Submission No 39

INQUIRY INTO COSTS FOR REMEDIATION OF SITES CONTAINING COAL ASH REPOSITORIES

Organisation: Hunter Community Environment Centre

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Hunter Community Environment Centre.

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Legislative Council Public Works Committee
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SUBMISSION TO:

Inquiry into the costs for remediation of sites containing coal ash repositories

16 FEBRUARY 2020

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1. Introduction

Thank you for the opportunity to make a submission on this important public interest issue.

The Hunter Community Environment Centre (HCEC) was established in 2004 in recognition of the value of our unique landscape and bioregion. Together with 2,000 supporters and affiliates, we work with our community to protect biological diversity and special places, and enhance the quality of life in our region.

The Hunter suffers the brunt of the impacts of the State's coal-fired electricity generation with four of the five coal power stations operating, along with the impacts from the mines that supply them with coal.

In light of the metal and metalloid pollution associated with coal ash worldwide, the HCEC supports the thorough decontamination and remediation of sites containing coal ash repositories and the allocation of adequate funding and assistance to complete such works.

We encourage the NSW Government to ensure the comprehensive rehabilitation of the Vales Point and Eraring power station sites and the return of the land to public ownership. The power stations have a combined area of 2,857 hectares - 1147 ha at Eraring and 1700 ha at Vales Point. Much of which is wetland and high conservation value coastal forest. These lands should be return to public ownership once the power stations are decommissioned. Reserve proposals for the wetlands, shore-front, and vegetated buffer lands within these sites are being prepared.

As coal is a concentrated source of many trace elements, its combustion produces residual ash with further concentrated non-volatile trace elements known to stress aquatic ecosystems by generating anoxic conditions, enhanced microbial activity, and metal toxicity.

Over the past 18 months HCEC has investigated the impacts that Eraring and Vales Point power stations are having on Lake Macquarie. In March 2019, we released *Out of the Ashes: water pollution and Lake Macquarie's ageing coal-fired power stations* (Appendix 1) that identified significant contamination of southern Lake and its ecosystems with heavy metals and the contribution made to this long-standing issue by the two ash dams associated with the power stations.

Recently, we have reviewed and analysed the Environmental Site Assessments (ESA) for Eraring and Vales Point by Environmental Resources Australia (ERM) and other relevant documents provided to the NSW Legislative Council under Standing Order 52. These documents, including the Stage 2 ESAs, provide stark evidence of the significant contribution the ash dams have made to the heavy metal contamination of southern Lake Macquarie.

The issues identified by the ESAs for Eraring and Vales Point include groundwater contamination through the leaching of metals from the ash dams and the subsequent contamination of Lake Macquarie, including high selenium concentrations in sediment in Wyee Creek and Mannering Bay, Whitehead Lagoon and Crooked Creek. A 2014 Treasury Brief cited the extraction of this groundwater for potable, domestic or stock watering or for commercial purposes as representing a risk to human

health and livestock.[1] Despite groundwater contamination existing in the north, west and south of the Vales Point ash dam where residential communities are located, no public health warning was ever made.

There is a further liability issue associated with the Munmorah Power Station site from a hydrocarbon plume (fuel oil lens) in the groundwater beneath the Munmorah operating plant that may require rehabilitation and chlorinated hydrocarbons and some compounds found in firefighting equipment have been detected in groundwater at the Colongra Site and have migrated onto the Munmorah site. [2]

Of great concern to the ongoing contamination of groundwater beneath the Eraring and Vales Point ash dams is the identification by the ESAs of the presence of acid sulfate soil (ASS) conditions, probably arising from the disturbance by the dam itself and nearby underground coal workings. As such acidic conditions have been found in the groundwater which is likely to increase metals leaching from the ash.

Metal and metalloid contamination has further been identified in Lake Macquarie seafood. The findings of a 2018 internal report by the NSW Office of Environment and Heritage (OEH) (Appendix 2) identified elevated concentrations of metals and metalloids in 12 species of fish and crustacea caught from Lake Macquarie. The study found that consumption of modest quantities of crabs from Lake Macquarie could result in exposure to cadmium, and that consumption of somewhat higher quantities of commonly caught fish, prawn, or crab, could result in exposure to selenium, particularly in children.

The HCEC has begun to study heavy metal uptake by Lake Macquarie birds. In our pilot study, we identified significant concentrations of a number of metals in the feathers of white-faced herons found near to Vales Point. These feathers contain lead and zinc at concentrations associated with reduced breeding success and a number of debilitating diseases. We intend to undertake a comprehensive study by analysing feathers from seabirds and waders around the Lake to identify whether the contaminants found in water, sediment, and marine life has migrated up the food chain.

Finally, we had ANSTO date a sediment core sample taken from near to Vales Point in Mannering Bay, a known metal hotspot. The analysis of metals, at those years determined by ANSTO, shows substantial metal contamination rising after the Vales Point ash dam was built.

Both Vales Point and Eraring ash dams are declared dams under the section 5 of the *Dams Safety Act 2015*. On 29 March 2019, visitors and occupants of Myuna Bay Sport and Recreation Centre, directly below the Eraring ash dam, were evacuated and the Centre permanently closed due to an engineer's report identifying the dam wall at risk of failure in the event of a 5.9 category earthquake.

There are 60 million tonnes of coal ash on the shores of Lake Macquarie and 500 millions of tonnes of coal ash accumulating in ash dumps around Australia. The most responsible way of dealing with this waste is one that prevents the metals and metalloids within the ash from leaching into surrounding waterways.

As impermeable barriers were never installed beneath the Vales Point and Eraring ash dams, groundwater contamination was inevitable. To retrofit such a barrier is not feasible at Vales Point and Eraring ash dams and may cause additional contamination issues.

[1] NSW Treasury, 2014.
[2] ibid

If we are to one day rid Lake Macquarie of its heavy metal contamination, the 60 million tonnes of coal ash that has been allowed to accumulate on the shores of southern Lake Macquarie over the past 50 or so year must be removed. We believe that responsible beneficial reuse of the ash is the only feasible option to remove the ash over an extended period of time. However, currently less than 25 percent of the 550,000 tonnes of coal ash annually generated by Vales Point and 29 percent of the 1.34 million tonnes of coal ash generated by Eraring is reused, mainly for road-base, cement and concrete.

Coal ash is best disposed of through a process of encapsulation that involves heating the ash in a sinter plant, fusing ash particles together so that metals and metalloids are locked up within a glassy crystalline matrix. Encapsulated coal ash has a number of economic uses, such as light weight aggregates and sands for the construction industry.

Currently, coal ash is used by the cement industry for addition to concrete and dry cement. However, the cement industry has only managed to utilise a proportion of the coal ash produced and does not appear to be interested in investing in reusing coal ash that has already been dumped in landfills.

Other uses of coal ash are less responsible and may be harmful. A high proportion of the coal ash generated in NSW is used as backfilling in mine voids, as road base, and as soil amendments in agriculture and horticulture. These uses are wasteful of a useable material and are high risk, as the heavy metals are not encapsulated and can be introduced into surrounding waterways where they can bioaccumulate and cause significant harm to the environment and human health.

Government assistance and policy is required to encourage environmentally-responsible coal ash reuse to remove a key source of heavy metal contamination, reduce a key source of greenhouse gas pollution from the manufacture of cement, and encourage new on-site enterprises that could provide new jobs for displaced workers when these aging facilities are decommissioned.

To achieve this, coal ash regulation needs urgent reform. This reform needs to consider the whole life-cycle of coal burning, ash production, handling, storage, transport, and reuse. Regulatory amendments are required that put the financial burden for safe disposal of coal ash back onto the power station operators who produce the waste and the pollution it is causing.

We include our recommendations and the initial results of our investigations below. We would be happy to present these to the Committee.

1.1 Recommendations

- **Recommendation 1:** The NSW Government commit to comprehensively decontaminating the Vales Point and Eraring power station sites.
- **Recommendation 2:** The NSW EPA declare Vales Point and Eraring ash dams contaminated sites under the *Contaminated Lands Management Act 1997* and serve the Department of Planning, Industry and Environment with an order to prepare and submit comprehensive site management plans to the EPA for approval.

- **Recommendation 3**: The NSW Government establish a financial assurance mechanism, such as a sinking fund, to cover the risk of long-term environmental degradation after power stations are decommissioned.

- **Recommendation 4**: The NSW EPA undertake an investigation into coal ash generated in NSW to determine the environmental risks associated with all current and proposed uses and whether these uses are appropriate due to the concentrations of metal/metalloid and the risk of them leaching, and whether any meets the specifications for high volume sintered ash products. The final report from this investigation should be published on the EPA website.

- **Recommendation 5**: The EPA amend the *Coal Ash Exemption 2014* to ensure all coal ash metal analyses and leach testing results are made public. The EPA must take a much more active role is encouraging safe coal ash reuse and determining the safety and suitability of coal ash for its various current and proposed uses.

- **Recommendation 6:** The NSW Government list coal ash as an assessable pollutant in Schedule 1 of the *Protection of the Environment Operations (General) Regulation 2009* and impose a load based licence fee of at least $20 a tonne on all coal ash disposed of in ash dams, landfills, and mine voids.

- **Recommendation 7:** The EPA make a public announcement of the risks to human health, livestock, irrigated plants and crops of using groundwater identified by ERM and EPA at the five NSW coal-fired power stations as above NHMRC drinking water quality guidelines or ANZECC irrigation and livestock guidelines.

- **Recommendation 8:** The NSW Government commission a feasibility study into the environmentally-responsible reuse of coal ash in NSW. The study should include an assessment of the economic feasibility of manufacturing sand and aggregates from fly ash in NSW. HCEC recommends the NSW government look for investors to assist in the process of trialling a pilot plant. We recommend the following:

    - Through an open tender process select appropriately-skilled and resourced companies interested in utilising large volumes of coal ash for the on-site manufacture of light weight aggregates and sands, or other suitable high volume sintered product.

    - Sample ash from all NSW power stations to determine the ideal compositional matrix for the required products.

    - With the assistance of the selected companies:

        - design, build, operate, and evaluate a pilot plant, and test the products for market suitability and human health and environmental safety.

        - Develop a business plan that includes an estimate of final production costs, market appraisals, and transport logistics.

- **Recommendation 8:** To ensure that coal ash is not itself contaminated with material that may diminish its suitability for high volume sintered ash products, the EPA immediately amend any

EPL condition that allows for material other than coal ash to be disposed of in coal ash dams at the five NSW coal-fired power stations.

- **Recommendation 9.** The NSW EPA amend EPL 1429 (Eraring) and EPL 761 (Vales Point) so that the maximum concentrations of any water discharged into Lake Macquarie, including groundwater, is set at ANZECC (2000) trigger values or at levels it can guarantee will not cause harm to the environment or human health.

2. Eraring Power station ash dam

Originally built in 1958 to accommodate coal ash generated by the Wangi power station, the unlined ash dam at Eraring was expanded to 250ha in 1976 to accommodate 20 million cubic metres of ash expected to be generated by the newly built Eraring power station. The expansion raised the ash level from 10m above sea level to 25m above sea level with ash decant discharged into a return water reservoir used for further ash transport. However, runoff from the ash dam in excess of ash transport requirements discharges over a control weir into Crooked Creek, which flows into Whitehead's Lagoon and Myuna Bay.[3]

The 1975 Environmental Impact Statement (EIS) for Eraring admitted that the geology of the site was not ideal. Alluvial material under the ash dam overlies a number of coal seams[4] that have since been mined.

