EPBC 2017/7861 Annual Compliance Report 2025

Sanjiv Ridge Direct Shipping Ore (DSO) Project – Stage 1 (2024 – 2025)

28/06/2025

179-EN-REP-0027 v1

Authorisation

Version	Reason for Issue	Prepared	Checked	Authorised	Date
1	Required under EPBC 2017/7861	N. Liaros	R. Gardner	T. Sprenkles	28/06/2025

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1 Introduction

Atlas Iron Pty Ltd (Atlas) is operating and developing the Sanjiv Ridge Direct Shipping Ore (DSO) Project (the Project). The Project is an iron ore mine located in the Pilbara region of Western Australia, approximately 240 km southeast of Port Hedland and 33 km south of Marble Bar.

Stage 1 of the Project (the Project), approved under EPBC 2017/7861 (as varied on 14 December 2021), involves mining five open pits (Sparrow, Razorback, Shark Gully, Runway North and Runway South), using conventional drill and blast, load and haul methods to extract an iron ore resource of approximately 36.7 million tonnes (Mt) over a mine life of approximately eight years. Ore is trucked to the run-of-mine (ROM) pad for crushing and screening with the final product hauled to Utah Point in Port Hedland for export overseas.

Stage 2 of the Project is a satellite operation which includes three open pits, four additional waste rock landforms and a 4 km haul road connecting to Stage 1. Ore will be hauled to Stage 1, to the existing processing centre to produce a further 10 million tonnes of DSO. Stage 2 of the Project was approved under EPBC 2021/8885, published on 5 October 2022.

As part of EPBC 2017/7861, Atlas is required to submit a compliance report (this compliance report) to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) (here after the Department) annually by 17 July (within 60 business days of the 12-month reporting period) to satisfy condition 8. This compliance report is for the reporting period 21 April 2024 to 20 April 2025.

2 Objective

This compliance report addresses condition 8 of EPBC 2017/7861, whereby:

*The approval holder must prepare a **compliance report** for each 12-month period following the date of **commencement** of the action, or otherwise in accordance with an annual date that has been agreed to in writing by the **Minister**. The approval holder must:*

a) *publish each **compliance report** on the **website** within 60 **business days** following the relevant 12-month period;*
b) *notify the **Department** by email that a **compliance report** has been published on the **website** and provide the weblink for the **compliance report** within five **business days** of the date of publication;*
c) *keep all **compliance reports** publicly available on the **website** until this approval expires;*
d) *exclude or redact **sensitive ecological data** from **compliance reports** that are to be published on the **website**; and*
e) *where any **sensitive ecological data** has been excluded from the version published, submit the full **compliance report** to the **Department** within 5 **business days** of publication.*

3 Scope

This compliance report details the commitments within EPBC 2017/7861 (as varied on 14 December 2021) and assessment of compliance against conditions 1-12 for the reporting period 21 April 2024 to 20 April 2025.

4 Statement of Compliance

4.1 Proposal and Proponent Details

Proposal Title	CORUNNA DOWNS IRON ORE MINING PROJECT
Location of the Project	PILBARA REGION, 33 KM SOUTH MARBLE BAR, WA
Approved action number	EPBC 2017/7861
Proponent Name	Atlas Iron Pty Ltd
Proponent's Australian Company Number *(where relevant)*	110 396 168

4.2 Proponent Declaration

In making this declaration, I am aware that section 490 and 491 of the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) make it an offence in certain circumstances to knowingly provide false or misleading information or documents. The offence is punishable on conviction by imprisonment or a fine, or both. I declare that all the information and documentation supporting this compliance report is true and correct in every particular. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed	
Full Name (please print)	Theodore Sprenkels
Position (please print)	Superintendent Environment and Approvals
Organisation (please print including ABN/ACN if applicable)	Atlas Iron Pty Ltd ACN110396168
Date	28 June 2025

5 Designations to record findings

5.1 Assessment of Compliance

The compliance report has been prepared in accordance with the recommended compliance table provided in Appendix A of the DCCEEW *Annual Compliance Report Guidelines 2023* (Annual Compliance Report Guidelines). The assessment of compliance was reported against the audit elements of the DCCEEW compliance table (Table 1), including the compliance status of conditions 1 – 12 of EPBC 2017/7861.

The terminology used to record findings in the compliance report (Table 1) is consistent with section 3.7 of the Annual Compliance Report Guidelines.

Table 1 Compliance Status Terminology

Status	Description
Compliant	'Compliance' is achieved when all the requirements of a condition have been met, including the implementation of management plans or other measures required by those conditions.
Non-compliant	A designation of 'non-compliance' should be given where the requirements of a condition or elements of a condition, including the implementation of management plans and other measures, have not been met.
Not applicable	A designation of 'not applicable' should be given where the requirements of a condition or elements of a condition fall outside of the scope of the current reporting period. For example, a condition which apprise to an activity that has not yet commenced.

5.2 Compliance Status

There were **no non-compliances** found during the Audit.

A detailed assessment of compliance with the conditions of EPBC 2017/7861 is presented in Table 2.

6 Compliance Assessment

Table 2 EPBC 2017/7861 Audit Table

EPBC 2017/7861			
Condition Number/ reference	Condition	Compliant/ Non-Compliant/ Not Applicable	Evidence/ Comments
1	For the protection of **EPBC Act listed species** the approval holder must: a) Clear no more than 423.19 ha within the **disturbance footprint** b) **Clear** no more than two nocturnal refuge caves for the **Pilbara Leaf-nosed Bat** within the **disturbance footprint** c) Implement the **Significant Species Management Plan**	**Compliant**	a) A total of 13.83 ha was cleared during the reporting period. Since the start of the Project, a total of 317.06 ha has been cleared within the 423.19 ha disturbance footprint. b) No more than two nocturnal refuge caves for the Pilbara Leaf-nosed bat have been cleared within the disturbance footprint. c) The Corunna Downs Significant Species Management Plan (179-LAH-EN-PLN-0001) is currently being implemented. *Evidence:* Appendix A – Extent of native vegetation clearing (EPBC 2017/7861 – 21 April 2024 to 20 April 2025) Attachment A – EPBC_2017/7861 – Disturbance reporting period (21 April 2024 to 20 April 2025).zip
2	For the protection of the **Pilbara Leaf-nosed Bat** the approval holder must: a) maintain at least a 340 metre **buffer** around the **lateral extent** of **cave CO-CA-01** b) maintain at least a 25 metre **buffer** around the **lateral extent** of **cave CO-CA-03**	**Compliant**	Cave CO-CA-01 inclusive of a 340 m buffer and cave CO-CA-03 inclusive of 50 m buffer has been excised from the Development Envelope. Demarcation around CO-CA-01 and CO-CA-03 was undertaken in accordance with the Atlas Significant Site Demarcation Standard and Significant Site Demarcation Procedure, to protect them from inadvertent disturbance by people, vehicles and machinery. The buffers around CO-CA-01 and CO-CA-03 have not been breached by unauthorised people, vehicles or machinery during the reporting period. *Evidence:* Appendix A – Extent of native vegetation clearing (EPBC 2017/7861 – 21 April 2024 to 20 April 2025)
3	The approval holder must demonstrate that, both during and after mining ceases at the **Razor Back Pit, cave CO-CA-03** and waterhole **CO-WS-14** remain suitable habitat available for use by the **Pilbara Leaf-nosed Bat.**	**Compliant**	Mining (blasting, load and haul activities) in Razorback pit commenced on 25 May 2024 during the current reporting period. Mining activities have not occurred in the Razorback pit since the 22 of July 2024. Atlas conducts monitoring in accordance with the approved Monitoring Strategy required by condition 4 of the EPBC 2021/8885. Monitoring data during the reporting period indicated continual use of CO-CA-03 and by virtue CO-WS-14 by the Pilbara Leaf Nose Bat (PLNB). Continual use by the Pilbara Leaf Nose Bat during the reporting period indicates that of CO-CA-03 and CO-WS-14 remain suitable habitat and available for use by the Pilbara Leaf Nose Bat. *Evidence*: Appendix B – Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy Annual Report 2024
4	The approval holder must develop and submit a Monitoring Strategy to the **Minister** for approval. The Monitoring Strategy must be based on: • mapping and monitoring at **cave CO-CA-03** by an **independent scientific expert(s);** and • the collection of at least 12 months of baseline humidity and temperature recordings inside **cave CO-CA-03**; and • 12 months of baseline water quality sampling of **waterhole CO-WS-14.**	**Compliant**	The Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy was submitted to the Department via email on 14 July 2020. The Department approved the Monitoring Strategy on 30 October 2020. Atlas implemented the approved Monitoring Strategy during the reporting period and developed the first Monitoring Strategy Annual Report to assess performance of the Monitoring Strategy. The Annual Report which has been provided in Appendix B.

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	The Monitoring Strategy must be designed to demonstrate that the structure of **cave CO-CA-03** remains unchanged from the **pre-mining structure** during mining of the **Razor Back Pit**. The monitoring strategy must also be designed to demonstrate, unless otherwise **justified** and approved by the **Minister**, that: a) without anthropogenic supplementation of its water level, **waterhole CO-WS-14** has water in it during and continuously for three consecutive years following the cessation of mining of **Razor Back Pit**; and b) the water quality of **waterhole CO-WS-14** remains **suitable** for **Pilbara Leaf-nosed Bat** during and continuously for three consecutive years following the cessation of mining of **Razor Back Pit**; and c) **cave CO-CA-03** maintains: i. humidity between 85-100 per cent relative humidity; and ii. temperature between 28 and 32 degrees Celsius during and continuously for five years following cessation of the mining of **Razor Back Pit**. The approval holder must not commence mining in **Razor Back Pit** until the Monitoring Strategy has been approved by the **Minister**. The approval holder must implement the approved Monitoring Strategy.		*Evidence:* Appendix B – Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy Annual Report 2024 Appendix C – DAWE Letter (EPBC 2017/7861 variation to conditions of approval, and approval of experts and Monitoring Program, 30 October 2020).
5	To compensate for the residual significant impacts to **EPBC Act listed species**, the approval holder must: a) offset the residual significant impacts of **clearing** of up to: i. 57.76 hectares identified as **critical habitat** for at least one **EPBC Act listed species** within the disturbance footprint; and ii. 358.03 hectares identified as **suitable foraging habitat for the Pilbara leaf-nosed Bat** within the **disturbance footprint** and not already counter under a) i.; by either submitting an Offset Strategy for the **Minister's** approval, as set out in 5.b), or contributing to a **Conservation Offset Fund**, as set out in 5.f); b) within 12 months of the commencement of the action, submit an Offset Strategy for the written approval of the **Minister**. The approved Offset Strategy must be implemented. The Offset Strategy must be a framework for how the residual significant impacts to **EPBC Act listed species** in conditions 5.a) i. and 5.a) ii. will be offset and must: i. review and account for relevant **approved conservation advices, recovery plans** and **threat abatement plans**; ii. identify threats to **EPBC Act listed species**, and potential recovery actions and research opportunities; and iii. outline a process for developing Offset Projects, and a staged process for submitting Offset Projects to the **Department** for the written approval of the **Department.** c) In accordance with the approved Offset Strategy, submit Offset Projects to the **Department** for the written approval of the **Department**. Offset Project proposals submitted to the **Department** must: i. include project goal(s), budget and a detailed Offset Project description, including timeframes for implementing the Offset Project, and reporting and publishing of the Offset Project results; ii. demonstrate how the Offset Project is consistent with the Offset Strategy; iii. outline consultations associated with developing the Offset Project;	**Not applicable**	Conditions 5.b) – 5.e) do not apply. PEOF payments are due biennially during each subsequent 2-year period ending 30 June. The next Conservation Offset Fund payment period is 1 July 2023 to 30 June 2025.

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	iv. outline how the Offset Project complies with the principles of the **EPBC Act Environmental Offsets Policy** and, if relevant, details of how the Offset Project meets the criteria for research and educational programs identified in Appendix A of the **EPBC Act Environmental Offsets Policy**; and v. identify and manage risks associated with implementing the Offset Project. d) not commence an Offset Project until that Offset Project has been approved in writing by the **Department**. Approved Offset Projects must be implemented. The approval holder must make payments on Offset Projects, approved in accordance with condition 5.c), that are no less than the payments determined in accordance with condition 5.f). If the approval holder wishes to implement an Offset Project otherwise than in accordance with the approved Offset Project, the approval holder must submit the revised Offset Project to the **Department** for approval. e) not continue the action for more than 18 months for the date of **commencement** of the action unless either the **Department** has approved an Offset Project as specified in condition 5.c) or an advance payment has been made in accordance with condition 5.f)iv. f) If contributing to the **Conservation Offset Fund**, rather than implementing conditions 5.b) – 5.e): i) for each hectare that is **cleared** from the date of **commencement** of the action to 30 June 2021, and then biennially during each subsequent 2-year period ending 30 June, determine the number of hectares as described under 5.a) i. and 5.a) ii. based on **evidence** of the **actual clearing footprint** which must be submitted by 30 October in the year following the reporting period**;** ii) for each period identified in f) i., make a payment to the **Conservation Offset Fund** of $3,000 for each hectare specified in a) i. and $1,500 for each hectare specified in a) ii.. All payments must be exclusive of GST and increased in accordance with the **CPI** from 1 July 2017. A payment may be reduced by an equal amount to compensate for advance payments made under f) iv.; iii) make the first payment no later than 31 January immediately following the end of the period to which the payment relates; iv) as an advance payment of f) ii., contribute: • $35,000 towards an offset that reduces the rate of decline of **EPBC Act listed species**, and ensures that viable populations of **EPBC Act listed species** remain in the Pilbara region; and • $75,000 towards an offset that reduces the rate of decline of the **Pilbara Leaf-nosed Bat**, and ensures that viable populations of **Pilbara Leaf-nosed Bat** remain in the Pilbara region; no later than 13 months from the **Conservation Offset Fund** being approved by the **Minister** for the purpose of providing environmental offsets in the Pilbara; v) submit **evidence** of each payment made under f) ii.. and f) iv. to the **Department** within 2 months of the date of the payment; and vi) on completion of **clearing**, submit to the **Department** an **impact reconciliation report** verified by an **independent third party**. The		

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	Minister may adjust the final year payment and notify the approval holder in writing of the adjusted final payment amount required under f) ii. above, based on **evidence** of the **actual clearing footprint** provided in the **impact reconciliation report**.		
6	Within 30 days after the **commencement** of the action, the person taking the action must advise the Department in writing of the actual date of **commencement.**	**Compliant**	On 15 May 2020, Atlas notified the DCCEEW (then DAWE) via letter that the action commenced on 21 April 2020. The date of action commencement was confirmed by DAWE on 19 May 2020.
7	The person taking the action must maintain accurate records substantiating all activities associated with or relevant to the conditions of the approval, including measures taken to implement the **Significant Species Management Plan**, Offset Strategy and Monitoring Strategy required by this approval, and make them available upon request to the **Department**. Such records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the **EPBC Act**, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the **Department's** website. The results of audits may also be publicised through the general media.	**Compliant**	All records related to compliance with the conditions of EPBC 2017/7861, including measures taken to implement the Significant Species Management Plan (SSMP), Offset Strategy and Monitoring Strategy are retained on Atlas' document management system.
8	Annual compliance reporting The approval holder must prepare a **compliance report** for each 12-month period following the date of **commencement** of the action, or otherwise in accordance with an annual date that has been agreed to in writing by the **Minister**. The approval must: a. publish each **compliance report** on the **website** within 60 **business days** following the relevant 12-month period; b. notify the **Department** by email that a **compliance report** has been published on the **website** and provide the weblink for the **compliance report** within five **business days** of the date of publication; c. keep all **compliance reports** publicly available on the **website** until this approval expires; d. exclude or redact **sensitive ecological data** from **compliance reports** that are to be published on the **website**; and e. where any **sensitive ecological data** has been excluded from the version published, submit the full **compliance report** to the **Department** within 5 **business days** of publication.	**Compliant**	This compliance report is for the 12-month period 21 April 2024 to 20 April 2025. a. **Compliant** – The 2021, 2022, 2023 and 2024 Annual Compliance Reports were submitted electronically to the Department and published on the Atlas website on 2 July 2021, 20 June 2022, 13 July 2023, and 14 July 2024 respectively, within 60 business days. b. **Compliant** – Atlas notified the Department via email on 2 July 2021, 20 June 2022, 13 July 2023 and 14 July 2024 that the Annual Compliance Report had been published on the Atlas Website, within five business days of the date of publication. c. **Compliant** – all compliance reports will be available on the Atlas website until the expiry of EPBC 2017/7861. d. **Compliant** – Sensitive ecological data will be excluded (when required) from compliance reports that are published on the website. e. **Not applicable** – No sensitive ecological data has been excluded from the published version. *Evidence:* Appendix D – Annual report notification to DCCEEW 2 July 2021, 20 June 2022, 13 July 2023 and 14 July 2024.
8A	The approval holder must notify the **Department in writing of any** incident**; non-compliance with the conditions; or non-compliance with the commitments made in** plans. The notification must be given as soon as practicable, and no later than two **business days** after becoming aware of the **incident** or non-compliance. The notification must specify: a. any condition which is or may be in breach; b. a short description of the **incident** and/or non-compliance; and c. the location (including co-ordinates, date, and time of the **incident** and/or non-compliance. In the event the exact information cannot be provided, provide the best information available.	**Compliant**	Atlas notified the Department via email within two business days after becoming aware of the non-compliance with conditions 8A and 8B. Details of notifications sent to the Department is described below. a) Four (4) conservation significant fauna deaths occurred during the reporting period, including two (2) Northern Quolls (*Dasyurus hallucatus*) and two (2) Pilbara Olive Pythons (*Liasis olivaeus barroni*). Each death requires a separate notification provided to the department and an example of this is provided in Appendix E. Under notification to the department Atlas list the details of the fauna impact as well as corrective actions that have been put in place to mitigate further impacts. *Evidence:* Appendix E – Email notification to DCCEEW

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8B	The approval holder must provide to the **Department** the details of any **incident** or non-compliance with the conditions or commitments made in **plans** as soon as practicable and no later than 10 **business days** after becoming aware of the **incident** or non-compliance, specifying: a. any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future; b. the potential impacts of the **incident** or non-compliance; and c. the method and timing of any remedial action that will be undertaken by the approval holder.	**Compliant**	Atlas provided to the Department via email the details of any incident no later than 10 days after becoming aware of a non-compliance with conditions 8A and 8B. Details of notifications sent to the Department is described below. a) Four (4) conservation significant fauna deaths occurred during the reporting period, including two (2) Northern Quolls (Dasyurus hallucatus) and one (2) Pilbara Olive Pythons (Liasis olivaeus barroni). Each death requires a separate notification provided to the department and an example of this is provided in Appendix E. Under notification to the department Atlas list the details of the fauna impact as well as corrective actions that have been put in place to mitigate further impacts. *Evidence:* Appendix E – Email notification to DCCEEW
9	Upon the direction of the **Minister**, the person taking the action must ensure that an independent audit of compliance with the condition of approval is conducted and a report submitted to the **Minister**. The independent auditor must be approved by the **Minister** prior to the commencement of the audit. Audit criteria must be agreed to by the **Minister** and the audit report must address the criteria to the satisfaction of the **Minister**.	**Not applicable**	The requirements of this condition were not triggered during the reporting period. There were no independent audits conducted during the reporting period.
10	The person taking the action may choose to revise a management plan, strategy or program approved by the **Minister** under condition 1, condition 4 or condition 5 without submitting it for approval under section 143A of the **EPBC Act**, if the taking of the action in accordance with the revised plan, strategy or program would not be likely to have a **new or increased impact**. If the person taking the action makes this choice they must: i. notify the **Department** in writing that the approved plan, strategy or program has been revised and provide the **Department** with an electronic copy of the revised plan or program; ii. implement the revised plan or program from the date that the plan, strategy or program is submitted to the **Department**; and iii. for the life of this approval, maintain a record of the reasons the approval holder considers that taking the action in accordance with the revised plan, strategy or program would not be likely to have a **new or increased impact.**	**Not applicable**	The requirements of this condition were not triggered during the reporting period. Atlas did not revise a management plan, strategy or program approved by the Minister under condition 1, condition 4 or condition 5 during the reporting period.
10A	The person taking the action may revoke their choice under condition 10 at any time by notice to the **Department**. If the person taking the action revokes the choice to implement a revised plan, strategy or program, without approval under section 143A of the **EPBC Act**, the plan or program approved by the **Minister** must be implemented.	**Not applicable**	The requirements of this condition were not triggered during the reporting period.

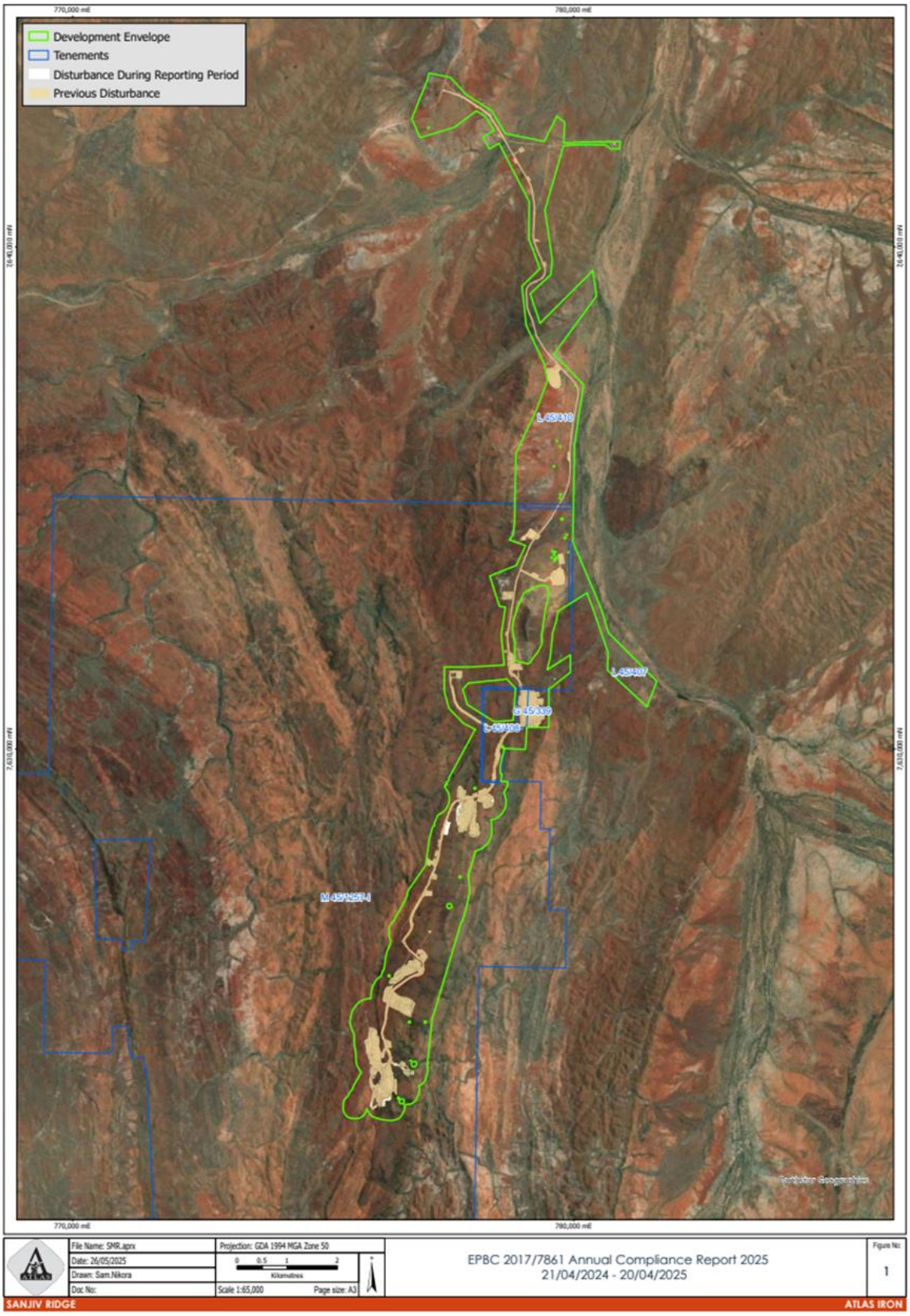
EPBC 2017/7861			
10B	If the **Minister** gives a notice to the person taking the action that the **Minister** is satisfied that the taking of the action in accordance with the revised plan, strategy or program would be likely to have a **new or increased impact**, then: i. Condition 10 does not apply, or ceases to apply, in relation to the revised plan or program; and ii. The person taking the action must implement the plan or program approved by the **Minister.** To avoid any doubt, this condition does not affect any operation of conditions 10, 10A and 10B in the period before the day the notice is given. At the time of giving the notice the **Minister** may also notify that for a specified period of time that condition 9 does not apply for one or more specified plans, strategies	**Not applicable**	The requirements of this condition were not triggered during the reporting period.
10C	Conditions 10,10A, 10B and 10C are not intended to limit the operation of section 143A of the EPBC Act which allows the person taking the action to submit a revised plan, strategy or program to the **Minister** for approval.	**Not applicable**	The requirements of this condition were not triggered during the reporting period.
11	If, at any time after five (5) years from the date of this approval, the person taking the action has not substantially commenced the action, then the person taking the action must not substantially **commence** the action without the written agreement of the **Minister**.	**Compliant**	Substantial commencement of the action commenced on 21 April 2020, within five (5) years from the date of approval on 23 April 2018.
12	Unless otherwise agreed to in writing by the **Minister**, the person taking the action must publish all management plans, strategies or programs referred to in these conditions of approval on their website until the expiry date of approval. Each management plan, strategy or program must be published on the website within 1 month of being approved by the **Minister** or being submitted under condition 10.i.	**Compliant**	The SSMP (Revision 3, 9 June 2017) and CO-CA-03 and CO-WS-14 Monitoring Strategy (Revision 6, dated 8 October 2020) are publicly available on the Atlas Iron website. The SSMP for Stage 2 of the project (Revision 7, 1 August 2023) has also been made publicly available. *Evidence:* Appendix F – Atlas Iron Environmental Publications

7 References

DCCEEW.2023. *Annual Compliance Report Guidelines*. Department of Environment, Canberra ACT.

Australian Government Department of the Environment.2016. *Sensitive Ecological Data - Access and Management Policy V1.0*.

Appendix A. Extent of native vegetation clearing (EPBC 2017/7861 – 21 April 2024 to 20 April 2025)



Appendix B. Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy Annual Report

Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy Annual Report 2024

Sanjiv Ridge Direct Shipping Ore (DSO) Project – Stage 1

22/06/2025

179-EN-REP-0026 v1

Authorisation

Version	Reason for Issue	Prepared	Checked	Authorised	Date
1	Required by Corunna Downs CO-CA-03 & CO-WS-14 Monitoring Strategy	C.Lewis N. Liaros	R.Gardner	T.Sprenkels	22/06/2025

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Abbreviations

Atlas	Atlas Iron Pty Ltd
Biologic	Biologic Environmental Survey
CO-CA-03	Cave 3
CO-WS-14	Pool 14
EPBC	Environmental Protection and Biodiversity Conservation Act
EWS	Early Warning System
INX	INX InControl (Incident Software)
KPI	Key Performance Indicator
m	Metres
Mg/L	Milli-grams per Litre
mRL	Metres Reduced Level
NATA	National Association of Testing Authorities
PCPV	Peak Component Particle Velocity
POI	Point of Interest
PPV	Peak Particle Velocity
P80	80th Percentile SSGV
RH	Relative Humidity
SSGV	Site Specific Guideline Values

1 Introduction

Atlas Iron Pty Ltd (Atlas) is operating and developing the Sanjiv Ridge Direct Shipping Ore (DSO) Project (the Project), an iron ore mine located in the Pilbara region of Western Australia, approximately 240 km southeast of Port Hedland and 33 km south of Marble Bar.

Stage 1 of the Project, approved under Ministerial Statement 1125 (MS 1125), involves mining 5 open pits (Sparrow, Razorback, Shark Gully, Runway North and Runway South), using conventional drill and blast, load and haul methods to extract an iron ore resource of approximately 36.7 million tonnes (Mt) over a mine life of approximately eight years. Ore is trucked to the run-of-mine (ROM) pad for crushing and screening with the final product hauled to Utah Point in Port Hedland for export overseas.

Cave CO-CA-03 has been identified as critical roosting habitat for the Pilbara Leaf-nosed Bat (PLNB) as a non-permanent breeding roost. Adjacent to CO-CA-03 is a permanent waterhole (CO-WS-14) which provides foraging habitat and a water source for the PLNB. Given the proximity of Razorback pit to cave CO-CA-03 and waterhole CO-WS-14, a Monitoring Strategy was developed to ensure the long-term viability of CO-CA-03 and CO-WS-14 as suitable habitat for Pilbara Leaf-nosed Bat.

2 Purpose

Under condition 4 of EPBC 2017/7861, Atlas was required to develop and submit a Monitoring Strategy to demonstrate that, both during and after mining ceases at the Razorback Pit, cave CO-CA-03 and pool CO-WS-14 remain suitable habitat available for use by the Pilbara leaf-nosed bat.

The Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy (the Monitoring Strategy) was approved on 30 October 2020 by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) and requires Atlas to prepare a standalone report (this report) at the conclusion of each annual monitoring period (January to December).

This report is for monitoring period 1 January 2024 to 31 December 2024 and is the first standalone report prepared following the commencement of active mining which began in May 2024.

The aim of this annual report is to provide an assessment of the Monitoring Strategy's Performance Objectives and Key Performance Indicators.

3 Scope

This report has been compiled by a suitably qualified zoologist to provide the following:

- Summary and analysis of microclimate and ultrasonic data as well as water quality and quantity data including methods, results, and discussion.
- Comparison of microclimate and ultrasonic data with baseline levels.
- Summary of outcomes of cave inspections and laser scans.
- Assess performance against each of the monitoring strategies key performance objectives and KPIs.
- Detail any corrective actions undertaken or considered (or reasoning as to why any corrective actions were not undertaken or considered).
- Make any necessary recommendations.

In accordance with the Monitoring Strategy, data collected prior to the commencement of mining activities (blast, load and haul) on 24 May 2024 has been considered baseline (pre-mining) data. Data

collected from 25 May 2024 to 31 December 2024 is considered as part of the first active mining monitoring period.

4 Summary of Analysis of Microclimate and Ultrasonic Data

Atlas commissioned an independent specialist (Biologic Environmental Survey Pty Ltd ("Biologic")) to undertake data analysis of microclimate and ultrasonic data in accordance with the Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy (Appendix A). The Pilbara Leaf-nosed Bat Razorback CO-CA-03 Monitoring Report 2024 (Appendix B) developed by Biologic includes methods, results and discussion of microclimate and ultrasonic data collected from CO-CA-03. The key results and findings have been summarised in the subsequent sections of this report.

4.1 Microclimate Data

Monitoring of microclimate data (temperature and relative humidity) has been undertaken since 2018 via a logger that is connected to a telemetry early warning system (EWS). This allows for remote validation and storage of microclimate data. Microclimate data throughout the current monitoring period was compared to pre-mining baseline levels using statistical analysis to identify significant changes in microclimate since mining at Razorback pit commenced.

4.1.1 Results – Key Findings

- Relative humidity levels at CO-CA-03 were within the preferred range of 85-100% for 66.06% of the monitoring period.
- Relative humidity levels recorded at CO-CA-03 during the monitoring period were similar to relative humidity levels previously recorded prior to mining commencing at Razorback pit.
- Temperatures within CO-CA-03 were consistent with the range which supports roosting by Pilbara leaf-nosed bats for 100% of the monitoring period.
- Temperatures recorded at CO-CA-03 during the monitoring period were similar to temperatures recorded prior to mining commencing at Razorback pit.
- There is no evidence to suggest the microclimate of CO-CA-03, and therefore suitability as a Category 2 roosting habitat for PLNB, has deviated from baseline conditions since the commencement of mining at the Razorback pit.

4.2 Ultrasonic Data

CO-CA-03 is fitted with a SongMeter ultrasonic recorder which has been collecting continuous data since 2018. Ultrasonic data is used to determine PLNB activity levels (estimated mean number of calls per recording night and probability of roosting). PLNB activity during the monitoring period was statistically compared against pre-mining baseline levels to determine whether a significant change in the species' use of the cave has occurred since mining commenced at Razorback Pit.

4.2.1 Results – Key Findings

- Pilbara Leaf-nosed Bats were detected every recording night (except on 3 occasions) during the reporting period.
- Calls increased in May and June, coinciding with the start of the breeding season and the commencement of mining.
- Bat activity levels during the monitoring period were statistically lower than levels recorded during 2019, 2020, 2021 and 2022 baseline monitoring years, but there was no evidence of a significant difference in activity levels compared to the 2018, 2023 and 2024 baseline years.

4.3 Discussion

Roosting and higher levels of Pilbara Leaf-nosed Bat activity typically occurred when microclimate conditions were favourable (temperature and humidity within preferred range), suggesting these variables are still a prerequisite for roosting (Biologic, 2025).

Bat activity levels during the monitoring period were statistically lower than activity levels recorded during pre-mining 2019, 2020, 2021 and 2022 monitoring years, but there was no evidence of a significant difference when compared to 2018, 2023 and 2024 pre-mining monitoring years. There were also significant differences in bat activity levels between pre-mining years (2018 to 2024), indicating activity levels naturally fluctuate from year to year, in response to yet unknown environmental or behavioural influences (localised and/or regional). For example, activity levels were significantly higher in 2019 than all other pre-mining years (with the exception of 2020), and bat activity in 2018 was significantly lower than 2019, 2020 and 2021 pre-mining years (Biologic, 2025).

Pilbara leaf-nosed bat roosting activity at CO-CA-03 was indicated most often between April and September/October across all monitoring periods (pre-mining and active mining, 2018 to 2024). When taking seasonality and microclimate (temperature) into consideration, the probability of roosting by the species' ranged from 48.34% (2022) to 82.11% (2021), with these two years (2021 and 2022) showing a statistically significant difference from one another. There was no significant difference between the probability of roosting during the active mining monitoring period and all individual pre-mining monitoring years (Biologic, 2025).

5 Summary of Analysis of Water Quality and Quantity Data at CO-WS-14

Routine monitoring of waterhole CO-WS-14 was undertaken by an Atlas Hydrogeologist in accordance with the Monitoring Strategy. Water level and quality results taken during the monitoring period have been compared to the 2019/2020 baseline and October 2017 to April 2020 baseline respectively (Biologic, 2020) to identify any significant changes to the water quality at CO-WS-14 whilst addressing the relevant performance indicators.

5.1 Water Levels

Relative changes in water level at CO-WS-14 were recorded through an installed logger which records pressure (as a surrogate for water depth). The Monitoring Strategy stipulates a water level trigger value of no less than 320.17mRL (mAHD). The pool base level equates to 320.09mRL, which puts the trigger depth at 0.18m.

Water was continuously present within pool CO-WS-14 during the monitoring period without anthropogenic supplementation, and did not drop below 320.77 mRL (or 320.17 mRL on staff gauge). Water levels remained well above this level during the monitoring period. A summary of the water levels has been provided in Table 5-1.

Table 5-1: Water depth (mRL) at CO-WS-14

Summary Statistics	Water Depth (mRL)	
	Baseline Monitoring Period (April 2019 – April 2020)	Monitoring Period (May 2024 – Dec 2024)
Average	321.00	321.06
Minimum	320.98	320.92
Maximum	321.04	321.18
Difference	0.06	0.26

CO-WS-14 water depth from January 2018 to January 2025 is displayed in Figure 1. High spikes indicate periods of significant rainfall and stream flow which creates temporary increases in pressure that the logger interprets as a greater depth of water. Variations in uncompensated water pressure are minimal, approximately ±10cm.

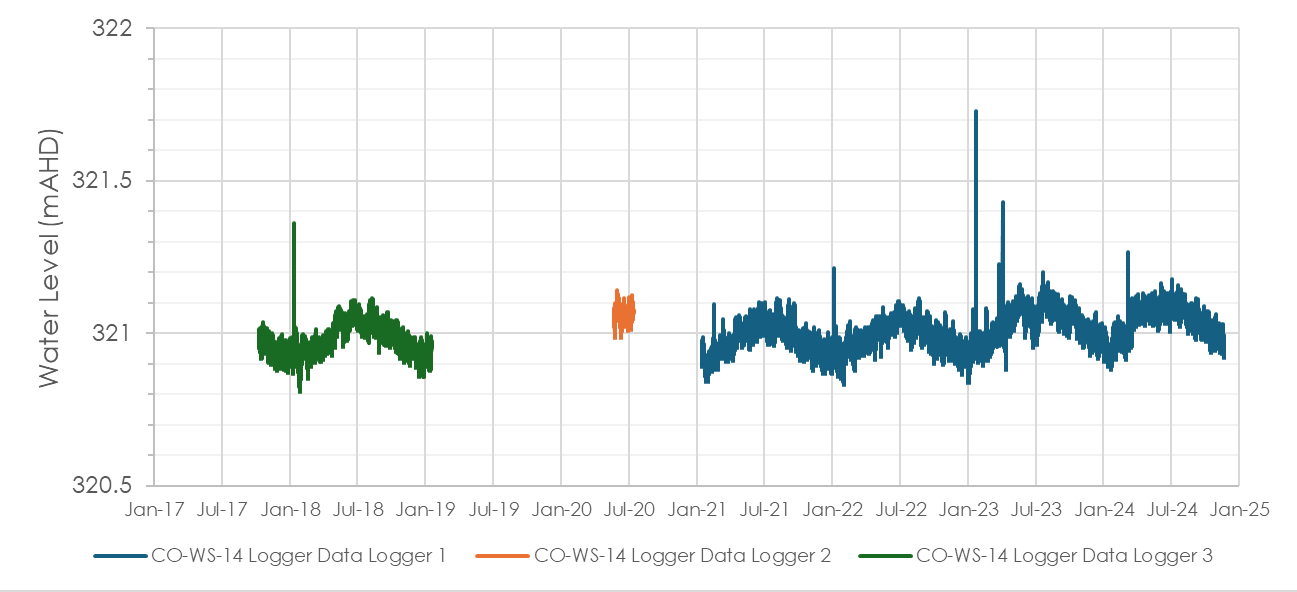


Figure 1: Logger data collected at CO-WS-14 (January 2017 – January 2025)

5.2 Water Quality

Quarterly water sampling of CO-WS-14 was undertaken by Atlas Hydrogeologist personnel and provided to a NATA accredited laboratory for analysis. Quarterly sampling commenced in May 2024 to align with the start of mining in Razorback pit. Samples were not collected in December 2024 due site inaccessibility caused by a significant rainfall event.

Analyte concentration results from CO-WS-14 and comparison with the 80th Percentile (P80) and Site-Specific Guideline Values (SSGVs) are provided in Appendix C. Analyte concentrations remained within the SSGVs for all sample events except for pH, silica, barium, and zinc, while potassium, sodium, and boron exceeded the P80 on two consecutive quarterly monitoring events.

5.2.1 Analyte Exceedance of 80th Percentile SSGVs

The following analytes exceeded the P80 SSGV over two consecutive quarterly monitoring periods:

- The potassium P80 of 3 mg/L exceeded over two consecutive quarterly monitoring events.
- The sodium P80 of 24 mg/L was exceeded over two consecutive quarterly monitoring.
- The Nickel P80 of 0.0005 mg/L was exceeded over two consecutive quarterly monitoring events
- The boron P80 of 0.37 mg/L was exceeded over three consecutive monitoring events.

5.2.2 Analyte Exceedance of the SSGVs

The analyte SSGV exceedances during active mining have been outlined below:

- The pH SSGV of 6 to 8 was exceeded on one occasion.
- The silica SSGV of 20 mg/L was exceeded on one occasion.
- The barium SSGV of 0.0086 mg/L was exceeded on seven occasions.
- The zinc SSGV of 0.008 mg/L was exceeded on five occasions.

6 Outcomes of Cave Inspections and Laser Scans

6.1 Cave Inspections

A visual cave inspection of CO-CA-03 was conducted prior to the commencement of mining in Razorback pit to document the baseline condition. Subsequent monthly visual cave inspections were conducted by Atlas during the monitoring period to monitor the structure and compare to the baseline condition.

As per the Monitoring Strategy inspections included:

- Entrance photographs (at two established photo monitoring points);
- Evidence of structural damage;
    - Are there any new open or intersecting joints or fractures along the roof, wall or bedding planes of the cave?
    - Are there any loose rocks or signs of fresh rock fall within the cave? If yes, note;
        - Amount of dust and/or fallen rocks
        - Size of largest rock
- Water presence; and
- Presence of target species: no. individuals, and/or secondary evidence.

A summary of the CO-CA-03 visual inspections conducted during the monitoring period is provided in Table 6-1.

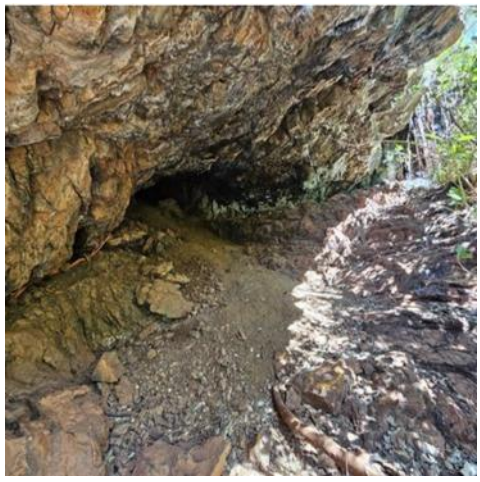
Table 6-1 Summary of visual cave inspections during 2024

Month	New open or intersecting joints or fractures within cave	Signs of fresh rockfall within cave	Presence of water within cave	Opportunistic findings of presence of target species
February	No	No	No	No
March	No	No	No	No
April	No	No	No	No

Month	New open or intersecting joints or fractures within cave	Signs of fresh rockfall within cave	Presence of water within cave	Opportunistic findings of presence of target species
May[1]	No	No	No	No
June	No	No	No	No
July	No	No	No	No
August	No	No	No	No
September	No	No	No	No
October	No	No	No	No
November	No	No	No	No
December	No	No	No	No

[1] Commencement of mining at Razorback Pit. All subsequent inspections are considered as active mining results.

Table 6-2: CO-CA-03 Visual Inspection Photographs

Pre-mining | April 2024	During Mining | December 2024
	
Pre-mining | April 2024	**During Mining | November 2024**
	

The results of visual inspections conducted during the monitoring period include:

- No visible changes to the physical structure and condition of the cave, including no minor to moderate rockfall within or at the entrance of the cave.
- No new fractures evident.
- Water seepages, wall moisture, damp soil at the cave entrance, calcium build up and algae growth were identified in pre-mining commencement inspections and remained consistent throughout the monitoring period.
- No evidence of unauthorised access.

6.2 Laser Scans

Atlas commissioned a suitably qualified professional to undertake a laser scan of CO-CA-03 in March 2025 (outside species' mating season to avoid disturbance). The scan output was compared against a baseline scan completed in 2020 to identify whether there has been any change compared to the pre-mining condition/structure of the cave. It should be noted that a laser scan was undertaken in December 2024 (during the monitoring period), however, the model output of the scan was deemed not appropriate for comparison, and thus a follow-up scan was conducted in March 2025 and used for the comparative analysis.

6.2.1 Data Analysis and Results

During the processing of the raw data, the positional accuracy of the origin point demonstrated to be 0.5m-5m. The accuracy of scanning from point to point in the cloud is below 10mm. A registration process is undertaken using processing software that registers the scans geospatial position against the baseline scan.

Point clouds are registered and then filtered, with flora and areas with poor data removed to be able to establish an accurate surface model.

By overlaying the 2025 and 2020 models, there is no evidence of structural change to the entrance of the cave. Figure 2.**Error! Reference source not found.** below illustrates the slight discrepancies between the models. However, the value changes are small, and can indicate movement of material on the ground surface or inaccurate data from one of the models.

Therefore, no new fractures, or minor to moderate rockfall was identified via laser scans during this reporting period.

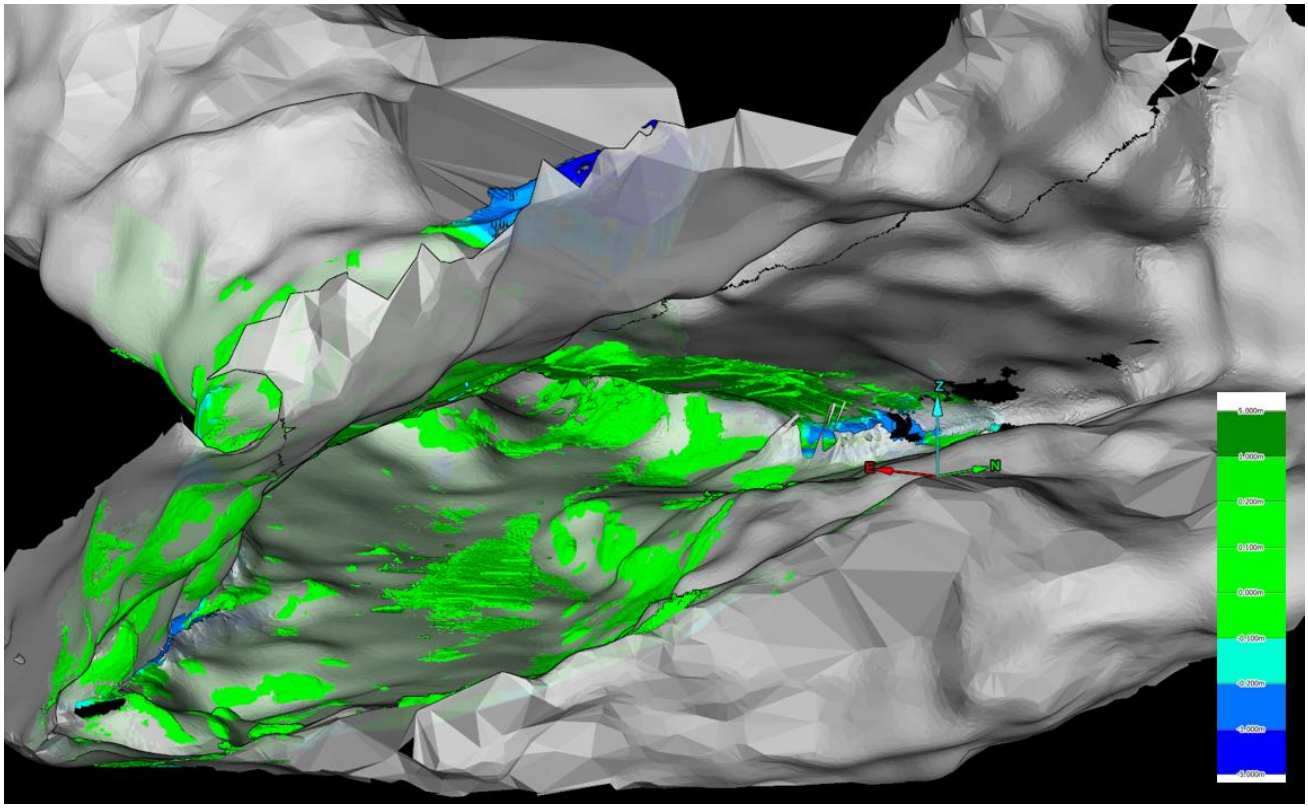


Figure 2: Baseline Surface Model (2020) Overlayed With Active-Mining Surface Model (2025)

Note: Grey areas represent 2020 baseline scan

Note: Coloured areas represent 2025 scan

7 Performance Objectives and Key Performance Indicators

7.1 Audit Process

The audit was conducted by Atlas Environmental Advisors and reviewed by the Environment Supervisor. The audit process involved consultation of Atlas Hydrogeology and Survey personnel, and review of third-party specialist reports.

7.2 Performance Objectives and Key Performance Indicator Assessment

There was one key performance indicator that was not met during the reporting period.

The detailed assessment of performance objectives and indicators is presented in Table 7-1.

Table 7-1: Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy Audit Table

Performance Objective	Key Performance Indicator	Trigger value	Trigger Value Recorded?	KPI Achieved?	Comments	Corrective Action Required?
No significant damage to CO-CA-03 that would prevent its ongoing use by Pilbara Leaf-nosed bats as a non-permanent breeding roost	Development and implementation of Razorback Blast Management Plan prior to mining commencing by a qualified specialist, which establishes appropriate blast parameters, blast vibration limits at the cave, blasting procedures and blast vibration monitoring.	• Exceedance of Blast vibration limit. • Non-compliance with Razorback Blast Management Plan.	No	Yes	Blast Management and Monitoring Plan implemented on 07/09/2021 prior to mining commencing in Razorback pit.	No
	No major structural damage to cave CO-CA-03 (i.e., collapse of cave entrance or entrance to main chamber, or opening of large fractures which result in loss/change microclimate)	• Minor to moderate rockfall within or at the entrance of the cave (i.e., does not impede bat movements/entrance into the cave and rear chamber) • New fractures	No	Yes	No minor to moderate rockfall or new fractures within or at the entrance of the cave were identified via monthly visual inspections and annual laser scan.	No
	CO-CA-03 is used as a non-permanent breeding roost by Pilbara Leaf-nosed Bat at least once in the five years following cessation of mining of Razorback pit	• No record of Pilbara Leaf-nosed Bat roosting in the first two years following cessation of mining at Razorback pit.	N/A	N/A	Cessation of mining in Razorback pit has not occurred.	N/A

Performance Objective	Key Performance Indicator	Trigger value	Trigger Value Recorded?	KPI Achieved?	Comments	Corrective Action Required?
Maintain a suitable microclimate for Pilbara Leaf-nosed Bats within cave CO-CA-03 during, and for five years following cessation of mining at Razorback pit	Cave CO-CA-03 maintains 85-100 per cent relative humidity for at least 50% of each year of monitoring	• Cave CO-CA-03 maintains 85-100 per cent relative humidity for less than 75% of a monitoring year	Yes	Yes	Cave CO-CA-03 maintained 85-100 per cent relative humidity for 66.06% of the active mining period (25 May and 31 December 2024).	No. Relative humidity levels are similar to pre-mining levels. When looking at mating period (April to October), relative humidity levels are 81.41% of this period.
	Cave CO-CA-03 maintains a temperature between 28 and 32 degrees Celsius for 95% of each monitoring year	• Cave CO-CA-03 maintains a temperature between 28 and 32 degrees Celsius for less than 98% of a monitoring year	No	Yes	Cave CO-CA-03 maintained a temperature between 28 and 32 degrees Celsius for 100% of the monitoring period.	No
Persistence of CO-WS-14 during, and continuously for three consecutive years following the cessation of, mining of Razorback Pit	CO-WS-14 continuously contains water during, and for three consecutive years following the cessation of, mining of Razor-back Pit	• Water level drops below 320.77 mRL (or 320.17 mRL on staff gauge) – equates to 95% of the minimum baseline reading	No	Yes	Minimum water level was 320.88 mRL.	No

Performance Objective	Key Performance Indicator	Trigger value	Trigger Value Recorded?	KPI Achieved?	Comments	Corrective Action Required?
Maintain suitable water quality for Pilbara Leaf-nosed Bats within pool CO-WS-14 during, and for three consecutive years following cessation of, mining of Razorback Pit	Development and implementation of a specific Razorback Hydrocarbon (and chemical) Spill Management Procedure prior to mining of the Razorback pit commencing. Exceedance of acceptable Naphthalene levels (in accordance with ANZECC (2000) 95% GV's	• Non-compliance with Razorback Hydrocarbon (and chemical) Spill Management Procedure • Exceedance of acceptable Naphthalene levels (in accordance with ANZECC (2000) 99% GV's	No	Yes	The Razorback Hydrocarbon (and chemical) Spill Management Plan was developed and implemented in November 2023, prior to mining commencing in Razorback pit. Naphthalene levels were below the Limit of Reporting for all sampling events.	No
	Water quality of pool CO-WS-14 shall not exceed site-specific GV (SSGV's)	• Exceedance of 80th percentile SSGVs over two consecutive quarterly monitoring events	Yes	No	Four analytes exceeded the site-specific SSGVs on multiple sampling events.	Yes. Atlas undertook additional sampling in response to P80 SSGV exceedances over two consecutive quarterly monitoring events and SSGV exceedances.

8 Conclusion

There were two trigger values recorded, and one Key Performance Indicator not met during the monitoring period which are discussed in this section.

8.1 Microclimate of CO-CA-03

During the monitoring period, relative humidity levels at CO-CA-03 were within the preferred range of 85-100% for PLNB roosting, for 66.06% of the monitoring period. Consequently, the associated trigger value has been recorded:

- Trigger Value: "*Cave CO-CA-03 maintains 85-100 per cent relative humidity for less than 75% of a monitoring year*".

Fluctuations in relative humidity within CO-CA-03 have previously been observed since the commencement of microclimate monitoring 2018 and is likely a natural response to changes in local ambient climatic conditions (Biologic, 2025).

This was not the first instance in which the relative humidity was below the preferred 85-100% range for less than 75% of the monitoring period. This occurred in baseline (pre-mining) years 2019, 2022, 2023, and 2024 (pre-mining) with a percentage of 66.53%, 73.15%, 49.04% and 51.72% respectively (Biologic, 2025).

When considering the months of the species' known mating season (April to October), where higher levels of bat activity and roosting were observed at CO-CA-03, relative humidity levels were within the 85-100% preferred range for 93.46% of this period during the monitoring period. Taking into consideration seasonality and temperature, the probability of Pilbara leaf-nosed bat roosting during the current monitoring period was 81.41%. These results indicate that despite the trigger value being recorded, relative humidity levels within CA-CA-03 continued to be suitable for roosting during active mining at Razorback pit, and no further corrective actions is required at this time (Biologic, 2025).

8.2 Water quality of pool CO-WS-14

During the monitoring period there were four analytes (pH, silica, barium, and zinc) that exceeded the relevant SSGV, consequently the following Key Performance Indicator was not met:

- Key Performance Indicator: "*Water quality of pool CO-WS-14 shall not exceed site-specific GV (SSGV's)*"

Importantly, all bar one of SSGV exceedances remained within baseline ranges established prior to the commencement of mining:

- pH: The single exceedance remained within the baseline (pre-mining) range. Additional follow-up sampling did not result in any further exceedances.
- Silica: The single exceedance was outside the baseline (pre-mining) range. However, additional follow-up sampling did not result in any further exceedances.
- Barium: All exceedances (including additional follow-up sampling results) remained within the baseline (pre-mining) range.
- Zinc: All exceedances remained within the baseline (pre-mining) range.

Table 8-1 provides a comparison of exceedances and baseline (pre-mining) concentration ranges for each analyte.

Table 8-1: SSGV Exceedances Compared to Baseline (pre-mining) Concentration Range

Analyte	Unit	P80	SSGV	Laboratory Analysis Results							Baseline (pre-mining) Range
				2024							
				25-May	08-Jun	23-Jul	15-Aug	19-Sep	18-Oct	22-Nov	
pH		7.98	6 to 8	7.91			**8.14**	7.81*		7.79	7.3 - 8.2
Silica	mg/L	18.8	20	17.2			**20.3**	17.6*		17.9	8.2 - 20
Barium	mg/L	0.0086	0.0086	**0.0616**	**0.0382***	**0.0402***	**0.0406**	**0.0235***	**0.0249***	**0.056**	0.004 - 0.1
Zinc	mg/L	0.0025	0.008	**0.017**	**0.016***	**0.021***	**0.017**	**0.004***	**0.006***	**0.027**	0 - 0.1

All metal analytes are dissolved
Red values indicate exceedance of the SSGV
Orange values indicate exceedance of the P80 SSGV
* denotes additional follow-up sampling undertaken in response to P80 SSGV or SSGV exceedances

Despite the SSGV exceedances, it should be noted that there is no published research or data on suitable water quality parameters for the Pilbara Leaf-nosed Bat. However, given the consistency at which the species utilises CO-CA-03 as a foraging location, it suggests that water quality recorded at CO-WS-14 during baseline monitoring was suitable for the species. Considering that all SSGV exceedances remained within the baseline monitoring ranges (with the exception of one silica result), it is reasonable to conclude that the water quality of pool CO-WS-14 remained suitable for the Pilbara Leaf-nosed bat during mining the monitoring period.

The silica exceedance and outlier could be due to sampling methodology, cross-contamination or an analysis. Follow up sampling has indicated that silica levels have remained within the SSGV. However, many rocks in the Pilbara contain silicon dioxide (silica). Overtime the weathering of rocks releases silica into the environment, including via groundwater and surface water systems. Currently, there is no evidence that natural silica is harmful to the natural pools of the Pilbara or the Pilbara Leaf-nosed Bat.

8.2.1 Corrective Actions

In accordance with the Monitoring Strategy, Atlas conducted additional sampling on a monthly basis in response to exceedances of analyte P80 SSGVs over two consecutive quarterly sampling events, and single exceedance of an analyte SSGV. Additional sampling enabled trend analysis and an understanding as to whether concentrations were increasing. Additional sampling results are presented in Table 8-1 (June and July, September and October), and demonstrate that SSGV exceedances remain consistent and within baseline levels (with the exception of one silica result) and do not appear to be trending upwards.

In accordance with the Site Water Operating Plan (SWOP), Atlas Hydrogeologists frequently reviewed monitoring data and abstraction rates during the monitoring period. Groundwater monitoring of within proximity of CO-WS-14 do not show any evidence of impact from mining activities. Atlas will continue to monitor and review groundwater data in accordance with the SWOP throughout the subsequent monitoring period.

9 Recommendations

In addition to continuing to conduct additional water quality sampling, Atlas will review recommendation for exceedances provided by Australian and New Zealand guidelines for fresh and marine water quality (ANZG, 2018) and implement further action where appropriate.

Data will be reviewed on a quarterly basis by Atlas Hydrogeologists and submitted to the Atlas Environmental Advisors for review, with any further investigations being implemented if required.

References

Atlas Iron. (2023). *Razorback Hydrocarbon (and Chemical) Spill Management Plan*. West Perth, WA.

Biologic. (2020a). *Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy*. East Perth, WA.

Biologic, (2025). Sanjiv Ridge Project: *Pilbara Leaf-nosed Bat Razorback CO-CA-03 Monitoring Report 2024*. Unpublished report prepared for Atlas Iron Pty Ltd. Biologic Environmental Survey. East Perth, WA.

Appendix A. Pilbara Leaf-nosed Bat Razorback CO-CA-03 Monitoring Report 2024 (Biologic, 2025)

Sanjiv Ridge
Pilbara Leaf-nosed Bat
Razorback CO-CA-03
Monitoring Report 2024

Report to Atlas Iron Pty Ltd

9 June 2025

Document Status				
Revision No.	Author	Review / Approved for Issue	Approved for Issue to	
			Name	Date
1	Verity Steptoe, Lisa Dinis	Jess Johnston	Riley Gardner, Nick Liaros, Claudia Lewis	23/05/2025
2	Verity Steptoe	Jess Johnston	Riley Gardner, Nick Liaros, Claudia Lewis	09/06/2025
3				

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Executive Summary

Atlas Iron Pty Ltd (Atlas) operates the Sanjiv Ridge Project (Project), located approximately 33 kilometres (km) south of Marble Bar, Western Australia. The Project was approved on 23 February 2018 (EPBC 2017/7861), and subject to 12 conditions, of which four relate directly to the Pilbara leaf-nosed bat (*Rhinonicteris aurantis*, Pilbara form), listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* and *Biodiversity Conservation Act 2016*. The species' has been previously recorded in the Project area and two caves within the Project area are known to provide critical roosting habitat for the species'; CO-CA-01, a permanent diurnal roost and CO-CA-03, a non-permanent breeding roost.

Given the proximity of CO-CA-03 to one of the five open mining pits (Razorback), there is the potential for an adverse impact on Pilbara leaf-nosed bat usage of the cave due to effects from blasting noise, vibration and dust once mining-related activities commence. Accordingly, a Monitoring Strategy was developed in 2020, under Condition 4 of EPBC 2017/7861, to document any changes to the suitability of habitat for the species', namely CO-CA-03 and a water hole CO-WS-14, during and following the completion of mining at Razorback pit. Specifically for CO-CA-03, this includes monitoring for changes to the structural integrity and microclimate of the cave, along with bat activity levels over time (pre-mining, during active mining and post-mining).

In May 2024, Atlas commissioned Biologic Environmental Survey Pty Ltd (Biologic) to monitor the microclimate and Pilbara leaf-nosed bat activity levels at CO-CA-03, once mining-related activities commenced at Razorback pit, in accordance with the Monitoring Strategy. The first blast, load and haul event occurred at Razorback pit on 25 May 2024, representing the commencement of mining operations, approximately 145 metres (m) from CO-CA-03. The current monitoring period includes microclimate and ultrasonic monitoring from 25 May to 31 December 2024 and represents the first 'active' mining monitoring period under the Monitoring Strategy. Methods were consistent with previous monitoring undertaken within the Study Area, in accordance with a Significant Species Management Plan (SSMP), developed in 2017, and the Monitoring Strategy.

During the current monitoring period, the microclimate of CO-CA-03 recorded similar temperatures and relative humidity levels as those recorded prior to mining commencing at Razorback pit. Temperatures were within the preferred range for Pilbara leaf-nosed bat roosting (28-32°C) for 100% of the monitoring period, ranging from 29°C to 31.75°C. Differences between minimum and maximum temperatures were minor despite large variations and generally higher than average ambient temperatures recorded at Marble Bar

over the same period. Similar to pre-mining, relative humidity levels within CO-CA-03 during the current monitoring period fluctuated widely, from 20.16 %to 90.99%, with levels within the preferred range for Pilbara leaf-nosed bat (85-100%) for 66.06% of the current monitoring period. No significant structural changes to CO-CA-03 were identified through visual inspections and laser scans of CO-CA-03,during active mining of Razorback pit.

Pilbara leaf-nosed bat calls were recorded at CO-CA-03 every day (except on three occasions, 8 and 20 January, and 7 December 2024), where data were available. Taking seasonality and microclimate into consideration, activity levels at CO-CA-03 were lower during the current monitoring period than those recorded during all pre-mining monitoring periods from 2018 to 2024. This difference was statistically significant for four pre-mining monitoring periods, between 2019 to 2022. While this could indicate a response to mining activity at Razorback pit, significant differences in bat activity were also recorded between individual monitoring periods where mining had yet to commence. This indicates there is likely some degree of natural fluctuation and/or other influencing factors that are impacting Pilbara leaf-nosed bat activity at CO-CA-03. The cave continued to be used for diurnal roosting during the current monitoring period. There was no evidence of a significant difference between the probability of roosting before mining commenced, and during mining operations at Razorback pit, when seasonality and microclimate were taken into consideration.

In accordance with the Monitoring Strategy, Atlas is committed to employing specific corrective actions when relevant performance objectives, key performance indicators (KPIs) and trigger values relating to CO-CA-03 are recorded. Outcomes against these criteria for the current monitoring period are summarised in ES 1, with one trigger value being exceeded during the current monitoring period. CO-CA-03 maintained the preferred range (85-100%) relative humidity for less than 75% (66.06%) of the current monitoring year. However, as relative humidity levels were within the preferred range for greater than 50% of current monitoring period, the associated KPI was met. As relative humidity levels during the current monitoring period were similar to observed pre-mining levels, within the preferred range for 93.46% of the species' known mating season (April and October), and the probability of roosting for the species was 81.41% of the current monitoring period (when taking season and microclimate into consideration), no further corrective action is required at this time.

Pilbara leaf-nosed bat activity and microclimate at CO-CA-03, in relation to mining-related activity at Razorback pit and regional influences, will continue to be investigated throughout the course of the monitoring program, in accordance with the Monitoring Strategy and SSMP.

ES 1: Summary of outcomes against Monitoring Strategy during current monitoring period

Performance Objective	Key Performance Indicator	Trigger Value	Outcome	Trigger Value Met?	KPI Met?	Corrective Action Required?
No significant damage to CO-CA-03 that would prevent its ongoing use by Pilbara leaf-nosed bats as a non-permanent breeding roost[1]	No major structural damage to cave CO-CA-03 (i.e., collapse of cave entrance or entrance to main chamber, or opening of large fractures which result in loss/change microclimate).	Minor to moderate rock fall within or at the entrance of the cave (i.e. does not impede bat movements/entrance into the cave and rear chamber).	No significant changes to internal structure of cave observed.	No	No	No
		New fractures.	No fractures observed.	No	No	No
	CO-CA-03 is used as a non-permanent breeding roost by Pilbara leaf-nosed bat at least once in the five years following the cessation of mining of Razorback pit.[2]	No record of Pilbara leaf-nosed bat roosting in the first two years following cessation of mining at Razorback pit.	Species continuing to use CO-CA-03 during active mining, including diurnal roosting.	N/A	N/A	N/A
Maintain suitable microclimate for Pilbara leaf-nosed bats within cave COCA-03 during, and for five years following cessation of, mining of Razorback pit	Cave CO-CA-03 maintain 85-100 per cent relative humidity for at least 50% of each year of monitoring.	Cave CO-CA-03 maintain 85-100 per cent relative humidity for less than 75% of a monitoring year	Relative humidity levels within preferred range 66.06% of monitoring year.	**Yes**	No	No. Relative humidity levels are similar to pre-mining levels. When looking at mating period (April to October), relative humidity levels are 81.41% of this period.
	Cave CO-CA-03 maintains a temperature between 28 and 32 degrees celsius for 95% of each year of monitoring.	Cave CO-CA-03 maintains a temperature between 28 and 32 degrees Celsius for less than 98% of a monitoring year	Temperature within preferred range 100% of monitoring year.	No	No	No

[1] Monitored by Altas (visual inspection, laser scan) and Biologic (annual significant species monitoring)

[2] Not measurable during current monitoring period but provides context during active mining monitoring periods for when mining ceases at Razorback pit.

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1 Introduction

1.1 Project Background

Atlas Iron Pty Ltd (Atlas) is developing the Sanjiv Ridge Project (formerly known as the Corunna Downs Project), an iron ore project located in the Pilbara region of Western Australia, 33 kilometres (km) south of Marble Bar (Figure 1.1). The Project involves the development and operation of an open cut iron ore mine and associated mining infrastructure, with iron ore being extracted from five open pits, Sparrow Lake (formerly Split Rock), Shark Gully, Runway North, Runway South and Razorback using conventional drill and blast, load and haul methods (Atlas Iron, 2019).

Several species of significance have been recorded previously within the Project area, including the Pilbara leaf-nosed bat (*Rhinonicteris aurantia* – Pilbara form). The Sanjiv Ridge Project was approved on 23 February 2018 (EPBC 2017/7861), subject to 12 conditions, of which four relate directly to the Pilbara leaf-nosed bat. Two caves within the Project area are known to provide critical roosting habitat for the Pilbara leaf-nosed bat; CO-CA-01, a permanent diurnal roost and CO-CA-03, a non-permanent breeding roost. Exclusion zones (delineated zones within which development will be excluded) were applied to these two significant caves. Through assessment of the geology of the area and Atlas' proposed mining operations, it was deemed appropriate that a 50 m lateral buffer from cave CO-CA-03 was required to maintain the structural integrity of the cave (Atlas Iron, 2018). This lateral buffer translates to a distance of 100 m overland from the entrance of the cave to the closest boundary of the Razorback pit and 68 m from the back of the cave to the nearest point inside the Razorback pit.

