Intended for
Transport Asset Holding Entity (TAHE)

Document type
Sampling and Analysis Quality Plan

Date
June 2024

Captains Flat Rail Corridor SAQP

Captains Flat Rail Corridor – Detailed Remediation Design

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Captains Flat Rail Corridor SAQP

Captains Flat Rail Corridor – Detailed Remediation Design

Project name	**Captains Flat Rail Corridor Detailed Remediation Design**
Project no.	**318001968**
Recipient	**Transport Asset Holding Entity**
Description	This report presents a Sampling and Analysis Quality Plan to address identified data gaps at the Captains Flat Rail Corridor.

Revision	Date	Prepared by	Checked by	Approved by	Description
1	29/04/2024	J Auld	S Maxwell CEnvP SC 41184	F Robinson	Draft
2	20/06/2024	J Auld	S Maxwell CEnvP SC 41184	F Robinson	Final

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1. Introduction

Ramboll Australia Pty Ltd (Ramboll) was engaged by Transport Asset Holding Entity (TAHE) on behalf of Transport for NSW (TfNSW) to prepare an additional Detailed Site Investigation (DSI) at the Captains Flat Rail Corridor, in the Country Regional Network (CRN) at Captains Flat, New South Wales (NSW) (the site). It is understood that Ramboll completed a Remedial Action Plan (RAP) (Ramboll, 2022a) for reuse of the Captains Flat rail corridor for community open space land use and the SES Depot for commercial/industrial use, informed by a previous DSI (Ramboll 2022b). Due to revised changes of the future land use to public open space (heritage walking trail), soil contamination concentrations exceeding public open space criteria were not delineated in the Ramboll 2022 DSI.

Data gaps identified in the RAP have noted that an additional DSI is required to specifically target the Copper Creek embankment and surrounding area of the SES facility. Additionally, an assessment of lime dosages to determine lime dosage rates is required to chemically immobilize lead in soil during proposed offsite disposal remediation from the RAP.

The following Sampling and Analysis Quality Plan (SAQP) has been prepared to provide context, justification and details of the selected sampling and analysis approach for the additional DSI. This SAQP was prepared in general accordance with Table 2.2 of the NSW Environmental Protection Authority (EPA) (2020) *Consultants reporting on contaminated land: Contaminated Land Guidelines*.

1.1 Objectives

The objective of this SAQP is to further assess lateral extent of soil contamination south and east of the SES compound and the vertical extent of soil contamination within and around the Copper Creek culvert embankments such that the extent of remediation required to render the site suitable for proposed public open space land use can be refined.

1.2 Scope of Work

The scope of work for preparation of this SAQP included:

- Identification of the site
- Description of the site setting and surrounding environment
- A preliminary Conceptual Site Model (CSM) outlining potential Source-Pathway-Receptor (SPR) linkages
- Data Quality Objectives (DQOs) to 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. Site Identification

2.1 Site Identification

Site details are summarised in **Table 2-1**. The site locality is presented in **Figure 1, Appendix 1**.

Table 2-1: Site Identification

Information	Description
Street Address:	Copper Creek Road, Captains Flat NSW
Identifier:	Lot 4425 Deposited Plan (DP) 1217100 and Lot 1 DP 572636
Zoning	SP2 - Infrastructure
Site Area:	Approximately 2.05 hectares (Ha)[1]
Local Government:	Queanbeyan–Palerang Regional Council
Owner:	Owned by TAHE, managed by TfNSW under license to UGL Regional Linx as part of the CRN
Current Site Use:	Commercial/industrial (non-operational rail line)
Proposed Site Use:	Public open space (heritage walking trail)

[1] The area of assessment is a linear land parcel within the CRN. Site boundaries within this report are defined based on the area of rail corridor assessed. The CRN continues beyond the northern site boundary.

2.2 Site Details

The site forms a section of the Bungendore Junction to Captains Flat Line that operated between Bungendore and Captains Flat between 1940 and 1969 and is part of the Captains Flat Railway Precinct that is Heritage Listed under the *Palerang Local Environmental Plan LEP 2014*. The rail corridor between Captains Flat and Bungendore is not operational, and vegetation has overgrown existing rail tracks. A former residence located at 2 Copper Creek Road (Lot 1 DP 572636) has recently been acquired by TfNSW and now forms part of the site.

The former ore loadout facility located in the central portion of the site has been partially demolished and few of the existing structures remain such as remnants of a gantry crane and a rail turntable. The timber loading ramp and weighbridge shed were removed around 2013.

A filled portion of the track extends from Copper Creek Road to the former rail turntable to the north (which forms part of the heritage trail).

A fenced off portion of the site including the former railway goods shed is currently leased by the NSW State Emergency Services (SES) as the Captains Flat Depot.

Endangered ecological communities – plant type community PCT 283 (GHD, 2022) are located to the south-west of the site and in areas identified as contaminated. These areas are proposed to be fenced off and not remediated to limit access and exposure to site users.

2.3 Site History

A detailed review of historical records relevant to site contamination is presented in the Captains Flat Rail Corridor Preliminary Site Investigation (PSI) (Ramboll, 2021a). The Ramboll 2022 RAP summarised that the site was used as a section of the Bungendore Junction to Captains Flat railway line and as part of the former ore loadout facility for the adjacent Lake George (legacy) Mine between 1939 until 1969. Since then, the site has remained largely unused however it is understood that the site now forms a portion of the Captains Flat Heritage Trail, a walking path which follows historic landmarks of the former mine and the associated town.

The presence of contamination associated with the Lake George mine appears to have been first formally identified in 1911 when contamination from the mine and the potential impact on downstream areas was noted in the NSW parliament. In 2018 GHD was commissioned by the NSW Department of Planning and Environment (DPE) Division of Resources and Geoscience (DRG) which hosts the Legacy Mines Program (LMP), to perform an assessment of the Lake George mine. The mine area was mostly devoid of vegetation and had large areas of sulfidic and other metalliferous waste rock and mineralisation exposed at surface, as well as accumulation of metallic sulfate salts. A very high potential for erosion and off-site transportation of dissolved and solid contamination through runoff and wind-borne dust was identified.

The adjacent Lake George mine is the primary source of contamination related to metalliferous mining and potential contamination within the surrounding area.

3. Site Condition and Surrounding Environment

A detailed review of the site condition and surrounding environment is presented in the previous DSI (Ramboll, 2022b). A summary of the site condition and surrounding environment was provided in the Ramboll 2022 RAP and below in **Table 3-1**.

