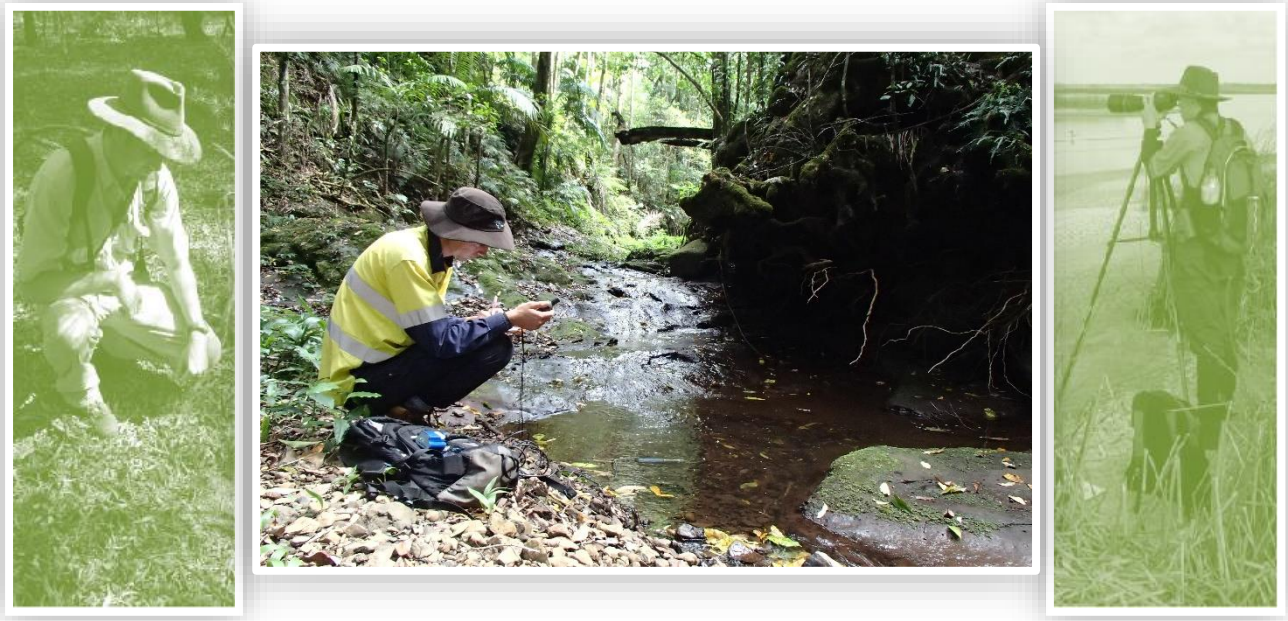
RIPARIAN HABITAT QUALITY AND WATER QUALITY BASELINE SURVEY

SCENIC RIM TRAIL, MAIN RANGE

Prepared for
Spicers Retreats Hotels and Lodges Pty Ltd



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Project Summary: This report presents the results of a baseline survey of riparian habitat quality and water quality in the vicinity of two proposed new hiking trail creek crossings in Main Range National Park for the Scenic Rim Trail proposal.

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RIPARIAN HABITAT QUALITY AND WATER QUALITY BASELINE SURVEY

SCENIC RIM TRAIL, MAIN RANGE

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Table of Abbreviations

BAAM	Biodiversity Assessment and Management Pty Ltd
DPEMP	Development Proposal and Environmental Management Plan
EPBC Act	*Commonwealth Environment Protection and Biodiversity Conservation Act 1999*
NC Act	*Queensland Nature Conservation Act 1992*
WQOs	Water Quality Objectives

1.0 INTRODUCTION

1.1 BACKGROUND

The Scenic Rim Trail –Thornton Trailhead to Spicers Peak Nature Refuge is a commercial proposal to establish a multi-day bushwalking experience in the Main Range on the western part of the Scenic Rim, including through parts of Main Range National Park and the Gondwana Rainforests of Australia World Heritage Area. The length of the proposed Class 5 Trail is approximately 53 km and is made up of existing National Park public walking tracks, Queensland Parks and Wildlife Service (QPWS) management roads, existing private walking tracks and new walking tracks through Main Range National Park and adjacent private lands (Tony Charters and Associates 2016). The new walking track sections through Main Range National Park are proposed to cross two perennial streams, Blackfellow Creek and Dalrymple Creek.

The Commonwealth Department of Environment and Energy (the Department) proposed conditions of approval for the Scenic Rim Trail EPBC 2016/7847 specify under Condition 8 that works must not commence at new creek trails (the portion of new trails situated within a 100 m of Blackfellow Creek crossing and Dalrymple Creek crossing) until the collection of the following has been completed in accordance with the Baseline Data Collection and Monitoring Plan (BDCMP) for the Project:

- **baseline riparian habitat quality data** within 100 metres upstream and downstream of each crossing of the new trails at Blackfellow Creek and Dalrymple Creek; and
- **baseline water quality data** within 100 metres upstream and downstream of each crossing of the new trails at Blackfellow Creek and Dalrymple Creek.