Given the proximity of CO-CA-03 to Razorback pit and potential impact on Pilbara leaf-nosed bat from blasting noise, vibration and dust, it is likely the species will temporarily abandon (or relocate) from CO-CA-03 during active mining at Razorback pit. However, should the structural integrity and microclimate of the cave be maintained in a similar condition as recorded prior to mining at Razorback pit, it is expected the species will return following the cessation of mining. Similarly, if a perennial pool, CO-WS-14 (located at the entrance of CO-CA-03) persists and continues to provide an important water source to the species during and following mining at Razorback pit, it is anticipated the species will return to CO-CA-03 upon completion of mining at Razorback pit. During active mining at Razorback pit, the species is likely to continue to use CO-CA-03 as a nocturnal refuge and for foraging, as indicated through monitoring of Atlas' Mt Dove operations (MWH, 2014).

Condition 4 of the EPBC 2017/7861 required the development and implementation of a Monitoring Strategy relating to CO-CA-03 and CO-WS-14. The Monitoring Strategy was developed in July 2020, and implemented upon commencement of mining-related activities

at Razorback pit in May 2024 (Biologic, 2020a). The objective of the Monitoring Strategy is to ensure the long-term viability of CO-CA-03 and CO-WS-14 as habitat for Pilbara leaf-nosed bat, thereby meeting Condition 3 of the EPBC 2017/7861. A number of performance objectives were developed, along with key performance indicators (KPIs) and trigger values to monitor and assess the impact on the suitability of CO-CA-03 and CO-WS-14 as habitat for Pilbara leaf-nosed bats during the active mining phase and following cessation of mining at Razorback pit (Table 1.1). Note that there are no performance objectives, KPIs or trigger values directly related to Pilbara leaf-nosed bat activity at CO-CA-03 during active mining of Razorback pit.

760000
770000
780000
7640000
7630000
7620000
CO-CA-03
CO-WS-14

LEGEND

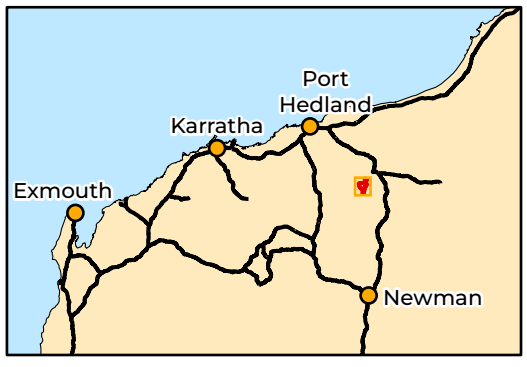
Study Area

Monitoring Site

Scale 1:110,000

0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Transverse Mercator Created: 23/05/2025



Biologic

ATLAS IRON PTY LTD

Sanjiv Ridge Pilbara leaf-nosed bat Razorback Monitoring 2024

Figure 1.1: Study Area and monitoring sites

Table 1.1: Performance objectives and key performance indicators (Monitoring Strategy)

Performance Objective	Key Performance Indicator	Trigger Values
No significant damage to CO-CA-03 that would prevent its ongoing use by Pilbara leaf-nosed bats as a non-permanent breeding roost	• Development and implementation of Razorback Blast Management Plan prior to mining commencing by a qualified specialist, which establishes appropriate blast parameters, blast vibration limits at the cave, blasting procedures and blast vibration monitoring.	• Exceedance of Blast vibration limit. • Non-compliance with Razorback Blast Management Plan.
	• No major structural damage to cave CO-CA-03 (i.e., collapse of cave entrance or entrance to main chamber, or opening of large fractures which result in loss/change microclimate).	• Minor to moderate rock fall within or at the entrance of the cave (i.e. does not impede bat movements/entrance into the cave and rear chamber). • New fractures.
	• CO-CA-03 is used as a non-permanent breeding roost by Pilbara leaf-nosed bat at least once in the five years following the cessation of mining of Razorback Pit.	• No record of Pilbara Leaf-nosed Bat roosting in the first two years following cessation of mining at Razorback pit.
Maintain suitable microclimate for Pilbara leaf-nosed bats within cave COCA-03 during, and for five years following cessation of, mining of Razorback pit	• Cave CO-CA-03 maintain 85-100 per cent relative humidity for at least 50% of each year of monitoring.	• Cave CO-CA-03 maintain 85-100 per cent relative humidity for less than 75% of a monitoring year
	• Cave CO-CA-03 maintains a temperature between 28 and 32 degrees Celsius for 95% of each year of monitoring.	• Cave CO-CA-03 maintains a temperature between 28 and 32 degrees Celsius for less than 98% of a monitoring year
Persistence of CO-WS-14 during, and continuously for three consecutive years following the cessation of, mining of Razorback pit	• CO-WS-14 continuously contains water during, and for three consecutive years following the cessation of, mining of Razorback pit. • No anthropogenic supplementation of CO-WS-14 water level.	• Water level drops below 320.77 mRL (or 320.17 mRL on staff gauge) – equates to 95% of the minimum baseline reading.
Maintain suitable water quality for Pilbara leaf-nosed bats within pool COWS-14 during, and for three consecutive years following cessation of, mining of Razorback pit	• Development and implementation of a specific Razorback Hydrocarbon (and chemical) Spill Management Procedure prior to mining of the Razorback pit commencing. • Exceedance of acceptable Naphthalene levels (in accordance with ANZECC (2000) 95% GVs.	• Non-compliance with Razorback Hydrocarbon (and chemical) Spill Management Procedure. • Exceedance of acceptable Naphthalene levels (in accordance with ANZECC (2000) 99% GVs.
	• Water quality of pool CO-WS-14 shall not exceed site-specific GV (SSGV's) (Appendix B).	• Exceedance of 80th percentile SSGVs (Appendix B) over two consecutive quarterly monitoring events.

Adapted from Table 4.1 in Biologic (2020a).

1.2 Survey Scope and Objectives

Atlas commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake data analysis during the first monitoring period of CO-CA-03 during active mining at Razorback pit, in accordance with the Monitoring Strategy (Biologic, 2020a). Microclimate and ultrasonic data collected in accordance with the Significant Species Management Plan – Corunna Downs (SSMP) was utilised to conduct this analysis (Atlas Iron, 2017). The overarching objective was to assess changes in the suitability of CO-CA-03 as habitat for Pilbara leaf-nosed bat, in accordance with condition 4 of EPBC Approval Decision 2017/7861, during and following the cessation of mining at Razorback pit.

Additionally, bat activity will be discussed in relation to CO-CA-03 microclimate, mining activity at Razorback pit, seasonal fluctuations, and environmental variables (such as rainfall). This analysis will assist in assessing usage of CO-CA-03 by Pilbara leaf-nosed bats following cessation of mining at Razorback pit. Specific comment will be made on relevant performance objectives and KPIs outlined in the Monitoring Strategy (Biologic, 2020a). Those relating to CO-WS-14 are beyond the scope of the current analysis and have been investigated by Atlas. Therefore, findings relating to CO-WS-14, are not reported on further here, unless to provide context, where relevant. Specifically, this report:

- summarises the analysis of microclimate and ultrasonic data at CO-CA-03;
- compares the current monitoring period microclimate and ultrasonic data at CO-CA-03 with baseline (pre-mining) levels;
- assesses performance against each of the relevant Monitoring Strategy key performance objectives, indicators and trigger values;
- details any corrective actions undertaken or considered (or reasoning as to why any corrective actions were not undertaken or considered); and
- makes any necessary recommendations.

1.3 Compliance

Monitoring was carried out in consideration of the following guidelines and recommendations developed by the relevant state and federal regulatory bodies, as well as the Monitoring Strategy:

- Atlas Iron (2017) Significant Species Management Plan Corunna Downs;
- Biologic (2020a) – Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy;
- Bat Call (2021) A review of Pilbara leaf-nosed bat ecology, threats and survey requirements;
- DEWHA (2010) EPBC Act survey guidelines for Australia's threatened bats; and
- EPA (2020) Technical guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment.

1.4 Species of Interest: Pilbara leaf-nosed bat (*Rhinonicteris aurantia*)

The Pilbara leaf-nosed bat is listed as Vulnerable under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), and the Western Australian *Biodiversity Conservation Act 2016* (BC Act). The Pilbara leaf-nosed bat represents a population of the orange leaf-nosed bat that is geographically isolated from tropical populations of the species by 400 km of the Great Sandy Desert (Armstrong, 2001). It is restricted to the Pilbara region of Western Australia, where it is thought to occur as a single interbreeding population comprising multiple colonies (TSSC, 2016). At least 17 confirmed diurnal roosts (including maternity roosts) and 31 unconfirmed roosts are known to occur in the Pilbara region (Bat Call, 2021), although unpublished data suggests these numbers underestimate the number of roosts present across the Pilbara.

Pilbara leaf-nosed bats typically roost in undisturbed caves, deep fissures or abandoned mine shafts (Armstrong, 2000, 2001). The species' limited ability to conserve heat and water (Baudinette *et al.*, 2000) means they are believed to require warm (28-32°C) and very humid (85-100%) roost sites to persist in arid and semi-arid climates (Armstrong, 2001; Churchill, 1991). Roost sites with such attributes are relatively uncommon in the Pilbara and the limiting factor of the species' distribution (Armstrong, 2001). During the dry season (April to October), individuals are believed to aggregate in roosts that provide a suitably warm, humid microclimate (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). While in the wet season (November to March), when conditions are generally wetter and more humid, individuals typically disperse, roosting in seasonally suitable features (Armstrong, 2000, 2001; Bullen & McKenzie, 2011).

The importance of a roost site to Pilbara leaf-nosed bat can be categorised according to its potential nature of use by the species. The Monitoring Strategy classified caves used by Pilbara leaf-nosed bats based on the categories provided by TSSC (2016). Since then, updated classifications have been provided in *A review of Pilbara Leaf-nosed bat ecology, threats and survey requirements* (Bat Call, 2021). This followed a classification system defined by Bat Call (2021) in a report prepared for the Australian Government Department of Agriculture, Water and the Environment (DAWE). Most roost types are considered critical habitat essential for the long-term survival of the species (Table 1.2).

Foraging sites surrounding known or suspected roosts can be critical to the survival of the species as the species forages within the vicinity of roost caves and more broadly along waterbodies with suitable fringing vegetation supporting prey species (TSSC, 2016). The species is predicted to travel up to 20 km from roost caves during nightly foraging (Cramer *et al.*, 2016) in the dry season and up to 50 km during the wet season (Bullen, 2013). The importance of potential foraging habitat can be categorised following a classification system defined by (Bat Call, 2021) (Table 1.3).

Table 1.2: Roost categories for Pilbara leaf-nosed bat

Category	Description	Typical Features	Importance to Pilbara leaf-nosed bat
Category 1	Maternity roost sites with year-round occupancy (proven presence of young).	Deep, dark caves with at least one roosting chamber behind a narrow entrance or in-cave constriction, a ceiling over 1.5 m in height, steady microclimate and high humidity, within flying range of a permanent water source.	Critical habitat essential for the long-term survival of the species.
Category 2	Diurnal roost sites with regular occupancy (no proven presence of young).	These sites are similar to Category 1 sites but are usually less complex (e.g. may only contain a single chamber), have a more variable microclimate, and/or are located in less productive areas which may only periodically attract Pilbara leaf-nosed bats.	Critical habitat essential for the long-term survival of the species.
Category 3	Diurnal roost sites with occasional occupancy.	These sites are similar to Category 1 and 2 sites but are usually less complex (e.g. may only contain a single chamber), have a more variable microclimate, and/or are located in less productive areas which may only periodically attract Pilbara leaf-nosed bats.	Critical habitat essential for the long-term survival of the species.
Category 4	Nocturnal roost sites with opportunistic usage.	Caves and deep overhangs which may be visited during the night during foraging activity, but are unlikely to support diurnal roosting (e.g. roosting locations are exposed or exhibit low levels of humidity)	Not considered critical habitat for Pilbara leaf-nosed bat, but still important for the persistence of the species within a local area.

Adapted from information presented by Bat Call (2021).

Table 1.3: Foraging habitat categories for Pilbara leaf-nosed bat

Habitat Rating	Description	Typical Features
0 (Poor)	Unlikely to be used by the species.	Open ground with no vegetation cover.
1 (Low)	Unlikely to be used for foraging but may be traversed during dispersal.	Open plains and low hills with simple vegetation structure (e.g. one or two-layer with no trees); or minor ridgelines, gullies and mesas with minimal caves and overhangs and sparse vegetation cover.
2 (Moderate)	May be used occasionally for foraging.	Plains and low hills with simple vegetation structure (e.g. one or two-layer with no trees) and at least one ephemeral water source nearby; or ridgelines, gullies and mesas with caves and overhangs and at least one ephemeral water source nearby.
3 (High)	Likely to be used for foraging if located within flying range of a diurnal roost.	Plains and low hills with complex vegetation structure (e.g. three-layer) and at least one ephemeral water source nearby; or ridgelines, gullies, mesas and gorges with complex vegetation structure, caves and overhangs and at least one ephemeral water source nearby.
4 (Very high)	Very likely to be used for foraging and/or as a source of drinking water, if located within flying range of a diurnal roost.	Plains and low hills with complex vegetation structure (e.g. three-layer) and semi-permanent or permanent surface water; or ridgelines, gullies, mesas and gorges with complex vegetation structure, caves and overhangs, and semi-permanent or permanent surface water.
5 (Outside diurnal roost)	Areas outside permanently occupied roosts where Pilbara leaf-nosed bats are present nightly.	n/a

Adapted from information presented by Bat Call (2021).

1.5 Pilbara leaf-nosed bat Habitat

1.5.1 Cave CO-CA-03

Cave CO-CA-03 (Plate 1.1) was first discovered in 2014 (MWH, 2016). The cave is situated in geological layer defined as “very competent chert” (ACG, 2017), at the bottom of a gorge within Rocky Ridge and Gorge habitat (MWH, 2016). It is surrounded “by multiple water seepages and a large spring system that feeds into a large water pool” (MWH, 2016) (CO-WS-14) approximately 5 m downslope from the mouth of the cave. The cave comprises a large/ deep entrance and one major internal chamber. The entrance faces north-east and is triangular in shape measuring 5 metres (m) high by 18 m wide. The entrance extends 30 m backward toward a constriction (entrance to the main chamber) measuring 2 m high by 2 m wide. The chamber measures 4 m high by 4 m wide by 10 m deep (adapted from (Terra Rosa, 2017). Two water seeps have been noted within the second chamber along the western wall (ACG, 2017; MWH, 2016), the presence of which persist independent of season (Stantec, 2018). The presence of permanent water inside and immediately surrounding CO-CA-03 may contribute to a suitable microclimate within the cave.

Plate 1.1: Entrance of CO-CA-03 (Biologic, 2024)

1.5.1.1 Species Use of Cave

Pilbara leaf-nosed bats have previously been recorded roosting at CO-CA-03 between 2014 and 2024 (Bat Call, 2018; Biologic, 2019a; MWH, 2016, 2017, 2018a, 2018b; Outback Ecology, 2014). Due to the relative locations of CO-CA-03 and CO-WS-14, Pilbara leaf-nosed bat activity recorded at CO-CA-03 is inferred to represent activity for both sites. An in-depth analysis of Pilbara leaf-nosed bat activity at CO-CA-03 in 2019/2020, prior to mining activities commencing at the Project, indicates that the species was recorded on all but one recording night between April 2019 and April 2020, ranging from 64 calls (18 January 2020) to 56,699 calls (12 July 2019), and averaging 7,033 (± 619) calls per recording night (Biologic, 2020b). Roosting was indicated on 47.00% of recording nights during this monitoring period, of which 91.30% of roosting events occurred between April and October 2019 (Biologic, 2020b). Between October 2019 and the April 2020, the timing of most of these calls suggested that individuals were roosting for 8.40% of recording nights, with the majority of calls suggesting the animals were in flight, possibly foraging, and roosting at another location. Activity levels and timing of roosting observed over this monitoring period coincides with the species mating period and therefore may indicate such activities at the cave. The pattern of usage at CO-CA-03 is consistent with a 'non-permanent breeding roost', Category 2, as defined by Bat Call (2021) in Section 1.4.

Between April 2019 and April 2020, the maximum ambient temperature, maximum cave temperature, range in cave relative humidity and percentage moon illumination were not significant variables influencing roosting status at CO-CA-03 (Biologic, 2020b). However, roosting and peaks in activity levels typically occurred when conditions were more favourable (i.e. temperature and relative humidity within the preferred ranges) suggesting that these conditions are preferred for roosting. Activity levels and roosting were influenced by the date of sampling, exclusive to the other variables tested. This indicates that roosting was driven by untested variables related to timing and/ or a behavioural response (e.g. reproductive cues). Activity levels were also significantly influenced by fluctuations in relative humidity within CO-CA-03. Based on these observations, it can be inferred that activity levels and the probability of roosting at CO-CA-03 increases during the mating and gestation period prior to parturition when cave relative humidity is high and relatively stable.

1.5.2 Waterhole CO-WS-14

1.5.2.1 Overview

In 2014, waterhole CO-WS-14 was discovered at the same time as cave CO-CA-03 (MWH, 2016). CO-WS-14 is a 5 m wide by 5 m long by ~0.9-1 m deep perennial pool (SRK, 2019; Stantec, 2018), located approximately 5 m downslope from the entrance of CO-CA-03. The waterhole has been observed to contain water since its' discovery in 2014. Bat Call (2021) defines "gorges with complex vegetation structure, caves and overhangs, and semi-permanent or

permanent surface water" as a Category 4 foraging habitat and drinking water source for Pilbara leaf-nosed bats. CO-WS-14 is considered a Category 4 foraging habitat and water source of very high significance to the species (MWH, 2016), due to its location immediately adjacent to Category 2 diurnal roost CO-CA-03 (see Section 1.4). Due to the relative locations of CO-CA-03 and CO-WS-14, Pilbara leaf-nosed bat activity recorded at CO-CA-03 is inferred to represent activity for both sites.

A hydrogeological investigation of CO-WS-14 was undertaken between October 2017 and March 2018 (Stantec, 2018). It was determined that CO-WS-14 is likely groundwater dependent, with water levels marginally fluctuating by 0.01 m, reflecting the recession observed within the water table (SRK, 2019; Stantec, 2018). The waterhole is likely replenished during rainfall events, with additional replenishment from surface water overland flow over a ledge located directly above the waterhole. This water flowing over the ledge has been observed to flow independent of rainfall events and seasonality. Therefore, the seepage is likely fed by a combination of groundwater discharge and unsaturated flow (Stantec, 2018). Biologic (2020b) undertook a 12 month study of CO-WS-14 to provide an indication of baseline levels and natural fluctuations in pool water quality and levels, to assist in assessing performance objectives and indicators, under Conditions in EPBC 2017/7861. These results are discussed further in Biologic (2020b) and therefore not discussed in further detail here.

Plate 1.2: CO-WS-14. Photo taken in 2018 (Biologic, 2020b)

2 Methods

2.1 Survey Licensing

The field survey which collected microclimate and ultrasonic data for the current analysis was conducted under a Department of Biodiversity, Conservation and Attraction's (DBCA) Regulation 27 "Fauna Taking (Biological Assessment)" licence, issued to Chris Knuckey (licence number BA27000450-2b). Under Section 40 of the BC Act, threatened species sampling was completed under a DBCA "Authorisation to Take or Disturb Threatened Species" issued to Chris Knuckey (authorisation number TFA 2021-0065-2).

The survey was conducted under the *Animal Welfare Act 2002* Licence to Use Animals for Scientific Purposes (License No. U244/2022-2024), administered through the Department of Primary Industries and Regional Development (DPIRD). This licence is enabled through Biologic's chosen Animal Ethics Committee (AEC), Murdoch University, under permit RW3354/21.

2.2 Timing

The Pilbara bioregion has a semi-desert to tropical climate, with rainfall occurring sporadically throughout the year, although mostly during summer (Thackway & Cresswell, 1995). Summer rainfall is usually the result of tropical storms in the north or tropical cyclones that impact upon the coast and move inland (Leighton, 2004). Winter rainfall is generally lighter and is the result of cold fronts moving north easterly across the state (Leighton, 2004). The average annual rainfall for the Pilbara bioregion ranges from 200-350 millimetres (mm), although there are significant fluctuations between years, with some locations receiving up to 1,200 mm in some years (McKenzie *et al.*, 2009).

The first 'active mining' monitoring period under the Monitoring Strategy commenced when mining-related activity (first blast, load and haul) at Razorback pit commenced, on 25 May 2024, and continued until 31 December 2024. Subsequent active mining and 'post-mining' monitoring periods in relation to the Monitoring Strategy will cover 1 January to 31 December, until such time as five years have passed since mining activities ceased (Biologic, 2020a).

According to the Bureau of Meteorology (BoM) weather station (approximately 14 km north-east of the Project area), average monthly temperatures recorded at Marble Bar across 12 months (January to December 2024 were 0.2°C to 4.4°C warmer than long-term conditions for both minimum (10 out of 12 months) and maximum (nine out of 12 months) temperatures (Figure 2.1) (BoM, 2024). Between January and December 2024, Marble Bar station recorded 457.0 millimetres (mm) of rainfall, 74.4 mm higher than the long-term average rainfall for the same period (382.6 mm) and 48.2 mm higher rainfall than the previous 12 months (408.8 mm) (BoM, 2024) (Figure 2.1). Considerably higher than average rainfall occurred in March,

November and December 2024, while lower than average rainfall in the overall six months from January to June, specifically January (37.6 mm, compared to long-term average of 107.3 mm) and February 2024 (39.6 mm, compared to long-term average of 82.7 mm) (Figure 2.1).

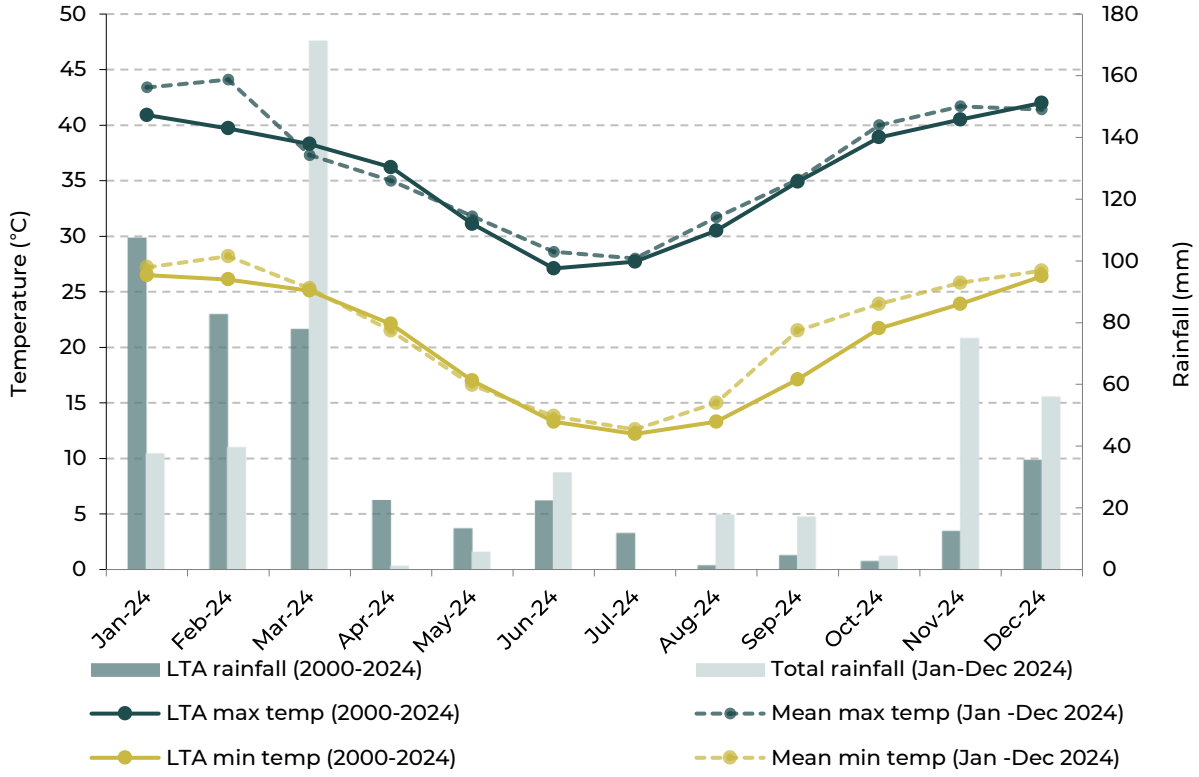


Figure 2.1: Climate data recorded at BOM Marble Bar station

Source: BoM (2024).

2.3 Personnel

Microclimate and ultrasonic monitoring data collection was undertaken by Biologic personnel, with long-term monitoring equipment at CO-CA-03 maintained as required and data collected on a three-monthly basis by Atlas or Biologic personnel. A visual cave inspection of CO-CA-03 was conducted by Biologic staff once during the annual significant species monitoring program in July 2024. Atlas were responsible for collecting and reporting on detailed structural information on CO-CA-03 throughout the current monitoring period, through visual inspections and laser scans.

2.4 Monitoring Sites

In accordance with the Monitoring Strategy, there are two monitoring sites, non-permanent diurnal roost CO-CA-03 and perennial waterhole CO-WS-14, located within the Stage 1 indicative disturbance envelope (Biologic, 2020a) (Figure 1.1; Table 2.1). CO-WS-14 is included for context, although monitoring results for CO-WS-14 will not be discussed in detail in this report.

Table 2.1: Summary of monitoring sites

Site	Site Type	Location		Roost Category[1]	Description	Water Seepage	Water Presence
		Latitude	Longitude				
CO-CA-03	Cave	-21.4678	119.6711	Category 2: non-permanent maternity roost	Cave located at the bottom of a major gorge in rocky ridge and gorge habitat. The cave is located next to water seepage which feeds a water source at the cave entrance. The cave is characterised by two main chambers connected by a constriction, with Pilbara leaf-nosed bats observed roosting in rear chamber. Water seepage has been observed intermittently from the cave walls.	Yes	N/A
CO-WS-14	Foraging/drinking location	-21.4677	119.6712	-	Perennial water source in rocky ridge and gorge habitat. Likely groundwater dependant.	Yes	Yes

[1]Based on the classification system developed by Bat Call (2021) (refer to Section 1.4).

2.5 Monitoring Schedule

The Monitoring Strategy came into effect on 25 May 2024, with the commencement of mining-related activity at Razorback pit and will continue for up to five years following the cessation of mining at Razorback pit. A summary of the monitoring schedule is outlined in Table 2.2, with Biologic responsible for the collection and analysis of microclimate and ultrasonic monitoring, in accordance with the Monitoring Strategy and SSMP (Atlas Iron, 2017; Biologic, 2020a). To adequately capture the species' breeding season, quarterly monitoring will occur in January, April, July and October of each year.

Table 2.2: Monitoring schedule

Monitoring	Frequency	During Mining	Post Mining				
			Year 1	Year 2	Year 3	Year 4	Year 5
Visual cave inspection[1]	Monthly during mining, annually thereafter	Every month	Between April and September				
Laser scan[2]	Annually	Between October and March	Between October and March	-	-	-	-
Pool monitoring – water levels[2]	Monthly during mining, quarterly for the first year post-mining, annually thereafter	Every month	January, April, July and October	October	October	-	-
Pool monitoring – water quality[2]	Quarterly during mining and for the first year postmining, annually thereafter	January, April, July and October	January, April, July and October	October	October	-	-
Microclimate monitoring[3]	Continuous collection of data with quarterly analysis during mining and annual analysis thereafter	January, April, July and October	Between April and March				
Ultrasonic monitoring[3]	Annually in conjunction with SSMP requirements	Between April and September	Between April and September				

[1] Monitoring undertaken by Biologic and/or Atlas

[2] Monitoring and reporting undertaken by Atlas only

[3] Monitoring undertaken by Biologic only

2.6 Survey Methods

2.6.1 Microclimate

Regular monitoring of the temperature and relative humidity of CO-CA-03 has been undertaken since 2018. This includes prior to the commencement of mining within the Project area, and since mining-related activities commenced in 2020, as part of the SSMP (Atlas Iron, 2017; Biologic, 2020b, 2022b, 2023, 2024). In accordance with the Monitoring Strategy, data collected prior to the commencement of mining at Razorback pit (21 April 2018 to 24 May 2024) are considered baseline (pre-mining). Microclimate data collected from 25 May 2024, when blast, load and haul activities at Razorback pit commenced, to 31 December 2024, were considered as part of the first active mining monitoring period, and were assessed against pre-mining data (Biologic, 2020a).

The microclimate (temperature and relative humidity) of CO-CA-03 were collected via a logger that records microclimate continuously in accordance with methodology outlined in the SSMP (Atlas Iron, 2017). The long-term logger consisted of an EWS system installed in the same location as the microclimate logger deployed during the 2019/2020 baseline review study (Biologic, 2020b). The EWS system consists of a HMP60 Vaisala Intercap humidity and temperature probe installed inside the cave and attached via a cable to an EWS Switch Data Logger (EWS Switch) located outside the cave. An EWS Switch is a solar-powered multi-communications transmitter that utilises either (and can be switched between) satellite or cellular connection for transmission of microclimate data to a web portal, allowing data to be accessed remotely.

The microclimate logger is set to record temperature (°C) and relative humidity (RH, %) every three hours at set times, i.e. at 12.00am, 3.00am, 6.00am, 9.00am, 12.00pm, 3.00pm, 6.00pm and 9.00pm. Microclimate data was collected for the entirety of the current monitoring period, a total of 221 sampling days. Daily minimum and maximum temperature and relative humidity values were plotted against the preferred ranges (preferred microclimatic conditions for Pilbara leaf-nosed bat roosting); 28–32°C for temperature and 85–100% for relative humidity.

Temperature and relative humidity data recorded at CO-CA-03 throughout the current monitoring period were statistically compared to pre-mining values recorded during previous monitoring events, to ascertain whether there have been any significant changes in microclimate since mining at Razorback pit commenced (Section 2.7.1).

2.6.2 Ultrasonic

Ultrasonic data has been collected at CO-CA-03 since 2014, and continuously since 2018 to ascertain Pilbara leaf-nosed bat activity levels. This includes prior to mining and following commencement of mining within the Project area in 2020, as part of the SSMP (Atlas Iron, 2017; Biologic, 2020b, 2022b, 2023, 2024). Data collected prior to the commencement of mining-related activities at Razorback pit (21 April 2018 to 24 May 2024) are considered baseline (pre-mining). Ultrasonic data collected from 25 May 2024, when active mining commenced at Razorback pit, to 31 December 2024 were assessed against pre-mining data, in accordance with the Monitoring Strategy (Biologic, 2020a).

A solar powered SongMeter ultrasonic recorder (SM4BATs; Wildlife Acoustics, USA) was used to record Pilbara leaf-nosed bat calls, to help describe levels of bat activity at CO-CA-03. The SM unit was fitted with an external, directional SMX-US ultrasonic microphone and positioned to provide an unobstructed 'line of sight' between the microphone and the likely bat flyway. The unit is positioned in the same location as the SM unit during the 2019/2020 baseline review and has been collecting data continuously since deployment in 2020. Monitoring was undertaken in accordance with the SSMP (Atlas Iron, 2017). The SM unit was preconfigured to activate at astronomical sunset each day and deactivate at astronomical sunrise the following morning. Audio settings which were configured to define the range of volume and frequencies being recorded were selected following the manufacturer's recommendations for bat detection (Wildlife Acoustics, 2017).

Information on bat activity will supplement the microclimate monitoring so as to better inform Pilbara leaf-nosed bat usage of CO-CA-03 following the cessation of mining at Razorback pit. Bat activity was not monitored for the entirety of the continuous monitoring period, as ultrasonic data were not available 23 July to 7 August, and 9 to 26 August 2024 (34 nights) due to technical errors with the SD card. A total of 187 recording nights were sampled during the current monitoring period.

At CO-CA-03, Pilbara leaf-nosed bat activity (estimated mean number of calls and probability of roosting per recording night) during the current monitoring period were statistically compared against pre-mining levels to determine whether the species' usage of the cave has changed since mining at Razorback pit commenced (Section 2.7.2). Additionally, bat activity levels (including estimated mean number of calls per recording night and probability of roosting) and CO-CA-03 microclimate (using temperature) were statistically investigated to determine whether there was any significant correlations between the two factors.

2.6.3 Supplementary Information Provided by Atlas

2.6.3.1 Visual cave inspections

A visual inspection of CO-CA-03 was conducted by Atlas in April 2024, one month ahead of mining commencing at Razorback pit, to inform the current baseline condition of the cave structure (Atlas, 2025 pers. comm). Visual cave inspections were conducted by Atlas during the current active mining monitoring period at Razorback pit in order to compare the physical features of CO-CA-03 against the cave's structure (adapted from Terra Rosa (2017) prior to mining activities commencing. Findings from these comparisons are not discussed here, as they are beyond the scope of this report.

Visual cave inspections were supplemented by blast monitoring conducted in accordance with the Razorback Blast Management Plan (in prep.), which includes geotechnical assessment of changes in cave condition during blasting activities. The results of these inspections have been addressed separately to the current report, although any changes in cave structure observed during inspections will be discussed as they relate to bat activity and microclimate at CO-CA-03 during the current monitoring period.

2.6.3.2 Laser scans

A suitably qualified professional was commissioned by Atlas to undertake a laser scan of cave CO-CA-03 in March 2025 (outside species' mating season to avoid disturbance) during active mining of Razorback pit (Atlas, 2025). The results of the laser scan were compared to the baseline scan undertaken by Terra Rosa (2017) to identify whether there has been any change in pre-mining condition/structure of the cave. A summary of the laser scan report will be discussed in this report, in the context of any structural changes that may have impacted microclimate or Pilbara leaf-nosed bat activity levels at CO-CA-03 during the current monitoring period.

2.6.3.3 Pool monitoring – water levels and quality

Routine monitoring of waterhole CO-WS-14 was undertaken by Atlas in accordance with the frequency and schedule in the Monitoring Strategy, in order to track changes in water quantity and quality. A water logger was deployed in the water body to measure water levels, water height, depth, temperature, pressure, water colour and water flow as well as temperature, pH and conductivity. Water quality samples were collected using best practice procedures to minimise any potential for contamination (Ahlers *et al.*, 1990; Batley, 1989; Madrid & Zayas, 2007). Undisturbed water samples were taken for laboratory analyses of ionic composition, nutrients, dissolved metals and total suspended solids and Polycyclic Aromatic Hydrocarbons (PAH) The data collected during each monitoring event was compared to the 2019/2020 baseline review (Biologic, 2020b) to determine any significant changes to the

water quality at CO-WS-14 that may impact its' suitability as habitat for the Pilbara leaf-nosed bat. Results of water monitoring at CO-WS-14 will be covered in a separate report by Atlas and are therefore not discussed further in this report.

2.6.4 Opportunistic Observations

During the deployment, maintenance, and retrieval of monitoring equipment and data, primary (i.e. direct observation of species) or secondary (e.g. scats, remains etc.) evidence of Pilbara leaf-nosed bat presence at CO-CA-03. Additionally, evidence of the ghost bat (*Macroderma gigas*) at CO-CA-03, a known predator of the Pilbara leaf-nosed bat (Bat Call, 2021), were also documented, where information was available.

2.7 Data Analysis

2.7.1 Microclimate Analysis

Summary statistics (including minimum and maximum daily readings) of microclimate at CO-CA-03 during the pre-mining monitoring periods and current ('active mining') monitoring period considered all temperature and relative humidity readings recorded each sampling day (i.e. between 12am and 9pm).

2.7.2 Ultrasonic Analysis

All recordings were analysed by Robert Bullen of Bat Call WA using standardised bat call detection techniques. Raw files were first scanned for Pilbara leaf-nosed bat calls using Kaleidoscope software (Wildlife Acoustics, USA), then reviewed for significant times and call numbers using Cool Edit software (Adobe, USA). The total number of calls and the time of the first and last call for each sampling night were recorded. During analysis, a recording night was considered from astronomical sunset to sunrise the following day. Because any individual is likely to emit multiple calls at any site during any night, the total number of calls was treated as a measure of 'activity' rather than providing a total number of individuals present. While activity is likely to reflect individuals present, the exact correlation between the two is likely to vary per night (e.g. other animals present may change the time spend at the cave).

Diurnal roosting at CO-CA-03 was indicated if one of the following criteria were satisfied: (1) if the last call during the previous recording night occurred after dawn, (2) if the first call during the current monitoring night was within ≤10 minutes of dusk or (3) if the last call during the previous recording night occurred ≤10 minutes before dawn or first call during the current monitoring night was within ≤30 minutes of dusk.

2.7.3 Statistical Analysis

The relationship between cave temperature and relative humidity and their correlation in time was investigated using a cross-correlation function (CCF). For meaningful cross-correlation, it was necessary first to transform both series to remove dependencies. Cross-correlation was performed on the residuals of the temperature ARIMA (autoregressive moving average model) applied to both series, with the R package *forecast* (Hyndman *et al.*, 2025), a method known as *prewhitening*

The influence of microclimate at CO-CA-03 and time of year (seasonality) on Pilbara leaf-nosed bat activity was evaluated using a generalized additive model (GAM) with *mgcv* package (Wood, 2011), with a negative binomial distribution and log-link function. The high association between temperature and relative humidity at CO-CA-03 means that one partly describes the other (Section 3.2). Consequently, if both temperature and relative humidity were included in the same model when investigating the influence of microclimate on bat activity, their separate effects on calls would not be possible to isolate. Therefore, further statistical investigation considered temperature only. Observations by month and year were obtained by averaging daytime temperature records (6am to 6pm) and matching to the summed call data. Call data spanned most months of each year, introducing a strong seasonal component to the series and so smoothing functions were used to fit the non-linear relationships of month (cubic regression spline) and temperature to calls, with a fixed effect for mining-year and an offset for the log number of sampling nights per month. Mining-year described the portion of the year in pre-mining (baseline) and from when mining commenced (25 May 2024), giving the categories “base-2018”, “base-2019”, “base-2020”, “base-2021”, “base-2022”, “base-2023”, “base-2024”, and “mining-2024”. Model diagnostics were performed using the R package *gratia* (Simpson, 2024).

The influence of temperature at CO-CA-03 and time of year (seasonality) on probability of roosting by Pilbara leaf-nosed bats was evaluated using a generalized additive model (GAM) with *mgcv* package (Wood, 2011) with a binomial distribution and log-link function. Overdispersion was detected and so standard errors were corrected using a quasi-GAM model where the variance was given by the mean multiplied by the dispersion parameter. Information on roosting spanned most months of each year which introduced a strong seasonal component to the data. Monthly measurements by year were obtained by averaging temperature records from 6am to 6pm and matching to the probability of roosting that same night. Mining-year described the portion of the year in pre-mining (baseline) from when mining commenced at Razorback pit, giving the categories “base-2018”, “base-2019”, “base-2020”, “base-2021”, “base-2022”, “base-2023”, “base-2024”, and “mining-2024”. Smoothing functions were used to fit the non-linear relationships of month

(cubic regression spline) and temperature to proportion of roosting nights, with a fixed effect for mining-year. Model diagnostics were performed using the R package *gratia* (Simpson, 2024).

Estimated mean number of calls were calculated with the R package 'emmeans' (Lenth, 2024) and percentage differences from pre-mining (baseline) levels were calculated by performing contrasts within the emmeans package, at the 0.05 level.

3 Results and Discussion

3.1 Habitat and Disturbance Monitoring

Mining-related activities commenced at Sanjiv Ridge Project in 2020, with previous disturbance comprising of small areas of clearing for exploration and historical mining activities, and general degradation due to pastoralism (Biologic, 2019b, 2019c). In 2020, vegetation clearing for mine development, and construction commenced, and mining-related activities, including ore extraction, commenced at Runway South and Runway North pits in 2021 (Biologic, 2021, 2022b, 2022c) (Table 3.1). Split Rock pit was developed in 2022 and vegetation clearing associated with Razorback pit commenced in December 2023, with first blast occurring on 25 May 2024 (Table 3.1) (Biologic, 2022b, 2023, 2024). This date is considered the first day of active mining in the context of the Monitoring Strategy.

Mining-related activities continued throughout the current monitoring period at Runway North pit and Sparrow Lake (formerly Split Rock) pit, with activities ceasing at Runway South pit in March 2024 and Razorback pit on 22 July 2024 (Biologic, 2022b, 2023, 2024, in prep.). There were no further active mining (blasting, load and haul) activities at Razorback pit from 23 July 2024 to 31 December 2024 of the current monitoring period. The distance of mining-related activity and potential impacts of activity on the structure of CO-CA-03 was previously investigated during the Pilbara leaf-nosed bat annual significant species survey in July 2024, as well as previous years, in accordance with the SSMP (Atlas Iron, 2017; Biologic, 2022b, 2023, 2024, in prep.) (Table 3.1). The nature of mining-related activities occurring within the Study Area and proximal to CO-CA-03 during the current monitoring period included:

- blasting and ore-production activities commenced at Razorback pit on 25 May 2024, 120 m south-west of CO-CA-03. Active mining ceased on 22 July 2024;
- ongoing development of Sparrow Lake pit, including drilling, blasting and clearing, with the closest disturbance 450 m west of CO-CA-03; and
- use of haul roads and access tracks throughout the Study Area, with one haul road located approximately 480 m west of CO-CA-03.

Table 3.1: History of disturbance in vicinity of CO-CA-03 (Biologic, 2021, 2022a, 2023, 2024)

Record of Disturbance					
2017-2019	2020	2021	2022	2023	2024
None recorded.	Wildfire	Exploration activities undertaken within ~121 m to east. Haul road developed within ~480 m to west.	Pit (Split Rock) developed within ~450m to west. Haul road activities continued within ~480 m to west.	No additional disturbances recorded. Ore production activities associated with Split Rock pit continued within ~450m to west. Haul road activities continued within ~480 m to west. Vegetation clearing associated with Razorback pit commenced in December 2023, ~120 m to south-west.	Blasting, ore-production, and hauling associated with Razorback pit commenced on 25 May 2024 and ceased on 22 July 2024. Ore production associated with Sparrow Lake (formerly Spilt Rock) pit continued within ~450m to west. Haul road activities continued within ~480 m to west.

3.1.1 CO-CA-03 Cave Structure

During the most recent annual significant species monitoring survey undertaken by Biologic in July 2024, no additional physical disturbances (since the previous surveys) were noted at CO-CA-03 (Appendix A) (Biologic, 2021, 2022b, 2022c, 2023, 2024). Visual inspections of CO-CA-03 by Atlas in March, April, August, September, November and December 2024, show no signs of recent or new loose rocks, fresh rock falls or changes to rockface/structure (Atlas, pers. comms., 2025). A recent LiDAR scan of the internal cave structure of CO-CA-03 in March 2025 (Atlas, 2025) shows no movement or disturbance to the internal structure of the cave since the original baseline scan (Terra Rosa, 2017).

3.2 Microclimate

For five to six months of the eight months of the current monitoring period, warmer than average ambient minimum and maximum temperatures were recorded at Marble Bar (BoM, 2024). Daily ambient temperatures fluctuated between 6.9°C minimum and 45.9°C maximum over the current monitoring period (Section 2.2; Figure 2.1). Despite the warmer and highly variable ambient temperatures, temperatures inside CO-CA-03 were relatively stable during the current monitoring period, ranging between 29.75°C (minimum) and 31.75°C (maximum) (Table 3.2;

Figure 3.1). There were minimal daily (and slight seasonal) fluctuations in cave temperatures compared to ambient temperatures outside the cave. Temperatures within CO-CA-03 were consistent with the range which supports roosting by Pilbara leaf-nosed bats (i.e. preferred temperature range of 28-32°C; Armstrong, 2001) for 100% of the monitoring period, indeed for the entirety of 1 January to 31 December 2024 (Table 3.2;

Figure 3.1).

Temperatures recorded at CO-CA-03 during the current monitoring period are similar to temperatures previously recorded between April 2018 and May 2024, prior to mining commencing at Razorback pit (Atlas Iron, 2017; Biologic, 2020b, 2022b, 2023, 2024) (Table 3.2). During the current monitoring period, temperatures were warmest in May, June and July, and coolest in November and December 2024.

Table 3.2: Temporal comparison of temperature data recorded inside CO-CA-03

Summary Statistics[1]	Pre-mining								Active
	20 April to 15 July 2018	1 January to 31 December 2019	17 April 2019 to 24 April 2020 (Biologic, 2020b)	1 January to 31 December 2020 (Biologic, 2020b)	1 January to 31 December 2021 (Biologic, 2022b)	1 January to 31 December 2022 (Biologic, 2023)	1 January to 31 December 2023 (Biologic, 2024)	1 January to 24 May 2024	25 May to 31 December 2024
Mean Daytime (9am to 6pm)	30.45 ± 0.01	30.23 ± 0.03	30.31 ± 0.02	30.92 ± 0.02	30.63 ± 0.01	30.06 ± 0.40	30.22 ± 0.01	30.96 ± 0.01	30.76 ± 0.02
Mean Night-time (6pm to 9am)	30.35 ± 0.05	30.25 ± 0.03	30.34 ± 0.02	30.91 ± 0.02	30.60 ± 0.01	30.60 ± 0.45	30.19 ± 0.01	30.93 ± 0.02	30.74 ± 0.02
Minimum	30.02	28.03	28.03	28.00	29.38	29.38	29.00	29.75	29.75
Maximum	30.52	31.62	31.62	31.60	34.68	31.50	31.38	31.75	31.75
Number recording nights within preferred range	84 out of 87 nights (96.55%)	245 out of 245 nights (100%)	359 out of 359 nights (100%)	349 out of 357 nights (97.76%)	365 out of 365 nights (100%)	365 out of 365 nights (100%)	365 out of 365 nights (100%)	145 out of 145 nights, (100%)	221 out of 221 nights (100%)

[1]Doesn't include records where microclimate data was not recorded

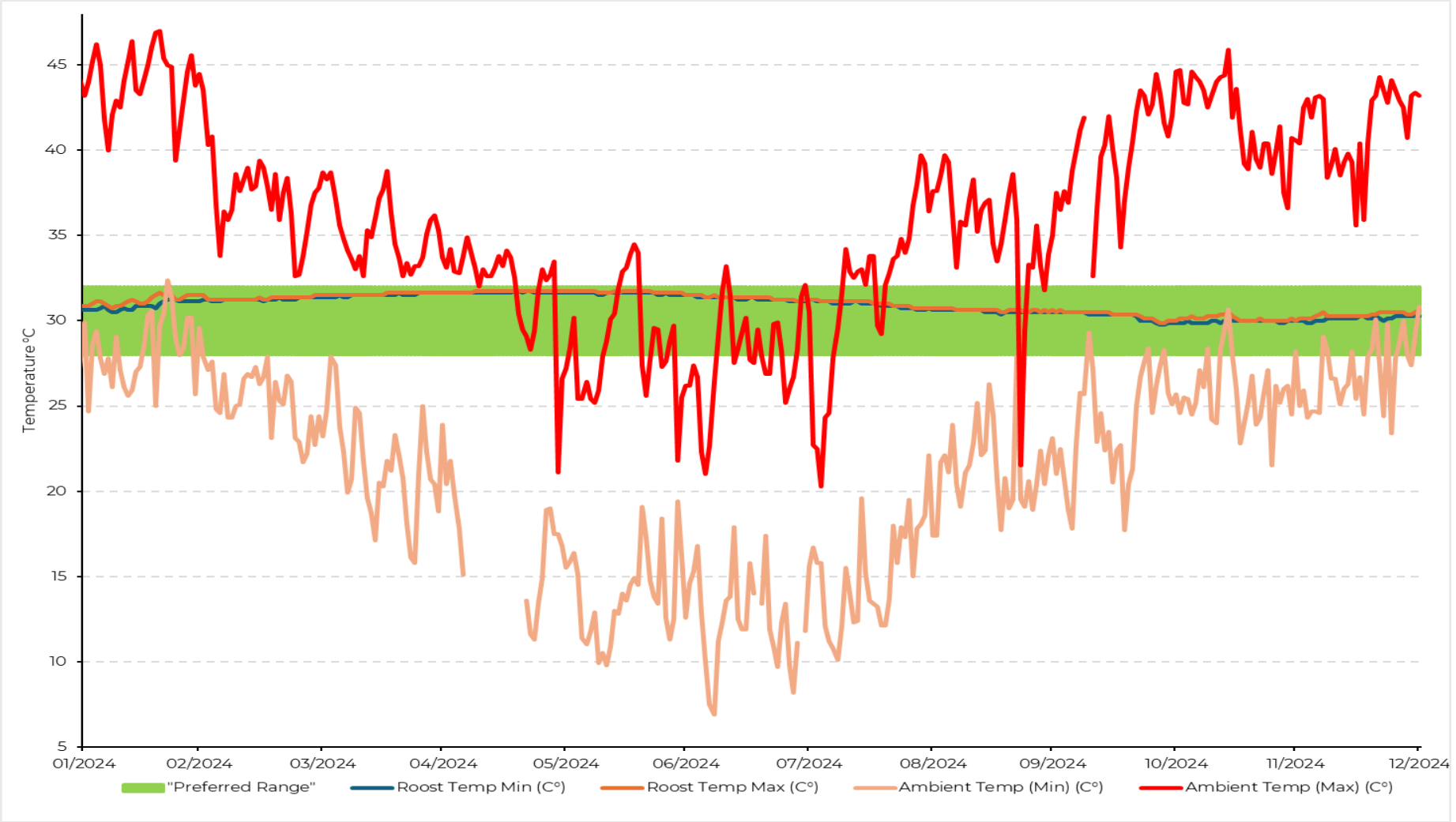


Figure 3.1: Daily temperature range recorded inside CO-CA-03 during the 2024 monitoring period compared with ambient temperature

Note: Red box indicates monitoring period (25 May to 31 December 2024)

Relative humidity within CO-CA-03 fluctuated between 20.16% and 90.99% throughout the current monitoring period (Table 3.3; Figure 3.2). Levels were consistent with the preferred range of 85-100% (Churchill, 1991) required for Pilbara leaf-nosed bat roosting for 66.06% of the currrent monitoring period (Table 3.3; Figure 3.2). Variation in the caves' relative humidity is expected, as levels are more sensitive to changes in local weather conditions (such as rainfall) and seasonality than ambient temperature.

Relative humidity levels recorded at CO-CA-03 during the current monitoring period are similar to the relative humidity previously recorded prior to mining commencing at Razorback pit (Atlas Iron, 2017; Biologic, 2020b, 2022b, 2023, 2024) (Table 3.3). Previously, relative humidity has been recorded within the preferred range for relative for Pilbara leaf-nosed bat roosting between 49.04% (2023) and 100% (2018) of total monitoring periods. Similar to previous monitoring years, relative humidity was highest in the dry season (between April and October) during the current monitoring period, and corresponded with periods of higher cave temperatures, as broadly demonstrated in Figure 3.3. This is similar to the baseline roost review in 2019/2020, whereby relative humidity was observed to be highest when ambient temperatures were between 35-40°C and two week rainfall was ≥250 mm (Biologic, 2020b).

The species' mating season is considered to occur during the dry season, between April and October (Armstrong, 2000, 2001; Bullen & McKenzie, 2011), with temperature and relative humidity levels at CO-CA-03 within the preferred range for roosting 100% and 93.46% for these seven months of the current monitoring period, respectively.

Table 3.3: Temporal comparison of relative humidity data recorded inside CO-CA-03

Summary Statistics[1]	Pre-mining								Active
	20 April to 15 July 2018	1 January to 31 December 2019	17 April 2019 to 24 April 2020 (Biologic, 2020b)	1 January to 31 December 2020 (Biologic, 2020b)	1 January to 31 December 2021 (Biologic, 2022b)	1 January to 31 December 2022 (Biologic, 2023)	1 January to 31 December 2023 (Biologic, 2024)	1 January to 24 May 2024	25 May to 31 December 2024
Mean Daytime (9am to 6pm)	97.11 ± 0.05	79.75 ± 0.77	82.97 ± 0.65	91.48 ± 0.31	87.11 (± 0.44	82.67 ± 1.13	72.40 ± 0.62	75.47 ± 0.53	78.42 ± 0.56
Mean Night-time (6pm to 9am)	97.27 ± 0.06	85.27 ± 0.53	87.37 ± 0.37	92.68 ± 0.20	88.48 (± 0.35	83.59 ± 1.25	75.92 ± 0.47	80.67 ± 0.48	80.67 ± 0.48
Minimum (%)	93.59	18.13	18.13	22.88	21.98	23.33	15.78	15.64	20.16
Maximum (%)	100	99.52	99.52	99.18	96.45	91.96	91.49	90.99	90.99
Percentage of recordings within preferred range	87 out of 87 nights (100%)	163 out of 245 nights (66.53%)	359 out of 359 nights (75.30%)	298 out of 357 nights (83.47%)	310 out of 365 nights (84.93%)	267 out of 365 nights (73.15%)	179 out of 365 nights (49.04%)	75 out of 145 nights (51.72%)	146 out of 221 nights (66.06%)

[1] Doesn't include records where microclimate data was not recorded.

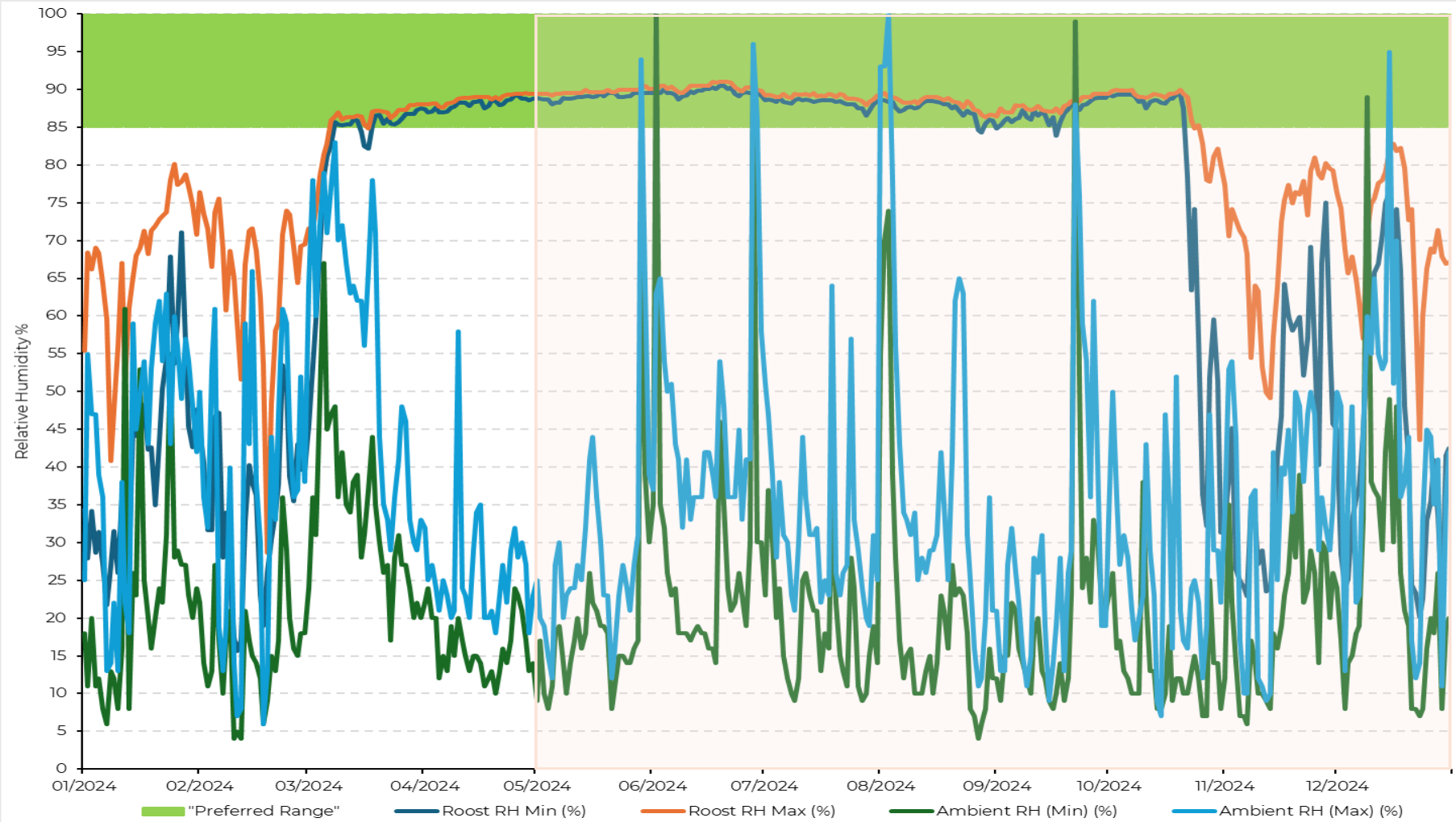


Figure 3.2: Daily relative humidity range recorded inside CO-CA-03 during the 2024 monitoring period compared with ambient temperature

Note: Red box indicates monitoring period (25 May to 31 December 2024)

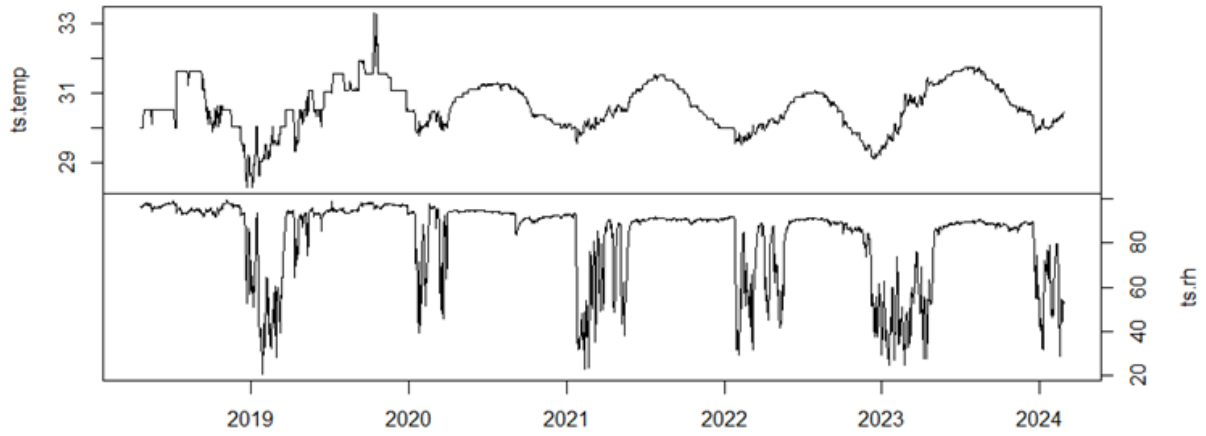


Figure 3.3: Temporal relationship between temperature and relative humidity at CO-CA-03

The application of a cross-correlation function on microclimate data at CO-CA-03, shows that temperature and relative humidity are closely correlated with one another (Section 2.7.3). High and significant correlations were at 0, -1, -2, -3 and -4, the highest at lag -2. This indicates that temperature leads relative humidity, i.e. that relative humidity has a two day lag behind temperature, with positive association up to four days afterwards (Figure 3.4).

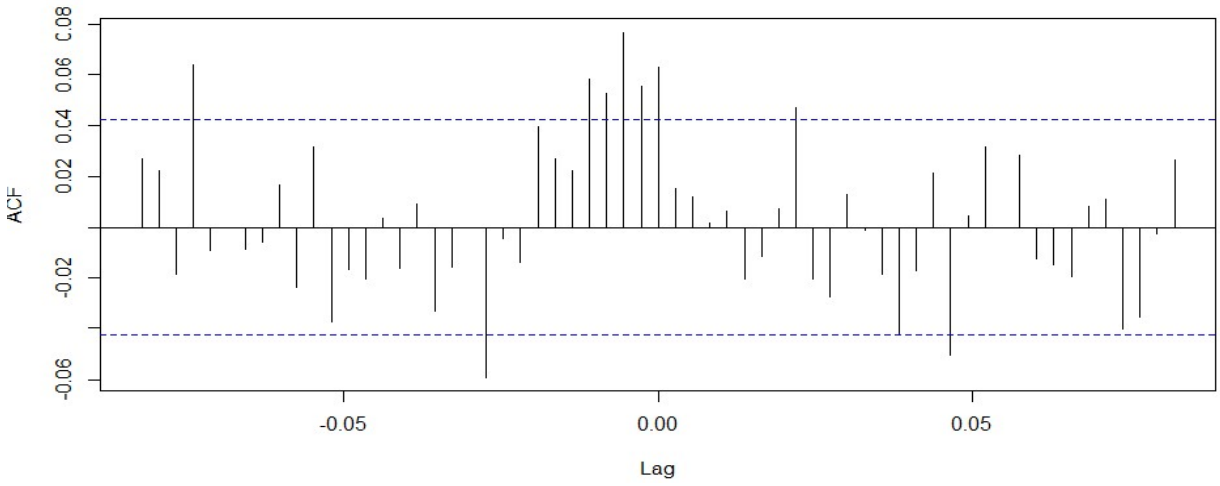


Figure 3.4: CCF plot indicating temperature predicts relative humidity at CO-CA-03

Currently, there is no evidence to suggest the microclimate of CO-CA-03 and therefore, suitability as a Category 2 roosting habitat for Pilbara leaf-nosed bat has deviated from conditions observed prior to mining commencing nearby at Razorback pit. As there have been no visible changes in the physical structure and condition of CO-CA-03 since mining commenced at Razorback pit (Section 3.1.1), the likelihood of mining activities having had an

impact on the microclimate of CO-CA-03 during the current monitoring period is considered to be negligible.

3.3 Ultrasonic

Pilbara leaf-nosed bats were detected at CO-CA-03 every recording night (except on three occasions, 8 and 20 January, and 7 December 2024), total 187 recording nights) of the current monitoring period (Figure 3.5; Appendix B). Note that data were not available between 23 July to 7 August and 9 to 26 August due to technical issues with the SM unit. Calls ranged from one to 3,705 (8 August 2024) per recording night, with an average of 112 calls per recording night throughout the current monitoring period. The number of calls increased in May and June, coinciding with the start of the breeding season, when individuals aggregate for mating purposes (Bat Call, 2021; TSSC, 2016). The number of calls peaked in July and declined in September (no data available for the majority of August 2024) (Figure 3.5; Appendix B).

Based on the timing of calls, Pilbara leaf-nosed bats are continuing to roost diurnally (52.54% of recording nights, where data were available) at CO-CA-03 since mining-related activities at Razorback pit commenced, until 31 December 2024 (Appendix B). When taking into consideration the species' mating and gestation period prior to parturition (April to October), roosting by Pilbara leaf-nosed bats was indicated for 54.73% of this period (Figure 3.6). Roosting and higher levels of Pilbara leaf-nosed bat activity typically occurred when microclimate conditions were more favourable (temperature and relative humidity within preferred range), suggesting these variables are still a prerequisite for roosting (Biologic, 2020b). This is supported by the results of the baseline 2019/2020 roost review, whereby roosting and bat activity was significantly affected by day of sampling (Biologic, 2020b).