Table 3-1 Summary of site condition and surrounding environment

Site Aspect	Summary
Topography	Moderate north facing slope intersected by a moderate – steep gully directing Copper Creek which flows in a south-westerly direction.
Elevation	860 – 870 mAHD
Nearby sensitive receptors	Human receptors include: • Residence located approximately 150 m west of the site • Nearby township of Captains Flat Environmental receptors include: • Copper Creek which flows through the site beneath the rail corridor via a culvert
Surrounding land use	The site is primarily surrounded by land zoned RU1 Primary Production with several surrounding sites Heritage Listed under the Palerang LEP 2014. Surrounding land use includes: North: Copper Creek, Captains Flat Road, bushland, former Captains Flat Railway Station and Captains Flat to Bungendore Rail Line. East: Former goods shed Miners Road, Northern Tailings Dump of the former Lake George Mine, Captains Flat Sewage Treatment Plant, residential community of Captains Flat South: Processing area of the Former Lake George Mine adjacent and uphill from the site and known to be contaminated by historic mining practices, bushland West: Copper Creek, Roscommon, large lot residential properties
Nearby heritage	Heritage listings apply to the site and surrounds and include: The Captains Flat Railway Precinct including a Goods Shed (leased to the State Emergency Service (SES)) and other remnant rail infrastructure from the southern end of the rail corridor to the north side of the Station The Captains Flat Railway Station Group – constructed in 1939 and converted into a private home in 1974 (Pryke 1995). Former Station Master's cottage – constructed between 1939 and 1940, now owned by TAHE and vacant. Lake George Mine – including the smelter site, and several related mining and processing sites (adjacent the site) Roscommon – miners hut constructed in the 19^{th} century (near the site)
Geology	Bumballa Formation comprising fine-grained sandstone interbedded with siltstone and mudstone, and Warbisco Shale comprising pyritic carbonaceous shale in the central portion. Captains Flat Shale and Kohinoor Volcanics (which includes rhyodacitic ignimbrite, agglomerate and minor argillaceous sediments) in the western portion.
Hydrogeology	Based on local topography and geology, local groundwater is expected to flow in an east/northeast direction in line with Copper Creek towards the Molonglo River. The Hydrogeology Map of Australia database indicates the site is within a fractured or fissured aquifer with extensive aquifers of low to moderate productivity.

Site Aspect	Summary
Direction of surface water runoff	The site appears mostly unsealed with rainfall expected to mostly infiltrate to ground. During moderate to high rainfall events water could be expected to flow overland, be received in rail cess drains (remnant from when the rail line was operational) and would likely to enter Copper Creek.
Extent of fill	The PSI (Ramboll, 2021a) stated that soils on the site to the west and east of the rail formation towards Copper Creek, comprised fill material containing coal and foreign materials including the observation of several fragments of fibre sheeting suspected of containing asbestos. Intrusive soil investigations completed as part of the previous DSI (Ramboll, 2022b) determined that the site comprised up to 2 m of fill in most locations on-site.

4. Previous Results

Ramboll (Ramboll, 2022) completed a detailed site investigation (DSI) to assess the level of contamination at and from the site. The results of the DSI are summarised in the following subsections.

4.1 Soil Lithology

The site was underlain by less than 2 m of fill in most locations and shallow sandstone was encountered on the north-eastern portion of the site towards the end of the rail line. Shale and dacite were observed around the middle of the site and at the southern end of the site respectively.

The soil lithology within the corridor comprised:

- SLAG Ballast: GRAVEL with Silt and Sand: dark brown, dry, fine to medium grained gravel (slag). Encountered from the surface to 0.1 -0.2 mbgl. It is considered likely that slag observed as ballast in the rail formation was a waste product from smelting that historically occurred at the Lake George mine.
- FILL: Sandy CLAY/Gravelly CLAY: dry, firm, high plasticity, with shale gravel and cobbles present. Encountered below the ballast layer to 0.4 to >2 mbgl.
- Sandy/Silty CLAY: Grey-brown, moist, low to medium plasticity (dry of plastic limit). Encountered below the fill layer ranging from 0.4 - >2 mbgl.
- SANDSTONE / SHALE / DACITE. Rock types observed during drilling correlated with regional geology.

Green / grey staining indicative of ore spillage was observed around the former load-out / weigh bridge area and in shallow fill associated with the rail formation. Fibre cement sheeting fragments (ACM) were observed in rail formation fill from the Copper Creek culvert embankment north. These observations were consistent across surface soil assessment, test pitting and drilling.

Perched water was observed below the ballast layer in test pit TP16 at 0.5 mbgl perched above sandstone.

4.2 Soil Results

A summary of contaminant concentrations that exceeded Tier 1 assessment criteria is summarised in **Table 4-1**.

Table 4-1: Summary of Soil Exceedances

Analyte	HIL C (mg/kg)	EIL/ESL Open Space (mg/kg)	Count	Minimum (mg/kg)	Maximum (mg/kg)	Average (mg/kg)	No > HIL	No > EIL
Arsenic	300	100	218	2.5	10305	296	38	67
Chromium	300	190	218	2.5	131	19	0	0
Copper	17000	220	218	2.5	5119	329	0	66
Iron	---	---	218	5.0	218530	35326	---	---
Lead	600	1100	218	2.5	315567	6659	108	86
Nickel	1200	220	218	1.0	168	9	0	0
Zinc	30000	630	218	2.5	116599	2831	4	101
B(aP)[1]		20	10	0.25	1.2	0.345	0	0
TRH >C10-C16 less Naphthalene (F2)		170	10	25	280	87.6	0	2[2]

Includes data collected during the DSI (Ramboll, 2022) and ESA (Ramboll, 2021)
Samples from the SES Depot are included in the assessment against HIL D criteria in accordance with the tiered risk assessment approach recommended in the NEPM (NEPC 2013).
Asbestos was detected through sample analyses at three locations and was also observed as visible fragments in surface soils at multiple locations.
[1]Benzo(a)Pyrene ESL derived from Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Canadian Council of Ministers of the Environment (CCME), 2010 (Residential/Parkland Land Use).
2 Raised LOR in one sample was above the ESL for F2.

Lead, arsenic, and asbestos are considered the primary drivers of potential risks to human health. Arsenic, copper, lead, and zinc are considered the primary drivers of potential risks to ecology.

Concentrations of B(a)P were below the derived Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Canadian Council of Ministers of the Environment (CCME), 2010 (Residential/Parkland Land Use). One minor exceedance and one raised LOR for TRH >C10-C16 less Naphthalene (F2) were reported. All other concentrations were below the site criteria or below the LOR and the average concentration was below the ESL criteria, as such it is not considered to be a contaminant of concern.

The distribution of contaminant concentrations exceeding Tier 1 criteria protective of human health and ecology are described in Section 4.2.1 and 4.2.2.

4.2.1 Tier 1 Human Health Risk Assessment

Ramboll 2022 presents the distribution of contaminants identified during the DSI exceeding assessment criteria protective of human health for recreational land use.

The highest lead concentrations were observed in surface soils at the loader and within the rail formation. Lead exceedances in soil were not found to extend to the western site boundary though were observed along the eastern site boundary around the loader and to the northern extent of the area assessed. Field portable x-ray fluorescence (fpXRF) measurement of metals in test pits at 0.1 m vertical intervals indicates lead exceedances are generally limited to the upper 0.5 mbgl within the rail formation and to the upper 0.2 mbgl in soils adjacent the rail formation.

For consideration of potential risks associated with asbestos, Ramboll 2022 indicates areas where asbestos was observed during the DSI. Results from laboratory analyses of fibre cement sheeting fragments at three locations (TP08, TP09, TP12) identified presence of chrysotile asbestos within the fragments. Analytical results for asbestos % w/w at locations where visible ACM fragments were observed at the surface (TP08, TP09, TP12) did not identify asbestos fines or friable asbestos. Cumulatively, the analytical results indicate asbestos impacts can be characterised by visible fibre cement fragments that contain bonded chrysotile asbestos.