Baseline riparian habitat quality data means data including but not limited to, stream bank condition and terrestrial flora as determined and collected by a suitably qualified person over a timeframe that serves as a sound basis for comparison to data acquired after commencement of the action. **Baseline water quality data** means data including, but not limited to, pH, turbidity, dissolved oxygen, electrical conductivity and total suspended solids as determined and collected by a suitably qualified person over a timeframe that serves as a sound basis for comparison to data acquired after commencement of the action.

1.2 STUDY OBJECTIVES

The primary objectives of this study are to collect and report on the baseline riparian habitat quality and water quality data collected in accordance with the methods outlined in the BDCMP to ensure compliance with the proposed conditions of approval of EPBC 2016/7847.

2.0 FIELD SURVEY APPROACH

2.1 SURVEY METHODS BACKGROUND

Table 2.1 below summarises the survey methods (including survey methodology, effort, timing, frequency and responsibility) for the collection of baseline riparian habitat quality and water quality that are outlined in the BDCMP.

Table 2.1. Description of baseline riparian habitat quality and water quality data collection survey methods (including survey methodology, effort, timing, frequency and responsibility).

Baseline Riparian Habitat Quality	Baseline Water Quality
Methodology: Stream bank condition and riparian vegetation, will be assessed upstream and downstream of each of the Blackfellow Creek and Dalrymple Creek crossing points using a modified AUSRIVAS habitat assessment methodology, as described in the Monitoring and Sampling Manual (DES 2018). The abundance and distribution of Mt Mistake Spiny Crayfish, a key aquatic fauna species in the study area will be assessed through nocturnal survey for crayfish active on the creek banks or at their burrow entrances and daytime survey to quantify the locations and numbers of all active burrows along both banks of a 100m section of creek both upstream and downstream of each of the Blackfellow and Dalrymple Creek crossings. **Effort**: Stream bank condition and riparian vegetation assessed once immediately upstream and downstream of the each of the Blackfellow and Dalrymple Creek crossings in conjunction with the water quality assessment. Mt Mistake Spiny Crayfish surveyed on 100m transects upstream and downstream of each crossing point. **Timing and frequency**: September-December, following good rainfall but not within a week of high rainfall. Sampling will be implemented in conjunction with baseline water quality survey. **Responsibility**: A suitably qualified person.	**Methodology**: Water quality measurements will be undertaken for temperature, pH, electrical conductivity, dissolved oxygen, turbidity and total suspended solids (TSS). Sampling and quality assurance protocols will be in accordance with the latest version of the Monitoring and Sampling Manual (DES 2018). Temperature, pH, electrical conductivity, dissolved oxygen and turbidity will be measured in situ, and TSS measured in a NATA accredited laboratory. **Effort**: Sampling will be at seven sites (four reference sites and three downstream test sites). The four reference sites will include one site upstream of each of the Blackfellow and Dalrymple Creek crossings and one site at each of two unimpacted creeks of similar size elsewhere in Main Range National Park to provide spatial replication of control sites to sufficiently account for variability. **Timing and frequency**: September-December, following good rainfall but not within a week of high rainfall. **Responsibility**: A suitably qualified person, being a person who has professional qualifications, training, skills or experience relevant to the matter of concern, and who can give authoritative assessment, advice and analysis using relevant protocols, standards, codes of conduct, methods or literature.

2.2 RIPARIAN HABITAT QUALITY SAMPLING METHODS

2.2.1 Stream physical condition and terrestrial stream-bank vegetation

Potential impacts of the proposed new trail crossings of Blackfellow and Dalrymple creeks on riparian habitat quality may eventuate through three processes:

- Trail construction, potentially resulting in introduction of weeds, trampling of sensitive riparian groundcover vegetation and increased sedimentation from soil disturbance and subsequent erosion during heavy rainfall;
- Trail hikers potentially deviating from the trail to explore the creek, causing trampling of sensitive riparian groundcover vegetation and potentially introducing weeds; and
- Feral pigs and domestic cattle potentially using the trail to access the creeks, with impacts including introduction of weeds, damage to groundcover vegetation and riparian bank stability from cattle browsing and pugging or pig diggings and mud wallowing behaviour leading to increased erosion and sedimentation.

