

PCU56769

Our reference:
DOC14/257524;
EF13/3625 and
EF13/3933.

Department of Planning
Received
6 NOV 2014
Scanning Room

Mr Howard Reed
Manager Mining Projects
Department of Planning and Environment
GPO Box 39
SYDNEY NSW 2001

Attention: Margaret Kirton

4 November 2014

Dear Ms Kirton

I refer to your email of 9 October 2014 and the attached links to the Department of Planning and Environment's (DPE) website exhibiting the Response to Submissions (the "Response") by Centennial Coal for the Springvale Mine Extension Project (State Significant Development 5594) and the Angus Place Mine Extension Project (State Significant Development 5602).

The DPE has invited the Environment Protection Authority (EPA) to provide advice by 31 October 2014 whether the Responses adequately address the issues raised by the EPA in its response dated 3 June 2014 to the Environmental Impact Statements (EIS) for both of these Projects.

Previous EPA Advice

In its letter of 3 June 2014 the EPA stated its position as:

"The EPA is unable to support the Springvale and Angus Place expansions in their current form given the absence of any commitment in the EISs to address the handling/treatment of the mine water, in either the short or long term.

It is important to the EPA that any approval by the Department, if granted, aligns with the ongoing programs of the EPA. The EPA recommends that treatment to significantly reduce the salt and contaminant levels of this mine water, or achieve beneficial re-use (or a combination of both) by a set date should be a condition of consent if the extension projects are approved."

Current EPA Advice on the Responses

From the recent media (28-29 October 2014) the EPA knows that Angus Place Colliery is now mothballed, potentially until 2023, as part of a company restructuring in light of the prolonged downturn in international coal markets. Nevertheless, given this late change and without further advice provided by Centennial Coal ('the proponent'), the EPA has been left with little alternative but to continue to fulfil its role and responsibilities to review the Responses, as requested by DPE. It is acknowledged that the announcement last week by the proponent introduces a level of uncertainty about the role Angus Place Mine will, or conversely will not, play in the Water Management Strategies the proponent may seek to implement.

The EPA, without the benefit of being able to exclude the Angus Place Extension project (because of the obvious linkages with Springvale in the two planning documents), the EPA has no alternative but to object to the approach proposed by the proponent in its Response to handling its mine water (which is to continue to discharge it without any further treatment beyond flocculation). As such the proponent's Responses has not satisfied the EPA, and the EPA's position, as stated above, remains current.

The proponent has provided a considerable amount of information in its Responses. In order to review all this information, the EPA has engaged the specialist services of the Office of Environment and Heritage's (OEH) Water and Science Branch and Environmental Forensics, Ecotoxicology; and, its Water Technical Advisory Unit to provide detailed, specific advice. This advice is provided the following Attachments One to Three. In Attachment Four is additional advice from the EPA, including a recommendation for DPE's consideration now that the Angus Place Mine has been mothballed.

In objecting to the approach taken by the proponent and maintaining its position, the EPA wishes to summarise the attached advice as follows:

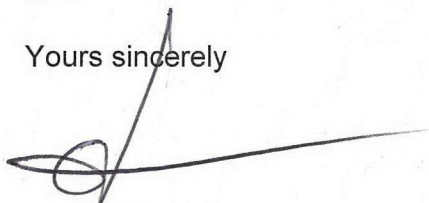
- In its Responses the proponent's approach has been to regard salt, expressed as Electrical Conductivity in micro-Siemens per Centimetre ($\mu\text{S}/\text{cm EC}$), as being a pollutant of no particular significance in the upper Cocks River. This is not the case. Refer to Attachment One.
- In its Responses the proponent's application of the Site Specific Trigger Values using the Australian and New Zealand Environment Conservation Council 2000 Guidelines (ANZECC) is flawed. Refer to Attachments One, Two and Three.
- In its Responses the proponent indicates it remains committed to addressing the toxicity characteristics of the mine water discharge from Licensed Discharge Point 9 (LDP9) from Springvale Colliery. The EPA agrees that Centennial needs to find the reason for this toxicity and prepare to eliminate it. Refer to Attachments One and Two.
- The EPA has previously raised the need for the proponent to address the salinity of the discharge authorised by Environment Protection Licence (EPL 3607) for Springvale Colliery and the EPA's current position is a continuation of a regulatory effort to reduce the salinity concentrations of the upper Cocks River. The EPA considers the current limits on LDP9 to be interim until a change in management of the mine water (handling, treatment etc) is implemented. Refer to Attachment 4A.
- In its Responses the proponent's *Cocks River Catchment Restoration Program* outlines a variety of measures to improve the catchment riparian zone and landscape; however, none relate to a stated goal of improving water quality. Refer to Attachment 4B.
- The EPA recommends, now that Angus Place has been mothballed indefinitely, that the proponent considers implementing a previously proposed option of storing mine water within the old Angus

Place workings, but this time with Springvale mine water (thus eliminating the need to discharge the full volume of mine water). Refer to Attachment 4C.

The EPA awaits further advice from DPE, now that it appears the Angus Place Mine Extension Project will not be part of the proponent's original plans. The EPA understands that the Department of Planning and Environment (DPE) intends referring the Project(s) to a Planning and Assessment Commission (PAC).

Should you have any questions please contact me at the EPA's Central West Regional Office on 63 327 601.

Yours sincerely

A handwritten signature in dark ink, appearing to be 'Richard Whyte', with a long horizontal stroke extending to the right.

RICHARD WHYTE
Manager Central West
Environment Protection Authority

Attachments:

1. One – Review of Springvale and Angus Place Mine Extension EISs – Response to Submissions (OEH).
2. Two – Comments on Appendix 9 and 10 (OEH Environmental Forensics).
3. Three – Water Technical Advisory Unit (WTAU) comments on the Response to Submissions Appendix 3.
4. Four – EPA Comments on the Response to submissions for the Springvale and Angus Place Mine Extension Projects.

ATTACHMENT ONE (DOC14/257524-01) - Review of Springvale and Angus Place Mine Extension EIS's Response to Submissions

Centennial Coal is seeking a new development consent under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for two major expansions: the Springvale and Angus Place Mine Projects. A request from EPA (Richard Whyte) to review the proponent's Response to Submissions (RTS) was received by Science Division (Martin Krogh).

Regional Water Quality Assessment

Appendix 2 (RPS 2014) of the Response to Submissions (RTS) considers the issue of water quality and water quantity in the Coxs River affected by the proposed mine expansions at Angus Place and Springvale. The report stated that a rainfall-runoff (AWBM) model was constructed "*with view to be integrated with detailed site water balances prepared by GHD Pty Ltd, RPS and others at a later stage and to serve as a platform for water management by Centennial in the Coxs River catchment.*" It further claimed that "*The model was calibrated based on observed flow and salinity data within the Coxs River catchment during the period 1 January 1979 to 30 June 2014.*"

For both the Angus Place and Springvale reports the conclusions were:

- *Modelling indicates that predicted salinity in the Coxs River between Lake Wallace and Lake Lyell will be elevated compared to the null condition, however, is well below historical observation.*
- *Predicted salinity under the proposed water strategy is a median of 552mg/L compared to a median of 231mg/L in the null case, at the location, compared to historical average salinity of ~800mg/L. For the purpose of reference, the 95% ANZECC default trigger value for the protection of aquatic ecosystems is 235mg/L (assuming a 0.67 conversion factor on salinity, as Electrical Conductivity, of 350µS/cm).*

It is noted that these general conclusions do not appropriately address the areas directly affected by the LDP discharges. One of the simplest comparisons that can be made to verify the statements and conclusions in the RTS is the concordance between model predictions (suggested to have been appropriately calibrated) and the observed flows and quality at the two NOW gauges in the Upper Coxs River catchment (212054 Coxs River u/s Wallerawang and 212055 Neubecks Ck). If this is done, it is clear that the model under-predicts median flow at the NOW gauge 212054 (Node #047 in AWBM model; RPS 2014) and considerably over-predicts conductivity at the NOW gauge 212054 when compared to the observed measurements by NOW (See Table 1). Median flows at 212054 are underestimated by approximately 22% and median conductivities are overestimated by approximately 45%. There is no discussion in the RTS reports of these major discrepancies between prediction and reality. There is also no appropriate discussion of the fact that current and historic flows and conductivity levels at gauge 212054 are partially composed of upstream discharge waters (i.e. Springvale LDP009 & LDP0010, Angus Place LDP001 & LDP002 and Lamberts Gully LDP006 discharges).

	Observed NOW Gauge 212054	Modelled #047	% Error ¹
Median Flow (ML/day)	13.3	10.3	-22.56
Median Conductivity ($\mu\text{S}/\text{cm}$)	615.9	894.03	45.16

Table 1. Median flow for NOW 212054 gauge for period 18/1/1992 to 30/6/2014; Median Conductivity for NOW gauge for period 2/4/1992 to 30/6/2014; Median modelled flow from RPS (2014) Table 3.14 (#047 Coss River upstream Lake Wallace NUL 50%ile value=10.3 ML/day); Median modelled flow from RPS (2014) Table 3.15 (#047 Coss River upstream Lake Wallace NUL 50%ile value=599 mg/L; value converted² from mg/L to $\mu\text{S}/\text{cm}$).

It appears that the actual **daily flows** from LDP009, LDP001 and others may not have been appropriately utilised in the modelling. From May 2012 to March 2013 average flows³ from Angus Place LDP001 ranged between 2837 to 6796 kL/day (2.8 to 6.8 ML/day; Centennial Monitoring Data). This represents approximately 10-40% of average flows in between the two NOW gauges (212054 and 212055)⁴ for these periods (ignoring evaporative losses).

From March 2013 to September 2014 average flows⁵ from Angus Place LDP001⁶ ranged between 9.63 to 1432 kL/day (0.009 to 1.4 ML/day; Centennial Monitoring Data). This represented approximately 0.03 to 5% of average flows in between the two NOW gauges (212054 and 212055) for these periods (ignoring evaporative losses).

As identified in earlier comments, extremely limited information was available for the actual LDP009 discharge⁷ in both the EIS and RTS. It is clearly the responsibility of the proponent to provide the information upon which major Government decisions need to be made and the EIS and RTS are considered deficient in this regard⁸. GHD (2014) identify flows from LDP009 of about 22 ML/day on 21 August 2014 and 22 August 2014. RPS (2014; Springvale Colliery LDP009 SSTV Assessment) stated that “*Median discharge from LDP009: 19.95 ML/d (actual data December 2012 to July 2013).*” If the limited flow information reported by GHD (2014) and RPS (2014) are used, then the LDP009 discharges potentially represented 54% of the difference in average flow in between the two NOW gauges on those periods reported (ignoring evaporative losses).

