

Analysis	Method Code	Component	Location
			MEL
W-OES-SCAN	WG005A (Si not NATA); EA065-69	CA	20%
		K	17%
		MG	20%
		NA	22%

Analysis	Method Code	Component	Location
			MEL
W-CL-DA	WD045G	W-CHLORIDE(DA)	16%
W-NO3-N	EK058GV	W-NO3-N	12%
W-NOX	EK058V & 059GV	NOX_HL	12%
W-TKNTP-H	WK061A	TKN_HL	17%
		TOTAL P_HL	17%

**Eurofins Environment Testing Australia Pty Ltd**

ABN: 50 005 085 521

Melbourne	Geelong	Sydney	Canberra	Brisbane	Newcastle
6 Monterey Road Dandenong South VIC 3175 Tel: +61 3 8564 5000 NATA# 1261 Site# 1254	19/8 Lewalan Street Grovedale VIC 3216 Tel: +61 3 8564 5000 NATA.JI. 1261 Site# 25403	179 Magowar Road Girraween NSW2145 Tel: +61 2 9900 8400 NATA# 1261 Site# 18217	Unit 1.2 Dacre Street Mitchell ACT 2911 Tel: +61261138091 NATA# 1261 Site# 25466	1/21 Smallwood Place Murarie QLD 4172 Tel: +61 7 3902 4600 NATA# 1261 Site# 20794	1/2 Frost Drive Mayfield West NSW 2304 Tel: +61 2 4968 8448 NATA# 1261 Site# 25079 & 25289

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**Eurofins Environment Testing NZ Ltd**

NZBN: 9429046024954

Auckland	Christchurch
35 O'Rorke Road Penrose, Auckland 1061 Tel: +64 9 526 45 51 IANZ# 1327	43 Detroit Drive Rolleston, Christchurch 7675 Tel: 0800 856 450 IANZ# 1290

**Sample Receipt Advice**

**Company name:** GHD Pty Ltd VIC  
**Contact name:** Meg Turner  
**Project name:** MT BULLER  
**Project ID:** 12565989  
**Turnaround time:** 5 Day  
**Date/Time received:** Feb 22, 2023 2:00 PM  
**Eurofins reference:** 966000

**Sample Information**

- / A detailed list of analytes logged into our LIMS, is included in the attached summary table.
- / All samples have been received as described on the above COC.
- / COC has been completed correctly.
- / Attempt to chill was evident.
- / Appropriately preserved sample containers have been used.
- / All samples were received in good condition.
- / Samples have been provided with adequate time to commence analysis in accordance with the relevant holding times.
- / Appropriate sample containers have been used.
- / Sample containers for volatile analysis received with zero headspace.
- X Split sample sent to requested external lab.
- X Some samples have been subcontracted.
- N/A Custody Seals intact (if used).

**Notes**

PLEASE CONFIRM TESTING IN SUITE "EKO59GV".

**Contact**

If you have any questions with respect to these samples, please contact your Analytical Services Manager:

**Harry Bacalis on phone : or by email: HarryBacalis@eurofins.com**

Results will be delivered electronically via email to Meg Turner - meg.turner@ghd.com.

Note: A copy of these results will also be delivered to the general GHD Pty Ltd VIC email address.





web: www.eurofins.com.au  
email: EnviroSales@eurofins.com

Melbourne	Geelong	Sydney	Canberra	Brisbane	Newcastle
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<b>Company Name:</b>	GHD Ply Ltd VIC	<b>Order No.:</b>	12565989	<b>Received:</b>	Feb 22, 2023 2:00 PM
<b>Address:</b>	Level 8, 180 Lonsdale St Melbourne VIC 3000	<b>Report#:</b>	966000	<b>Due:</b>	Mar 1, 2023
<b>Project Name:</b>	MT BULLER	<b>Phone:</b>	8687 8000	<b>Priority:</b>	5 Day
<b>Project ID:</b>	12565989	<b>Fax:</b>	8687 8111	<b>Contact Name:</b>	Meg Turner

**Eurofins Analytical Services Manager : Harry Bacalis**

Sample Detail						Se: <input type="checkbox"/>	As: <input type="checkbox"/>	Co: <input type="checkbox"/>	Cr: <input type="checkbox"/>	Fe: <input type="checkbox"/>	Mn: <input type="checkbox"/>	Ni: <input type="checkbox"/>	Pb: <input type="checkbox"/>	Zn: <input type="checkbox"/>
Melbourne Laboratory - NATA# 1261 Site# 1254						X	X	X	X	X	X	X	X	X
External Laboratory														
SampleID	Sample Date	Sampling Time	Matrix	LABID										
SW-D2	Feb 15, 2023		Water		X	X	X	X		X	X			
GW-D2	Feb 16, 2023		Water	M2 Fe0051806 MnFe0051807										
Test Counts														

**GHD Melbourne**  
**Level 8, 180 Lonsdale St**  
**Melbourne**  
**VIC 3000**



**NATA Accredited**  
 Accreditation Number 1261  
 Site Number 1254

Accredited for compliance with ISO/IEC 17025 - Testing  
 NATA is a signatory to the ILAC Mutual Recognition  
 Arrangement for the mutual recognition of the  
 equivalence of testing, medical testing, calibration,  
 inspection, proficiency testing scheme providers and  
 reference materials producers reports and certificates.

**Attention:** Meg Turner

**Report** 966000-W  
 Project name MT BULLER  
 Project ID 12565989  
 Received Date Feb 22, 2023

Client Sample ID			SW-D2	GW-D2
Sample Matrix			Water	Water
Eurofins Sample No.			M23- Fe0051806	M23- Fe0051807
Date Sampled			Feb 15, 2023	Feb 16, 2023
TesUReference	LOR	Unit		
Ammonia (as N)	0.01	mg/L	< 0.01	< 0.01
Chloride	1	mg/L	< 1	< 1
Conductivity (at 25 °C)	10	uS/cm	27	54
Nitrate & Nitrite (as N)	0.05	mg/L	0.05	3.6
Nitrate (as N)	0.02	mg/L	0.04	3.6
Nitrite (as N)	0.02	mg/L	< 0.02	< 0.02
Phosphate total (as P)	0.01	mg/L	< 0.01	< 0.01
Sulphate (as SO4)	5	mg/L	<5	<5
Total Dissolved Solids Dried at 180 °C ± 2 °C	10	mg/L	28	42
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	0.5	2.8
Total Nitrogen (as N)*	0.2	mg/L	0.55	6.4
Turbidity		NTU	< 1	11
Organic Nitrogen (as N)*	0.2	mg/L		2.8
<b>Alkalinity (speciated)</b>				
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	140	88
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10
<b>Alkali Metals</b>				
Calcium	0.5	mg/L	1.8	3.0
Magnesium	0.5	mg/L	0.7	1.4
Potassium	0.5	mg/L	< 0.5	0.6
Sodium	0.5	mg/L	2.1	2.3