From 1981 to 1999, Eraring utilised a wet fly ash disposal system which allowed fly ash slurry to be pumped to the ash dam. In 1999, the power station installed a system to convey dry fly ash to silos which fed a system that mixed fly ash with water into a lean phase paste and used recycled ash dam decant to transport the ash to the dam. Leachates were apparently reduced 30 percent and more material could be held in the dam. In 2007, approval was granted for the first expansion of the Eraring ash dam and a goal introduced to reuse 80 percent of all produced ash (both fly ash and bottom ash) by 31 December 2015.[5] By 2015 the power station was only achieving 55 percent reuse. [6] By 2019, this had declined to 29 percent.[7]

The need for additional ash storage capacity is due to Origin Energy's failure to meet the target set by the Department of Planning for beneficial reuse of the coal ash. The deadline for reaching the 80 percent reuse target was again pushed back to 2021, just two years away, but only 29 percent of the 1.34 million tonnes of ash generated is currently reused, adding an additional 950,000 tonnes of ash to the Eraring ash dam each year.[8]

[3] ELCOM NSW, 1975
[4] ELCOM NSW, 1980
[5] Eraring Energy, 2007.
[6] ibid
[7] NSW Independent Planning Commission, 2019
[8] Origin Energy, 2018.

About 35 million tonnes of coal ash has already been dumped in Eraring ash dam. Based on an inadequate Environmental Impact Statement (EIS) and very poor public consultation, the Independent Planning Commission approved the expansion of Eraring ash dam capacity by 5 million m^3 in 2019.[9]

Origin Energy's preferred option is to raise the ash dam wall by 14 metres which would increase ash holding capacity by 5 million m^3 and extend its operational life to approximately 2024. No mention is made in the EIS of what disposal or use is proposed for the ash generated by the power station after that time.

Abandoned coal mine shafts just 20m below may be draining ash leachate from the ash dump. There is likely to be cracking between the surface and the coal mine shafts that would allow coal ash leachate to migrate into groundwater and into tributaries of Lake Macquarie. There is also potential for subsidence in the form of either pillar collapse or roof failures leading to sink-hole formation on the ash dam and the western embankment. Centennial Coal proposes to extend its Newstan mine operation under the ash dam (See Figure 1), potentially further destabilising the dam.

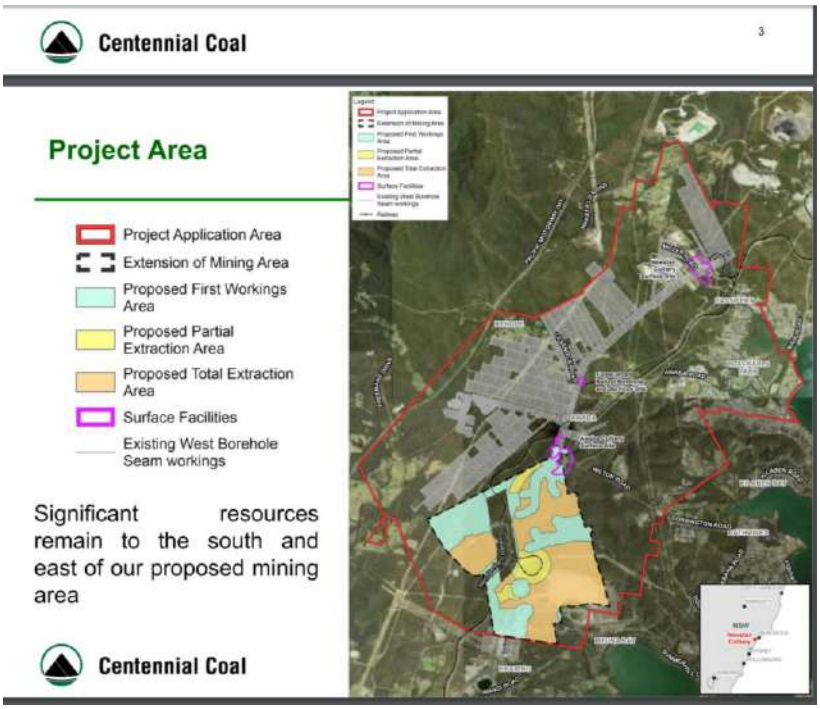


Figure 1: Centennial Newsman[10] Colliery expansion plans

In March 2019, Origin Energy advised the NSW Office of Sport that the Myuna Bay Sport and Recreation Centre (MBSRC) was at risk of inundation of coal ash in the event of a category 5.9 earth quake. On 29 March 2019 the MBSRC was evacuated and closed.

The NSW Independent Planning Commission Statement of Reasons for approving the ash dam argumentation revealed the events that precipitated the decision to close the MBSRC.[11] In November 2018, Origin Energy engaged an engineering consultant to undertake a Dam Break Assessment, which

[9] Origin Energy, 2018
[10] Centennial Coal, 2019.
[11] NSW Independent Planning Commission, 2019

considered the population at risk and severity of damage and loss in the event of a dam break. The assessment concluded that due to an increase in the level of occupancy of Myuna Bay Sport and Recreation Centre, located 450 metres below the southern edge of ash dam wall, the population at risk had increased, compared to previous assessments.

In March 2019 Origin Energy again engaged the engineering consultant to undertake a *Geotechnical Stability Assessment — Southern Embankment* to determine whether the Ash Dam still met Dam Safety NSW safety requirements based on the seismic requirements for the "High A" category. This assessment concluded that the Ash Dam no longer met the required factor of safety due to the increased seismic requirements and recommended that stability works be undertaken to the southern embankment to meet the required factor of safety.

3. Vales Point Power Station Ash Dam

Originally built in 1962 with a capacity of 18.5 million m^3, the unlined Vales Point ash dam was expanded in 1982 to increase its capacity to 30 million m^3. At the time, this was thought sufficient volume to host ash from both Munmorah and Vales Point power stations until about 2000.[12]

We estimate the Vales Point ash dam currently holds about 26 million tonnes of coal ash, and a further 550,000 tonnes of ash is generated per annum. As only about 25 percent of this ash is reused, about 412,000 tonnes is dumped in the ash dam each year.

Water decanting from the ash (leachate) as well as runoff was once discharged into Lake Macquarie through Mannering Bay Creek into Mannering Bay.[13] The 1982 augmentation included the construction of the Wyee Channel to divert the flow of Mannering Creek to Wyee Creek and the Wyee Dam. The Dam was built to ameliorate flooding of Wyee caused by the raising of the 13m ash dam earth wall to between 18.5 and 21.5m using natural clay fill and coal washery refuse.[14]

The 15 page EIS for the 1982 expansion, which pre-dates contemporary NSW pollution control law by 15 years, blithely concluded that the expansion of the Vales Point ash dam would not introduce any significant environmental problems.[15]

Since 1995, water has been removed from the ash dam and recycled back to the power station, where it is mixed with cooling water before being discharged into Wyee Bay[16]. The new procedures were expected to raise selenium concentrations within the ash dam but reduce the amount of suspended and dissolved trace metals reaching the lake.[17]

Figure 11 below indicates that selenium concentrations discharged at once of the power station's licenced monitoring points - LMP 2 - into the cooling water canal that drains into Wyee Bay has actually

[12] ELCOM NSW, 1980
[13] ibid.
[14] ibid
[15] ibid
[16] Kirby et al, 2001
[17] Peters, 1999.

increased to 30 ppb since 2013. Well above the 2ppb concentration recommended for ecosystem health.

4. Decontamination liability for Eraring and Vales Point power station sites.

The Stage 2 Environmental Site Assessments to support the completion of the sale of Vales Point and Eraring Power Station identified the key impacts including metals, benzene and PFOS in groundwater and PFOS, Total Recoverable Hydrocarbons, benzo(a)pyrene, asbestos and metals in soil across the sites.

By far the greatest challenge for the safe and economically feasible decontamination of these facilities is the large coal ash impoundments that store of over 60 million tonnes of coal ash. Originally built in the late 1950s and early 1960s, these ash dams were poorly designed, situated, and engineered. Coal ash dams built around the world today, particularly those that use water to transport the ash from the power station boilers to the ash dam as do Vales Point and Eraring, limit groundwater contamination by the installation of impermeable membranes or grout at the base of the dam to restrict water from moving through the ash and into underlying groundwater. While we believe the Eraring ash dump does have a clay lining, Vales Point has no liner what so ever. However, groundwater beneath both the ash dump is now highly contaminated with heavy metals mobilised from the wet coal ash.

The NSW Government sold Vales Point to Sunset International in 2015 and Eraring to Origin Energy in 2013. Conditions of sale for both power stations sale included agreements as to the apportionment of liability for decommissioning and rehabilitating the sites. These agreements were made after a set of Environmental Site Assessments (ESA) identified significant contamination of both sites attributed to a number of operational sources including the very large coal ash dams.

Those environmental site assessments were only made public in 2019 following Standing Order 52 in the Legislative Council.

The NSW Government built, owned, and utilsed these power station ash dams for 55 of the 60-odd years they have been in operation. As such, Sunset and Origin are indemnified against costs associated with contamination caused before the sale. It appears that as long as Sunset and Origin operate the power stations such that contamination does not exceed the baselines set, no further rehabilitation liability is owed.

In relation to Vales Point power station the liabilities are as follows;

- Sunset International P/L are responsible for the decommissioning costs of Vales Point Power Station including the removal of all hazardous liquids and gases and making the plants safe (electrically, mechanically, and hydraulically) prior to handing the site over to a demolition contractor.
- The State has indemnified Sunset International P/L for remediation costs associated with the ash dam and legacy property contamination, subject to the purchaser complying with certain obligations during the operation period.

- The State of NSW remains responsible for pre-existing contamination at the time of the sale. The purchaser/operator is responsible for operating period contamination (ie. contamination caused during their period of ownership.)
- The State of NSW is also responsible for demolition of the power station should it be handed back via the triggering of "put and call" options by a decision by the operator to cease operating the power station.
- The State of NSW provided an indemnity to the purchaser regarding pre-existing contamination which is triggered if the EPA issues a cleanup order.
- As part of the sale of Vales Point power station there is a $12 million guarantee from Sunset International to cover any operational period contamination and decommissioning. In the event of the operator becoming insolvent and not able to fund such costs, the State of NSW is not obliged to take back the power stations.[18]

In relation to Eraring power station, the liabilities are as follows;

- The State has indemnified Origin Energy for remediation costs associated with pre-sale contamination.
- The State is required to manage any request by Origin Energy including assignments requests, approvals of voluntary management plans and the replacement of guarantees.
- The State's obligations are scheduled to end three years after the Eraring Power Station is decommissioned and the site rehabilitated so as to comply with minimum legal standards.
- The State will share the costs of implementing an alternative arrangement for ash disposal if the EPA does not permit the current approval for further backfilling at the existing ash dam to be implemented. The State's Liability ceases if the issue is not resolved within 10 years (2023).

Eraring has installed dense phase ash transportation equipment to dispose of the coal ash along pipes from the power station to the ash dams in an attempt to reduce the mobilisation of the metals within the ash and the contamination of surrounding waterways. Vales Point power station continues to use ash slurry transport, and correspondingly, experiences far higher groundwater concentrations. Indeed, concentrations of many metals in groundwater has increased since ERM's assessments and both coal ash dams continue to contaminate Lake Macquarie with heavy metals leaching from the ash to the underlying groundwater.

The Lake's ecosystems have most certainly been affected. Health authorities' concern over the consumption of seafood caught from the Lake is evident as early as 2003[19] with more recent risk assessments identifying a number of edible species as having concentrations of metals above domestic and international guidelines.[20]

[18] NSW Treasury, 2019
[19] Dalton & Bird, 2003
[20] OEH EPS Branch, 2019 (See appendix 2)

As the State of NSW is liable for the vast majority of the decontaminating and decommissioning of the Lake Macquarie ash dumps, the public interest demands a far higher standard of rehabilitation than that expected if the works are left to private enterprise alone. Indeed, as the sale of the NSW coal-fired electricity generation assets totaled over $2.6 billion the government is in no position to shirk its responsibility to comprehensively decontaminate the sites.

5. Project Symphony

In 2013, prior to the power sell-off, Environmental Resources Management Australia P/L (ERM) was engaged by NSW Treasury as Site Contamination Environmental Advisor for the Electricity Generating Assets including Mount Piper, Wallerawang, Eraring, Shoalhaven, Bayswater, Liddell, Vales Point, and the Colongra Power Stations.[21] This process was dubbed "Project Symphony."

