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CAPTAINS FLAT QUARTERLY SURFACE WATER MONITORING 2021 - 2022

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CAPTAINS FLAT QUARTERLY SURFACE WATER MONITORING 2021 - 2022
CAPTAINS FLAT, NSW

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Description **This report describes the methodology and factual results for quarterly surface water monitoring from June 2021 – April 2022 undertaken as part of the Captains Flat Lead Management Plan at Captains Flat, NSW.**

Revision	Date	Prepared by	Checked by	Approved by	Description
0	27/09/2022	Stephen Maxwell	Rowena Salmon	Fiona Robinson	Draft
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1. INTRODUCTION

Ramboll Australia Pty Ltd (Ramboll) was retained by the Department of Regional NSW (Regional NSW) to prepare the Captains Flat Lead Management Plan (LMP) to address exposure risks from lead within the environment and the community that relates to the legacy Lake George Mine. The LMP sets out a framework for management activities applicable to the landowners and land use scenarios that fall within Captains Flat. An infographic describing key elements of the LMP is presented as **Figure 1-1** below.

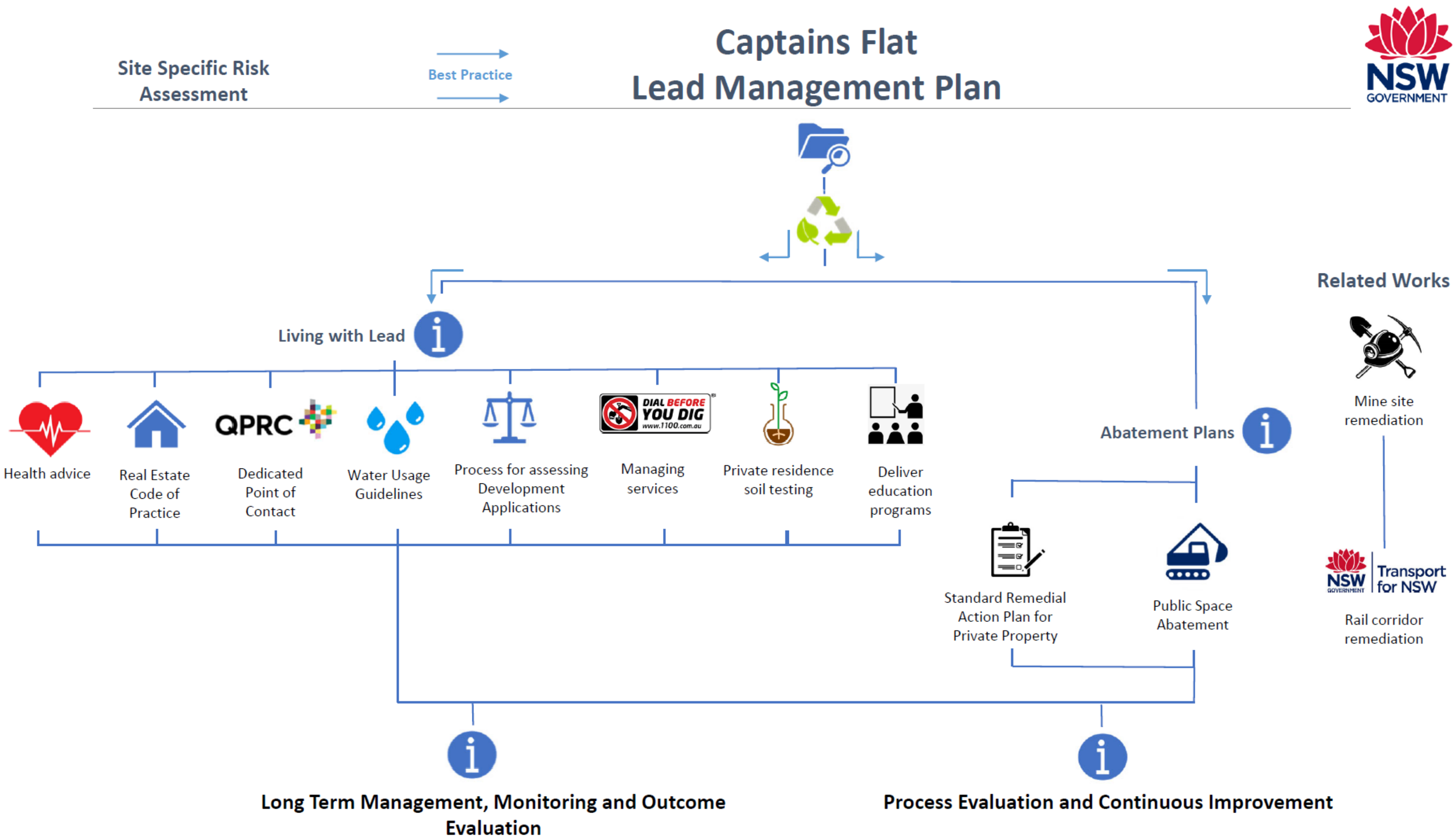

Figure 1-1: The Captains Flat Lead Management Plan

1.1 Background

The Captains Flat Lead Management Plan Precinct (the Precinct) encompasses built areas of the Captains Flat community, the legacy Lake George Mine site and the Molonglo River from upstream of the water supply reservoir to a waterhole approximately 1.5 km downstream of the mine. The Precinct includes roads accessing Captains Flat (to a distance of at least 400 m), the rail corridor (to a distance of 1 km) and bushland areas at the perimeters of the community where these may have been impacted by the mine operations.

A conceptual site model (CSM) for contaminants associated with historic mining in the Precinct was developed by The NSW Department of Planning, Industry and Environment (DPIE) Contaminants and Risks Team (C&R), Environment, Energy and Science Branch and refined by Ramboll through additional site assessment (Ramboll 2021). The refined CSM identified that the effects of meteorological variability in contaminant mobility via airborne, surface water and groundwater migration pathways remains as a data gap.

Previous literature on contamination into Molonglo River has been conducted by Norris (1986) and Chamani et al (2016) and notes impacts to sediment contributes to ongoing contamination of the Molonglo River. Sediment sampling results conducted by Ramboll (2021) reaffirms that impacted sediment is co-located with higher contaminant concentrations in surface water.

Previous surface water sampling was completed by GHD in August 2017 (GHD, 2018), the NSW EPA in August 2019 (EPA, 2019) and Ramboll in February 2021 (Ramboll, 2021). Data from these monitoring events is presented in **Appendix 4**.

1.2 Objective and Scope of Work

The objective of the surface water monitoring program was to collect reliable water quality data, on quarterly increments to inform consideration of the effects of meteorological variability at a seasonal scale.

The scope of work included quarterly surface water monitoring events in June 2021, October 2021, January 2022 and April 2022. Each event included:

- Measurement of surface water physico-chemical properties including pH, temperature, electrical conductivity (EC), dissolved oxygen (DO), redox potential and total dissolved solids (TDS)
- Collection of surface water samples into laboratory supplied sampling containers; and
- Laboratory analysis of all samples for total and dissolved metals (As, Cd, Cr, Cu, Fe, Pb, Mn, Mo, Ni, Se, Ti, Zn, Hg)
- Assessment of contaminant concentrations against criteria protective of human health and the environment

Sampling locations are presented in **Table 1-1** and **Figure 2**, **Appendix 1**. Wherever feasible, locations historically sampled were replicated to allow for limited assessment of long-term trends.

Table 1-1: Surface Water Monitoring Locations

Sample ID	Previous Sample ID*	Reference	Location
SW1	Swimming Hole	EPA (2019)	Swimming hole at northern end of the Precinct
SW2	Molonglo River Bridge	EPA (2019)	Molonglo River downstream of Copper Creek
SW3	SW04	GHD (2018)	Copper Creek confluence with Molonglo River
SW4	SW06	GHD (2018)	Captains Flat Road bridge
SW5	SW02 (mine leachate) and Sample site 6 Mine Leachate*	GHD (2018) and EPA (2019)	Main Adit Spring
SW6	SW05	Ramboll (2021)	Copper Creek downstream of rail corridor
SW7	SW04	Ramboll (2021)	Copper Creek upstream of rail corridor
SW8	SW02	Ramboll (2021)	Drainage line downstream of mine site sediment dams and rail corridor
SW9	SW01	Ramboll (2021)	Drainage line downstream of mine site sediment dams. Upstream of rail corridor
SW10	N/A	N/A	Forsters Creek Confluence
SW11	N/A	N/A	Upstream Forsters Creek confluence
SW12	N/A	N/A	Southern Tailings Dump seepage (north end)
SW13	SW08	GHD (2018)	Southern Tailings Dump seepage (east side)
SW14	CF001-W	GHD (2018)	Water supply reservoir
SW15	Sample Site 3: Upstream of reservoir	EPA (2019)	Upstream of water supply reservoir

*Ramboll's interpretation of location data provided by EPA (2019) and GHD (2018)

2. SAMPLING ANALYSIS AND QUALITY PLAN

Additional assessment to inform refinement of the CSM was completed in June 2021, November 2021, January 2022 and April 2022 in accordance with a Sampling and Analyses Quality Plan (SAQP) which includes the sampling methodology for surface water monitoring and has been implemented for this monitoring program (Ramboll 2021b).

A summary of the SAQP relevant to surface water monitoring is provided below and the SAQP report is attached as **Appendix 2**.

2.1 Data Quality Objectives

Specific Data Quality Objectives (DQOs) have been developed for the tasks to be completed for surface water monitoring. The DQO process is a systematic, seven step process that defines the criteria that the sampling should satisfy in accordance with the National Environment Protection Measure Schedule B2 (NEPC 2013).

The seven step DQO process has been completed for surface water monitoring as outlined in **Table 2-1**.

Table 2-1: Summary of Data Quality Objectives

DQO	Outcome
State the Problem	Historic metalliferous mining has contaminated Captains Flat. Previous assessments have characterised the degree and extent of contamination with sufficient detail to inform development of the Captains Flat Lead Management Plan. However previous assessments have had a limited temporal scale and an assessment of long-term surface water impacts are not well understood. Additionally, continued runoff and sedimentation into surface water within the Precinct may be an ongoing source of contamination through the pre-remediation to post-remediation period and it is important to establish a baseline for contaminant concentrations in surface water across an adequate range of meteorological variability to assist with long term environmental monitoring of the Lead Management Plan.
Identify the Decision	The goal of the study is to assess the degree and extent of metal contamination within the Precinct and to establish a baseline for contaminant concentrations in surface water across an adequate range of meteorological variability. Based on the decision-making process for assessing urban redevelopment sites, detailed in NEPM Schedule B2 (NEPC 2013), the following decisions must be made with respect to the targeted validation goals: • Is the data collected of sufficient quality to meet the project objectives? • Is the data reliable? • What are the potential risks to human health and the environment within the Precinct? • Is the cumulative dataset adequately representative of meteorological variability?
Identify Inputs to the Decision	Inputs to the decisions will be sourced from: • Review of historical surface water monitoring results • Physico-chemical properties collected for each of the 15 surface water sampling locations • Sampling of surface water and analysis for contaminants of concern • Analytical results for total and dissolved metals for each of the 15 sampling locations • Quality Assurance / Quality Control data review • Comparison of the above samples to the site acceptance criteria outlined in Section 4. • All sample analyses conducted using National Association of Testing Authorities (NATA) registered methods in accordance with ANZECC (1996) and NEPC (1999) guidelines • All samples appropriately preserved and handled in accordance with the sampling methodology • PQLs less that the adopted assessment criteria
Define the Study Boundaries	The spatial boundaries are shown on **Figure 1**, **Appendix 1**.

DQO	Outcome
	The vertical boundaries are limited to surface waters and the collection of samples is limited to the upper 0.2 m of the water column (i.e. no samples are collected in deeper stratified layers within dams, creeks or rivers). The temporal boundary includes historical surface water results as well as data collected under this report comprising quarterly monitoring events over the pre-remediation period.
Develop a Decision Rule	The decisions rules for this investigation are as follows: • If Tier 1 assessment of risk is not clear, then does Tier 2 / Tier 3 risk assessment define absence of unacceptable risk? • Are there any remaining data gaps?
Specify Limits on Decision Errors	The tolerable limits on decision errors are as follows: Probability that 95% of data will satisfy the DQIs, therefore a limit on decision error will be 5% that a conclusive statement may be incorrect: • A 5% probability of a false negative (i.e. assessing that the average concentration of contaminants of concern are less than the assessment criteria when they are not); and • A 5% probability of a false positive (i.e. assessing that the average concentration of contaminants of concern are more than the assessment criteria when they are not). The potential for significant errors will be minimised by: • Completion of QA/QC measures of the investigation data to assess if the data satisfies the DQIs. • Assessment of whether appropriate sampling and analytical densities were completed for the purposes of the investigation. • Ensuring that the criteria set for the investigation were appropriate for the land use. DQIs have been established to set acceptance limits on field and laboratory data collected as part of the investigation and are discussed in **Table 2-2.**
Optimise the Design for Obtaining Data	The overall design of the sampling plan considers migration of surface water within the Precinct.

2.2 Data Quality Indicators

DQIs have been established to set acceptance limits on field and laboratory data collected as part of the surface water program. The DQIs are outlined in **Table 2-2**.

Table 2-2: Summary of Data Quality Indicators

DQI	Field	Laboratory
Completeness – a measure of the amount of useable data from a data collection activity	All critical locations sampled. Experienced sampler. Documentation is correct and complete.	All critical samples analysed. All analysis completed according to standard operating procedures. Appropriate methods.
Comparability – the confidence that data may be considered to be equivalent for each sampling and analytical event	Experienced sampler. Same types of samples collected using approved sampling methods. Samples collected into laboratory supplied metals bottles.	Same analytical methods used. Same sample PQLs. Same NATA accredited laboratories used. Same units.
Representativeness – the confidence that data are representative of each medium present onsite.	Appropriate media sampled.	All samples analysed according to standard operating procedures.
Precision – a quantitative measure of the variability of the data.	Collection of intra-laboratory duplicates at a rate of 1 in 10 primary samples. Collection of inter-laboratory duplicate samples at a rate of 1 in 10 primary samples.	Analysis of field duplicate samples, relative percent difference (RPDs) to be $\leq$30%. Laboratory duplicates analysed, RPDs to be $\leq$ 30%.
Accuracy – a quantitative measure of the closeness of the reported data to the "true" value.	Sampling methodologies appropriate and complied with.	Analysis of: Method blanks. Matrix spikes. Surrogate spikes. Laboratory control samples. Results for blank samples to be non-detect. Results for spike samples to be between 70% and 130%.
Sensitivity - is a measure of the suitability of the laboratory results against the adopted assessment criteria.	Collection of sufficient sample volume.	Appropriate Practical Quantitation Limits (PQLs). Appropriate units.

3. QUALITY ASSURANCE / QUALITY CONTROL

A quality assurance/quality control (QA/QC) assessment was completed for the field investigations undertaken during the four surface water sampling periods in June 2021, November 2021, January 2022 and April 2022 and is presented in **Table 3-1**.

Table 3-1: Sampling and Analysis Methodology Assessment

Sampling Methodology	Assessment
Sampling Locations	Samples were collected from 15 designated sampling locations as presented in **Table 1-1** and **Figure 1**, **Appendix 1** during each monitoring event in June 2021, November 2021, January 2022 and April 2022. Sampling includes locations upstream and downstream of identified contaminant source areas within the Precinct.
Sampling Rate	QA/QC for a total of four monitoring rounds is considered within this report, including the surface water sampling undertaken on 3rd June 2021, 1st November 2021, 23rd January 2022 and 12th April 2022.
Sampling Density	The 15 sampling locations include creeks, rivers, dams and springs from within the Precinct and include locations upstream and downstream of potential contaminant sources. The sampling density of surface water is considered adequate to assess the concentrations of heavy metals present in surface water bodies in and nearby the Precinct.
Sample Depths	Surface water samples were collected from a minimum depth of 0.1 m below the water surface where feasible. Sampling consistently occurred at less than 0.1 m at SW5, SW8, SW9, SW12 and SW13 as water was shallow at these locations. Samples collected from less than 0.1 m may have resulted in conservatively high metal concentrations from surface debris or disturbance of sediment A sampling arm was used where appropriate, and every effort was made to avoid disturbing sediments.
Field Records	Each sample was labelled with a unique identification or sample ID, as presented in **Table 1-1**. Surface water parameters including pH, temperature, EC, dissolved oxygen and redox potential were measured and recorded for each of the sampling locations using a calibrated multi-parameter water quality meter. Measurements of field parameters were recorded once parameters had stabilized.
Sample Collection Method	All samples were collected by personnel trained and experienced in the collection of water samples for analysis, using standard industry techniques for sample collection. Samples were collected using an extendable sampling arm from 100 mm below the surface where practical, using dedicated disposable equipment (i.e., unpreserved laboratory bottles) that were discarded after use. Samples were collected into laboratory provided sampling containers (dosed with the correct preservative), with field filtration for dissolved metal(loid)s (0.45 µm). Samples were transported to the laboratory in chilled coolers under chain of custody documentation to the laboratory for analysis of total and dissolved metals (Al, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, Zn).
Decontamination Procedures	Samples were collected directly into sampling containers using dedicated disposable sampling equipment. Field parameters were recorded after analytical samples had been collected. Non disposable sampling equipment i.e., water quality meter and sampling arm, were rinsed between sampling locations with a solution of Decon®90 and potable water.
Sample Storage	Samples were stored in an ice filled cooler in the field and during transit to the laboratory.

Sampling Methodology	Assessment
Chain of Custody	Samples were submitted to the laboratory under chain of custody conditions.
Calibration of Field Equipment	A rental water quality meter was used for the purposes of the sampling event. The water quality meter was calibrated prior to lease and the calibration certificates are provided in **Appendix 3**.

Table 3-2: Field and Laboratory QA/QC

Sampling Methodology	Assessment
Field Quality Control Samples	Intra-laboratory duplicate samples were collected at a rate of 6.67%. Inter-laboratory duplicate samples were collected at a rate of 6.67%.
Field Quality Control Results	Intra-laboratory and inter-laboratory duplicate results are presented in **Table T3**, **Appendix 4**. A total of nine Relative Percentage Differences (RPDs) outside the acceptance limits were identified across the four rounds of monitoring including: • SW5 / QA35 RPD for dissolved selenium 40.0 % • SW5 / QA35 RPD for total chromium 191.3 % • SW5 / QA35 RPD for dissolved copper 40.0 % • SW5 / QA35 RPD for total nickel 181.5 % • SW5 / QA35 RPD for dissolved nickel 180.4 % • SW5 / QA35 RPD for total selenium 138.5 % • SW8 / T01_20211101 RPD for total aluminium 51.6 % • SW8 / T01_20211101 RPD for total iron 44.6 % • SW5 / QC01 RPD for total selenium 100.0 % • SW15 / D01 RPD for total iron 39.1% • SW15 / D01 RPD for total lead 66.7% • SW15 / D01 RPD for total zinc 88.4% • SW15 / D01 RPD for dissolved zinc 56.0% The exceedances in the RPD criteria are minor and associated with levels close to the limit of reporting. As a conservative measure and where applicable, the higher concentration has been used in the assessment of the analytical results. These minor discrepancies are not considered to affect the reliability of the data. Metals were detected in the rinsate sample for total and dissolved zinc (November 2021 rinsate sample R01_20211101) and total chromium (April 2022 rinsate sample) out of a total of 26 analytes. Results were close to the limit of reporting and considered to be acceptable. Spike and blank samples were not analysed.
NATA Registered Laboratory and NATA Endorsed Methods	Eurofins was the primary analytical laboratory, and the laboratory certificates are NATA stamped.
Analytical Methods	A summary of analytical methods was included in the laboratory certificates.
Holding Times	Review of the CoC and laboratory certificates indicate that holding times were met.
Practical Quantitation Limit (PQL)	PQLs for all analytes were below the adopted guideline values.
Laboratory Quality Control Samples	Laboratory quality control testing was undertaken at appropriate frequencies.
Laboratory Quality Control Results	The results are contained within the laboratory certificates attached in **Appendix 5**.

Ramboll makes the following conclusion regarding the DQIs:

- Completeness: All proposed samples were collected (where water was present).
- Comparability: The data collected is considered comparable because the sampling, analysis and quality control methods and sampling locations were the same between sampling rounds.
- Representativeness: The sampling of surface water bodies within the Precinct in upgradient and downgradient locations is considered to provide data that is suitable for the assessment of contamination in the Precinct.
- Precision: In the field, precision was achieved by using standard operating procedures for the collection of surface water samples and by collecting duplicate samples for analysis.
- Accuracy: In the field, accuracy was achieved by using standard operation procedures for the collection of surface water samples. Laboratory quality control results indicate accuracy was achieved at the laboratory.

In general, the DQIs outlined above have been met and Ramboll considers that the data is of suitable quality to meet the project objectives.

4. ASSESSMENT CRITERIA

The receptors that may be exposed to mine discharges, seepages, surface runoff and waters within Copper Creek and Molonglo River may potentially include humans, ecology (aquatic and terrestrial), plants (via irrigation and direct absorption from surface water) and livestock.

The tier 1 assessment criteria adopted for different receptor groups are shown in **Table 4-1**. Note that:

- Australian Drinking Water Guidelines (ADWG) Section 6.3.1 (2011) states that guideline values refer to the total amount of the substance present, regardless of its form (e.g. in solution or attached to suspended matter) and so analytical results from unfiltered samples should be assessed against human health criteria. Similar reasoning is also applicable to irrigation and livestock guideline values. Irrigation and livestock guidelines have been applied to total concentration analyses for surface water.

- ANZG (2018) guidelines for metals in freshwater states that the major toxic effect of metals comes from the dissolved fraction, so it is valid to filter samples (e.g. to 0.45 µm) and compare the filtered concentration against the respective guideline values.

Table 4-1: Surface Water Assessment Criteria (mg/L)

Total Metals	**Assessment Criteria – ADWG or (USEPA RSL)**	**Assessment Criteria - Recreation**	**Assessment Criteria - Irrigation**	**Assessment Criteria – Stock Water**	**Assessment Criteria – ANZG (2018) 95% Protection - Freshwater**
Total or dissolved Criteria	**Total**	**Total**	**Total**	**Total**	**Dissolved**
Aluminium	20	200	5	20	0.055[a]
Arsenic	0.01	0.1	0.5	2	0.024[b]
Barium	2	20	-	-	-
Cadmium	0.002	0.06	0.01	0.05	0.0002
Chromium	0.05	0.5	1	1	0.001[c]
Cobalt	0.006	0.03	1	0.1	0.09
Copper	2	20	0.5	0.1	0.014
Iron	(1.4)	119	-	10	0.3
Lead	0.01	0.2	0.1	5	0.0034
Manganese	0.5	12	10	2.5	1.9
Mercury	0.001	0.01	0.002	0.002	0.00006[d, e]
Molybdenum	0.05	-	-	-	0.034
Nickel	0.02	0.2	1	2	0.011
Selenium	0.01	-	-	-	0.011
Titanium	-	-	-	-	-
Zinc	(0.6)	26	20	5	0.008

blank cell denoted with – indicates no criterion available.

** Values based on site-specific exposures will be used in final assessment*

**** Recreational exposure guidelines values for Cd, Co, Pb, Mn and Zn were estimated based on water intake from estimated frequency of exposure. This is based on an approach applied by the National Health and Medical Research Council Guidance on Per and Polyfluoroalkyl substances (PFAS) in Recreational Water (2019)*

[a] Aluminium guidelines for pH > 6.5 and pH <6.5 based on variable (acidic-neutral-alkaline) pH measured previously in various surface waters, seeps and runoffs.

[b] Guideline value for total arsenic.

[c] Guideline value for chromium (VI).

[d] Guideline value for inorganic mercury.

[e] 99% species protection level default guideline value (DGV) has been adopted to account for the bioaccumulating nature of this contaminant.

The primary human health risk from contaminants in surface water at Captains Flat is via recreational use. Assessment criteria protective of human health during recreational exposure were primarily derived from ADWG; however, US EPA RSLs for tap water were adopted for analytes where no ADWG was available. The National Health and Medical Research Council (NHMRC) (2008) suggests that 10-times the ADWG values may provide a conservative estimate of acceptable recreational exposure guidelines values. This approach was applied to all metals analysed except Cd, Co, Pb, Mn and Zn and is based on the assumption that recreational activities contribute to 10% of drinking water consumption, which is equivalent to a daily lifetime consumption of about 0.2 L of water.

NHMRC (2019) provides an approach for estimating recreational exposure guidelines values based on water intake from estimated frequency of exposure. The NHMRC (2019) approach has been used to calculate recreational exposure guideline values based on estimated exposure frequencies or events for Cd, Co, Pb, Mn and Zn. The applied exposure frequency to derive the site-specific guideline values was based on the water usage survey and included an assumption of up to 150 days/year of recreational activities at surface water within the Precinct.

5. RESULTS

5.1 Monitoring Events

A total of four monitoring events have been completed in June 2021, November 2021, January 2022 and April 2022.

Table 5-1 includes information on rainfall conditions precedent to each monitoring event, including the five-day (120 hours) rainfall preceding the day of the surface water sampling event. Average monthly rainfall data compared to actual monthly rainfall data during the month of surface water sampling in June 2021, November 2021, January 2022 and April 2022 is also included to indicate the general climate conditions during the month of sampling.

A photographic log is presented as **Appendix 6**.

Table 5-1: Indicative Summary of Rainfall Preceding Sampling Events

	Monitoring Events						
	8-9-Aug-2017 (GHD)	26-Aug-2019 (EPA)	10-Feb-21 (Ramboll)	3-Jun-21 (Ramboll)	1-Nov-21 (Ramboll)	24-Jan-22 (Ramboll)	13-Apr-22 (Ramboll)
5-day (120 hour) Preceding Rainfall (mm) not including day of sampling	23.2	0.0	13.0	0.6	1.0	0.0	37.4
Monthly Rainfall Observed (mm)	47.4 (August)	3.0 (August)	76.2 (February)	78.8 (May)	99.0 (October)	138.0 (January)	123.8 (April)
Average Monthly Rainfall (mm)	61.5	61.5	61.8	54.2	67.8	69.4	54.9
Comment	Slightly below average rainfall month, wet conditions prior to monitoring event.	Substantially below average rainfall month, dry conditions prior to monitoring event.	Slightly above average rainfall month, wet conditions prior to monitoring event.	Above average rainfall month, wet conditions prior to monitoring event.	Above average rainfall month, relatively dry conditions prior to monitoring event.	Above average rainfall month, slightly wet conditions prior to monitoring event.	Above average rainfall month, wet conditions prior to monitoring event.

Notes: All rainfall data was sourced from the Australian Bureau of Meteorology. Daily rainfall was sourced from the closest weather station with rainfall records preceding each monitoring event (Captains Flat Station - Foxlow Street; Bureau of Meteorology station number 70016).

**Monthly observations and averages are for rainfall in the calendar month preceding the monitoring event unless it falls at the end of the month in which case the current months would be used. Based on this the monthly data is not a direct representation of rainfall preceding monitoring, although it is considered as an indicator of general conditions around each monitoring event.*

Average monthly rainfall is based on a 25-year data set and incorporating effects of longer weather cycles such as El Nino and La Nina.

AEP – Annual Exceedance Probability

Rainfall measured in the month of all quarterly monitoring events in 2021/22 was above average and wet conditions were encountered in three of the four monitoring events (June 2021, January 2022 and April 2022). In contrast, the historical monitoring events undertaken by Ramboll (2021), NSW EPA (2019) and GHD (2018) were slightly above, substantially below and slightly below the average monthly rainfall occurring at Captains Flat, respectively. Therefore, the quarterly surface water monitoring data by Ramboll in 2021/22 and the surface data monitoring undertaken by Ramboll in February 2021 is likely to be representative of contaminant concentrations that could be expected during periods of high rainfall and comparatively high river flow rates. In contrast, the drier conditions during the EPA (2019) surface water monitoring may be more representative of dry conditions when river flow rates are lower and the potential accumulation of contaminants in surface water may be higher during these dry periods.

5.1.1 Physico-Chemical Results

Surface water physico-chemical parameters were measured in the field during the sampling rounds. The surface water parameters are summarised in **Table 5-2**. The full physico-chemical parameter dataset is provided as **Table T2** of **Appendix 4**.

Table 5-2 Surface Water Physico-chemical Parameters (Field Results)

Sample Location ID	No. of Events	Statistics	Temp (°C)	pH (pH units)	Conductivity (mS/cm)	DO (mg/L)	ORP (mV)
SW1	4	Minimum	7.5	7.06	93.6	7.9	21.0
		Maximum	18.9	7.70	180.4	10.4	199.1
		Average	14.6	-	132.5	9.4	114.7
SW2	4	Minimum	7.6	5.39	90.9	7.33	-20.4
		Maximum	18.5	7.26	192.5	10.51	143.4
		Average	14.1	-	134.8	9.04	52.0
SW3	4	Minimum	8.2	6.38	90.8	8.8	-21.0
		Maximum	18.5	6.90	277.5	9.8	147.6
		Average	14.2	-	156.7	9.2	91.5
SW4	4	Minimum	7.7	6.33	87.6	7.64	-76.0
		Maximum	18.3	6.96	173.3	9.43	162.1
		Average	13.9	-	125.2	8.95	26.5
SW5	4	Minimum	14.2	3.56	2.7	7.37	159.4
		Maximum	18.9	3.71	3049	8.36	377.4
		Average	16.7	-	2086.2	7.72	293.4
SW6	4	Minimum	7.3	6.83	150.3	6.64	-58.8
		Maximum	18.8	7.38	208.6	10.77	161.2
		Average	14.0	-	178.3	8.52	85.8
SW7	4	Minimum	7.3	6.46	135.3	0.44	-24.3
		Maximum	19.2	7.33	170.8	10.64	162.9
		Average	14.2	-	149.9	7.38	73.2
SW8	4	Minimum	8.1	3.74	741	2.74	-56.0
		Maximum	19.1	6.18	1174	9.75	435.0
		Average	15.4	-	955.8	5.42	149.7
SW9	4	Minimum	8.4	2.83	681	5.91	256.6

Sample Location ID	No. of Events	Statistics	Temp (°C)	pH (pH units)	Conductivity (mS/cm)	DO (mg/L)	ORP (mV)
		Maximum	20.3	3.45	1251	9.73	451.3
		Average	15.2	-	941	7.12	366.9
SW10	4	Minimum	8.1	4.49	81.6	8.32	14.9
		Maximum	16.9	6.29	481.9	10.20	470.2
		Average	12.7	-	234.4	8.87	249.0
SW11	4	Minimum	8.3	3.24	67.8	6.35	150.4
		Maximum	16.7	6.69	662.0	9.66	449.0
		Average	13.3	-	240.5	8.40	313.2
SW12	4	Minimum	9	2.38	2618	4.19	448.9
		Maximum	26.1	2.92	7946	9.73	526.4
		Average	15.9	-	5159	6.74	490.5
SW13	4	Minimum	7.9	5.16	143.3	7.74	-60.6
		Maximum	21.5	8.22	177.7	10.14	361.5
		Average	14.9	-	159.2	9.15	195.4
SW14	4	Minimum	8.3	7.03	57.5	6.61	-66.2
		Maximum	21.0	7.64	69.1	7.87	270.3
		Average	15.4	-	62.9	7.17	128.6
SW15	4	Minimum	8.6	6.56	58.3	6.51	-52.9
		Maximum	20.9	7.92	70.3	7.66	307.6
		Average	15.7	-	63.8	6.92	129.3

SPC – Specific Conductivity
DO – Dissolved Oxygen
ORP – Oxidation-Reduction Potential
TDS – Total Dissolved Solids
pH is based on a logarithmic scale and therefore arithmetic averages were not calculated for pH.

5.1.2 Analytical Results

An assessment of April 2022 analytical data against adopted criteria protective of recreational use and ecology is summarised in **Table 5-3** below as an indicator of current potential risks. A complete assessment of analytical results for the four quarterly sampling events in 2021/2022 are presented in **Table T1** in **Appendix 4**.

Table 5-3: Summary of Surface Water Analytical Results within the Precinct for April 2022 Monitoring Round (mg/L)

Analyte	No. of Samples	No. of Detects	Min.	Max	Avg	No. above Tier 1 criteria: Health-based Screening Criteria (Recreational Waters)	No. above Tier 1 criteria: Eco Screening Criteria (ANZG 95% Protection) Fresh Water
Aluminium	15	15	0.2	48.0	5.5	0	-
Arsenic	15	12	<LOR	0.023	0.004	0	-
Barium	15	4	<LOR	0.060	0.038	0	-
Cadmium	15	13	<LOR	0.120	0.027	3	-
Chromium	15	7	<LOR	0.009	0.003	0	-
Cobalt	15	13	0.001	0.300	0.036	3	-
Copper	15	15	0.002	1.100	0.2	0	-
Iron	15	15	0.960	260.0	29.6	2	-
Lead	15	15	0.002	1.2	0.2	3	-
Manganese	15	15	0.026	27.0	2.9	2	-
Mercury	15	0	<LOR	<LOR	-	0	-
Molybdenum	15	0	<LOR	<LOR	-	0	-
Nickel	15	15	0.002	0.120	0.017	0	-
Selenium	15	5	<LOR	0.029	0.010	0	-
Titanium	15	4	<LOR	0.010	0.007	0	-
Zinc	15	15	0.031	130.0	23.3	4	-
Aluminium (filtered)	15	15	0.1	56.0	5.8	-	15
Arsenic (filtered)	15	5	<LOR	0.008	0.004	-	0
Barium (filtered)	15	2	<LOR	0.060	0.055	-	0
Cadmium (filtered)	15	12	0.0	0.130	0.032	-	12
Chromium (filtered)	15	5	<LOR	0.011	0.003	-	4
Cobalt (filtered)	15	11	<LOR	0.38	0.05	-	2
Copper (filtered)	15	15	0.002	1.100	0.225	-	14
Iron (filtered)	15	15	0.520	320.0	32.6	-	15
Lead (filtered)	15	14	<LOR	1.3	0.2	-	11
Manganese (filtered)	15	15	0.010	33.0	3.3	-	4
Mercury (filtered)	15	15	<LOR	<LOR	-	-	15
Molybdenum (filtered)	15	0	<LOR	<LOR	-	-	0
Nickel (filtered)	15	15	0.002	0.150	0.020	-	5
Selenium (filtered)	15	5	<LOR	0.035	0.010	-	0
Titanium (filtered)	15	4	<LOR	0.064	0.029	-	0
Zinc (filtered)	15	15	0.016	160.0	26.6	-	15

The final surface water assessment occurred in April 2022 during a seasonally cool and substantially above average wet period. Contaminant concentrations in surface water could be expected to vary in response to variable meteorological conditions. The surface water data presented in this report is considered an indicator of contaminant impacts within publicly accessible surface water bodies within the Precinct.

Exceedances to the health-based recreational criteria were observed in surface water samples for cadmium, cobalt, iron, lead, manganese and zinc.

Exceedances to the ecological criteria were observed in surface water samples for aluminium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel and zinc.

Contaminant concentrations in surface water were observed to be highest in discharge from the Main Adit Spring (SW5), overflow from mine dams flowing through the southern end of the rail corridor (SW8 and SW9) and to a lesser extent in leachate drainage from the Southern Tailings Dump (SW12).

5.2 Temporal Trends in Analytical Results (Quarterly Sampling 2021/22)

An assessment of concentration trends of concentrations of total metals that exceeded the health-based criteria was undertaken to compare concentrations over time of key contaminants of concern within the Precinct during the 2021/22 monitoring period. Lead is the main driver of risk to human health within the Precinct and a therefore a comparison of total lead against human health criteria was undertaken separately.

5.2.1 Lead

Figure 5.1 describes total lead concentrations in surface water within the Precinct in upstream and downstream locations during the 2021/22 four quarterly sampling rounds undertaken by Ramboll. The data are shown relative to the adopted recreational criteria. Rainfall is presented across the same period.

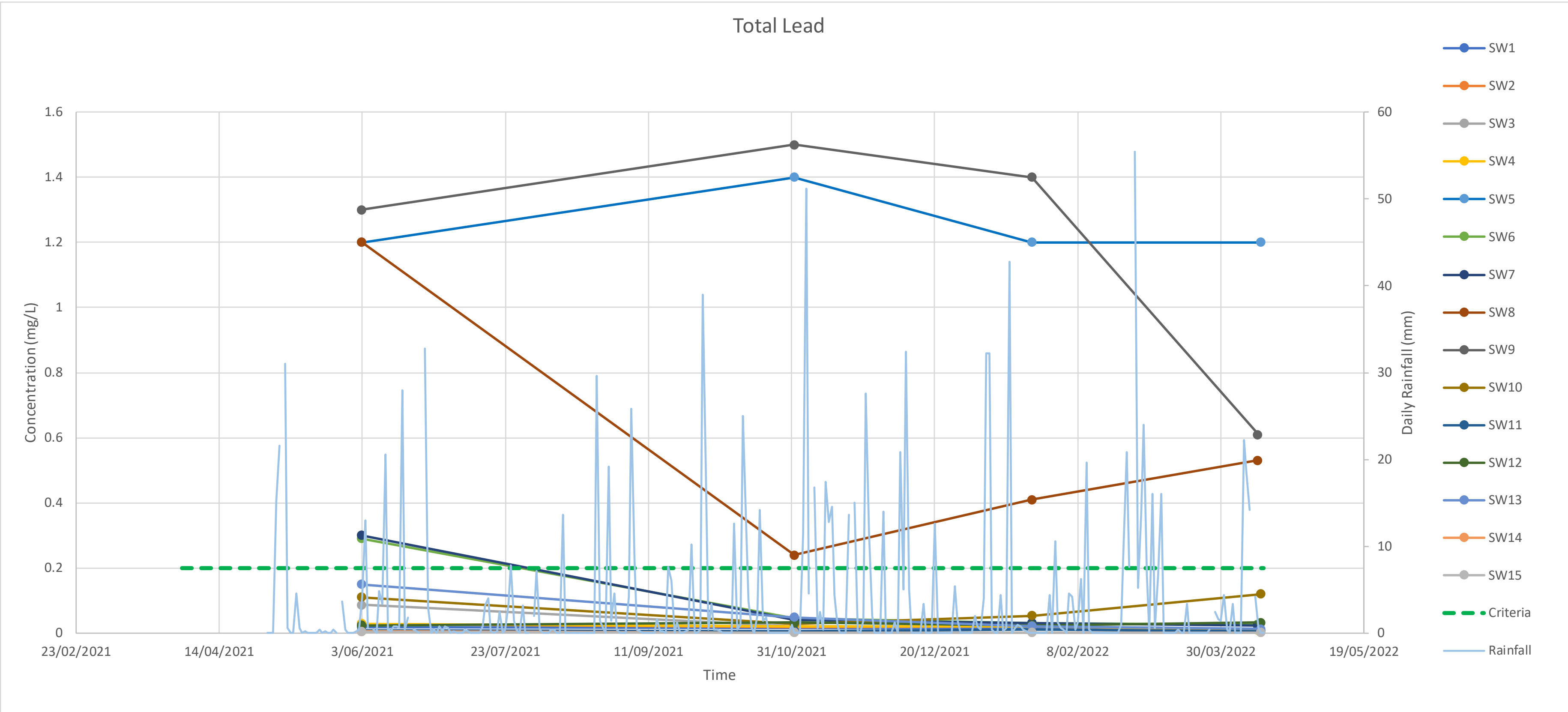

Figure 5.1: Total Lead Concentration Trend Across the Precinct

Concentrations of lead exceeded the recreational criteria at three locations (SW5, SW8 and SW9) in all four monitoring rounds in 2021/22. All other locations showed lower and relatively stable lead concentrations during the four monitoring rounds in 2021/22, with concentrations of total lead at these other locations below the recreational criteria, except for the concentration of lead at SW6 and SW7 in June 2021 (0. 29 mg/L and 0.3 mg/L), which subsequently decreased to below the recreational criteria during the monitoring events in November 2021, January 2022 and April 2022.

5.2.2 Other Heavy Metals

Figures 5.2-5.7 describes total heavy metal concentrations that exceed the adopted health-based recreational criteria (Al, Cd, Co, Mn, Ni, Zn) in surface water within the Precinct in upstream and downstream locations during the four 2021/22 monitoring rounds. The data are shown relative to the adopted recreational criteria. Rainfall is presented across the same period.