Asbestos was observed (as bonded fibre cement fragments) within the rail formation and adjacent soils from the Copper Creek culvert embankment to the northern site extent. Distribution appeared limited to the rail formation and adjacent soils. All ACM fragments observed were disposed of at a licensed waste facility as a best practice measure however clearance of asbestos from the site surface is not considered complete.

4.2.2 Tier 1 Ecological Risk Assessment

Contaminants identified during the DSI have been screened against ecological criteria relevant to recreational / public open space land use and exceedances of these criteria are mapped in Ramboll 2022.

Concentrations of arsenic, copper, lead, and zinc were reported above ecological assessment criteria at multiple locations. The distribution included exceedances on the eastern and western site boundaries particularly around the former loader. TRH (F2) exceeded adopted ecological assessment criteria at one location. The average concentration was below the ESLs and is not considered to be a contaminant of concern. The primary driver of potential ecological risk at the site is metals.

4.3 Surface Water Results

Six surface water samples were collected upstream and downstream of the site and/or the mine site as follows:

- SW01 and SW02 were collected downstream of a dam on the mine site within a drainage line that passes through the southern end of the site.
- SW03 was collected from Copper Creek upstream of the both the adjacent mine and the site.
- SW04 – SW06 were collected from Copper Creek downstream of the site.

A tabulated assessment of surface water results against adopted assessment criteria is summarised in **Table 4-2**.

Table 4-2: Summary of Surface Water Results

Contaminants (mg/L)	95% Fresh Water Protection for Aquatic Ecosystems[a]	Drinking Water Guidelines[b]	Human Health - Recreational[c]	Irrigation[d]	Stock[e]	SW01	SW02	SW03	SW04	SW05	SW06
Arsenic		0.01	0.1			< 0.001	< 0.001	0.002	< 0.001	0.001	0.001
Arsenic (filtered)	0.013			0.1	0.5	0.001	0.001	0.002	0.002	0.002	0.002
Cadmium		0.002	0.02			***0.032***	***0.024***	0.0014	**0.0057**	**0.012**	**0.0093**
Cadmium (filtered)	0.0002			0.01	0.01	0.028	0.023	0.0014	0.0051	0.011	0.0092
Chromium		0.05	0.5			< 0.001	< 0.001	0.002	0.001	0.001	0.001
Chromium (filtered)	0.001			0.1	1	< 0.001	< 0.001	0.002	< 0.001	0.001	< 0.001
Copper		2	20			0.2	0.15	0.045	0.04	0.049	0.042
Copper (filtered)	0.0014	0.3	3	0.2	0.4	0.16	0.13	0.039	0.036	0.039	0.036
Iron				0.2	Not sufficiently toxic						
Lead		0.01	0.1			***0.35***	***0.41***	**0.075**	***0.22***	***0.25***	***0.17***
Lead (filtered)	0.0034			2	0.1	0.26	0.34	0.052	0.16	0.13	0.12
Mercury		0.001	0.01			< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Mercury (filtered)	0.0006			0.002	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel		0.02	0.2			0.013	0.017	0.005	0.01	0.015	0.014
Nickel (filtered)	0.011			0.2	1	0.01	0.015	0.004	0.009	0.013	0.013
Zinc		3	30			**18**	**27**	0.73	2.5	**3.8**	**3.3**
Zinc (filtered)	0.008			2	20	15	23	0.66	2.3	3.5	3.3

- indicates no criterion available
All results are in mg/L
Concentrations below the LOR noted as <value
[A] ANZG 2018, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2018
[B] **NHMRC 2019, Australian Drinking Water Guidelines (2011) — Updated May 2019, National Health and Medical Research Council, Canberra.**
[C] *NHMRC 2008, Guidelines for Managing Risks in Recreational Water, National Health and Medical Research Council, Canberra*
[D] ANZECC (2000) guidance for primary industries - irrigation
[E] ANZECC (2000) guidance for primary industries - livestock drinking water

The 95% Fresh water criteria were exceeded for cadmium, copper, lead and zinc at all sample locations. Chromium was exceeded at upgradient sample SW03, and nickel was exceeded at SW02, SW05 and SW06.

The ANZECC (2000) irrigation criteria were exceeded for cadmium at SW01, SW02 and SW05 and for zinc at all sample locations except for the background sample SW03.

The ANZECC (2000) stock criteria were exceeded for lead at all sample locations except for the background sample SW03, for cadmium at SW01, SW02 and SW05 and zinc at SW02.

The human health recreational criteria were exceeded for cadmium at SW01 and SW02 and for lead at all locations except the upgradient sample (SW03). The human health drinking water criteria were exceeded for cadmium at SW04-SW06, zinc at SW01, SW02, SW05 and SW06 and for lead at all locations. Concentrations of cadmium, lead and zinc were reported highest at SW01 and SW02. The results indicate contaminated surface water is migrating from a dam on the mine site via a drainage line through the southern end of the site.

4.4 Sediment Results

Sediment was sampled at each surface water sampling location plus one location within a drainage channel onsite (DRAIN01). Samples were collected with hand tools and analysed for heavy metals. Results are assessed against ANZG (2018) sediment quality assessment criteria and HIL C – Recreational criteria and are summarised in **Table 4-3**.

Table 4-3: Summary of Sediment Results

	ANZG (2018) DGV	ANZG (2018) GV-high	HIL C (mg/kg)	SED01	SED02	SED03	SED04	SED05	SED06	DRAIN01
Arsenic	20	70	300	65	44	16	21	18	24	25
Cadmium	1.5	10		0.8	0.5	0.8	0.5	0.9	2.2	1.9
Chromium	80	*370*	300	9	15	23	21	19	21	22
Copper	65	*270*	17000	210	210	100	55	68	80	150
Lead	50	220	600	**<u>1100</u>**	**<u>1100</u>**	**590**	**<u>670</u>**	**<u>780</u>**	**<u>1000</u>**	**<u>1500</u>**
Mercury	0.15	1		0.2	0.2	< 0.1	< 0.1	< 0.1	< 0.1	0.2
Nickel	21	*52*	1200	< 5	< 5	12	8	9	10	7
Zinc	200	*410*	30000	**800**	**600**	**3800**	**490**	**470**	**910**	**920**

Australia and New Zealand Guidelines for Fresh and Marine Water Quality (2018)

Concentrations in green box exceed adopted default guideline value (ANZG, 2018)

Concentrations in **bold font** exceed adopted Guideline Value - High (ANZG, 2018)

Concentrations underlined exceed adopted HIL C – Recreational value (NEPM, 2013)

Analytical results from sediment exceeded adopted GV-high criteria for lead and zinc at all seven locations. Exceedances of the sediment DGV were reported for arsenic, cadmium, copper, lead, mercury, and zinc.

Concentrations of contaminants in SED01 and SED02 were similar for lead and zinc. However, the concentrations of lead in sediment increased downgradient from the rail corridor in Copper Creek (SED04-SED06). DRAIN01 reported the highest lead concentrations indicating the drainage channel is highly contaminated with lead.

Concentrations of lead exceeded the HIL C – Recreational criteria for human health at all sample locations except for upgradient sample (SED03).

Upgradient sample (SED03) was generally lower in contaminant concentrations than the other samples except for zinc, which was 4-8 times higher than the other sediment samples.

