CCSN response to:

1. An investigation into metals in sediments from domestic rainwater tanks around the Newmont gold mine in Cadia
2. An investigation into metals in domestic tank water around the Newmont gold mine in Cadia

Background and Approach Taken

The community surrounding Cadia Valley Operations (CVO) has expressed concern over the amount of dust leaving the site from exposed and tailings dams, mine rehabilitation land forms and unfiltered emissions from vent shafts.

Blood serum tests, urine and hair sample analysis indicate high levels of Hg, Ni, Co, Mo, Cu, Ar and Se.

The EPA Report (An Investigation into metals in sediments from domestic rainwater tanks around the Newmont gold mine in Cadia) compared the metal concentration in sediment in rainwater tanks in the Cadia district with other industrial urban regions identified in previous Australian studies. The EPA did not compare sediment in rainwater tanks in the rural Cadia district with other rural areas.

Whilst six metals of concern were identified by the EPA, Hg and Mo which were present in blood tests and many residents' tanks were not considered.

The EPA has attempted to make an assessment of the concentration of metals and sediment in rainwater tanks relative to distance of the tank from the mine. The EPA did not take into consideration:

- a previous study (An Evaluation of Lead Isotopic and other Geochemical Information of Relevance to the Cadia Mine Operation, Gulson 2023). This study interpreted a University of Adelaide isotope study which identified lead from Cadia in rain water tanks up to 18 km from CVO.
- the age and construction of the rainwater tanks.
- the time since tanks were last cleaned.
- the amount of sediment accumulating in each tank.
- the rate of accumulation in each tank.

Test Results

- The EPA has compared Cadia Valley rural water tanks to the results of 10 research papers, summarised in Attachment 1. All of these research papers had very small data sets and were based upon small water tanks retro fitted to existing houses in an attempt to combat water restrictions. These papers examined contamination in industrial and urban rainwater tanks, with the exception of Kus 2011, which compared 5 tanks in the Kangaroo Valley to 11 in urban Sydney. The rural tanks reported no detectable lead or iron compared to the metro tanks which significantly exceeded ADWG levels.

- The EPA tested 52 samples of which 41 had sufficient mass for analysis. EPA tests were carried out during the period June – August 2023, following CVO testing 96 tanks in March 2023 and subsequent cleaning of an undisclosed number of tanks. EPA Report Figure 1, number of properties sampled in proximity to the mine shows only 32 samples.

- EPA Report Figure 1 shows 5 samples in the 16-20km zone and only 1 sample in the 20 – 24 km zone. This is an extremely small data set on which to base any conclusion.
  The Gulson report identified lead matching the Cadia isotope fingerprint 18km from the mine. This would suggest that any analysis attempting to determine a correlation between a potential source for the sediment, Cadia mine, and the distribution should be performing a significant number of tests well beyond the 20-24km zone.

- NSW EPA and CVO test ranges are tabulated as ranges based upon dry weight concentrations measured in mg/kg, these values are compared to literature concentrations in both mass concentrations' mg/kg, and volume concentrations in μg/l which the EPA has incorrectly assumed to be identical and ignored relative density.

- EPA Arsenic range 0.8-20mg/kg is incorrectly compared to literature range of 4,800 – 30,600 μg/l (Spinks et al 2006). EPA incorrectly converted the Spinks range to 4.8-30.6 mg/kg.

- EPA Cadmium range 0.1 – 11mg/kg is compared to literature range of <1 – 50mg/kg, the low range Cd is based on sludge 1000 – 15,000 μg/l (Spinks et al 2006) and tabulated as 1 mg/kg dry weight.

  - The upper range 50 mg/kg is based on tests done in Melbourne on 9 rainwater tanks (Magyar et al 2011).
  - The 50mg/kg sediment sample is not representative as it is based on a single sample from tank S9 which was a 7year old stainless steel tank located in Northcote.
    - The tank had a volume of 0.23m^3 and was located 15m from a busy road (basically a 44-gallon drum) in an industrial area.
    - pH in the tank water was measured in a range 4.3-5.2. The 2006 Cd recording was 2.5 g/kg. The 2007 recording was closer to 45mg/kg but was rounded up to 50mg/kg by NSW EPA. The following year 2008 tank S9 recorded cadmium of less than 1 mg/kg (fig 9) (Spinks 2006)

- EPA Copper range measured in June – August 2023 was 24 – 830 mg/kg and is compared to a maximum range value of 1500mg/kg taken from tank S9 referred to above.

- EPA lead range 5.9 – 1600mg/kg

  - compared to a minimum range of 184mg/kg which is derived from a single sample collected in a glass bulk deposition gauge in Brisbane (Huston 2009).