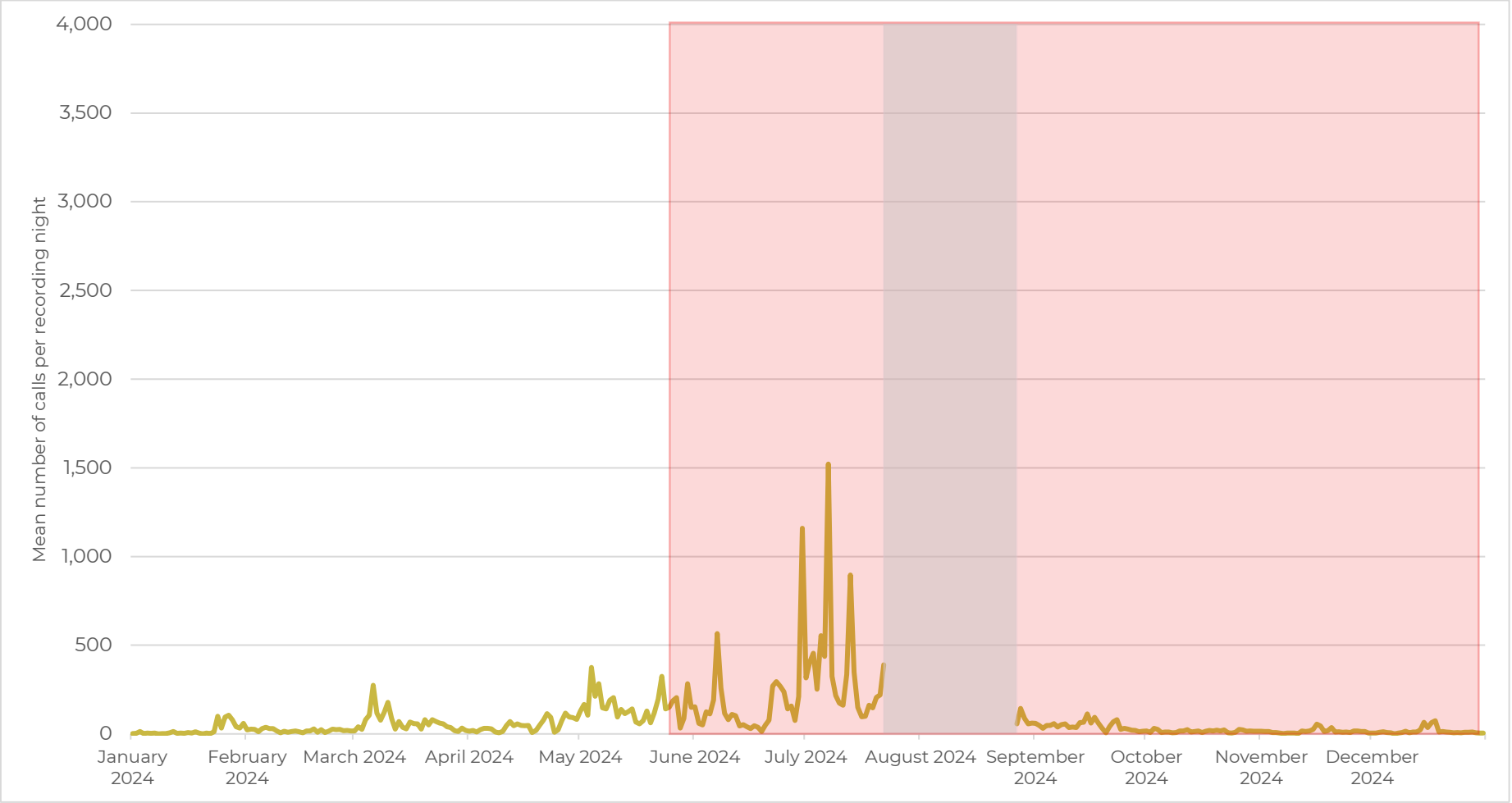


Figure 3.5: Average nightly Pilbara leaf-nosed bat activity recorded 1 January to 31 December 2024, including the current monitoring period

Note: Red box indicates monitoring period (25 May to 31 December 2024)

Note: Blue box indicates where data were unavailable

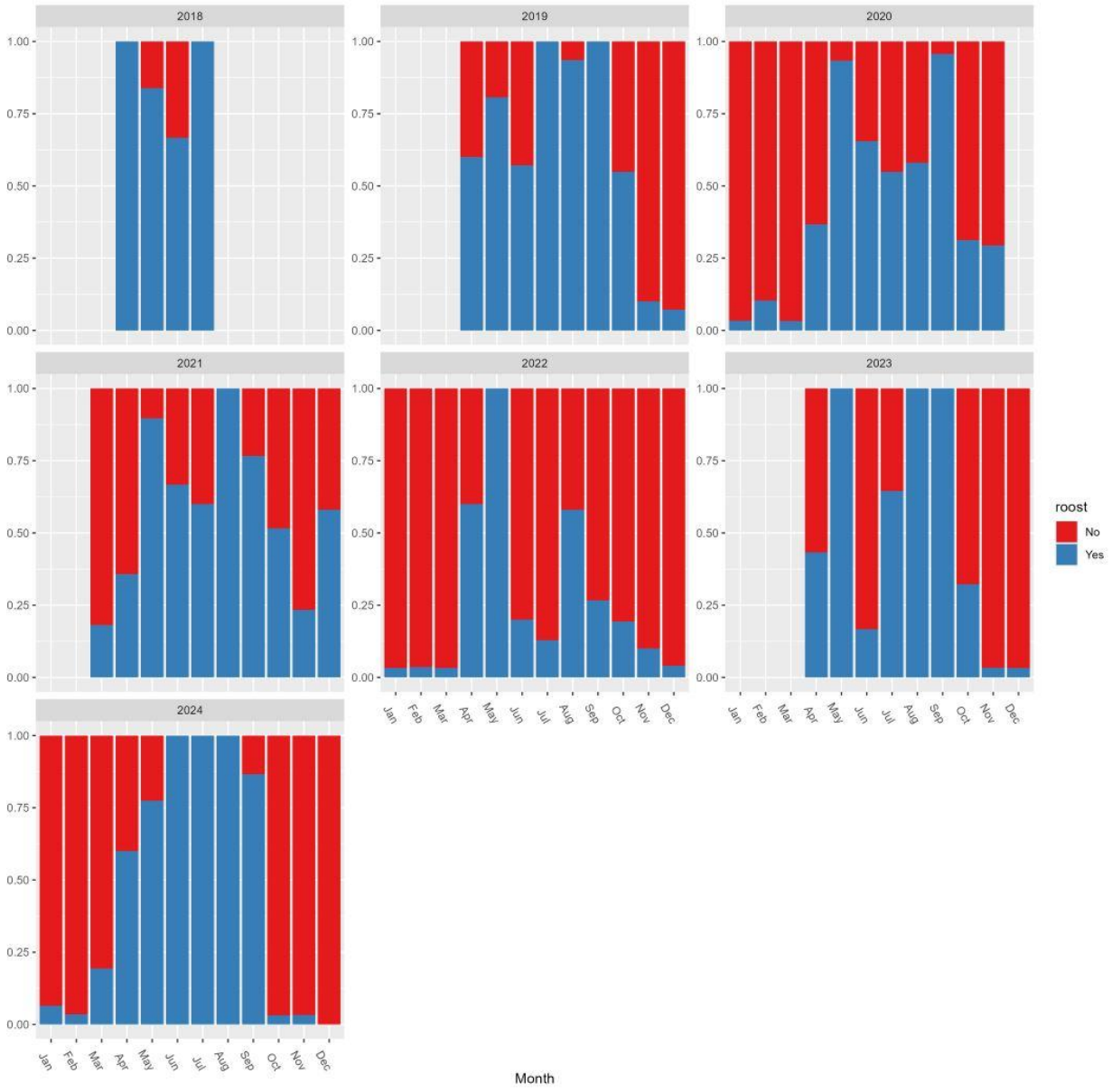


Figure 3.6: Roosting by Pilbara leaf-nosed bat at CO-CA-03 over time

Note: counts are presented as a proportion of the total number roosting and non-roosting nights

As Pilbara leaf-nosed bat activity at CO-CA-03 is influenced by the time of year (seasonality) as well as microclimatic conditions, a GAM was applied on observed ultrasonic data to account for these influences. This allowed an estimated mean number of calls and probability of roosting per recording night for each individual monitoring period (pre-mining and active mining) to be calculated. From this data, it was ascertained whether any significant differences existed between individual pre-mining and active mining monitoring periods. Following the commencement of blasting at Razorback pit on 25 May 2024, an average of 1,474 (± 498) calls per recording night were estimated for CO-CA-03 up to 31 December 2024 (Figure 3.7). The probability of roosting by Pilbara leaf-nosed bats was

estimated as occurring on 81.41% of recording nights during the current monitoring period (Table 3.4).

Table 3.4: Pilbara leaf-nosed bat activity (estimated mean number of calls per recording night) over time

Monitoring Year		Estimated Mean Number of Calls (per recording night) ± SE[1]	Total Number Recording Nights[2]	Estimated Mean Probability of Roosting[3]
Pre-mining	20 April to 15 July 2018	3,103 ± 1,088	83	73.28%
	1 January to 31 December 2019	48,604 ± 15,034	242	77.61%
	1 January to 31 December 2020	21,001 ± 7,164	297	73.00%
	1 January to 31 December 2021	15,697 ± 4,716	292	82.11%
	1 January to 31 December 2022	5,619 ± 1,661	359	48.34%
	1 January to 31 December 2023	2,034 ± 563	242	58.18%
	1 January to 24 May 2024	3,363 ± 1,560	145	77.03%
Active	25 May to 31 December 2024	1,474 ± 498	187	81.41%

[1] Derived from generalised additive model and taking into consideration seasonality (time of year) and microclimate (temperature).

[2] Number of recording nights where both ultrasonic and microclimate (temperature) data were available.

[3] Roosting is based on the interpretation of timing of observed calls by Bat Call (Bob Bullen, pers. comms, 2025) and Biologic. Estimated mean probability of roosting for each monitoring period, taking into consideration seasonality and microclimate.

3.4 Temporal Trends

CO-CA-03 the only known non-permanent maternity roost for Pilbara leaf-nosed bats in the Sanjiv Ridge Project area. It is expected that bat activity levels at CO-CA-03 may be affected by active mining operations at Razorback pit, due to its' close proximity to this cave and ongoing disturbance to surrounding foraging and dispersal habitat. By comparing bat activity levels at CO-CA-03 prior to active mining operations at Razorback pit, any differences in Pilbara leaf-nosed bat activity over time can be investigated relating to mining-related disturbance versus natural fluctuation.

Estimated mean number of calls per recording night ranged from 1,474 (± 498) during the current monitoring period (lowest levels since monitoring commenced) to 48,604 (± 15,034) calls per recording night in 2019 (Table 3.4; Figure 3.7). Current bat activity levels were statistically lower than activity levels recorded during pre-mining 2019, 2020, 2021 and 2022 monitoring years, but there was no evidence for any significant difference from 2018, 2023 and 2024 pre-mining monitoring years (Table 3.5). There were also significant differences in bat activity levels between individual pre-mining years, between 2018 to 2024, indicating activity levels naturally fluctuate from year to year, in response to as yet unknown

environmental or behavioural influences (localised and/or regional). For example, activity levels were significantly higher in 2019 than all other pre-mining years (with the exception of 2020), and bat activity in 2018 was significantly lower than 2019, 2020 and 2021 pre-mining years (Table 3.5).

Pilbara leaf-nosed bat roosting activity at CO-CA-03 was indicated most often between April and September/October, across all monitoring periods (pre-mining and active mining, 2018 to 2024), with roosting extending from January to October in 2019 (Figure 3.6). When taking seasonality and microclimate (temperature) into consideration, the probability of roosting by the species' ranged from 48.34% (2022) to 82.11% (2021), with these two years (2021 and 2022) showing a statistically significant difference from one another (Table 3.4; Table 3.6). There was no significant difference between the probability of roosting during the active mining monitoring period and all individual pre-mining monitoring years.

Mining-related activities (vegetation clearing) associated with Razorback pit commenced in December 2023, with the first blast, load and haul operations commencing on 25 May 2024 and ceasing on 22 July 2024. These activities approached within 120 m south-west of CO-CA-03 in June 2024, approximately 295 m closer than previously reported in 2024, although still further than the closest previous mining-related disturbance (exploration activities in 2021) (Biologic, in prep.). It is important to consider the possibility that ongoing disturbance of foraging and dispersal habitat as a result of nearby mining activities (including those not related to Razorback pit) is also impacting bat activity at CO-CA-03, even if proximity to activity hasn't altered significantly between monitoring periods.

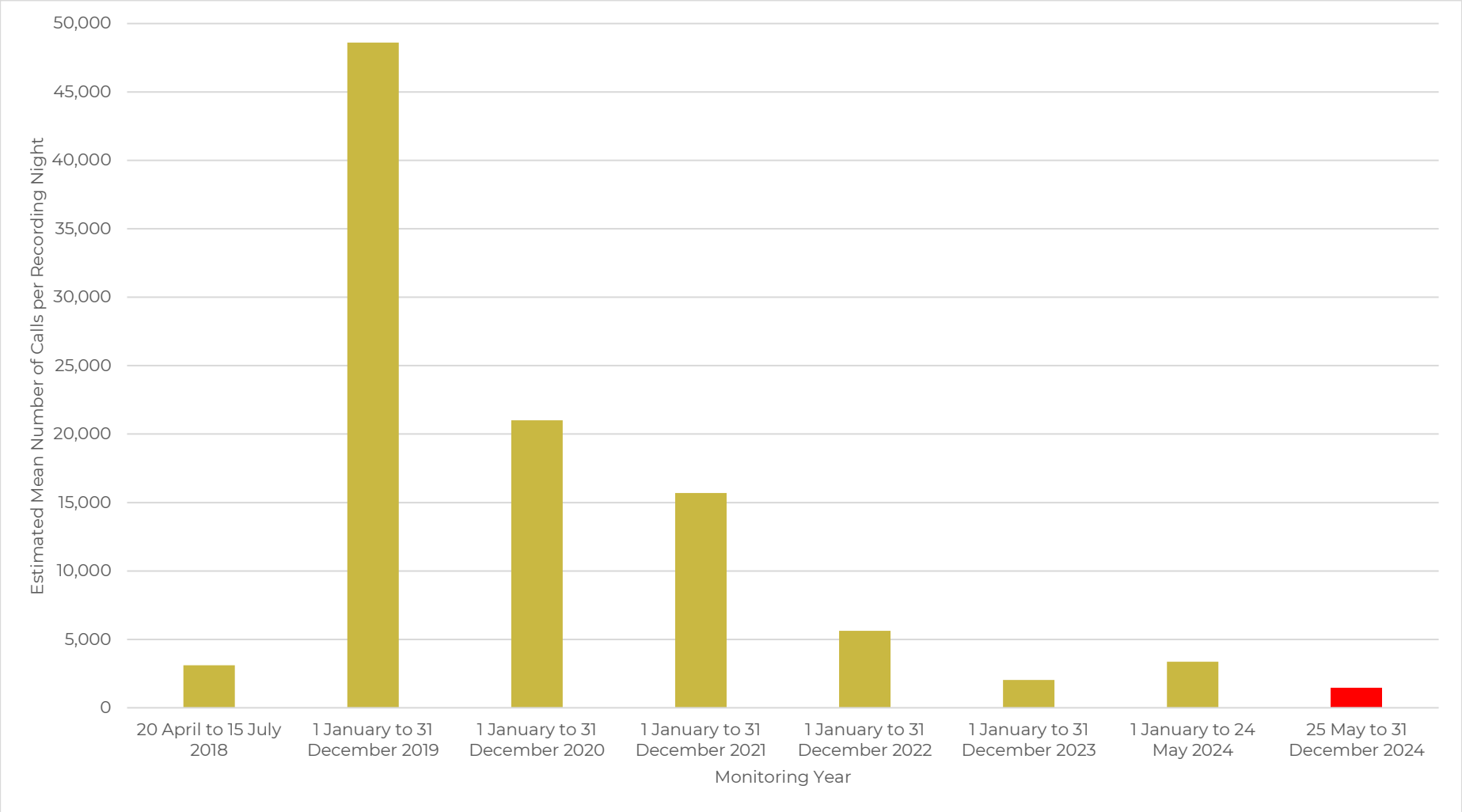


Figure 3.7: Estimated mean number of calls at CO-CA-03 over time

Note: Red column indicates current active mining monitoring period

Table 3.5: Temporal trends in Pilbara leaf-nosed bat activity

Year		Significant difference[3]							
		Pre-mining							Active Mining
		2018	2019	2020	2021	2022	2023	2024	2024 (current)
Pre-mining	2018	-	*p«0.05* significant	*p«0.05* significant	*p«0.05* significant	*p=0.864*	*p=0.961*	*p=1.000*	*p=0.767*
	2019	-	-	*p=0.154*	*p«0.05* significant	*p«0.05* significant	*p«0.05* significant	*p«0.05* significant	*p«0.05* significant
	2020	-	-	-	*p=0.958*	*p«0.05* significant	*p«0.05* significant	*p«0.05* significant	*p«0.05* significant
	2021	-	-	-	-	*p«0.05* significant	*p«0.05* significant	*p«0.05* significant	*p«0.05* significant
	2022	-	-	-	-	-	*p«0.05* significant	*p=0.833*	*p«0.05* significant
	2023	-	-	-	-	-	-	*p=0.940*	*p=0.795*
	2024[1]	-	-	-	-	-	-	-	*p=0.360*
Active	2024[2]	-	-	-	-	-	-	-	-

- not applicable

[1] 1 January to 24 May 2024

[2] 25 May to 31 December 2024

[3] p values greater than 0.05 indicate there is not enough evidence to detect a significant difference

Table 3.6: Temporal trends in Pilbara leaf-nosed bat probability of roosting over time

Year		Significant difference[3]							
		Pre-mining							Active Mining
		2018	2019	2020	2021	2022	2023	2024	2024 (current)
Pre-mining	2018	-	*p=1.00*	*p=1.00*	*p=0.999*	*p=0.916*	*p=0.989*	*p=1.000*	*p=1.00*
	2019	-	-	*p=1.00*	*p=1.00*	*p=0.240*	*p=0.656*	*p=1.00*	*p=1.00*
	2020	-	-	-	*p=0.964*	*p=0.373*	*p=0.957*	*p=1.00*	*p=0.987*
	2021	-	-	-	-	*p«0.05* significant	*p=0.386*	*p=1.00*	*p=1.00*
	2022	-	-	-	-	-	*p=0.995*	*p=0.634*	*p=0.119*
	2023	-	-	-	-	-	-	*p=0.963*	*p=0.646*
	2024[1]	-	-	-	-	-	-	-	*p=1.00*
Active	2024[2]	-	-	-	-	-	-	-	-

- not applicable

[1] 1 January to 24 May 2024

[2] 25 May to 31 December 2024

[3] p values greater than 0.05 indicate there is not enough evidence to detect a significant difference

Previous annual significant species monitoring undertaken within the Study Area, in accordance with the SSMP, support the current findings that bat activity at CO-CA-03 were lower during active mining years than pre-mining years. Activity levels during the 2024 annual monitoring survey (15-25 July 2024, including during active mining of Razorback pit) were the lowest levels recorded at CO-CA-03 since mining activities in the Study Area commenced in 2020. This difference was statistically significant for the 2024 annual survey and grouped active mining years (2020 to 2024) when compared to grouped pre-mining activity levels (2014 to 2019) (Atlas Iron, 2017; Biologic, in prep.). Within the Study Area, the observed decrease in bat activity at an impact monitoring site during annual monitoring was not limited to CO-CA-03. Impact monitoring caves CO-CA-01 (Category permanent diurnal roost), CO-CA-05 (Category 3 transitory diurnal roost), CO-CA-10 (Category 4 nocturnal roost) and impact water sources CO-WS- 01 and CO-WS-03 saw similarly lower levels of activity during the 2024 annual monitoring period (and grouped active mining years; 2020 to 2024), when compared to grouped pre-mining year activity levels (Biologic, in prep.).

The findings of lower bat activity at impact sites during the 2024 annual monitoring survey suggest that mining activity may be having an impact. However, whether mining is having a significant impact on Pilbara leaf-nosed bat activity is unclear as lower activity at control sites were also observed. This included control sites over 10 km [LR-MI-01 and MW-CA-02] from active mining operations, which recorded a decline in bat activity between pre-mining and active mining monitoring periods. Any influence on bat activity from the close proximity of mining operations is difficult to distinguish from regional factors. Lalla Rookh (LR-MI-01) and MW-CA-02 are both known permanent diurnal roosts for Pilbara leaf-nosed bat in the broader region, outside of the Study Area. The lower Pilbara leaf-nosed bat activity observed at these control sites during the 2024 annual monitoring survey compared to pre-mining levels suggests that the regional and/or local population of the species' may be experiencing a decline caused by other environmental and/or ecological mechanisms. This is supported by fluctuations in Pilbara leaf-nosed bat activity observed at monitoring sites during periods where mining activities had yet to commence (i.e. pre-mining, 2014 to 2019) (Biologic, in prep.).

Similar to the annual significant species monitoring, there is no clear pattern between environmental factors that impact the availability and quality of foraging resources in the Study Area and Pilbara leaf-nosed bat activity during the current active mining and previous pre-mining monitoring periods. Wildfire events have previously been discussed as having the potential to disturb or reduce the availability of foraging habitat in a particular area (Biologic, 2023). A wildfire in December 2022 affected large areas of the Sanjiv Ridge Project, but did not affect vegetation and habitat proximal to CO-CA-03, so is unlikely to have had a negative impact on availability of foraging resources. Rainfall was variable in the months

preceding the current monitoring period, with higher than average rainfall overall between 1 January and 31 December 2024, specifically the month of March. Conversely, lower than average rainfall was recorded in January and February 2024. Higher levels of rainfall preceding a monitoring period may promote an increase in the availability of foraging resources in the Study Area. However, the extent that rainfall impacts bat activity is not clear as previous annual significant species monitoring has shown, and indicates there may be other factors contributing to variability in Pilbara leaf-nosed bat activity within the Study Area, and specifically CO-CA-03 (Biologic, in prep.).

3.5 Predator Records

Ghost bats were recorded at CO-CA-03 during the current monitoring period on seven occasions, with probable roosting indicated in December 2024 (Table 3.7). Introduced predators are also active in the Study Area (e.g. feral cat *Felis catus*); however, no predation of Pilbara leaf-nosed bats has been observed, and it is unknown how the distribution, abundance or activity of introduced predators has changed over time.

Table 3.7: Ghost bat presence at CO-CA-03, 1 January to 31 December 2024

Date	Observed number of calls per recording night	Roosting Indicated?[1]
4 February 2024	1	No
16 February 2024	1	No
19 February 2024	2	No
20 March 2024	1	No
14 October 2024	1	No
4 December 2024	2	No
31 December 2024	21	Probable

[1] Based on interpretation of timing of calls by Bat Call (Bob Bullen, pers. comms., 2024).

3.6 Limitations and Constraints

The EPA outlines a number of factors that can affect the adequacy of fauna surveys (EPA, 2020). These were assessed in relation to continuous monitoring at CO-CA-03, in accordance with the SSMP and Monitoring Strategy and no significant limitations were identified (Table 3.8).

Table 3.8: Survey limitations

Potential limitation or constraint	Applicability to the current monitoring period	Limitation
Availability of data and information	All contextual resources required to complete the survey were available (previous surveys, database searches, environmental information, climate data etc.). Contextual information on the habitats and landforms present within the Study Area, as well as previous records of Pilbara leaf-nosed bat is also well documented (MWH, 2018b).	No
Competency and experience of the survey team	The Biologic field personnel involved in the survey have a combined total of 30 years' experience undertaking fauna surveys in the Pilbara. Atlas or Biologic personnel collected microclimate and SongMeter data approximately every three months. Biologic have conducted surveys at Sanjiv Ridge for seven years and have experience with similar scopes throughout the Pilbara.	No
Scope of the survey	The scope was a monitoring survey and was conducted within that framework. All chosen methods were able to be executed as expected.	No
Timing, weather and season	Weather conditions were appropriate for detecting Pilbara leaf-nosed bat activity. The monitoring period was continuous and included pre-mining and active mining periods.	No
Disturbance that may have affected results	The monitoring program is designed to track the occurrence of disturbances within the Study Area. Signs of historical and recent disturbances observed in the Study Area were described.	No
Adequacy of the survey intensity	Monitoring was undertaken in accordance with the SSMP and Monitoring Strategy, using standardised and established techniques which are considered suitable for an ongoing monitoring program targeting significant species. The survey employed the same methods as were applied in previous years.	No
Problems with data and analysis	Ultrasonic data were not available at CO-CA-03 for 34 sampling nights during the current monitoring period due to technical issues with the SM unit (refer to Section 2.6.2).	Partial

4 Conclusion

Microclimate (temperature and relative humidity) monitoring has been undertaken at CO-CA-03 in the Sanjiv Ridge Project area since 2018, with Pilbara leaf-nosed bats recorded at CO-CA-03 since 2014. Bat activity levels at CO-CA-03 from 2018 to 2024 were assessed in order to further understand the way the cave is being used by the species over time. Specifically in relation to the caves' microclimate and mining-related activities at Razorback pit, in accordance with the Monitoring Strategy. Vegetation clearing associated with Razorback pit commenced in December 2023, with active mining (blasting, load and haul) activities commencing on 25 May 2024 and ceasing on 22 July 2024. The current monitoring period covers 25 May to 31 December 2024 and represents the first active mining monitoring period since mining commenced at Razorback pit.

Microclimate and ultrasonic monitoring at CO-CA-03 during previous pre-mining monitoring periods and the current monitoring period will assist Atlas to identify whether mining activities associated with Razorback pit are having a significant impact on the suitability of CO-CA-03 for use by Pilbara leaf-nosed bat. Specifically, as they relate to relevant performance objectives and KPIs outlined in the Monitoring Strategy.

Pilbara leaf-nosed bats were recorded at CO-CA-03 during every month of the current active mining monitoring period (where data available), indicating the species' are continuing to use CO-CA-03 during active mining operations at Razorback pit in 2024. Taking seasonality (date of sampling) and microclimate (temperature) into consideration, activity levels at CO-CA-03 were lower during the current monitoring period than those recorded during all pre-mining monitoring periods from 2018 to 2024. This difference was statistically significant for four pre-mining monitoring periods, 2019 to 2022. While this could indicate a response to mining activity at Razorback pit, significant differences in Pilbara leaf-nosed bat activity were also recorded between individual pre-mining monitoring periods, namely 2018 (and 2019, 2021), 2019 (and 2021, 2022, 2023, 2024), 2020 (and 2022, 2023, 2024), 2021 (and 2022, 2023, 2024) and 2022 (and 2023). This indicates it is likely there is some degree of natural fluctuation and/or other influencing factors that are impacting Pilbara leaf-nosed bat activity at CO-CA-03. Along with possible mining-related activities, the supposition that other factors may be influencing bat activity at CO-CA-03 is supported by previous annual significant species monitoring. The level of activity recorded at five impact sites as well as two control sites, including Lalla Rookh, during the 2024 monitoring period were significantly lower than average pre-mining activity levels (2014-2019) (Biologic, in prep.).

The observed decline in Pilbara leaf-nosed bat activity at CO-CA-03 during the current monitoring period suggests that changes in activity levels within the Sanjiv Ridge Project area are largely reflective of changes across the broader region. No clear pattern has been

observed between bat activity levels each monitoring period and environmental factors such as rainfall and wildfire, that may affect availability and quality of foraging resources.

It remains possible that mining activity at Razorback pit (and elsewhere within the Study Area) is influencing activity levels at CO-CA-03 to some extent. As there is no evidence that mining disturbance is affecting the microclimate of the roost, the most likely mechanism by which mining activity may be affecting activity levels at CO-CA-03 is disturbance through noise, vibration and dust resulting from nearby active mining operations, including blasting. Importantly, there is no evidence that the suitability of the CO-CA-03 has changed since before mining of Razorback pit commenced. More specifically, there is no evidence of damage to the structure, or microclimate of the roost and CO-CA-03 is continuing to be used as a diurnal roost within the Study Area during active mining of Razorback pit.

4.1 Relevance of Findings to Management Commitments

In accordance with the Monitoring Strategy (Atlas Iron, 2017; Biologic, 2020a), Atlas are committed to employing specific corrective actions when the following key performance objectives and indicators are recorded:

Performance Objective: Maintain suitable microclimate for Pilbara leaf-nosed bats within cave CO-CA-03 during, and for five years following cessation of, mining of Razorback pit.

Key Performance Indicator: Cave CO-CA-03 maintain 85-100 per cent relative humidity for at least 50% of each year of monitoring.

- **Trigger Value: Cave CO-CA-03 maintains 85-100 per cent relative humidity for less than 75% of a monitoring year.**

During the current (and first active mining) monitoring period, relative humidity levels at CO-CA-03 were within the preferred range of 85-100% for Pilbara leaf-nosed bat roosting, for 66.06% between 25 May and 31 December 2024. Consequently, the trigger value has been recorded. Fluctuations in relative humidity within CO-CA-03 have previously been observed in the years since microclimate monitoring began in 2018 and is likely a natural response to changes in local ambient climatic conditions. Furthermore, cave inspections during the current monitoring period, including monthly laser scans indicate no significant changes to the internal structure of CO-CA-03 that may account for observed fluctuations in relative humidity (Atlas, pers. comms., 2025) (Atlas, 2025).

Roosting at CO-CA-03 was indicated from observed call data to occur 52.54% of recording nights during the current monitoring period. When considering the months of the species' known mating season (April to October), where higher levels of bat activity and roosting were observed at CO-CA-03, relative humidity levels were within the 85-100% preferred range for 93.46% of this period, with roosting indicated for 54.73% during this time. Taking into

consideration seasonality and temperature, the probability of Pilbara leaf-nosed bat roosting during the current monitoring period was 81.41%. These results indicate that despite the trigger value being recorded, relative humidity levels within CA-CA-03 continued to be suitable for roosting during active mining at Razorback pit.

The KPI was met, as relative humidity levels were within the preferred range for more than 50% of the monitoring year.

Key Performance Indicator: Cave CO-CA-03 maintains a temperature between 28 and 32 degrees Celsius for 95% of each year of monitoring.

- **Trigger Value: Cave CO-CA-03 maintains a temperature between 28 and 32 degrees Celsius for less than 98% of a monitoring year.**

The temperature within CO-CA-03 remained within the preferred range for roosting (28-32°C) for 100% of the current monitoring period. Therefore, the KPI was met, and the trigger value was not exceeded. CO-CA-03 continues to provide suitable roosting habitat for the Pilbara leaf-nosed bat during active mining of Razorback pit. This is demonstrated by observed call data indicating roosting occurred 52.54% of recording nights during the current monitoring period, and an 81.41% probability of roosting.

Performance Objective: No significant damage to CO-CA-03 that would prevent its ongoing use by Pilbara Leaf-nosed bats as a non-permanent breeding roost.

Key Performance Indicator: No major structural damage to cave CO-CA-03 (i.e., collapse of cave entrance or entrance to main chamber, or opening of large fractures which result in loss/change microclimate).

- **Trigger Value: Minor to moderate rock fall within or at the entrance of the cave (i.e. does not impede bat movements/entrance into the cave and rear chamber).**
- **Trigger Value: New fractures.**

Based on field observations undertaken during the annual significant species monitoring survey in July 2024 (Biologic, in prep.), and ongoing monitoring by Atlas (Atlas, pers. comms., 2025), including LiDAR scans (Atlas, 2025), there have been no changes to the internal or external structure of CO-CA-03. Therefore, there has been no significant damage during active mining of Razorback pit that would prevent ongoing use by Pilbara leaf-nosed bats

during the current monitoring period, and the KPI has been met, and the trigger value was not exceeded.

Key Performance Indicator: CO-CA-03 is used as a non-permanent breeding roost by Pilbara leaf-nosed bat at least once in the five years following the cessation of mining of Razorback pit.

While not linked to a specific KPI during the active mining monitoring period, Pilbara leaf-nosed bat activity levels were investigated to provide context and support for analysis into the future KPI (above).

Pilbara leaf-nosed bats were recorded utilising CO-CA-03, including diurnal roosting, during every month of the current monitoring period (where data were available). Roosting was indicated for 52.54% of recording nights during the current monitoring period (probability of 81.41%), indicating Pilbara leaf-nosed bats are continuing to use CO-CA-03 as a diurnal roost during active mining of Razorback pit, up until 31 December 2024.

The scale and extent to which broader environmental factors such as rainfall, wildfire, and warmer ambient climatic conditions, and localised, mining-related activities at Razorback pit are impacting Pilbara leaf-nosed bat activity at CO-CA-03 (and more broadly other caves and water sources including CO-WS-14 within the Study Area) is unclear. Bat activity in relation to mining-related activity at Razorback pit and regional influences will continue to be investigated throughout the course of the monitoring program, with no additional corrective actions required at this time.

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Appendix A: CO-CA-03 photo records over time

CO-CA-03					
Photo point ID	Location		Photo point ID	Location	
	Latitude	Longitude		Latitude	Longitude
PPA	**-21.4678°**	**119.6711°**	**PPB**	**-21.4681°**	**119.6717°**
2018[1]			2018		

CO-CA-03			
2019[1]		2019	No photo available
2020[1]		2020	

CO-CA-03			
2021[1]		2021	
2022[1]		2022	

CO-CA-03			
2023[1]		2023	
16 April 2024[2]		2024	No photo available

CO-CA-03			
20 December 2024[2]	No photo available		No photo available

[1] Sourced from (Biologic, 2021, 2022b, 2022c, 2023, 2024) Atlas (pers. comms., 2025)

[2] Sourced from Atlas (pers. comms., 2025)

Appendix B: Pilbara leaf-nosed bat calls – 2024

Date	Number of Calls	Roosting Indicated
1/01/2024	1	No
2/01/2024	3	No
3/01/2024	14	No
4/01/2024	1	No
5/01/2024	4	No
6/01/2024	3	No
7/01/2024	4	No
8/01/2024	0	No
9/01/2024	1	No
10/01/2024	1	No
11/01/2024	6	No
12/01/2024	14	No
13/01/2024	3	No
14/01/2024	4	No
15/01/2024	3	No
16/01/2024	8	No
17/01/2024	5	No
18/01/2024	12	No
19/01/2024	5	No
20/01/2024	0	No
21/01/2024	4	No

Date	Number of Calls	Roosting Indicated
22/01/2024	1	No
23/01/2024	12	No
24/01/2024	100	No
25/01/2024	33	No
26/01/2024	95	No
27/01/2024	105	Yes
28/01/2024	79	Yes
29/01/2024	40	No
30/01/2024	33	No
31/01/2024	59	No
1/02/2024	22	No
2/02/2024	27	Yes
3/02/2024	25	No
4/02/2024	12	No
5/02/2024	29	No
6/02/2024	37	No
7/02/2024	30	No
8/02/2024	29	No
9/02/2024	16	No
10/02/2024	6	No
11/02/2024	15	No

Date	Number of Calls	Roosting Indicated
12/02/2024	9	No
13/02/2024	14	No
14/02/2024	17	No
15/02/2024	12	No
16/02/2024	6	No
17/02/2024	17	No
18/02/2024	17	No
19/02/2024	28	No
20/02/2024	9	No
21/02/2024	23	No
22/02/2024	8	No
23/02/2024	15	No
24/02/2024	26	No
25/02/2024	24	No
26/02/2024	25	No
27/02/2024	18	No
28/02/2024	20	No
29/02/2024	17	No
1/03/2024	16	No
2/03/2024	39	No
3/03/2024	25	No

Date	Number of Calls	Roosting Indicated
4/03/2024	81	Yes
5/03/2024	105	Yes
6/03/2024	274	Yes
7/03/2024	117	Yes
8/03/2024	78	Yes
9/03/2024	121	No
10/03/2024	177	No
11/03/2024	87	No
12/03/2024	26	No
13/03/2024	70	No
14/03/2024	37	No
15/03/2024	28	No
16/03/2024	66	No
17/03/2024	58	No
18/03/2024	57	No
19/03/2024	27	No
20/03/2024	80	No
21/03/2024	51	No
22/03/2024	80	No
23/03/2024	69	No
24/03/2024	61	No

Date	Number of Calls	Roosting Indicated
25/03/2024	56	No
26/03/2024	40	No
27/03/2024	35	No
28/03/2024	18	No
29/03/2024	14	No
30/03/2024	33	Yes
31/03/2024	20	No
1/04/2024	15	No
2/04/2024	20	No
3/04/2024	11	No
4/04/2024	24	No
5/04/2024	31	No
6/04/2024	31	No
7/04/2024	28	No
8/04/2024	11	No
9/04/2024	6	No
10/04/2024	14	No
11/04/2024	47	No
12/04/2024	69	No
13/04/2024	47	Yes
14/04/2024	56	Yes

Date	Number of Calls	Roosting Indicated
15/04/2024	48	Yes
16/04/2024	47	Yes
17/04/2024	48	Yes
18/04/2024	8	Yes
19/04/2024	20	Yes
20/04/2024	50	Yes
21/04/2024	77	Yes
22/04/2024	115	Yes
23/04/2024	93	Yes
24/04/2024	9	Yes
25/04/2024	22	Yes
26/04/2024	75	Yes
27/04/2024	117	Yes
28/04/2024	95	Yes
29/04/2024	92	Yes
30/04/2024	82	Yes
1/05/2024	128	Yes
2/05/2024	166	Yes
3/05/2024	105	Yes
4/05/2024	375	Yes
5/05/2024	212	Yes

Date	Number of Calls	Roosting Indicated
6/05/2024	282	Yes
7/05/2024	147	Yes
8/05/2024	141	Yes
9/05/2024	189	Yes
10/05/2024	205	Yes
11/05/2024	94	Yes
12/05/2024	138	Yes
13/05/2024	114	Yes
14/05/2024	126	Yes
15/05/2024	141	Yes
16/05/2024	67	No
17/05/2024	57	No
18/05/2024	73	No
19/05/2024	128	No
20/05/2024	63	No
21/05/2024	118	No
22/05/2024	196	No
23/05/2024	324	Yes
24/05/2024	141	Yes
25/05/2024	150	Yes
26/05/2024	186	Yes

Date	Number of Calls	Roosting Indicated
27/05/2024	204	Yes
28/05/2024	33	Yes
29/05/2024	87	Yes
30/05/2024	283	Yes
31/05/2024	150	Yes
1/06/2024	153	Yes
2/06/2024	59	Yes
3/06/2024	51	Yes
4/06/2024	125	Yes
5/06/2024	112	Yes
6/06/2024	191	Yes
7/06/2024	566	Yes
8/06/2024	259	Yes
9/06/2024	116	Yes
10/06/2024	81	Yes
11/06/2024	109	Yes
12/06/2024	102	Yes
13/06/2024	45	Yes
14/06/2024	52	Yes
15/06/2024	40	Yes
16/06/2024	30	Yes

Date	Number of Calls	Roosting Indicated
17/06/2024	47	Yes
18/06/2024	37	Yes
19/06/2024	14	Yes
20/06/2024	50	Yes
21/06/2024	78	Yes
22/06/2024	270	Yes
23/06/2024	295	Yes
24/06/2024	268	Yes
25/06/2024	238	Yes
26/06/2024	140	Yes
27/06/2024	157	Yes
28/06/2024	76	Yes
29/06/2024	211	Yes
30/06/2024	1,160	Yes
1/07/2024	315	Yes
2/07/2024	404	Yes
3/07/2024	455	Yes
4/07/2024	252	Yes
5/07/2024	554	Yes
6/07/2024	437	Yes
7/07/2024	1,521	Yes

Date	Number of Calls	Roosting Indicated
8/07/2024	324	Yes
9/07/2024	216	Yes
10/07/2024	173	Yes
11/07/2024	162	Yes
12/07/2024	335	Yes
13/07/2024	896	Yes
14/07/2024	348	Yes
15/07/2024	150	Yes
16/07/2024	97	Yes
17/07/2024	100	Yes
18/07/2024	161	Yes
19/07/2024	147	Yes
20/07/2024	206	Yes
21/07/2024	220	Yes
22/07/2024	389	Yes
23/07/2024	-	-
24/07/2024	-	-
25/07/2024	-	-
26/07/2024	-	-
27/07/2024	-	-
28/07/2024	-	-

Date	Number of Calls	Roosting Indicated
29/07/2024	-	-
30/07/2024	-	-
31/07/2024	-	-
1/08/2024	-	-
2/08/2024	-	-
3/08/2024	-	-
4/08/2024	-	-
5/08/2024	-	-
6/08/2024	-	-
7/08/2024	-	-
8/08/2024	3,705	Yes
9/08/2024	-	-
10/08/2024	-	-
11/08/2024	-	-
12/08/2024	-	-
13/08/2024	-	-
14/08/2024	-	-
15/08/2024	-	-
16/08/2024	-	-
17/08/2024	-	-
18/08/2024	-	-

Date	Number of Calls	Roosting Indicated
19/08/2024	-	-
20/08/2024	-	-
21/08/2024	-	-
22/08/2024	-	-
23/08/2024	-	-
24/08/2024	-	-
25/08/2024	-	-
26/08/2024	-	-
27/08/2024	56	Yes
28/08/2024	144	Yes
29/08/2024	88	Yes
30/08/2024	56	Yes
31/08/2024	61	Yes
1/09/2024	60	Yes
2/09/2024	48	Yes
3/09/2024	31	Yes
4/09/2024	47	Yes
5/09/2024	47	Yes
6/09/2024	58	Yes
7/09/2024	38	Yes
8/09/2024	52	Yes

Date	Number of Calls	Roosting Indicated
9/09/2024	57	Yes
10/09/2024	35	Yes
11/09/2024	39	Yes
12/09/2024	36	Yes
13/09/2024	64	Yes
14/09/2024	66	Yes
15/09/2024	113	Yes
16/09/2024	61	Yes
17/09/2024	93	Yes
18/09/2024	61	Yes
19/09/2024	33	Yes
20/09/2024	6	Yes
21/09/2024	41	Yes
22/09/2024	69	Yes
23/09/2024	80	Yes
24/09/2024	25	Yes
25/09/2024	31	Yes
26/09/2024	27	Yes
27/09/2024	21	No
28/09/2024	19	No
29/09/2024	12	No

Date	Number of Calls	Roosting Indicated
30/09/2024	15	No
1/10/2024	17	No
2/10/2024	7	No
3/10/2024	32	No
4/10/2024	25	No
5/10/2024	8	No
6/10/2024	10	No
7/10/2024	10	No
8/10/2024	6	Yes
9/10/2024	7	No
10/10/2024	17	No
11/10/2024	17	No
12/10/2024	24	No
13/10/2024	10	No
14/10/2024	13	No
15/10/2024	16	No
16/10/2024	8	No
17/10/2024	15	No
18/10/2024	19	No
19/10/2024	17	No
20/10/2024	21	No

Date	Number of Calls	Roosting Indicated
21/10/2024	16	No
22/10/2024	22	No
23/10/2024	6	No
24/10/2024	5	No
25/10/2024	9	No
26/10/2024	25	No
27/10/2024	22	No
28/10/2024	15	No
29/10/2024	16	No
30/10/2024	15	No
31/10/2024	15	No
1/11/2024	15	No
2/11/2024	13	No
3/11/2024	13	No
4/11/2024	7	No
5/11/2024	7	No
6/11/2024	5	No
7/11/2024	2	No
8/11/2024	5	No
9/11/2024	5	No
10/11/2024	4	No

Date	Number of Calls	Roosting Indicated
11/11/2024	1	No
12/11/2024	16	No
13/11/2024	13	No
14/11/2024	16	No
15/11/2024	26	No
16/11/2024	55	No
17/11/2024	45	Yes
18/11/2024	14	No
19/11/2024	18	No
20/11/2024	35	No
21/11/2024	10	No
22/11/2024	12	No
23/11/2024	9	No
24/11/2024	11	No
25/11/2024	8	No
26/11/2024	16	No
27/11/2024	17	No
28/11/2024	13	No
29/11/2024	14	No
30/11/2024	4	No
1/12/2024	4	No

Date	Number of Calls	Roosting Indicated
2/12/2024	4	No
3/12/2024	9	No
4/12/2024	12	No
5/12/2024	7	No
6/12/2024	6	No
7/12/2024	0	No
8/12/2024	4	No
9/12/2024	8	No
10/12/2024	15	No
11/12/2024	6	No
12/12/2024	10	No
13/12/2024	10	No
14/12/2024	22	No
15/12/2024	66	No
16/12/2024	35	No
17/12/2024	64	No
18/12/2024	74	No
19/12/2024	11	No
20/12/2024	13	No
21/12/2024	11	No
22/12/2024	9	No

Date	Number of Calls	Roosting Indicated
23/12/2024	6	No
24/12/2024	8	No
25/12/2024	6	No
26/12/2024	9	No
27/12/2024	9	No
28/12/2024	10	No
29/12/2024	6	No
30/12/2024	4	No
31/12/2024	5	No

Note: '- '= no sampling

Appendix B. Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy

Corunna Downs

CO-CA-03 and CO-WS-14 Monitoring Strategy

Biologic Environmental Survey

Prepared for Atlas Iron

October 2020

Document Status				
Revision No.	Author	Review / Approved for Issue by	Approved for Issue to	
			Name	Date
1	B. Downing; C. Knuckey	C. Knuckey	N. Bell	13/06/2020
2	C. Knuckey	C. Knuckey	N. Bell	10/07/2020
3	B. Downing	C. Knuckey	N. Bell	13/07/2020
4	B. Downing	C. Knuckey	N. Bell	14/07/2020
5	B. Downing	C. Knuckey	N. Bell	14/07/2020
6	B. Downing	C. Knuckey	N. Bell	08/10/2020

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1 INTRODUCTION

1.1 Project Overview

Atlas Iron Pty Ltd (Atlas Iron) are looking to develop the Corunna Downs Project (the Project), located approximately 25 kilometres (km) south-west of Marble Bar within the Chichester subregion of Western Australia's Pilbara bioregion (Figure 1.1). The Project involves the development and operation of an open cut iron ore mine and associated mining infrastructure, waste rock dumps, borefield, and accommodation camp. The Project will source iron ore from five open pits (Split Rock, Razorback, Shark Gully, Runway North and Runway South) using conventional drill and blast, load and haul methods (Atlas Iron, 2019).

1.2 Project Background

In January 2017, Atlas Iron referred the Project to the Department of Environment and Energy (now the Department of Agriculture, Water and the Environment, DAWE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The DAWE determined that the Project was a controlled action under Section 75 of the EPBC Act and required assessment by Preliminary Documentation, on the basis it was likely to have a significant impact on listed threatened species and communities (sections 18 and 18A), including the Pilbara Leaf-nosed Bat.

This species was recorded on 41 occasions, including within 16 caves. Two of which, cave CO-CA-01, a permanent diurnal roost, and cave CO-CA-03, a non-permanent breeding roost, are considered critical habitat for the species (Figure 1.1). The remaining 14 caves were classified as nocturnal refuges (MWH, 2016b). There were also a number of perennial pools located within the vicinity of the Project including pool CO-WS-14 located directly in front of the entrance of Cave CO-CA-03 (Figure 1.1), regarded as important due to the species' high levels of water loss (Baudinette *et al.*, 2000),

To minimise mining related impacts, and consequently ensure the long-term viability of the local population, exclusion zones (delineated zone within which development will be excluded) were applied to these two significant caves (Atlas Iron Limited, 2018). An assessment of the geology and review of Atlas Iron's other operations determined that a 50 m lateral buffer from cave CO-CA-03 was adequate to maintain a suitable level of structural integrity of this cave (Atlas Iron Limited, 2018). Atlas Iron subsequently revised and optimised the pit design outside of this 50 m buffer and surveyed and laser scanned this cave. Consequently, this 50 m lateral buffer is now known to translate to a distance of 100 m overland from the entrance of the cave to the nearest edge of the Razorback pit, and 68 m from the back of the cave to the nearest point inside the Razorback pit (Figure 1.2).

Given the proximity of cave CO-CA-03 to the Razorback pit and the species' sensitivity to blasting noise, vibration and dust impacts the assessment considered the potential that the Project may result in the temporary relocation/abandonment of this species from cave CO-CA-03. However, the return of this species following cessation of mining is anticipated where the structural integrity and microclimate of this cave could be maintained along with the persistence of pool CO-WS-14. It was also considered probable that this species could continue to utilise this cave as a nocturnal refuge and for foraging during this time, as supported by monitoring at Atlas Iron's Mt Dove operations (MWH, 2014).

The Project was granted approval on 23 February 2018 (EPBC 2017/7861) subject to 12 conditions. Four of these conditions related directly to the Pilbara leaf-nosed bat, including condition 4 pertaining to the development and implementation of a Monitoring Strategy:

4. *The approval holder must develop and submit a Monitoring Strategy to the Minister for approval. The Monitoring Strategy must be based on:*
   - *mapping and monitoring of cave CO-CA-03 by an independent scientific expert(s) approved by the Department;*
   - *the collection of at least 12 months of baseline humidity and temperature recordings inside cave CO-CA-03; and*
   - *12 months of baseline water quality sampling of pool CO-WS-14.*

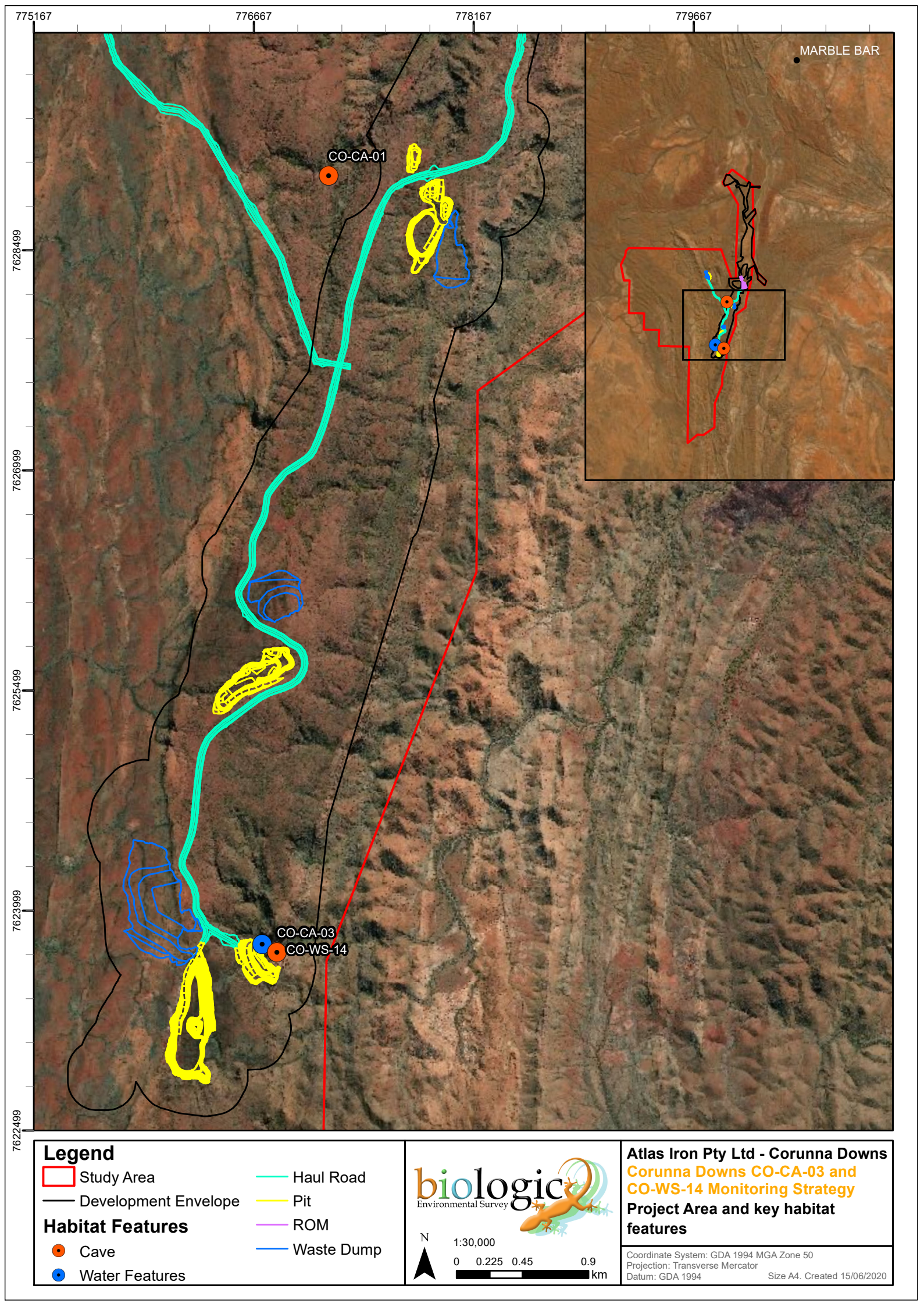
   The Monitoring Strategy must be designed to demonstrate that the structure of cave CO-CA-03 remains unchanged from the pre-mining structure during mining of the Razorback Pit. The Monitoring Strategy must also be designed to demonstrate, unless otherwise justified and approved by the Minister, that:
   - *a) without anthropogenic supplementation of its water level, waterhole CO-WS-14 has water in it during and continuously for three consecutive years following the cessation of mining of Razorback Pit; and*
   - *b) the water quality of pool CO-WS-14 remains suitable for Pilbara leaf-nosed bat during and continuously for three consecutive years following the cessation of mining of Razorback Pit; and*
   - *c) cave CO-CA-03 maintains:*
     - *i. humidity between 85-100 per cent relative humidity;*
     - *ii. temperature between 28 and 32 degrees Celsius during and continuously for five years following cessation of the mining of Razorback Pit.*

   Mining in Razorback Pit cannot commence until the Monitoring Strategy has been approved by the Minister.

This Monitoring Strategy will also be used to inform condition 3 of the EPBC Approval Decision.

3. *The approval holder must demonstrate that, both during and after mining ceases at the Razorback Pit, cave CO-CA-03 and pool CO-WS-14 remain suitable habitat available for use by the Pilbara leaf-nosed bat.*

Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by Atlas Iron to prepare the CO-CA-03 and CO-WS-14 Monitoring Strategy. The strategy is designed to wholly address conditions 3 and 4 from the EPBC Approval Decision. Furthermore, the overall objective is to ensure that the long-term viability of CO-CA-03, and inherently CO-WS-14, as habitat for Pilbara Leaf-nosed Bat is maintained. This is accomplished by prescribing achievable performance criteria for CO-CA-03 and CO-WA-14 following the collection and analysis of 12 months of baseline data, which may differ from those stipulated in condition 4 of the EPBC Approval Decision, as well as establishing methods to monitor and assess the achievement of these criteria.



Legend

- Study Area
- Development Envelope

Habitat Features

- Cave
- Water Features
- Haul Road
- Pit
- ROM
- Waste Dump

biologic Environmental Survey

N

1:30,000

0 0.225 0.45 0.9 km

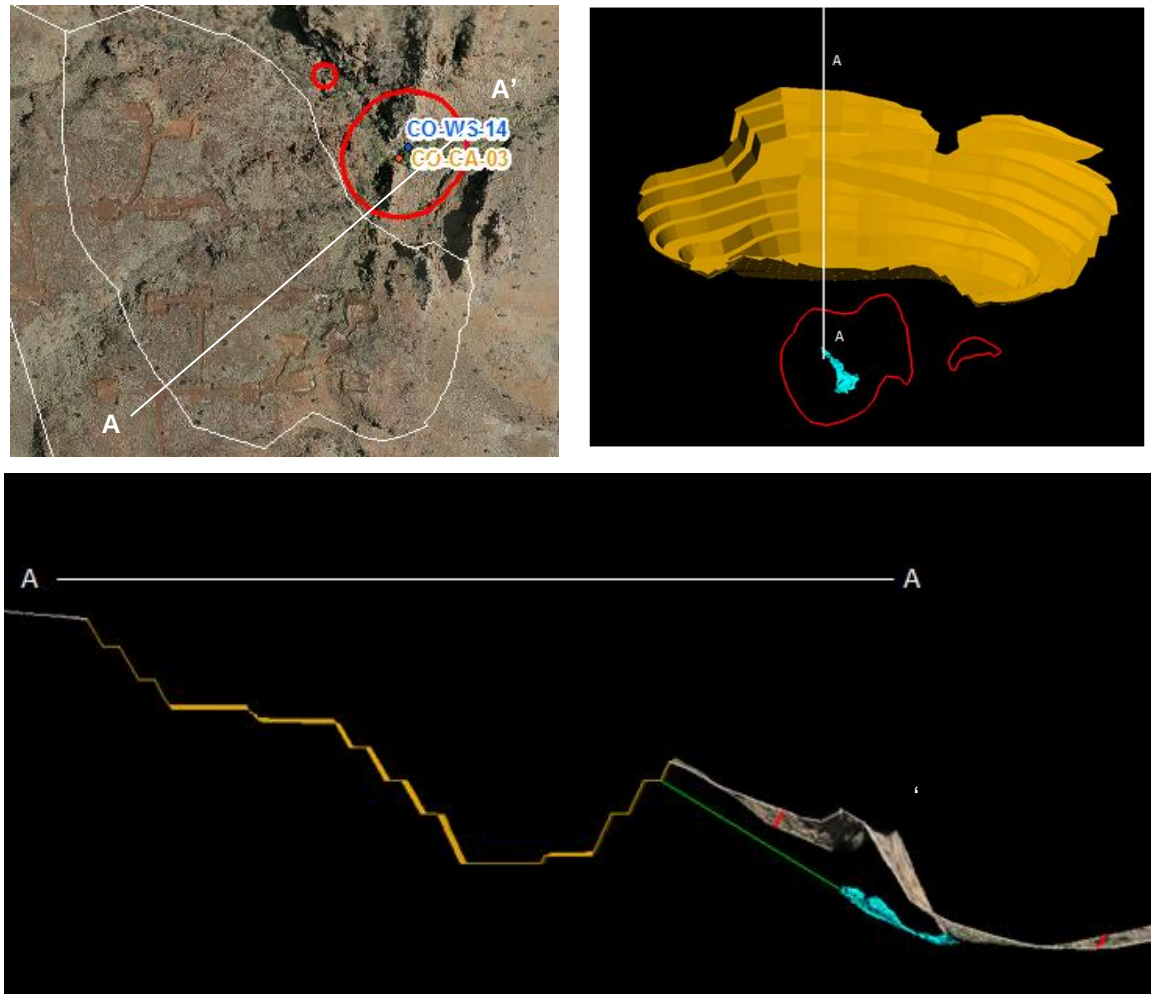
Atlas Iron Pty Ltd - Corunna Downs

Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy

Project Area and key habitat features

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A4. Created 15/06/2020



Note: The green line denotes a distance of 68 m between the Razorback pit (in orange) and the rear of cave CO-CA-03 (in light blue).

Figure 1.2: Plan and Cross-section Illustrating the 2D Buffer and 3D Distance Between Non-Permanent Breeding Roost CO-CA-03 and Razorback Pit

2 BACKGROUND INFORMATION

2.1 Pilbara Leaf-nosed Bat

The Pilbara leaf-nosed bat is listed as Vulnerable under the EPBC Act and the Western Australian *Biodiversity Conservation Act 2016* (BC Act). The Pilbara leaf-nosed bat is recognised as a geographically isolated population of the orange leaf-nosed bat, distributed across northern Australia and separated from the Pilbara populations by approximately 400 km of the Great Sandy Desert (Armstrong, 2001). The Pilbara population is regarded as representing a single interbreeding population comprising multiple colonies (TSSC, 2016). The most updated conservation advice (TSSC, 2016) stated that there were at least 10 confirmed day roosts (including maternity roosts) and a further 23 unconfirmed roosts throughout the Pilbara region, although this is likely to be an underestimate based on unpublished data.

Pilbara leaf-nosed bats typically roost in undisturbed caves, deep fissures or abandoned mine shafts (Armstrong, 2000, 2001). The species' limited ability to conserve heat and water (Baudinette *et al.*, 2000) means they are believed to require warm (28-32 ºC) and very humid (85-100 %) roost sites to persist in arid and semi-arid climates (Armstrong, 2001; Churchill, 1991). Roost sites with such attributes are relatively uncommon in the Pilbara and the limiting factor of the species' distribution (Armstrong, 2001). During the dry season (June to November), individuals are believed to aggregate in roosts that provide a suitably warm, humid microclimate (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). While in the wet season (December to May), when conditions are generally wetter and more humid, individuals typically disperse, roosting in seasonally suitable features (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). TSSC (2016) categorised underground refuges used by the species into four categories:

- **Permanent Diurnal Roosts** (Priority 1 – critical habitat for daily survival): are occupied year-round and are likely to be the focus for some part of the 9-month breeding cycle.
- **Non-Permanent Breeding Roosts** (Priority 2 - critical habitat for daily and long-term survival): are used during some part of the 9-month breeding cycle but not year-round.
- **Transitory Diurnal Roosts** (Priority 3 – critical habitat for daily and long-term survival): are occupied outside the breeding season and could facilitate long distance dispersal.
- **Nocturnal Refuge** (Priority 4 – not considered critical but important for persistence in a local area): are occupied or entered at night for resting, feeding or other purposes (excluding overhangs).

Foraging sites surrounding known or suspected roosts can be critical to the survival of the species as the species forages within the vicinity of roost caves and more broadly along waterbodies with suitable fringing vegetation supporting prey species (TSSC, 2016). TSSC (2016) categorised foraging habitat into five categories: gorges with pools (Priority 1); gullies (Priority 2); rocky outcrops (Priority 3); major watercourses (Priority 4); and open grass and woodland (Priority 5). The species is predicted to travel up to 20 km from roost caves during nightly foraging (Cramer *et al.*, 2016) in the dry season and up to 50 km during the wet season (Bullen, 2013).

2.2 Pilbara Leaf-nosed Bat Habitat

2.2.1 Cave CO-CA-03

Overview

Cave CO-CA-03 (Plate 2.1) was discovered in 2014 (MWH, 2016a). The cave is situated in geological layer defined as “very competent chert” (ACG, 2017), at the bottom of a gorge within Rocky Ridge and Gorge habitat (MWH, 2016a). It is surrounded *“by multiple water seepages and a large spring system that feeds into a large water pool*” (MWH, 2016a) (CO-WS-14) approximately 5 m downslope from the mouth of the cave. The cave comprises a large/ deep entrance and one major internal chamber. The entrance faces north-east and is triangular in shape measuring 5 metres (m) high by 18 m wide. The entrance extends 30 m backward toward a constriction (entrance to the main chamber) measuring 2 m high by 2 m wide. The chamber measures 4 m high by 4 m wide by 10 m deep (adapted from Terra Rosa, 2017). Two water seeps have been noted within the second chamber along the western wall (ACG, 2017; MWH, 2016a), the presence of which persist independent of season (Stantec, 2018). The presence of permanent water inside and immediately surrounding CO-CA-03 may contribute to a suitable microclimate within the cave.

Previous studies have undertaken isolated measurements of the cave’s microclimate, which show that the cave’s microclimate fluctuates throughout the year (Bat Call, 2018; Biologic, 2019a; MWH, 2018). In addition, Pilbara leaf-nosed bat have intermittently roosted with CO-CA-03 during some previous surveys (Bat Call, 2018; Biologic, 2019b; Ecology, 2014; MWH, 2017, 2018) but on every recording night during the breeding season of other surveys (Biologic, 2019a; MWH, 2016a) consequently classifying it as a Non-Permanent Breeding Roost (Priority 2) as defined in Section 2.1.

A 12 month study of ultrasonic recordings and microclimate data was recently undertaken to provide an indication of baseline levels and natural fluctuations in cave microclimate (to compare to those specified in Condition 4c-i and 4c-ii), to determine the scale and frequency with which the cave is used by the Pilbara leaf-nosed bat (to meet Condition 3) and to assess whether the internal microclimate of CO-CA-03 is the primary factor influencing Pilbara leaf-nosed bat roosting preferences (Biologic, 2020). The results of this analysis are summarised below and provided in full in Appendix C.

Plate 2.1: Cave CO-CA-03 (photo taken in 2018)

Microclimate

During the baseline review period (April 2019 to April 2020), temperatures inside CO-CA-03 were notably stable, with minimal daily fluctuation (Biologic, 2020). Temperatures inside the roost remained within the target range (28-32^{o}C) for the entire monitoring period and did not appear to be influenced by ambient (i.e. external to the cave) temperatures.

Overall, humidity ranged from 18.1% to 99.5%, averaging 85.2% (*SE* ± 0.34). During the monitoring period, relative humidity (RH) inside CO-CA-03 was relatively high and stable from April to October 2019, whereby 100% of recordings fell within the target range (85-100%). Following this, RH declined until January 2020, whereby 12.1% of recordings fell within the target range. Finally, RH increased again from January 2020 until the end of the monitoring period. Internal RH was found to be negatively correlated with ambient temperature (above 35^{o}C), and the relationship was mediated by two-week rainfall. Specifically, cave RH was highest when ambient temperature was between 35-40^{o}C and two-week rainfall was ≥250 mm.

Species Use of Cave

Pilbara leaf-nosed bats were recorded on every night during the study at CO-CA-03 except for a single night; on the 8th January 2020 when Cyclone Blake hit Marble Bar. Activity ranged from 64 calls (on the 18th of January 2020) to 56,699 calls (12th of July 2019), averaging 7,033 (±619) calls per night. Roosting was indicated on 47% of recording nights during the monitoring period, of which 91.3% of roosting events occurred between April and October 2019. The level of activity and the consistency of roosting observed over this period coincides with the species mating period and therefore may indicate such activities at the cave and supports the caves classification as a Non-Permanent Breeding Roost (Priority 2). Between October 2019 and April 2020, roosting was only indicated on 8.4% of recording nights. The timing of the remaining calls suggested that individuals were in flight, possibly foraging, and roosting at another location (likely CO-CA-01).

Maximum ambient temperature, maximum cave temperature, range in cave RH and percentage moon illumination were not significant variables influencing roosting status at CO-CA-03. However, roosting (93%) and peaks in activity typically occurred when conditions were more favourable (i.e. temperature and RH within the target ranges) suggesting that these conditions are a prerequisite for roosting. Activity and roosting were however influenced by day of sampling, indicating fluctuations in roosting activity at certain times of the year, exclusive to the other variables tested. This indicates that roosting was driven by untested variables related to timing and/or a behavioural response (e.g. reproductive cues). Moreover, activity was also significantly influenced by range in RH. Therefore, it can be inferred that activity levels and the probability of roosting at CO-CA-03 increases during the mating and gestation period prior to parturition when cave RH is high and relatively stable.

2.2.2 Waterhole CO-WS-14

Overview

Along with the discovery of CO-CA-03, waterhole CO-WS-14 was discovered in 2014 (MWH, 2016a). CO-WS-14 is a 5 m wide by 5 m long (Stantec, 2018) by ~0.9-1 m deep perennial pool (SRK, 2019; Stantec, 2018), located approximately 5 m downslope from the mouth of cave CO-CA-03 and likely constitutes an important drinking source for the Pilbara leaf-nosed bat (MWH, 2016a). The TSSC (2016) defines gorges with pools as Priority 1 Foraging Habitat; "*watercourses through upland areas bounded by sheer rock walls for parts of their length, often containing pools that remain for weeks or months, sites of relatively large biomass production, sometimes containing caves*". For this reason, CO-WS-14 was considered a significant feature for the species within the local area.

During a hydrogeological investigation undertaken between October 2017 and March 2018, it was noted that water levels marginally fluctuated by 0.01 m, which reflected the recession that was observed within the water table (Stantec, 2018). Therefore, while rainfall would periodically replenish water levels within CO-WS-14, it was concluded that the pool was likely groundwater dependant (SRK, 2019; Stantec, 2018). Moreover, the waterhole is located directly under a ledge over which water flows continually. While the water flowing over the ledge may be replenished by surface water overland flow following a rainfall event, it has been observed independent of seasonality. Therefore, the seepage is likely fed by a combination of groundwater discharge and unsaturated flow (Stantec, 2018).

A 12 month study of this pool was recently undertaken to provide an indication of baseline levels and natural fluctuations in pool water quality and levels (required by Condition 4.3), to inform Condition 4a and Condition 4b (Biologic, 2020). The results of this analysis are summarised below and provided in full in Appendix C.

Plate 2.2: Pool CO-WS-14 (photo taken in 2018)

Water Level

Water was observed at CO-WS-14 during the entire monitoring period and has been observed at the pool since its discovery. The pool base level equates to 320.09 metres reduced level (mRL). During the monitoring period (April 2019 to April 2020), water depth at CO-WS-14 was relatively stable (Biologic,

2020). Field observations of water depth ranged from 320.98 mRL to 321.04 mRL (0.06 m difference), averaging ~0.91 meters (m) relative to a staff gauge of 321.00 (std = 0.02) mRL (Table 2.1). Results were emulated in supplementary water logger data (available from the 1st April 2019 until the 30th July 2019) as well as long-term field observations and long-term water logger data (from October 2017 until April 2020; ~2.5 years) recorded at the site (Table 2.1).

Table 2.1: Water depth (mRL) at CO-WS-14

Summary Stats	Field Observations		Water Logger Data	
	April 2019 – April 2020	Long-Term	April – July 2019	Long-Term
Average	321.00	320.99	320.96	320.98
Std	0.02	0.02	0.03	0.03
Min	320.98	320.94	320.90	320.90
Max	321.04	321.04	321.03	321.57
Difference	0.06	0.95	0.1	0.7

Water Quality

Due to the relative locations of CO-CA-03 and CO-WS-14, Pilbara leaf-nosed bat activity recorded at CO-CA-03 is inferred to represent activity for both sites. Pilbara leaf-nosed bats were recorded at CO-CA-03 on every night during the study period, except for a single night (on the 8th January 2020 when Cyclone Blake hit Marble Bar) suggesting the water quality at the CO-WS-14 through the monitoring period was suitable for the species.

During the baseline review period (April 2019 to April 2020), 42 organics, inorganics, physicals, and dissolved metals were analysed to delineate water quality parameters at the site (Biologic, 2020). Water quality was generally good and characterised by circum-neutral to slightly basic pH, fresh waters, with generally low dissolved metals and nutrient concentrations. For analytes with corresponding ANZECC (2000) default guideline values (DGVs), comparisons were made to the 95% DGVs for the protection of aquatic systems (ANZECC, 2000). While most analytes were within ANZG DGV's, two were in excess of the 95% DGV (electrical conductivity and N_NOx). Iron concentrations were within DGVs during the baseline review period. However, the 95% DGV for iron was exceeded on one occasion in December 2017.