4.5 Groundwater

4.5.1 Groundwater Gauging Data

The seven monitoring wells were gauged on the 2 November 2021 including one existing monitoring well (GW10) and six newly installed monitoring wells (GW101-GW106). Based on the contoured water levels, the site sits downgradient of the mine to the south-west. Inferred groundwater flow directions were north and east toward Copper Creek and indicate that groundwater flow is influenced by Copper Creek. The water level at Copper Creek was surveyed at five locations and ranged between approximately 860.7 m AHD and 863.1 m AHD and an average of 861.8 m AHD which correlate with the calculated groundwater contours indicating that Copper Creek is likely hydraulically connected to the groundwater at the site. The groundwater flow in the eastern portion of the site appears to flow north and possibly enters Copper Creek further north of the site.

4.5.2 Water Quality Parameters

Groundwater quality parameters were measured in the field prior to sampling to ensure collection of water that is representative of the groundwater conditions. The groundwater quality parameters for the seven monitoring wells are summarised below:

- pH measurements ranged from 3.98-11.81 pH, most wells reported pH below 7 indicating slightly acidic to neutral conditions however GW105 reported a pH of 11.81 indicating basic conditions.
- Electrical conductivity (EC) measurements ranged from 651 µS/cm to 3434 µS/cm, and reported an average of 1723 µS/cm, indicating fresh to slightly saline groundwater conditions.
- Dissolved oxygen ranged from 1.17 mg/L to 4.32 mg/L, with an average of 2.82 mg/L. medium to high dissolved oxygen levels were generally reported across the site, indicating slightly aerobic conditions.
- Redox potential measurements varied between -96.7 mV to 137.90 mV, indicating slightly reducing conditions. All monitoring wells except GW103 reported negative redox conditions and this is likely due to the proximity of this well to Copper Creek.

The groundwater quality parameters reported a freshwater system with neutral to slightly acidic pH, slightly aerobic conditions and redox measurements generally indicate a slightly reducing environment in majority of the wells across the site.

4.5.3 Analytical Results

A tabulated assessment of groundwater results against adopted assessment criteria is summarised in **Table 4-4**.

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Table 4-4: Summary of Groundwater Results

Contaminants (mg/L) - filtered	95% Fresh Water Protection for Aquatic Ecosystems[a]	Drinking Water Guidelines[b]	Human Health - Recreational[c]	Irrigation[D]	Stock[E]	GW10	GW101	GW102	GW103	GW104	GW105	GW106
Arsenic [F]	0.013	0.01	0.1	0.1	0.5	< 0.001	0.003	< 0.001	0.002	< 0.001	< 0.001	< 0.001
Barium		2	20			0.03	0.25	0.03	< 0.02	0.04	0.03	0.04
Cadmium	0.0002	0.002	0.02	0.01	0.01	*0.0044*	*0.0062*	***0.017***	***0.25***	***0.0027***	< 0.0002	***0.0034***
Chromium [G]	0.001	0.05	0.5	0.1	1	< 0.001	0.044	< 0.001	0.004	< 0.001	0.031	< 0.001
Cobalt	0.0014			0.05	1	0.021	0.21	0.066	0.49	0.049	< 0.001	0.015
Copper	0.0014	2	20	0.2	0.4	0.002	0.11	0.012	1.1	0.002	0.002	0.002
Iron		0.3	3	0.2	Not sufficiently toxic	< 0.05	***11***	< 0.05	< 0.05	*0.32*	< 0.05	< 0.05
Lead	0.0034	0.01	0.1	2	0.1	< 0.001	***0.39***	***0.61***	**0.092**	0.002	< 0.001	0.003
Manganese	1.9	0.1	1	0.2	Not sufficiently toxic	*0.58*	***1.9***	*0.95*	***4.1***	*0.87*	< 0.005	***2.8***
Mercury	0.0006	0.001	0.01	0.002	0.002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Molybdenum	0.034	0.05	0.5	0.2	1	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.014	< 0.005
Nickel	0.011	0.02	0.2	0.01	0.01	*0.082*	*0.15*	***0.051***	***0.59***	***0.039***	< 0.001	***0.032***
Selenium	0.011	0.01	0.1			0.002	*0.017*	*0.011*	***0.028***	0.006	0.005	0.005
Tin						< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Titanium						< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	0.008	3	30	2	20	0.64	2	***13***	***75***	0.47	< 0.005	0.96

Concentrations below the LOR noted as <value
[A] ANZG 2018, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2018
[B] NHMRC 2019, Australian Drinking Water Guidelines (2011) — Updated May 2019, National Health and Medical Research Council, Canberra.
[C] NHMRC 2008, Guidelines for Managing Risks in Recreational Water, National Health and Medical Research Council, Canberra.
[D] ANZECC (2000) guidance for primary industries - irrigation
[E] ANZECC (2000) guidance for primary industries - livestock drinking water
[F] Arsenic was based on the lowest criteria of As (III) and As (V) as speciation of arsenic was not measured
[G] Based on the Chromium (VI) criteria as more conservative

Concentrations of cadmium, cobalt, nickel and zinc exceeded the 95% Fresh Water criteria at six of the seven groundwater wells.

Concentrations of chromium and lead exceeded the 95% Fresh Water criteria at three groundwater wells and manganese and selenium at two groundwater wells.

Concentrations of cadmium, cobalt, copper, iron, manganese, nickel and zinc exceeded the irrigation criteria at a number of groundwater wells.

Concentrations of cadmium, copper, lead, nickel and zinc exceeded the stock drinking water criteria at a number of wells.

Analytical results exceeded adopted human health criteria for cadmium at six locations, iron at two locations, lead at three locations, manganese and nickel at six locations, selenium at three locations and zinc at two locations.

There were no exceedances of lead on the south-western (upgradient) boundary at GW106 however exceedance of the human health criteria for cadmium, manganese and nickel were observed.

Concentrations of lead were higher around the central portion of the site and to the west of the former loadout facility.

There were no exceedances of lead on the northern (downgradient) boundary at GW10 however exceedance of the human health criteria for cadmium and nickel were observed.

5. Preliminary Conceptual Site Model

A Conceptual Site Model (CSM) is a site-specific qualitative description of the source(s) of contamination, the pathway(s) by which contaminants may migrate through the environmental media, and the populations (human and / or ecological) that may be potentially exposed. This relationship is commonly known as a Source-Pathway-Receptor (SPR) linkage. Where one or more elements of the SPR linkage are missing, the exposure pathway is incomplete, and no further assessment is required.

5.1 Environmental Site Setting

The site is zoned for use as a rail corridor (SP2 – Infrastructure) though is located within an area zoned RU1 Primary Production and local receiving waters (Copper Creek and then the Molonglo River) are understood to form part of a drinking water catchment (GHD 2018). The Palerang local environment plan (2014) indicates the site is located within the Googong Dam drinking water Catchment. The site is also located adjacent the Lake George (legacy) mine and so within a highly disturbed area with known contaminant issues.

The current use of the site is as a non-operational rail corridor with access restricted by fencing and signage except at the SES Depot. The NSW SES lease an area in the eastern portion as the Captains Flat Depot. It is fenced off from public access and previously has had soil capping and/or a spray seal applied to the surface.

