THRL Pty Ltd

Sewage and Wastewater Monitoring Plan (SWMP) for Amphitheatre and Woodcutters EcoCamps.

Main Range National Park, Queensland, Australia.

Scenic Rim Trail – Thornton Trailhead to Spicers Canopy Nature Reserve, Queensland (EPBC 2016/7847)

11th November 2025

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This Sewage and Wastewater Monitoring Plan (SWMP) for Amphitheatre and Woodcutters EcoCamps has been reviewed by an independent expert Josh Radford, MSc, Associate Geologist, EMM Pty Ltd, in accordance with Variation of Conditions attached to Approval (Scenic Rim Trail – Thornton Trailhead to Spicers Canopy Nature Reserve, Queensland (EPBC 2016/7847) (the Variation)).

Transmission Register

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1 Introduction

Moreton Environmental and Health Pty Ltd (MEH) was engaged by THRL Pty Ltd ACN 137 592 593 (Scenic Rim Trail) to complete this Sewage and Wastewater Monitoring Plan (SWMP) for their Amphitheatre and Woodcutters Eco Camps.

In accordance to Condition 8A in Variation of Conditions attached to Approval (Scenic Rim Trail – Thornton Trailhead to Spicers Canopy Nature Reserve, Queensland (EPBC ref 2016/7847)), dated 2019), as shown in **Appendix A**, this Sewage and Wastewater Monitoring Plan (SWMP) outlines the methods (including survey methodology, effort, timing, frequency and responsibility) that will be implemented for the collection and analysis of data regarding soil and water quality to establish a baseline, and to subsequently detect any change from baseline outside the boundaries of the **Woodcutters Eco Camp** and **Amphitheatre View Wilderness Eco Camp** attributable to onsite disposal of sewage or wastewater.

Surface water assessment has been, and will continue to be, conducted at monitoring sites in the Main Range National Park as part of a 10-year monitoring program, outlined in the Scenic Rim Trail Management Plan (SRTMP). This will determine whether activities associated with the operation of the Scenic Rim Trail Eco Camps, including disposal of treated effluent, have had an adverse impact on water quality and therefore potential to impact Matters of National Environmental Significance (MNES) and world heritage values of the Gondwana Rainforests of Australia World Heritage area (GRAWHA).

1.1 Objectives

The objective of the SWMP is to monitor any potential impacts from the disposal of treated effluent and operation of the Scenic Rim Trail Eco Camps. The SWMP specifies methods for collection and analysis of the following:

This SWMP will monitor the **soil quality data** of soil profiles within the boundaries of **Woodcutters Eco Camp** and **Amphitheatre View Wilderness Eco Camp** and within all areas proposed for disposal of treated sewage and wastewater and all areas within 50 metres of the **Woodcutters Eco Camp** and **Amphitheatre View Wilderness Eco Camp.**

This SWMP will monitor the **water quality data** including surface water and groundwater underlying **Woodcutters Eco Camp** and **Amphitheatre View Wilderness Eco Camps** and all drainage channels and downstream water bodies outside of the boundaries of **Woodcutters Eco Camp** and **Amphitheatre View Wilderness Eco Camp** with potential hydraulic connectivity with sewage and wastewater disposal areas**.**

1.2 Legislation and Guidance for Recycled Water Use

The following legislation and guidance are pertinent to recycled or treated effluent waters.

- *Environmental Protection Act 1994 Qld, (Queensland, 1994).*
- *Environmental Protection Regulation 1998 (Qld), (Queensland, 2019b);*
- *Environmental Protection (Water) Policy 2009, (Queensland, 2012);*
- *Environmental Protection (Water and Wetland Biodiversity) Policy 2019, (Queensland, 2019a);*
- *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy, (NHMRC and NRMMC, 2011);*
- *Sustainable Planning Act 2009 (Qld), (State of Queensland, 2009);*
- *Work Health and Safety Act 2011 (Qld),(Queensland, 2011);*
- *Public Health Regulation 2018, (Queensland, 2018b);*
- *Water Supply (Safety and Reliability Act) 2008, (Queensland, 2017b).*
- *Drainage and Plumbing Act 2018 (Qld), (Queensland, 2024);*
- *Eligibility criteria and standard conditions for sewage treatment works (ERA63), (Queensland, 2015);*
- *Model operating conditions ERA 63—Sewage Treatment, (Queensland, 2017a);*
- *Guideline for low- exposure recycled water schemes, (Health, 2022);*
- *Disposal of effluent using irrigation - Technical guideline, (Tennakoon and Ramsay, 2020);*
- *Water quality guidelines for recycled water schemes (Queensland, 2013);*
- *Monitoring and Sampling Manual, Environmental Protection (Water) Policy 2009, (Queensland, 2018a);*

2 Baseline Water Quality and Soils

MEH has conducted the following investigations at Main Range National Park and in proximity of the Eco Camps Amphitheatre and Woodcutters between 2018 and 2024.

- Surface Water Investigations for Baseline Data Collection Plan at Amphitheatre and Timber Getters EcoCamps, Main Range National Park, Queensland, Australia for Spicers Retreats Hotels & Lodges Pty Ltd, dated 5th September 2019, (MEL, 2019c).
- Surface Water Investigations for 1st Round of Annual Monitoring at Amphitheatre and Timber Getters EcoCamps, Main Range National Park, Queensland, Australia for Spicers Retreats Hotels & Lodges Pty Ltd, dated 14th October 2020 (MEL, 2020).
- Surface Water Investigations for 2nd Round of Annual Monitoring at Amphitheatre and Timber Getters EcoCamps, Main Range National Park, Queensland, Australia for Spicers Retreats Hotels & Lodges Pty Ltd, dated 27th July 2021, (MEH, 2021).
- Surface Water Investigations for 3rd Round of Annual Monitoring at Amphitheatre and Timber Getters EcoCamps, Main Range National Park, Queensland, Australia for Spicers Retreats Hotels & Lodges Pty Ltd, dated 7th December 2022, (MEH, 2022).
- Surface Water Investigations for 4th Round of Annual Monitoring at Amphitheatre and Timber Getters EcoCamps. Main Range National Park, Queensland, Australia for Spicers Retreats Hotels & Lodges Pty Ltd, dated 5 May 2024, (MEH, 2024b).
- Surface Water Investigations for 5th Round of Annual Monitoring at Amphitheatre and Timber Getters EcoCamps. Main Range National Park, Queensland, Australia. Scenic Rim Trail – Thornton Trailhead to Spicers Canopy Nature Reserve, Queensland (EPBC 2016/7847), dated 25 Nov 2024, (MEH, 2024c).

In addition, MEH have written the following reports for Scenic Rim Trail:

- Soil and Surface Water Investigations for Baseline Data Collection Plan at Amphitheatre and Woodcutters EcoCamps, Main Range National Park, Queensland, Australia. Scenic Rim Trail), dated 8 May 2019, (MEL, 2019b).
- MEDLI Modelling of Land Application of Treated Effluent at Amphitheatre and Woodcutters EcoCamps, Main Range National Park, Queensland, Australia, dated 18th April 2019, (MEL, 2019a).
- Reporting Hydraulic Assessment at Timber Getters EcoCamp. Main Range National Park, Queensland, Australia. Scenic Rim Trail – Thornton Trailhead to Spicers Canopy Nature Reserve, Queensland (EPBC 2016/7847), dated 20th November 2024,(MEH, 2024a) .

2.1 Soils at Amphitheatre and Woodcutters

Following baseline soil investigations in 2018 in irrigation disposal areas at Amphitheatre and Woodcutters Eco Camps, two soil types have been identified as having potential differential hydraulic loading characteristics, as shown in Table 1 (MEL, 2019b).

Table 1: Soil Classification, %Clay and CEC levels

	Amphitheatre				Woodcutters			
Sample ID	Comp_A_0.1	Comp_A_0.3	Comp_A_0.5	Comp_A_0.8	Comp_W_0.1	Comp_W_0.3	Comp_W_0.5	Comp_W_1.0
CEC	23.36	25.3	25.3	33.5	25.1	19.7	19.7	17.9
%CLAY	48(50)	27(31)	29(33)	21(24)	24(28)	38(41)	36(41)	49(49)
%SAND	4(4)	3(3)	4(5)	2(2)	6(7)	6(6)	2(2)	5(5)
%SILT	44(46)	57(66)	54(62)	65(74)	56(65)	49(52)	49(56)	45(45)
%GRAVEL	4	13	13	12	14	7	13	1
Soil Type	Silty CLAY	Silty Clay LOAM	Silty Clay LOAM	Silt LOAM	Silty Clay LOAM	Silty CLAY	Silty CLAY	Silty CLAY

The samples highlighted in light yellow are considered to be in the root zone of grasses in the irrigation areas.

The root zone 0.1 – 0.5 was predominantly Silty Clay Loams with % Clay 30 – 50% and CEC 25 meq/100g. The underlying layer, which would be the layer restricting water flow, was Silt Loam, clay content >30% and CEC of 33.5 meq/100g.

The profile in BH22 and 23, (see **Figure 12** in **Figures** for location) showed a confining layer of CLAY between 0.35 and 0.5 mbgl, overlain with a suitable topsoil of Silty CLAY from surface to 0.35 mbgl. The layer below the confining CLAY layer was a decomposed basalt. The %Clays increased with depth and with Silty Clay Loams at the surface moving into Silty Clays and decomposed basalt with depth. The root zone of 0.1 – 0.35 was predominantly Silty Clay Loams with % Clay ~30 % (estimated in the field) with a confining layer 0.35 – 0.6 with Clay content ~>50% (estimated in the field). The layer below of decomposed Basalt would have reduced clays and be more porous.

MEH composited BH22 and 23 for further analysis for MEDLI modelling, field capacity, wilting point and saturated water content, as well as porosity and bulk density, as shown in Table 2.

At Woodcutters the %Clays increased with depth and with Silty Clays Loams at the surface moving into Silty Clay with depth. The root zone 0.1 – 0.5 were predominantly Silty Clays with % Clay 30 – 40% and CEC 20-25 meq/100g. The underlying layer, which would be the layer restricting water flow, was Silt Clay content ~50% and CEC of 18 meq/100g. Overall, the particle size analysis reported that the dominant soil horizon in which the treated effluent would be impacting was a Silty Clay Loam or Silty Clay with a clay content of ~30-40%.

MEH composited a further two boreholes at Woodcutters, BH25 and 26, which showed similar soil properties to BH10 - 17 in the first round of sampling (see **Figure 13** in **Figures** for location). A composite of lithologies at BH25 and 26 was further analysis for MEDLI modelling, field capacity, wilting point and saturated water content, as well as porosity and bulk density, as shown in Table 2.

Table 2: Soil Testing for Moisture Content

			Amphitheatre			Woodcutters			
	Client's I.D.		COMP_A_0.1	COMP_A_0.3	COMP_A_0.5	COMP_W_0.1	COMP_W_0.3	COMP_W_0.5	COMP_W_0.8
	Laboratory No.		1	2	3	5	6	7	8
	Units	LOR							
Moisture *(air-dried)*	%	0.1	28	24	35	47	41	33	42
Porosity (calc)	%		52	37	51	68	64	61	59
Bulk Density$_{(Core)}$	Mg/m^3	0.001	1.3	1.7	1.3	0.86	0.96	1	1.1
Field capacity @ 30 kPa	%	1	47	46	76	56	44	43	46
Permanent wilting point @ 1500 KPa	%	1	31	28	43	32	31	27	32
Available water capacity	%		16	18	33	24	13	16	14
Saturated Water Content	%	1	102	83	112	105	92	85	100

2.1.1 MEDLI Modelling

The soils at Amphitheatre are dominated by silty clays or clay loams, or Vertosols, and there is a confining layer with a lower hydraulic conductivity from 600mm below the surface, which is underlaid by a permeable decomposed trachyte.

The soils at Woodcuttters are dominated by silty clays, or Vertosols, with a good depth of soil greater than 1 meter of clay soils and there is also a confining layer with a lower hydraulic conductivity from 600mm below the surface, which is underlaid by a permeable decomposed trachyte.

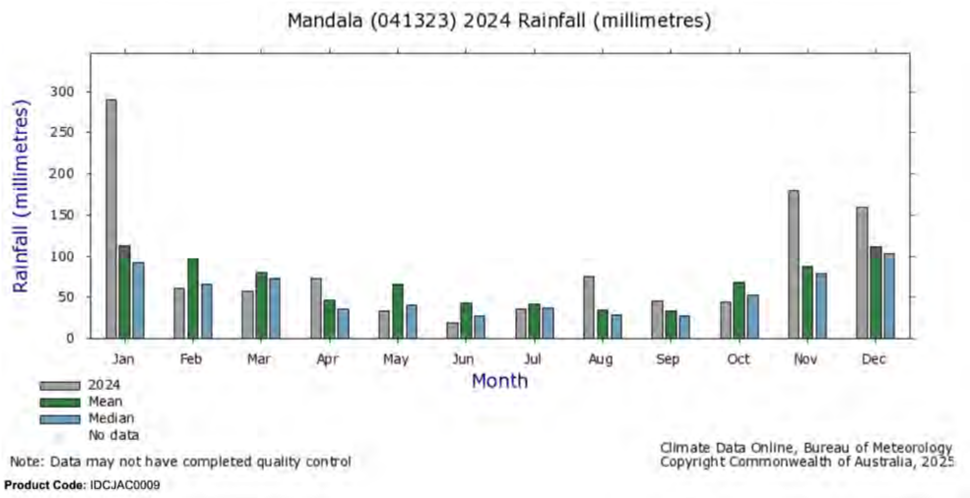
MEL setup the MEDLI model assuming the use of a non-generic pasture and a choice of endemic species from main Range National Park: Cutty Grass (*Carex appressa*); Creek Mat-rush (*Lomandra hystrix*); and Basket Grass (*Lomandra longifolia*).

The results of the modelling overall at Amphitheatre and Woodcutters indicate the use of improved pasture having the least predicted leaching of nitrogen and negligible Phosphorus.

Therefore, MEL would recommend the use of improved pastures, Cutty Grass (*Carex appressa*), Creek Mat-rush (*Lomandra hystrix*), and Basket Grass (*Lomandra longifolia*) on the smaller area of 150m^2 for waste water disposal at Amphitheatre and Woodcutters.

The results of the modelling demonstrate the additional area of 250m^2, as opposed to 150m^2, only marginally improved efficiency due to the strong nature of nutrient removal by the chosen pasture mixture above.

The climatic averages for the Main Range National Park (Mandala, BOM station 041323) region obtained from the Bureau of Meteorology (http://www.bom.gov.au) are shown below in Error! Reference source not found..



Graph 1: Bureau of Meteorology Mandala 2024

The highest daily rainfall at Mandala in 2024 was 315mm, Therefore, the addition of Black Sheoak (*Allocasuarina littoralis*) could be considered on the outside bund wall for stabilisation.

The water quality data collected over the last six years has been designed to ensure monitoring will detect any downstream changes in surface water (SW) and groundwater (GW) quality from impacts of the Woodcutters EcoCamp and Amphitheatre EcoCamp and creek crossings in accordance with the Scenic Rim Trail Management Plan, dated 31st March 2019 (O'Hara, 2019).

In 2024 the median values above the Water Quality Objectives (WQO) demonstrate:

- The 110% median baseline levels over the five year period have been exceeded for Ammonia 2.5% of the time, Oxidised Nitrogen 15% of the time, Total Phosphorus 7.5% of the time, but TKN, Total Nitrogen (TN) and Filterable Phosphorus levels were never exceeded.
- However, Ammonia, Oxidised Nitrogen and Filterable Phosphorus levels have exceeded the WQO much of the time in the creek systems studied and, therefore, are not considered a reliable trigger level for exceedances of nutrients from impacts in the creek systems being studied.
- The median value for TN exceeded the low-flow WQO of 740 µg/L once in 2019 (baseline) at location SW05 in the Dalrymple Creek system.
- The median value for Total Phosphorus exceeded the low-flow WQO of 140 µg/L once in 2021 at SW08 in the Blackfellow Creek system.

Considering the changes of nutrients over time, the following observations are made:

- There have been eleven occasions over the past five years where results for individual sampling locations of TN and Total Phosphorus have exceeded the WQO in the Dalrymple and Blackfellow Creek systems.
- There have been ten occasions where individual results have exceeded the WQO over the last five years.
- There have been 17 occasions in the last five years where an individual sample median has exceeded the 110% median value of the baseline survey, though none were in 2024.
- There have been 18 occasions in the last five years where individual results have exceeded the 110% maximum value of the baseline survey.
- Considering the changes in nutrient levels over time, the following observations are made:

- There is no discernible trend between control sites and impacted sites;
- The 13 relatively high results in the last four years above the WQO for TN and Total Phosphorus are across both control and potentially impacted sites, as well as at locations monitoring creek crossings and Eco Camps; and
- There is no increase in Nitrogen or Phosphorus over time.

In order to make inferences on whether the median nutrient levels in the potentially impacted sites are greater than in the control sites, as discussed above, MEH conducted some statistical analysis using basic descriptive statistics, Mann-Whitney tests, and Mood's median tests to determine whether the difference in sample medians of the impacted sites and the control sites were statistically different.

The Mood's median tests confirmed that for both TN and Total Phosphorus all median values in the potentially impacted sites and the control sites were not statistically different. The exceptions were the control site SW02 and the potentially impacted site SW01. As the control site SW02 has a greater value than the potentially impacted site SW01, it can be concluded that no impact is indicated, and the greater value is due to the large natural variance in nutrient levels in the Dalrymple and Blackfellow creek systems (see comment in preceding paragraph).

However, in addition, Mood's median testing showed potential impact in SW09 compared to the control site SW10 as the medians for SW09 and SW10 in 2024 were 100 and 52.5 mg/L respectively. Since SW09 is the potentially impacted site, there is potential for it to have been impacted upon by anthropologic use of the stream. In the recommendations, MEH, suggested further monitoring of this location should continue and if impact is detected again in a subsequent monitoring season, there should be further discussion with the Scenic Rim Trail' fauna expert to ascertain if the impact on water quality is affecting Matters of National Environmental Significance (MNES), especially the endangered Mountain Frog (*Philoria kundagungan)*. It should be noted that this instance of difference in mediums of control and impacted site could reflect the background variability in water quality within the riparian systems. Further monitoring and statistical analysis are required prior to any firm inferences being made on potential impacts on the riparian ecosystems.

The minor metalloid concentrations, and difference between total and dissolved oxygen, demonstrate that the metalloids are chemically bound in the sediments and are naturally derived from the volcanic bedrock.

Other parameters measured during annual monitoring events of 2024, such as total dissolved salts, total hardness, alkalinity, chloride, major cations and SAR, the values are all similar between all locations over time, including to baseline conditions. This uniformity adds to the weight of evidence that Blackfellow and Dalrymple Creeks and their tributaries are currently predominantly being groundwater-fed.

The E. coli levels in both creek systems in 2024 were 66% >10 CFU/100mL and 34% <10 CFU/100mL, with a maximum value of 300 CFU/100mL and median value of 29 CFU/100mL, compared to 2023 results of 65% >10 CFU/100mL and 35% <10 CFU/100mL, with a maximum value of 180 CFU/100mL and median value of 36 CFU/100mL, which are consistent with background concentrations of E. coli in Australian River Systems (Sinclair, 2019).

Guidelines on primary contact (including bathing) in recreational waters indicates median values of over 150 CFU/100ml are considered likely to be disease-causing with long-term exposure, (ANZECC and ARMCANZ, 2000).

3 Environmental Values

The values of GRAWHA include outstanding examples of major stages of the Earth's evolutionary history, ongoing geological and biological processes, and exceptional biological diversity. A wide range of plant and animal lineages and communities with ancient origins in Gondwana, many of which are restricted largely or entirely to the Gondwana Rainforests, survive in this collection of reserves. The Gondwana Rainforests also provides the principal habitat for many threatened species of plants and animals, (www.https://www.dcceew.gov.au/parks-heritage/heritage/places/world/gondwana#outstanding-universal-value).

It should be noted that the upper catchment has evidence of feral pigs, and it is known that feral pigs degrade water quality, and the lower catchment has evidence of feral cattle, which is also known to degrade water quality. The pollution from feral animals will be episodic to some extent due to ongoing pest control and attenuation is likely to be low in upper catchments, partly due to the fast flowing nature of streams and low water residence times. (Mitchell, 2010) and (James D. Vincent et al., 2021).

The health of the MNES in GRAWHA, specifically the Hastings River Mouse, Fleay's Frog and the Mountain Frog, is assessed by Penn Lloyd of Biodiversity Assessment and Management Pty Ltd (BAAM) on an annual basis. In BAAM's 2024 report, riparian habitat quality had not changed upstream or downstream of the two creek crossings, (BAAM, 2024). The threaten species or MNES have **potential** to be impacted from the activities of the Eco Camps, in particular the disposal of treated effluent, through adverse effects on water quality. Therefore, the principal indicator of diminishing value or impact on MNES is changes in water quality downstream of the Eco Camps. Any changes in soil quality within 50 meters of the Eco Camps will also be used to determine potential impact.

In terms of water quality, the Water Quality Objectives (WQO) for the Condamine Basin, including Dalrymple and Glengallan Creeks, were finalised in October 2020 and the relevant catchments, including Dalrymple and Glengallan Creeks are shown in **Figure 3** and **4** in **Figures.** The Dalrymple Creek and the tributary Blackfellow Creek systems are considered to be in the south eastern Condamine Basin, as shown in **Figure 3** in **Figures**.

As indicated above feral animals are likely to have more impact on the threaten species or MNES than the EcoCamps and the Main Range National Park and values of GRWHA are under threat from the impact of feral pigs and cattle in the national park, (Gondwana—Threat management, https://www.qld.gov.au/environment/plants-animals/conservation/bushfires-threatened-species-recovery/recovery-projects/gondwana-wha/threat-management).

The Surface fresh water associated with Dalrymple and Glengallan Creek systems have Environmental Values zone defined in the basin map **WQ4223,** as shown in **Figure 3** in **Figures** and outlined in **Table 3** overleaf**.**

The Groundwater at the site is associated with the Upper Condamine Basalts Environmental Vale zone as defined in the fractured rock zone map **GWQ4162** as shown in **Figure 4** in **Figures** and outlined in **Table 3** overleaf**.**

The environmental values outlined in Table 3 are in accordance with the Condamine River Basin Environmental Values and Water Quality Objectives, (Queensland, 2020) and Healthy Waters Management Plan Condamine River Basin (Queensland, 2019c)

Table 3 : Environmental Values of Dalrymple and Glengallan Creeks

	Aquatic ecosystems	Irrigation	Farm Supply/use	Stock water	Aquaculture	Human consumer	Primary contact	Secondary contact	Visual recreation	Drinking water	Industrial use	Cultural, spiritual and ceremonial
Dalrymple and Glengallan Creeks	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Upper Condamine Basalts	✓	✓	✓	✓						✓	✓	✓

The WQO (Queensland, 2020) for the Dalrymple and Glengallan Creeks systems are not considered robust to inform trigger values and are only to be used a general indication of declining values in the GRAWHA, should values change over time.