**Sample History**

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

<b>Description</b>	<b>Testing Site</b>	<b>Extracted</b>	<b>Holding Time</b>
<b>Eurofins Suite B19D: Total N, TKN, NOx, NO2, NO3, NH3, Total P Ammonia (as N)</b> - Method: APHA 4500-NH3 Ammonia Nitrogen by FIA	Melbourne	Feb 23, 2023	28 Days
<b>Nitrate &amp; Nitrite (as N)</b> - Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA	Melbourne	Feb 23, 2023	28 Days
<b>Nitrate (as N)</b> - Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA	Melbourne	Feb 23, 2023	28 Days
<b>Nitrite (as N)</b> - Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA	Melbourne	Feb 23, 2023	2 Days
<b>Phosphate total (as P)</b> - Method: LTM-INO-4040 Phosphate by CFA	Melbourne	Feb 23, 2023	28 Days
<b>Total Kjeldahl Nitrogen (as N)</b> - Method: APHA 4500-Norg B,D Total Kjeldahl Nitrogen by FIA	Melbourne	Feb 23, 2023	28 Days
<b>Major Anions</b>			
<b>Chloride</b> - Method: LTM-INO-4090 Chloride by Discrete Analyser	Melbourne	Feb 23, 2023	28 Days
<b>Sulphate (as SO4)</b> - Method: LTM-INO-4110 Sulfate by Discrete Analyser	Melbourne	Feb 23, 2023	28 Days
<b>Alkalinity (speciated)</b> - Method: LTM-INO-4250 Alkalinity by Electrometric Titration	Melbourne	Feb 23, 2023	14 Days
<b>Conductivity (at 25 °C)</b> - Method: LTM-INO-4030 Conductivity	Melbourne	Feb 23, 2023	28 Days
<b>Turbidity</b> - Method: Turbidity by classical using APHA 2130B (LTM-INO-4140)	Melbourne	Feb 23, 2023	28 Days
<b>Total Dissolved Solids Dried at 180 °C ± 2 °C</b> - Method: LTM-INO-4170 Total Dissolved Solids in Water	Melbourne	Feb 23, 2023	28 Days
<b>Nitrogens (speciated)</b>			
<b>Organic Nitrogen (as N)*</b> - Method: APHA 4500 Organic Nitrogen (N)	Melbourne	Feb 23, 2023	7 Days
<b>Major Cations</b>			
<b>Alkali Metals</b> - Method: LTM-MET-3010 Alkali Metals Sulfur Silicon Phosphorus by ICP-AES	Melbourne	Feb 23, 2023	180 Days



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<b>Company Name:</b> GHD Ply Ltd VIC	<b>Order No.:</b> 12565989	<b>Received:</b> Feb 22, 2023 2:00 PM
<b>Address:</b> Level 8, 180 Lonsdale St Melbourne VIC 3000	<b>Report#:</b> 966000	<b>Due:</b> Mar 1, 2023
<b>Project Name:</b> MT BULLER	<b>Phone:</b> 8687 8000	<b>Priority:</b> 5 Day
<b>Project ID:</b> 12565989	<b>Fax:</b> 8687 8111	<b>Contact Name:</b> Meg Turner

Eurofins Analytical Services Manager : Harry Bacalis

Sample Detail						Se: <input type="checkbox"/>	Co: <input type="checkbox"/>	Cr: <input type="checkbox"/>	Fe: <input type="checkbox"/>	Mn: <input type="checkbox"/>	Ni: <input type="checkbox"/>	Pb: <input type="checkbox"/>	Zn: <input type="checkbox"/>
Melbourne Laboratory - NATA# 1261 Site# 1254						X	X	X	X	X	X	X	X
External Laboratory													
SampleID	Sample Date	Sampling Time	Matrix	LABID									
SW-D2	Feb 15, 2023		Water		X	X	X	X		X	X		
GW-D2	Feb 16, 2023		Water	M2 Fe0051806 MnFe0051807									
Test Counts													

**Internal Quality Control Review and Glossary**

**General**

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer that may have an impact on the results.
9. This report replaces any interim results previously issued.

**Holding Times**

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA. If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

**Units**

<b>mg/kg:</b> milligrams per kilogram	<b>mg/L:</b> milligrams per litre	<b>µg/L:</b> micrograms per litre
<b>ppm:</b> parts per million	<b>ppb:</b> parts per billion	<b>%:</b> Percentage
<b>org/100 ml:</b> Organisms per 100 millilitres	<b>NTU:</b> Nephelometric Turbidity Units	<b>MPN/100 ml:</b> Most Probable Number of organisms per 100 millilitres
<b>CFU:</b> Colony forming unit		

**Terms**

<b>APHA</b>	American Public Health Association
<b>COC</b>	Chain of Custody
<b>CP</b>	Client Parent - QC was performed on samples pertaining to this report
<b>CRM</b>	Certified Reference Material (IS017034)- reported as percent recovery.
<b>Dry</b>	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
<b>Duplicate</b>	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
<b>LOR</b>	Limit of Reporting.
<b>LCS</b>	Laboratory Control Sample - reported as percent recovery.
<b>Method Blank</b>	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
<b>NCP</b>	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
<b>RPO</b>	Relative Percent Difference between two Duplicate pieces of analysis.
<b>SPIKE</b>	Addition of the analyte to the sample and reported as percentage recovery.
<b>SRA</b>	Sample Receipt Advice
<b>Surr - Surrogate</b>	The addition of a like compound to the analyte target and reported as percentage recovery.
<b>TBTO</b>	Tributyltin oxide (bis-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment however free tributyltin was measured and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
<b>TCLP</b>	Toxicity Characteristic Leaching Procedure
<b>TEQ</b>	Toxic Equivalency Quotient or Total Equivalence
<b>QSM</b>	US Department of Defense Quality Systems Manual Version 5.4
<b>US EPA</b>	United States Environmental Protection Agency
<b>WADWER</b>	Sum of PFBA, PFPa, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6 2 FTSA, 8 2 FTSA

**QC - Acceptance Criteria**

The acceptance criteria should be used as a guide only and may be different when site specific Sampling Analysis and Quality Plan (SAQP) have been implemented

RPO Duplicates: Global RPO Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR: No Limit

Results between 10-20 times the LOR: RPO must lie between 0-50%

Results >20 times the LOR RPO must lie between 0-30%

NOTE: pH duplicates are reported as a range not as RPO

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.4 where no positive PFAS results have been reported have been reviewed and no data was affected.

**QC Data General Comments**

1. Where a result is reported as a less than(<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. pH and Free Chlorine analysed in the laboratory -Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test		Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
<b>Method Blank</b>								
Ammonia (as N)		mg/L	< 0.01			0.01	Pass	
Chloride		mg/L	< 1				Pass	
Conductivity (at 25 °C)		uS/cm	< 10			10	Pass	
Nitrate & Nitrite (as N)		mg/L	< 0.05			0.05	Pass	
Nitrate (as N)		mg/L	< 0.02			0.02	Pass	
Nitrite (as N)		mg/L	< 0.02			0.02	Pass	
Phosphate total (as P)		mg/L	< 0.01			0.01	Pass	
Sulphate (as SO4)		mg/L	<5			5	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C		mg/L	< 10			10	Pass	
Total Kjeldahl Nitrogen (as N)		mg/L	< 0.2			0.2	Pass	
Turbidity		NTU	< 1				Pass	
<b>Method Blank</b>								
<b>Alkalinity (speciated)</b>								
Bicarbonate Alkalinity (as CaCO3)		mg/L	< 20			20	Pass	
Carbonate Alkalinity (as CaCO3)		mg/L	< 10			10	Pass	
<b>Method Blank</b>								
<b>Alkali Metals</b>								
Calcium		mg/L	< 0.5			0.5	Pass	
Magnesium		mg/L	< 0.5			0.5	Pass	
Potassium		mg/L	< 0.5			0.5	Pass	
Sodium		mg/L	< 0.5			0.5	Pass	
<b>LCS - % Recovery</b>								
Ammonia (as N)		%	127			70-130	Pass	
Chloride		%	112			70-130	Pass	
Conductivity (at 25 °C)		%	110			70-130	Pass	
Nitrate & Nitrite (as N)		%	95			70-130	Pass	
Nitrate (as N)		%	95			70-130	Pass	
Nitrite (as N)		%	98			70-130	Pass	
Phosphate total (as P)		%	91			70-130	Pass	
Sulphate (as SO4)		%	112			70-130	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C		%	119			70-130	Pass	
Total Kjeldahl Nitrogen (as N)		%	94			70-130	Pass	
<b>LCS - % Recovery</b>								
<b>Alkali Metals</b>								
Calcium		%	85			80-120	Pass	
Magnesium		%	97			80-120	Pass	
Potassium		%	93			80-120	Pass	
Sodium		%	97			80-120	Pass	
Test	Lab Sample ID	QA Source	Units	Result 1		Acceptance Limits	Pass Limits	Qualifying Code
<b>Spike - % Recovery</b>								
				Result 1				
Ammonia (as N)	B23-Fe0046250	NCP	%	86		70-130	Pass	
Nitrate & Nitrite (as N)	B23-Fe0046250	NCP	%	98		70-130	Pass	
Nitrate (as N)	B23-Fe0046250	NCP	%	98		70-130	Pass	
Total Kjeldahl Nitrogen (as N)	W23-Fe0043534	NCP	%	119		70-130	Pass	
<b>Spike - % Recovery</b>								
				Result 1				
Calcium	M23-Fe0051806	CP	%	94		75-125	Pass	
Magnesium	M23-Fe0051806	CP	%	98		75-125	Pass	
Potassium	M23-Fe0051806	CP	%	94		75-125	Pass	
Sodium	M23-Fe0051806	CP	%	96		75-125	Pass	