It is therefore not surprising that there is very little dilution being achieved for the LDP009 discharge either downstream in Sawyers Swamp Creek or once it joins the Coss River. This conclusion is further supported by the data collected by GHD (2014) in their ecotoxicology

¹ [(modelled-observed)/observed]

² Assumed conversion factor is $\text{EC } (\mu\text{S}/\text{cm}) \times 0.67 = \text{TDS } (\text{mg}/\text{L})$ as per Springvale EIS.

³ Maximum flows ranged between 3523 and 8332 kL/day (Centennial Monitoring Data).

⁴ The difference between flows at 212055 and 212054 was calculated and this difference presumably reflects catchment and LDP inputs inbetween the two NOW gauges, ignoring evaporative loss effects and any movement of surface flows to groundwater. GHD (2013) have previously suggested that Lamberts Gully discharges an average of 1.479 ML/day. Overall, this analysis is considered a very simplistic analysis but was deemed necessary because of the lack of information supplied in the EIS and RTS modelling results regarding actual flows from LDPs in the Upper Coss River catchment and the proportion of flows they represent at various nodes in the Water Balance model (relative to what was actually measured at the 212054 gauge).

⁵ Maximum flows ranged between 33.81 and 2562 kL/day (Centennial Monitoring Data).

⁶ The maximum limit on LDP001 appears to have changed from 30ML/day to 2ML/day around July 2013. It is further noted that:

- In April 2014 (26/3/14-25/4/14) Maximum Discharge is stated to be **2127.89** kL/day when the EPL flow limit is 2000 kL/day
- In July 2014 (26/6/14-24/9/14) Maximum Discharge is stated to be **2288.36** kL/day when the EPL flow limit is 2000 kL/day

⁷ There appears to be no consistent reporting of either LDP009 flows or quality. It is notable that this raw data has been requested twice from the proponent, but has not been supplied.

⁸ Only limited additional data for LDP flow and quality have been supplied in the RTS.

study where the LDP009 discharge had a measured conductivity of 1200 $\mu\text{S}/\text{cm}$ and the LDP009 DS site had a measured conductivity of 1100 $\mu\text{S}/\text{cm}$; TDS levels of 780 mg/L (LDP009) and 716 mg/L (LDP009 DS); Bicarbonate levels of 625 mg/L (LDP009) and 512 (LDP009 DS); and Arsenic levels (0.024 mg/L (LDP009) and 0.021 (LDP009 DS). The actual quality of the LDP009 discharge is discussed further below.

A plot of flows at the NOW 212054 gauge actually identifies a significant increase in flows in the most recent times, potentially as a result of the LDP009 discharge (Figure 1). This has not been acknowledged in the Surface Water Impact Assessment. A plot of Conductivity levels at the same Gauge also demonstrates a significantly increasing trend in Conductivity levels (ie an increasing salinization) of Upper Cocks River waters (Figure 2). This is most likely a result of the ongoing and increasing mine water discharges in the Upper Cocks River catchment. Instead of moving to arrest the decline in water quality (as indicated by conductivity) in this area, the EIS and RTS both advocate increasing this further by increasing the LDP009 discharge to up to 30 to 50 ML/day of poorly treated highly saline mine water⁹. This approach to the disposal of unwanted, poorly treated and (for LDP009) toxic mine water is not supported.

Further issues associated with the water balance model include:

- Unclear assumptions, particularly whether the coefficients have been assigned a value (and the justification for these values) or whether the coefficients were calculated from the data. If the latter, it is noted that there is no estimate of standard error for these coefficient estimates and no sensitivity analysis allowing for variation in coefficients and their effect on model predictions.
- In the latest assessment, RPS (2014) states: “*Evaporation in the model was based on average daily evaporation for each month at BOM Station No. 061089 (Scone SCS.*”. This is different to the original EIS surface water assessment where evaporation was stated to come from: “*Daily Pan A evaporation has been recorded at the Bathurst Agricultural Station (BOM Station No. 63005) from 1966 to current*”. It is unclear why the evaporation stations have been changed in the latest iteration of the model and what effect this has had on the model and its predictions. It is also worth noting that BoM rainfall records for stations 61089 and 63005 indicate 100 mm less rainfall on an annual average basis than the Lidsdale gauge 63162 (BoM online data). This raises significant questions as to whether the evaporation data used in the model is actually appropriate for this area. Such inconsistencies in the model and the appropriateness or justification of their use places even greater uncertainty on the model and its applicability/sufficiency and its ability to predict reality.
- The RPS (2014) report still talks about Daily demand at Wallerawang Power Station when it is currently ‘mothballed’.
- The Angus Place EIS highlighted that *the water balance model was calibrated to discharge in July 2013, which included a period where mine water make was being temporarily held underground (March to July 2013). Discharge at LDP001 has now resumed at a rate of 2ML/d.* It is unclear whether the latest ‘calibration’ has used this information in daily flow calculations and whether the actual flows from LDP009, LDP001 and other discharges have been appropriately utilised in the modelling.

⁹ It is also recommended in the EIS that the Angus Place LDP001 discharge is increased from 2 ML/day to 30 ML/day.

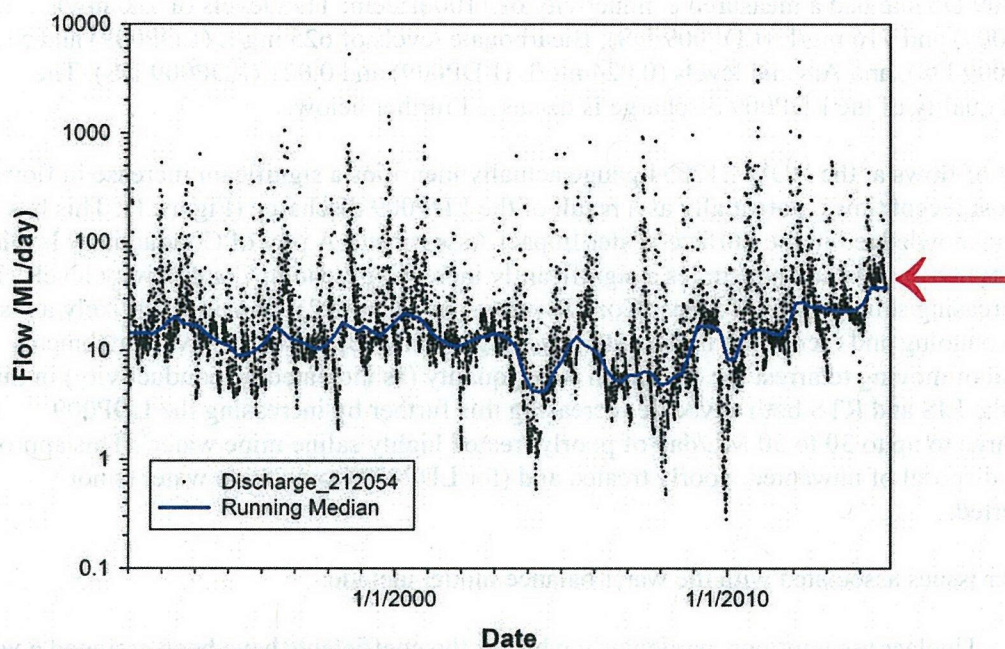


Figure 1. Flow at NOW Gauge 212054.

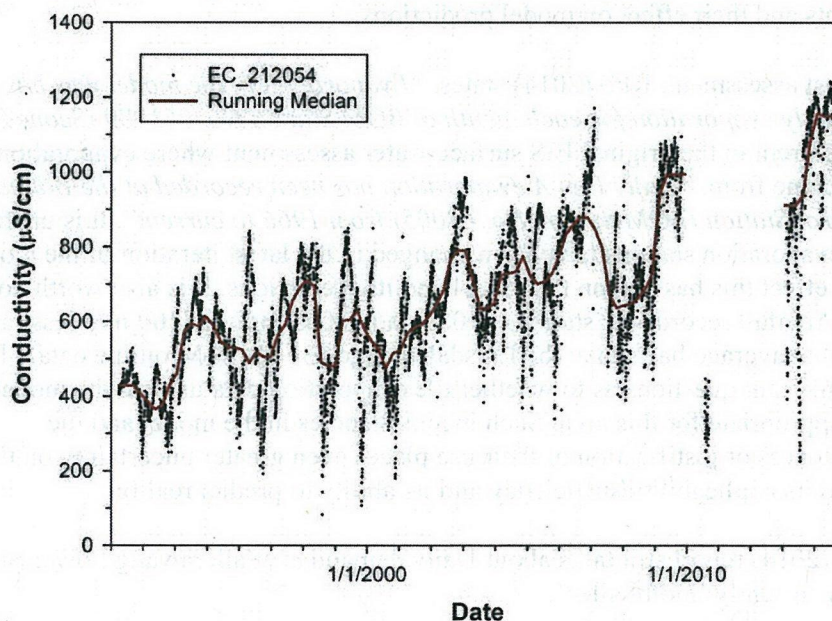


Figure 2. Electrical Conductivity at NOW Gauge 212054.

- The Angus Place EIS Water quality modelling *indicates that historical discharge at Angus Place LDP001 accounts for observed increase in salinity in Kangaroo Creek and the Upper Coks River above Blue Lagoon*. As pointed out in comments on the original EIS, the Angus Place LDP001 discharge actually represents the first major impact of mine discharges on the Upper Coks River. Conductivity in Kangaroo Creek is increased from a median level of 51 ($\mu\text{S}/\text{cm}$) upstream of LDP001 to 900 $\mu\text{S}/\text{cm}$ downstream of LDP001 (GHD 2010; Figures of 65 $\mu\text{S}/\text{cm}$ upstream and 770 $\mu\text{S}/\text{cm}$ upstream are given in the EIS Table 3.9). This represents a 12-fold to 18-fold increase

in median conductivity in Kangaroo Creek as a result of the Angus Place LDP001 discharge. Median concentration in the Cocks River upstream of the Kangaroo Creek confluence was 107 $\mu\text{S}/\text{cm}$ while median concentration in the Cocks River downstream of the Kangaroo Creek confluence was 513 $\mu\text{S}/\text{cm}$ (Angus Place EIS Table 3.9). This represents an almost 5-fold increase in median conductivity in the Cocks River likely to be due in large part to the Angus Place LDP001 discharge.

Two uncertainty analysis conditions were presented in the RTS (Low Rainfall Condition and High Rainfall Condition), but there has been no assessment of model uncertainty or parameter (ie coefficient) uncertainty. Description and presentation of calibration results (eg fitted versus actual) is considered poor. As identified earlier the model under-predicts median flow at the NOW gauge 212054 (Node #047 in AWBM model; RPS 2014) and considerably over-predicts conductivity at the NOW gauge 212054 when compared to the observed measurements. There appears to be no presentation of validation results of the model based on more recent flows (and conductivity) measured at the NOW gauging stations.