ERM prepared Stage 1 and Stage 2 reports covering soil, sediment, surface water and groundwater assessment that may pose risks to human health and the environment.

Following the release of these documents to the Legislative Council, HCEC has analysed the results, which are presented and reviewed below.

5.1. Analysis of Stage 2 Environmental Site Assessments for Eraring and Vales Point

The following charts set out the groundwater and Lake sediment results of ERM's Stage 2 ESA and Jacobs *Vales Point Additional Baseline Contamination Assessment* [22]. The horizontal lines represent relevant water and sediment quality guidelines – Green represents ANZECC (2000) trigger values for slightly to moderately disturbed marine ecosystems,[23] the red line represents National Health and Medical Research Council (NHMRC) drinking water guidelines, and the blue line represents ANZECC (2000) Recreation Use water quality guidelines.

The horizontal axes plot "areas of environmental concern" (AEC), which are sampling locations at each power station for the metals presented.

[21] NSW Treasury, 2014.
[22] Jacobs, 2017.
[23] ANZECC (2000) and ANZECC (2013) do not include a trigger value or sediment guideline for selenium. Selenium green line represents recommendations in Lemly (2002) and British Columbia Ministry of Environment (2012).

5.1.1 Arsenic

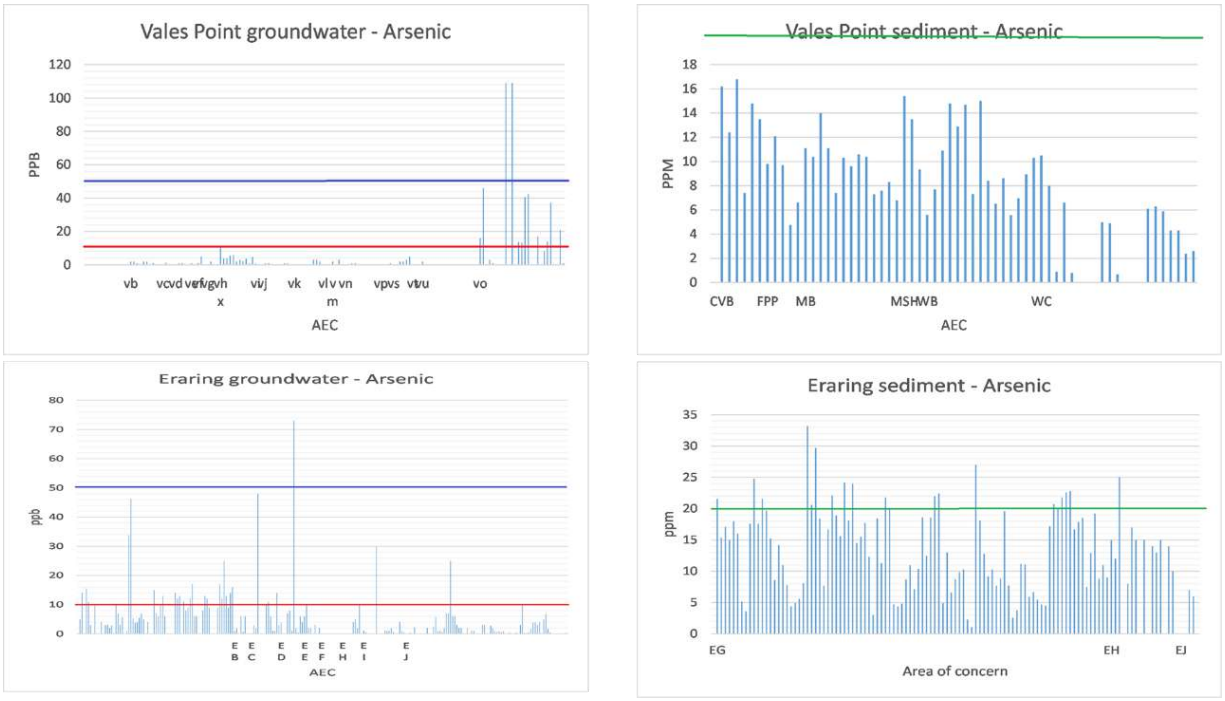


Figure 2: Arsenic in Vales Point and Eraring Power Station groundwater and nearby Lake Sediment.

Significantly more arsenic contamination of Lake sediments were found near to Eraring than Vales Point, with numerous exceedances of ANZECC sediment guidelines. However, the ESAs revealed numerous exceedances of ANZECC recreational use guidelines, NHMRC drinking water quality guidelines for groundwater at both sites. ANZECC guidelines do not list a trigger level for arsenic in marine waters.

5.1.2 Cadmium

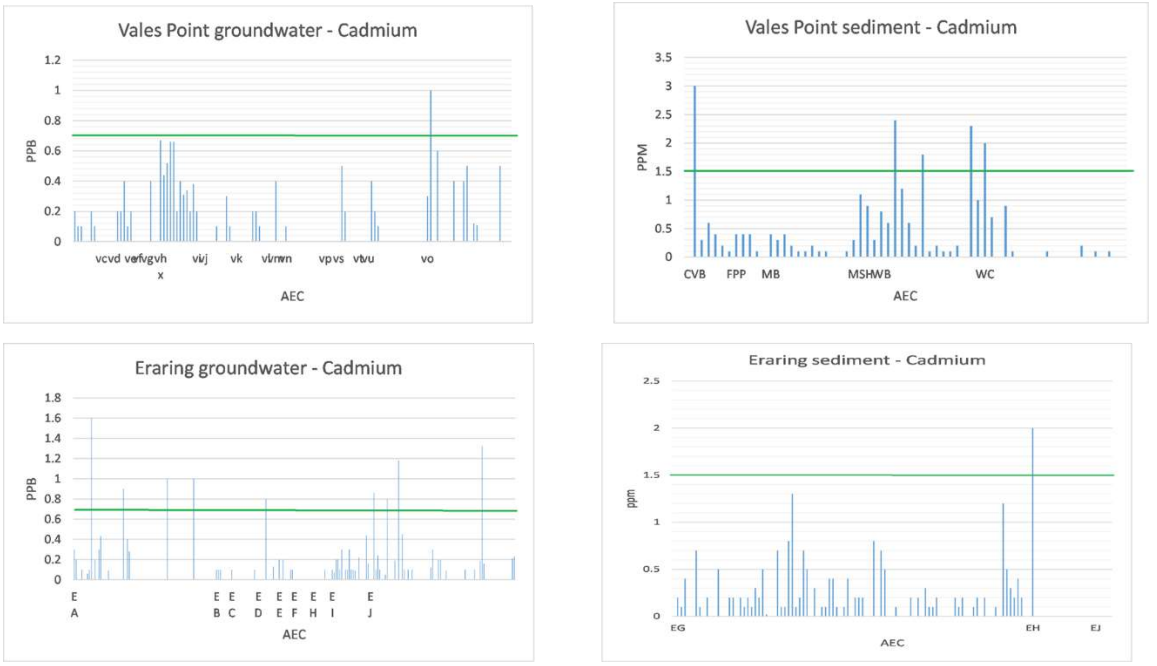


Figure 3: Cadmium in Vales Point and Eraring Power Station groundwater and nearby Lake Sediment.

Cadmium contamination of groundwater was evident at areas of environmental concern for both Eraring and Vales Point, with a number of exceedances of ANZECC marine waters guidelines. Sediment contamination was higher at Vales Point.

5.1.3 Chromium

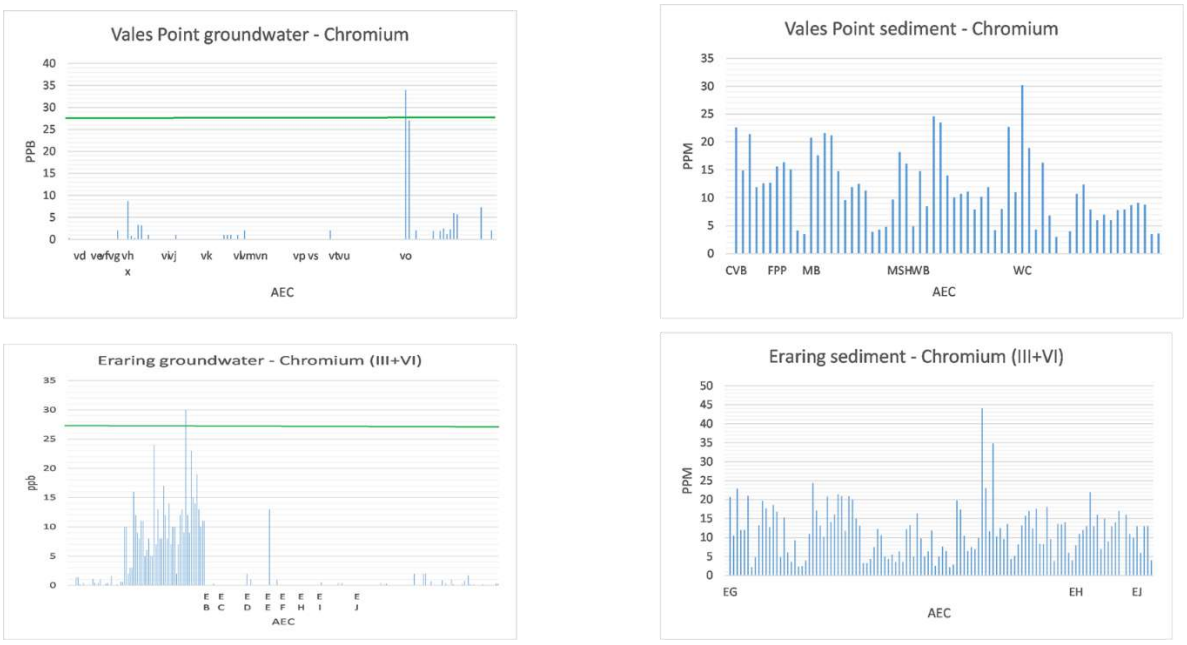


Figure 4: Chromium for Vales Point and Eraring Power Station groundwater and nearby Lake Sediment.

Fewer locations had exceedances of human health and environmental protection guidelines for chromium.

5.1.4 Copper

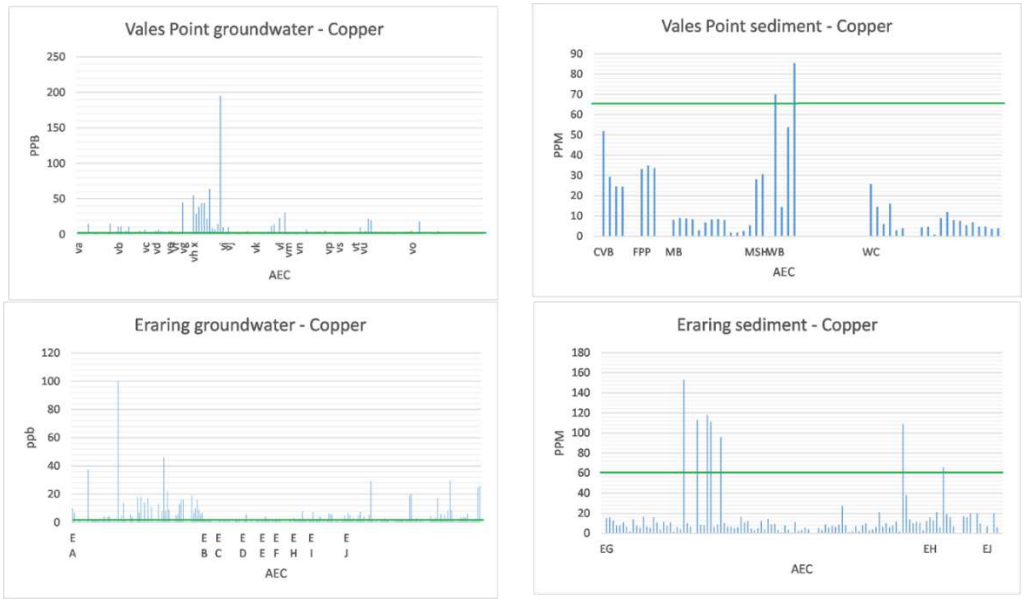


Figure 5: Copper for Vales Point and Eraring Power Station groundwater and nearby Lake Sediment.