Test	Lab Sample ID	Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
<b>Duplicate</b>									
				Result 1	Result 2	RPO			
Ammonia (as N)	M23-Fe0055159	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Chloride	M23-Fe0051482	NCP	mg/L	550	580	4.3	30%	Pass	
Nitrate & Nitrite (as N)	M23-Fe0055159	NCP	mg/L	0.24	0.24	<1	30%	Pass	
Nitrate (as N)	M23-Fe0055159	NCP	mg/L	0.24	0.24	<1	30%	Pass	
Nitrite (as N)	M23-Fe0055159	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Phosphate total (as P)	M23-Fe0051806	CP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Sulphate (as S04)	M23-Fe0051806	CP	mg/L	<5	<5	<1	30%	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	M23-Fe0047974	NCP	mg/L	150	180	21	30%	Pass	
Total Kjeldahl Nitrogen (as N)	M23-Fe0051806	CP	mg/L	0.5	0.3	42	30%	Fail	015
Turbidity	M23-Fe0051806	CP	NTU	< 1	< 1	<1	30%	Pass	
<b>Duplicate</b>									
<b>Alkali Metals</b>				Result 1	Result 2	RPO			
Calcium	M23-Fe0053299	NCP	mg/L	17	17	2.8	30%	Pass	
Magnesium	M23-Fe0053299	NCP	mg/L	6.2	6.0	2.1	30%	Pass	
Potassium	M23-Fe0053299	NCP	mg/L	31	32	<1	30%	Pass	
<b>Duplicate</b>									
				Result 1	Result 2	RPO			
Total Kjeldahl Nitrogen (as N)	M23-Fe0051807	CP	mg/L	2.8	2.3	21	30%	Pass	

**Comments**

**Sample Integrity**

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
<b>Sample containers for volatile analysis received with minimal headspace</b>	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

**Qualifier Codes/Comments**

Code	Description
015	The RPO reported passes Eurofins Environment Testing's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

**Authorised by:**

Harry Bacalis	Analytical Services Manager
Mary Makarios	Senior Analyst-Inorganic
Mary Makarios	Senior Analyst-Metal
Scott Beddoes	Senior Analyst-Inorganic



**Glenn Jackson**  
**General Manager**

Final Report - this report replaces any previously issued Report

- Indicates Not Requested

\* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please [click here](#).

Eurofins shall not be liable for loss, cost, damages or expenses incurred by the client, or any other person or company, resulting from the use of any information or interpretation given in this report. In no case shall Eurofins be liable for consequential damages including, but not limited to, lost profits, damages for failure to meet deadlines and lost production arising from this report. This document shall not be reproduced except in full and relates only to the items tested. Unless indicated otherwise, the tests were performed on the samples as received.



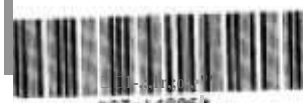
**CHAIN OF CUSTODY**  
Water Resources Group

M:IN • B:PI • MiO 3:W  
Page... of ... & . - .

Melbourne Office  
22 Dalmore Drive  
Scoresby VIC 3177  
Phone: 03 8755 8000  
Fax: 03 9763 1882  
Email: melbourne@als.com.au

GHD Pty Ltd  
GHD VSG  
23-14906

OFFICIAL



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Wangaratta Office  
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Traralgon Office  
4/55 Hazelwood Rd,  
PO Box 1469  
Traralgon VIC 3844  
Phone: 03 5176 4170  
Fax: 03 5176 4473  
traralgon@als.com.au

Customer Reference: **Due Oma**  
ts/m2/2021

Client: **GHD** TAT: 5  
Contact: (results) **Meg.Turner@ghd.com** Laib'Wori< Omc-r' No:  
(invoice)  
Address: IMS Program Code:  
Fax: **1 1** !!:ST: ml FE -m Tr77

P/O No.: **12565989** Quote No:  
T/A Time: Sampler:  
Job/Proj Ref: **12565989**

Sample ID	Sample Description	No of Containers	Date Sampled	Time sampled	IV Im;	
GW-D1	Groundwater	4	16/2/23			
GW-D2						
BH06						
BH09						
BH16						15/2/23
BH17						16/2/23
BH18	16/2/23					

Cations	Anions	Nutrients	EC, TDS, Turbidity	Field Parameters	Send to Eurofins
X	X	X	X	X	
X	X	X	X	X	X
X	X	X	X	X	
X	X	X	X	X	
X	X	X	X	X	
X	X	X	X	X	

Spec.ia| Instructions: **Suite Codes as per page 1 of COC**

Relinquished By:	Company:	Date:	Time:	Received By:
M.T	GHD	17/2/23		me

Company:	Date:	Time:
AL	21/02/23	10:50

This form is for recording of sample data after prior consultation with an analyst regarding sampling procedures and does not over-ride pricing agreements, OHS requirements and our terms and conditions.  
As an Occupational Health and Safety consideration, it is a requirement of ALS Water Resources Group that all samples received be undamaged and prior advice given in writing of any potential health risks.