The modelling results and conclusions in RPS (2014) should not be relied upon until the above significant issues are addressed. In general, there is a lack of appropriate upstream-downstream comparisons for each LDP discharge in the Upper Cocks River catchment. Little allowance appears to be made for the fact that a proportion of the flows measured in various parts of the Upper Cocks River are actually sourced from upstream LDPs. **As a result of this confounding of LDP discharges, flows and water quality in the model and assessment, an inadequate assessment of the true impact of the LDP discharges is achieved (particularly that of LDP009).**

Ecotoxicology Assessment

The RTS includes a report (GHD 2014a) critical of EPA/OEH's preliminary toxicity assessment of LDP009. EPA/OEH would like to point out that this preliminary assessment was undertaken because of the inadequacy of the characterisation of the LDP009 discharge (quality, flow, toxicity) in the Angus Place and Springvale EIS's. It is clearly the responsibility of the proponent to provide the information upon which major Government decisions need to be made. Government should not be required to have to collect this information itself before it can adequately assess the impact of the proposal.

Far from refuting the findings of EPA/OEH's preliminary toxicity assessment of LDP009, the GHD (2014) toxicity assessment confirms the acute toxicity of the discharge and identified reproductive impairment for considerable distances downstream of the LDP009 discharge. The GHD (2014) study concluded that:

- *The results of this study show that the discharge at SV LDP009 is having an acute impact on cladoceran species at the Sawyers Swamp Creek site downstream of discharges*
- *The results of the toxicity testing were used to determine the concentration of SV LDP009 discharge of 2.7% to provide protection to 95% of the species in the downstream ecosystem.*
- *The target dilution of SV LDP009 discharge was not found to be met under median rainfall conditions.*
- *Impacts on cladoceran reproduction show a decreasing trend in the Cocks River with distance downstream of the SV LDP009 discharge point until no toxic impacts are detected in the upper portion of Lake Wallace.*

A number of other claims made in the GHD (2014) report are not supported by their data or other data that has been collected in the upper Cocks River catchment including:

- *This acute toxicity is **ameliorated** as the discharge enters the Cocks River.*
- *Aquatic ecology monitoring results provide supporting evidence that the discharges from AP LDP001 and SV LDP009 are not adversely impacting the aquatic health of the Cocks River.*
- *The sites downstream of discharges from AP LDP001 were found to have more pollution sensitive taxa present in the macroinvertebrate assemblages than the upstream Cocks River site.*
- *The water quality results for SV LDP009 do not indicate any parameters that are present in concentrations that could cause the significant toxicity observed in the ecotoxicology results.*
- *Furthermore, the chemistry of discharge from AP LDP001, which did not show any toxicity to the cladoceran species, was found to be very similar to that of SV LDP009.*

These claims are discussed further below. One conclusion that EPA/OEH can agree with GHD (2014) is that:

“Further investigations are required to determine the source of the toxicity at SV LDP009”.

Ecotoxicity Assessment Comments

This acute toxicity is ameliorated as the discharge enters the Cocks River.

Table 3.2 of RPS (2014) identifies 100% survival of *Daphnia* at the Cocks River confluence but that reproduction was only 29% that of the control. These results relate only to the cladoceran (*Ceriodaphnia cf dubia*) and there has been limited testing of freshwater species that could potentially be even more susceptible to the discharge quality than cladocerans (e.g. *Atalophlebia* or *Paratya*). An assessment of mine water salinity impacts can be found in the ACARP study on the effects of mine water salinity on freshwater biota (Cardno Ecology Lab Pty Ltd 2010). Cardno Ecology Lab Pty Ltd (2010) found that discharge waters from mines in the Hunter and Illawarra/Macarthur regions induced deleterious responses in a range of aquatic biota. Arthropods were the most sensitive organisms tested, with the mayfly *Atalophlebia* spp. being the most sensitive of these. The salinity levels at which effects occurred were below those reported in the literature for sodium chloride (NaCl) based solutions and highlighted the need for site-specific toxicity information that takes into account the variable composition of saline mine waters, including the consideration of other constituents (Cardno Ecology Lab Pty Ltd 2010).

Cardno Ecology Lab Pty Ltd (2010) used species sensitivity distribution (SSD) curves for single-species toxicity information to develop protective concentration (PC) values that protect a large proportion of the aquatic species present in the receiving waters. In Brennans Creek/Georges River (where West Cliff Colliery discharges) the SSD curve suggested a conductivity of 585 $\mu\text{S}/\text{cm}$ to protect 95 per cent of species and a value of 921 $\mu\text{S}/\text{cm}$ to protect 80 per cent of species. For Tea Tree Hollow (where Tahmoor Colliery discharges) the respective values were 1000 $\mu\text{S}/\text{cm}$ and 1146 $\mu\text{S}/\text{cm}$; and for Bowmans Creek (where Ravensworth Colliery discharges) the respective values were 876 $\mu\text{S}/\text{cm}$ and 1992 $\mu\text{S}/\text{cm}$. According to Cardno Ecology Lab Pty Ltd (2010), the small PC 95 per cent values

determined for Brennans Creek/Georges River were strongly influenced by the sensitivity of the mayfly *Atalophlebia* sp. in the laboratory tests. No cladocerans, leptophlebiids or atyid shrimps were collected from Bowmans Creek and consequently, no field toxicity estimates were able to be derived for these taxa in Bowmans Creek (Cardno Ecology Lab Pty Ltd 2010).

The very small and limited study conducted by GHD (2014) has clearly not established that *acute toxicity is ameliorated as the discharge enters the Coxs River*. There is actually very little dilution of LDP009 waters because of the high flow rate (approximately 22 ML/day) relative to natural flows in Sawyers Swamp Creek and the Upper Coxs River. This fact is obscured by poor sampling of the discharge and downstream sites, and inappropriate mixing of data from time periods before and after LDP009 was discharging direct to Sawyers Swamp Creek (ie inferences are drawn on 'dilution/amelioration' based on water quality samples collected prior to LDP009 discharges¹⁰).

Aquatic ecology monitoring results provide supporting evidence that the discharges from AP LDP001 and SV LDP009 are not adversely impacting the aquatic health of the Coxs River.

&

The sites downstream of discharges from AP LDP001 were found to have more pollution sensitive taxa present in the macroinvertebrate assemblages than the upstream Coxs River site.

As identified in OEH's response to the EIS:

To address the concerns about the impact of salinity and other contaminants from the Wallerawang power station (and other discharges) on the aquatic ecology of the Coxs River above Lake Lyell, 30 sites in the Coxs River catchment were sampled by DECCW scientists in September - October 2009. Samples were collected for water quality analysis as well as an assessment of the macroinvertebrate communities present at these sampling sites. This program included sampling sites upstream and downstream of licensed discharges, as well as reference sites in the Coxs River and its tributaries. The results of this study were reported in Krogh and Miller (2011).

The major conclusions from this study were that:

- The water quality analyses showed that dissolved and total metals were generally highest in waters downstream of the Wallerawang blowdown discharge, Neubecks Creek and Sawyers Swamp Creek below the ash dam.
- High salinity and metal levels appeared to extend for at least 6-7 km downstream from the blowdown source.
- It was evident that salinity levels in parts of the Coxs River catchment have been increased above natural levels by discharges from power generation and mining activities.
- Delta's blowdown discharges were around 2500 $\mu\text{S/cm}$ conductivity, while those of the minewater discharges were typically around 1200 $\mu\text{S/cm}$ ¹¹.
- Upstream areas have much lower conductivity levels (typically between 20 and 200 $\mu\text{S/cm}$).

¹⁰ This issue is acknowledged to some extent (but not appropriately addressed) in the Springvale Colliery LDP009 SSTV Assessment where RPS states: *The EC at the downstream monitoring location falls below the Guideline value; however it is not clear if this data incorporates LDP009 discharge.*

¹¹ The default ANZECC guideline trigger value for conductivity for upland rivers ranges up to 350 $\mu\text{S/cm}$.

- Since the period 1980s -1990s salinity levels have increased in the Coxs River at locations upstream of the Wallerawang Power Station, downstream of the Great Western Highway, at and downstream of Lake Lyell, and at Duddawarra.
- These impacts on water quality appear to be influencing the aquatic macroinvertebrate assemblages, which were dominated by pollution-tolerant taxa such as worms and/or chironomids or supported fewer taxa at most sampled sites on the Coxs River between the Neubecks Creek inflow and Lake Lyell, Farmers Creek downstream of the STP and Lithgow township, in Neubecks Creek and in Sawyers Swamp Creek (below the ash dam).
- The site on Kangaroo Creek downstream of the Angus Place discharge had an impoverished macroinvertebrate fauna.

The OEH study does not provide *supporting evidence that the discharges from AP LDP001 and SV LDP009 are not adversely impacting the aquatic health of the Coxs River*. In reality, GHD (2014) has only considered a very limited dataset in their analysis and their conclusions cannot be claimed to be a rigorous assessment of all available data on the aquatic ecology of the Upper Coxs River. It is notable that while CR1 CR2 and CR4 improved their AusRivas rankings in 2012, the AusRivas ranking at CR5 (downstream of Sawyers Swamp Creek and LDP009 discharge) actually decreased. GHD (2014) have also not cited or reviewed the extensive literature on salinity impacts on aquatic ecosystems (eg Kefford et al 2013, Farag & Harper 2012, OEH 2012, Cardno Ecology Lab Pty Ltd 2010, Dunlop et al 2011, and many others) or the effects of salinity on aquatic ecology. Much greater replication of sampling and investigation is required before any claim that *discharges from AP LDP001 and SV LDP009 are not adversely impacting the aquatic health of the Coxs River* can be substantiated. The fact that the LDP009 discharge has been found to be acutely toxic and cause reproductive impairment down to Lake Wallace, clearly contradicts this conclusion.

The water quality results for SV LDP009 do not indicate any parameters that are present in concentrations that could cause the significant toxicity observed in the ecotoxicology results.

This conclusion appears to largely be based on the linear regression analysis of reproduction versus electrical conductivity and bicarbonate alkalinity. The results of these analyses should be treated with a great deal of caution since:

- Sample sizes are very small (n=12)
- There is no assessment of the satisfaction of the statistical assumptions of the test
- The data have not been controlled for variation in other parameters (eg pH, metal levels etc)
- The effect of high influence points (ie the Coxs River upstream site¹² where 0% reproduction was measured) have not been considered
- The analysis has not considered the scientific literature detailing impacts associated with salinity (including electrical conductivity and bicarbonate alkalinity; e.g. Kefford et al 2013, Farag & Harper 2012, OEH 2012, Cardno Ecology Lab Pty Ltd 2010 etc.).

