Huntly Bauxite Mine – WQMS Data Review

April 2025

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RARE Environmental

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Contents

1. Executive Summary

This report, prepared by RARE Environmental Pty Ltd and SciDev Pty Ltd for Alcoa, provides an analysis of turbidity data collected from Water Quality Monitoring Systems (WQMSs) deployed at the Huntly bauxite mining operations during April 2025. The primary objective of this analysis was to evaluate the quality of the data, identify potential "true" turbidity exceedance events, and support Alcoa's compliance reporting obligations under Schedule 1, Division 2, Clause 6 of the **Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023**.

The analysis focused on identifying and classifying turbidity events where levels exceeded 25 nephelometric turbidity units (NTU) for at least one hour. Events were categorized as "true" or "false" based on Alcoa's **Turbidity Event Classification Guidelines**, which distinguish actual turbidity increases (true events) from false readings caused by environmental factors such as debris, air bubbles, or fluctuating water levels.

Key findings include:

- **True Events**: Zero "true" turbidity exceedance events were identified.
- **Further Investigation**: Zero event's were flagged for further investigation.
- **False Events**: Twenty-three 'false' events were identified, primarily attributed to factors such as debris accumulation, sensor obstructions, and water turbulence.
- **Excluded Units**: Twenty-nine WQMS units were excluded from the analysis due to invalid data caused by equipment faults or environmental interference.

The report also highlights periods of missing data, which occurred due to system logoffs, equipment faults, or unplanned shutdowns. These gaps are detailed in the report to ensure transparency in data handling.

2. Scope

RARE Environmental Pty Ltd and SciDev Pty Ltd were engaged by Alcoa to analyse turbidity data collected from the Huntly Water Quality Monitoring Systems (WQMSs). The primary objective of this engagement is to assess the quality of the collected data and identify potential "true" turbidity events. This analysis supports Alcoa's reporting obligations under *Schedule 1, Division 2, Clause 6 of the Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023*.

3. Introduction

3.1. Background

Alcoa of Australia Ltd (Alcoa) operates two bauxite mines, Huntly and Willowdale, approximately 100 km southeast of Perth, Western Australia. These mining operations are subject to environmental controls mandated by the *Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023*.

Under this Exemption Order, Alcoa is required to implement drainage control measures and monitor effectiveness in water bodies within and downstream of mining operations. Turbidity, a critical water quality parameter, is monitored using Water Quality Monitoring Systems (WQMSs), to detect deviations and identify high-turbidity events.

Alcoa is obligated to report monthly on-stream turbidity, including the identification and classification of any "true" high-turbidity exceedance events. (Refer to Appendix B for the site map showing WQMS locations.)

3.2. Monitoring requirements

Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023 specifies that a drainage incident occurs when:

> *a) runoff from a disturbance area enters the surrounding environment, resulting in surface water turbidity of at least 25 NTU for a duration of at least one hour; or*
>
> *b) a discharge from containment infrastructure includes, or may include, environmentally hazardous material.*

Trigger levels for drainage incidents are outlined in *Schedule 1* of the Exemption Order. To meet these requirements, Alcoa has developed "Turbidity Event Classification Guidelines" which define a true turbidity exceedance event as a WQMS recording turbidity levels of at least 25 NTU for a period exceeding one hour.

3.3. Water Quality Management Systems (WQMSs)

During the April 2025 monitoring period, forty-four WQMS units were deployed to monitor turbidity levels in streams subject to surface water runoff within and downstream of Huntly mining operations.

Each WQMS unit consists of the following components:

Aquas SMR10 Turbidity Probe

> Positioned at a 90-degree angle to water flow, each probe is equipped with an automatic lens wiper and a guard to protect against larger debris.

Data Taker DT82 Logger

> Records data locally every 6 seconds, with 6-minute averages transmitted via IoT-enabled modems to a cloud-based platform.

Float Switch

Detects whether the sensor is submerged, or the stream is dry.

3.4. Purpose

This report aims to analyse turbidity data collected during April 2025, focusing on the identification and classification of "true" turbidity exceedance events based on Alcoa's Turbidity Event Classification Guidelines.

3.5. Exclusions

This report is not intended as:

- An assessment of the WQMS network or Alcoa's compliance with relevant legislation and requirements.
- An evaluation of the suitability of the trigger levels or event classification procedures adopted by Alcoa.

3.6. Abbreviations

	Term
IoT	Internet of Things
NTU	Nephelometric Turbidity Units
WQMS	Water Quality Management System

4. Methodology

4.1. WQMS Locations

A site map showing the WQMSs locations is provided in Appendix B.

4.2. Data Review

Data recorded by the WQMS Units was reviewed and potential events where turbidity levels exceeded 25 NTU for at least one hour. Each potential event was categorised as either 'true 'or 'false'.

4.2.1. True Turbidity Exceedance Events

These events are caused by an actual increase in stream turbidity. Per Alcoa's "Turbidity Event Classification Guidelines" true exceedance events typically exhibit:

- A sharp, sudden incline in turbidity levels.
- A return to baseline turbidity levels in a pattern resembling a normal (Gaussian) distribution.

Figure 1 Typical 'true' exceedance event showing the sharp incline and gradual return to background levels.

4.2.2. False Turbidity Exceedance Events

These events are caused by factors unrelated to actual turbidity increase, such as:

- Organic debris (e.g., leaves, sticks, algae) obstructing the sensor
- Air bubbles or water turbulence near the sensor
- Fluctuating water levels intermittently covering and uncover the sensor lens.

False events typically exhibit sharp inclines and declines without the characteristic bell curve shape of true events.

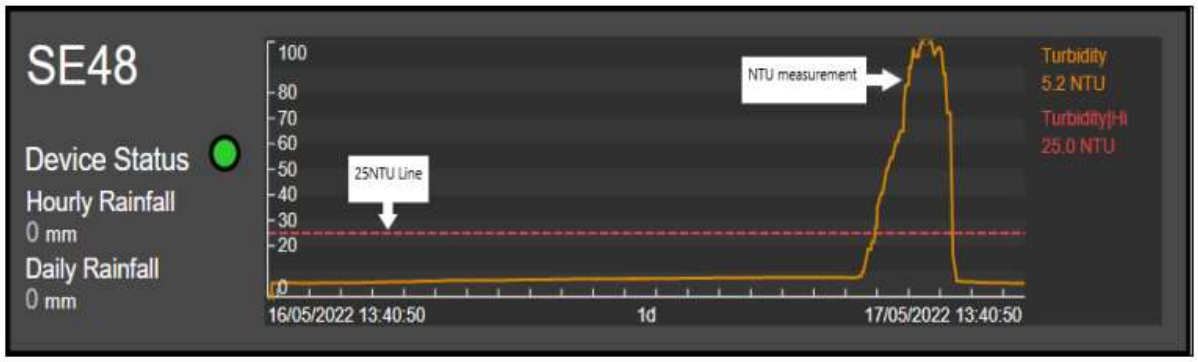

Figure 2 Typical 'false' exceedance event showing both a sharp incline and decline

4.2.3. Missing Data

Missing data occurs when a WQMS unit fails to record information, this can occur from unexpected system logoffs, equipment faults, or unplanned shutdowns.

5. Results and Discussion

5.1. Events

Table 1 provides a summary of identified events. Table 2 offers detailed information about each event.