Copper contamination was found to be very high at both power station sites in groundwater and Lake sediments at several locations.

5.1.5 Lead

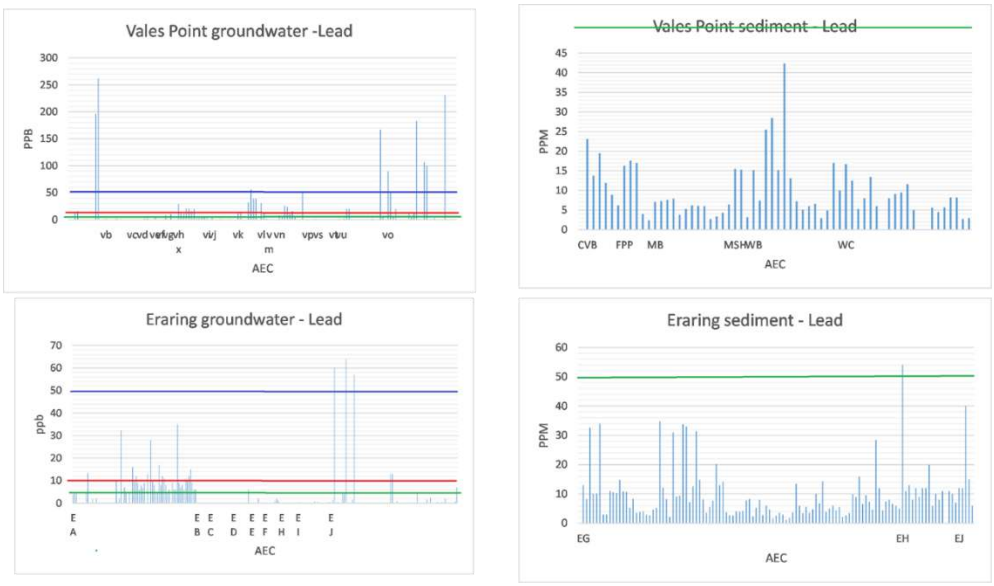


Figure 6: Lead for Vales Point and Eraring Power Station groundwater and nearby Lake Sediment.

Lead contamination was very sever at both power stations. With exceedances of recreational use water, drinking water, and environmental guidelines at several locations. However, only a single location exceeded the lead guideline in nearby Lake sediment at Eraring.

5.1.6 Mercury

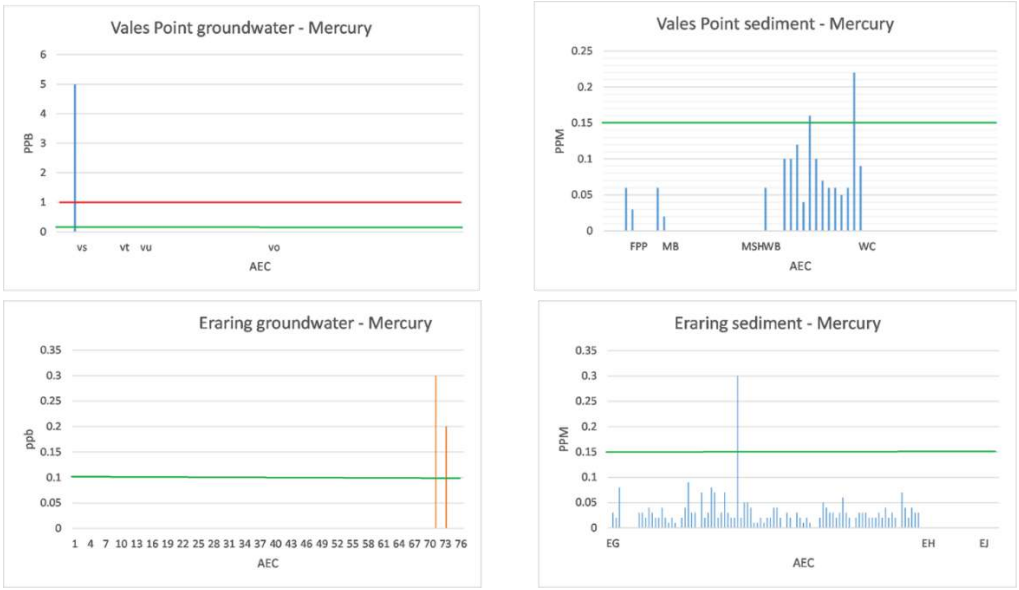


Figure 7: Mercury for Vales Point and Eraring Power Station groundwater and nearby Lake Sediment.

The lack of specific mercury air pollution technology employed at Australian power stations means that mercury concentrations in coal ash is relatively low, but a small number of exceedances of water quality guidelines were found in groundwater and nearby Lake sediment.

5.1.7 Nickel

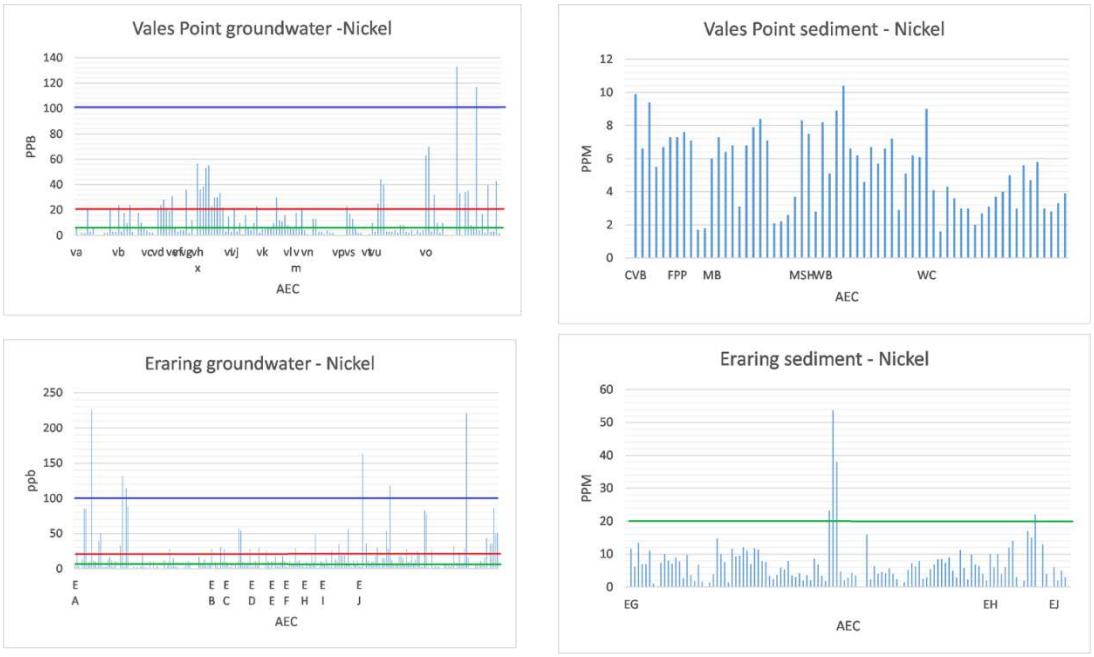


Figure 8: Nickel for Vales Point and Eraring Power Station groundwater and nearby Lake Sediment.

A number of locations recorded exceedances of NHMRC and ANZECC Recreational Use and environmental protection guidelines for nickel at both sites. Concentrations in nearby Lake sediment was higher at Eraring with a number of exceedances of ANZECC marine sediment guidelines.

5.1.8 Selenium

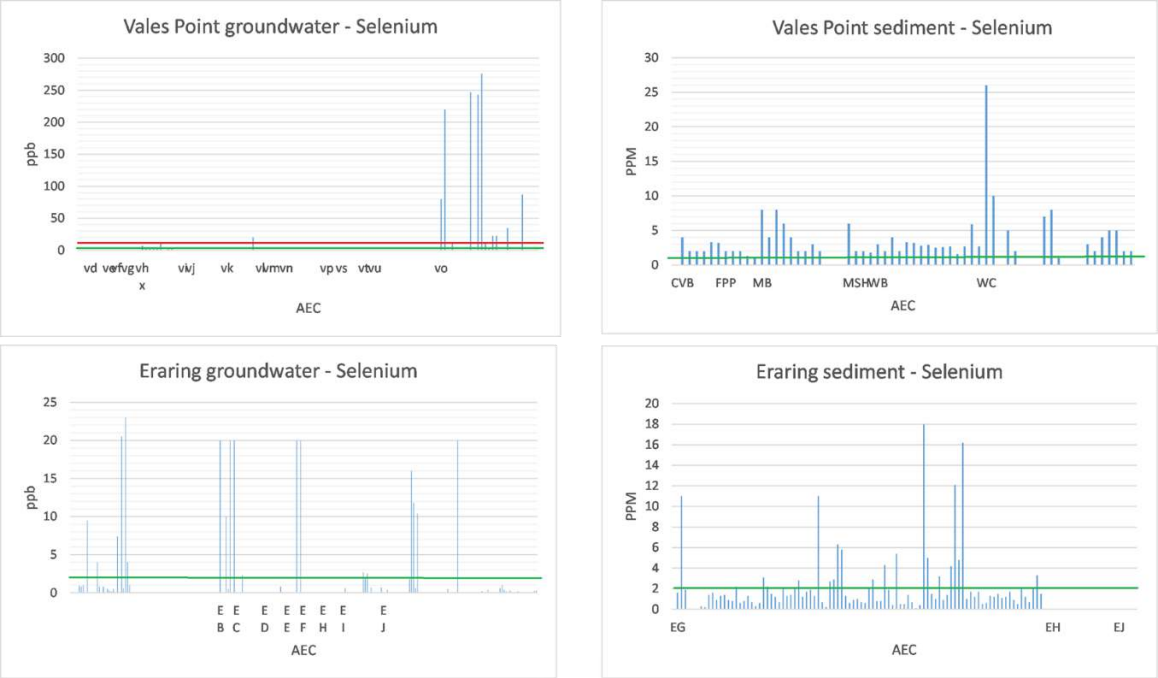


Figure 9: Selenium for Vales Point and Eraring Power Station groundwater and nearby Lake Sediment.

Selenium contamination of groundwater and Lake sediment was high and widespread at both sites. However, Vales Point groundwater selenium concentrations were an order of magnitude higher than Eraring, with numerous exceedances of NHMRC drinking water guidelines, ANZECC Recreational Use guidelines,[24]and recommended concentrations for the protection of the marine species, some by several orders of magnitude.

Selenium concentrations in nearby Lake sediment is also higher at Vales Point. However, both nearby Lake sediment concentrations show numerous exceedances of ANZECC guidelines, as does groundwater selenium at Eraring.

[24] The ANZECC (2000) guidelines set the same concentration (10 micrograms per litre) for selenium in waters used for recreation as the NHMRC drinking water guidelines.