In particular, Farag and Harper (2012) constructed a database of toxicity evaluations of sodium bicarbonate (NaHCO₃) on aquatic life and used these data to establish acute and chronic criteria for the protection of aquatic life¹³. Chronic toxicity was observed at concentrations that ranged from 450 to 800 milligrams NaHCO₃ per litre (also defined as 430

¹² It is probably inappropriate to include this data point since the cladoceran naturally appears to be absent from this area, potentially as a result of the very low conductivity levels.

¹³ This was for US species, but see also OEH (2012). The ACARP report (Cardno 2010) on impacts of mine water salinity also investigated toxicity issues associated with saline mine water discharges.

to 657 milligrams HCO_3^- per litre or total alkalinity expressed as 354 to 539 milligrams CaCO_3 per litre) and the specific concentration depended on the sensitivity of the four species of invertebrates and fish exposed. Acute and chronic criteria of 459 and 381 milligrams NaHCO_3 per litre, respectively, were calculated to protect 95 per cent of the most sensitive species (Farag and Harper 2012).

It is noted that in the most recent sampling Bicarbonate alkalinity in the LDP009 discharge was measured at **625 mg/L** (GHD 2014) and **580 mg/L** (EPA/OEH data). Many other contaminants are above background levels for natural Coxs River waters (Coxs US).

Furthermore, the chemistry of discharge from AP LDP001, which did not show any toxicity to the cladoceran species, was found to be very similar to that of SV LDP009.

Contrary to this opinion, there are actually some significant differences between the LDP009 and LDP001 discharge waters. It is noted (Moreno Julli advice):

- In addition to high bicarbonate alkalinity, the LDP009 discharge has an exceptionally low hardness value of 2 mg/L as CaCO_3 , i.e. very low calcium (Ca) and magnesium (Mg), which differs markedly from the non-toxic LDP001 (116 mg/L CaCO_3).
- Further, LDP009 has high sodium (Na) (291mg/L) and low potassium (K) (9mg/L), while LDP001 has Na at 182mg/L and K at 32mg/L.

This is reinforced if further water quality data from the discharges and nearby locations are considered (Figure 3).

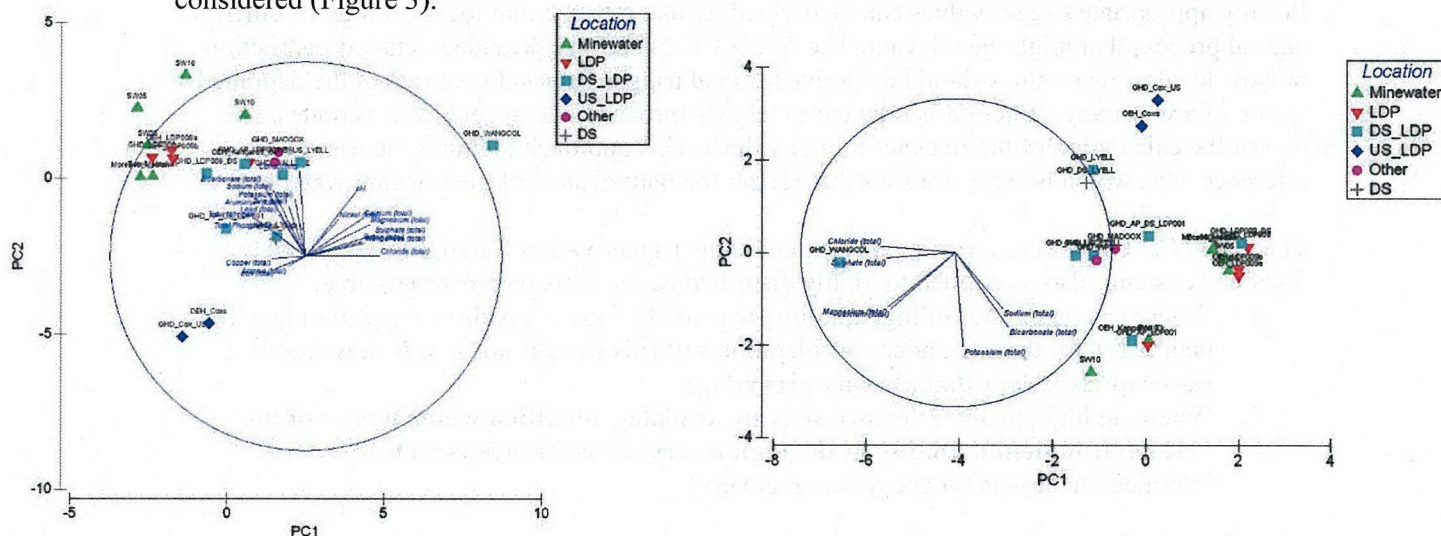


Figure 3. Principal components analysis¹⁴ of water samples from LDP discharges, minewater and upstream and downstream sites in the Upper Coxs River Catchment. Physico-chemical variables including metals (left), ionic constituents (right). Points closer together in the graphs are more similar in terms of their water quality.

It is clear from Figure 3 that there are significant differences between reference site waters, raw minewater, LDP discharge waters and water quality downstream of LDP discharges. There are also clear differences in the ionic composition of LDP001 and LDP009 waters.

¹⁴ The first principal components analysis used the analytes pH, TN, TP, Al, B, Fe, Mn, Ca, Mg, Na, K, Cl, SO_4 , HCO_3 , As, Cu, Pb, Ni & Zn and the first two principal components explained approximately 52% of the variation in the data. The second principal components analysis used the ionic (cation and anion) analytes Ca, Mg, Na, K, Cl, SO_4 , HCO_3 and the first two principal components explained approximately 83% of the variation in the data.

It is further noted that the EIS claimed that:

In general, water quality of discharge from LDP001 and LDP009 is very good, with near neutral pH and salinity that is essentially consistent with ADWG, including concentrations of dissolved metals and nutrients.

This claim is considered highly misleading.

ANZECC/ARMCANZ Assessment

The ANZECC/ARMCANZ(2000) Guidelines provides a rigorous way in which to assess water quality impacts on the environment. These Guidelines recommend the setting of levels of protection be carried out in an open and transparent way, involving all key stakeholders so that a fair and reasonable outcome is achieved.

The ANZECC/ARMCANZ(2000) Guidelines state that for some water quality indicators users will need to define a *reference condition* that provides both a target for management actions to aim for and a meaningful comparison for use in a monitoring or assessment program. The reference condition is particularly appropriate for slightly-moderately and highly disturbed ecosystems and is a key component of the ANZECC framework for applying the guidelines. **The reference condition must be chosen using information about the physical and biological characteristics of both catchment and aquatic environment to ensure the sites are relevant and represent suitable target conditions.**

Locally appropriate trigger values can be derived to take into account local geology or other natural process that might be relevant. The ANZECC guidelines provided detailed instruction on how local trigger values should be derived. Local trigger values do not reflect the degraded nature of a waterway. Where it is relevant to take disturbance into account this is done as a part of the calculation of the relevant trigger values. This approach includes the use of reference sites which broadly are sites that reflect the natural state of the relevant waterway.

The ANZECC Guidelines recommend that guideline trigger values for slightly-moderately disturbed systems also be applied to highly disturbed ecosystems wherever possible.

1. Where reference sites of high quality are available, lower levels of protection may be negotiated for the site under consideration **but this should not result in water of lesser quality than that already prevailing.**
2. Where no high quality reference sites are available, **modified water bodies of the best environmental quality in the region serve as reference targets** (or intermediate targets for ecosystem recovery).

The RTS includes two reports by RPS that claim to *specifically addresses concerns raised regarding the quality of the discharge water with respect to ANZECC and ARMCANZ (2000) guideline (the Guidelines) values:*

- Angus Place Colliery LDP001 SSTV Assessment
- Springvale Colliery LDP009 SSTV Assessment

EPA/OEH agrees with the following statements made in these reports:

- *The altitude of LDP001 is approximately 950 mAHD, therefore the upland river and streams values are to be used for consideration in this assessment.*
- *The altitude of LDP009 is approximately 950 mAHD, therefore the upland river and streams values are to be used for consideration in this assessment.*

- On that basis the guideline values for Aquatic Ecosystems are considered the most appropriate for use within the catchment containing LDP009 [and LDP001].
- The 95% protection level is most commonly applied to ecosystems that could be classified as slightly to moderately disturbed.
- Following establishment of the appropriate Guideline trigger values for the waterbody in question, these values must be compared against water quality data collected upstream of the discharge point to understand background concentrations. Where background values exceed Guideline trigger values, the 80th percentile concentration of the background data may¹⁵ be adopted as the SSTV.
- Water hardness is known to influence the bioavailability of certain metals to aquatic organisms. The reduction in bioavailability of Cd, Cr(III), Cu, Ni, Pb and Zn as a function of hardness is described mathematically and presented in the Guidelines. The requirement for Hardness Modified Trigger Values (HMTV) has been assessed, where applicable, in this investigation.

However, the ANZECC/ARMCANZ(2000) guidelines have actually been misapplied in the RPS assessments in determining trigger values because:

- For some assessments (particularly LDP009) an appropriate reference site has not been chosen for comparison and therefore inappropriate “adopted” trigger values have been used
- The assessments focus on an extremely small subset of water quality variables to consider further (EC, Al, Fe, Zn & Cu)
- They do not adequately consider the ionic composition of LDP discharge waters which are very different to the ionic composition of local (reference site) waters.
- At each point when adopting trigger levels the assessment has chosen the highest value of either the ANZECC default guideline levels or local water quality trigger values (based on 80th percentile values at a reference site) – this is an inconsistent and inappropriate application of ANZECC Guidelines trigger value derivation methods.
- The assessments do not allow for confounding of LDP sources (ie trigger values calculated for LDP009 ignore the upstream influence of LDP001 and other discharges).
- Both the LDP001 and LDP009 discharges (and adopted trigger values) clearly **result in water of lesser quality than that already prevailing.**
- The assessments do not appropriately address the increasing salinization of Upper Cocks River waters (see Figure 2 above) which is likely to be a direct result of the increasing concentration and load of salt from LDP discharges.
- The assessments advocate no treatment of the highly saline and (for LDP009) toxic discharges which will likely cause further deterioration in water quality and result in adverse ecosystem health effects
- The assessments have not undertaken an adequate review of the literature on the effects of salinity and ionic constituents on aquatic ecosystems.