The use of a Before-After Control-Impact (BACI) study design is used to monitor soil surface and groundwater for impact of operations and wastewater disposal within 50m and downstream of Eco Camps, as discussed in section **Error! Reference source not found.** of t his plan.

Flow conditions in the Dalrymple and Blackfellows Creek Systems are determined by flows at Swan Creek at Swanfels as shown below.

- Low-flow Conditions are <0.3 m^3/s at gauge 422306A – Swan Creek at Swanfels.
- High-flow Conditions are > or = 0.3 m^3/s at gauge 422306A – Swan Creek at Swanfels.

Table 4 : Water Quality Objectives for Southeastern Condamine Basin high ecological value

	Percentile	Ammonia–N	Oxidised–N	Total N	Filterable P	Total P	Chlorophyll-a	DO	Turbidity	Suspended Solids	pH	EC	Sulfate	Alkalinity
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	%	NTU	mg/L	pH Units	µS/cm	mg/L	mg/L ($CaCO_3$)
WQO Indicator percentiles Low-Flow, HEV	**20th**	**2**	2	200	35	80	2	60-110	4	6	7.7	330	2	140
	50th	**4**	4	270	50	110	5		8	10	8.0	440	2	190
	80th	**9**	12	450	80	150	16		20	25	8.3	650	5	250
WQO Indicator percentiles High-Flow, HEV	**20th**	**6**	35	340	75	120	ID	60-110	8	9	7.5	145		50
	50th	**13**	80	460	90	200	ID		25	18	7.8	190	2	70
	80th	**40**	270	1500	130	560	ID		90	110	8.1	330	3	140

4 Summary of Activities at EcoCamps

Scenic Rim Trail operates guided multi day walking tours, mostly within the Main Range National Park along southern Queensland's Scenic Rim. These are from Thornton to Scenic Rim Trail Peak Nature Refuge, a distance (by walking trail) of 53 km, made up of 32 km of new class 3, 4 and 5 track and utilising 24 km of existing track.

Accommodation during the supervised tours comprise the use of several existing Eco Lodges on private land (that required no new approvals) and the use of two Eco Camps – Amphitheatre View and Woodcutters – at separate locations within the northern extent of GRAWHA and a National Heritage listed area (approved, constructed and operating).

The EcoCamps have wastewater treatment plants (WWTPs) installed and are subject to conditions of approval for the on-site disposal being able to demonstrate compliance with stated conditions, as follows:

In the Climate Change, Energy, the Environment and Water (DCCEEW) variation of conditions attached to approval - Scenic Rim Trail – Thornton Trailhead to Spicers Canopy Nature Reserve, Queensland (EPBC 2016/7847) (Variation), condition 8A sets out the requirements for an approved Sewage and Wastewater Monitoring Plan (SWMP). It includes survey method, effort, timing, frequency and responsibility for the collection and analysis of data regarding soil and water quality to establish a baseline, and subsequently to provide a basis for measuring change to the receiving environment attributable to the on-site disposal of sewage or wastewater.

Condition 15A of the Variation requires an approved Plan for Wastewater and Sewage Management (PWaSM) that sets out implementation measures, a sampling program for treated effluent, corrective actions and subsequent further correction measures to be implemented if samples fall outside specified standards and/or contain contaminants.

The description of the WWTP is taken from Scenic Rim Trail Scenic Walks, Woodcutters EcoCamp Wastewater Treatment Plant Performance Report dated 27 November 2024, (Solutions, 2024). The WWTP at Amphitheatre is exactly the same as the one at Woodcutters.

4.1 Overview of WWTP at both EcoCamps

The WWTP servicing the Amphitheatre and Woodcutters EcoCamps are a 2-stage AdvanTex AX-Max system which was supplied by ENVR Solutions Pty Ltd, USA based partner, Orenco Systems Inc and installed by ENVR Solutions Pty Ltd (formally ENVIA Holdings Pty Ltd). Orenco has supplied and installed thousands of AdvanTex systems all over the world, particularly in places that are environmentally sensitive and require strict levels of treatment quality and efficiency.

The AdvanTex AX-Max unit is a multi-chambered unit, with pH and carbon augmentation input feeds, that produces Class A recycled water quality. The system is state-of-the-art and incorporates AdvanTex textile media, treatment chambers, submersible pumps, disinfection and control systems into a pre-installed unit. Core to the effectiveness of the AdvanTex system in providing high-quality and reliable treatment is the lightweight textile media filter installed inside the unit, which provides a large surface area, significant void space, and a high degree of water-holding capacity. This creates the perfect environment for billions of microorganisms to populate on the textile which consume the organic matter in the wastewater to provide consistent treatment 24 hours a day.

Because the textile filter material is suspended above the water inside the unit, expensive aerators and high energy-use blowers are not required. This makes the treatment process much more efficient and less energy demanding by allowing microorganisms access to atmospheric oxygen rather than dissolved oxygen. Furthermore, treatment efficiency will occur during times of full occupancy or when little to no wastewater is being generated.

Image 1: Dual AX-Max Units installed at the Woodcutters EcoCamp

Most importantly, activated sludge is not produced from the treatment process and therefore, does not require daily draw-off and disposal management. The addition of a nitrate return-line back to the anoxic tank within the AdvanTex recirculation chamber facilitates the removal of nitrogen via biological denitrification. Removal of nitrogen is further enhanced by integrating an alkalinity and carbon dosing system and dosing ratios are automated according to the daily hydraulic loading on each system.

Following the advanced secondary treatment process, treated water is pumped through a UV disinfection system to ensure all pathogens and coliforms are destroyed prior to being pumped into the Recycled Water Storage Tank.

4.2 Overview of Irrigation areas at both EcoCamps

After treatment and disinfection, a purple pipe reticulation system delivers Class A recycled water to a designated 152 m^2 land application area following MEDLI assessment, (MEL, 2019a), where it is distributed via a sub-surface dripline irrigation network. The use of subsurface driplines ensures an even distribution of recycled water throughout the soil profile and prevents spray drift, surface pooling and over-saturation of the soil. The use of 'trickle' irrigation within the soil also maximises the potential for evapotranspiration in addition to soil percolation. Furthermore, beneficial residual nutrients remaining in the water are made available to plant root-mass within the rhizosphere of the soil profile. The irrigation area has been plated with native strappy leaf plants, ferns and small native shrubs which are all in good health.

Image 2: Installation of Subsurface Irrigation Driplines at the Woodcutters EcoCamp

Image 3: Current irrigation Area Showing Mature Growth of Vegetation

Table 5 : 2-stage AdvanTex AX-Max system

PEAK DESIGN:	600 L/day
SYSTEM DESCRIPTION:	The Treatment Plant consists of: • 1 x AX-MAX037-14 (unit #1) with: ○ 14-ft (4.3-m) enclosure ○ 37.5-ft^2 (3.5 m^2) of textile ○ septic chamber ○ pre-anoxic chamber ○ recirculation chamber ○ discharge chamber ○ recirc pump ○ anoxic return pump ○ discharge pump. • 1 x AX-Max025-14 (unit #2) with: ○ 14-ft (4.3-m) enclosure ○ 25-ft^2 (2.3 m^2) of textile ○ post-anoxic chamber ○ recirculation chamber ○ discharge chamber ○ recirc pump ○ discharge pump ○ Orenco UV units. • 1 x Fiberglass Liquid Chem feed Units: • Alkalinity Dosing (sodium bicarbonate) • 1 x Fiberglass Liquid Chem feed Units: • Carbon Dosing (Micro-C) • 1 x Custom Control Panel with remote monitoring and alarm issuing • 1 x 5,000 L Recycled Water Storage Tank • 1 x 152 m2 subsurface dripline irrigation area.

5 Context of the Sites

5.1 Geology and Hydrogeology

5.1.1 Local Geology

The predominant underlying geology of the Main Range National Park is basalt, agglomerate, shale, and dolomite of the Main Range Volcanics of Oligocene to Miocene age. Within the Main Range Volcanics, isolated outcrops of trachyte (derived from more explosive volcanic activity) form ridges and cliffs as exemplified by the Amphitheatre area. The Geology of the area is shown in **Figure 2** in **Figures** and taken from 1:250000 series map published by the Geological Survey of Queensland, complied by Whitaker and Green 1978.

5.1.2 Local Hydrogeology

Dr John Harbison, a hydrogeologist, investigated the local geology during a site visit in March 2020 and made inferences on the interactions between surface water and groundwater at both sites.

Brodie and Green (Queensland, 2018c), clearly state that the basalts in Main Range National Park do not consist of a single homogeneous basalt flow or single aquifer, rather, many overlapping flows with maximum thicknesses of 10 m, stacked together commonly separated by lower permeable layers including clay-rich weathered profiles that developed between volcanic periods. The differing permeability affects the capacity of the aquifers to store or transmit ground water with zones consisting of broken vesicles, which provide primary pore space that can contain or transmit ground water. At the edge of the massive basalt layers, highly permeable basalts and low permeable alluvial aquifers discharge to the surface as springs and may indeed feed streams. In addition, Brodie and Green (Queensland, 2018c), estimated that along the eastern margin of the Condamine Basin at depths of 11 – 41 m, the aquifers in the upper Condamine basin generally consist of an upper unconfined, weathered and fractured zone with a lower more-limited extent of semi-confined fractured zone with average thicknesses of 38 m (Skelt KID and Hillier JR, 2004).

Given the sites are topographically 900 m above the Condamine Basin, with complex high and low-permeability layers beneath the sites, the expected depth to any unconfined weathered and fractured zones would be 30 – 100 m below the sites, making it impracticable to reach by drilling.

5.1.3 Local Streamflow

The geometry of the underlying consolidated rocks is significant for groundwater flow. It appears there is geologic control over sub-surface flow and this flow is also predominantly to the west.

Amphitheatre EcoCamp is situated on a topographical divide and the EcoCamp is situated on the southern side of the ridge and all surface water overland and subsequent groundwater flow will flow to the Unnamed creek and the Dalrymple creek system.

Woodcutters EcoCamp is situated on a steep hillside and all surface water overland and groundwater flow will flow to the Dalrymple Creek.

Annual rainfall in Main Range National Park in 2019 was 337mm, 1165mm in 2020, 1436mm in 2021, and 2005mm in 2022. Rainfall data for Cunningham's Gap National Park ceased in

March 2023, although the nearest current station Mandala had 273mm in 2019, 725.4mm in 2020, 1043.2mm in 2021, 1486.2mm in 2022 and 671mm in 2023. Therefore, rainfall increased in 2021, compared to 2020, and was close to the 90th percentile of 1541mm for 2021 and 2022, with a decrease in 2023. Rainfall for 2024 had above average rainfall with 1073.6mm for the year. (www.bom.gov.au).

5.1.4 Ground Water Flow Directions

Graph 2 : Cumulative rainfall mass deficit curve for Upper Forest Springs

In summary, in the upper reaches of creeks in the park, the sub-surface flow of water is largely controlled by local geology. As a result, the flow of shallow ground water is predominantly to the west in the direction of the dip of the many massive layers of volcanic rock. Due to the disparity in ground water elevations on either side of the Main Divide, some deeper ground water flow toward the east cannot be discounted, but this process would operate at much larger time scales.

Importantly, ground water flow from the two EcoCamp sites to local creeks during baseflow conditions is likely to be insignificant and is also expected to be insignificant during wetter conditions

5.1.5 Groundwater Bore Search

A groundwater bore search (https://qldglobe.information.qld.gov.au/) of the region around the sites including government bores within 10 km of the sites and private registered bores in the Goomburra, Upper Laidley Creek and Tarome areas. All but two (2) of the ten (10) bores regularly monitored by government staff represent alluvial aquifers, as shown in **Figure 5**in **Figures**.

The bores are mainly near either Allora or Clintonvale and since these aquifers are predominantly alluvial and heavily utilised, with water levels heavily influenced by this use, no analysis or interpretation of these levels has been made in this report. Of the private bores, most have reports on bore yields and water quality (mostly only Electrical Conductivity), but there are almost no comprehensive chemical results for these private bores.

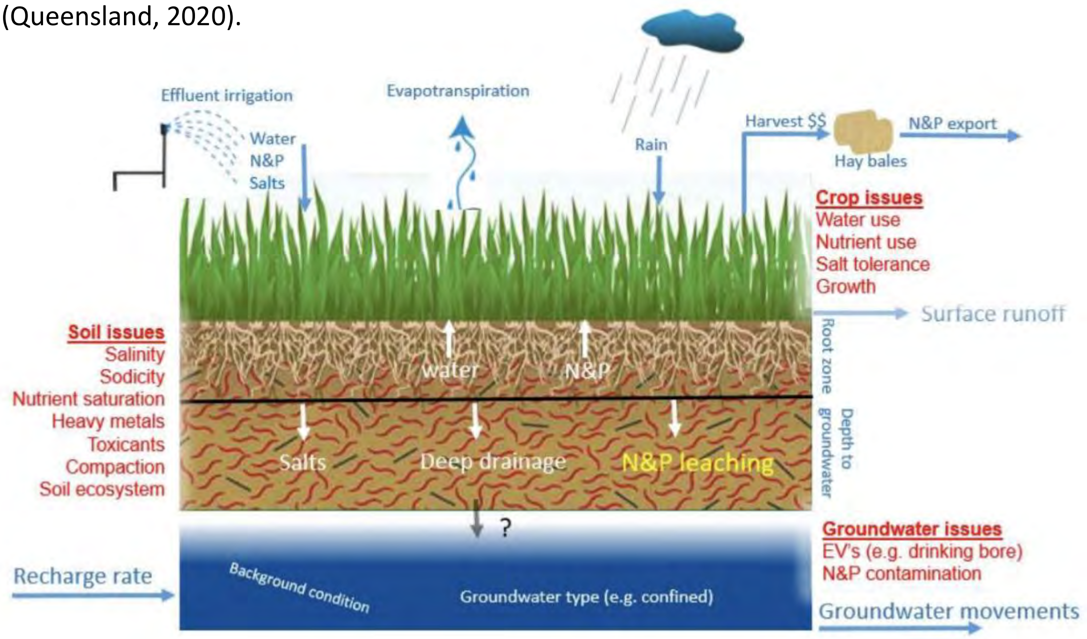
5.2 Conceptual Site Models

MEH has completed three visual conceptual site models to demonstrate the following:

- Figure 7 demonstrates the relationships of soils, bedrock, rainfall, evapotranspiration and deep draining used in the MEDLI modelling as reported in MEDLI Modelling of Land Application of Treated Effluent at Amphitheatre and Woodcutters Ecocamps, Main Range National Park, Queensland, Australia, dated 18th April 2019, (MEL, 2019a).
- Figure 8 demonstrates the relationship between rainfall, surface water flow and groundwater originating under Amphitheatre Eco Camp and the location of potentially impacted monitoring locations SW01 (The closest permanent surface water to Amphitheatre Eco Camp) and SW05 (This location is considered far enough downstream of SW01 to have potential to be fed by groundwater from beneath Amphitheatre EcoCamp).
- Figure 9 demonstrates the relationship between rainfall, surface water flow and groundwater originating under Woodcutters Eco Camp and the location of potentially impacted locations SW03 (The closest permanent surface water to Woodcutters EcoCamp) and SW06 (This location is considered far enough downstream of SW03 to have potential to be fed by groundwater from beneath Woodcutters Eco Camp). Locations of monitoring points for Amphitheatre and Woodcutters EcoCamps are shown in Figure 11 in Figures.
- Figure 10 demonstrates a conceptual site model for contaminants from the following:
    - potential sources.
        - Building materials if upgrades or repairs are conducted at the Eco Camps;
        - The irrigation disposal areas;
        - The Eco Camps operations and residential status.
    - Release mechanisms, dust, soil, subsurface, overland flow, infiltration.
    - Pathways, soil, air, soil and surface water, soil and ground water.
    - Exposure routes, ingestion, dermal and physical hazard.
    - Receptors include Human (recreational, residential and workers).
        - Ecosystems both terrestrial and aquatic.

5.3 Rationale

The DEPH 2012 Technical Guideline for Disposal of Effluent via Irrigation states that land disposal requires proper planning and management to reduce the risk of impact to surface waters and groundwater, protect human health and maintain soil sustainability (Queensland, 2020).



Schematic 1 : Effluent irrigation and environmental interaction conceptual model, (Queensland, 2020).

The eligibility criteria and standard conditions for sewage treatment works (Environmental Relevant Activity (ERA) 63) states that treated effluent is permitted to be released to land provided that it is done in accordance with a written procedure that ensures:

- infiltration to groundwater and subsurface flows of contaminants to surface waters are prevented;
- surface pondage and run-off of effluent are prevented;
- degradation of soil structure is minimised;
- soil sodicity and the build-up of nutrients and heavy metals in the soil and subsoil are minimised;
- spray drift or overspray do not carry beyond effluent disposal areas;
- effluent disposal areas are maintained with an appropriate crop in a viable state for transpiration; and
- the crop on the disposal area is harvested and removed from the disposal area.

When weather conditions or soil conditions preclude the release of effluent to land, effluent must be directed to wet weather storage or be lawfully removed from the site.

A site-specific conceptual site model of the micro scale of interactions of the disposal of treated effluent on the land with the environment is shown in **Figure 7** in **Figures**.

6 Scope and Methodology for Soil and Water Quality

Currently, MEH maintains that the monitoring regime outlined in this section is sufficient for the Environment Protection and Biodiversity Conservation Act 1999 (EPBC) assessment as outlined in the Scenic Rim Trail Management Plan, dated 31st March 2019, (O'Hara, 2019) and is in accordance with the DES Monitoring and Sampling Manual, (Queensland, 2018a).

The Scenic Rim Trail Management Plan (SRTMP), dated 31st March 2019, (O'Hara, 2019) is the overarching management plan for the Scenic Rim Trial operations and the SWMP and the Plan for Wastewater and Sewage Management (PWaSM) are subordinate to the SRTMP.

The annual reports on soil and water quality data collected as outlined in this SWMP and the SRTMP, may make recommendations of any corrective actions or any changes to the Scenic Rim Trail Management Plan, dated 31st March 2019, (O'Hara, 2019).

This data collection is designed to ensure monitoring will detect any on-site or downstream changes in soil, surface water (SW) and groundwater (GW) quality from impacts of the Woodcutters and Amphitheatre EcoCamps, in accordance with the Scenic Rim Trail Management Plan, dated 31st March 2019, (O'Hara, 2019).To address requirements of condition 8A of the Variation, we propose to complete the following monitoring regime, which MEH maintains is sufficient for the Environment Protection and Biodiversity Conservation (EPBC) Act 1999 assessment as outlined in the BDCP (O'Hara, 2019) and to monitor any potential impacts from the disposal of treated effluent and operation of the Scenic Rim Trail EcoCamps. .

1. Annual monitoring and assessment of changes of concentration of parameters in soil over time;
2. Annual monitoring of soils against site specific EILs;
3. Annual monitoring of soils within irrigation disposal areas to be sustainable in the long term, 50 years as determined by MEDLI modelling;
4. Quarterly monitoring of surface water and groundwater networks and assessment of changes of concentration of parameters in water over time;
5. Using the Before-After Control-Impact (BACI) study design;
6. Report on annual reporting. of parameters in soil or water quality over time;

6.1 Scope of works

MEH has devised the following sample design and methodology to monitor baseline conditions and any potential impact on soil and waters from the activities at the EcoCamps including disposal of wastewater treatment and irrigation of treated effluent. The sample design and methodology has been derived at both EcoCamps by:

- Assessment of the potential drainage pathways, both groundwater and surface water, from the EcoCamps including the wastewater disposal areas, to the nearest surface water body (ephemeral or permanent);
- Define soils within 50m of the EcoCamps and the irrigation disposal areas.

Soil, Groundwater and Surface water monitoring points will be selected and/or installed using the following guidance:

- *ANZECC and ARMCANZ (2000), National Water Quality Management Strategy, No. 7, Australian Guidelines for Water Quality Monitoring and Reporting, October 2000, Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management and Council of Australia and New Zealand (ARMCANZ, 2000).*

- *EPA Vic. (2000), Groundwater Sampling Guidelines, EPA Victorian Government,* (EPA, 2000).
- *AS 4482 1-2005 Guide to the investigation and sampling of sites with potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds, (Australia, 2005).*
- *NEPC, Schedule, B1 - Guideline on investigation levels for soil and groundwater, (NEPC, 2013b).*

Details of Location, Geology, Water Quality Objectives, Bores, Creeks and Watercourses, Conceptual Site Models, EcoCamps, Surface Water and Soil monitoring locations can be found in Figures 1 – 15 in Figures.

6.2 Surface water monitoring locations and analysis

Using the conceptual site models presented in **Figures 7, 8, 9 and 10 In Figures,** MEH has designed a surface water sampling regime which has potential to detect both surface water run-off and groundwater seepage impacts from the EcoCamps.

Explanations for the rationale of why the monitoring locations were chosen for continued monitoring over the 10-year period is given below in **Table 6**. It should be emphasised that this rationale for monitoring and surface water sampling encompasses monitoring of surface and groundwater impacts from wastewater disposal areas. Refer to section 5.2 on Conceptual Site Models and section 5.1 on Geology and Hydrogeology for rationale of using surface water locations to monitor groundwater impacts.

Table 6 : Surface Water Sample Locations and Rationale

Sample ID	GPS Coordinates	Description of locations	Rationale for locations
SW01	**27°58'1.50"S 152°21'23.40"E**	450 m down-gradient of Amphitheatre site at the confluence of the gully Unnamed Creek 1 and 2.	The closest permanent surface water to Amphitheatre EcoCamp, potentially impacted site
SW02	**27°58'2.20"S 152°21'24.51"E**	40 m upstream of SW01 in Unnamed Creek 2, which is itself a tributary of Dalrymple Creek.	Upstream of SW01 as a background water quality sample. **Control site**
SW03	**27°59'0.12"S 152°21'38.21"E**	380 m down-gradient of Woodcutters EcoCamp on the confluence of a gully and Dalrymple Creek.	The closest permanent surface water to Woodcutters EcoCamp potentially impacted site
SW04	**27°59'10.44"S 152°21'58.80"E**	640 m upstream of SW03 and up-gradient of Woodcutters EcoCamp in Dalrymple Creek.	Upstream of SW03 and SW06 as a background water quality sample. **Control site**.
SW05	**27°59'23.34"S 152°21'14.15"E**	950 m down-gradient of SW01 in Unnamed Creek 1.	This location is considered far enough downstream of SW01 to have potential to be fed by groundwater from beneath Amphitheatre EcoCamp, potentially impacted site
SW06	**27°58'58.56"S 152°21'23.52"E**	550 m down-gradient of SW01 in Dalrymple Creek.	This location is considered far enough downstream of SW03 to have potential to be fed by groundwater from beneath Woodcutters EcoCamp, potentially impacted site

There are more locations included in the quarterly water quality monitoring above the six locations shown above as part of creek crossing monitoring included in the SRTMP, as shown in **Figure 11** in **Figures**.