Table 1 Events Summary

Category	# of events
Flagged for further investigation	0
False	23

Table 2 Events Details

Event ID	WQMS ID	Event Category	Start	End	Duration	Peak Turbidity (NTU)	Average Turbidity (NTU)
HUN-2504-001	ND07T	'FALSE'	1/04/2025 0:00	9/04/2025 9:24	8d 9hr 23min	1155.35	155.28
HUN-2504-002	SE02T	'FALSE'	1/04/2025 0:00	4/04/2025 10:48	3d 10hr 47min	1739.92	1057.14
HUN-2504-003	SE02T	'FALSE'	11/04/2025 4:54	12/04/2025 14:35	1d 9hr 40min	170.32	61.32
HUN-2504-004	SE02T	'FALSE'	21/04/2025 7:48	21/04/2025 15:28	0d 7hr 40min	34.05	29.11
HUN-2504-005	ND06T	'FALSE'	1/04/2025 16:54	1/04/2025 18:12	0d 1hr 17min	128.51	84.86
HUN-2504-006	ND06T	'FALSE'	2/04/2025 18:18	3/04/2025 0:54	0d 6hr 36min	134.39	81.10
HUN-2504-007	SE03INV1	'FALSE'	11/04/2025 18:48	14/04/2025 3:12	2d 8hr 24min	858.25	128.04
HUN-2504-008	SE03INV2	'FALSE'	1/04/2025 17:54	1/04/2025 23:24	0d 5hr 30min	1299.03	789.45
HUN-2504-009	SE03T	'FALSE'	1/04/2025 18:12	1/04/2025 19:48	0d 1hr 36min	107.56	64.46
HUN-2504-010	SE03T	'FALSE'	2/04/2025 20:30	2/04/2025 23:48	0d 3hr 18min	109.70	68.54
HUN-2504-011	SE05T	'FALSE'	1/04/2025 10:42	1/04/2025 22:06	0d 11hr 23min	55.27	34.47
HUN-2504-012	SE05T	'FALSE'	3/04/2025 22:00	4/04/2025 3:30	0d 5hr 29min	50.01	31.90
HUN-2504-013	SE05T	'FALSE'	7/04/2025 17:48	10/04/2025 1:24	2d 7hr 35min	478.04	187.30
HUN-2504-014	SE05T	'FALSE'	13/04/2025 23:42	14/04/2025 1:36	0d 1hr 53min	67.24	44.17
HUN-2504-015	SE05T	'FALSE'	26/04/2025 8:24	26/04/2025 14:00	0d 5hr 35min	55.25	44.68
HUN-2504-016	SE06T	'FALSE'	3/04/2025 22:18	4/04/2025 20:30	0d 22hr 11min	221.87	90.63

Event ID	WQMS ID	Event Category	Start	End	Duration	Peak Turbidity (NTU)	Average Turbidity (NTU)
HUN-2504-017	SE06T	'FALSE'	9/04/2025 15:30	30/04/2025 23:54	21d 8hr 23min	1532.46	375.51
HUN-2504-018	SE52T	'FALSE'	23/04/2025 9:18	23/04/2025 15:18	0d, 6hr, 0min	38.83	34.38
HUN-2504-019	SE61T	'FALSE'	1/04/2025 0:00	4/04/2025 18:00	3d, 18hr, 0min	422.71	220.02
HUN-2504-020	SE61T	'FALSE'	9/04/2025 23:18	11/04/2025 15:30	1d, 16hr, 12min	111.39	54.53
HUN-2504-021	SE61T	'FALSE'	12/04/2025 18:36	13/04/2025 12:06	0d, 17hr, 30min	50.73	31.72
HUN-2504-022	SE61T	'FALSE'	13/04/2025 21:42	14/04/2025 4:30	0d, 6hr, 48min	104.99	46.94
HUN-2504-023	SE61T	'FALSE'	19/04/2025 0:36	30/04/2025 23:54	11d, 23hr, 18min	602.03	296.74

* End date and time provided by Alcoa

5.2. Additional Investigation

Zero events were flagged for additional investigation.

5.3. True Event(s)

Zero 'True' turbidity events were identified during the reporting period.

5.4. False Event(s)

Twenty-three 'False' events were identified during the reporting period. Rationale on potential causes is summarised below.

Table 3 False Events Rationale

Event ID	Monitor ID	Rationale	Field Notes
HUN-2504-001	ND07T	This event is marked by sporadic peaks. This is indicative of a false event	Site inspection on 12/04/2025. Stream is stagnant and ponded with stick floating on top. Data indicates a false event.
HUN-2504-002	SE02T	This event is marked by a gradual increase and a rapid decrease in turbidity. This is indicative of a false event.	Site visited on 12/04/2025. Stream low and heavily impacted by algae. Data trend indicates false event. NTU on arrival 113.9412, post clean 1.3675 NTU.
HUN-2504-003	SE02T	This event is marked by a gradual increase and a rapid decrease in turbidity. This is indicative of a false event.	Site visited on 12/04/2025. Stream low and heavily impacted by algae. Data trend indicates false event. NTU on arrival 113.9412, post clean 1.3675 NTU.
HUN-2504-004	SE02T	This event is marked by a gradual increase and a rapid decrease in turbidity. This is indicative of a false event.	Site visited 21/04/2025. Stream is low, flowing and heavily impacted by red algae. NTU arrival 33.9669, post clean 1.3675. Data trend indicates false event.
HUN-2504-005	ND06T	This event is marked by a gradual increase and a gradual decrease in turbidity. This is indicative of a false event.	Site inspected on the 2/05/2025. Stream was very shallow. Sensor was positioned into water but will likely be impacted by sediment due to the shallow stream.
HUN-2504-006	ND06T	This event is marked by a gradual increase and a gradual decrease in turbidity. This is indicative of a false event.	Site inspected on the 2/05/2025. Stream was very shallow. Sensor was positioned into water but will likely be impacted by sediment due to the shallow stream.
HUN-2504-007	SE03INV1	This event is marked by sporadic peaks. This is indicative of a false event.	Site visited on 12/04/2025. Stream low and heavily impacted by algae. Data trend indicates false event. NTU on arrival 113.9412, post clean 1.3675 NTU.
HUN-2504-008	SE03INV2	This event is marked by a rapid increase and a rapid decrease in turbidity. This is indicative of a false event.	Site visited on 12/04/2025. Stream low and heavily impacted by algae. Data trend indicates false event. NTU on arrival 113.9412, post clean 1.3675 NTU.
HUN-2504-009	SE03T	This event is marked by a gradual increase and a gradual decrease in turbidity. This is indicative of a false event.	Site visited 05/03. Stream clear and flowing. Algae blooms was noted. SE03T is consistently showing the same exceedance events, during same time period. potential for sun interaction with sensor
HUN-2504-010	SE03T	This event is marked by a gradual increase and a gradual decrease in turbidity. This is indicative of a false event.	Site visited 05/03. Stream clear and flowing. Algae blooms was noted. SE03T is consistently showing the same exceedance events, during same time period. potential for sun interaction with sensor