Salinity Impacts

Salinity is an indicative measure of the total concentration of cations (Na^+ , Ca^{2+} , Mg^{2+} , K^+), and anions (i.e. SO_4^{2-} , CO_3^{2-} , HCO_3^{2-} , Cl^-) in solution (ANZECC/ARMCANZ 2000). Measures of Electrical Conductivity are indicative of the total ions present in solution. Concentrations of individual ions contributing to these measures can vary in their composition. Some organisms (osmoregulators) possess varied mechanisms for regulating ions hence the ionic composition of a saline solution is a significant factor in determining its toxicity. For this reason the use of integrative measures of salinity (TSS and EC) may not be

¹⁵ If local water quality criteria are being developed for an area then it is these local criteria that **should** be used in assessing impacts of discharges on the environment.

reliable predictors of toxicity for all water types (Mount *et al.*, 1997). Studies by Burnham & Peterka (1975), Dwyer *et al.* (1992), Nielsen *et al.* (2003), Bayly (1969), Clunie *et al.* (2002), Dunlop *et al.* (2008, 2011) and Zalizniak (2006) have indicated that ionic composition affects salinity toxicity.

The high bicarbonate alkalinity recorded for the mine water suggests that bicarbonate ions could be an important ecological health issue for the LDP discharges. Farag and Harper (2012) constructed a database of toxicity evaluations of sodium bicarbonate (NaHCO_3) on aquatic life and used these data to establish acute and chronic criteria for the protection of aquatic life. Chronic toxicity was observed at concentrations that ranged from 450 to 800 milligrams NaHCO_3 per litre (also defined as 430 to 657 milligrams HCO_3^- per litre or total alkalinity¹⁶ expressed as 354 to 539 milligrams CaCO_3 per litre) and the specific concentration depended on the sensitivity of the four species of invertebrates and fish exposed. **Acute and chronic criteria of 459 and 381 milligrams NaHCO_3 per litre, respectively, were calculated to protect 95 per cent of the most sensitive species** (Farag and Harper 2012). More recently, OEH (2012) also found toxic effects of West Cliff mine water, citing bicarbonate as an important potential contributor to the toxic effects. Other potential toxicants found in the mine water at levels exceeding the ANZECC/ARMCANZ (2000) guidelines were aluminium, nickel, zinc, cobalt and copper (OEH 2012).

LDP001 Impacts

The RPS (2014) report states:

- *Available flow data indicates that median flow in Kangaroo Creek is typically an order of magnitude less than LDP001 discharge:*
 - *Median flow in Kangaroo Creek: 0.66 ML/d (actual data July 2011 to July 2012)*
 - *Median discharge from LDP001: 3.3 ML/d (actual data Jan 2010 to July 2012).*
- *The results demonstrate that a dilution factor of 2.8 is achieved approximately 5% of the time therefore the water quality criteria for EC will not be met 95% of the time. For zinc, a dilution factor of 4.2 is only achieved 3.5% of the time, therefore the water quality criteria for Zinc will not be met 96.5% of the time.*

Median LDP001 discharges are therefore 5 times that of natural median flows in Kangaroo Creek. In addition, relative to natural waters, the LDP001 discharge has elevated levels of pH, TDS, EC, Ba, B, Cu, Mg, Ni, K, Na, Sulphate, U, Zn, $\text{NH}_3\text{-N}$, NO_x , TN, Bicarbonate, Alkalinity, Hardness and F (see also concentrations measured in GHD 2014). Based on actual measurements at the downstream location, concentrations are still an order of magnitude higher than upstream background levels for EC, Ca, K, Na, Sulphate, NO_x , Bicarbonate and Fluoride (RPS 2014 Table 1 and GHD 2014).

It is considered misleading to suggest that the flow, concentration and loads being released from LDP001 would be having a benign effect on ecosystem health. As indicated previously, the site on Kangaroo Creek downstream of the Angus Place discharge was found to have an impoverished macroinvertebrate fauna (Krogh and Miller 2011).

RPS (2014) also states:

¹⁶ It is noted that in the most recent sampling Bicarbonate alkalinity in the LDP009 discharge was measured at **625 mg/L** (GHD 2014) and **580 mg/L** (EPA/OEH 2014).

It is worth noting that research undertaken by Hart et al (1991) shows that the Total Dissolved Solids (TDS) concentration needs to be above 1000 mg/L before it can lead to toxic effects, this equates to an EC of approximately 1500 μ S/cm.

It is clear that RPS (2014) have considered a 20 year old reference but not appropriately considered the more recent (and extensive) literature on the ecosystem effects of salinity and components of salinity (ie bicarbonate) in the scientific literature (Kefford et al 2013, Farag & Harper 2012, OEH 2012, Cardno Ecology Lab Pty Ltd 2010, Dunlop et al 2011). This literature pays close attention to the ionic composition of waters and their effects on aquatic species, identifying significant issues with the ionic composition of some discharge waters. This literature was identified in EPA/OEH's previous response to the EIS but this literature still does not appear to have been consulted in the most recent assessments. RPS (2014) also appear to be unaware of the effect that high levels of bicarbonate can have in increasing Zn toxicity even though zinc was an identified issue for the LDP001 discharge (see recent paper by Lopez Vera et al 2014)

LDP009 Impacts

The RPS (2014) report states:

- A number of variables shown in bold in Table 1 represent concentrations exceeding the ANZECC 95% species protection trigger values.
- LDP009 has shown two isolated occurrences of elevated cyanide concentration
- The EC at the downstream monitoring location falls below the Guideline value; however it is not clear if this data incorporates LDP009 discharge.
- The LDP009 discharge EC exceeds the ANZECC 95% species protection trigger values.
- There is no flow monitoring on Sawyers Creek, however modelled flows from the Regional Water Quality Impact Assessment (RPS 2014a) indicate that flows are typically two orders of magnitude less than LDP009 discharge:
 - Median flow in Sawyers: 0.2 ML/d (modelled data December 2012 to July 2013)
 - Median discharge from LDP009: 19.95 ML/d (actual data December 2012 to July 2013).
- Figure 3 shows that a dilution factor of 2.6 is achieved approximately 5% of the time therefore the water quality criteria for EC will not be met 95% of the time.

Median LDP009 discharges are therefore almost 100 times that of natural median flows in Sawyers Swamp Creek. It is also approaching twice the median flows measured at the NOW gauge 212054. In addition, relative to natural waters, the LDP009 discharge has elevated levels of pH, TDS, EC, As, B, Cn, Ni and F. No data was supplied in RPS (2014; Table 1) for Ba, Cd, Ca, Cr, Cl, Pb, Mg, K, Na, Sulphate, NH₃-N, NO_x, TN, TP or bicarbonate - but see concentrations measured in EPA/OEH 2014 and GHD 2014, many of which are much higher than reference site waters. Very little dilution of these analytes is achieved at the Sawyers Swamp Creek downstream site or in the Coffs River downstream of Sawyers Swamp Creek (eg see GHD 2014). As identified earlier, if the limited flow information reported by GHD (2014) and RPS (2014) are used, then the LDP009 discharges potentially represented 54% of the difference in average flow in between the two NOW gauges in the period reported (ignoring evaporative losses). It is therefore not surprising that there is very little dilution being achieved for the LDP009 discharge either downstream in Sawyers Swamp Creek or once it joins the Coffs River.

It is considered misleading to suggest that the very high flow, concentration and loads being released from LDP009 would be having a benign effect on ecosystem health. As indicated previously, the LDP009 discharge has been found to be acutely toxic with reproductive

impairment measured down to Lake Wallace. The 'adopted TV' for SV Cocks River U/S in Table 4 & 6 for conductivity of 1539 $\mu\text{S}/\text{cm}$ is clearly inappropriate for this area.

Further macroinvertebrate monitoring of the effects of the discharge on the stream ecology is clearly required. Transplant experiments for *Paratya* may also be needed to assess the field survival of this species which appears to be quite sensitive to bicarbonate ions in mine water discharges (Cardno Ecology Lab Pty Ltd 2010, OEH 2012).

Summary

In a variety of recent salinity reviews, saline discharges and mine water toxicity was an important issue for the ecological health of the river (Kefford et al 2013, Farag & Harper 2012, Cardno Ecology Lab Pty Ltd 2010, Krogh et al 2013, Dunlop et al 2008, 2011). Conductivity and bicarbonate ions in particular were identified as an emerging issue causing mortality in aquatic species in both the USA and Australia (Kefford et al 2013, Farag & Harper 2012, OEH 2012, Cardno Ecology Lab Pty Ltd 2010, Krogh et al 2013). Cardno Ecology Lab Pty Ltd (2010) found that discharge waters from mines in the Hunter and Illawarra/Macarthur regions induced deleterious responses in a range of aquatic biota. Arthropods were the most sensitive organisms tested, with the mayfly *Atalophlebia* spp. being the most sensitive of these. The salinity levels at which effects occurred were below those reported in the literature for sodium chloride (NaCl) based solutions and highlighted the need for site-specific toxicity information that takes into account the variable composition of saline mine waters, including the consideration of other constituents (Cardno Ecology Lab Pty Ltd 2010). Cardno Ecology Lab Pty Ltd (2010) used species sensitivity distribution (SSD) curves for single-species toxicity information to develop protective concentration (PC) values that protect a large proportion of the aquatic species present in the receiving waters. In Brennans Creek/Georges River (where West Cliff Colliery discharges) the SSD curve suggested a conductivity of 585 $\mu\text{S}/\text{cm}$ to protect 95 per cent of species and a value of 921 $\mu\text{S}/\text{cm}$ to protect 80 per cent of species. For Tea Tree Hollow (where Tahmoor Colliery discharges) the respective values were 1000 $\mu\text{S}/\text{cm}$ and 1146 $\mu\text{S}/\text{cm}$; and for Bowmans Creek (where Ravensworth Colliery discharges) the respective values were 876 $\mu\text{S}/\text{cm}$ and 1992 $\mu\text{S}/\text{cm}$.

It is noted that the discharge waters, particularly LDP009, have bicarbonate levels above those identified by Farag and Harper (2012) for acute and chronic effects. Many other contaminants are well above background levels for natural Upper Cocks River waters (Cocks US).

ANZECC/ARMCANZ(2000) guidelines have actually been misapplied in the RPS assessments in determining trigger values because:

- For some assessments (particularly LDP009) an appropriate reference site has not been chosen for comparison and therefore inappropriate "adopted" trigger values have been used
- The assessments focus on an extremely small subset of water quality variables to consider further (EC, Al, Fe, Zn & Cu)
- They do not adequately consider the ionic composition of LDP discharge waters which are very different to the ionic composition of local (reference site) waters.
- At each point when adopting trigger levels the assessment has chosen the highest value of either the ANZECC default guideline levels or local water quality trigger values (based on 80%ile values at a reference site) – this is an inconsistent and inappropriate application of ANZECC Guidelines trigger value derivation methods.
- The assessments do not allow for confounding of LDP sources (ie trigger values calculated for LDP009 ignore the upstream influence of LDP001 and other discharges).