5.2.2.1 Aluminium

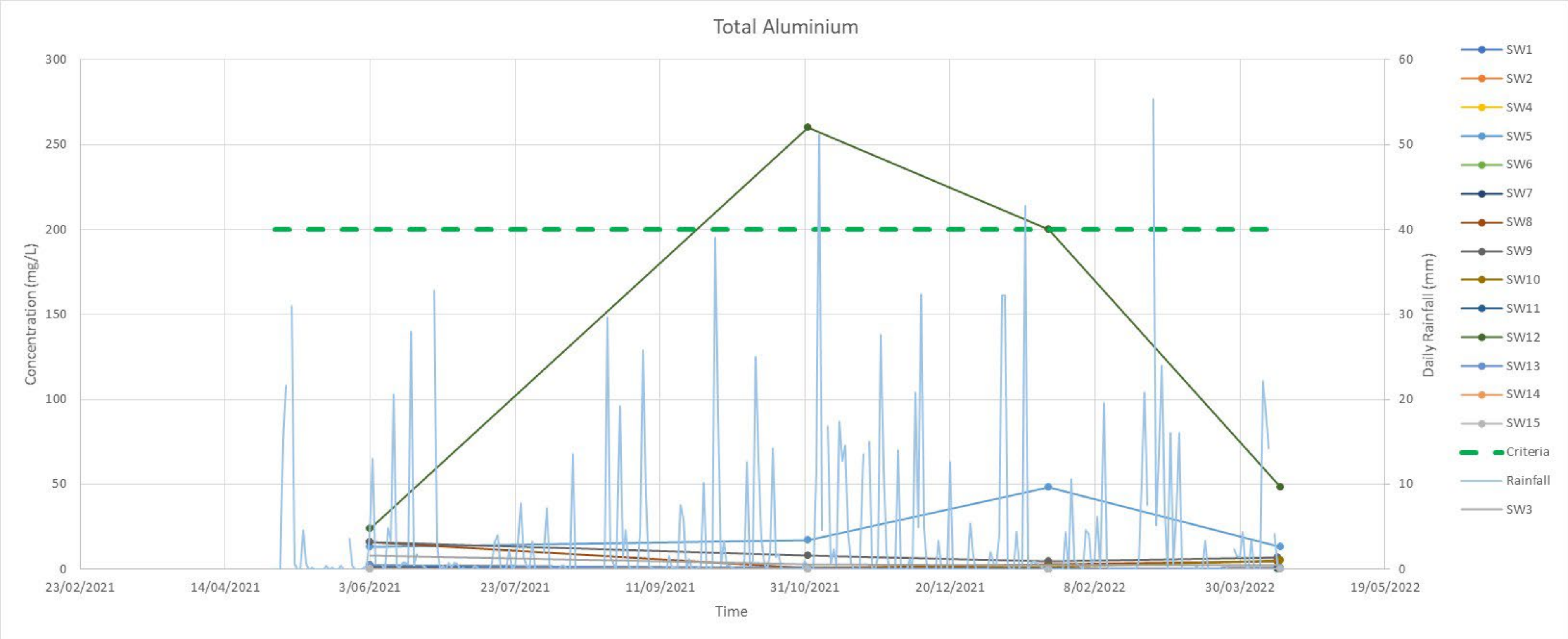

Figure 5.2: Total Aluminium Concentration Trend

5.2.2.2 Cadmium

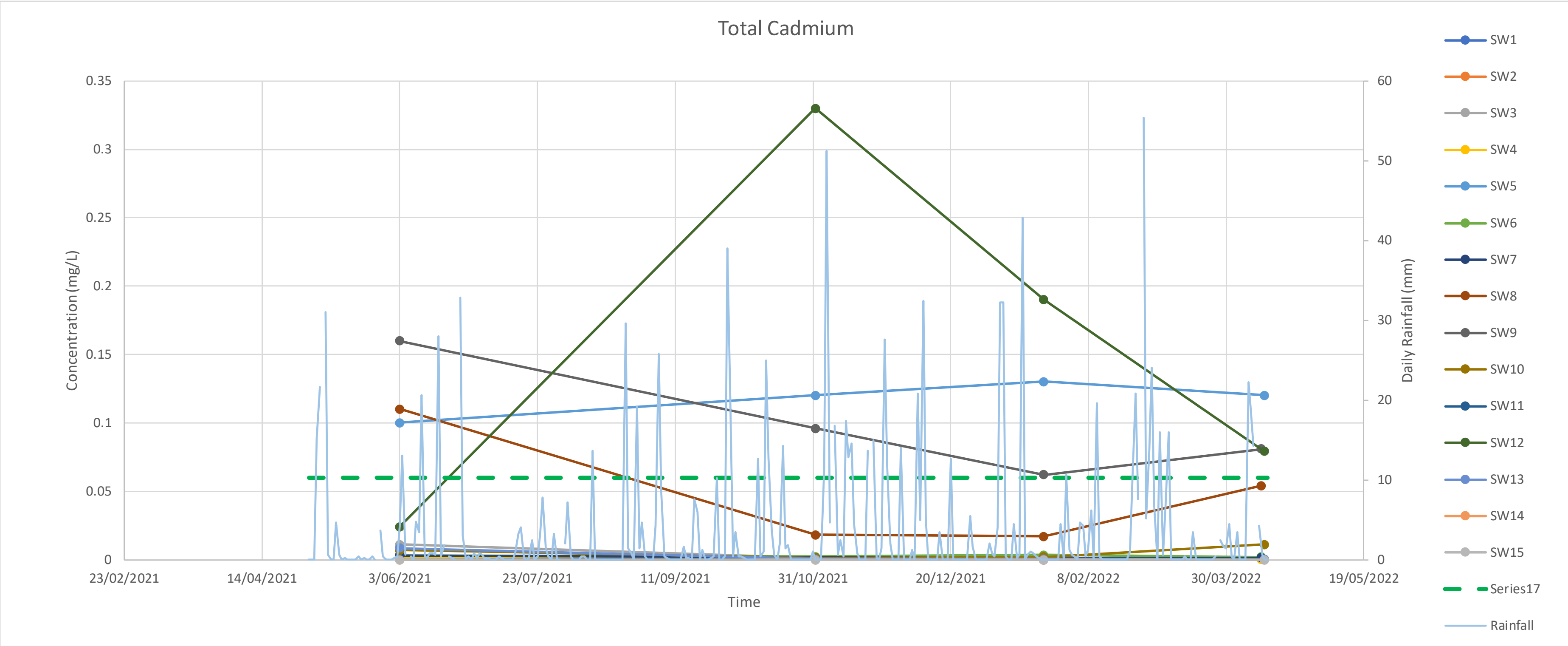

Figure 5.3: Total Cadmium Concentration Trend

5.2.2.3 Cobalt

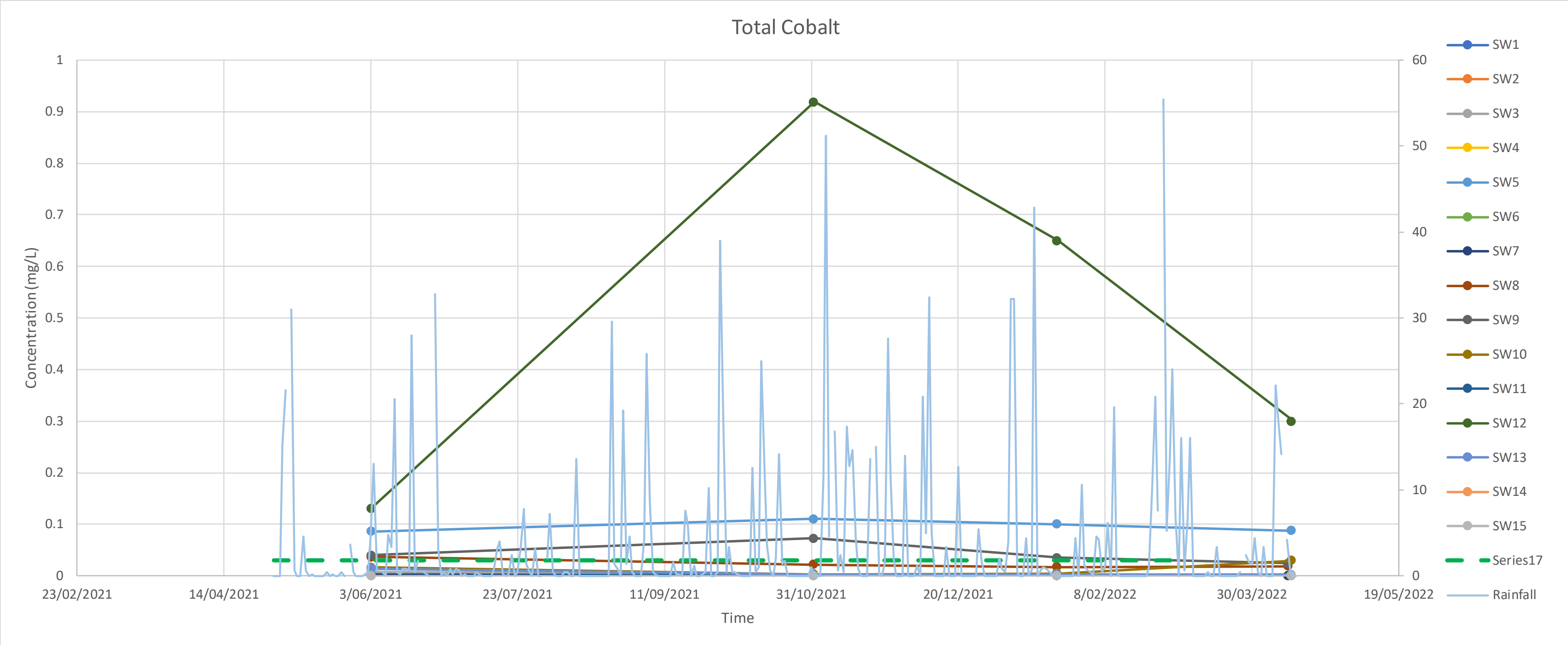

Figure 5.4: Total Cobalt Concentration Trend

5.2.2.4 Manganese

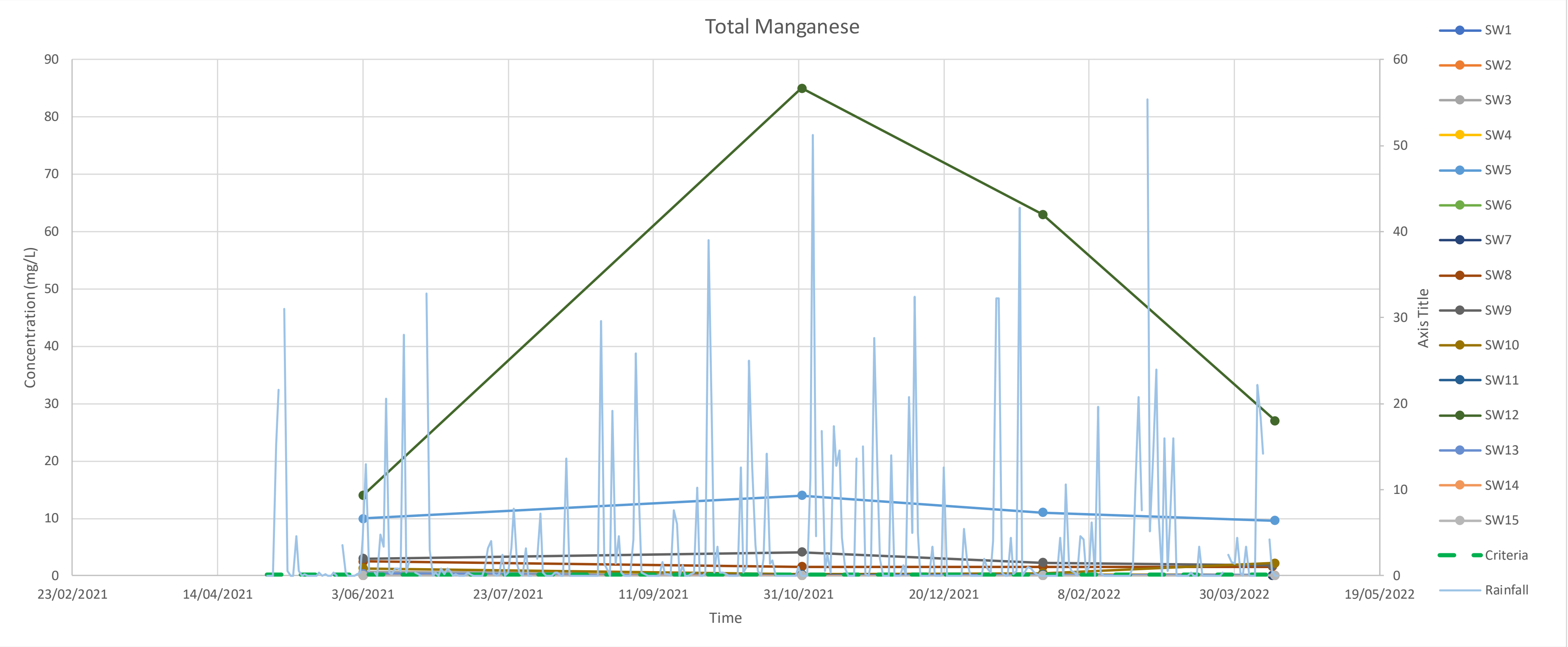

Figure 5.5: Total Manganese Concentration Trend

5.2.2.5 Nickel

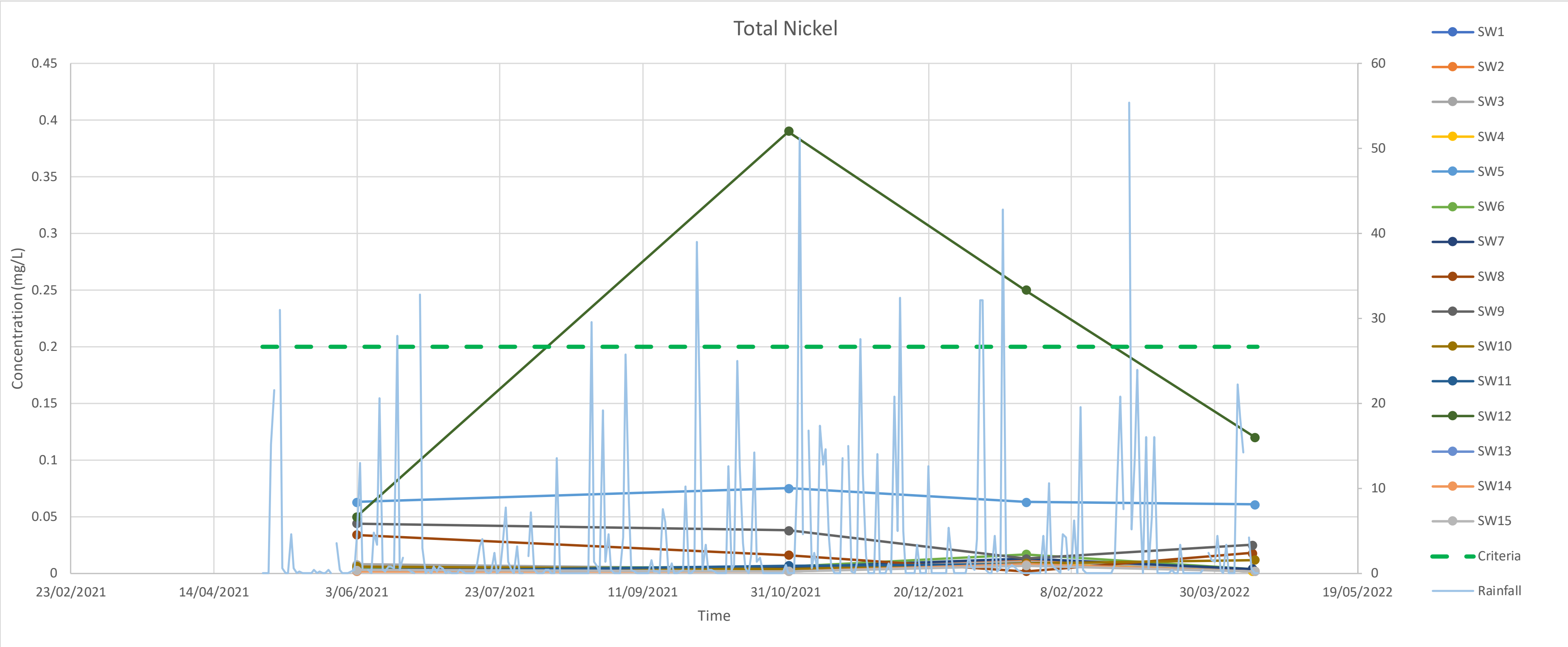

Figure 5.6: Total Nickel Concentration Trend

5.2.2.6 Zinc

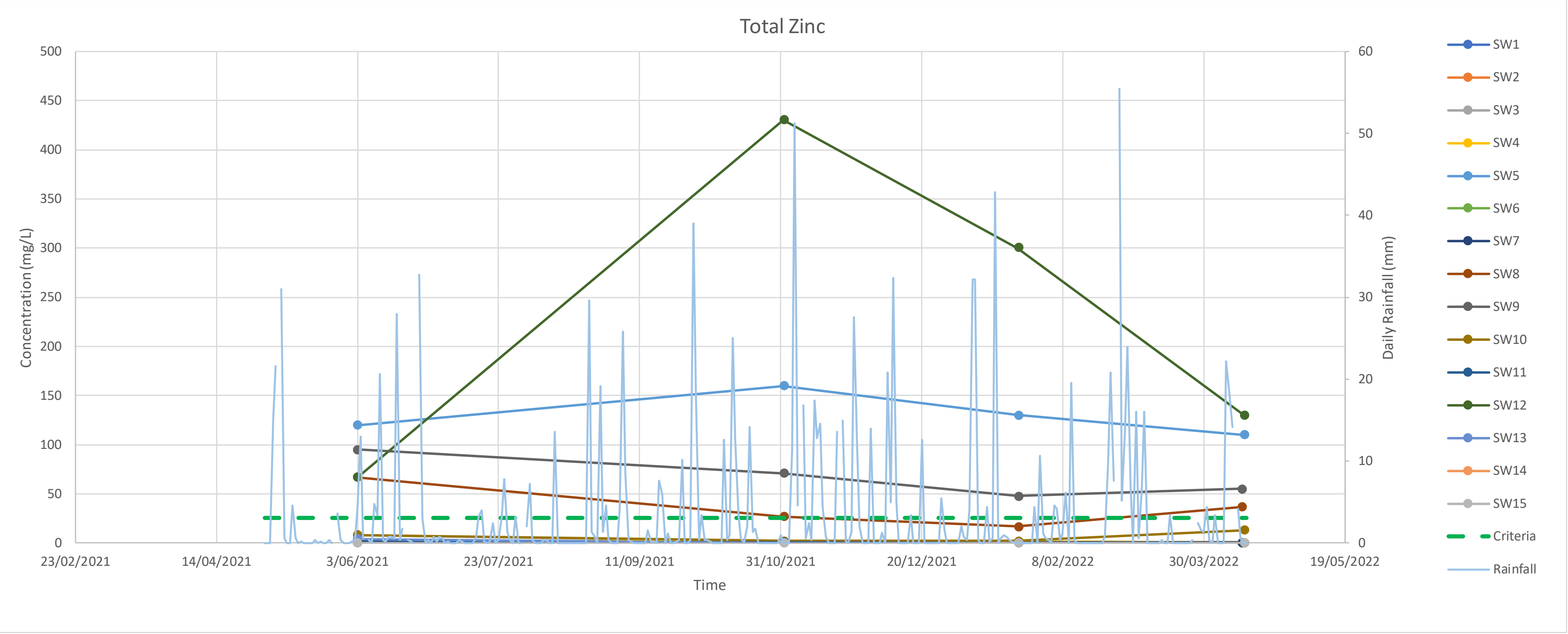

Figure 5.7: Total Zinc Concentration Trend

5.2.2.7 Discussion

Concentrations of heavy metals at location SW12 were generally higher for all heavy metals and aluminium during the four monitoring rounds in 2021/22 and compared to the other sampling locations. The highest concentrations of all contaminants at SW12 were observed during the November 2021 monitoring round, subsequently decreasing during the January 2022 and April 2022 monitoring rounds.

The concentrations of heavy metals and aluminium at all other locations showed relatively consistent and generally slightly lower concentrations compared to concentrations observed at location SW12 during the four monitoring rounds in 2021/22.

5.3 Long-term Temporal Trends in Analytical Results Including Historical Data From GHD (2018), EPA (2019) and Ramboll (2021)

The determination of longer-term temporal trends in the concentrations of key contaminants in surface waters is dependent on the availability of additional analytical data from the same locations or from nearby locations that were sampled by Ramboll during the four monitoring rounds in 2021/22.

Previous historical investigations by GHD (2018), EPA (2019) and Ramboll (2021) included sampling and analysis of surface waters at some of these fifteen monitoring locations (SW1 to SW15; refer **Table 1-1**).

Twelve of Ramboll's fifteen sample locations were previously sampled by either GHD (2018), EPA (2019) or Ramboll (2021) (i.e. Ramboll sample locations SW1, SW2, SW3, SW4, SW5, SW6, SW7, SW8, SW9, SW13, SW14, and SW15), with only sample location SW5 previously sampled by both GHD (2018) and EPA (2019).

Therefore, in order to further assess a long-term trend of the concentrations of key contaminants in surface waters within the Precinct it is possible to extend the temporal assessment of the Ramboll 2021/22 surface water sampling to include one or more older historical sampling events.

GHD (2018) and EPA (2019) sampled and analysed surface waters that were filtered through a 0.45 μm filter to determine the dissolved-phase metal concentrations. Ramboll (2021) sampled and analysed surface waters that were both filtered and unfiltered to determine the dissolved and total concentrations of key contaminants in surface waters.

In order to compare the GHD (2018), EPA (2019) and Ramboll (2021) chemical analytical data for surface water analyses to the Ramboll surface water data from the four monitoring rounds in 2021/22, only the dissolved-phase analytical data from all historical monitoring rounds are directly comparable without introducing confounding factors from potentially elevated concentrations of total metals in unfiltered waters relative to the dissolved phase concentrations measured in filtered waters.

A review of historical surface water sampling at selected locations (SW1, SW2, SW5 and SW13) is presented in the sections below.

5.3.1 Historical Surface Water Sampling at SW1

The concentrations of dissolved-phase contaminants that were analysed by EPA (2019) in the surface water sample from SW1 were substantially elevated for manganese, nickel and zinc compared to the concentrations of these analytes in subsequent sampling undertaken by Ramboll in 2021/22 (**Table 5-4**). The observed elevated concentrations reflect the dry conditions with below average rainfall in the catchment of the Precinct in August 2019.

Table 5-4: Precinct Historical Surface Water Sampling at SW1 (filtered samples) (mg/L)

Location ID		**EPA ID Site 2 Swimming Hole[1] Ramboll ID SW1[2]**				
Analyte	**Ecological Screening Criteria[3]**	**August 2019**	**June 2021**	**November 2021**	**January 2022**	**April 2022**
Aluminium	0.055	-	0.09	0.17	0.11	0.13
Arsenic	0.024	-	< 0.001	< 0.001	< 0.001	< 0.001
Cadmium	0.0002	-	0.0019	0.001	0.0009	0.0004
Cobalt	0.09	-	0.003	0.002	0.002	< 0.001
Copper	0.0014	-	0.008	0.01	0.01	0.007
Lead	0.0034	-	0.007	0.007	0.008	0.005
Manganese	1.9	0.6	0.3	0.18	0.2	0.1
Nickel	0.011	0.02	0.004	0.003	0.003	0.003
Zinc	0.008	8.8	1.6	0.9	0.85	0.48
Chromium	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001
Mercury	0.00006	-	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Iron	0.3	-	0.63	0.73	0.9	0.7

Criteria and results presented in mg/L

[1]EPA sampling occurred in August 2019

[2] Ramboll sampling occurred in June and November 2021 and January and April 2022

[3] 95% Protection – Freshwater ANZG (2018)

"-": No Analysis

5.3.2 Historical Surface Water Sampling at SW2

The concentrations of dissolved-phase contaminants that were analysed by EPA (2019) in the surface water sample from SW2 were substantially elevated for cobalt, manganese, nickel and zinc compared to the concentrations of these analytes in subsequent sampling undertaken by Ramboll in 2021/22 (**Table 5-5**). The observed elevated concentrations reflect the conditions during the dry period in the catchment of the Precinct in August 2019.

Table 5-5: Precinct Historical Surface Water Sampling at SW2 (filtered samples) (mg/L)

Location ID		EPA ID: Site 4 Molonglo Bridge[1] Ramboll ID: SW2[2]				
Analyte	**Ecological Screening Criteria[3]**	**August 2019**	**June 2021**	**November 2021**	**January 2022**	**April 2022**
Aluminium	0.055	-	0.06	0.15	0.08	0.1
Arsenic	0.024	-	< 0.001	0.001	< 0.001	< 0.001
Cadmium	0.0002	-	0.002	0.0012	0.0011	0.0005
Cobalt	0.09	0.01	0.003	0.002	0.002	0.001
Copper	0.0014	-	0.008	0.01	0.009	0.007
Lead	0.0034	-	0.005	0.007	0.009	0.005
Manganese	1.9	1.3	0.35	0.2	0.23	0.11
Nickel	0.011	0.03	0.006	0.004	0.004	0.003
Zinc	0.008	10	1.8	1.1	0.99	0.53
Chromium	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001
Mercury	0.00006	-	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Iron	0.3	-	0.87	0.79	0.93	0.74

Criteria and results presented in mg/L

[1]EPA sampling occurred in August 2019

[2] Ramboll sampling occurred in June and November 2021 and January and April 2022

[3] 95% Protection – Freshwater ANZG (2018)

"-": No Analysis

5.3.3 Historical Surface Water Sampling at SW5

The concentrations of dissolved-phase contaminants that were analysed by GHD (2018) and EPA (2019) in the surface water sample from SW5 were similar to the concentrations of contaminants that were measured in surface water sampling undertaken by Ramboll in 2021/22, with the exception of zinc, which was slightly elevated in the surface water sample obtained by GHD (2018) (1,420 mg/L) relative to subsequent concentrations of zinc (130 to 170 mg/L) (**Table 5-6**). The observed concentrations of dissolved phase contaminants across the five sampling periods reflect generally similar conditions during the dry and wet periods in the catchment of the Precinct for the sampling undertaken between August 2017 and April 2022.

Table 5-6: Precinct Historical Surface Water Sampling at SW5 (filtered samples) (mg/L)

Location ID		GHD ID: SW02[1] EPA ID: Site 6 Mine leachate[2] Ramboll ID: SW5[3]					
Analyte	**Ecological Screening Criteria[4]**	**August 2017**	**August 2019**	**June 2021**	**November 2021**	**January 2022**	**April 2022**
Aluminium	0.055	12.8	16	13	15	31	15
Arsenic	0.024	0.006	-	0.008	0.011	0.01	0.008
Cadmium	0.0002	0.0864	-	0.11	0.11	0.12	0.13
Cobalt	0.09	-	0.12	0.097	0.1	0.096	0.1
Copper	0.0014	0.168	0.2	0.36	0.28	0.48	0.39
Lead	0.0034	1.02	0.87	1.3	1.2	1.2	1.3
Manganese	1.9	11.3	15	12	12	10	11
Nickel	0.011	-	0.073	0.072	0.068	0.07	0.073
Zinc	0.008	1420	170	140	130	130	130
Chromium	0.001	-	-	< 0.001	0.001	0.001	0.001
Mercury	0.00006	-	-	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Iron	0.3	177	-	190	170	150	150

Criteria and results presented in mg/L

[1]GHD sampling occurred in August 2017 and was reported in 2018

[2]EPA sampling occurred in August 2019

[3] Ramboll sampling occurred in June and November 2021 and January and April 2022

[4] 95% Protection – Freshwater ANZG (2018)

"-": No Analysis

5.3.4 Historical Surface Water Sampling at SW13

The concentrations of dissolved-phase contaminants that were analysed by GHD (2018) in the surface water sample from SW13 were substantially greater for the measured contaminants compared to the concentrations of these analytes in subsequent sampling undertaken by Ramboll in 2021/22 (**Table 5-7**), with the exception of iron (0.21 mg/L), which was lower than in the surface water sampled during the last three sampling events by Ramboll in 2021/22 (0.81 to 2.2 mg/L).

The observed concentrations of surface water sampled by GHD (2018) reflect the average rainfall conditions during the sampling period in the catchment of the Precinct in August 2017 relative to the substantially above average rainfall conditions during the sampling undertaken by Ramboll in 2021/22.

Table 5-7: Precinct Historical Surface Water Sampling at SW13 (filtered samples) (mg/L)

Location ID		**GHD ID: SW06[1]**	**Ramboll ID: SW13[2]**			
Analyte	**Ecological Screening Criteria[3]**	**August 2018**	**June 2021**	**November 2021**	**January 2022**	**April 2022**
Aluminium	0.055	2.88	1.1	0.26	0.16	0.54
Arsenic	0.024	0.001	< 0.001	0.001	0.002	0.002
Cadmium	0.0002	0.0485	0.009	0.0004	0.0003	0.0003
Cobalt	0.09	-	0.016	0.001	0.002	0.002
Copper	0.0014	1.5	0.37	0.037	0.034	0.026
Lead	0.0034	0.614	0.14	0.021	0.014	0.011
Manganese	1.9	3.38	0.38	0.033	0.11	0.07
Nickel	0.011	-	0.003	0.001	0.006	0.002
Zinc	0.008	35.3	3.7	0.22	0.3	0.16
Chromium	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001
Mercury	0.00006	-	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Iron	0.3	0.21	0.22	0.81	1.2	2

Criteria and results presented in mg/L

[1]GHD sampling occurred in August 2017 and was reported in 2018

[2] Ramboll sampling occurred in June and November 2021 and January and April 2022

[3] 95% Protection – Freshwater ANZG (2018)

"-": No Analysis

6. CONCLUSIONS

Quarterly surface water monitoring was completed at Captains Flat, NSW in June 2021, October 2021, January 2022 and April 2022.

Multiple exceedances of the health-based screening criteria were observed within the Precinct for heavy metals (Cd, Co, Fe, Pb, Mn and Zn).

Lead concentrations in surface water were assessed against the health-based recreational criteria in surface water from within the Precinct in both upstream and downstream locations. Concentrations of total lead exceeded the recreational criteria at three locations (SW5, SW8 and SW9) in all monitoring rounds. All locations showed stable lead concentrations compared to previous rounds noting some fluctuation above and below the recreational criteria at SW6 and SW7.

Concentrations of heavy metals in surface water were assessed against the recreational criteria for waters in surface water from within the Precinct in both upstream and downstream locations. Concentrations of heavy metals fluctuated significantly at SW12 across the four rounds of monitoring in 2021/22. All other locations showed relatively consistent concentrations of heavy metals from June 2021 to April 2022.

An assessment of the historical surface water monitoring data (dissolved-phase concentrations obtained in filtered water) from sampling undertaken by GHD (2018), EPA (2019) and Ramboll (2021) and a comparison of the historical contaminant concentrations in surface water with the concentrations in surface water obtained by Ramboll in 2021/22 showed that the dissolved phase concentrations of contaminants in surface water appear to be elevated during conditions of lower rainfall or drought. Conversely, the concentrations of contaminants in surface water during the periods of above average rainfall resulted in measuring lower concentrations of contaminants in surface water. Concentrations of aluminium, copper, iron and zinc were consistently reported above ecological assessment criteria including upstream of the water supply reservoir (background). Concentrations of other metals (cadmium, chromium, cobalt, manganese and nickel) were reported above ecological criteria downstream of the water supply reservoir.

The inverse relationship between dissolved-phase concentrations of contaminants in surface water and rainfall conditions throughout the catchment may account for a substantial portion of the observed temporal variability of the analytical data in surface water. Further, potential downstream impacts may be augmented by elevated contaminant concentrations that are likely to be present during low-flow conditions that are present during drought periods.

The effect of short-term variability of meteorological conditions (e.g. flooding, single high flow event) on contaminant concentrations in surface water is less well known in the catchment area of the Precinct and potentially dependent on other factors such as the antecedent period prior to the rainfall event and the potential for a greater contaminant accumulation and subsequent release of contaminants during the first flush period through the catchment area.

7. LIMITATIONS

Ramboll Australia Pty Ltd prepared this report in accordance with the scope of work as outlined in our proposal to Regional NSW and in accordance with our understanding and interpretation of current regulatory standards.

A representative program of sampling and laboratory analyses is proposed as part of this investigation, based on past and present known uses of the Precinct. While every care has been taken, concentrations of contaminants measured may not be representative of conditions between the locations sampled and investigated. We cannot therefore preclude the presence of materials that may be hazardous.

Site conditions may change over time. This report is based on conditions encountered at the Site at the time of the report and Ramboll disclaims responsibility for any changes that may have occurred after this time.

The conclusions presented in this report represent Ramboll's professional judgment based on information made available during the course of this assignment and are true and correct to the best of Ramboll's knowledge as at the date of the assessment.

Ramboll did not independently verify all of the written or oral information provided to Ramboll during the course of this investigation. While Ramboll has no reason to doubt the accuracy of the information provided to it, the report is complete and accurate only to the extent that the information provided to Ramboll was itself complete and accurate.

This report does not purport to give legal advice. This advice can only be given by qualified legal advisors.

7.1 User Reliance

This report has been prepared exclusively for Regional NSW and may not be relied upon by any other person or entity without Ramboll's express written permission.

8. REFERENCES

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Ramboll (2021). *Conceptual Site Model (CSM) – Captains Flat Lead Management*, document reference 318001193-T9 -Rev1, Ramboll Australia Pty Ltd, November 2021.

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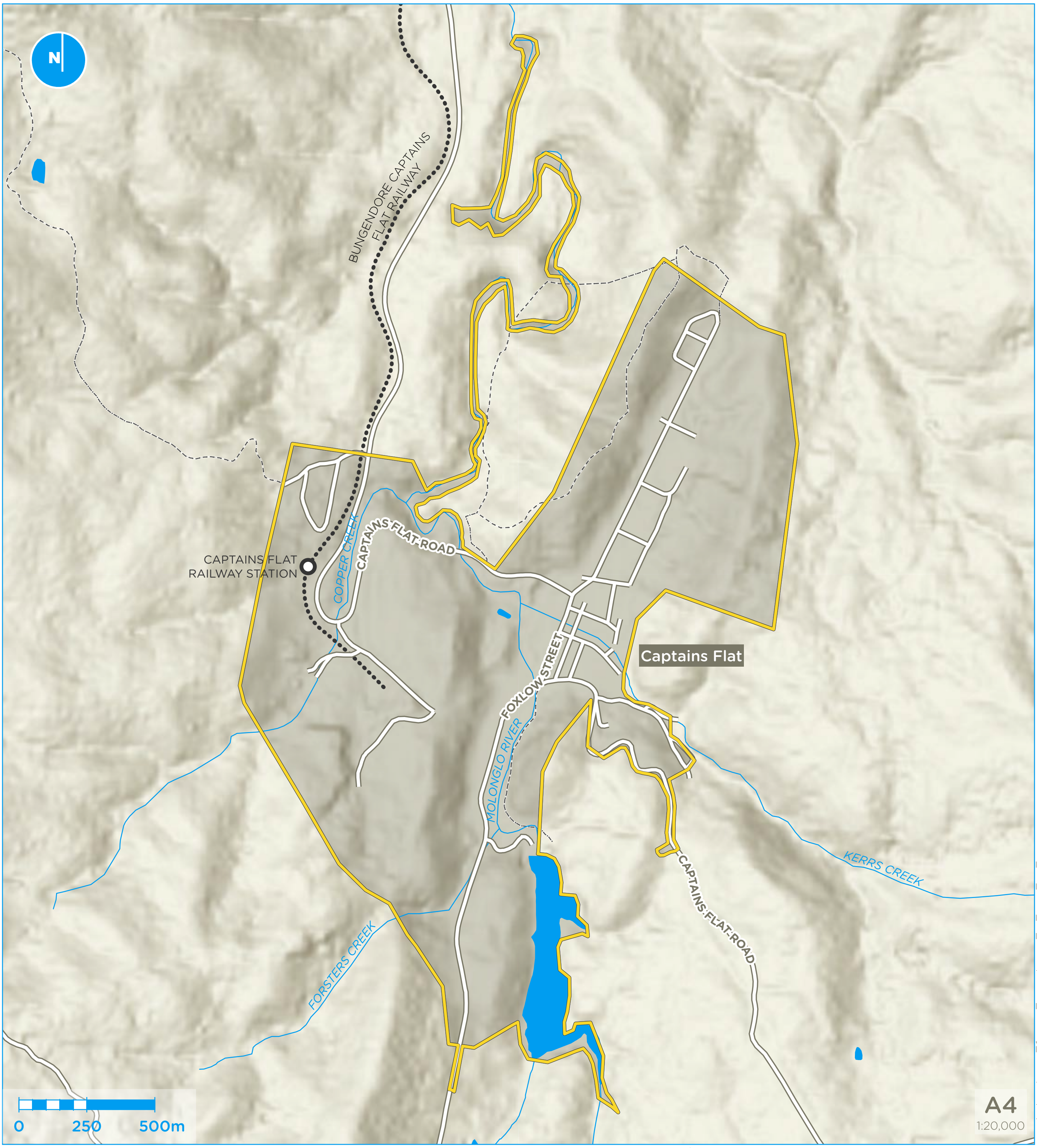
US EPA Regional Screening Levels (RSL) for tap water https://www.epa.gov/risk/regional-screening-levels-rsls

APPENDIX 1
FIGURES



RAMBOLL AUSTRALIA - GIS MAP file : 318001193_GIS_P002_T9_CSM | F001_Locality_V04 | 26/10/2021

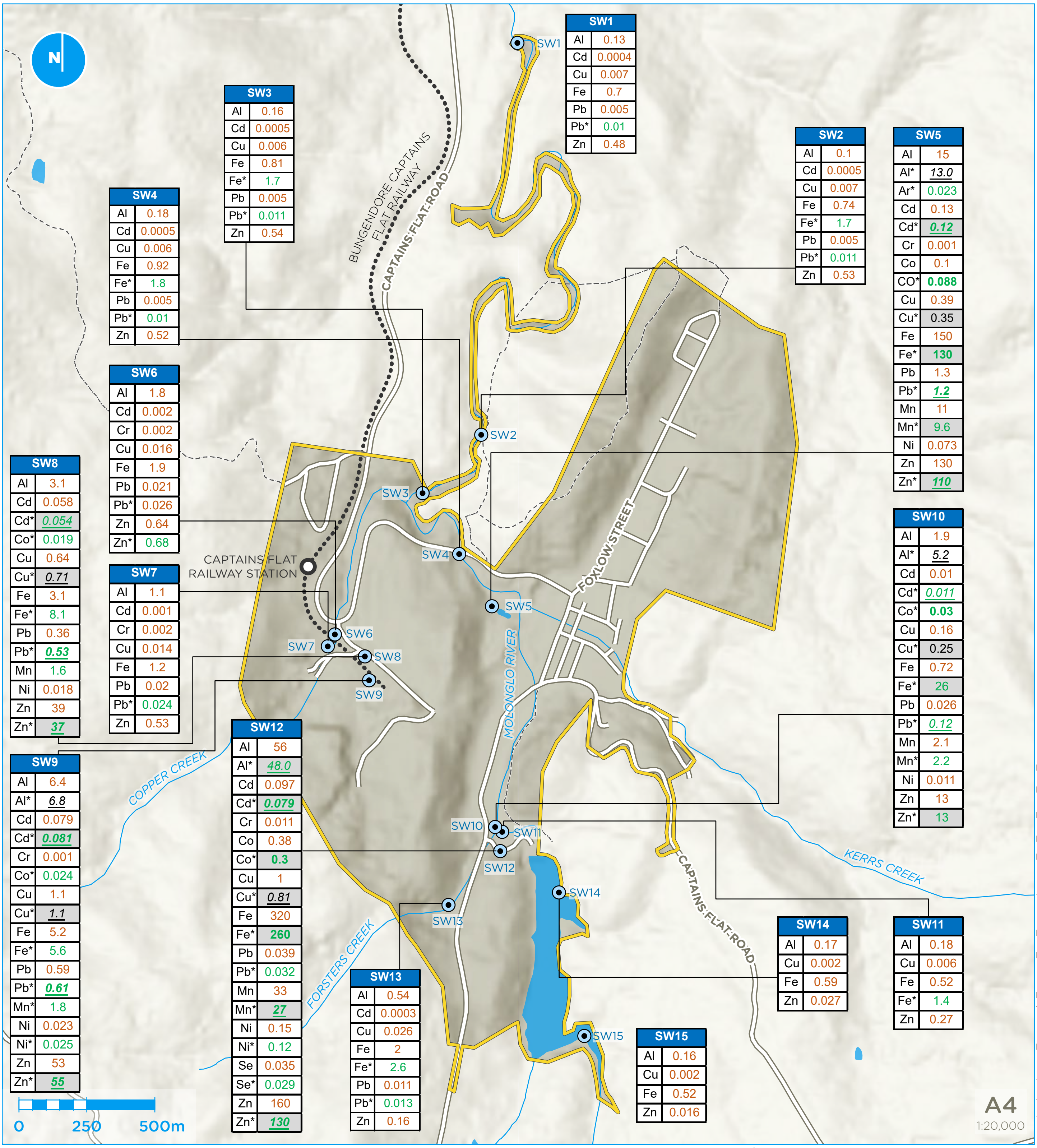
Esri, Geoscience Australia, NASA, NGA, USGS, Esri, HERE, Garmin, FAO, NOAA, USGS, Esri, USGS

Legend

Precinct boundary

Figure 1 : Site location

Captains Flat Lead Management Plan - CSM



RAMBOLL AUSTRALIA - GIS MAP file : 318001193_GIS_P011_T26_02_SWM | F003_SW_Results_April2022_V02 | 27/09/2022

Vicmap, Esri, HERE, Garmin, Foursquare, METI/NASA, USGS, Esri, Geoscience Australia, NASA, NGA, USGS

Legend

Precinct boundary

Surface water sampling location

Exceedance criteria (*indicates total metals)

Dissolved Metals in SW (mg/L)	95% Protection Fresh Water
Al	0.055
Ar	0.024
Cd	0.0002
Cr	0.001
Co	0.09
Cu	0.0014
Fe	0.3
Pb	0.0034
Mn	1.9
Ni	0.011
Se	0.011
Zn	0.008

Total Metals in SW (mg/L)	Drinking Water Guidelines	Recreation (Exposure Adjusted)	Irrigation	Stock Water
Al	20	**200**	5	20
Ar	0.01	**0.1**	0.5	2
Cd	0.002	**0.06**	0.01	0.05
Cr	0.05	**0.5**	1	1
Co	0.006	**0.03**	1	0.1
Cu	2	**20**	0.5	0.1
Fe	1.4	**119**		10
Pb	0.01	**0.2**	0.1	5
Mn	0.5	**12**	10	2.5
Ni	0.02	**0.2**	1	2
Se	0.01	**0.1**		
Zn	0.6	**26**	20	5

Figure 2 : Surface water sampling locations (April 2022)

Captains Flat Surface Water Monitoring

APPENDIX 2
SAMPLING ANALYSIS AND QUALITY PLAN

Intended for

Department of Regional NSW

Document type

Report

Date

June 2021

Project Number

318001193-T02

REVIEW OF INFORMATION AND SAMPLING AND ANALYSIS QUALITY PLAN

CAPTAINS FLAT LEAD MANAGEMENT PLAN

Bright ideas. Sustainable change.