3 REVIEW OF CONDITIONS RELATING TO MONITORING STRATEGY

Following the completion of 12 months of baseline monitoring (Biologic, 2020; Appendix C), required by Condition 4.2 and 4.3 of the EPBC Approval (2017/7861) to inform this Monitoring Strategy, it has become apparent that some of the other components of Condition 4 may not be achievable, specifically Condition 4(c). This section aims to review and provide justification for any proposed alternative condition components/ performance objective (Table 3.1). All alternatives have been developed using the SMART principles of specific, measurable, achievable, realistic, and timely.

Table 3.1: Review of EPBC Approval (2017/7861) Condition 4 and Proposed Alternatives

Original Condition Component	Alternate Condition Component/ Performance Objective	Justification
4. The approval holder must develop and submit a Monitoring Strategy to the Minister for approval. The Monitoring Strategy must be based on: • mapping and monitoring of cave CO-CA-03 by an independent scientific expert(s) approved by the Department; • the collection of at least 12 months of baseline humidity and temperature recordings inside cave CO-CA-03; and • 12 months of baseline water quality sampling of pool CO-WS-14.	N/A	Atlas Iron has complied with all three requirements: • In 2017, pre-mining structure was reported by ACG (2017); • a subsequent 3D laser scan of the cave interior was completed by (Terra Rosa, 2017). • 12 months of consecutive baseline monitoring of Cave CO-CA-03 and pool CO-WS-14 was completed between April 2019 and April 2020 (Biologic, 2020; Appendix C).
The Monitoring Strategy must be designed to demonstrate that the structure of cave CO-CA-03 remains unchanged from the pre-mining structure during mining of the Razorback Pit.	The Monitoring Strategy must be designed to demonstrate that during the mining of Razorback Pit, the structure of cave CO-CA-03 is not significantly altered in any way that would prevent its ongoing use as a non-permanent breeding roost for Pilbara Leaf-nosed Bats	Atlas note that this condition varies from the associated performance objective in the Significant Species Management Plan reviewed and approved by the DAWE (Condition 7), which states: '*No significant damage to identified caves* [cave CO-CA-03 and cave CO-CA-01 not within the scope of this monitoring strategy] *that would prevent their ongoing use by Pilbara Leaf-nosed bats*.' The assessment and SSMP recognised that there may be minor structural damage (i.e., rock fall) within the cave which would present no risk to the species. Also note that the approval defined Pre-mining structure as: *'…The structure of cave CO-CA-03 as described in the document (particularly figures 2 and 3) dated 7 August 2017, authored by Dr Phil Dight of Australian Centre of Geomechanics, entitled Corunna Cave Project – CO-CA_03 Cave Stability Assessment, which was provided to the Department on 15 August 2017.'* Atlas Iron note that subsequent to the above report a 3D laser scan of the cave interior was completed by (Terra Rosa, 2017). This pre-mining structure (Figures 2 and 3 of ACG (2017)) has been adapted in consideration of the more accurate laser scan data and is provided in Appendix A

Original Condition Component	Alternate Condition Component/ Performance Objective	Justification
The Monitoring Strategy must also be designed to demonstrate, unless otherwise justified and approved by the Minister, that: 4a) without anthropogenic supplementation of its water level, pool CO-WS-14 has water in it during and continuously for three consecutive years following the cessation of mining of Razorback Pit	N/A	This condition is appropriate, pool CO-WS-14 has been confirmed to be permanent (i.e. contains water all year round) as detailed in Section 2.2.2.
The Monitoring Strategy must also be designed to demonstrate, unless otherwise justified and approved by the Minister, that: 4b) the water quality of pool CO-WS-14 remains suitable for Pilbara leaf-nosed bat during and continuously for three consecutive years following the cessation of mining of Razorback Pit	N/A	While there is no published research/data on suitable water quality parameters for this species, given the consistency at which the species utilises this site as a foraging location (i.e. CO-CA-03 and by virtue CO-WS-14) it suggests water quality recorded at CO-WS-14 during the baseline monitoring was suitable for the species. Data collected over the 12 month baseline monitoring period, in conjunction with national freshwater standards (ANZECC, 2000) will serve to inform the establishment of suitable water quality parameter targets as detailed in Section 2.2.2. A total of 32 analytes will be used to monitor water suitability (Appendix B).
The Monitoring Strategy must also be designed to demonstrate, unless otherwise justified and approved by the Minister, that: 4c-i) cave CO-CA-03 maintains humidity between 85-100 per cent relative humidity during and continuously for five years following cessation of the mining of Razorback Pit	4c-i) cave CO-CA-03 maintain 85-100 per cent relative humidity for at least 50% of each year during, and for five years following cessation of, mining of Razorback Pit	Over the 12-month baseline monitoring period, humidity ranged from 18.1% to 99.5%, averaging 85.2% (SE ± 0.32). However, only 75.3% of humidity recordings over this period fell within the target range (85-100%). Roosting was only indicated at CO-CA-03 on 47% of the sampling days, indicating that humidity is not the only factor influencing roosting behaviour. Relative humidity was significantly correlated with rainfall. A total of 725 mm of rainfall was received during the monitoring period, higher than the long term average for the same period. It is therefore likely that the occurrence of relative humidity within the target range (85-100%) will be less than what was recorded during the baseline monitoring (~75%). Given that Pilbara leaf-nosed bats utilised cave CO-CA-03 as a diurnal roost for approximately 50% of the monitoring year, it is recommended that the relative humidity remain within the optimal range for a similar portion of each monitoring year, to permit consistent use by the species. This target, whilst lower than that recorded, takes into consideration annual rainfall variability (and therefore annual relative humidity variation) and ensures that relative humidity is within the optimal range for at least 25% of the 9 month breeding cycle (July to March), therefore increasing likelihood the cave being used as non-permanent breeding roost for Pilbara Leaf-nosed Bats.

Original Condition Component	Alternate Condition Component/ Performance Objective	Justification
The Monitoring Strategy must also be designed to demonstrate, unless otherwise justified and approved by the Minister, that: 4c-ii) cave CO-CA-03 maintains temperature between 28 and 32 degrees Celsius during and continuously for five years following cessation of the mining of Razorback Pit	4c-ii) cave CO-CA-03 maintains temperature between 28 and 32 degrees Celsius for at least 95% of each year during, and for five years following cessation of, mining of Razorback Pit	Over the 12-month baseline monitoring period, temperature within this cave were notably stable with very little daily fluctuation and ranged from 28.0 to 31.6ºC, averaging 30.3ºC (SE ± 0.02ºC). Temperatures inside the roost remained within the target range (28-32ºC) for the entire monitoring period (100%). However, as the minimum temperature recorded was also the lower limit of the target range (28.0°C), it is possible that the temperature may drop below this threshold under natural conditions not captured within the 12-month baseline monitoring period. Therefore, temperatures maintained between 28 and 32 degrees Celsius for at least 95% of each year would allow for natural year to year variability in temperature to be captured.

4 MONITORING STRATEGY

This Monitoring Strategy aims to document changes to the suitability of CO-CA-03 and CO-WS-14 as habitat for Pilbara leaf-nosed bat, in line with condition 4 of EPBC Approval Decision 2017/7861, during and following the cessation of mining at Razorback pit.

Following the review and proposal of alternative condition components/ performance objectives in Section 3, key performance indicators (KPI's) have been defined and outlined in Table 4.1. Trigger values were also developed to monitor progress toward achieving the key performance objective and to indicate when corrective actions need to be investigated and implemented. Key performance objectives, KPI's, trigger values and likely corrective actions are provided in Table 4.1 along with a summary of the relevant monitoring methods and timing which are discussed further in the following sections.

Table 4.1: Monitoring Strategy Overview

Alternative Condition Components/ Performance Objectives	Key Performance Indicators	Monitoring Technique/ Frequency	Trigger Values	Corrective Actions
No significant damage to CO-CA-03 that would prevent its ongoing use by Pilbara Leaf-nosed bats as a non-permanent breeding roost	Development and implementation of Razorback Blast Management Plan prior to mining commencing by a qualified specialist, which establishes appropriate blast parameters, blast vibration limits at the cave, blasting procedures and blast vibration monitoring.	Blast vibration monitoring as detailed within the Razorback Blast Management Plan (*in prep.).*	• Exceedance of Blast vibration limit. • Non-compliance with Razorback Blast Management Plan.	Where any of these trigger values are recorded, Atlas Iron will, within one month, review the likely cause (with input by suitably qualified specialists as required) and implement one or more of the following corrective actions as appropriate: • Review Razorback Blast Management Plan; • Increase frequency of cave inspections; • Review cave microclimate data; • Commission additional laser scan of cave; • Undertake a geotechnical assessment to reassess the structural integrity and the susceptibility of the cave to structural changes, in light of blast monitoring details and laser scans. • Undertake any practical corrective rehabilitation (e.g. removal of rock fall or sealing of significant fractures), where any identified damage is considered to have the potential to affect ongoing use by bats (i.e. damage which may prevent exit/entry or alter microclimate).
	No major structural damage to cave CO-CA-03 (i.e., collapse of cave entrance or entrance to main chamber, or opening of large fractures which result in loss/change microclimate).	Monthly visual cave inspections during mining (at Razorback pit) and annually thereafter as detailed in Section 4.2.2. Blast vibration monitoring as detailed within the Razorback Blast Management Plan (*in prep.).* Annual laser scan of cave CO-CA-03 during, and a year after cessation of, mining of Razorback pit.	• Minor to moderate rock fall within or at the entrance of the cave (i.e. does not impede bat movements/entrance into the cave and rear chamber). • New fractures.	
	CO-CA-03 is used as a non-permanent breeding roost by Pilbara leaf-nosed bat at least once in the five years following the cessation of mining of Razorback Pit.	Annual Pilbara leaf-nosed bat ultrasonic monitoring annually for up to five years following the cessation of mining at Razorback pit, in accordance with the methodology detailed in the SSMP (Condition 7) and summarised in Section 4.2.6.	• No record of Pilbara Leaf-nosed Bat roosting in the first two years following cessation of mining at Razorback pit.	
Maintain suitable microclimate for Pilbara leaf-nosed bats within cave CO-CA-03 during, and for five years following cessation of, mining of Razorback Pit	Cave CO-CA-03 maintain 85-100 per cent relative humidity for at least 50% of each year of monitoring.	Continuous microclimate monitoring, during (to be analysed quarterly and reported annually) and for up to five years following the cessation of mining (to be analysed and reported annually) at Razorback pit, as detailed in Section 4.2.5.	• Cave CO-CA-03 maintain 85-100 per cent relative humidity for less than 75% of a monitoring year	
	Cave CO-CA-03 maintains a temperature between 28 and 32 degrees Celsius for 95% of each year of monitoring.		• Cave CO-CA-03 maintains a temperature between 28 and 32 degrees Celsius for less than 98% of a monitoring year	
Persistence of CO-WS-14 during, and continuously for three consecutive years following the cessation of, mining of Razorback Pit	CO-WS-14 continuously contains water during, and for three consecutive years following the cessation of, mining of Razorback pit. No anthropogenic supplementation of CO-WS-14 water level	Monthly visual inspection of pool staff gauge (and download of data loggers) during mining of the Razorback pit as detailed in Section 4.2.3. This monitoring will continue for three years following the cessation of mining at the Razorback pit quarterly in the first year and annually thereafter.	• Water level drops below 320.77 mRL (or 320.17 mRL on staff gauge) – equates to 95% of the minimum baseline reading.	Where this trigger value is recorded, Atlas Iron will, within one month, review the likely cause and implement one or more of the following corrective actions as appropriate: • Review WL field measurement and logger data. • Increase pool monitoring frequency. • Review Site Water Operating Plan, monitoring data and water abstraction rates and requirements. • Investigate ongoing use by Pilbara leaf-nosed bats.

Alternative Condition Components/ Performance Objectives	Key Performance Indicators	Monitoring Technique/ Frequency	Trigger Values	Corrective Actions
Maintain suitable water quality for Pilbara Leaf-nosed Bats within pool CO-WS-14 during, and for three consecutive years following cessation of, mining of Razorback Pit	Development and implementation of a specific Razorback Hydrocarbon (and chemical) Spill Management Procedure prior to mining of the Razorback pit commencing. Exceedance of acceptable Naphthalene levels (in accordance with ANZECC (2000) 95% GV's (Appendix B)	Quarterly water sampling and testing during mining of the Razorback pit as detailed in Section 4.2.4. This monitoring will continue for three years following the cessation of mining at the Razorback pit quarterly in the first year and annually thereafter.	• Non-compliance with Razorback Hydrocarbon (and chemical) Spill Management Procedure. • Exceedance of acceptable Naphthalene levels (in accordance with ANZECC (2000) 99% GV's (Appendix B)	Where any of these trigger values are recorded, Atlas Iron will within one month review the likely cause (with input by suitably qualified specialists as required) and implement one or more of the following corrective actions as appropriate: • Additional sampling and testing for hydrocarbons after a non-compliance with Razorback Hydrocarbon (and chemical) Spill Management Procedure. • Increase pool monitoring frequency. • Review Razorback Hydrocarbon (and chemical) Spill Management Procedure. • Review Site Water Operating Plan, monitoring data and water abstraction rates and requirements. • Investigate surface water and sediment runoff around the pit and implement any necessary repairs to surface water controls (i.e. bunds). • Review recommendation for exceedances provided by (ANZG, 2018).
	Water quality of pool CO-WS-14 shall not exceed site-specific GV (SSGV's) (Appendix B).		• Exceedance of 80th percentile SSGVs (Appendix B) over two consecutive quarterly monitoring events.	

4.1 Monitoring Schedule

This Monitoring Strategy comes into action at the commencement of mining at the Razorback pit (currently planned for September 2021) and stays in force for up to 5 years following the cessation of mining of this pit (currently anticipated July 2023). A summary of the monitoring schedule is outlined in Table 4.2. To adequately capture the breeding season, quarterly monitoring should occur in January, April, July and October of each year. Please note these dates are subject to change dependent on the actual start and end of mining at Razorback and will be adjusted accordingly.

Table 4.2: Monitoring schedule

Monitoring Technique	Frequency	During Mining*			Post-mining				
		2021	2022	2023	2024	2025	2026	2027	2028
Visual cave inspection	Monthly during mining, annually thereafter	Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec			Between Apr-Sep				
Laser scan	Annually	Between Oct-Mar			Oct-Mar	-			
Pool monitoring – water levels	Monthly during mining, quarterly for the first year post-mining, annually thereafter	Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec			Jan, Apr, Jul, Oct	Oct		-	
Pool monitoring – water quality	Quarterly during mining and for the first year post-mining, annually thereafter	Jan, Apr, Jul, Oct			Jan, Apr, Jul, Oct	Oct		-	
Microclimate monitoring	Continuous collection of data with quarterly analysis during mining and annual analysis thereafter	Jan, Apr, Jul, Oct			Between Apr-Mar				
Ultrasonic monitoring	Annually in conjunction with SSMP requirements	Between Apr-Sep			Between Apr-Sep				

Note: Above schedule based on the commencement of mining at the Razorback pit in September 2021 and completion of mining in July 2023. these dates are subject to change dependent on the actual start and end of mining at Razorback and will be adjusted accordingly.

4.2 Monitoring Methods

4.2.1 Visual cave inspection

Visual cave inspections will be conducted in accordance with the frequency and schedule in Table 4.2 to compare physical features of the cave against the pre-mining structure, as adapted from Terra Rosa (2017), to document any changes over time. In addition, a visual cave inspection will also be conducted a month ahead of mining commencing to inform current baseline condition and to install drop sheets across the cave floor to support the identification of any rockfall during mining. Each visual cave inspection will record the following characteristics (see Appendix A):

- Entrance photographs (at two established photo monitoring points);
- Evidence of structural damage;
    - Are there any new open or intersecting joints or fractures along the roof, wall or bedding planes of the cave?
    - Are there any loose rocks or signs of fresh rock fall within the cave? If yes, note;
        - Amount of dust and/or fallen rocks
        - Size of largest rock
- Water presence; and
- Presence of target species: no. individuals, and/or secondary evidence.

Given the proximity of the proposed Razorback Pit, mining activity during visual cave inspections will need to be considered to ensure the safety of personnel inspecting the cave.

Visual cave inspections will be supplemented by blast monitoring conducted in accordance with the Razorback Blast Management Plan (*in prep*.), which will include monitoring for changes in cave condition during blasting by geotechnical engineers.

4.2.2 Laser scan cave CO-CA-03

A suitably qualified professional will be commissioned by Atlas Iron to undertake a laser scan of cave CO-CA-03 each year between October-March (outside the breeding season to limit disturbance to the species) during mining of the Razorback pit and in the first year after mining.

The results of the laser scan will be compared to the baseline (conducted by, Terra Rosa, 2017) and any subsequent scans to identify whether there has been any change in pre-mining condition/structure of the cave.

4.2.3 Pool monitoring – water levels

Routine monitoring of waterhole CO-WS-14 will be undertaken in accordance with the frequency and schedule in Table 4.2 to track changes in water quantity.

To delineate water quantity visual observations including water height (relative to the staff gauge), water colour and water flow as well as temperature, pH and conductivity will be noted. To supplement these observations, a water logger will be deployed in the water body to measure water temperature, pressure, and depth on a more regular basis.

4.2.4 Pool monitoring – water quality

Routine monitoring of waterhole CO-WS-14 will be undertaken in accordance with the frequency and schedule in Table 4.2 to track changes in water quality.

Water quality samples will need to be collected from the site using best practice procedures to minimise any potential for contamination (Ahlers *et al.*, 1990; Batley, 1989; Madrid & Zayas, 2007). Undisturbed water samples should be taken for laboratory analyses of ionic composition, nutrients, dissolved metals and total suspended solids and Polycyclic Aromatic Hydrocarbons (PAH) (Table 4.3). Samples collected for dissolved metals should be filtered through 0.45 µm Millipore nitrocellulose filters in the field (up to 250 mL). All water samples should be collected using clean Nalgene sample bottles, and clean/new filters and syringes. All water quality sampling equipment should be stored in polyethylene bags, and samplers should wear polyethylene gloves whilst sampling water quality. All water samples need to be kept cool in an esky whilst in the field, and either refrigerated (ions, dissolved metals, nutrients, general water), or frozen (total nutrients) as soon as possible for subsequent transport to the laboratory. A NATA accredited chemical analysis laboratory should always be used that can achieve sufficiently low LODs to allow comparison with ANZECC (2000) DGVs and/or site-specific guideline values (SSGVs) developed here.

Table 4.3: Water quality analytes to be monitored

Analyte	Unit	Analyte	Unit
pH		Dissolved Antimony (dSb)	mg/L
Electrical Conductivity (EC)	µS/cm	Dissolved Arsenic (dAs)	mg/L
Nitrate as NO_3	mg/L	Dissolved Barium (dBa)	mg/L
Nitrite as NO_2	mg/L	Dissolved Boron (dBo)	mg/L
NOx as N (N_NOx)	mg/L	Dissolved Cadmium (dCd)	mg/L
Calcium (Ca)	mg/L	Dissolved Chromium (dCr)	mg/L
Potassium (K)	mg/L	Dissolved Cobalt (dCo)	mg/L
Magnesium (Mg)	mg/L	Dissolved Copper (dCu)	mg/L
Sodium (Na)	mg/L	Dissolved Iron (dFe)	mg/L
Bicarbonate HCO_3	mg/L	Dissolved Lead (dPb)	mg/L
Carbonate CO_3^{2-}	mg/L	Dissolved Manganese (dMn)	mg/L
Total Alkalinity	mg/L	Dissolved Mercury (dHg)	mg/L
Chloride (Cl)	mg/L	Dissolved Molybdenum (dMo)	mg/L
Sulphate (SO_4)	mg/L	Dissolved Nickel (dNi)	mg/L
Silica (Si)	mg/L	Dissolved Selenium (dSe)	mg/L
Dissolved Aluminium (dAl)	mg/L	Dissolved Zinc (dZn)	mg/L
		Polycyclic Aromatic Hydrocarbons (PAH) - Napthalene	mg/L

The data collected during each monitoring event will be compared to the baseline review (Biologic, 2020) to determine any significant changes to the water quality at CO-WS-14. For analytes that were within ANZECC/ANZECC (2000) guidelines during the baseline review, the DGV's are proposed as the operational guideline. Additionally, where the ANZG DGV for 95% species protection was greater than the 80th percentile value derived from the baseline data, the default ANZG DGV is proposed as the operational guideline. Analytes within DGVs include pH, nitrate, dAl, dAs, dBo, dCd, dCr, dCu, dPb, dMn, dNi, dFe, dZn and dSe (see Appendix B for levels). For analytes where the 80th percentile value of baseline data was greater than the default 95% GV, the 80th percentile value is proposed as the operational guideline. Moreover, for the analytes which do not have a corresponding ANZG GV, SSGVs

were based solely on the 80% percentile of reference data. Analytes for which the 80th percentile will be used for ongoing monitoring include EC, nitrite, N_NOx, Ca, K, Mg, Na, HCO_3, CO_3^{2-}, total alkalinity, Cl, SO_4, Si, dSb, dBa, dCo, dHg and dMo (see Appendix B for levels).

4.2.5 Microclimate monitoring

Cave microclimate (temperature and relative humidity) will be monitored continuously, analysed quarterly, and reported annually during mining (analysed and reported annually thereafter). To assess the interior microclimate within CO-CA-03, temperature and humidity loggers will be deployed in the same location as during the baseline review (Biologic, 2020). Data loggers will be set to record at a minimum of every 6 hours starting from 00:00.

The temperature and humidity range recorded (daily minimum and maximum) will then be plotted against the target ranges; 28–32^{o}C for temperature and 85–100% for RH. The data collected during each monitoring event will be statistically compared to the baseline review (Biologic, 2020) and any previous monitoring event (Biologic, 2019a; MWH, 2018).

4.2.6 Ultrasonic monitoring

To supplement the microclimate monitoring, and to track the use of CO-CA-03 during mining so as to better inform its' use following the cession of mining at Razorback pit, an ultrasonic recorder will be established at CO-CA-03 (deployed in the same location as during the baseline review (Biologic, 2020). To determine ongoing use of cave CO-CA-03 during and post mining, ultrasonic monitoring will be undertaken in accordance with the frequency and schedule in Table 4.2. Monitoring will be undertaken in accordance with SSMP.

The data collected during each monitoring visitation will be analysed following the methods of the review (Biologic, 2020) and statistically compared to the baseline monitoring data (Biologic, 2020) and any previous monitoring event (Biologic, 2019a; MWH, 2018).

4.2.7 Pre-mining activities

Prior to the commencement of mining at Razorback, the following will need to be implemented to ensure monitoring can be effectively completed as per this document:

- One baseline visual cave inspection needs to be conducted and drop sheets need to be placed in the floor of cave CO-CA-03 to inform cave inspections;
- Ultrasonic bat recording system to be established in way to permit regular download of data without need to enter cave;
- Microclimate monitoring system to be established in way to permit regular download of data without need to enter cave. Equipment should be set to allow comparison with baseline dataset

4.3 Reporting

Microclimate data will be analysed and reported to Atlas Iron on a quarterly basis to ensure regular assessment against the trigger values and Key Performance Indicators. All results are to be summarised and presented in annual monitoring period. A standalone report at the conclusion of each annual monitoring period (January to December) will be prepared. Annual reporting should follow activity within a calendar year to best align with species reproductive cycle.

The report will be compiled by a suitably qualified zoologist, and will:

- Summarise the analysis of microclimate and ultrasonic data as well as water quality and quantity data including methods, results, discussion.
- Compare microclimate and ultrasonic data with baseline levels.
- Summarise the outcomes of cave inspections and laser scans.
- Assess performance against each of the monitoring strategies key performance objectives and KPIs.
- Detail any corrective actions undertaken or considered (or reasoning as to why any corrective actions were not undertake or considered)
- Make any necessary recommendations.

The report will be appended to Atlas Irons AER and submitted to the DAWE by 30 June of each year.

5 REFERENCES

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6 APPENDICES

Appendix A: Visual Cave Inspection Checklist

Visual Cave Inspection at CO-CA-03 Against the Pre-mining Structure	
Date: ____/_____/_____	Personnel:
Time:	
Assessment Criteria	**Observation**
Presence of Pilbara leaf-nosed bats (no. individuals and/or secondary evidence)	
Main Entrance	
Any new open or intersecting joints or fractures along the roof, wall or bedding planes?	
Loose rocks or signs of fresh rock fall within the cave? If yes, note; • Amount of dust/fallen rocks • Size of largest rock	
Entrance to Roosting Chamber	
Any new open or intersecting joints or fractures along the roof, wall or bedding planes?	
Loose rocks or signs of fresh rock fall within the cave? If yes, note; • Amount of dust/fallen rocks • Size of largest rock	
Roosting Chamber	
Water Seeps Present?	
Any new open or intersecting joints or fractures along the roof, wall or bedding planes?	
Loose rocks or signs of fresh rock fall within the cave? If yes, note; • Amount of dust/fallen rocks • Size of largest rock	

Visual Cave Inspection at CO-CA-03 Against the Pre-mining Structure

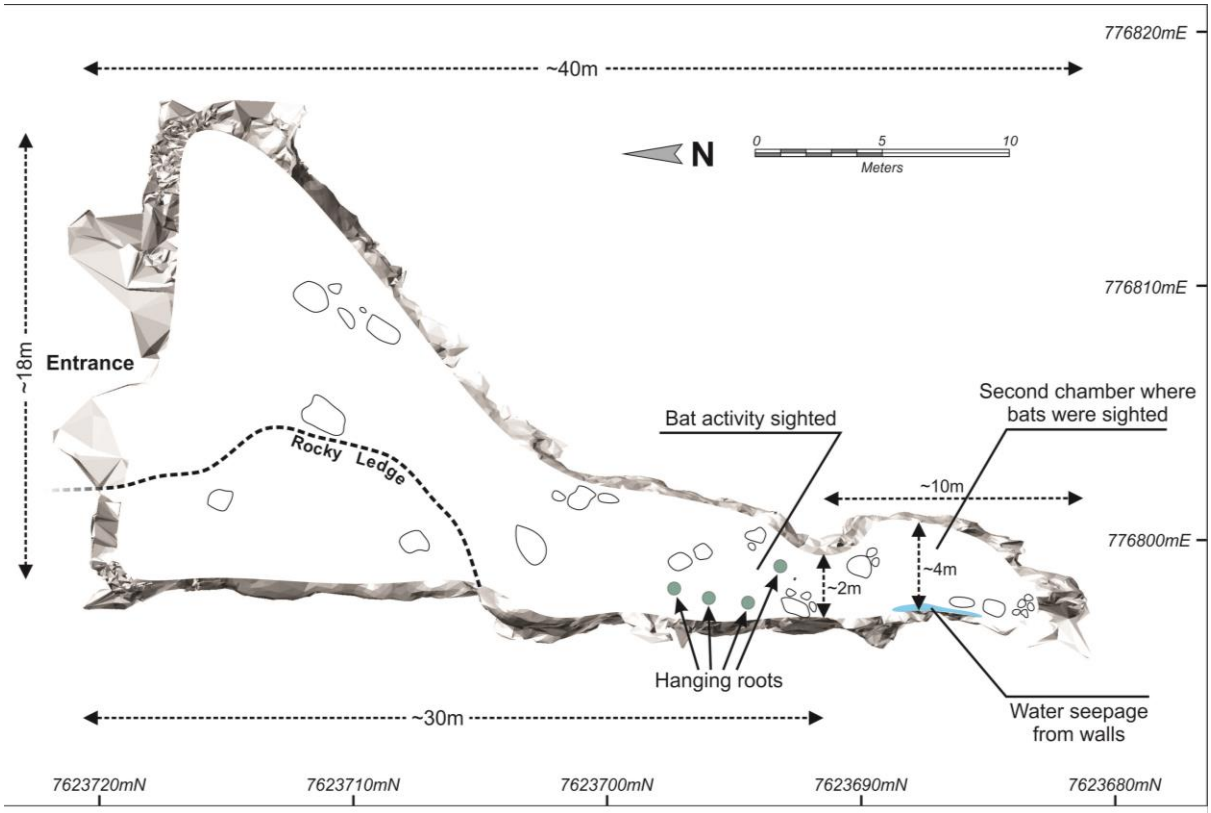

Figure 6.1: Bird Eye View of CO-CA-03 (adapted from Terra Rosa, 2017)

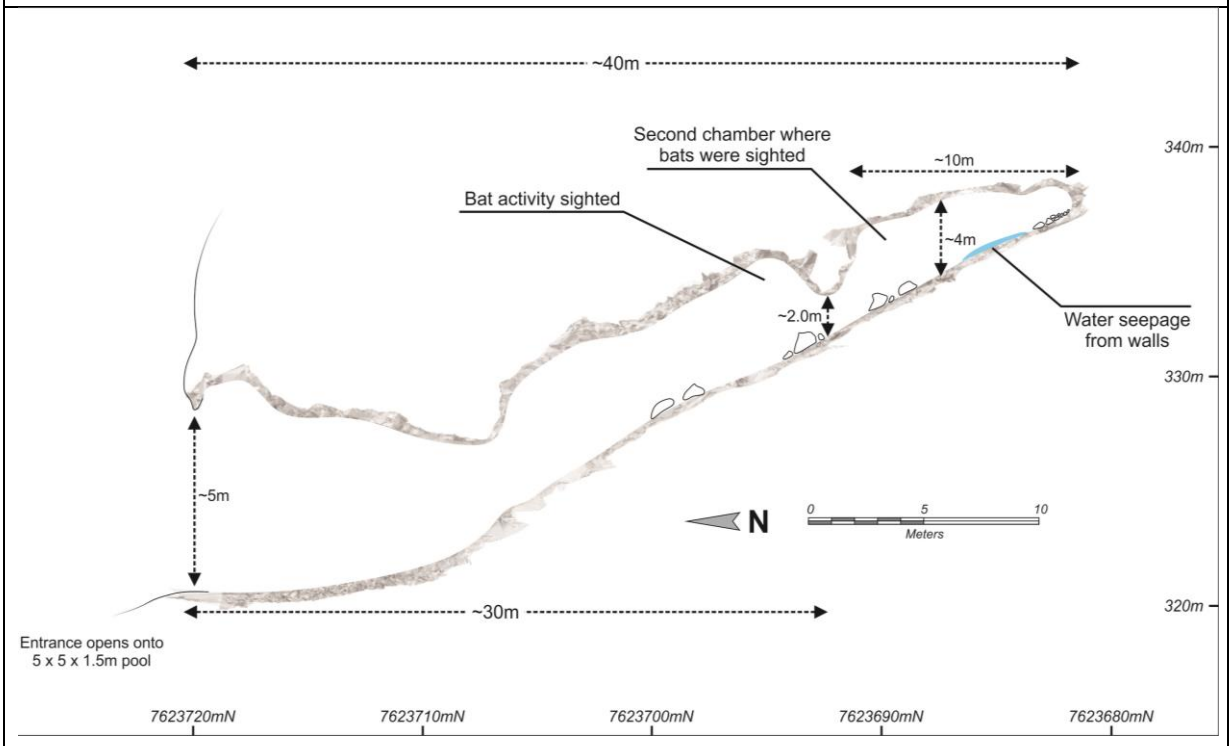

Figure 6.2: Lateral View of CO-CA-03 (adapted from Terra Rosa, 2017)

Appendix B: Water Quality

Where baseline levels of the analytes exceeded the 95% GV (prescribed by ANZECC, 2000) or where 95% GV were unavailable, 95th percentiles were calculated as site specific GVs [SSGVs]. SSGVs are usually set as targets in which to maintain a system; once the values fall outside of the SSGV, a level of disturbance may be inferred. SSGVs are usually set in terms of some identified, acceptable level of change from 'reference' condition, with the extent of allowable change sufficiently small as to represent a low level of risk of considerable disturbance to the ecosystem. ANZECC (2000) provide the national standard for developing these targets with respect to water and sediment quality and set SSGVs at the 80th percentile and/or 20th percentile (for analytes which also require a lower GV, i.e. pH and dissolved oxygen) of the baseline condition. These percentiles are deemed to be approximately equivalent to ± one standard deviation around the median, and this level of change is considered unlikely to result in a high risk of disturbance to the ecosystem (ANZECC, 2000).

Note that the number of monitoring analytes has been reduced to those that reflect quality of freshwater for aquatic systems (e.g. removing laboratory checks and tests such as ionic balance, sum on anions, sum of cations etc.) and to avoid duplicating tests (e.g. TDS which is a surrogate of EC).

Analyte	Unit	20th Percentile	80th Percentile	95th Percentile	ANZECC (2000) DGV95%	ANZECC (2000) DGV99%	SSGV
Naphthalene					0.016	0.0025	TV = 0.0025 KPI = 0.016
pH		7.5	7.98	8	6 - 8		6 - 8
Electrical Conductivity (EC)	µS/cm	-	348	360	250		360
Nitrate as NO_3	mg/L	-	0.25	1	2.4		2.4
Nitrite as NO_2	mg/L	-	0.25	1			1
NOx as N (N_NOx)	mg/L	-	0.0252	0	0.01		0.0252
Calcium (Ca)	mg/L	-	12	13			13
Potassium (K)	mg/L	-	1.64	3			3
Magnesium (Mg)	mg/L	-	22	23			23
Sodium (Na)	mg/L	-	22	24			24
Bicarbonate HCO_3	mg/L	-	93.8	100			100
Carbonate CO_3^{2-}	mg/L	-	2.5	3			3
Total Alkalinity	mg/L	-	93.8	100			100
Chloride (Cl)	mg/L	-	33	135			135
Sulphate (SO_4)	mg/L	-	30	79			79
Silica (Si)	mg/L	-	18.8	20			20
Dissolved Aluminium (dAl)	mg/L	-	0.005	0	0.055		0.055
Dissolved Antimony (dSb)	mg/L	-	0.0005	0			0.0005
Dissolved Arsenic (dAs)	mg/L	-	0.0005	0	0.024		0.024
Dissolved Barium (dBa)	mg/L	-	0.0086	0			0.0086
Dissolved Boron (dBo)	mg/L	-	0.1	0	0.37		0.37
Dissolved Cadmium (dCd)	mg/L	-	0.00005	0	0.0002		0.0002
Dissolved Chromium (dCr)	mg/L	-	0.0005	0	0.001		0.001
Dissolved Cobalt (dCo)	mg/L	-	0.0005	0			0.0005
Dissolved Copper (dCu)	mg/L	-	0.0005	0	0.0014		0.0014
Dissolved Iron (dFe)	mg/L	-	0.048	0	0.3		0.3
Dissolved Lead (dPb)	mg/L	-	0.0005	0	0.0034		0.0034
Dissolved Manganese (dMn)	mg/L	-	0.258	0	1.9		1.9
Dissolved Mercury (dHg)	mg/L	-	0.00005	0			0.00005

Analyte	Unit	20th Percentile	80th Percentile	95th Percentile	ANZECC (2000) DGV95%	ANZECC (2000) DGV99%	SSGV
Dissolved Molybdenum (dMo)	mg/L	-	0.0005	0			0.00005
Dissolved Nickel (dNi)	mg/L	-	0.0005	0	0.011		0.011
Dissolved Selenium (dSe)	mg/L	-	0.0005	0	0.011		0.011
Dissolved Zinc (dZn)	mg/L	-	0.0025	0	0.008		0.008

Appendix C: Corunna Downs Pilbara Leaf-nosed Bat Roost Analysis

Corunna Downs Pilbara Leaf-nosed Bat Roost Analysis

Biologic Environmental Survey

Report to Atlas Iron Pty Ltd

July 2020

Document Status				
Revision No.	Author	Review / Approved for Issue	Approved for Issue to	
			Name	Date
1	B. Downing; C. Knuckey; L. Dinis	C. Knuckey	N. Bell	5/06/2020
2	B. Downing;	C. Knuckey	N. Bell	17/06/2020
3	A. Hutchison	C. Knuckey	N. Bell	10/07/2020
4	B. Downing	C. Knuckey	N. Bell	13/07/2020

"IMPORTANT NOTE"

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In preparing this report we have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request or enquiry were complete, accurate and up-to-date. Where we have obtained information from a government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware of any reason why any of the assumptions are incorrect.

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EXECUTIVE SUMMARY

Atlas Iron Pty Ltd (Atlas Iron) are looking to develop the Corunna Downs Project (the Project) located approximately 25 kilometres (km) south-west of Marble Bar within the Chichester subregion of Western Australia's Pilbara bioregion. The Project was approved by the Department of the Environment and Energy (DoEE) on the 23rd of February 2018 (*Environment Protection and Biodiversity Conservation (EPBC) Act 1999* Approval Decision 2017/7861) subject to four conditions directly relevant to the Pilbara leaf-nosed bat, including condition 3 and 4 that specifically relate to the potential impacts to and management of cave CO-CA-03 and pool CO-WS-14. Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by Atlas Iron to accurately define conditions and activity at the cave and the pool to inform the development of a 'CO-CA-03 Monitoring Strategy'. Focus was given to assessing whether Conditions specified in EPBC Approval Decision 2017/7861 are appropriate. The specific objectives of the review were to:

- review and summarise water sampling conducted at CO-WS-14 (Condition 4.3) to determine natural fluctuations in water level and quality (inform adequacy of Condition 4a and to inform parameters for Condition 4b).
- analyse and review 12 months of microclimate data collected from within the cave (Condition 4.2) to provide an indication of baseline levels and natural fluctuations to compare to those specified in Condition 4c-i and 4c-ii and where justified provide scientifically based alternative parameters.
- analyse ultrasonic recordings from CO-CA-03 to confirm the scale and frequency with which the cave is used by the Pilbara leaf-nosed bat (to meet Condition 3) and to assess whether the internal microclimate of CO-CA-03 is the primary factor influencing Pilbara leaf-nosed bat roosting preferences.

Ultrasonic and microclimate data from CO-CA-01 and CO-CA-03, and water depth and quality data from pool CO-WS-14 were collected over a 12 month period; from the 17th of April 2019 until the 25th of April 2020.

Cave Microclimate

During the monitoring period (April 2019 to April 2020), temperatures inside both CO-CA-01 and CO-CA-03 were notably stable, with minimal daily fluctuation. Overall temperatures were slightly higher inside CO-CA-03 than CO-CA-01, on average. Temperatures inside CO-CA-03 remained within the target range (28-32ºC) for the entire monitoring period (100%), while temperatures inside CO-CA-01 remained within the target range for 99.89% of the monitoring period. Ambient temperatures appeared to have very little influence on temperatures inside the roost.

During the monitoring period, relative humidity (RH) inside CO-CA-03 occurred over a greater range than CO-CA-01, though was on average, significantly higher than at CO-CA-01. There was a non-linear monthly trend in humidity. Additionally, cave RH was found to be negatively correlated with ambient temperature (after 35ºC), and the relationship was mediated by two-week rainfall. Specifically, cave RH

was highest when ambient temperature was between 35-40ºC and two-week rainfall was ≥250 mm. Cave RH was relatively high and stable from April to late-September 2019 and from April to early-October 2019 at CO-CA-01 and CO-CA-03, respectively. During this period, 94.8% of recordings fell within the target range at CO-CA-01 and 100% fell within the target range at CO-CA-03. Following this, RH declined in both caves until January 2020, whereby 6.5% and 12.1% of recordings fell within the target range at CO-CA-01 and CO-CA-03, respectively. This coincided with an increase in ambient daily maxima (averaged 42.2ºC) and limited two-week rainfall. Finally, RH increased again within both caves from January 2020 until the end of the monitoring period. Water seeps have been noted in both caves and are likely to contribute to humid internal conditions. It is likely these seeps are supplemented by rainfall emanating through the rock strata.

Cave Utilisation

Pilbara leaf-nosed bats were recorded at both CO-CA-01 and CO-CA-03 on every night during the monitoring period except for a single night at CO-CA-03; on the 8th January 2020 when Cyclone Blake hit Marble Bar. Activity occurred over a greater range at CO-CA-03 compared to CO-CA-01 and was significantly higher on average.

Roosting was indicated on all recording nights during the monitoring period at CO-CA-01. The pattern of usage is consistent with a 'Permanent Diurnal Roost' as defined by Threatened Species Scientific Committee (TSSC) in the species conservation advise. Pilbara leaf-nosed bat activity and roosting events remained relatively constant throughout the monitoring period regardless of the apparent cyclic and delayed seasonal variation in cave RH.

Conversely, roosting at CO-CA-03 was indicated on 47% of recording nights during the monitoring period, of which 91.3% of roosting events occurred between the April 2019 and October 2019. The level of activity and the consistency of roosting observed over this period coincides with the species mating period and therefore may indicate such activities at the cave. Moreover, this pattern of usage is consistent with a 'Non-Permanent Breeding Roost' as defined by TSSC in the species conservation advise. Between October 2019 and the April 2020, the timing of most of these calls suggested that individuals were in flight, possibly foraging, and roosting at another location.

Maximum ambient temperature, maximum cave temperature, range in cave RH and percentage moon illumination were not significant variables influencing roosting status at CO-CA-03. However, roosting and peaks in activity typically occurred when conditions were more favourable (i.e. temperature and RH within the target ranges) suggesting that these conditions are a prerequisite for roosting. Activity and roosting were however influenced by day of sampling, indicating fluctuations in roosting activity at certain times of the year, exclusive to the other variables tested. This indicates that roosting was driven by untested variables related to timing and/or a behavioural response (e.g. reproductive cues). Moreover, activity was also significantly influenced by range in RH. Therefore, it can be inferred that activity levels and the probability of roosting at CO-CA-03 increases during the mating and gestation period prior to parturition when cave RH is high and relatively stable.

Water Monitoring

Water was continuously present within pool CO-WS-14 during the entire monitoring period (April 2019 to April 2020), as well as over the long-term (October 2017 to April 2020). During the current monitoring period water levels averaged ~1.1 meters (m) relative to a staff gauge or 321.00 (Std ±0.02) meters reduced level (mRL), indicating a permanent source of water for the species. Given the consistency at which the species uses CO-CA-03 (and by virtue CO-WS-14) as a foraging location (outside of roosting), it is inferred that the quality and the water levels recorded are suitable for Pilbara leaf-nosed bat usage. CO-WS-14 is likely to represent foraging habitat critical to Pilbara leaf-nosed bat presence.

1 INTRODUCTION

1.1 Project Background

Atlas Iron Pty Ltd (Atlas Iron) are looking to develop the Corunna Downs Project (the Project) located approximately 25 kilometres (km) south-west of Marble Bar within the Chichester subregion of Western Australia's Pilbara bioregion (Figure 1.1). The Project involves the development and operation of an open cut iron ore mine and associated mining infrastructure, waste rock dumps, borefield, and accommodation camp. The Project will source iron ore from five open pits using conventional drill and blast, load and haul methods (Atlas Iron, 2019). To date, several surveys have been conducted over the Project area to delineate environmental impacts to vertebrate fauna. A two phase Level 2 terrestrial vertebrate fauna survey was conducted between 2014 and 2016, which included extended deployments of ultrasonic recorders (MWH, 2016). Seven species of conservation significance were recorded within the Project area during these baseline surveys, including the Pilbara leaf-nosed bat, which was confirmed to permanently reside in the Study Area within a Permanent Diurnal Roost (CO-CA-01). In addition to this a Non-permanent Breeding Roost (CO-CA-03) for the species as well as a permanent and likely ground water dependent pool (CO-WS-14) at the base of CO-CA-03 was identified.

Several surveys and investigations have since been conducted to better understand the significance and classification of CO-CA-03, as well as the sources and mechanisms driving the discharge of water into cave CO-CA-03 (two water seeps have been noted within the second chamber) and pool CO-WS-14. These included bat echolocation monitoring (MWH, 2017), video census (Bat Call, 2018), cave stability (ACG, 2017) assessments and a laser scan by Terra Rosa in 2017, baseline monitoring surveys in 2017 (MWH, 2018), 2018 (Biologic, 2019c) and 2019 (Biologic, 2019a) as well as a hydrogeological investigation in 2018 (Stantec, 2018) and 2019 (SRK, 2019). Bat echolocation monitoring and a video census has also been conducted at the Permanent Diurnal Roost CO-CA-01 (Bat Call, 2018).

The Project was approved by the Department of the Environment and Energy (DoEE) on the 23rd of February 2018 (*Environment Protection and Biodiversity Conservation (EPBC) Act 1999* Approval Decision 2017/7861) subject to four conditions directly relevant to the Pilbara leaf-nosed bat, including condition 3 and 4 that specifically relate to the potential impacts to, and management of, cave CO-CA-03 and pool CO-WS-14:

3. The approval holder must demonstrate that, both during and after mining ceases at the Razorback Pit, cave CO-CA-03 and waterhole CO-WS-14 remain suitable habitat available for use by the Pilbara Leaf-nosed Bat.
4. The approval holder must develop and submit a Monitoring Strategy to the Minister for approval. The Monitoring Strategy must be based on:
    - 4.1 mapping and monitoring of cave CO-CA-03 by an independent scientific expert(s) approved by the Department;
    - 4.2 the collection of at least 12 months of baseline humidity and temperature recordings inside cave CO-CA-03; and
    - 4.3 12 months of baseline water quality sampling of waterhole CO-WS-14.

The Monitoring Strategy must be designed to demonstrate that the structure of cave CO-CA-03 remains unchanged from the pre-mining structure during mining of the Razorback Pit. The monitoring strategy must also be designed to demonstrate, unless otherwise justified and approved by the Minister, that:

a) without anthropogenic supplementation of its water level, waterhole CO-WS-14 has water in it during and continuously for three consecutive years following the cessation of mining of Razorback Pit; and

b) the water quality of pool CO-WS-14 remains suitable for Pilbara leaf-nosed bat during and continuously for three consecutive years following the cessation of mining of Razorback Pit; and

c) cave CO-CA-03 maintains:

i. humidity between 85-100 per cent relative humidity

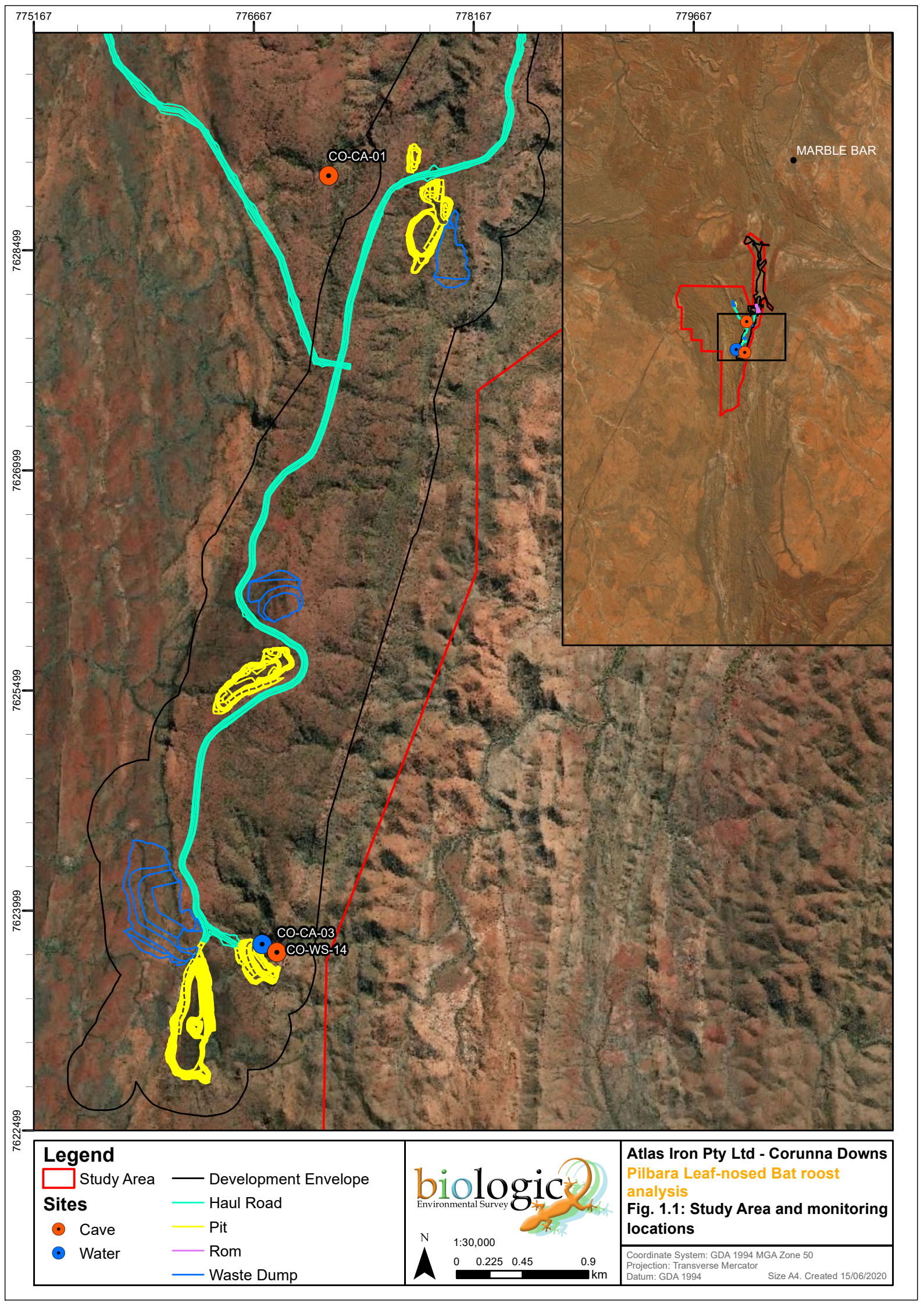
ii. temperature between 28 and 32 degrees Celsius

during and continuously for five years following cessation of the mining of Razorback Pit.

1.2 Survey Objectives

Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by Atlas Iron to accurately define conditions and activity at the cave to inform development of a 'CO-CA-03 Monitoring Strategy'. Focus was given to assessing whether conditions specified in EPBC Approval Decision 2017/7861 were appropriate. The specific objectives of the review were to:

- review and summarise water sampling conducted at CO-WS-14 (Condition 4.3) to determine natural fluctuations in water level and quality (inform adequacy of Condition 4a and to inform parameters for Condition 4b).
- analyse and review 12 months of microclimate data collected from within the cave (Condition 4.2) to provide an indication of baseline levels and natural fluctuations to compare to those specified in Condition 4c-i and 4c-ii and where justified provide scientifically based alternative parameters; and
- analyse ultrasonic recordings from CO-CA-03 to confirm the scale and frequency with which the cave is used by the Pilbara leaf-nosed bat (to meet Condition 3) and to assess whether the internal microclimate of CO-CA-03 is the primary factor influencing Pilbara leaf-nosed bat roosting preferences.



Legend

- Study Area
- Development Envelope
- Haul Road
- Pit
- Rom
- Waste Dump

Sites

- Cave
- Water

biologic Environmental Survey

N

1:30,000

0 0.225 0.45 0.9 km

Atlas Iron Pty Ltd - Corunna Downs

Pilbara Leaf-nosed Bat roost analysis

Fig. 1.1: Study Area and monitoring locations

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A4. Created 15/06/2020

2 SPECIES OF INTEREST

2.1 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form)

The Pilbara leaf-nosed bat is listed as Vulnerable under the EPBC Act and the Western Australian *Biodiversity Conservation Act 2016* (BC Act). The Pilbara leaf-nosed bat is recognised as a geographically isolated population of the orange leaf-nosed bat, distributed across northern Australia and separated from the Pilbara populations by approximately 400 km of the Great Sandy Desert (Armstrong, 2001). The Pilbara population is regarded as representing a single interbreeding population comprising multiple colonies (TSSC, 2016). The most updated conservation advice (TSSC, 2016) stated that there were at least 10 confirmed day roosts (including maternity roosts) and a further 23 unconfirmed roosts throughout the Pilbara region, although this is likely to be an underestimate based on unpublished data.

Pilbara leaf-nosed bats typically roost in undisturbed caves, deep fissures or abandoned mine shafts (Armstrong, 2000, 2001). The species' limited ability to conserve heat and water (Baudinette *et al.*, 2000) means they are believed to require warm (28-32 ºC) and very humid (85-100 %) roost sites to persist in arid and semi-arid climates (Armstrong, 2001; Churchill, 1991). Roost sites with such attributes are relatively uncommon in the Pilbara and the limiting factor of the species' distribution (Armstrong, 2001). During the dry season (June to November), individuals are believed to aggregate in roosts that provide a suitably warm, humid microclimate (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). While in the wet season (December to May), when conditions are generally wetter and more humid, individuals typically disperse and roost in seasonally suitable features (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). TSSC (2016) categorised underground refuges used by the species into four categories:

- **Permanent Diurnal Roosts** (Priority 1 – critical habitat for daily survival): are occupied year-round and are likely to be the focus for some part of the 9-month breeding cycle.
- **Non-Permanent Breeding Roosts** (Priority 2 - critical habitat for daily and long-term survival): are used during some part of the 9-month breeding cycle but not year-round.
- **Transitory Diurnal Roosts** (Priority 3 – critical habitat for daily and long-term survival): are occupied outside the breeding season and could facilitate long distance dispersal.
- **Nocturnal Refuge** (Priority 4 – not considered critical but important for persistence in a local area): are occupied or entered at night for resting, feeding or other purposes (excluding overhangs).

Foraging sites surrounding known or suspected roosts can be critical to the survival of the species as the species forages within the vicinity of roost caves and more broadly along waterbodies with suitable fringing vegetation supporting prey species (TSSC, 2016). TSSC (2016) categorised foraging habitat into five categories: gorges with pools (Priority 1); gullies (Priority 2); rocky outcrops (Priority 3); major watercourses (Priority 4); and open grass and woodland (Priority 5). The species is predicted to travel up to 20 km from roost caves during nightly foraging (Cramer *et al.*, 2016) in the dry season and up to 50 km during the wet season (Bullen, 2013).

3 MICROHABITAT FEATURES OF INTEREST

3.1 Cave CO-CA-03

Cave CO-CA-03 (Plate 3.1) was discovered in 2014 during the first phase of the Level 2 terrestrial vertebrate fauna survey (MWH, 2016). The cave is situated in geological layer defined as "*very competent chert*" (ACG, 2017), at the bottom of a gorge within Rocky Ridge and Gorge habitat (MWH, 2016). It is surrounding *"by multiple water seepages and a large spring system that feeds into a large water pool*" (MWH, 2016) (CO-WS-14) approximately 5 m downslope from the mouth of the cave. The cave comprises a large/ deep entrance and one major internal chamber. The entrance faces north-east and is triangular in shape measuring 5 metres (m) high by 18 m wide. The entrance extends 30 m backward toward a constriction (entrance to the main chamber) measuring 2 m high by 2 m wide. The chamber measures 4 m high by 4 m wide by 10 m deep (adapted from Terra Rosa, 2017). Two water seeps have been noted within the second chamber along the western wall (ACG, 2017; MWH, 2016), "*the presence of which has also been observed to be independent of seasonality (i.e. persisting during the dry season*" (Stantec, 2018).

Plate 3.1: Cave CO-CA-03 (photo taken in 2018)

The presence of permanent water inside and immediately surrounding CO-CA-03 may contribute to a suitable microclimate within the cave. The internal microclimate of the cave was first measured during the baseline monitoring survey conducted between July and September 2017 (RH averaged 95.88% [Std ±1.12]). Temperature and humidity levels were found to be suitable for the species and consistent with the microclimates recorded at other diurnal roosts (including CO-CA-01) (MWH, 2018). Bat Call (2018) completed a roost census in November 2017 during which no Pilbara leaf-nosed bats were observed roosting within the cave and humidity was closer to ambient (52%). The lower humidity was said to be on account of outward flowing air. Bat Call (2018) noted that the "*presence of the outward flowing air was a significant observation that had not been observed previously. The reason for this airflow can only be explained by a crack in the rear chamber's strata that is either open through to the top of the ridge above or open to a very large cavity within the hill behind the cave. However, the lack of humidity in the air suggests that the former is most likely, as a large cavity within the hill is likely to be very humid due to the presence of ground water. This crack may at times be closed by ground water within the strata or some*

other process that cuts the airflow and allows the high humidity to form within the chamber" (Bat Call, 2018).

Pilbara leaf-nosed bat have intermittently roosted with CO-CA-03 during previous surveys (Bat Call, 2018; Biologic, 2019b; MWH, 2017, 2018). The species was recorded roosting on every recording night during Phase 2 of the Level 2 terrestrial vertebrate fauna survey (late September to early October: MWH, 2016) and the 2019 baseline monitoring survey (July: Biologic, 2019a). As such the cave has been classified as a Non-Permanent Breeding Roost (Priority 2), as defined in Section 2.1.

To collect baseline data and to better understand the factors driving roosting by Pilbara leaf-nosed bats at CO-CA-03, an automated solar powered Song Meter (SM) unit was installed at the entrance of the main chamber, and a Hydrochron humidity and temperature logger (iButton) was deployed in a location as representative as possible of the roosting area in 2017 for the provision of permanent monitoring (MWH, 2017). Additionally, annual monitoring in accordance with the Corunna Downs Significant Species Management Plan (SSMP) has since been undertaken in 2017 (MWH, 2018), 2018 (Biologic, 2019c) and 2019 (Biologic, 2019a), prior to the commencement of mining.

3.2 Pool CO-WS-14

Along with the discovery of CO-CA-03, pool CO-WS-14 (Plate 3.2) was discovered in 2014 during the first phase of the Level 2 terrestrial vertebrate fauna survey (MWH, 2016). CO-WS-14 is a 5 m wide by 5 m long, (Stantec, 2018) by ~0.9-1 m deep (SRK, 2019) perennial pool (Stantec, 2018). It is located approximately 5 m from the mouth of cave CO-CA-03 and likely constitutes an important drinking source for the Pilbara leaf-nosed bat (MWH, 2016). The TSSC (2016) defines gorges with pools as Priority 1 Foraging Habitat; "*watercourses through upland areas bounded by sheer rock walls for parts of their length, often containing pools that remain for weeks or months, sites of relatively large biomass production, sometimes containing caves*". For this reason, CO-WS-14 was considered a significant feature for the species within the local area.

Plate 3.2: Pool CO-WS-14 (photo taken in 2018)

During a hydrogeological investigation undertaken between October 2017 and March 2018, it was noted that water levels marginally fluctuated by 0.01 m, which reflected the recession that was observed within the water table (Stantec, 2018). Therefore, while rainfall would periodically replenish water levels within CO-WS-14, it was concluded that the pool was likely groundwater dependant (SRK, 2019; Stantec, 2018). Moreover, the pool is located directly under a ledge over which water flows continuously. While the water flowing over the ledge may be replenished by surface water overland flow following a rainfall event, it has been observed independently of season. Therefore, the seepage is likely fed by a combination of groundwater discharge and unsaturated flow (Stantec, 2018).

The Pilbara leaf-nosed bat is frequently recorded via ultrasonic recorders in the vicinity of open water, suspected of using such features as drinking sources. The parameters surrounding water quantity and quality required by the species is however unknown. Though, it is assumed that if the Pilbara leaf-nosed bat currently utilises CO-WS-14 (either as a source of drinking water or a foraging location) then the current (natural) levels and fluctuations in water quantity and quality at CO-WS-14 are suitable for the species.

4 METHODS

4.1 Survey Locations and Timing

The current project aimed to provide a targeted analysis of the temporal use of CO-CA-03 (and by virtue CO-WS-14) and the natural factors that influenced its' use by the Pilbara leaf-nosed bat, including changes in cave microclimate and water quantity and quality at pool CO-WS-14.

The Permanent Diurnal Root (CO-CA-01) was also monitored during this period to better understand the relationship between the two caves (i.e. whether CO-CA-03 is a satellite cave for individuals from CO-CA-01) as well as to provide a comparison of the natural factors that may influence roosting by the Pilbara leaf-nosed bat. Microclimate data (refer to Section 4.3) and ultrasonic data (refer to Section 4.4) were collected from both caves over a 12 month period; from the 17th of April 2019 until the 25th of April 2020. Data was downloaded every one-to-three months by Atlas Iron staff, Theo Sprenkels (Atlas Iron Senior Environmental Advisor) and Arnold Slabber (Atlas Iron Environmental Advisor). Water level and quality data (refer to Section 4.54.4) at pool CO-WS-14 was collected monthly by Atlas Iron Staff over the same 12 month period (where not impeded by extreme weather events and associated loss of access).

4.2 Climate

The Pilbara bioregion has a semi-desert to tropical climate, with rainfall occurring sporadically throughout the year, although mostly during summer (Thackway & Cresswell, 1995). Summer rainfall is usually the result of tropical storms in the north or tropical cyclones that impact upon the coast and move inland (Leighton, 2004). The winter rainfall is generally lighter and is the result of cold fronts moving north easterly across the state (Leighton, 2004). The average annual rainfall ranges from 200-350 mm, although there are significant fluctuations between years, with some locations receiving up to 1,200 mm in some years (McKenzie *et al.*, 2009).

From January 2019 to April 2020, Marble Bar Station (weather station 004106) recorded 725 millimetres (mm) of rainfall, which is higher than the long term annual average rainfall for the same period (677.7 mm; Figure 4.1) (BoM, 2020). A substantial amount of rainfall was received in March 2019 (246.2 mm was received compared to the long-term average of 81.3 mm), on account of Cyclone Veronica, and in January 2020 (311.6 mm was received compared to the long-term average of 114.7 mm), on account of Cyclone Blake.

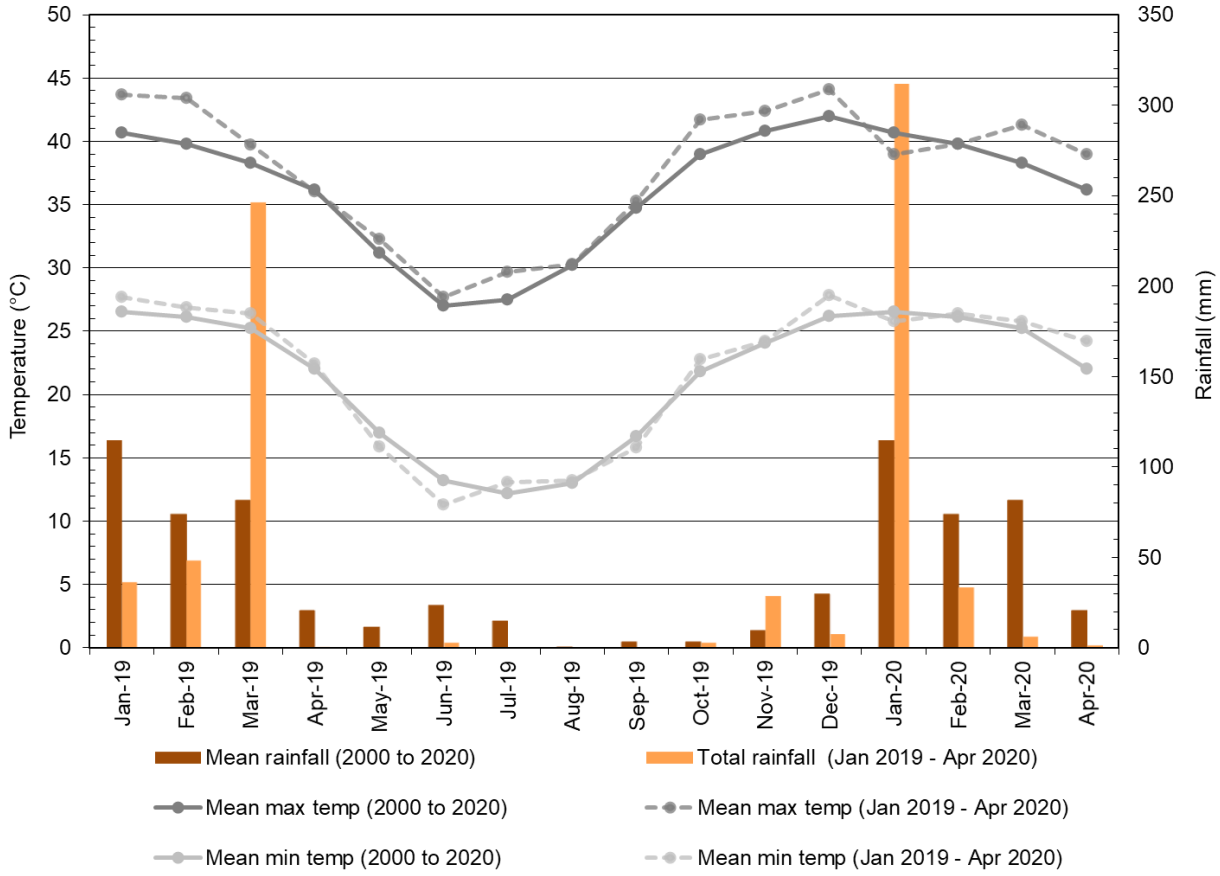


Figure 4.1: Long-term and current climatic data for Marble Bar (BoM, 2020)

4.3 Microclimate Monitoring

Hydrochron (DS1923) temperature and humidity loggers (iButtons; Plate 4.1) were deployed to assess the interior microclimate (temperate and relative humidity [RH]) within cave CO-CA-01 and CO-CA-03. Two iButtons (one for redundancy) were deployed in locations as representative as possible of the roosting area.

Plate 4.1: Hydrochron (DS1923) temperature and humidity loggers at CO-CA-03

4.4 Ultrasonic Monitoring

During a previous annual monitoring survey (Biologic, 2019c), Song Meter (SM4BAT FS) ultrasonic recorders (SM4; Wildlife Acoustics, USA) powered by an external solar power supply, were permanently installed at CO-CA-01 and CO-CA-03 (Plate 4.2) to record bat echolocation calls. The SM4 units were fitted with an external, directional SMX-US ultrasonic microphone. The unit was positioned to provide an unobstructed 'line of sight' between the microphone and the likely bat flyway. Recorders were preconfigured to activate at astronomical sunset each day and deactivate at astronomical sunrise the following morning. Audio settings and selectable filters used to preconfigure each unit, and hence define the volume and frequency ranges sought, followed the manufacturer's recommendations for bat detection (Wildlife Acoustics, 2017). Parameters used during this survey are outlined in Table 4.1.

Table 4.1: SM4 Software Parameters and Settings

Parameter	Setting
Sample rate	384kHz
Compression protocol	W4V-4
Gain	12dB
16k High filter	Off
Minimum Trigger Frequency	12kHz
Trigger Level	6dB
Triggering window	3 seconds

Due to technical issues, no ultrasonic data was captured between the 20th of April and the 20th of July 2019.