Key indicators of riparian habitat condition relevant to the baseline assessment and subsequent monitoring of such potential impacts therefore include the following:

- Evidence and extent of trampling of sensitive groundcover vegetation along the riparian bank;
- Evidence and extent of erosion along the hiking trail in the vicinity of the creek crossings;
- Evidence and extent of feral pig tracks, scats, diggings or mud wallows;

- Evidence and extent of domestic cattle tracks, pugging, scats or browsing of groundcover vegetation;
- Evidence and extent of sediment in the in-stream channel;
- Evidence and extent of damage to riparian bank stability; and
- Evidence and extent of weeds.

Riparian habitat quality within 100 metres upstream and downstream of each crossing of the new trails at Blackfellow Creek and Dalrymple Creek was described on the basis of relevant parameters included the Australian River Assessment System (AusRivAS) Physical Assessment Protocol (Parsons 2002), a standardised protocol for the assessment of stream physical condition, and a description of riparian groundcover vegetation community composition and structure. Signs of disturbance to riparian habitats from humans or feral or domestic animals were searched for and noted.

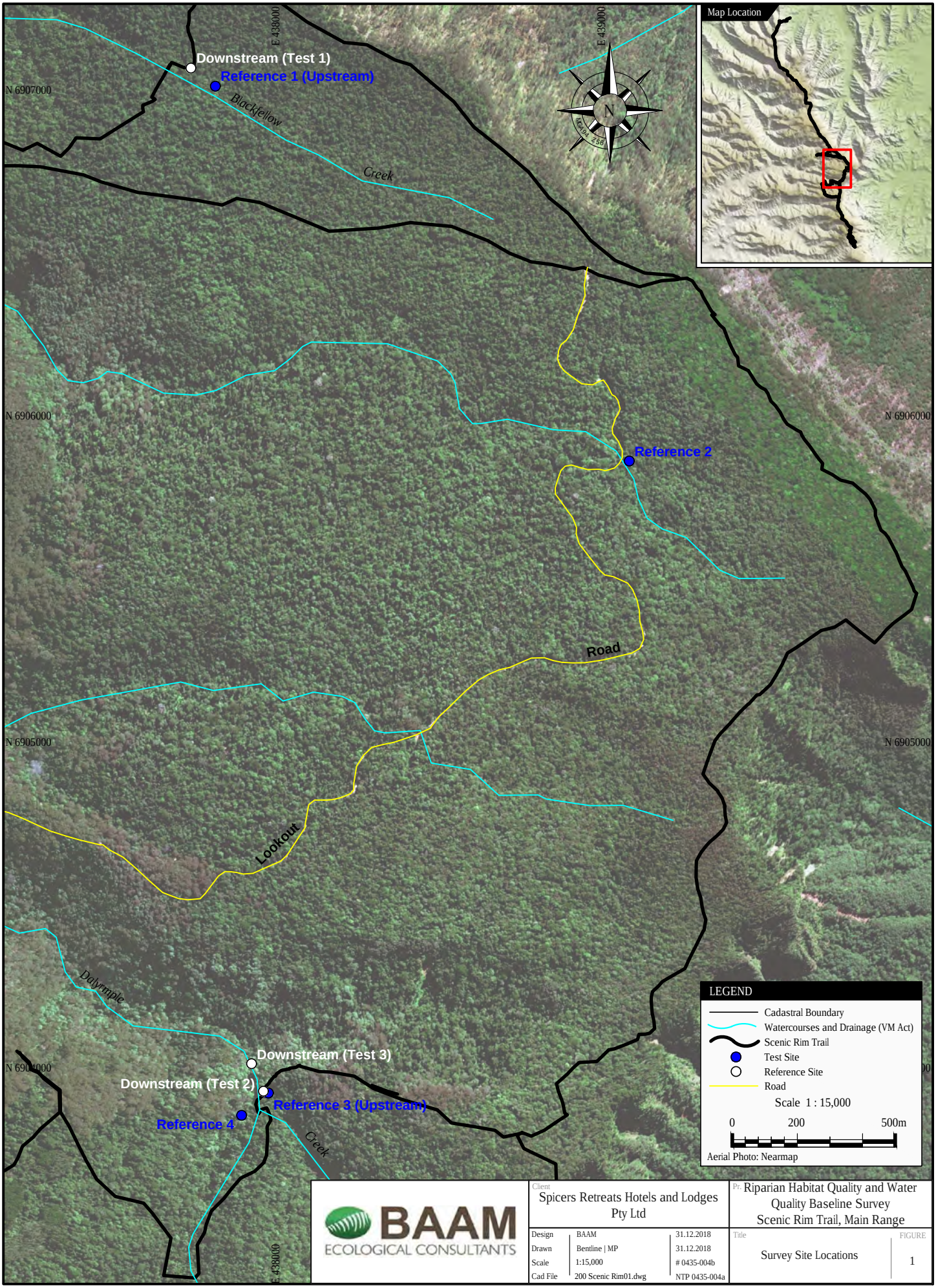
2.2.2 Mt Mistake Spiny Crayfish

The Mt Mistake Spiny Crayfish (*Euastacus jagara*) is listed as a critically endangered species by the IUCN (Coughran and Furse 2010), but it is not a listed threatened species under either the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the Queensland *Nature Conservation Act 1992* (NC Act). However, the species satisfies the NC Act criteria for listing as endangered (McCormack *et al.* 2010). It occupies a highly restricted distribution (extent of occurrence less than 10 km^2) within several highland creeks in the rainforests of Main Range National Park (Coughran and Furse 2010), where it has not been found below an altitude of 700 m and appears to be the only crayfish found within its range (McCormack *et al.* 2010). It has been previously recorded from upper tributaries of Dalrymple Creek and the Flaggy Creek and Shady Creek tributaries of Blackfellow Creek (McCormack *et al.* 2010). *E. jagara* constructs intricate burrows, preferably in finer substrates, within a short distance to the stream (usually within 2 m), with five or more entrances and numerous chambers. Their diet is suspected to be omnivorous, as they are attracted to meat baits and they also collect and store fallen rainforest fruit (McCormack *et al.* 2010). The occurrence of *E. jagara* appears to coincide with the presence of *Elatostema reticulatum* (Rainforest Spinach) growing in soils that are perennially damp along the banks of creeks (McCormack *et al.* 2010).