Event ID	Monitor ID	Rationale	Field Notes
HUN-2504-011	SE05T	This event is marked by a rapid increase and a rapid decrease in turbidity with multiple peaks. This is indicative of a false event.	Site inspected on 12/04/2025. Stream low, clear and impacted by red algae. Cleaned sensor & returned into stream. NTU on arrival 14.0086, post clean 2.4548 NTU. Data trend indicates false event.
HUN-2504-012	SE05T	This event is marked by a rapid increase and a rapid decrease in turbidity. This is indicative of a false event.	Site inspected on 12/04/2025. Stream low, clear and impacted by red algae. Cleaned sensor & returned into stream. NTU on arrival 14.0086, post clean 2.4548 NTU. Data trend indicates false event.
HUN-2504-013	SE05T	This event is marked by a gradual increase and a rapid decrease in turbidity with multiple peaks. This is indicative of a false event.	Site inspected on 12/04/2025. Stream low, clear and impacted by red algae. Cleaned sensor & returned into stream. NTU on arrival 14.0086, post clean 2.4548 NTU. Data trend indicates false event.
HUN-2504-014	SE05T	This event is marked by a gradual increase and a gradual decrease in turbidity with multiple peaks. This is indicative of a false event.	Stream flowing, organic matter built up around sensor. Heavy algae growth in stream bed and on surrounding vegetation, pig activity just upstream from sensor and wash from bare burnt ground has reached the stream. Also completed catchment inspection 16/04/2025. The areas visually inspected - Marshall 10, Hill 2 & 3, Doherty 2 & 3. There was no evidence of impact from mining.
HUN-2504-015	SE05T	This event is marked by a rapid increase and a rapid decrease in turbidity with multiple peaks. This is indicative of a false event.	Site inspected on 26/04/2025. Stream low, clear and flowing. Stream bed impacted by red algae/iron. Cleaned sensor & returned into stream. NTU on arrival 52.5522, post clean 2.9935 NTU. Data trend indicates false event.
HUN-2504-016	SE06T	This event is marked by sporadic peaks. This is indicative of a false event.	Continued event from 31/03. Site inspected 05/04, stream dry. Dust build up on sensor. Cleaned and dropped to 7NTU
HUN-2504-017	SE06T	This event is marked by sporadic peaks. This is indicative of a false event.	Continued event from 31/03. Site inspected 05/04, stream dry. Dust build up on sensor. Cleaned and dropped to 7NTU
HUN-2504-018	SE52T	This event is marked by a gradual increase and a rapid decrease in turbidity with multiple peaks. This is indicative of a false event.	Site visited on 23/04/2025. Stream low, clear and flowing. Stream bed and sensor impacted by green algae. Leaf litter also present on the stream bed. NTU on arrival 44.6664, post clean 0.4183. Data trend indicates false event. Likely caused by algae and organic debris.

Event ID	Monitor ID	Rationale	Field Notes
HUN-2504-019	SE61T	This event is marked by a gradual increase and a rapid decrease in turbidity with multiple peaks. This is indicative of a false event.	Site visited on 12/04/2025. Stream low and heavily impacted by algae. Data trend indicates false event. NTU on arrival 36.8020, post clean 1.4117 NTU.
HUN-2504-020	SE61T	This event is marked by a gradual increase and a rapid decrease in turbidity with multiple peaks. This is indicative of a false event.	Site visited 2/05/2025. Stream is clear, flowing and heavily impacted with red algae. Cleaned sensor and returned into stream. NTU on arrival 629.8, post clean 12.24. Temp on arrival 4018.6, post clean 19.43. Float= 0.
HUN-2504-021	SE61T	This event is marked by a gradual increase and a rapid decrease in turbidity with multiple peaks. This is indicative of a false event.	Site visited 2/05/2025. Stream is clear, flowing and heavily impacted with red algae. Cleaned sensor and returned into stream. NTU on arrival 629.8, post clean 12.24. Temp on arrival 4018.6, post clean 19.43. Float= 0.
HUN-2504-022	SE61T	This event is marked by sporadic peaks. This is indicative of a false event.	Site visited 2/05/2025. Stream is clear, flowing and heavily impacted with red algae. Cleaned sensor and returned into stream. NTU on arrival 629.8, post clean 12.24. Temp on arrival 4018.6, post clean 19.43. Float= 0.
HUN-2504-023	SE61T	This event is marked by a gradual increase with multiple peaks. This is indicative of a false event.	Site visited 2/05/2025. Stream is clear, flowing and heavily impacted with red algae. Cleaned sensor and returned into stream. NTU on arrival 629.8, post clean 12.24. Temp on arrival 4018.6, post clean 19.43. Float= 0.

5.5. Excluded WQMS Units

Twenty-nine WQMS Units were excluded from analysis due to erroneous data. Alcoa confirmed the invalidity of data recorded from these units and provided commentary on the condition of each.

Table 4 Excluded WQMS Units

Unit	Dates	Comments
DB01T	01/04/2025-30/04/2025	Stream dry as of 3/01/2025
DB02T	01/04/2025-30/04/2025	Stream dry as of 15/02/2025
FPWR1	01/04/2025-30/04/2025	Stream dry as of 1/01/2025. Monitor offline due to fault.
ND04T	01/04/2025-30/04/2025	Stream dry as of 1/01/2025
ND12T	01/04/2025-30/04/2025	Stream dry as of 21/12/2024
ND13T	01/04/2025-30/04/2025	Stream dry as of 16/01/2025
PD02T	01/04/2025-30/04/2025	Access not yet obtained
PD03T	01/04/2025-30/04/2025	
SE01T	01/04/2025-30/04/2025	Stream dry as of 4/01/2025
SE03INV3	01/04/2025-30/04/2025	Stream dry as of 28/11/2024. Sensor reading high values. Fault repairs have been scheduled.
SE07T	01/04/2025-30/04/2025	Stream dry as of 28/11/2024
SE08T	01/04/2025-30/04/2025	Stream dry as of 31/01/2025
SE09T	01/04/2025-30/04/2025	Stream dry as of 5/01/2025
SE10T	01/04/2025-30/04/2025	Stream dry as of 5/01/2025
SE11T	01/04/2025-30/04/2025	Stream dry as of 28/10/2024
SE12INV	01/04/2025-30/04/2025	Stream dry as of 5/11/2024
SE12T	01/04/2025-30/04/2025	Stream dry as of 8/12/2024
SE15T	01/04/2025-30/04/2025	Stream dry as of 16/11/2024
SE22T	01/04/2025-30/04/2025	Stream dry as of 14/12/2024
SE23T	01/04/2025-30/04/2025	Stream dry as of 15/10/2024
SE24T	01/04/2025-30/04/2025	Stream dry as of 2/11/2024
SE25T	01/04/2025-30/04/2025	Stream dry as of 2/11/2024
SE26T	01/04/2025-30/04/2025	Stream dry as of 15/10/2024
SE34T	01/04/2025-30/04/2025	Stream dry as of 28/12/2024
SE36T	01/04/2025-30/04/2025	Stream dry as of 5/01/2025
SE48T	01/04/2025-30/04/2025	Stream dry as of 23/12/2024
SE60T	01/04/2025-30/04/2025	Stream dry as of 5/12/2024
SE62T	01/04/2025-30/04/2025	Stream dry as of 28/12/2024
SN07T	01/04/2025-30/04/2025	Stream dry as of 26/01/2025

5.6. Missing Data

Periods of missing data are detailed in Table 5.

Table 5 Missing Data Summary

Missing Data ID	Unit	Start	End	Comments
MD-2504-001	ND14T	22/04/2025 14:34	28/04/2025 11:21	Sensor Malfunction No Data Available
MD-2504-002	PD01T	28/04/2025 16:05	28/04/2025 20:51	Sensor Malfunction No Data Available
MD-2504-003	SE02T	28/04/2025 16:05	28/04/2025 20:51	Sensor Malfunction No Data Available
MD-2504-004	SE03T	24/04/2025 3:11	24/04/2025 7:52	Sensor Malfunction No Data Available
MD-2504-005	SE06T	10/04/2025 4:42	12/04/2025 10:30	Sensor Malfunction No Data Available
MD-2504-006	SE06T	14/04/2025 22:30	17/04/2025 10:36	Sensor Malfunction No Data Available
MD-2504-007	SE06T	19/04/2025 7:36	21/04/2025 11:24	Sensor Malfunction No Data Available
MD-2504-008	SE06T	23/04/2025 4:00	25/04/2025 12:48	Sensor Malfunction No Data Available
MD-2504-009	SE06T	27/04/2025 1:54	29/04/2025 12:18	Sensor Malfunction No Data Available
MD-2504-010	SE53T	29/04/2025 19:59	30/04/2025 0:49	Sensor Malfunction No Data Available