Project name	Captains Flat Lead Management Plan
Project No.	318001193-T02
Recipient by	Department of Regional NSW
Document type	Report
Description	This report presents a review of information relevant to contamination from the Lake George Mine within the community of Captains Flat and a Sampling and Analyses Quality Plan to address identified data gaps.

Revision	Date	Prepared by	Checked by	Approved by	Description
Draft/Rev0	26/5/21	S Maxwell	K Greenfield	R Salmon	For client review
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ABBREVIATIONS

Measures	Description
%	per cent
μg/L	Micrograms per Litre
μg/m³	Micrograms per Cubic Metre
ha	Hectare
km	Kilometres
m	Metre
mAHD	Metres Australian Height Datum
mbgl	Metres below ground level
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
mg/m³	Milligrams per Cubic Metre
mm	Millimetre
ppm	Parts Per Million

Contaminant	Description
Al	Aluminium
As	Arsenic
Ba	Barium
Cd	Cadmium
Co	Cobalt
Cr	Chromium (III)
Cu	Copper
Fe	Iron
Hg	Mercury
Pb	Lead
Mn	Manganese
Mo	Molybdenum
Ni	Nickel
Sb	Antimony
Se	Selenium
Ti	Titanium
Zn	Zinc
BTEX	Benzene, toluene, ethylbenzene, xylene
OCP	Organochlorine pesticides
OPP	Organophosphate pesticides
PAH	Polycyclic aromatic hydrocarbons
TRH	Total recoverable hydrocarbons

General	Description
ADWG	Australian Drinking Water Guidelines
AHD	Australian Height Datum
ALS	Australian Laboratory Services
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
BoM	Bureau of Meteorology
C&R	Contaminants and Risk Team, Environment, Energy and Science Branch of DPIE
CEC	Cation exchange capacity
CLM Act	NSW Contaminated Land Management Act 1997
COC	Chain of Custody
Council	Queanbeyan-Palerang Regional Council
CSM	Conceptual Site Model
DGV	Default guideline value
DO	Dissolved oxygen
DoE	Department of Education (NSW)
DPIE	Department of Planning, Industry and Environment (NSW)
DQI	Data Quality Indicator
DQO	Data Quality Objective
EC	Electrical conductivity
EIL	Ecological Investigation Level
EMP	Environmental Management Plan
Envirolab	Envirolab Services Pty Ltd
EPA	Environment Protection Authority (NSW)
fpXRF	Field portable x-ray fluorescence metals analyser
GIL	Groundwater Investigation Level
GME	Groundwater Monitoring Event
HVAS	High volume air sampler
HIL	Health Investigation Level
LCS	Laboratory Control Sample
LEP	Local Environment Plan
LOR	Limit of Reporting
Mercury	Inorganic mercury unless noted otherwise
MS	Matrix Spike
NATA	National Association of Testing Authorities
ND	Not Detected
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NL	Non-Limiting
n	Number of Samples
OEH	Office of Environment and Heritage
pH	A measure of acidity, hydrogen ion activity
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
QPRC	Queanbeyan-Palerang Regional Council

General	Description
RAP	Remediation Action Plan
Regional NSW	NSW Department of Regional NSW
RFS	Rural Fire Service
RPD	Relative Percent Difference
SAQP	Sampling and Analysis Quality Plan
SES	State Emergency Services
SPR	Source-Pathway-Receptor
SWL	Standing Water Level
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total dissolved solids
TfNSW	Transport for NSW
TSP	Total suspended particulates
US EPA	United States Environmental Protection Agency
-	On tables is "not calculated", "no criteria" or "not applicable"

EXECUTIVE SUMMARY

Ramboll was retained by the Department of Regional NSW (Regional NSW) to prepare the Captains Flat Lead Management Plan to address exposure risks from lead within the environment and the community that relates to the legacy Lake George Mine. The NSW Department of Planning, Industry and Environment (DPIE) Contaminants and Risks Team (C&R), Environment, Energy and Science Branch (EES) completed a Literature Review on Nature and extent of contamination in the Captains Flat Region, NSW in April 2021 (C&R 2021). A preliminary conceptual site model (CSM) was developed as a qualitative representation of contaminant sources, migration pathways and potential receptors for potential contaminants from the legacy Lake George Mine.

The objectives of this report are to:

- Refine the existing preliminary CSM (C&R 2021) to provide a suitable platform for detailed data gaps assessment and development of the Captains Flat Lead Management Plan. This will include review of existing sampling and analytical data relevant to contamination within the Captains Flat community
- Define a Sampling and Analysis Quality Plan (SAQP) to address identified data gaps.

The extent of the sampling and analytical program is limited to assessing contaminant exposure risks that may exist for the Captains Flat community and immediate surrounding environment.

The primary data gaps identified in C&R (2021) were information regarding soil contamination impacts in the Captains Flat residential area, groundwater hydrogeological information and groundwater impacts in the region. Data gaps in relation to potential receptors were also identified, for example, use of groundwater, potential agricultural receptors and potential for home grown produce.

Ramboll has undertaken a review of available data and has expanded on the preliminary CSM developed by C&R. The following data gaps were identified to supplement those identified by C&R:

- Systematic assessment of metals concentrations in soils within the community and vertical delineation of elevated lead concentrations in soil within the community. Specific areas requiring assessment and/or vertical delineation are identified
- Bioavailability of metals in soils impacted by dust, ore, mine waste and slag, relevant to assessing human health risks
- Details of surface water and groundwater usage within the Precinct and the alluvial flats some kilometres downstream
- The effect of meteorological variability on the degree and distribution of surface water contamination
- Assessment of dissolved metals concentrations in surface water, relevant to assessing ecological risks
- The distribution of contaminated sediments and exposure risks within the receiving environment
- Potential for sediment to act as an ongoing source of impact to surface water
- Meteorology data in the vicinity of Captains Flat to inform assessment of source to receptor movement of air pollutants in the local airshed
- Assessment of internal dust within public buildings.

An assessment program has been designed to address these data gaps and to characterise the degree and extent of contamination with sufficient detail to confirm the CSM and inform development of the Captains Flat Lead Management Plan.

It is assumed that information relating to surface water and groundwater usage within the Precinct will be made available to Ramboll to inform the preparation of interim water usage guidelines.

Data gaps that will not be resolved under the proposed sampling and analyses include:

- Details of surface water and groundwater usage for the Molonglo River downstream of the Precinct
- Assessment of contaminant impacts to the Molonglo River downstream of the Precinct or interactions with the alluvial aquifer and downstream water users
- Sediment contamination assumed to be present in the water supply dam will not be comprehensively assessed under the proposed sampling and analyses. The Captains Flat Lead Management Plan will be developed under the assumption that contaminant exposure risks exist for benthic and aquatic ecology in the water supply dam. Comprehensive assessment of sediment in the water supply dam should be considered as part of ongoing surface water monitoring
- Effects of meteorological variability on contaminant mobility via airborne, surface water and groundwater migration pathways will remain as a data gap and require ongoing monitoring
- Site specific risk assessment considering bioavailability of metals may be warranted depending on the results of the assessment, the identified risks to human health and ecology and the associated management requirements
- Human health effects from contaminant exposure within Captains Flat and the downstream receiving environment. A systematic assessment of community health effects is recommended as a basis for understanding effects from current exposure scenarios and for validating the Captains Flat Lead Management Plan once implemented.

1. INTRODUCTION

Ramboll Australia Pty Ltd (Ramboll) was retained by the Department of Regional NSW (Regional NSW) to prepare the Captains Flat Lead Management Plan to address exposure risks from lead within the environment and the community that relates to the legacy Lake George Mine. A process diagram for preparation of the Captains Flat Lead Management Plan is presented as Figure 1-1 below.

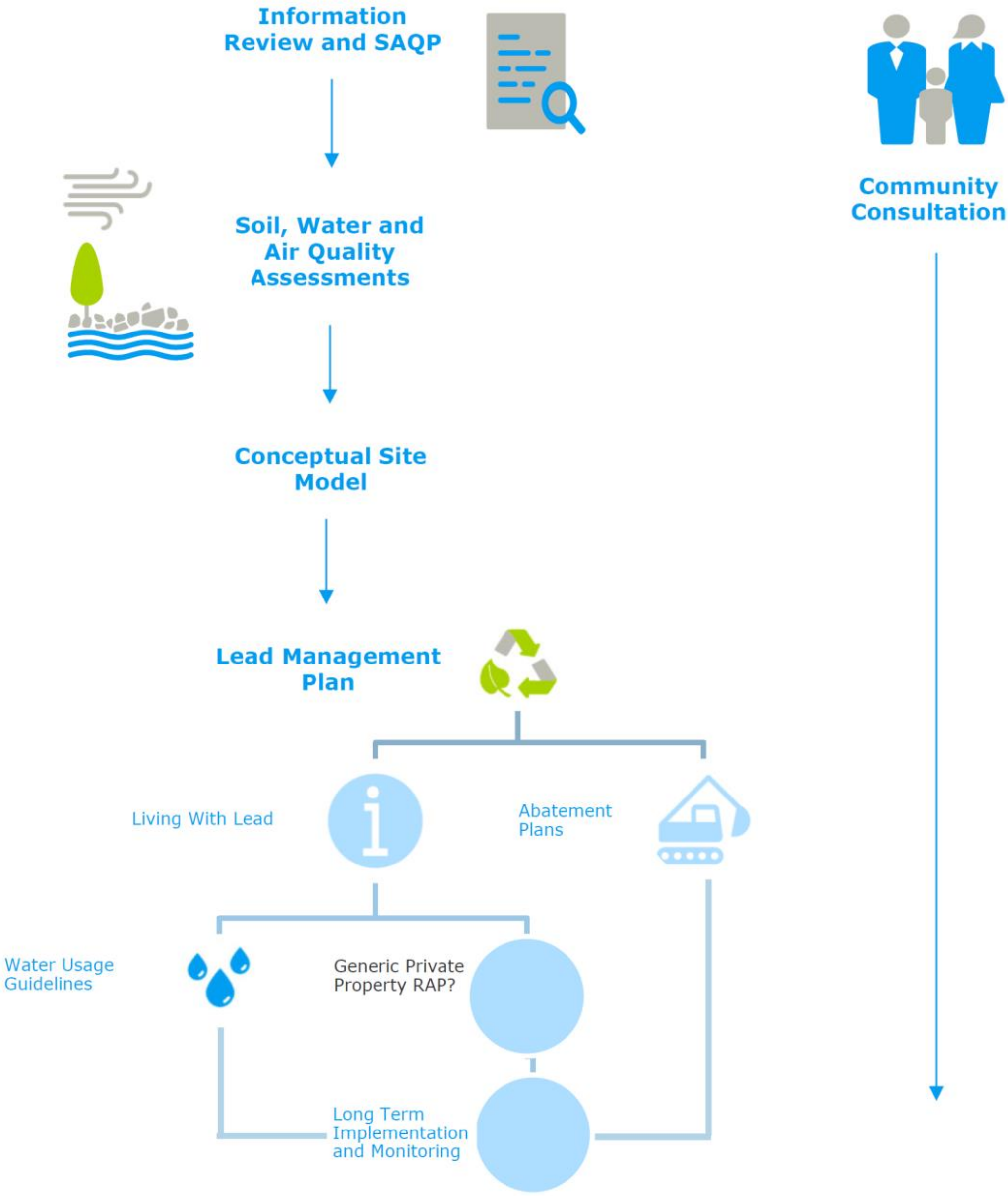

Figure 1-1 Pathway for development of the Captains Flat Lead Management Plan

The NSW Department of Planning, Industry and Environment (DPIE) Contaminants and Risks Team (C&R), Environment, Energy and Science Branch completed the Literature Review – Nature and extent of contamination in the Captains Flat Region, NSW in April 2021. This document includes a preliminary Conceptual Site Model (CSM) as a qualitative representation of contaminant sources, migration pathways and receptors. The CSM is critical element of the legislated framework for management of contaminated land in Australia.

1.1 Objectives

The objectives of this report are to:

- Refine the existing preliminary CSM (C&R 2021) to provide a suitable platform for detailed data gaps assessment and development of the Captains Flat Lead Management Plan. This will include review of existing sampling and analytical data relevant to contamination within the Captains Flat community
- Define a Sampling and Analysis Quality Plan (SAQP) to address identified data gaps.

The extent of the sampling and analytical program is limited to assessing contaminant exposure risks that may exist for the Captains Flat community and immediate surrounding environment.

1.2 Scope of Work

The scope of work performed to meet the objectives comprised review of recent assessments (as cited) and preparation of a SAQP including:

- Identification of the Captains Flat Lead Management Plan Precinct including preliminary identification of geographic boundaries and specific reference to the proposed public space abatement areas and boundaries of the mine and rail corridor, land parcels adjacent the mine and rail corridor and areas where data gaps have been identified
- Review of previous investigations
- Inspection of site condition and surrounding environment
- Review of analytical data and site plans including site boundaries, cadastral boundaries, historic sampling locations, service alignments and service invert depths
- A preliminary Conceptual Site Model (CSM) outlining potential Source-Pathway-Receptor (SPR) linkages including a tabulated summary and detailed discussion
- Data Quality Objectives (DQOs) to define criteria the sampling plan should satisfy
- Criteria for Tier 1 contaminant risk assessment
- Data Quality Indicators to describe how performance against DQOs will be assessed
- A sampling strategy, sampling methods and plans presenting proposed sampling locations
- QA/QC provisions to be completed during the proposed sampling.

2. IDENTIFICATION OF THE CAPTAINS FLAT LEAD MANAGEMENT PLAN PRECINCT

The Captains Flat Lead Management Plan Precinct (the Precinct) encompasses built areas of the Captains Flat community, the legacy Lake George Mine site and the Molonglo River from upstream of the water supply dam to a waterhole approximately 1.5 km downstream of the mine. The Precinct includes roads accessing Captains Flat (to a distance of at least 400 m), the rail corridor (to a distance of 1 km) and bushland areas at the perimeters of the community where these may have been impacted by the mine operations.

Private property assessments are an important aspect of managing lead exposure risks in Captains Flat though to preserve confidentiality the NSW Environment Protection Authority (EPA) is managing private property assessments (except those within the footprint of the former Lake George Mine) and results have not been made available for this report[1]. The Precinct is presented on **Figure 1**, **Appendix 1**. Precinct details are presented in Table 2-1**.**

Table 2-1: Site Identification

Information	Description
Site Area:	Approximately 295 Ha
Local Government Area:	Queanbeyan-Palerang Region
Owners:	Crown Lands (integrating land managed under the Legacy Mines Program), Queanbeyan-Palerang Regional Council (QPRC), Department of Education (DoE), Transport for NSW (TfNSW), Aboriginal Land Councils, numerous private land owners
Current Site Uses:	Land uses within the Precinct include: • Crown Lands (Legacy Mine areas, former preschool, parks, rivers, the water supply dam and bushland)2 • QPRC (public roads, sewerage treatment plant (STP), potable water treatment plant (WTP) and community buildings including the Community Hall, Rural Fire Service (RFS), State Emergency Services (SES) and Men's Shed) • DoE (Captains Flat Public School and the new preschool) • TfNSW (non-operational Captains Flat–Bungendore rail line) • Mogo Local Aboriginal Land Council (areas west of the rail corridor and north of the Northern Tailings Dump) • Numerous discrete private commercial/industrial and residential land parcels.

The site environmental setting information was summarised in C&R (2021) and relevant extracts are included in **Appendix 4**.

[1] Results from assessment of the mine site are included in this report.

[2] Based on review of Crown Lands as presented on the NSW Resources and Geosciences Minview web mapping application (https://minview.geoscience.nsw.gov.au/#/?lon=149.4471&lat=-35.60473&z=17&bm=bm1&l=wa3:y:100,ad6:y:100) accessed 25 May 2021.

3. REGULATORY REQUIREMENTS

This SAQP has been prepared in general accordance with the following guidance documents:

1. NSW EPA, *Contaminated Land Guidelines: Consultants Reporting on Contaminated Land* (NSW EPA 2020)
2. Australia and New Zealand Environment and Conservation Council, *Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000)
3. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia*. Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018)
4. National Environment Protection Council (NEPC), *National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013* (NEPM, 2013)
5. NSW EPA, *Guidelines for the Site Auditor Scheme (3rd Edition)* (NSW EPA, 2017)

4. PREVIOUS INVESTIGATIONS

The C&R Literature Review (2021) integrated an extensive review of research, guidelines and available geospatial data relevant to contamination associated with the legacy Lake George Mine.

A full list of references from the literature review is presented as **Appendix 3.**

Previous assessments relevant to lead exposure risks within Captains Flat that were provided for review are listed below and discussed in the following sections:

- Lake George Captains Flat Mine Review, Assessment of Remediation Options (GHD 2018)
- Sampling data relating to blue water reported in the Molonglo River (NSW EPA 2019)
- Captains Flat Rail Corridor Detailed Site Investigation (Ramboll 2021)
- Captains Flat Surface Soil Testing Report (NSW EPA 2021)
- Human Health Detailed Site Investigation, Captains Flat Preschool, 27 Foxlow Street, Captains Flat NSW (EnviroScience Solutions 2021a)
- Human Health Detailed Site Investigation, Captains Flat Oval, Foxlow Street, Captains Flat NSW (EnviroScience Solutions 2021b)
- Captains Flat Surface Soil Testing Report (NSW EPA 2021).

Sampling locations from these data sources are presented on **Figures 2 – 4**, **Appendix 1.**

The primary source areas described in the following sections are shown on **Figure 8** extracted from C&R (2021) and included in **Appendix 5.**

4.1 GHD 2018 Lake George Captains Flat Mine Review Assessment of Remediation Options

The objectives of GHD 2018 assessment were to assess the effectiveness of remediation that had occurred at the time to identify ongoing point sources of pollution and quantify their relative contribution to dissolved and suspended pollution loads / contamination flux reporting to the Molonglo River.

The scope of works completed under this assessment targeted pre-identified high-risk source areas including:

- The Main Adit Spring
- Exposed or only partly vegetated contaminated soils in the Rail Loading and Mill areas (Copper Creek catchment) and
- Exposed waste and mineralised rock in the Central and Elliot's Mine area (Molonglo River and Copper Creek catchment).

Assessment included 149 field portable x-ray fluorescence metals analyser (fpXRF) measurements from 69 locations and collection and analysis of 22 soil/waste rock samples, nine sediment samples and 13 surface water samples.

Key findings were:

- The Main Adit Spring contributes around 80 to 90 % of dry weather, point source dissolved zinc and some 99 % of dissolved lead loads into the Molonglo River
- Metals in sediment (As, Cd, Cu, Ni, Sb, Zn) were observed above adopted assessment criteria. Additionally, Al and Mn were elevated though assessment criteria were not identified
- Bare areas on site and, to a lesser extent, areas colonised by pine trees have significant levels of metal contamination
- The exposed surface areas noted above remain a significant source of lead contaminated dust that could cause windborne contamination within the town of Captains Flat

- Exposed waste rock and soil on the mine site is acid-forming and there is a high risk of ongoing acid, saline and metalliferous drainage unless key contaminant sources are targeted for remediation
- Environmentally significant zinc contamination was observed to extend at least 40 km downstream from Captains Flat.

4.2 NSW EPA 2019 Response to Molonglo River pollution event

In 2019 the NSW EPA responded to a reported pollution event in the Molonglo River. The objective was to determine the cause of blue water and dead fish within the Molonglo River.

The scope of work included sampling of surface water at 13 locations targeting discharge points from the mine and the receiving Molonglo River. Samples were analysed for total and dissolved metals (Al, Co, Cu, Pb, Ni, Zn), pH, alkalinity (as calcium carbonate) and anions.

Key findings were:

- Al, Co, Cu, Pb, Ni, Zn in mine leachate exceeded assessment criteria relevant to the receiving environment
- Zn exceeded assessment criteria to the extent sampled within the downstream receiving environment and was considered likely to be the primary driver of toxicity within the Molonglo River
- The blue water was likely caused by an increased amount of calcium and sulfate coming from the mine in conjunction with low flow, low rainfall and cold weather. It was concluded that this formed a calcium sulfate precipitate that changed the optical properties of the water.

4.3 Ramboll 2021 Captains Flat Rail Corridor Detailed Site Investigation

The Captains Flat Rail Corridor DSI was completed to assess potential soil, dust, sediment and surface water contamination related to historical and current land uses in and around the southern end of the Captains Flat-Bungendore rail corridor and potential effects on surrounding human and ecological receptors.

The scope of work comprised:

- Systematic site inspection for visible asbestos on the site surface
- Assessment of the lateral and vertical extent of metals through fpXRF
- Advancement of test pits and hand augers to facilitate assessment of potential contaminants associated with the general operation of the rail corridor
- Assessment of surface water and sediment upstream and downstream of the site to inform consideration of contaminant migration to and from the site via overland flow
- Assessment of internal dust and paint in buildings on and adjacent the site to inform consideration of risks to sensitive receptors associated with site contamination and potential for lead based paints to contribute risk.

The key findings were:

- Contamination was identified in the rail corridor that is consistent with contamination associated with the adjacent legacy Lake George Mine and with the historic loadout and transport of ore by rail
- The legacy Lake George Mine was identified as the source of site contamination and the rail corridor was identified as a secondary source
- Asbestos was also identified in surface soils within the rail formation including the Copper Creek rail embankment and in surface soils adjacent the rail formation.

4.4 NSW EPA 2021 Captains Flat Surface Soil Testing Report

In 2021, the NSW EPA carried out precautionary testing of surface soils on public and community spaces in the town, including the former preschool, primary school, community hall, parks, roads and road reserves. The testing aimed to:

- Identify if the surface soils were contaminated with lead, arsenic, copper and/or zinc
- Determine if actions were required to protect human health.

The scope of work comprised:

- Screening of lead, arsenic, copper and zinc concentrations using fpXRF
- Laboratory analyses of soil samples collected where elevated metal concentrations were measured in the field. A total of 33 samples were analysed.

The key finding was that 14 of the 33 soil samples that were tested at the laboratory had concentrations of lead above the health investigation level (HIL) for the relevant land use. Areas where elevated metals concentrations were observed included the former Captains Flat Preschool and surrounds, the southern part of Foxlow Street and Foxlow Parklet.

4.5 EnviroScience Solutions 2021a Human Health Detailed Site Investigation Captains Flat Preschool

In 2021, a DSI was completed at the former Captains Flat Preschool. The objective was to assess the suitability of the former preschool for ongoing use.

The scope of works comprised:

- Collection of 18 soil samples from 10 locations to a maximum depth of 0.5 metres below ground level (mbgl). Analyses of all soil samples for metals (As, Cd, Cr, Cu, Pb, Ni, Zn, Hg) and five samples for TRH, BTEX, PAH, metals, OCP, OPP and PCB
- Collection of four dust samples from external areas and the ceiling cavity and analysis for lead
- Air monitoring for lead at four external perimeter locations.

Key findings were:

- 18 of 20 soil samples reported lead above the relevant HIL. All other analytes were reported below adopted assessment criteria
- Dust and air monitoring results were reported below adopted assessment criteria.

4.6 EnviroScience Solutions 2021b Human Health Detailed Site Investigation, Captains Flat Oval

In 2021, a DSI was completed at Colin Winchester Oval off Foxlow Street. The objective was to assess the suitability of the oval for ongoing use.

The scope of works comprised:

- Collection of 40 soil samples from 20 locations to a maximum depth of 0.5 mbgl. Analyses of all soil samples for metals (As, Cd, Cr, Cu, Pb, Ni, Zn, Hg) and six samples for TRH, BTEX, PAH, metals, OCP, OPP and PCB
- Air monitoring for lead at four locations.

Key findings were:

- 3 of 40 soil samples reported lead above the relevant HIL. All other analytes were reported below adopted assessment criteria
- Dust and air monitoring results were reported below adopted assessment criteria.

4.7 Data Summary

4.7.1 Soil

Key findings from soil data include:

- Elevated metal concentrations (As, Cd, Co, Cu, Pb, Mn, Hg, Ni, Zn) have been identified in mine site soils
- Elevated lead concentrations have been identified in shallow soils within the community. Distribution around the former preschool and at the south end of Foxlow Street appears related to application of mine waste as fill, surficial deposition (potential runoff from the eastern embankment of the mine and/or windborne dust deposition). Distribution at Foxlow Parklet appears related to application of fill.

Gaps identified in soil data include:

- The extended period of historic mining infers potential for a wide range of potentially contaminating activities. Systematic assessment of metals concentrations in soils within the community has not occurred and as a result the extent of contamination in soil within the community is not well understood
- Elevated lead concentrations in soil within the community have not been vertically delineated
- Bioavailability of metals in soils impacted by dust, ore, mine waste and slag has not been assessed.

4.7.2 Surface Water

Key findings from surface water data include:

- Al, Co, Cu, Pb, Ni, Zn in mine leachate exceeded assessment criteria relevant to the receiving environment
- Zn exceeded assessment criteria to the extent sampled within the downstream receiving environment and was considered likely to be the primary driver of toxicity within the Molonglo River.

Gaps identified in surface water data include:

- Surface water usage within the Precinct
- The effect of rainfall variability on the degree and distribution of surface water contamination
- Assessment of dissolved metals (relevant to assessing ecological risks) is limited.

4.7.3 Sediment

A slump of tailings from the southern tailings dump is known to have occurred into the water supply dam in the 1940s. Risks to benthic and aquatic ecology in the water supply dam are therefore assumed to exist and this assumption will inform the Captains Flat Lead Management Plan.

The key findings from sediment data include:

- Metals in sediment (As, Cd, Cu, Ni, Sb, Zn) were observed above adopted assessment criteria. Additionally, Al and Mn were elevated though assessment criteria were not identified

Gaps identified in sediment data include:

- The current distribution of contaminated sediments within the Precinct
- Potential for sediment to act as an ongoing source of impact to surface water.

4.7.4 Air Quality

No known ambient air quality data was available for review in the vicinity of Captains Flat. GHD 2018 provided a high-level commentary of historic meteorological conditions which is of relevance to air quality in the region, where meteorology is a primary driver of atmospheric dispersion.

The GHD hydrology and climate review describes rainfall data collected in Captains Flat (Foxlow Street) from 1898 to 2017. Average monthly rainfall collected for the period did not show an annual seasonal trend. Average monthly rainfall varied from approximately 50 mm average in July to just over 70 mm average in November for the period reviewed.

Data from the Tuggeranong Bureau of Meteorology (BoM) station was reviewed by GHD, a station located approximately 36 km to the northwest of Captains Flat. The GHD report presents the BoM-produced 3 pm average wind rose, which indicates a prevailing north-westerly at 10 – 30 km/h. The data collected at Tuggeranong is unlikely to be representative of Captains Flat given the differences in terrain, where Tuggeranong is a relatively flat urban environment compared to Captains Flat which has distinctive valley terrain orientated roughly from north to south. The terrain is likely to steer winds through the valley and influence dispersion of particulate matter. It is also noted that the 3 pm average wind conditions at Tuggeranong only consider an hourly average, where dispersion conditions are likely to change throughout a diurnal period.

The nearest BoM station to Captains Flat is located in Braidwood, approximately 34.5 km to the northeast of Captains Flat, a considerable distance to be considered representative. Braidwood may be more representative of the conditions at Captains Flat than Tuggeranong, but again the terrain differs. The absence of known meteorology data in the vicinity of Captains Flat presents a data gap for the air quality monitoring program, where these conditions will influence source to receptor movement of air pollutants in the local airshed.

4.7.5 Internal Dust

Limited assessment of internal dust within public buildings has occurred. Data from the Captains Flat SES (assessed by Ramboll 2021) indicates lead loadings exceeded the adopted assessment criteria however an exposure assessment integrating limited use of the building supported the conclusion that risks were acceptable.

It is understood that assessment of internal dust has occurred at the former preschool and the RFS building however this data has not been provided for review to date.

4.7.6 Groundwater

There has been no assessment of groundwater or groundwater usage within the Precinct.

5. PRELIMINARY CONCEPTUAL SITE MODEL

Contaminants of potential concern (CoPC) identified by C&R in the literature review include As, Cd, Cu, Pb, Hg, Mn, Ni, and Zn. The review found that the mine site's unvegetated areas could be a source of significant contaminant transport to surrounding areas due to increased chance of erosion, dissolved and solid run-off, and contamination via wind-borne dust. Contamination from the mine site has been recorded in sediments of the Molonglo River extending up to 63 km downstream to Lake Burleigh Griffin in the north (C&R 2021). Along with metalliferous contamination, other contributing factors to environmental degradation in off-site surface waters include suspended particulates and the formation of thick iron oxide precipitates in the Molonglo River from mine seeps, and the ongoing issues of acid mine drainage/ seepage from on-site sources.

C&R developed a preliminary CSM as a qualitative representation of contaminant sources, migration pathways and potential receptors for CoPC from the legacy Lake George Mine. C&R developed cross-section figures representative of potential SPR linkages which are included in **Appendix 5**.

C&R identified the following knowledge/information gaps when undertaking the literature review. Answering the data gaps will better define SPR relationships in the CSM. The data gaps identified by C&R were as follows:

- Soil contamination impacts in the Captains Flat residential area: there was no literature/ investigations identified which provide information on the extent of soil contamination in the Captains Flat residential area. C&R is aware that the EPA has recently undertaken soil survey/sampling for lead in the area. However, these data were not available at the time of preparing this literature review. The soil survey and sampling results may be useful to address this gap.
- Groundwater hydrogeological information: groundwater flow is inferred towards the east/north-east, in line with Copper Creek flowing into the Molonglo River. However, no supporting groundwater surveys are available to confirm this information.
- Groundwater impacts in the region: there was no literature/ investigations identified during the review which address groundwater impacts in the area.
- Groundwater use in the area: there is no information on the use of groundwater within the Captains Flat residential area. C&R's bore search identified the closest groundwater bore is within 5 km of the area for domestic purposes. However, it is not clear whether this is representative of the Captains Flat region.
- Agricultural receptors in the area: it is not clear in the literature/ reports collected by C&R as to whether agricultural or horticultural activities are undertaken in the area.
- Home grown produce in the area: it is not clear whether residents in the Captains Flat area grow home-grown vegetables/ produce.

A tabulated summary of the preliminary CSM is presented as **Appendix 2** which integrates the literature review (C&R 2021) with Ramboll's review of data as described in **Section 4**. Ramboll has identified the following additional data gaps to supplement those identified by C&R:

- Systematic assessment of metals concentrations in soils within the community and vertical delineation of elevated lead concentrations in soil within the community. Specific areas requiring assessment and/or vertical delineation are identified in Table 7-2
- Bioavailability of metals in soils impacted by dust, ore, mine waste and slag, relevant to assessing human health risks
- Details of surface water and groundwater usage within the Precinct and the alluvial flats some kilometres downstream

- The effect of meteorological variability on the degree and distribution of surface water contamination
- Assessment of dissolved metals concentrations in surface water, relevant to assessing ecological risks
- The current distribution of contaminated sediments and exposure risks within the receiving environment
- Potential for sediment to act as an ongoing source of impact to surface water
- Meteorology data in the vicinity of Captains Flat to inform assessment of source to receptor movement of air pollutants in the local airshed
- Assessment of internal dust within public buildings.

An assessment program has been designed to address these data gaps and confirm the CSM. This in turn will inform preparation of the Captains Flat Lead Management Plan, as outlined in Figure 1-1**.**

It is assumed that information relating to surface water and groundwater usage within the Precinct will be made available to Ramboll to inform the preparation of interim water usage guidelines.

Data gaps that will not be resolved under the proposed sampling and analyses include:

- Details of surface water and groundwater usage for the Molonglo River downstream of the Precinct
- Assessment of contaminant impacts to the Molonglo River downstream of the Precinct or interactions with the alluvial aquifer and downstream water users
- Sediment contamination assumed to be present in the water supply dam will not be comprehensively assessed under the proposed sampling and analyses. The Captains Flat Lead Management Plan will be developed under the assumption that contaminant exposure risks exist for benthic and aquatic ecology in the water supply dam. Comprehensive assessment of sediment in the water supply dam should be considered as part of ongoing surface water monitoring
- Effects of meteorological variability in contaminant mobility via airborne, surface water and groundwater migration pathways will remain as a data gap and require ongoing monitoring
- Site specific risk assessment considering bioavailability of metals may be warranted depending on the results of the assessment, the identified risks to human health and ecology and the associated management requirements
- Human health effects from contaminant exposure within Captains Flat and the downstream receiving environment. A systematic assessment of community health effects is recommended as a basis for understanding effects from current exposure scenarios and for validating the Captains Flat Lead Management Plan once implemented.

6. ASSESSMENT CRITERIA

Tier 1 assessment criteria relevant to each environmental media are presented in sub sections below.

6.1 Soil

The NEPM (2013) provides health-based soil investigation levels (HILs) and ecological investigation levels (EILs) for various land uses. The assessment criteria to be adopted will depend on the local land use, as follows:

- HIL A – HIL for residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools
- HIL C – HIL for public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths
- HIL D – HIL for commercial / industrial such as shops, offices, factories and industrial sites.
- The HILs are applicable for assessing human health risk via all relevant pathways of exposure. The HILs are generic to all soil types and apply generally to a depth of 3 mbgl.
- If the above exposure assumptions are not applicable (e.g. poultry), site specific risk assessment may be required.
- EILs for Urban Residential and Public Open Space or Commercial/Industrial land use. EILs depend on specific soil physio-chemical properties such as pH, clay content, cation exchange capacity (CEC) and background concentrations. The published range of the added contaminant limits are listed in Table 6-1 as an initial screen. To define site-specific EILs, pH, clay content, CEC and background contaminant concentrations will be measured during the proposed sampling and the EILs presented in Table 6-1 will be modified accordingly.

The soil assessment criteria for metals are summarised in Table 6-1.

Table 6-1: Soil Assessment Criteria (mg/kg)

Contaminant	HIL A	HIL C	HIL D	EIL (Urban residential/ public open space)	EIL (Commercial/ Industrial)
Arsenic	100	300	3,000	100	160
Barium	-	-	-	-	-
Cadmium	20	90	900	-	-
Chromium	100[a]	300[a]	3,600[a]	130	320
Cobalt	100	300	4,000	-	-
Copper	6,000	17,000	240,000	95	140
Iron	-	-	-	-	-
Mercury	40	80	730	-	
Lead	300	600	1,500	1,100	1,800
Manganese	3,800	19,000	60,000	-	-
Molybdenum	-	-	-	-	-
Nickel	400	1,200	6,000	30	55
Selenium	-	-	-	-	-
Titanium	-	-	-	-	-
Zinc	7,400	30,000	400,000	70	110

- Indicates no criteria available

[a]HIL for chromium (VI)

6.2 Surface Water and Groundwater

The site receptors that can be exposed to mine discharges, seepages, surface runoff and waters within Copper Creek and Molonglo River may potentially include humans, ecology (aquatic and terrestrial), livestock and plants (via irrigation and direct absorption from surface water and groundwater).

The tier 1 assessment criteria adopted for different receptor groups are shown in Table 6-2. Note that:

- Australian Drinking Water Guidelines (ADWG) Section 6.3.1 (2011) states that guideline values refer to the total amount of the substance present, regardless of its form (e.g. in solution or attached to suspended matter) and so analytical results from unfiltered samples should be assessed against human health criteria. Similar reasoning is also applicable to irrigation and livestock guideline values. Total concentration analyses are proposed for surface water however groundwater samples will be field filtered, in accordance with Australian Standards
- ANZG (2018) guidelines for metals in freshwater states that the major toxic effect of metals comes from the dissolved fraction, so it is valid to filter samples (e.g. to 0.45 µm) and compare the filtered concentration against the respective guideline values
- Water hardness is identified as a physical parameter for which quantifiable effects correction factors are defined in the ANZG (2018) guidelines to address the effect of water hardness on the bioavailability of cadmium, chromium, lead, nickel and zinc to ecology. To define appropriate hardness correction factors, water hardness will be measured during the proposed sampling and the ecological screening criteria presented in Table 6-2 will be modified accordingly.

Table 6-2: Surface Water and Groundwater Assessment Criteria (mg/L)

Contaminant	**Drinking Water (NHMRC 2011) mg/L *(or US EPA RSL (for Tap Water))***	**Human Health - Recreation Screening***	**95% Fresh water (ANZG 2018)**	**Irrigation – Screening (ANZG 2018)**	**Stock Water – Screening (ANZG 2018)**
Criteria Applied to	Total concentration**	Total concentration**	Filtered (dissolved) concentration	Total concentration**	Total concentration**
Aluminium	*(20)*	200	0.055 (pH>6.5) & 0.0008 (pH<6.5)[a]	20	5
Arsenic	0.01[b]	0.1[b]	0.024 (III) 0.013 (V)	2[b]	0.5-5[b]
Cadmium	0.002	0.02	0.0002	0.05	0.01
Chromium	0.05	0.5	0.001	1	1
Cobalt	*(0.006)*	0.06	0.0014	0.1	1
Copper	2	20	0.0014	5	0.4-5
Iron	*(14)*	140	-	10	not sufficiently toxic
Lead	0.01	0.1	0.0034	5	0.1
Manganese	0.5	5	1.9	10	not sufficiently toxic
Mercury	0.001	0.01	0.00006[d, e]	0.002	0.002
Nickel	0.02	0.2	0.011	2	1
Zinc	*(6)*	60	0.008	5	20

blank cell denoted with – indicates no criterion available.