6.2.1 Water Parameters & Observations

MEH recommends the following monitoring program:

i. for surface and groundwaters for the following parameters:
   - ***i.*** E. coli (cfu/100 mL);
   - ***ii.*** Ammonia-N (mg/L N as Ammonia), Total Kjeldahl Nitrogen, Nitrate, Nitrite (mg/L as N);
   - ***iii.*** Total Phosphorus, Ortho-Phosphate (mg/L);
   - ***iv.*** Major Anions (Cl, SO_4, HCO_3, F);
   - ***v.*** Major Cations (Na, K, Ca, Mg);

vi. Total and dissolved metal concentrations (Al, Fe, Mn, As, Cd, Cr, Cu, Ni, Pb, Zn);
vii. Field Parameters of pH, DO, ORP, TDS, Temperature, EC and Turbidity. Observations of flow conditions and aesthetics.

6.3 Soil monitoring locations and analysis

The number of soil sampling locations has been calculated using AS 4482 1-2005 Guide to the investigation and sampling of sites with potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds, (Australia, 2005).

AS 4482.1 2005 recommends the number of sample locations in the Std risk profile as shown in Table 7 below. However, MEH has assessed the risk profile of contaminating the environment as low due to pristine environment, small footprint of occupants (>25) and has therefore increased the hot spot diameter from 30m to 40m subsequently the number of sample locations has reduced as shown in Table 7 below.

Table 7 : AS 4482 1-2005 Calculated Values

WOODCUTTER ECOCAMP		RISK PROFILE	
	Qualitative Level of Risk	Std	Low
Radius =	m	15	20
Grid size =	m	25.42	33.90
Area =	m^2	17500	17500
number of samples =		27.07	15.23
		27	15
	Diameter of hot spot detection	30	40
AMPHITHEATRE ECOCAMP		**RISK PROFILE**	
	Qualitative Level of Risk	Std	Low
Radius =	m	15	20
Grid size =	m	25.42	33.90
Area =	m^2	21875	21875
number of samples =		33.84	19.04
		34	19
	Diameter of hot spot detection	30	40

Nineteen hand auger boreholes are proposed to be representative of the soils in the Amphitheatre EcoCamp area.

Fifteen hand auger boreholes are proposed to be representative of the soils in the Amphitheatre EcoCamp area.

A background sample will be taken at each EcoCamp in order to facilitate site specific EILs. The location of the background sample will be in location, preferable up gradient of the EcoCamp and in a position that is not influenced by the EcoCamps and their activities.

Hand auger boreholes will be advanced to surface samples within 0.10 meters below ground level (mbgl). An additional three boreholes will be advanced in the irrigation disposal areas to a maximum depth of 1.0 meters below ground level (mbgl) or until refusal due to hard conditions or bedrock.

The sampling will be undertaken in accordance with MEH standard operating procedures, which are consistent with EPA approved guidelines and industry standards.

Soil samples will be recovered from near or below the surface, being 0.15mbgl for all boreholes, and an additional two samples of 0.5 and 0.9 mbgl for boreholes in the irrigation disposal areas. Soil will be taken directly from within clods removed by an excavator, and soil representing that distinct depth or lithology will be sampled using new nitrile gloves.

Soil samples will be placed into sample jars using disposable nitrile gloves and a new pair of nitrile gloves will be used for each sample taken. The glass jars will be labelled with the trial pit number, depth of discrete sample collection, site reference and date before being placed in a chilled, darkened cooler (maximum temperature of 4°C) and sent to a NATA-accredited laboratory for analysis. The following parameters will be measured in the disposal areas:

6.3.1 Soil Parameters

a) For soils within 50m of the EcoCamps:

i. *Total Nitrogen, Total Kjeldahl Nitrogen, Nitrate, Nitrite, Ammonia and total phosphorous and reactive phosphorous (mg/kg);*

ii. *Heavy metals ((As, Cd, Cr, Cu, Ni, Pb, Zn).*

b) *For soils within the irrigation disposal areas:*

i. *Soil Classification by Particle Size Analysis (Sieve Hydrometer and SPD analysis;*

ii. *Emerson Aggregate Testing;*

iii. *Total Soluble Salts;*

iv. *Major Cations;*

v. *Major Anions;*

vi. *Salinity Chloride - Soluble (1.5 soil water leach);*

vii. *Exchange Acidity;*

viii. *Sodium Absorption Ration (SAR) Calc;*

ix. *Sulphur - Total as S;*

x. *Phosphorus Sorption Capacity;*

xi. *Bicarbonate Extractable P (Colwell);*

xii. *Organic Matter in Soil (Walkley Black);*

xiii. *pH, EC, moisture, Exchangeable Cations,*

xiv. *TP, TN, TKN, NO2, NO3, Nox, NH3, TP;*

xv. *Reactive Phosphorus*

6.4 Sampling Methodology

The investigation will be undertaken in accordance with MEH standard operating procedures (SOP_PROC_001-Soil sampling, SOP_PROC_002-Surface Water sampling, SOP_PROC_004-Quality Assurance and Quality Control) as shown in **Appendix B**, which are consistent with Qld Government-approved guidelines and industry standards, including the 2018 Monitoring and Sampling Manual, (Queensland, 2018a).

The soil surface will be sampled by firstly clearing the soil of any organic material, e.g. grass and roots, and the sample collected from fresh, exposed soil. Fresh soil will be exposed prior to sampling to remove any smear affects from the sampling equipment. Soil peds or clods will be removed from the auger or trowel and split so that samples can be taken from the middle of the peds or clods. The sampler should not sample from exposed surfaces, which may not be representative of contamination, for more details on protocols for soil sampling protocol see SOP-001 in **Appendix C.**

The surface waters samples should be sampled directly into sample containers (new plastic 250mL bottles). This content will then be transferred to sample containers with preservatives in them. The original sample containers, not containing preservative, are then refilled with water taken directly from the surface water body. All sample containers are return to a chilled darkened cooler and cooled to 4°C . For more details on protocols for water sampling protocol see SOP-002 in **Appendix C.**

Soil and Surface water samples will be placed into sample containers using disposable nitrile gloves and a new pair of nitrile gloves was used for each sample taken. All sample containers will be labelled with the surface water location, site reference and date before being placed in a chilled, darkened cooler (maximum temperature of 4°C).

7 Assessment Criteria

MEH recommends a Before-After Control-Impact (BACI) study design be used to monitor soil, surface water and groundwater for impact of operations and wastewater disposal within 50m and downstream of EcoCamps.

MEH has recommended the soil and water quality conditions at the monitoring points must not vary more than 10% when compared to baseline conditions, using median values (see https://www.waterquality.gov.au/anz-guidelines/monitoring/study-design/preparation#ecological).

7.1 Soil

The soil assessment criteria will address the overarching objectives of this SWMP by assessing the **soil quality data** of soil profiles within the boundaries of **Woodcutters Eco Camp** and **Amphitheatre View Wilderness EcoCamp** and within all areas proposed for disposal of treated sewage and wastewater and all areas within 50 metres of the **Woodcutters EcoCamp** and **Amphitheatre View Wilderness EcoCamp**.

The two areas of soil assessment, in the irrigation area and the surrounding area have differing parameter listings, see section 6.3.1 and differing assessment criteria.

All the soils including soils within the irrigation disposal areas and within 50m the EcoCamps shall be evaluated for contamination with heavy metals.

The irrigation disposal areas have an additional assessment goal of maintaining soil sustainability, (Tennakoon and Ramsay, 2020), therefore the assessment criteria is to also considered the long term sustainability with regards to Nutrients and Physico-chemical Parameters, pH, EC and CEC, Salinity, Soil Sodicity, Sodium Adsorption Ratio. In addition, in order to assess the sustainability of the plants to remove nutrients plant analysis will be undertaken within the irrigation areas. The following sections outline details of the soil and plant analysis assessment criteria for the irrigation areas and within 50m of both EcoCamps.

Soils will be assessed against baseline and if soils within the 50m of the EcoCamps are more than 110% of the soil concentration of the baseline data OR are above the site specific EILs as described below, then the trigger point will deemed to have been breached and further action may be required as outlined in sections 7.4 and 8.2.

7.1.1 Ecological Investigation Levels for Heavy Metals

The applicable soil assessment criteria for heavy metals that may be present in the soils within 50m of the EcoCamps and have potential to impact on the environment are the environmental investigation levels (EILs) from the *National Environment Protection (Draft Assessment of Site Contamination) Amendment Measure (2013)*. The EILs are required to be determined with reference to the *National Environment Protection (Assessment of Site Contamination) Measure (2013) Schedule B(1) and B(5b)* (NEPC, 2013a) (Schedule, 2013).

Table 8 : Risk Decision on ecological impact

Type of SQG	Toxicity data used to calculate the SQGs	Expected toxic effects if the SQG is not exceeded
SQG(NOEC & EC10)	NOEC and EC10	slight toxic effects
SQG(LOEC & EC30)	LOEC and EC30	moderate toxic effects
SQG(EC50)	EC50	significant toxic effects

As determined in the baseline soil investigations to be carried out by MEH within 50m of both EcoCamps. Therefore, the appropriate land use is areas of ecological significance, based on end use and current physical conditions. Given historical and current land use, a Lowest Observed Effect Concentration (LOEC) and a 50% effect concentration data (EC50) has been adopted from the NEPM for the derivation of the following EILs for the irrigation areas.

The reference tables below are for the derivation of EILs as soil assessment criteria for metal concentrations in the soil of irrigation areas. The metals are considered likely contaminants resulting from the land application of treated effluent and public use of a pristine environment are (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg), (Hart and Lake, 1987).

The derivation of EILs for the metals of interest and the Soil Quality Guideline (SQG) specific to the soil being investigated in future assessments will be calculated by the addition of the Added Contaminant Level (ACL) to the ambient background concentration (ABC), thus:

$(SQG_{(LOEC\ \&\ EC30)})\ (EC50) = ACL(EC50) + ABC$

For the above to be valid, pH must be measured using the $CaCl_2$ method (Rayment & Higginson 1992) and Cation Exchange Capacity (CEC) measured using the silver thiourea method (Chabra et al. 1972).

The range of ACLs shown in the tables below have been calculated using the reported results to determine the range of CEC, pH and % clay content of the soils observed on-site. The most applicable criteria for the irrigation areas are highlighted in red in these tables.

Using the reported results for the samples analysed in the 0-0.5 mbgl depth profile (root zone), the range of expected ACLs have shown for the metals of interest [As], [Cr III], [Cu], [Ni] and [Zn].

During the field investigation 2018, (MEL, 2019b), the soils within the root zone of the proposed irrigation disposal areas at Amphitheatre and Woodcutters EcoCamp, two soil types have been identified as having potential differential hydraulic loading characteristics, as shown in Table 1 (MEL, 2019b). Details are shown in section 2.1.

7.1.1.1 Arsenic

In **Table 9**, the generic SQG based on Lowest Observed Effect Concentration (LOEC) and 30% effect concentration (EC30) toxicity data ($SQG_{(LOEC\ \&\ EC30)}$) and based on 50% Effect Concentration (EC50) toxicity data ($SQG_{(EC50)}$) for soil with different land uses has been used for this investigation.

Table 9 : Soil quality guidelines for fresh arsenic contamination

Land use	SQG(LOEC & EC30) (mg/kg total As)	SQG(EC50) (mg/kg total As)
Areas of ecological significance	20	30
Urban residential/public open space	50	90
Commercial/industrial	80	140

Note: The value in red has been chosen for this investigation.

7.1.1.2 Copper

In **Table 10** below, the soil-specific ACLs (mg/kg) based on LOEC and EC30 data for freshwater copper (Cu) contamination that should theoretically provide the appropriate level of protection (that is 99, 80 or 60% of species) to soil processes, soil invertebrate species and plant species in soils with a pH ranging from 4.5 to 8 and a CEC ranging from 5 to 60 cmolc/kg for various land uses are shown, (Schedule, 2013). The lower of the CEC- or the pH-derived ACLs for a particular land use that apply to a soil is to be used.

Table 10 : Soil-specific ACLs (mg/kg) for Copper

Urban residential/public open space land use						
Type of ACL	CEC(cmolc/kg)					
CEC-based ACLs	5	10	20	30	40	60
	50	100	110	110	120	120
	pH					
pH-based ACLs	4.5	5.5	6	6.5	7.5	8
	30	70	100	140	290	420

Note: The values in red have been chosen for this investigation.

7.1.1.3 Chromium III

In **Table 10** below, the soil-specific ACLs (mg/kg) based on LOEC and EC30 data for chromium III (Cr) contamination that should theoretically provide the appropriate level of protection soil invertebrate species.

There was toxicity data for a total of 21 species or soil microbial processes. There was data for 2 soil invertebrate species, 12 species of plants and 7 soil microbial processes. This data meets the minimum data requirements recommended in Schedule B5b to use the BurrliOZ SSD method (Campbell et al. 2000). The ACLs are based on clay content of the soil and it is assumed (not measured) in this investigation all soil samples had a greater than 10% clay content.

Table 11 : Soil-specific ACLs (mg/kg) for Chromium III

Urban residential/public open space land use				
Type of ACL	Clay Content (%clay)			
	1	2.5	5	>=10
CEC-based ACLs	190	250	320	400

Note: The values in red have been chosen for this investigation.

i. Aged values apply to contamination present in soil for at least two years. For fresh contamination refer to Schedule B5c.

ii. The EIL is calculated from summing the ACL and the ABC.

iii. CEC measured using the silver thiouera method (Chabra et al, 1972)

7.1.1.4 Nickel

In Table 12 below, the soil-specific ACLs (mg/kg) at a range of cation exchange capacities for fresh nickel (Ni) contamination based on LOEC and EC30 toxicity data, and based on EC50 toxicity data are shown.

Table 12 : Soil-specific ACLs (mg/kg) for Nickel

Land Use	Cation exchange capacities (cmolc/kg)					
	5	10	20	30	40	60
Areas of ecological significance	5	30	45	60	70	95

Note: The values in red have been chosen for this investigation.

i. Aged values apply to contamination present in soil for at least two years. For fresh contamination refer to Schedule B5c.

ii. The EIL is calculated from summing the ACL and the ABC.

iii. CEC measured using the silver thiouera method (Chabra et al, 1972)

7.1.1.5 Mercury

Mercury is an extremely toxic substance and 0.25 mg/kg (lowest-observed-effect concentration [LOEC]) was (Liu et al., 2010),and (al, 2002).

The Soil Quality Guideline (SQG) specific to the soil being investigated will be calculated by the addition of the Added Contaminant Level (ACL) to the ambient background concentration (ABC), thus:

$(SQG_{(LOEC\ \&\ EC30)}) = ACL(LOEC) + ABC$

7.1.1.6 Lead

In Table 12 below, the soil-specific ACLs (mg/kg) at a range of cation exchange capacities for fresh nickel (Ni) contamination based on LOEC and EC30 toxicity data, and based on EC50 toxicity data are shown.

Table 13 : Generic added contaminant limit for lead in soils irrespective of their physiochemical properties

Chemical	Pb added contaminant level (ACL), mg added contaminant/kg) for various land uses
	Areas of ecological significance
Lead (Pb)	470

Notes:

1. Aged values are applicable to lead contamination present in soil for at least 2 years. For Fresh contamination refer to Schedule B5c.
2. The EIL is calculated from summing the ACL and the ABC.

7.1.1.7 Zinc

In **Table 14** below, soil-specific ACLs based on lowest observed effect concentration and 30% effect concentration toxicity data ($ACL_{(LOEC\ \&\ EC30)}$, mg/kg) for fresh zinc (Zn) that should theoretically provide the appropriate level of protection (this 80% of species) to soil processes, invertebrate species and plant species in soils with a pH ranging from 4.0 to 7.5 and CEC values ranging from 5 to 60 cmolc/kg are shown. These are the recommended ACL values in freshly contaminated soils with each land use.

Table 14 : Soil-specific ACLs (mg/kg) for Zinc

Protection of 99% species for areas of ecological significance						
pH				**CEC (cmolc/kg)**		
	5	**10**	**20**	**30**	**40**	**60**
4	4	5	5	5	5	5
4.5	6	8	8	8	8	8
5	8	10	10	10	10	10
5.5	10	15	15	15	15	15
6	5	25	25	25	25	25
6.5	15	25	35	35	35	35
7	15	25	45	55	55	55
7.5	90	25	45	60	75	80

The above derivation of EILs for the metals of interest and the Soil Quality Guideline (SQG) specific to the soil being investigated in this assessments have been calculated by the addition of the Added Contaminant Level (ACL) to the ambient background concentration (ABC), thus:

SQG(LOEC & EC30) = ACL(LOEC & EC30) + ABC

The following assessment criteria will be used to assess the long term sustainability of the irrigation disposal areas.

7.1.2 Nutrients and Physico-chemical Parameters

The decision on the applicable soil assessment criteria to select Nutrients and Physico-chemical parameters for this investigation was made with reference to the MEDLI Modelling completed for the site.

The physico-chemical properties, anions and cations, nutrients and level of organic matter in the soil have the ability to promote or retard growth of the plants or grasses used to further polish treated wastewaters. The plant medium selected by the operator of the Whitsunday Shores STP is pastures and the assessment criteria for this monitoring program uses the selected pasture as the target receptor for foliage assessment.

7.1.3 pH, EC and CEC

Soil pH affects the availability of nutrients in the soil, with various nutrient availability having different affected pH range. In general, most nutrients are available to plants in the range of pH 5 – 9, (Hazelton P & Murphy B, 2013).

Cation Exchange Capacity (CEC) is the capacity of the soil to hold and exchange cations, and provides buffering capacity to changes in pH, available nutrients, calcium levels and soil structure, (Hazelton P & Murphy B, 2013).

Metson, (1961) suggests the following ratings of CEC cmol(+)/kg, (Metson, 1961).

Table 15 : Ratings of CEC

Ratings	CEC cmol(+)/kg
Very Low	<6
Low	6-12
Moderate	12-25
High	25-40
Very High	>40

7.1.4 Salinity

Soil salinity refers to the accumulation of water-soluble salts in soils, which are predominantly sodium, but also potassium, calcium and magnesium have an effect on salinity, usually in the forms of chlorides, sulphates or carbonates (Hazelton P and Murphy B, 2013).

MEH will converted EC 1:5 (µS/m) to electrical conductivity of saturated conductivity ECe (dS/m) by using the method of Slavich and Petterson (1993), i.e. multiplying the EC 1:5 by a factor of 8.6 and dividing by 100 (Slavich, 1993).

Hazelton and Murphy suggest that using values adapted from Richards (1954), the following Saline ratings can be given, (Hazelton P & Murphy B, 2013), (Richards, 1954).

Table 16 : Salinity ratings for soil based on ECe

Rating	ECe dS/m	Effects on Plants	WQO for the site
Non-saline	<2	salinity effects mostly negligible	
Slightly Saline	2-4	yields of sensitive crops affected	
Moderately Saline	4-8	yields of many crops are affected	Average root zone salinity ECSE 4.5 – 7.7 dS/cm
Highly Saline	8-16	only tolerant crops yield satisfactorily	
Extremely Saline	>16	only very tolerant crops yield satisfactorily	

7.1.5 Soil Sodicity

Sodicity of soils occurs when exchangeable sodium on the cation-exchange complex leads to clay dispersion in soil, when soil becomes wet, (Hazelton P & Murphy B, 2013).

The exchangeable sodium percentage (ESP) is the proportion of exchangeable sodium to all other exchangeable cations by way of CEC (CEC).

7.1.6 Sodium Adsorption Ratio

Sodium Adsorption Ratio (SAR) is an empirical measure of the sodium imbalance of a soil solution and is a measure of the sodium in the infiltrating water, which may lead to deflocculation or dispersal of the soil, (Hazelton P & Murphy B, 2013).

Hart (ANZECC 1992) suggests that very sensitive plants such as citrus and avocado can only tolerate levels of 2 – 8 SAR in irrigation water, (Hart, 1974), (ANZECC & ARMCANZ, 2000). The WQO suggest irrigation water ranging from 16 – 46 level of SAR.

7.2 Plant Tissue Analysis

There are no criteria for plant tissue analysis defined in the EA. The certificate of analysis from the laboratory provides an optimal range for parameters based upon the region, soil type, crop, crop stage and sample type provided. The optimal range for tested parameters, provided by the laboratory for pasture crop, are shown in Table 17 below.

Table 17: Optimal Ranges for Plant Tissue Analysis

Parameter of Interest	Units	Optimal Range	Parameter of Interest	Units	Optimal Range
Total Nitrogen	%	3-4.5	**Boron**	ppm	30-80
Nitrate N	ppm		**Copper**	ppm	6-15
Phosphate	%	0.2-0.35	**Iron**	ppm	50-200
Potassium	%	2-2.5	**Manganese**	ppm	50-250
Calcium	%	0.25-0.55	**Zinc**	ppm	15-20
Magnesium	%	0.2-0.6	**Sodium**	%	0.1-1
Sulfate	%	0.25-0.4	**Chloride**	%	0.05-1.4

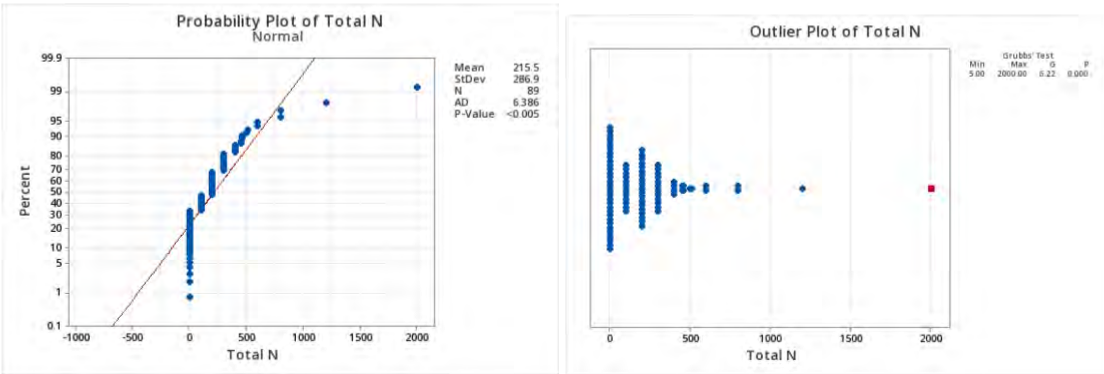
7.3 Water

The assessment criteria for the monitoring of surface and ground waters will monitor the **water quality data** including surface water and groundwater underlying **Woodcutters Eco Camp** and **Amphitheatre View Wilderness EcoCamps** and all drainage channels and downstream water bodies outside of the boundaries of **Woodcutters EcoCamp** and **Amphitheatre View Wilderness EcoCamp** with potential hydraulic connectivity with sewage and wastewater disposal areas**.**

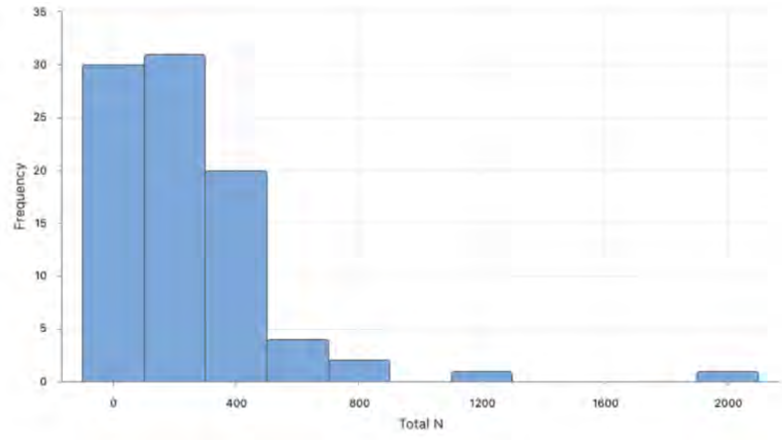
7.3.1 Statistical Analysis

MEH has not developed trigger values, such as the 50 percentile values in the reference or control sites as recommended for high ecological value such as national parks. Due to the high degree of variability in water quality measured in the Dalrymple Creek System. MEH has been using nonparametric statistics to determine if the difference in the medians of potentially impacted and control sites are statistically significant.