All recordings over the monitoring period were analysed by Robert Bullen of Bat Call WA using standardised bat call detection techniques. Raw files were first scanned for Pilbara Leaf-nosed Bat calls using Kaleidoscope software (Wildlife Acoustics, USA), then reviewed for significant times (first call and last call per recording night) and call numbers (total between first call and last call per recording night) using Cool Edit software (Adobe, USA). During analysis, a recording night was considered from sunset to sunrise the following day. Because any individual is likely to emit multiple calls at any site during any night, the call numbers were treated as a measure of 'activity' rather than providing a total number of individuals present. While activity is likely to reflect individuals present, the exact correlation between the two is likely to vary per site (i.e. depending on how the bats use and navigate the site) and per night (e.g. other animals present may change the time spend at a particular site).

Roosting was indicated if one of the following criteria were satisfied: (1) if last call during the previous recording night occurred after dawn, (2) if first call during the current monitoring night was within ≤10 minutes of dusk or (3) if last call during the previous recording night occurred ≤10 minutes before dawn or occurred after dawn and first call during the current monitoring night was within ≤30 minutes of dusk. First call at the permanently used CO-CA-01 was 7.9 minutes before dusk, on average, confirming its status as a permanent diurnal roost. If the Pilbara leaf-nosed bat flies at a rate of 22 km/hr (McKenzie & Bullen, 2009), it would take an individual at least 14.5 minutes to fly directly from CO-CA-01 to CO-CA-03. Consequently, any calls at cave CO-CA-03 received before 10 minutes after dawn eliminates the likelihood of foraging and confirms roosting behaviour at this cave.

During monthly retrieval of data, the number of Pilbara Leaf-nosed bats observed roosting in the cave was also noted. However, the absence of individuals is not considered conclusive, given the numerous cavities within which the Pilbara leaf-nosed bat could hide.

Plate 4.2: Ultrasonic recorders at monitoring caves CO-CA-01 (left) and CO-CA-03 (right)

4.5 Water Monitoring

Routine monitoring of pool CO-WS-14 was undertaken to assist in understanding how the pools' water quantity and quality may vary seasonally.

Atlas Iron staff conducted ten field visitations (approximately one month apart) between the 17th of April 2019 and the 25th of April 2020. During each visitation, six readings were taken including three visual observations (water height relative to the staff gauge, water colour and water flow) and three measured recordings (temperature, pH and conductivity). To supplement these monthly observations, water logger data was available from the 1st of April 2019 until the 30th July 2019. Variables including water temperature, pressure and depth were measured hourly via a Level TROLL 400. Long-term water logger data collected at pool CO-WS-14 (since October 2017) was also available and thus, compared to data collected during the current monitoring period to gain a better understanding of temporal trends.

To delineate water quality, water samples were also collected during each monitoring visitation. A 1 Litre (L) bottle was filled with site water for the analysis of routine organics, inorganics, or physicals (Table 4.2). Additionally, 250mL of water was filtered for the evaluation of metals (Table 4.2). The samples were then placed into a cooler on ice for the remainder of the sampling day. At the end of the sampling day, samples were stored in a refrigerator until they could be dispatched to ENVIROLAB for analysis (Appendix A). Long-term water quality data collected at pool CO-WS-14 (since October 2017) was also available and thus, compared to data collected during the current monitoring period to gain a better understanding of temporal trends.

Table 4.2: Routine Organics, Inorganics, Physicals and Metals Analysed

Analyte	Unit	Analyte	Unit
pH		Sum of Cations	meq/L
Electrical Conductivity	µS/cm	Silica	mg/L
Total Dissolved Solids	mg/L	Aluminium-Dissolved	mg/L
Total Suspended Solids	mg/L	Antimony-Dissolved	mg/L
Fluoride	mg/L	Arsenic-Dissolved	mg/L
Nitrate as NO_3	mg/L	Barium-Dissolved	mg/L
Nitrite as NO_2	mg/L	Boron-Dissolved	mg/L
NOx as N	mg/L	Cadmium-Dissolved	mg/L
Calcium - Dissolved	mg/L	Chromium-Dissolved	mg/L
Potassium - Dissolved	mg/L	Cobalt-Dissolved	mg/L
Magnesium - Dissolved	mg/L	Copper-Dissolved	mg/L
Sodium - Dissolved	mg/L	Iron-Dissolved	mg/L
Bicarbonate HCO_3 as $CaCO_3$	mg/L	Lead-Dissolved	mg/L
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	Manganese-Dissolved	mg/L
Hydroxide OH- as $CaCO_3$	mg/L	Mercury-Dissolved	mg/L
Total Alkalinity as $CaCO_3$	mg/L	Molybdenum-Dissolved	mg/L
Chloride	mg/L	Nickel-Dissolved	mg/L
Sulphate	mg/L	Selenium-Dissolved	mg/L
Ionic Balance	%	Strontium-Dissolved	mg/L
Hardness as $CaCO_3$	mg/L	Tin-Dissolved	mg/L
Sum of Anions	meq/L	Zinc-Dissolved	mg/L

Prior to the current monitoring period, routine monitoring was conducted at CO-WS-14 along with a further seven pools in the Project area (Appendix A). Therefore, long-term water quality and quantity data collected at pool CO-WS-14 was compared to data collected at the additional water pools where available (Appendix A) to provide a comparative understanding of the natural variability and factors driving such variation at CO-WS-14. However, a direct comparison could not be completed due to differences in sampling periods.

4.6 Statistical Analysis

4.6.1 Microclimate Variation at CO-CA-01 and CO-CA-03

Summary statistics (generated in excel) considered all temperature and RH readings recorded each sampling day (i.e. between 0000 and 2100). Daily climactic data (i.e. rainfall, minimum and maximum temperatures) were retrieved from Marble Bar Station (weather station 004106) (BoM, 2020). Daily percentage moon illumination data was retrieved from Moongiant (2020).

In a bid to see whether cave microclimate was directly affected by climatic conditions outside the cave we performed three tests. Note: to delineate the daytime microclimate that may influence diurnal roosting by Pilbara leaf-nosed bats, only microclimate data obtained during a typical diurnal roosting period (between 0600 and 1800 each day) was used for this statistical analysis):

1. internal temperature (within each cave) was plotted against ambient temperature to determine the degree to which the two variables were correlated;
2. as temperature influences the amount of water vapor held in air (Perry, 2012), maximum cave RH (within each cave) was plotted against ambient temperature (daily maxima) to determine the degree to which the two variables were correlated; and
3. cumulative two-weekly rainfall was plotted against maximum cave RH.

Modelling was then used to test for a cave effect, a nonlinear monthly trend, and a nonlinear interaction of ambient temperature and two-week rainfall on cave RH. The mixed GAM computation vehicle (mgcv) package in R with the beta regression family of data distributions and a logit link function was used. It is appropriate where the response (cave RH) is a proportion (0,1). A cubic regression spline was fitted to the nonlinear month effect and a tensor spline was fitted to the nonlinear interaction effect of ambient temperature and two-week rainfall. All analyses were performed in R (R Core Team, 2017). The R package “mgcViz” (Fasiolo *et al.*, 2018) was used to plot the effects and check the model fit the data appropriately. P values were used to define significant results.

4.6.2 Ultrasonic Analysis

Effects on Roosting by Pilbara Leaf-nosed Bats at CO-CA-03

To better delineate the daytime microclimate that may influence diurnal roosting by Pilbara leaf-nosed bats, only microclimate data obtained during a typical diurnal roosting period (between 0600 and 1800 each day) was used for this statistical analysis. As diurnal roosting was demonstrated throughout the monitoring period at CO-CA-01, the following analyses were only conducted for CO-CA-03 in a bid to see what factors influence diurnal roosting at this cave. Two GAM models were generated to investigate:

1. maximum cave temperature, maximum ambient temperature, percentage moon illumination and day of sampling (day 1 equates to 17th April 2019 and day 374 equates to 24th April 2020) versus the binary response variable of roosting (0 = not roosting, 1 = roosting).
2. maximum cave temperature, range of cave RH, percentage moon illumination and day of sampling versus roosting.

The mgcv package in R with the binomial regression family was used. Model fit diagnostics were assessed with the R package mgcViz (Fasiolo *et al.*, 2018). P values were used to define significant results.

Effects on Pilbara Leaf-nosed Bat Activity at CO-CA-01 and CO-CA-03

Only microclimate data between 0600 and 1800 each day was used for this statistical analysis. Through a visual interrogation of microclimate data, average day-time temperature did not fluctuate from average night-time temperature (20.9ºC at CO-CA-01 and 30.3ºC at CO-CA-03). Moreover, average day-time RH (76.8% at CO-CA-01 and 85% at CO-CA-03) did not fluctuate by more than 0.6% RH from night-time RH (77.4% at CO-CA-01 and 85.6% at CO-CA-03). To determine the factors that influence Pilbara leaf-nosed bat activity the following models were produced:

1. GAM model investigating the effect of maximum cave humidity, percentage moon illumination and day of sampling.
2. GAM model investigating the effect of range in cave humidity, percentage moon illumination and day of sampling.

The mgcv package was used in R with the Tweedie regression family. Cubic regression smoothing splines were fit to cave humidity and day of sampling so their nonlinear effects on activity could be estimated. Additionally, linear effects in the model were cave and percentage moon illumination. Temporal autocorrelation (order=1) was also included in the model. Cave temperature was not included because of problems of model convergence. All analyses were performed in R. The R package “mgcViz” (Fasiolo *et al.*, 2018) was used to check the residuals. P values were used to define significant results.

4.6.3 Water Analysis

To ensure pool CO-WS-14 remains suitable for Pilbara leaf-nosed bat, natural levels were delineated via summary statistics (including minimum, maximum, range, median, mean and standard error). R function 'stat.desc' from the package 'pastecs' was used to obtain the descriptive statistics (Grosjean & Ibanez, 2018).

Supplementary to this, the Australian and New Zealand Guidelines (ANZG) were used to better understand the water quality of the site with regards to its ecological suitability (ANZECC & ARMCANZ, 2019). The primary objective of the ANZG guidelines is “*to provide an authoritative guide for setting water quality objectives required to sustain current, or likely future, environmental values (users) for natural and semi-natural water resources in Australia and New Zealand*” (ANZECC & ARMCANZ, 2019). The guidelines aim to provide industry standard but are not mandatory and have no formal legal status.

ANZECC and ARMCANZ (2019) broadly classify physical and chemical stressors into groups depending on their effects to aquatic ecosystems; whether they are direct or indirect effects, and whether these effects include direct toxicity to biota. The guidelines provide default guideline values (GVs) for a range of water quality analytes designed to protect aquatic ecosystems at a low level of risk but are not designed as pass or fail compliance criteria. Rather, exceedances of default GVs are intended to act as triggers to inform managers and regulators that changes in water quality are occurring and may need to be investigated. In this context, GVs are defined as a “measurable quantity (threshold) or condition of an indicator for a specific community value below or above which we consider to be a low risk of

unacceptable effects occurring". The default GVs are inherently conservative assessment levels and are intended to be applied to systems for which there are no baseline data or where baseline data are insufficient to adequately describe the natural or existing seasonal or annual fluctuations in water quality.

Summary statistics (median, average, minimum and maximum) were compared against the 95% and 99% (protection level signifies the percentage of species expected to be protected) GV's. Moreover, long-term water quality data collected at pool CO-WS-14 was compared to data collected during the current monitoring year where available (Appendix E) to provide a better understanding of the natural variability.

All less than values were removed from the data set and less than value was assumed to be the true value (for instance Copper levels were assumed to be 0.001 mg/L). However, if the data sets for each analyte also contained true values, then less than values were halved (i.e. <0.001 mg/L was assumed to be 0.0005 mg/L). An outlier was removed from the Lead-Dissolved (mg/L) data set during the current monitoring year and from the Molybdenum-Dissolved (mg/L) within the long-term data set. Almost all values equated to <0.001 mg/L, with a single value equating to <0.00005 mg/L. As none of the values were true values, it was not possible to estimate a true value below <0.001 mg/L and thus, perform summary statistics on the data. Therefore, the <0.00005 mg/L results were removed. Outliers were removed from the water logger dataset if the water logger was retrieved (for the purpose of downloading data) around the same time as the hourly log, particularly if the resulting log varied greatly in comparison to logs recorded immediately prior and immediately preceding the retrieval.

5 RESULTS

5.1 Temperature

5.1.1 CO-CA-03

During the monitoring period (April 2019 to April 2020), temperatures inside CO-CA-03 were notably stable, with very little daily fluctuation. Overall temperatures ranged from 28.0 to 31.6 °C (3.6 °C difference) inside the roost (Table 5.1, Appendix C), averaging 30.3ºC (*SE* ± 0.02ºC) throughout the monitoring period. Comparatively, ambient temperatures ranged from 7.2 to 47.8ºC (40.6ºC difference). Therefore, ambient temperatures had very little influence on temperatures inside the roost (Figure 5.1). Although, temperature within the cave declined marginally between October and December 2019, there was little temporal variation. Temperatures inside the roost remained within the target range (28-32 °C) for the entire monitoring period (100%).

Table 5.1: Summary of temperature data (April 2019 to April 2020) recorded inside CO-CA-03.

Summary Stats	Temperature (°C)								
	3am	6am	9am	12pm	3pm	6pm	9pm	12am	OVERALL
Average	30.3	30.3	30.4	30.4	30.3	30.3	30.3	30.3	**30.3**
SE	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.04	**0.02**
Minimum	28.5	28.5	29.0	28.5	28.0	28.0	28.0	28.5	**28.0**
Maximum	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	**31.6**
Difference between Minimum and Maximum	3.1	3.1	2.6	3.1	3.6	3.6	3.6	3.1	**3.6**
Number of recordings between 28 - 32ºC									**2,848**
Percentage of recordings within 28 - 32ºC									**100%**

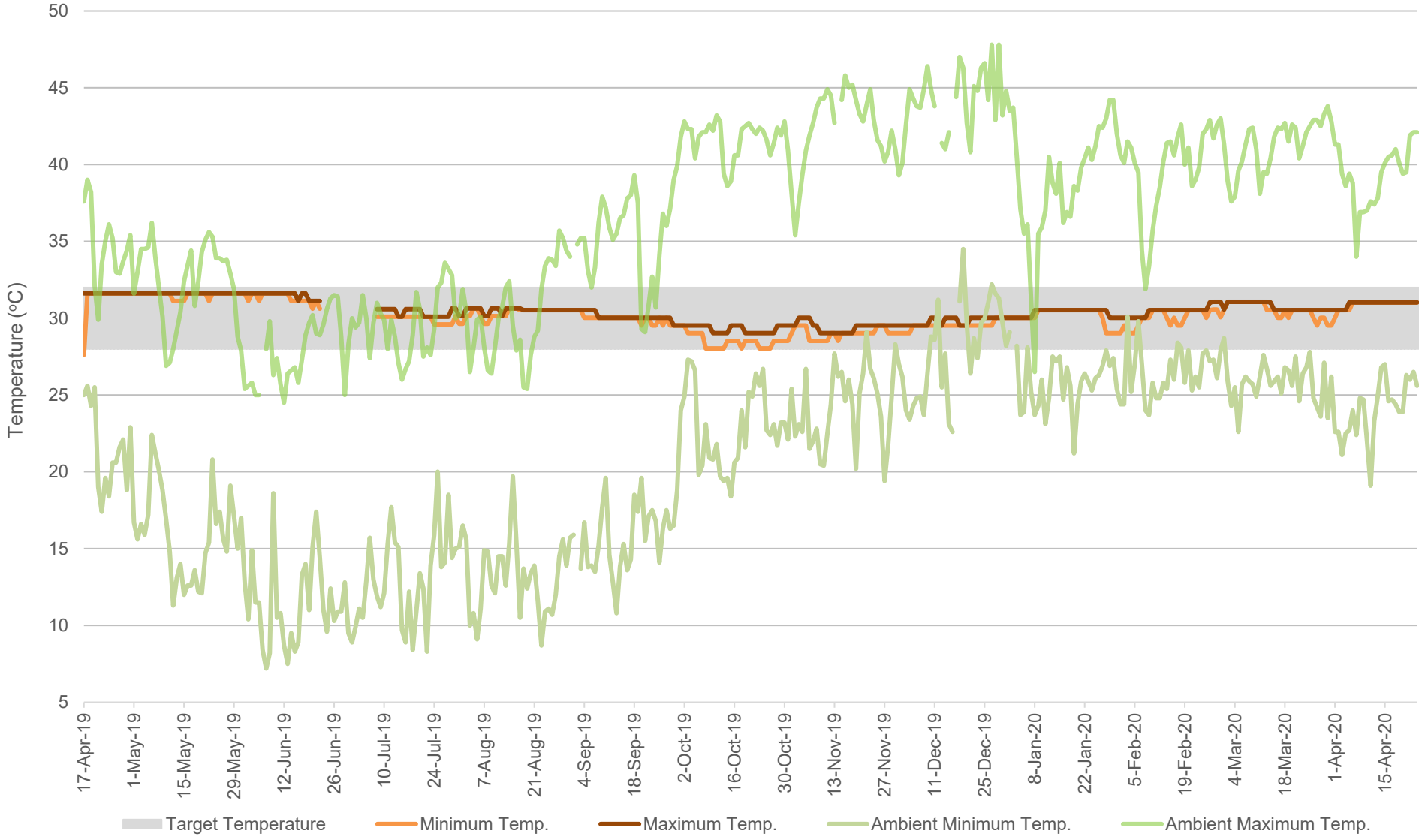


Figure 5.1: Daily temperature (°C) range (minimum and maximum) recorded at CO-CA-03

5.1.2 CO-CA-01

During the monitoring period (April 2019 to April 2020), temperatures inside CO-CA-01 were notably stable, with minimal daily fluctuation. Overall temperatures ranged from 27.6 to 31.1 °C (3.5ºC difference) inside the roost (Table 5.2; Appendix D), averaging 29.9ºC (*SE* ± 0.01ºC) throughout the monitoring period. Comparatively, ambient temperatures ranged from 7.2 to 47.8ºC (40.6ºC difference). Therefore, ambient temperatures had very little influence on temperatures inside the roost (Figure 5.2). Temperatures within the cave declined marginally between late January and mid-March 2020, approximating minimum ambient temperatures. However, minimum ambient temperatures were toward the upper range recorded during the monitoring period. Therefore, temperature within CO-CA-01 are unlikely to have been influenced by ambient temperature.

Temperatures inside the roost remained within the target range (28-32ºC) for almost the entire monitoring period (99.89%). Inside the roost, temperatures were slightly below the target range on three occasions; 27.6ºC at 6pm and 9pm on the 18th of February 2020 and 9pm on the 19th of February 2020.

Table 5.2: Summary of temperature data (April 2019 to April 2020) recorded inside CO-CA-01.

Summary Stats	Temperature (°C)								
	3am	6am	9am	12pm	3pm	6pm	9pm	12am	OVERALL
Average	29.9	29.9	29.9	29.9	29.8	29.8	29.9	29.9	**29.9**
SE	0.04	0.03	0.03	0.04	0.04	0.04	0.04	0.04	**0.01**
Minimum	28.1	28.1	28.1	28.1	28.1	27.6	27.6	28.1	**27.6**
Maximum	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	**31.1**
Difference between Minimum and Maximum	3.0	3.0	3.0	3.0	3.0	3.5	3.5	3.0	**3.5**
Number of recordings between 28 - 32ºC									**2,850**
Percentage of recordings within 28 - 32ºC									**99.89%**

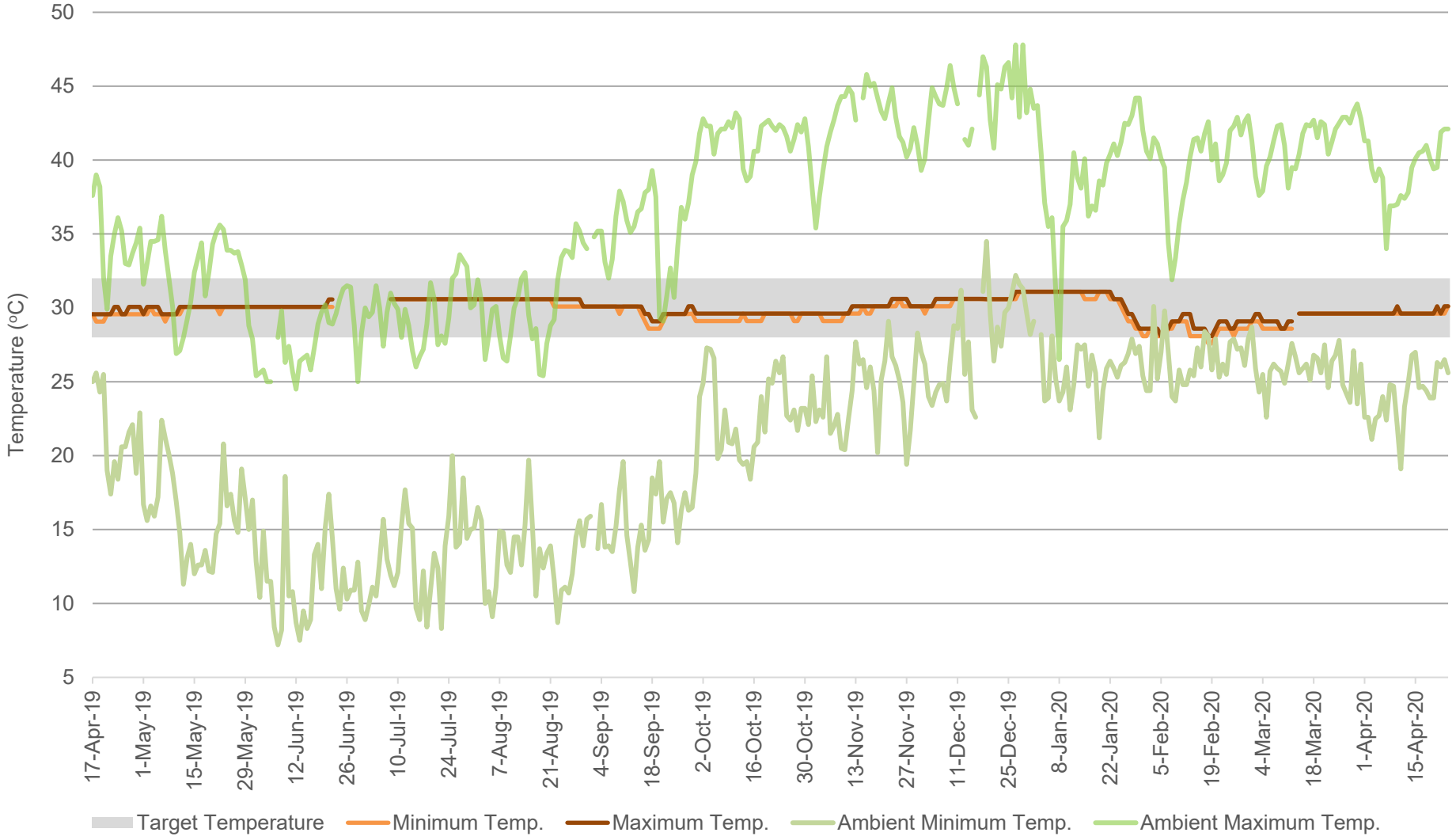


Figure 5.2: Daily temperature (°C) range (minimum and maximum) recorded at CO-CA-01

5.2 Humidity

5.2.1 CO-CA-03

During the monitoring period (April 2019 to April 2020), RH inside CO-CA-03 ranged from 18.1% to 99.5% (81.4% difference), averaging 85.2% (*SE* ± 0.34) (Table 5.3). On average, minimum humidity occurred at 6pm (81.0% [*SE* ± 1.21]) and maximum humidity occurred at 6am (88.3% [*SE* ± 0.63]). A substantial amount of rainfall was received in March 2019 (246.2 mm was received in March compared to the long-term average of 85.5 mm), on account of Cyclone Veronica, with a majority of the rainfall occurring on the 25th of March 2019 (138 mm; Figure 5.3). Following Cyclone Veronica, below average rainfall was then received between April and December 2020 (41.8 mm was received between April and December compared to the long-term average of 117.7 mm). Following Cyclone Veronica, humidity within the cave was notably stable with minimal daily fluctuation between the 18th of April and the 7th of October 2019; humidity ranged from 88.4% to 99.5% (11.2% difference). All recordings during this period fell within the target range (85-100%) whereby RH within the cave was 95.1% (*SE* ± 0.05) on average.

Average humidity decreased between the 8th of October 2019 and the 7th of January 2020, prior to the next substantial rainfall event: a peak in rainfall occurred in January 2020 (311.6 mm was received in January compared to the long-term average of 114.7 mm) on account of Cyclone Blake (144.2 mm; Figure 5.3). Between October 2019 and January 2020 RH decreased to 60.6% (*SE* ± 0.7) on average, ranging from 18.1% to 94.5% (76.4% difference) with 12.1% of recordings falling within the target range. Finally, RH increased within the caves from the 8th of January 2020 (coinciding with Cyclone Blake) until the end of the monitoring period, averaging 91.7% (*SE* ± 0.2). RH was also more stable during this time and ranged from 50.4% to 96.7% (46.3% difference) with 92.9% of recordings falling within the target range.

Table 5.3: Summary of humidity data (April 2019 to April 2020) recorded inside CO-CA-03.

Summary Stats	Humidity (%)								
	3am	6am	9am	12pm	3pm	6pm	9pm	12am	OVERALL
Average	87.5	88.3	88.0	85.2	82.4	81.1	83.5	85.9	**85.2**
SE	0.74	0.63	0.73	0.98	1.15	1.21	1.06	0.88	**0.34**
Min	31.1	36.6	21.5	18.1	20.2	19.5	20.2	25.6	**18.1**
Max	99.0	99.0	99.5	99.0	99.5	99.5	99.5	99.5	**99.5**
Difference between Minimum and Maximum	68.0	62.4	78.0	80.9	79.3	80.0	79.3	73.9	**81.4**
Number of recordings between 85-100%									**2142**
Percentage of recordings within 85-100%									**75.3%**

To determine what factors drive cave RH and to avoid including correlated variables in subsequent analyses, modelling was used to test for a cave effect, a non-linear monthly trend, and a nonlinear interaction of ambient temperature (Figure 5.4) and two-week rainfall on cave RH. There was a significant non-linear monthly effect on humidity (p = <0.0001). There was also a significant non-linear relationship between ambient temperature and two-week rainfall (p = <0.0001). Ambient temperature was found to be negatively correlated with cave RH (after about 35°C), and the relationship was mediated by two-week rainfall (p = <0.0001). Specifically, cave RH is highest when ambient temperature is between 35-40°C and two-week rainfall is ≥250 mm.

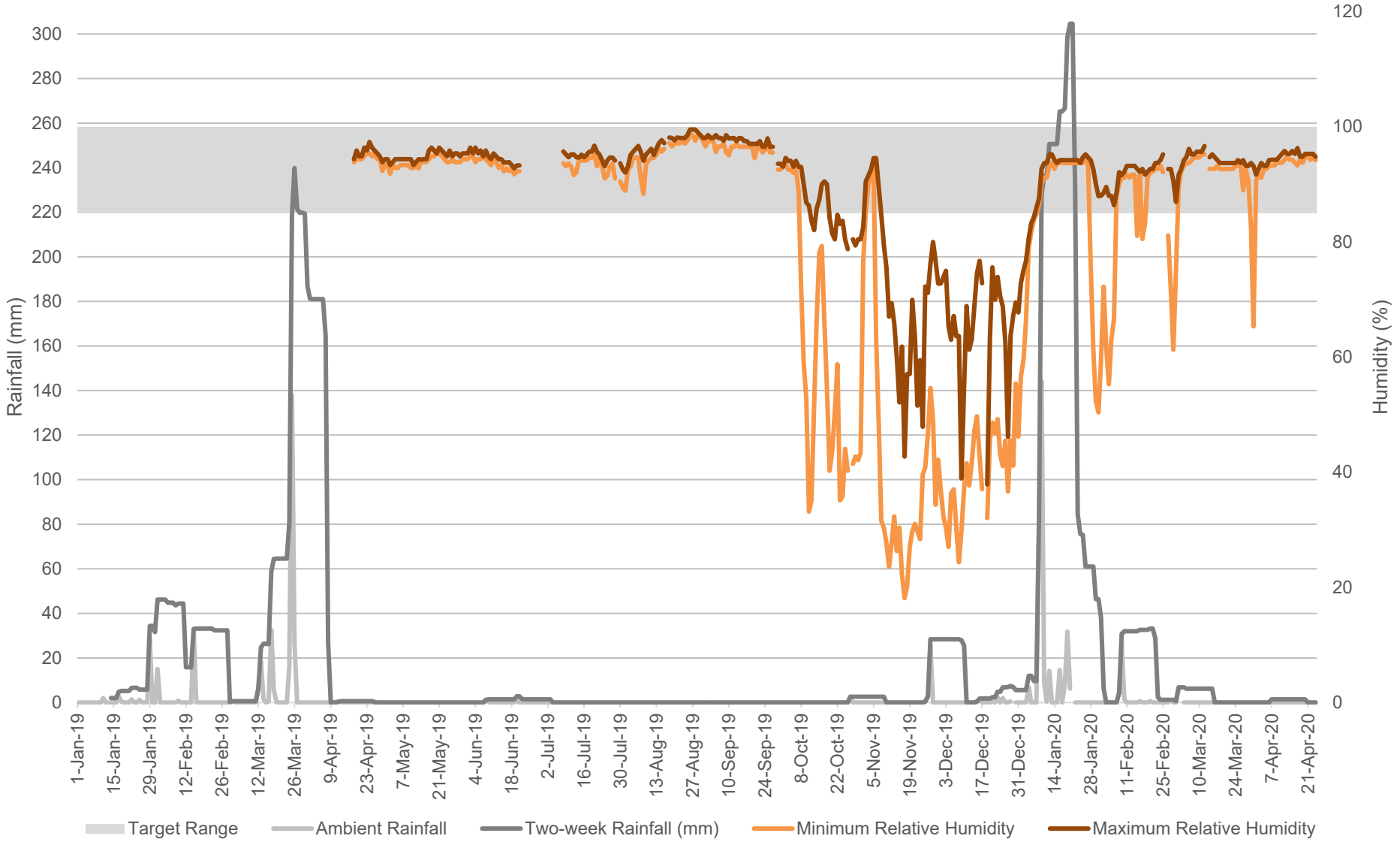


Figure 5.3: Daily humidity (%) range (minimum and maximum) recorded at CO-CA-03 against rainfall

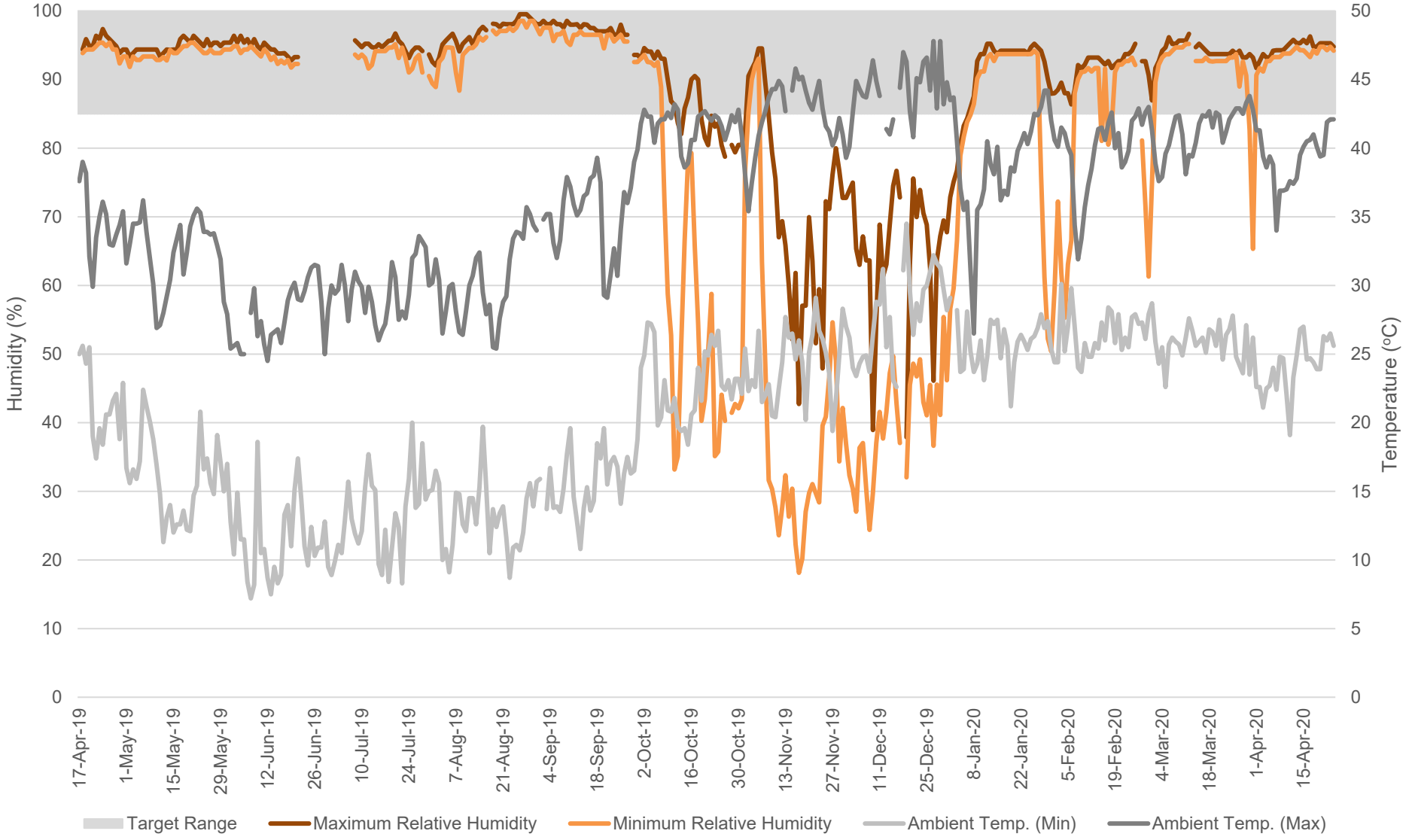


Figure 5.4: Daily humidity (%) range (minimum and maximum) recorded at CO-CA-03 against ambient temperature

5.2.2 CO-CA-01

During the monitoring period (April 2019 to April 2020), RH inside CO-CA-01 ranged from 31.3% to 100% (68.7% difference), averaging 77.01% (*SE* ± 0.35) (Table 5.4). Overall daily fluctuations in humidity were low whereby minimum humidity occurred at 6pm (73.9% [*SE* ± 1.13]) and maximum humidity occurred at 6am (80.0% [*SE* ± 0.84]).

During a routine monitoring visit to cave CO-CA-01 (16th April 2019), Arnold Slabber noted that a substantial amount of water had come through the roosting chamber, at the back of the cave. Moreover, a yellow lid previously housing an iButton was buried approximately 2 m away from its' deployment location. On the 22nd of June 2019, the iButton previously deployed within this yellow lid was retrieved and the data log indicated that it had suddenly recorded 100% humidity on the 13th of March 2019 at 6am (having recorded 63% on average since the beginning of March 2019) and continued to record >99.5% humidity until it was retrieved. Given the stability and sudden onset of 100% humidity it is thought that the iButton became inundated within the water that seeped through the cave. This is supported by the fact that a second iButton, which was deployed within the cave at the same time, only recorded 66-96% humidity. For this reason, this iButton was eliminated from the analysis.

A substantial amount of rainfall was received in March 2019 (on account of Cyclone Veronica) followed by below average rainfall between April and December 2020. Following Cyclone Veronica, humidity within the cave was notably stable with minimal daily fluctuation, ranging from 65.9% to 95.2% (29.4% difference) between April 2019 to 22 May 2019. Moreover, 80.2% of recordings fell within the target range (85-100%) during this period whereby RH averaged 87.9% (*SE* ± 0.3). From the 22nd of May 2019 until 15th of September 2019, RH further stabilised (ranged from 87.6% to 98.4% [10.7% difference]) with 100% of recordings falling within the target range (averaging 93.5% [*SE* ± 0.03]).

Changes in internal cave humidity were only later observed toward the end of the dry season (from the 16th of September 2019 until the 7th of January 2020). During this time, RH decreased to 55.7% (*SE* ± 0.46) on average. During this period, RH was also more variable, ranging from 31.3% to 90.7% (59.5% difference) with only 6.5% of recordings falling within the target range.

Finally, RH steeply increased on the 8th of January 2020, with a peak in rainfall in January 2020, on account of Cyclone Blake, to an average of 90.9% (*SE* ± 0.4). RH was also more stable during this time and ranged from 67.9% to 100% (32.2% difference) with 76.7% of recordings falling within the target range. However, this increase and stabilisation was not maintained; humidity declined to 67.1% (*SE* ± 0.3) until the end of the monitoring period whereby no recordings fell within the target range from the 8th of March 2020.

Modelling was used to test for a cave effect, a nonlinear monthly trend, and a nonlinear interaction of ambient temperature (Figure 5.6) and two week rainfall on cave RH. There was a significant non-linear monthly effect on humidity (p = <0.0001). There was also a significant non-linear relationship between ambient temperature and two-week rainfall (p = <0.0001). Ambient temperature was found to be negatively correlated with cave RH (after about 35°C), and the relationship was mediated by two-week rainfall (p = <0.0001). Specifically, cave RH is highest when ambient temperature is between 35-40°C two-week rainfall is ≥250 mm.

Table 5.4: Summary of humidity data (April 2019 to April 2020) recorded inside CO-CA-01.

Summary Stats	Humidity (%)								
	3am	6am	9am	12pm	3pm	6pm	9pm	12am	OVERALL
Average	78.7	80.0	78.9	76.7	74.6	73.9	75.9	77.7	**77.01**
SE	0.92	0.84	0.91	1.02	1.10	1.13	1.05	0.97	**0.35**
Min	37.1	41.5	39.6	34.5	32.6	31.3	31.9	33.2	**31.3**
Max	100	100	100	100	100	100	100	100	**100**
Difference between Minimum and Maximum	62.9	58.5	60.4	65.5	67.4	68.7	68.1	66.8	**68.7**
Number of recordings between 85-100%									**1,459**
Percentage of recordings within 85-100%									**51.3%**

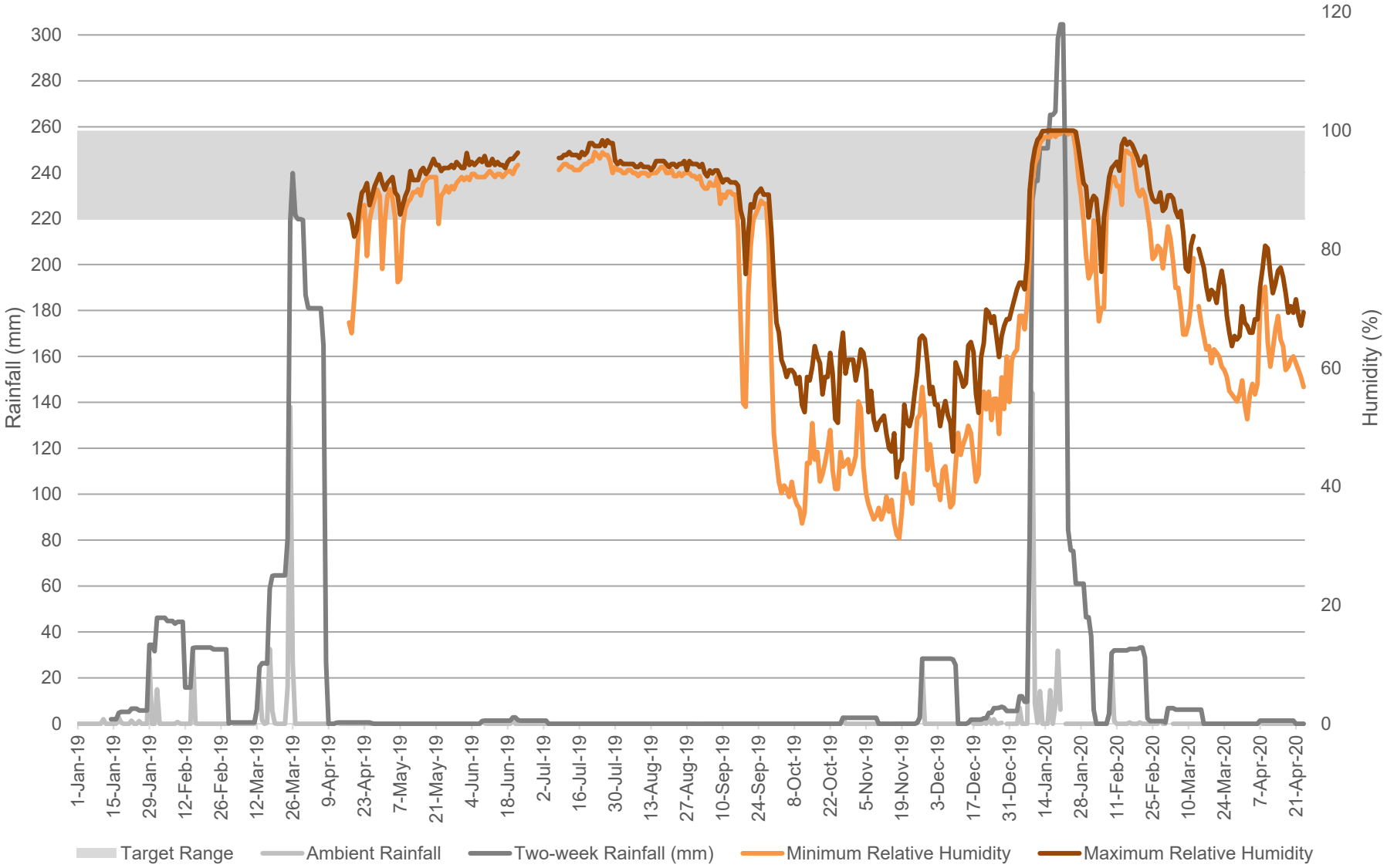


Figure 5.5: Daily humidity (%) range (minimum and maximum) recorded at CO-CA-01 against rainfall

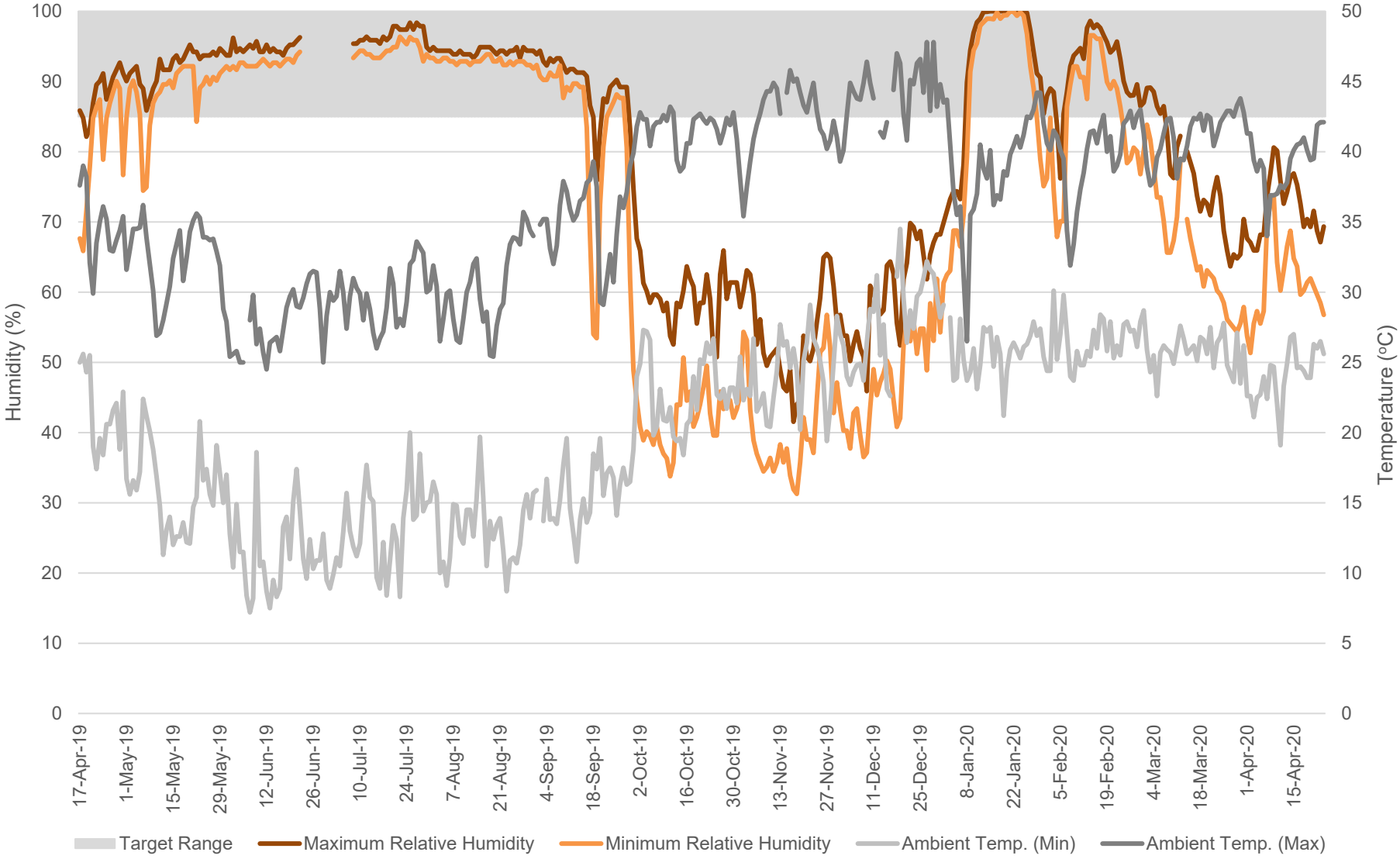


Figure 5.6: Daily humidity (%) range (minimum and maximum) recorded at CO-CA-01 against ambient temperature

5.3 Ultrasonic Analysis

5.3.1 CO-CA-03

Pilbara Leaf-nosed Bats were recorded on every night during the monitoring period, except for the 8th of January 2020. Activity ranged from 64 calls (on the 18th of January 2020) to 56,699 calls (12th of July 2019), averaging 7,033 (*SE* ± 619) calls per night (Appendix C).

Roosting was indicated on 47% of recording nights during the monitoring period, of which 91.3% of roosting events occurred between the 17th of April 2019 and the 25th of October 2019 (Figure 5.7, Figure 5.8). When the species was roosting, 13,440 calls were detected per recording night on average. Pilbara leaf-nosed bats were encountered on three of five visitations in high numbers during routine visits to the cave between April and October 2019 (Table 5.5).

Between the 26th of October 2019 and the 24th of April 2020, roosting was only indicated on 8.4% of recording nights (Figure 5.7, Figure 5.8). When roosting was not indicated, the timing of most calls suggested that individuals were in flight, possibly foraging, and roosting at another location. During this period 1,346 calls were detected per recording night on average. Pilbara leaf-nosed bats were encountered on one of five visitations in low numbers during routine visits Between October 2019 and April 2020 (Table 5.5).

Table 5.5: Pilbara leaf-nosed bat observations at CO-CA-03

Date	Pilbara leaf-nosed bats observed
01/05/2019	-
22/06/2019	Second chamber full of bats
29/07/2019	250-500
17/08/2019	None
28/09/2019	Large Number
27/10/2019	None
18/12/2019	-
26/02/2020	None
13/03/2020	None
25/04/2020	One

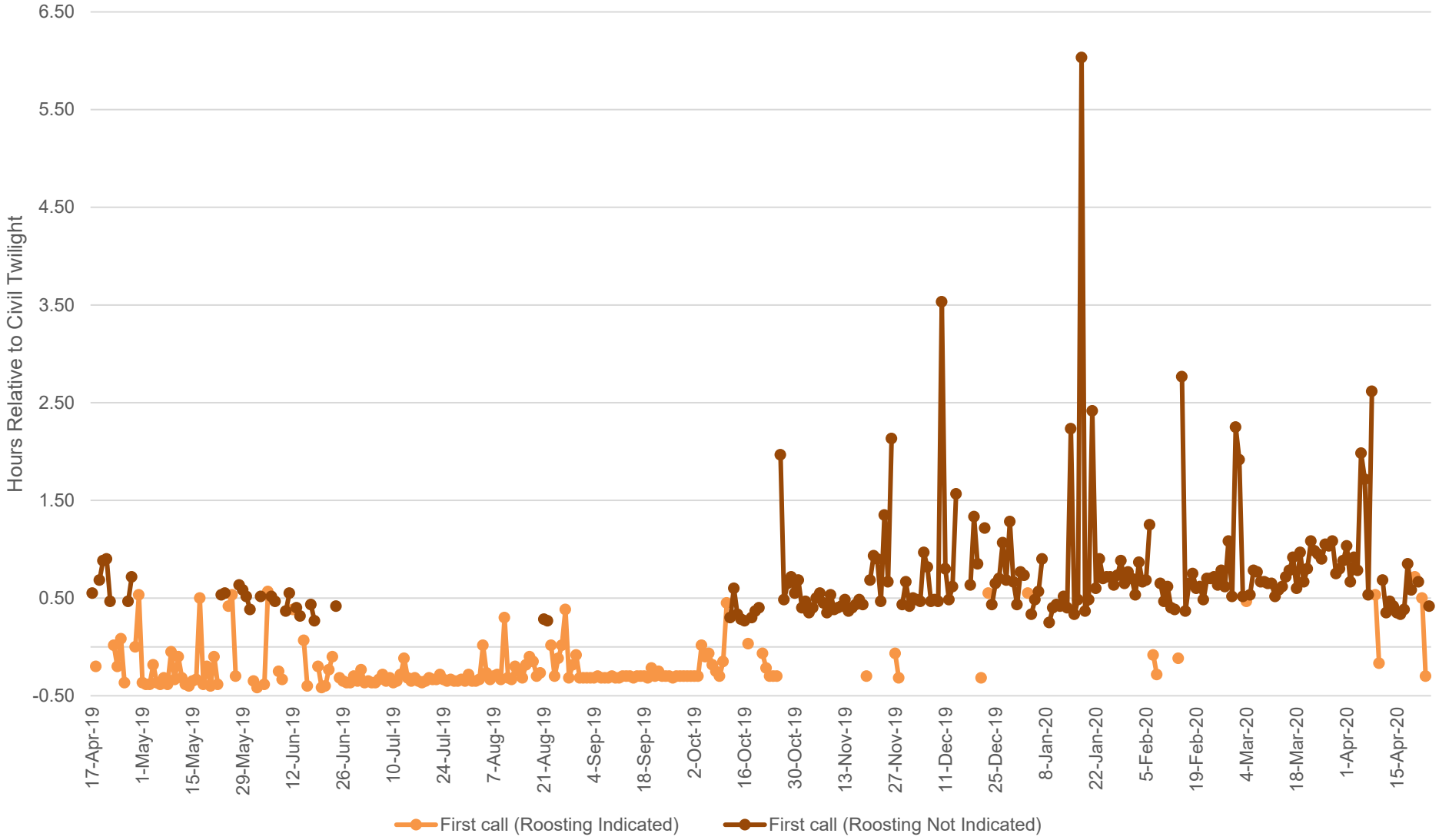


Figure 5.7: Timing of first call (relative to Civil Dusk) when the species was and was not roosting per day at CO-CA-03 during the monitoring period (April 2019 – April 2020)

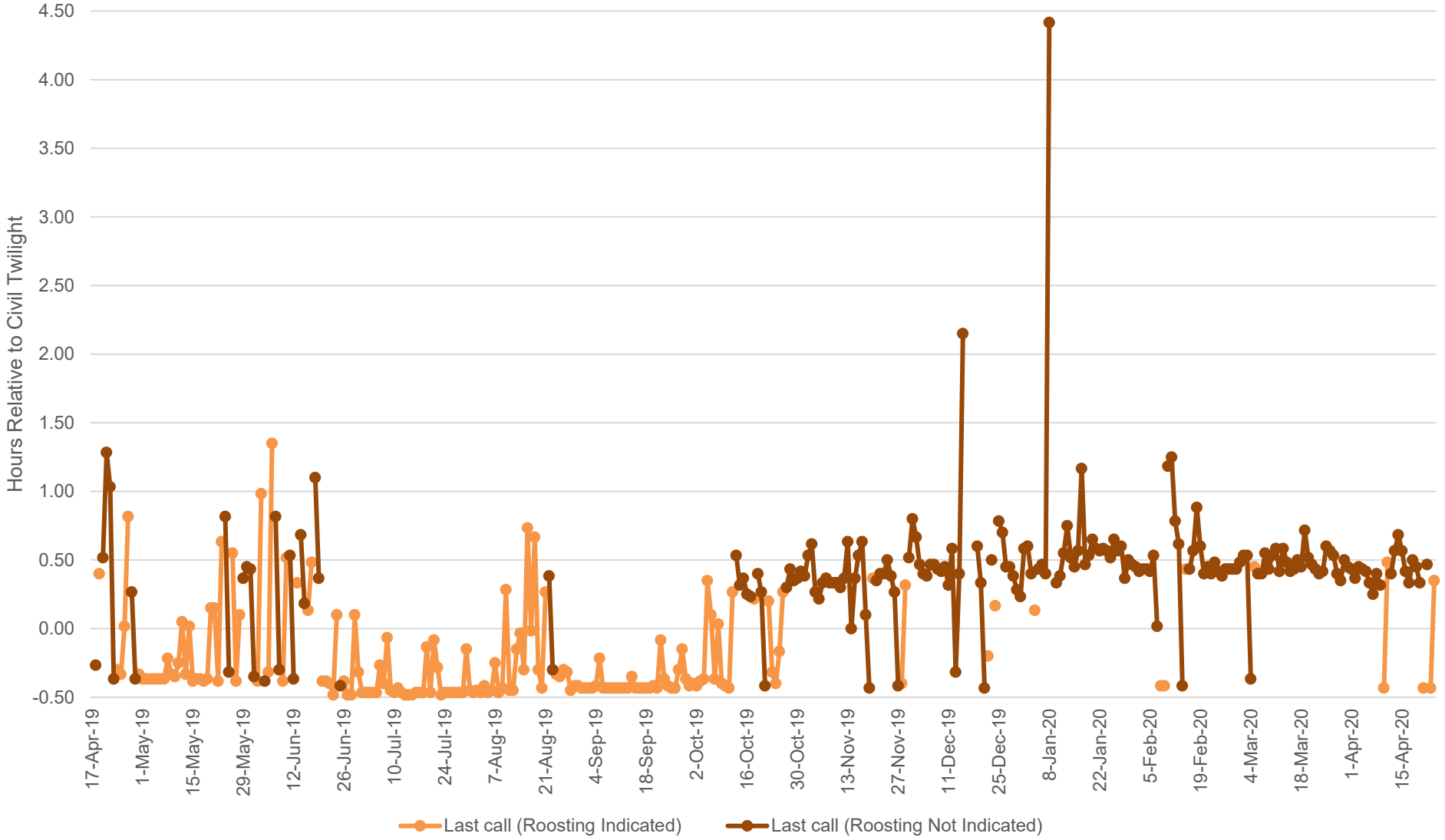


Figure 5.8: Timing of last call (relative to Civil Dawn) when the species was and was not roosting per day at CO-CA-03 during the monitoring period (April 2019 – April 2020)

The decline in roosting observed from October 2019 coincided with a decline and increased variability in cave RH as well as decline in internal temperature although marginal (approximately ~1.5ºC) (Figure 5.10, Figure 5.11). However, roosting did not increase relative to temperature and cave RH from January 2020. GAM model 1 (See 4.6.2 Effects on Roosting by Pilbara Leaf-nosed Bats at CO-CA-03) showed that maximum ambient temperature, maximum cave temperature, percentage moon illumination did not significantly affect the roosting status of the species at the cave. The model was able to explain 66.3% of the variation recorded. GAM model 2 showed that maximum cave temperature, range in cave RH and percentage moon illumination did not significantly affect the roosting status of the species at the cave. The model was able to explain 60.9% of the variation recorded. However, day of sampling significantly affected roosting in both models (p = <0.0001). This indicates that untested variables likely influence whether bats roost at the cave.

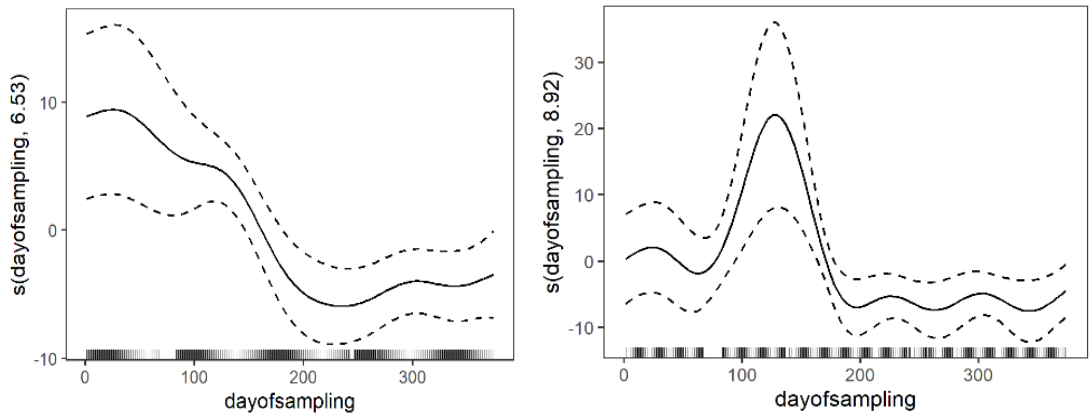


Figure 5.9: Effects on Day of Sampling on Roosting at CO-CA-03 (model including range cave RH and cave temperature left, model including ambient temperature and cave temperature right).

Patterns in Pilbara leaf-nosed bat activity followed a similar trend to roosting. Activity was high on average prior to October 2019 with a peak of activity occurring from approximately mid-June to early August 2019. Activity then declined from October 2019 relative to the marginal decline in internal temperature (Figure 5.10) and decline and increased variability in cave RH (Figure 5.11). However, activity did not increase relative to increase in temperature and humidity from January 2020. Model 1 (outlined in 4.6.2 Effects on Pilbara Leaf-nosed Bat Activity at CO-CA-01 and CO-CA-03) demonstrated that Pilbara leaf-nosed bat activity was significantly affected by day of sampling (p = <0.0001) (Figure 5.12). However, maximum cave RH did not significantly affect activity after accounting for seasonality. Moreover, percentage moon illumination did not significantly affect activity at the caves. The model explains 69.2% of the variation recorded. Model 2 (outlined in 4.6.2 Effects on Pilbara Leaf-nosed Bat Activity at CO-CA-01 and CO-CA-03) demonstrated that Pilbara leaf-nosed bat activity was significantly affected by day of sampling (p = <0.0001) (Figure 5.12). Additionally, range in cave RH (difference between maximum and minimum) significantly affected activity at CO-CA-03 after accounting for seasonality (p = <0.05). However, percentage moon illumination did not significantly affect activity at the caves. The model explains 68.7% of the variation recorded.

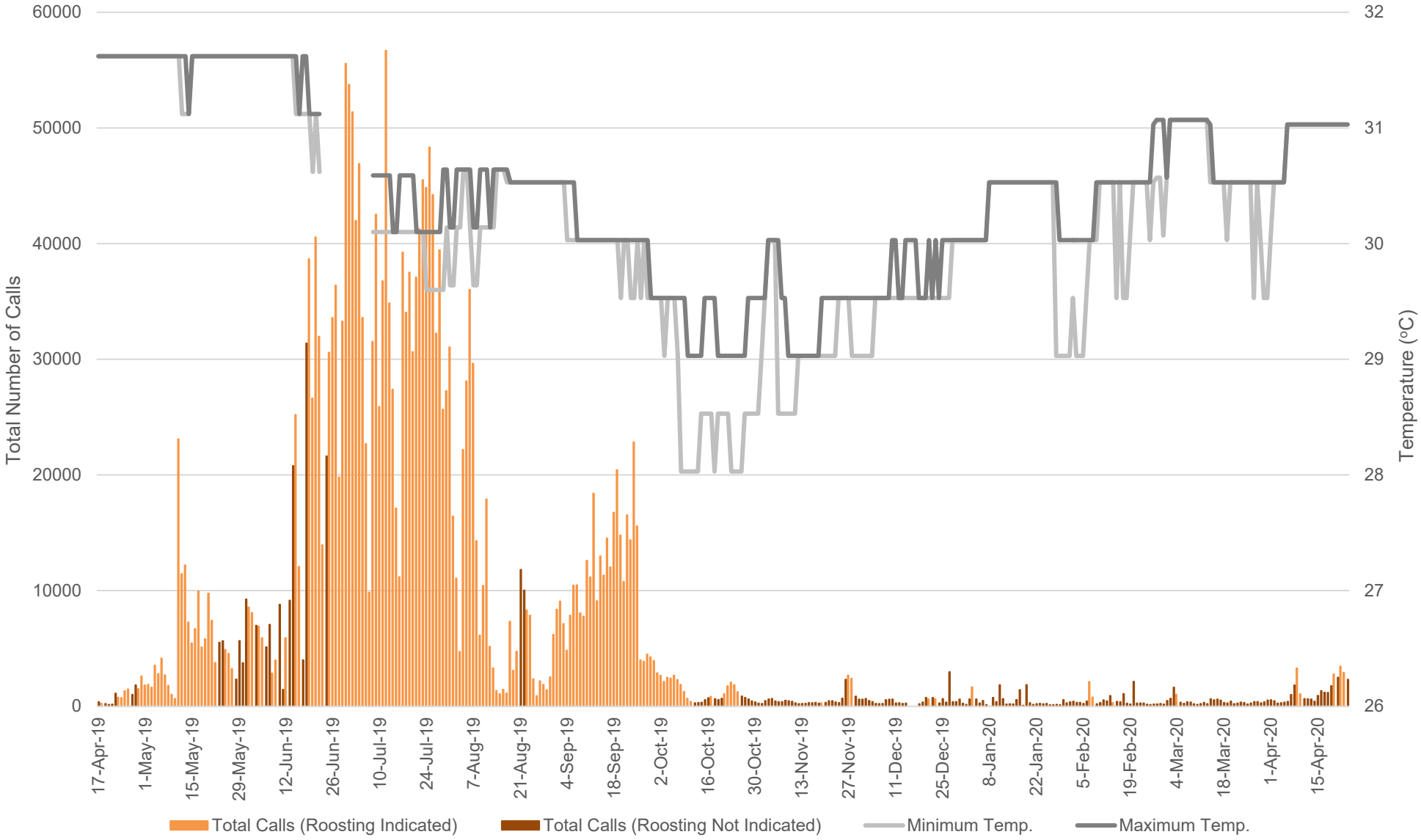


Figure 5.10: Number of calls per day plotted against internal temperature at CO-CA-03 during the monitoring period (April 2019 – April 2020)

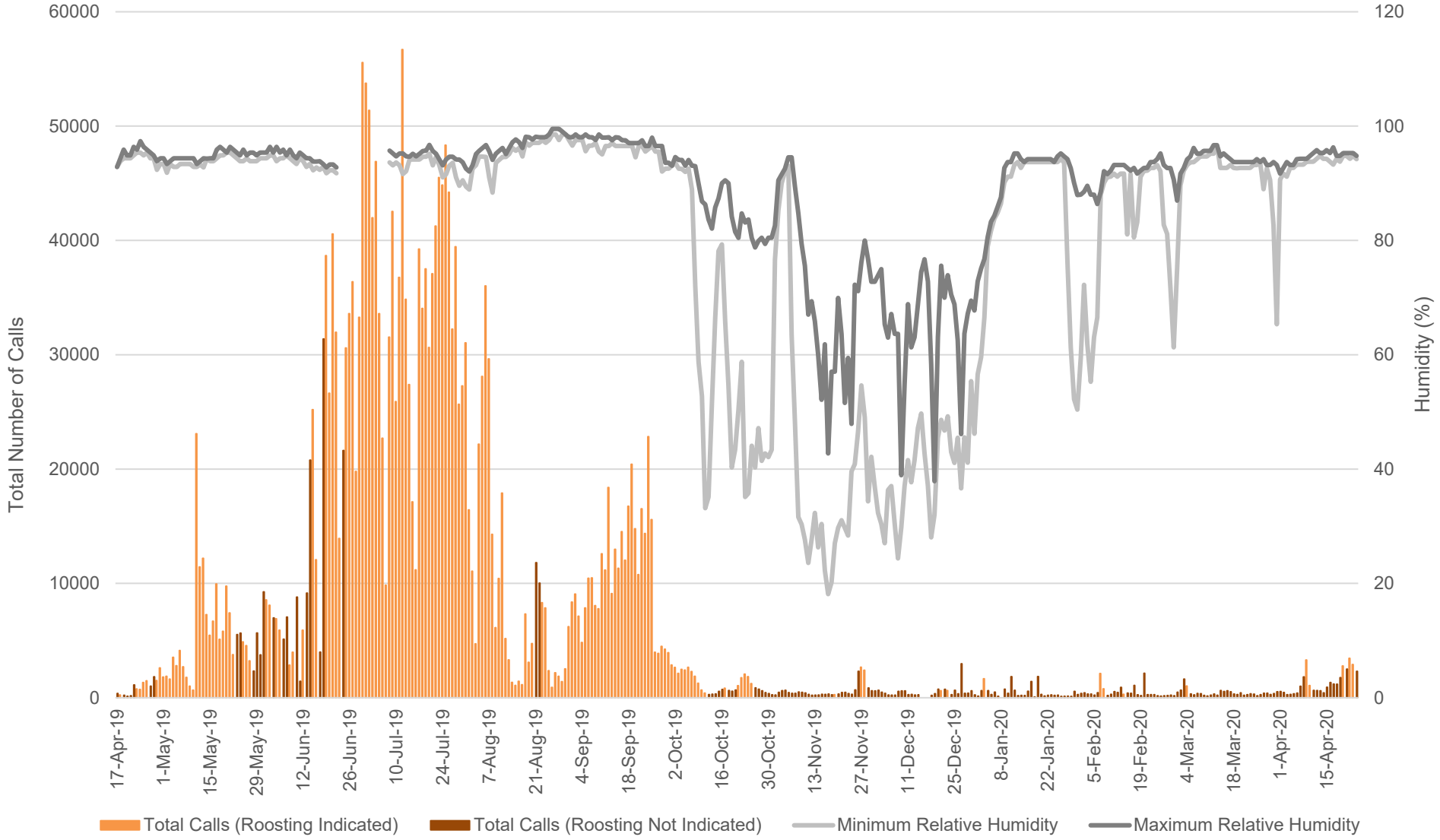


Figure 5.11: Number of calls per day plotted against cave RH at CO-CA-03 during the monitoring period (April 2019 – April 2020)

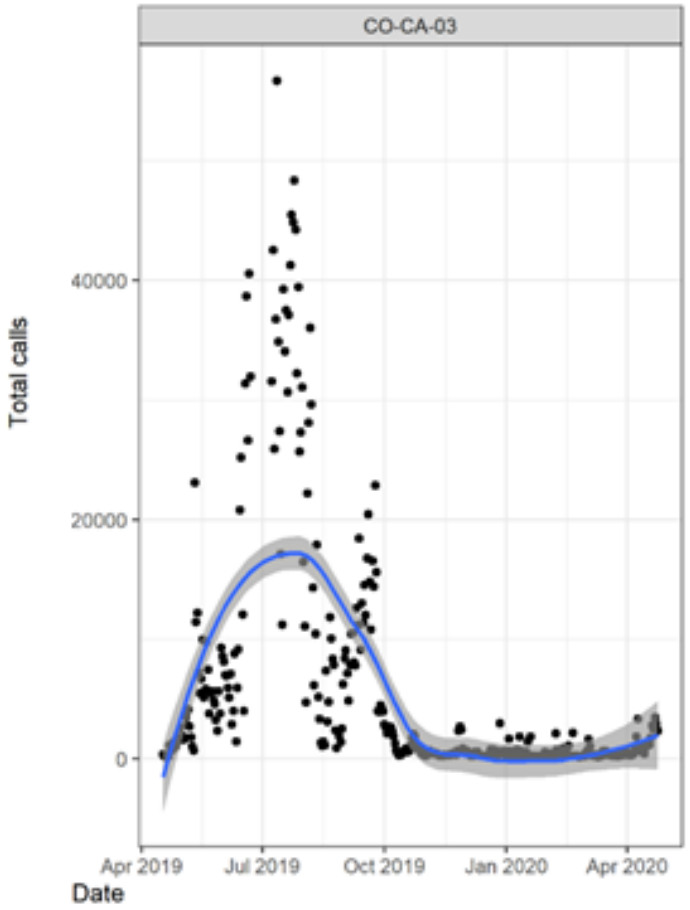


Figure 5.12: Pilbara Leaf-nosed Bat Activity at CO-CA-03

5.3.2 CO-CA-01

Due to technical issues, no ultrasonic data was captured between the 20th of April and the 20th of July 2019. Pilbara Leaf-nosed Bats were recorded on every night during the monitoring period for which data was available. Moreover, roosting was indicated on all recording nights during the monitoring period (Figure 5.13, Figure 5.14). Pilbara leaf-nosed bat activity ranged from 470 calls (on the 5th of January 2020) to 30,452 calls (7th of January 2020), averaging 4,726 (*SE* ± 229) calls per night.