  - Upper lead range is 6,580 mg/kg is based on a dry weight conversion by the EPA of data published (Spinks 2006) 721,700 – 6,580,000 μg/l . Reference was also made to (Magyar 2011) where the maximum lead reading of 3,100 mg/kg was obtained from tank S5 which was a 20 year old concrete tank never cleaned collecting water from an old painted metal roof in Brunswick.

  - Tank S5 recorded results as follows: 2006 lead 3,100 mg/kg pH 4.8 and 2007 lead 1,500 mg/kg pH 6.0.

- EPA Nickel range 3 – 210 mg/kg
  - Compared to a reported nickel range of 13000-45000 μg/l (Spinks 2006) and incorrectly converted to 13 mg/kg by NSW EPA. The upper range 100mg/kg is derived from S9 (0.23m^3 stainless steel tank in Northcott – Magyar 2011).

- Selenium range was only tested by the EPA based on community concerns in regard to high blood levels there was no comparison to other rural, industrial or urban areas.

- EPA zinc range was 28 – 25,000mg/kg this complied reasonably well with the 9 tanks tested in Melbourne by Magyar 100 – 40,000mg/kg. The maximum value of 40,000 was taken from tank S2 in Brunswick Vic from a 2.25m^3 PVC tank collecting water from a PVC roof. Tank S2 recorded zinc and pH as follows: 2006 zinc 40,000mg/kg and pH 4.9, 2007 zinc 23,000mg/kg and pH 5.9, 2008 zinc 3,000 mg/kg and pH 6.5.

  Brunswick is an industrial area with several electroplating and zinc plating facilities and may not be representative of a typical urban environment. Water from the tanks was used for residential outdoor uses including irrigation and car washing.

- The maximum concentrations of all elements in sediment tested by CVO were higher than those tested by the EPA. The variation in upper ranges between Cadia and EPA samples suggests potential sampling error which calls into question whether it is appropriate to compare the two data sets at all:
  - the community observed inconsistent sampling techniques and equipment between EPA staff and representatives of CVO collecting samples;
  - testing of CVO samples was performed by ALS, multiple sludge test reports provided in the Sage Human Health Risk Assessment are marked “not to be tested” as the sampler touched the bottom of the tank. This is inconsistent with the EPA method which aimed to scrape along the bottom of the tank.

  As at 1 June 2023, Cadia had cleaned water tanks for 35 residents, and continued to clean tanks until the end of August. Cadia has been very selective about which tanks it will clean, are these the most heavily contaminated tanks, or the tanks which match the lead isotope fingerprint for the mine? Either way if Cadia has removed the sludge from more that 35 contaminated tanks before the EPA commenced testing and was allowed to continue to clean tanks whilst the EPA was collecting samples, any data produced by the EPA will be missing the most significant tests performed by CVO and included in its data set. Removal of this number of cleaned contaminated tanks from the EPAs data set may compromise any attempt to determine a correlation between contamination and distance from Cadia.

  The number of cleaned tanks (35+) is very significant compared to both the EPA data set (41 tests) and the CVO data set (96).

- NSW EPA, states that the results are similar to studies in Newcastle (Spinks) and Melbourne (Magyar). This is incorrect, for example the upper value for lead concentration attributed by the EPA (Spinks 2005) is incorrectly taken from Table 3, as 6,580 mg/kg. The correct value is on Table 4 Lead Content of Sludge Fractions which shows a range, dependant on settling time, of 830 – 3000 mg/kg. This range in industrial Newcastle and Melbourne is directly comparable with the EPA and CVO ranges of 1,600 – 4,150 mg/kg for the Cadia district.

- Nickel and selenium are showing up as a concern in community blood tests. The EPA investigation ignores both these elements but acknowledges that nickel levels are atypical and 2-3 times higher than their reference levels.

- Contrary to the EPA statement, a small sediment layer is inevitable in any rainwater tank. Historically rural tank sedimentation is low and inconsequential, tanks are left undisturbed for many years.

In urban Australia and in former industrial sites and mining precincts metals such as lead, chromium, silver, nickel, copper, arsenic and manganese have been detected above health limits (Chubaka 2018, p2, Sinclair 2005, Rodrixx 2009, Huston 2009).

Comparison with Typical Australian Rain Water Tank Sediment Metal Concentrations

The EPA conclusion that sediments collected in the Cadia district are similar to heavily contaminated non potable tanks in industrial / urban parts of Melbourne and Newcastle understates the significance of the level of contamination in the Cadia district. The CCSN considers this conclusion to be irresponsible considering the adverse health impacts of such a conclusion.

- The highest concentration of lead found in rain water tanks by CVO was twice that found in reviewed literature (Magyar 2011).
- Nickel concentration in sediments were 2-3 times higher than that in any of the referenced sources.