As a key aquatic fauna species present within the study area, the abundance and distribution of Mt Mistake Spiny Crayfish was assessed as an indicator of terrestrial habitat quality within 100 metres upstream and downstream of each crossing of the new trails at Blackfellow Creek and Dalrymple Creek. This assessment included nocturnal survey for crayfish active on the creek banks or at their burrow entrances and daytime survey to quantify the locations and numbers of all active burrows along both banks of a 100m section of creek both upstream and downstream of each of the Blackfellow and Dalrymple Creek crossings. Burrows were searched for within 10 m of the stream edge during daylight, with the assistance of a head-torch where necessary, and the number of burrows and the distance to the edge of the stream were recorded. While not required to be undertaken by the conditions of approval for the Project, this assessment represents an additional commitment by Spicers Retreats Hotels and Lodges Pty Ltd to the monitoring of an iconic and threatened aquatic fauna species.

2.3 WATER QUALITY SAMPLING METHODS

Sampling was implemented on 25 October 2018 at four reference sites and two test sites (see **Figure 1** for locations and **Tables 3.3** and **3.4** for site coordinates) in accordance with the requirements set out in **Table 2.1** above during base flow conditions following a 1mm shower the previous day, and regular showers totaling 155mm since 6 October (**Figure 2**).



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Client	Spicers Retreats Hotels and Lodges Pty Ltd	
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Title	Survey Site Locations	FIGURE 1

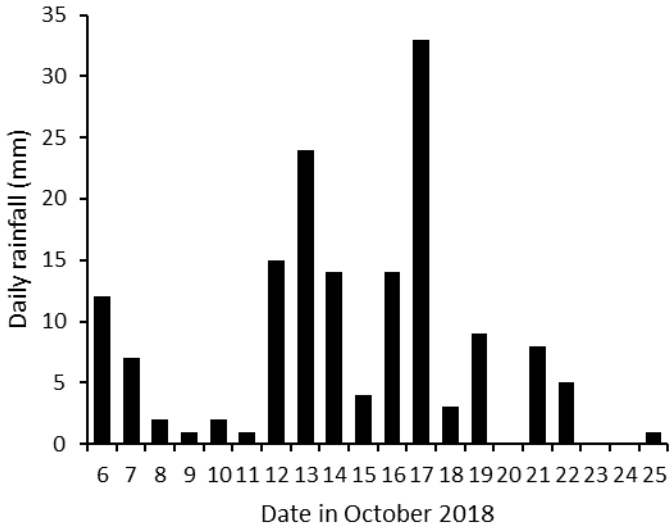

Figure 2. Daily rainfall preceding the survey, as measured at the nearby Mount Castle Alert rain gauge (BoM 2018).

In situ measurements of temperature, pH, electrical conductivity and dissolved oxygen were taken approximately 0.1 m below the surface of the water using a calibrated SmarTroll Water Quality Meter. Turbidity was measured approximately 0.1 m below the surface of the water using a calibrated HACH 2100Q portable turbidity meter.

Water samples for TSS analysis were collected using sample bottles provided by the NATA accredited laboratory (Eurofins), chilled and delivered to the laboratory the day after collecting along with chain-of custody documentation; thus, achieving sampling holding times.