The following graph of Probability Plot shows the degree away from a normal distribution is total nitrogen data in the Dalrymple Creek System as well as outliers in the data set.



Graph 3 : Probability and the outliers plot for Total Nitrogen in the Dalrymple Creek System.



Graph 4 : Histogram of Toal Nitrogen in the Dalrymple Creek System

"Water quality data do not usually follow convenient probability distributions such as the well-known normal and lognormal distributions on which many classical statistical methods are based", (Lettenmaier et al., 1991).

The main reason why non-parametric statistics are being used is to determine potential impacts on water quality are for the following reasons:

- A high degree of results below the level of reporting (LORs);
- The observation of outliers frequently in the data set;
- Positive skewness, due to the previous two points; and
- The observation of the population of water quality data in the Dalrymple, Unnamed and Blackfellows creek systems not being normally distributed.

Water quality data often exhibits a non-normal distribution, values below the level of reporting and the presence of outliers. The water quality data in the Dalrymple creek system shows these tendencies especially in the key parameter of concern nitrogen.

- nonparametric tests are not affected by the inclusion of outliers; and
- for some datasets, nonparametric analyses provide an advantage because they assess the median rather than the mean. Of various nonparametric test methods, Mood's Median test method is most suitable for comparison of sample medians.

Statistical Methods in Water Resources from U.S. Department of the Interior and U.S. Geological Survey, USGS, (Helsel et al., 2020) outlines the above argument for use of non-parametric statistics in assessing water quality in freshwater ecosystems.

The Qld Monitoring and Sampling Manual and Queensland Water Quality Guidelines do not address the issue of non-normality of water quality data even though they indicate that more advanced statistical analysis may be required if the dataset is not normally distributed, (Queensland, 2009), (Queensland, 2018a). The Qld government guide for groundwater quality assessment describes the use of nonparametric tests but does not provide rationale for their use, (Queensland, 2021).

Once the irrigation disposal fields are in use MEH may use Trend Analysis to further analyse if the nutrient levels are increasing over time or not statistically.

7.4 Trigger Points

If the soil data from within 50m of the EcoCamps is above the heavy metal assessment criteria as outlined in section 7.1 or above baseline nutrient levels further investigation may be required.

Soils will be assessed against baseline and if soils within the 50m of the EcoCamps are more than 110% of the soil concentration of the baseline data OR are above the site specific EILs as described below, then the trigger point will deemed to have been breached and Scenic Rim Trail must employ an independent contamination consultant to verify the source of the pollutant, further action may be required as outlined in sections 8.2.

If the soil data from the irrigation disposal area demonstrates the soils or plants within the irrigation are under stress and their capacity to ameliorate the water being applied is diminished, Scenic Rim Trail must take action to resume the sustainability of the irrigation disposal area. This may include:

- If the condition of vegetation over the irrigation area is determined to be degraded, actions may include replanting of the irrigation area with a species more suited to the nutrient levels and soil type.
- Increasing the irrigation area is the existing disposal area is not capable of absorbing the nutrient load.
- Construction of a new irrigation disposal area with new metrics if the existing area is not sustainable.

The water quality data can be compared to water quality objectives and baseline data, however, given the data presented in section 7.3.1 this may not be sufficient to justify an action, unless changes over time or trend analysis reviewed during annual reporting demonstrates a definitive change in the status of the water quality.

However, if non-parametric statistical analysis demonstrates that there is potential for impact on water quality by the following:

a) If the medians based on the data set from baseline and ongoing are proven to be statistically different between a control site and potentially impacted site, it should be demonstrated that there is a causation to the impact from the EcoCamps and that this is not due to the high variability in background water quality within the creek systems.
b) Additional investigations may be required to prove what has caused the difference in the medians between a control site and potentially impacted site.

8 Quality Assurance/Quality Control (QA/QC)

For any given project, all investigation data is potentially subject to sampling and data reduction errors. Therefore, data quality objectives (DQO) are established to control the sources of errors and quantify the errors whenever possible. Quality control (QC) procedures are designed to both increase sample data quality and help interpret discrepancies in results.

All work was conducted in accordance with industry-accepted standards and quality assured procedures. Field quality control includes rigorous sample collection, decontamination procedures, and sample documentation.

Methodology of the quality assurance (QA) and quality control (QC) are further discussed in this section of the report with further details presented in **Appendix B.** Results are discussed in Section 9.

QC samples will be collected and/or analysed in accordance with National Environmental Protection Measure (NEPM) guidelines, (NEPC, 2013a). One field duplicate and one field triplicate sample will be collected per 10 primary samples and one trip blank per sampling event. Further details of MEH quality control and quality assurance procedures are shown in Quality Assurance and Control (**Appendix B).**

8.1 Reporting

Results of all monitoring activities undertaken shall be forwarded to DEECCW annually or as required in the SRTMP.

The annual soils and water quality reports will consider multiple lines of evidence such as breaches of WQO, statistical tests, time series and trend analysis in verifying any impacts on soils and water quality and the causation of change. The reports will also complete an adequacy review of the monitoring regime and may suggest change not previously considered in this plan or the SRTMP. Any change will be in accordance with **8A and 15A** of the variation (**Appendix A**).

8.2 Corrective Action

Management shall investigate and document events of non-compliance with the above assessment criteria in section 7, including soils and surface water quality data.

If a decrease in a population of the MNES, or change in soil, water or habitat quality referred to in condition **8A, 14.c. or 15A** of the Variation as shown in **Appendix A**, has occurred or is likely to occur, the approval holder must report this to the Department within **5 business days** of being detected. This is the current corrective action protocol in line with the Variation as shown in **Appendix A.**

If multiple lines of evidence such as breaches of WQO, statistical tests, time series and trend analysis in verifying any impacts on soils and water quality and the causation of change leads to conclusions of a decrease in a population of the MNES, or change in soil, water or habitat quality referred to in condition **8A, 14.c. or 15A** of the Variation as shown in **Appendix A**, has occurred or is likely to occur, the approval holder must report this to the Department within **5 business days** of being detected. This is our proposed corrective action protocol and the Variation as shown in **Appendix A,** would require change**.**

Management procedures shall be modified where necessary to achieve compliance with conditions of the Variation as shown in **Appendix A**.

Non-conformance with this SWMP shall be documented included in the Non-conformance Register.

Management shall implement the corrective action as required within the agreed time frame noted on the corrective action record (CAR).

A record of the corrective action required will be implemented by the operations manager of the WWTP and will include the use of the PDCA cycle which has four stages:

1. Plan determine goals for the required action and the required actions changes to achieve the goal.
2. Do implement the changes.
3. Check evaluate the results in terms of performance.
4. Act standardise and stabilise the change or begin the cycle again, depending on the results. The actions and/or changes to the operational processes must be sustainable and achieve the goal in the long term.

9 Disclaimer

This Sewage and Wastewater Monitoring Plan (SWMP) has been prepared for the exclusive use of the by THRL Pty Ltd ACN 137 592 593 (Scenic Rim Trail) for its own use for the purpose of assessment of surface waters in the land application areas in Amphitheatre and Woodcutters EcoCamps (the “sites”).

The SWMPT must be read in light of:

- The limited readership and purposes for which it was intended.
- Its reliance upon information provided by the client and others which MEH has not verified and over which MEH has no control.
- The limitations and assumptions referred to throughout the Report.
- The cost and other constraints imposed on the Report.
- Other relevant issues which are not within the scope of the Report.

Subject to the limitations referred to above, MEH has exercised all due care in the preparation of the Report and believes that the information, conclusions, interpretations and recommendations of the Report are both reasonable and reliable.

No warranty or representation is made to finance or third parties (express or implied) in respect of the Report, particularly with regard to any commercial investment decision made on the basis of the Report. Use of the Report by Finance or third parties shall be at their own risk and extracts from the Report may only be published with permission of MEH. This disclaimer must accompany every copy of the Report, which is an integral document and must be read in its entirety.

10 Limitations of this plan

The outcome of this plan is limited to information supplied for the activities associated with the scope of works only. It is intended that this assessment provide a description of the potential surface or groundwater contamination, and recommendations on how to address and manage any contamination issues at the site.

This plan has been prepared for by THRL Pty Ltd ACN 137 592 593 (Scenic Rim Trail) for its own use and is based on information provided by Scenic Rim Trail. MEH takes no responsibility and disclaims all liability whatsoever for any loss or damage that Scenic Rim Trail Retreats Hotels & Lodges Pty Ltd may suffer as a result of using or relying on any such information or recommendations contained in this Report, except that expressly indicated in this Report where MEH has been able to verify the information to its satisfaction. This Report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein.

Should further information become available regarding the conditions at the site, including previously unknown likely sources of contamination, MEH reserves the right to review the Report in the context of the additional information.

The findings, observations and conclusions expressed in this report are not, and should not be considered as an opinion concerning the commercial feasibility of the property or asset.

The plan may contain various remarks about and observations on legal documents and arrangements such as contracts, supply arrangements, leases, licences, permits and authorities. A consulting scientist can make remarks and observations about the technical aspects and implications of those documents and general remarks and observations of a non-legal nature about the context of those documents. However, as a consulting scientist MEH is not qualified, cannot express and should not be taken as in any way expressing any opinion or conclusion about the legal status, validity, enforceability, effect, completeness or effectiveness of those arrangements or documents.

This plan has been prepared by **Moreton Environmental and Health Pty Ltd** ABN: 68 169 746 123 in response to and subject to the following limitations:

1. The specific instructions received from THRL Pty Ltd ACN 137 592 593 (Scenic Rim Trail);
2. The specific scope of works set out in PO25003, **Proposal for Production of Sewage and Wastewater Monitoring Plan (SWMP).** dated 4th April 2025;
3. This report may not be relied upon by any third party not named in this report for any purpose except with the prior written consent of **Moreton Environmental and Health Pty Ltd** (which consent may or may not be given at the discretion of **Moreton Environmental and Health Pty Ltd**);
4. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;
5. The report only relates to the site referred to in the scope of works being located at the Scenic Rim Trail – Thornton Trailhead to Spicers Canopy Nature Reserve, Queensland ("the site");
6. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;
7. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;
8. Fill, soil, groundwater and rock to the depth tested on the site may be fit for the use specified in this report. Unless it is expressly stated in this report, the fill, soil and/or rock may not be suitable for classification as clean fill if deposited off-site; and
9. Our General Limitations set out at the back of the body of this report.

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12 Glossary and Terms

Acidify addition of acid to lower pH.

AHD Australian Height Datum, equivalent to Mean Sea Level in south-east Queensland

Aquifer rock or sediment in a formation, group of formations, or part of a formation, which is/are saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Aquifer, confined aquifer that is overlain by a confining bed with significantly lower hydraulic conductivity than the aquifer.

Aquifer, perched region in the unsaturated zone where the soil is locally saturated because it overlies soil or rock of low permeability.

Aquitard a unit of low permeability that can store groundwater and also transmit it slowly.

Background natural level of a property/parameter.

Baseline initial value of a measure.

Borehole an uncased well drill hole.

Cobble rock fragment rounded or abraded between 64 and 256 mm in diameter. Cobbles are larger than gravel and smaller than boulders.

Coliform count coliform bacteria are found in the gut of many vertebrates and are commonly associated with decaying organic matter.

Conductivity (EC) - Electrical Conductivity of water is an expression of its ability to conduct an electric current. This property is related to the ionic content of the sample, which is in turn a function of the Total Dissolved (ionisable) Solids (TDS) concentration. An estimate of TDS (mg/L) in fresh water can be obtained by multiplying EC (□S/cm) by 0.65.

Confidence Limits (statistics) an interval so constructed as to have a prescribed probability of containing the true value of an unknown parameter.

Confined Aquifer an aquifer with upper and/or lower boundaries confined by an almost impermeable geological formation, e.g. a clay layer. The water in these aquifers is usually under hydraulic pressure, e.g. artesian or sub-artesian conditions with a hydraulic head (or "water head") elevated above the top of the aquifer.

Confining layer an aquitard or sparingly permeable layer that confines the upper limits of an underlying saturated aquifer.

Contaminant generally, any chemical species introduced into the soil or water. More particularly relates to those species that render soil or water unfit for beneficial use.

Contamination is considered to have occurred when the concentration of a specific element or compound is established as being greater than the normally expected (or actually quantified) background concentration.

CSM Conceptual Site Model(s), simplified diagrams /descriptions of physical settings and processes.

Discrete sample samples collected from different locations and depths that will not be composited but analysed individually.

Effective Persons (EPs) are a theoretical number of people to occupy a dwelling for the purposes of estimating influent loads on a wastewater treatment plant.

Electrolytic Conductivity (EC) (see **Conductivity**)

Fracture break in the geological formation, e.g. a shear or a fault.

Gleyed soils waterlogged soils. Develop where drainage is poor or the water table is high. A reducing environment exists in the saturated layers, which become mottled greyish-blue or brown because of the content of ferrous iron and organic matter.

Gradational lower boundary between soil layers (horizons) has a gradual transition to the next layer. The solum (soil horizon) becomes gradually more clayey with depth.

Groundwater investigation level (GIL) is the concentration of a ground-water parameter at which further investigation (point of extraction) or a response (point of use) is required. Includes Australian water quality guidelines/drinking water guidelines/guidelines for managing risk in recreational water criteria and site-specific derived criteria.

Groundwater, (or "ground water") water held in the saturated pore spaces of an aquifer.

Head space air space at the top of a soil or water sample.

Hectares (ha) is a measure of area, equivalent to 10,000 meters squared.

Heterogeneous condition of having different characteristics in proximate locations. Non-uniform. (Opposite of **homogeneous**).

Horizon individual soil/sediment layer, based on texture and colour, which differs from those above and below.

Humic/Humus referring to organic matter within soil.

Investigation levels and screening levels are the concentrations of a contaminant above which further appropriate investigation and evaluation will be required. Ecological investigation levels (EILs) may also be referred to as soil quality guidelines in relevant references (see NEPM Schedules B5b and B5c).

Laboratory of Reporting (LOR) is the lowest concentration a laboratory technique or procedure can report with the appropriate confidence of accuracy.

Lithosol shallow soils showing minimal profile development and dominated by the presence of weathered rock and rock fragments.

Loam median textured soil of approximate composition 10-25% clay, 25-50% silt and >50% sand.

Massive refers to the condition of the soil layer in which the layer appears to be as a coherent or solid mass, which is largely devoid of peds.

Metals are elements, compounds, or alloys that are good conductors of both electricity and heat. Common metals analysed are Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), and Zinc (Zn).

Mottled a pattern where soils or sediments have masses, blobs or blotches of sub-dominant, varying colours indicating regular water saturation/unsaturation.

National Association of Testing Authorities (NATA), NATA accreditation provides a means of determining, formally recognising and promoting the competence of facilities to perform specific types of testing, inspection, calibration, and other related activities

National Environment Protection Measure (NEPM), NEPMs are broad framework-setting statutory instruments defined in the NEPC Act. They outline agreed national objectives for protecting or managing particular aspects of the environment.

Occupational Health and Safety (OH&S) is a cross-disciplinary area concerned with protecting the safety, health and welfare of people engaged in work or employment.

Organics chemical compounds comprising atoms of carbon, hydrogen and others (commonly oxygen, nitrogen, phosphorus, sulphur). Opposite is inorganic, referring to chemical species not containing carbon.

ORP Oxidation Reduction Potential, a physio-chemical measurement of the oxidizing or reducing potential of a water body.

Oxidation originally referred only to the addition of oxygen to elements. However, oxidation now encompasses the broader concept of the loss of electrons by electron transfer to other ions.

Parameters population value of a particular characteristic, which is descriptive of the distribution of a random variable.

Perched Aquifer (or water table) a body of water located above an impermeable geological formation. These perched aquifers (or water tables) are nearly always seasonal or periodic.

Permeability property of porous median relating to its ability to transmit or conduct liquid (usually water) under the influence of a driving force. Also referred to as hydraulic conductivity.

pH logarithmic index for the concentration of hydrogen ions in an aqueous solution, which is used as a measure of acidity.

Plastic soil material, which is in a condition, that allows it to undergo permanent deformation without appreciable volume change or elastic rebound, and without rupture.

Potentiometric Surface water level that represents the standing or total hydraulic standing head. In an aquifer system it represents the levels to which water will rise in tightly cased walls (e.g. a cased borehole).

Precision is a measure of the reproducibility of results under a given set of conditions and is assessed on the basis of agreement between a set of duplicate results obtained from duplicate analyses.

Profile the solum. This includes the soil A and B horizons and is basically the depth of soil to weathered rock.

QA/QC Quality Assurance / Quality Control involves all of the actions, procedures, checks and decisions undertaken to ensure the representativeness and integrity of samples, and accuracy and reliability of analytical results. Quality control is the component of QA, which monitors and measures the effectiveness of other procedures by the comparison of these measures to previously decided objectives.

Reducing Conditions can be simply expressed as the absence of oxygen, though chemically the meaning is more complex. For more details refer to OXIDATION.

Relative Percentage Difference (RPD) expresses the precision of results by comparing the difference between the two samples to the average of the two samples.

Representative Sample assumed not to be significantly different than the population of samples available. In many investigations, samples are collected to represent the worst-case situation.

Standing water level (SWL) is depth to groundwater (m) below a datum point or reference point, usually from the top of casing or natural ground surface.

Stratigraphy vertical sequence of geological units.

Subsoil subsurface material comprising the B and C horizons of soils with distinct profiles. They often have brighter colours and higher clay content than topsoils.

Suspended Solids (SS) matter, which is suspended in water, which will not pass through a 0.45 µm filter membrane.

Texture is the size of particles in the soil. Texture is divided into six groups, depending on the amount of coarse sand, fine sand, silt and clay in the soil.

Topsoil part of the soil profile, typically the A1 horizon, containing material, which is usually darker, more fertile and better, structured than the underlying layers.

Total Acidity (TA) difference between the soil CEC and ANC.

Total Actual Acidity (TAA) moles of titratable protons per unit mass of soil displaced by an un-buffered KCl solution, otherwise known as the salt-replaceable acidity.

Toxicity the inherent potential or capacity of a material to cause adverse effects in a living organism.

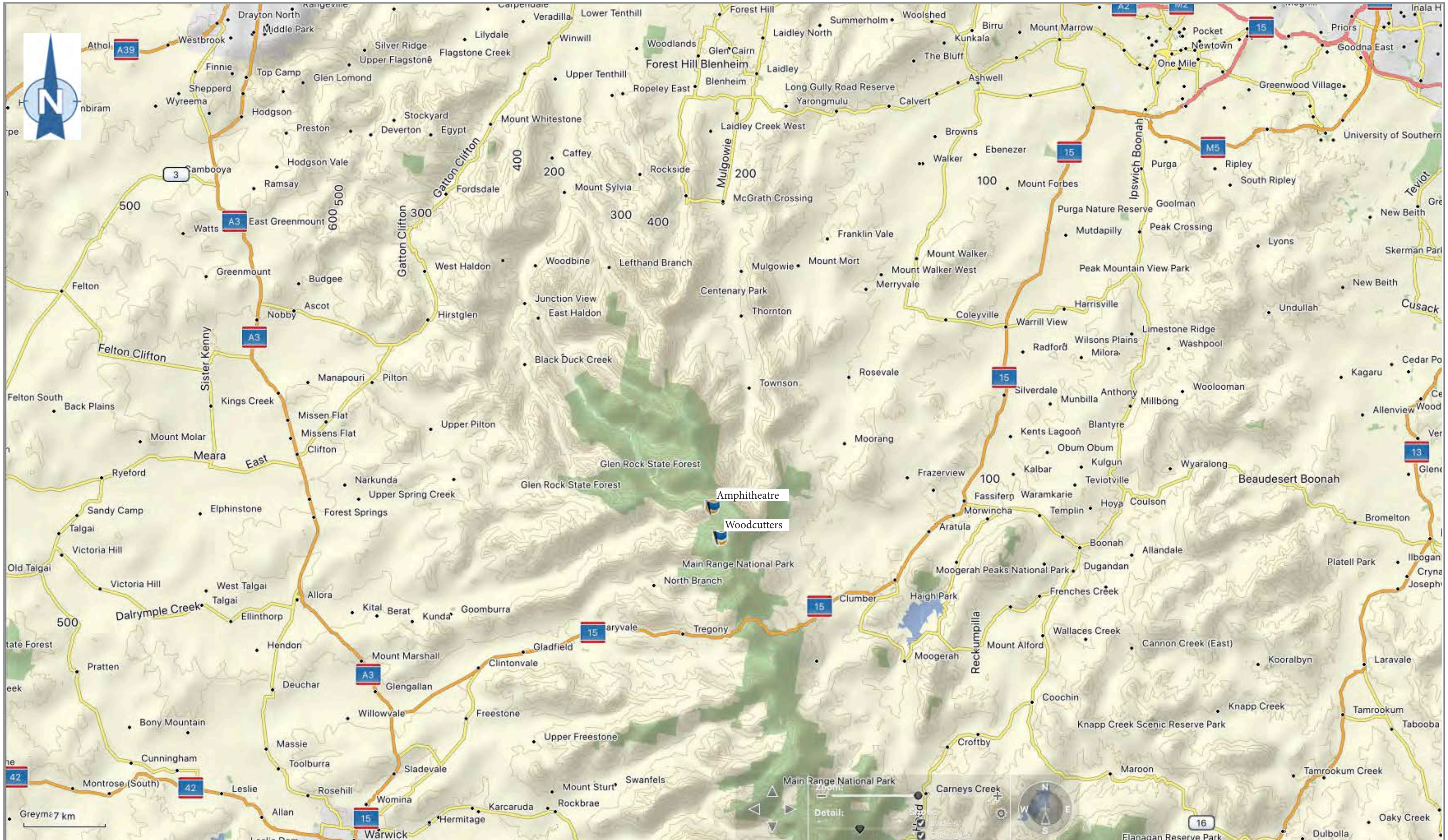
Transmissivity rate at which water is transmitted through a unit width aquifer under a unit hydraulic gradient.

Unsaturated zone vadose zone. The zone between the land surface and the water table, in which the rock or soil pores contain both air and water.

Upper Confidence Limit (UCL) is the upper confidence Interval of a two-sided estimated interval of a parameter. This interval is expected to include the true value of the parameter with a specified confidence percentage, e.g., 95% of such intervals are expected to include the true values of the estimated parameters.