Specific contaminant issues from the mine that appear to affect the site include:

- Evidence of erosion indicating migration of contaminated soil/sediment entrained in surface water likely occurs during rainfall.
- Contaminated surface water migrating from a dam on the mine site via a drainage line through the southern end of the site.

These contaminant issues indicate contaminant migration from the mine onto the site and into the surrounding environment is occurring.

5.2 Sources of Contaminant

The following were identified as potential sources of site contamination in the Ramboll 2022 RAP:

- The main source of metals (As, Cd, Pb and Zn) contamination are from site activities including the historic loading and transport of ore concentrate and slag from historic smelting on the adjacent mine that has been extensively used throughout the rail corridor as ballast.
- An additional source of metals contamination to the site is the migration of contaminants from the adjacent mine. Elevated metals concentrations measured on the adjacent Lake George (legacy) mine (GHD 2018), visible evidence of erosion from the mine on site and elevated contaminant concentrations in surface water upstream of the site are evidence indicating contamination is migrating from the mine to the site via sediment, surface water and to a lesser extent through airborne dust.
- The likely source of asbestos contamination is a result of historical filling of portions of the site.

5.3 Potentially Affected Environmental Media

Potentially affected environmental media identified is:

- Soil at and around the site
- Surface water and sediment in Copper Creek adjacent and downstream of the site.
- Groundwater at and downgradient of the site.
- Soils, groundwater and surface water are also potentially affected in the area from the Lake George (legacy) mine

5.4 Human and Ecological Receptors

Human receptors are considered to include:

- Onsite workers including rail workers and workers maintaining above ground and underground services passing through the site
- Recreational users of the Captains Flat Heritage Trail which passes through the site
- Occupants of the former Station Master's residence located adjacent the eastern boundary of the site[1]
- Users of the SES Depot.
- Offsite recreational users of the receiving waters (Copper Creek, Molonglo River and Googong Dam.
- Offsite consumers of drinking water from the Googong Dam drinking water catchment

Ecological receptors are considered to include:

- Onsite terrestrial ecology, including native and introduced flora and fauna
- Current and future livestock located along the receiving waters
- Aquatic receptors of the receiving waters (Copper Creek, Molonglo River and Googong Dam).

Previous assessment (GHD 2018) indicates contamination from the Lake George (legacy) mine has impacted the surrounding environment and the township of Captains Flat.

5.5 Exposure Pathways

For a receptor to be exposed to a contaminant derived from a site, there should be an exposure pathway linking the source of contamination and the exposed population. An exposure pathway describes the course a chemical or physical agent takes from the source to the exposed individual and generally includes the following elements (USEPA, 1989):

- A source and mechanism of chemical release
- A retention or transport medium (or media where chemicals are transferred between media)
- A point of potential human contact with the contaminated media and
- An exposure route (e.g., ingestion, inhalation) at the point of exposure.

Table 5-1 summarises the potential exposure pathways, which have been developed based on a review of the soil results collected as part of the Ramboll 2022 DSI investigation.

[1] The risk to occupants of the Station Master's cottage has been addressed separately to the Ramboll 2022 DSI and this report.

Table 5-1: Exposure Pathway Assessment

Exposure Route	Users of the SES lease area	Recreational users of the heritage trail	Onsite workers	Recreational users of the Molonglo River	Consumers of water from Copper Creek / Molonglo River	Onsite ecological receptors	Offsite ecological receptors	Offsite aquatic ecological receptors	Offsite livestock and irrigation	Justification
Soil										
Direct Contact	P	P	P	N/A	N/A	**Y**	N	N/A	N/A	Metals concentrations and asbestos in soil were observed above the Ramboll 2022 DSI's adopted health and ecological criteria (lead only) within the rail corridor including the SES Depot. SPR linkages to onsite terrestrial receptors were identified.
Inhalation	P	P	P	N/A	N/A	N/A	N/A	N/A	N/A	
Incidental Ingestion	P	P	P	N/A	N/A	**Y**	N/A	N/A	N/A	
Root Uptake	N/A	N/A	N/A	N/A	N/A	**Y**	N	N/A	N/A	
Sediment										
Direct Contact	N	N/A	P	P	N	**Y**	**Y**	**Y**	P	Sediment is present in drainage lines within the corridor. The concentrations of lead in sediment present a potential risk to onsite workers, recreational users of the heritage trail and onsite / offsite ecological receptors.
Incidental Ingestion	N	N/A	P	P	N	**Y**	**Y**	**Y**	P	
Root Uptake	N/A	N/A	N/A	N/A	N/A	**Y**	**Y**	**Y**	N/A	The concentration of lead and zinc in sediment in the drainage channels and downgradient in Copper Creek from the Ramboll 2022 DSI exceed the GV-high criteria which indicates a potential complete exposure pathway to ecological receptors, aquatic receptors and a potential risk to livestock.
Surface Water										
Direct Contact	N/A	N/A	P	P	P	**Y**	**Y**	**Y**	**Y**	Concentrations of metals in surface water in Ramboll's 2022 DSI exceeded the recreational criteria. Surface water exists in the rail corridor and flows offsite.
Incidental Ingestion	N/A	N/A	P	P	P	**Y**	**Y**	**Y**	**Y**	SPR linkages are complete for onsite and offsite ecological receptors in Copper Creek and downgradient Molonglo River as well as livestock downgradient from the site.
Root Uptake	N/A	N/A	N/A	N/A	N/A	**Y**	**Y**	**Y**	N/A	Potential SPRs for surface water and sediment to offsite recreational receptors in the downstream environment are identified though can not be confirmed as the contribution from the rail corridor compared to the mine site to downstream locations accessible for recreational use remains unclear.
Groundwater										
Groundwater Extraction	N	N	N	N	N	N/A	N/A	N	N	Concentrations of metals in groundwater exceeded the Ramboll 2022 DSI's adopted human health criteria. There is no current residential use of groundwater and groundwater is at a depth of six metres below the site and therefore contact by maintenance workers is considered unlikely. Exposure to onsite ecological receptors could occur through root uptake however tree stands are generally limited to areas of the site up hydraulic gradient of the loader area and /or rail formation – the primary areas of contamination.
Direct Contact	N	N	N	P	P	N	P	P	N	
Incidental Ingestion	N	N	N	P	P	N	P	P	N	
Root Uptake	N/A	N/A	N/A	N/A	N/A	P	**P**	P	N/A	Copper Creek and the Molonglo River are noted as a high likelihood groundwater dependent ecosystems and ecological exposure to groundwater via receiving surface waters is possible. Exposure via root uptake to offsite ecological receptors and livestock via groundwater extraction is likely.
Airborne Dust										
Direct Contact	N	N	N	N/A	N/A	N	N	N/A	N/A	Airborne dust was associated with the operational mine. Monitoring of air quality since mine closure at the site and around Captains Flat has not identified airborne dust at concentrations which pose a risk to human health.
Inhalation	P	P	P	N/A	N/A	P	P	N/A	N/A	
Incidental Ingestion	N	N	N	N/A	N/A	N	N	N/A	N/A	

5.6 Data Gaps

Due to revised changes of the future land use from commercial/industrial to public open space (heritage walking trail), soil contamination concentrations exceeding public open space criteria were not delineated in the Ramboll 2022 DSI.