All sampling of water quality was completed in accordance with the standards and quality assurance protocols of the Monitoring and Sampling Manual (DES 2018).

Water quality results for sites in the Blackfellow Creek Section were compared to Water Quality Objectives (WQOs) for upland freshwaters of Lockyer Creek (DERM 2010). While the sites in the Blackfellow Creek section occur in High Ecological Value Waters (i.e. HEVm1203), there are no published WQOs for this water type; thus, the published WQOs for upland freshwaters are the best available guidelines.

Water quality results for sites in the Dalrymple Creek section were compared to draft WQOs for moderately disturbed waters under low flow condition in the South-Eastern Condamine River of the Queensland Murray-Darling Basin (DES 2018b).

2.4 QUALIFICATIONS OF THE FIELD TEAM

The riparian habitat quality survey was undertaken by Dr Penn Lloyd (Principal Ecologist, BAAM), a suitably qualified person who has a PhD in ecology, 25 years of field experience as a terrestrial ecologist, has published 60 peer-reviewed scientific publications in ecology and authored over 210 consultancy reports. The water quality survey was undertaken by Lachlan Webster (Ecologist, frc environmental), a suitably qualified person with Bachelor and Honours degrees in marine science and four years of academic and industry experience as an aquatic ecologist. Reporting for water quality was completed by Dr Ben Cook (Principal Ecologist, frc environmental), a suitably qualified person who has a PhD in aquatic ecology, over 18 years of experience as an aquatic ecologist, has published over 20 peer-reviewed scientific publications in aquatic ecology and authored over 150 consultancy reports.

3.0 RESULTS AND DISCUSSION

3.1 BASELINE RIPARIAN HABITAT QUALITY

3.1.1 Blackfellow Creek Section and Reference Site 2

Blackfellow Creek within 100m upstream and downstream of the proposed new trail crossing is a high-energy headwater perennial stream located in the bed of a steep valley on an escarpment plateau. The stream has a bankfull width of 3-4m and comprises a series of mostly shallow pools separated by short riffle zones, with occasional pools that reach a depth of a little over 0.5m (**Photos 3.1** and **3.2**). The streambed is stable, having a range of sediment sizes and comprised of consolidated (tightly arranged and packed) material (**Photo 3.3**), with a channel that is in a relatively natural state (not deepened or infilled) with bed and bar sediments roughly the same size. Many pools have a bedrock bed with loose cobbles and limited fine sediments.

Photo 3.1 Blackfellow Creek within 100m upstream of the proposed crossing point.

Photo 3.2 Blackfellow Creek within 100m downstream of the proposed crossing point.

Photo 3.3 Stable streambed with a range of sediment sizes and limited fine sediments.

Photo 3.4 Recent erosion on a vegetated sidebar immediately downstream of the proposed crossing.

The creek is located in complex notophyll vine forest, a type of rainforest. The concave, steeply-sloped creek banks are continuously vegetated, with a moderate abundance of trailing bank vegetation. The banks are stable, with little evidence of erosion and little potential for future problems evident; evidence of erosion was limited to occasional erosion of vegetated side-bars (**Photo 3.4**), a natural fluvial process. More than 90% of the streambank surfaces and immediate riparian zone are covered by native vegetation, with the remaining surface area covered by leaf litter, fallen tree logs or bedrock. The ground vegetation at the stream edges and along the banks is dominated by Rainforest Spinach (*Elatostema reticulatum*), with patchy co-dominance by *Pollia crispata*. A variety of ferns occur frequently, particularly Soft Bracken (*Calochlaena dubia*) and *Asplenium attenuatum*, Scaly Treefern (*Cyathea cooperi*), Bangalow Palm (*Archontophoenix cunninghamiana*), *Cordyline petiolaris* and a variety of rainforest tree saplings occur commonly

along the banks in the shrub layer. There was no evidence of introduced plant weed species anywhere along the creek.

The proposed crossing point of Blackfellow Creek occurs on a narrow, shallow, run and riffle section of the stream with gently sloping banks on either side (**Photos 3.5** to **3.8**). The creek will be crossed on a deposition bar of cobbles where the surrounding groundcover is dominated by Rainforest Spinach (**Photo 3.8**).

Photo 3.5 Upstream from the proposed crossing point on Blackfellow Creek during high flow conditions on 21 March 2017.

Photo 3.6 View of the proposed crossing point of Blackfellow Creek looking downstream during high flow conditions on 21 March 2017.

Photo 3.7 Upstream from the proposed crossing point on Blackfellow Creek during base flow conditions on 25 October 2018.

Photo 3.8 View of the proposed crossing point of Blackfellow Creek looking downstream during base flow conditions on 25 October 2018.