6. Appendices

Appendix A. Huntly Raw WQMS Data

Date	Huntly WQMS Data – April 2025 - Events with turbidity > 25 NTU for an hour or more																
	DB01T	DB02T	FPWR1	ND04T	ND06T	ND07T	ND12T	ND13T	ND14T	PD01T	SE01T	SE02T	SE03T	SE05T	SE06T	SE07T	SE08T
1/04/2025						**1**						**1**	**1**	**1**			
2/04/2025					**1**								**1**				
3/04/2025					**1**									**1**	**1**		
4/04/2025																	
5/04/2025																	
6/04/2025																	
7/04/2025														**1**			
8/04/2025																	
9/04/2025															**1**		
10/04/2025																	
11/04/2025												**1**					
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13/04/2025														**1**			
14/04/2025																	
15/04/2025																	
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21/04/2025												**1**					
22/04/2025																	
23/04/2025																	
24/04/2025																	
25/04/2025																	
26/04/2025														**1**			
27/04/2025																	
28/04/2025																	
29/04/2025																	
30/04/2025																	

Note: False events have been annotated by **black** bold text. True events for further investigation are annotated by **red** bold text

Date	Huntly WQMS Data -April 2025 - Events with turbidity > 25 NTU for an hour or more																
	SE09T	SE10T	SE11T	SE12T	SE12INV	SE15T	SE34T	SE36T	SE48T	SE51T	SE52T	SE53T	SE59T	SE60T	SE61T	SE62T	SN07T
1/04/2025															**1**		
2/04/2025																	
3/04/2025																	
4/04/2025																	
5/04/2025																	
6/04/2025																	
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29/04/2025																	
30/04/2025																	

Note: False events have been annotated by **black** bold text. True events for further investigation are annotated by **red** bold text

Date	Huntly WQMS Data – April 2025 - Events with turbidity > 25 NTU for an hour or more																	
	SE03INV2	SE22T	SE23T	SE25T	SE24T	SE03INV1	SE03INV3	SE24T										
1/04/2025	**1**																	
2/04/2025																		
3/04/2025																		
4/04/2025																		
5/04/2025																		
6/04/2025																		
7/04/2025																		
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9/04/2025																		
10/04/2025																		
11/04/2025						**1**												
12/04/2025																		
13/04/2025																		
14/04/2025																		
15/04/2025																		
16/04/2025																		
17/04/2025																		
18/04/2025																		
19/04/2025																		
20/04/2025																		
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24/04/2025																		
25/04/2025																		
26/04/2025																		
27/04/2025																		
28/04/2025																		
29/04/2025																		
30/04/2025																		

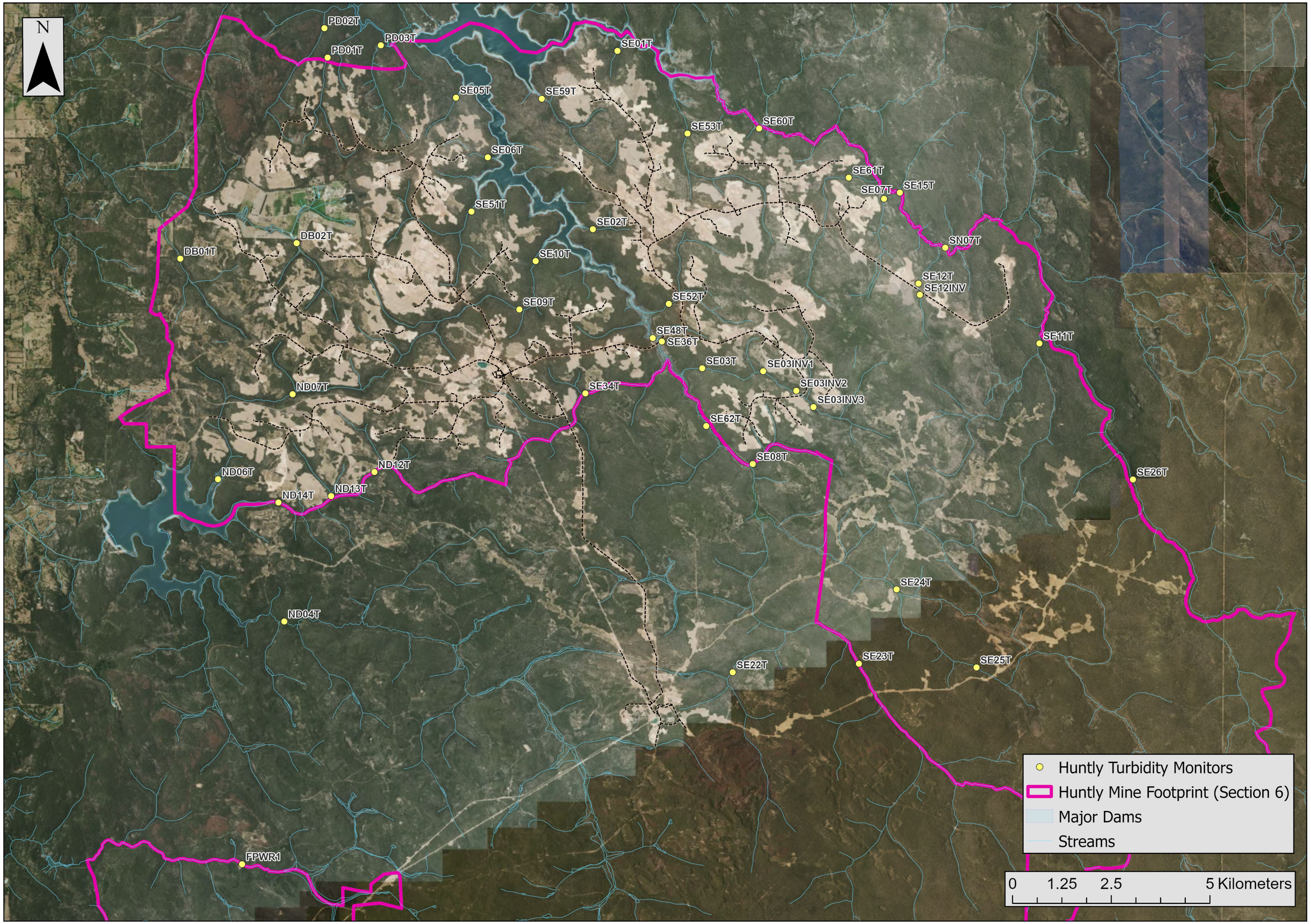
Note: False events have been annotated by **black** bold text. True events for further investigation are annotated by **red** bold text