- Both the LDP001 and LDP009 discharges (and adopted trigger values) clearly **result in water of lesser quality than that already prevailing**.
- The assessments do not appropriately address the increasing salinization of Upper Coxs River waters (see Figure 2 above) which is likely to be a direct result of the increasing concentration and load of salt from LDP discharges.
- The assessments advocate no treatment of the highly saline and (for LDP009) toxic discharges which will likely cause further deterioration in water quality and result in adverse ecosystem health effects
- The assessments have not undertaken an adequate review of the literature on the effects of salinity and ionic constituents on aquatic ecosystems.

The plot of Conductivity levels at the NSW Office of Water Gauge 212054 demonstrates a significantly increasing trend in Conductivity levels (ie an increasing salinization) of Upper Coxs River waters (Figure 2). This is most likely a result of the ongoing and increasing mine water discharges in the Upper Coxs River catchment. This increasing salinization of the Upper Coxs River is likely to lead to further problems in the future if it is not appropriately addressed. The 'adopted TV' for SV Coxs River U/S in Table 4 & 6 of the RPS (2014) report for conductivity of **1539 $\mu\text{S}/\text{cm}$** is considered highly inappropriate for this area and well outside reference water quality for the Upper Coxs River.

The fact that sections of the Upper Coxs River have been disturbed by previous mining in the area should not be used as an excuse to continue to degrade the stream further when appropriate treatment of wastewater and contaminated runoff is in fact a feasible and viable option. The proposed approach to dealing with unwanted waste minewater from the two expansion proposals is not considered a satisfactory approach.

References

ANZECC/ARMCANZ (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. Canberra.

Bayly, I.A.E. (1969). The occurrence of calanoid copepods in athalassic saline waters in relation to salinity and anionic proportions", *Vernandlungen Internationale Vereinigung fur Theoretische and Angewandthe Limnologie*. 17: 445–449.

Burnham, B.L. and Peterka, J.J. (1975). Effects of saline water for North Dakota lakes on survival of fathead minnow (*Pimephales promelas*) embryos and sac fry, *Journal of the Fisheries Research Board of Canada*. 32: 809–812.

Cardno Ecology Lab Pty Ltd (2010). *Effects of mine water salinity on freshwater biota investigations of coal mine water discharge in NSW*. Australian Coal Association Research Program and Cardno (NSW) Pty Ltd Trading as Cardno Ecology Lab, Brookvale, New South Wales.

Clunie, P., Ryan, T., James, K. and Cant, B. (2002). Implications for Rivers from Salinity Hazards: Scoping Study. Report to the Murray Darling Basin Commission. Department of Natural Resources and Environment, Heidelberg. R2003.

Dunlop, J., D. Hobbs, D., Mann, R., Nanjappa, V., Smith, R., Vardy, S., and Vink, S. (2011). ACARP PROJECT C18033 DEVELOPMENT OF ECOSYSTEM PROTECTION TRIGGER VALUES FOR SODIUM SULFATE IN SEASONALLY FLOWING STREAMS OF THE FITZROY RIVER BASIN November 2011.

Dunlop, J.E., Horrigan, N., McGregor, G., Kefford, B.J., Choy, S., and Prasad, R. (2008). Effect of spatial variation on salinity tolerance of macroinvertebrates in Eastern Australia and implications for ecosystem protection trigger values. *Environmental Pollution* 151:621-630.

- Dwyer, F.J., Burch, S.A., Ingersoll, C.G. and Hunn, J.B. (1992). Toxicity of trace element and salinity mixtures to striped bass (*Morone saxatilis*) and *Daphnia magna*, *Environmental Toxicology and Chemistry* 11: 513–520.
- Farag, A.M. and D.D. Harper, editors (2012). *The Potential Effects of Sodium Bicarbonate, a Major Constituent of Produced Waters from Coalbed Natural Gas Production, on Aquatic Life*. U.S. Geological Survey, Reston, Virginia, USA.
- GHD (2010). Angus Place Colliery Water Quality Baseline Study (ANZECC Assessment) Report to Centennial Coal Pty Ltd. June 2010.
- GHD 2013 *Western Coalfield Water Balance* Centennial Coal November 2013.
- GHD (2014) Centennial Coal Company Limited Cocks River Ecotoxicology Assessment September 2014
- GHD (2014a) Springvale Coal Pty Ltd Springvale EPA Water Quality and Toxicity Assessment Interpretive Report August 2014
- Kefford, B.J., J. Miller, M. Krogh and R.B. Schafer (2013). *Salinity and stream macroinvertebrate community structure – the case of the Hunter River Catchment, Eastern Australia*. Report prepared for NSW Office of Environment and Heritage.
- Lopez Vera, C., Hyne, R.V., Patra, R., Ramasamy, S., Pablo, F., Julli, M. and Kefford, B.J. (2014) Bicarbonate toxicity to *Ceriodaphnia dubia* and the freshwater shrimp *Paratya australiensis* and its influence on zinc toxicity. *Env. Toxicology and Chemistry*. 33(5): 1179-1186.
- Nielsen, D.L., Brock, M.A., Rees, G.N. and Baldwin, D.S. (2003). Effects of increasing salinity on freshwater ecosystems in Australia. *Australian Journal of Botany* 51: 655 – 665.
- Krogh, M. and Miller, J. (2011). Cocks River Catchment - Water Quality and Macroinvertebrate Communities. Monitoring Unit – Waters & Coastal Science Section, Scientific Services Division, Office of Environment and Heritage. November 2011
- Krogh, M., Dorani, F., Foulsham, E., McSorley, A and Hoey, D. (2013). Hunter Catchment Salinity Assessment. Final Report. Environment Protection Authority, Sydney.
- Mount D.R., Gully D.D., Hockett J.R., Garrison T.D., and Evans J.M. (1997). Statistical models to predict the toxicity of major ions to *Ceriodaphnia dubia*, *Daphnia magna*, and *Pimephales promelas* (fathead minnows). *Environmental Toxicology and Chemistry* 16: 2009 – 2019.
- OEH (2012). *Chemical and Ecotoxicology Assessment of Discharge Waters from West Cliff Mine, For samples collected between 14 May and 25 June 2012 from Licensed Discharge Point 11, Brennans Creek Dam and Upper Georges River (upstream and downstream of the Brennans Creek confluence)*. Report to the NSW Environment Protection Authority, August 2012.
- RPS 2014 REGIONAL WATER QUALITY IMPACT ASSESSMENT - ANGUS PLACE AND SPRINGVALE MINE EXTENSION PROJECTS. Report S187E/021b. 10 September 2014
- Zalizniak, L., Kefford, B.J., Nuggeoda, D., (2006). Is salinity all the same? I. The effect of ionic compositions on the salinity tolerance of five species of freshwater invertebrates. *Marine and Freshwater Research* 57: 75-82.

Martin Krogh

Principal Scientist Major Assessments
Office of Environment and Heritage
3 November 2014

ATTACHMENT TWO (DOC14/257524-02) - Comments on Appendix 10 Coxs River Ecotoxicology Assessment (GDH September 2014).

M Julli (OEH Environmental Forensics) 30 October 2014

Comments

Executive Summary, paragraph 3

The results of this study show that the discharge at SV LDP009 is having an acute impact on cladoceran species at the Sawyers Swamp Creek site downstream of discharges; however this acute toxicity is ameliorated as the discharge enters the Coxs River. Impacts on cladoceran reproduction show a decreasing trend in the Coxs River with distance downstream of the SV LDP009 discharge point until no toxic impacts are detected in the upper portion of Lake Wallace.

Comments:

- LDP009 was found to be significantly toxic to most of the tested species of animals and plants, with algae and hydra being more sensitive than the cladoceran (see extracted Table 3.1(p21) below. LDP009 discharge was acutely toxic (i.e effectively lethal) to the tested fish.

Table 3-1 Summary of AP LDP001 and SV LDP009 Ecotoxicology Results

Bioassay	Concentration (95% confidence limits)	
	EC ₁₀	EC ₅₀
SV LDP009 discharge		
Eight day cladoceran reproduction	9.3% (5.2%–16.0%)	29.1% (16.3%–50.3%)
72 hour microalgal growth inhibition	3.7% (2.3%–3.8%)	6.0% (5.5%–6.7%)
96 hour duckweed growth inhibition	>100%	>100%
96 hour hydra population growth	5.1% (2.4%–7.3%)	18.0% (13.9%–24.8%)
96 hour eastern rainbowfish imbalance	25% (0.0%–34.2%)	50% (41.7%–59.2%)

- Sampling for the study was carried out immediately after significant rainfall events (see Fig 2.2 p12), so assessments of “decreasing trends” in toxicity downstream are considered unreliable and may not reflect impacts under low flow conditions given the large LDP009 discharge volume relative to normal creek/river flows.

- Further, the report obviously could not consider the potential impacts on toxicity if LDP001 discharge rates are reduced due to the closure of the Angus Place Colliery. Given the marked toxicity in the LDP009 discharge, the absence of flow from the LDP001 discharge may actually adversely impact on amelioration of toxicity in the receiving environments downstream of LDP009.

Executive Summary Paragraph 4

The results of the toxicity testing were used to determine the concentration of SV LDP009 discharge of 2.7% to provide protection to 95% of the species in the downstream ecosystem. An estimate of the runoff contributing to the Coxs River was obtained from the water balance model developed by RPS (2014a). The estimated catchment runoff to the Coxs River at each location was compared to the predicted maximum daily discharge volume from AP LDP001 and SV LDP009 to determine the expected dilution of discharge within the river. The target dilution of SV LDP009 discharge was not found to be met under median rainfall conditions.

Comments:

- The Site Specific Trigger Value (SSTV) for the LDP009 discharge calculated by GDH, following ANZECC/ARMCANZ 2000 Water Quality Guideline Procedures and based on the study ecotoxicity results, indicate **that the discharge needs to be diluted approximately 40 times** in order to protect 95% of aquatic species (slightly to moderately disturbed ecosystems).
- The report indicates the required dilution is not achievable under natural median river flows in the Coxs River for an extended distance downstream (i.e. 5km upstream of Lake Burragorang).
- Based on the reported absence of chronic toxicity in the cladoceran for the sample from Lake Wallace (and further downstream) it would appear that amelioration of the LDP009 discharge occurred at the time of sampling (albeit, following significant rainfall events).
- It is implied in the report that discharge limits and environmental safeguards will not be applied to “end of pipe” LDP009 discharge, and, rather than any effluent treatment process, an extended “mixing zone” within Coxs River is to be maintained and utilized. This is not consistent with the principles and recommendations regarding mixing zones in the Australian Water Quality Guidelines (ANZECC/ARMCANZ 2000, see Attachment 1).