It is important to note that the tanks referred to in the literature were never intended to be used for drinking water but in general were small tanks installed on existing buildings in response to urban water shortages.

The conclusion by the EPA that Table 1 is representative of Australian rainwater tanks is absurd and has no scientific basis. The EPA has not considered sediments in any tanks in a comparable rural district.

The EPA investigation failed to understand that some accumulation of sediment at the bottom of the tank is normal and is probably the single most beneficial process tank water undergoes. However, excess sediment accumulation in industrial locations, urban districts and areas close to mining operations is of concern, the volume of sediment can totally overwhelm the tank decant pipework. In general, the concentration of sediment at the base of rainwater tanks has no direct correlation with the quality of the rainwater (Spinks 2006, Magyar). The principal determinant of soluble metal contamination is pH.

Cadia Valley Compared to Lue District

The CCSN believes that the sediment in the rainwater tanks in the Cadia valley is not consistent with sediment in other rural areas. Assoc Prof Ian Wright has performed a pilot study of 8 tanks in the Lue district in NSW. The Lue water samples were collected using a dipper tube from the bottom of rainwater tanks using a method consistent with the sampling conducted by the CCSN in the Cadia Valley.

Lue Water Tanks

Measuring water tanks at Lue shearing shed, approx. 100 years old. Last clean 5 years ago.

Measuring a domestic tank approximately 6-8 years old. Never cleaned. Positioned under a tree canopy and has sieve on the inlet

Cadia Water Tanks

Tank approximately 10-15 years old galvanised shed and plastic pipes. Never cleaned.

Tank cleaned 10 months prior to this photo being taken, it was also cleaned twice in the previous 24mths.

Cadia / Lue comparison results are summarised as follows:

μg/L		Al	As	Co	Cu	Fe	Pb	Mn	Ni
Cadia tanks	Min	1900	0.50	1.00	11.00	3000		34	3.00
Cadia tanks	Max	160000	94.00	100.00	5800.00	190000	8900	15000	120.00
Cadia tanks	Mean (Avg)	29926	11.71	16.94	450.53	41929	669	1103	25.76
Cadia tanks	Median	21000	5.00	8.00	215.00	25000	93	500	14.50
Lue	Mean (Avg)	15411	8.67	9.89	98.56	31600	732	693.33	14.40
Cadia mean vs Lue mean		**1.94**	**1.35**	**1.71**	**4.57**	**1.33**	**0.91**	**1.59**	**1.78**

All elements identified in the Cadia sediment at multiple times the concentration of the Lue sediment is present in the Cadia ore and tailings. Arsenic, Cobalt, Copper and Iron at up to 96x the presence in the earth's crust.

Arsenic, Cobalt, Copper, and Nickel are present at elevated levels in many residents' blood and hair tests.

The Cadia tanks are clearly atypical and have 450% more copper than the Lue tanks.

Visual evidence collected by the CCSN as samples were collected indicates there is a significant difference in the volume of sediment between rainwater tanks in the Cadia Valley and the rural Lue district.

Relationship between concentration of metals in sediments and distance from the mine

The methodology adopted in the EPA study, based on component analysis and regression analysis of sediment concentrate, is not supported by any of the reference papers. Indeed, from the wide range of concentrations and the small number of samples in a fairly concentrated area it would be unlikely to demonstrate any significant relationship.

A generally accepted approach to apportioning the contribution from emission sources would be to utilize the US EPA Positive Matrix Factorisation Model (PMF 3). This model requires real bulk deposition (BD) data and considers the rate of deposition and collection area to accurately categorise the sediment source composition for a rainwater collection system. Following this study an isotope study can further identify the source of particular elements.

What do the results mean?

1. It is false and misleading to suggest that the data collected by the EPA investigation is typical of concentrations found in rural Australian rainwater tanks. The EPA has not presented any evidence to support this claim.

2. The conclusion that no statistically significant relationship could be found between concentrations of metals in sediment and distance from the mine indicates that this study was

poorly conceived and ignored established methods such as isotope ratio comparison and EPA PMF3.

3. Sediment and sludge in rural tanks is normal and not usually a health issue. The sludge does not generally cause a problem in normal tanks as it does not usually resuspend in the water column during rain events. The practice of desludging may provide a marginal improvement to water quality and is not essential to the maintenance of high-water quality (Spinks 2006).

   Desludging may only be necessary with water tanks in urban and industrial/mining areas, but generally NSW Health Guidelines would recommend that in these areas rain water tanks not be used for drinking water purposes.