Date	Huntly WQMS Data – April 2025 - Turbidity (Daily Average, NTU)																
	DB01T	DB02T	FPWR1	ND04T	ND06T	ND07T	ND12T	ND13T	ND14T	PD01T	SE01T	SE02T	SE03T	SE05T	SE06T	SE07T	SE08T
1/04/2025					11.06	154.44			2.73	2.22		522.18	8.78	27.22	2.84		
2/04/2025					23.31	149.85			3.39	2.24		975.98	13.68	5.00	6.60		
3/04/2025					5.79	155.93			2.47	2.34		1406.17	6.19	15.75	16.57		
4/04/2025					1.29	155.98			1.52	3.10		749.18	3.70	10.50	89.26		
5/04/2025					1.25	160.03			1.25	2.79		3.45	3.63	3.94	17.09		
6/04/2025					1.26	164.14			1.26	3.23		3.40	3.93	6.45	14.02		
7/04/2025					1.27	153.04			1.45	3.56		3.46	4.12	20.80	16.59		
8/04/2025					1.30	149.73			1.32	3.56		3.37	2.66	91.46	19.74		
9/04/2025					1.43	64.81			1.29	3.29		2.96	2.78	311.98	24.62		
10/04/2025					1.65	0.32			1.30	3.52		11.52	3.60	26.72	33.45		
11/04/2025					1.79	0.31			1.31	3.70		37.24	3.50	7.92			
12/04/2025					1.63	0.72			1.43	3.16		54.76	3.59	6.14	253.56		
13/04/2025					2.07	0.24			1.55	2.62		1.48	3.77	5.05	248.39		
14/04/2025					53.28	0.40			1.88	3.25		3.11	5.96	8.43	583.35		
15/04/2025					3.35	0.44			1.40	3.57		1.37	4.06	2.65			
16/04/2025					3.36	0.82			1.42	3.53		1.90	4.36	3.24			
17/04/2025									1.41	3.94		3.37	4.85	5.81	45.51		
18/04/2025						0.81			1.38	4.17		1.38	3.95	3.66	49.79		
19/04/2025						0.90			1.51	4.73		2.51	4.18	3.62	44.92		
20/04/2025						0.79			1.48	5.42		10.60	4.29	4.19			
21/04/2025						0.82			1.40	6.99		16.91	3.91	4.42	48.39		
22/04/2025						0.80			1.36	6.07		1.38	3.54	6.54	52.94		
23/04/2025						25.00				3.68		1.38	3.27	9.53	62.52		
24/04/2025						0.86				3.95			3.66	7.36			
25/04/2025						0.81				4.46		5.26	5.27	7.76	88.26		
26/04/2025						0.80				4.87		2.45	5.33	19.79	102.41		
27/04/2025						0.78				5.49		3.66	7.86	6.05	114.13		
28/04/2025						3.72			1.42	5.79		5.79	6.53	3.81			
29/04/2025						4.79			1.58	5.23		5.23	8.63	4.15	438.56		
30/04/2025						4.53			1.43	5.53		5.53	7.05	4.84	114.91		

Date	Huntly WQMS Data – April 2025 - Turbidity (Daily Average, NTU)																
	SE09T	SE10T	SE11T	SE12T	SE12INV	SE15T	SE34T	SE36T	SE48T	SE51T	SE52T	SE53T	SE59T	SE60T	SE61T	SE62T	SN07T
1/04/2025										0.14	11.40	0.48	12.61		176.78		
2/04/2025										0.06	9.30	0.62	16.58		204.46		
3/04/2025										0.07	3.06	1.34	12.24		306.83		
4/04/2025										0.25	0.97	0.42	14.29		139.19		
5/04/2025										0.24	0.80	0.72	14.67		9.66		
6/04/2025										0.09	0.77	0.43	14.56		2.40		
7/04/2025										0.09	0.81	0.61	14.58		2.54		
8/04/2025										0.09	2.02	1.18	13.82		4.17		
9/04/2025										0.78	4.25	1.71	12.47		13.68		
10/04/2025										0.13	5.08	0.54	13.12		42.57		
11/04/2025										0.11	4.55	0.69	14.98		51.60		
12/04/2025										1.31	2.44	0.58	11.28		19.12		
13/04/2025										0.08	0.42	0.81	4.05		23.52		
14/04/2025										1.55	1.67	1.81	7.22		10.96		
15/04/2025										0.09	0.65	0.73	1.95		1.26		
16/04/2025										0.05	0.78	0.47	1.34		1.74		
17/04/2025										0.05	3.65	0.41	1.49		5.44		
18/04/2025										0.12	6.35	0.68	1.99		15.24		
19/04/2025										0.19	4.80	0.16	2.53		31.34		
20/04/2025										0.20	5.69	0.61	2.88		49.31		
21/04/2025										0.12	7.39	1.06	3.13		116.25		
22/04/2025										0.06	12.50	0.65	4.42		252.64		
23/04/2025										0.14	15.14	0.29	5.41		364.88		
24/04/2025										0.14	0.44		4.43		271.22		
25/04/2025										0.13	0.39	1.26	3.25		258.03		
26/04/2025										0.62	0.51	1.26	4.91		300.91		
27/04/2025										0.24	0.42	1.27	4.94		373.91		
28/04/2025										0.13	0.42	1.26	5.12		444.11		
29/04/2025										0.12	0.48	1.25	6.23		517.14		
30/04/2025										0.33	0.46	1.23	5.21		572.07		

Date	Huntly WQMS Data – April 2025 - Turbidity (Daily Average, NTU)																	
	SE03INV2	SE22T	SE23T	SE25T	SE24T	SE03INV1	SE03INV3	SE24T										
1/04/2025	185.83					2.47												
2/04/2025	3.39					3.72												
3/04/2025	7.73					2.82												
4/04/2025	11.79					4.53												
5/04/2025	7.51					2.95												
6/04/2025	1.38					3.17												
7/04/2025	1.37					13.66												
8/04/2025	1.45					3.17												
9/04/2025	1.95					5.58												
10/04/2025						4.63												
11/04/2025	1.68					29.23												
12/04/2025	1.55					88.00												
13/04/2025	2.25					152.48												
14/04/2025	5.11					59.22												
15/04/2025						1.57												
16/04/2025						1.59												
17/04/2025						1.62												
18/04/2025						1.70												
19/04/2025						1.79												
20/04/2025						1.83												
21/04/2025						1.86												
22/04/2025						5.19												
23/04/2025						1.95												
24/04/2025						2.11												
25/04/2025						2.24												
26/04/2025						2.41												
27/04/2025						2.63												
28/04/2025						2.13												
29/04/2025	185.83					2.11												
30/04/2025	3.39					2.14												

Appendix B. Huntly WQMS Locations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PD03T
PD01T
SE01T
SE05T
SE59T
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SE60T
SE06T
SE61T
SE07T
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SE51T
SE02T
DB02T
DB01T
SE10T
SN07T
SE12T
SE12INV
SE52T
SE09T
SE48T
SE36T
SE11T
SE03T
SE03INV1
SE03INV2
SE03INV3
ND07T
SE34T
SE62T
SE08T
ND12T
ND06T
ND13T
ND14T
SE26T
SE24T
ND04T
SE23T
SE25T
SE22T
FPWR1
Huntly Turbidity Monitors
Huntly Mine Footprint (Section 6)
Major Dams
Streams
0
1.25
2.5
5 Kilometers

Appendix C. WQMS General Arrangement

ANTENNA

SOLAR PANEL

DATA TRANSMISSION TO IOT

DATA OUTLET

POWER INLET

40 X 60 MM CABLE DUCT

20 AMP MPPT
SOLAR CHARGER

40 X 60 MM CABLE DUCT

SIERRA WIRELESS FX30

40 X 60 MM CABLE DUCT

12 V, 120 AH LI-ION BATTERY

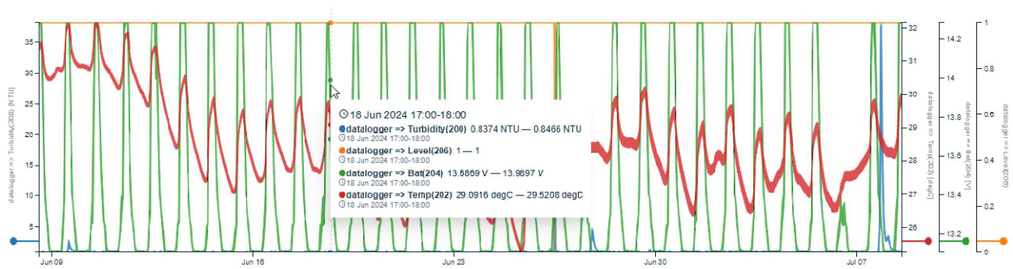
DATA INLET

SENSOR

STREAM DRY

SENSOR

STREAM FLOWING



REV.	REMARKS	DATE	DESIGNED	DRAWN	CHECKED	APPROVED	REFERENCE DRAWINGS
0	ISSUE FOR APPROVAL	05.07.2024	A.K.	S.A.	A.K.	A.K.	