- Allowing the LDP009 discharge to continue “as is”, would be affording the receiving waters of the Coxs River a level of protection equivalent to, or less than, a “Highly disturbed System...of lower ecological value” (80% species protection – Section 3.1.2, ANZECC/ARMCANZZ 2000).
- The intention of Centennial Coal to identify and remediate the toxic characteristics of the LDP009 discharge is noted and urgency is encouraged.

Possible Causes of Observed Ecotoxicity of LDP009 discharge

- It is considered unlikely that dissolved metals (as analysed and reported in the GDH report), contributed to the observed toxicity of LDP009.
- As noted in the report there are not apparent differences of significance in metal concentrations between LDP001 (non-toxic to the cladoceran) and LDP009 (toxic to cladoceran, algae, hydra and fish).
- The report notes there is no correlation between bicarbonate and chronic cladoceran toxicity.
- It is noted that in addition to high bicarbonate alkalinity, the LDP009 discharge has an exceptionally low hardness value of 2 mg/L as CaCO_3 , i.e. very low calcium (Ca) and magnesium (Mg), which differs markedly from the non-toxic LDP001 (116 mg/L CaCO_3).
- Further, LDP009 has high sodium (Na) (291mg/L) and low potassium (K) (9mg/L), while LDP001 has Na at 182mg/L and K at 32mg/L.
- The unusual ionic composition of LDP009 discharge may be a significant contributor to the observed toxic effects. Preliminary re-evaluation of data detailed in Figure 3.3 of the report, showed that normalisation of bicarbonate alkalinity to $\text{Ca}+\text{Mg}+\text{K}$ concentration resulted in the R^2 value improving from 0.0099 (Fig 3.3 in report) to $R^2 = 0.601$.
- A modified Toxicity Identification and Evaluation (TIE) process investigating modifications to the ionic composition of LDP009 on acute Cladoceran toxicity at 100% would be feasible.

- The report cites flocculants as a possible cause of observed toxicity in the LDP009 discharge. It is recommended that Centennial Coal should immediately discuss this with EPA and quickly evaluate this as a possible toxic source.

Nutrients

- Table 2.3 (p13) Ammonia and NOx not considered as nutrient pollutants.
- It is noted that the LDP009 discharge has ammonia at 0.44mg/L (33X the ANZECC/ARMCANZ 2000 nutrient trigger value – see Attachment 2). Mixing zones are not appropriate for nutrients (Attachment 1).
- Given the large discharge volumes of LDP 009 relative to natural flows and the apparent extensive algal growth reported in sections of the Coks River downstream of the LDP009 and LDP001 discharges, this would seem to be an issue requiring resolution

General Comments

Section 2 Methodology

A total of 45 L of water was collected at SV LDP009, 10 L at AP LDP001 and 1 L at all other sites with samples put on ice and immediately transferred to the Ecotox Services Australasia (ESA) laboratory in Sydney for toxicity testing. Samples from each location were also sent to the ALS Environmental Division laboratory in Sydney for water quality analysis.

Comment: It is noted that the phrase "immediately transferred" above, appears actually be a 4-5 day delay between collection and delivery for testing, and that samples were at ambient temperature when delivered rather than at 0-4°C (see below). It is not known how this may have affected the toxicity or chemical test results.

	
Toxicity Test Report: TR1223/7 (Page 1 of 2)	
Accredited for compliance with ISO/IEC 17025	
Client: GHD Pty Ltd GHD Tower, 24 Honeysuckle Drive Newcastle NSW 2300	ESA Job #: PR1223 Date Sampled: 21 & 22 August 2014 Date Received: 25 August 2014
Attention: Stuart Gray	Sampled By: Client
Client Ref: Not supplied	ESA Quote #: PL1223 q01
Lab ID No.: 6809	Sample Name: SVLDP009 DS Sample Description: Aqueous sample, pH 8.8*, conductivity 1089µS/cm*. Sample received at 16°C* in apparent good condition.

Appendix 1 Mixing zones adjacent to effluent outfalls

The nature of mixing zones

In a management context, mixing zones are often defined as an explicit area around an effluent discharge where the Management Goals of the ambient waters do not need to be achieved and hence the designated Environmental Values (EVs) may not be protected. In this context mixing zones are sometimes termed *exclusion zones*. The boundaries of these zones are usually determined under worst case scenarios.

Mixing zones are generally designated to manage the controlled discharge of soluble, non-bioaccumulatory toxicants whose impacts on local biota are primarily related to their concentration. The use of mixing zones is not appropriate for managing the discharge of nutrients, bio-accumulatory or particulate substances. With respect to nutrients, for example, stimulation of algae (e.g. phytoplankton) may occur considerable distances away from the outfall and is mediated by the biological characteristics of the waterbody as a whole.

The boundary of the mixing zone is usually defined in terms of the concentrations of indicator species in the effluent. Where these are statistically indistinguishable from ambient water concentrations (for example, statistical *t*-tests performed on sets of samples taken at progressively greater distances from the release point, with $\alpha = 0.05$), the mixing zone is presumed to have ended (α , or the probability of committing a Type I error, is explained further in box 2.3 and in Sections 3.1.7 and 7.2.3, Volume 1).

The extent and nature of mixing zones depend on hydrological conditions at the outfall site. At high-energy sites (such as open marine systems or streams with large flows, tides, currents, or wave action) effluent may more quickly disperse and the mixing zone may be relatively small. Conversely, in low-energy systems such as lakes and slow streams, mixing may be slower and the mixing zone will be larger. Simple models for mixing zones assume a smooth gradient of concentration from the source to the boundary. In high energy systems characterised by turbulence or for cases where water flow is not unidirectional, irregular concentration gradients may be observed, giving large short-range variability in indicator concentrations, and resulting in the boundary of the mixing zone being somewhat indeterminate. Where stratification is likely (due to differences in density between the effluent and the receiving water) models used in predicting the size of the mixing zone must take this into account. For example, differences in density may be caused by temperature or salt load, and may increase the stability of the plume.

Difficulties with mixing zones

The major problems with mixing zones are:

- They are areas of water, albeit usually small, where prudent environmental safeguards may need to be suspended. For sedentary species acutely sensitive to effluent components, the mixing zone may become a sacrificial zone from which ecological recovery is slow when effluent release is stopped.
- Where hydrological conditions are variable, the rate of mixing and the extent of the contaminant field will vary over time, sometimes necessitating continual monitoring and the ability to suspend effluent release at short notice.

- Subtle ecological detriment may be caused at sites remote from the mixing zone, especially in fluvial systems, when particulate material is either present in the effluent or generated by interaction with ambient water. Such particulates may settle in low-energy deposition zones from which remobilisation may be possible under certain circumstances.
- Where an effluent contains compounds which bioaccumulate or biomagnify through food chain effects, gradual dilution into the ambient environment will not necessarily keep concentrations of these compounds below acceptable levels.
- Mixing zones may inhibit fish migration in small rivers, particularly during low river flow conditions.

The management of mixing zones

Before a mixing zone is permitted, every effort should be made to reduce the amount and concentration of liquid waste by applying the waste hierarchy: avoid, reduce, reuse, recycle, treat, dispose. In applying the hierarchy, best practice should be used as benchmarks throughout the planning process.

A mixing zone should have a maximum agreed size. Effective discharge controls that consider the level of waste treatment, the concentration and the total mass of pollutants, and the *in situ* dilution, should ensure that the area of a mixing zone is small and the values of the waterbody as a whole are not prejudiced. The point of discharge should be chosen to minimise the size and impact of the mixing zone. If considerations of the effluent quality and receiving water characteristics indicate that high initial dilutions are required, then a diffuser at the point of discharge may be the best option. Where mixing zones occur, management should ensure that impacts are effectively contained within the agreed zone, and that the size of the mixing zone is sufficiently small so as not to compromise the agreed and designated values and uses of the ecosystem as a whole. In keeping with the philosophy of continual improvement, efforts should be made to reduce the size of mixing zones over time.

A management objective in the allocation and monitoring of mixing zones should be to minimise the potential for ecological detriment, especially permanent degradation. This assumes that an assessment has been made that alternative means of effluent disposal are not best practice. Human health considerations would not normally be relevant in the allocation of mixing zone permits, because a licence to release effluent would be unlikely to be issued where the EVs for the mixing zone include protection of fish, crustacea and shellfish for human consumption.

Similarly, recreational use inside a mixing zone would not usually be prudent unless the effluent was known to be benign (for example characterised only by differences in temperature from ambient water). Mixing-zone management is influenced by a number of considerations. In locations of high environmental significance, severe restrictions may be placed on the creation of mixing zones, if they are allowed at all. Depending on the stringency of the environmental requirements being suspended, some or all of the following restrictions, and their extent, may be applied to achieve best practice in mixing zone management:

- Treatment and toxicity testing: pre-release effluent treatment may be required, or only permits for effluent known to be benign may be issued. These stipulations may be accompanied by a requirement for pre-release toxicity testing.
- Temporal restrictions: release may only be permitted under specified hydrological conditions. For example, discharge to marine or estuarine environments may only be

allowed when certain tidal conditions are met. For fluvial systems, threshold streamflow discharge may be required for release.

- Temporal restrictions: a requirement may be made for the effluent release to be pulsed, with extended periods of no release to maximise the possibility of ecological recovery between episodes.
- Mixing zone size: the mixing zone must be as small as practical in accordance with the waste management hierarchy, and either alone, or in combination with other mixing zones, should not occupy a significant proportion of the receiving waters. The overall integrity of the ecosystem should not be compromised; for example, the entire width of a stream should not be occluded by the zone. This may allow migrating species to avoid the contaminated zone.
- Mixing zones not applicable to certain waters: mixing zones should not generally be designated in waters which have values or characteristics which are not compatible with the existence of a plume of water which does not meet ambient management goals. Examples include waters which either: (a) receive significant and regular use for primary contact recreation; (b) are recognised as of significant value as spawning or nursery areas; (c) are close to areas used for aquaculture; (d) are close to potable water supply intakes; (e) are of outstanding ecological or scientific importance; (f) have high conservation ecosystem values; or (g) where the mixing zone plume is likely to hug the shoreline.
- Emission limits: emission discharge limits should be set such that, within the mixing zone, the emission does not cause either: (a) objectionable odours which would adversely affect the use of the surrounding environment; (b) objectionable discoloration at the surface of the mixing zone which could adversely affect the use of the surrounding environment; (c) visible floating foam, oils, grease, scum, litter or other objectionable matter; (d) acute toxicity to fish or other aquatic vertebrates; (e) significant irreversible harm within the mixing zone, including objectionable bottom deposits; (f) at levels which, when the size of the mixing zone is considered, may constitute a barrier to the migration of aquatic organisms; or (g) the growth of undesirable aquatic life or dominance of nuisance species (algal blooms, for example).
- Prohibition of certain substances: mixing zones should not be used for chemicals which bioaccumulate, unless it can be demonstrated that the discharge of these substances into the environment will not result in long-term adverse effects to biota.
- Mixing zones should not be used to manage the biostimulant impacts of nutrients, since the stimulation of algae (e.g. phytoplankton) may occur at considerable distances away from the nutrient source and is mediated by the biological characteristics of the waterbody as a whole.
- Monitoring programs: monitoring may be mandatory. Apart from chemical, physical and biological monitoring in the affected area, the rate of dispersal of the mixing zone after suspension of release may need to be evaluated, particularly in low-energy waterbodies such as lakes. Ecotoxicity testing should be evaluated and conducted where necessary (for example, to assess the toxicity of effluent containing mixtures of pollutants).