Rainforest Spinach, the predominant groundcover along the stream banks is a weak-stemmed herb that is highly sensitive to trampling i.e. trampling impacts are readily identifiable and immediately apparent. There was no evidence of groundcover vegetation trampling either upstream or downstream of the proposed crossing point. Feral pig evidence was detected at a single location on Blackfellow Creek in October 2018, a mud wallow with fresh pig tracks on the creek bank approximately 150m downstream of the proposed crossing point (**Photo 3.9**). During the March 2017 survey there had been no evidence of feral pig along Blackfellow Creek, but there were abundant fresh feral pig diggings just 200m upslope along the Winder Track where ranger staff had installed a pig trap. There had been no evidence of feral pigs in this area during a November 2016 survey, and there was limited evidence of feral pigs along the Winder Track during a survey in June 2018. Domestic cattle were present in the park during every survey since March 2017; however, evidence of recent domestic cattle presence on the Winder Track (scats, tracks) was only detected in October 2018 and there was no evidence that domestic cattle had accessed Blackfellow Creek.

Mt Mistake Spiny Crayfish was observed active on the edge of Blackfellow Creek during the March 2017 survey (**Photo 3.10**), and active crayfish burrows were common along the banks of Blackfellow Creek during both the March 2017 and October 2017 surveys. The total number of active Mt Mistake Spiny Crayfish burrows was 58 burrows within 150m upstream of the proposed crossing point and 18 burrows within 100m downstream of the proposed crossing point, confirming that Blackfellow Creek is an important habitat area for this species. The maximum distance of burrows from the stream edge was four metres.

Photo 3.9 Feral Pig mud wallow on the bank of Blackfellow Creek, October 2018.

Photo 3.10 *Euastacus jagara* on the bank of Blackfellow Creek, evening of 20 March 2017.

Table 3.1 below summarises the baseline status of key indicators of riparian habitat quality at Blackfellow Creek with respect to the predicted potential impact pathways identified under **Section 2.2.1** above.

Table 3.1. Baseline status of key indicators of riparian habitat quality within 100m upstream and downstream of the proposed new crossing of Blackfellow Creek.

Key indicator	Within 100m upstream	Within 100m downstream
Evidence and extent of trampling of sensitive groundcover vegetation along the riparian bank	No evidence of trampling.	No evidence of trampling.
Evidence and extent of erosion along the hiking trail in the vicinity of the creek crossings	Not applicable – trail not yet constructed.	Not applicable – trail not yet constructed.
Evidence and extent of feral pig and/or domestic cattle activity	None.	A single feral pig mud wallow and fresh tracks 150m downstream.
Evidence and extent of sediment in the in-stream channel	Occasional vegetated side bars, some showing erosion from recent high water flows; limited sediment in pools, which have a range of sediment sizes.	Occasional vegetated side bars, some showing erosion from recent high water flows; limited sediment in pools, which have a range of sediment sizes.
Evidence and extent of damage to riparian bank stability	No damage to bank stability.	No damage to bank stability.
Evidence and extent of weeds	No weeds present.	No weeds present.
Mt Mistake Spiny Crayfish population	A total of 58 active burrows detected within 150m upstream of the proposed crossing point, confirming a healthy population.	A total of 18 active burrows detected within 100m downstream of the proposed crossing point, confirming a healthy population.

Reference site 2 is located on an unnamed creek 100m upstream of the Lookout Road crossing of the creek, approximately 0.6 km south of the Mt Castle Lookout car park. This creek is of similar size and character as Blackfellow Creek (**Photo 3.11**). There had been extensive browsing of Rainforest Spinach and pugging of softer creek banks (**Photo 3.12**) by recent domestic cattle activity along this creek as also evidenced by 10 fresh dung piles within the first 100m along the bed of the creek.

Photo 3.11 Reference site 2, October 2018.

Photo 3.12 Browsing and pugging of creek banks by cattle near Reference site 2.

3.1.2 Dalrymple Creek Section and Reference Site 4

Dalrymple Creek within 100m upstream and downstream of the proposed new trail crossing is a high-energy headwater perennial stream located in the bed of a steep valley. The stream is sharply incised in the valley and has a bankfull width of 5-10m above the crossing and 10-15m below the crossing below the junction with another stream. The stream above the proposed crossing comprises a series of mostly shallow pools separated by short riffle zones or flows over bedrock, with occasional pools that reach a depth of a little over 0.5m (**Photos 3.13**). The stream below the proposed crossing has larger, deeper pools interspersed with short riffle zones or flows over bedrock slopes or platforms (**Photo 3.14**).

Photo 3.13 Dalrymple Creek within 100m upstream of the proposed crossing point.

Photo 3.14 Dalrymple Creek within 100m downstream of the proposed crossing point.