** Values based on site-specific exposures will be used in final assessment*

*** For surface water samples. Groundwater samples will be field filtered, in accordance with Australian Standards*

[a] Aluminium guidelines for pH > 6.5and pH <6.5 based on variable (acidic-neutral-alkaline) pH measured previously in various surface waters, seeps and runoffs.

[b] Guideline value for total arsenic.

[c] Guideline value for chromium (VI).

[d] Guideline value for inorganic mercury.

[e] 99% species protection level DGV has been adopted to account for the bioaccumulating nature of this contaminant.

The water quality criteria protective of human health adopted for assessment is primarily adopted from Australian Drinking Water guidelines; however, US EPA RSL for tap water is adopted for analytes where no Australian guideline (ADWG) was available. It is considered likely that primary human health exposures will occur via recreational activities. The National Health and Medical Research Council (NHMRC) (2008) suggests that 10-times the ADWG values may provide a conservative estimate of acceptable recreational exposure guidelines values. This approach is based on the assumption that recreational activities contribute to 10% of drinking water consumption, which is equivalent to a daily lifetime consumption of about 0.2 L of water. NHMRC (2019) suggests that this approach may not provide realistic site-specific recreational exposure estimate as:

- The method makes no allowance for other exposure routes, such as inhalation and dermal absorption, which may be significant for some chemicals. In the case of heavy metals at the site these exposure routes may be considered to be negligible.
- The method does not apply explicit assumptions for rates of accidental water ingestion during recreational water use.
- The method does not provide explicit assumptions regarding patterns of recreational water use. Therefore, it is not possible for communities to assess whether the assumptions apply to realistic patterns of recreational activity at specific sites, which may vary according to location, availability of alternative recreational facilities, and cultural practices.

NHMRC (2019) provides an approach for estimating recreational exposure guidelines values based on water intake from estimated frequency of exposure. The NHMRC (2019) approach will be used to calculate recreational exposure guideline values based on estimated exposure frequencies or events for the final assessment and development of water use guidelines. The site-specific exposure frequencies will be determined from a review of water use practices within the Precinct. The recreational guideline values (based on 10-fold adjusted drinking water values) shown in Table 6-2 will be replaced by the exposure adjusted recreational guideline values for assessment. Currently, no health-based sediment guideline values are available. Background sediment concentrations will be used in the assessment, although any exceedances may not indicate risks to human health, as background values are not based on health effects.

6.3 Sediment

The criteria proposed for the assessment of sediment contamination are sourced from the default guideline values (DGVs) for sediment quality in ANZG (2018). The adopted assessment criteria for sediment are summarised in Table 6-3.

Table 6-3: Sediment Assessment Criteria (mg/kg)

Contaminant	Sediment DGV	GV-High
Aluminium	-	-
Arsenic	20	70
Barium	-	-
Beryllium	-	-
Cadmium	1.5	10
Chromium	80	370
Cobalt	-	-

Contaminant	Sediment DGV	GV-High
Copper	65	270
Iron	-	-
Lead	50	220
Manganese	-	-
Mercury	0.15	1.0
Nickel	21	52
Zinc	200	410

The DGV was derived using a ranking of both observed field and laboratory ecotoxicity-effects and represents the 10th percentiles of that data distribution.

GV-high represents the median of that data distribution to provide an upper guideline value. Effects on sediment biota are rarely seen for concentrations below the DGV, while effects are more frequently evident above the GV-high value.

6.4 Air Quality

Relevant ambient air quality criteria for NSW are defined in Table 6-4 from the following sources:

- NEPC (1998). Ambient Air – National Environment Protection Measure for Ambient Air Quality, National Environment Protection Council, Canberra
- NHMRC (1996). Ambient Air Quality Goals Recommended by the National Health and Medical Research Council, National Health and Medical Research Council, Canberra.

Table 6-4: Air Quality Assessment Criteria

Pollutant	Averaging period	Criteria	Source
Lead	Annual	0.5 µg/m³	NEPC (1998)
Total suspended particulates (TSP)	Annual	90 µg/m³	NHMRC (1996)

6.5 Internal Dust

The preliminary screening criteria proposed for the assessment of dust contamination are sourced from the following references:

- USEPA (2020) Protect your family from lead in your home. US Environmental Protection Agency – January 2020.
- AS 4361.2-1998 Guide to lead paint management - Residential and commercial buildings.

The dust results are to be presented as lead loadings (µg lead/m²). Where dust samples are collected by vacuum, the lead loading is calculated using the following equation:

$$\textit{Lead loading } (\mu g/m^2) = \frac{\textit{lead concentration (mg/kg) x dust sample mass (g)}}{\textit{sample area } (m^2)}$$

Where samples are collected by swab, the lead loading is calculated using the following equation:

$$\textit{Lead loading } (\mu g/m^2) = \frac{\textit{total lead } (\mu g)}{\textit{sample area } (m^2)}$$

Assessment criteria adopted for lead dust contamination within public buildings are summarised in Table 6-5.

Table 6-5: Lead Dust Assessment Criteria (µg/m²)

	Assessment Criteria - Commercial Property (µg/m²)
Dust interior – hard floors	1,000
Dust interior – windowsills and shelves	5,000

7. DATA QUALITY OBJECTIVES

To refine the preliminary CSM to appropriately represent lead exposure risks within Captains Flat, both the field and laboratory programs must result in data that is representative of the conditions at the site. Data Quality Objectives (DQOs) have been developed for the tasks to be completed to address data gaps identified in the preliminary CSM. The DQO process is a systematic, seven-step process that defines the criteria that the sampling should satisfy in accordance with the *Guidelines for the NSW Site Auditor Scheme (3rd Edition)* (NSW EPA 2017).

The seven step DQOs process comprises:

1. Step 1: State the problem
2. Step 2: Identify the decisions/ goal of the study
3. Step 3: Identify the information inputs
4. Step 4: Define the boundaries of the study
5. Step 5: Develop the decision rules or analytical approach
6. Step 6: Specify the performance or acceptance criteria
7. Step 7: Develop the plan for obtaining data.

7.1 Step 1: State the problem

Historic metalliferous mining has contaminated Captains Flat. Previous assessments define some of the impacts however further assessment is required to characterise the degree and extent of contamination with sufficient detail to inform development of the Captains Flat Lead Management Plan.

7.2 Step 2: Identify the decisions/ goal of the study

Goals of the study are:

1. To determine the lateral and vertical extent of lead contamination in soil in the Precinct with sufficient detail to inform a refined CSM and development of the Captains Flat Lead Management Plan
2. To identify whether other metal contamination exists within the Precinct soils
3. To determine the degree and extent of metals contamination in surface water and groundwater
4. To determine the current distribution of contaminated sediments within the Precinct
5. To determine the degree and extent of lead contamination in ambient air and indoor dust in public buildings
6. To complete a Tier 1 risk assessment for human health and ecology within the area of assessment.

7.3 Step 3: Identify the information inputs

Inputs to the decisions will be sourced from:

1. Historical soil and surface water data from previous investigations completed within the Precinct
2. Additional analyses of soils by fpXRF and laboratory analysis of soils for lead for correlation to fpXRF samples
3. Laboratory analysis for CoPC in sediment, surface water and groundwater
4. Analysis for lead in internal dust in public buildings and for lead and TSP in ambient air
5. Site-specific meteorological data

6. Information regarding surface water and groundwater usage within the Precinct (it is assumed this will be made available to Ramboll)
7. Surveyed groundwater levels from installed groundwater monitoring wells.

7.4 Step 4: Definition of the Study Boundary

The boundaries for the assessment are the Precinct boundaries as defined in **Figure 1**, **Appendix 1**.

The assessment will be limited vertically to an indicative depth of 1.5 mbgl in soil to assess potential risks to maintenance workers with groundwater well installation proposed to a maximum depth of 10 mbgl targeting shallowest serviceable aquifer or shallowest groundwater observed.

The temporal boundaries of the assessment will cover one mobilisation and sampling event for soil, sediment, surface water, groundwater and internal dust approximately within June 2021. Air quality will be monitored for an initial two-month period, to be repeated in two further monitoring periods covering an overall monitoring period of 6 months.

7.5 Step 5: Develop the decision rules or analytical approach

1. Do contaminant concentrations exceed Tier 1 assessment criteria?
2. Is the extent of contamination defined?
3. Does the degree and extent of exceedances warrant further assessment or remediation/management?
4. Have all identified data gaps been addressed?
5. If not, what further assessment is required to assess data gaps and determine remediation/management requirements?

7.6 Step 6: Specify the performance or acceptance criteria

Performance criteria are defined to assess potential for a false positive or false negative in data. Data quality indicators (DQIs) and performance criteria for fpXRF measurements of lead in soil, and sampling for laboratory analyses of sediment, internal dust, groundwater, surface water and airborne dust are presented in Table 7-1 following. Further details of the proposed sampling and QA/QC procedures are provided in the subsequent sections.

Decision Error Protocol

If the data received is not in accordance with the defined acceptable limits outlined in Steps 5 and 6, it may be considered to be an estimate or be rejected. Determination of whether this data may be used or if re-sampling is required will be based on the following considerations:

- Closeness of the result to the guideline concentrations
- Specific contaminant of concern (e.g. response to carcinogens may be more conservative)
- The area of site and the potential lateral and vertical extent of questionable information
- Whether the uncertainty can be effectively incorporated into site management controls.

Table 7-1: Performance Criteria

Data quality indicator	Performance Criteria			
	Soil	**Sediment, Groundwater, Surface Water**	**Internal Dust**	**Air Quality**
Field Quality Control Samples	Intra- and inter-laboratory duplicate sampling density of 5% (1 in 20 samples) 1 rinsate sample per day	Intra- and inter-laboratory duplicate sampling density of 5% (1 in 20 samples) 1 rinsate sample per day	Intra- and inter-laboratory duplicate sampling density of 5% (1 in 20 samples) 1 rinsate sample (cleaned barrel swab) per day for vacuum sampling	-
Field Quality Control Results	Relative Percentage Differences (RPDs) should be below 30% for inorganic analytes. No detections in rinsate samples The correlation coefficient (R) should be above 0.7.	RPDs below 30% for inorganic analytes. No detections in rinsate samples	RPDs below 30% for inorganic analytes. No detections in rinsate samples	-
NATA Registered Laboratory and NATA Endorsed Methods	Laboratories used should be NATA accredited and laboratory certificates should be NATA stamped.			
Analytical Methods	As stated in US EPA Method 6200 (2007), to increase accuracy of the results, complete digestion of soil and sediment samples is valuable to ensure accurate correlation. Ideally, Method 3052 should be adopted for analysis of soil and sediment, however, this method is not available at the NATA accredited laboratories considered for this project and Method 3050 will be used. To reduce dilution errors in reported results, the laboratory will be advised a likely metals concentration range based on fpXRF readings for each sample sent for laboratory analysis.			
Holding Times	Holding times for all analytes should be met.			
Practical Quantitation Limit (PQL)	PQLs should be below the adopted assessment criteria.			
Laboratory Quality Control Samples	Laboratory quality assurance testing should be undertaken at appropriate frequencies.			
Laboratory Quality Control Results	Laboratory Quality Control Results should meet laboratory acceptance limits.			

7.7 Step 7: Develop the Plan for Obtaining Data

7.7.1 Soil Sampling

The proposed soil sampling is summarised in Table 7-2 with reference to SAQP item numbers from the preliminary CSM tabulated summary in **Appendix 2**. A systematic sampling approach is proposed within each Area of Concern. Primary soil measurements will be collected using fpXRF. 5% of soil fpXRF samples will be laboratory analysed to establish a correlation, targeted based on field observed concentrations to provide coverage of the total concentration distribution range.

Proposed sampling locations are shown on **Figure 6a – 6b**, **Appendix 1**.

Table 7-2: Proposed Soil Sampling Program

Area of Concern	SAQP Item	CoPC	Proposed Soil Sampling
Above Ground Tailings and Mine Waste	2	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	8 surface XRF measurements along ephemeral drainage line from tailings dumps.
Southern Smelter	5	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	10 shallow hand augers to 0.3 m depth with XRF measurements at surface, 0.1 and 0.25 m depth
Northern Ridge	6	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	5 shallow hand augers to 0.3 m depth with XRF measurements at surface, 0.1 and 0.25 m depth
Sewage Treatment Area	7	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	10 shallow hand augers to 0.3 m depth with XRF measurements at surface, 0.1 and 0.25 m depth
Mogo Land adjacent (west of) the Rail Loader	8	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	8 shallow hand augers to 0.3 m depth with XRF measurements at surface, 0.1 and 0.25 m depth
Foxlow Parklet	9	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	5 push tubes to 1.0 m depth with XRF measurements at surface, 0.1, 0.25, 0.5, 0.75 and 1 m depth.
Foxlow Street	10	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	6 shallow push tubes to 1.5 m depth with XRF measurements at surface, 0.1, 0.25, 0.5, 0.75, 1, 1.25 and 1.5 m depth.
Areas behind the former preschool	11	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	10 shallow push tubes to 1.0 m depth with XRF measurements at surface, 0.1, 0.25, 0.5, 0.75 and 1 m depth.
Western embankment at southern end of town	13	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	5 shallow push tubes to 1.0 m depth with XRF measurements at surface, 0.1, 0.25, 0.5, 0.75 and 1 m depth. 10 shallow hand augers to minimum 0.3 m depth (maximum 1 m depth) with XRF measurements at surface, 0.1 and 0.25 m depth
Foxlow Street public amenity areas (playing fields swimming pool etc)	14	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	25 shallow hand augers to 0.3 m depth with XRF measurements at surface, 0.1 and 0.25 m depth
Subdivisions east and west of north end of town	15	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	10 shallow hand augers to 0.3 m depth with XRF measurements at surface, 0.1 and 0.25 m depth

Area of Concern	SAQP Item	CoPC	Proposed Soil Sampling
Land northeast of the water supply dam	16	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	5 shallow hand augers to 0.3 m depth with XRF measurements at surface, 0.1 and 0.25 m depth
Crown land	18	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	18 shallow hand augers to 0.3 m depth with XRF measurements at surface, 0.1 and 0.25 m depth
Community Gardens	19	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	5 shallow hand augers to 0.3 m depth with XRF measurements at surface, 0.1 and 0.25 m depth
Miners Road	20	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	14 shallow hand augers to 0.3 m depth with XRF measurements at surface, 0.1 and 0.25 m depth
Public roads to assess community exposure	106	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	Surface soil fpXRF measurements in public road reserves on 50 lineal metre increments where buildings are present south of the river (approx. 1 km - 20 locations), 100 lineal metre increments where buildings are north of the river (approx. 7 km - 70 locations) and on 250 lineal metre increments in other areas (approx. 4 km - 16 locations).

To facilitate bioavailability analyses, three bulk samples (approx. 2 kg) will be collected from three areas of contamination within the community (the southern smelter slag stockpile, the eastern embankment of the mine site and the rail corridor). That is, a total of nine samples will be collected. Sampling locations will be informed based on review of fpXRF measured lead to represent a range of concentrations from each location.

7.7.2 Surface Water Sampling

Surface water sampling will occur at a total of 15 locations targeted to assess contaminant concentrations in the background environment (upstream of the water supply dam), discharge points and the downstream receiving environment.

Proposed sampling locations target historic sampling locations as described in Table 7-3 and on **Figure 2**, **Appendix 1**.

Table 7-3: Proposed Surface Water Sampling Locations

Previous Sample ID	Reference	Location
Sample Site 3: Upstream of reservoir	EPA 2019	Upstream of water supply dam (will be moved further upstream)
CF001-W	GHD 2018	Water supply dam
SW07	GHD 2018	Southern Tailings Dump seepage (east side)
Second Seepage Point	EPA 2019	Southern Tailings Dump seepage (north end)
Upstream Forsters Creek Confluence	GHD 2018	Upstream Forsters Creek confluence
Forsters Creek Confluence	GHD 2018	Forsters Creek Confluence

Previous Sample ID	Reference	Location
SW02	EPA 2019	Main Adit Spring
SW01	Ramboll 2021	Drainage line downstream of mine site sediment dams. Upstream of rail corridor.
SW02	Ramboll 2021	Drainage line downstream of mine site sediment dams and rail corridor.
SW04	Ramboll 2021	Copper Creek upstream of rail corridor.
SW05	Ramboll 2021	Copper Creek downstream of rail corridor.
SW04	GHD 2018	Copper Creek confluence with Molonglo River
SW06	GHD 2018	Captains Flat Road bridge
Molonglo River Bridge	EPA 2019	Molonglo River downstream of Copper Creek
Swimming Hole	EPA 2019	Swimming hole at northern end of precinct

All surface water samples will be analysed for total and dissolved metals (Al, As, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Zn). To facilitate dissolved metals analyses surface water samples will be filtered in the field using 0.45 µm filters. pH, temperature, dissolved oxygen (DO), electrical conductivity (EC), redox and total dissolved solids (TDS) will be measured using a water quality meter in the field at the time of sampling at each location.

7.7.3 Sediment Sampling

Sediment samples will be co-located with surface water sampling locations described in Table 7-3: Proposed Surface Water Sampling Locations

. Sediment samples will target the upper 5 cm of sediment in the drainage channel/ creek/ dam.

Sediment samples will be analysed for total metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn).

7.7.4 Air Quality Monitoring

Five locations in Captains Flat are proposed for monitoring heavy metals in airborne particulate matter. The five proposed monitoring locations are summarised in Table 7-4. The air quality criteria are relevant at sensitive receptors, so it is preferable to monitor in community locations such as residences and schools rather than industrial locations such as the sewage treatment plant or SES. Should measurement of meteorological conditions be further considered for this location, it is recommended that equipment be located at AQM4 given the elevated terrain in this location which would be representative of prevailing regional conditions.

Proposed Air quality monitoring locations are presented on **Figure 3**, **Appendix 1**.

Table 7-4: Air Quality Monitoring Locations

ID	Location	Reason for selection	Monitoring Technique	Parameters measured
AQM1	Residence, 2 Copper Creek Road	Identified as the nearest sensitive receptor to identified mining areas to the north-west	High-volume air sampler (HVAS) with total suspended particulate (TSP) size selective inlet, measuring for 24-hours every 1 day in 6	Heavy metals in TSP (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)
AQM2	Captains Flat former Preschool, 27 Foxlow Street	Identified as a sensitive receptor of interest and representative of potential impacts to the south-east	HVAS with TSP inlet, measuring for 24-hours every 1 day in 6	Heavy metals in TSP (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)

AQM3	Captains Flat Public School, Montgomery Street	Representative of potentials impacts of the largest community to the north-east	HVAS with TSP inlet, measuring for 24-hours every 1 day in 6	Heavy metals in TSP (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)
AQM4	Residence, Old Mine Road	Representative of potential impacts to the south-west. Elevated terrain may provide a less localised, regional measure of lead in particulate compared to other locations	HVAS with TSP inlet, measuring for 24-hours every 1 day in 6	Heavy metals in TSP (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)
AQM5	Adjacent Residential property south-east of the mine	Representative impacts to residents down-wind of the mine	HVAS with TSP inlet, measuring for 24-hours every 1 day in 6	Heavy metals in TSP (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)

The initial monitoring program will be maintained for six months, after which the scope may be reviewed (e.g. metals analysed). It is noted that the ambient air quality criteria for lead is based on an annual average and that air quality can exhibit distinct annual patterns contributed to by seasonal changes in meteorology. An annual monitoring period would be considered representative and could be compared to the air quality criteria. Data reporting will be completed on a two-monthly basis, as requested in the tender.

The air quality monitoring program will be completed in the following steps:

- Selection of five suitable monitoring locations in Captains Flat with consideration of potential source locations, prevailing meteorology, accessible power source, appropriate security, and the recommendations of *AS/NZS 3580.1.1 – Methods for sampling and analysis of ambient air – Part 1.1: Guide to siting air monitoring equipment*.
- Commissioning of five high-volume air samplers with size selective inlets for total suspended particulate (TSP) in Captains Flat. The instruments will be calibrated and maintained consistent with *AS/NZS 3580.9.3 – Method 9.3 – Determination of suspended particulate matter – Total suspended particulate matter (TSP) – High volume sampler gravimetric method.* Sampling will be configured for a 24-hour period every 1 day in 6.
- Mobilisation of experienced field staff to replace filters, complete instrument checks and clean the equipment every 1 day in 6. Calibration will be completed on a 2-monthly basis consistent with *AS/NZS 3580.9.3*.
- Submission of samples to a NATA accredited laboratory and analysed for 15 metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn) in accordance with *AS/NZS 3580.9.15 – Method 9.15: Determination of suspended particulate matter – Particulate metals high or low volume sampler gravimetric collection – Inductively coupled plasma (ICP) spectrometric method*. TSP concentration will be calculated through filter weighing before and after sampling and flow volume.
- A report will be prepared on a 2-monthly basis outlining the methodology and summarising the sampling results with comparison to publicly available meteorology data and relevant air quality criteria. All reports will be peer reviewed by a senior air quality specialist prior to submission.

7.7.5 Internal Dust Sampling

Internal dust sampling will be undertaken at four public buildings (locations TBC). A total of 16 samples will be collected comprising four samples per building (vacuum and swab at each location).Internal dust sampling locations remain to be confirmed though will target public buildings adjacent the rail loading area, eastern embankment of the mine and areas north of the Molonglo River.

Swab sampling of internal dust sampling will be completed in general accordance with US EPA 2009 Lead Dust Sampling Technician Field Guide (US EPA 2009) as well as the following:

- Sample areas will be marked out using masking tape. Sampling areas of 0.09 m^2 will be targeted where feasible
- Dust sampling will be completed wearing single use disposable nitrile gloves and using single use sanitary wipes. Dust will be collected by making S-shaped motions through the sampling area, folding the wipe in half and repeating the process at least three times and until all visible dust is removed.
- The swab will be collected and analysed for total lead.

Vacuum samples will be collected in general accordance with the Guidance for the sampling and analysis of lead in indoor residential dust for use in the integrated exposure uptake biokinetic (IEUBK) model (US EPA 2008) and will include:

- Marking out of 2 m^2 sampling areas using masking tape
- subdividing sample areas into 0.5 m^2 sub-sample areas
- A high-flow cyclonic vacuum will be run in strips to cover each sub-sample area four times back and forth
- Dust from the vacuum will be collected and analysed for total dust and total lead.

7.7.6 Groundwater Sampling

For the purpose of assessing groundwater contamination, 10 monitoring wells will be installed to a maximum depth of 10 m targeting the upper aquifer.

Monitoring well locations have been proposed to assess:

- The presence/absence and flow direction of a shallow alluvial aquifer assumed to exist and contaminant impacts via seepage from identified contaminant sources
- Interaction between the assumed alluvial aquifer and surface water in the Molonglo River with specific regard for contaminant distribution and effects on potential receptors
- Potential groundwater contamination from the rail loading area as measured along an anticipated flow path north to Copper Creek
- Potential groundwater contamination from the northern tailing dump as measured along an anticipated flow path north to the Molonglo River.

Wells will be constructed using a licensed drilling contractor and will be constructed as per the Minimum Construction Requirements for Water Bores in Australia, Fourth Edition, 2020 and will comprise the following:

- 50 mm PVC class 18 factory slotted (0.5mm) well screen (no filter socks will be used to assess the presence of LNAPL/DNAPL)
- 50 mm PVC class 18 blank casing
- A push-on end cap at the base of each well
- A top cap suitable for suspension of groundwater level data loggers
- A graded 2 mm gravel pack installed from the base, generally to 0.5 m above the top of the well screen in the annulus between the well screen/casing and the borehole wall
- An annular seal consisting of at least 1 m of 3/8" bentonite chips installed on top of the gravel pack
- A cementitious grout slurry installed on top of the bentonite annular seal to near surface
- Wells will be completed on the surface with a surface bentonite seal and a concrete plinth in which a flush mount well cover will be set and the well capped with a lockable steel cap that is finished flush with the surrounding surface level.

Wells will be installed ensuring screens are located within the aquifer of concern (shallow) and are not screened across the two distinct aquifers causing cross contamination.

Following installation, the wells will be developed/purged to remove disturbed fines and to try to re-establish the natural hydraulic flow conditions of the formations which may have been disturbed by well construction, around the immediate vicinity of each well. The wells will be left for up to one week to equilibrate prior to collection of groundwater samples. Completed monitoring wells will be surveyed by an accredited land surveyor, recording easting, northing, ground elevation and top of casing elevation for all wells. Coordinates will be collected in GDA2020 Zone 56 datum.

Purge water and liquid waste generated during well installation will be stored in 205 L drums onsite and clearly marked with the appropriate liquid waste category. These materials will be removed by a waste contractor to an appropriately licensed waste receival facility.

Groundwater sampling will utilise low-flow sampling techniques and be carried out as follows:

- Mobilisation of two field staff experienced in sampling of contaminated groundwater
- Chemical and physical parameters, including temperature, pH, EC, DO, redox potential and TDS will be measured in the field. A filtered sample for metals analysis will be collected from each location.
- To facilitate dissolved metals analyses groundwater samples will be filtered in the field using 0.45 µm filters.
- Groundwater samples will be collected when parameters are stabilised.
- Each sample bottle will be clearly labelled with a unique sample name, date and location

Samples will be analysed for dissolved metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn).

7.7.7 Proposed Methodology and Quality Assurance/Quality Control Procedures

Table 7-5: Methodology and QA/QC

Category	Performance Criteria					
	fpXRF Measurements	**Sediment**	**Internal Dust**	**Groundwater**	**Surface Water**	**Air Quality**
Accuracy: Accuracy in the collection of field data will be controlled by:	Appropriate sampling methodologies will be utilised and complied with. Works to be completed in accordance with US EPA 2007, *Method 6200, Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment*. These will include: • Daily system checks and internal calibration as recommended by the instrument manual. • Measurement of blank reference material (silicon dioxide, SiO2) – this will be done at the start of the day and repeated every 10 samples. This will mitigate potential inaccuracies associated with cross-contamination of samples. The analyser window will also be cleaned regularly to prevent cross-contamination. • Certified reference materials will be measured to check instrument response and calibration. This will be conducted every 20 samples. • Adopting a dwell time appropriate for measurement of CoPC. A dwell of 60 seconds is considered to provide sufficient precision for the sampling program.	Sediment sampling will be completed in general accordance with the Handbook for Sediment Quality Assessment (Simpson et al, 2005). Sediment samples will be collected using plastic tubing (bailers) cut down to act as disposable sediment core samplers targeting the upper 5 cm of sediment in the drainage channel/creek/dam.	Swab sampling of internal dust sampling will be completed in general accordance with US EPA 2009 Lead Dust Sampling Technician Field Guide (US EPA 2009) as well as the following: • Sample areas will be marked out using masking tape. Sampling areas of 0.09 m2 will be targeted where feasible • Dust sampling will be completed wearing single use disposable nitrile gloves and using single use sanitary wipes. Dust will be collected by making S-shaped motions through the sampling area, folding the wipe in half and repeating the process at least three times and until all visible dust is removed.	• Calibrated measurement equipment used. The water quality meter will be calibrated by the technical rental company prior to use. • Appropriate sampling methodologies utilised and complied with. Works to be completed with regard for *AS/NZS 5667.11:1998 Water quality - Sampling - Guidance on sampling of groundwaters.*	• Calibrated measurement equipment used. The water quality meter will be calibrated by the technical rental company prior to use. • Appropriate sampling methodologies utilised and complied with. Works to be completed with regard for *AS NZS 5667.6-1998 Water quality - Sampling - Guidance on sampling of rivers and streams*.	Airborne lead in particulate matter will be measured in accordance with *AS/NZS 3580.9.3 Determination of suspended particulate matter – Total suspended particulate matter (TSP) High volume sampler gravimetric method*. All samples will be analysed by a NATA accredited laboratory in accordance with *AS/NZS 3580.9.15 Determination of suspended particulate matter – Particulate metals high or low volume sampler gravimetric collection – Inductively coupled plasma (ICP) spectrometric method.* Air quality monitoring instruments will be sited, as far as practicable, with the recommendations of *AS/NZS 3580.1.1 Guide to siting air monitoring equipment*. The instruments will be maintained in accordance with the manufacturer's guidance.
Precision: The degree to which data generated from replicate or repetitive measurements differ from one another due to random errors. Precision of field data will be maintained by:	• XRF readings will be collected by an experienced scientist holding a NSW EPA license required for field based XRF testing • XRF readings will be collected from soil in-situ and measurements will be taken by placing the XRF directly on the ground surface. • The soil surface to be measured will be cleared of debris and grass prior to taking the measurement to ensure that there is no obstruction, that the analyser window is protected and that contact with the sample surface is maintained during measurements. • As moisture is known to affect measured concentrations, visually dry surfaces will be chosen for measurement. • Soil sampling for confirmatory laboratory analyses will occur at a frequency of 5% covering the observed distribution of concentrations in general accordance with AS 4482.1-2005 Guide to the investigation and sampling of sites with potentially contaminated soil - Non-volatile and semi-volatile compounds. This will include: o Collection of samples by a suitably experienced environmental scientist o Use of disposable nitrile rubber gloves between locations o Soil samples will be placed immediately into laboratory supplied and appropriately preserved sampling vessels. o Sample numbers, preservation and analytical requirements are to be recorded on chain of custody documents.	In the field, precision will be maintained by: • Using standard operating procedures for the collection of sediment samples. • Collection of sediment samples by suitably experienced environmental scientists. • Use of disposable nitrile rubber gloves between sampling locations. • Placement of samples directly into designated single use sampling containers. • Collection of intra-laboratory and inter-laboratory duplicate samples at a rate of 1 in 20 primary samples. • Collection of one rinsate sample on reusable sampling equipment at the end of each day. • Recording of sample identification and analytical requirements on chain of custody documents. • Samples transported to the laboratory under chain of custody conditions to a laboratory with NATA accreditation for the analytical methods prescribed.	In the field, precision will be maintained by: • Using standard operating procedures for the collection of dust samples. • Collection of dust samples by suitably experienced environmental scientists. • Use of disposable nitrile rubber gloves between sampling locations. • Placement of samples directly into designated single use sampling containers. • Collection of intra-laboratory and inter-laboratory duplicate samples at a rate of 1 in 20 primary samples. • Recording of sample identification and analytical requirements on chain of custody documents. • Samples transported to the laboratory under chain of custody conditions to a laboratory with NATA accreditation for the analytical methods prescribed.	• Groundwater sampling will be completed by experienced scientists • A new pair of disposable nitrile gloves to handle each sample. • Samples will be placed immediately into laboratory supplied and appropriately preserved sampling vessels • Samples will be stored in chilled, insulated containers with ice for transportation to the laboratory • Sample numbers, preservation and analytical requirements will be recorded on chain of custody documents. • Samples will be transported to the laboratory under chain of custody conditions. • Collection of intra-laboratory and inter-laboratory duplicate samples at a rate of 1 in 20 primary samples. • Collection of one rinsate sample on reusable sampling equipment at the end of each day.	• Surface water sampling will be completed by experienced scientists • A new pair of disposable nitrile gloves to handle each sample. • Samples will be placed immediately into laboratory supplied and appropriately preserved sampling vessels • Samples will be stored in chilled, insulated containers with ice for transportation to the laboratory • Sample numbers, preservation and analytical requirements will be recorded on chain of custody documents. • Samples will be transported to the laboratory under chain of custody conditions. • Collection of intra-laboratory and inter-laboratory duplicate samples at a rate of 1 in 20 primary samples. • Collection of one rinsate sample on reusable sampling equipment at the end of each day.	In the field, precision will be maintained by: • Using standard operating procedures for air quality monitoring. • Completion of air quality monitoring by suitably experienced environmental scientists. • Recording of sample identification and analytical requirements on chain of custody documents. • Samples transported to the laboratory under chain of custody conditions to a laboratory with NATA accreditation for the analytical methods prescribed.

Category	Performance Criteria					
	fpXRF Measurements	**Sediment**	**Internal Dust**	**Groundwater**	**Surface Water**	**Air Quality**
Completeness: The completeness of the data set shall be judged by:	• All locations sampled as outlined in Section 7.7.1. • Sampling completed by experienced personnel • Field documentation completed correctly	• All locations sampled as outlined in Section 7.7.3. • Sampling completed by experienced personnel • Field documentation completed correctly	• All locations sampled as outlined in Section 7.7.5 • Sampling completed by experienced personnel • Field documentation completed correctly	• All locations sampled as outlined in Section 7.7.6 • Sampling completed by experienced personnel • Field documentation completed correctly	• All locations sampled as outlined in Section 7.7.2 • Sampling completed by experienced personnel • Field documentation completed correctly	• All locations sampled as outlined in Section 7.7.4. • Sampling completed by experienced personnel • Field documentation completed correctly
Representativeness: The representativeness of the field data will be judged by:	• Non-disposable sampling equipment, such as the hand auger, will be thoroughly decontaminated between locations using Decon 90 solution and deionised rinsate water. • At each location, a pair of disposable nitrile gloves will be worn while sampling and handling the sample; gloves will be replaced between each successive sample. • Soil analytical samples will be collected directly into the sampling vessels.	• Non-disposable sampling equipment, such as the hand auger/trowel/sediment sampler will be thoroughly decontaminated between locations using Decon®90 solution and deionised rinsate water. • At each location, a pair of disposable nitrile gloves will be worn while sampling and handling the sample; gloves will be replaced between each successive sample. • Sediment analytical samples will be transferred directly from the sediment corer to the sample container. • Each sample jar will be clearly labelled with a unique sample name, date and location.	• All dust sampling will be undertaken wearing disposable nitrile rubber gloves. Samples will be in single use zip lock bags labelled with unique identifiers which will be cross-referenced with site plans and submitted to the laboratory under chain of custody. • Sampling areas will be measured and marked out, the actual area sampled will be recorded in the field notes.	• Non-disposable sampling equipment, such as the water quality meter, will be thoroughly decontaminated between locations using Decon 90 solution and deionised rinsate water. • At each location, a pair of disposable nitrile gloves will be worn while sampling and handling the sample; gloves will be replaced between each successive sample. • Groundwater analytical samples will be collected directly into the sampling vessels from the sample tubing via 0.45 µm disposable filters. • Filtered samples will be collected for analysis of heavy metals which will be representative of dissolved concentrations.	• Non-disposable sampling equipment, such as the grab sampler and water quality meter, will be thoroughly decontaminated between locations using Decon 90 solution and deionised rinsate water. • At each location, a pair of disposable nitrile gloves will be worn while sampling and handling the sample; gloves will be replaced between each successive sample. • Surface water analytical samples will be collected directly into the sampling vessels using an extendable pole sampler where appropriate via 0.45 µm disposable filters. • Both filtered and non-filtered samples will be collected for analysis of heavy metals which will be representative of both dissolved and total metal concentrations.	• At each location, a pair of disposable nitrile gloves will be worn while sampling and handling the sample; gloves will be replaced between each successive sample • Dust HV filters will be transported in disposable zip-lock bags
Comparability: Comparability to existing field data will be maintained by:	• Use of the same appropriate sampling methodologies • Same sampling depths will be used (i.e.: 0-0.05 mbgl) • Analytical samples will be collected for submission to the laboratory to establish a correlation between fpXRF and laboratory results • Photographs will be taken of sampling location conditions at the time of sampling.	• Use of the same appropriate sampling methodologies • Same sampling depths will be used (where practical) • Analytical samples will be collected for submission to the laboratory • Photographs will be taken of sampling location conditions at the time of sampling.	• Use of the same appropriate sampling methodologies • Same sampling areas (or justification where a different area was used) • Analytical samples will be collected for submission to the laboratory • Photographs will be taken of sampling location conditions at the time of sampling.	• Use of the same appropriate sampling methodologies • Same sampling depths (i.e. middle of the screen) for groundwater (where practical) • Consistent field staff undertaking the groundwater and consistent methodologies used to measure water quality parameters and take samples. • Visual and olfactory observations will also be recorded on the field sheet. • Photographs will be taken of sampling location conditions at the time of sampling.	• Use of the same appropriate sampling methodologies • Same sampling depths for surface water (where practical) • Visual and olfactory observations will also be recorded on the field sheet. • Photographs will be taken of sampling location conditions at the time of sampling.	• Use of the same appropriate sampling methodologies • Same sampling locations will be used • Analytical samples will be collected for submission to the laboratory • Photographs will be taken of sampling location conditions at the time of sampling.

7.7.8 Proposed Analytical Schedule

Table 7-6: Analytical Schedule

Sampling Method	Media	Number of Sampling Points	Analysis - number of analyses
Borehole	Soil	8	Heavy metals by fpXRF (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn) - 80*
Hand Auger		102	Heavy metals by fpXRF (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn) - 306* pH, clay content, CEC - 10
Push Tubes		26	Heavy metals by fpXRF (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn) - 147*
Surface XRF		106	Heavy metals by fpXRF (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn) – 106*
	Total soil	***242***	***639***
Grab Sample	Sediment	15	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn) – 14
Grab Sample	Surface Water	15	Dissolved and total Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn) – 15 Hardness - 15
Low-Flow Sampling	Groundwater	10	Dissolved Heavy metals (As III and As V, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn) – 10 Hardness - 10
Vacuum	Internal Dust	16	Lead – 16
Swab		16	Lead - 16
High Volume Air Sampler	Air Quality	4	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn) and TSP 36 (over two month period)

* 5% of soil fpXRF samples will be laboratory analysed to establish a correlation, targeted based on field observed concentrations to provide coverage of the total concentration distribution range

**Sediment samples will be co-located with each surface water sample.

8. CONCLUSIONS AND RECOMMENDATIONS

Historic metalliferous mining has contaminated Captains Flat. C&R (2021) developed a preliminary CSM as a qualitative representation of contaminant sources, migration pathways and potential receptors for potential contaminants from the legacy Lake George Mine. The primary data gaps identified were information regarding soil contamination impacts in the Captains Flat residential area, groundwater hydrogeological information and groundwater impacts in the region. Data gaps in relation to potential receptors were also identified, for example, use of groundwater, potential agricultural receptors and potential for home grown produce.

Ramboll has undertaken a review of available data and has expanded on the preliminary CSM developed by C&R. The following data gaps were identified to supplement those identified by C&R:

- Systematic assessment of metals concentrations in soils within the community and vertical delineation of elevated lead concentrations in soil within the community. Specific areas requiring assessment and/or vertical delineation are identified
- Bioavailability of metals in soils impacted by dust, ore, mine waste and slag, relevant to assessing human health risks
- Details of surface water and groundwater usage within the Precinct and the alluvial flats some kilometres downstream
- The effect of meteorological variability on the degree and distribution of surface water contamination
- Assessment of dissolved metals concentrations in surface water, relevant to assessing ecological risks
- The current distribution of contaminated sediments and exposure risks within the receiving environment
- Potential for sediment to act as an ongoing source of impact to surface water
- Meteorology data in the vicinity of Captains Flat to inform assessment of source to receptor movement of air pollutants in the local airshed
- Assessment of internal dust within public buildings.

An assessment program has been designed to address these data gaps and to characterise the degree and extent of contamination with sufficient detail to confirm the CSM and inform development of the Captains Flat Lead Management Plan.

The extent of the sampling and analytical program is limited to assessing contaminant exposure risks that may exist for the Captains Flat community and immediate surrounding environment.

It is assumed that information relating to surface water and groundwater usage within the Precinct will be made available to Ramboll to inform the preparation of interim water usage guidelines.

Data gaps that will not be resolved under the proposed sampling and analyses include:

- Details of surface water and groundwater usage for the Molonglo River downstream of the Precinct
- Assessment of contaminant impacts to the Molonglo River downstream of the Precinct or interactions with the alluvial aquifer and downstream water users
- Sediment contamination assumed to be present in the water supply dam will not be comprehensively assessed under the proposed sampling and analyses. The Captains Flat Lead Management Plan will be developed under the assumption that contaminant exposure risks exist for benthic and aquatic ecology in the water supply dam. Comprehensive

assessment of sediment in the water supply dam should be considered as part of ongoing surface water monitoring

- Effects of meteorological variability on contaminant mobility via airborne, surface water and groundwater migration pathways will remain as a data gap and require ongoing monitoring
- Site specific risk assessment considering bioavailability of metals may be warranted depending on the results of the assessment, the identified risks to human health and ecology and the associated management requirements
- Human health effects from contaminant exposure within Captains Flat and the downstream receiving environment. A systematic assessment of community health effects is recommended as a basis for understanding effects from current exposure scenarios and for validating the Captains Flat Lead Management Plan once implemented.