5.1.9 Zinc

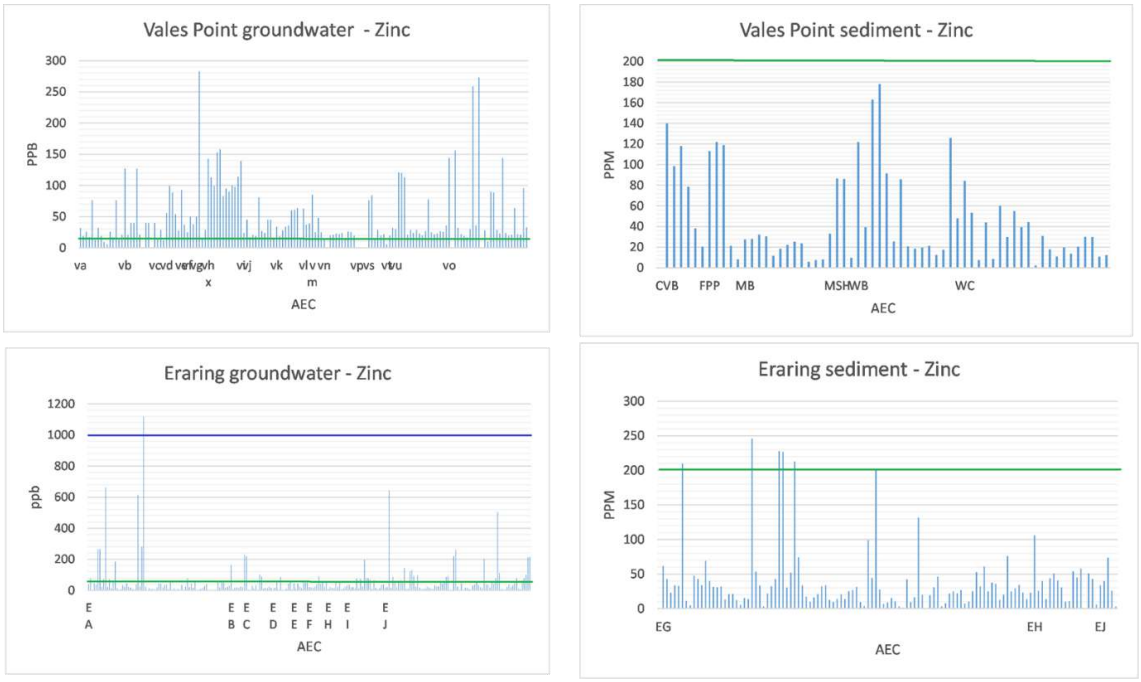


Figure 10: Zinc for Vales Point and Eraring Power Station groundwater and nearby Lake Sediment.

Zinc contamination of groundwater and Lake sediment was high at both sites with most locations recording zinc concentrations above ANZECC trigger value. One groundwater bore at Eraring's ash dam boundary exceeded ANZECC Recreational Use guideline. A number of samples of Lake sediments near to Eraring also exceeded ANZECC guidelines.

6. Review of Environmental Protection Licence Monitoring

The Vales Point EPL (EPL 761)[25] does not set any maximum concentrations for metals or metalloids in Lake discharge. The only monitored licensed discharge points for Vales Point are from LMP 1 (Cooling water outlet at Wyee Bay) and LMP 2 (Discharge from the ash water recycle system to the cooling water outlet canal). However, monitoring data from LMP 1 is not available from the operator's website.

Pollutants licenced to be disposed of in the Vales Point ash dam under EPL 761 include a number of contaminants that could affect the usefulness of the coal ash for reuse. Materials allowed to be disposed include, "Mill pyrites, residual detergents and oil sheens, sand, concrete products, boiler blowdown, minor chemical spill residues, chemicals for environmental control, ash dam water treatment plant residues, dust returned from the ash recovery plant, marine growth, debris, seaweed, chemical cleaning solutions, oil and chemically impacted soil, de-silting of settling basins, dredge spoil, waste wood, wood chips, dirty water drains, treatment plant discharges, coal handling plant stormwater, neutralised demineralisation effluent, polisher plant effluent, spent ion exchange resins, chlorine plant storage vessel precipitates, cable tunnel drainage, fabric filter bags, coal chitter and soil

[25] https://apps.epa.nsw.gov.au/prpoeoapp/ViewPOEOLicence.aspx?DOCID=162982&SYSUID=1&LICID=761

capping materials, coal mine dewatering discharges," and "Any other material approved in writing by the EPA."

This licence must be amended to stop the ash dam being used as a refuse tip and to impose strict limits on the concentrations of metals finding its way to Lake Macquarie.

The Eraring EPL (EPL 1429)[26] monitoring points are far more extensive than those for Vales Point and include a number of ambient water quality sites in Lake Macquarie. Monthly and quarterly data for these monitoring points are published on Origin Energy's website, including surface water monitoring points 1, 6, 10, and 17, and groundwater monitoring points 21, 22, 23, and 24 (in purple on Figure 12).

However, Origin Energy's Eraring EPL only sets discharge concentration limits at the cooling water outlet (LMP 1) which establishes maximum allowable concentrations for:

- copper (5 ppb),
- iron (300ppb),
- selenium (2ppb),
- temperature, and pH,

The copper concentration limit is considerably higher than ANZECC trigger value for these waters.

The siphon weir below the decant pond (LMP 10) is monitored for some heavy metals, but no limits are set. The overflow from the ash dam into Crooked Creek, which drains into Lake Macquarie and where high heavy metals were found by HCEC in water and sediment samples, is not even regularly monitored for heavy metals. LMP 2 at the top of Crooked Creek is monitored for pH and TSS, for which limits are set. However, this monitoring is not made public on Origin Energy's website.

As can be seen from surface water monitoring (see Figure 11 below) selenium concentrations from ash dam surface water has increased since 2013, particularly at Vales Point, which still uses ash slurry transport and mobilises far more metals than the drier dense phase transport employed at Eraring.

Both the EPLs for Vales Pont and Eraring state that, "Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the *Protection of the Environment Operations Act 1997*.[27]" Monitoring data reveals numerous exceedances of water quality guidelines for a number of metals and metalloids at both power stations (see charts of EPL groundwater monitoring below). As no maximum concentrations are set for any metals or metalloids caused to be discharged into Lake Macquarie from the Vales Point site, and the Eraring EPL does not set maximum concentrations for the metals leaching into the Lake from groundwater, it would appears that Sunset Power Pty Ltd International and Origin Energy Eraring Pty Ltd maybe in breach of the *POEO Act*.

The following charts set out the available results of Vales Point and Eraring quarterly EPL monitoring. Green horizontal lines represents ANZECC (2000) trigger values for slightly to moderately disturbed

[26] https://apps.epa.nsw.gov.au/prpoeoapp/ViewPOEOLicence.aspx?DOCID=108672&SYSUID=1&LICID=1429

[27] S120 Prohibition of pollution of waters (1) A person who pollutes any waters is guilty of an offence - "pollute" waters includes cause or permit any waters to be polluted.

marine ecosystems.[28] Red lines represents NMHRC drinking water guidelines. Blue horizontal lines represent ANZECC (2000) recreational use water quality guideline.

6.1 Surface water selenium

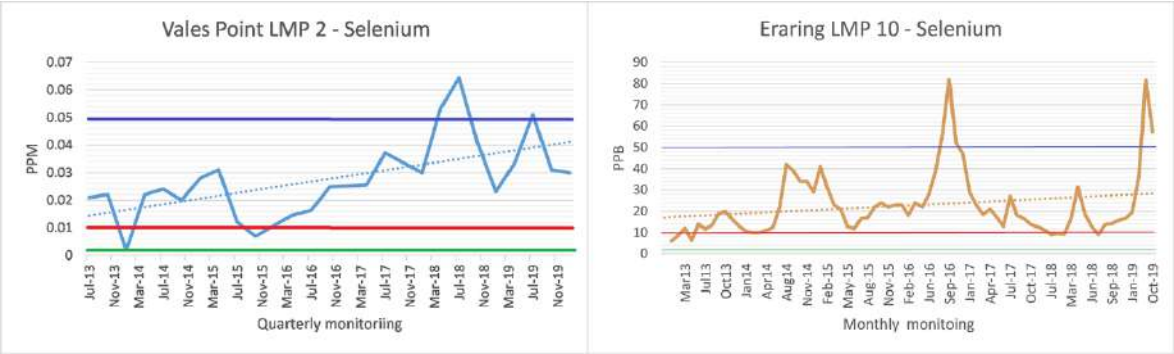


Figure 11: Selenium for Vales Point and Eraring Power Station surface water monitoring.[29]

Selenium concentrations at ash dam surface water monitoring points has been increasing at both sites. Pollution concentration at Vales Point LMP2, which discharges into the cooling water canal that drains into Wyee Bay, has increased markedly since 2013, spiking to 65 ppb. Eraring's LMP 10 shows a number of significant spikes to 80 ppb, well above the 2ppb concentration recommended for environmental protection.

6.2 Groundwater EPL monitoring

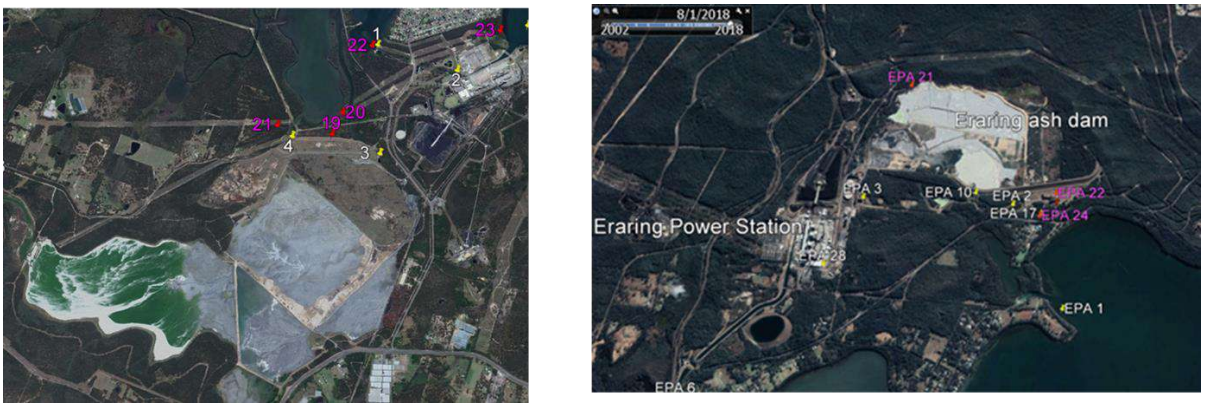


Figure 12: Groundwater monitoring wells for Vales Point and Eraring Power Station EPL.

A number of groundwater monitoring wells are in place at the Eraring and Vales Point sites – three at Eraring and five at Vales Point. These wells are monitored quarterly and the results published on the companies' web sites. However, data are often missing from both websites and the results for Vales Point are often expressed in the wrong units. These omissions and errors do not engender confidence that the operators are capable or indeed willing to abide by NSW laws in relation to pollution of Lake Macquarie.

[28] ANZECC (2000) and ANZECC (2013) do not include a trigger value or sediment guideline for selenium. Selenium green line represents recommendations in Lemly (2002) and British Columbia Ministry of Environment (2002).
[29] ANZECC (2000) and ANZECC (2013) do not include a trigger value or sediment guideline for selenium. Selenium green line represents recommendations in Lemly, 2002 and British Columbia Ministry of Environment (2002).

6.2.1 Arsenic

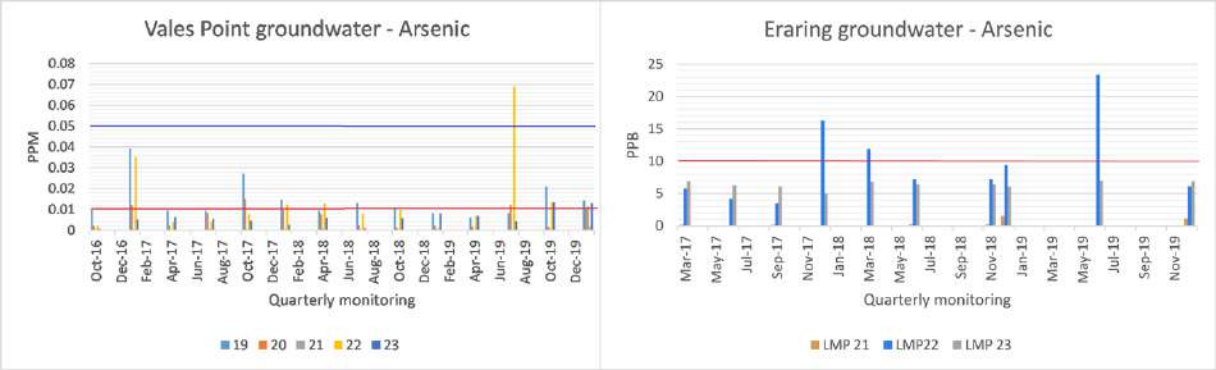


Figure 13: Arsenic results for EPL groundwater monitoring for Vales Point and Eraring Power Station.