Table 5.6: Pilbara leaf-nosed bat observations at CO-CA-01

Date	Pilbara leaf-nosed bats observed
16/04/2019	-
22/06/2019	Could not hear any bats
29/07/2019	Bats observed roosting
28/09/2019	Large number
18/12/2019	-
13/03/2020	-

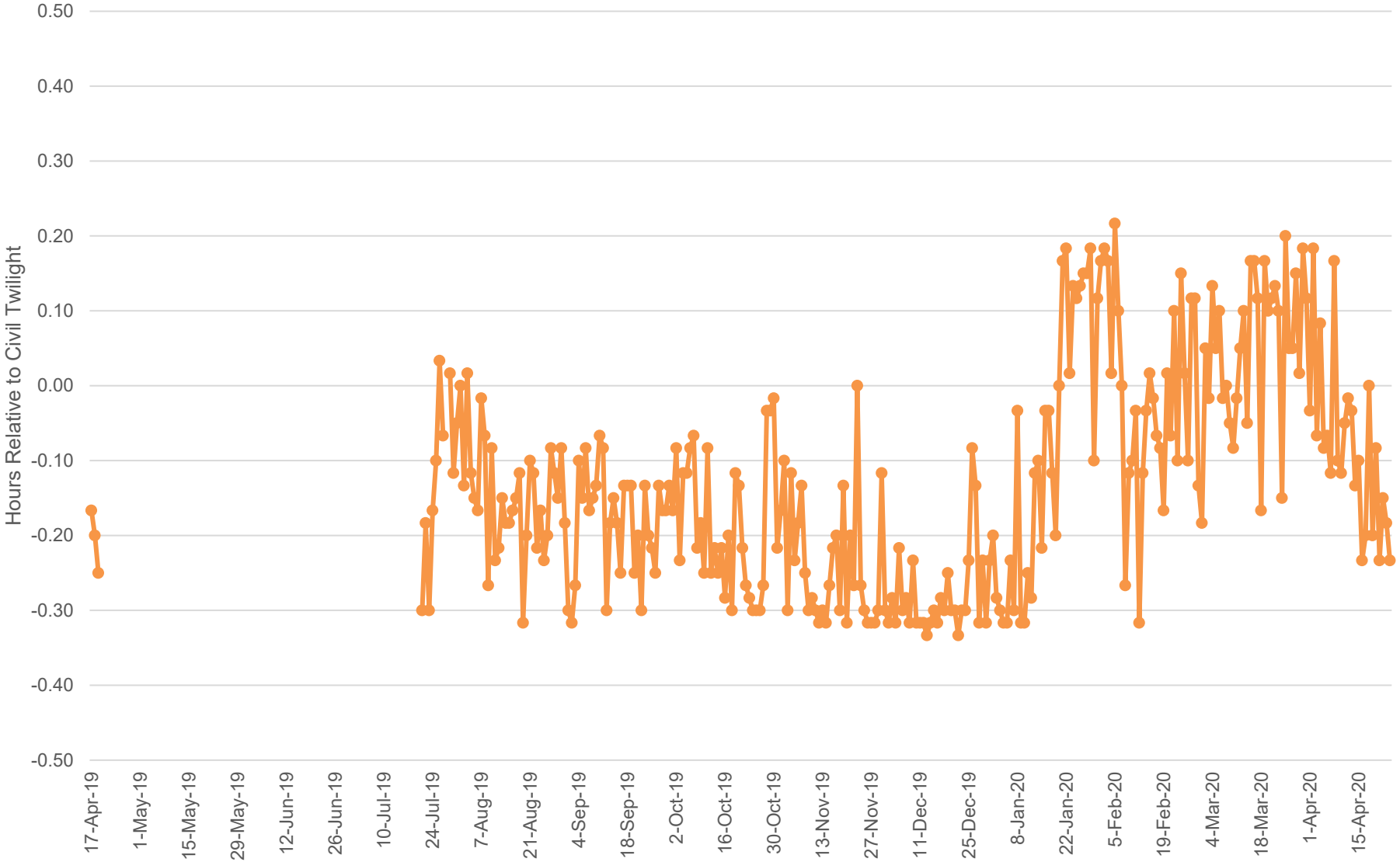


Figure 5.13: Timing of first call (relative to Civil Dusk) per day at CO-CA-01 during the monitoring period (April 2019 – April 2020)

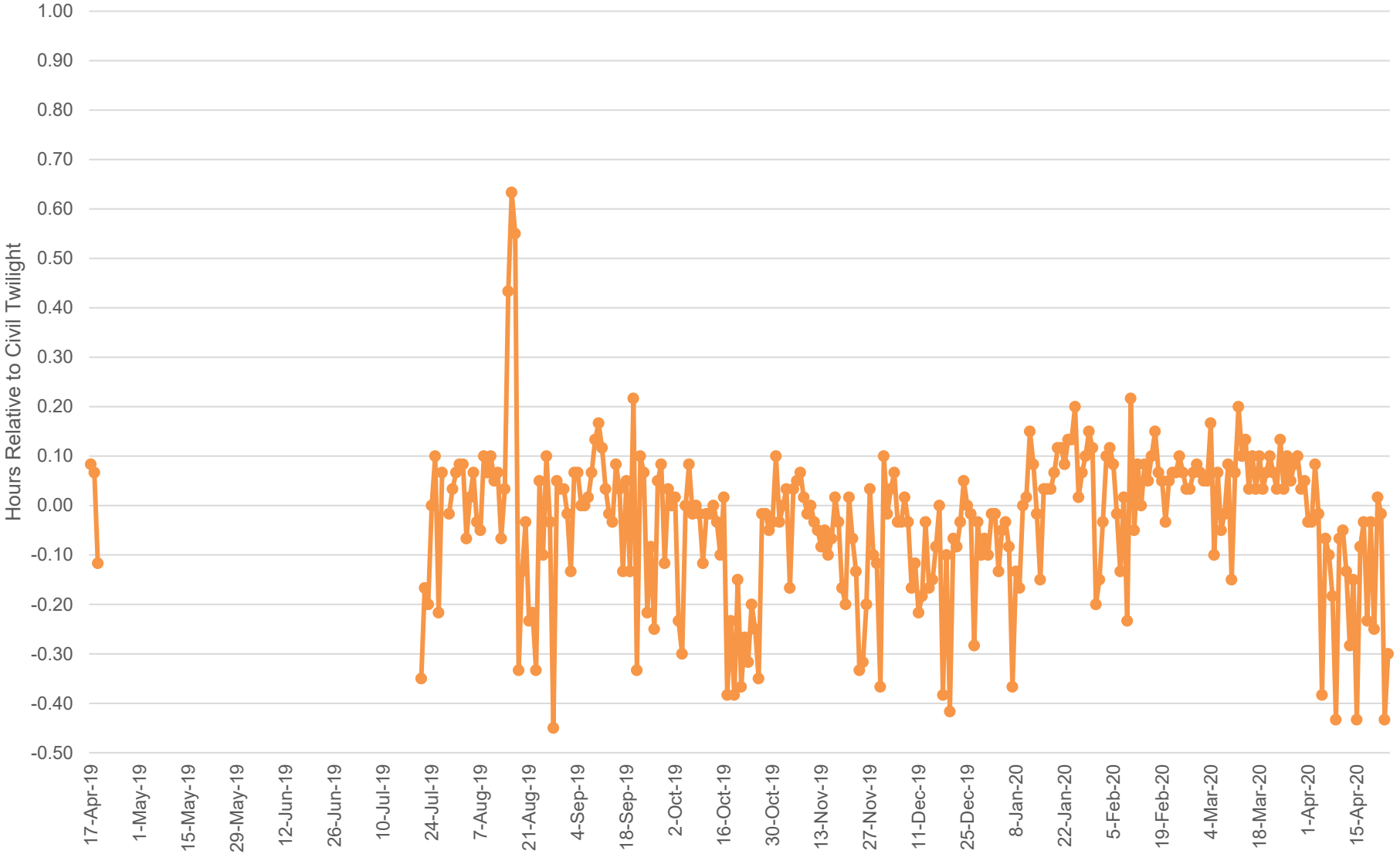


Figure 5.14: Timing of last call (relative to Civil Dawn) per day at CO-CA-01 during the monitoring period (April 2019 – April 2020)

There was little variation in temperature during the monitoring period (Figure 5.16). However, temperature within the cave declined slightly between late January and mid-March 2020 (approximately ~1.3ºC). Conversely, cave RH varied throughout the monitoring period (Figure 5.17). Cave RH was relatively high and stable until mid-September 2019 when humidity declined and became more variable. RH steeply increased again in early January 2020. This increase was not maintained, declining again in early March 2020 until the end of the monitoring period. However, Pilbara leaf-nosed bat activity remained relatively constant throughout the monitoring period (Figure 5.17). Model 1 and 2 (outlined in 4.6.2 Effects on Pilbara Leaf-nosed Bat Activity at CO-CA-01 and CO-CA-03) demonstrated that Pilbara leaf-nosed bat activity was significantly affected by day of sampling (p = <0.05) (Figure 5.15). However, maximum cave RH as well as range in cave RH did not significantly affect activity at CO-CA-01 after accounting for seasonality. Moreover, percentage moon illumination did not significantly affect activity at the caves. The model explains 68.7% of the variation recorded.

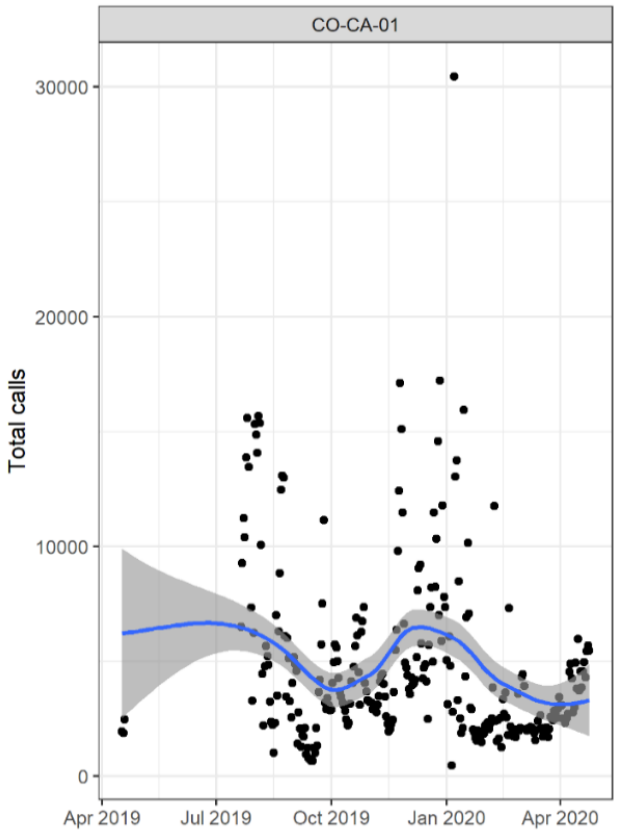


Figure 5.15: Pilbara Leaf-nosed Bat Activity at CO-CA-01

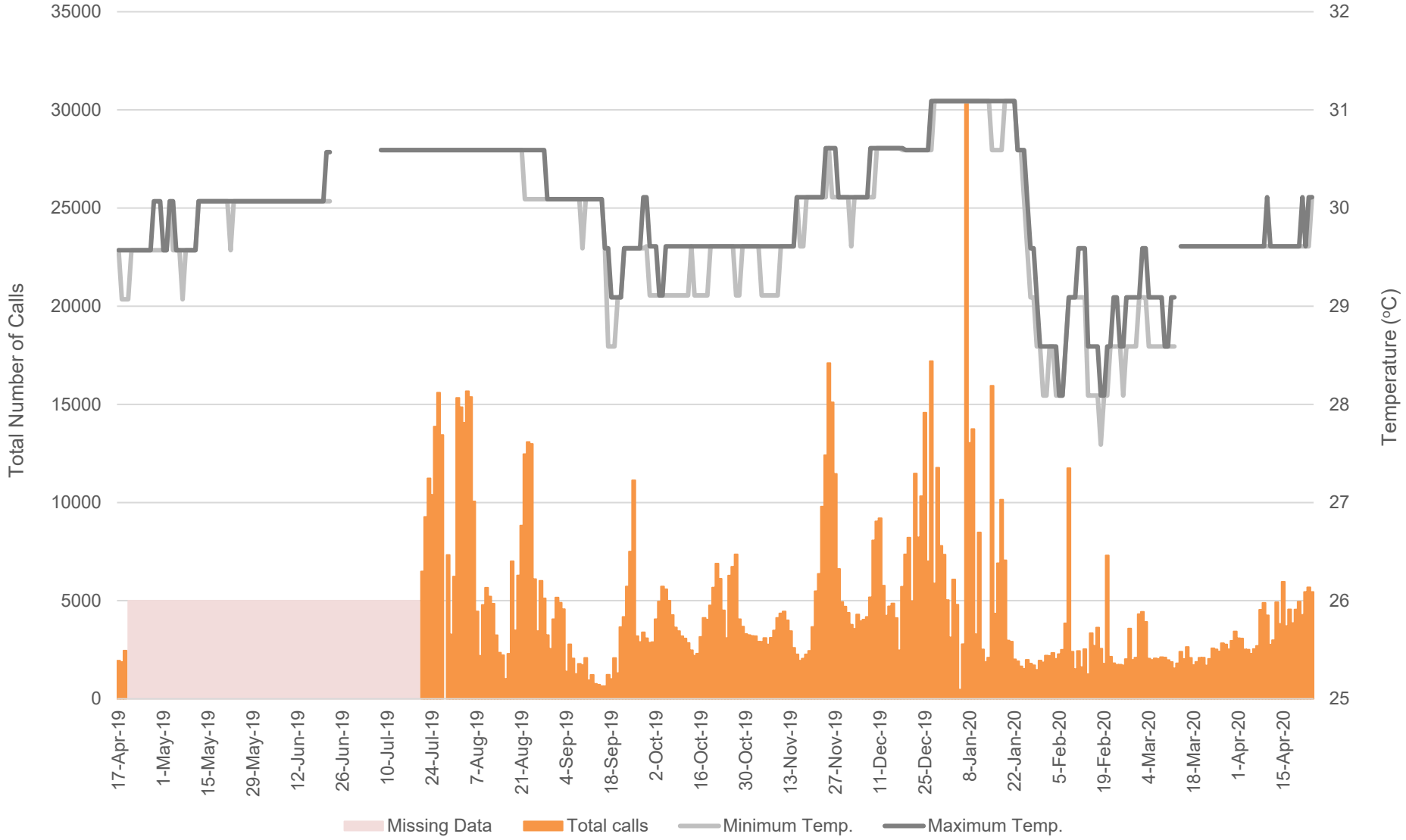


Figure 5.16: Number of calls per day plotted against internal temperature at CO-CA-01 during the monitoring period (April 2019 – April 2020)

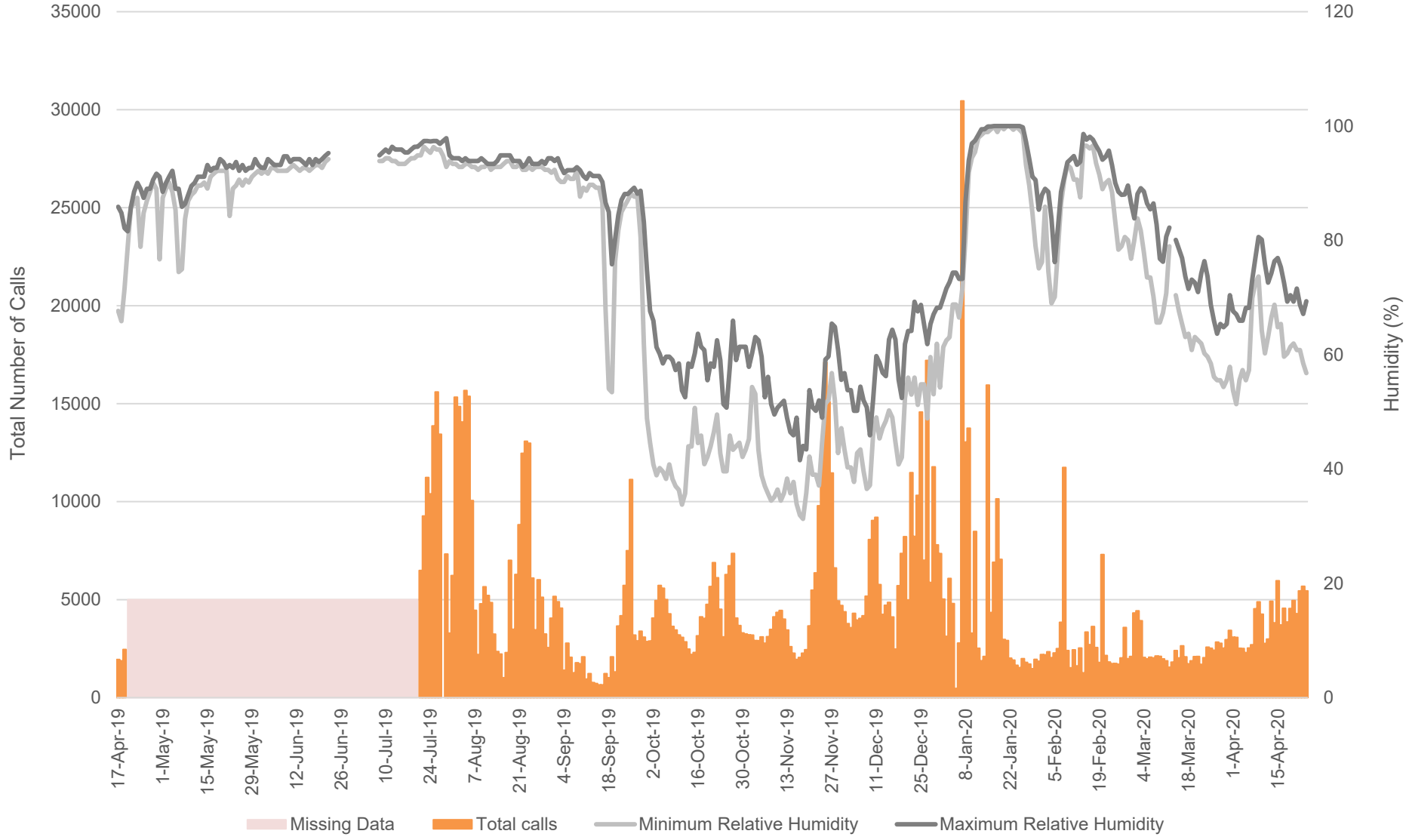


Figure 5.17: Number of calls per day plotted against cave RH at CO-CA-01 during the monitoring period (April 2019 – April 2020)-

5.4 CO-WS-14

5.4.1 Water Quantity

Water was observed at CO-WS-14 during the entire monitoring period and has been observed at the pool since monitoring began in October 2017.

The pool base level equates to 320.09 metres reduced level (mRL). During the monitoring period (April 2019 to April 2020), water depth at CO-WS-14 was relatively stable. Field observations of water depth ranged from 320.98 mRL to 321.04 mRL (0.06 m difference), averaging ~1.1 meters (m) relative to a staff gauge or 321.00 (std = 0.02) mRL (Table 5.7, Figure 5.18). Results were emulated in supplementary water logger data (available from the 1st April 2019 until the 30th July 2019) as well as long-term field observations and long-term water logger data (from October 2017 until April 2020; ~2.5 years) recorded at the site (Table 5.7).

Table 5.7: Water Depth (mRL) at CO-WS-14

Summary Stats	Field Observations		Water Logger Data	
	April 2019 – April 2020	Long-Term	April – July 2019	Long-Term
Average	321.00	320.99	320.96	320.98
Std	0.02	0.02	0.03	0.03
Min	320.98	320.94	320.90	320.90
Max	321.04	321.04	321.03	321.57
Difference	0.06	0.95	0.1	0.7

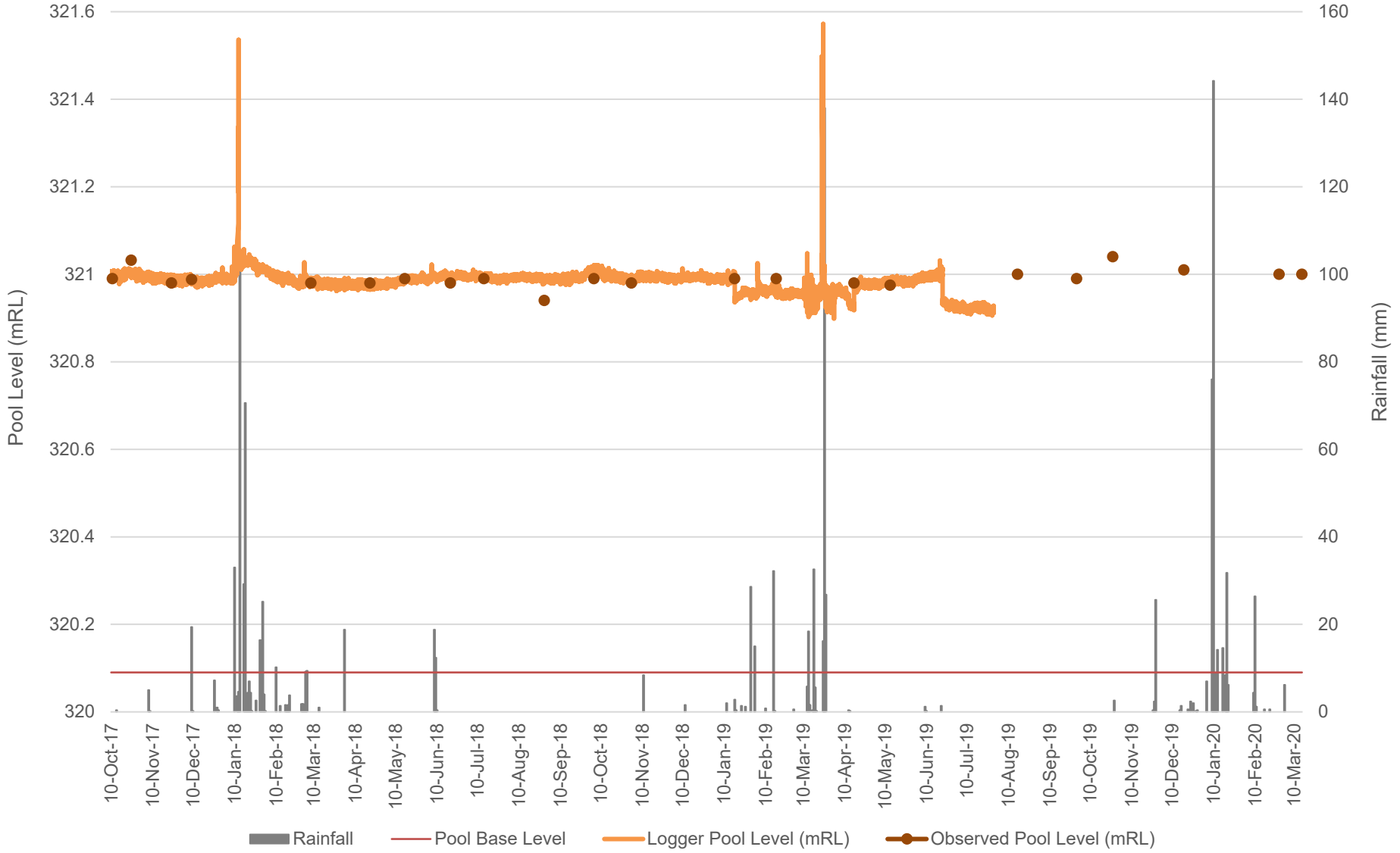


Figure 5.18: Water depth recorded during field observations at CO-WS-14

Prior to the current monitoring period, routine monitoring was conducted at CO-WS-14 along with a further seven pools in the Project Area. CO-WS-11 showed the greatest degree of differentiation in depth (1.64 m based on field observations and 2.6 m based on water logger results) and variability (averaged 399.23 [std = 0.55] mRL based on field observations and 399.3 [std = 0.64] mRL based on water logger results; Table 5.8). CO-WS-14 showed the lowest degree of differentiation in depth (0.1 m based on field observations and 0.7 m based on water logger results) and variability (averaged 320.99 [std = 0.02] mRL based on field observations and 321.0 [std = 0.03] mRL based on water logger results; Table 5.8). Similarly, CO-CA-05 showed the lowest degree of differentiation in depth (0.09 m) and variability (averaged 313.19 [std = 0.03] mRL) based on field observations (Table 5.8). Water was continuously observed at CO-WS-14 since monitoring began in October 2017 (Table 5.8). The water logger at CO-WS-01 is located downstream, in a potentially unsuitable location. Therefore, water logger data should be treated with caution at this pool. This is supported by the fact that water was collected for the purpose of water quality monitoring the day prior to an apparent drop in water depth that was sustained for approximately one month.

Table 5.8: Water Depth (mRL) based at multiple Corunna Downs pools

Summary Stats	CO-WS-01	CO-WS-05	CO-WS-08	CO-WS-10	CO-WS-11	CO-WS-12	CO-WS-13	CO-WS-14
Permanency (SRK, 2019)	Perennial	Perennial	Ephemeral	Perennial	Ephemeral	Perennial	Ephemeral	Perennial
Field Observations								
Average	N/A	313.19	321.86	297.14	399.23	373.94	327.02	320.99
SE	N/A	0.03	0.27	0.21	0.55	0.17	0.29	0.02
Min	N/A	313.17	321.71	296.81	398.53	373.67	326.68	320.94
Max	N/A	313.26	322.26	297.32	400.17	374.14	327.44	321.04
Difference	N/A	0.09	0.54	0.51	1.64	0.46	0.76	0.1
Dry Observations (%)	N/A	20%	36%	22%	25%	8.3%	50%	0%
Water Logger Data								
Average	255.61	N/A	321.74	297.10	399.27	374.00	326.86	320.98
Std	0.10	N/A	0.58	0.27	0.64	0.12	0.35	0.03
Min	254.92	N/A	321.30	296.63	398.44	373.74	326.44	320.90
Max	256.08	N/A	323.54	297.87	401.08	374.80	328.61	321.57
Difference	1.2	N/A	2.2	1.2	2.6	1.1	2.2	0.7
Base Level	255.013	Unknown	321.31	296.65	398.52	373.81	326.59	320.09
Logs < Base Level (#/ %)	*0.06%**		0.7%	7.0%	0.4%	6.7%	36.6%	0.0%

** =The water logger at CO-WS-01 may not be in a representative location for the pool and so this data should be treated with caution as field observations to date confirm permanency of this pool.*

5.4.2 Water Quality

Natural levels and fluctuations in physical stressors (i.e. temperature, conductivity, turbidity, suspended particulate matter, flow and organic matter decay processes) and chemical stressors (i.e. dissolved oxygen (DO), alkalinity, hardness, major ions, total dissolved solids, pH, nutrients, metals, pesticides *etc*.) during the monitoring period are summarised in Table 5.9. Average levels of 11 analytes were comparable with long-term data (Appendix E) including Carbonate (CO_3^{2-} as $CaCO_3$), Hydroxide (OH as $CaCO_3$), Antimony, Arsenic, Cadmium, Chromium, Cobalt, Copper, Lead, Nickel and Selenium. Average levels between the current monitoring year and long-term data were marginal. The largest relative differences in average mg/L were recorded in Mercury (current year was 0.6mg/L higher than the long term average), Iron (current year was 0.25mg/L lower than the long term average) and NOx as N (current year was 0.18mg/L higher than the long term average).

Four of the analytes exceeded the 99% GV by ANZECC and ARMCANZ (2019). Median Boron levels conductivity exceeded the GV on 5 occasions (Table 5.9) during the current monitoring year (and on nine occasions when considering long-term data). Mercury, Zinc and Nitrate (as NO_3) exceeded the GV on one occasion during the monitoring year. Considering long-term data, Zinc exceeded the GV on a further three occasions. Two of the analytes exceeded the 95% GV stipulated by ANZECC and ARMCANZ (2019). The median electrical conductivity exceeded the GV on 10 occasions (Table 5.9) during the current monitoring year (and on 20 occasions when considering long-term data). NOx as N exceeded the GV on five occasions (and on seven occasions when considering long-term data). Iron did not exceed the 95% or 99% GV during the current monitoring period. However, Iron exceeded 95% GV on one occasion in December 2017.

Table 5.9: Summary Statistics of Chemical Analytes at CO-WS-14 (April 2019 to April 2020)

Analyte	Unit	Min	Max	Range	Median	Mean	SE	ANZECC and ARMCANZ (2019) Default GV		Number of exceedances	
								99%	95%	99%	95%
pH		7.3	7.9	0.6	7.75	7.7	0.1	-	6-8	-	-
Electrical Conductivity	µS/cm	330	360	30	340	342	2.5	-	250	-	10
Total Dissolved Solids	mg/L	180	250	70	190	197	7.2	-	-	-	-
Total Suspended Solids	mg/L	2.5	9	6.5	2.5	3.75	0.71	-	-	-	-
Fluoride	mg/L	0.1	0.4	0.3	0.3	0.3	0.03	-	-	-	-
Nitrate as NO_3	mg/L	0.025	1.1	1.1	0.3	0.3	0.09	1	2.4	1	-
Nitrite as NO_2	mg/L	0.025	0.25	0.225	0.25	0.182	0.034	-	-	-	-
NOx as N	mg/L	0.002	0.3	0.3	0.02	0.04	0.03	-	0.01	-	5
Calcium Dissolved	mg/L	11	13	2	12	11.9	0.2	-	-	-	-
Potassium Dissolved	mg/L	1	3	2	1.3	1.4	0.2	-	-	-	-
Magnesium Dissolved	mg/L	19	22	3	20.5	20.7	0.3	-	-	-	-
Sodium Dissolved	mg/L	19	24	5	21.5	21.4	0.4	-	-	-	-
Bicarbonate HCO_3 as CaCO3	mg/L	72	100	28	89	89.1	2.5	-	-	-	-
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	<5	<5	0	<5	<5	0	-	-	-	-
Hydroxide OH as $CaCO_3$	mg/L	<5	<5	0	<5	<5	0	-	-	-	-
Total Alkalinity as $CaCO_3$	mg/L	72	100	28	89	89.1	2.5	-	-	-	-
Chloride	mg/L	29	40	11	32	32.6	1.04	-	-	-	-
Sulphate	mg/L	27	34	7	29.5	29.4	0.7	-	-	-	-
Ionic Balance	%	-2	3	5	0.004	0.4	0.7	-	-	-	-
Hardness as $CaCO_3$	mg/L	110	120	10	115	115	1.7	-	-	-	-
Sum of Anions	meq/L	2.9	3.1	0.2	3.0	3.0	0.03	-	-	-	-
Sum of Cations	meq/L	3.2	3.4	0.2	3.4	3.3	0.03	-	-	-	-
Silica	mg/L	14	18	4	17	16.8	0.4	-	-	-	-
Aluminium Dissolved	mg/L	0.005	0.02	0.02	0.005	0.007	0.001	0.027	0.055	-	-
Antimony Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0	-	-	-	-
Arsenic Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0	0.001	0.024	-	-
Barium Dissolved	mg/L	0.005	0.1	0.095	0.005	0.02	0.009	-	-	-	-
Boron Dissolved	mg/L	0.005	0.1	0.095	0.095	0.08	0.01	0.09	0.37	5	-
Cadmium Dissolved	mg/L	<0.0001	<0.0001	0	<0.0001	<0.0001	0	0.00006	0.0002	-	-
Chromium Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0	0.00001	0.001	-	-
Cobalt Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0	-	-	-	-
Copper Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0	0.001	0.0014	-	-
Iron Dissolved	mg/L	0.005	0.05	0.05	0.02	0.02	0.005	-	0.3	-	-
Lead Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0	0.001	0.0034	-	-
Manganese Dissolved	mg/L	<0.001	0.3	0.3	0.2	0.2	0.03	1.2	1.9	-	-
Mercury Dissolved	mg/L	<0.00005	0.1	0.13	0	0.01	0.01	0.00006	0.0006	1	-
Molybdenum Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0	-	-	-	-
Nickel Dissolved	mg/L	<0.001	0.001	0	0	0.001	0	0.008	0.011	-	-
Selenium Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0	0.005	0.011	-	-
Strontium Dissolved	mg/L	0.04	0.056	0.016	0.048	0.047	0.001	-	-	-	-
Tin Dissolved	mg/L	<0.001	0.01	0.01	0	0.002	0.001	-	-	-	-
Zinc Dissolved	mg/L	<0.001	0.003	0.002	0.002	0.002	0	0.0024	0.008	1	-

Note: orange cells exceed 99% GV, yellow cells exceed 95% GV

6 DISCUSSION

6.1 Cave Microclimate

During the monitoring period (April 2019 to April 2020), temperatures inside both CO-CA-01 and CO-CA-03 were notably stable, with minimal daily fluctuation. Overall temperatures were slightly higher, on average, in CO-CA-03 compared with CO-CA-01 (30.3ºC [*SE* ± 0.02ºC] and 29.9ºC [*SE* ± 0.01ºC], respectively). Temperatures inside CO-CA-03 remained within the target range (28-32ºC) for the entire monitoring period (100%), while temperatures inside CO-CA-01 remained within the target range for 99.89% of the monitoring period. Ambient temperatures appeared to have very little influence on temperatures inside the roost. Although there was little temporal variation, temperatures within CO-CA-03 declined marginally between October and December 2019 while temperatures within CO-CA-01 declined marginally between late January and mid-March 2020. Therefore, while both caves exhibited temperatures within the same range, they did not follow the same pattern, suggesting that the factor/s controlling temperate are different at the caves such as cave morphology (Perry, 2012). Though both are upward sloping caves and readily trap upward rising air, as is a common trend of such caves (Perry, 2012), they are very different with respect to entrance size, shape and position in the landscape.

During the monitoring period, RH in CO-CA-03 occurred over a greater range and was significantly higher (p = <0.0001), on average, than in CO-CA-01 (Figure 6.1). Both caves exhibited similar temporal trends in cave RH levels, except for between March and April 2020 whereby CO-CA-01 exhibited a decline in RH outside of the target range. There was a significant non-linear monthly trend in caver RH. Moreover, variation in RH was negatively correlated with ambient temperature (after 35ºC Figure 6.1), and the relationship was mediated by two- week rainfall (p = <0.0001). Specifically, cave RH was highest when ambient temperature was between 35-40ºC and two-week rainfall was ≥250 mm. In addition, water seeps have been noted in both caves. It is likely these seeps are supplemented by rainfall emanating through the rock strata and likely contribute to humid internal conditions.

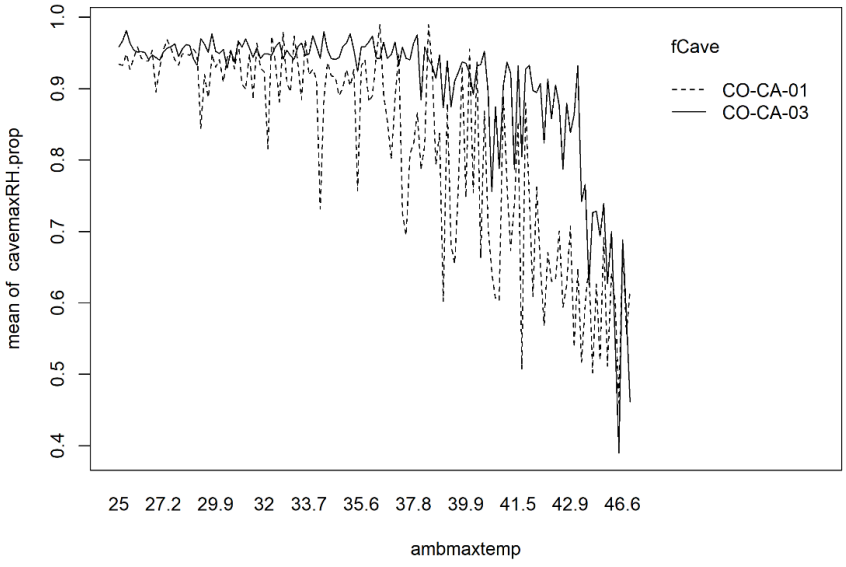


Figure 6.1: Relationship between RH at CO-CA-01 and CO-CA-03 and ambient temperature during the monitoring period

RH fell within the target range (85-100%) between April to late-September 2019 and from April to early-October 2019 at CO-CA-01 and CO-CA-03, respectively. During this period, 94.8% of recordings fell within the target range at CO-CA-01 and 100% fell within the target range at CO-CA-03. Following, RH at both caves declined outside the target range until January 2020. These results highlight the fact that caves naturally fluctuate outside of the target range. Moreover, it would be assumed that CO-CA-03 offers a more suitable environment for the species, in consideration of microclimate data only. However, low humidity levels recorded at CO-CA-03 in November 2017 was suggested to be on account of an outward flowing draft likely emanating from a crack in the strata of the second chamber that may open to the top of the ridge and periodically close on account of ground water contained within the strata or some other process that blocks the airflow (Bat Call, 2018). Moreover, it could be that the iButton within CO-CA-01 was not in the most representative roosting location for the species, given lack of access to rear chamber.

6.2 Cave Utilisation

Pilbara leaf-nosed bats were recorded at both CO-CA-01 and CO-CA-03 on every night during the monitoring period except for a single night at CO-CA-03; on the 8th January 2020 when Cyclone Blake hit Marble Bar. Interestingly, activity by the species peaked at CO-CA-01 on the 7th of January. Overall, activity occurred over a greater range at CO-CA-03 (64 to 56,699 calls) compared to CO-CA-01 (470 to 30,452 calls). Moreover, average activity was significantly greater at CO-CA-03 (7,033 [*SE* ± 619] calls per night) in comparison to CO-CA-01 (4,726 [*SE* ± 229] calls per night). During previous baseline monitoring event, average activity was also greater at CO-CA-03 than at CO-CA-01 in July 2017 (MWH, 2018), but marginally lower in 2018 (Biologic, 2019c).

Pilbara leaf-nosed bat activity at CO-CA-01 was significantly affected by day of sampling (p = <0.05). This indicates that activity is driven by an untested variable related to timing and/or a behavioural response. Roosting was indicated on all recording nights during the monitoring period at CO-CA-01. This pattern of usage is consistent with a Permanent Diurnal Roosts (Priority 1) defined by TSSC (2016) as a roost "*occupied year-round and are likely to be the focus for some part of the 9-month breeding cycle*". Roosting remained relatively constant throughout the monitoring period regardless of the apparent temporal variation in cave RH.

Bats, and particularly bats of small body size, experience a disadvantage in temperature regulation and evaporative water loss on account of greater surface area and vascularisation of flight membranes (Baudinette *et al.*, 2000). The rate of evaporative water loss in the Pilbara leaf-nosed bat is double that of other bat species. Therefore, humid microclimates help to reduce the consequence of dehydration (Baudinette *et al.*, 2000). Moreover, at temperatures lower than 30°C, the Pilbara leaf-nosed bat cannot maintain a body temperature of 36°C as such conditions require energy consumption rates of at least double that within thermoneutrality (Baudinette *et al.*, 2000). Therefore, the species is dependent on warm and humid roosting sites, especially during the dry Pilbara winter months (Baudinette *et al.*, 2000). This supports the theory that the iButton at CO-CA-01 may not be in the most representative roosting location of the species. As such cave RH at CO-CA-01 may be more consistent than that recorded during the monitoring period, given the Pilbara leaf-nosed bat roosted on all recording nights during the monitoring

period, and have consistently been recorded roosting within the cave during previous monitoring surveys (Biologic, 2019a, 2019c).

Conversely, roosting at CO-CA-03 was indicated on 47% of recording nights during the monitoring period, of which 91.3% of roosting events occurred between the 17th of April 2019 and the 25th of October 2019. In the Pilbara, mating by the species is thought to commence in July, and parturition is thought to commence in December after a long gestation period (Armstrong, 2001; Churchill, 1995). The level of activity and the consistency of roosting observed at CO-CA-03 over this period coincides with the species mating period and therefore may indicate such activities at the cave. Moreover, this pattern of usage is consistent with a Non-Permanent Breeding Roosts (Priority 2), defined by TSSC (2016) as roosts containing "*evidence of usage during some part of the 9-month breeding cycle (July–March), but not occupied year-round; considered as critical habitat that is essential for both the daily and long-term survival of the Pilbara leaf-nose bat*". Between the 26th of October and the 24th of April 2020, roosting was only indicated on 8.4% of recording nights. When roosting was not indicated, the timing of most of these calls suggested that individuals were in flight, possibly foraging, and roosting at another location.

Maximum ambient temperature, maximum cave temperature, range in cave RH and percentage moon illumination were not significant variables influencing roosting status at CO-CA-03. However, roosting typically occurred when conditions were more favourable (i.e. temperature and RH within the target ranges) suggesting that these conditions are still a prerequisite for roosting. Roosting was however correlated with day of sampling, indicating fluctuations in roosting activity at certain times of the year, exclusive to the other variables tested. This indicates that roosting was driven by untested variables related to timing and/or a behavioural response (e.g. reproductive cues).

Modelling also demonstrated that Pilbara leaf-nosed bat activity was significantly affected by day of sampling (p = <0.0001). This indicates that activity is also driven by an untested variable related to timing and/or a behavioural response (i.e. a behavioural preference for roosting at CO-CA-03). Although maximum cave RH and percentage moon illumination were not significant variables influencing activity at CO-CA-03, activity was significantly influence by range in cave RH (after accounting for seasonality; p = <0.05). Peaks in activity typically occurred when conditions were more favourable (i.e. temperature and RH within the target ranges). Therefore, it can be inferred that Pilbara leaf-nosed bats utilise CO-CA-03 during the mating and gestation period prior to parturition when cave RH is high and stable. Furthermore, during the mating and gestation period, it may be that Pilbara leaf-nosed bats are preferentially roosting within CO-CA-03 given the greater levels of activity observed in comparison to CO-CA-01 (although this is based on limited data at CO-CA-01, for which no ultrasonic recordings were available between April and July 2019). The species may have also preferentially used CO-CA-03 in July 2017 (MWH, 2018). However, average activity was marginally lower in 2018 at CO-CA-03 compared to CO-CA-01 (Biologic, 2019c).

6.3 Water Quality and Quantity

Foraging sites surrounding known or suspected roosts can be critical to the survival of the Pilbara leaf-nosed bat. The species forages within the vicinity of roost caves and more broadly along waterbodies

with suitable fringing vegetation supporting prey species (TSSC, 2016). Riparian zones are preferentially used by the species likely on account of their high productivity and water availability (Cramer *et al.*, 2016). As such gorges with pools are considered Priority 1 foraging habitat for the species (TSSC, 2016). Therefore, CO-WS-14 is considered foraging habitat critical to Pilbara leaf-nosed bat survival.

Pilbara leaf-nosed bats were recorded at CO-CA-03 on every night during the monitoring period except for a single night (8th January 2020). Roosting at the cave was recorded on 47% of recording nights during the monitoring period. However, on 53% of recording nights, the timing of calls suggested that individuals were in flight and possibly foraging at the site and by virtue CO-WS-14 (activity at CO-WS-14 cannot be directly recorded due to its proximity to CO-CA-03). The consistency at which the species uses the site as a forging location suggests CO-WS-14 is currently suitable habitat for the species. Therefore, the water quantity (tabulated in Sections 5.4.1) can be inferred as suitable for Pilbara leaf-nosed bats. CO-WS-14 contained water for the entire monitoring period and since monitoring began in October 2017. The pool is unlikely to dry out without interference in consideration of this and in consideration of the depth of CO-WS-14. Moreover, the quality (tabulated in Section 5.4.2) of the water can be inferred as suitable for Pilbara leaf-nosed bats. Some exceedances in six of the analytes relative to 95% and 99% GV stipulated in the ANZG Guidelines were observed (ANZG, 2019).

6.4 Evaluation of EPBC Approval Decision Condition 4

Condition 3 and 4 of the EPBC Approval Decision relate to potential impacts and management of the Pilbara leaf-nosed bat, specifically at cave CO-CA-03 and pool CO-WS-14. Currently, a monitoring strategy must be designed to demonstrate the maintenance of Condition 4, unless otherwise justified and approved by the Minister. The analysis, review and assessment of baseline monitoring data collected between April 2019 and April 2020 was used to help inform the adequacy and achievability of these objectives (Table 6.1).

Table 6.1: Conditions stipulated in EPBC Approval Decision 2017/7861

Condition	Assessment Against Baseline Data
4a) without anthropogenic supplementation of its water level, pool CO-WS-14 has water in it during and continuously for three consecutive years following the cessation of mining of Razor Back Pit	Water was continually present during the entire monitoring period (April 2019 to April 2020) as well as over the long-term (October 2017 to April 2020). Based on field observation, pool water level averaged 321.00 mRL [Std ± 0.02] during the monitoring period and 320.99 mRL [Std ± 0.02] over the long term.
4b) the water quality of pool CO-WS-14 remains suitable for Pilbara leaf-nosed bat during and continuously for three consecutive years following the cessation of mining of Razor Back Pit	Given the consistency at which the species uses the site as a foraging location (i.e. CO-CA-03 and by virtue CO-WS-14) suggests CO-WS-14 is currently suitable for the species. Therefore, the current quality documented over the monitoring period can be inferred as suitable for Pilbara leaf-nosed bats.
4c-i) cave CO-CA-03 maintains humidity between 85-100 per cent relative humidity during and continuously for five years following cessation of the mining of Razor Back Pit	Overall, humidity ranged from 18.1% to 99.5%, averaging 85.2% (*SE* ± 0.34). There was cyclic variation in RH; RH was highest between April to October 2019 (100% fell within the target range) and January to April 2020 (92.7% of recordings falling within the target range) and lowest between October 2019 and January 2020 (12.1% of recordings fell within the target range). Over a 12-month period, 75.3% of humidity recordings were within the target range (85-100%). Between April and October, RH within the cave was 95.1% (*SE* ± 0.05) on average. This coincided with roosting by the species on 91.3% of recording nights over this period and days of sampling was found to significantly influence the probability of roosting. Pilbara leaf-nosed bat activity was also significantly affected by day of sampling as well as range in cave RH. Therefore, it can be inferred that Pilbara leaf-nosed bats utilise CO-CA-03 during the mating and gestation period prior to parturition when cave RH is high and more stable. Overall, RH was not maintained within the target range for the entire monitoring period, rendering this condition unachievable.
4c-ii) cave CO-CA-03 maintains temperature between 28 and 32 degrees Celsius during and continuously for five years following cessation of the mining of Razor Back Pit	Temperature ranged from 28.0 to 31.6°C, averaging 30.3°C (*SE* ± 0.02°C) over the monitoring period. Overall, temperatures inside the roost were maintained within the target range for the entire monitoring period (within the target range (28-32°C) for 100% of the 12-month monitoring period), rendering this condition achievable

7 CONCLUSIONS

7.1 Cave Microclimate and Cave Utilisation

Roosting was indicated on all recording nights during the monitoring period at CO-CA-01. This pattern of usage is consistent with a Permanent Diurnal Roost (Priority 1) defined by TSSC (2016) as a roost "*occupied year-round and are likely to be the focus for some part of the 9-month breeding cycle*". Pilbara leaf-nosed bat roosting events remained relatively constant throughout the monitoring period regardless of the temporal variation in internal temperature and RH. However, given the species dependence on warm and humid microclimates it is possible that the iButton at CO-CA-01 may not have been placed in the most representative roosting location within the cave.

Roosting at CO-CA-03 was indicated on 47% of recording nights during the monitoring period, of which 91.3% of roosting events occurred between April and October 2019. The level of activity and the consistency of roosting observed over this period suggests individuals potentially congregate at the cave for the purposes of mating. Moreover, this pattern of usage is consistent with a Non-Permanent Breeding Roost (Priority 2), defined by TSSC (2016) as roosts containing "*evidence of usage during some part of the 9-month breeding cycle (July–March), but not occupied year-round; considered as critical habitat that is essential for both the daily and long-term survival of the Pilbara leaf-nose bat*".

Conditions 4c-i in EPBC Approval Decision 2017/7861, stipulated that cave CO-CA-03 should maintain humidity between 85-100%. However, there is a significant non-linear trend in cave RH. Moreover, ambient temperature was found to be negatively correlated with cave RH (above 35ºC), and the relationship was mediated by two-week rainfall. At CO-CA-03, RH was highest (100% of recordings fell within the target range) between April to October 2019 (coinciding with the mating period for the species) and January to April 2020 (92.7% of recordings fell within the target range). In comparison, RH was lowest between October 2019 and January 2020 over which only 12.1% of recordings were within the target range. Similarly, RH was not maintained within the target range for the entire monitoring period at CO-CA-01, although the iButton may not have been in the most representative roosting location for the species.

At CO-CA-03, Pilbara leaf-nosed bat activity and roosting was significantly affected by day of sampling. This suggests that an untested variable and/or a behavioural response may be driving roosting and activity at the cave. Additionally, range in cave RH significantly influenced activity. Roosting and peaks in activity typically occurred when conditions were more favourable (i.e. temperature and RH within the target ranges) suggesting that these conditions are still a prerequisite for roosting. Therefore, in summary Pilbara leaf-nosed bats utilise CO-CA-03 during the mating season prior to parturition when cave RH is high and relatively stable. Consequently, it is recommended that Condition 4c-i be altered to consider that RH remains in the target range (85%-100%) for part of the year only, perhaps during the mating season in order to avoid disruption of breeding by the species that may have a significant impact on the species (TSSC, 2016). Some consideration should also be provided to the effect of rainfall given its correlation with changes in RH; RH may vary according to year to year rainfall variability.

Conditions 4c-ii in EPBC Approval Decision 2017/7861, stipulated that cave CO-CA-03 should maintain temperature between 28-32ºC. Temperatures inside both roosts remained within the target range (28-32ºC) for the monitoring period (100%) and did not appear to be influenced by ambient temperatures. Although there was little cyclic and seasonal variation, temperatures within CO-CA-03 declined marginally between October and December 2019 while temperatures within CO-CA-01 declined marginally between late January and mid-March 2020. Therefore, while both caves exhibited temperatures within the same range, they did not follow the same pattern, suggesting that the factor/s controlling temperate are different at the caves. Neither ambient temperature or cave temperature significantly affected activity or roosting by the species. However, ambient temperature was found to be negatively correlated with cave RH, and the relationship was mediated by two-week rainfall. Consequently, Condition 4c-ii does not require alteration.

The results of this analysis are based on 12-month monitoring period. However, trends maybe more or less apparent over a longer sampling period.

7.2 Water Quality and Quantity

Condition 4a in EPBC Approval Decision 2017/7861, stipulated that without anthropogenic supplementation of its water level, pool CO-WS-14 has water in it during and continuously for three consecutive years following the cessation of mining of Razorback Pit. During the entire monitoring period (April 2019 to April 2020) as well as over the long-term (October 2017 to April 2020) water was present at the site; pool water level averaged 321.00 mRL [Std ± 0.02] and 320.99 mRL [Std ± 0.02] respectively. No drawdown is anticipated from the Project (SRK, 2019).

Additionally, Condition 4b stipulates that the water quality of pool CO-WS-14 remains suitable for Pilbara leaf-nosed bat during and continuously for three consecutive years following the cessation of mining of Razor Back Pit. Pilbara leaf-nosed bats were recorded at CO-CA-03 on every night during the monitoring period except for a single night (8th January 2020 likely due to Cyclone Blake). On 53% of recording nights, the timing calls suggested that individuals were in flight and possibly foraging at the site and by virtue CO-WS-14. Given the consistency at which the species uses the site as a forging location suggests CO-WS-14 is currently suitable for the species. Therefore, the quality of the water can be inferred as suitable for Pilbara leaf-nosed bats. Suitable parameters for the species are not known.

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9 APPENDICES

Appendix A: Sample Water Quality Report from ENVIROLAB

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 218256

Client Details

Client	Atlas Iron Limited
Attention	David Nyquest
Address	Level 18, 300 Murray Street, PERTH, WA, 6000

Sample Details

Your Reference	**Atlas Iron / Corunna / Surface Water**
Number of Samples	4 Waters
Date samples received	05/11/2018
Date completed instructions received	05/11/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	09/11/2018
Date of Issue	09/11/2018

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Todd Lee, Laboratory Manager, Perth

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorganics						
Our Reference	UNITS	PQL	218256-1	218256-2	218256-3	218256-4
Your Reference			CO-WS-01	CO-WS-14	CO-WS-12	CO-WS-10
Date Sampled			03/11/2018	02/11/2018	01/11/2018	01/11/2018
Type of sample			Water	Water	Water	Water
Date prepared	-		05/11/2018	05/11/2018	05/11/2018	05/11/2018
Date analysed	-		05/11/2018	05/11/2018	05/11/2018	05/11/2018
pH	pH Units		7.9	7.6	6.3	8.0
Electrical Conductivity (EC)	µS/cm	1	380	340	140	910
Total Dissolved Solids (grav)	mg/L	5	230	200	85	540
Total Suspended Solids	mg/L	5	<5	<5	17	<5
Fluoride	mg/L	0.1	<0.1	0.3	0.2	0.3
Nitrate as NO_3	mg/L	0.5	<0.5	<0.5	<0.5	<0.5
Nitrite as NO_2	mg/L	0.5	<0.5	<0.5	<0.5	<0.5
NOx as N	mg/L	0.005	0.017	<0.005	<0.005	<0.005

Ionic Balance						
Our Reference	UNITS	PQL	218256-1	218256-2	218256-3	218256-4
Your Reference			CO-WS-01	CO-WS-14	CO-WS-12	CO-WS-10
Date Sampled			03/11/2018	02/11/2018	01/11/2018	01/11/2018
Type of sample			Water	Water	Water	Water
Date prepared	-		08/11/2018	08/11/2018	08/11/2018	08/11/2018
Date analysed	-		08/11/2018	08/11/2018	08/11/2018	08/11/2018
Calcium - Dissolved	mg/L	0.5	12	12	3.3	13
Potassium - Dissolved	mg/L	0.5	1.0	1.2	<0.5	2.2
Magnesium - Dissolved	mg/L	0.5	27	21	6.4	36
Sodium - Dissolved	mg/L	0.5	24	20	13	110
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	130	92	39	170
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	<5	<5	<5	<5
Hydroxide OH^- as $CaCO_3$	mg/L	5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	5	130	92	39	170
Chloride	mg/L	1	32	29	18	170
Sulphate	mg/L	1	13	26	<1	28
Ionic Balance	%		0.37	0.053	-0.97	-2.1
Hardness as $CaCO_3$	mg/L	3	140	110	35	180
Sum of Anions	meq/L	0	3.39	2.87	1.14	8.13
Sum of Cations	meq/L	0	3.91	3.20	1.26	8.39

Dissolved Metals in Water						
Our Reference	UNITS	PQL	218256-1	218256-2	218256-3	218256-4
Your Reference			CO-WS-01	CO-WS-14	CO-WS-12	CO-WS-10
Date Sampled			03/11/2018	02/11/2018	01/11/2018	01/11/2018
Type of sample			Water	Water	Water	Water
Date prepared	-		06/11/2018	06/11/2018	06/11/2018	06/11/2018
Date analysed	-		06/11/2018	06/11/2018	06/11/2018	06/11/2018
Silica	mg/L	0.2	17	19	26	32
Aluminium-Dissolved	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Antimony-Dissolved	mg/L	0.001	<0.001	<0.001	0.002	<0.001
Arsenic-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Barium-Dissolved	mg/L	0.001	0.016	0.007	0.030	0.029
Boron-Dissolved	mg/L	0.02	0.09	0.1	0.07	0.34
Cadmium-Dissolved	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Copper-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Cobalt-Dissolved	mg/L	0.001	<0.001	<0.001	0.001	<0.001
Iron-Dissolved	mg/L	0.01	0.03	0.01	0.07	<0.01
Lead-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese-Dissolved	mg/L	0.005	0.033	0.26	0.46	0.026
Mercury-Dissolved	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Nickel-Dissolved	mg/L	0.001	<0.001	<0.001	0.002	<0.001
Selenium-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Strontium-Dissolved	mg/L	0.001	0.071	0.050	0.055	0.15
Tin-Dissolved	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Zinc-Dissolved	mg/L	0.001	0.002	0.001	<0.001	<0.001

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-006	Alkalinity - determined titrimetrically based on APHA latest edition, Method 2320-B. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
INORG-019	Suspended Solids - determined gravimetrically by filtration of the sample. The samples are dried at 104+/-5oC.
INORG-040	Ion Balance Calculation: Cations in water by ICP-OES; Anions in water by IC; Alkalinity in water by Titration using APHA methods.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
INORG-081	Anions - a range of anions are determined by Ion Chromatography based on APHA latest edition Method 4110-B. Soils and other sample types reported from a water extract unless otherwise specified (standard soil extract ratio 1:5).
METALS-008	Hardness calculated from Calcium and Magnesium as per APHA latest edition 2340B.
METALS-020	Metals in soil and water by ICP-OES.
METALS-021	Determination of Mercury by Cold Vapour AAS. For urine samples total Mercury is determined, however, mercury in urine is almost entirely in the inorganic form (CDC).
METALS-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	218256-2
Date prepared	-			05/11/2018	1	05/11/2018	05/11/2018		05/11/2018	05/11/2018
Date analysed	-			05/11/2018	1	05/11/2018	05/11/2018		05/11/2018	05/11/2018
pH	pH Units		INORG-001	[NT]	1	7.9	[NT]		101	[NT]
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	1	380	[NT]		104	[NT]
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	1	230	[NT]		104	[NT]
Total Suspended Solids	mg/L	5	INORG-019	<5	1	<5	<5	0	103	[NT]
Fluoride	mg/L	0.1	INORG-081	<0.1	1	<0.1	<0.1	0	93	92
Nitrate as NO_3	mg/L	0.5	INORG-081	<0.5	1	<0.5	<0.5	0	100	77
Nitrite as NO_2	mg/L	0.5	INORG-081	<0.5	1	<0.5	<0.5	0	98	93
NOx as N	mg/L	0.005	INORG-055	<0.005	1	0.017	0.017	0	103	77

QUALITY CONTROL: Ionic Balance						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	218256-2
Date prepared	-			08/11/2018	1	08/11/2018	08/11/2018		08/11/2018	08/11/2018
Date analysed	-			08/11/2018	1	08/11/2018	08/11/2018		08/11/2018	08/11/2018
Calcium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	12	[NT]		96	[NT]
Potassium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	1.0	[NT]		97	[NT]
Magnesium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	27	[NT]		98	[NT]
Sodium - Dissolved	mg/L	0.5	METALS-020	<0.5	1	24	[NT]		98	[NT]
Bicarbonate HCO_3 as $CaCO_3$	mg/L	5	INORG-006	<5	1	130	[NT]		100	[NT]
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	5	INORG-006	<5	1	<5	[NT]		100	[NT]
Total Alkalinity as $CaCO_3$	mg/L	5	INORG-006	<5	1	130	[NT]		100	[NT]
Chloride	mg/L	1	INORG-081	<1	1	32	32	0	99	93
Sulphate	mg/L	1	INORG-081	<1	1	13	13	0	97	94
Hardness as $CaCO_3$	mg/L	3	METALS-008	<3	1	140	[NT]		[NT]	[NT]

QUALITY CONTROL: Dissolved Metals in Water						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	218256-2
Date prepared	-			06/11/2018	1	06/11/2018	06/11/2018		06/11/2018	06/11/2018
Date analysed	-			06/11/2018	1	06/11/2018	06/11/2018		06/11/2018	06/11/2018
Silica	mg/L	0.2	METALS-020	<0.2	1	17	[NT]		104	[NT]
Aluminium-Dissolved	mg/L	0.01	METALS-022	<0.01	1	<0.01	<0.01	0	93	95
Antimony-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	90	85
Arsenic-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	106	108
Barium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.016	0.016	0	107	103
Boron-Dissolved	mg/L	0.02	METALS-022	<0.02	1	0.09	0.09	0	118	128
Cadmium-Dissolved	mg/L	0.0001	METALS-022	<0.0001	1	<0.0001	<0.0001	0	108	109
Chromium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	95	93
Copper-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	94	91
Cobalt-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	97	93
Iron-Dissolved	mg/L	0.01	METALS-022	<0.01	1	0.03	0.03	0	94	92
Lead-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	102	99
Manganese-Dissolved	mg/L	0.005	METALS-022	<0.005	1	0.033	0.032	3	98	107
Mercury-Dissolved	mg/L	0.00005	METALS-021	<0.00005	1	<0.00005	[NT]		109	[NT]
Molybdenum-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	106	107
Nickel-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	94	91
Selenium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	103	105
Strontium-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.071	0.068	4	101	102
Tin-Dissolved	mg/L	0.001	METALS-022	<0.001	1	<0.001	<0.001	0	107	106
Zinc-Dissolved	mg/L	0.001	METALS-022	<0.001	1	0.002	0.001	67	99	99

QUALITY CONTROL: Dissolved Metals in Water					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	218256-4
Date prepared	-			[NT]	3	06/11/2018	06/11/2018		[NT]	06/11/2018
Date analysed	-			[NT]	3	06/11/2018	06/11/2018		[NT]	06/11/2018
Silica	mg/L	0.2	METALS-020	[NT]	3	26	[NT]		[NT]	[NT]
Aluminium-Dissolved	mg/L	0.01	METALS-022	[NT]	3	<0.01	[NT]		[NT]	[NT]
Antimony-Dissolved	mg/L	0.001	METALS-022	[NT]	3	0.002	[NT]		[NT]	[NT]
Arsenic-Dissolved	mg/L	0.001	METALS-022	[NT]	3	<0.001	[NT]		[NT]	[NT]
Barium-Dissolved	mg/L	0.001	METALS-022	[NT]	3	0.030	[NT]		[NT]	[NT]
Boron-Dissolved	mg/L	0.02	METALS-022	[NT]	3	0.07	[NT]		[NT]	[NT]
Cadmium-Dissolved	mg/L	0.0001	METALS-022	[NT]	3	<0.0001	[NT]		[NT]	[NT]
Chromium-Dissolved	mg/L	0.001	METALS-022	[NT]	3	<0.001	[NT]		[NT]	[NT]
Copper-Dissolved	mg/L	0.001	METALS-022	[NT]	3	<0.001	[NT]		[NT]	[NT]
Cobalt-Dissolved	mg/L	0.001	METALS-022	[NT]	3	0.001	[NT]		[NT]	[NT]
Iron-Dissolved	mg/L	0.01	METALS-022	[NT]	3	0.07	[NT]		[NT]	[NT]
Lead-Dissolved	mg/L	0.001	METALS-022	[NT]	3	<0.001	[NT]		[NT]	[NT]
Manganese-Dissolved	mg/L	0.005	METALS-022	[NT]	3	0.46	[NT]		[NT]	[NT]
Mercury-Dissolved	mg/L	0.00005	METALS-021	[NT]	3	<0.00005	<0.00005	0	[NT]	126
Molybdenum-Dissolved	mg/L	0.001	METALS-022	[NT]	3	<0.001	[NT]		[NT]	[NT]
Nickel-Dissolved	mg/L	0.001	METALS-022	[NT]	3	0.002	[NT]		[NT]	[NT]
Selenium-Dissolved	mg/L	0.001	METALS-022	[NT]	3	<0.001	[NT]		[NT]	[NT]
Strontium-Dissolved	mg/L	0.001	METALS-022	[NT]	3	0.055	[NT]		[NT]	[NT]
Tin-Dissolved	mg/L	0.001	METALS-022	[NT]	3	<0.001	[NT]		[NT]	[NT]
Zinc-Dissolved	mg/L	0.001	METALS-022	[NT]	3	<0.001	[NT]		[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available).