**LAB USE ONLY**  
Sample conditions:  
Samples received undamaged [Yes/No]  
Samples adequately preserved [Yes/No]  
Samples within recommended holding times: [Yes/No]  
Samples transported at appropriate temperature [Yes/No]

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**CHAIN OF CUST'OD-**  
Water Resources Group

ABN- 9-i 10'5 OcID ij,2JJ  
ao.e.J... oL.□--

Melbourne Office:  
22 Dalmore Drive  
Scoresby VIC 3171  
Ph: 03 9770 11000  
Fax: 03 9770 11000  
Email: melbournew@alsglobal.com

Geelong Office:  
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Geelong VIC 3220  
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Fax: 03 5248 1110  
Email: geelong@alsglobal.com

Warrarunga Office:  
48 Faghtull Street  
Warrarunga VIC 3747  
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Mobile: 0419 007 749  
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Traralgon Office  
455 Hazelwood Rd,  
PO Box 1489  
Traralgon VIC 3844  
Ph: 03 5176 4170  
Fax: 03 5176 4473  
Email: traralgon@alsglobal.com

OFFICIAL

Client: GHD						Offu□, uoo only								
Contact: (results) Meg.Turner@ghd.com						Lab Wor,k Ol"a@r No.:								
(invoice) GHD Job 12565989 to the attention of Meg Turner						LIMS Program Co.:								
Address: 130 Longdale St Melbourne 3000						TESTS rJC...ul RE								
Phone: 03 9637 8000			Fax: 613 9637 8111			Cations (Ca, Mg, Mn, K) Anions (Cl, SO4, Alk, Total) Nutrients (Nites) (NT-11 and Ekos) EC, TDs, Turbidity Field parameters Send to Eurofins								
P/O No.: 12565989		Qoo□ No-:				Zinc 1								
T/A Time:		Sampler:				1								
Job/Proj Ref: 12565989 - Mt Buller														
Lab Sample ID	Sample Description	No of Containers	Date Sampled	Time sampled	Matrix	Cations (Ca, Mg, Mn, K)	Anions (Cl, SO4, Alk, Total)	Nutrients (Nites)	(NT-11 and Ekos)	EC, TDs, Turbidity	Field parameters	Send to Eurofins	Zinc	1
Boggy 1.1	Surface Water	4	15/2/23		SW	X	X	X	X	X				
Boggy 1.2	"					X	X	X	X	X				
Boggy 2	"					X	X	X	X	X				
SW-D1						X	X	X	X	X				
SW-D2						X	X	X	X	X		X		
EWS						X	X	X	X	X				
Special Instructions: Suite Codes: 101-1						Mf-1, EKC:S7								
Relinquished By: M.T						Company: GHD								
Date: 17/2/23						Received By: Garm?iil'J:								
						Date:								
						Time:								
This form is for recording of sample data after prior consultation with an analyst regarding sampling procedures and does not override prior agreements, OHS requirements and our terms and conditions.						f:iitf USE (H.L.y								
As an Occupational Health and Safety consideration, it is a requirement of ALS Water Resources Group that all samples received be unc□□N□ prior advice given in writing of any potential health risks.						Sample conditions: Samples received undamaged [Yes/No] Samples adequately preserved [Yes/No] Samples within recommended holding times: [Yes/No] Samples transported at appropriate temperature [Yes/No]								

OFFICIAL

**Eurofins Environment Testing Australia Pty Ltd**

ABN: 50 005 085 521

<b>Melbourne</b> 6 Monterey Road Dandenong South VIC 3175 Tel: +61 3 8564 5000 NATA# 1261 Site# 1254	<b>Geelong</b> 19/8 Lewalan Street Grovedale VIC 3216 Tel: +61 3 8564 5000 NATA.JI. 1261 Site# 25403	<b>Sydney</b> 179 Magowar Road Girraween NSW2145 Tel: +61 2 9900 8400 NATA# 1261 Site# 18217	<b>Canberra</b> Unit 1.2 Dacre Street Mitchell ACT 2911 Tel: +61261138091 NATA# 1261 Site# 25466	<b>Brisbane</b> 1/21 Smallwood Place Murarie QLD 4172 Tel: +61 7 3902 4600 NATA# 1261 Site# 20794	<b>Newcastle</b> 1/2 Frost Drive Mayfield West NSW 2304 Tel: +61 2 4968 8448 NATA# 1261 Site# 25079 & 25289
---	---	---	---	--	--

**Eurofins ARL Pty Ltd**

ABN: 91 05 0159 898

<b>Perth</b> 46-48 Banksia Road Welshpool WA6106 Tel: +61 8 6253 4444 NATA# 2377 Site# 2370
--

**Eurofins Environment Testing NZ Ltd**

NZBN: 9429046024954

<b>Auckland</b> 35 O'Rorke Road Penrose, Auckland 1061 Tel: +64 9 526 45 51 IANZ# 1327	<b>Christchurch</b> 43 Detroit Drive Rolleston, Christchurch 7675 Tel: 0800 856 450 IANZ# 1290
---	---

## Sample Receipt Advice

<b>Company name:</b>	GHD Pty Ltd VIC
<b>Contact name:</b>	Meg Turner
<b>Project name:</b>	MOUNT BULLER WATER STORAGE ONGOING MONITORING PROGRAM
<b>Project ID:</b>	12565989
<b>Turnaround time:</b>	5 Day
<b>Date/Time received</b>	Apr 24, 2023 4:00 PM
<b>Eurofins reference</b>	983641

## Sample Information

- / A detailed list of analytes logged into our LIMS, is included in the attached summary table.
- / All samples have been received as described on the above COC.
- / COC has been completed correctly.
- / Attempt to chill was evident.
- / Appropriately preserved sample containers have been used.
- / All samples were received in good condition.
- / Samples have been provided with adequate time to commence analysis in accordance with the relevant holding times.
- / Appropriate sample containers have been used.
- / Sample containers for volatile analysis received with zero headspace.
- X Split sample sent to requested external lab.
- X Some samples have been subcontracted.
- N/A Custody Seals intact (if used).

## Notes

## Contact

If you have any questions with respect to these samples, please contact your Analytical Services Manager:

**Harry Bacalis on phone : or by email: [HarryBacalis@eurofins.com](mailto:HarryBacalis@eurofins.com)**

Results will be delivered electronically via email to Meg Turner - [meg.turner@ghd.com](mailto:meg.turner@ghd.com).

*Note: A copy of these results will also be delivered to the general GHD Pty Ltd VIC email address.*





web: www.eurofins.com.au  
email: EnviroSales@eurofins.com

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NATA# 1261 Site# 20794

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NATA# 1261 Site# 25079 & 25289

**Perth**  
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Tel: +61 8 6253 4444  
NATA# 2377 Site# 2370

**Auckland**  
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IANZ# 1327

**Christchurch**  
43 Detroit Drive  
Rolleston,  
Christchurch 7675  
Tel: 0800 856 450  
IANZ# 1290

<b>Company Name:</b>	GHD Ply Ltd VIC	<b>Order No.:</b>		<b>Received:</b>	Apr 24, 2023 4:00 PM
<b>Address:</b>	Level 8, 180 Lonsdale St Melbourne VIC 3000	<b>Report#:</b>	983641	<b>Due:</b>	May 2, 2023
		<b>Phone:</b>	8687 8000	<b>Priority:</b>	5 Day
		<b>Fax:</b>	8687 8111	<b>Contact Name:</b>	Meg Turner
<b>Project Name:</b>	MOUNT BULLER WATER STORAGE ONGOING MONITORING PROGRAM				
<b>Project ID:</b>	12565989				

Eurofins Analytical Services Manager : Harry Bacalis

Sample Detail						Chloride	Ammonia	Nitrate	Nitrite	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate
Melbourne Laboratory - NATA# 1261 Site# 1254						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
External Laboratory						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SampleID	Sample Date	Sampling Time	Matrix	LABID																	
SW-D2	Apr 18, 2023		Water	M23-Ap0052002	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
GW-D2	Apr19,2023		Water	M23-Ap0052003	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<b>Test Counts</b>					2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

GHD Melbourne  
 Level 8, 180 Lonsdale St  
 Melbourne  
 VIC 3000



NATA Accredited  
 Accreditation Number 1261  
 Site Number 1254

Accredited for compliance with ISO/IEC 17025 - Testing  
 NATA is a signatory to the ILAC Mutual Recognition  
 Arrangement for the mutual recognition of the  
 equivalence of testing, medical testing, calibration,  
 inspection, proficiency testing scheme providers and  
 reference materials producers reports and certificates.