Data gaps identified in the RAP have noted that additional assessment is required. Contamination to the east and south of the SES Depot within the proposed public open space land use has not been fully characterised, specifically, the lateral extent of contamination east and south of CFX91 and TP16.

Similarly, the vertical extent of contamination in soil near the Copper Creek culvert embankments remains unclear.

Previous assessment (GHD, 2018) indicates contamination from the Lake George (legacy) mine has impacted the surrounding environment via, dust, soil, sediment, surface water and groundwater. This may complicate assessment of impacts from the site to the surrounding environment. Airborne dust is currently being assessed for the broader community and it’s considered the effects of airborne dust to offsite receptors would be captured within this.

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6. Assessment Criteria

The NEPM (2013) provides health-based soil investigation levels (HILs) and ecological investigation levels (EILs) for various land uses. Based on the current land use, the assessment criteria adopted for the Site that are relevant to addressing data gaps in the extent of soil contamination are:

- HIL C – HIL for public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. It does not include undeveloped public open space (such as urban bushland and reserves) which should be subject to a site-specific assessment where appropriate. 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 for residential use. Site-specific conditions should determine the depth to which HILs apply for other land uses.
- EIL for urban residential/public open space - EILs depend on specific soil physio-chemical properties and generally apply to the top 2 m of soil. Site-specific EILs for public open space were calculated using pH and Cation Exchange Capacity results from samples collected onsite (Ramboll 2022) and will be adopted for this investigation...

Assessment criteria for this investigation are summarised in **Table 6-1**.

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

Contaminant	HIL C (public open space)	Site-specific EIL (urban residential/public open space) – Fill
Arsenic	300	160[b]
Chromium	300[a]	190
Copper	17,000	220
Lead	600	1,100[b]
Nickel	1,200	220
Zinc	30,000	630

- Indicates no criteria available

[a]HIL for chromium (VI)

[b]The EIL for these contaminants is generic, not site specific.

7. Quality Assurance and Quality Control

7.1 Data Quality Objectives

Ramboll developed Data Quality Objectives (DQOs) and Data Quality Indicators (DQIs) for the investigation in accordance with the seven-step DQO process, endorsed in Schedule B2 of the NEPM (2013). The DQOs set quality assurance and quality control parameters for the field and laboratory program to ensure data of appropriate reliability will be used to assess site contamination.

The DQOs are outline in **Table 7-1** .

Table 7-1: Data Quality Objectives

DQO	Outcome
Step 1: State the Problem	The problem is the lateral extent of soil contamination south and east of the SES compound and the vertical extent of soil contamination within and around the Copper Creek culvert embankments is not understood well enough to adequately to inform remediation.
Step 2: Identify the Decisions	The following decisions are required: • Is the data collected of sufficient quality to identify impacts to meet the project objectives? • Do the results of the investigation provide understanding of the lateral and vertical extent of soil contamination? • Can a conclusion be made on site suitability or are further investigations required? • Does the site present a risk to human health or ecology?
Step 3: Identify Inputs to the Decision	The following inputs to the decisions are required: • Identification of sampling locations • Visual or olfactory evidence of contamination • fpXRF field screening of lead concentrations • Laboratory analysis of soils for lead and co-located metals.

Step 4: Define the Study Boundaries	The study boundaries for the DSI are defined as follows:
	• The physical boundaries of the investigation are the site boundary as defined in **Figure 1, Appendix 1**.
	• The vertical extent is to a maximum depth of 10 m bgl for mechanically drilled boreholes[2], 3 m bgl for test pits and 0.5 m bgl for hand drilled boreholes noting that advancement at all locations will terminate on rock. Depth to rock has been previously observed at approximately two meters though is expected to be deeper beneath the Copper Creek culvert embankment.
	• The temporal boundary is limited to data to be collected under this investigation.
	• Investigations within the study boundary are limited by accessibility issues, including:
	  o The location of underground and overhead services
	  o The location of materials or storage of equipment
	  o The locations of structure on site (e.g. old load out equipment)

Step 5: Develop a Decision Rule	If it is determined that the data generated through this investigation is reliable, complete, comparable, accurate and representative then this information will be used to address the assessment objectives. • If it is determined that the data generated through this investigation is not suitable, comprehensive or reliable for use in achieving the goals of the study, then further investigations may be recommended to reduce uncertainties. • If it is determined that insufficient information is available to make conclusions on the risk to ecological receptors, then further information may be required. • If CoPC are reported above the assessment criteria, it will be considered whether further assessment or management measures are required.

[2]10m bgl machanically drilled boreholes are for geotech purposes only, not contamination sampling.

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<table>
<tr><th>DQO</th><th colspan="4">Outcome</th></tr>
<tr><td>Step 6: Specify the Performance or Acceptance Criteria</td><td colspan="4">Performance criteria are presented in Section 7.2.</td></tr>
<tr><td rowspan="5">Step 7: Optimise the Design for Obtaining Data</td><td colspan="4">A plan for soil sampling and analyses to address the identified data gaps is summarised below. Indicative sampling locations are presented on Figure 2, Appendix 1.</td></tr>
<tr><td>Method of Advancement</td><td>No. Locations</td><td>Sample Depths (m bgl)</td><td>Analytes</td></tr>
<tr><td>Soil Bore – solid flight auger</td><td>2</td><td>0 – 0.2
0.3 – 0.5
0.8 – 1
1.3 – 1.5
1.8 – 2*
2.3 – 2.5*
2.8 – 3*
3.3 – 3.5*
3.8 – 4*</td><td rowspan="3">fpXRF field measurement of lead and laboratory analyses of As, Cr, Cu, Pb, Ni, Zn</td></tr>
<tr><td>Test pit</td><td>8</td><td>0 – 0.1
0.4 – 0.5
0.9 – 1
1.4 – 1.5
1.9 – 2.0*
2.4 – 2.5*
2.9 – 3*</td></tr>
<tr><td>Hand excavation</td><td>14</td><td>0 – 0.1
0.4 – 0.5</td></tr>
</table>

7.2 Data Quality Indicators

Sampling and analytical methods are presented against Data Quality Indicators (DQIs) in **Table 7-2** to define how data quality will be assured and controlled during the proposed investigation.

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Table 7-2: Data Quality Indicators and Performance Criteria

DQI	Field		Laboratory
	fpXRF sampling of site soils as a screening measurement to delineate contamination	**Sampling of excavation surfaces for lab analysis**	
Completeness – a measure of the amount of useable data from a data collection activity.	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 contaminants of potential concern (CoPC). A dwell of 60 seconds is considered to provide sufficient precision for the sampling program.	Site visits completed. Sampling completed using the following methodology; • Boreholes advanced with non-destructive digging to 1.2 mbgl, followed by push tube to the target depth of 3 mbgl, and as far as practicable for monitoring well boreholes. Where impenetrable material is encountered, solid stem auger used to achieve the target depth. Soil logged in accordance with AS1726-1993 – Geotechnical Site Investigations and be visually inspected for contamination (i.e., staining, odour, visual asbestos). Photographic log maintained. All critical locations sampled. Experienced sampler. Documentation corrects. Soil sampling locations will be backfilled with original material from the location.	All critical samples analysed for COPC (heavy metals: arsenic, copper, chromium, lead, nickel and zinc). All analysis completed according to standard operating procedures. Appropriate methods. Appropriate Practical Quantitation Limits (PQLs).
Comparability – the confidence that data may be considered equivalent for each sampling and analytical event.	• XRF readings will be collected by an experienced scientist holding a NSW EPA radiation users license as 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	Experienced sampler. Climatic conditions noted during sampling. Same types of samples collected using approved sampling methods. Soil samples labelled in accordance with Ramboll's naming convention: • Test Pits: TP##_X.X-X.X • Boreholes: BH##_X.X-X.X	Same analytical methods used. Same sample PQLs. Same NATA accredited laboratories used. Same units.