ALL DIMENSIONS IN MILLIMETRES U.N.O.
LEVELS ARE IN METRES ON AHD U.N.O.
DO NOT SCALE DRAWING
IF IN DOUBT - ASK
TOLERANCES ISO2768-m U.N.O.

CLIENT

NSW - BUILDING G, 22 POWERS RD, SEVEN HILLS, NSW 2147
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SCIDEV

TITLE
IOT TURBIDITY MONITORING STATION
SITE LAYOUT
GENERAL ARRANGEMENT

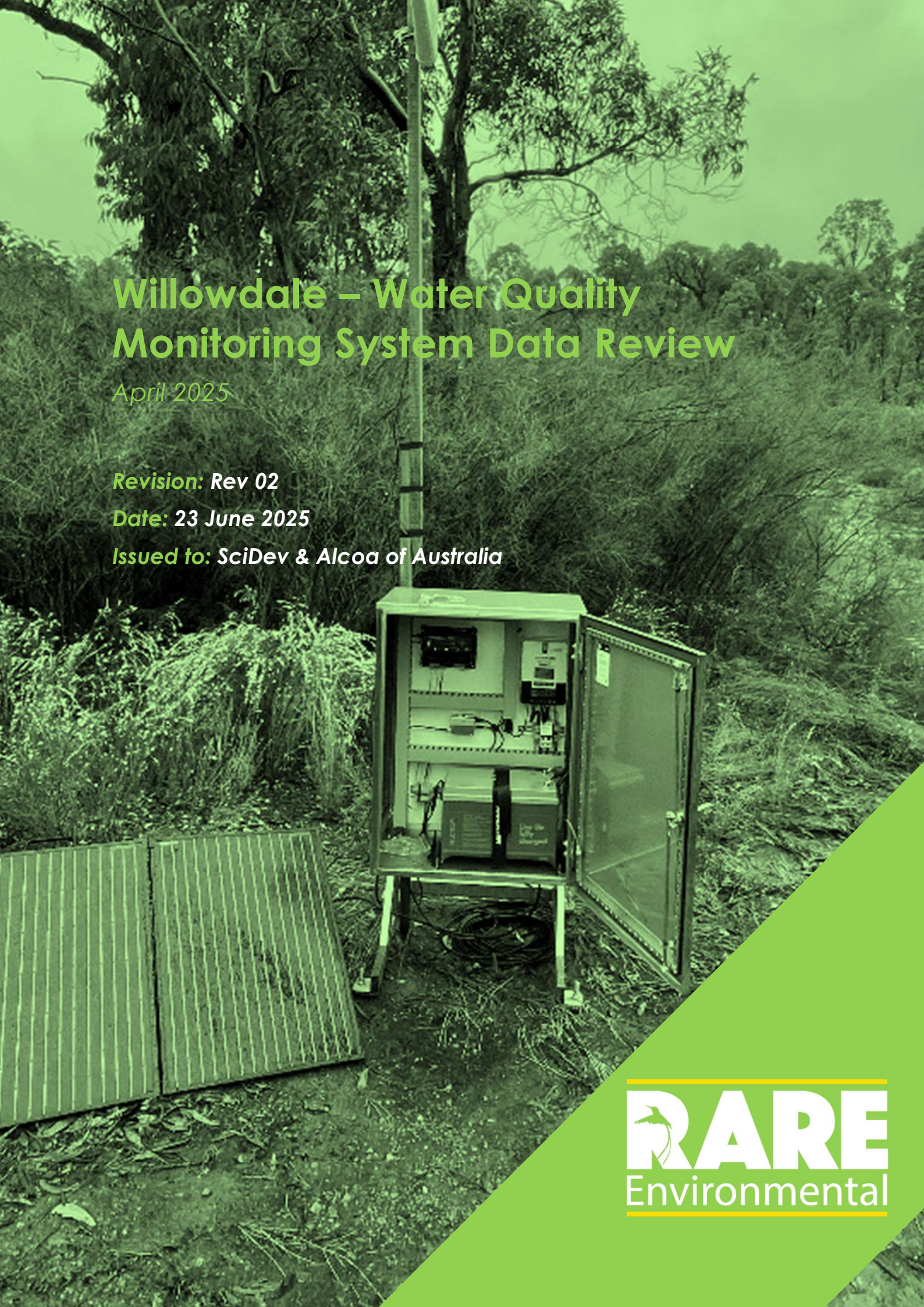
SHEET 1 OF 2

SCALE NTS OR AS SHOWN

DRAWING NO.
HI0090 - ALCOA WQMS

SHEET SIZE
A3

REV.
1



Willowdale – Water Quality Monitoring System Data Review

April 2025

Revision: ***Rev 02***

Date: ***23 June 2025***

Issued to: ***SciDev & Alcoa of Australia***

RARE Environmental

Document Control

Project Details	
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Document No	RP24050 WDL WQMS Data Review - April 2025
Project Name	WQ Data Processing
Project Number	RP24050
Client Reference	PO002447

Document History and Status						
Revision	Date	Description	Prepared	Reviewed	Approved	Issued to
01	28/05/25	Issued to client	MM	GD	GD	Alcoa
02	23/06/25	Amended with Comments	MM	GD	GD	Alcoa

Report Sign Off					
Report Version	02				
Prepared by		Technical Review		Approved for Issue	
Michael Minter		Georgia Duffy		Georgia Duffy	
Name	Michael Minter	Name	Georgia Duffy	Name	Georgia Duffy
Position	Env. Engineer	Position	Chemical Engineer	Position	Chemical Engineer
Date	23/06/25	Date	23/06/25	Date	23/06/25

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Contents

1. Executive Summary

This report, prepared by RARE Environmental Pty Ltd and SciDev Pty Ltd for Alcoa, provides an analysis of turbidity data collected from Water Quality Monitoring Systems (WQMSs) deployed at the Willowdale bauxite mining operations during April 2025. The primary objective of this analysis was to evaluate the quality of the data, identify potential "true" turbidity exceedance events, and support Alcoa's compliance reporting obligations under Schedule 1, Division 2, Clause 6 of the **Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023**.

The analysis focused on identifying and classifying turbidity events where levels exceeded 25 nephelometric turbidity units (NTU) for at least one hour. Events were categorized as "true" or "false" based on Alcoa's **Turbidity Event Classification Guidelines**, which distinguish actual turbidity increases (true events) from false readings caused by environmental factors such as debris, air bubbles, or fluctuating water levels.

Key findings include:

- **True Events**: Zero "true" turbidity exceedance events were identified.
- **Further Investigation**: Zero events were flagged for further investigation.
- **False Events**: Zero 'false' events were identified, primarily attributed to factors such as debris accumulation, sensor obstructions, and water turbulence.
- **Excluded Units**: Two WQMS units were excluded from the analysis due to invalid data caused by equipment faults or environmental interference.

The report also highlights periods of missing data, which occurred due to system logoffs, equipment faults, or unplanned shutdowns. These gaps are detailed in the report to ensure transparency in data handling.