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) a

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

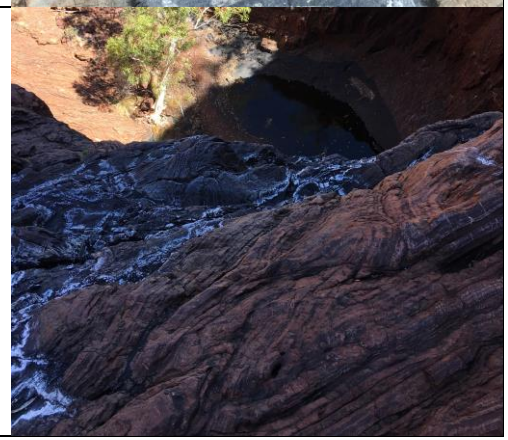
When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Appendix B: Pools Monitored within the Corunna Project Area

Pool ID	Latitude	Longitude	Permanency/ ground water dependency (SRK, 2019)	Monthly field observations and chemical data	Hourly water logger data	Photo
CO-WS-01	-21.411	119.687	Perennial/ Likely	20/12/2017 - 29/07/2019	11/10/2017 - 24/04/2020	
CO-WS-05	-21.467	119.639	Perennial/ Likely	24/11/2017 - 15/05/2019	N/A	

Pool ID	Latitude	Longitude	Permanency/ ground water dependency (SRK, 2019)	Monthly field observations and chemical data	Hourly water logger data	Photo
CO-WS-08	-21.452	119.651	Ephemeral/ Likely	25/10/2017 - 15/05/2019	25/10/2017 - 17/04/2019	
CO-WS-10	-21.416	119.676	Perennial/ Likely	24/11/2017 - 14/05/2019	25/10/2017 - 19/01/2019	

Pool ID	Latitude	Longitude	Permanency/ ground water dependency (SRK, 2019)	Monthly field observations and chemical data	Hourly water logger data	Photo
CO-WS-11	-21.439	119.678	Ephemeral/ Unlikely	20/12/2017 - 14/05/2019	11/10/2017 - 16/04/2019	
CO-WS-12	-21.420	119.673	Perennial/ Likely	25/10/2017 - 30/07/2019	11/10/2017 - 24/04/2020	
CO-WS-13	-21.466	119.650	Ephemeral/ Likely	25/10/2017 - 15/05/2019	13/10/2017 - 17/04/2019	

Pool ID	Latitude	Longitude	Permanency/ ground water dependency (SRK, 2019)	Monthly field observations and chemical data	Hourly water logger data	Photo
CO-WS-14	-21.468	119.671	Perennial/ Likely	25/10/2017 - 25/04/2020	10/10/2017 - 30/07/2019	

Appendix C: Raw Ultrasonic and Microclimate Data at CO-CA-03

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
17-Apr-19	18:44	6:08	371						31.62	31.62	31.16						92.85	94.87	93.32
18-Apr-19	17:58	5:28	239	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	94.37	94.37	94.37	93.86	94.37	94.37	93.86
19-Apr-19	18:50	5:21	215	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.87	95.88	94.37	95.88	94.37	94.37	94.87	94.37
20-Apr-19	19:02	4:36	134	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.38	94.37	94.37	94.87	94.37	94.87	94.37	94.87
21-Apr-19	19:02	4:51	168	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.87	94.87	94.87	94.37	94.87	94.87	94.87	94.87
22-Apr-19	18:35	6:15	1114	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	95.38	94.87	95.38	95.88	96.38	95.38	94.87
23-Apr-19	18:07	6:12	769	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.87	95.38	95.88	95.38	95.88	95.38	95.38	95.38
24-Apr-19	17:54	6:14	724	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.87	95.38	95.88	95.88	95.38	97.37	95.38	96.38
25-Apr-19	18:10	5:53	1330	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.38	94.87	95.88	95.88	96.38	95.38	95.38	95.38
26-Apr-19	17:42	5:06	1476	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.88	95.88	95.88	95.88	95.88	95.38	96.38	95.88
27-Apr-19	18:32	5:39	1009	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.38	94.87	95.38	94.37	94.37	94.37	94.87	94.87
28-Apr-19	18:46	6:17	1834	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	94.37	94.37	94.37	94.87	94.87	94.37	94.87
29-Apr-19	18:02	6:16	1502	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	93.86	92.34	93.36	93.36	92.85	92.85	94.37
30-Apr-19	18:34	6:18	2607	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	93.36	93.86	93.86	93.86	94.37	94.37	93.86
1-May-19	17:39	6:18	1810	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	93.86	94.37	93.86	93.36	93.36	93.36	94.37
2-May-19	17:38	6:19	1879	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	93.86	92.85	92.85	92.85	91.83	93.36	93.86	93.36
3-May-19	17:37	6:19	1633	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	93.36	93.36	93.86	93.36	93.36	93.86	93.86	92.85
4-May-19	17:48	6:19	3535	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	93.36	93.86	93.86	92.85	93.36	94.37	93.86	94.37
5-May-19	17:37	6:20	2804	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	93.86	94.37	92.85	93.86	93.86	93.36	93.86
6-May-19	17:35	6:20	4135	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	93.36	93.86	93.36	94.37	93.86	93.86	92.34	94.37
7-May-19	17:39	6:12	2700	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	93.86	93.86	94.37	93.36	93.86	93.86	92.34
8-May-19	17:34	6:19	1784	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	93.86	93.36	93.36	93.86	94.37	93.86	93.36	93.36
9-May-19	17:54	6:20	1015	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	92.85	94.37	93.36	93.36	93.36	93.36	93.86	93.86
10-May-19	17:36	6:15	660	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	93.86	93.86	93.86	93.36	92.85	94.37	93.36	93.86
11-May-19	17:50	5:57	23095	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	93.36	93.36	92.85	93.36	93.36	93.36	92.85	93.86
12-May-19	17:37	6:20	11445	31.12	31.12	31.12	31.62	31.62	31.62	31.62	31.62	94.3	93.79	93.28	93.36	93.86	93.86	93.86	94.37
13-May-19	17:32	6:00	12197	31.62	31.12	31.12	31.12	31.12	31.62	31.12	31.12	93.86	92.78	92.78	93.79	94.3	94.37	94.3	94.3
14-May-19	17:31	6:24	7267	31.12	31.12	31.12	31.12	31.12	31.12	31.62	31.12	93.28	94.3	94.3	94.3	94.3	94.3	94.37	94.3
15-May-19	17:33	6:24	5463	31.12	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.8	94.37	94.37	94.37	94.37	93.86	93.86	94.87
16-May-19	17:34	6:24	6694	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	93.86	94.37	94.37	94.37	93.86	94.37	94.37
17-May-19	18:24	6:25	9953	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.38	94.37	95.38	94.37	95.88	94.37	94.87	94.37
18-May-19	17:30	6:25	5114	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.38	96.38	95.38	95.38	94.87	94.87	94.87	94.87
19-May-19	17:41	5:54	5814	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.38	95.88	94.87	94.87	95.38	94.87	95.38	95.38
20-May-19	17:29	5:54	9763	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.38	95.38	95.38	95.38	95.38	95.38	96.38	95.38
21-May-19	17:46	6:27	7422	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.88	95.38	95.88	96.38	95.38	95.38	95.88	95.38
22-May-19	17:29	5:26	3764	31.12	31.62	31.62	31.62	31.62	31.62	31.62	31.62	96.3	94.87	95.38	95.88	95.88	95.38	95.88	94.87
23-May-19	18:24	5:16	5523	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.87	94.87	94.87	94.37	95.38	94.87	94.37	94.87
24-May-19	18:25	6:24	5655	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.87	94.37	94.87	94.87	94.87	93.86	94.37	94.37
25-May-19	18:17	5:32	4885	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	94.87	95.38	93.86	95.88	94.87	94.87	94.87
26-May-19	18:23	6:29	4555	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	94.37	94.37	94.37	94.87	94.87	95.38	94.87
27-May-19	17:33	6:00	3230	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	94.37	94.87	95.38	93.86	94.87	95.38	94.37
28-May-19	18:29	5:45	2328	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	94.87	94.87	95.38	93.86	94.37	93.36	94.37
29-May-19	18:26	5:40	5663	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	93.86	94.87	94.37	94.37	94.87	94.37	94.37
30-May-19	18:22	5:41	3749	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.37	94.37	94.37	95.38	94.37	95.38	95.38	94.87
31-May-19	18:14	6:29	9256	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.38	94.37	94.87	95.38	94.87	95.38	95.38	95.38

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
1-Jun-19	17:30	6:31	8562	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.38	94.37	95.38	94.87	94.87	94.87	95.38	94.87
2-Jun-19	17:26	5:09	8091	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.12	95.88	95.88	96.38	94.87	95.38	94.87	95.88	94.8
3-Jun-19	18:22	6:32	6978	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.87	94.87	95.38	94.87	95.38	95.38	95.88	95.38
4-Jun-19	17:27	6:28	6910	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	96.38	96.38	95.38	94.87	93.86	94.87	94.87	95.38
5-Jun-19	18:24	4:49	5908	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.12	95.88	94.37	95.38	94.87	95.38	94.87	95.38	95.3
6-Jun-19	18:21	5:21	5118	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.38	95.38	94.37	94.87	95.38	95.88	95.38	94.87
7-Jun-19	18:18	6:28	7061	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.87	94.87	94.87	94.87	94.87	94.87	94.87	94.87
8-Jun-19	17:36	6:34	2858	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.38	95.38	95.88	95.38	94.37	94.87	95.38	94.87
9-Jun-19	17:31	5:40	3981	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.87	94.87	94.87	94.37	93.86	94.37	94.87	95.38
10-Jun-19	18:13	5:39	8799	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	94.87	93.86	94.37	93.36	94.37	94.37	95.88	94.87
11-Jun-19	18:24	6:34	1435	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	95.88	94.37	95.38	94.37	94.37	94.37	94.87	94.87
12-Jun-19	18:14	5:52	5908	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	93.36	94.37	93.86	94.37	94.87	94.37	94.37	93.86
13-Jun-19	18:15	5:31	9150	31.62	31.62	31.62	31.62	31.62	31.62	31.62	31.62	93.36	93.86	94.37	93.86	92.85	93.86	93.86	95.88
14-Jun-19	18:10	6:01	20787	31.62	31.62	31.62	31.62	31.62	31.62	31.12	31.12	93.86	93.86	93.86	93.86	94.37	93.36	93.28	93.79
15-Jun-19	17:55	6:05	25205	31.12	31.12	31.12	31.12	31.62	31.62	31.12	31.12	92.27	92.27	93.28	93.79	93.36	93.36	92.78	92.27
16-Jun-19	17:27	5:44	12064	31.12	31.12	31.12	31.12	31.12	31.12	31.12	31.12	93.28	92.78	93.79	92.78	92.78	92.78	92.78	93.28
17-Jun-19	18:17	5:07	3992	31.12	31.12	31.12	31.62	31.62	31.62	31.12	31.12	92.78	92.78	93.28	93.36	93.86	92.34	93.28	92.78
18-Jun-19	18:08	5:52	31386	31.12	31.12	31.12	31.62	31.62	31.62	31.12	31.12	93.79	93.28	93.28	93.36	92.85	92.85	93.28	93.28
19-Jun-19	17:40	6:37	38673	31.12	31.12	31.12	31.12	31.12	31.12	31.12	31.12	93.79	92.78	92.27	92.27	91.75	91.75	92.27	93.28
20-Jun-19	17:27	6:37	26633	31.12	30.62	30.62	31.12	31.12	31.12	31.12	31.12	93.28	92.71	93.21	92.27	92.78	93.28	92.78	93.79
21-Jun-19	17:28	6:38	40561	31.12	31.12	31.12	31.12	31.12	31.12	31.12	31.12	93.28	93.28	92.27	92.78	92.27	92.27	91.75	92.27
22-Jun-19	17:38	6:43	31966	31.12	30.62	31.12	31.12					92.27	92.71	91.75	92.78				
23-Jun-19	17:47	6:09	13934																
24-Jun-19	18:18	6:40	21630																
25-Jun-19	17:34	6:38	30590																
26-Jun-19	17:32	6:44	33591																
27-Jun-19	17:32	6:44	36382																
28-Jun-19	17:32	6:09	19798																
29-Jun-19	17:36	6:34	33278																
30-Jun-19	17:33	6:44	55563																
1-Jul-19	17:41	6:44	53748																
2-Jul-19	17:33	6:44	51380																
3-Jul-19	17:34	6:44	41977																
4-Jul-19	17:34	6:44	46900																
5-Jul-19	17:34	6:32	33591																
6-Jul-19	17:36	6:40	22696																
7-Jul-19	17:40	6:20	9844																
8-Jul-19	17:36	6:43	31538	30.59	30.1	30.59	30.59	30.59	30.59	30.59	30.59	95.72	93.64	95.22	94.21	95.72	95.72	95.22	94.72
9-Jul-19	17:38	6:44	42529	30.59	30.1	30.1	30.59	30.59	30.59	30.59	30.59	95.22	93.14	94.65	94.72	95.22	95.22	94.72	94.72
10-Jul-19	17:36	6:42	25900	30.59	30.1	30.1	30.59	30.59	30.59	30.59	30.59	95.22	94.15	93.64	94.72	94.72	94.72	94.72	95.22
11-Jul-19	17:37	6:44	36764	30.59	30.1	30.59	30.59	30.59	30.59	30.59	30.59	94.72	93.14	94.72	95.22	95.22	94.72	95.72	95.22
12-Jul-19	17:41	6:44	56699	30.59	30.1	30.1	30.1	30.59	30.59	30.1	30.1	94.72	91.61	93.64	94.15	95.22	93.71	93.64	92.63
13-Jul-19	17:52	6:44	34850	30.1	30.1	30.1	30.1	30.59	30.59	30.59	30.1	93.14	92.12	93.64	94.15	94.21	94.72	94.72	94.65
14-Jul-19	17:40	6:44	27395	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	93.64	94.65	94.15	94.65	94.15	94.65	94.15	94.15
15-Jul-19	17:38	6:43	17132	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	94.15	94.15	94.15	94.15	94.15	95.15	94.65	93.64

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
16-Jul-19	17:41	6:43	11181	30.1	30.1	30.1	30.59	30.59	30.59	30.59	30.1	94.15	94.15	94.15	94.21	94.72	94.72	95.22	94.65
17-Jul-19	17:39	6:43	39249	30.1	30.1	30.1	30.1	30.1	30.59	30.59	30.1	94.65	94.15	95.15	94.65	94.15	94.21	95.22	94.15
18-Jul-19	17:39	6:22	34054	30.1	30.1	30.1	30.1	30.1	30.59	30.59	30.1	94.65	95.15	95.65	94.65	95.15	95.22	94.72	95.15
19-Jul-19	17:40	6:42	37513	30.1	30.1	30.1	30.59	30.59	30.59	30.59	30.1	95.15	94.65	95.65	95.22	95.72	95.22	94.72	95.15
20-Jul-19	17:42	6:19	30640	30.1	30.1	30.1	30.1	30.1	30.59	30.1	30.1	95.15	95.65	95.15	96.65	96.15	96.71	96.15	95.65
21-Jul-19	17:42	6:31	37083	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	95.15	93.14	95.65	95.65	95.15	94.65	94.65	95.15
22-Jul-19	17:42	6:42	41255	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	94.65	95.15	94.65	94.65	94.65	95.15	94.65	93.64
23-Jul-19	17:45	6:41	45501	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	93.64	93.14	94.15	94.15	94.15	94.15	94.65	93.64
24-Jul-19	17:43	6:41	44845	30.1	29.6	29.6	29.6	30.1	30.1	30.1	30.1	93.14	91.03	92.56	92.06	93.14	93.14	94.15	93.64
25-Jul-19	17:42	6:40	48333	30.1	29.6	29.6	30.1	30.1	30.1	30.1	30.1	94.15	91.55	92.56	93.64	94.15	94.15	94.15	93.64
26-Jul-19	17:43	6:40	44218	30.1	29.6	30.1	30.1	30.1	30.1	30.1	30.1	93.64	93.07	93.64	94.15	94.15	94.65	94.65	94.65
27-Jul-19	17:43	6:40	32242	30.1	29.6	30.1	30.1	30.1	30.1	30.1	30.1	94.15	93.58	94.15	94.15	94.15	94.65	94.65	94.65
28-Jul-19	17:43	6:39	39453	30.1	29.6	29.6	30.1	30.1	30.1	30.1	30.1	95.15	91.03	94.08	94.15	93.64	94.15	94.65	94.15
29-Jul-19	17:44	6:20	25670	30.1	29.6	30.1	30.1	30.64	30.64	30.64	30.64	93.64	93.07	93.64	94.15	89.55	91.62	91.62	92.64
30-Jul-19	17:44	6:38	27272	30.64	30.14	30.14	30.64	30.64	30.64	30.64	30.14	92.13	90.52	92.57	93.15	93.66	93.15	93.66	92.57
31-Jul-19	17:48	6:38	31042	30.14	29.64	30.14	30.14	30.14	30.14	30.14	30.14	94.1	89.42	91.55	91.55	92.57	92.06	92.57	92.06
1-Aug-19	17:45	6:37	16433	30.14	29.64	29.64	30.14	30.14	30.14	30.14	30.14	92.06	88.9	90.45	92.06	92.06	92.06	92.57	91.55
2-Aug-19	17:45	6:37	11065	30.14	30.14	30.14	30.14	30.64	30.14	30.14	30.14	93.59	92.57	92.57	93.08	93.15	93.08	93.59	93.59
3-Aug-19	17:46	6:34	4719	30.14	30.14	30.14	30.14	30.14	30.64	30.64	30.64	93.08	93.59	93.59	93.59	95.11	93.15	94.17	93.15
4-Aug-19	18:08	6:36	22181	30.64	30.64	30.64	30.64	30.64	30.64	30.64	30.64	93.66	95.68	94.67	94.67	95.18	94.67	96.18	95.18
5-Aug-19	17:51	6:35	28101	30.64	30.64	30.64	30.64	30.64	30.64	30.64	30.64	95.18	94.67	94.67	95.68	96.18	96.18	95.18	95.68
6-Aug-19	17:47	6:22	36023	30.64	30.14	30.14	30.14	30.64	30.64	30.64	30.64	96.18	94.6	95.61	96.11	96.68	96.18	94.67	95.18
7-Aug-19	17:49	6:34	29637	30.14	29.64	30.14	30.14	30.14	30.14	30.14	30.14	94.6	90.97	94.1	94.1	94.6	95.61	93.59	94.1
8-Aug-19	17:51	6:32	14296	30.14	29.64	29.64	30.14	30.14	30.14	30.14	30.14	93.08	88.37	91.49	93.59	93.59	94.1	93.59	93.59
9-Aug-19	17:48	5:48	6130	30.14	30.14	30.14	30.14	30.14	30.64	30.14	30.14	93.59	94.1	93.59	94.1	94.6	95.18	94.1	94.1
10-Aug-19	18:26	6:32	10431	30.64	30.14	30.64	30.64	30.64	30.64	30.64	30.14	94.67	94.1	95.68	94.17	95.18	95.18	95.18	95.11
11-Aug-19	17:50	6:31	17900	30.14	30.14	30.14	30.64	30.64	30.64	30.14	30.14	95.61	94.6	95.61	95.68	96.18	95.68	94.6	95.11
12-Aug-19	17:49	6:12	5168	30.14	30.14	30.14	30.14	30.14	30.14	30.14	30.14	94.6	94.6	94.6	94.6	95.11	95.11	95.11	95.11
13-Aug-19	17:57	6:05	3309	30.14	30.14	30.14	30.64	30.64	30.64	30.64	30.64	96.11	95.61	95.11	96.18	95.18	95.68	96.18	95.68
14-Aug-19	17:55	6:20	1341	30.64	30.64	30.64	30.64	30.64	30.64	30.64	30.64	96.68	96.18	97.18	96.68	96.18	96.18	95.68	96.18
15-Aug-19	17:51	5:17	1074	30.64	30.64	30.64	30.64	30.64	30.64	30.64	30.64	96.18	97.67	96.68	96.68	95.68	97.67	96.18	95.18
16-Aug-19	17:59	6:02	1438	30.64	30.64	30.64	30.64	30.64	30.64	30.64	30.64	96.68	96.18	96.68	97.18	97.18	97.18	96.18	96.68
17-Aug-19	18:04	5:20	1136	30.64	30.64		30.53	30.53	30.53	30.53	30.53	96.68	96.18		94.68	95.67	94.68	95.67	96.66
18-Aug-19	18:02	6:17	7327	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	97.15	97.15	97.64	97.64	97.64	98.13	98.13	96.1
19-Aug-19	17:53	6:25	3096	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	96.59	96.59	97.57	97.08	98.06	98.06	96.59	97.57
20-Aug-19	17:55	5:42	4739	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	97.57	97.57	97.08	97.57	97.08	97.64	98.55	97.57
21-Aug-19	18:29	5:34	11812	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	97.57	97.08	98.06	97.57	98.13	98.13	98.06	97.08
22-Aug-19	18:28	6:14	10028	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	97.08	97.57	97.08	97.57	98.06	98.06	97.57	97.57
23-Aug-19	18:13	6:16	8312	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	97.57	97.57	98.06	97.57	98.06	98.06	98.06	97.57
24-Aug-19	17:54	6:16	7853	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	97.57	97.08	97.57	97.57	97.57	98.06	98.06	98.06
25-Aug-19	18:06	6:12	2366	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	97.57	98.06	98.06	97.57	98.06	98.55	98.06	98.06
26-Aug-19	18:14	6:12	901	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	98.06	98.55	99.03	99.03	99.03	99.52	99.52	98.55
27-Aug-19	18:36	6:19	2184	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	99.03	98.55	99.52	99.03	99.52	99.52	99.03	98.55
28-Aug-19	17:54	6:16	1879	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	98.06	99.03	99.52	97.57	99.03	99.03	99.03	98.06
29-Aug-19	18:03	6:16	1409	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	99.03	98.55	98.55	98.55	99.03	98.55	99.03	99.52

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
30-Aug-19	18:09	6:16	2522	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	97.57	98.55	98.55	98.55	98.55	98.55	98.55	98.55
31-Aug-19	17:55	6:15	6212	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	98.55	97.57	98.06	97.57	98.06	98.06	97.57	97.57
1-Sep-19	17:55	6:14	8370	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	98.06	97.57	96.59	97.57	98.06	98.06	98.55	99.03
2-Sep-19	17:56	6:13	9068	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	97.57	98.55	98.06	98.06	97.57	97.57	96.59	98.06
3-Sep-19	17:56	6:11	7134	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	97.08	98.06	98.06	98.06	98.06	97.57	98.06	98.55
4-Sep-19	17:56	5:58	4832	30.53	30.03	30.53	30.53	30.53	30.53	30.03	30.03	97.57	97.57	97.57	98.06	97.57	97.57	97.08	97.08
5-Sep-19	17:57	6:10	7853	30.53	30.03	30.03	30.53	30.53	30.53	30.03	30.53	97.57	95.6	98.06	96.59	97.08	98.55	97.08	97.08
6-Sep-19	17:57	6:09	10455	30.53	30.03	30.03	30.53	30.53	30.53	30.03	30.53	97.57	96.59	97.57	97.08	98.06	97.08	98.06	97.57
7-Sep-19	17:57	6:09	10478	30.53	30.03	30.03	30.03	30.03	30.03	30.03	30.03	97.57	96.59	98.06	97.57	97.08	96.59	97.08	98.06
8-Sep-19	17:57	6:08	8055	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	98.06	97.08	97.08	97.08	97.57	97.57	97.99	98.06
9-Sep-19	17:58	6:07	7776	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	96.59	97.08	98.55	97.51	95.54	97.99	96.03	97.51
10-Sep-19	17:58	6:06	12595	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	96.1	97.99	96.52	96.03	95.04	95.54	97.02	96.03
11-Sep-19	17:58	6:05	11163	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	96.52	97.99	97.02	96.52	97.02	96.52	96.03	97.02
12-Sep-19	17:59	6:04	18395	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	97.51	96.52	97.51	97.08	97.08	98.06	96.52	96.1
13-Sep-19	17:59	5:58	9106	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	97.02	97.02	97.51	97.08	97.02	97.51	96.52	97.51
14-Sep-19	17:59	6:02	12979	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	96.03	96.52	97.51	98.06	97.51	97.02	96.52	97.02
15-Sep-19	17:59	6:01	11328	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	96.52	97.02	96.52	97.99	97.51	96.52	96.52	96.52
16-Sep-19	18:00	6:00	14524	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	97.02	97.02	96.52	97.02	96.52	97.51	97.02	97.02
17-Sep-19	18:00	5:59	12026	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	97.51	97.02	96.52	97.51	97.51	97.02	96.52	96.52
18-Sep-19	18:00	5:58	16751	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	96.52	97.02	96.52	97.02	96.52	97.02	96.03	96.52
19-Sep-19	18:00	5:56	20424	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	96.03	96.52	96.52	96.52	97.02	97.02	96.52	96.52
20-Sep-19	18:06	5:56	14782	30.03	29.53	30.03	30.03	30.03	30.03	30.03	30.03	96.52	94.54	96.52	97.02	97.02	96.03	97.02	96.52
21-Sep-19	18:01	5:34	10776	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	96.52	97.02	96.52	97.02	97.02	96.52	97.02	96.03
22-Sep-19	18:04	5:50	16529	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	96.52	97.02	97.51	97.51	96.52	97.02	97.02	97.02
23-Sep-19	18:02	5:52	14372	30.03	29.53	30.03	30.03	30.03	30.03	30.03	30.03	96.52	95.54	95.54	96.52	96.52	96.03	95.54	94.54
24-Sep-19	18:02	5:52	22835	30.03	29.53	30.03	30.03	30.03	30.03	30.03	30.03	97.02	96.03	96.52	96.52	96.03	96.03	96.52	97.02
25-Sep-19	18:02	5:51	15582	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	96.52	96.52	97.99	97.02	97.99	97.02	97.02	96.52
26-Sep-19	18:02	5:42	3985	30.03	29.53	30.03	30.03	29.53	30.03	30.03	30.03	96.52	95.54	96.52	96.03	96.03	96.03	96.52	96.52
27-Sep-19	18:03	5:33	3877	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	96.52	96.52	96.52	96.03	95.54	95.54	96.03	97.02
28-Sep-19	18:03	5:45	4492	30.03	30.03	30.03			29.53	29.53	29.53	97.02	96.52				92.06	92.56	92.56
29-Sep-19	18:03	5:47	4252	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	93.07	92.56	92.56	93.07	93.58	93.07	93.58	92.56
30-Sep-19	18:04	5:45	3934	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	93.58	92.56	93.58	93.07	93.07	93.58	93.07	93.07
1-Oct-19	18:04	5:45	2865	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	93.07	93.07	93.07	93.07	93.07	93.07	93.07	93.07
2-Oct-19	18:04	5:42	2657	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	93.58	93.58	93.58	93.58	93.58	94.58	92.56	94.58
3-Oct-19	18:05	5:40	2125	29.53	29.53	29.53	29.53	29.53	29.03	29.03	29.03	94.08	93.58	94.08	93.58	92.56	93.01	91.99	91.99
4-Oct-19	18:24	4:56	2486	29.03	29.53	29.53	29.53	29.53	29.53	29.03	29.03	91.99	93.01	93.07	94.08	92.5	93.01	92.5	91.99
5-Oct-19	18:17	5:10	2416	29.03	29.53	29.53	29.53	29.53	29.53	29.53	29.53	92.5	91.99	92.56	92.56	93.07	93.07	92.06	92.5
6-Oct-19	18:20	5:37	2664	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.03	93.01	92.56	93.58	93.07	94.08	94.08	92.5	92.5
7-Oct-19	18:13	5:12	2291	29.03	29.53	29.53	29.53	29.53	29.03	29.03	29.03	93.01	92.5	92.06	93.07	92.06	88.91	90.97	91.48
8-Oct-19	18:09	5:37	1876	29.03	29.03	29.53	29.53	29.03	28.03	28.53	29.03	92.5	91.99	93.01	91.48	79.3	72.06	87.81	88.91
9-Oct-19	18:07	5:37	1270	29.03	29.03	29.03	29.53	28.03	28.03	28.03	28.53	89.95	89.95	89.95	89.95	68.09	58.76	72.06	83.07
10-Oct-19	18:16	5:37	676	29.03	29.03	29.03	29.03	28.03	28.03	28.53	28.53	86.31	86.31	86.83	70.48	61.13	52.74	74.91	82.54
11-Oct-19	18:52	4:55	404	29.03	29.03	29.03	29.03	28.03	28.03	28.03	28.53	83.66	86.31	85.78	60.59	54.56	33.17	51.52	73.8
12-Oct-19	18:44	4:38	280	28.53	29.03	29.03	28.53	28.03	28.03	28.03	28.53	77.67	80.98	83.66	61.18	38.35	35.13	45.33	69.86
13-Oct-19	19:02	4:50	315	28.53	29.03	29.03	29.03	28.53	28.03	28.53	29.03	75.46	78.82	81.52	82.06	58.81	51.52	77.12	81.52

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
14-Oct-19	18:46	4:46	334	29.03	29.03	29.03	29.03	28.53	28.53	29.03	29.03	82.06	84.19	84.72	85.78	66.43	73.74	83.66	85.78
15-Oct-19	18:44	4:52	550	29.03	29.03	29.03	29.53	29.03	28.53	29.03	29.03	85.25	86.83	87.35	86.83	84.72	78.16	84.72	85.78
16-Oct-19	18:43	4:52	722	29.03	29.03	29.53	29.53	29.53	28.53	29.03	29.03	86.31	86.83	87.41	88.97	90.01	79.3	86.31	86.83
17-Oct-19	18:30	4:52	836	29.03	29.03	29.03	29.53	29.53	28.53	29.03	29.03	86.83	87.87	88.39	89.49	90.52	65.79	84.67	85.78
18-Oct-19	18:46	4:41	634	29.03	29.03	29.53	29.53	28.53	28.03	28.03	28.53	86.83	87.87	88.46	90.01	67.52	54.56	58.16	78.76
19-Oct-19	18:50	4:48	564	29.03	29.03	29.03	28.53	28.53	28.53	28.53	28.53	82	83.66	84.19	68.15	45.95	40.27	45.95	69.29
20-Oct-19	18:53	5:28	671	29.03	29.03	29.03	29.03	28.53	28.53	28.53	28.53	77.12	79.36	81.52	68.15	54.01	43.44	48.5	67
21-Oct-19	18:25	4:50	1060	28.53	29.03	29.03	29.03	28.53	28.53	28.53	29.03	75.46	78.27	80.44	68.15	50.35	66.43	75.46	80.98
22-Oct-19	18:17	5:20	1747	29.03	29.03	29.03	29.03	28.53	28.53	28.53	28.53	85.25	84.72	84.72	84.19	63.53	58.76	68.66	78.21
23-Oct-19	18:12	5:25	2069	29.03	29.03	29.03	29.03	28.53	28.03	28.03	28.53	81.52	81.52	83.13	68.21	47.82	35.13	59.94	78.76
24-Oct-19	18:13	5:10	1844	29.03	29.03	29.03	29.03	28.03	28.03	28.03	28.53	80.39	82	83.66	82.6	40.27	35.78	61.71	73.24
25-Oct-19	18:13	4:43	1237	28.53	29.03	29.03	28.53	28.03	28.03	28.03	28.53	77.67	79.84	80.44	67.57	49.06	44.07	46.58	67.57
26-Oct-19	20:30	4:41	865	28.53	28.53	29.03	28.53	28.53	28.03	28.53	28.53	74.35	77.12	78.76	66.43	50.29	40.27	65.85	73.8
27-Oct-19	19:01	4:32	747	29.03	29.03				28.53	28.53	29.03	80.44	79.9				47.16	54.57	73.26
28-Oct-19	19:12	4:36	612	29.03	29.53	29.53	29.03	28.53	28.53	29.03	29.03	77.75	78.84	80.47	60.58	41.45	46.53	53.35	69.88
29-Oct-19	19:16	4:34	450	29.03	29.03	29.53	29.03	29.03	28.53	29.03	29.03	76.1	78.3	79.39	65.92	53.35	42.73	56.39	73.82
30-Oct-19	19:07	4:31	366	29.03	29.53	29.53	29.03	28.53	28.53	29.03	29.03	78.3	78.84	80.47	62.94	47.78	42.09	56.39	71.01
31-Oct-19	19:15	4:32	260	29.03	29.53	29.53	29.53	29.03	28.53	28.53	29.03	76.1	78.3	79.39	80.47	54.57	43.37	49.03	68.17
1-Nov-19	18:59	4:23	235	29.03	29.03	29.03	29.53	29.53	29.53	29.53	29.53	73.82	76.65	78.84	79.93	81.54	82.61	85.26	85.26
2-Nov-19	19:03	4:17	471	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	85.26	85.26	85.85	88.45	89.48	90.51	88.97	88.45
3-Nov-19	18:57	4:37	615	29.53	30.03	30.03	30.03	30.03	30.03	30.03	29.53	88.97	90	90	91.53	90.51	90.51	91.02	90.51
4-Nov-19	19:01	4:40	653	29.53	30.03	30.03	30.03	30.03	30.03	30.03	30.03	90.51	92.03	92.54	92.54	92.03	92.54	92.03	92.54
5-Nov-19	19:07	4:32	447	30.03	30.03	30.03	30.03	30.03	30.03	29.53	30.03	92.54	93.54	93.04	93.54	94.04	94.54	92.54	92.54
6-Nov-19	19:11	4:30	383	30.03	30.03	30.03	30.03	29.03	28.53	29.03	29.53	93.54	94.54	94.54	94.54	65.28	63.47	85.79	87.35
7-Nov-19	19:05	4:31	385	29.53	29.53	29.53	29.53	28.53	28.53	29.03	29.03	89.42	89.42	89.48	78.3	55.73	48.35	74.94	79.39
8-Nov-19	19:00	4:31	502	29.53	29.53	29.53	29.03	28.53	28.53	28.53	28.53	82.61	84.21	84.74	62.94	40.17	31.61	31.67	58.8
9-Nov-19	19:12	4:30	466	29.03	29.03	29.03	28.53	28.53	28.53	28.53	28.53	72.7	77.2	79.39	43.37	32.33	30.33	29	55.79
10-Nov-19	19:03	4:32	416	29.03	29.03	29.03	28.53	28.53	28.53	28.53	28.53	75.49	74.94	75.55	43.37	30.33	27.65	29	42.73
11-Nov-19	19:05	4:27	285	29.03	29.03	29.03	28.53	28.53	29.03	29.03	29.03	59.99	67.02	66.44	32.33	25.63	23.59	40.81	53.35
12-Nov-19	19:07	4:11	211	29.03	29.03	29.03	29.03	29.03	29.03	29.03	29.03	64.11	69.37	69.37	37.58	30.33	27.65	30.33	40.17
13-Nov-19	19:11	4:49	227	29.03	29.03	29.03	29.03	29.03	29.03	29.03	29.03	41.45	58.8	65.86	40.81	34.31	32.33	32.99	33.65
14-Nov-19	19:05	4:26	239	28.53	29.03	29.03	29.03	29.03	29.03	29.03	29.03	39.52	59.99	42.73	32.33	28.33	26.31	31	30.33
15-Nov-19	19:08	4:16	298	29.03	29.03	29.03	29.03	29.03	29.03	29.03	29.03	33.65	52.13	38.88	33.65	30.39	36.33	39.52	50.89
16-Nov-19	19:10	4:10	287	29.03	29.03	29.03	29.03	29.03	29.03	29.03	29.03	57.05	61.82	40.17	25.63	23.64	22.27	22.27	34.97
17-Nov-19	19:14	4:41	325	29.03	29.03	29.03	29.03	29.03	29.03	29.03	29.03	36.93	42.73	21.53	18.13	20.21	19.52	25	32.33
18-Nov-19	19:12	5:13	258	29.03	29.03	29.03	29.03	29.03	29.03	29.03	29.03	47.21	57.05	39.52	22.96	20.9	20.21	20.21	25.63
19-Nov-19	18:28	4:25	272	29.03	29.53	29.03	29.03	29.03	29.53	29.53	29.53	45.33	57.05	44.06	29.05	27.03	27.03	36.98	54.63
20-Nov-19	19:28	4:26	320	29.53	29.53	29.53	29.53	29.03	29.03	29.03	29.03	63	68.8	69.94	50.33	31.72	29.72	35.68	41.51
21-Nov-19	19:44	4:23	463	29.53	29.53	29.53	29.03	29.03	29.03	29.03	29.03	55.84	63.59	54.02	34.36	31.06	32.38	33.05	38.93
22-Nov-19	19:42	4:22	466	29.03	29.53	29.03	29.03	29.03	29.53	29.03	29.03	45.33	51.57	37.63	33.05	32.38	29.72	31.72	36.98
23-Nov-19	19:17	4:16	365	29.53	29.53	29.03	29.03	29.53	29.53	29.53	29.53	49.09	59.45	38.93	31.06	32.38	28.38	33.71	35.02
24-Nov-19	20:11	4:23	305	29.03	29.53	29.53	29.53	29.53	29.53	29.53	29.53	35.02	44.69	41.51	42.79	39.58	47.9	48.47	58.25
25-Nov-19	19:30	4:30	682	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	65.98	69.43	72.26	52.8	46.59	40.87	51.57	64.17
26-Nov-19	20:59	5:11	2314	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	68.22	69.94	71.13	59.45	46.59	49.71	64.17	70.57
27-Nov-19	18:48	5:10	2675	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	73.94	75.61	76.16	58.85	54.63	61.23	70.51	78.9

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
28-Nov-19	18:34	4:27	2407	29.53	29.53	29.53	29.53	29.03	29.03	29.03	29.53	81.61	79.99	79.99	79.45	55.84	49.03	54.63	67.65
29-Nov-19	19:19	4:15	858	29.53	29.53	29.53	29.03	29.03	29.03	29.03	29.03	72.76	75.55	76.71	50.95	39.58	34.36	36.98	54.63
30-Nov-19	19:34	3:58	606	29.53	29.53	29.53	29.53	29.03	29.03	29.03	29.03	67.07	70.51	72.76	55.24	44.69	42.15	42.79	49.09
1-Dec-19	19:20	4:06	594	29.53	29.53	29.53	29.53	29.53	29.03	29.03	29.03	61.82	68.22	70.51	72.76	47.21	36.93	40.81	60.05
2-Dec-19	19:25	4:18	652	29.53	29.53	29.53	29.53	29.03	29.03	29.03	29.53	67.07	71.07	73.88	73.88	42.73	32.33	53.41	66.5
3-Dec-19	19:25	4:22	482	29.53	29.53	29.53	29.03	29.03	29.03	29.03	29.03	70.51	72.76	74.99	44	33.65	30.39	34.97	40.17
4-Dec-19	19:25	4:23	389	29.03	29.53	29.53	29.03	29.03	29.03	29.53	29.53	60.05	65.34	47.21	31.06	28.38	27.03	35.68	40.22
5-Dec-19	19:55	4:18	235	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	54.63	63	52.8	41.51	36.33	38.99	48.47	49.71
6-Dec-19	19:47	4:19	224	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	62.41	67.13	55.84	40.87	37.63	37.04	36.33	39.58
7-Dec-19	19:27	4:21	226	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	54.02	63.65	48.47	33.05	31.11	30.44	29.05	39.58
8-Dec-19	19:28	4:22	554	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	55.84	63.65	47.84	33.71	28.38	24.38	27.03	30.39
9-Dec-19	19:28	4:20	598	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	31.06	38.93	34.36	33.1	31.11	29.78	33.1	33.1
10-Dec-19	22:33	4:28	602	29.53	29.53	30.03	30.03	30.03	30.03	30.03	30.03	37.69	37.04	54.69	46.64	44.12	47.27	57.71	65.4
11-Dec-19	19:49	4:13	270	30.03	30.03	30.03	29.53	29.53	29.53	29.53	29.53	66.56	68.86	62.47	42.2	41.56	41.56	45.38	47.27
12-Dec-19	19:31	5:07	288	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	46.59	58.91	61.29	41.51	38.99	37.69	41.56	45.33
13-Dec-19	19:40	4:24	233	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	58.31	63.06	60.7	44.12	42.84	41.56	46.01	57.11
14-Dec-19	20:37	2:40	257	30.03	30.03	30.03	29.53	29.53	29.53	29.53	29.53	65.98	68.86	62.47	55.24	47.21	49.09	62.47	65.4
15-Dec-19				30.03	30.03	30.03	29.53	29.53	29.53	29.53	30.03	71.13	73.38	74.5	58.25	49.71	55.24	63.65	70
16-Dec-19				30.03	30.03	30.03	29.53	29.53	29.53	29.53	29.53	73.38	75.06	76.71	61.29	50.95	42.79	50.33	62.47
17-Dec-19				30.03	30.03	30.03	29.53	29.53	29.53	29.53	29.53	70	72.82	72.26	50.33	40.28	37.04	38.34	44.75
18-Dec-19	19:44	4:14	205	29.53	29.53				29.53	29.53	29.53	48.52	58.31				28.06	28.73	37.88
19-Dec-19	20:26	4:31	349	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	39.16	36.59	37.88	37.23	32.03	32.03	41.71	57.14
20-Dec-19	19:58	5:17	748	29.53	29.53	29.53	29.53	29.53	29.53	29.53	29.53	60.71	63.06	58.33	51.69	45.49	62.47	63.06	67.69
21-Dec-19	18:48	5:04	616	29.53	30.03	30.03	29.53	29.53	29.53	29.53	29.53	71.67	73.36	75.58	66.54	58.33	48.61	51.69	62.47
22-Dec-19	20:21	4:22	739	29.53	29.53	29.53	29.53	29.53	29.53	29.53	30.03	68.26	69.97	63.06	49.84	46.74	61.3	68.26	71.11
23-Dec-19	19:41	4:43	626	30.03	30.03	29.53	29.53	29.53	29.53	29.53	29.53	73.91	73.91	65.96	54.12	49.23	55.33	57.74	61.88
24-Dec-19	19:35	4:06	271	29.53	29.53	29.53	29.53	29.53	29.53	30.03	30.03	66.54	70.54	60.12	47.99	44.24	42.98	58.93	65.96
25-Dec-19	19:48	4:12	647	29.53	30.03	29.53	29.53	29.53	29.53	29.53	29.53	65.96	68.84	65.39	55.94	47.37	41.08	38.52	43.61
26-Dec-19	19:52	4:27	339	29.53	30.03	30.03	29.53	29.53	30.03	30.03	30.03	49.23	62.53	59.52	52.3	45.49	45.55	47.42	48.61
27-Dec-19	20:14	4:28	2968	29.53	29.53	29.53	29.53	30.03	30.03	30.03	30.03	46.74	45.49	46.12	40.44	38.58	36.64	36	41.13
28-Dec-19	19:51	4:33	385	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	47.42	45.55	61.94	63.7	54.79	52.36	50.52	51.74
29-Dec-19	20:28	4:39	392	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	60.17	67.18	60.77	42.98	41.13	52.36	49.9	48.05
30-Dec-19	19:51	4:43	607	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	64.28	66.6	69.47	67.18	59.58	55.39	55.39	55.99
31-Dec-19	19:37	4:22	250	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	60.77	67.75	63.12	55.99	48.05	46.18	63.7	66.6
1-Jan-20	19:58	4:22	145	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	69.47	71.17	72.86	64.28	61.36	56.6	68.32	71.17
2-Jan-20	19:56	4:35	614	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	72.3	73.42	75.09	66.02	59.58	59.58	67.75	71.73
3-Jan-20	19:45	4:51	1663	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	75.09	75.64	76.75	66.6	66.54	73.98	75.64	78.39
4-Jan-20	19:33	4:34	617	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	77.85	79.48	80.57	80.03	78.94	79.48	81.65	80.57
5-Jan-20	19:42	4:33	274	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	81.65	81.65	82.72	82.72	82.18	83.25	82.72	83.25
6-Jan-20	19:47	4:37	487	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	82.72	83.79	83.79	84.32	84.32	84.32	84.85	84.32
7-Jan-20	20:07	0:37	133	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	84.85	84.85	84.85	85.9	85.38	85.9	86.43	86.43
8-Jan-20			0	30.03	30.53	30.53	30.53	30.53	30.53	30.53	30.53	86.43	86.43	87.48	86.95	86.43	87.54	88.58	89.62
9-Jan-20	19:28	4:44	745	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	91.16	91.16	90.14	90.14	92.69	90.65	92.19	92.19
10-Jan-20	19:38	4:41	382	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	92.69	91.16	93.71	92.19	92.19	93.2	92.69	93.2
11-Jan-20	19:40	4:32	1844	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.2	91.16	91.68	93.71	93.2	92.69	93.2	92.69

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
12-Jan-20	19:39	4:21	647	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	94.72	93.2	94.72	93.2	94.72	95.22	94.21	93.2
13-Jan-20	19:45	4:35	181	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	95.22	94.72	95.22	94.72	93.71	95.22	95.22	94.72
14-Jan-20	19:38	4:40	205	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	92.69	93.71	92.69	94.21	93.71	93.2	93.71	94.21
15-Jan-20	21:28	4:34	190	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.71	93.71	93.71	93.71	93.71	93.71	93.2	93.71
16-Jan-20	19:34	3:59	568	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	94.21	94.21	93.71	93.71	93.71	93.71	94.21	94.21
17-Jan-20	19:43	4:41	1414	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	94.21	94.21	93.71	93.71	93.71	94.21	93.71	94.21
18-Jan-20	1:36	4:38	64	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	94.72	94.21	93.71	94.21	94.21	93.71	94.21	94.21
19-Jan-20	19:36	4:32	1849	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.71	93.71	94.21	93.71	93.71	94.21	94.21	94.72
20-Jan-20	19:42	4:37	289	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.2	93.71	93.71	94.21	94.21	93.71	94.21	94.21
21-Jan-20	21:38	4:38	146	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.71	93.71	94.21	93.71	94.21	93.71	93.71	93.71
22-Jan-20	19:49	4:38	210	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.71	94.21	94.21	93.71	93.71	94.21	94.21	94.72
23-Jan-20	20:07	4:40	244	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.71	94.21	94.21	93.71	94.21	93.71	94.21	94.21
24-Jan-20	19:55	4:44	205	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.71	93.71	93.71	93.71	93.71	93.71	93.71	94.72
25-Jan-20	19:55	4:36	228	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	94.72	94.21	94.21	93.71	94.21	94.72	94.72	94.72
26-Jan-20	19:55	4:42	114	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	94.21	94.21	94.21	94.72	94.72	95.22	95.22	95.22
27-Jan-20	19:50	4:41	133	30.53	30.53	30.53	30.53	30.53	30.53	30.03	30.03	94.21	93.71	93.71	93.71	94.72	94.72	94.65	94.65
28-Jan-20	19:56	4:55	145	30.53	30.53	30.53	30.53	30.03	29.03	29.53	30.03	93.64	93.64	94.21	93.71	92.12	76.07	90.52	92.63
29-Jan-20	20:04	4:48	123	30.03	30.03	30.03	30.03	29.03	29.03	29.03	29.53	92.63	92.63	92.63	76.69	82.6	61.24	71.05	85.84
30-Jan-20	19:50	4:51	556	29.53	30.03	30.03	29.53	29.03	29.03	29.03	29.03	88.46	89.55	90.07	67.12	55.88	52.24	57.08	79.9
31-Jan-20	19:57	4:52	281	29.53	29.53	29.53	30.03	29.03	29.03	29.03	29.53	82.66	86.37	87.94	87.41	68.78	50.4	76.07	81.05
1-Feb-20	19:52	4:55	374	29.53	29.53	30.03	30.03	29.53	29.03	29.03	29.53	84.26	85.84	87.94	88	82.66	59.46	76.63	84.26
2-Feb-20	19:42	4:55	427	29.53	30.03	30.03	30.03	29.53	29.53	29.53	29.53	86.89	87.41	88.52	88.52	77.24	72.23	83.72	85.84
3-Feb-20	20:01	4:55	319	29.53	30.03	30.03	30.03	29.53	29.03	29.03	29.53	86.37	88.52	89.04	89.55	66.54	61.83	64.17	83.19
4-Feb-20	19:49	4:57	323	29.53	29.53	30.03	30.03	30.03	29.03	29.03	29.53	84.79	86.37	87.48	88	88	55.28	74.41	82.66
5-Feb-20	19:49	4:51	227	29.53	30.03	30.03	30.03	29.53	29.03	29.03	29.53	85.31	86.89	88	87.48	63.06	64.17	60.65	79.96
6-Feb-20	20:23	5:22	434	29.53	29.53	30.03	29.53	29.53	29.53	29.53	30.03	83.72	85.84	86.37	75.03	69.97	66.54	82.66	88.52
7-Feb-20	19:02	5:49	2122	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	86.95	88	88.52	88	88	88	89.04	90.59
8-Feb-20	18:50	5:50	778	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	91.61	91.61	92.12	90.07	90.07	90.59	91.1	91.61
9-Feb-20	19:45	4:14	196	30.03	30.03	30.03	30.53	30.53	30.53	30.53	30.53	90.59	91.61	91.1	91.61	91.61	91.61	92.12	92.12
10-Feb-20	19:34	4:11	303	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	91.1	92.12	92.19	92.19	91.16	92.19	92.19	92.19
11-Feb-20	19:42	4:40	536	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.2	92.69	92.69	93.2	92.69	91.68	92.69	93.2
12-Feb-20	19:29	4:50	457	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.71	93.2	91.68	91.16	91.16	91.16	94.21	93.2
13-Feb-20	19:27	5:53	907	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.2	92.19	91.68	93.2	91.68	93.2	91.68	92.19
14-Feb-20	18:56	5:02	305	30.53	30.53	30.53	30.53	30.53	30.53	30.03	30.03	94.21	91.68	92.19	93.2	92.69	93.14	93.14	91.61
15-Feb-20	21:49	5:03	406	30.03	30.53	30.53	30.53	30.03	29.53	30.03	30.03	92.12	91.61	92.69	92.69	85.84	81.05	89.49	90.59
16-Feb-20	19:24	4:55	385	30.03	30.53	30.53	30.53	30.53	30.53	30.03	30.03	91.61	91.61	92.12	91.68	92.19	92.12	91.61	92.12
17-Feb-20	19:40	4:37	1080	30.53	30.53	30.53	30.53	30.03	29.53	30.03	30.03	92.12	92.19	92.19	92.69	81.11	80.51	89.04	90.59
18-Feb-20	19:46	4:54	255	30.03	30.03	30.53	30.53	30.53	29.53	30.03	30.03	91.1	91.61	91.61	91.68	91.1	83.19	90.59	91.1
19-Feb-20	19:36	5:07	182	30.03	30.03	30.53	30.53	30.53	30.53	30.53	30.53	91.1	91.1	91.61	92.19	92.19	91.61	92.12	91.68
20-Feb-20	19:36	5:05	2139	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	92.19	92.19	92.19	92.19	92.69	92.19	93.71	93.2
21-Feb-20	19:28	5:08	265	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	92.19	92.19	92.69	92.69	92.69	92.19	92.69	93.2
22-Feb-20	19:40	5:04	271	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.71	93.2	93.2	92.69	93.71	93.71	93.71	94.72
23-Feb-20	19:39	5:08	273	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	94.72	93.71	92.69	92.69	93.2	92.69	94.72	93.71
24-Feb-20	19:39	5:11	168	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	92.69	93.2	93.2	93.71	93.71	94.21	94.72	93.71
25-Feb-20	19:34	5:08	142	30.53	30.53	30.53	30.53	30.53	30.03	30.03	30.03	94.21	94.21	94.21	94.21	95.22	92.12	92.63	93.64

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
26-Feb-20	19:42	5:08	177	30.53	30.53	30.53			31.03	30.57	30.57	92.12	93.2	82.72				84.73	89.36
27-Feb-20	19:31	5:09	188	31.07	31.07	31.07	31.07	31.07	30.57	30.57	30.57	92.67	91.66	92.67	92.17	92.67	81.13	86.44	90.57
28-Feb-20	19:58	5:09	226	31.07	31.07	31.07	31.07	30.57	30.57	30.57	30.57	91.15	92.17	92.67	90.13	81.13	71.7	78.36	88.52
29-Feb-20	19:23	5:07	169	30.57	31.07	31.07	30.57	30.07	30.07	30.07	30.07	89.04	89.62	90.64	82.74	74.5	61.29	62.47	72.26
1-Mar-20	21:07	5:04	481	30.57	30.57	30.57	30.57	30.57	30.57	30.57	30.57	81.67	84.86	86.96	86.96	75.67	75.12	83.81	88
2-Mar-20	20:46	5:05	667	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	88.07	89.62	90.13	90.64	91.15	91.66	91.15	92.67
3-Mar-20	19:21	5:59	1633	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	93.68	92.17	92.67	92.67	92.67	92.67	94.18	94.18
4-Mar-20	19:17	5:11	1021	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	94.18	94.18	93.18	94.18	94.18	93.68	94.68	94.68
5-Mar-20	19:20	5:14	336	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	93.68	93.68	94.18	93.68	94.68	94.18	94.18	94.68
6-Mar-20	19:34	5:14	243	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	94.18	94.68	95.18	93.68	94.18	96.17	95.18	95.67
7-Mar-20	19:32	5:06	371	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	93.68	94.68	94.68	94.18	95.18	95.18	94.68	95.18
8-Mar-20	19:25	5:13	349	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	95.18	94.68	94.68	95.18	95.18	94.68	96.66	95.18
9-Mar-20	19:25	5:08	205	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	95.18	94.68	95.18	94.68	95.67	95.67	96.17	95.67
10-Mar-20	19:23	5:05	149	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	95.67	95.18	95.18	95.67	94.68	95.67	95.18	95.67
11-Mar-20	19:22	5:15	224	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	95.18	95.67	95.67	95.18	95.67	95.67	95.18	96.17
12-Mar-20	19:13	5:06	326	31.07	31.07	31.07	31.07	31.07	31.07	31.07	31.07	96.17	96.66	96.17	95.18	96.66	96.66	96.66	96.66
13-Mar-20	19:16	5:12	213	31.07	31.07					30.53	30.53	96.66	96.66					92.19	92.69
14-Mar-20	19:17	5:16	631	30.53	30.53	30.53	30.53	31.03	30.53	30.53	30.53	93.71	94.72	93.2	94.21	93.2	92.69	94.72	93.2
15-Mar-20	19:22	5:16	548	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	95.72	95.22	93.71	94.72	94.21	92.69	93.71	92.69
16-Mar-20	19:25	5:12	609	30.53	30.53	30.53	30.53	30.53	30.53	30.03	30.03	94.21	94.72	93.2	92.69	94.21	93.71	93.14	93.64
17-Mar-20	19:32	5:15	518	30.53	30.53	30.53	30.53	30.53	30.53	30.03	30.53	93.2	93.2	93.2	94.21	93.71	93.71	94.15	92.69
18-Mar-20	19:12	5:00	316	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.71	93.71	93.71	93.71	92.69	93.2	92.69	93.2
19-Mar-20	19:34	5:12	274	30.53	30.53	30.53	30.53	30.53	30.03	30.03	30.53	93.2	93.2	93.71	93.71	93.2	92.63	92.12	93.64
20-Mar-20	19:15	5:15	431	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.2	93.2	93.71	92.69	93.2	93.14	93.14	92.69
21-Mar-20	19:22	5:18	214	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.71	92.69	92.69	93.2	93.71	92.69	93.2	93.2
22-Mar-20	19:38	5:20	263	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.2	93.2	92.69	93.2	93.71	93.71	93.71	94.21
23-Mar-20	19:31	5:19	344	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.2	92.69	93.71	93.71	93.71	93.71	93.2	93.71
24-Mar-20	19:28	5:09	315	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.71	93.71	93.2	93.2	93.2	93.71	93.71	93.71
25-Mar-20	19:24	5:11	177	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.2	93.71	94.21	93.71	93.2	93.71	93.2	93.2
26-Mar-20	19:32	5:13	267	30.53	30.53	30.53	30.53	30.53	30.53	30.03	30.53	93.2	93.71	93.71	93.71	93.71	93.71	94.15	93.14
27-Mar-20	19:30	5:22	395	30.53	30.53	30.53	30.53	30.53	29.53	30.03	30.03	93.71	93.71	94.21	93.71	93.2	88.97	93.14	92.12
28-Mar-20	19:32	5:25	395	30.03	30.53	30.53	30.53	30.53	30.53	30.53	30.53	92.63	92.63	93.2	93.2	92.69	93.2	93.2	93.2
29-Mar-20	19:11	5:16	280	30.53	30.53	30.53	30.53	30.53	30.03	30.03	30.03	93.2	92.19	93.2	92.69	93.2	90.59	92.12	92.12
30-Mar-20	19:13	5:19	368	30.53	30.53	30.53	30.53	29.53	29.53	30.03	30.03	93.14	92.19	93.71	93.71	82.66	90.01	92.12	92.12
31-Mar-20	19:18	5:21	523	30.03	30.53	30.53	30.53	30.03	29.53	30.03	30.03	91.61	91.61	93.2	93.2	88.52	65.33	87.48	89.55
1-Apr-20	19:26	5:25	548	30.03	30.03	30.53	30.53	30.53	30.53	30.53	30.53	89.55	91.1	90.65	91.68	91.16	90.65	91.16	91.16
2-Apr-20	19:03	5:20	460	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	93.2	91.68	92.69	92.19	91.68	91.68	91.68	92.69
3-Apr-20	19:17	5:22	265	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	92.69	91.16	92.69	91.68	93.71	93.2	93.2	93.2
4-Apr-20	19:08	5:23	288	30.53	30.53	30.53	30.53	30.53	30.53	30.53	30.53	92.69	92.69	92.69	93.2	92.69	93.2	93.2	93.2
5-Apr-20	20:19	5:28	344	30.53	30.53	30.53	30.53	30.53	30.53	31.03	31.03	93.2	92.69	93.2	92.69	92.69	93.2	93.2	93.71
6-Apr-20	20:02	5:34	403	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	93.71	94.21	93.71	93.71	93.71	93.27	93.27	93.27
7-Apr-20	18:50	5:25	1005	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	93.78	94.28	93.27	93.78	93.78	93.78	93.78	94.28
8-Apr-20	20:55	5:30	1823	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	94.28	94.28	93.27	93.78	94.28	94.28	93.78	94.28
9-Apr-20	18:49	6:15	3299	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	94.21	94.28	93.78	94.28	94.28	94.28	94.28	94.28
10-Apr-20	18:06	5:21	1063	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	94.79	93.78	94.79	94.79	93.78	93.78	95.29	94.79

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
11-Apr-20	18:56	5:26	645	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	95.29	94.28	94.28	93.78	95.29	94.79	95.29	94.79
12-Apr-20	18:35	5:16	631	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	95.29	94.28	95.29	94.28	95.79	94.79	94.79	94.79
13-Apr-20	18:41	5:10	609	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	94.28	95.29	94.79	95.29	94.79	95.29	95.29	94.28
14-Apr-20	18:38	5:17	423	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	95.79	94.28	94.28	95.29	94.28	94.79	95.29	95.29
15-Apr-20	18:33	5:26	919	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	94.79	95.79	94.28	94.28	95.29	94.28	95.79	95.29
16-Apr-20	18:31	5:32	1332	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	94.79	95.29	95.29	94.28	93.78	93.78	93.78	94.28
17-Apr-20	18:33	5:22	1192	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	94.28	95.79	93.78	93.78	93.27	96.29	93.78	95.79
18-Apr-20	19:01	5:25	1179	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	94.28	94.28	94.79	94.28	94.79	94.28	95.29	94.79
19-Apr-20	18:44	5:33	1761	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	94.28	93.78	94.79	94.79	93.78	94.79	95.29	94.79
20-Apr-20	18:51	6:19	2782	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	95.29	95.29	95.29	94.79	94.79	95.29	94.79	95.29
21-Apr-20	18:47	5:25	2498	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	94.79	95.29	95.29	94.79	95.29	95.29	95.29	94.79
22-Apr-20	18:37	6:20	3447	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	94.79	94.28	94.79	94.79	95.29	94.79	94.79	94.79
23-Apr-20	17:48	5:33	2906	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	95.29	94.79	95.29	94.79	94.79	94.79	94.79	94.79
24-Apr-20	18:30	6:13	2311	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	95.22	94.21	94.79	94.79	94.79	94.79	94.79	94.79

Appendix D: Raw Ultrasonic and Microclimate Data at CO-CA-01

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
17-Apr-19	18:01	5:47	1947	29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57	85.86	85.86	85.86	76.12	67.65	76.12	75.56	79.96
18-Apr-19	17:58	5:48	1877	29.57	29.57	29.57	29.07	29.07	29.07	29.07	29.57	82.67	84.8	79.96	68.16	65.86	71.58	71.58	76.67
19-Apr-19	17:54	5:59	2456	29.57	29.57	29.57	29.07	29.07	29.07	29.07	29.07	80.51	82.13	81.59	76.61	71.58	76.61	71.58	73.27
20-Apr-19				29.07	29.57	29.57	29.57	29.07	29.07	29.57	29.57	77.71	80.51	79.42	81.59	78.81	79.36	80.51	83.2
21-Apr-19				29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57	84.8	85.86	85.86	85.86	85.86	85.86	86.39	86.92
22-Apr-19				29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57	87.44	87.44	86.39	86.92	87.44	88.49	88.49	89.53
23-Apr-19				29.57	29.57	29.57	29.57	29.57	29.57	29.57	30.07	89.01	88.49	88.49	87.44	90.05	87.97	89.01	89.59
24-Apr-19				30.07	29.57	29.57	29.57	29.57	29.57	29.57	29.57	91.14	88.49	89.01	89.01	83.2	78.87	83.2	84.8
25-Apr-19				29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57	84.8	85.33	85.86	87.44	85.86	84.8	86.39	86.92
26-Apr-19				29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57	86.92	87.44	86.92	87.97	89.01	87.97	87.97	88.49
27-Apr-19				29.57	29.57	29.57	29.57	29.57	29.57	29.57	30.07	89.01	89.01	88.49	88.49	88.49	89.01	89.53	90.63
28-Apr-19				30.07	30.07	29.57	30.07	29.57	30.07	30.07	30.07	90.63	90.63	90.05	90.11	90.05	90.63	90.11	91.66
29-Apr-19				30.07	30.07	30.07	30.07	30.07	29.57	30.07	30.07	91.14	91.14	91.66	89.59	90.11	89.01	89.07	92.68
30-Apr-19				30.07	30.07	30.07	30.07	29.57	29.57	29.57	29.57	91.14	90.11	91.14	90.63	76.67	80.51	81.59	84.8
1-May-19				29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57	84.8	87.44	87.44	87.44	87.97	88.49	88.49	90.05
2-May-19				29.57	29.57	29.57	29.57	29.57	29.57	30.07	30.07	89.53	89.01	89.53	89.53	90.05	89.53	90.11	91.14
3-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	91.14	91.14	90.11	91.14	90.11	90.11	90.63	91.66
4-May-19				30.07	30.07	30.07	30.07	29.57	29.57	29.57	30.07	91.66	90.63	90.11	92.17	89.01	88.49	90.05	90.63
5-May-19				30.07	29.57	29.57	29.57	29.57	29.57	29.57	29.57	89.59	89.01	89.01	89.01	85.86	85.33	87.97	88.49
6-May-19				29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57	89.01	89.01	88.49	81.05	74.45	79.42	79.96	83.74
7-May-19				29.57	29.57	29.57	29.57	29.07	29.07	29.57	29.57	84.27	84.8	84.27	85.86	74.95	78.26	81.05	83.74
8-May-19				29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57	83.74	83.74	83.74	85.86	85.86	86.39	87.44	87.44
9-May-19				29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57	88.49	87.44	87.97	87.97	86.92	87.97	87.97	89.01
10-May-19				29.57	29.57	29.57	29.57	29.57	29.57	29.57	29.57	88.49	87.97	89.01	89.01	89.53	89.01	89.53	90.05
11-May-19				29.57	29.57	29.57	29.57	29.57	29.57	30.07	30.07	90.05	89.53	89.53	89.53	88.49	90.05	90.11	93.19
12-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	91.66	91.14	89.59	90.63	90.63	90.63	90.63	91.14
13-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	91.66	91.14	90.11	90.63	89.59	90.11	90.11	91.66
14-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	91.14	91.14	90.63	90.63	90.11	90.63	91.14	91.66
15-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	92.17	91.66	89.07	93.19	91.66	89.59	91.14	92.17
16-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.7	91.66	91.66	92.17	92.17	91.14	92.17	92.17
17-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	92.68	92.17	92.17	92.68	91.66	92.17	91.66	92.68
18-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	92.68	92.17	92.17	92.17	92.68	92.17	93.19	92.68
19-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	92.17	93.19	92.17	94.21	93.7	92.17	93.7	93.7
20-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.7	93.7	92.17	93.19	92.17	93.19	95.22	93.7
21-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	94.21	92.68	92.17	92.68	92.17	92.68	92.68	93.7
22-May-19				30.07	30.07	30.07	30.07	29.57	30.07	30.07	30.07	94.21	93.19	92.17	91.66	84.27	90.11	90.63	92.68
23-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	92.17	92.68	91.66	92.68	89.07	90.11	92.68	93.19
24-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	92.68	93.7	89.59	91.14	90.11	89.59	91.66	92.17
25-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	92.68	92.17	92.17	91.66	90.63	91.14	92.68	93.7
26-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.7	93.19	92.17	91.14	89.59	91.66	91.66	93.19
27-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.7	92.17	91.14	91.14	90.63	92.17	92.68	94.21
28-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.7	92.68	90.11	91.14	90.63	92.17	92.17	93.7
29-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.19	91.14	91.66	92.17	92.17	92.68	93.7	94.71
30-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	94.21	94.21	91.66	92.17	93.19	93.19	94.21	94.21
31-May-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.7	92.17	92.17	93.19	93.19	93.19	93.7	93.7

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
1-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.19	92.68	91.66	92.17	92.17	92.17	93.19	93.7
2-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	92.68	92.68	92.17	92.17	92.17	92.17	93.7	96.22
3-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	94.21	93.7	91.66	94.21	91.66	93.19	93.7	94.21
4-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.7	93.7	93.19	93.19	92.68	93.19	94.21	94.71
5-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.19	93.19	92.68	92.68	92.68	92.68	93.7	94.21
6-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.19	93.19	92.68	92.17	92.68	93.19	94.71	94.71
7-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.7	93.19	92.68	92.17	92.68	93.19	95.22	94.71
8-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	94.21	93.19	94.71	92.17	92.17	92.68	94.21	94.71
9-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	95.72	94.71	92.17	94.21	92.68	94.71	94.71	94.71
10-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.19	93.7	93.19	93.19	92.68	93.7	93.7	94.21
11-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.7	94.21	93.19	93.7	93.19	93.19	93.19	93.7
12-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	94.21	93.19	92.68	92.68	94.21	94.21	95.22	93.7
13-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	94.21	92.17	92.17	93.7	94.21	93.7	93.19	94.21
14-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	94.71	93.19	93.19	93.19	93.7	92.68	94.71	93.19
15-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	94.21	93.19	93.19	93.19	92.68	92.68	94.21	93.19
16-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.7	92.17	93.19	94.21	92.68	93.7	94.21	94.21
17-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	93.7	93.19	93.19	92.68	92.68	93.19	93.7	93.7
18-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	94.21	93.7	93.7	93.19	94.21	93.7	94.71	94.71
19-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	94.21	93.7	93.19	93.19	93.7	93.7	95.22	93.7
20-Jun-19				30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	95.22	94.21	93.19	93.7	92.68	93.19	94.21	94.71
21-Jun-19				30.57	30.07	30.07	30.07	30.07	30.57	30.57	30.57	94.78	94.21	94.71	93.7	94.21	94.78	95.78	95.78
22-Jun-19				30.57	30.57	30.07													
23-Jun-19																			
24-Jun-19																			
25-Jun-19																			
26-Jun-19																			
27-Jun-19																			
28-Jun-19																			
29-Jun-19																			
30-Jun-19																			
1-Jul-19																			
2-Jul-19																			
3-Jul-19																			
4-Jul-19																			
5-Jul-19																			
6-Jul-19																			
7-Jul-19																			
8-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	95.38	93.87	94.88	94.37	94.88	94.88	94.37	93.36
9-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	95.38	94.37	94.37	94.88	93.87	93.87	93.87
10-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	95.38	95.88	94.37	95.88	95.38	94.88	94.37	94.37
11-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	95.88	94.37	94.37	94.37	94.88	95.38	94.37	94.88
12-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	95.88	96.38	93.87	94.88	95.38	94.37	95.38	95.88
13-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	94.37	93.87	95.88	94.37	94.88	94.37	94.37	94.88
14-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	94.37	94.88	94.88	94.88	95.88	93.36	95.38	95.88
15-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	94.37	94.37	94.88	95.88	94.37	93.36	93.87	93.87