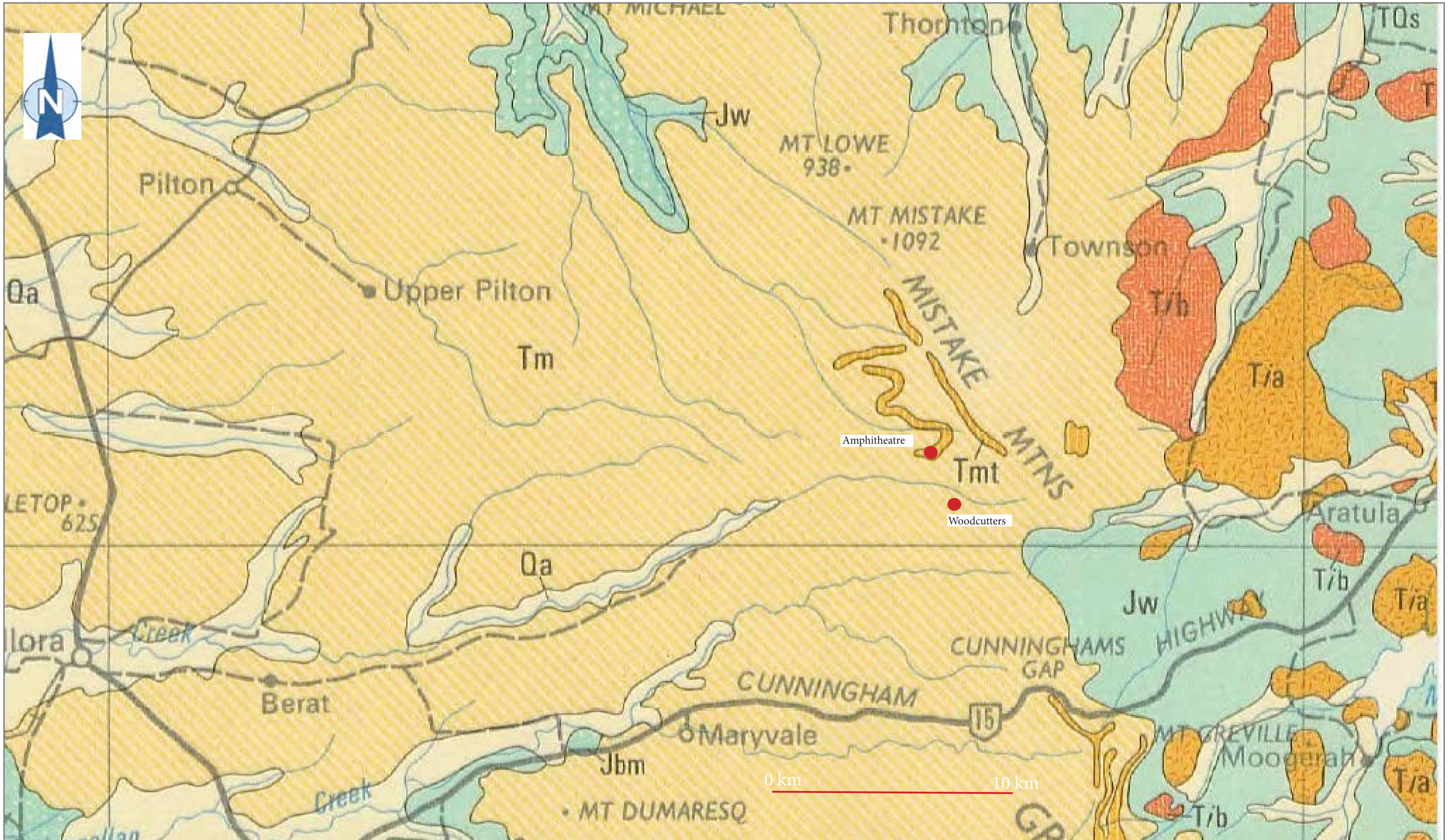
Water table interface between the saturated zone and unsaturated zones. The surface in an aquifer at which pore water pressure is equal to atmospheric pressure.

FIGURES



Legend

moreton environmental and health	Title: Location Map
	Location: Main Range National Park, Queensland
Client: Spicers Retreats Hotels & Lodges Pty Ltd	Source: Google Earth
Drawn by: Dan Morton	Scale: Scale Bar Job No: 25005
Project Manager: Dan Morton	Date: March 2025 FIGURE : 01



Legend

Tm / Tmt	Main Range Volcanics	Basalt, agglomerate, shale, dolomite (Tmt — tr
Qa		Flood plains, river terraces

Main Range Volcanics - *Basalt, agglomerate, shale, dolomite*

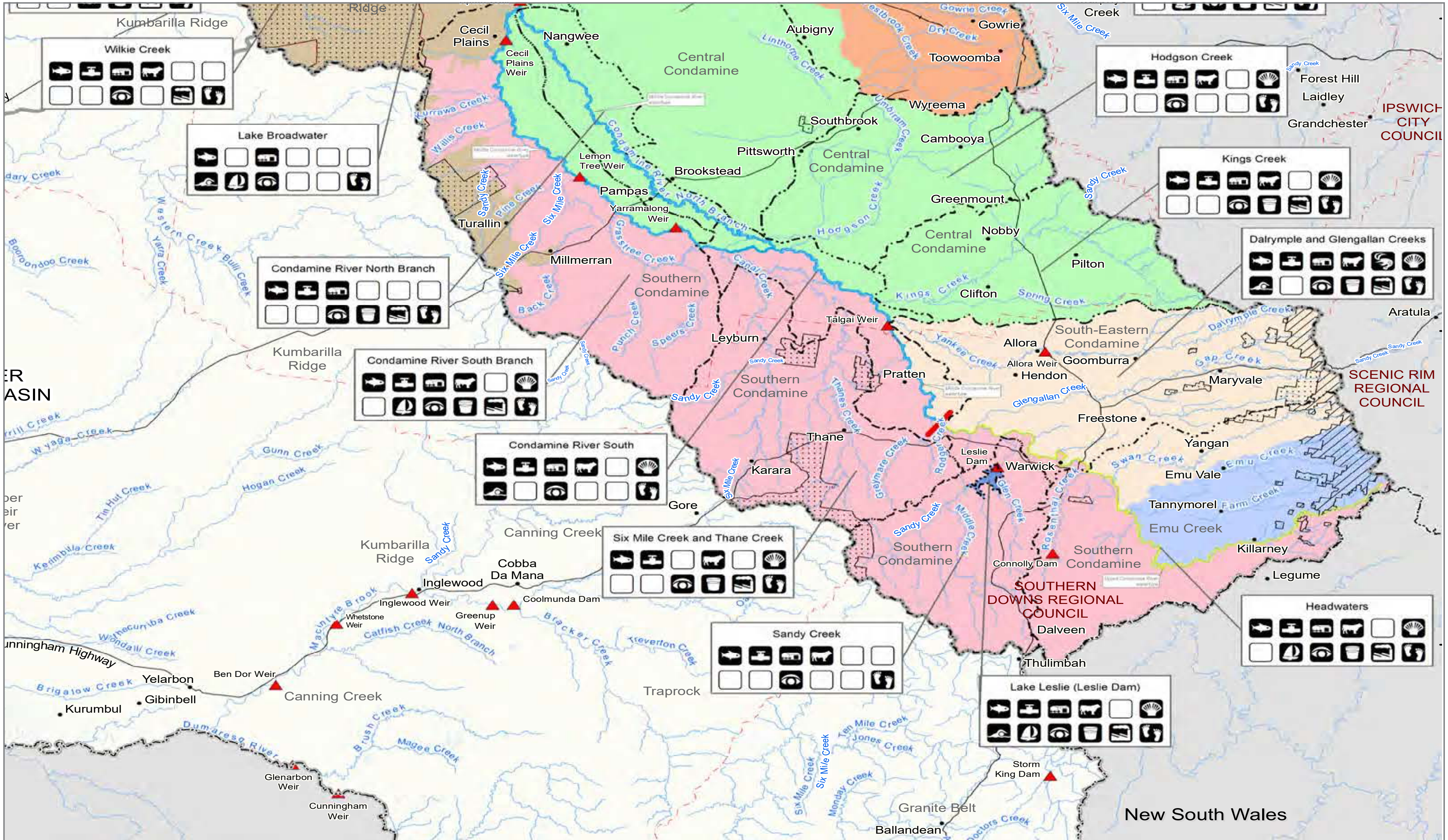
Flood Plains, river terraces

Compiled by W.G. Whitaker and P.M. Green, Regional Mapping Section, from data available at June, 1978.

Geology from 1:250 000 series maps published by the Geological Survey of Queensland (GSQ), Geological Survey of New South Wales (GSNSW) and the Bureau of Mineral Resources, Geology and Geophysics; 1:100 000 series maps published or in preparation by GSQ and GSNSW, and other sources.

moreton environmental and health

Title:	Geology
Location:	Main Range National Park, Queensland
Client:	Spicers Retreats Hotels & Lodges Pty Ltd
Source:	
Drawn by:	Dan Morton
Scale:	Scale Bar — Job No: 25005
Project Manager:	Dan Morton
Date:	March 2025 — FIGURE : 02



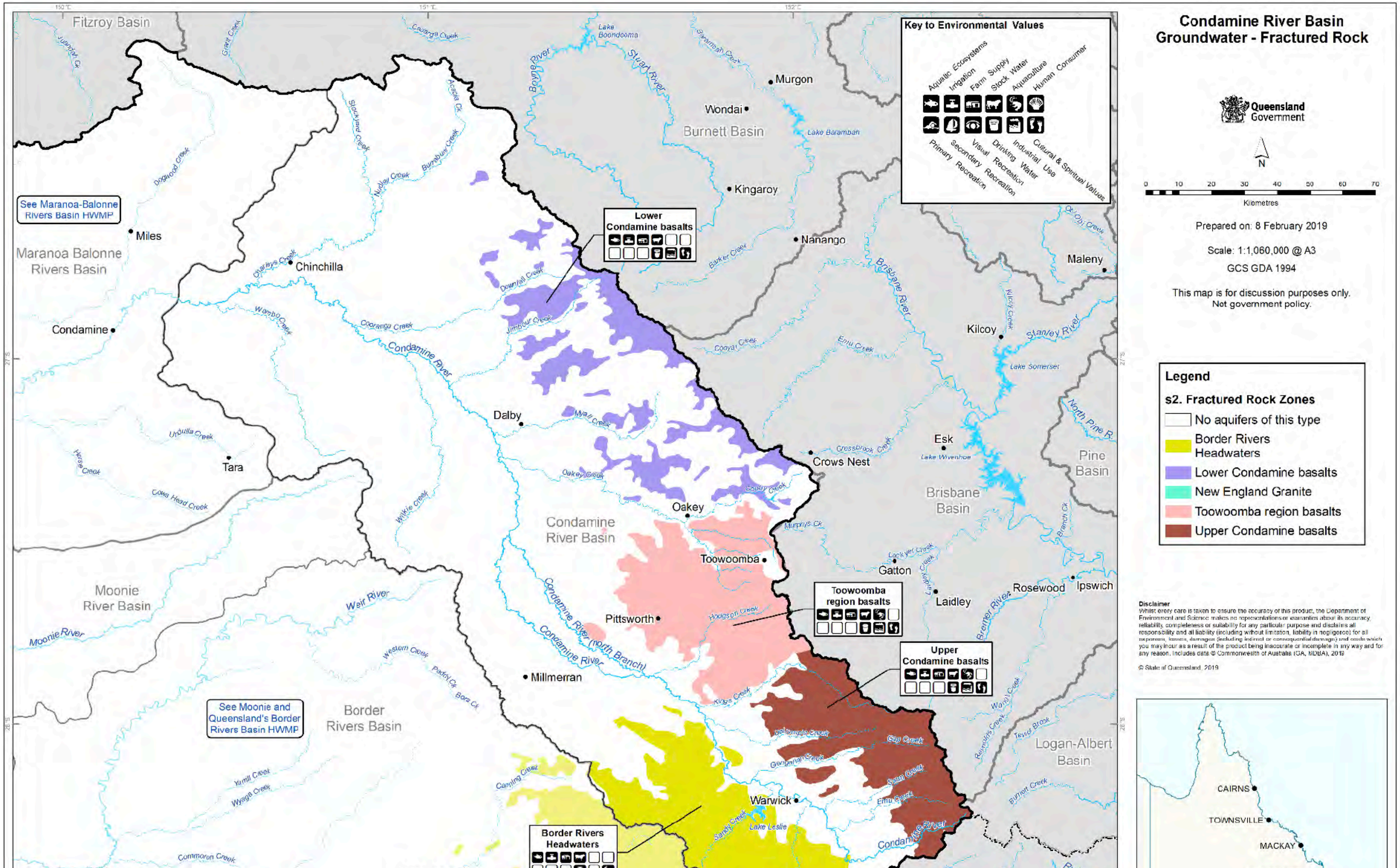
Legend

WQ4223 - Condamine River Basin Part of basin 422 under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019.

moreton environmental and health

Client:	Spicers Retreats Hotels & Lodges Pty Ltd
Drawn by:	Dan Morton
Project Manager:	Dan Morton

Title:	Surface Water Environmental Values
Location:	Main Range National Park, Queensland
Source:	
Scale:	Scale Bar Job No: 25005
Date:	March 2025 FIGURE : 03

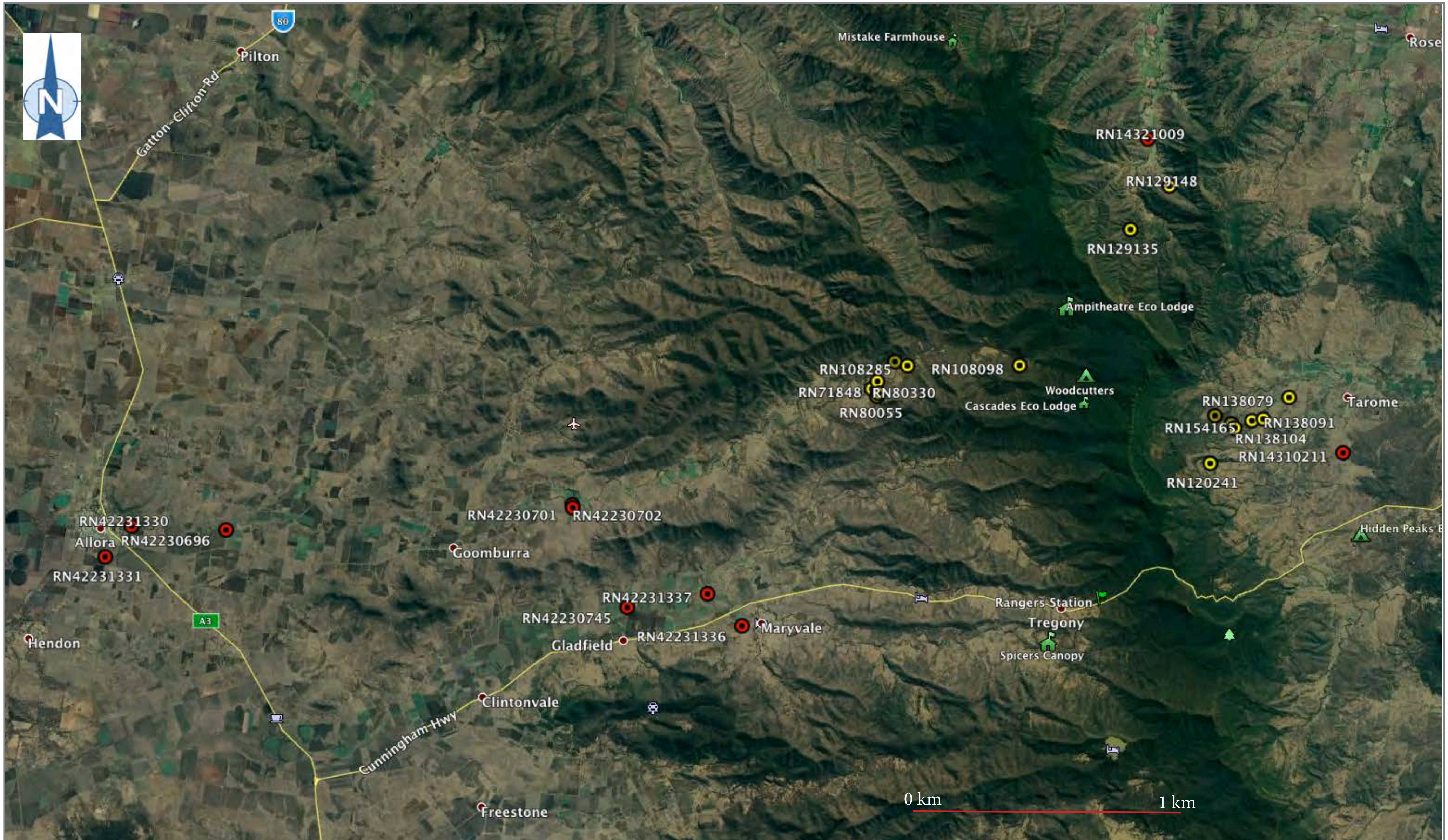


Legend

Title:	Groundwater Environmental Values
Location:	Main Range National Park, Queensland
Source:	
Scale:	Scale Bar Job No: 25005
Date:	March 2025 FIGURE : 04

moreton environmental and health

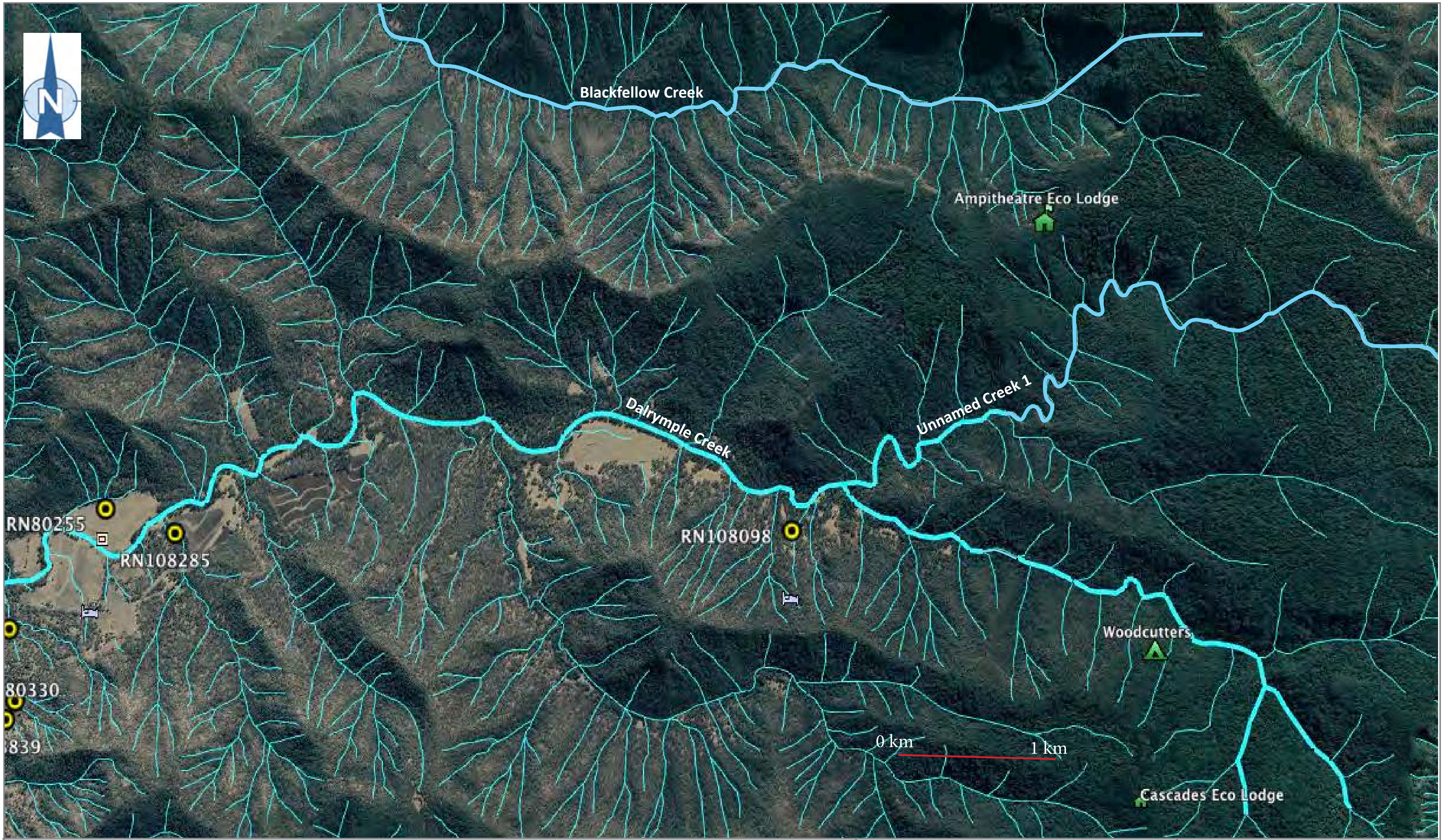
Client:	Spicers Retreats Hotels & Lodges Pty Ltd
Drawn by:	Dan Morton
Project Manager:	Dan Morton



Legend

moreton environmental and health

Title:	Bore Search
Location:	Main Range National Park, Queensland
Client:	Spicers Retreats Hotels & Lodges Pty Ltd
Source:	
Drawn by:	Dan Morton
Scale:	Scale Bar Job No: 25005
Project Manager:	Dan Morton
Date:	March 2025 FIGURE : 05