2. Scope

RARE Environmental Pty Ltd and SciDev Pty Ltd were engaged by Alcoa to analyse turbidity data collected from the Willowdale Water Quality Monitoring Systems (WQMSs). The primary objective of this engagement is to assess the quality of the collected data and identify potential "true" turbidity events. This analysis supports Alcoa's reporting obligations under *Schedule 1, Division 2, Clause 6 of the Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023*.

3. Introduction

3.1. Background

Alcoa of Australia Ltd (Alcoa) operates two bauxite mines, Huntly and Willowdale, approximately 100 km southeast of Perth, Western Australia. These mining operations are subject to environmental controls mandated by the *Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023*.

Under this Exemption Order, Alcoa is required to implement drainage control measures and monitor effectiveness in water bodies within and downstream of mining operations. Turbidity, a critical water quality parameter, is monitored using Water Quality Monitoring Systems (WQMSs), to detect deviations and identify high-turbidity events.

Alcoa is obligated to report monthly on-stream turbidity, including the identification and classification of any “true” high-turbidity exceedance events. (Refer to Appendix B for the site map showing WQMS locations.)

3.2. Monitoring requirements

Environmental Protection (Darling Range Bauxite Mining Proposal) Exemption Order 2023 specifies that a drainage incident occurs when:

> *a) runoff from a disturbance area enters the surrounding environment, resulting in surface water turbidity of at least 25 NTU for a duration of at least one hour; or*
>
> *b) a discharge from containment infrastructure includes, or April include, environmentally hazardous material.*

Trigger levels for drainage incidents are outlined in *Schedule 1* of the Exemption Order. To meet these requirements, Alcoa has developed "Turbidity Event Classification Guidelines" which define a true turbidity exceedance event as a WQMS recording turbidity levels of at least 25 NTU for a period exceeding one hour.

3.3. Water Quality Management Systems (WQMSs)

During the April 2025 monitoring period, 4 Turbidity units were deployed in section 6 areas to monitor turbidity levels in streams subject to surface water runoff within and downstream of Willowdale mining operations.

Each WQMS unit consists of the following components:

Aquas SMR10 Turbidity Probe

> Positioned at a 90-degree angle to water flow, each probe is equipped with an automatic lens wiper and a guard to protect against larger debris.

Data Taker DT82 Logger

> Records data locally every 6 seconds, with 6-minute averages transmitted via IoT-enabled modems to a cloud-based platform.

Float Switch

Detects whether the sensor is submerged, or the stream is dry.

3.4. Purpose

This report aims to analyse turbidity data collected during April 2025, focusing on the identification and classification of "true" turbidity exceedance events based on Alcoa's Turbidity Event Classification Guidelines.

3.5. Exclusions

This report is not intended as:

- An assessment of the WQMS network or Alcoa's compliance with relevant legislation and requirements.
- An evaluation of the suitability of the trigger levels or event classification procedures adopted by Alcoa.

3.6. Abbreviations

	Term
IoT	Internet of Things
NTU	Nephelometric Turbidity Units
WQMS	Water Quality Management System

4. Methodology

4.1. WQMS Locations

A site map showing the WQMSs locations is provided in Appendix B.

4.2. Data Review

Data recorded by the WQMS Units was reviewed and potential events where turbidity levels exceeded 25 NTU for at least one hour. Each potential event was categorised as either 'true 'or 'false'.

4.2.1. True Turbidity Exceedance Events

These events are caused by an actual increase in stream turbidity. Per Alcoa's "Turbidity Event Classification Guidelines" true exceedance events typically exhibit:

- A sharp, sudden incline in turbidity levels.
- A return to baseline turbidity levels in a pattern resembling a normal (Gaussian) distribution.

Figure 1 Typical 'true' exceedance event showing the sharp incline and gradual return to background levels.

4.2.2. False Turbidity Exceedance Events

These events are caused by factors unrelated to actual turbidity increase, such as:

- Organic debris (e.g., leaves, sticks, algae) obstructing the sensor
- Air bubbles or water turbulence near the sensor
- Fluctuating water levels intermittently covering and uncover the sensor lens.

False events typically exhibit sharp inclines and declines without the characteristic bell curve shape of true events.

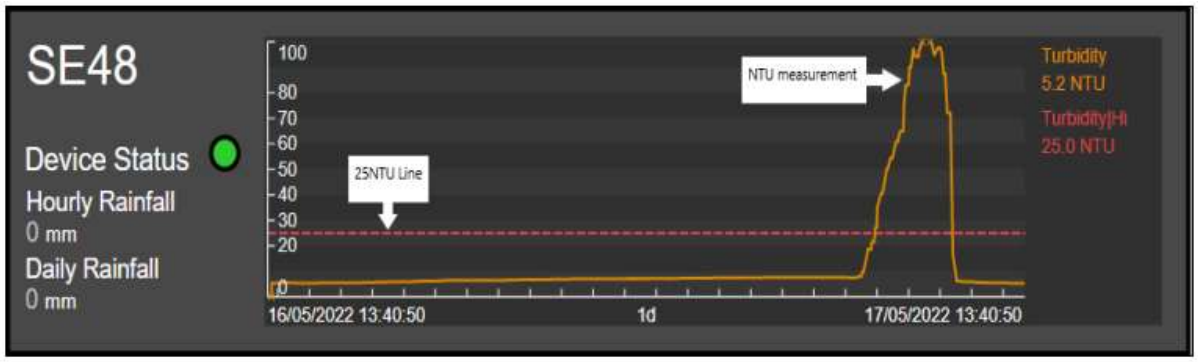


Figure 2 Typical 'false' exceedance event showing both a sharp incline and decline

4.2.3. Missing Data

Missing data occurs when a WQMS unit fails to record information, this can occur from unexpected system logoffs, equipment faults, or unplanned shutdowns.

5. Results and Discussion

5.1. Events

Table 1 provides a summary of identified events.

Table 1 Events Summary

Category	# of events
Flagged for further investigation	0
False	0

5.2. Additional Investigation

Zero events were identified for further investigation.

5.3. True Event(s)

Zero potential 'true' turbidity events were identified during the reporting period.

5.4. False Event(s)

Zero events were identified during the reporting period. Rationale on potential causes is summarised below.

5.5. Excluded WQMS Units

Two WQMS Units were excluded from analysis due to erroneous data. Alcoa confirmed the invalidity of data recorded from these units and provided commentary on the condition of each.

Table 2 Excluded WQMS Units

Unit	Dates	Comments
HV07	01/04/2025-30/04/2025	Stream dry, probe installed in a bucket of deionised water for protection
HV49T	01/04/2025-30/04/2025	Stream dry, probe installed in a bucket of deionised water for protection

5.6. Missing Data

Periods of missing data are detailed in Table 3.

Table 3 Missing Data Summary

Missing Data ID	Unit	Start	End	Comments
MD-2505-01	RHB2	01/04/2025	11/04/2025	Data gap from 01/04/2025 to 11/04/2025 due to probe connection.
MD-2505-02	RHB3	1/04/2025	08/04/2025	No data available between 01/04/2025 and 08/04/2025 due to stolen equipment.