   The EPA recommendation that sludge be examined every 2-3 years fails to explain how this may be accomplished in a large tank with limited access and full of water. The sediment / sludge in the rainwater tanks in the Cadia Valley exceeded the maximum concentration which would allow the sludge to be disposed of as a fill material. The sediment in the Cadia Valley tanks is actually a prescribed waste, contaminated soil category C or B (EPA Vic 2007) and in some cases would require chemical immobilisation by chemical reaction or physical encapsulation in a sealed matrix (EPA 2007) prior to disposal to a licensed site for contaminated waste (Magyar 2011). Siphoning of sludge by a homeowner is not legally feasible or recommended.

4. EPA recommendation in regard to flushing of tanks only refers to new tanks (NSW Health Rainwater tanks). Point of use filtration generally does not reduce soluble metals and is not regarded as essential by either NSW Health or the published literature. Tank inlet strainers may provide some protection from build-up of vegetation and production of humic acid in the tank sludge. First flush systems are recommended and help reduce contamination but are not totally effective in eliminating particulate matter contamination.

   In rural areas NSW Health acknowledges that properly designed rainwater systems are a reliable source of drinking water. Concerns are primarily bacterial contamination not heavy metal contamination.

   In urban areas NSW Health supports the use of rainwater tanks only for non-drinking uses such as rainwater tanks for non-drinking uses such a toilet flushing, washing clothes and cars, filling swimming pools, spas and ornamental ponds and firefighting. NSW Health recommends that in urban areas people use the public water supply for drinking and cooking. (NSW Health Rainwater Tanks September 2022)

Summary of Research Relied upon by EPA. Attachment 1

The EPA's Investigation refers to 10 research papers, these papers are summarised below.

Paper	Tanks Tested	Location	Conclusions / Comments
Huston et al 2009 Characterisation of atmospheric deposition as a source of contaminants in urban rainwater tanks	26	Brisbane - urban	Atmospheric deposition contributes to contamination in rainwater in an urban environment. Increase in contamination in traffic / industrial areas compared to outer suburbs. First flush devices may reduce sludge build up for particulate Pb but are unlikely to reduce soluble Pb.
Huston et al 2012 Source apportionment od heavy metals and ionic contaminants in rainwater tanks….	31	Brisbane - urban	Pb concentration was lower in tank water from houses in outer suburban areas. Pb higher where houses had lead flashing. Pb lower with galvanized and concrete tanks, where first flush systems installed and non-acidic tank water.
Kus et al 2010 Water quality characterisation of rainwater in tanks at different times & locations	10 1	Kogarah Wollongong Base of tank tap	Kogarah selected for sampling as Sydney air quality is worst in South Western suburbs. Water is predominantly compliant with ADWG. Pollutants that did not comply in a few tanks were heavy metals (Fe &Pb) pH and turbidity. 1 first flush tested was heavily polluted.
Kus et al 2011 Water Quality in Rainwater Tanks in Rural and Metro NSW	11 5	As above Kangaroo valley	Metro tanks: Fe 0.31 mg/L Pb 0.067 mg /L Rural tanks: Fe <0.01 mg/L Pb <0.01 mg /L
Magyar et al 2006 Water & sediment quality from rainwater tanks	6 pilot study small roof & tank	Melbourne suburban	All metals in very high concentrations in sediment. Contamination influenced by traffic and industry.
Magyar et al 2007 An investigation of rainwater tanks quality and sediment dynamics	6 pilot tanks 9 urban tanks	5 km NW central Melbourne Base of tank tap mg/L	Sediments in urban tanks contain metal concentrations that are a potential source of pollution.
Magyar et al 2008 Lead and other heavy metals: common contaminants of rainwater tanks in Melbourne	6 pilot tanks 9 urban tanks 40 urban tanks	Metro Melbourne Base of tank tap mg/L	% of 49 tanks with metal content above ADWG: Aluminium. 4 Cadmium. 2 Copper 0 Iron 8 Lead 33 Zinc 10
Magyar et al 2011 Sediment transport in rainwater tanks and implications for water quality	9	Doveton - 1 Brunswick - 2 Northcott - 3 Industrial, electroplating, Zn, Pb, Cu, Ag	Metal contamination of tank water and sediment is common in urban areas. Sediment in tanks can become a source of pollution in the water (re-suspension and leaching). pH in the tanks was usually acidic. Sediment re-suspension was common under conditions that usually occur in urban tanks (pH and temperature changes)
Rodrigo et al 2010 A survey of the characteristics and maintenance of rainwater tanks in urban areas of SA	630 tanks 325 households	Metro Adelaide and surrounding areas (μg/L)	High level of adherence to recommended maintenance procedures is required if rainwater in urban areas is to be considered for drinking.
Spinks et al 2005 Tank sludge as a sink for bacterial and heavy metal contaminants and its capacity for settlement…	5	Newcastle – industrial city	Settlement of particulate matter is probably the single most beneficial process harvested rainwater undergoes. Accumulation rates vary widely between tanks. Sludge contains highly magnified concentrations of metals.