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DQI	Field		Laboratory
	fpXRF sampling of site soils as a screening measurement to delineate contamination	**Sampling of excavation surfaces for lab analysis**	
	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. · Sample numbers, preservation and analytical requirements are to be recorded on chain of custody documents.	• Hand Auger: HA##_X.X-X.X Where ## equals the location number and X.X-X.X equals the sample collection depth in m bgl.	
Representativeness – the confidence that data are representative of each medium present on-site.	Sampling locations and frequency compliant with provisions described in Section XXX. · Sampling completed by experienced personnel · Field documentation completed correctly	Existing sampling Ramboll DSI (2022) combined with the proposed sampling delineates the vertical and horizontal extent of contamination with sufficient confidence to inform remediation (noting that validation sampling will also be completed during / on completion of remediation). Soil samples placed immediately into laboratory supplied and appropriately preserved sampling vessels. Samples stored in chilled, insulated containers with ice for transportation to the laboratory.	All samples analysed according to standard operating procedures.

DQI	Field		Laboratory
	fpXRF sampling of site soils as a screening measurement to delineate contamination	**Sampling of excavation surfaces for lab analysis**	
		Sample numbers, preservation and analytical requirements recorded on chain of custody documents. Samples transported to the laboratory under chain of custody conditions.	
Precision – a quantitative measure of the variability of the data.	· Non-disposable sampling equipment, such as the hand auger, will be thoroughly decontaminated between locations using Decon 90 solution and deionised rinsate water.	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. Where less than 10 primary samples are collected in one event, one intra and one inter-laboratory duplicate collected. Rinsate blank samples collected for each day of sampling where re-useable equipment is used.	Analysis of field duplicate samples, relative percent difference (RPDs) to be ≤30%. Laboratory duplicates analysed, RPDs to be ≤ 30%.
Accuracy – a quantitative measure of the closeness of the reported data to the "true" value.	· 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	Sampling methodologies appropriate and complied with. Collection of one rinsate sample per day of sampling from reusable field equipment. Disposable nitrile gloves donned for collection of soil samples and changed between samples. Excavator samples collected from the centre of the excavator bucket mimising cross contamination from the walls of the excavator bucket. Hand auger and drill rig soil samples collected from each borehole either from the hand auger cutting blades, from within the push tube liner or from solid stem auger cuttings as practicable. Non-disposable sampling equipment, i.e., hand auger, decontaminated between sampling locations using Decon 90™ solution and deionised rinsate water.	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%.

Performance criteria for analyses of soil duplicates are defined as follows:

- The correlation between fpXRF and laboratory data will be assessed for lead with a minimum correlation 0f 0.7 required to support use of fpXRF data for screening purposes
- Data will be analysed adopting RPD control limits of +/- 30%.

  Where concentration levels are less than two times the Practical Quantitation Limit (PQL), the Absolute Difference (AD) shall be calculated. Data will be considered acceptable if: AD <2.5 times the PQL.

  Any data which does not conform to these acceptance criteria will be examined for determination of suitability.

- Blank samples will be submitted with the analytical samples and analysed for the contaminants of concern: One Field Blank will be collected each day.
- The laboratory will additionally undertake a method blank with each analytical batch of samples. Laboratory method blank analyses are to be below the PQLs. Results shall be examined, and any concentrations in blank samples may not be subtracted from concentrations in primary samples.

  Positive results may be acceptable if sample analyte concentrations are significantly greater than the amount reported in the blank (ten times for laboratory reagents such as methylene chloride, chloroform, and acetone etc., and five times for all other analytes). Alternatively, the laboratory PQL may be raised to accommodate blank anomalies provided that regulatory guidelines are not compromised by any adjustment made to the PQL.

7.2.1 Decision Error Protocol

If the data received is not in accordance with the defined acceptable limits outlined above 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 site-specific trigger levels
- 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

7.2.2 Rectifying Non-conformances

If any of the procedures or criteria identified above are not followed or met, this will constitute a non-conformance. The significance of the non-conformance will determine if rectification is required and should be considered in the subsequent investigation report.

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8. Reporting

The results of the soil investigation will be incorporated into an update to the existing DSI or in an addendum DSI report. The report will be prepared in general accordance with the *NSW EPA Contaminated Land Guidelines, Consultants Reporting on Contaminated Land* (NSW EPA, 2020).

9. References

National Environment Protection Council (NEPC). National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013

NSW EPA (2020). Consultants reporting on contaminated land: Contaminated Land Guidelines.

Ramboll, 2021. Captains Flat Rail Corridor Preliminary Site Investigation. (Ramboll, 2021a)

Ramboll, 2022. Captains Flat Rail Corridor Detailed Site Investigation. (Ramboll, 2022b)

Ramboll, 2022. Captains Flat Rail Corridor Remediation Action Plan. (Ramboll, 2022a)