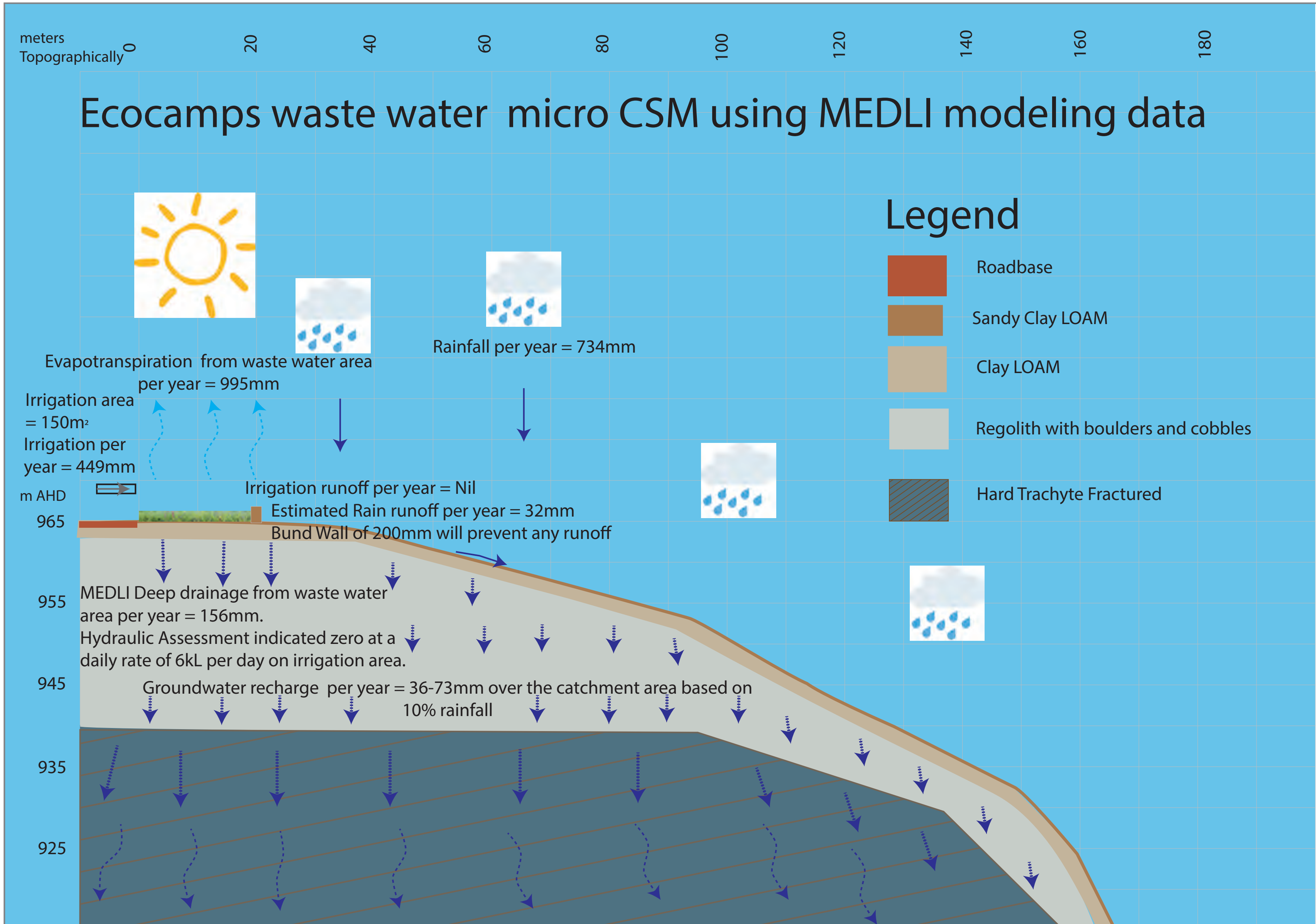


Legend

moreton environmental and health

Client:	Spicers Retreats Hotels & Lodges Pty Ltd
Drawn by:	Dan Morton
Project Manager:	Dan Morton

Title:	Creeks and Watercourses		
Location:	Main Range National Park, Queensland		
Source:			
Scale:	Scale Bar	Job No: 25005	
Date:	March 2025	FIGURE :	06

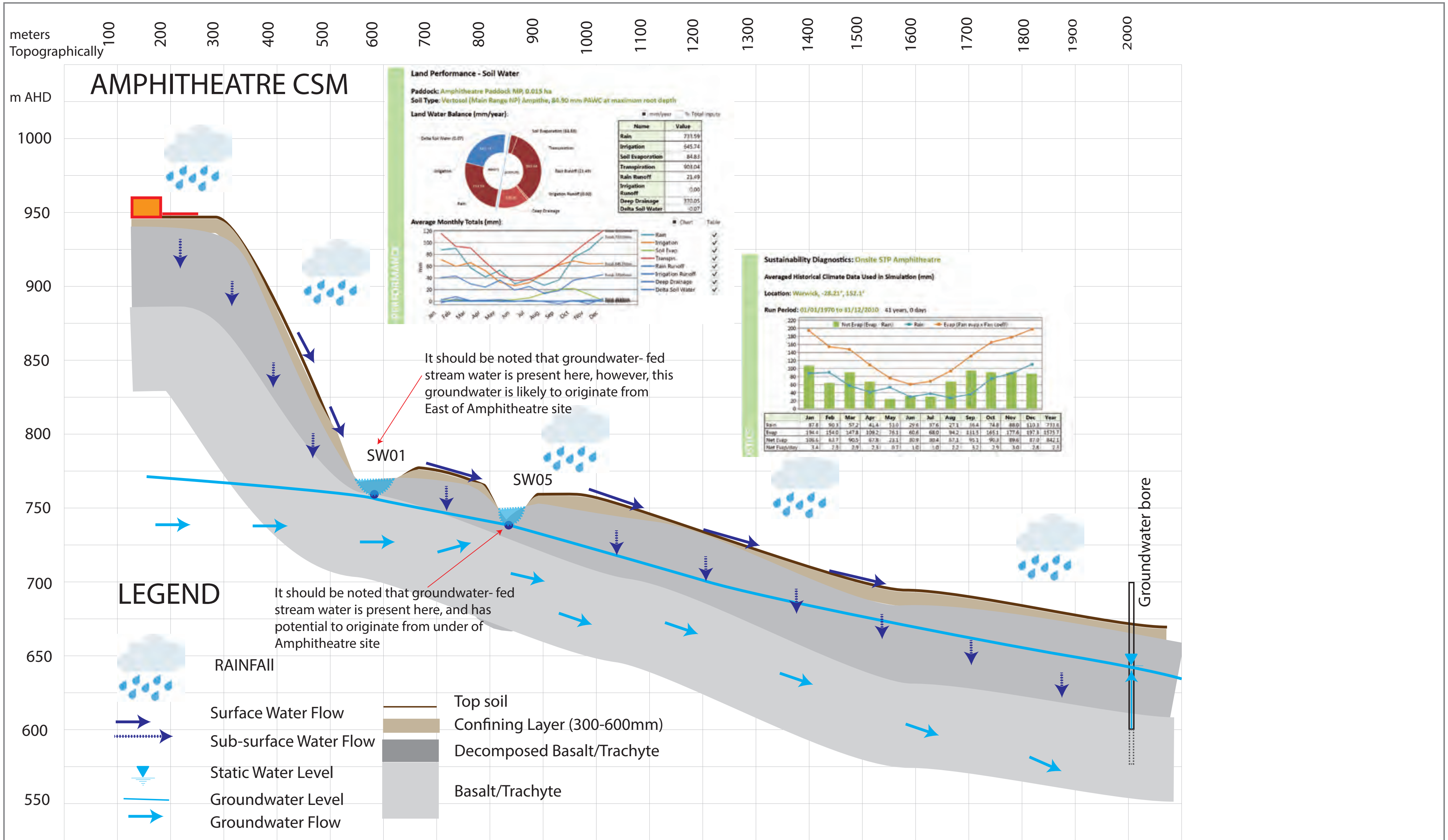


Legend

Title:	EcoCamps Waste Water Micro CSM using MEDLI Data
Location:	Main Range National Park, Queensland
Source:	
Scale:	Scale Bar Job No: 25005
Date:	March 2025 FIGURE : 07

moreton environmental and health

Client: Spicers Retreats Hotels & Lodges Pty Ltd
Drawn by: Dan Morton
Project Manager: Dan Morton

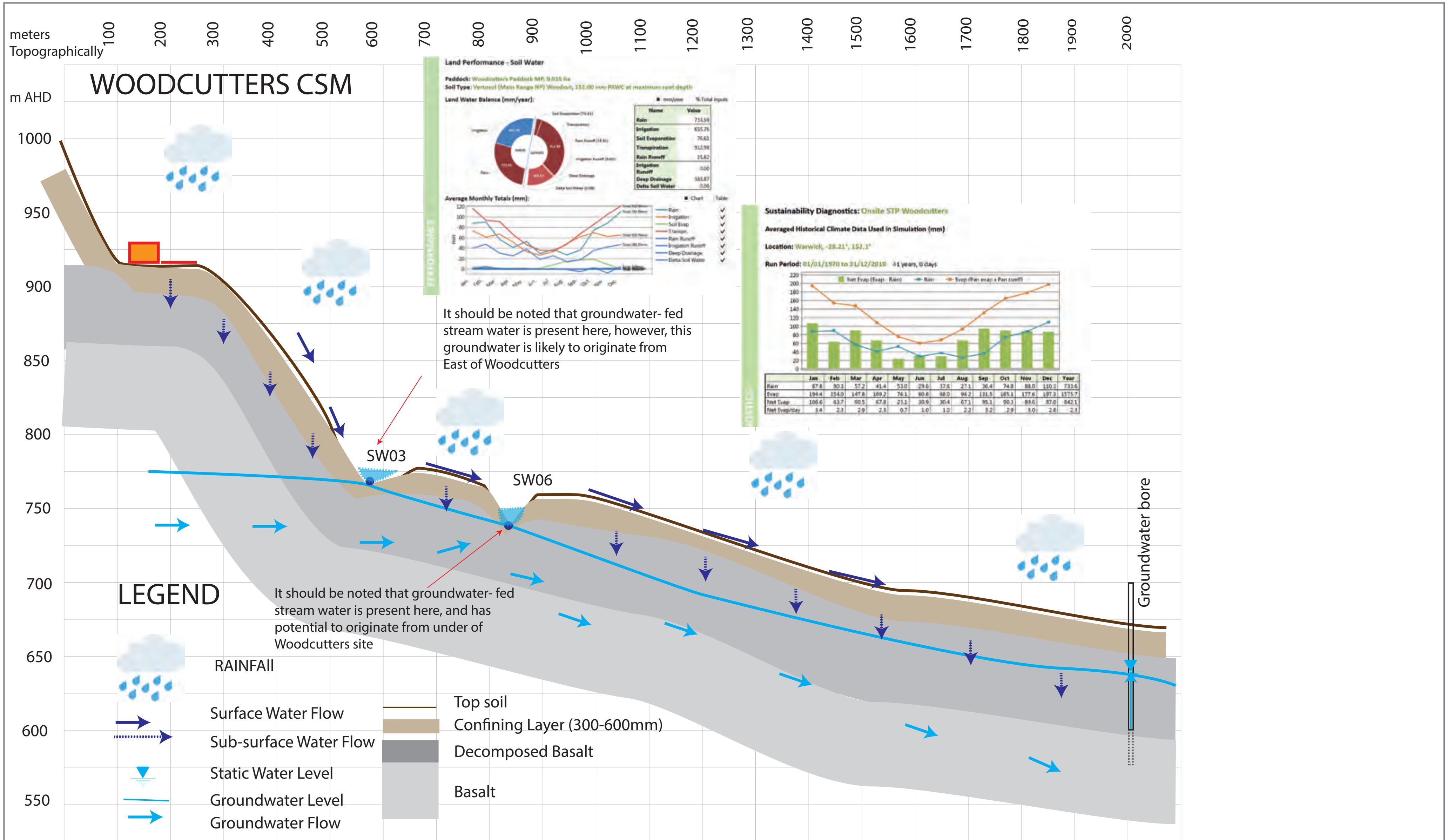


Legend

moreton environmental and health

Client:	Spicers Retreats Hotels & Lodges Pty Ltd
Drawn by:	Dan Morton
Project Manager:	Dan Morton

Title:	Amphitheatre Groundwater Conceptual Site Model		
Location:	Main Range National Park, Queensland		
Source:			
Scale:	Scale Bar	Job No: 25005	
Date:	March 2025	FIGURE :	08

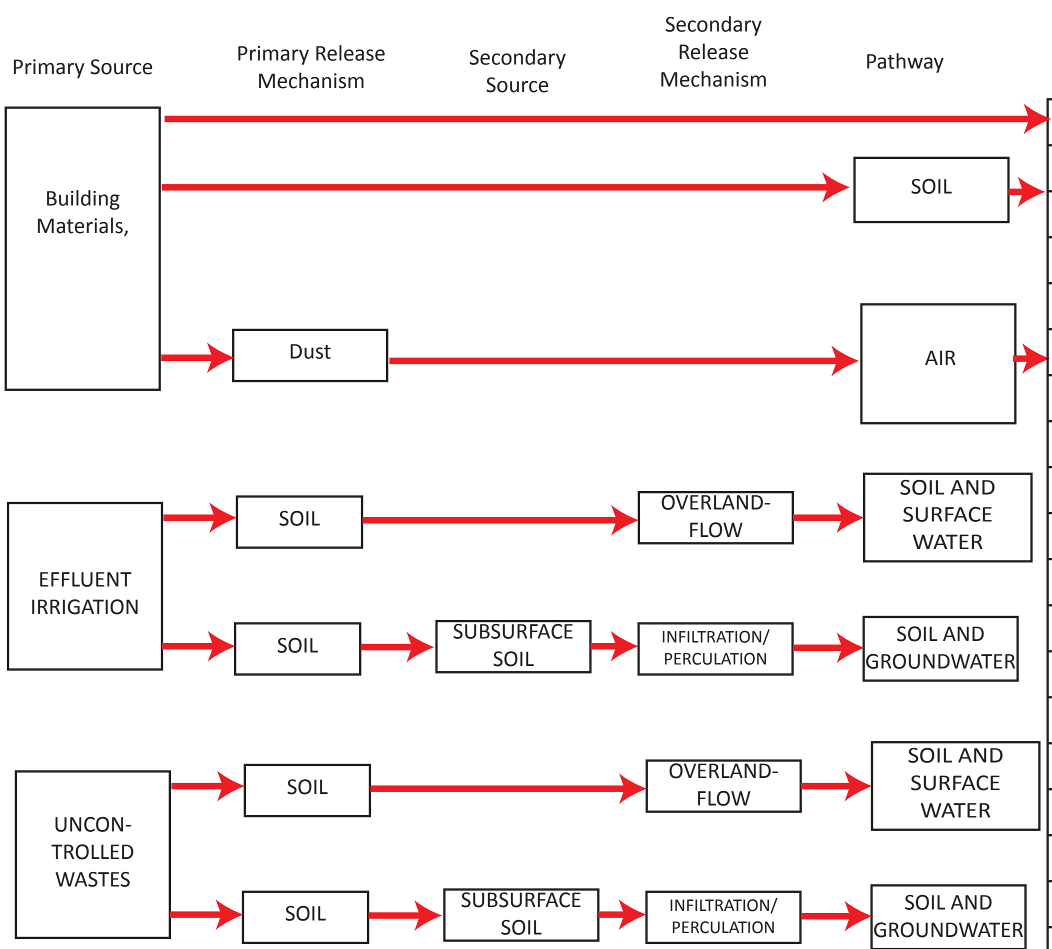


Legend

moreton environmental and health

Client:	Spicers Retreats Hotels & Lodges Pty Ltd
Drawn by:	Dan Morton
Project Manager:	Dan Morton
Title:	Timber Getters Groundwater Conceptual Site Model
Location:	Main Range National Park, Queensland
Source:	
Scale:	Scale Bar Job No: 25005
Date:	March 2025 FIGURE : 09

CONCEPTUAL SITE MODEL Spicers Eco Camps



RECEPTOR

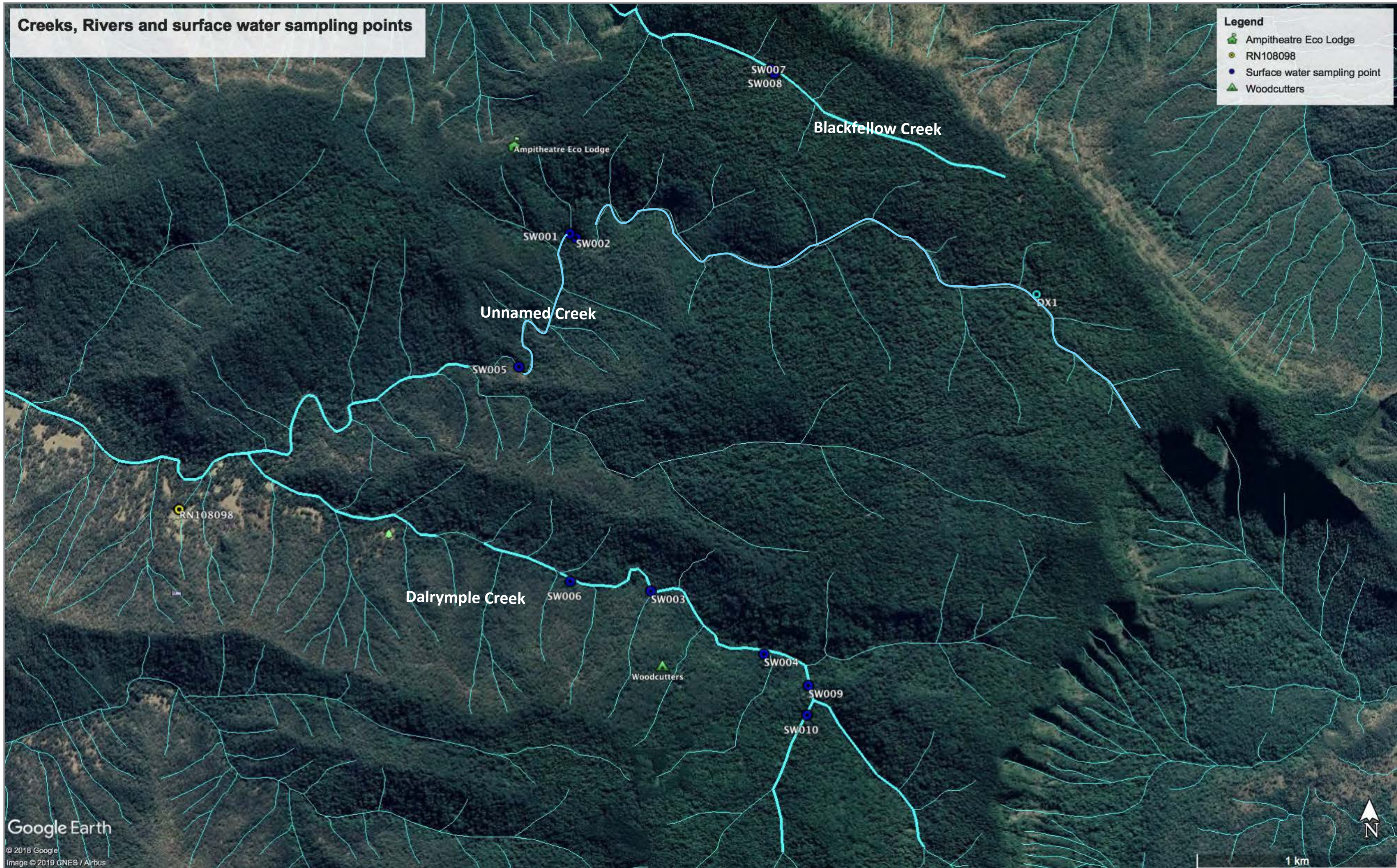
Exposure Route	Human: Recreational	Human: Residential	Human: Workers	Ecosystem: Terrestrial	Ecosystem: Aquartic
PHYSICAL HAZARD	●	✗	●	●	✗
INGESTION	●	✗	●	●	✗
DERMAL	●	✗	●	●	✗
INHALATION	●	✗	●	●	✗
INGESTION	✗	✗	✗	✗	✗
DERMAL	✗	✗	✗	✗	✗
INGESTION	●	✓	●	●	●
DERMAL	●	✓	●	●	●
INGESTION	●	✗	●	●	●
DERMAL	●	✗	●	●	●
INGESTION	●	✗	●	●	✓
DERMAL	●	✗	●	●	✓
INGESTION	✓	✗	●	●	✓
DERMAL	✓	✗	●	●	✓
PHYSICAL HAZARD	✗	●	●	●	✗

Legend

moreton environmental and health

Client: Spicers Retreats Hotels & Lodges Pty Ltd
Drawn by: Dan Morton
Project Manager: Dan Morton

Title: Eco Camps Conceptual Site Model
Location: Main Range National Park, Queensland
Source:
Scale: Scale Bar Job No: 25005
Date: March 2025 FIGURE : 10



Legend

SW01

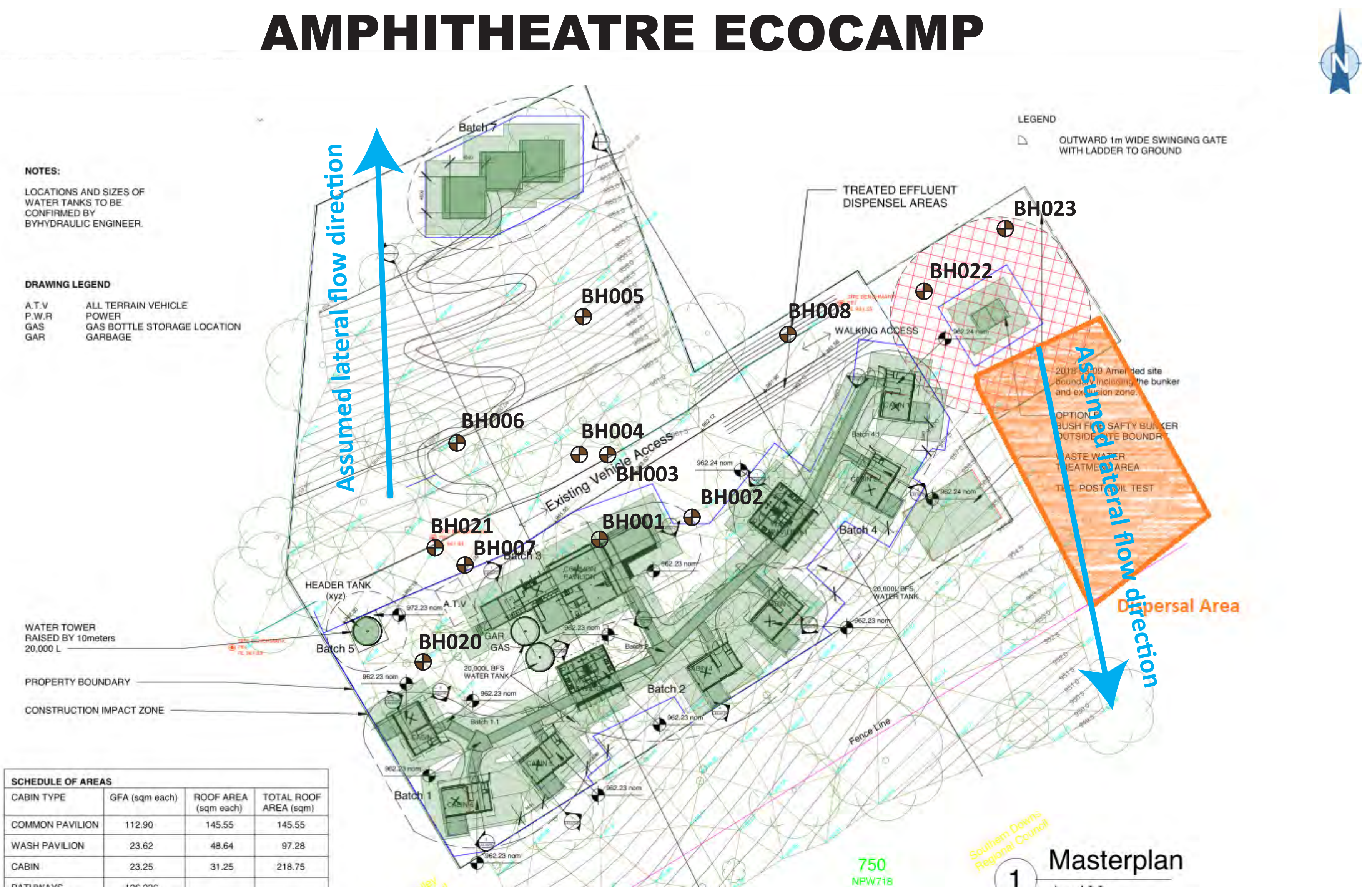
Surface Water Monitoring Point

Resource Groundwater Bore

moreton environmental and health

Client: Spicers Retreats Hotels & Lodges Pty Ltd		Title:	Recommended Surface Water Sampling
		Location:	Main Range National Park, Queensland
Drawn by:	Dan Morton	Source:	
Project Manager:	Dan Morton	Scale:	Scale Bar Job No: 25005
		Date:	March 2025 FIGURE : 11