9. REFERENCES

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10. LIMITATIONS

Ramboll Australia Pty Ltd prepared this report in accordance with the scope of work as outlined in our proposal to Regional NSW and in accordance with our understanding and interpretation of current regulatory standards.

A representative program of sampling and laboratory analyses is proposed as part of this investigation, based on past and present known uses of the Precinct. While every care has been taken, concentrations of contaminants measured may not be representative of conditions between the locations sampled and investigated. We cannot therefore preclude the presence of materials that may be hazardous.

Site conditions may change over time. This report is based on conditions encountered at the Site at the time of the report and Ramboll disclaims responsibility for any changes that may have occurred after this time.

The conclusions presented in this report represent Ramboll's professional judgment based on information made available during the course of this assignment and are true and correct to the best of Ramboll's knowledge as at the date of the assessment.

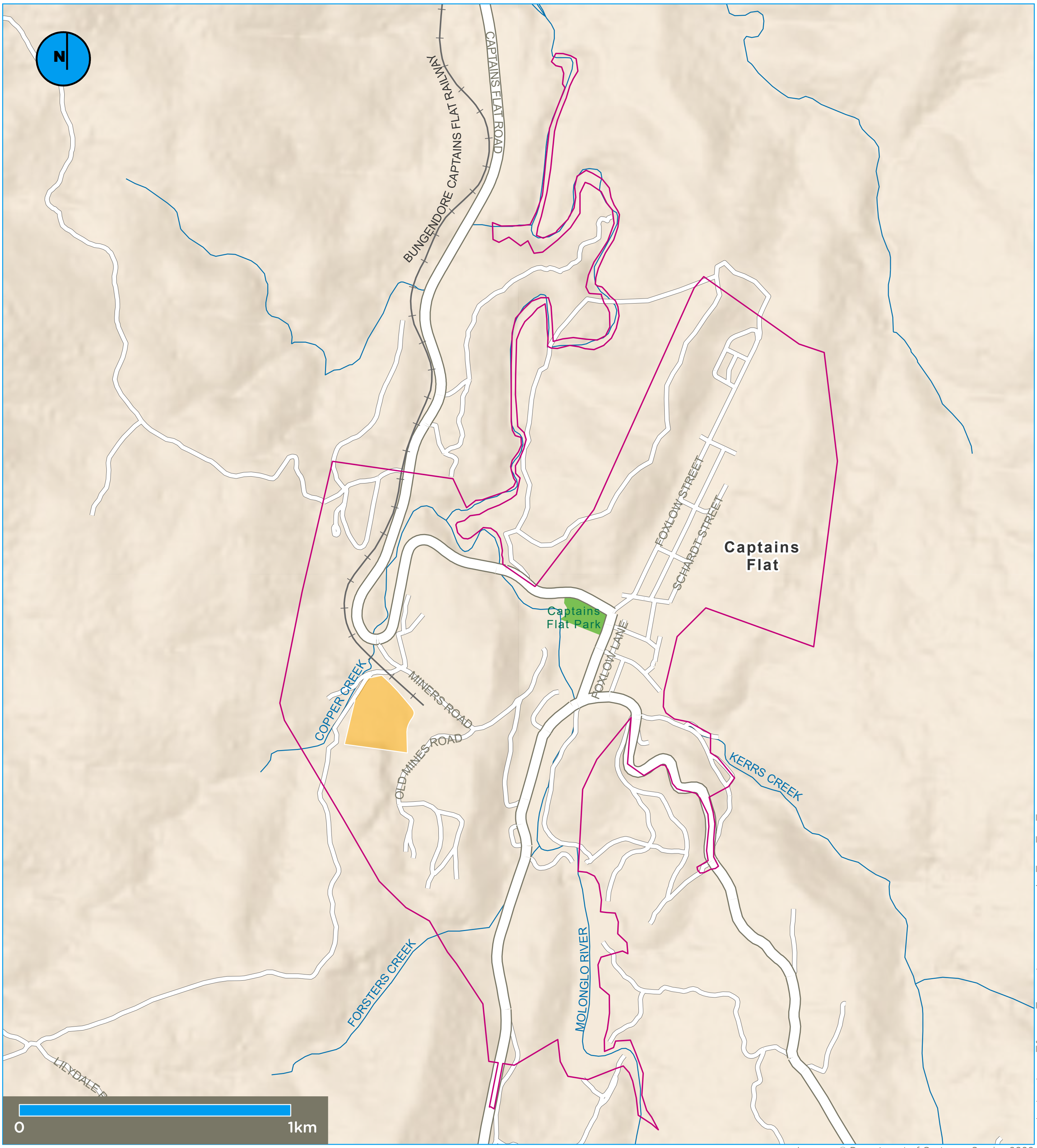
Ramboll did not independently verify all of the written or oral information provided to Ramboll during the course of this investigation. While Ramboll has no reason to doubt the accuracy of the information provided to it, the report is complete and accurate only to the extent that the information provided to Ramboll was itself complete and accurate.

This report does not purport to give legal advice. This advice can only be given by qualified legal advisors.

10.1 User Reliance

This report has been prepared exclusively for Regional NSW and may not be relied upon by any other person or entity without Ramboll's express written permission.

APPENDIX 1
FIGURES



Imagery © Department of Customer Service 2020

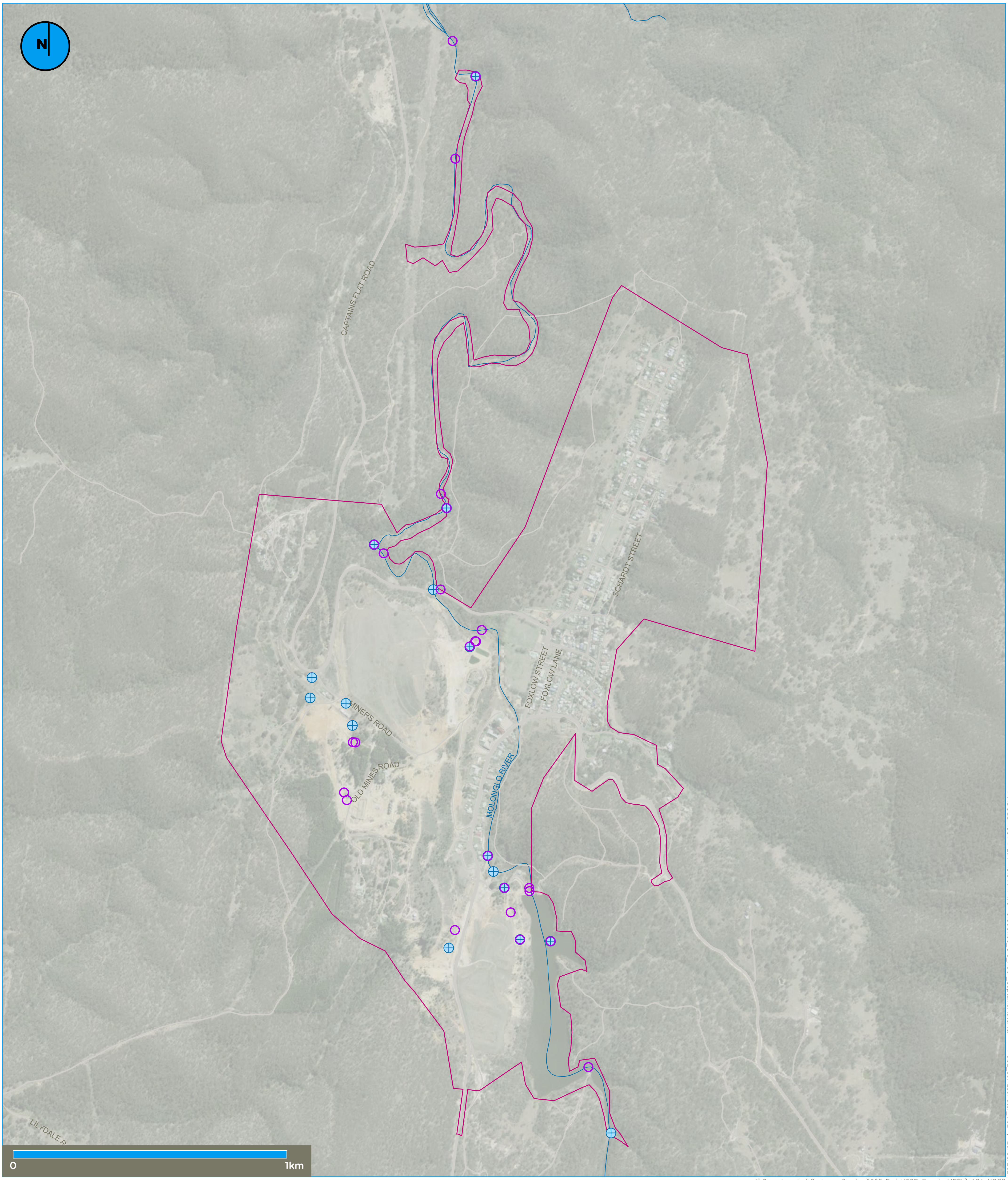
RAMBOLL AUSTRALIA - GIS MAP file : 318001193_GIS_P001_CaptainsFlatSAQP | F001_Locality_V01 | 26/05/2021

A4
1:20,000

Legend

- Precinct boundary
- Railway
- Former Processing Area Lake George Mine

Figure 1 : Site locality plan



Legend

- Precinct boundary
- Previous surface water location
- Proposed surface water location
- Creek

A3
1:13,000

Figure 2 : Surface water and sediment sampling locations

RAMBOLL

Legend

Precinct boundary

Proposed air quality monitoring location

Creek

A3
1:4,000

Figure 3 : Air quality monitoring locations

RAMBOLL

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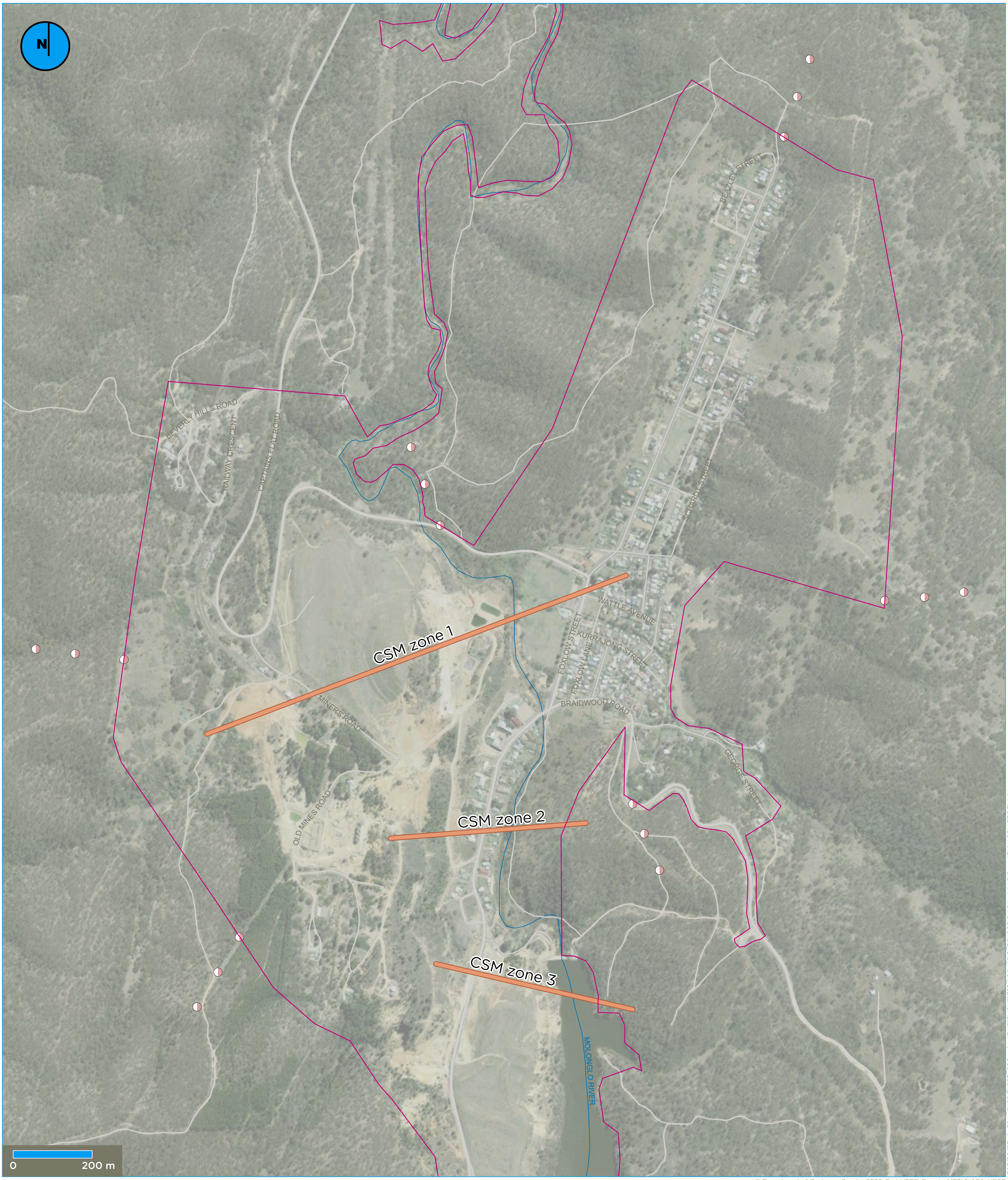
Legend

- Precinct boundary
- Proposed groundwater location
- Creek

A3
1:4,500

Figure 4 : Groundwater monitoring locations

RAMBOLL



RAMBOLL AUSTRALIA - GIS MAP file : 318001193_GIS_P001_CaptainsFlatSAQP | F005_Background_V02 | 26/05/2021

Legend

- Precinct boundary
- Proposed soil sample location
- Creek
- CSM zone

A3
1:9,000

Figure 5 : Background soil assessment locations and CSM zones

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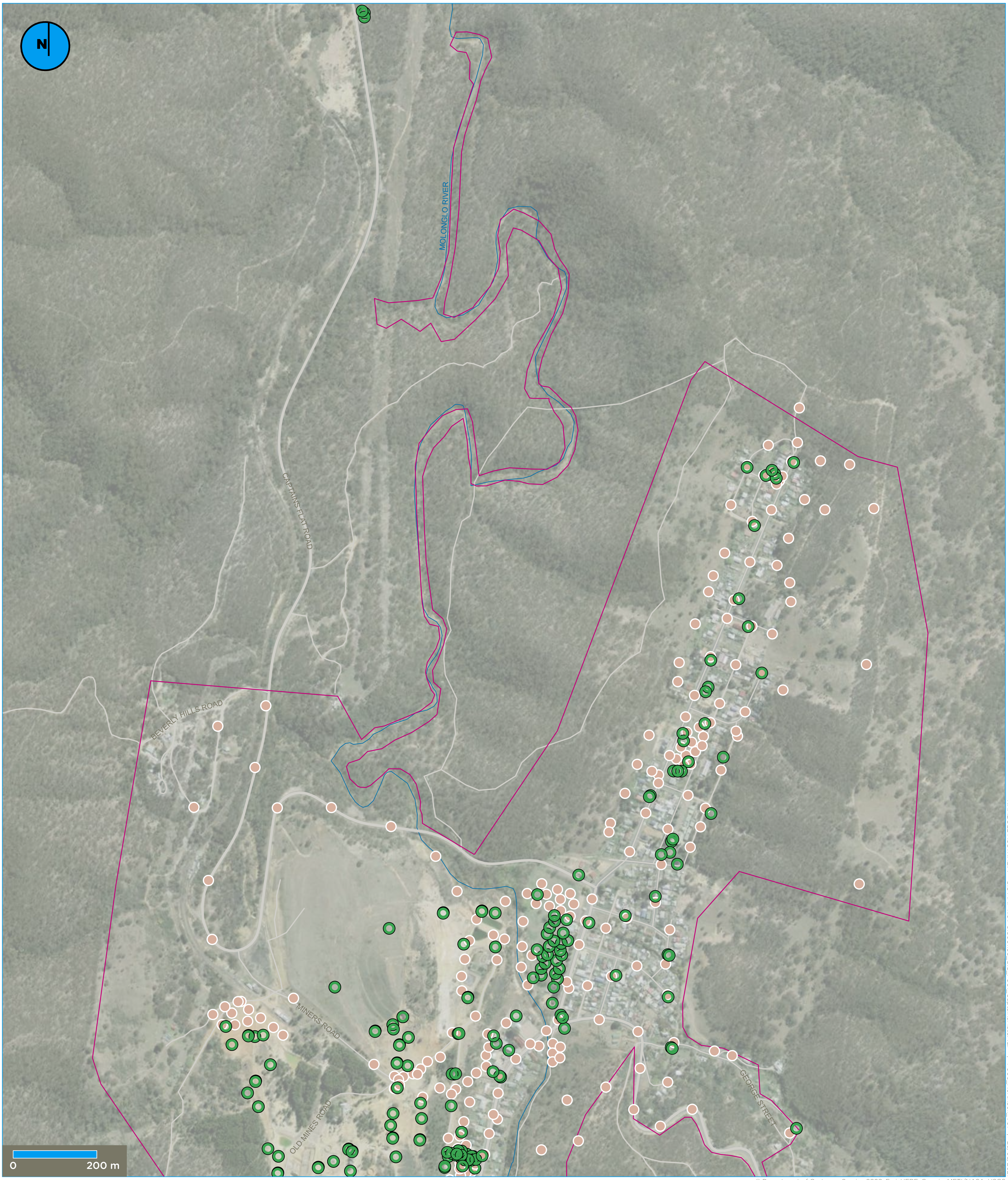


RAMBOLL AUSTRALIA - GIS MAP file : 318001193_GIS_P001_CaptainsFlatSAQP | F006_NorthSoil_V01 | 26/05/2021

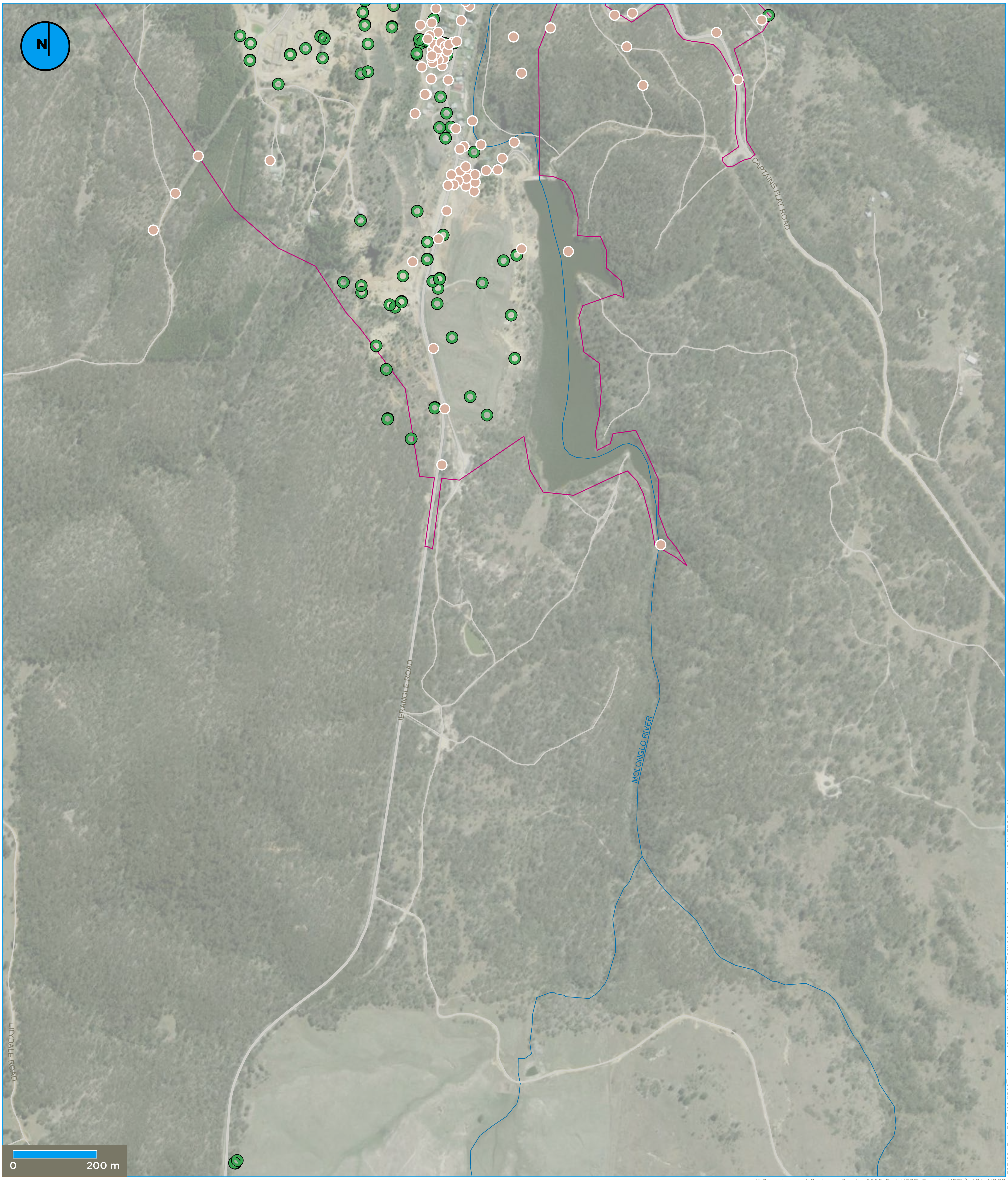
Legend

Precinct boundary
Previous soil sample location
Proposed soil sample location
Creek

A3
1:8,500

Figure 6a : Soil sampling locations

RAMBOLL



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RAMBOLL AUSTRALIA - GIS MAP file : 318001193_GIS_P001_CaptainsFlatSAQP | F007_SouthSoil_V02 | 27/05/2021

Legend

Precinct boundary
Previous soil sample location
Proposed soil sample location
Creek

A3
1:8,500

Figure 6b : Soil sampling locations

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APPENDIX 2
PRELIMINARY CONCEPTUAL SITE MODEL TABULATED SUMMARY

Table 1 - Captains Flat Conceptual Site Model

Source	Source Area of Concern	Migration Pathways	Receptors and Exposure Pathways	Existing Data	Data Gaps	SAQP Item
Underground mine workings	Central Mine Area North Mine Mine Adit Spring Keatings mine Open cut areas Magazine / Explosives Adit Spring and nearby fracture seeps	Acid mine drainage and seeps	Public: Incidental ingestion and dermal contact during access to the mine site or recreational use of the Molonglo River	GHD (2018) Targeted assessment of high risk areas on the mine with lesser assessment in the surrounding environment. Assessment included: 149 fpXRF measurements from 69 locations targeting 22 soil/waste rock samples 9 sediment samples 13 surface water samples (totals only) NSW EPA (2019) - total and dissolved phase data from Molonglo River and mine leachate.	Onsite public access frequencies Nature and frequency of onsite workers current and future Surface water and groundwater usage Groundwater contaminant impacts Contaminants in airborne dust Dissolved concentration data for metals in seepage and runoffs Effect of meteorological variability on surface water and groundwater contamination	1 See 17 below
			Mine site workers: incidental ingestion and dermal contact with soil and seepage/runoff/groundwater; inhalation of dusts (wind blown and excavation generated) Uptake by aquatic and/or terrestrial ecology at the Molonglo River	NSW EPA 2019 Assessment of surface water targeting mine discharge points and the downstream environment. Assessment included 13 locations and samples were analysed for total and dissolved metals (Al, Co, Cu, Pb, Ni, Zn), pH, alkalinity (as calcium carbonate) and anions		
		Leaching into groundwater and migration downgradient to Molonglo River (unknown)	Uptake by aquatic and/or terrestrial ecology at the Molonglo River	GHD (2018) NSW EPA (2019)		
			Extraction for beneficial use			
			Incidental ingestion by people during recreational use of the Molonglo River	NSW EPA (2019)		
		Public access to the mine site	Direct contact/inhalation and incidental ingestion of contaminated soils	GHD (2018) NSW EPA (2019)	Bioavailability of metals remains unclear and would support development of site specific trigger levels (SSTLs).	
		Private ownership of areas of the mine site	Direct contact/inhalation and incidental ingestion of contaminated soils under current and future approved uses of the land.	Confidential	Unknown	
Above ground tailings and mine waste	Northern and southern tailings dumps Mill areas Old mill areas Exposed slag, smelter and ores processing areas Keatings collapse	Seepage and overland runoff	Uptake by aquatic and/or terrestrial ecology at the Molonglo River Members of the public - direct contact / incidental ingestion of soils along ephemeral drainage lines. Incidental ingestion by people during recreational use of the Molonglo River	GHD (2018) NSW EPA (2019)	Contaminant concentrations in overland flow paths from the tailings and mine through the community	2
		Windborne dust (deposition)	Uptake by terrestrial ecology,	GHD 2018, NSW EPA 2021, Ramboll 2021, EnviroScience Solutions 2021. Cumulatively these data sources include approximately 500 surficial soil samples targeting the mine, rail corridor and community public spaces.	Contaminant concentrations in surficial soils (deposited dust) throughout the community	3
		Direct exposure to contaminated soil				
		Windborne dust (inhalation)	Human health - (on-site) visitors (adults and children) accessing the site. Human health - (off-site) rural residents and Captains Flat residents.	None	Contaminant concentrations in airborne dust	4
Contaminant point Sources within the Community	Southern Smelter		Members of the public (direct contact, incidental ingestion) and uptake by terrestrial ecology	GHD 2018	Minimal historic soil assessment	5
	Northern Ridge				Minimal historic soil assessment adjacent Miners Road	6
	Sewerage treatment area		STP workers (direct contact, incidental ingestion) and uptake by terrestrial ecology		Minimal historic soil assessment along western bank of the mine	7
	Mogo Land adjacent Rail Corridor				Minimal historic soil assessment	8

Table 1 - Captains Flat Conceptual Site Model

Source	Source Area of Concern	Migration Pathways	Receptors and Exposure Pathways	Existing Data	Data Gaps	SAQP Item
Identifed abatement areas	Foxlow Parklet	Windborne dust, surface water, seepage to groundwater	Members of the public (direct contact, incidental ingestion) and uptake by terrestrial ecology	NSW EPA 2021	Vertical delineation	9
	Foxlow Street			NSW EPA 2021	Delineation of contamination in soil horizontally and vertically	10
	Areas behind childcare centre			NSW EPA 2021, EnviroScience Solutions 2021	Vertical delineation not known and limited data assessing degree in shallow soils	11
Additional Risk Area	Childcare Centre		Uptake by terrestrial ecology (now closed to the community)	NSW EPA 2021, EnviroScience Solutions 2021	Vertical delineation	12
	Western embankment at southern end of town			GHD 2018	Delineation of contamination in soil horizontally and vertically	13
Sensitive receptors	Foxlow Street public amenity areas (playing fields swimming pool etc)	Windborne dust, surface water, seepage to groundwater	Members of the public (direct contact, incidental ingestion) and uptake by terrestrial ecology	NSW EPA 2021	Delineation of contamination in soil horizontally and vertically. Groundwater contamination impacts	14
	School	Windborne dust		NSW EPA 2021	Delineation of contamination in soil horizontally and vertically	
	Community Gardens			None		19
Future development areas	Subdivisions east and west of north end of town			None		15
	Miners Road			NSW EPA 2021		20
	Land north-east of the water supply dam			None		16
Rail Loading area	Rail Loading area	Overland runoff Windborne dust Direct exposure to contaminated soil	Ecological - Molonglo River and Copper Creek aquatic receptors. Human health - recreational users of Molonglo River. Ecological - terrestrial organisms exposed to soil.	Ramboll (2021) Detailed site investigation including: 346 fpXRF measurements of metals in soil to depths of up to 2m and extending from the southern rail corridor terminus approximately 1.7 km north. 6 co-located surface water and sediment samples targeting Copper Creek and mine site sediment dam overflow upstream and downstream of the rail corridor. Internal dust sampling at the SES lease area (9 swabs and 3 vacuum samples) 3 external paint samples.	Bioavailability of metals remains unclear and would support development of SSTLs.	
Sediment dams	Lower and upper sediment dam	Existing water and sediment contamination in dam Seepage and overland run-off and leaching into groundwater with offsite transport	Public: Incidental ingestion and dermal contact of waters and sediments in the dam/surface runoff/groundwater Onsite ecology - Ecology within he dam is expected to be limited however terrestrial ecology likely drinks from the dam. It has been shown previously that species richness is reduced with only metal tolerant species remaining. Public: Incidental ingestion during recreational use of the Molonglo River (see below); any groundwater users for watering and irrigation in the vicinity Uptake by aquatic and/or terrestrial ecology	GHD 2018	No total concentration data. Single round of measurement only.	
Secondary Sources						
Water supply dam	Waters and sediments acting as a secondary source of contaminants.	Contamination existing in water column (particulate and dissolved phase) and sediments	Public: Incidental ingestion during recreational use of the water supply dam Public: Potable use after treatment Uptake by aquatic and/or terrestrial ecology	GHD 2018, NSW EPA 2019	Effect of water level and meteorological (temperature and rainfall) on contaminant distribution and bioavailability. Metal accumulation in biota that can be consumed	
Molonglo River and Copper Creek	Waters and sediments acting as a secondary source of contaminants.	Migration of particulates and dissolved phase in water	Human Health: Ingestion, dermal contact, domestic consumption of aquatic biota	NSW EPA - Total and dissolved metal conc (various locations); Ramboll data for Copper Creek; GHD sediment data, dissolved metals	Only single round of total metal data biota data	

Table 1 - Captains Flat Conceptual Site Model

Source	Source Area of Concern	Migration Pathways	Receptors and Exposure Pathways	Existing Data	Data Gaps	SAQP Item
			Ecological - Aquatic receptors.			
Groundwater	Captains Flat	Interface with Molonglo River	Ecological - Molonglo River and Copper Creek aquatic receptors. Human health - recreational users of Molonglo River. (Possible) Human health - groundwater use.	None	Groundwater use and groundwater contamination	17
Background Assessment including Crown land transitioning to aboriginal ownership				None	Delineation of contamination in soil horizontally and vertically	18

APPENDIX 3
LITERATURE REVIEW REFERENCE LIST

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APPENDIX 4
LITERATURE REVIEW EXTRACT – ENVIRONMENTAL SETTING

2. Environmental setting

The Captains Flat region sits on the Lachlan Fold Belt, a volcanic-hosted massive pyritic ore body derived from Silurian shale and volcanics. This geology comprises a heterogeneous mixture of shale, siltstone, dacite, tuff, minor basalt, limestone and conglomerate. The dominant ore mineral within the deposit is pyrite (FeS_2), followed by arsenopyrite (AsFeS), chalcopyrite (CuFeS), galena (PbS), sphalerite (ZnS), tennantite ($Cu_{12}As_4S_{13}$), and minor veins of silver (Ag) and gold (Au) (Chapter 3 Hyperspectral case study 2. Captains Flat (NSW) – Acid Mine Drainage pollution; Jacobson and Sparksman, 1988).

Mining operations in the area operated from 1882 to1962 starting as two separate ventures, Koh-i-noor to the north and El Capitan to the south, before merging into a single venture, the Lake George Mine (Stinton et al., 2020; Mindat.org, 2021). The locations of the various mines and related infrastructure are shown in Figure 1 and Figure 2. Mining originally targeted alluvial gold using mercury-based amalgamation processes. It expanded to include smelting of the pyritic ores (galena, sphalerite, chalcopyrite and pyrite) to extract lead (Pb), zinc (Zn), copper (Cu) and iron (Fe) (Stinton et al. 2020; Bierwirth and Pfitzner, 2001).

Mining operations are reported to have consisted of underground mining works, surface ore processing (Ag, Au, Cu, Fe, Pb, Zn), smelting and waste storage facilities. It is reported that milling, smelting and storage of waste materials were performed near the Molonglo River (Wadige et al. 2016; GHD, 2018). A summary of the mineralogy encountered at the mines and tailings dumps in Captains Flat is provided in Table 2.

Table 2: Mineralogy of mines and tailings in the Captains Flat region. Information sourced from Mindat.org

Location	Characteristics and metal mineralogy
Lake George mine and adits Dominant metals: Al, As, Cu, Fe, K, Mg, Pb, Sb, Sn, Zn.	A pyritic copper-zinc-lead deposit. Arsenopyrite, biotite, cerussite, chalcopyrite, chlorite group minerals, feldspar group minerals, galena, gold iron oxide, muscovite, sericite, pyrite, pyromorphite, pyrrhotite, quartz, sphalerite, stannite, tetrahedrite.
Mine workings and tailings Metals: Al, As, Au, Ba, Bi, Ca, Cu, Fe, K, Mg, Pb, Sb, Si, Sn, Te and Zn	Heterogenous mixture of waste rock and minerals including anglesite, arsenopyrite, azurite, baryte, biotite, bournonite, calcite, cerussite, chalcopyrite, covellite, chlorite group minerals, dolomite, feldspar group minerals, galena, gold, iron oxides, K-feldspar, limonite, malachite, montanite, muscovite, pyrite, pyromorphite, pyrrhotite, quartz, sphalerite, stannite, tellurobismuthite, tennantite, tetradymite, tetrahedrite.

During mine operations, direct and indirect releases of metal-contaminated wastes into the Molonglo River occurred. The literature has attributed major sources of contamination to the failure of tailings dumps at the southern and northern ends of the mine and ongoing acid mine drainage and seepage from the mines and adits[1] (Dames and Moore, 1993; Hogg, 1990). The two main tailings dumps are the Northern Tailings Dumps, to the north of the central mine area, and the Southern Tailings Dumps, to the south of the central mine area on

[1] An adit is a horizontal or near-horizontal passage into a mine, constructed for the purpose of working, ventilation or removal of waters from the mine.

the western side of the town water supply. The location of tailings dumps, dams and areas of historical contaminant breaches are shown in Figure 3 (sourced from Bierwirth and Pfitzner, 2001).

Rehabilitations works (in excess of $3M) involving the reshaping and capping of tailings dumps with clay, shale and soil and the planting of grasses and legumes is reported to have been undertaken in the 1970s (Craze, 1980; Bierwirth and Pfitzner, 2001). Rehabilitation also included the diversion of surface waters from the underground mine to minimise the release of mine waste into the river but did not involve the remediation of tailings associated with sediments and surrounding floodplains (Singh, 2012; Wadige et al., 2016).

Figure 1: Location of Captains Flat (red dot)

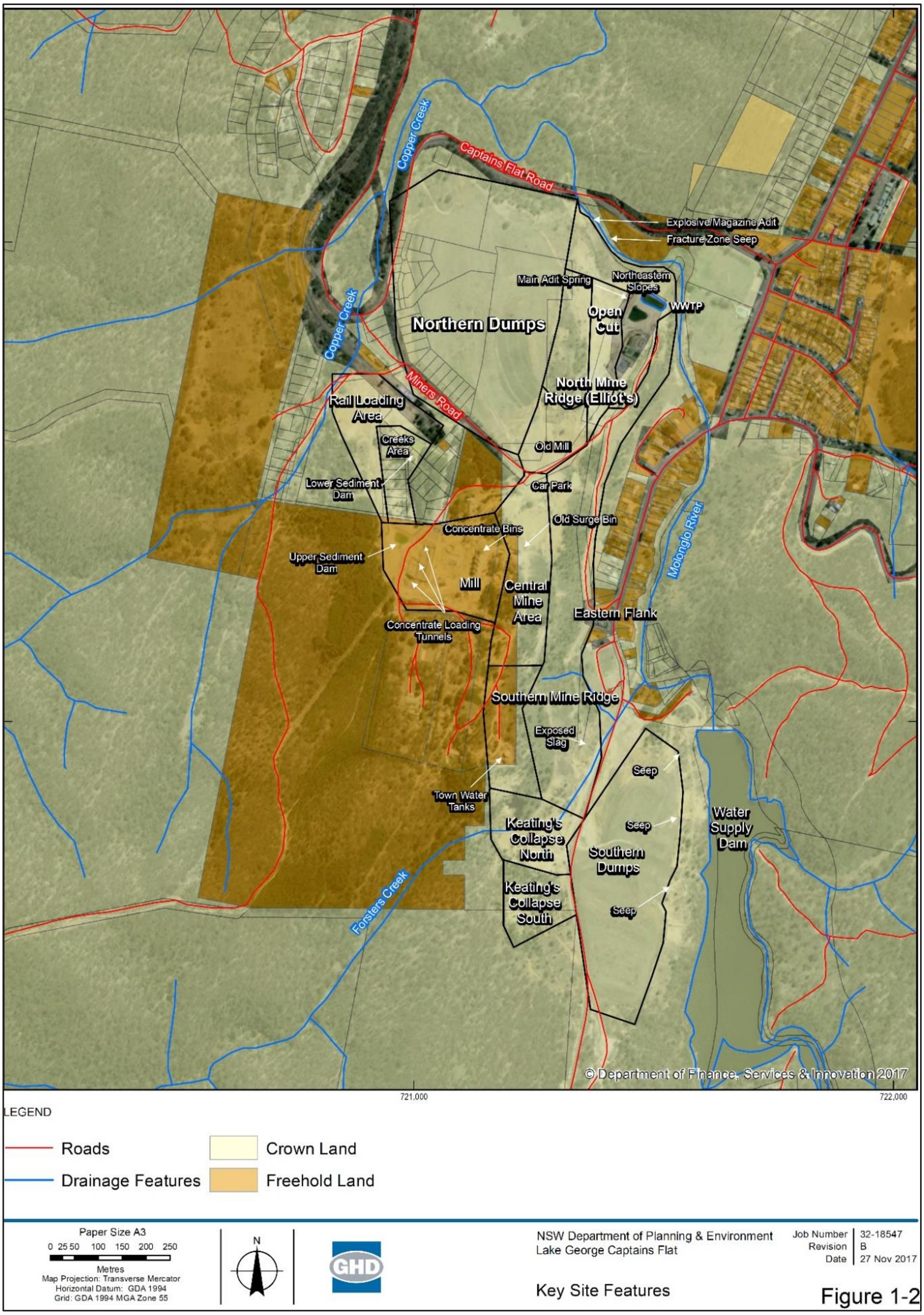

Figure 2: Layout of the mining infrastructure in Captains Flat. Image source: GHD (2018)

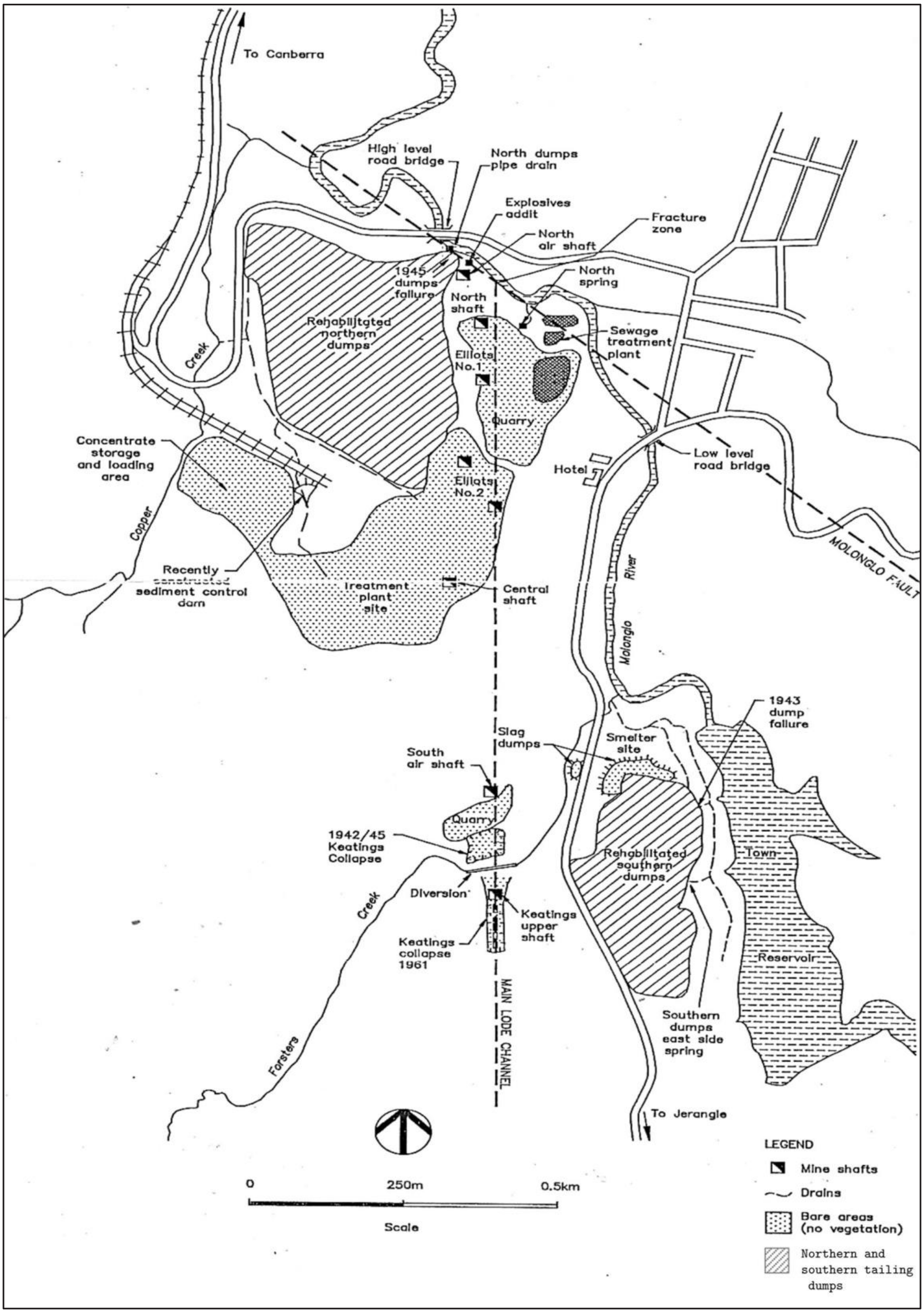

Figure 3: Locations of mine utilities, tailings dumps and dams. Published in Dames and Moore (1993)

2.1 Climate

Similar to the nearby city of Queanbeyan (approximately 35 km to the north-west), Captains Flat is classified as subtropical highland climate with warm to hot summers and cold winters. Based on data from the Captains Flat weather station (Foxlow Street), average annual rainfall for the area, from January 1898 to February 2021, is approximately 737 mm. Rainfall appears quite consistent throughout the year with some increase in rainfall over late spring, summer and early autumn (Figure 4). Average monthly temperatures range from ~ 12 °C in winter (June - July) to ~ 29 °C in summer (January - February).