6. Appendices

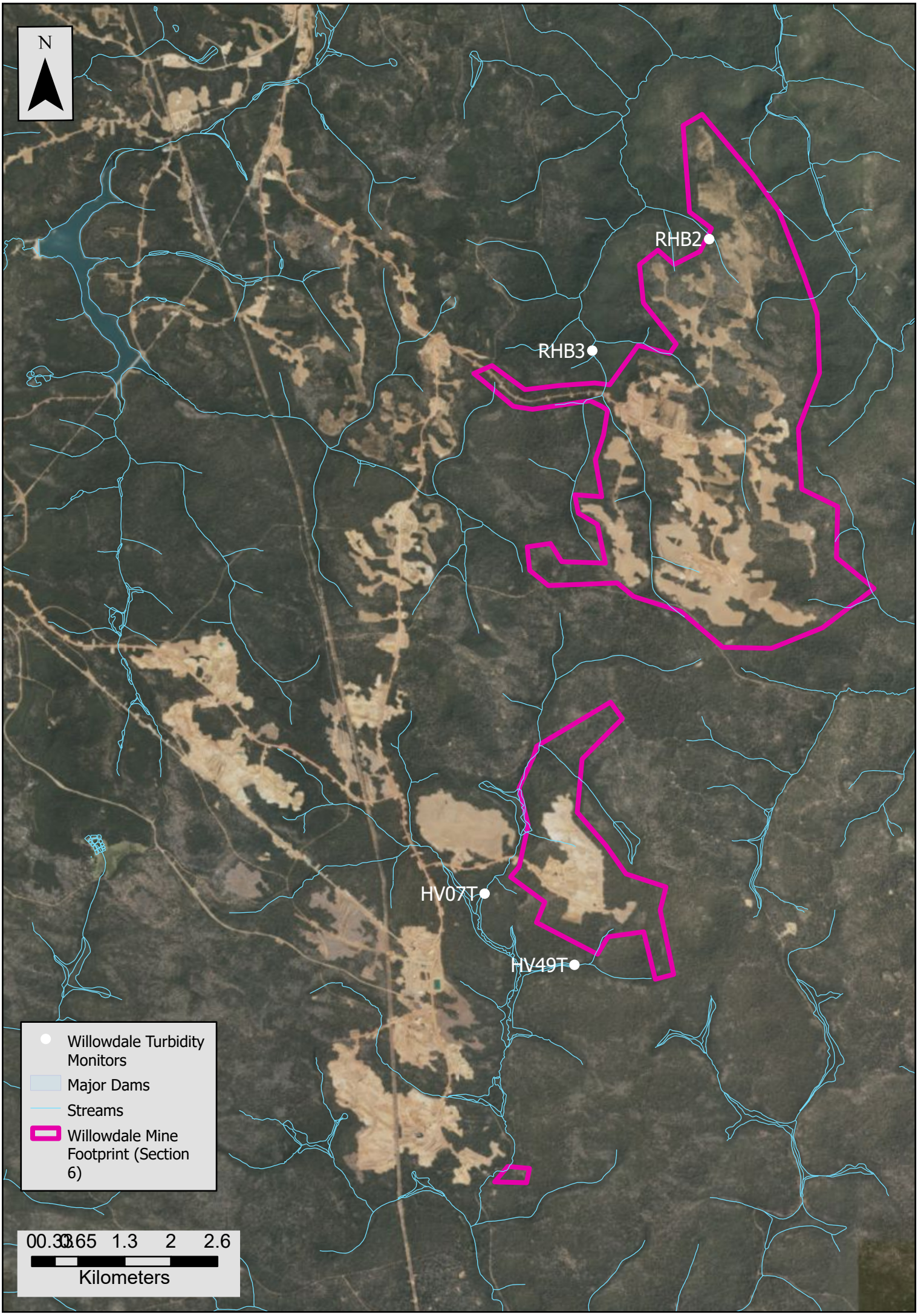
Appendix A. Willowdale Raw WQMS Data

Date	Willowdale WQMS Data - April 2025 - Events with turbidity > 25 NTU for an hour or more			
	HV07T	HV49T	RHB2	RHB3
1/03/2025				
2/03/2025				
3/03/2025				
4/03/2025				
5/03/2025				
6/03/2025				
7/03/2025				
8/03/2025				
9/03/2025				
10/03/2025				
11/03/2025				
12/03/2025				
13/03/2025				
14/03/2025				
15/03/2025				
16/03/2025				
17/03/2025				
18/03/2025				
19/03/2025				
20/03/2025				
21/03/2025				
22/03/2025				
23/03/2025				
24/03/2025				
25/03/2025				
26/03/2025				
27/03/2025				
28/03/2025				
29/03/2025				
30/03/2025				
31/03/2025				

Date	Willowdale WQMS Data - April 2025 – Daily Average Turbidity (NTU)			
	HV07T	HV49T	RHB2	RHB3
1/04/2025				
2/04/2025				
3/04/2025				
4/04/2025				
5/04/2025				
6/04/2025				
7/04/2025				
8/04/2025				0.64
9/04/2025				0.62
10/04/2025				0.65
11/04/2025			1.98	0.67
12/04/2025			3.30	0.74
13/04/2025			3.65	0.76
14/04/2025			3.69	0.77
15/04/2025			6.08	0.72
16/04/2025			4.28	0.77
17/04/2025			4.63	0.78
18/04/2025			4.45	0.72
19/04/2025			4.50	0.73
20/04/2025			4.73	0.74
21/04/2025			4.99	0.78
22/04/2025			4.93	0.77
23/04/2025			5.25	0.79
24/04/2025			5.70	0.75
25/04/2025			5.44	0.73
26/04/2025			7.22	0.72
27/04/2025			7.88	0.74
28/04/2025			6.49	0.72
29/04/2025			7.79	0.75
30/04/2025			5.98	0.76

* - Adjusted average with sensor fault data removed

Appendix B. Willowdale WQMS Locations


N
RHB2
RHB3
HV07T
HV49T
Willowdale Turbidity Monitors
Major Dams
Streams
Willowdale Mine Footprint (Section 6)
0 0.33 0.65 1.3 2 2.6
Kilometers

Appendix C. WQMS General Arrangement

ANTENNA

SOLAR PANEL

DATA TRANSMISSION TO IOT

DATA OUTLET

POWER INLET

40 X 60 MM CABLE DUCT

20 AMP MPPT
SOLAR CHARGER

40 X 60 MM CABLE DUCT

SIERRA WIRELESS FX30

40 X 60 MM CABLE DUCT

12 V, 120 AH LI-ION BATTERY

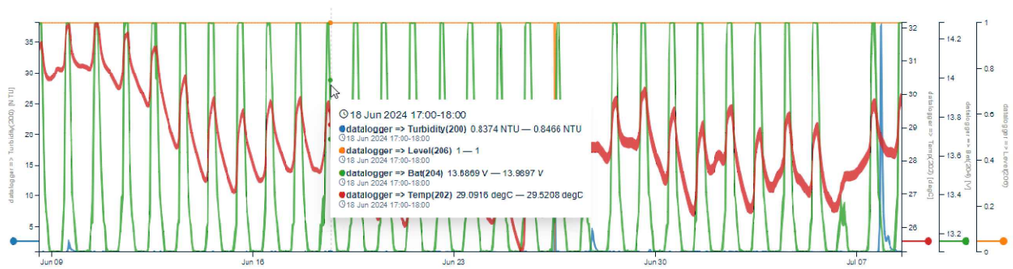
DATA INLET

SENSOR

STREAM DRY

SENSOR

STREAM FLOWING



REV.	REMARKS	DATE	DESIGNED	DRAWN	CHECKED	APPROVED	REFERENCE DRAWINGS
0	ISSUE FOR APPROVAL	05.07.2024	A.K.	S.A.	A.K.	A.K.	

ALL DIMENSIONS IN MILLIMETRES U.N.O.
LEVELS ARE IN METRES ON AHD U.N.O.
DO NOT SCALE DRAWING
IF IN DOUBT - ASK
TOLERANCES ISO2768-m U.N.O.

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TITLE
IOT TURBIDITY MONITORING STATION
SITE LAYOUT
GENERAL ARRANGEMENT

SHEET 1 OF 2

SCALE NTS OR AS SHOWN

DRAWING NO.
HI0090 - ALCOA WQMS

SHEET SIZE
A3

REV.
1