AMPHITHEATRE ECOCAMP



SCHEDULE OF AREAS			
CABIN TYPE	GFA (sqm each)	ROOF AREA (sqm each)	TOTAL ROOF AREA (sqm)
COMMON PAVILION	112.90	145.55	145.55
WASH PAVILION	23.62	48.64	97.28
CABIN	23.25	31.25	218.75

Legend

Peizometer

Borehole

Irrigation Area

moreton environmental and health

Title: Amphitheatre EcoCamp

Location: Main Range National Park, Queensland

Client: Spicers Retreats Hotels & Lodges Pty Ltd

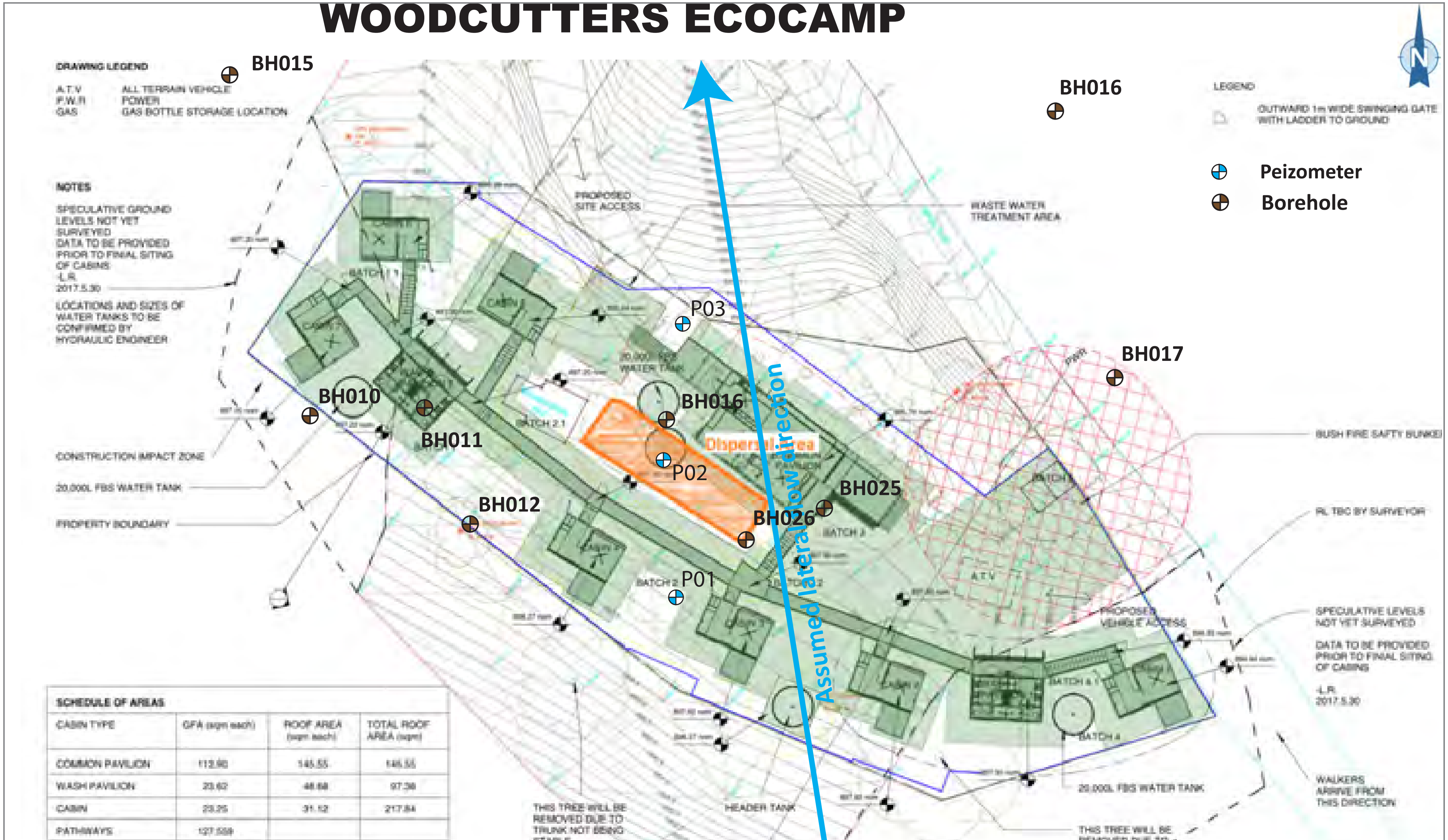
Source:

Drawn by: Dan Morton

Scale: Scale Bar Job No: 25005

Project Manager: Dan Morton

Date: March 2025 FIGURE : 12



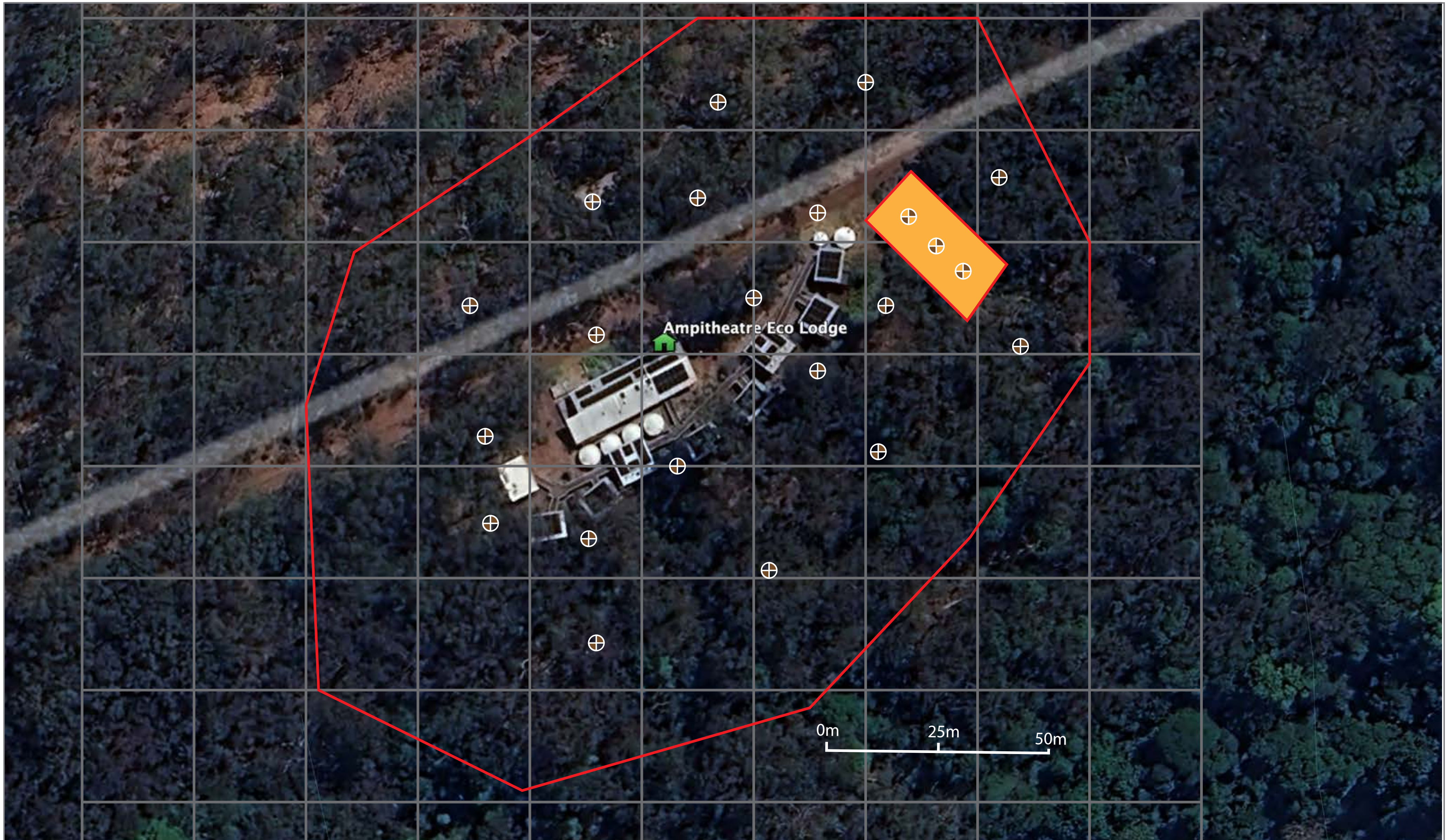
Legend

- Peizometer
- Borehole
- Irrigation Area

moreton environmental and health

Client:	Spicers Retreats Hotels & Lodges Pty Ltd
Drawn by:	Dan Morton
Project Manager:	Dan Morton

Title:	Woodcutters EcoCamp		
Location:	Main Range National Park, Queensland		
Source:			
Scale:	Scale Bar	Job No:	25005
Date:	March 2025	FIGURE :	13



Legend

moreton environmental and health

Client:	Spicers Retreats Hotels & Lodges Pty Ltd
Drawn by:	Dan Morton
Project Manager:	Dan Morton

Title:	Proposed Soil Monitoring Locations at Amphitheatre EcoCamp		
Location:	Main Range National Park, Queensland		
Source:			
Scale:	Scale Bar	Job No: 25005	
Date:	March 2025	FIGURE :	14

Legend

Peizometer

Borehole

Irrigation Area

moreton environmental and health

Title:	Proposed Soil Monitorong Locations at Woodcutters
Location:	Main Range National Park, Queensland
Client:	Spicers Retreats Hotels & Lodges Pty Ltd
Source:	
Drawn by:	Dan Morton
Scale:	Scale Bar
Job No:	25005
Project Manager:	Dan Morton
Date:	March 2025
FIGURE :	15

APPENDIX A Variation of Conditions attached to Approval (Scenic Rim Trail – Thornton Trailhead to Spicers Canopy Nature Reserve, Queensland (EPBC 2016/7847))

APPENDIX B Quality Assurance/Quality Control (QA/QC)

QUALITY ASSURANCE AND QUALITY CONTROL – SOP-004

1. Purpose and scope

This is a standard procedure for the use of quality assurance and quality control procedures during project samples for environmental assessment. This procedure must be followed to ensure that all samples are collected in an appropriate and consistent manner, that the sampling is appropriate for the media and analytes, and to allow the documentation of standard operating procedures used for sample plans, design, collection and interpretation of results.

This procedure has been written for environmental assessment of all media, soils, water and air general physical and chemical tests and non-volatile, semi-volatile, and volatile analyses.

2. Definitions

CoC - chain of custody form

OH&S - occupational health and safety

PID - photo-ionisation detector

VOCs - volatile organic compounds

PARCC parameters - precision, accuracy, representativity, comparability and completeness

QA – quality assurance

QC – quality control

Precision - measure of the reproducibility

Accuracy - measure of the agreement between an experimental determination and the true value of the parameter being measured

Representativity - degree to which the samples reflect the site specific conditions

3. Reference List

- Australian New Zealand Environment and Conservation Council (1996) *Guidelines for the laboratory analysis of contaminated soils*. ANZECC, Canberra, ACT.
- Australian Standard AS 4482.1 (2005) *Guide to the sampling and investigation of potentially contaminated soil, Part 1: Non-volatile and Semi-volatile compounds*. Standards Australia, Homebush, NSW.

- National Environment Protection Council (NEPC) (1999) *National Environmental Protection (Assessment of Site Contamination) Measure, Schedule B(2) Guideline on Data Collection, Sample Design and Reporting*. National Environment Protection Council Service Corporation. Adelaide, SA.
- National Environment Protection Council (NEPC) (1999) *National Environmental Protection (Assessment of Site Contamination) Measure, Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soil*. National Environment Protection Council Service Corporation. Adelaide, SA.
- NSW Environment Protection Authority (1994) *Contaminated Sites: Guidelines for Assessing Service Station Sites*. NSW EPA, Chatswood, NSW.
- NSW Environment Protection Authority (1997) *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*. NSW EPA, Chatswood, NSW.
- United States Environmental Protection Agency, Contract Laboratory Program (1994) *National Functional Guidelines for Inorganic Data Review*. USEPA, Washington, DC.
- United States Environment Protection Agency, Contract Laboratory Program (1999) *National Functional Guidelines for Organic Data Review*. USEPA, Washington, DC.

4. General

Related environmental procedures include:

- SOP_PROC_002-Surface Water Sampling
- SOP_PROC_003-Gropundwater Sampling
- SOP_PROC_004-Air Quality Sampling
- SOP_PROC_005-Personal protective equipment
- SOP_PROC_006-Establishment of contaminant control zones
- SOP_PROC_007-Quality Assurance and Quality Control
- SOP_PROC_008-Decontamination of personnel
- SOP_PROC_009-Decontamination of plant and equipment
- SOP_PROC_010-Decontamination of sampling equipment
- SOP_PROC_011-Vehicle and heavy machinery operations.
- SOP_PROC_012-Manaul handling
- SOP_PROC_013-First Aid
- SOP_PROC_014- Measurement of volatiles – PIDs.

5. Introduction to Date Usability

Information generated from environmental investigations requires some statement in regard to the usability of the data[1], and therefore quality assurance (QA) and quality control (QC) are an integral part of the analysis and interpretation of environmental data. QA/QC used in contaminated sites investigations is briefly reviewed in this section.

Moreton Environmental would like to acknowledge the NSW Auditor Mark Salmon, Principal Scientist in Easterly Point Environmental and colleague, mentor and friend of Dan Morton, originally produced the development of these QAQC procedures.

Quality assurance involves all of the actions, procedures, checks and decisions undertaken to ensure the representativity and integrity of samples, and accuracy and reliability of analytical results (NEPC 2013). Quality control is the component of QA, which monitors and measures the effectiveness of other procedures by the comparison of these measures to previously decided objectives.

There are various components of QA/QC, which address the operation of the laboratories and the routine procedures conducted to achieve a minimum level of quality. Examples of QA components include sample control, data transfer, instrument calibration, staff training, etc. Examples of QC components include the measurement of samples to access the quality of reagents and standards, cleanliness of apparatus, accuracy and precision of methods and instruments, etc. Generally, the National Association of Testing Authorities (NATA) addresses the management of laboratory QA issues through accreditation, or similar, and monitoring of these issues is not addressed on a project-by-project basis.

On a project specific basis, those involved in collecting, assessing or reviewing the relevant data should ensure the minimum level of QA is conducted. Appropriate numbers and types of QC samples should be collected and analysed, both field QC samples and laboratory QC samples. While minimum levels of QA/QC are specified in some guidelines, e.g. NSW EPA 1994, AS 4482.1-1997, NEPC 1999, the minimum level required may vary between projects, based on site and project specific aspects. This means that the minimum specified requirements may not be sufficient for a particular project. As described in the NEPM (NEPC 1999):

> *As a general rule, the level of required QC is that which adequately measures the effects of all possible influences upon sample integrity, accuracy and precision, and is capable of predicting their variation with a high degree of confidence.*

A common example of where site requirements dictate additional QA and associated QC samples is when site history indicates the use of petrol or volatile solvents, field procedures may need to be more stringently adhered to and additional QC samples may be required, including trip blanks and trip spikes.

6. PARCC parameters

Following receipt of laboratory analytical results, data validation is conducted to determine if the specified acceptance criteria have been met. This is conducted to ensure that all data, and subsequent decisions based on that data, are technically sound. Data quality is typically discussed in terms of precision, accuracy,

[1] To avoid confusion with the data quality objectives (DQOs) process, the term data usability is used rather than data quality.

representativity, comparability and completeness. These are referred to as the PARCC parameters[2]. Field QA/QC and laboratory QC is described below within the PARCC framework.

6.1. Precision

6.1.1. *Duplicates*

Precision is a measure of the reproducibility of results under a given set of conditions and is assessed on the basis of agreement between a set of duplicate results obtained from duplicate analyses. The precision of a duplicate determination is measured by comparing the difference between the two samples to the average of the two samples, expressed as a relative percentage difference (RPD).

The determination is:

RPD = (P-D)/(P+D/2) x 100

P = primary sample

D = duplicate sample

Three types of duplicates are commonly used:

A. field duplicates are used to measure the precision of the sampling and analytical process;

B. inter-laboratory duplicates are used to check on the analytical performance of the primary laboratory; and

C. laboratory duplicates are used to measure the precision of the analytical process.

6.1.2. *Field Duplicates*

Field duplicates (or blind replicates) are collected from the same location and submitted to the laboratory for analyses, as a primary sample. The sample nomenclature is such that the laboratory is not aware which sample is a duplicate. The RPD is calculated to determine the degree of repeatability (precision) of results obtained from the duplicate analysis. Where results are below the practical quantification limit (PQLs) or limits of reporting (LORs), i.e. non detects, RPDs cannot be calculated. Where one result is detected, the results are considered to conform when the detected result is less than five times the PQL/LOR.

The PQL/LOR is the lowest concentration of an analyte that can be determined with acceptable precision (repeatability) and accuracy under the test conditions. The PQL/LOR is usually calculated as five times the lower limit of detection (or method detection limit). However, adjustments in PQLs/LORs may be required due to interference from high contaminant concentrations.

As environmental samples can exhibit a high degree of heterogeneity, field duplicates often exceed the acceptance criterion, particularly if the samples are co-collected, for example, because of the potential for losing volatiles during sample splitting. The NSW EPA require that before results which fail the acceptance criterion are described as due to low concentrations or sample heterogeneity, the sample should be re-analysed. This may not be necessary when the analytical results are significantly less than the landuse criteria.

6.1.3. *Inter-laboratory duplicates*

Inter-laboratory duplicates (or split samples) are field duplicates which are sent to a second laboratory and analysed for the same analytes and, as far as possible, by the same methods. These provide a check on the analytical performance of the primary laboratory.

[2] The PARCC parameters are sometimes referred to as data quality indicators (DQIs).

6.1.4. *Laboratory Duplicates*

Laboratory duplicates (or check samples) are field samples which are split by the laboratory and thereafter treated as separate samples. The RPD is calculated to determine the degree of repeatability (precision) of results obtained from the duplicate analysis.

USEPA (1994) specifies that for inorganics, if the results for laboratory duplicates fall outside of the recommended control limits for a particular analyte, all results for that analyte, in all associated samples of the same matrix, should be qualified as an estimated quantity. For organics, USEPA (1999) does not specify recommended actions for laboratory duplicates.

6.2. Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. Inasmuch as the true sample concentrations are not known, the determination of accuracy is achieved through the analysis of known reference materials or assessed by the analysis of matrix spikes. Spiking of reference material into the actual sample matrix is the preferred technique because it provides a measure of the matrix effects on the analytical recovery.

Accuracy is measured in terms of percentage recovery as defined by:

$$\%R = ((SSR - SR) / SA) \times 100$$

%R = percentage recovery spike

SSR = spiked sample result

SR = sample result

SA = spike added

6.2.1. *Matrix spikes/matrix spike duplicates*

These are samples prepared in the laboratory by dividing a sample into two aliquots and then spiking each with identical concentrations of specific analytes. The matrix spike (MS) and matrix spike duplicate (MSD) are then analysed separately and the results compared to determine the accuracy and precision of the analytes.

6.2.2. *Surrogate spikes*

Surrogate spikes provide an indication of analytical accuracy. They are used only for analyses, which use gas chromatography and are compounds which are similar to the organic analytes of interest in chemical composition, extraction and chromatography, but which are not normally found in field samples. Surrogates are generally spiked into all sample aliquots prior to preparation and analysis.

If the surrogate spike recovery does not meet the prescribed DQO, the samples should be re-analysed.

6.2.3. *Laboratory control samples*

Laboratory control samples (quality control check samples) are laboratory prepared samples of an appropriate clean matrix (i.e. sand or distilled water) which are spiked with known concentrations of specific analytes. The laboratory control sample (LCS) is then analysed and the results are used to assess sample preparation and analytical accuracy, free of matrix effects. Certified reference material (CRM) is another form of LCS, and involves the analysis of a known standard as part of the laboratory batch, e.g. British Columbia sediment samples for analysis of metals.

6.3. Representativity

Representativity refers to the degree to which the samples reflect the site specific conditions. It is primarily dependent on the design and implementation of the sampling program, with representativity of the data being partially ensured by the avoidance of cross-contamination, adherence to sample handling and analytical methods, use of field duplicates, ensuring that samples do not exceed holding times prior to analysis, use of chain-of-custody forms and other appropriate documentation.

There are a number of QC samples which can be collected to assist in the qualification of representativity, including:

6.3.1. Rinsate blanks

Used to determine if sampling equipment has been adequately decontaminated to ensure that cross-contamination between samples has not occurred. The frequency for rinsate blanks is one per piece of equipment per day (AS 4482.1-1997), however it should be noted that cross-contamination will bias samples upwards, and the frequency should therefore be at the investigators discretion.

6.3.2. Trip blanks

Used only when volatile organics are sampled to determine if transport in motor vehicles or similar has resulted in contamination of the samples. For trip blanks, a sufficient number should be analysed to allow the Representativity of the sampling to be determined. However, it should be noted that cross-contamination would bias samples upward, and the frequency should therefore be at the investigators discretion.

6.3.3. Trip spikes

Used only when volatile organics are sampled to attempt to quantify loss of volatiles during the analytical process. For trip spikes, a sufficient number of samples should be analysed to allow qualification of the likely loss of volatiles during the field sampling.

6.3.4. Laboratory blanks

Laboratory blanks (or method blanks, or analysis blanks) are used to verify that contaminants are not introduced into the samples during sample preparation and analysis. The NEPM (NEPC 1999) specifies that laboratory blanks should be conducted at a frequency of “at least one per process batch”. The DQO for laboratory blanks is non-detect at the PQL/LOR.

6.4. Comparability

Comparability is a qualitative parameter designed to express the confidence with which one data set may be compared with another, including established criteria. Using consistent methods and ensuring that PQLs/LORs are below the relevant criteria maintain comparability.

6.4.1. QC sample completeness

Quality control sample completeness is defined as the number of QC samples which should have been analysed, compared to the actual number analysed. If the appropriate number of QC samples are not analysed with each matrix or sample batch, then the data reviewer should use professional judgement to determine if the associated sample data should be qualified.

6.4.2. *QC sample frequency and criteria*

Based on EPA made or approved guidelines, the following QC samples are required for all contaminated site investigations, unless otherwise specified as part of the data quality objectives (DQOs) process review. All data to be used for validation should conform as a minimum to the requirements specified, regardless of minimum sample size.