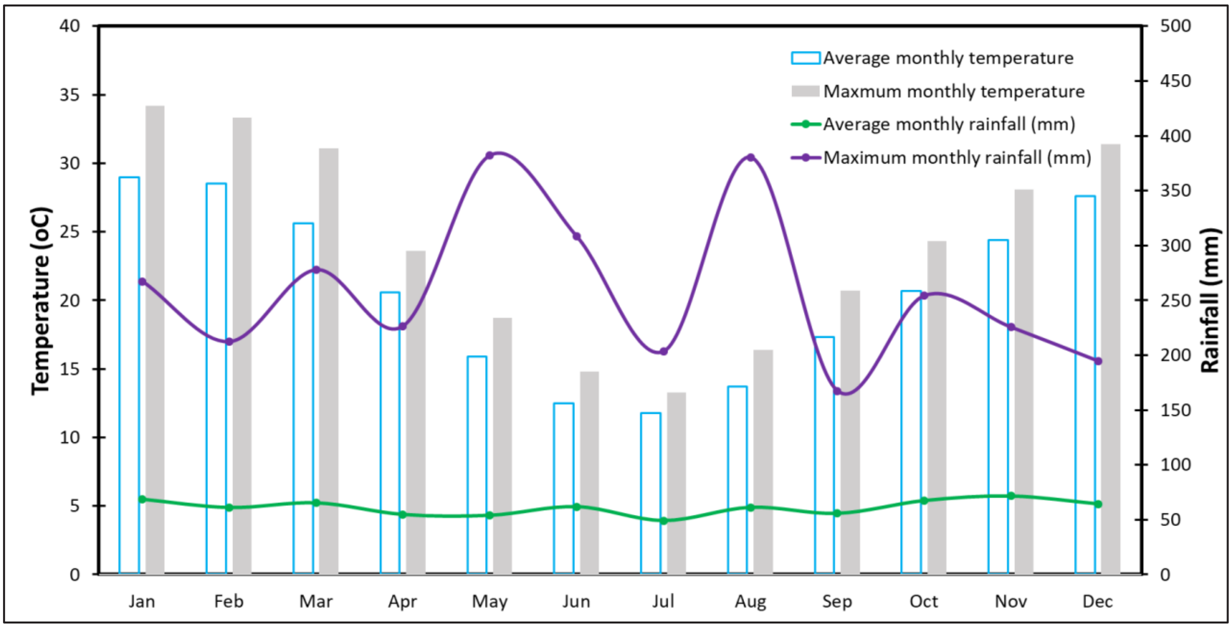

Figure 4: Average and maximum monthly temperature (columns) and rainfall (lines) for the region. Data for the temperature recorded at the Queanbeyan Bowling Club (data from January 1909 to February 2021) and rainfall data recorded at Captains Flat Foxlow Street (data from January 1898 to February 2021). Source: Australian Bureau of Meteorology (data search on 3 March 2021)

2.2 Topography and hydrology

The Captains Flat area is part of the Southern Highlands of New South Wales and located on the western slopes of the Great Dividing Range. Overall, the area is of rugged relief and is characterised by a prominent north-south trending ridge bisected by a saddle and alluvial flats in the northern part of the Molonglo River. The main headworks and processing facilities of the mine are located along the ridge line with several adits and collapsed areas along the Eastern Flank. The extent of height variations across the site range from 840 m Australian Height Datum (AHD) at the Molonglo River to 940 m AHD at the top of the mine ridge (GHD, 2018).

The area is situated within the Molonglo River catchment. The river runs towards the north and has a confluence with its major tributary, the Queanbeyan River (55 km downstream). The river then continues to Lake Burley Griffin and subsequently towards the Murrumbidgee River (BOM, 2019). GHD (2018) identified local drainage features to include:

- Cooper Creek - receives drainage from the Mill, Rail Loading, western slopes of the Central Mine, and Northern Tailings Dumps.

- Forsters Creek - receives drainage from Keating's Collapse diversion channels, Southern tailings dumps on the western side, areas of slag associated with the former smelter, and the Central Mine.
- Molonglo River - receives drainage from the Cooper Creek (confluence is ~ 100 m north of the Northern Tailings Dumps), Forsters Creek (confluence is ~ 100 m north of the Southern Tailings Dumps), Southern Tailings Dumps, Eastern Flank of the Central and Elliot's mines, Open Cut, Main Adit and Explosive/Magazine Adit Springs, seepage through Molonglo Fault fractures, Northern Dumps at the northeast corner, and Southern Dumps on the eastern side

2.3 Geology

The Captains Flat mining site is a volcanic hosted massive sulfide (VHMS) zinc-lead-copper deposit hosted by Late Silurian volcanic and associated siliciclastic (meta-) sedimentary rocks (Davis, 1990). These rocks are found within the eastern Lachlan Fold Belt, a >1000 km-wide orogenic system developed along the Pacific margin of Australia.

The geological structure in the Captains Flat area is characterised by a well-defined north-south trending graben[2] (2 to 8 km wide), bounded by two horsts[3] at its southern and northern ends. The horsts comprise tightly folded Middle to Upper Silurian felsic pyroclastics, volcanogenic sediments and shales (GHD, 2018; Downes and Seccombe, 2004).

The sequence, from the base, is the following (Davis, 1990):

- Copper Creek Shale - 60 to 150 m thick of sediments with subordinate tuffs.
- Kohinoor Volcanics - 50 to 850 m thick of coarsely porphyritic andesitic to dacitic to rhyolitic lavas, tuffs, volcanic breccias, tuffaceous shales and volcanic cherts. This unit hosts the orebodies.
- Captains Flat Formation - 850 to 1200 m thick of predominantly shales and siltstones with minor volcanic flows and tuffs.

An extensional geodynamic environment is critical to the development of VHMS mineralisation. Extensional geological structures (e.g. horsts, grabens) are common in the Captains Flat area. Faults at the boundaries of these structures have the potential to be preferential pathways for groundwater (e.g. Molonglo Fault) (Frenda, 1965; GHD, 2018).

2.4 Soils

Information on soil types in the Captains Flat area is limited. Ramboll (2020b) reported information from a previous site assessment undertaken by URS in 2004 where soils were described in the former load-out area approximately 50-100 m south of the rail loading area. The soil profile described in Table 3.

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[2] A graben is defined as a valley caused by the downward displacement of a section of the earths crust. These are produced by parallel faults.

[3] A horst is a raised block of land bounded by parallel normal faults. Horsts are bits of land which have either been lifted or has remained stationary while the land on either side (graben) have fallen.

Table 3: Soil profile as described by Ramboll (2020b) in the former load-out area

Depth (mbgl)	Soil Description
0.0 - 0.3 (up to 1.0)	FILL: Sandy clay fill of yellow/orange colour, moist, loose, containing oxidised rock fragments, increasing clay content with depth
0.3 - 1.2	NATURAL: clay of yellow/white colour with moderate to high plasticity, moist becoming extremely weathered bedrock included rock fragments of orange-red colour
1.2 - bedrock depth	Weathered shale of orange-red colour

Soil descriptions from the NSW DPIE eSPADE v2.1 database appear to be overall consistent with the soil profile showing that on-site soils are composed of sandy clay fill material with abundant gravel fragments (top 0.5-0.7 mbgl) grading towards natural light brown/yellow clay with coarse gravel and pebbles until 1.3-1.5 mbgl (OEH, 2021a-d).

The eSPADE database reports natural red/yellow Podzolic soils (Great Soil Group classification) approximately 1.5-2 km to the north (OEH, 2021e-g), 1-1.5 km to the south (OEH, 2021h), and 1-1.5 km to the south-west (OEH, 2021i). Podzolic soils are typical of eucalypt forests and heathlands in southern Australia.

Alluvial soils (clayey and sandy loam) appear to be present approximately 2 km south (OEH, 2021j), and 1-1.5 km to the north-west (OEH, 2021k).

2.5 Hydrogeology

GHD (2018) stated that there are potentially three main natural aquifers based on the general geology of the site, which comprises:

- a thin narrow zone of alluvial sediment along the Molonglo River
- regionally fractured rock
- fault-associated aquifers, such as the ~10 m wide Molonglo Fault, which runs north-north-west (NNW) along the eastern edge of the deposit, adjacent to the Molonglo River.

Local groundwater within alluvial deposits is expected to flow towards the east/north-east, in line with the Copper Creek flowing into the Molonglo River (Ramboll, 2020b). Regional groundwater within the fractured rock is expected to flow towards the north direction (Ramboll, 2020b).

A search of the online groundwater database (on 08 March 2021) from the Bureau of Meteorology Australian Groundwater Explorer indicated eight registered groundwater bores within 5 km of Captains Flat (Figure 5, Table 4) and none on-site. The nearest registered bore (GW414772) is across the Molonglo River, approximately 1 km east of the southern tailings' storage facility. The remaining registered bores are located to the south-west, south-east, east and north-east, within 2-4 km from the Captains Flat site.

Table 4: Registered groundwater bores within a 5 km radius of the Captains Flat site

Bore ID	Bore Depth (m)	Drilled Date	Purpose	Status
GW414798.1.1	36	01/08/2008	Water Supply	Functioning
GW402606.1.1	20	15/06/1998	Water Supply	Unknown
GW402396.1.1	49	19/04/2003	Water Supply	Unknown
GW402934.1.1	84	07/02/2005	Monitoring	Unknown
GW414772.1.1	70	30/05/2000	Water Supply	Functioning
GW416013.1.1	66	01/01/1985	Water Supply	Functioning
GW402331.1.1	65	06/02/2003	Water Supply	Unknown
GW402995.1.1	36	02/02/2005	Water Supply	Unknown

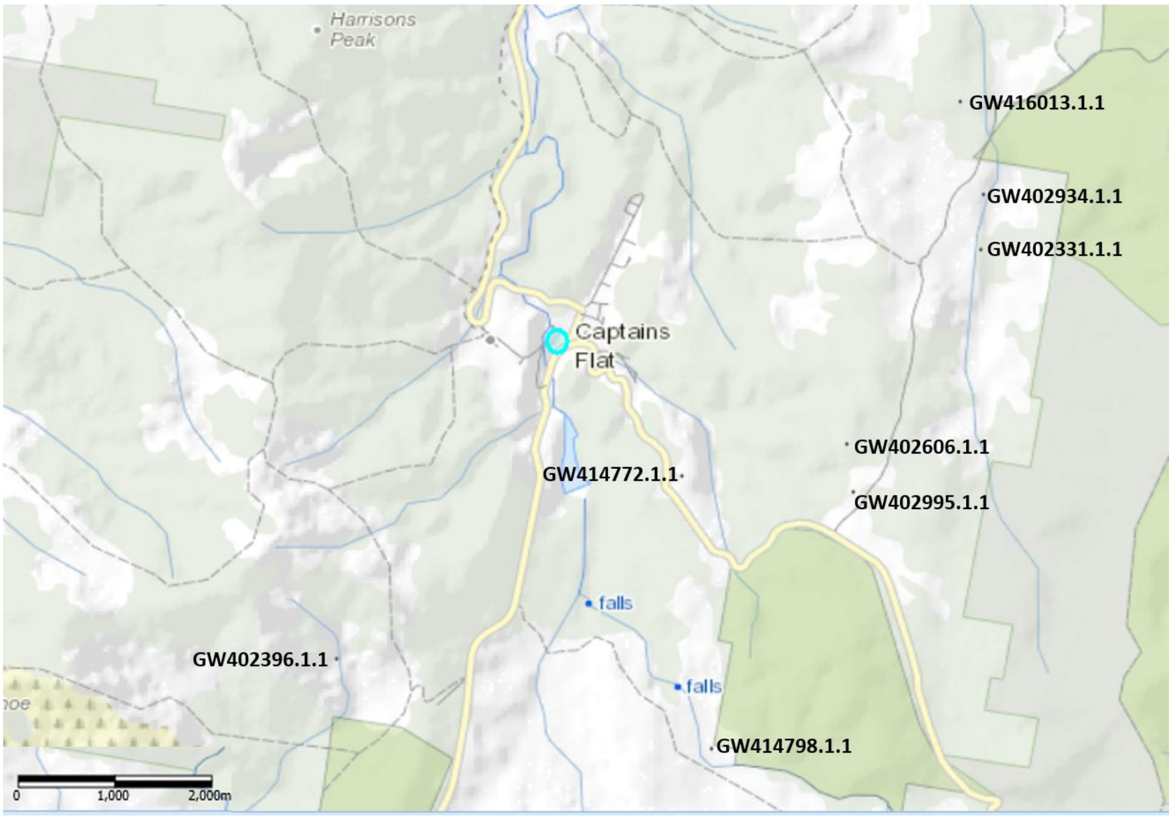

Figure 5: Locations of registered groundwater bores within a 5 km radius of Captains Flat from a search on 08 March 2021 on the Australian Groundwater Explorer

2.6 Land use in the area

The NSW Government ePlanning Spatial Viewer (ePlanning, 2021) indicates that the predominant land use in the area is split into six types including rural villages (RU5), primary production zones (RU1), public and private recreational areas (RE1 and RE2), environmental conservation areas (E2) and special purpose infrastructure zones (SP2). This land zonation is shown in Figure 6.

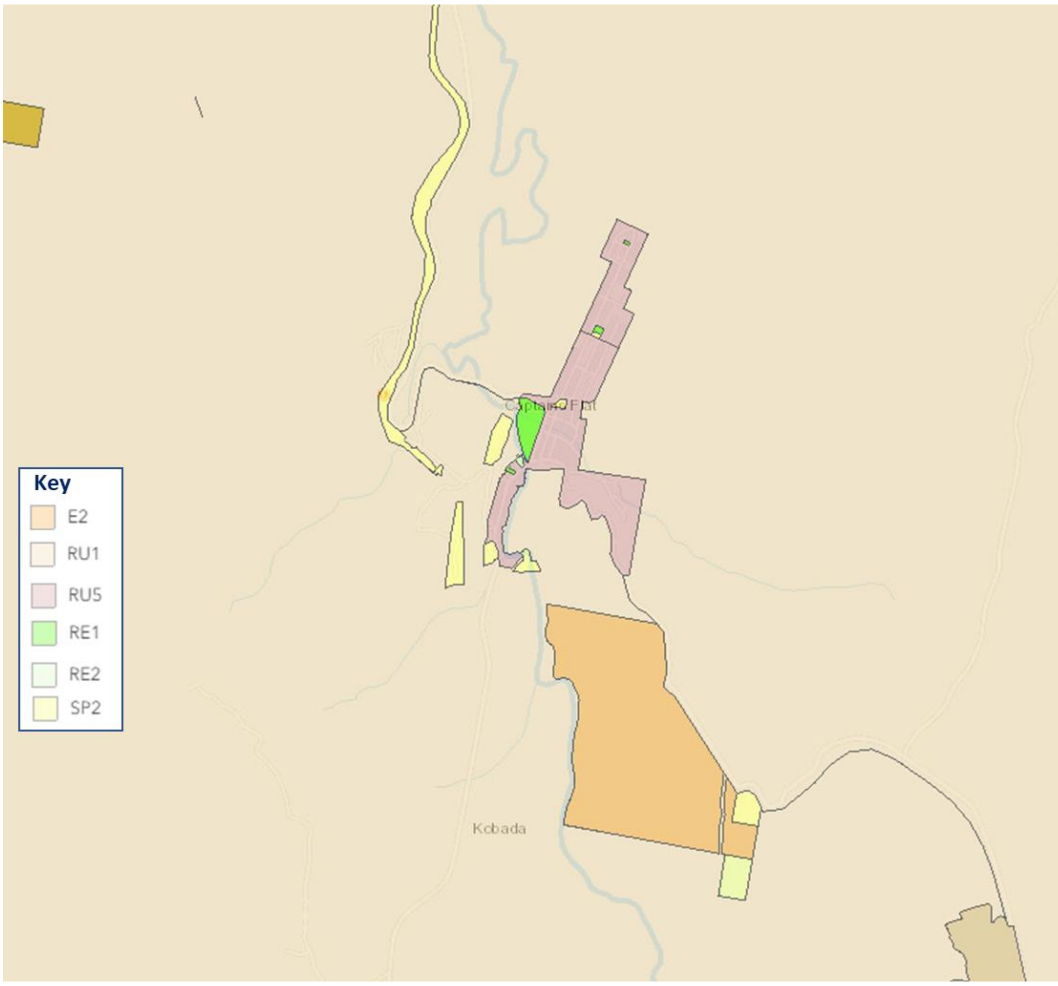

Figure 6: Land use zonation of the Captains Flat area and surround. Data sourced from the NSW Government ePlanning Spatial Viewer (2021)

3. Contamination

The literature and investigation reports for the Captains Flat area indicate that the main contaminants of potential concern (CoPC) are arsenic, copper, mercury, lead and zinc (Bierwirth and Pfitzner, 2001; Chapter 3 Hyperspectral case study 2. Captains Flat (NSW); GHD, 2018). Additional stressors include acid mine drainage and the deposition of hydrous iron oxide precipitates in receiving waters (Wadige et al., 2014; Reich et al., 2019). Mercury contamination has been reported off-site (Stinton et al., 2020), which was initially sourced from the extraction of gold from alluvial sediments through amalgamation. However, it was also an impurity in pyrites and was extracted during smelting operations. This section provides a review of the state of contamination in the Captains Flat area and surrounds.

APPENDIX 5
LITERATURE REVIEW EXTRACT – CSM FIGURES

4.3 Cross-sectional CSMs

Based on the literature review, C&R constructed a cross-sectional CSM, separating the area into three zones of interest (shown in Figure 8). These zones are:

- **CSM Zone 1** (Figure 9), which includes Copper Creek, Rail Loading Area, Northern Tailings Dumps, Molonglo River and Captains Flat Township.
- **CSM Zone 2** (Figure 10), which includes Central Mine area, Eastern Flank, Residential Area and Molonglo River.
- **CSM Zone 3** (Figure 11), which includes Exposed Slag area, Southern Tailings Dump, Water Supply Dam and Captains Flat Township.

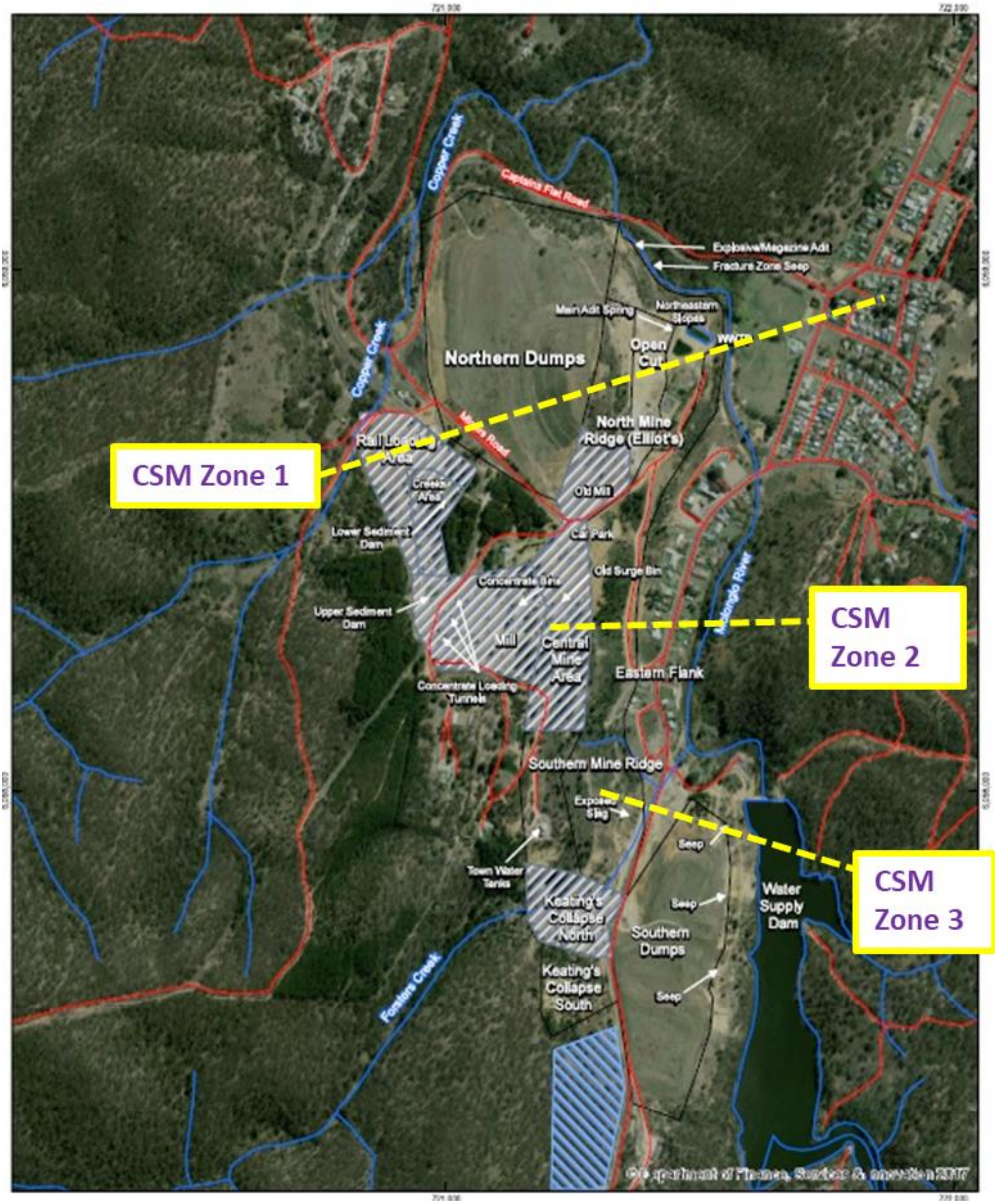

Figure 8: Zones represented by cross-sectional CSMs

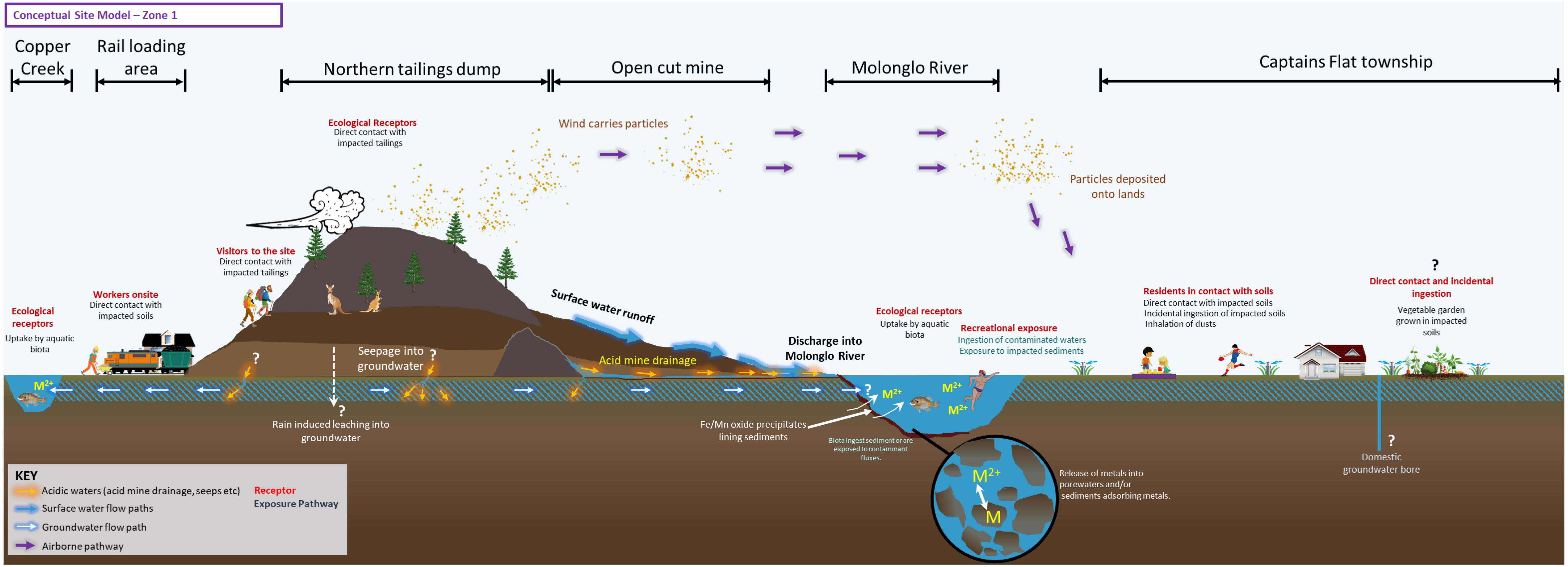

Figure 9: Preliminary cross-sectional CSM for Zone 1.

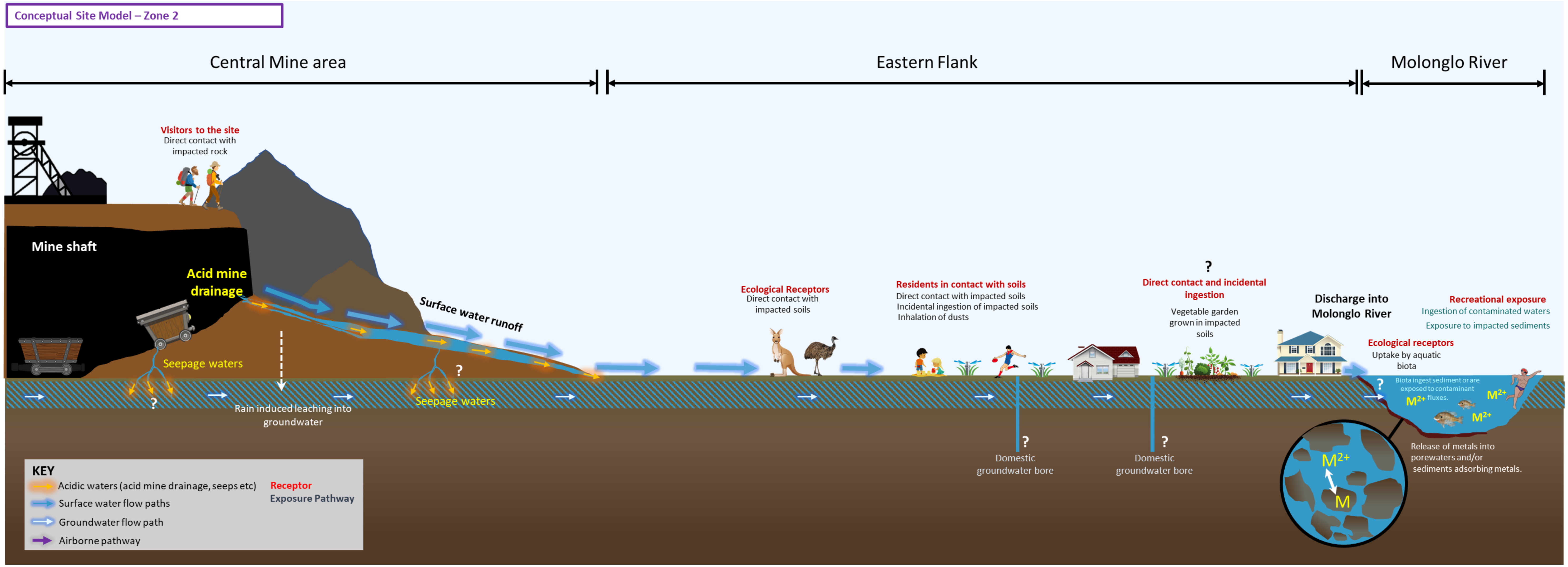

Figure 10: Preliminary cross-sectional CSM for Zone 2.

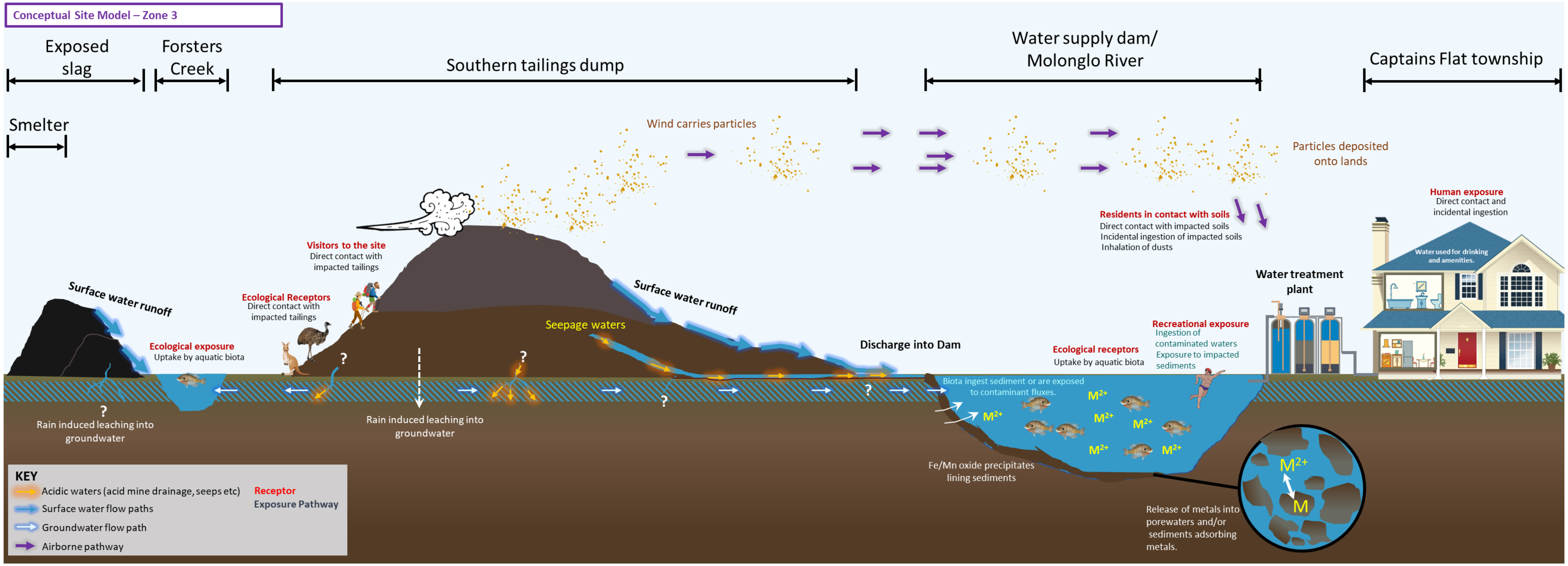

Figure 11: Preliminary cross-sectional CSM for Zone 3.

APPENDIX 3
CALIBRATION CERTIFICATES

5/4/22

Multi Parameter Water Meter

Instrument **YSI Quatro Pro Plus**
Serial No. **18L102021**

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. pH 7.00		pH 7.00		377339	pH 6.99
2. pH 4.00		pH 4.00		372347	pH 4.05
3. ORP		236.2mV		365451/370891	236.2mV
4. EC		2.76mS		377099	2.766mS
5. D.O		-1.10%		371864	-0.02
6. Temp		21.7°C		MultiTherm	21.2°C

Calibrated by: **Gary Needs**

Calibration date: **5/04/2022**

Next calibration due: **5/05/2022**

APPENDIX 4
TABLES OF RESULTS

Table H1:
Captains Flat Surface Water Samples
GHD 2018 and NSW EPA 2019

Guidelines	95% Fresh Water Protection for Aquatic Ecosystems C	Drinking Water Guidelines D	Human Health - Recreational E	Units	LOR							
Sample Type:												
ALS Sample number:												
Sample date:						8/08/2017	8/08/2017	8/08/2017	8/08/2017	9/08/2017	9/08/2017	9/08/2017
Sample ID:						SW01	SW02	SW03	SW04	SW05	SW06	SW07
Project Name:						GHD 2018	GHD 2018	GHD 2018	GHD 2018	GHD 2018	GHD 2018	GHD 2018
Compound:												
Site:												
Sampling Method:												
Sample Description:						surface water	surface water	surface water	surface water	surface water	surface water	surface water
Analyte grouping/Analyte				**Units**	**LOR**							
EG020T: Dissolved Metals by ICP-MS												
Aluminium				µg/L	1	10500	12800	30	10	70	100	112000
Arsenic	24			µg/L	1	2	6	2	1	1	1	7
Cadmium	0.2	2	60	µg/L	0.1	19.5	86.4	0.1	9.5	1.3	1.2	51.9
Cobalt	90	6	30	µg/L	0.1	-	-	-	-	-	-	-
Copper	14	2000	20000	µg/L	1	96	168	5	7	6	9	1810
Iron				µg/L	1	290000	177000	150	6010	770	1410	11900
Lead	3.4	10	200	µg/L	1	3	1020	4	2	5	6	251
Manganese	1900	500	12000	µg/L	1	48600	11300	99	1810	272	287	34900
Nickel	11	20	200	µg/L	1	-	-	-	-	-	-	-
Zinc	8			µg/L	1	142000	1420000	365	10400	2180	2360	1400000
Field Parameters												
pH				pH units	0.1	2.63	3.47	7.23	6.55	6.83	6.71	2.96
EC				µS/cm		5700	2800	490	1308	191	186	5030
Cations and Anions												
Calcium - Dissolved						376	305	20	121	11	11	345
Chloride, Cl						18	9	34	11	6	6	18
Magnesium - Dissolved						522	171	13	66	10	10	418
Potassium - Dissolved						2	3	13	2	1	1	1
Sodium - Dissolved						123	27	48	42	8	7	106
Sulphate, SO4						4740	2030	102	696	62	66	3830

Guidelines								
Sample Type:								
ALS Sample number:								
Sample date:	9/08/2017	9/08/2017	9/08/2017	9/08/2017	9/08/2017	9/08/2017	15/07/2017	15/07/2017
Sample ID:	SW08	SW09	SW10	SW11	SW12	SW13	CF001-W*	CF002-W*
Project Name:	GHD 2018	GHD 2018	GHD 2018	GHD 2018	GHD 2018	GHD 2018		
Compound:								
Site:								
Sampling Method:								
Sample Description:	surface water	surface water	surface water	surface water	surface water	surface water		
Analyte grouping/Analyte								
EG020T: Dissolved Metals by ICP-MS								
Aluminium	2880	4570	16700	50	20	10	2	5
Arsenic	1	1	3	1	1	1	13.6	
Cadmium	48.5	214	153	1.3	0.1	0.1	65	18
Cobalt	-	-	-	-	-	-	-	-
Copper	1500	1100	3360	3	2	1	3720	3620
Iron	210	280	4410	280	90	100	3800	6300
Lead	614	1970	1080	6	1	1	3910	3790
Manganese	3380	1600	2110	72	71	19	6400	9900
Nickel	-	-	-	-	-	-	-	-
Zinc	35300	102000	90400	1600	288	64	8800	8800
Field Parameters								
pH	4.9	3.88	3.19	6.05	7.04	7.43	7.45	7.48
EC	1445	649	1098	197	275	175	27.4	27.1
Cations and Anions								
Calcium - Dissolved	68	20	40	12	15	19	-	-
Chloride, Cl	18	2	2	8	19	34	-	-
Magnesium - Dissolved	87	10	29	9	12	17	-	-
Potassium - Dissolved	2	2	2	1	1	1	-	-
Sodium - Dissolved	28	2	6	9	17	27	-	-
Sulphate, SO4	639	298	492	57	56	42	-	-

Guidelines						
Sample Type:						
ALS Sample number:						
Sample date:	26/08/2019	26/08/2019	26/08/2019	26/08/2019	26/08/2019	26/08/2019
Sample ID:	Site 5 STP Discharge	Site 7 Upstream of STP and mine	Site 6 Mine leachate	Site 4 Molonglo Bridge	Upstream Molonglo River (note not truly upst	Site 2 Swimming Hole
Project Name:	NSW EPA 2019	NSW EPA 2019	NSW EPA 2019	NSW EPA 2019	NSW EPA 2019	NSW EPA 2019
Compound:						
Site:						
Sampling Method:						
Sample Description:	surface water	surface water	surface water	surface water	surface water	surface water
Analyte grouping/Analyte						
EG020T: Dissolved Metals by ICP-MS						
Aluminium	-	-	16000	-	-	-
Arsenic	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-
Cobalt	0.5	2.7	120	10	-	-
Copper	1.8	1.1	200	-	-	-
Iron	-	-	-	-	-	-
Lead	6.8	0.1	870	-	-	-
Manganese	140	330	15000	1300	680	600
Nickel	1.7	5.3	73	30	20	20
Zinc	70	3300	170000	10000	8900	8800
Field Parameters						
pH	7.7	7	3.2	7	7.1	7.1
EC	550	350	3500	780	740	740
Cations and Anions						
Calcium - Dissolved	-	-	-	-	-	-
Chloride, Cl	40	9.2	9.8	11	10	10
Magnesium - Dissolved	-	-	-	-	-	-
Potassium - Dissolved	-	-	-	-	-	-
Sodium - Dissolved	-	-	-	-	-	-
Sulphate, SO4	113	88	2400	320	270	300

Guidelines						
Sample Type:						
ALS Sample number:						
Sample date:	26/08/2019	26/08/2019	26/08/2019	26/08/2019	26/08/2019	26/08/2019
Sample ID:	Property Boundary (not included on map)	Site 2 Councilers Property	Site 1 Railway Bridge	Site 8 Carwoola Pastrol	Site 4 Briars Sharrow Rd Bridge	Site 3 Upstream of reservoir
Project Name:	NSW EPA 2019	NSW EPA 2019	NSW EPA 2019	NSW EPA 2019	NSW EPA 2019	NSW EPA 2019
Compound:						
Site:						
Sampling Method:						
Sample Description:	surface water	surface water	surface water	surface water	surface water	surface water
Analyte grouping/Analyte						
EG020T: Dissolved Metals by ICP-MS						
Aluminium	-	-	-	-	-	-
Arsenic	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-
Cobalt	-	0.3	0.5	0.3	0.2	0.2
Copper	-	1.7	0.9	0.9	0.8	1.4
Iron	-	-	-	-	-	-
Lead	-	0.2	0.1	0.5	0.6	6.9
Manganese	570	70	130	100	170	40
Nickel	20	14	5.6	0.9	1.1	1.2
Zinc	9000	6800	2300	90	50	60
Field Parameters						
pH	7.2	7.1	7.2	7.8	7.6	7.5
EC	740	720	660	390	380	110
Cations and Anions						
Calcium - Dissolved	-	-	-	-	-	-
Chloride, Cl	10	10.5	13.08	21	28.07	5.6
Magnesium - Dissolved	-	-	-	-	-	-
Potassium - Dissolved	-	-	-	-	-	-
Sodium - Dissolved	-	-	-	-	-	-
Sulphate, SO4	300	290	270	75	72	17