The streambed is stable, having eroded to bedrock over much of its length within the assessment area (**Photos 3.13** and **3.14**), with a channel that is in a relatively natural state (not deepened or infilled) with bed and bar sediments roughly the same size (**Photo 3.15**). Many pools have a bedrock bed with loose cobbles and limited fine sediments.

The creek is located in complex notophyll vine forest. The concave, steeply-sloped creek banks are continuously vegetated, with a moderate abundance of trailing bank vegetation. The banks are stable, with little evidence of erosion and little potential for future problems evident; occasional bars of accumulated coarse sediment (**Photo 3.16**) suggests occasional sediment inputs from landslips, a natural process in the very steep surrounding mountain slopes. The streambank surfaces and immediate riparian zone are covered by a mosaic of native vegetation, leaf litter, fallen tree logs and extensive areas of bedrock; exposed bedrock on the stream banks is substantially covered with moss.

Photo 3.15 Stable streambed with a range of sediment sizes and limited fine sediments.

Photo 3.16 Coarse sediment accumulation behind a log obstruction upstream of the proposed crossing point.

The ground vegetation at the stream edges and along the banks is dominated by Rainforest Spinach (*Elatostema reticulatum*), with patchy co-dominance by *Pollia crispata*. Other groundcover species include Cunjevoi (*Alocasia brisbanensis*) and a variety of ferns, particularly Soft Bracken (*Calochlaena dubia*), Sickle Fern (*Pellaea nana*), Tender Brake (*Pteris umbrosa*) and Birds Nest Fern (*Asplenium australasicum*). Scaly Treefern (*Cyathea cooperi*), *Cordyline petiolaris* and a variety of rainforest tree saplings occur commonly along the banks in the shrub layer. There was no evidence of introduced plant weed species anywhere along the creek.

The proposed crossing point of Dalrymple Creek is on a rock platform in shallow water below a small waterfall (**Photos 3.17** to **3.20**) approximately 20 m above the junction of Dalrymple Creek with a similar-sized tributary. The banks on either side of the crossing point are composed of rock, and the proposed new trail approach from the north-eastern side would be via a relatively steep slope.

Photo 3.17 View upstream from the proposed crossing point (rock platform at centre of photo) of Dalrymple Creek during high flow conditions on 21 March 2017.

Photo 3.18 View downstream from the proposed crossing point (at centre of photo) on Dalrymple Creek during high flow conditions on 21 March 2017.

Photo 3.19 Upstream from the proposed crossing point on Blackfellow Creek during base flow conditions on 25 October 2018.

Photo 3.20 View of the proposed crossing point of Blackfellow Creek looking downstream during base flow conditions on 25 October 2018.

There was no evidence of groundcover vegetation trampling either upstream or downstream of the proposed crossing point, as well as no evidence of feral pig visitation during March 2017, June and October 2018 surveys. While there was evidence (dung piles) that domestic cattle had recently ranged along much of the length of the Cascades Circuit trail between Manna Gum campground and the proposed new trail crossing point in the October 2018 survey, there was no evidence of domestic cattle visitation within 100m upstream and downstream of the proposed new trail crossing.

Mt Mistake Spiny Crayfish were observed active at the entrances of active burrows on Dalrymple Creek during the March 2017 and October 2018 surveys. The total number of active Mt Mistake Spiny Crayfish burrows was 28 burrows within 100m upstream of the proposed crossing point and 3 burrows within 100m downstream of the proposed crossing point, confirming that Dalrymple Creek is an important habitat area for this species. The paucity of burrows along the downstream section is likely a consequence of the greater surface area of exposed bedrock and fewer earth banks. The maximum distance of burrows from the stream edge was two metres.

Table 3.2 below summarises the baseline status of key indicators of riparian habitat quality at Dalrymple Creek with respect to the predicted potential impact pathways identified under **Section 2.2.1** above.

Table 3.2. Baseline status of key indicators of riparian habitat quality within 100m upstream and downstream of the proposed new crossing of Blackfellow Creek.

Key indicator	Within 100m upstream	Within 100m downstream
Evidence and extent of trampling of sensitive groundcover vegetation along the riparian bank	No evidence of trampling.	No evidence of trampling.
Evidence and extent of erosion along the hiking trail in the vicinity of the creek crossings	Not applicable – trail not yet constructed.	Not applicable – trail not yet constructed.
Evidence and extent of feral pig and/or domestic cattle activity	None.	None.
Evidence and extent of sediment in the in-stream channel	Occasional vegetated and unvegetated side bars; limited sediment in pools, which have a range of sediment sizes.	Limited sediment in pools, which have a range of sediment sizes.
Evidence and extent of damage to riparian bank stability	No damage to bank stability.	No damage to bank stability.
Evidence and extent of weeds	No weeds present.	No weeds present.
Mt Mistake Spiny Crayfish population	A total of 28 active burrows detected within 100m upstream of the proposed crossing point, confirming a healthy population.	A total of 3 active burrows detected within 100m downstream of the proposed crossing point, confirming a healthy population.