Arsenic concentrations are consistently above NHMRC guidelines and Vales Point results show one exceedance of recreational use guidelines. There is no sign of improvement over time. If anything, arsenic concentrations have increased at some wells.

No apparent reductions in arsenic groundwater concentrations at either site is apparent since the ERM ESAs.

6.2.2 Cadmium

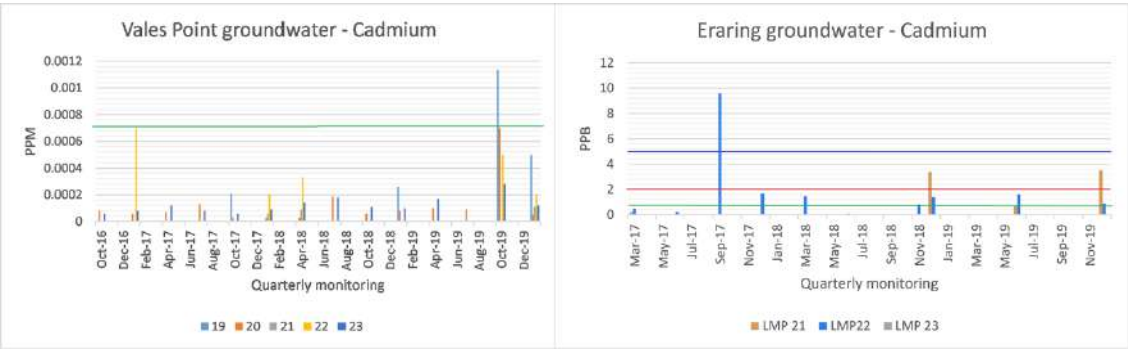


Figure 14: Cadmium results for EPL groundwater monitoring for Vales Point and Eraring Power Station.

Cadmium concentrations are significantly higher at Eraring. Cadmium does appear to have reduced at one well (LMP 22). However, an increase is apparent at LMP 21.
The most recent results for cadmium at Vales Point show a sharp increase in cadmium concentrations. Cadmium concentrations in Eraring's groundwater has substantially increased since ERM's ESA.

6.2.3 Chromium

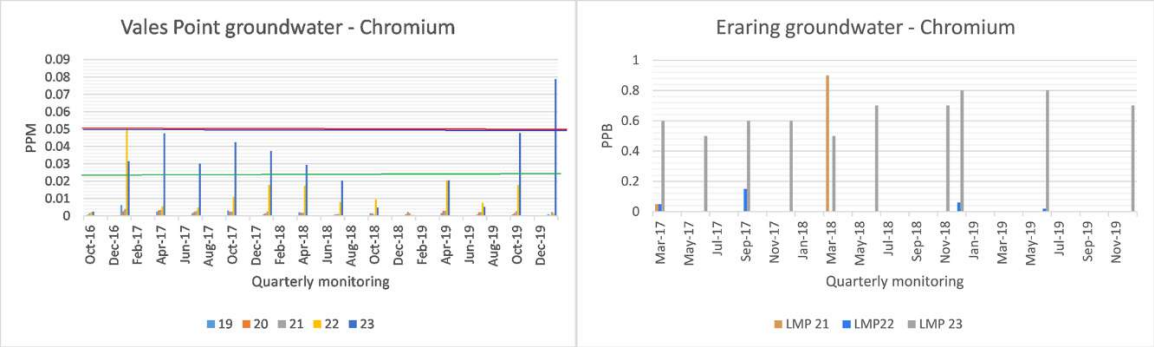


Figure 15: Chromium results for EPL groundwater monitoring for Vales Point and Eraring Power Station.

Chromium groundwater contamination is significantly worse at Vales Point. While no exceedances were found at Eraring, no reduction is apparent, and recent results at Vales Point show an increase.

Chromium concentrations groundwater appears to have improved at Eraring since ERM's ESA. However, Vales Point groundwater chromium appears to have increased significantly.

6.2.4 Copper

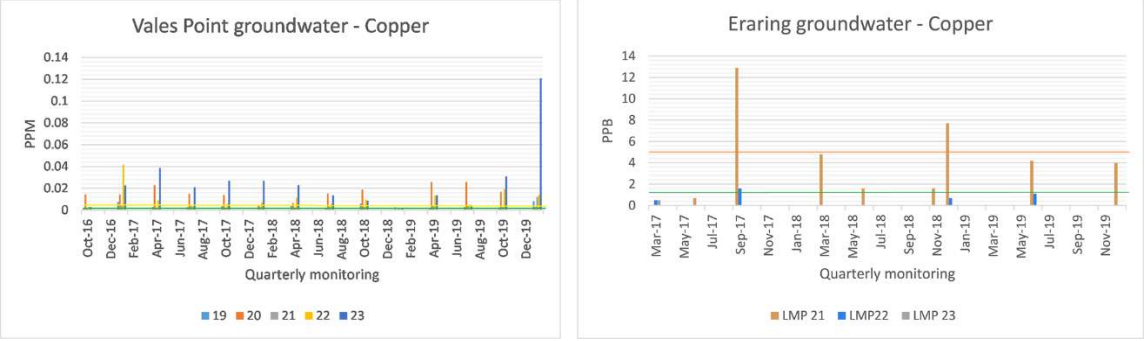


Figure 16: Copper results for EPL groundwater monitoring for Vales Point and Eraring Power Station.

Copper contamination of groundwater is much higher at Vales Point, where recent results show a substantial increase at LMP23.

The orange horizontal line for Eraring results represent the discharge limit for its EPL at the cooling water outlet. Eraring groundwater exceeded this limit twice over the period of data available on the company's website.

Some improvement in Eraring's copper groundwater concentrations is apparent since ERM's ESA. However, Vales Point groundwater shows no improvement.

6.2.5 Lead

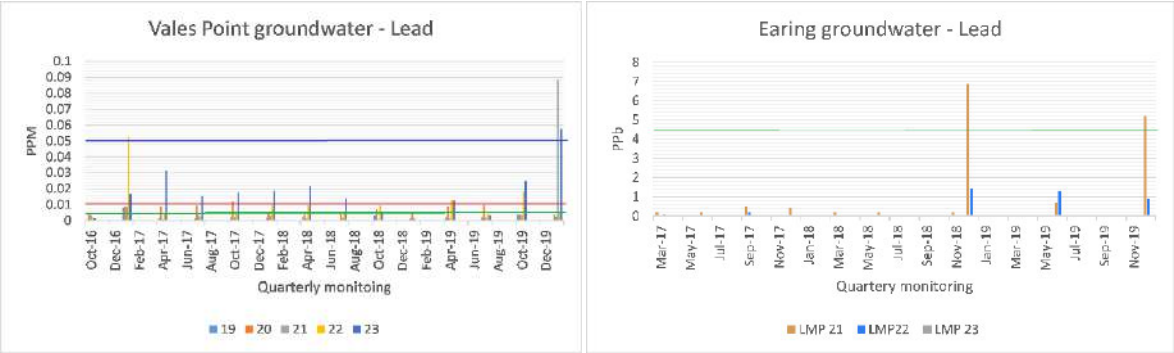


Figure 17: Lead results for EPL groundwater monitoring for Vales Point and Eraring Power Station.

Groundwater beneath the Vales Point site is heavily contaminated with lead, with a few exceedances of ANZECC Recreational water use guidelines, numerous exceedances of NHMRC drinking water guidelines, and levels consistently above ANZECC trigger values for slightly to moderately disturbed marine waters. The highest concentrations were found in the most recently available monitoring results of December 2019.

Lead concentrations in Eraring groundwater are much lower. However, exceedances of ANZECC trigger values are apparent recently, and lead concentrations spike above the ANZECC trigger value in the last monitoring results, and in December 2018.

Overall, lead concentrations has decreased at both sites since ERM's ESAs.

6.2.6 Manganese

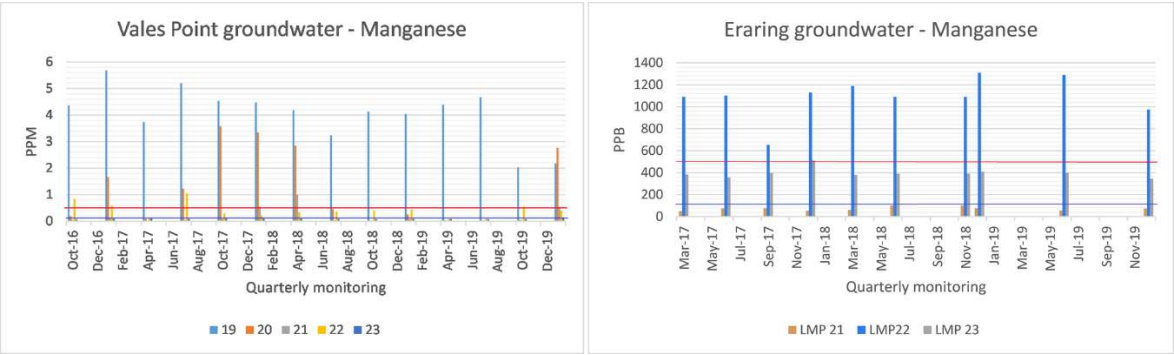
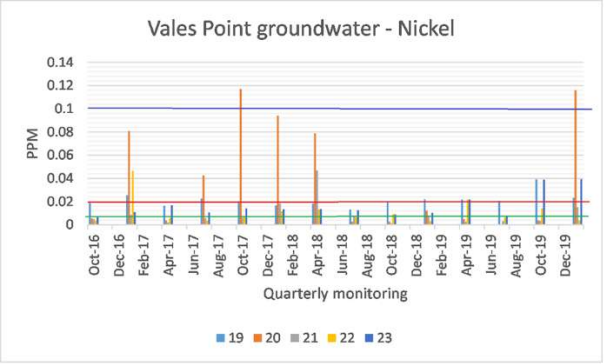


Figure 18: Manganese results for EPL groundwater monitoring for Vales Point and Eraring Power Station.

Manganese concentrations are very high at both power stations, with numerous exceedances of human health standard. Vales Point groundwater is significantly higher than Eraring. No apparent reductions at both sites.

6.2.7 Nickel



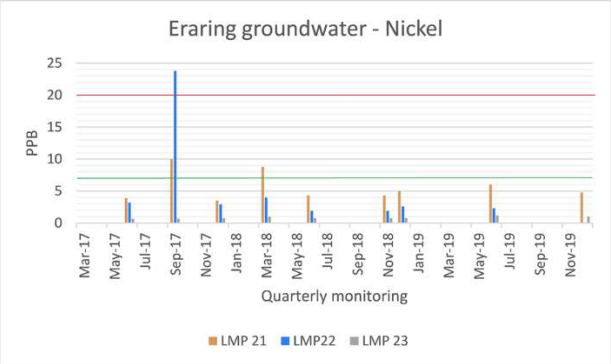
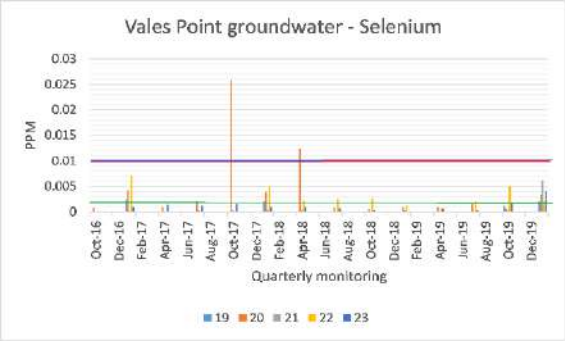


Figure 19: Nickel results for EPL groundwater monitoring for Vales Point and Eraring Power Station

Nickel concentrations in groundwater remains high at Vales Point with a numerous exceedances of human health and environmental guidelines. Nickel concentrations appear to have reduced at Eraring.

Nickel concentrations appears to have reduced at Eraring, but Vales Point groundwater shows no improvement since ERM's ESA.