Blank Cell indicates no criterion available
All results are in µg/L unless stated
LOR = Limit of Reporting
Concentrations below the LOR noted as <value
NOC = No observed contamination
[A] National Environment Protection Council (2013) National Environmental Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (NEPM) Health Screening Levels for Groundwater.
[B] National Environment Protection Council (2013) National Environmental Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (NEPM) Groundwater Investigation Levels for Fresh and Marine Water Quality. Investigation levels apply to typical slightly-moderately disturbed systems. See ANZECC & ARMCANZ (2000) for guidance on applying these levels to different ecosystem conditions.
[C] Australia and New Zealand Environment and Conservation Council (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
[D] National Health and Medical Research Council, National Resource Management Ministerial Council (2011) Australian Drinking Water Guidelines, updated November 2016.
[E] National Health and Medical Research Council (2008) Guidelines for Managing Risks in Recreational Water
* USEPA RSL residential tap water value (updated June 2017), adjusted for a cancer risk level of 1:100,000 and adjusted for incidental ingestion of groundwater by applying a x10 factor (NHMRC 2008)
Guideline values exist for both meta-xylene and para-xylene as per ANZECC (2000). The guideline value for meta- & para-Xylene guideline has been adopted as the meta-Xylene value from ANZECC (2000) as it is the most conservative of the two guideline values.
Guidelines in *italics* are low level reliability guidelines
Underlined indicates freshwater value adopted for marine value in accordance with ANZECC (2000).
Bold indicates the 99% protection level should be adopted for slightly-moderately disturbed ecosystems protection level due to potential for bio-accumulation or acute toxicity to particular species
Arsenic guideline based on As (V) for fresh, the lowest of presented guidelines for ANZECC.
NHMRC arsenic guidelines are based on total arsenic
ANZECC, NEPM and NHMRC guidelines for chromium are based on Cr (VI)
ANZECC, NEPM and NHMRC guidelines for mercury are based on total mercury.
Concentration in **red** font and grey box exceed the HSL 'A & B' for Low and High Density Residential use / 'D' for Commercial/Industrial use
Concentration in **green** font and grey box exceed the adopted ecosystem guideline value
Concentration in **blue** font and grey box exceed the adopted drinking water guideline value
Concentration in **orange** font and grey box exceed the adopted recreational guideline value
Concentrations in **light blue** indicate the LOR is greater than the guideline value

Client: Department of Regional NSW
Job No: 318001193
Project Name: Captains Flat Surface Water Monitoring
27/09/2022

Table H2:
Captains Flat DSI Corridor Results Summary - Surface Water
Ramboll 2021B

	Health-based Screening Criteria (Recreational Waters)	Ecological Sceening Criteria (ANZG 95% Protection) Fresh Water	Sample Type:		Surface Water	Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
			Lab ID		S21-Fe25618	S21-Fe25619	S21-Fe25620	S21-Fe25621	S21-Fe25622	S21-Fe25623
			Sample date:		10/Feb/21	10/Feb/21	10/Feb/21	10/Feb/21	10/Feb/21	10/Feb/21
			Sample ID:		SW01	SW02	SW03	SW04	SW05	SW06
			Project Name:		Captains Flat DSI	Captains Flat DSI	Captains Flat DSI	Captains Flat DSI	Captains Flat DSI	Captains Flat DSI
			Project No:		318001025	318001025	318001025	318001025	318001025	318000780
			Sample Location		Copper Creek	Copper Creek	Copper Creek	Copper Creek	Copper Creek	Copper Creek
			Sampling Method:		Grab Sample	Grab Sample	Grab Sample	Grab Sample	Grab Sample	Grab Sample
Guidelines			Sample Description:		Clear-light orange.	Clear	Clear	Clear	Clear	Clear
Analyte grouping/Analyte			**Units**	**LOR**						
Dissolved and Total Metals										
Arsenic	0.07		mg/L	0.001	< 0.001	< 0.001	0.002	< 0.001	0.001	0.001
Arsenic (filtered)		0.024	mg/L	0.001	0.001	0.001	0.002	0.002	0.002	0.002
Cadmium	0.02		mg/L	0.0002	**0.032**	**0.024**	0.0014	0.0057	0.012	0.0093
Cadmium (filtered)		0.0002	mg/L	0.0002	0.028	0.023	0.0014	0.0051	0.011	0.0092
Chromium	0.5		mg/L	0.001	< 0.001	< 0.001	0.002	0.001	0.001	0.001
Chromium (filtered)		0.001	mg/L	0.001	< 0.001	< 0.001	0.002	< 0.001	0.001	< 0.001
Copper	20		mg/L	0.001	0.2	0.15	0.045	0.04	0.049	0.042
Copper (filtered)		0.0014	mg/L	0.001	0.16	0.13	0.039	0.036	0.039	0.036
Iron	3		mg/L	0.05						
Lead	0.1		mg/L	0.001	**0.35**	**0.41**	0.075	**0.22**	**0.25**	**0.17**
Lead (filtered)		0.0034	mg/L	0.001	0.26	0.34	0.052	0.16	0.13	0.12
Mercury	0.01		mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)		0.0006	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	0.2		mg/L	0.001	0.013	0.017	0.005	0.01	0.015	0.014
Nickel (filtered)		0.011	mg/L	0.001	0.01	0.015	0.004	0.009	0.013	0.013
Zinc	30		mg/L	0.005	18	27	0.73	2.5	3.8	3.3
Zinc (filtered)		0.008	mg/L	0.005	15	23	0.66	2.3	3.5	3.3

- indicates no criterion available
All results are in mg/L
LOR = Limit of Reporting
Concentrations below the LOR noted as <value
NOC = No observed contamination
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)
Australia and New Zealand Environment and Conservation Council (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
NHMRC (2008 updated 2018) Guidelines for Manageing Risks in Recreational Water. National Health and Medical Research Council.
ANZECC, NEPM and NHMRC guidelines for mercury are based on total mercury.
Concentration in **red bold** font exceed the Health-based Recreational Use Criteria
Concentration in yellow box exceed the Ecological Criteria
(1) Generally 95% protective level for fresh water ecosystems.

Table T1:
Surface Water Results

Guidelines	Drinking Water Guidelines[D]	Recreation (Exposure Adjusted)	ANZECC Fresh Water Guidelines - Irrigation[B]	ANZECC Fresh Water Guidelines - Stock Water[B]	Ecological Sceening Criteria (ANZG 95% Protection) Fresh Water	Units	LOR
Analyte grouping/Analyte						**Units**	**LOR**
Hardness							
Hardness mg equivalent CaCO3/L						μg/L	10
Cations/Anions							
Calcium						μg/L	10
Magnesium		-	-	-	-	μS/cm	100
Total Metals							
Aluminium	20	200	5	20	-	mg/L	0.05
Arsenic	0.01	0.1	0.5	2	-	mg/L	0.001
Barium	2	20	-	-	-	mg/L	0.001
Cadmium	0.002	0.06*	0.01	0.05	-	mg/L	0.0002
Chromium	0.05	0.5	1	1	-	mg/L	0.001
Cobalt	0.006	0.03^	1	0.1	-	mg/L	0.001
Copper	2	20	0.5	0.1	-	mg/L	0.001
Iron	1.4	119^	-	10	-	mg/L	0.05
Lead	0.01	0.2'	0.1	5	-	mg/L	0.001
Manganese	0.5	12*	10	2.5	-	mg/L	0.005
Mercury	0.001	0.01	0.002	0.002	-	mg/L	0.0001
Molybdenum	0.05	0.5	-	-	-	mg/L	0.005
Nickel	0.02	0.2	1	2	-	mg/L	0.001
Selenium	0.01	0.1	-	-	-	mg/L	0.001
Titanium	-	-	-	-	-	mg/L	0.005
Zinc	0.6	26"	20	5	-	mg/L	0.005
Dissolved							
Aluminium (filtered)	-	-	-	-	0.055	mg/L	0.05
Arsenic (filtered)	-	-	-	-	0.024	mg/L	0.001
Barium (filtered)	-	-	-	-	-	mg/L	0.001
Cadmium (filtered)	-	-	-	-	0.0002	mg/L	0.0002
Chromium (filtered)	-	-	-	-	0.001	mg/L	0.001
Cobalt (filtered)	-	-	-	-	0.09	mg/L	0.001
Copper (filtered)	-	-	-	-	0.0014	mg/L	0.001
Iron (filtered)	-	-	-	-	0.3	mg/L	0.05
Lead (filtered)	-	-	-	-	0.0034	mg/L	0.001
Manganese (filtered)	-	-	-	-	1.9	mg/L	0.005
Mercury (filtered)	-	-	-	-	0.00006	mg/L	0.0001
Molybdenum (filtered)	-	-	-	-	0.034	mg/L	0.005
Nickel (filtered)	-	-	-	-	0.011	mg/L	0.001
Selenium (filtered)	-	-	-	-	0.011	mg/L	0.001
Titanium (filtered)	-	-	-	-	-	mg/L	0.005
Zinc (filtered)	-	-	-	-	0.008	mg/L	0.005

Lab ID	S21-Jn12561	S21-No11144	S22-Ja37943	N22-Ap0040960	S21-Jn12562	S21-No11145	S22-Ja37944	N22-Ap0040961	S21-Jn12563	S21-No11146	S22-Ja37945	N22-Ap0040962	S21-Jn12564	S21-No11147	S22-Ja37946
Sample date:	3/06/2021	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sample ID:	SW1	SW1	SW1	SW1	SW2	SW2	SW2	SW2	SW3	SW3	SW3	SW3	SW4	SW4	SW4
Project Name:	Captains Flat LM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Project No:	318001193	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sample Location	North end of Precinct	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sampling Method:	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct
Sample Description:															
Hardness mg equivalent CaCO3/L	63	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Calcium	11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Magnesium	8.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aluminium	0.33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Arsenic	< 0.001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Barium	0.02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cadmium	0.0019	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Chromium	< 0.001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cobalt	0.003	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Copper	0.012	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Iron	2.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lead	0.019	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Manganese	0.31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mercury	< 0.0001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Molybdenum	< 0.005	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nickel	0.005	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Selenium	0.001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Titanium	< 0.005	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Zinc	2.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aluminium (filtered)	0.09	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Arsenic (filtered)	< 0.001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Barium (filtered)	0.02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cadmium (filtered)	0.0019	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Chromium (filtered)	< 0.001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cobalt (filtered)	0.003	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Copper (filtered)	0.008	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Iron (filtered)	0.63	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lead (filtered)	0.007	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Manganese (filtered)	0.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mercury (filtered)	< 0.0001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Molybdenum (filtered)	< 0.005	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nickel (filtered)	0.004	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Selenium (filtered)	< 0.001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Titanium (filtered)	< 0.005	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Zinc (filtered)	1.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Lab ID	N22-Ap0040963	S21-Jn12565	S21-No11148	S22-Ja37947	N22-Ap0040964	S21-Jn12566	S21-No11149	S22-Ja37948	N22-Ap0040965	S21-Jn12567	S21-No11150
Sample date:	12/04/2022	3/06/2021	1/11/2021	23/01/2022	13/04/2022	3/06/2021	1/11/2021	23/01/2022	12/04/2022	3/06/2021	1/11/2021
Sample ID:	SW4	SW5	SW5	SW5	SW5	SW6	SW6	SW6	SW6	SW7	SW7
Project Name:	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM
Project No:	318001193	318001193	318001193	318001194	318001193	318001193	318001193	318001194	318001193	318001193	318001193
Sample Location	North end of Precinct	Main Adit Spring	Main Adit Spring	North end of Precinct	North end of precinct	Copper Ck DS of the rail corridor	Copper Ck DS of the rail corridor	North end of Precinct	Copper Ck DS of the rail corridor	Copper Ck US of the rail corridor	Copper Ck US of the rail corridor
Sampling Method:	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct
Sample Description:											
Hardness mg equivalent CaCO3/L		1400	-			33	-			32	-
Calcium		280	-			4.2	-			4.2	-
Magnesium		170	-			5.5	-			5.3	-
Aluminium	0.5	13	17	48	13.0	2.5	0.41	0.15	0.4	2	0.58
Arsenic	0.001	0.01	0.012	0.013	0.023	0.002	< 0.001	0.001	< 0.001	0.002	< 0.001
Barium	< 0.02	< 0.02	-	< 0.02	< 0.02	0.03	-	< 0.02	< 0.02	0.03	-
Cadmium	0.0005	0.1	0.12	0.13	0.12	0.0029	0.0022	0.0033	0.0018	0.003	0.0016
Chromium	< 0.001	0.002	0.001	0.001	< 0.001	0.003	0.004	< 0.001	< 0.001	0.003	0.001
Cobalt	0.001	0.086	0.11	0.1	0.088	0.001	0.001	0.001	0.001	0.002	0.001
Copper	0.008	0.33	0.32	0.5	0.35	0.063	0.022	0.02	0.016	0.06	0.02
Iron	1.8	150	210	160	130	2.2	1.1	0.53	0.96	2	0.82
Lead	0.01	1.2	1.4	1.2	1.2	0.29	0.046	0.03	0.026	0.3	0.041
Manganese	0.12	10	14	11	9.6	0.042	0.032	0.024	0.026	0.042	0.03
Mercury	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.002	0.063	0.075	0.063	0.061	0.004	0.006	0.017	0.004	0.003	0.005
Selenium	< 0.001	0.011	-	0.003	0.009	0.002	-	< 0.001	< 0.001	0.001	-
Titanium	< 0.005	< 0.005	-	< 0.005	< 0.005	0.053	-	< 0.005	< 0.005	0.042	-
Zinc	0.53	120	160	130	110	1.4	0.94	1.1	0.68	1.4	0.79
Aluminium (filtered)	0.18	13	15	31	15.00	0.74	0.27	0.09	1.80	0.51	0.26
Arsenic (filtered)	< 0.001	0.008	0.011	0.01	0.008	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001
Barium (filtered)	< 0.02	< 0.02	-	< 0.02	< 0.02	0.02	-	< 0.02	< 0.02	0.02	-
Cadmium (filtered)	0.0005	0.11	0.11	0.12	0.13	0.003	0.002	0.0031	0.0017	0.0032	0.0015
Chromium (filtered)	< 0.001	< 0.001	0.001	0.001	0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001
Cobalt (filtered)	0.001	0.097	0.1	0.096	0.1	0.001	0.001	0.001	0.001	0.001	0.001
Copper (filtered)	0.006	0.36	0.28	0.48	0.39	0.045	0.017	0.017	0.016	0.046	0.016
Iron (filtered)	0.92	190	170	150	150	0.65	0.4	0.34	1.9	0.63	0.39
Lead (filtered)	0.005	1.3	1.2	1.2	1.3	0.11	0.028	0.024	0.021	0.13	0.026
Manganese (filtered)	0.11	12	12	10	11	0.033	0.026	0.022	0.025	0.034	0.024
Mercury (filtered)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum (filtered)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Nickel (filtered)	0.002	0.072	0.068	0.07	0.073	0.003	0.005	0.006	0.004	0.003	0.004
Selenium (filtered)	< 0.001	0.003	-	0.001	0.008	< 0.001	-	< 0.001	< 0.001	< 0.001	-
Titanium (filtered)	< 0.005	< 0.005	-	< 0.005	< 0.005	0.012	-	< 0.005	0.064	0.011	-
Zinc (filtered)	0.52	140	130	130	130	1.1	0.76	0.99	0.64	1.2	0.64

Lab ID	S22-Ja37949	N22-Ap0040966	S21-Jn12568	S21-No11151	S22-Ja37950	N22-Ap0040967	S21-Jn12569	S21-No11152	S22-Ja37951	N22-Ap0040968	S21-Jn12570
Sample date:	23/01/2022	12/04/2022	3/06/2021	1/11/2021	23/01/2022	12/04/2022	3/06/2021	1/11/2021	23/01/2022	12/04/2022	3/06/2021
Sample ID:	SW7	SW7	SW8	SW8	SW8	SW8	SW9	SW9	SW9	SW9	SW10
Project Name:	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM	Captains Flat LM
Project No:	318001194	318001193	318001193	318001193	318001194	318001193	318001193	318001193	318001194	318001193	318001193
Sample Location	North end of Precinct	Copper Ck US of the rail corridor	Mine dam overflow DS of the rail corridor	Mine dam overflow DS of the rail corridor	North end of Precinct		Mine dam overflow US of the rail corridor	Mine dam overflow US of the rail corridor	North end of Precinct	North end of Precinct	Adjacent / DS of the confluence of Forsters Ck and Molonglo River
Sampling Method:	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct
Sample Description:											
Hardness mg equivalent CaCO3/L			300	-			330	-			96
Calcium			55	-			72	-			13
Magnesium			40	-			36	-			15
Aluminium	0.22	0.5	16	0.78	2.8	4.8	16	7.8	4.5	6.8	2.6
Arsenic	0.001	0.001	0.003	< 0.001	0.002	0.004	0.002	0.002	0.002	0.002	0.001
Barium	< 0.02	< 0.02	0.02	-	0.04	0.06	0.03	-	0.05	0.06	< 0.02
Cadmium	0.001	0.0014	0.11	0.018	0.017	0.054	0.16	0.096	0.062	0.081	0.0069
Chromium	< 0.001	0.001	0.003	< 0.001	< 0.001	0.003	0.004	0.001	< 0.001	0.003	0.001
Cobalt	< 0.001	0.001	0.037	0.022	0.017	0.019	0.04	0.073	0.035	0.024	0.016
Copper	0.014	0.015	1.7	0.082	0.19	0.71	2.6	0.93	0.65	1.1	0.19
Iron	0.64	1.2	15	7.4	17	8.1	7.5	13	7.6	5.6	3.8
Lead	0.031	0.024	1.2	0.24	0.41	0.53	1.3	1.5	1.4	0.61	0.11
Manganese	0.019	0.028	2.5	1.6	1.6	1.6	3	4.1	2.3	1.8	1.3
Mercury	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.013	0.004	0.034	0.016	0.002	0.018	0.044	0.038	0.013	0.025	0.006
Selenium	< 0.001	< 0.001	0.007	-	< 0.001	0.003	0.009	-	< 0.001	0.004	0.004
Titanium	< 0.005	0.007	< 0.005	-	< 0.005	0.01	< 0.005	-	< 0.005	< 0.005	< 0.005
Zinc	0.43	0.57	67	27	17	37	95	71	48	55	8.2
Aluminium (filtered)	0.07	1.10	13	0.5	0.08	3.10	15	6.2	4.1	6.40	1.2
Arsenic (filtered)	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001	0.002	0.002	0.002	0.001	< 0.001
Barium (filtered)	< 0.02	< 0.02	0.03	-	0.03	0.05	0.03	-	0.05	0.06	< 0.02
Cadmium (filtered)	0.001	0.0013	0.12	0.016	0.016	0.058	0.18	0.081	0.058	0.079	0.0072
Chromium (filtered)	< 0.001	0.002	0.002	< 0.001	< 0.001	< 0.001	0.004	< 0.001	< 0.001	0.001	< 0.001
Cobalt (filtered)	< 0.001	0.001	0.041	0.019	0.016	0.02	0.043	0.059	0.032	0.023	0.016
Copper (filtered)	0.013	0.014	1.9	0.073	0.071	0.64	2.7	0.74	0.59	1.1	0.18
Iron (filtered)	0.34	1.2	11	3.9	7	3.1	8.3	9.9	6.8	5.2	1.2
Lead (filtered)	0.024	0.02	1.2	0.17	0.018	0.36	1.4	1.1	1.3	0.59	0.069
Manganese (filtered)	0.017	0.024	3	1.3	1.5	1.6	3.3	3.4	2.1	1.7	1.3
Mercury (filtered)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum (filtered)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Nickel (filtered)	0.004	0.004	0.036	0.014	0.012	0.018	0.047	0.03	0.022	0.023	0.007
Selenium (filtered)	< 0.001	< 0.001	0.002	-	< 0.001	0.002	0.002	-	< 0.001	0.003	< 0.001
Titanium (filtered)	< 0.005	0.033	< 0.005	-	< 0.005	< 0.005	< 0.005	-	< 0.005	< 0.005	< 0.005
Zinc (filtered)	0.39	0.53	78	22	14	39	110	59	40	53	6.8

- indicates no criterion available
All results are in μg/L
LOR = Limit of Reporting
Concentrations below the LOR noted as <value
NOC = No observed contamination
Australian and New Zealand Guidelines
for Fresh and Marine Water Quality
Australia and New Zealand Environment and Conservation Council (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
[A]NRMMC (2011 updated 2018) Australian Drinking Water Guidelines (ADWG) Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council.
ANZECC, NEPM and NHMRC guidelines for mercury are based on total mercury.

Table T2 - Surface Water Physical Parameter Data

RAMBOLL

Well ID	Purge Date	Temperature (°C)	pH	SPC (μScm-¹)	DO (mg/L)	Eh (mV)	Comments
SW1	3/06/2021	7.5	7.50	180.4	10.4	124.7	
SW1	1/11/2021	16.7	7.08	142	9.19	114.1	
SW1	23/01/2022	18.9	7.70	113.9	7.9	21.0	
SW1	12/04/2022	15.1	7.06	93.6	9.91	199.1	
SW2	3/06/2021	7.6	7.01	192.5	10.51	62.4	
SW2	1/11/2021	15.7	5.39	142.5	8.97	-20.4	
SW2	23/01/2022	18.5	6.97	113.3	7.33	22.6	
SW2	12/04/2022	14.4	7.26	90.9	9.33	143.4	
SW3	3/06/2021	8.2	6.38	277.5	9.78	147.6	
SW3	1/11/2021	15.7	6.43	144.6	8.8	96.5	
SW3	23/01/2022	18.5	6.87	114	9.2	-21.0	
SW3	12/04/2022	14.4	6.90	90.8	9.19	142.8	
SW4	3/06/2021	7.7	6.88	173.3	9.35	52.3	
SW4	1/11/2021	15.3	6.33	133.7	9.39	-76.0	
SW4	23/01/2022	18.3	6.96	106	7.64	-32.5	
SW4	12/04/2022	14.4	6.83	87.6	9.43	162.1	
SW5	3/06/2021	14.2	3.56	2952	7.67	377.4	
SW5	1/11/2021	18.9	3.66	3049	7.49	303.8	
SW5	23/01/2022	17.5	3.70	2341	7.37	159.4	
SW5	13/04/2022	16.2	3.71	2.727	8.36	332.8	
SW6	3/06/2021	7.3	7.38	150.3	10.77	141.1	
SW6	1/11/2021	14.7	7.23	184.4	7.67	-58.8	
SW6	23/01/2022	18.8	6.83	208.6	6.64	99.7	
SW6	12/04/2022	15.0	7.37	169.7	9	161.2	
SW7	3/06/2021	7.3	7.28	150.4	10.64	146.5	
SW7	1/11/2021	15.2	6.77	170.8	9.26	-24.3	
SW7	23/01/2022	19.2	6.46	135.3	0.44	7.7	
SW7	12/04/2022	15.0	7.33	142.9	9.18	162.9	
SW8	3/06/2021	8.1	3.74	1062	9.75	435.0	
SW8	1/11/2021	19.1	5.17	1174	2.74	-56.0	
SW8	23/01/2022	16.5	6.18	846	3.3	25.8	
SW8	12/04/2022	18.0	4.70	741	5.87	193.8	
SW9	3/06/2021	8.4	3.19	1251	9.73	451.3	
SW9	1/11/2021	14.8	2.83	1116	6.61	376.6	
SW9	23/01/2022	17.2	3.15	681	5.91	256.6	
SW9	12/04/2022	20.3	3.45	714	6.21	382.9	
SW10	3/06/2021	8.1	5.38	250.4	8.47	253.5	
SW10	1/11/2021	13.9	5.81	81.6	8.32	14.9	
SW10	23/01/2022	16.9	6.29	123.6	8.5	257.3	
SW10	13/04/2022	12.0	4.49	481.9	10.2	470.2	
SW11	3/06/2021	8.3	6.32	129.2	9.26	272.2	
SW11	1/11/2021	14.7	3.24	662	8.32	150.4	
SW11	23/01/2022	16.7	5.03	102.9	6.35	381.3	
SW11	13/04/2022	13.5	6.69	67.8	9.66	449.0	
SW12	3/06/2021	9.0	2.92	2618	9.73	476.3	
SW12	1/11/2021	26.1	2.38	7946	4.74	526.4	
SW12	23/01/2022	17.2	2.59	5204	4.19	448.9	
SW12	13/04/2022	11.4	2.74	4868	8.3	510.7	
SW13	3/06/2021	7.9	5.16	177.7	10.14	299.7	
SW13	1/11/2021	21.5	8.22	162.2	7.74	-60.6	
SW13	23/01/2022	17.5	7.03	143.3	9.3	181.0	
SW13	13/04/2022	12.8	7.19	153.5	9.4	361.5	
SW14	3/06/2021	8.3	7.03	60.8	7.21	187.3	
SW14	1/11/2021	17.2	7.64	69.1	7.87	-66.2	
SW14	23/01/2022	21.0	7.42	57.5	7	122.8	
SW14	13/04/2022	14.9	7.34	64.2	6.61	270.3	
SW15	3/06/2021	8.6	6.56	65.6	6.74	153.9	
SW15	1/11/2021	18.5	7.9	70.3	6.8	-52.9	
SW15	23/01/2022	20.9	7.1	58.3	6.5	108.7	
SW15	13/04/2022	14.8	7.3	60.8	7.7	307.6	

Notes

L = Litre
DO = Dissolved Oxygen
ppm = parts per million
SPC = Specific Conductivity
μScm-¹ = microSiemens per centimetre
Eh = Redox
mV = milli Volts
\- = No result recorded

Client: Department of Regional NSW
Job No: 318001193
Project Name: Captains Flat Surface Water Monitoring
27/09/2022

Table T3 - Surface Water RPDs

RAMBOLL

Guidelines			Eurofins	Eurofins	RPD	Eurofins	Envirolab	RPD	Eurofins	Eurofins	RPD
	Laboratory Sample number:		S21-Jn12565	S21-Jn12592		S21-Jn12565	271012-2		S21-No11151	S21-No11159	
	Sample date:		3/06/2021	3/06/2021		3/06/2021	3/06/2021		1/11/2021	1/11/2021	
	Sample ID:		SW5	QA35		SW5	QA35		SW8	D01_20211101	
	Sample Description:		PRIMARY	DUPLICATE OF SW5		PRIMARY	TRIPLICATE OF 006_GW005		PRIMARY	DUPLICATE OF SW8	
Analyte grouping/Analyte	**Units**	**LOR**									
EG020T: Dissolved Metals by ICP-MS											
Aluminium	mg/L	0.05	13	14	*7.4*	13	14	*7.4*	0.78	0.74	*5.3*
Aluminium (filtered)	mg/L	0.05	13	12	*8.0*	13	16	*20.7*	0.5	0.47	*6.2*
Arsenic	mg/L	0.001	0.01	0.011	*9.5*	0.01	0.011	*9.5*	< 0.001	< 0.001	*nc*
Arsenic (filtered)	mg/L	0.001	0.008	0.008	*0.0*	0.008	0.006	*28.6*	0.001	< 0.001	*nc*
Barium	mg/L	0.001	< 0.02	< 0.02	*nc*	< 0.02	0.009	*nc*	-	-	*nc*
Barium (filtered)	mg/L	0.001	< 0.02	< 0.02	*nc*	< 0.02	0.006	*nc*	-	-	*nc*
Cadmium	mg/L	0.0002	0.1	0.11	*9.5*	0.1	0.12	*18.2*	0.018	0.02	*10.5*
Cadmium (filtered)	mg/L	0.0002	0.11	0.11	*0.0*	0.11	0.1	*9.5*	0.016	0.016	*0.0*
Chromium	mg/L	0.001	0.002	0.002	*0.0*	0.002	0.09	***191.3***	< 0.001	< 0.001	*nc*
Chromium (filtered)	mg/L	0.001	< 0.001	< 0.001	*nc*	< 0.001	0.067	*nc*	< 0.001	< 0.001	*nc*
Cobalt	mg/L	0.001	0.086	0.096	*11.0*	0.086	<1	*nc*	0.022	0.024	*8.7*
Cobalt (filtered)	mg/L	0.001	0.097	0.098	*1.0*	0.097	<1	*nc*	0.019	0.018	*5.4*
Copper	mg/L	0.001	0.33	0.37	*11.4*	0.33	0.33	*0.0*	0.082	0.091	*10.4*
Copper (filtered)	mg/L	0.001	0.36	0.37	*2.7*	0.36	0.24	***40.0***	0.073	0.072	*1.4*
Iron	mg/L	0.05	150	170	*12.5*	150	160	*6.5*	7.4	7.4	*0.0*
Iron (filtered)	mg/L	0.05	190	190	*0.0*	190	170	*11.1*	3.9	3.8	*2.6*
Lead	mg/L	0.001	1.2	1.3	*8.0*	1.2	<1	*nc*	0.24	0.28	*15.4*
Lead (filtered)	mg/L	0.001	1.3	1.4	*7.4*	1.3	<1	*nc*	0.17	0.17	*0.0*
Manganese	mg/L	0.005	10	11	*9.5*	10	11	*9.5*	1.6	1.7	*6.1*
Manganese (filtered)	mg/L	0.005	12	12	*0.0*	12	11	*8.7*	1.3	1.3	*0.0*
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	*nc*	< 0.0001	<1	*nc*	< 0.0001	< 0.0001	*nc*
Mercury (filtered)	mg/L	0.0001	< 0.0001	< 0.0001	*nc*	< 0.0001	<1	*nc*	< 0.0001	< 0.0001	*nc*
Molybdenum	mg/L	0.005	< 0.005	< 0.005	*nc*	< 0.005	0.066	*nc*	< 0.005	< 0.005	*nc*
Molybdenum (filtered)	mg/L	0.005	< 0.005	< 0.005	*nc*	< 0.005	0.047	*nc*	< 0.005	< 0.005	*nc*
Nickel	mg/L	0.001	0.063	0.071	*11.9*	0.063	1.3	***181.5***	0.016	0.017	*6.1*
Nickel (filtered)	mg/L	0.001	0.072	0.072	*0.0*	0.072	1.4	***180.4***	0.014	0.013	*7.4*
Selenium	mg/L	0.001	0.011	0.013	*16.7*	0.011	0.002	***138.5***	-	-	*nc*
Selenium (filtered)	mg/L	0.001	0.003	0.002	***40.0***	0.003	<1	*nc*	-	-	*nc*
Titanium	mg/L	0.005	< 0.005	< 0.005	*nc*	< 0.005	0.0011	*nc*	-	-	*nc*
Titanium (filtered)	mg/L	0.005	< 0.005	< 0.005	*nc*	< 0.005	<1	*nc*	-	-	*nc*
Zinc	mg/L	0.005	120	130	*8.0*	120	130	*8.0*	27	29	*7.1*
Zinc (filtered)	mg/L	0.005	140	140	*0.0*	140	140	*0.0*	22	21	*4.7*

Laboratory:	Eurofins	Envirolab	RPD	Eurofins	Eurofins	Envirolab	RPD	Eurofins	RPD	Eurofins	Eurofins	Eurofins	RPD	Envirolab	RPD
Laboratory Sample number:	S21-No11151	1		S21-No11160	S22-Ja37947	S22-Ja37958		287740		N22-Apo0040976	N22-Ap0040974	N22-Ap0040975		294083-1	
Sample date:	1/11/2021	1/11/2021		1/11/2021	25/01/2022	25/01/2022		25/01/2022		13/04/2022	13/04/2022	13/04/2022		13/04/2022	
Sample ID:	SW8	T01_20211101		R01_20211101	SW5	QC01		QC02		RINSATE	SW15	D01		T01	
Sample Description:	PRIMARY	TRIPLICATE OF SW8		RINSATE	PRIMARY	DUPLICATE OF SW5		TRIPLICATE OF SW5		RINSATE	PRIMARY	DUPLICATE OF SW15		TRIPLICATE OF SW15	
Aluminium	0.78	0.46	***51.6***	< 0.05		-	**-**	-	**-**			-	**-**		**-**
Aluminium (filtered)	0.5	0.44	*12.8*	< 0.05		-	-	-	-			-	-		-
Arsenic	< 0.001	<0.001	*nc*	< 0.001	0.013	0.012	*8.0*	0.01	*26.1*	< 0.001	< 0.001	< 0.001	*nc*	0.001	*nc*
Arsenic (filtered)	0.001	<0.001	*nc*	< 0.001	0.01	0.01	*0.0*	0.01	*0.0*	< 0.001	< 0.001	< 0.001	*nc*	< 0.001	*nc*
Barium	-	-	*nc*	-	< 0.02	< 0.02	*nc*	0.006	*nc*	< 0.02	< 0.02	< 0.02	*nc*	0.01	*nc*
Barium (filtered)	-	-	*nc*	-	< 0.02	< 0.02	*nc*	0.006	*nc*	< 0.02	< 0.02	< 0.02	*nc*	0.008	*nc*
Cadmium	0.018	0.017	*5.7*	< 0.0002	0.13	0.13	*0.0*	0.14	*7.4*	< 0.0002	< 0.0002	< 0.0002	*nc*	< 0.0001	*nc*
Cadmium (filtered)	0.016	0.018	*11.8*	< 0.0002	0.12	0.12	*0.0*	0.14	*15.4*	< 0.0002	< 0.0002	< 0.0002	*nc*	< 0.0001	*nc*
Chromium	< 0.001	<0.001	*nc*	< 0.001	0.001	0.001	*0.0*	0.001	*0.0*	**0.004**	< 0.001	< 0.001	*nc*	< 0.001	*nc*
Chromium (filtered)	< 0.001	<0.001	*nc*	< 0.001	0.001	0.001	*0.0*	<0.001	*nc*	< 0.001	< 0.001	< 0.001	*nc*	< 0.001	*nc*
Cobalt	0.022	0.02	*9.5*	< 0.001	0.1	0.098	*2.0*	0.085	*16.2*	< 0.001	< 0.001	< 0.001	*nc*	< 0.001	*nc*
Cobalt (filtered)	0.019	0.02	*5.1*	< 0.001	0.096	0.097	*1.0*	0.11	*13.6*	< 0.001	< 0.001	< 0.001	*nc*	< 0.001	*nc*
Copper	0.082	0.078	*5.0*	< 0.001	0.5	0.5	*0.0*	0.41	*19.8*	< 0.001	0.002	0.002	*0.0*	0.002	*0.0*
Copper (filtered)	0.073	0.072	*1.4*	< 0.001	0.48	0.48	*0.0*	0.54	*11.8*	< 0.001	0.002	0.002	*0.0*	0.002	*0.0*
Iron	7.4	4.7	***44.6***	< 0.05	160	170	*6.1*	170	*6.1*	< 0.05	1.1	1.1	*0.0*	0.74	***39.1***
Iron (filtered)	3.9	3.7	*5.3*	< 0.05	150	140	*6.9*	150	*0.0*	< 0.05	0.52	0.52	*0.0*	0.48	*8.0*
Lead	0.24	0.2	*18.2*	< 0.001	1.2	1.2	*0.0*	1.4	*15.4*	< 0.001	0.002	0.002	*0.0*	0.001	***66.7***
Lead (filtered)	0.17	0.19	*11.1*	< 0.001	1.2	1.2	*0.0*	1.4	*15.4*	< 0.001	< 0.001	< 0.001	*nc*	< 0.001	*nc*
Manganese	1.6	1.3	*20.7*	< 0.005	11	11	*0.0*	12	*8.7*	< 0.005	0.028	0.029	*3.5*	0.028	*0.0*
Manganese (filtered)	1.3	1.4	*7.4*	< 0.005	10	10	*0.0*	11	*9.5*	< 0.005	0.01	0.01	*0.0*	0.01	*0.0*
Mercury	< 0.0001	<0.00005	*nc*	< 0.0001	< 0.0001	< 0.0001	*nc*	<0.00005	*nc*	< 0.0001	< 0.0001	< 0.0001	*nc*	< 0.00005	*nc*
Mercury (filtered)	< 0.0001	<0.00005	*nc*	< 0.0001	< 0.0001	< 0.0001	*nc*	<0.00005	*nc*	< 0.0001	< 0.0001	0.0002	*nc*	< 0.00005	*nc*
Molybdenum	< 0.005	<0.001	*nc*	< 0.005	< 0.005	< 0.005	*nc*	<0.001	*nc*	< 0.005	< 0.005	< 0.005	*nc*	0.001	*nc*
Molybdenum (filtered)	< 0.005	<0.001	*nc*	< 0.005	< 0.005	< 0.005	*nc*	0.002	*nc*	< 0.005	< 0.005	< 0.005	*nc*	0.001	*nc*
Nickel	0.016	0.015	*6.5*	< 0.001	0.063	0.064	*1.6*	0.062	*1.6*	0.003	0.002	0.002	*0.0*	0.002	*0.0*
Nickel (filtered)	0.014	0.014	*0.0*	< 0.001	0.07	0.074	*5.6*	0.079	*12.1*	< 0.001	0.002	0.002	*0.0*	0.002	*0.0*
Selenium	-	-	*nc*	-	0.003	0.001	***100.0***	<0.001	*nc*	< 0.001	< 0.001	< 0.001	*nc*	< 0.001	*nc*
Selenium (filtered)	-	-	*nc*	-	0.001	< 0.001	*nc*	0.001	*0.0*	< 0.001	< 0.001	< 0.001	*nc*	< 0.001	*nc*
Titanium	-	-	*nc*	-	< 0.005	< 0.005	*nc*	<0.001	*nc*	< 0.005	< 0.005	< 0.005	*nc*	0.0051	*nc*
Titanium (filtered)	-	-	*nc*	-	< 0.005	< 0.005	*nc*	<0.001	*nc*	< 0.005	< 0.005	< 0.005	*nc*	0.0048	*nc*
Zinc	27	26	*3.8*	**0.012**	130	140	*7.4*	140	*7.4*	< 0.005	0.031	0.028	*10.2*	0.012	***88.4***
Zinc (filtered)	22	22	*0.0*	**0.008**	130	120	*8.0*	130	*0.0*	< 0.005	0.016	0.015	*6.5*	0.009	***56.0***

LOR = Limit of Reporting
<value = Less than the laboratory Limit of Reporting (LOR)
Bold and Shaded cells exceed RPD >30% (RPDs where concentrations were < 10 x LOR were discounted from assessment)
Bold indicates when above the acceptance criteria for Trip Spikes/Blanks and Rinsates
nc = not calculated as one or more results are below the LOR.