Attention: Meg Turner

Report 983641-W  
 Project name MOUNT BULLER WATER STORAGE ONGOING MONITORING PROGRAM  
 Project ID 12565989  
 Received Date Apr24,2023

Client Sample ID			SW-D2	GW-D2
Sample Matrix			Water	Water
Eurofins Sample No.			M23- Ap0052002	M23- Ap0052003
Date Sampled			Apr 18, 2023	Apr 19, 2023
TesUReference	LOR	Unit		
Chloride		mg/L	< 1	< 1
Conductivity (at 25 °C)	10	uS/cm	25	19
Nitrate (as N)	0.02	mg/L	0.20	0.77
Nitrite (as N)	0.02	mg/L	< 0.02	< 0.02
pH (at 25 °C)	0.1	pH Units	7.4	7.0
Phosphate total (as P)	0.01	mg/L	0.02	0.02
Phosphorus reactive (as P)	0.01	mg/L	< 0.01	0.01
Reactive Silica (as SiO2)	2	mg/L	6.7	6.3
Sulphate (as SO4)	5	mg/L	<5	<5
Total Dissolved Solids Dried at 180 °C ± 2 °C	10	mg/L	46	34
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	< 0.2	< 0.2
Total Suspended Solids Dried at 103 °C to 105 °C	5	mg/L	<5	86
Hardness mg equivalent CaCO3/L	5	mg/L	7.3	<5
<b>Alkalinity (speciated)</b>				
Total Alkalinity (as CaCO3)	20	mg/L	< 20	23
<b>Alkali Metals</b>				
Calcium	0.5	mg/L	1.8	0.9
Magnesium	0.5	mg/L	0.7	< 0.5
Potassium	0.5	mg/L	< 0.5	< 0.5
Sodium	0.5	mg/L	1.6	1.7
<b>Heavy Metals</b>				
Arsenic (filtered)	0.001	mg/L	< 0.001	< 0.001
Cadmium (filtered)	0.0002	mg/L	< 0.0002	< 0.0002
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001
Copper (filtered)	0.001	mg/L	< 0.001	0.006
Lead (filtered)	0.001	mg/L	< 0.001	< 0.001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001
Nickel (filtered)	0.001	mg/L	< 0.001	< 0.001
Zinc (filtered)	0.005	mg/L	< 0.005	< 0.005

**Sample History**

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
<b>Chloride</b> - Method: LTM-INO-4090 Chloride by Discrete Analyser	Melbourne	Apr25,2023	28 Days
<b>Conductivity (at 25 °C)</b> - Method: LTM-INO-4030 Conductivity	Melbourne	Apr25,2023	28 Days
<b>Nitrate (as N)</b> - Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA	Melbourne	Apr25,2023	28 Days
<b>Nitrite (as N)</b> - Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA	Melbourne	Apr25,2023	2 Days
<b>pH (at 25 °C)</b> - Method: LTM-GEN-7090 pH in water by ISE	Melbourne	Apr25,2023	0 Hours
<b>Phosphate total (as P)</b> - Method: LTM-INO-4040 Phosphate by CFA	Melbourne	Apr25,2023	28 Days
<b>Phosphorus reactive (as P)</b> - Method: APHA 4500-P	Melbourne	Apr25,2023	2 Days
<b>Reactive Silica (as SiO2)</b> - Method: APHA 4500-SiO2 C	Melbourne	Apr28,2023	5 Days
<b>Sulphate (as SO4)</b> - Method: LTM-INO-4110 Sulfate by Discrete Analyser	Melbourne	Apr25,2023	28 Days
<b>Total Kjeldahl Nitrogen (as N)</b> - Method: APHA 4500-Norg B,D Total Kjeldahl Nitrogen by FIA	Melbourne	Apr25,2023	28 Days
<b>Total Suspended Solids Dried at 103 °C to 105 °C</b> - Method: LTM-INO-4070 Analysis of Suspended Solids in Water by Gravimetry	Melbourne	Apr25,2023	7 Days
<b>Alkalinity (speciated)</b> - Method: LTM-INO-4250 Alkalinity by Electrometric Titration	Melbourne	Apr25,2023	14 Days
<b>Alkali Metals</b> - Method: LTM-MET-3010 Alkali Metals Sulfur Silicon Phosphorus by ICP-AES	Melbourne	Apr25,2023	180 Days
<b>Metals M8 filtered</b> - Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS	Melbourne	Apr25,2023	28 Days
<b>Total Dissolved Solids Dried at 180 °C ± 2 °C</b> - Method: LTM-INO-4170 Total Dissolved Solids in Water	Melbourne	Apr25,2023	28 Days
<b>Hardness Set</b> <b>Hardness mg equivalent CaCO3/L</b> - Method: APHA 2340B Hardness by Calculation	Melbourne	Apr25,2023	28 Days



web: www.eurofins.com.au  
email: EnviroSales@eurofins.com

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Perth	Auckland	Christchurch
46-48 Banksia Road Welshpool WA6106 Tel: +61 8 6253 4444 NATA# 2377 Site# 2370	35 O'Rorke Road Penrose, Auckland 1061 Tel: +64 9 526 45 51 IANZ# 1327	43 Detroit Drive Rolleston, Christchurch 7675 Tel: 0800 856 450 IANZ# 1290

<b>Company Name:</b>	GHD Ply Ltd VIC	<b>Order No.:</b>		<b>Received:</b>	Apr 24, 2023 4:00 PM
<b>Address:</b>	Level 8, 180 Lonsdale St Melbourne VIC 3000	<b>Report#:</b>	983641	<b>Due:</b>	May 2, 2023
<b>Project Name:</b>	MOUNT BULLER WATER STORAGE ONGOING MONITORING PROGRAM	<b>Phone:</b>	8687 8000	<b>Priority:</b>	5 Day
<b>Project ID:</b>	12565989	<b>Fax:</b>	8687 8111	<b>Contact Name:</b>	Meg Turner

**Eurofins Analytical Services Manager : Harry Bacalis**

Sample Detail						Chloride	Ammonia	Nitrate	Nitrite	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	Phosphate	
Melbourne Laboratory - NATA# 1261 Site# 1254						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
External Laboratory						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SampleID	Sample Date	Sampling Time	Matrix	LABID																	
SW-D2	Apr 18, 2023		Water	M23-Ap0052002	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
GW-D2	Apr19,2023		Water	M23-Ap0052003	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<b>Test Counts</b>					2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

**Internal Quality Control Review and Glossary**

**General**

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer that may have an impact on the results.
9. This report replaces any interim results previously issued.