APPENDIX 1
FIGURE

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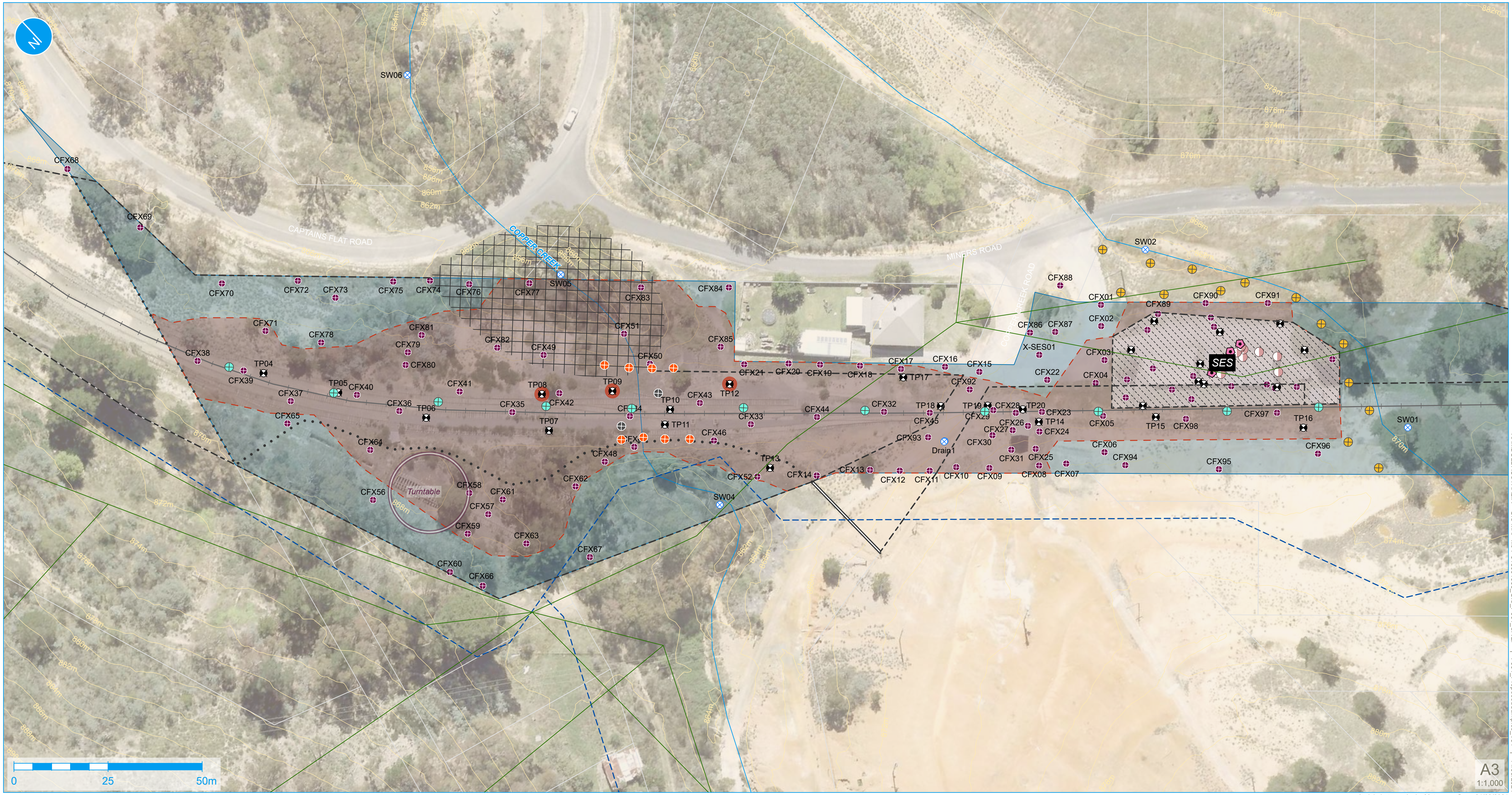

Aerial photography by Metromap, flown 01/03/2021

Key

Declared area
Railway
2 m contour line
Captains Flat State Emergency Services
Extent of human health criteria exceedance and area of excavation proposed to remediate human health risks

Note: An indicative area of where exceedances to the human health criteria (HIL C) occurs is presented in this figure, for XRF sample result values refer to results table.

Approximate location of turntable
Existing access gate
Existing fencing
Proposed fencing
Steep dip

Service lines
Fibre optics cable
Potable water

Data sourced from: Telstra, 2021. Queanbeyan Palerang Regional Council, 2021. Land and Property Information, 2018.

Sample type
Dust interior sample
Paint sample
Surface water sample
Test pit
XRF sample
Asbestos identified

Proposed sample locations
Hand auger
Test pit
Borehole
Lead leachate analysis

Asbestos was observed (as bonded fibre cement fragments) within the rail formation and adjacent soils from the Copper Creek culvert embankment to the northern site extent. Distribution appeared limited to the rail formation and adjacent soils however the capacity to inspect other areas was limited by vegetation, steep embankments and/or time such that extents of impact could not be accurately defined.

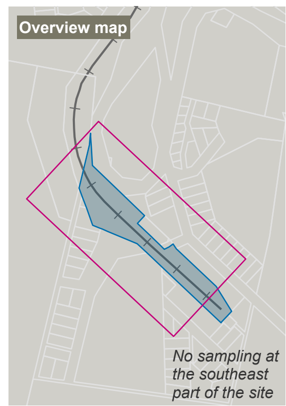

Figure 1 | Proposed sample locations

APPENDIX 2
EIL CALCULATIONS

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Inputs
Select contaminant from list below
Cr_III
Below needed to calculate fresh and aged ACLs
Enter % clay (values from 0 to 100%)
1
Below needed to calculate fresh and aged ABCs
Measured background concentration (mg/kg). Leave blank if no measured value
or for fresh ABCs only
Enter iron content (aqua regia method) (values from 0 to 50%) to obtain estimate of background concentration
1.5
or for aged ABCs only
Enter State (or closest State)
NSW
Enter traffic volume (high or low)
low

Outputs		
Land use	Cr III soil-specific EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	50	70
Urban residential and open public spaces	100	190
Commercial and industrial	150	320

Inputs
Select contaminant from list below
Cu
Below needed to calculate fresh and aged ACLs
Enter cation exchange capacity (silver thiourea method) (values from 0 to 100 cmolc/kg dwt)
15
Enter soil pH (calcium chloride method) (values from 1 to 14)
6.4
Enter organic carbon content (%OC) (values from 0 to 50%)
8.3
Below needed to calculate fresh and aged ABCs
Measured background concentration (mg/kg). Leave blank if no measured value
or for fresh ABCs only
Enter iron content (aqua regia method) (values from 0 to 50%) to obtain estimate of background concentration
1.5
or for aged ABCs only
Enter State (or closest State)
NSW
Enter traffic volume (high or low)
low

Outputs		
Land use	Cu soil-specific EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	60	85
Urban residential and open public spaces	110	220
Commercial and industrial	160	310

Inputs
Select contaminant from list below
Ni
Below needed to calculate fresh and aged ACLs
Enter cation exchange capacity (silver thiourea method) (values from 0 to 100 cmolc/kg dwt)
15
Below needed to calculate fresh and aged ABCs
Measured background concentration (mg/kg). Leave blank if no measured value
or for fresh ABCs only
Enter iron content (aqua regia method) (values from 0 to 50%) to obtain estimate of background concentration
1.5
or for aged ABCs only
Enter State (or closest State)
NSW
Enter traffic volume (high or low)
low

Outputs		
Land use	Ni soil-specific EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	20	40
Urban residential and open public spaces	75	220
Commercial and industrial	150	380

Inputs
Select contaminant from list below
Zn
Below needed to calculate fresh and aged ACLs
Enter cation exchange capacity (silver thiourea method) (values from 0 to 100 cmolc/kg dwt)
15
Enter soil pH (calcium chloride method) (values from 1 to 14)
6.4
Below needed to calculate fresh and aged ABCs
Measured background concentration (mg/kg). Leave blank if no measured value
or for fresh ABCs only
Enter iron content (aqua regia method) (values from 0 to 50%) to obtain estimate of background concentration
1.5
or for aged ABCs only
Enter State (or closest State)
NSW
Enter traffic volume (high or low)
low

Outputs		
Land use	Zn soil-specific EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	65	200
Urban residential and open public spaces	230	630
Commercial and industrial	350	930

Inputs
Select contaminant from list below
As
Below needed to calculate fresh and aged ACLs
Below needed to calculate fresh and aged ABCs
or for fresh ABCs only
or for aged ABCs only

Outputs		
Land use	Arsenic generic EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	20	40
Urban residential and open public spaces	50	100
Commercial and industrial	80	160

Inputs
Select contaminant from list below
Pb
Below needed to calculate fresh and aged ACLs
Below needed to calculate fresh and aged ABCs
or for fresh ABCs only
or for aged ABCs only

Outputs		
Land use	Lead generic EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	110	470
Urban residential and open public spaces	270	1100
Commercial and industrial	440	1800