APPENDIX 5
LABORATORY REPORTS

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 294083

Client Details

Client	Ramboll Australia Pty Ltd
Attention	Stephen Maxwell
Address	PO Box 560, North Sydney, NSW, 2060

Sample Details

Your Reference	**318001193, Captains Flat Management Plan**
Number of Samples	1 Water
Date samples received	26/04/2022
Date completed instructions received	26/04/2022

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	03/05/2022
Date of Issue	03/05/2022

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Results Approved By
Giovanni Agosti, Group Technical Manager

Authorised By

Nancy Zhang, Laboratory Manager

All metals in water - total		
Our Reference		294083-1
Your Reference	UNITS	T01
Date Sampled		13/04/2022
Type of sample		Water
Date prepared	-	27/04/2022
Date analysed	-	27/04/2022
Arsenic-Total	µg/L	1
Barium-Total	µg/L	10
Cadmium-Total	µg/L	<0.1
Chromium-Total	µg/L	<1
Cobalt-Total	µg/L	<1
Copper-Total	µg/L	2
Iron-Total	µg/L	740
Mercury-Total	µg/L	<0.05
Lead-Total	µg/L	1
Manganese-Total	µg/L	28
Molybdenum-Total	µg/L	1
Nickel-Total	µg/L	2
Selenium-Total	µg/L	<1
Titanium-Total	µg/L	5.1
Zinc-Total	µg/L	12

All metals in water-dissolved		
Our Reference		294083-1
Your Reference	UNITS	T01
Date Sampled		13/04/2022
Type of sample		Water
Date prepared	-	28/04/2022
Date analysed	-	28/04/2022
Arsenic-Dissolved	µg/L	<1
Barium-Dissolved	µg/L	8
Cadmium-Dissolved	µg/L	<0.1
Chromium-Dissolved	µg/L	<1
Cobalt-Dissolved	µg/L	<1
Copper-Dissolved	µg/L	2
Iron-Dissolved	µg/L	480
Mercury-Dissolved	µg/L	<0.05
Lead-Dissolved	µg/L	<1
Manganese-Dissolved	µg/L	10
Molybdenum-Dissolved	µg/L	1
Nickel-Dissolved	µg/L	2
Selenium-Dissolved	µg/L	<1
Titanium-Dissolved	µg/L	4.8
Zinc-Dissolved	µg/L	9

Method ID	Methodology Summary
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: All metals in water - total					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			28/04/2022	[NT]	[NT]	[NT]	[NT]	28/04/2022	[NT]
Date analysed	-			28/04/2022	[NT]	[NT]	[NT]	[NT]	28/04/2022	[NT]
Arsenic-Total	μg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	96	[NT]
Barium-Total	μg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	92	[NT]
Cadmium-Total	μg/L	0.1	Metals-022	<0.1	[NT]	[NT]	[NT]	[NT]	95	[NT]
Chromium-Total	μg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	95	[NT]
Cobalt-Total	μg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	96	[NT]
Copper-Total	μg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Iron-Total	μg/L	10	Metals-022	<10	[NT]	[NT]	[NT]	[NT]	94	[NT]
Mercury-Total	μg/L	0.05	Metals-021	<0.05	[NT]	[NT]	[NT]	[NT]	101	[NT]
Lead-Total	μg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Manganese-Total	μg/L	5	Metals-022	<5	[NT]	[NT]	[NT]	[NT]	93	[NT]
Molybdenum-Total	μg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Nickel-Total	μg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Selenium-Total	μg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Titanium-Total	μg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Zinc-Total	μg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	85	[NT]

QUALITY CONTROL: All metals in water-dissolved					Duplicate					Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date prepared	-			28/04/2022	[NT]	[NT]	[NT]	[NT]	28/04/2022	[NT]
Date analysed	-			28/04/2022	[NT]	[NT]	[NT]	[NT]	28/04/2022	[NT]
Arsenic-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	99	[NT]
Barium-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	88	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	[NT]	[NT]	[NT]	[NT]	104	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	92	[NT]
Cobalt-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	95	[NT]
Copper-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Iron-Dissolved	µg/L	10	Metals-022	<10	[NT]	[NT]	[NT]	[NT]	93	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	[NT]	[NT]	[NT]	[NT]	101	[NT]
Lead-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	108	[NT]
Manganese-Dissolved	µg/L	5	Metals-022	<5	[NT]	[NT]	[NT]	[NT]	92	[NT]
Molybdenum-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	93	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	96	[NT]
Selenium-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Titanium-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	87	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	<1	[NT]	[NT]	[NT]	[NT]	88	[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). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

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 (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

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.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Company	Ramboll Australia Pty Ltd	Project №	318001193	Project Manager	Stephen Maxwell	Sampler(s)	Steve Cadman/Sam Buckley
Address	Suite 18, 50 Glebe Road, The Junction, NSW 2291	Project Name	Captains Flat Lead Management Plan	EDD Format (ESdat, EQuIS, Custom)		Handed over by	
Contact Name	Stephen Maxwell					Email for Invoice	asiapac-accounts@ramboll.com
Phone №	0478 658 194					Email for Results	smaxwell@ramboll.com
Special Directions							
Purchase Order	318001193						
Quote ID №							

Turnaround Time (TAT) Requirements: ☐ Overnight (9am)* ☐ 1 Day* ☐ 2 Day* ☐ 3 Day* ☑ 5 Day ☐ Other ( ) *Surcharges apply

№	Client Sample ID	Sampled Date/Time (dd/mm/yy hh:mm)	Matrix (Solid (S) Water (W))	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Tl, Zn)	pH, CEC, % clay	Total Lead	Total Dust	Total metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Tl, Zn)	Dissolved metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Tl, Zn)	1L Plastic	250mL Plastic	125mL Plastic	200mL Amber Glass	40mL VOA vial	500mL PFAS Bottle	Jar (Glass or HDPE)	Other (Asbestos AS4964, WA Guidelines)	Sample Comments / Dangerous Goods Hazard Warning
1	SW1	12/04/22	W					X	X									
2	SW2	12/04/22	W					X	X									
3	SW3	12/04/22	W					X	X									
4	SW4	12/04/22	W					X	X									
5	SW5	13/04/22	W					X	X									
6	SW6	12/04/22	W					X	X									
7	SW7	12/04/22	W					X	X									
8	SW8	12/04/22	W					X	X									
9	SW9	12/04/22	W					X	X									
10	SW10	13/04/22	W					X	X									
11	SW11	13/04/22	W					X	X									
12	SW12	13/04/22	W					X	X									
13	SW13	13/04/22	W					X	X									
14	SW14	13/04/22	W					X	X									
15	SW15	13/04/22	W					X	X									
16	D01	13/04/22	W					X	X									
17	T01 (1)	13/04/22	W					X	X									PLEASE SEND TO ENVIRC
18	Rinsate_13/4/22	13/04/22	W					X	X									
	Total Counts							18	18									

Method of Shipment: ☐ Courier (#) ☑ Hand Delivered ☐ Postal | Name: Sam Buckley | Signature | Date: 44665 | Time: 830am

Eurofins | mgt Laboratory Use Only							
Received By		SYD | BNE | MEL | PER | ADL | NTL | DRW	Signature	Date: __/__/__	Time	Temperature	0.0°C
Received By	(signature)	SYD | BNE | MEL | PER | ADL | NTL | DRW	Signature	Date: 20/4/22	Time: 2pm	Report №	881430

Submission of samples to the laboratory will be deemed as acceptance of Eurofins | mgt Standard Terms and Conditions unless agreed otherwise. A copy of Eurofins | mgt Standard Terms and Conditions is available on request.

Eurofins Environment Testing Australia Pty Ltd trading as Eurofins | mgt

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 294083
Date Received: 20/4/22
Time Received: 1405
Received By: UM
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Company	Ramboll Australia Pty Ltd	Project №	318001193
Address	Suite 18, 50 Glebe Road, The Junction, NSW 2291	Project Name	Captains Flat Lead Management Plan
Contact Name	Stephen Maxwell	Project Manager	Stephen Maxwell
Phone №	0478 658 194	EDD Format (ESdat, EQuIS, Custom)	
Special Directions		Sampler(s)	Steve Cadman/Sam Buckley
Purchase Order	318001193	Handed over by	
Quote ID №		Email for Invoice	asiapac-accounts@ramboll.com
		Email for Results	smaxwell@ramboll.com

Analyses (Note: Where metals are requested, please specify "Total" or "Filtered") SUITE code must be used to attract SUITE pricing)

Containers: 1L Plastic; 250mL Plastic; 125mL Plastic; 200mL Amber Glass; 40mL VOA vial; 500mL PFAS Bottle; Jar (Glass or HDPE); Other (Asbestos AS4964, WA Guidelines)

Turnaround Time (TAT) Requirements (Default will be 5 days if not ticked)
☐ Overnight (9am)*
☐ 1 Day* ☐ 2 Day*
☐ 3 Day* ☑ 5 Day
☐ Other ( )
* Surcharges apply

№	Client Sample ID	Sampled Date/Time (dd/mm/yy hh:mm)	Matrix (Solid (S) Water (W))	Heavy metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	pH, CEC, % clay	Total Lead	Total Dust	Total metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	Dissolved metals (As, Ba, Cd, Cr, Co, Cu, Fe, Hg, Pb, Mn, Mo, Ni, Se, Ti, Zn)	Sample Comments / Dangerous Goods Hazard Warning
1	SW1	12/04/22	W					X	X	
2	SW2	12/04/22	W					X	X	
3	SW3	12/04/22	W					X	X	
4	SW4	12/04/22	W					X	X	
5	SW5	13/04/22	W					X	X	
6	SW6	12/04/22	W					X	X	
7	SW7	12/04/22	W					X	X	
8	SW8	12/04/22	W					X	X	
9	SW9	12/04/22	W					X	X	
10	SW10	13/04/22	W					X	X	
11	SW11	13/04/22	W					X	X	
12	SW12	13/04/22	W					X	X	
13	SW13	13/04/22	W					X	X	
14	SW14	13/04/22	W					X	X	
15	SW15	13/04/22	W					X	X	
16	D01	13/04/22	W					X	X	
17	T01	13/04/22	W					X	X	PLEASE SEND TO ENVIRC
18	Rinsate_13/4/22	13/04/22	W					X	X	
	Total Counts							18	18	

Method of Shipment	☐ Courier (#)	☑ Hand Delivered	☐ Postal	Name	Sam Buckley	Signature		Date	44665	Time	830am
Eurofins | mgt Laboratory Use Only	Received By	[signature]	SYD | BNE | MEL | PER | ADL | NTL | DRW	Signature		Date	__/__/__	Time	____	Temperature	0.0°C
	Received By		SYD | BNE | MEL | PER | ADL | NTL | DRW	Signature	[signature]	Date	20.4.22	Time	2pm	Report №	881430

Eurofins Environment Testing Australia Pty Ltd trading as Eurofins | mgt eurofins

Environment Testing

Certificate of Analysis

Ramboll Environ Australia Pty Ltd
Level 3/100 Pacific Highway
North Sydney
NSW 2060

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates.

Attention: **Stephen Maxwell**

Report	**881430-W-V2**
Project name	CAPTAINS FLAT LEAD MANAGEMENT PLAN
Project ID	318001193
Received Date	Apr 21, 2022

Client Sample ID			**SW1**	**SW2**	**SW3**	**SW4**
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins Sample No.			**N22-Ap0040960**	**N22-Ap0040961**	**N22-Ap0040962**	**N22-Ap0040963**
Date Sampled			**Apr 12, 2022**	**Apr 12, 2022**	**Apr 12, 2022**	**Apr 12, 2022**
Test/Reference	LOR	Unit				
Heavy Metals						
Arsenic	0.001	mg/L	< 0.001	0.001	0.001	0.001
Arsenic (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Barium	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Barium (filtered)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Cadmium	0.0002	mg/L	0.0006	0.0006	0.0006	0.0005
Cadmium (filtered)	0.0002	mg/L	0.0004	0.0005	0.0005	0.0005
Chromium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	0.001	0.001	0.001	0.001
Cobalt (filtered)	0.001	mg/L	< 0.001	0.001	0.001	0.001
Copper	0.001	mg/L	0.008	0.009	0.008	0.008
Copper (filtered)	0.001	mg/L	0.007	0.007	0.006	0.006
Iron	0.05	mg/L	1.3	1.7	1.7	1.8
Iron (filtered)	0.05	mg/L	0.70	0.74	0.81	0.92
Lead	0.001	mg/L	0.010	0.011	0.011	0.010
Lead (filtered)	0.001	mg/L	0.005	0.005	0.005	0.005
Manganese	0.005	mg/L	0.11	0.12	0.12	0.12
Manganese (filtered)	0.005	mg/L	0.10	0.11	0.11	0.11
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.002	0.003	0.003	0.002
Nickel (filtered)	0.001	mg/L	0.003	0.003	0.003	0.002
Selenium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Titanium	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Titanium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	0.54	0.58	0.58	0.53
Zinc (filtered)	0.005	mg/L	0.48	0.53	0.54	0.52

Client Sample ID			SW5	SW6	SW7	SW8
Sample Matrix			Water	Water	Water	Water
Eurofins Sample No.			N22-Ap0040964	N22-Ap0040965	N22-Ap0040966	N22-Ap0040967
Date Sampled			Apr 13, 2022	Apr 12, 2022	Apr 12, 2022	Apr 12, 2022
Test/Reference	LOR	Unit				
Heavy Metals						
Arsenic	0.001	mg/L	0.023	< 0.001	0.001	0.004
Arsenic (filtered)	0.001	mg/L	0.008	0.001	< 0.001	< 0.001
Barium	0.02	mg/L	< 0.02	< 0.02	< 0.02	0.06
Barium (filtered)	0.02	mg/L	< 0.02	< 0.02	< 0.02	0.05
Cadmium	0.0002	mg/L	0.12	0.0018	0.0014	0.054
Cadmium (filtered)	0.0002	mg/L	0.13	0.0017	0.0013	0.058
Chromium	0.001	mg/L	< 0.001	< 0.001	0.001	0.003
Chromium (filtered)	0.001	mg/L	0.001	0.002	0.002	< 0.001
Cobalt	0.001	mg/L	0.088	0.001	0.001	0.019
Cobalt (filtered)	0.001	mg/L	0.10	0.001	0.001	0.020
Copper	0.001	mg/L	0.35	0.016	0.015	0.71
Copper (filtered)	0.001	mg/L	0.39	0.016	0.014	0.64
Iron	0.05	mg/L	130	0.96	1.2	8.1
Iron (filtered)	0.05	mg/L	150	1.9	1.2	3.1
Lead	0.001	mg/L	1.2	0.026	0.024	0.53
Lead (filtered)	0.001	mg/L	1.3	0.021	0.020	0.36
Manganese	0.005	mg/L	9.6	0.026	0.028	1.6
Manganese (filtered)	0.005	mg/L	11	0.025	0.024	1.6
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.061	0.004	0.004	0.018
Nickel (filtered)	0.001	mg/L	0.073	0.004	0.004	0.018
Selenium	0.001	mg/L	0.009	< 0.001	< 0.001	0.003
Selenium (filtered)	0.001	mg/L	0.008	< 0.001	< 0.001	0.002
Titanium	0.005	mg/L	< 0.005	< 0.005	0.007	0.010
Titanium (filtered)	0.005	mg/L	< 0.005	0.064	0.033	< 0.005
Zinc	0.005	mg/L	110	0.68	0.57	37
Zinc (filtered)	0.005	mg/L	130	0.64	0.53	39

Client Sample ID			SW9	SW10	SW11	SW12
Sample Matrix			Water	Water	Water	Water
Eurofins Sample No.			N22-Ap0040968	N22-Ap0040969	N22-Ap0040970	N22-Ap0040971
Date Sampled			Apr 12, 2022	Apr 13, 2022	Apr 13, 2022	Apr 13, 2022
Test/Reference	LOR	Unit				
Heavy Metals						
Arsenic	0.001	mg/L	0.002	0.004	0.001	0.007
Arsenic (filtered)	0.001	mg/L	0.001	< 0.001	< 0.001	0.007
Barium	0.02	mg/L	0.06	0.02	< 0.02	< 0.02
Barium (filtered)	0.02	mg/L	0.06	< 0.02	< 0.02	< 0.02
Cadmium	0.0002	mg/L	0.081	0.011	0.0002	0.079
Cadmium (filtered)	0.0002	mg/L	0.079	0.010	< 0.0002	0.097
Chromium	0.001	mg/L	0.003	0.003	< 0.001	0.009
Chromium (filtered)	0.001	mg/L	0.001	< 0.001	< 0.001	0.011
Cobalt	0.001	mg/L	0.024	0.030	0.001	0.30
Cobalt (filtered)	0.001	mg/L	0.023	0.030	< 0.001	0.38

Client Sample ID			SW9	SW10	SW11	SW12
Sample Matrix			Water	Water	Water	Water
Eurofins Sample No.			N22-Ap0040968	N22-Ap0040969	N22-Ap0040970	N22-Ap0040971
Date Sampled			Apr 12, 2022	Apr 13, 2022	Apr 13, 2022	Apr 13, 2022
Test/Reference	LOR	Unit				
Heavy Metals						
Copper	0.001	mg/L	1.1	0.25	0.008	0.81
Copper (filtered)	0.001	mg/L	1.1	0.16	0.006	1.0
Iron	0.05	mg/L	5.6	26	1.4	260
Iron (filtered)	0.05	mg/L	5.2	0.72	0.52	320
Lead	0.001	mg/L	0.61	0.12	0.007	0.032
Lead (filtered)	0.001	mg/L	0.59	0.026	0.003	0.039
Manganese	0.005	mg/L	1.8	2.2	0.089	27
Manganese (filtered)	0.005	mg/L	1.7	2.1	0.058	33
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.025	0.012	0.002	0.12
Nickel (filtered)	0.001	mg/L	0.023	0.011	0.002	0.15
Selenium	0.001	mg/L	0.004	0.004	< 0.001	0.029
Selenium (filtered)	0.001	mg/L	0.003	0.002	< 0.001	0.035
Titanium	0.005	mg/L	< 0.005	0.007	< 0.005	< 0.005
Titanium (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	55	13	0.33	130
Zinc (filtered)	0.005	mg/L	53	13	0.27	160

Client Sample ID			SW13	SW14	SW15	D01
Sample Matrix			Water	Water	Water	Water
Eurofins Sample No.			N22-Ap0040972	N22-Ap0040973	N22-Ap0040974	N22-Ap0040975
Date Sampled			Apr 13, 2022	Apr 13, 2022	Apr 13, 2022	Apr 13, 2022
Test/Reference	LOR	Unit				
Heavy Metals						
Arsenic	0.001	mg/L	0.002	< 0.001	< 0.001	< 0.001
Arsenic (filtered)	0.001	mg/L	0.002	< 0.001	< 0.001	< 0.001
Barium	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Barium (filtered)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Cadmium	0.0002	mg/L	0.0003	< 0.0002	< 0.0002	< 0.0002
Cadmium (filtered)	0.0002	mg/L	0.0003	< 0.0002	< 0.0002	< 0.0002
Chromium	0.001	mg/L	0.001	0.001	< 0.001	< 0.001
Chromium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	0.001	mg/L	0.002	< 0.001	< 0.001	< 0.001
Cobalt (filtered)	0.001	mg/L	0.002	< 0.001	< 0.001	< 0.001
Copper	0.001	mg/L	0.029	0.002	0.002	0.002
Copper (filtered)	0.001	mg/L	0.026	0.002	0.002	0.002
Iron	0.05	mg/L	2.6	1.1	1.1	1.1
Iron (filtered)	0.05	mg/L	2.0	0.59	0.52	0.52
Lead	0.001	mg/L	0.013	0.002	0.002	0.002
Lead (filtered)	0.001	mg/L	0.011	0.001	< 0.001	< 0.001
Manganese	0.005	mg/L	0.078	0.034	0.028	0.029
Manganese (filtered)	0.005	mg/L	0.070	0.013	0.010	0.010
Mercury	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001

Client Sample ID			SW13	SW14	SW15	D01
Sample Matrix			Water	Water	Water	Water
Eurofins Sample No.			N22-Ap0040972	N22-Ap0040973	N22-Ap0040974	N22-Ap0040975
Date Sampled			Apr 13, 2022	Apr 13, 2022	Apr 13, 2022	Apr 13, 2022
Test/Reference	LOR	Unit				
Heavy Metals						
Molybdenum	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Nickel	0.001	mg/L	0.002	0.002	0.002	0.002
Nickel (filtered)	0.001	mg/L	0.002	0.002	0.002	0.002
Selenium	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Titanium	0.005	mg/L	0.005	< 0.005	< 0.005	< 0.005
Titanium (filtered)	0.005	mg/L	0.015	0.005	< 0.005	< 0.005
Zinc	0.005	mg/L	0.21	0.050	0.031	0.028
Zinc (filtered)	0.005	mg/L	0.16	0.027	0.016	0.015

Client Sample ID			RINSATE_13/4/22
Sample Matrix			Water
Eurofins Sample No.			N22-Ap0040976
Date Sampled			Apr 13, 2022
Test/Reference	LOR	Unit	
Heavy Metals			
Arsenic	0.001	mg/L	< 0.001
Arsenic (filtered)	0.001	mg/L	< 0.001
Barium	0.02	mg/L	< 0.02
Barium (filtered)	0.02	mg/L	< 0.02
Cadmium	0.0002	mg/L	< 0.0002
Cadmium (filtered)	0.0002	mg/L	< 0.0002
Chromium	0.001	mg/L	0.004
Chromium (filtered)	0.001	mg/L	< 0.001
Cobalt	0.001	mg/L	< 0.001
Cobalt (filtered)	0.001	mg/L	< 0.001
Copper	0.001	mg/L	< 0.001
Copper (filtered)	0.001	mg/L	< 0.001
Iron	0.05	mg/L	< 0.05
Iron (filtered)	0.05	mg/L	< 0.05
Lead	0.001	mg/L	< 0.001
Lead (filtered)	0.001	mg/L	< 0.001
Manganese	0.005	mg/L	< 0.005
Manganese (filtered)	0.005	mg/L	< 0.005
Mercury	0.0001	mg/L	< 0.0001
Mercury (filtered)	0.0001	mg/L	< 0.0001
Molybdenum	0.005	mg/L	< 0.005
Molybdenum (filtered)	0.005	mg/L	< 0.005
Nickel	0.001	mg/L	0.003
Nickel (filtered)	0.001	mg/L	< 0.001
Selenium	0.001	mg/L	< 0.001
Selenium (filtered)	0.001	mg/L	< 0.001
Titanium	0.005	mg/L	< 0.005
Titanium (filtered)	0.005	mg/L	< 0.005
Zinc	0.005	mg/L	< 0.005
Zinc (filtered)	0.005	mg/L	< 0.005

Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Metals M8	Sydney	Apr 29, 2022	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Metals M8 filtered	Sydney	Apr 29, 2022	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Heavy Metals	Sydney	Apr 29, 2022	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Heavy Metals (filtered)	Sydney	Apr 29, 2022	180 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**	318001193	**Received:**	Apr 21, 2022 2:00 PM
Address:	Level 3/100 Pacific Highway	**Report #:**	881430	**Due:**	Apr 29, 2022
	North Sydney	**Phone:**	02 9954 8118	**Priority:**	5 Day
	NSW 2060	**Fax:**	02 9954 8150	**Contact Name:**	Stephen Maxwell
Project Name:	CAPTAINS FLAT LEAD MANAGEMENT PLAN				
Project ID:	318001193				

Eurofins Analytical Services Manager : Andrew Black

Sample Detail						Barium	Barium (filtered)	Cobalt	Cobalt (filtered)	Iron	Iron (filtered)	Manganese	Manganese (filtered)	Molybdenum	Molybdenum (filtered)	Selenium	Selenium (filtered)	Titanium	Titanium (filtered)	Metals M8	Metals M8 filtered
Melbourne Laboratory - NATA # 1261 Site # 1254																					
Sydney Laboratory - NATA # 1261 Site # 18217						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brisbane Laboratory - NATA # 1261 Site # 20794																					
Mayfield Laboratory - NATA # 1261 Site # 25079																					
Perth Laboratory - NATA # 2377 Site # 2370																					
External Laboratory																					
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																
1	SW1	Apr 12, 2022		Water	N22-Ap0040960	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	SW2	Apr 12, 2022		Water	N22-Ap0040961	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	SW3	Apr 12, 2022		Water	N22-Ap0040962	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	SW4	Apr 12, 2022		Water	N22-Ap0040963	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5	SW5	Apr 13, 2022		Water	N22-Ap0040964	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6	SW6	Apr 12, 2022		Water	N22-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Company Name:	Ramboll Australia Pty Ltd	**Order No.:**	318001193	**Received:**	Apr 21, 2022 2:00 PM
Address:	Level 3/100 Pacific Highway North Sydney NSW 2060	**Report #:**	881430	**Due:**	Apr 29, 2022
		Phone:	02 9954 8118	**Priority:**	5 Day
		Fax:	02 9954 8150	**Contact Name:**	Stephen Maxwell
Project Name:	CAPTAINS FLAT LEAD MANAGEMENT PLAN				
Project ID:	318001193				

Eurofins Analytical Services Manager : Andrew Black

Sample Detail						Barium	Barium (filtered)	Cobalt	Cobalt (filtered)	Iron	Iron (filtered)	Manganese	Manganese (filtered)	Molybdenum	Molybdenum (filtered)	Selenium	Selenium (filtered)	Titanium	Titanium (filtered)	Metals M8	Metals M8 filtered
Melbourne Laboratory - NATA # 1261 Site # 1254																					
Sydney Laboratory - NATA # 1261 Site # 18217						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brisbane Laboratory - NATA # 1261 Site # 20794																					
Mayfield Laboratory - NATA # 1261 Site # 25079																					
Perth Laboratory - NATA # 2377 Site # 2370																					
External Laboratory																					
					Ap0040965																
7	SW7	Apr 12, 2022		Water	N22-Ap0040966	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8	SW8	Apr 12, 2022		Water	N22-Ap0040967	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
9	SW9	Apr 12, 2022		Water	N22-Ap0040968	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
10	SW10	Apr 13, 2022		Water	N22-Ap0040969	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
11	SW11	Apr 13, 2022		Water	N22-Ap0040970	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
12	SW12	Apr 13, 2022		Water	N22-Ap0040971	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Company Name: Ramboll Australia Pty Ltd
Address: Level 3/100 Pacific Highway, North Sydney, NSW 2060

Project Name: CAPTAINS FLAT LEAD MANAGEMENT PLAN
Project ID: 318001193

Order No.: 318001193
Report #: 881430
Phone: 02 9954 8118
Fax: 02 9954 8150

Received: Apr 21, 2022 2:00 PM
Due: Apr 29, 2022
Priority: 5 Day
Contact Name: Stephen Maxwell

Eurofins Analytical Services Manager : Andrew Black

Sample Detail						Barium	Barium (filtered)	Cobalt	Cobalt (filtered)	Iron	Iron (filtered)	Manganese	Manganese (filtered)	Molybdenum	Molybdenum (filtered)	Selenium	Selenium (filtered)	Titanium	Titanium (filtered)	Metals M8	Metals M8 filtered
Melbourne Laboratory - NATA # 1261 Site # 1254																					
Sydney Laboratory - NATA # 1261 Site # 18217						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brisbane Laboratory - NATA # 1261 Site # 20794																					
Mayfield Laboratory - NATA # 1261 Site # 25079																					
Perth Laboratory - NATA # 2377 Site # 2370																					
External Laboratory																					
13	SW13	Apr 13, 2022		Water	N22-Ap0040972	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
14	SW14	Apr 13, 2022		Water	N22-Ap0040973	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
15	SW15	Apr 13, 2022		Water	N22-Ap0040974	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16	D01	Apr 13, 2022		Water	N22-Ap0040975	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
17	RINSATE_13/4/22	Apr 13, 2022		Water	N22-Ap0040976	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Test Counts						17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17

eurofins | Environment Testing

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**µg/L:** micrograms per litre
ppm: parts per million	**ppb:** parts per billion	**%:** Percentage
org/100 mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100 mL:** Most Probable Number of organisms per 100 millilitres

Terms

APHA	American Public Health Association
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
TBTO	Tributyltin oxide (*bis*-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment however free tributyltin was measured and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 5.4
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should be used as a guide only and may be different when site specific Sampling Analysis and Quality Plan (SAQP) have been implemented

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR: No Limit

Results between 10-20 times the LOR: RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.4 where no positive PFAS results have been reported have been reviewed and no data was affected.

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QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time.Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Heavy Metals							
Arsenic	mg/L	< 0.001			0.001	Pass	
Arsenic (filtered)	mg/L	< 0.001			0.001	Pass	
Barium	mg/L	< 0.02			0.02	Pass	
Barium (filtered)	mg/L	< 0.02			0.02	Pass	
Cadmium	mg/L	< 0.0002			0.0002	Pass	
Cadmium (filtered)	mg/L	< 0.0002			0.0002	Pass	
Chromium	mg/L	< 0.001			0.001	Pass	
Chromium (filtered)	mg/L	< 0.001			0.001	Pass	
Cobalt	mg/L	< 0.001			0.001	Pass	
Cobalt (filtered)	mg/L	< 0.001			0.001	Pass	
Copper	mg/L	< 0.001			0.001	Pass	
Copper (filtered)	mg/L	< 0.001			0.001	Pass	
Iron	mg/L	< 0.05			0.05	Pass	
Iron (filtered)	mg/L	< 0.05			0.05	Pass	
Lead	mg/L	< 0.001			0.001	Pass	
Lead (filtered)	mg/L	< 0.001			0.001	Pass	
Manganese	mg/L	< 0.005			0.005	Pass	
Manganese (filtered)	mg/L	< 0.005			0.005	Pass	
Mercury	mg/L	< 0.0001			0.0001	Pass	
Mercury (filtered)	mg/L	< 0.0001			0.0001	Pass	
Molybdenum	mg/L	< 0.005			0.005	Pass	
Molybdenum (filtered)	mg/L	< 0.005			0.005	Pass	
Nickel	mg/L	< 0.001			0.001	Pass	
Nickel (filtered)	mg/L	< 0.001			0.001	Pass	
Selenium	mg/L	< 0.001			0.001	Pass	
Selenium (filtered)	mg/L	< 0.001			0.001	Pass	
Titanium	mg/L	< 0.005			0.005	Pass	
Titanium (filtered)	mg/L	< 0.005			0.005	Pass	
Zinc	mg/L	< 0.005			0.005	Pass	
Zinc (filtered)	mg/L	< 0.005			0.005	Pass	
LCS - % Recovery							
Heavy Metals							
Arsenic	%	99			80-120	Pass	
Barium	%	99			80-120	Pass	
Cadmium	%	96			80-120	Pass	
Chromium	%	92			80-120	Pass	
Cobalt	%	93			80-120	Pass	
Copper	%	94			80-120	Pass	
Iron	%	95			80-120	Pass	
Lead	%	97			80-120	Pass	
Manganese	%	95			80-120	Pass	
Mercury	%	99			80-120	Pass	
Molybdenum	%	101			80-120	Pass	
Nickel	%	92			80-120	Pass	
Selenium	%	96			80-120	Pass	
Titanium	%	94			80-120	Pass	
Zinc	%	93			80-120	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
Heavy Metals				Result 1					
Arsenic	N22-Ap0040976	CP	%	107			75-125	Pass	
Arsenic (filtered)	N22-Ap0040976	CP	%	87			75-125	Pass	
Barium	N22-Ap0040976	CP	%	106			75-125	Pass	
Barium (filtered)	N22-Ap0040976	CP	%	89			75-125	Pass	
Cadmium	N22-Ap0040976	CP	%	101			75-125	Pass	
Cadmium (filtered)	N22-Ap0040976	CP	%	97			75-125	Pass	
Chromium	N22-Ap0040976	CP	%	100			75-125	Pass	
Chromium (filtered)	N22-Ap0040976	CP	%	91			75-125	Pass	
Cobalt	N22-Ap0040976	CP	%	103			75-125	Pass	
Cobalt (filtered)	N22-Ap0040976	CP	%	92			75-125	Pass	
Copper	N22-Ap0040976	CP	%	104			75-125	Pass	
Copper (filtered)	N22-Ap0040976	CP	%	93			75-125	Pass	
Iron	N22-Ap0040976	CP	%	102			75-125	Pass	
Iron (filtered)	N22-Ap0040976	CP	%	89			75-125	Pass	
Lead	N22-Ap0040976	CP	%	102			75-125	Pass	
Lead (filtered)	N22-Ap0040976	CP	%	93			75-125	Pass	
Manganese	N22-Ap0040976	CP	%	104			75-125	Pass	
Manganese (filtered)	N22-Ap0040976	CP	%	90			75-125	Pass	
Mercury	N22-Ap0040976	CP	%	103			75-125	Pass	
Mercury (filtered)	N22-Ap0040976	CP	%	101			75-125	Pass	
Molybdenum	N22-Ap0040976	CP	%	104			75-125	Pass	
Molybdenum (filtered)	N22-Ap0040976	CP	%	89			75-125	Pass	
Nickel	N22-Ap0040976	CP	%	101			75-125	Pass	
Nickel (filtered)	N22-Ap0040976	CP	%	93			75-125	Pass	
Selenium	N22-Ap0040976	CP	%	101			75-125	Pass	
Selenium (filtered)	N22-Ap0040976	CP	%	89			75-125	Pass	
Titanium	N22-Ap0040976	CP	%	105			75-125	Pass	
Titanium (filtered)	N22-Ap0040976	CP	%	90			75-125	Pass	
Zinc	N22-Ap0040976	CP	%	101			75-125	Pass	
Zinc (filtered)	N22-Ap0040976	CP	%	99			75-125	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	N22-Ap0040962	CP	mg/L	0.001	0.001	<1	30%	Pass	
Arsenic (filtered)	N22-Ap0040962	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Barium	N22-Ap0040962	CP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Barium (filtered)	N22-Ap0040962	CP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Cadmium	N22-Ap0040962	CP	mg/L	0.0006	0.0006	8.0	30%	Pass	
Cadmium (filtered)	N22-Ap0040962	CP	mg/L	0.0005	0.0005	7.0	30%	Pass	
Chromium	N22-Ap0040962	CP	mg/L	< 0.001	0.001	13	30%	Pass	
Chromium (filtered)	N22-Ap0040962	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Cobalt	N22-Ap0040962	CP	mg/L	0.001	0.001	3.0	30%	Pass	
Cobalt (filtered)	N22-Ap0040962	CP	mg/L	0.001	0.001	2.0	30%	Pass	
Copper	N22-Ap0040962	CP	mg/L	0.008	0.008	4.0	30%	Pass	
Copper (filtered)	N22-Ap0040962	CP	mg/L	0.006	0.006	2.0	30%	Pass	
Iron	N22-Ap0040962	CP	mg/L	1.7	1.6	5.0	30%	Pass	
Iron (filtered)	N22-Ap0040962	CP	mg/L	0.81	0.80	<1	30%	Pass	
Lead	N22-Ap0040962	CP	mg/L	0.011	0.010	6.0	30%	Pass	
Lead (filtered)	N22-Ap0040962	CP	mg/L	0.005	0.005	<1	30%	Pass	
Manganese	N22-Ap0040962	CP	mg/L	0.12	0.12	5.0	30%	Pass	
Manganese (filtered)	N22-Ap0040962	CP	mg/L	0.11	0.11	2.0	30%	Pass	
Mercury	N22-Ap0040962	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Mercury (filtered)	N22-Ap0040962	CP	mg/L	< 0.0001	0.0002	29	30%	Pass	
Molybdenum	N22-Ap0040962	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Molybdenum (filtered)	N22-Ap0040962	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Nickel	N22-Ap0040962	CP	mg/L	0.003	0.003	4.0	30%	Pass	
Nickel (filtered)	N22-Ap0040962	CP	mg/L	0.003	0.003	1.0	30%	Pass	
Selenium	N22-Ap0040962	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Selenium (filtered)	N22-Ap0040962	CP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Titanium	N22-Ap0040962	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Titanium (filtered)	N22-Ap0040962	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Zinc	N22-Ap0040962	CP	mg/L	0.58	0.55	4.0	30%	Pass	
Zinc (filtered)	N22-Ap0040962	CP	mg/L	0.54	0.53	1.0	30%	Pass	
Duplicate									
Heavy Metals				Result 1	Result 2	RPD			
Arsenic	N22-Ap0040971	CP	mg/L	0.007	0.006	5.0	30%	Pass	
Arsenic (filtered)	N22-Ap0040971	CP	mg/L	0.007	0.007	4.0	30%	Pass	
Barium	N22-Ap0040971	CP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Barium (filtered)	N22-Ap0040971	CP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Cadmium	N22-Ap0040971	CP	mg/L	0.079	0.074	6.0	30%	Pass	
Cadmium (filtered)	N22-Ap0040971	CP	mg/L	0.097	0.098	1.0	30%	Pass	
Chromium	N22-Ap0040971	CP	mg/L	0.009	0.010	8.0	30%	Pass	
Chromium (filtered)	N22-Ap0040971	CP	mg/L	0.011	0.012	14	30%	Pass	
Cobalt	N22-Ap0040971	CP	mg/L	0.30	0.31	3.0	30%	Pass	
Cobalt (filtered)	N22-Ap0040971	CP	mg/L	0.38	0.42	11	30%	Pass	
Copper	N22-Ap0040971	CP	mg/L	0.81	0.83	2.0	30%	Pass	
Copper (filtered)	N22-Ap0040971	CP	mg/L	1.0	1.2	11	30%	Pass	
Iron	N22-Ap0040971	CP	mg/L	260	270	2.0	30%	Pass	
Iron (filtered)	N22-Ap0040971	CP	mg/L	320	360	10	30%	Pass	
Lead	N22-Ap0040971	CP	mg/L	0.032	0.030	5.0	30%	Pass	
Lead (filtered)	N22-Ap0040971	CP	mg/L	0.039	0.040	1.0	30%	Pass	
Manganese	N22-Ap0040971	CP	mg/L	27	28	2.0	30%	Pass	
Manganese (filtered)	N22-Ap0040971	CP	mg/L	33	37	10	30%	Pass	
Mercury	N22-Ap0040971	CP	mg/L	< 0.0001	< 0.0001	<1	30%	Pass	
Mercury (filtered)	N22-Ap0040971	CP	mg/L	< 0.0001	0.0001	39	30%	Fail	Q15
Molybdenum	N22-Ap0040971	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Molybdenum (filtered)	N22-Ap0040971	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Nickel	N22-Ap0040971	CP	mg/L	0.12	0.12	3.0	30%	Pass	
Nickel (filtered)	N22-Ap0040971	CP	mg/L	0.15	0.17	11	30%	Pass	
Selenium	N22-Ap0040971	CP	mg/L	0.029	0.027	7.0	30%	Pass	
Selenium (filtered)	N22-Ap0040971	CP	mg/L	0.035	0.035	2.0	30%	Pass	
Titanium	N22-Ap0040971	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Titanium (filtered)	N22-Ap0040971	CP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Zinc	N22-Ap0040971	CP	mg/L	130	130	3.0	30%	Pass	
Zinc (filtered)	N22-Ap0040971	CP	mg/L	160	180	10	30%	Pass	

Comments

V2- new version to amended error in all Hg filtered results

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
Q15	The RPD reported passes Eurofins Environment Testing's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised by:

Andrew Black	Analytical Services Manager
Gabriele Cordero	Senior Analyst-Metal

Glenn Jackson
General Manager

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

APPENDIX 6
PHOTOGRAPHIC LOG

Photograph 1: Sampling location SW1 at the swimming hole on Molonglo River (12/4/22).

Photograph 2: Sampling location SW2 in Molonglo River downstream of the confluence of Copper Creek (12/4/22).

Photograph 3: Sampling location SW3 immediately downstream of the confluence of Copper Creek (12/4/22).

Photograph 4: Sampling location SW4 at Molonglo River Bridge (12/4/22).

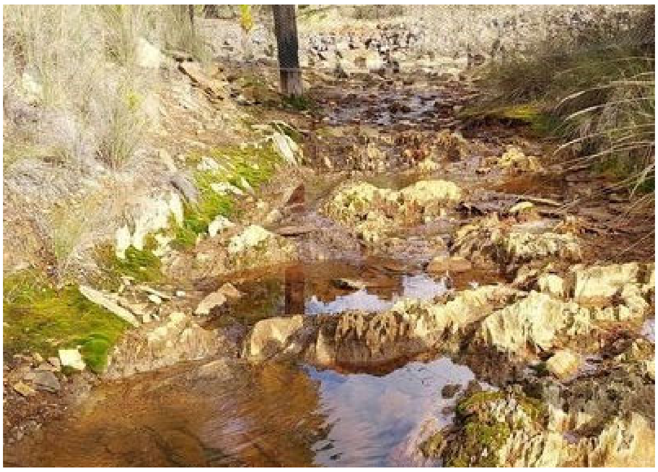
Photograph 5: Sampling location SW5 at the Main Adit Spring (13/4/22).

Photograph 6: Sampling location SW6 at the Copper Creek downstream of the rail corridor (12/4/22).

Title:	Surface Water Monitoring	Approved: SM	Project-Nr.: 318001193	Date: September 2022
Site:	Captains Flat			
Client:	Department of Regional NSW			RAMBOLL

Photograph 7: Sampling location SW7 at the Copper Creek upstream of the rail corridor (12/4/22.

Photograph 8: Sampling location SW8 at the drainage line downstream of mine site sediment dams and rail corridor (12/4/22).



Photograph 9: Sample location SW9 at the drainage line downstream of mine site sediment dams and upstream of the rail corridor (12/4/22)

Photograph 10: Sample location SW10 at Forsters Creek confluence (13/4/22).

Photograph 11: Sample location SW11 upstream of the Forsters Creek confluence (13/4/22)

Photograph 12: Sample location SW12 drainage channel near the southern tailings dump (13/4/22).

	
Photograph 13: Sample location SW13 at the eastern side of the southern tailings dump (13/4/22).	**Photograph 14:** Sample location SW14 at the main water supply dam (13/4/22).
	
Photograph 15: Sample location SW15 upstream of the main water supply dam (13/4/22).	