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
16-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	95.38	93.87	94.88	95.38	93.87	93.36	93.87	93.87
17-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	94.37	94.37	93.87	94.88	95.38	94.88	96.38	95.88
18-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	94.88	94.37	95.88	94.37	95.38	94.88	94.37	95.38
19-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	94.37	95.88	94.37	94.37	95.38	96.38	95.38	94.37
20-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	96.38	96.38	94.88	95.88	96.38	95.88	97.88	95.88
21-Jul-19	17:44	6:35	6490	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	95.88	96.88	94.88	95.38	95.88	96.38	97.88	97.88
22-Jul-19	17:51	6:23	9267	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	96.88	96.38	96.88	96.38	97.38	96.88	96.88	96.88
23-Jul-19	17:44	6:25	11234	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	96.38	97.38	96.82	96.32	95.82	96.32	97.38	97.38
24-Jul-19	17:53	6:13	10394	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	97.38	96.88	96.32	95.82	97.31	95.31	97.38	95.88
25-Jul-19	17:57	6:06	13868	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	98.37	96.88	96.82	97.38	96.32	97.31	96.88	96.38
26-Jul-19	18:05	6:25	15596	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	96.88	96.88	96.38	97.38	97.31	95.88	96.88	96.38
27-Jul-19	18:00	6:08	13442	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	96.38	95.88	96.38	95.88	95.88	96.88	96.38	98.37
28-Jul-19				30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	97.38	95.88	96.38	97.38	95.82	94.81	96.38	97.88
29-Jul-19	18:05	6:12	7328	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	94.88	97.88	96.32	92.85	93.36	93.36	94.37	94.37
30-Jul-19	17:58	6:09	3288	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	94.88	93.87	94.37	93.87	93.87	93.87	94.37
31-Jul-19	18:02	6:06	6229	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	94.37	93.87	93.87	93.36	93.36	93.87	93.87
1-Aug-19	18:06	6:05	15332	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	94.37	94.37	94.37	94.37	94.37	93.36	94.88	94.37
2-Aug-19	17:58	6:04	14855	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	94.37	94.37	93.87	93.87	92.85	93.36	93.87	93.36
3-Aug-19	18:07	6:13	14065	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	93.36	93.36	92.85	93.36	93.87	94.37	93.87
4-Aug-19	18:00	6:07	15671	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	93.36	93.36	93.87	94.37	93.36	93.87	93.87
5-Aug-19	17:58	6:04	15373	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	93.36	93.87	93.87	93.36	93.87	94.37	93.87
6-Aug-19	17:57	6:09	10060	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	94.37	93.87	92.85	93.36	93.87	93.36	93.87	93.87
7-Aug-19	18:06	6:09	4455	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	93.87	92.85	93.87	93.87	93.87	93.87	93.87
8-Aug-19	18:04	6:00	2196	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.36	93.87	93.36	92.85	93.36	92.34	93.36	93.36
9-Aug-19	17:52	6:01	4787	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.36	93.36	92.85	92.85	93.36	94.37	93.36	93.87
10-Aug-19	18:03	5:59	5660	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	92.85	93.36	92.85	93.36	93.36	93.87	93.36	93.87
11-Aug-19	17:55	6:01	5215	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.36	93.36	93.36	93.36	93.36	93.36	92.85	93.87
12-Aug-19	17:56	5:59	4850	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.36	93.36	92.34	93.36	92.85	92.85	93.87	93.87
13-Aug-19	18:00	6:07	3242	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.36	92.85	93.36	92.85	93.36	92.85	93.36	93.36
14-Aug-19	17:59	6:00	2355	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	93.36	93.87	93.87	92.85	93.87	93.87	93.36
15-Aug-19	17:59	5:35	2225	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.36	94.88	92.85	93.36	93.36	93.87	93.87	92.85
16-Aug-19	18:00	5:23	1017	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	94.88	93.87	93.36	93.87	93.87	94.37	93.87
17-Aug-19	18:01	5:27	2300	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	94.37	94.37	94.37	93.87	94.88	94.37	94.37
18-Aug-19	18:04	6:19	7007	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	94.37	93.87	93.87	94.37	94.88	94.37	93.87	93.87
19-Aug-19	17:52	6:07	3489	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	93.36	93.87	92.85	93.87	93.87	94.37	93.36
20-Aug-19	17:59	6:00	6288	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	93.87	93.36	92.85	92.85	92.85	93.87	93.36
21-Aug-19	18:06	6:11	8828	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	93.87	93.36	93.87	93.36	93.36	93.87	93.36	94.37
22-Aug-19	18:05	6:09	12468	30.59	30.59	30.09	30.09	30.09	30.09	30.59	30.59	93.36	92.85	92.85	92.34	92.85	92.34	93.36	94.37
23-Aug-19	17:59	6:16	13084	30.59	30.59	30.59	30.09	30.09	30.09	30.59	30.59	92.85	92.85	93.36	93.36	93.36	92.34	93.36	93.87
24-Aug-19	18:02	5:52	12984	30.59	30.59	30.59	30.59	30.09	30.09	30.59	30.59	94.37	94.37	93.36	93.36	93.36	92.85	92.85	93.87
25-Aug-19	17:59	6:00	6102	30.59	30.59	30.59	30.09	30.09	30.09	30.59	30.59	94.37	93.36	92.34	92.85	92.85	92.34	93.36	93.36
26-Aug-19	18:01	5:47	3455	30.59	30.59	30.09	30.09	30.09	30.09	30.59	30.59	94.37	93.36	93.36	92.85	93.36	93.36	94.88	93.87
27-Aug-19	18:08	5:54	6017	30.59	30.59	30.59	30.09	30.09	30.09	30.59	30.59	93.36	93.36	93.36	93.36	93.36	92.85	93.36	93.36
28-Aug-19	18:06	6:18	5120	30.59	30.09	30.59	30.09	30.09	30.09	30.09	30.59	93.36	93.87	93.36	92.85	92.85	93.87	93.36	94.88
29-Aug-19	18:05	5:48	3250	30.59	30.09	30.09	30.09	30.09	30.09	30.09	30.09	93.36	93.36	92.85	92.85	92.34	92.85	93.36	94.37

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
30-Aug-19	18:09	5:48	2552	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	92.85	94.37	93.36	92.34	92.85	92.85	93.87	93.87
31-Aug-19	18:03	5:47	4057	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	93.36	94.37	93.87	93.36	91.83	92.34	93.87	93.87
1-Sep-19	17:56	5:49	5164	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	92.85	93.87	93.36	93.36	93.87	92.34	92.85	92.85
2-Sep-19	17:56	5:55	4895	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	94.37	94.37	92.85	92.34	91.26	90.74	92.28	92.85
3-Sep-19	17:59	5:42	4569	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	92.34	92.85	92.79	92.28	90.23	90.74	91.77	91.77
4-Sep-19	18:09	5:41	1399	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	92.28	91.26	91.77	90.74	90.23	90.23	91.26	91.77
5-Sep-19	18:06	5:44	2778	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	91.77	91.77	91.77	92.28	91.26	91.26	92.28	93.29
6-Sep-19	18:11	5:43	2058	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	92.28	92.28	91.77	90.74	92.28	90.74	92.79	92.79
7-Sep-19	18:06	5:42	1267	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	92.79	90.74	92.28	91.77	92.28	92.28	93.29	92.79
8-Sep-19	18:07	5:38	1783	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	92.28	92.79	92.28	92.28	92.79	92.28	92.28	93.29
9-Sep-19	18:08	5:33	1726	30.09	30.09	30.09	30.09	30.09	29.59	30.09	30.09	91.26	92.28	92.28	91.26	91.77	87.64	90.23	90.23
10-Sep-19	18:13	5:30	2086	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	89.71	91.26	90.23	90.23	90.23	89.2	90.74	90.23
11-Sep-19	18:12	5:32	952	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	90.23	90.23	88.68	89.71	90.74	90.23	91.77	89.71
12-Sep-19	17:59	5:36	1226	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	89.71	90.23	89.71	91.77	90.23	90.74	90.23	89.71
13-Sep-19	18:06	5:38	770	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	90.74	90.74	91.26	91.26	89.71	91.26	90.23	90.23
14-Sep-19	18:08	5:38	724	30.09	30.09	30.09	30.09	30.09	30.09	30.09	30.09	90.23	89.2	89.71	91.26	89.71	90.23	89.2	89.2
15-Sep-19	18:07	5:30	651	30.09	30.09	30.09	30.09	30.09	30.09	30.09	29.59	90.74	89.2	90.74	91.26	90.74	89.2	89.2	90.23
16-Sep-19	18:03	5:32	651	29.59	29.59	29.59	29.59	29.59	29.59	29.09	29.59	90.74	90.23	89.71	88.68	89.71	86.59	83.43	84.43
17-Sep-19	18:10	5:41	1229	29.59	29.59	29.59	29.59	29.09	28.59	29.09	29.09	84.96	86.07	86.59	86.53	70.83	68.02	78	80.16
18-Sep-19	18:10	5:29	1014	29.09	29.09	29.09	29.09	28.59	28.59	28.59	28.59	82.3	83.9	84.96	79.08	57.58	54.03	62.24	69.09
19-Sep-19	18:11	5:39	2081	28.59	29.09	29.09	28.59	28.59	28.59	28.59	28.59	73.55	73.55	75.82	63.97	53.44	53.44	63.4	70.77
20-Sep-19	18:04	5:17	1311	28.59	29.09	29.09	29.09	29.09	29.09	29.09	29.09	72.44	76.3	76.3	76.3	79.08	80.16	81.24	82.84
21-Sep-19	18:07	5:49	3656	29.09	29.09	29.09	29.09	29.09	29.09	29.59	29.59	80.7	81.77	82.3	81.77	83.37	84.43	87.58	86.53
22-Sep-19	18:01	5:22	4177	29.59	29.59	29.59	29.59	29.59	29.59	29.59	29.59	86.01	85.48	87.05	87.05	84.96	87.05	86.53	86.53
23-Sep-19	18:12	5:23	5722	29.59	29.59	29.59	29.59	29.59	29.59	29.59	29.59	86.53	87.05	88.1	86.01	86.01	87.58	88.61	89.2
24-Sep-19	18:08	5:39	7501	29.59	29.59	29.59	29.59	29.59	29.59	29.59	29.59	88.68	88.1	87.05	87.58	87.58	87.05	89.71	89.2
25-Sep-19	18:07	5:30	11131	29.59	29.59	29.59	29.59	29.59	29.59	29.59	29.59	89.2	88.68	88.68	88.16	88.16	88.16	89.71	90.23
26-Sep-19	18:06	5:39	3190	29.59	29.59	29.59	29.59	29.59	29.59	29.59	29.59	89.2	89.2	88.68	88.68	88.16	87.64	89.2	89.2
27-Sep-19	18:13	5:21	2899	29.59	29.59	29.59	29.59	29.59	29.59	29.59	29.59	89.2	88.16	88.16	88.16	88.16	87.64	88.16	89.2
28-Sep-19	18:11	5:18	3389	29.59	29.59				30.11	30.11	30.11	89.2	88.68				80.6	82.71	83.76
29-Sep-19	18:11	5:29	3088	30.11	30.11	30.11	30.11	29.61	29.61	29.61	29.61	83.24	83.24	81.69	81.17	70.4	61.95	70.95	75.3
30-Sep-19	18:14	5:19	2858	29.61	29.61	29.61	29.61	29.11	29.11	29.11	29.61	73.68	74.22	74.76	56.71	50.68	48.86	56.06	61.37
1-Oct-19	18:12	5:20	2893	29.61	29.61	29.61	29.11	29.11	29.11	29.11	29.11	64.24	67.62	67.62	51.28	44.55	45.17	51.28	54.88
2-Oct-19	18:17	5:18	4059	29.11	29.61	29.11	29.11	29.11	29.11	29.11	29.11	60.74	65.94	56.65	45.17	40.8	40.8	47.02	54.28
3-Oct-19	18:09	5:32	4958	29.11	29.11	29.11	29.11	29.11	29.11	29.11	29.61	56.06	61.31	54.28	45.17	40.8	38.9	46.41	54.34
4-Oct-19	18:16	5:35	5724	29.11	29.11	29.11	29.11	29.11	29.11	29.11	29.61	56.06	60.16	53.09	46.41	41.43	40.16	45.79	53.14
5-Oct-19	18:16	5:16	5582	29.61	29.61	29.61	29.11	29.11	29.11	29.11	29.11	54.93	58.47	57.3	45.79	41.43	39.53	47.63	53.09
6-Oct-19	18:19	5:10	5005	29.61	29.61	29.11	29.11	29.11	29.11	29.11	29.61	57.88	59.64	57.83	47.02	40.8	38.26	45.79	53.14
7-Oct-19	18:20	5:15	4277	29.61	29.61	29.61	29.11	29.11	29.11	29.61	29.61	59.05	59.64	58.47	47.02	41.43	40.8	50.13	55.53
8-Oct-19	18:11	5:13	3637	29.61	29.61	29.61	29.11	29.11	29.11	29.11	29.61	57.88	59.05	56.71	48.25	40.8	38.26	45.79	50.74
9-Oct-19	18:14	5:13	3451	29.61	29.61	29.11	29.11	29.11	29.11	29.11	29.61	53.14	57.3	53.69	43.3	38.26	36.99	45.17	51.94
10-Oct-19	18:10	5:18	3196	29.61	29.61	29.61	29.11	29.11	29.11	29.11	29.61	55.53	58.47	53.14	43.93	38.26	36.34	42.68	46.46
11-Oct-19	18:20	5:12	3074	29.61	29.61	29.11	29.11	29.11	29.11	29.61	29.61	51.34	53.74	46.41	38.9	36.34	33.77	40.85	45.84
12-Oct-19	18:11	5:11	2847	29.61	29.61	29.61	29.11	29.11	29.11	29.61	29.61	49.52	52.54	49.52	40.16	35.7	35.7	42.11	48.3
13-Oct-19	18:13	5:09	2475	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	54.34	58.47	57.3	51.34	44.61	43.98	47.08	50.13

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
14-Oct-19	18:11	5:10	2200	29.61	29.61	29.61	29.11	29.11	29.11	29.61	29.61	55.53	57.88	56.71	47.63	43.93	44.55	48.3	52.54
15-Oct-19	18:14	5:13	2306	29.11	29.61	29.61	29.61	29.11	29.61	29.61	29.61	57.24	60.22	59.05	51.94	50.68	51.34	52.54	56.71
16-Oct-19	18:10	5:05	3158	29.61	29.61	29.61	29.61	29.11	29.11	29.61	29.61	60.8	63.67	62.52	56.71	47.02	44.55	51.94	56.71
17-Oct-19	18:16	5:28	4124	29.61	29.61	29.61	29.61	29.11	29.61	29.61	29.61	61.95	61.37	61.37	53.14	46.41	45.84	48.3	54.34
18-Oct-19	18:10	5:19	4041	29.61	29.61	29.61	29.11	29.11	29.61	29.61	29.61	56.12	60.8	56.12	47.02	42.68	40.85	44.61	51.34
19-Oct-19	18:21	5:27	4760	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	53.14	55.53	53.14	47.08	42.74	42.11	44.61	50.13
20-Oct-19	18:21	5:12	5668	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	53.74	58.47	56.71	48.3	43.98	44.61	48.3	51.94
21-Oct-19	18:16	5:24	6891	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	55.53	57.88	56.12	50.74	46.46	50.13	56.12	58.47
22-Oct-19	18:14	5:17	6119	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	60.8	62.52	62.52	57.88	50.13	49.52	51.94	54.93
23-Oct-19	18:13	5:20	4508	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	57.3	59.05	54.93	49.52	42.74	43.36	43.36	50.13
24-Oct-19	18:13	5:12	3102	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	50.13	51.34	51.34	43.98	39.59	41.48	40.85	44.61
25-Oct-19	18:13	5:14	6282	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	47.69	48.91	50.74	46.46	40.22	39.59	40.22	46.46
26-Oct-19	18:14	5:20	6730	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	50.74	57.3	57.88	51.34	49.52	45.84	60.22	62.52
27-Oct-19	18:16	4:59	7359	29.61	29.61	29.61	29.61	29.11	29.61	29.61	29.61	63.1	65.37	65.94	54.93	46.41	43.36	48.3	52.54
28-Oct-19	18:31	4:58	4060	29.61	29.61	29.61	29.11	29.61	29.61	29.61	29.61	57.88	59.05	53.14	46.41	43.98	43.98	48.91	55.53
29-Oct-19	18:31	4:59	3679	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	60.22	61.37	59.64	53.14	47.69	44.61	49.52	55.53
30-Oct-19	18:33	4:58	3304	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	59.05	61.37	56.71	46.46	42.74	42.11	48.91	56.12
31-Oct-19	18:21	4:49	3247	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	59.05	61.37	58.47	47.69	43.36	43.36	47.08	51.94
1-Nov-19	18:25	4:57	3206	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	54.34	57.88	55.53	50.74	45.23	45.23	48.91	52.54
2-Nov-19	18:29	4:54	3193	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	58.47	60.22	57.88	58.47	56.71	54.34	56.71	58.47
3-Nov-19	18:18	4:51	2915	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	61.37	63.1	61.95	63.1	57.88	53.14	56.12	59.05
4-Nov-19	18:30	5:03	2906	29.61	29.61	29.61	29.61	29.11	29.11	29.11	29.61	61.37	62.52	61.95	62.52	49.47	43.3	45.79	52.54
5-Nov-19	18:23	4:50	3102	29.61	29.61	29.61	29.11	29.11	29.11	29.61	29.61	57.3	59.64	58.47	50.68	41.43	38.9	45.23	47.69
6-Nov-19	18:27	4:49	2771	29.11	29.61	29.61	29.11	29.11	29.11	29.61	29.61	47.63	52.54	51.94	42.68	39.53	36.99	43.98	48.91
7-Nov-19	18:30	4:47	3113	29.61	29.61	29.61	29.11	29.11	29.11	29.61	29.61	51.34	56.12	51.94	43.3	37.62	35.7	38.95	43.98
8-Nov-19	18:24	4:50	3485	29.61	29.61	29.61	29.11	29.11	29.61	29.61	29.61	47.08	51.34	46.46	39.53	35.06	34.47	38.32	40.85
9-Nov-19	18:22	4:51	4124	29.61	29.61	29.61	29.11	29.61	29.61	29.61	29.61	46.46	49.52	43.98	40.16	37.68	35.11	38.95	43.36
10-Nov-19	18:23	4:50	4352	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	47.08	50.74	45.23	39.59	36.4	36.4	37.04	40.85
11-Nov-19	18:23	4:51	4451	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	47.69	51.34	44.61	38.95	35.11	34.47	40.22	47.08
12-Nov-19	18:23	4:52	4005	29.61	29.61	29.61	29.61	29.61	29.61	29.61	30.11	48.91	51.94	43.98	40.85	37.68	35.76	37.68	43.42
13-Nov-19	18:24	4:54	3451	30.11	29.61	29.61	29.61	29.61	29.61	29.61	29.61	46.52	48.91	46.46	42.74	39.59	38.32	39.59	38.95
14-Nov-19	18:24	4:51	2601	30.11	29.61	29.61	29.61	29.61	29.61	29.61	30.11	44.04	46.46	42.74	39.59	37.68	35.76	37.68	37.1
15-Nov-19	18:28	4:54	2267	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	40.91	45.9	44.04	41.54	39.01	37.74	41.54	43.42
16-Nov-19	18:31	4:52	1947	30.11	30.11	29.61	29.61	30.11	30.11	30.11	30.11	47.13	48.97	42.11	38.32	35.17	33.88	34.52	35.17
17-Nov-19	18:33	4:46	2051	30.11	30.11	29.61	29.61	30.11	30.11	30.11	30.11	37.1	41.54	39.59	34.47	32.58	31.93	33.23	33.88
18-Nov-19	18:28	4:49	2269	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	38.37	44.04	39.64	35.17	33.23	31.27	31.93	33.23
19-Nov-19	18:38	4:57	2444	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	39.64	43.42	41.54	39.64	37.1	35.81	41.54	44.66
20-Nov-19	18:28	4:59	3662	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	47.75	53.8	53.8	53.8	45.9	42.17	43.42	43.42
21-Nov-19	18:36	4:46	5484	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	45.9	50.79	45.9	42.17	39.64	39.01	42.79	47.75
22-Nov-19	18:32	4:50	6366	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	48.97	50.19	45.28	42.17	39.64	39.01	40.91	47.13
23-Nov-19	18:49	4:54	9793	30.11	30.11	30.11	30.11	30.11	30.11	30.61	30.61	48.36	52	43.42	39.64	39.64	37.1	40.33	43.48
24-Nov-19	18:34	5:06	12409	30.11	30.11	30.11	30.11	30.11	30.61	30.61	30.61	45.9	48.97	44.66	44.66	44.66	44.72	50.25	55.65
25-Nov-19	18:32	5:05	17106	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	56.83	59.17	59.17	56.83	51.46	52.66	56.83	59.17
26-Nov-19	18:32	4:58	15101	30.11	30.11	30.11	30.11	30.11	30.61	30.61	30.61	56.77	59.7	56.18	56.77	53.8	52.06	63.22	64.93
27-Nov-19	18:33	4:44	11462	30.61	30.61	30.11	30.11	30.11	30.11	30.11	30.11	63.22	64.93	65.43	62.58	56.77	59.11	65.43	63.73

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
28-Nov-19	18:34	4:52	6619	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	63.73	64.86	61.43	60.28	56.18	52	54.99	58.53
29-Nov-19	18:35	4:53	4937	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	59.7	60.86	57.36	51.4	47.75	42.79	45.9	50.19
30-Nov-19	18:47	5:08	4700	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	52.6	55.59	53.2	49.58	48.36	47.13	50.79	52
1-Dec-19	18:37	4:40	4382	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	53.8	56.77	54.4	52.6	44.66	43.42	45.28	48.36
2-Dec-19	18:36	4:47	3780	30.11	30.11	30.11	30.11	29.61	30.11	29.61	30.11	51.4	53.2	53.8	50.19	43.98	40.28	45.23	49.58
3-Dec-19	18:39	4:44	3568	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	50.79	53.8	51.4	47.13	42.17	40.28	41.54	44.66
4-Dec-19	18:38	4:42	4300	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	47.75	50.19	45.28	40.91	39.01	37.74	40.91	43.42
5-Dec-19	18:44	4:48	3959	30.11	30.11	30.11	30.11	30.11	30.11	30.61	30.11	45.9	50.19	47.75	45.28	42.79	44.04	49.03	52.6
6-Dec-19	18:40	4:49	4042	30.11	30.11	30.11	30.11	30.11	30.11	30.61	30.11	50.79	54.4	48.97	45.9	44.04	43.42	47.81	45.28
7-Dec-19	18:42	4:46	4176	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.61	47.13	52	47.75	43.42	40.28	39.64	40.91	44.1
8-Dec-19	18:40	4:49	5174	30.11	30.11	30.11	30.11	30.11	30.61	30.61	30.61	47.13	50.79	45.28	40.28	38.37	36.51	38.43	45.34
9-Dec-19	18:46	4:57	8069	30.61	30.11	30.11	30.11	30.61	30.61	30.61	30.61	44.1	45.9	40.91	39.64	38.43	37.15	39.07	44.72
10-Dec-19	18:42	4:54	9040	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	43.48	45.96	46.58	48.42	46.58	52.06	56.83	60.92
11-Dec-19	18:42	5:01	9202	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	58	59.76	57.42	50.85	49.03	49.03	55.05	55.05
12-Dec-19	18:43	4:59	5771	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	54.46	58.59	51.46	47.81	46.58	45.34	47.81	52.06
13-Dec-19	18:43	4:50	4244	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	52.66	56.83	53.86	49.64	48.42	47.19	51.46	49.64
14-Dec-19	18:44	4:59	4713	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	53.26	56.24	53.26	50.85	50.25	48.42	56.24	57.42
15-Dec-19	18:46	4:58	4862	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	59.76	62.64	58.59	55.05	50.25	53.26	59.17	63.79
16-Dec-19	18:45	4:54	4116	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	62.64	64.36	62.07	57.42	52.06	49.03	52.66	57.42
17-Dec-19	18:48	4:50	2476	30.61	30.61	30.61	30.61	30.61	30.61	30.61	30.61	60.92	62.64	58.59	49.03	45.96	44.72	47.81	47.19
18-Dec-19	18:48	5:13	5711	30.61	30.61				30.59	30.59	30.59	50.85	55.65				40.81	41.43	43.91
19-Dec-19	18:51	4:57	7360	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	46.97	52.42	45.75	45.75	43.91	42.05	48.19	51.82
20-Dec-19	18:49	5:16	8215	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	57.76	61.84	59.52	55.99	52.42	55.99	60.68	61.84
21-Dec-19	18:49	4:56	4980	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	61.84	63.58	64.15	63	58.35	55.99	58.93	61.84
22-Dec-19	18:48	4:57	11479	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	61.84	64.15	60.1	57.17	53.01	59.52	69.27	69.83
23-Dec-19	18:50	4:55	8225	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	68.71	69.27	65.3	59.52	55.99	57.76	64.73	66.44
24-Dec-19	18:51	4:50	10322	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	65.3	67.58	61.26	56.58	54.21	51.22	62.42	65.87
25-Dec-19	18:55	4:54	14577	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	65.3	68.71	62.42	61.84	58.93	54.8	58.93	58.35
26-Dec-19	19:05	4:55	7007	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	58.93	65.3	64.15	61.26	57.76	54.8	56.58	57.17
27-Dec-19	19:02	5:12	17205	30.59	30.59	30.59	30.59	30.59	31.09	31.09	31.09	57.76	61.84	55.99	54.8	51.22	48.86	51.88	56.05
28-Dec-19	18:51	4:58	5876	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	58.41	59.58	61.91	65.36	63.06	60.16	60.16	60.16
29-Dec-19	18:57	5:02	11775	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	60.16	67.07	65.93	57.82	53.07	54.86	61.33	62.49
30-Dec-19	18:52	5:01	7794	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	64.79	67.64	68.21	68.21	65.36	61.91	66.5	67.07
31-Dec-19	18:57	5:03	7351	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	65.36	68.21	66.5	61.91	57.82	54.27	62.49	67.07
1-Jan-20	19:00	4:59	5030	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	68.21	69.9	67.64	66.5	64.21	61.33	67.64	69.34
2-Jan-20	18:55	5:00	3129	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	69.34	71.58	69.34	65.93	63.64	62.49	65.93	67.07
3-Jan-20	18:54	5:07	6082	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	67.07	70.46	67.07	64.79	63.06	72.69	73.25	72.69
4-Jan-20	18:54	5:03	4801	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	72.14	74.36	71.02	71.02	68.77	69.34	73.25	73.8
5-Jan-20	18:54	5:03	470	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	72.69	74.36	71.58	70.46	69.9	68.77	72.14	71.58
6-Jan-20	18:59	5:06	2786	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	71.02	73.25	71.02	70.46	67.07	66.5	71.58	71.02
7-Jan-20	18:55	5:24	30452	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	71.02	73.25	71.58	72.14	72.14	71.58	74.91	78.19
8-Jan-20	19:11	5:11	13041	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	79.27	80.35	81.96	83.03	85.15	86.73	88.81	89.85
9-Jan-20	18:54	5:14	13747	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	91.39	91.9	92.92	93.43	93.43	93.94	94.44	94.44
10-Jan-20	18:55	5:04	3293	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	94.95	94.44	96.95	95.45	95.45	96.45	96.95	95.45
11-Jan-20	18:59	5:04	8481	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	98.44	96.95	97.45	95.45	97.45	97.45	97.45	97.45

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
12-Jan-20	18:57	4:57	2519	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	97.95	97.95	97.95	98.44	98.44	98.44	98.94	98.94
13-Jan-20	19:07	5:01	1877	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	98.44	98.44	98.94	99.43	98.94	99.43	98.94	99.92
14-Jan-20	19:08	5:08	2098	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	99.43	99.43	98.94	99.43	98.94	99.43	99.92	99.43
15-Jan-20	19:01	5:17	15948	31.09	31.09	31.09	31.09	31.09	30.59	30.59	31.09	99.92	99.43	99.92	98.94	99.43	99.85	100	99.43
16-Jan-20	19:12	5:07	4347	31.09	31.09	31.09	31.09	31.09	30.59	30.59	30.59	100	99.43	99.92	99.43	99.92	99.85	98.87	100
17-Jan-20	19:12	5:07	6909	31.09	31.09	31.09	30.59	30.59	30.59	30.59	31.09	100	100	99.92	100	100	100	99.85	100
18-Jan-20	19:07	5:08	10143	31.09	31.09	31.09	31.09	30.59	30.59	31.09	31.09	99.92	98.94	99.43	99.92	99.36	100	99.43	100
19-Jan-20	19:02	5:07	7057	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	99.43	100	100	100	100	100	100	100
20-Jan-20	19:13	5:05	2969	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	100	99.43	100	100	100	100	99.92	100
21-Jan-20	19:23	5:05	2915	31.09	31.09	31.09	31.09	31.09	31.09	31.09	31.09	100	100	100	100	100	100	100	100
22-Jan-20	19:24	5:08	2014	31.09	31.09	31.09	31.09	31.09	31.09	31.09	30.59	100	100	100	100	99.92	100	100	100
23-Jan-20	19:14	5:06	1916	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	100	99.36	99.85	100	100	99.85	99.85	100
24-Jan-20	19:21	5:07	1654	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	99.85	99.85	100	100	99.85	99.85	99.85	99.85
25-Jan-20	19:19	5:03	1532	30.59	30.59	30.59	30.59	30.59	30.09	30.09	30.09	99.85	100	99.85	99.36	99.85	100	99.78	100
26-Jan-20	19:20	5:15	1990	30.09	30.09	30.09	30.09	30.09	29.59	29.59	29.59	99.78	98.8	98.8	99.78	99.29	98.73	96.75	97.25
27-Jan-20	19:21	5:13	1801	29.59	29.59	29.59	29.59	29.59	29.09	29.09	29.09	96.75	97.25	97.25	96.25	95.25	93.17	92.15	92.15
28-Jan-20	19:21	5:11	1712	29.09	29.59	29.59	29.09	29.09	29.09	29.09	29.09	92.15	93.23	94.24	93.17	92.15	89.59	89.07	89.07
29-Jan-20	19:22	5:09	1477	29.09	29.09	29.09	29.09	29.09	28.59	28.59	28.59	89.59	91.13	91.13	90.1	88.03	84.84	84.84	85.36
30-Jan-20	19:05	5:12	1953	28.59	28.59	28.59	28.59	28.59	28.59	28.59	28.59	85.36	89.01	90.56	86.41	82.19	78.96	78.96	80.04
31-Jan-20	19:18	5:31	1857	28.59	28.59	28.59	28.59	28.09	28.09	28.09	28.09	81.12	85.36	85.36	81.12	77.28	75.09	77.82	80.52
1-Feb-20	19:20	5:29	2203	28.09	28.59	28.59	28.59	28.09	28.09	28.59	28.09	84.25	86.93	87.97	86.93	81.06	76.19	79.5	83.72
2-Feb-20	19:21	5:23	2185	28.59	28.59	28.59	28.59	28.59	28.59	28.59	28.59	85.36	87.45	88.49	89.01	86.93	85.89	84.84	86.41
3-Feb-20	19:19	5:15	2339	28.59	28.59	28.59	28.59	28.59	28.59	28.59	28.59	86.93	88.49	87.97	83.25	77.88	74.6	76.79	78.42
4-Feb-20	19:10	5:15	2041	28.09	28.59	28.59	28.09	28.09	28.09	28.09	28.09	77.82	82.19	83.78	76.73	72.33	68.98	67.85	71.22
5-Feb-20	19:21	5:18	2280	28.09	28.09	28.09	28.09	28.09	28.09	28.09	28.09	70.1	74.54	76.19	76.19	71.77	70.1	71.22	70.66
6-Feb-20	19:14	5:24	2503	28.09	28.09	28.09	28.09	28.09	28.09	28.09	28.59	70.1	78.37	80.52	82.13	79.99	79.45	82.13	85.36
7-Feb-20	19:07	5:32	3846	28.59	28.59	28.59	28.59	28.59	28.59	28.59	28.59	86.41	88.49	88.49	87.97	86.41	86.41	86.93	88.49
8-Feb-20	18:51	5:24	11748	28.59	29.09	29.09	29.09	29.09	29.09	29.09	29.09	89.53	90.62	90.62	91.13	91.13	91.13	92.15	92.15
9-Feb-20	18:59	5:39	2405	29.09	29.09	29.09	29.09	29.09	29.09	29.09	29.09	92.66	93.17	93.67	93.17	93.67	93.67	92.15	92.66
10-Feb-20	19:00	5:13	1521	29.09	29.09	29.09	29.09	29.09	29.09	29.09	29.09	93.67	92.66	94.18	93.17	93.67	93.17	92.15	93.67
11-Feb-20	19:03	5:30	2442	29.59	29.59	29.59	29.59	29.09	29.09	29.09	29.59	94.24	92.72	94.75	92.72	92.66	90.62	91.13	92.72
12-Feb-20	18:46	5:22	1620	29.59	29.59	29.59	29.59	29.59	29.09	29.09	29.09	91.7	92.21	93.23	92.72	92.21	90.62	90.62	90.62
13-Feb-20	18:57	5:28	2533	29.09	29.59	29.59	29.09	29.09	29.09	28.09	28.59	90.62	91.19	93.74	92.66	91.13	87.51	96.57	97.62
14-Feb-20	19:01	5:23	1262	28.59	28.59	28.59	28.59	28.09	28.09	28.09	28.59	98.61	98.12	98.61	98.12	96.57	96.57	96.57	96.63
15-Feb-20	19:04	5:26	3349	28.09	28.59	28.59	28.59	28.09	28.09	28.09	28.09	97.07	97.62	97.62	97.13	96.57	96.57	97.07	97.07
16-Feb-20	19:01	5:23	2704	28.59	28.59	28.59	28.09	28.09	28.09	28.09	28.59	98.12	98.12	98.12	97.56	96.07	96.07	96.07	97.13
17-Feb-20	18:57	5:21	3633	28.59	28.59	28.59	28.09	28.09	28.09	28.09	28.09	97.62	97.13	97.62	96.57	96.57	96.57	96.57	96.07
18-Feb-20	18:56	5:26	2557	28.09	28.09	28.09	28.09	28.09	27.59	27.59	28.09	95.57	96.57	96.57	96.07	94.57	93.5	93	94.06
19-Feb-20	18:50	5:28	1793	28.09	28.09	28.09	28.09	28.09	28.09	27.59	28.09	94.57	95.57	95.07	93.56	92.03	91.52	89.93	92.54
20-Feb-20	19:00	5:34	7304	28.59	28.59	28.59	28.59	28.09	28.09	28.09	28.59	93.11	94.12	94.12	91.07	88.95	89.47	90.5	92.6
21-Feb-20	18:55	5:29	2152	29.09	28.59	28.59	28.59	28.59	28.59	28.59	28.59	91.64	94.12	94.62	92.6	91.07	90.04	90.56	93.11
22-Feb-20	19:04	5:29	1819	28.59	29.09	29.09	28.59	28.59	28.59	28.59	28.59	93.61	95.69	93.17	92.09	92.09	90.56	89.01	90.04
23-Feb-20	18:51	5:29	1734	28.59	29.09	28.59	28.59	28.59	28.59	28.59	28.59	92.09	93.17	92.6	91.07	88.49	89.01	86.41	87.45
24-Feb-20	19:05	5:28	1741	28.59	28.59	28.59	28.59	28.59	28.59	28.59	28.59	87.97	90.04	88.49	85.36	84.31	83.25	84.84	85.89
25-Feb-20	18:57	5:30	1704	28.59	28.59	28.59	28.59	28.59	28.09	28.59	28.59	86.41	88.49	87.45	83.25	81.12	78.37	82.72	84.31

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
26-Feb-20	18:49	5:32	2026	28.59	28.59	29.09	29.09	28.59	28.59	28.59	29.09	85.36	87.97	87.51	86.47	81.65	78.96	84.31	86.99
27-Feb-20	19:01	5:33	3583	29.09	29.09	29.09	29.09	28.59	28.59	29.09	29.09	85.95	88.03	87.51	85.95	83.78	80.58	81.71	86.47
28-Feb-20	19:00	5:31	1982	29.09	29.09	29.09	29.09	28.59	28.59	28.59	29.09	88.03	89.59	88.55	85.95	81.65	80.04	82.72	83.84
29-Feb-20	18:44	5:31	2101	29.09	29.09	29.09	29.09	28.59	28.59	28.59	28.59	84.89	86.47	84.89	82.24	78.96	76.79	76.79	79.5
1-Mar-20	18:41	5:32	4318	29.09	29.09	29.09	29.09	29.09	29.09	29.09	29.09	82.24	83.84	82.78	81.71	80.1	81.17	84.37	86.99
2-Mar-20	18:54	5:34	4432	29.09	29.59	29.09	29.09	29.09	29.09	29.59	29.09	87.51	88.1	87.51	85.95	83.84	83.84	87.58	89.07
3-Mar-20	18:49	5:34	3925	29.09	29.59	29.09	29.09	29.09	29.09	29.09	29.09	88.55	89.13	89.07	87.51	83.84	81.71	83.31	83.84
4-Mar-20	18:57	5:28	2049	29.09	29.09	29.09	29.09	28.59	28.59	28.59	29.09	86.99	87.51	88.03	88.55	81.12	77.88	79.5	83.84
5-Mar-20	18:51	5:44	1980	29.09	29.09	29.09	28.59	28.59	28.59	28.59	29.09	84.37	86.47	86.47	79.5	74.6	73.5	75.7	81.71
6-Mar-20	18:53	5:34	2064	29.09	29.09	29.09	29.09	28.59	28.59	29.09	29.09	82.78	85.42	83.84	80.64	77.34	73.5	77.39	83.31
7-Mar-20	18:45	5:42	2030	29.09	29.09	29.09	28.59	28.59	28.59	28.59	29.09	84.37	86.47	84.37	77.88	72.94	70.16	70.71	77.94
8-Mar-20	18:45	5:40	2124	29.09	29.09	28.59	28.59	28.59	28.59	28.59	28.59	80.64	82.78	79.5	70.71	67.34	65.63	67.34	70.16
9-Mar-20	18:42	5:35	2105	28.59	28.59	28.59	28.59	28.59	28.59	28.59	28.59	71.83	76.79	74.05	67.34	65.63	65.63	69.03	71.27
10-Mar-20	18:39	5:49	1976	28.59	28.59	28.59	28.59	28.59	28.59	28.59	28.59	72.94	76.25	75.15	70.71	69.03	67.34	68.47	72.94
11-Mar-20	18:42	5:36	1877	29.09	29.09	29.09	28.59	28.59	28.59	29.09	29.09	75.21	80.64	78.48	74.05	70.71	70.71	74.66	76.85
12-Mar-20	18:45	5:29	1556	29.09	29.09	29.09	29.09	29.09	28.59	29.09	29.09	79.02	80.1	81.17	82.24	79.02	78.96	78.48	80.64
13-Mar-20	18:47	5:35	1811																
14-Mar-20	18:37	5:33	2403	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	77.43	79.54	80.07	77.96	73.13	70.4	71.5	73.13
15-Mar-20	18:49	5:40	2030	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	75.3	77.43	78.49	73.68	70.4	67.62	68.74	71.5
16-Mar-20	18:48	5:36	2646	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	73.13	76.9	76.37	71.5	68.18	65.37	68.18	70.95
17-Mar-20	18:44	5:40	2086	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	71.5	73.68	73.68	68.74	65.37	63.1	64.8	67.62
18-Mar-20	18:26	5:37	1724	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	67.62	71.5	69.85	66.5	64.8	63.67	65.94	66.5
19-Mar-20	18:46	5:41	1881	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	67.62	73.13	70.95	65.94	63.67	60.8	64.8	67.06
20-Mar-20	18:41	5:39	2094	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	68.74	72.59	70.95	68.18	65.94	63.1	65.37	68.74
21-Mar-20	18:41	5:38	2103	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	67.06	70.95	68.18	65.94	64.24	62.52	64.8	68.18
22-Mar-20	18:41	5:40	1697	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	70.95	74.22	72.59	67.06	62.52	61.95	65.37	70.4
23-Mar-20	18:38	5:42	2039	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	72.59	76.37	74.76	69.29	63.67	60.22	61.37	68.18
24-Mar-20	18:22	5:37	2576	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	70.4	73.68	70.95	64.8	62.52	59.64	61.37	64.24
25-Mar-20	18:42	5:43	2519	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	65.37	68.74	65.94	61.37	60.22	58.47	58.47	60.8
26-Mar-20	18:32	5:39	2414	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	60.8	65.94	61.95	58.47	56.71	56.12	56.71	58.47
27-Mar-20	18:31	5:43	2836	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	58.47	63.67	60.8	58.47	56.71	55.53	55.53	58.47
28-Mar-20	18:36	5:41	2771	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	59.64	65.37	64.8	59.05	57.3	55.53	54.93	57.88
29-Mar-20	18:27	5:40	2524	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	62.52	64.8	60.22	57.3	55.53	54.34	56.12	59.05
30-Mar-20	18:36	5:44	2956	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	64.8	65.37	61.37	58.47	55.53	55.53	57.3	64.8
31-Mar-20	18:32	5:44	3435	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	67.62	70.4	65.37	60.8	59.05	57.88	60.22	65.94
1-Apr-20	18:22	5:49	3089	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	66.5	67.62	65.94	56.71	54.93	53.74	54.93	59.64
2-Apr-20	18:34	5:49	3078	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	61.95	67.06	65.94	57.3	53.74	51.34	53.74	59.64
3-Apr-20	18:18	5:43	2519	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	61.95	65.94	63.67	57.88	56.12	55.53	56.71	61.95
4-Apr-20	18:26	5:49	2507	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	61.95	65.37	65.94	61.95	58.47	57.3	57.3	63.67
5-Apr-20	18:15	6:11	2300	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	64.24	68.18	67.62	61.37	57.3	55.53	56.71	61.95
6-Apr-20	18:15	5:53	2536	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	64.8	68.18	66.5	62.52	58.47	57.3	61.95	66.5
7-Apr-20	18:11	5:55	2697	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	70.4	73.13	72.59	73.13	72.04	69.85	72.04	73.68
8-Apr-20	18:28	6:00	4539	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	75.3	76.9	76.37	75.3	72.59	72.59	74.76	76.9
9-Apr-20	18:11	6:15	4888	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	77.43	80.07	80.59	78.49	75.83	73.68	76.37	77.96
10-Apr-20	18:09	5:54	4257	30.11	30.11	30.11	30.11	29.61	29.61	29.61	29.61	78.55	79.6	80.13	80.13	69.85	64.24	69.85	72.04

Date	First Call	Last Call	Number of Calls	Temperature								Humidity							
				3am	6am	9am	12pm	3pm	6pm	9pm	12am	3am	6am	9am	12pm	3pm	6pm	9pm	12am
11-Apr-20	18:12	5:53	2769	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	73.13	75.3	75.83	72.04	63.1	60.22	61.95	65.94
12-Apr-20	18:13	5:58	2992	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	68.74	72.04	72.59	67.62	63.67	63.1	67.06	70.4
13-Apr-20	18:11	6:08	4920	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	72.04	74.22	74.22	71.5	68.74	66.5	70.95	72.04
14-Apr-20	18:05	6:00	3816	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	74.76	76.37	76.37	74.76	70.4	68.74	70.95	72.59
15-Apr-20	18:06	6:17	5968	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	74.76	76.9	76.37	72.59	67.62	64.8	67.62	70.4
16-Apr-20	17:57	5:57	3712	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	72.59	75.3	74.76	70.4	68.18	65.37	63.67	68.18
17-Apr-20	17:58	5:54	4559	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	70.95	72.59	70.95	67.06	62.52	59.64	59.64	65.37
18-Apr-20	18:10	6:06	3861	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	67.06	69.29	68.18	65.37	61.95	60.22	61.95	65.37
19-Apr-20	17:57	5:55	4549	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	67.62	70.4	68.74	64.24	62.52	61.37	61.95	64.24
20-Apr-20	18:03	6:08	4952	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	67.06	69.29	69.29	64.8	61.95	61.95	63.1	66.5
21-Apr-20	17:53	5:52	4282	29.61	30.11	30.11	29.61	29.61	29.61	29.61	29.61	68.74	71.56	71.56	65.94	63.1	60.8	63.1	65.37
22-Apr-20	17:58	5:55	5446	29.61	29.61	29.61	29.61	29.61	29.61	29.61	29.61	67.06	68.74	65.37	63.1	60.8	60.8	59.64	61.37
23-Apr-20	17:55	6:20	5680	30.11	30.11	29.61	29.61	29.61	29.61	30.11	30.11	64.3	67.12	64.8	61.95	60.8	58.47	59.7	64.3
24-Apr-20	17:51	6:12	5450	30.11	30.11	30.11	30.11	30.11	30.11	30.11	30.11	65.43	68.24	69.35	63.16	59.7	56.77	60.28	65.43

Appendix E: Long-term Summary Statistics of Chemical Analytes at CO-WS-14 (October 2017 to April 2020)

Measure	Unit	Min	Max	Range	Median	Mean	SE
pH		7.3	8.2	0.9	7.75	7.737	0.053
Electrical Conductivity	µS/cm	285	360	75	340	339.25	3.33
Total Dissolved Solids	mg/L	175	250	75	200	200.25	4.206
Total Suspended Solids	mg/L	2.5	22	19.5	2.5	4.625	1.041
Fluoride	mg/L	0.1	0.4	0.3	0.3	0.285	0.015
Nitrate as NO_3	mg/L	0.002	1.1	1.098	0.25	0.214	0.058
Nitrite as NO_2	mg/L	0.002	0.61	0.608	0.25	0.16	0.036
NOx as N	mg/L	0.002	0.31	0.308	0.008	0.026	0.015
Calcium Dissolved	mg/L	9.2	13	3.8	12	11.76	0.197
Potassium Dissolved	mg/L	1	3	2	1.3	1.453	0.121
Magnesium Dissolved	mg/L	16.5	23	6.5	21	20.725	0.323
Sodium Dissolved	mg/L	18.5	24	5.5	21	21.075	0.282
Bicarbonate HCO_3 as CaCO3	mg/L	60	100	40	89.5	88.05	2.014
Carbonate CO_3^{2-} as $CaCO_3$	mg/L	<5	<5	0	<5	<5	0
Hydroxide OH as $CaCO_3$	mg/L	<5	<5	0	<5	<5	0
Total Alkalinity as $CaCO_3$	mg/L	60	100	40	89.5	88.05	2.014
Chloride	mg/L	29	140	111	31	37.1	5.447
Sulphate	mg/L	26	81	55	28.25	31.125	2.66
Ionic Balance	mg/L	-42	3.6	45.6	0.56	-1.605	2.557
Hardness as $CaCO_3$	mg/L	2.93	130	127.07	110	108.671	5.851
Sum of Anions	mg/L	2.82	7.21	4.39	3	3.308	0.327
Sum of Cations	mg/L	3.1	120	116.9	3.37	12.297	8.975
Silica	mg/L	8.2	20	11.8	18	16.985	0.561
Aluminium Dissolved	mg/L	0.005	0.02	0.015	0.005	0.006	0.001
Antimony Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0
Arsenic Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0
Barium Dissolved	mg/L	0.004	0.1	0.096	0.005	0.019	0.007
Boron Dissolved	mg/L	0.005	0.1	0.095	0.09	0.08	0.007
Cadmium Dissolved	mg/L	0	0	0	0	0	0
Chromium Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0
Cobalt Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0
Copper Dissolved	mg/L	0	0.001	0	0	0.001	0
Iron Dissolved	mg/L	0.005	0.415	0.41	0.03	0.048	0.02
Lead Dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0
Manganese Dissolved	mg/L	0	0.27	0.27	0.15	0.162	0.018
Mercury Dissolved	mg/L	0	0.13	0.13	0	0.007	0.006
Molybdenum Dissolved	mg/L	0	0.001	0.001	0.001	0.001	0
Nickel Dissolved	mg/L	0	0.001	0	0	0.001	0
Selenium Dissolved	mg/L	<0.001	<0.001	0	<0.001	<0.001	0
Strontium Dissolved	mg/L	0.038	0.056	0.018	0.048	0.048	0.001
Tin Dissolved	mg/L	0	0.01	0.01	0	0.001	0.001
Zinc Dissolved	mg/L	0	0.01	0.009	0.001	0.002	0

Appendix C. CO-WS-14 Water Quality Results During the Monitoring Period

Analyte	Unit	P80	SSGV	Laboratory Analysis Results						
				2024						
				25-May	08-Jun	23-Jul	15-Aug	19-Sep	18-Oct	22-Nov
Naphthalene			TV = 0.0025 KPI = 0.016	<0.005			<0.005			<0.005
pH		7.98	6 to 8	7.91			**8.14**	7.81*		7.79
EC	µS/cm	348	360	329			337			330
Nitrate as NO3	mg/L	0.25	2.4	<0.01			0.01			<0.01
Nitrite as NO2	mg/L	0.25	1	<0.01			<0.01			<0.01
NOx as N	mg/L	0.0252	0.0252	<0.01			0.01			<0.01
Calcium	mg/L	12	13	12			12			12
Potassium	mg/L	1.64	3	1			**2**			**2**
Magnesium	mg/L	22	23	21			22			20
Sodium	mg/L	22	24	22			**23**			**24**
Bicarbonate	mg/L	93.8	100	92			93			**97**
Carbonate	mg/L	2.5	3	<1			<1			<1
Total Alkalinity	mg/L	93.8	100	92			93			**97**
Chloride	mg/L	33	135	33			29			33
Sulphate	mg/L	30	79	30			28			29
Silica	mg/L	18.8	20	17.2			**20.3***	17.6*		17.9
Aluminium	mg/L	0.005	0.055	<0.005			<0.005			<0.005
Antimony	mg/L	0.0005	0.0005	<0.0002			<0.0002			<0.0002
Arsenic	mg/L	0.0005	0.024	<0.0002			<0.0002			<0.0002
Barium	mg/L	0.0086	0.0086	**0.0616**	**0.0382***	**0.0402***	**0.0406**	**0.0235***	**0.0249***	**0.056**
Boron	mg/L	0.1	0.37	**0.12**			**0.131**	**0.11***	0.08	**0.114**
Cadmium	mg/L	0.00005	0.0002	<0.00005			<0.00005			<0.00005
Chromium	mg/L	0.0005	0.001	<0.0002			0.0006			<0.0002
Cobalt	mg/L	0.0005	0.0005	0.0002			0.0001			<0.0001
Copper	mg/L	0.0005	0.0014	<0.0005			<0.0005			0.0014
Iron	mg/L	0.048	0.3	0.031			0.017			0.007
Lead	mg/L	0.0005	0.0034	<0.0001			<0.0001			<0.0001
Manganese	mg/L	0.258	1.9	**0.263**			0.176			0.197
Mercury	mg/L	0.00005	0.00005	<0.00004			<0.00004			<0.00004
Molybdenum	mg/L	0.0005	0.00005	<0.0001			<0.0001			<0.0001
Nickel	mg/L	0.0005	0.011	**0.0014**			**0.0012**	**0.0016**	**0.0009**	**0.0031**
Selenium	mg/L	0.0005	0.011	<0.0002			<0.0002			<0.0002
Zinc	mg/L	0.0025	0.008	**0.017**	**0.016***	**0.021***	**0.017**	**0.004***	**0.006***	**0.027**

All metal analytes are dissolved
Red values indicate exceedance of the SSGV
Orange values indicate exceedance of the P80 SSGV
* denotes additional follow-up sampling undertaken in response to P80 SSGV exceedances over two consecutive quarterly monitoring events or single SSGV exceedances
Note: Samples were not collected in December 2024 due to site in-accessibility from heavy rainfall events.

Appendix C. DAWE Letter (EPBC 2017/7861 variation to conditions of approval, and approval of experts and Monitoring Program, 30 October 2020)

Australian Government
Department of Agriculture, Water and the Environment

Ms Natassja Bell
Principal Advisor - Approvals
Atlas Iron Pty Ltd
Level 17, 300 Murray Street
PERTH WA 6000

Corunna Downs Iron Ore Mining Project (EPBC 2017/7861): Variation to conditions of approval, and approval of experts and Monitoring Program.

Dear Ms Bell

Thank you for your request to vary the conditions of approval for this project, and for submitting for approval independent scientific experts, and the Monitoring Program, in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Officers of the Department have advised me on the above requests and on the requirements of the EPBC Act conditions of approval for this project. On this basis, and as a delegate of the Minister for the Environment, I have decided to agree to the variation of conditions of approval attached to EPBC 2017/7861, and to approve:

- for the purpose of Condition 4 of the above approval, the independent scientific experts submitted to the Department by letter dated 3 September 2020; and
- in accordance with Condition 4 of the above approval, the *Corunna Downs CO-CA-03 and CO-WS-14 Monitoring Strategy*, Revision 6, dated 8 October 2020.

The conditions as varied are attached for your information.

The approved monitoring strategy must now be implemented. Please note that if you wish to vary the approved monitoring strategy you must do so in accordance with Condition 10 of the approval.

Should you require any further information please contact Vaughn Cox directly or by email at postapproval@awe.gov.au.

Yours sincerely

Declan O'Connor Cox, Assistant Secretary (A/g)
Environment Assessments (Vic, Tas) and Post Approvals Branch

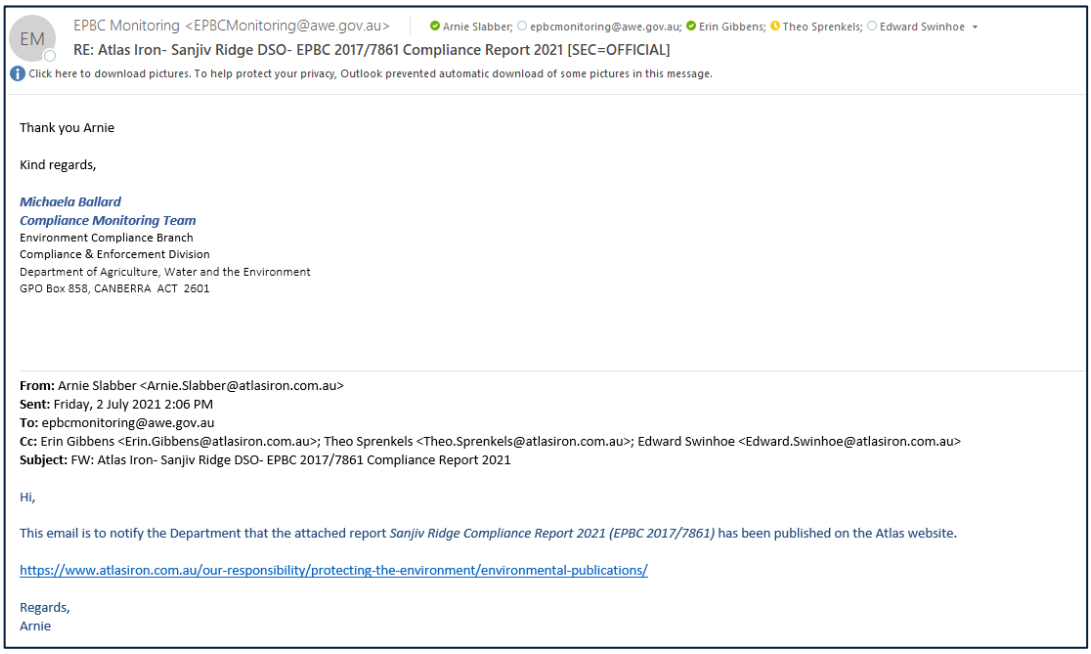
30 October 2020

Attach: Variation to conditions of approval for EPBC 2017/7861.

GPO Box 858 Canberra ACT 2601 • Telephone 02 6274 1111 • Facsimile 02 6274 1666 • www.awe.gov.au

Appendix D. Annual report notification to DCCEEW 2021 - 2023.

EPBC 2017/7861 Compliance Report 2021



EPBC Monitoring <EPBCMonitoring@awe.gov.au> — Arnie Slabber; epbcmonitoring@awe.gov.au; Erin Gibbens; Theo Sprenkels; Edward Swinhoe

RE: Atlas Iron- Sanjiv Ridge DSO- EPBC 2017/7861 Compliance Report 2021 [SEC=OFFICIAL]

Click here to download pictures. To help protect your privacy, Outlook prevented automatic download of some pictures in this message.

Thank you Arnie

Kind regards,

Michaela Ballard
Compliance Monitoring Team
Environment Compliance Branch
Compliance & Enforcement Division
Department of Agriculture, Water and the Environment
GPO Box 858, CANBERRA ACT 2601

From: Arnie Slabber <Arnie.Slabber@atlasiron.com.au>
Sent: Friday, 2 July 2021 2:06 PM
To: epbcmonitoring@awe.gov.au
Cc: Erin Gibbens <Erin.Gibbens@atlasiron.com.au>; Theo Sprenkels <Theo.Sprenkels@atlasiron.com.au>; Edward Swinhoe <Edward.Swinhoe@atlasiron.com.au>
Subject: FW: Atlas Iron- Sanjiv Ridge DSO- EPBC 2017/7861 Compliance Report 2021

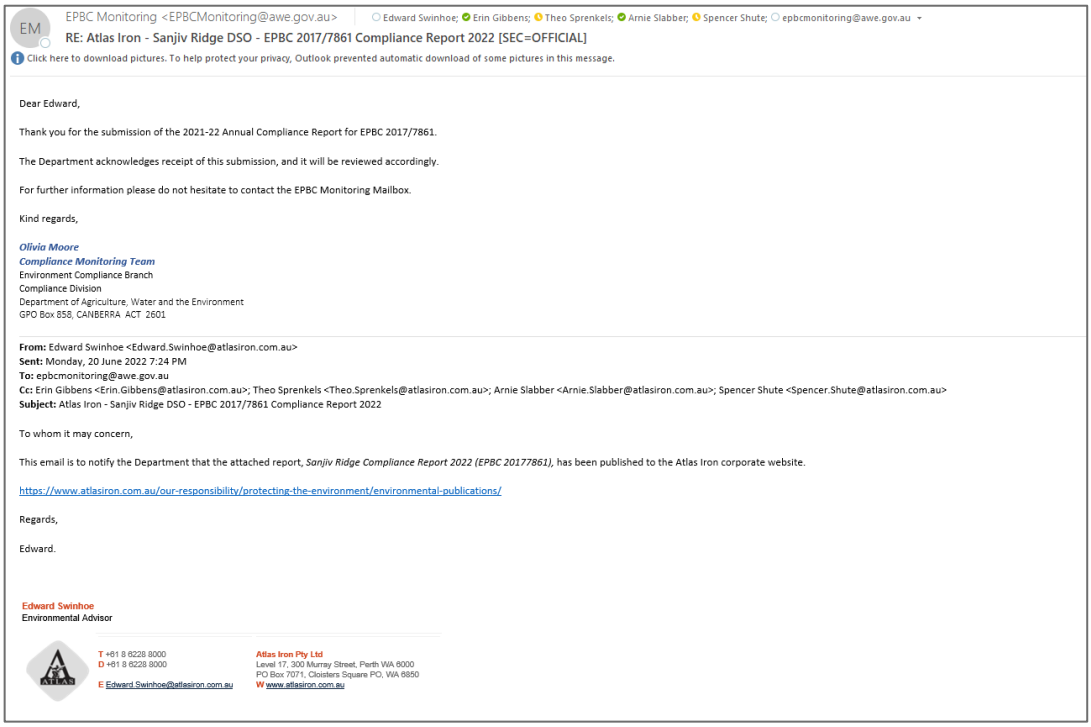
Hi,

This email is to notify the Department that the attached report *Sanjiv Ridge Compliance Report 2021 (EPBC 2017/7861)* has been published on the Atlas website.

https://www.atlasiron.com.au/our-responsibility/protecting-the-environment/environmental-publications/

Regards,
Arnie

EPBC 2017/7861 Compliance Report 2022



EPBC Monitoring <EPBCMonitoring@awe.gov.au> — Edward Swinhoe; Erin Gibbens; Theo Sprenkels; Arnie Slabber; Spencer Shute; epbcmonitoring@awe.gov.au

RE: Atlas Iron - Sanjiv Ridge DSO - EPBC 2017/7861 Compliance Report 2022 [SEC=OFFICIAL]

Click here to download pictures. To help protect your privacy, Outlook prevented automatic download of some pictures in this message.

Dear Edward,

Thank you for the submission of the 2021-22 Annual Compliance Report for EPBC 2017/7861.

The Department acknowledges receipt of this submission, and it will be reviewed accordingly.

For further information please do not hesitate to contact the EPBC Monitoring Mailbox.

Kind regards,

Olivia Moore
Compliance Monitoring Team
Environment Compliance Branch
Compliance Division
Department of Agriculture, Water and the Environment
GPO Box 858, CANBERRA ACT 2601

From: Edward Swinhoe <Edward.Swinhoe@atlasiron.com.au>
Sent: Monday, 20 June 2022 7:24 PM
To: epbcmonitoring@awe.gov.au
Cc: Erin Gibbens <Erin.Gibbens@atlasiron.com.au>; Theo Sprenkels <Theo.Sprenkels@atlasiron.com.au>; Arnie Slabber <Arnie.Slabber@atlasiron.com.au>; Spencer Shute <Spencer.Shute@atlasiron.com.au>
Subject: Atlas Iron - Sanjiv Ridge DSO - EPBC 2017/7861 Compliance Report 2022

To whom it may concern,

This email is to notify the Department that the attached report, *Sanjiv Ridge Compliance Report 2022 (EPBC 20177861),* has been published to the Atlas Iron corporate website.

https://www.atlasiron.com.au/our-responsibility/protecting-the-environment/environmental-publications/

Regards,

Edward.

Edward Swinhoe
Environmental Advisor

T +61 8 6228 8000
D +61 8 6228 8000
E Edward.Swinhoe@atlasiron.com.au

Atlas Iron Pty Ltd
Level 17, 300 Murray Street, Perth WA 6000
PO Box 7071, Cloisters Square PO, WA 6850
W www.atlasiron.com.au

EPBC 2017/7861 Compliance Report 2023

To: EPBC Monitoring <epbcmonitoring@dcceew.gov.au>
Subject: EPBC 2017/7861 Compliance Report 2023 - Sanjiv Ridge DSO Project, Western Australia

Good morning,

Atlas is required to submit a compliance report to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) annually by 16 July (within 60 business days of the 12-month reporting period) under condition 8 of EPBC 2017/7861. This compliance report is for the reporting period 21 April 2022 to 20 April 2023.

Two non-compliances were found during the 2023 Significant Species Management Plan audit. Atlas notified the DCCEEW via email on 30 June 2023 of these non-compliances as required by conditions 8A and 8B.

1. Eight (8) conservation significant fauna deaths occurred during the reporting period, including five (5) Northern Quolls (*Dasyurus hallucatus*) and three (3) Pilbara Olive Pythons (*Liasis olivaeus Barroni*). All fauna mortalities were caused by vehicle strike and occurred within the development envelope.

2. The fence surrounding one turkey's nest (TN94) is 1.5 meters (m) high, 0.3 m below the SSMP commitment to fence turkeys' nests to height of 1.8 m. TN94 is located at co-ordinates: -21.4340, 119.6741).

This email is to notify DCCEEW that the EPBC 2017/7861 Compliance Report 2023 has been uploaded to the Atlas website: https://www.atlasiron.com.au/wp-content/uploads/2023/07/EPBC_Annual_Compliance_Report_2023__FINAL.pdf

If you have any queries regarding this submission, please contact Environmental Advisor Erin Gibbens on 0488 973 803 or Erin.Gibbens@Atlasiron.com.au.

Kind regards,

EPBC 2017/7861 Compliance Report 2024

Sent: Sunday, 14 July 2024 9:24 AM
To: EPBC Monitoring <epbcmonitoring@dcceew.gov.au>
Cc: Erin Gibbens <Erin.Gibbens@atlasiron.com.au>; Theo Sprenkels <Theo.Sprenkels@atlasiron.com.au>; Ricky Catlin <ricky.catlin@atlasiron.com.au>
Subject: Atlas Iron - Sanjiv Ridge DSO - EPBC 2017/7861 Annual Compliance Report 2024

To whom it may concern,

Atlas is required to submit a compliance report to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) annually by 16 July (within 60 business days of the 12-month reporting period) under Condition 8-a of EPBC 2017/7861.

This compliance report is for the reporting period 21 April 2023 to 20 April 2024, and during this time no non-compliances were identified through the audit process.

To satisfy Condition 8-b this email is to notify DCCEEW within 5 days of publication that the EPBC 2017/7861 Annual Compliance Report 2024 has been uploaded to the Atlas website (15/07/2024): Environmental Publications - Atlas Iron

If you have any queries regarding this submission, please do not hesitate to contact myself or Erin Gibbens (Erin.Gibbens@atlasiron.com.au)

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D +61 8 6228 8000
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E Michael.Pezzaniti@atlasiron.com.au

Atlas Iron Pty Ltd
1314 Hay Street, West Perth WA 6005
PO Box 7071, Cloisters Square PO, WA 6850
W www.atlasiron.com.au

Appendix E. Email notification to DCCEEW

Atlas Iron Sanjiv Ridge Project | Northern Quoll mortality 23/08/2024

[redacted]

Reply | Reply All | Forward

To Species and Communities; fauna.data@dbca.wa.gov.au; epbcmonitoring@dcceew.gov.au; Kym Ottewell
Cc Ricky Catlin; Theo Sprenkels; Erin Gibbens; Claudia Lewis; Jarrad Dodson; Matt Dilmitis; Environment

Sun 25/08/2024 8:26 AM

20240824_DBCA Fauna Report Form Northern Quoll.pdf
.pdf File

20240824_DCCEEW EPBC 2017_7861 Notification of significant species mortality.pdf
.pdf File

Dear whom it may concern,

Please find attached DBCA Fauna Report Form and DCCEEW notification regarding a Northern Quoll (*Dasyurus hallucatus*) mortality at Sanjiv Ridge DSO Project, which occurred on 23 August 2024.

Specimen has been placed in a plastic bag and frozen. Tissue samples will been collected in the next two days when an Environmental Advisor is on site.

No photos were taken, however I will follow up with specimen photos shortly.

Should you have any questions, please feel free to reach out.

[redacted]

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E Riley.Pattinson@atlasiron.com.au

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Appendix F. Atlas Iron Environmental Publications

Environmental Publications available on the Atlas Website