Reference site 4 is located on a tributary of Dalrymple Creek, approximately 100m upstream of a crossing of the creek by the Cascades Circuit public walking track, which continues to cross the tributary several times further upstream. This creek is of similar size and character as Dalrymple Creek (**Photo 3.22**), with no evidence of disturbance.

Photo 3.21 *Euastacus jagara* burrow on the bank of Dalrymple Creek, with recently dug out material.

Photo 3.22 Reference site 4, October 2018.

3.2 BASELINE RIPARIAN WATER QUALITY

3.2.1 Blackfellow Creek Section and Reference Site 2

There is no published WQO for temperature, but the results indicate similar water temperature among the sites in the range expected for upland rainforest streams (**Table 3.3**). The pH of water complied with the WQO, with results indicating water very close to neutral pH (i.e. pH 7.0). The electrical conductivity of water complied with the WQO, with results indicating low salinity.

Table 3.3. Water quality results for sites in the Blackfellow Creek Section compared to the Water Quality Objective (WQO). Grey shading indicates results that did not achieve the applicable WQO.

Site	Temperature (ºC)	pH (units)	Electrical conductivity (µS/cm)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/L)	Turbidity (NTU)	TSS (mg/L)
WQO	–	6.5–8.2	<520*	90–110	–	<5.0	<6.0
Reference 1 (upstream) (27.960325° S 152.367589° E)	14.76	7.10	84.7	64.7	5.94	4.73	4.1
Test 1 (downstream) (27.959822° S 152.366826° E)	15.17	7.32	83.2	86.5	7.83	5.6	3.7
Reference 2 (27.970772° S 152.380442° E)	16.02	7.15	67.7	79.8	7.13	4.6	3.3

* DERM (2010) refers to Appendix G of the Queensland Water Quality Guidelines (DEHP 2013) for electrical salinity, with the 75th percentile for the southern coastal salinity zone the applicable guideline.

The percent saturation of dissolved oxygen did not achieve the WQO (i.e. the percent saturation of dissolved oxygen was lower than expected by the guideline), noting there is no published WQO for the concentration of dissolved oxygen (mg/L). However, the results for both percent saturation and concentration (i.e. mg/L) of dissolved oxygen indicated dissolved oxygen levels are well within the range needed for respiration by aquatic fauna. The results indicate that the published WQOs for dissolved oxygen are not appropriate guidelines for assessing water quality in Blackfellow Creek.

The turbidity of water complied with the WQO at all sites except site Test 1, which was slightly higher than the WQO. The results for TSS complied with the WQO at all sites. Overall, these results indicate high water clarity, but also indicate that the default WQO for turbidity may not always be appropriate for monitoring natural levels of turbidity in Blackfellow Creek.

3.2.2 Dalrymple Creek Section and Reference Site 4

There is no published WQO for temperature, but the results indicate similar water temperature among the sites in the range expected for upland rainforest streams (**Table 3.4**). The pH of water complied with the WQO and was similar among sites. The electrical conductivity of water complied with the WQO, with results indicating low salinity.

The percent saturation of dissolved oxygen complied with the WQO, noting there is no published WQO for the concentration of dissolved oxygen(mg/L). The results for both percent saturation and concentration (i.e. mg/L) of dissolved oxygen indicated dissolved oxygen levels well within the range needed for respiration by aquatic fauna. The turbidity of water complied with the WQO at all sites, as did the results for TSS. These results indicate high water clarity.

Table 3.4. Water quality results for sites in the Dalrymple Creek section compared to the Water Quality Objective (WQO).

Site (GPS coordinates, GDA94 datum)	Temperature (ºC)	pH (units)	Electrical conductivity (µS/cm)	Dissolved oxygen (% saturation)	Dissolved oxygen (mg/L)	Turbidity (NTU)	TSS (mg/L)
WQO	–	7.7–8.3	<440	60 – 110	–	<8.0	<10
Reference 3 (upstream) (27.988230° S 152.369078° E)	15.89	7.92	89.7	97.7	8.87	4.74	1.6
Test 2 (downstream) (27.988180° S 152.368927° E)	15.93	7.85	89.4	100.4	9.11	4.04	<1.0
Test 3 (downstream) (27.987417° S 152.368559° E)	16.78	7.94	87.6	98.5	8.78	5.81	1.8
Reference 4 (27.988844° S 152.368240° E)	16.2	7.84	84.4	94.2	8.49	4.16	2.1

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