**Holding Times**

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA. If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

**Units**

<b>mg/kg:</b> milligrams per kilogram	<b>mg/L:</b> milligrams per litre	<b>µg/L:</b> micrograms per litre
<b>ppm:</b> parts per million	<b>ppb:</b> parts per billion	<b>%:</b> Percentage
<b>org/100 ml:</b> Organisms per 100 millilitres	<b>NTU:</b> Nephelometric Turbidity Units	<b>MPN/100 ml:</b> Most Probable Number of organisms per 100 millilitres
<b>CFU:</b> Colony forming unit		

**Terms**

<b>APHA</b>	American Public Health Association
<b>COC</b>	Chain of Custody
<b>CP</b>	Client Parent - QC was performed on samples pertaining to this report
<b>CRM</b>	Certified Reference Material (IS017034)- reported as percent recovery.
<b>Dry</b>	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
<b>Duplicate</b>	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
<b>LOR</b>	Limit of Reporting.
<b>LCS</b>	Laboratory Control Sample - reported as percent recovery.
<b>Method Blank</b>	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
<b>NCP</b>	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
<b>RPO</b>	Relative Percent Difference between two Duplicate pieces of analysis.
<b>SPIKE</b>	Addition of the analyte to the sample and reported as percentage recovery.
<b>SRA</b>	Sample Receipt Advice
<b>Surr - Surrogate</b>	The addition of a like compound to the analyte target and reported as percentage recovery.
<b>TBTO</b>	Tributyltin oxide (bis-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment however free tributyltin was measured and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
<b>TCLP</b>	Toxicity Characteristic Leaching Procedure
<b>TEQ</b>	Toxic Equivalency Quotient or Total Equivalence
<b>QSM</b>	US Department of Defense Quality Systems Manual Version 5.4
<b>US EPA</b>	United States Environmental Protection Agency
<b>WADWER</b>	Sum of PFBA, PFPa, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6 2 FTSA, 8 2 FTSA

**QC - Acceptance Criteria**

The acceptance criteria should be used as a guide only and may be different when site specific Sampling Analysis and Quality Plan (SAQP) have been implemented

RPO Duplicates: Global RPO Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR: No Limit

Results between 10-20 times the LOR: RPO must lie between 0-50%

Results >20 times the LOR RPO must lie between 0-30%

NOTE: pH duplicates are reported as a range not as RPO

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.4 where no positive PFAS results have been reported have been reviewed and no data was affected.

**QC Data General Comments**

1. Where a result is reported as a less than(<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. pH and Free Chlorine analysed in the laboratory -Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1		Acceptance Limits	Pass Limits	Qualifying Code
<b>Method Blank</b>						
Chloride	mg/L	< 1			Pass	
Conductivity (at 25 °C)	uS/cm	< 10		10	Pass	
Nitrate (as N)	mg/L	< 0.02		0.02	Pass	
Nitrite (as N)	mg/L	< 0.02		0.02	Pass	
Phosphate total (as P)	mg/L	< 0.01		0.01	Pass	
Phosphorus reactive (as P)	mg/L	< 0.01		0.01	Pass	
Reactive Silica (as SiO <sub>2</sub> )	mg/L	<2		2	Pass	
Sulphate (as SO <sub>4</sub> )	mg/L	<5		5	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	mg/L	< 10		10	Pass	
Total Kjeldahl Nitrogen (as N)	mg/L	< 0.2		0.2	Pass	
Total Suspended Solids Dried at 103 °C to 105 °C	mg/L	<5		5	Pass	
<b>Method Blank</b>						
<b>Alkalinity (speciated)</b>						
Total Alkalinity (as CaCO <sub>3</sub> )	mg/L	< 20		20		
<b>Method Blank</b>						
<b>Alkali Metals</b>						
Calcium	mg/L	< 0.5		0.5	Pass	
Magnesium	mg/L	< 0.5		0.5	Pass	
Potassium	mg/L	< 0.5		0.5	Pass	
Sodium	mg/L	< 0.5		0.5	Pass	
<b>Method Blank</b>						
<b>Heavy Metals</b>						
Arsenic (filtered)	mg/L	< 0.001		0.001	Pass	
Cadmium (filtered)	mg/L	< 0.0002		0.0002	Pass	
Chromium (filtered)	mg/L	< 0.001		0.001	Pass	
Copper (filtered)	mg/L	< 0.001		0.001	Pass	
Lead (filtered)	mg/L	< 0.001		0.001	Pass	
Mercury (filtered)	mg/L	< 0.0001		0.0001	Pass	
Nickel (filtered)	mg/L	< 0.001		0.001	Pass	
Zinc (filtered)	mg/L	< 0.005		0.005	Pass	
<b>LCS - % Recovery</b>						
Chloride	%	120		70-130	Pass	
Conductivity (at 25 °C)	%	106		70-130	Pass	
Nitrate (as N)	%	105		70-130	Pass	
Nitrite (as N)	%	105		70-130	Pass	
Phosphate total (as P)	%	114		70-130	Pass	
Phosphorus reactive (as P)	%	95		70-130	Pass	
Sulphate (as SO <sub>4</sub> )	%	121		70-130	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	%	97		70-130	Pass	
Total Kjeldahl Nitrogen (as N)	%	76		70-130	Pass	
Total Suspended Solids Dried at 103 °C to 105 °C	%	95		70-130	Pass	
<b>LCS - % Recovery</b>						
<b>Alkalinity (speciated)</b>						
Total Alkalinity (as CaCO <sub>3</sub> )	%	91		70-130		
<b>LCS - % Recovery</b>						
<b>Alkali Metals</b>						
Calcium	%	85		80-120	Pass	
Magnesium	%	90		80-120	Pass	
Potassium	%	90		80-120	Pass	
Sodium	%	92		80-120	Pass	
<b>LCS - % Recovery</b>						

Test				Units	Result 1		Acceptance Limits	Pass Limits	Qualifying Code	
<b>Heavy Metals</b>										
Arsenic (filtered)				%	97		80-120	Pass		
Cadmium (filtered)				%	102		80-120	Pass		
Chromium (filtered)				%	101		80-120	Pass		
Copper (filtered)				%	102		80-120	Pass		
Lead (filtered)				%	104		80-120	Pass		
Mercury (filtered)				%	94		80-120	Pass		
Nickel (filtered)				%	101		80-120	Pass		
Zinc (filtered)				%	101		80-120	Pass		
Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code	
<b>Spike - % Recovery</b>										
Total Suspended Solids Dried at 103 °C to 105 °C				M23-Ap0050489	NCP	%	96	70-130	GJ	
<b>Spike - % Recovery</b>										
<b>Alkali Metals</b>					Result 1					
Calcium	M23-Ap0052002	CP	%	98			75-125	Pass		
Magnesium	B23-Ap0049026	NCP	%	92			75-125	Pass		
Potassium	B23-Ap0049026	NCP	%	82			75-125	Pass		
Sodium	M23-Ap0052002	CP	%	103			75-125	Pass		
<b>Spike - % Recovery</b>										
<b>Heavy Metals</b>					Result 1					
Arsenic (filtered)	M23-Ap0046788	NCP	%	98			75-125	Pass		
Cadmium (filtered)	M23-Ap0046788	NCP	%	101			75-125	Pass		
Chromium (filtered)	M23-Ap0046788	NCP	%	100			75-125	Pass		
Copper (filtered)	M23-Ap0046788	NCP	%	101			75-125	Pass		
Lead (filtered)	M23-Ap0046788	NCP	%	101			75-125	Pass		
Mercury (filtered)	M23-Ap0046788	NCP	%	95			75-125	Pass		
Nickel (filtered)	M23-Ap0046788	NCP	%	99			75-125	Pass		
Zinc (filtered)	M23-Ap0046788	NCP	%	100			75-125	Pass		
<b>Spike - % Recovery</b>										
Chloride	M23-Ap0052003	CP	%	96			70-130	Pass		
Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code	
<b>Duplicate</b>										
				Result 1	Result 2	RPO				
Chloride	M23-Ap0052002	CP	mg/L	< 1	< 1	<1	30%	Pass		
Nitrate (as N)	M23-Ap0039097	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass		
Nitrite (as N)	M23-Ap0039097	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass		
Phosphate total (as P)	M23-Ap0049854	NCP	mg/L	0.05	0.05	2.9	30%	Pass		
Sulphate (as SO4)	M23-Ap0052002	CP	mg/L	<5	<5	<1	30%	Pass		
Total Dissolved Solids Dried at 180 °C ± 2 °C	M23-Ap0051636	NCP	mg/L	4700	4600	2.9	30%	Pass		
Total Suspended Solids Dried at 103 °C to 105 °C	M23-Ap0050487	NCP	mg/L	19	17	8.9	30%	Pass		
Hardness mg equivalent CaCO3/L	B23-Ap0049026	NCP	mg/L	59	50	16	30%	Pass		
<b>Duplicate</b>										
<b>Alkali Metals</b>				Result 1	Result 2	RPO				
Magnesium	B23-Ap0049026	NCP	mg/L	5.5	4.2	25	30%	Pass		
Potassium	B23-Ap0049026	NCP	mg/L	5.9	5.4	7.7	30%	Pass		