6.2.8 Selenium



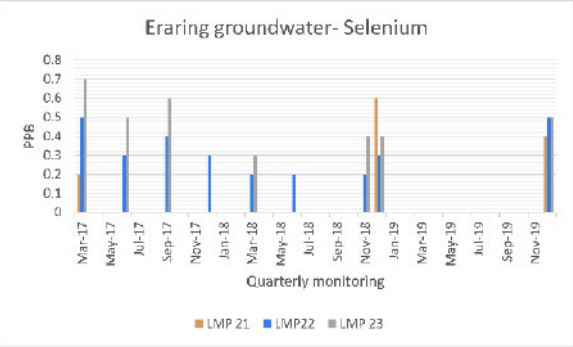


Figure 20: Selenium results for EPL groundwater monitoring for Vales Point and Eraring Power Station

Selenium concentrations in groundwater remains stubbornly high at Vales Point. Vales Point groundwater exceeded ANZECC Recreational Use guidelines and NHMRC drinking water guidelines twice in 2017/18 and is consistently above concentrations recommended for the protection of marine species. No reduction in selenium concentrations in Vales Point groundwater is apparent since the ERM ESA.

However, a marked improvement is apparent in concentrations of selenium in Eraring groundwater since ERM's ESA.

6.2.9 Zinc

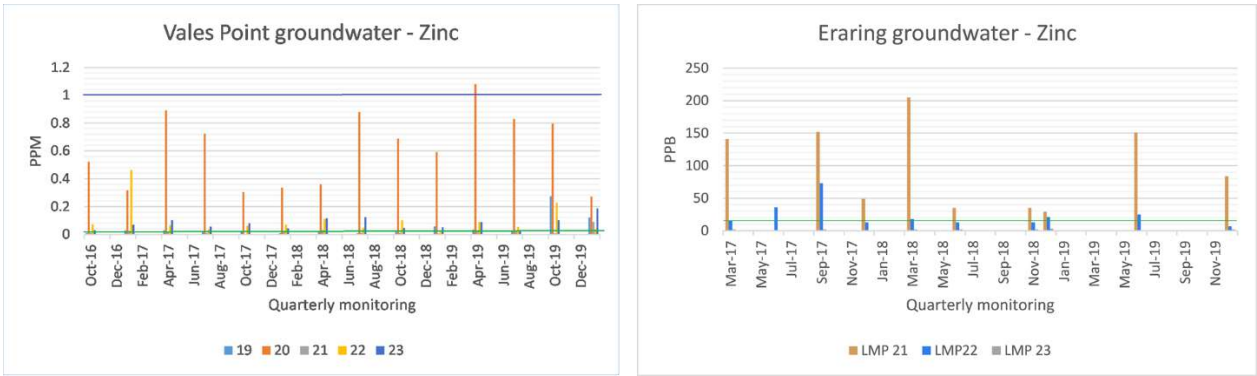


Figure 21: Zinc results for EPL groundwater monitoring for Vales Point and Eraring Power Station

Zinc concentrations in groundwater at both sites also remains stubbornly high, with Vales Point substantially worse than at Eraring. Wells at both sites consistently exceeded ANZECC (2000) trigger values. Vales Point groundwater exceeded human health standards in 2019.

Groundwater zinc concentrations have significantly increased at Vales Point, but have reduced at Eraring since ERM's ESAs

7. Lake Macquarie metal contamination and tidal influence

The release of heated cooling water and metals leaching from coal ash are problems that should never have been created in Lake Macquarie. Indeed, under modern environmental laws, it is unlikely that an ash dam would be built next to a Lake today. Due to the low tidal influence contamination in southern Lake Macquarie takes up to 500 days to be flushed out to sea. Therefore the metals leached into the lake from groundwater and surface water contamination are more able to drop out of solution and contaminate the sediments and then mobilised into the environment.

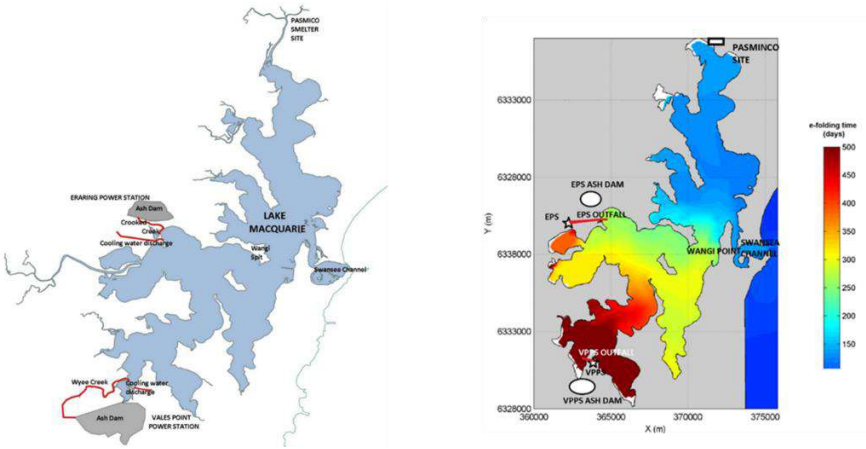


Figure 22: Contaminated sites and tidal influence in Lake Macquarie

8. Metals and metalloids in Lake Macquarie seafood

A 1996 NSW Health study found mean selenium concentration of the muscle of Lake Macquarie finfish was 1.2 ppm (dry weight).[30] Dalton and Bird (2003) conducted a risk assessment for consumption of fish species from Lake Macquarie based on sampling and analysis conducted in 1996.

Documents obtained by the HCEC from the NSW Office of Environment and Heritage (OEH) under freedom of information law suggest these concentrations have not changed markedly over the intervening 23 years.[31] In 2017, twelve species of fish and crustaceans were caught from Lake Macquarie as part of a NSW government study into PFAS and heavy metals in seafood.

Samples were analysed as 122 composite samples from 820 individual animals. Finfish muscle fillets with skin on, shelled prawns with heads removed, and claw muscle from crabs were analysed for metals and metalloids.

The dietary assessment by OEH, based on the laboratory analyses of the seafood, warns that consumption of Mud Crab and Blue Swimmer Crab from Lake Macquarie can result in exposure to cadmium, and the consumption of finfish can result in exposure to selenium, particularly among children

Based on calculations for exposure to selenium, the risk assessment warns that in one week children should not consume more than:

- 225 grams of Yellowfin Bream,
- 375 grams of Estuary Perch,
- 450 grams of Silver Trevally,
- 300 grams of Sand Whiting, or
- 300 grams of Giant Mud Crab.

In 2003, Dalton and Bird reported that the allowable intake of fish based on selenium concentrations was 1.35kg/week for an adult, which is consistent with the result of this risk assessment. However, the most recent NSW government study also warns that for cadmium, in one week, adults and children should not consume *any* Mud Crab, children should not consume *any* Blue Swimmer Crab, and no more than 150 grams of Eastern King Prawns, and adults should consume no more than 750 grams of Eastern King Prawns or 150 grams of Blue Swimmer Crab caught from Lake Macquarie.

The risk assessment also found mean zinc concentrations above the 90th percentile of the Generally Expected Level (GEL) for Luderick, Sand Whiting, and Tailor; concentrations of selenium and zinc exceeded the adopted criteria in Giant Mud Crab, and concentrations of copper in Eastern King Prawn were elevated.

Mud Crabs and Luderick had the highest mean concentrations of lead, with a Mud Crab and a Luderick sample from the area affected by Eraring power station (Zone 3) showing the highest concentrations

[30] Dalton & Bird, 2003
[31] OEH EPS Branch, 2019

The Australian food safety standard set a maximum of 0.5ppm for lead in fish, but does not include a maximum for crustaceans. The European Union sets a 0.3ppm safe maximum lead concentration in fish at and 0.5ppm in crustaceans.

Older organisms tend to contain the greatest body burdens of lead. In aquatic organisms, lead concentrations are usually highest in benthic organisms and algae, and lowest in upper trophic level predators (e.g., carnivorous fish).

Figures 23 below, set out the mean heavy metal concentrations of the species analysed by OEH.

Metals and metalloids found in Lake Macquarie seafood (Data from OEH EPS Branch, 2019)

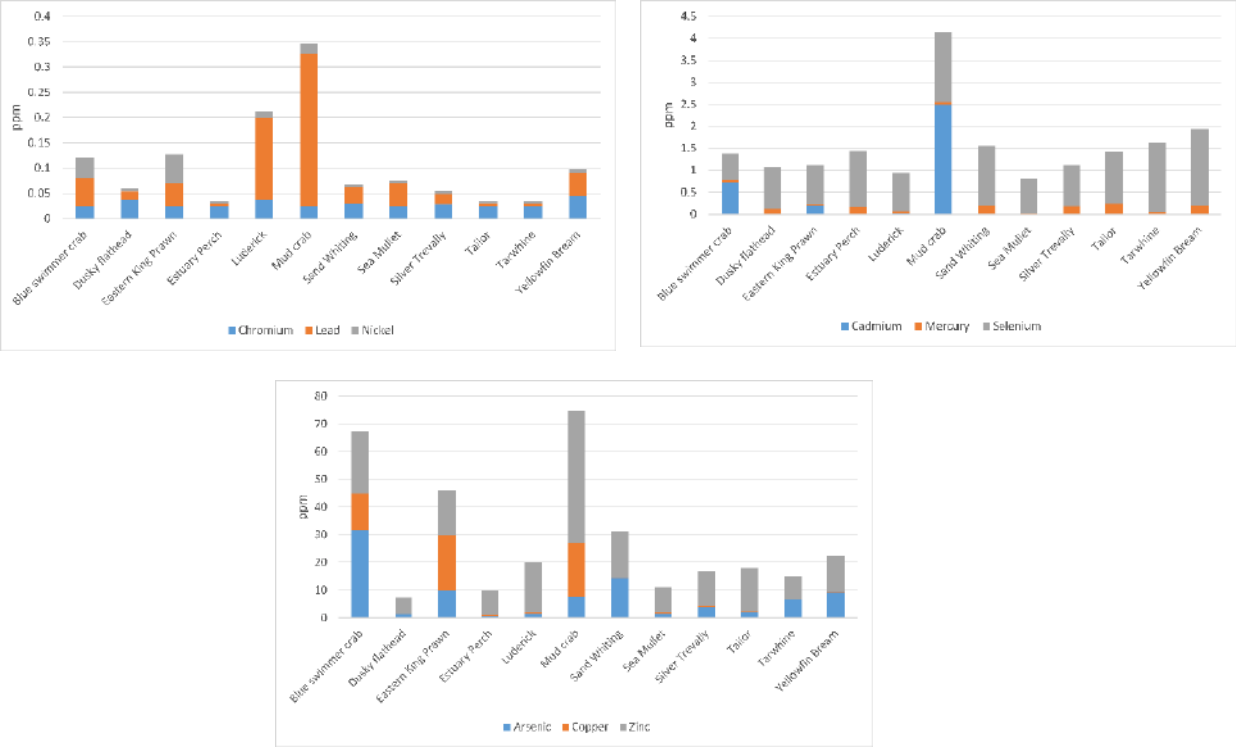


Figure 23: OEH 2018 assessment of metals and metalloids in Lake Macquarie seafood.

9. Metals in Lake Macquarie birds

As part of our investigation into southern Lake Macquarie contamination we have done a pilot study into metal contamination in birds. We found White-faced heron feathers gathered from Mannering Bay to contain high metal levels. Lead levels were 4mg/kg and these levels in bird feathers are associated with delayed parental and siblings recognition, impaired thermo-regulation, locomotion, depth perception, abnormal feeding behaviour and lowered nestling survival.[32] Lead is associated with breeding failure, decreased body weight and reproduction impairment in some egret and heron species.[33]

[32] Burger and Gochfield, 2000.
[33] Burger,1993; Hashmi et al., 2013.

The zinc threshold level for health impacts in birds is 1.2ppm.[34] The feathers tested from Mannering Bay were found to have 440ppm of zone. Zinc levels in these feathers is associated with passive regurgitation, lethargy, weakness, weight loss, anemia and a host of other impairments, and a number of other metals found will also have a profound impact on breeding success.