Table 1: Quality Control Samples

Quality control sample	Frequency	Results [1]
Precision		
Field duplicates.	≥ 5%	≤ 30 - 50% [2]
Inter-laboratory duplicates.	≥ 5%	≤ 30 - 50% [2]
Laboratory duplicates.	≥ 10%	Lab specified [3]
Accuracy		
Surrogate spikes.	Organics by GC	70 – 130% [4]
Matrix spikes (MSs).	≥ 1/media type	70 - 130% [5]
Laboratory control samples (LCSs).	≥ 1/lab batch	70 - 130% [6]
Certified reference material (CRM).	LCS for metals	Lab specified [7]
Representativity		
Rinsate samples.	≥ 1/field batch	< LOR
Trip blanks.	≥ 1/field batch (volatiles)	< LOR
Trip spikes.	≥ 1/field batch (volatiles)	70 - 130%, ≤ 30 - 50% [8]
Laboratory blanks.	≥ 1/lab batch	< LOR

Notes:

1. Where results are laboratory specified, the laboratory analytical reports should be consulted for specific information.
2. Relative percentage differences (RPDs) for field duplicates from AS 4482.1 (1997).
3. RPDs for laboratory duplicates specified by the laboratory. Based on the magnitude of the results compared to the level of reporting (LOR), e.g. ALS: result < 10 x LOR = no limit, 10 – 20 x LOR = 0-50%, > 20 x LOR = 0-20%. LabMark: < 5 x LOR = 0-100%, 5 – 10 x LOR = 0-75%, > 10 x LOR = 0-50% or 0-30% for metals.
4. Surrogate recoveries specified by laboratory based on global acceptance criteria or dynamic recovery limits based on statistical evaluation of actual laboratory data.
5. MS recoveries specified by laboratory based on global acceptance criteria.

6. LCS recoveries specified by laboratory based on global acceptance criteria or dynamic recovery limits based on statistical evaluation of actual laboratory data.
7. CRM recoveries specified by laboratory based on global acceptance criteria.
8. Trip spike results are specified as either recoveries or RPDs.

APPENDIX C Standard Operating Procedures

Field Test Procedure – Water Quality readings in the Field FTP001

1 Purpose and Scope

pH is a representation of the concentration of the hydronium ion (H+) in solution and is used to indicate the alkalinity or acidity of a substance as ranked on a logarithmic scale from 1.0 to 14.0. Acidity increases as the pH gets lower. 5.4 pH | Monitoring & Assessment | US EPA

Oxygen is measured in its dissolved form as dissolved oxygen (DO) in mg/L or parts per million. Wastewater contains organic materials that are decomposed by microorganisms, which use oxygen in the process. 5.2 Dissolved Oxygen and Biochemical Oxygen Demand | Monitoring & Assessment | US EPA

2 General

pH and dissolved oxygen are measured throughout the treatment process and are particularly significant during the biological nutrient removal process. Careful monitoring of both pH and dissolved oxygen are important for the health of the microorganisms responsible for the biological treatment of wastewater.

3 Equipment

Table 1 – Equipment Used

Description
Sampling gloves
Sample collection container
Field meter (pH, Temp, EC, DO, Turbidity).

4 Procedure

1. Take a sample of the water into a laboratory clean container. The use of a container being used for sampling at the laboratory is adequate, ensure no additives or preservatives are included in the bottle.
2. Rinse the bottle three times with sample water (surface or ground) and set aside.
3. Turn on the meter.
4. Rinse probes with distilled water and drip dry.
5. Submerse both probes entirely into the test solution and gently stir.
6. Wait for the readings on the meter display to stabilise.
7. Record the results in the appropriate weekly or monthly site data sheet.
8. Probes should be cleaned using distilled water and returned to their protective storage cases. The pH probe should be stored in the pH sensor storage solution.
9. Transfer the collected data to the appropriate site data spreadsheet file.

GENERAL SOIL SAMPLING – SOP-001

1 Purpose and scope

This is a standard procedure for the collection of soil or sediment samples for environmental assessment. This procedure must be followed to ensure that soil samples are collected in an appropriate and consistent manner, that the soil sampling is appropriate for the media and analytes, and to allow the documentation of standard operating procedures used for soil sample collection and handling.

This procedure has been written for environmental soil sampling of *in situ* and *ex situ* soils and fills for general physical and chemical tests and non-volatile, semi-volatile, and volatile analyses.

2 Definitions

CoC - chain of custody form

OH&S - occupational health and safety

PID - photo-ionisation detector

VOCs - volatile organic compounds

SVOCs – semi volatile organic compounds

3 References

Guidance considered in preparing this standard operating procedure included:

- Australian Standard AS 4482.1 (2005) Guide to sampling and investigation of potentially contaminated soil, Part 1: Non-Volatile and semi-volatile compounds
- Environment Protection Authority (September 1995) Contaminated Sites: Sampling Design Guidelines. NSW EPA, Chatswood, NSW
- National Environment Protection Council (NEPC) (2013) National Environmental Protection (Assessment of Site Contamination) Measure, Schedule B(2) Guideline on Data Collection, Sample Design and Reporting. National Environment Protection Council Service Corporation, Adelaide, SA
- Standards Australia (2005) Guide to the sampling and investigation of potentially contaminated soil,

Part 1: Non-volatile and semi-volatile compounds (AS 4482.1¬2005)

- Standards Australia (1999) Guide to the sampling and investigation of potentially contaminated soil, Part 2: Volatile substances (AS 4482.2-1999).

4 General

Related environmental procedures include:

- SOP_PROC_002-Surface Water Sampling
- SOP_PROC_003-Groundwater Sampling
- SOP_PROC_004-Air Quality Sampling
- SOP_PROC_005-Personal protective equipment
- SOP_PROC_006-Establishment of contaminant control zones
- SOP_PROC_007-Quality Assurance and Quality Control
- SOP_PROC_008-Decontamination of personnel
- SOP_PROC_009-Decontamination of plant and equipment
- SOP_PROC_010-Decontamination of sampling equipment
- SOP_PROC_011-Vehicle and heavy machinery operations.
- SOP_PROC_012-Manaul handling
- SOP_PROC_013-First Aid
- SOP_PROC_014- Measurement of volatiles – PIDs.

Sampling locations and depths should be clearly stated in a sampling analysis quality plan (SAQP) prior to commencement of fieldwork.

A health and safety plan (HSP) should be produced prior to the commencement of any field work.

Soil samples should be representative of the target depth, media and environmental condition from which they are collected. Soil samples should not be influenced by the method of extraction or sampling from the soil.

Soil samples should not be retained if they have come into direct contact with machinery or sampling equipment that has not been decontaminated.

In general samples should be collected at the surface, and at depth; such as at regular intervals for consistent with the lithology or contaminant transport encountered during the assessment. This may include soil profiles or horizons or areas of contamination or media.

The assessor must record all information on how the samples were taken in the geological log including refusal or exceedance of equipment reach. The geological log should clearly document the reason sampling was discontinued and a description of material if it continues to greater depths.

Surface samples should be 0 – 0.10 m or 0 – 0.15 m and samples from depth should not exceed a depth range of 0.3 m to avoid compositing effects. Some land uses may require shallower surface samples, e.g. banana lands 0.075 m, and this should be established as part of the SAQP.

As a general rule, never composite samples unless stated in the SAQP.

5 Procedure

5.1 Sample collection

All personnel who will come into contact with the soil must always use clean disposable gloves for each sample. Prevention of contamination exposure to personnel and cross-contamination of samples is paramount in soil sampling.

All sampling equipment is to be decontaminated before use and between samples

5.2 Sample Collection

Once collected, samples are to be transferred immediately to the appropriate sample container, ensuring that the container is filled to the top so that no head-space remains.

5.3 Hand tools

Hand tools, including spatulas, trowels, shovels, spades, etc, can be used to collect samples from the land surface, walls and floors of test pits or excavations, stockpiles, etc.

The surface to be sampled is first to be cleared of any organic material, e.g. grass and roots, and the sample collected from fresh, exposed soil. Fresh soil should be exposed prior to sampling to remove any smear affects from the sampling equipment. Soil peds or clods should be removed from the auger or trowel and split so that samples can be taken from the middle of the peds or clods. The sampler should not sample from exposed surfaces, which may not be representative of contamination, especially where release of volatiles may have occurred from the exposed soil.

Test pits or excavations are not to be entered unless appropriate assessment of stability has been conducted and documented. Test pits over 1 m depth are not to be entered.

5.4 Test Pits

The sampler should direct the excavator operator as to where the sample is to be collected and ensure the location is accurate. The sampler must be aware of the 'swing zone' of the machine and follow *SOP_PROC_008-Vehicle and heavy machinery operations.*

Sampling from excavator buckets is permissible, providing the procedures in *Section 5.1 – 5.3* are adhered to by the sampler, where appropriate, and the following sampling quality controls are observed by the sampler:

- The sample must be collected from within soil clods or material which has not contacted the excavator bucket
- The bucket must be screened with a PID prior to sampling where volatiles are a contaminant of concern.

5.5 Soil cores

For push tubes, split spoons, etc, samples should be transferred directly to the sampling container and procedures in *Section 5.1 – 5.3* adhered to by the sampler, where appropriate.

5.6 Augers

Samples should be collected from the auger with a trowel by cutting away the outside and collecting soil from the centre of the auger bit. Samples should then be transferred directly to the sampling container. Procedures in *Section 5.1 – 5.3* must be adhered to by the sampler, where appropriate.

5.7 Field screening for VOCs

If volatiles are a contaminant of concern and field screening using a photo-ionisation detector (PID) is required, a sample should also be transferred to a ziplock plastic bag. Refer to SOP_PROC_011- Measurement of volatiles – PIDs for field screening procedure.

5.8 Composite sampling

Composite sampling is used to reduce analytical costs and involves the bulking and thorough mixing of soil samples (collected as above) to form one composite sample for laboratory analysis. Generally, compositing is not encouraged and should only be undertaken if specifically stated in the SAQP. Samples should be sent to the laboratory for compositing with appropriate instructions recorded on the CoC. Composite sampling must not be undertaken where volatile substances are present, including BTEX compounds and C_6 – C_9 TPHs, or soils have high clay content.

Composite samples must be collected from the same soil/fill horizon and no more than four sub-samples should be included in a composite sample. The sub-samples should be equal in size, from immediately adjacent sampling points, evenly spaced, and composited laterally.

6 Sampling containers

Sample containers from a NATA laboratory, usually 125 mL to 250 mL clear glass jars, are to be used by the sampler. This will ensure the jars are decontaminated, clean and dry, and of the appropriate size and material. Ensure the appropriate preservative is present if required, and all jars have a gastight, non-absorptive seal, which allow no headspace. The laboratory should be contacted if numerous and/or specialty analytes are required, to confirm the required sample container type and size.

6.1 Sample Labelling

Samples should be labelled clearly on the outside wall of the container with the project number, sampler's initials, sample location, depth of sample and the date. The sample location and depth should also be provided on the container lid. All labelling should be with water proof pens/markers.

The sample location number should be followed by either the sample depth or a letter, e.g. BH1 0.0 - 0.15 or TP3 A.

6.2 Sample handling, storage and dispatch

The soil jars, once filled with sample with no head space, are to be wiped clean and wrapped in bubble wrap/padding, and immediately placed in a cooler such as an Esky. Coolers should be kept out of direct sunlight, hot vehicles, etc, as far as practical, and appropriate cooling media added (ice or ice bricks) to ensure samples are kept below 4˚C. For longer term storage, samples should be kept below 4˚C in a fridge/freezer.

A chain of custody (CoC) form is to be filled out and the CoC is to be sent with the sample/s to the laboratories. The CoC/s is to be placed in a ziplock plastic bag or plastic folder to prevent damage. All samples sent to the laboratories are to be included on the CoC/s, and if no analyses required, marked as 'Hold'.

If additional air space exists in the cooler, this should be filled with scrunched up newspaper, bubble wrap or similar to minimise movement of the samples. Coolers are to be secured with heavy tape and security seals, and clearly show the laboratory and sender contact information.

All samples, including QC samples, are to be transported to the primary and secondary laboratories. If dispatch is by courier, coolers are not to be dispatched on Fridays (or days before public holidays) unless delivery the next day has been organised.

If samples cannot be dispatched on the day of sampling with refreshed ice-blocks or ice for transport, then the samples are to be refrigerated until dispatch. The laboratory should be contacted if any delays to dispatch occur to confirm holding times available prior to extraction/analysis.

6.3 Sample location logging

A geological log is to be completed for each sample location by a qualified environmental scientist. Logs are to be completed for all sample locations, including surface samples and *ex situ* samples.

The log is to include:

- Job details, date, location, methods, climatic conditions
- Soil classification (material type and texture), colour, consistency or density, odour, staining, presence of artefacts, moisture content, sample number, and depth
- Depth of water inflow and/or groundwater level, if encountered, and comments regarding water if required; depth of excavation/drilling, excavation/drilling refusal and any field measurements taken or other relevant field observations.

7 QA documentation

A CoC is to be completed for all samples sent to the laboratories and/or to be analysed by the laboratories. Samples not to be analysed should be described as "Hold".

The CoC is to detail laboratory reference numbers (including quotes),site identification, the samplers initials, nature of the sample, collection time and date, analyses to be performed, sample preservation method, any relevant comments, e.g. level contamination expected, level of quality control required and dispatch information and signature.

7.1 Samples

QC sampling should be documented in the SAQP, which should include trip spikes and trip blanks as prepared by the laboratory and should be organised through the laboratory prior to conducting the field work. Trip spikes and trip blanks should be held for as little time as possible prior to the field work, and should be kept below 4°C in a fridge/freezer. After sample collection, trip spikes and trip blanks are to be handled as a primary sample, and should also be included on the CoC.

For detailed explanation MEH's QA/QC controls and procedures, refer SOP_PROC_007-Quality Assurance and Quality Control.

GENERAL SURFACE WATER SAMPLING – SOP-002

1 Purpose and scope

This is a standard procedure for the collection of surface water samples for environmental assessment. This procedure must be followed to ensure that surface water samples are collected in an appropriate and consistent manner, that the surface water sampling is appropriate for site, and to allow the documentation of standard operating procedures used for surface water sample collection and handling.

This procedure has been written for environmental surface water sampling of *fresh or marine waters* for general physical and chemical tests and non-volatile, semi-volatile, and volatile analyses.

2 Definitions

CoC - chain of custody form

OH&S - occupational health and safety

PID - photo-ionisation detector

VOCs - volatile organic compounds

SVOCs – semi volatile organic compounds

3 References

Guidance considered in preparing this standard operating procedure included:

- Australian Standard AS 4482.1 (2005) Guide to sampling and investigation of potentially contaminated soil, Part 1: Non-Volatile and semi-volatile compounds, (Australia, 2005).
- Environment Protection Authority (September 1995) Contaminated Sites: Sampling Design Guidelines. NSW EPA, Chatswood, NSW, (EPA, 1995).
- National Environment Protection Council (NEPC) (2013) National Environmental Protection (Assessment of Site Contamination) Measure, Schedule, B2 - Guideline on site characterization, National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 16 May 2013, (NEPC, 2013).
- Standards Australia (1999) Guide to the sampling and investigation of potentially contaminated soil, Part 2: Volatile substances, (Standards Australia, 1999).
- ANZECC & ARMCANZ, (2000), Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The guidelines, (ANZECC & ARMCANZ, 2000).
- ANZECC & ARMCANZ, (2000), Australian and New Zealand guidelines for fresh and marine water quality. Volume 2, Aquatic ecosystems, (ANZECC and ARMCANZ, 2000a).
- ANZECC & ARMCANZ, (2000), Australian and New Zealand guidelines for fresh and marine water quality. Volume 3, Primary industries, (ANZECC and ARMCANZ, 2000b).

4 General

Related environmental procedures include:

- SOP_PROC_002-Surface Water Sampling
- SOP_PROC_003-Groundwater Sampling
- SOP_PROC_004-Air Quality Sampling
- SOP_PROC_005-Personal protective equipment
- SOP_PROC_006-Establishment of contaminant control zones
- SOP_PROC_007-Quality Assurance and Quality Control
- SOP_PROC_008-Decontamination of personnel
- SOP_PROC_009-Decontamination of plant and equipment
- SOP_PROC_010-Decontamination of sampling equipment
- SOP_PROC_011-Vehicle and heavy machinery operations.
- SOP_PROC_012-Manaul handling
- SOP_PROC_013-First Aid
- SOP_PROC_014- Measurement of volatiles – PIDs.

Sampling locations should be clearly stated in a sampling analysis quality plan (SAQP) prior to commencement of fieldwork.

A health and safety plan (HSP) should be produced prior to the commencement of any field work.

Surface water samples should be collected:

- at the site of the reported pollution
- at the point of any contributing or suspected sources
- in an area upstream from the suspected source/s (control site)
- at points downstream of the suspected source (to measure extent). Samples should be collected as far downstream from the source as suspected of being polluted.

Reference or control sites must be sampled (if water is present) in order to understand the background conditions at the time of sampling, and in order to fully understand the potential impact from the pollution event under investigation. If assessing sediment, reference or control sites must be sampled. See Sampling design and preparation—Control and Reference sites.

As a general rule, never composite samples unless stated in the SAQP.

5 Procedure

5.1 Sample collection

All personnel who will come into contact with the surface water must always use clean disposable gloves for each sample. Prevention of contamination exposure to personnel and cross-contamination of samples is paramount in soil sampling.

All sampling equipment is to be disposable (one sample use) or decontaminated before use and between samples.

5.2 Sample Collection

Most samples taken will be grab samples—taken by filling sample containers over a 'short' period (seconds or minutes).

Place water quality meter (probe) in the flow of the stream, up stream of where you are sampling and allow to equilibrium over time, whilst you are sampling.

Surface water samples should be taken directly from the water body. Sample jars/containers should be labelled prior to sampling with permanent mark and allowed to dry and field sample bottles ticked for field filtered on container, if required. The sampler must use clean nitrile sampling gloves for each sample site (not each sample bottle).

The sampler should collect the samples in the following order:

1. Take any microbiological samples first to minimise cross contamination and minimise the time the lid is off the container.
2. Use the **1 x 250ml** green plastic with no preservative usually for Alkalinity, EC, pH, Cl, SO4, F, Hardness, Nitrite, Nitrate, Reactive P, Silica, plus TDS (Calc. only), Acidity:
    a. Rinse in water body three times; and
    b. Fill and use to fill other containers, usually with preservatives.
3. Sample dissolved metals Field Filtered sample next, use the Red, **1 x 60mL** plastic (HNO_3 acid)), ticked for field filtered and follow method below:
    a. Use the disposable syringe for filtered samples, usually for dissolved metals (Red, **1 x 60mL** plastic (HNO_3 acid));
    b. Extract a full syringe from green plastic container;
    c. Place filter on end of syringe ensuring it is placed with flow direction into the Red, **1 x 60mL**

plastic;

d. Press syringe filtering the water into the Red, **1 x 60mL** plastic (HNO_3 acid); and

e. Repeat b – d until Red, **1 x 60mL** plastic (HNO_3 acid) is full, **DO NOT OVER FILL** or you will lose some preservative.

4. Refill green plastic container and continue to fill other sample containers noting if containing preservative such as purple **1 x 60mL** plastic (H_2SO_4 acid).

5. When all other containers have been filled to the appropriate level, fill the 250ml green plastic with no preservative to full.

6. If collecting water samples for volatiles such as petroleum products using **1 x 100mL** glass bottle or **1 x 40mL** glass vials (Sulfuric Acid), then follow procedure below:

   a. Fill glass bottle or vial from 250ml green plastic until **nearly** full;

   b. Complete filling of the glass bottle or vial to full ensuring meniscus proud of bottle using the lid of the container and replace lid over proud meniscus thus preventing any air space in container.

   c. Check there are no air space in the container by inverting once, if air space is present, repeat b above.

7. Ensure you take duplicates and triplicates of surface water samples at the appropriate frequency, which is usually every ten samples. So every ten sample locations take a duplicate and triplicate at one location, labelled DUP01 and DUP02.

8. Finally record GPS location, Sample ID and field parameters on MEH Observations sheets provided.

6 Sampling containers

Sample containers from a NATA laboratory, usually **1 x 250ml** green plastic, Red, **1 x 60mL** plastic (HNO_3 acid)), purple **1 x 60mL** plastic (H_2SO_4 acid) or **1 x 100mL** glass bottle or **1 x 40mL** glass vials (Sulfuric Acid) for volatiles.

Always check with laboratory when ordering jars to ensure you have the right containers.

6.1 Sample Labelling

Samples should be labelled clearly on the outside wall of the container with the project number, sampler's initials, sample ID (eg SW01, etc) and the date. All labelling should be with waterproof pens/markers.

Sometimes labels are printed by the lab in advance, in which case only the date is required to be hand written on the bottles on site.

Use large, zipped lock bags (labelled) to group samples for each sample location i.e. SW01, etc. Keep sample containers in bags prior during and in eskis to minimise wrong ID.

6.2 Sample handling, storage and dispatch

The surface water samples, once filled with sample with no head space (if appropriate), are to be wiped clean and wrapped in bubble wrap/padding, and immediately placed in a cooler such as an Esky. If trekking to inaccessible sites it is OK to transport in ruck sack and when back at vehicle wiped clean and wrapped in bubble wrap/padding, and i placed in a cooler such as an Esky. Esky coolers should be kept out of direct sunlight, hot vehicles, etc, as far as practical, and appropriate cooling media added (party ice or ice bricks) to ensure samples are kept below 4˚C. For longer term storage, samples should be kept below 4˚C in a fridge/freezer.

A chain of custody (CoC) form is to be filled out and the CoC is to be sent with the sample/s to the laboratories. The CoC/s is to be placed in a ziploc plastic bag or plastic folder to prevent damage. All samples sent to the laboratories are to be included on the CoC/s, and if no analyses required, marked as 'Hold'.

If additional air space exists in the cooler, this should be filled with scrunched up newspaper, bubble wrap or similar to minimise movement of the samples. Coolers are to be secured with heavy tape and security seals, and clearly show the laboratory and sender contact information.

All samples, including QC samples, are to be transported to the primary and secondary laboratories. If dispatch is by courier, coolers are not to be dispatched on Fridays (or days before public holidays) unless delivery the next day has been organised.

The laboratory should be contacted if any delays to dispatch occur to confirm holding times available prior to extraction/analysis. Always check holding times when planning sampling events.

7 QA documentation

A CoC is to be completed for all samples sent to the laboratories and/or to be analysed by the laboratories. Samples not to be analysed should be described as "Hold".

The CoC is to detail laboratory reference numbers (including quotes),site identification, the samplers initials, nature of the sample, collection time and date, analyses to be performed, sample preservation method, any relevant comments, e.g. level contamination expected, level of quality control required and dispatch information and signature.

7.1 Samples

QC sampling should be documented in the SAQP, which should include trip spikes and trip blanks as prepared by the laboratory and should be organised through the laboratory prior to conducting the field work. Trip spikes and trip blanks should be held for as little time as possible prior to the field work, and should be kept below 4°C in a fridge/freezer. After sample collection, trip spikes and trip blanks are to be handled as a primary sample, and should also be included on the CoC.

For detailed explanation of MEH's QA/QC controls and procedures, refer SOP_PROC_007-Quality Assurance and Quality Control.

8 References

ANZECC & ARMCANZ 2000a. Australian and New Zealand guidelines for fresh and marine water quality. Volume 2, Aquatic ecosystems / *In:* AUSTRALIAN AND NEW ZEALAND ENVIRONMENT AND CONSERVATION COUNCIL, A. A. R. M. C. O. A. A. N. Z. (ed.).

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