<b>Duplicate</b>								
<b>Heavy Metals</b>				Result 1	Result 2	RPO		
Arsenic (filtered)	M23-Ap0046788	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass
Cadmium (filtered)	M23-Ap0046788	NCP	mg/L	< 0.0002	< 0.0002	<1	30%	Pass
Chromium (filtered)	M23-Ap0046788	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass
Copper (filtered)	M23-Ap0046788	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass
Lead (filtered)	M23-Ap0046788	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass
Mercury (filtered)	M23-Ap0046788	NCP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass
Nickel (filtered)	M23-Ap0046788	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass
Zinc (filtered)	M23-Ap0046788	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass
<b>Duplicate</b>								
				Result 1	Result 2	RPO		
Reactive Silica (as SiO <sub>2</sub> )	M23-Ap0052003	CP	mg/L	6.3	6.2	1.8	30%	Pass
Total Kjeldahl Nitrogen (as N)	M23-Ap0052003	CP	mg/L	< 0.2	< 0.2	<1	30%	Pass

**Comments****Sample Integrity**

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
<b>Sample containers for volatile analysis received with minimal headspace</b>	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

**Authorised by:**

Harry Bacalis	Analytical Services Manager
<b>Caitlin Breeze</b>	<b>Senior Analyst-Inorganic</b>
Emily Rosenberg	Senior Analyst-Metal
Mary Makarios	Senior Analyst-Inorganic



**Glenn Jackson**  
**General Manager**

Final Report - this report replaces any previously issued Report

- Indicates Not Requested

• Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please [click here](#).

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Table with multiple columns and rows, containing various data points and headers in a structured layout.



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Table with multiple columns and rows, containing various data points and headers. The table is organized into several sections with blue headers. The columns include various identifiers and numerical values. The rows are grouped into sections, each starting with a blue header row. The data appears to be organized into categories, possibly related to different types of services or products.

































CHAIN OF CUSTODY RECORD **FR W HT** Collection Date / Turnaround

DHD Melbourne Office Address  
180 Lonsdale Street, Melbourne 3000  
Telephone: 613 8687 8000  
Fax: 613 8687 8111  
Laboratory

Number: **ALS**

Item: **Water Storage Ongoing Monitoring Program**

Project Manager: **Broad Snibson**

Lab Address: **2-4 Westall Road, Springvale 3171**

Lab Contact: **Broad Snibson**

DHD Contact email: [mes.lerner@dhd.com](mailto:mes.lerner@dhd.com)

Sample I.D.	Date and Time	Containers	Analysis Required
3591 PU1	18/4/23	P 4	As per highlighted suits attached
3591 PU2			
3592			
V-D1			
V-D2			
WS	19/4/23	P 4	
106			
109			
116			
117			
118			
W-D1			
W-D2	19/4/23	P 4	
21			

NUMBER OF SAMPLES: **13/14**

NUMBER OF ESQES: **3**

DETAILS

R: **MT** Date/Time: **20/4/23** Requisitioned by:

S: **ALS** Date/Time: **11:20** Requisitioned by:

Environmental Division  
Melbourne  
Work Order Reference  
**EM230698**



Telephone: 03-9559 3600

Received by 21/4/23  
ALS 11:20



# ALS Water VIC - Sample Container Filling Instructions

**Warning:** Some containers contain chemicals which may be harmful to your health. Do not breathe vapours or fumes, do not ingest, do not get on your skin or clothes. If you experience any symptoms, seek medical attention immediately. **Wear gloves and eye protection when handling water.**

**Note:** With bottles containing preservative: **DO NOT RINSE** the container. Do not fill to the top. Do not overfill. Do not use the container for anything other than the intended purpose.

**Full - Exclude all air space (bottle can be filled to overflowing)**

• Fill only to the top of the bottle

Tap - Fill to the top but do not overfill (Preservative added)

5011 JD MATRIL SA PLE CONTAINERS [Soil / Sediment / Blasting / Campo.st]

No.	Label Colour	Container Type (Preservation)	Test Parameter(s)
Full	Orange	1 x 500mL plastic (none)	ALS Suite 51 - 56 plus two leaches (TCLP or ASLP) including ZHE
Full	Green	1 x 250g resealable plastic bag (samples can be frozen)	Acid Sulfate Soils
Full	N/A	50g ALS pre-labelled bag	Asbestos, Presence/Absence
Full	N/A	500g ALS pre-labelled bag	Asbestos, Friable
Full	Green	1 x 250g resealable plastic bag	Particle Sizing
Full	Grey	1 x 200g ALS pre-labelled plastic jar	PFAS
Full		1 x 500mL plastic (none)	Microbiological tests (E.coli, Salmonella, Viruses) Separate jar required if TS or other chemistry tests required to avoid contamination.

AQUOUS MIXED SAMPLE CONTAINERS (WATER)

Volumes listed below are recommended based on "clean" waters. Please contact ALS for further advice on sample volumes.

Fill to	Label Colour	Container Type (Preservation)	Test Parameter(s)
Full	Green	1 x 60ml plastic (none)	Cations (Ca, K, Mg, Na)
Full	Green	1 x 60ml plastic (none)	Anions (Cl, SO4)
Full	Green	1 x 250ml plastic (none)	Fluoride (F)
Full	Green	1 x 250mL plastic (none)	Nitrite, Nitrate, Reactive P, Total P, TKN, Reactive Silica
Full	Green	1 x 500mL plastic (none)	Colour, Turbidity, TDS, TSS
Full	Green	1 x 500mL plastic (none)	Alkalinity, EC, pH, Cl, SO4, F, Hardness
Full	Green	1 x 500mL plastic (none)	BOD
Full	Green	1 x 1,000mL plastic (none)	Low level TSS (Clean Water only)
Full	Green	1 x 1,000mL plastic (none)	Chlorophyll a (Standard LOR)
Full	Green	1 x 1,000mL White plastic (none)	Asbestos
Full	Green	1 x 250mL plastic (none) Sample to be held for 24hr holding time	ULTRAFILTRATE, Pt, Total N, Nitrate, Nitrite, Nitrogen
Full	Green	1 x 60ml plastic (none) sample to be held for 24hr holding time expected to be excess	Phosphate, "Nftl"
Top	Yellow	1 x 125mL plastic (Zinc Acetate)	Sulfide
Top	Yellow	1 x 250mL plastic (EDTA and Zinc Acetate)	Sulfite, Thiosulfate



INORGANICS - Continued

Fill to	Label Colour	Container Type (Preservation)	Test Parameter(s)
Full	White	1 x 60ml plastic (none)	MBAS
		1 x 500mL Amber glass (None)	
To	Black	1 x 60ml plastic (NaOH)	
To	Purple	1 x 60ml plastic (Sulfuric acid 1:4)	
Full	Circular	1 x 250ml plastic bottle (None)	
Top	Red	1 x 500mL Amber Glass bottle (pH 2 Nitric acid 1:4)	AOX (adsorbable Organic Halides)
Full	Circular	1 x 500mL Amber Glass bottle (Lab Acidified)	AOX (adsorbable Organic Halides)
Top	Purple	1 x 100mL Amber Glass bottle (Sulfuric acid 1:4)	TOC
Full	Green	1 x 100mL Amber Glass bottle (None)	DOC / TOC
Top	Purple/White	1 x 250ml wide mouth glass jar (Sodium Bisulfate)	Oil & Grease
Full	Green	2 x 500mL Amber Glass bottle (None)	Oil & Grease_LL (ALS Canberra)