Acid Extractable metals in biomass		
Our Reference		235545-1
Your Reference	UNITS	1 White-Faced Heron feathers
Date Sampled		18/01/2020
Type of sample		Feathers
Date prepared	-	04/02/2020
Date analysed	-	04/02/2020
Silver	mg/kg	<1
Aluminium	mg/kg	280
Arsenic	mg/kg	<4
Boron	mg/kg	20
Cadmium	mg/kg	<0.4
Chromium	mg/kg	2
Copper	mg/kg	15
Iron	mg/kg	690
Lead	mg/kg	4
Manganese	mg/kg	14
Mercury	mg/kg	0.4
Nickel	mg/kg	2
Selenium	mg/kg	<4
Thallium	mg/kg	<2
Vanadium	mg/kg	2
Zinc	mg/kg	440

Figure 24: Envirolab laboratory analysis of White faced heron feather and where they were found.

We are yet to undertake a larger study to confirm our findings, but these early results suggest that not only will the metals in the Lake impact on marine organism breeding success, but also birds.

10. Mannering Bay sediment core sample

A high proportion of the metals and metalloids in southern Lake Macquarie sediment affecting our fish and birds originates from the ash dams of the two coal fired power stations and a number of coal mines supplying the power stations. It is unlikely that former Pasminco smelter at Cockle Creek in the north of the Lake has contributed, given its distance to the north, the prevailing Lake currents and tidal influences, and the influence of Wangi Wangi Point which effectively divides the Lake in two.

To identify the contribution to the sediment contamination Vales Point ash dam makes, we had ANSTO date a sediment core that we took from Mannering Bay to understand sediment contamination over time. The dating identified a time series of metal concentrations from 1930 to 2019.

[34] Gasaway and Buss, 1972

Vales Point ash dam was built in 1962. The time series shows that at that time, marked with a black vertical line in Figure 21 below, metal contamination in Mannering Bay sediment took off and continued to increase.

While there have been a number of attempts to retrofit new technology and processes to slow the contamination, which has seen reductions in sediment concentrations for a number of metals, cadmium and selenium concentrations remain above recommended ecosystem protection levels, shown as a green horizontal line, and some metal concentrations, such as copper, continue to increase.

The only sure way of stopping the ongoing contamination of the Lake Macquarie ecosystems is to remove the ash.

Figure 25: Mannering Bay sediment metal/metalloid concentrations 1930 to 2019. Black line indicates commissioning of Vales Point A.

11. Coal ash utilisation

A rapid increase in coal ash utilisation is necessary to reduce the massive volumes of coal ash generated and stockpiled. Australia has so far dismally failed to reuse and manage coal ash. While rates of economically-beneficial coal ash utilisation in Australia have been rising, it still remains at about 20 percent of what is generated.[35]

In other parts of the world, coal ash reuse is perused more vigorously. For example between 1995 and 2011 Japan increased its utilisation of coal ash from 67 percent to 97 percent, a period when coal ash

[35] ADAA, 2015

generation almost doubled. Of the 97 percent utilisation by Japan in 2011, 67.3 percent was for cement/concrete, 14.3 percent for ground material and 3.2 percent for architectural material.[36]

It is estimated that about 12.3 Mt of coal ash was generated in Australia in 2016, of which 9.4 Mt was dumped in on-site ash dams.[37]

Only 1.8 Mt was used in high value-added applications such as cement and concrete. A further 0.48 Mt was used as flowable fills, structural fills, road bases, aggregates and mine site remediation and 2.3 Mt was used as low value land fill, mine backfilling and local haul roads[38] which generated little or no economic return and risks contaminating surrounding waterways with heavy metals. Indeed, many of these low value uses present significant human health and environmental risk.

More than 400 Mt of coal ash is sitting in unlined ash dumps around Australia.[39] These poorly designed- and -run unlicenced hazardous waste containment facilities are aging, increasing the risk of off-site contamination. Indeed, it is likely that all are causing some level of pollution. With the right incentives and appropriate regulation and oversight, this massive volume of hazardous waste could be beneficially re-used, alleviating pollution, assisting with ash dam rehabilitation, and providing transition opportunities for affected power station employees when they eventually close.[40]

Incentivising safe coal ash reuse also requires government intervention to alleviate some of the blockages currently being experienced. For example, power stations charge a royalty fee for coal ash. We understand from industry insiders that no power station in Australia directly subsidises the cost of providing ash to third parties to increase its rate of external use. Some operators are prepared to waive their royalty rights to encourage particular projects, but this is normally done on an ad hoc basis.

Royalties are normally paid by an ash marketing company to a power station operator to protect the market, and prevent an operator providing ash to any other party. These arrangements perpetuate the situation that only the highest value applications are pursued, in order to achieve a commercial return to the ash marketer in selling a product with a high enough return to cover all of its costs, primarily transport and processing costs.[41]

11.1 Light weigh aggregates

Sintered ash lightweight aggregate, more commonly known as Lytag® is made by pelletising fly ash.[42] Lytag aggregates can be manufactured to a variety of grades from sand to course aggregates. Lytag is primarily used in structural lightweight concrete which reduces the quantities of construction material, reduces vehicle movements and leads to significant overall cost savings. Lytag is also suitable for use in precast concrete products, fill, screed and drainage application.

[36] Kenichi et al, 2015
[37] ADAA, 2016
[38] ADAA, 2016
[39] Heidrich & Heeley, 2014
[40] Beyond Zero Emissions, 2017
[41] Worley Parsons, 2010a
[42] Lytag, 2017

By adding a controlled amount of water to coal ash in specially designed dish pelletising pans, rounded pellets are formed. The pellets are then heated on a sinter strand to a temperature of 1100°C. In such a way the heavy metals are encapsulated and cannot leach out. The result is a hard, honeycombed structure of interconnecting voids within the aggregate. The particles formed are rounded in shape and generally range in size from 14mm down to fines; these are processed to the required grading, depending on the final use.

Lytag structural concrete has a compressive strengths in excess of 60 MPa with an effective reduction in dead load of approximately 25% over normal weight concrete. The reductions in concrete density allows reduced foundation sizes, additional floors to be constructed, and thinner section beams and columns used. Lightweight aggregate can be used in precast units with an associated reduction in handling and transportation costs. As well as weight reductions, Lytag® also imparts improved durability benefits to concrete, improves thermal insulation, and reduces the quantity of cement required in construction.

Widely used as a structural fill to raise existing surfaces to achieve new falls or to construct ramps, provide a deep screed within which services may be buried, infill between items such as bridge beams to provide a level surface for the structural deck, formation of architectural features, infill for raised access flooring and permeable back fill for retaining walls, bridge abutments etc. Lytag is also used in filter media, vehicle arrestor beds, horticultural, sports areas, floor and roof screeds.

Lytag aggregate can be expected to sell at a price two to three times that of normal aggregates and is suited to Australian fly ashes with a Loss of Ignition (LOI – a test for unburnt carbon content) of fly ash of approximately 6% needed for fusion. Vales Point coal ash has an LOI above this. Eraring coal ash can be added to those of Vales Point to meet the required carbon content. For lower LOI ashes, such as for Eraring's ash, waste coal washery fines can be added to increase the carbon content.

Figure 26: Lytag plant at Drax Power Station, North Yorkshire, England

In the 1990s, Pacific Power and Fly Ash Australia carried out a major investigation into the Lytag process with a small lab-scale manufacturing plant set up at Eraring. Eraring fly ash was used and mixed with coal washery waste to achieve a LOI of 6%. A full design and costing of the plant was carried out for a 500,000 tonne pa plant. Fly ash aggregates were also made at the CSIRO facility at North Ryde with satisfactory test concretes made with the finished material. Unfortunately, with the privatisation and split up of the NSW power stations work did not proceed. Had the proposal gone ahead, together with the existing concrete market, most generated Eraring fly ash would have been utilised, alleviating the need to expand the ash dam, and the additional heavy metal load this additional ash is contributing to Lake Macquarie.

HCEC believes about 500,000 tonnes of Lytag (from the same amount of Lake Macquarie coal ash) could be sold into the high value lightweight concrete markets of Sydney, Newcastle, and Wollongong each year. With rail loups already in place at both Earring and Vales Point transport costs and truck movement could be significantly minimised.

12. Conclusion

Over 60 million tonnes of coal ash is stored in these two ash dams, about 26 million tonnes at Vales Point Ash Dam and 35 million tonnes at Eraring. An additional 1.9 million tonnes is produced each year. The ash dams of both power station are at or near their capacity and ash reuse rates are only 25 percent at Vales Point and 29 percent at Eraring, with little effort being made to increase reuse.

The power stations themselves are both near to the end of their designed lives. Origin Energy is committed to decommission Eraring by 2032 and the current plan to expand the ash dam capacity will only provide for ash storage to 2024 at the current ash production and re-use rates.

Delta Electricity has indicated a desire to maintain Vales Point for a further 30 years beyond its 2029 decommissioning date and has been shortlisted for a Federal Government subsidy to keep it open.

The Lake Macquarie community need to know when these highly polluting facilities will close and when decontamination of Lake Macquarie can begin. Concentrations of a number of heavy metals in surface water, groundwater and nearby Lake sediment reinforce the very substantial contribution the power station ash dams have and continue to make to the dangerous metal concentrations in the Lake's ecosystems, including commonly caught fish and crustacea. HCEC also believes heavy metals leached from coal ash has found its way into wading birds and may be affecting health and breeding success.

Metal and metalloid pollution in groundwater of the Eraring and Vales Point sites has been shown to be significant, with Environmental Protection Licence groundwater monitoring showing consistent exceedances of water quality guidelines. Sampling of nearby Lake sediments exceeds ANZECC sediment guidelines and a dated a sediment core from near to Vales Point substantiates that increases in the concentrations of a number of metals and metalloids have occurred since the ash dam was built.

While there have been reductions in groundwater concentrations of lead in groundwater at both power stations, and chromium, copper, nickel, selenium, and zinc have been reduced at Eraring, concentrations of cadmium in Eraring groundwater has substantially increased since ERM's ESA.

Groundwater concentrations of all metals and metalloids monitored under the Vales Point EPL, with the exception of lead, have either not improved or have substantially increased since ERM's ESA, particularly chromium and zinc.

Arguments over who or what is to blame for the high concentrations of metals and metalloids in Lake Macquarie sediment is moot. There is no doubt that the two Lake Macquarie power stations are substantially contributing to those concentrations and a significant effort by the EPA, the power station owners and the NSW Government is required to begin the process of decontamination.

Much stricter licence conditions are required, particularly for Vales Point, to bring down the concentrations of metals in ground and surface waters, and a sensible plan is required to remove the coal ash from the dams. Capping the ash dams with hard fill will not substantially reduce metals from leaching into groundwater and thereby being introduced into Lake Macquarie, as the moisture in the ash, coupled with the Acid Sulfate Soil conditions identified at both sites by ERM, means that leeching of metals and metalloids into groundwater will continue while ever coal ash remains at these sites.

The discharge of heavy metals from ash dams has been linked to a number of lethal and sub-lethal effects on fish and bird species, including reduced growth and reproductive success. Given the risk these ash dams pose and the damage they have inflicted on Lake Macquarie, HCEC recommends a comprehensive decontamination of both power station sites.

As the State of NSW is liable for the vast majority of the decontaminating and decommissioning of the Lake Macquarie ash dams, the public interest demands a higher standard of rehabilitation. Indeed, as the sale of the NSW coal-fired electricity generation assets totaled over $2.6 billion the government is in no position to shirk its responsibility to comprehensively decontaminate the sites.

The HCEC recommends the NSW Government look for suitable safe end uses for the ash, such as high volume sintered ash products, and companies who wish to profit from its utilisation and provide incentives and assistance in order for the ash to be removed over time. From discussions with companies interested in such uses, we believe it may take decades for the coal ash on Lake Macquarie's shores to ultimately be removed. But with the right policy frameworks work could start, providing new jobs and economic stimulus to Lake Macquarie, and one day a safe, healthy, and diverse Lake.

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