MICROBIOLOGY ALCAE

Fill to	Label Colour	Container Type (Preservation)	Test Parameter(s)
1/4	Grey	1 x 250mL Sterile plastic bottle (With Na <sub>2</sub> S <sub>2</sub> O <sub>5</sub> )	Coliforms, <i>E. coli</i> , <i>Salmonella</i> Coliforms
3/4	Circular	1 x 250mL Sterile plastic bottle (With Na <sub>2</sub> S <sub>2</sub> O <sub>5</sub> )	FRNA & Somatic Coliforms (MST) OF Thermophilic
3/4	Orange	2 x 250mL Sterile plastic bottle (With Na <sub>2</sub> S <sub>2</sub> O <sub>5</sub> ) or 1 500mL Sterile plastic bottle (With Na <sub>2</sub> S <sub>2</sub> O <sub>5</sub> )	Thermophilic Amoeba
full	Circular	ample volume requirements	Ova
1/4	Circular	1 x 2L Sterile plastic bottle (With Na <sub>2</sub> S <sub>2</sub> O <sub>5</sub> ) (2L for each test parameter)	<i>Salmonella</i> Coliforms
Top	Circular	1 x 100mL Amber Glass bottle (None)	Microtox
uU	White	sample volume requirements	Bacterial Endotoxin
1/4	Grey	sample volume requirements	Helminth Ova
Top	Green	1 x 500mL White plastic (none)	Algae (Return to lab within 24hrs required)
Top	Green	1 x 500mL White plastic (Lugol's solution)	Alg. 1.!!!

METALS & RADIONUCLIDES

Fill to	Label Colour	Container Type (Preservation)	Test Parameter(s)
Top	Red	1 x 60mL plastic (Nitric acid)	Heavy Metals Dissolved (Field Filtered)
Full	Red & Green stripe	1 x 60ml plastic (none) AIRFREIGHT OPTION	Heavy Metals Dissolved (Field Filtered)
Top	Maroon	1 x 60mL plastic (hydrochloric acid)	Ferrous Iron (Field Filtered)
Top	Blue	1 x 60mL plastic (Sodium Hydroxide)	Hexavalent Chromium (extended holding time) Field filtration required for dissolved Hex' Cr
Full	Red & Green stripe	1 x 1,000mL plastic (none) AIRFREIGHT OPTION	Gross alpha/ Gross beta
Full	Red & Green stripe	2 x 1,000mL plastic (none) AIRFREIGHT OPTION	Radium 226, Radium 228



AQUEOUS MATRIX SAMPLE CONTAINERS (WATER) continued...

ORGANICS			
Fill to	Label Colour	Container Type (Preservation)	Test Parameter(s)
Top	Maroon	2 x 40mL Clear or Amber vials (Sodium Bisulfate crystals) or 1 additional vial required for QC	TPH/TRH(C+ClO) pVJ 8TEX, 8TEXN, VOCs, Alcohol
Top		2 x 40mL Clear or Amber vials (Sodium Bisulfate crystals) or 1 additional vial required for QC	Trihalomethanes (THMs)
Top		1 x 100mL Amber vial (Ammonium Chloride)	Halogenated Acids (HAA) Chlorinated Acids (CAA)
Top	Orange	1 x 100mL Amber vial (Phosphoric Buffer, on-marium Chloride); 11ccvrlu QC	Olsnrctcl<n lty,hoducu (OAP)
Full	Orange	1 x 100mL Amber glass (1, u, 1uu.) ml/du QC	Her,t/ddts Includi"g Clyphosau:/A.MPA, Pht-noxv Adds {Stond,ud JtW,J ALEXI)IOSIv!S (St(UuiOYd /eve}
Full	Orange	1 x 500mL Amber glass (ur1pru.) for prim.,tv; analysis 1 x additional 500mL Amber glass for	Potable wa.t.t (AOWG SVOC) and SVOC • Ind,TRH,PAA, OCP, OPP, PC&CUE.h□IO· and non-halo flhtnols,Trl.a:rInd, Pytlthro'd-s, TRH
Full	Orange	2 x 500mL Amber glass (1, mpru., > fo 1 primuy •oal;ysis 2 x additional 500ml A. l'br □lass bottlu for Laboratory duplk.att or INriK spiktt.	Low-level or Ultra SVOC or d.on,po,l, TRH(C 10-C<O), "1tnoxy.l<h::l htrb!cidu. hOU.ttx losi'.-cs
Full	Orange	2 x 500mL Amber glass (rmprc.s.) for pri!N.IV□IWI!ySIS	otoXins & Furans 2! P80h
Full	Orange	1 x 500mL Amber glass (u11t.rc.g for prlrroy aMlysis	T8T (Or :11lotio.S)
Top	Guy	1 x 60ml plastic 11'fffrtd {unprH·howe.wr□nwy bt tJdded for chJOffnated wart.)	PFAS & PFOA at P1rlql.ra.t & Oigual
Top	C,...	1 x 250ml plastic (PTff (r□);UnpftS' huwvtv.l'□ moy bt oldtd ferchkJrituntd wnu,J	PFAS & PFOA - IL (S11J)tf Tract>

SPECIALIZED CATCHMENT, RECYCLED. DRINKING WATER MONITORING

AU to	Label Colour	Container Type (Preservation)	Test Parameter(s)
Top	Orange	2 x 40mL Amber glass (non-) or 1 x 200mL amber glass bottle	MII/GtOS'lri.l'
Full	Orange	1 x 100mL Amber glass (nan., h1111tW.r-N.11□0 m11v be a du/ c,r <hlorinoc.,d wor<")	Algal ToxiM (Ml<:rO<YSlinS, A;moxin, Cylindro, Dtox-YH Nodularln\
Top	Orange	1 x 100mL Amber glass (how, l'Cr N. 11.S.o,ltH'Y be addt.-d (o,-h,toriMrd wort.n	Atrylarride QL Phettoxy acid ltrbkldes
Top	C,...	1 x 12 Smt. o□sti (PTffE frtd (nMe, however Na.;S,0; nmyb, odderJ(Ot<.hlorinoredwoct.,?	PfOS& PFOA. 2£.,P□u.q11111& Okl,u.at,
Top	Orange	2 x 500mL Amber glass for I" s'ir11>I, (17MI,blt No.;S;0; 1Yb• oddfd fM <"-.,rinottd wort.>; I.it 500ml Amber 91.ts-s for substqUMt s.n.,tts	Nlt,outrin□ & NI)MA
Full	Orange	1 x 100ml Amber glass (UIIOttJ	UI1ra,rmcs Mv!tlreslduc Pestl<6es Suftt 'EP234L·\
Top	Orange	1 x 100ml Amber glass (t,01(1,e(not1., how,vu □ 171(1)'b1 oddcd for chlO'ffMtdc wo11n	EOC compound□ stL l'f<;Ps
Top	Orange	2 X 500ml Amber glass (b,011(<(p)fl", h:MCVU □ nw,yk oddt.d for a,rOrinord ware,)	Sltrol<1s

ln»A:CHOL Nosu;

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