As the environmental values which have been agreed upon through a public consultation program are likely to be prejudiced by the mixing zone, it is important that the existence of the mixing zone, and its size and location, be public knowledge and the actual location of the zone adequately marked.

Tables 3.3.2–3.3.3 South-east Australia

The following tables outline default trigger values applicable to Victoria, New South Wales, south-east Queensland, the Australian Capital Territory and Tasmania. Where individual states or territories have developed their own regional guideline trigger values, those values should be used in preference to the default values provided below. (Upland streams are defined as those at >150 m altitude, while alpine streams are those at altitudes >1500 m.)

Table 3.3.2 Default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems. Trigger values are used to assess risk of adverse effects due to nutrients, biodegradable organic matter and pH in various ecosystem types. Data derived from trigger values supplied by Australian states and territories. Chl a = chlorophyll a, TP = total phosphorus, FRP = filterable reactive phosphate, TN = total nitrogen, NO_x = oxides of nitrogen, NH₄⁺ = ammonium, DO = dissolved oxygen.

Ecosystem type	Chl a (µg L ⁻¹)	TP (µg P L ⁻¹)	FRP (µg P L ⁻¹)	TN (µg N L ⁻¹)	NO _x (µg N L ⁻¹)	NH ₄ ⁺ (µg N L ⁻¹)	DO (% saturation) ^j		pH	
							Lower limit	Upper limit	Lower limit	Upper limit
Upland river	na ^a	20 ^b	15 ^c	250 ^d	15 ^h	13 ⁱ	90	110	6.5	7.5 ^m
Lowland river ^d	5	50	20	500	40 ⁿ	20	85	110	6.5	8.0
Freshwater lakes & Reservoirs	5 ^e	10	5	350	10	10	90	110	6.5	8.0 ^m
Wetlands	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
Estuaries ^g	4 ^f	30	5 ^j	300	15	15	80	110	7.0	8.5
Marine ^g	1 ⁿ	25 ⁿ	10	120	5 ^k	15 ^k	90	110	8.0	8.4

na = not applicable;

a = monitoring of periphyton and not phytoplankton biomass is recommended in upland rivers — values for periphyton biomass (mg Chl a m⁻²) to be developed;

b = values are 30 µg L⁻¹ for Qld rivers, 10 µg L⁻¹ for Vic. alpine streams and 13 µg L⁻¹ for Tas. rivers;

c = values are 100 µg L⁻¹ for Vic. alpine streams and 480 µg L⁻¹ for Tas. rivers;

d = values are 3 µg L⁻¹ for Chl a, 25 µg L⁻¹ for TP and 350 µg L⁻¹ for TN for NSW & Vic. east flowing coastal rivers;

e = values are 3 µg L⁻¹ for Tas. lakes;

f = value is 5 µg L⁻¹ for Qld estuaries;

g = value is 5 µg L⁻¹ for Vic. alpine streams and Tas. rivers;

h = value is 190 µg L⁻¹ for Tas. rivers;

i = value is 10 µg L⁻¹ for Qld. rivers;

j = value is 15 µg L⁻¹ for Qld. estuaries;

k = values of 25 µg L⁻¹ for NO_x and 20 µg L⁻¹ for NH₄⁺ for NSW are elevated due to frequent upwelling events;

l = dissolved oxygen values were derived from daytime measurements. Dissolved oxygen concentrations may vary diurnally and with depth. Monitoring programs should assess this potential variability (see Section 3.3.3.2);

m = values for NSW upland rivers are 6.5–8.0, for NSW lowland rivers 6.5–8.5, for humic rich Tas. lakes and rivers 4.0–6.5;

n = values are 20 µg L⁻¹ for TP for offshore waters and 1.5 µg L⁻¹ for Chl a for Qld inshore waters;

o = value is 60 µg L⁻¹ for Qld rivers;

p = no data available for Tasmanian estuarine and marine waters. A precautionary approach should be adopted when applying default trigger values to these systems.

Comments on Appendix 9 Springvale EPA Water Quality and Toxicity Assessment Interpretative Report (GDH August 2014).

M Julli (OEH Environmental Forensics) 30 October 2014

Comments

GDH Report:

Introduction

1.2 Purpose of this report

The purpose of this report is to use information provided on the chemistry of LDP009 and the ecotoxicology conducted by the NSW EPA to determine impacts on the receiving environment and, if possible, to determine the need for water treatment.

Comment:

The preliminary OEH/EPA ecotoxicology and chemical assessment of the LDP009 discharge was carried out to provide basic acute toxicity screening information given the absence of data. This information was provided to Centennial Coal to assist them in developing a more detailed program.

Given the screening nature of the OEH/EPA work, it was not designed to be utilized for the purpose stated in section 1.2 (above) of the GDH report.

As such the criticisms contained in the GDH report regarding the limitations and poor quality of the OEH ecotoxicity tests would appear to be somewhat gratuitous, and primarily focussed on discounting the OEH observed acute toxic effects in the LDP009 discharge.

OEH can confirm that cladoceran acute tests on the LDP009 samples were actually repeated soon after the preliminary tests were completed and these subsequent tests confirmed the preliminary results. It is also noted that the subsequent ecotoxicity testing of LDP009 discharge by Centennial Coal reinforced the OEH preliminary results.

APPENDIX THREE (DOC14/257524-03) - Water Technical Advisory Unit (WTAU) comments on the Response to Submissions Appendix 3 in both the Angus Place and Springvale Colliery Extension Project *Environmental Impact Statements*.

Background

Central West Region requested comments on Appendix 3 for both projects which aim to address concerns raised by the EPA regarding the quality of the discharge water with respect to ANZECC and ARMCANZ (2000) water quality guidelines.

Office of Environment and Heritage (OEH) Contaminants and Risk Section and Water Science Section are providing advice to EPA on other water sections in the EIS. The focus of the following comments is on salinity as there are related other sections in the Response to Submission dealing with ecotoxicity that are being reviewed by OEH which will also deal with metals. Some metals issues, however, are noted below as they relate to the assessment of site specific trigger values.

WTAU supports the comments provide by Moreno Julli regarding the use of mixing zones for nutrients as being inappropriate. The ANZECC guidelines state that *"Mixing zones should not be used to manage the biostimulant impacts of nutrients, since the stimulation of algae (e.g. phytoplankton) may occur at considerable distances away from the nutrient source and is mediated by the biological characteristics of the waterbody as a whole."*

Angus Place and Springvale Appendix 3

The RPS reports (Appendix 3 for both projects) fails to correctly interpret the ANZECC and ARMCANZ (2000) water quality guidelines (ANZECC guidelines) and do not adequately address the EPA concerns raised in its submission to the EIS. These issues are discussed below.

Salinity

- Appendix 3 in both documents states that: *"Research undertaken by Hart et al. (1991) shows that the TDS needs to be above 1000 mg/L before it can lead to toxic effects, this equates to an EC of approximately 1500 μ S/cm."* This research is based on studies prior to 1991 and relates to the now superseded ANZECC (1992) water quality guidelines. The 1992 guidelines:
 - highlighted the dearth of information on the sensitivity of Australian freshwater organisms to increases in salinity and found few studies on sub-lethal or long term effects, or on possibly more-sensitive life stages; and
 - specifically cautioned against allowing existing freshwater systems that are well below the salinity of 1000 mg/L to be increased up to this level.

New information is now available and this is reflected in the ANZECC (2000) guideline trigger values. Note that the Krogh and Miller report on *Coxs River Catchment - Water Quality and Macroinvertebrate Communities*, referred to in the EPA submission to the EISs, also provides further information on salinity impacts).

- The RPS reports do not properly account for an overriding principle in the ANZECC (2000) guidelines that should guide management, which is continual improvement (see Section 2.2.1.7). For example, in waters that are of better quality than that set by the water quality objectives, some emphasis could still be given to reducing the level of contamination from all sources. Wherever possible, ambient water quality should not be allowed to degrade to the levels prescribed by the water quality objectives. It is also not acceptable to allow poor environmental performance or water pollution, simply because

a waterway is degraded. The NWQMS also notes that accepted modern technology, consistent with ongoing economic viability, should be maintained even where this will secure higher water quality outcomes than what the water quality objectives require.

Mixing zones

- It is agreed that within the area where initial mixing occurs, the water quality objectives and ANZECC trigger values are not necessarily met. Consistent with the policies and principles established under the National Water Quality Management Strategy, the relevant guiding principles used by the EPA when considering initial mixing and the environmental impact within a mixing area are that:
 - The mixing that is taken into account is the 'near-field' or initial mixing where the initial characteristics of momentum flux, buoyancy flux and outfall geometry influence the plume trajectory and mixing;
 - Mixing that occurs through buoyant spreading motion and passive diffusion due to ambient turbulence is referred to as 'far-field' mixing;
 - the area or volume of an individual zone should be limited to an area or volume as small as practicable that will not interfere with the designated uses or with the established community of aquatic life of the receiving waters;
 - Mixing zones should not be used for chemicals which bioaccumulate;
 - Mixing zones should not receive concentrations of pollutants that cause acute toxic impacts.
- The EPA's policy is that the water quality objectives/ANZECC trigger values should be met at the edge of the area where initial (near-field) mixing occurs. Options to meet this policy aim are considered and weighed against the matters to be considered in licensing decisions as set out under Section 45 of the *Protection of the Environment Operations Act 1997*. The matters that need to be taken into account include the impact of the pollution being caused, the environmental values of the waterway and the practicable measures that can be taken to mitigate the impacts of the pollution and maintain or restore the environmental values of the waterway. While the EPA's licensing approach is to consider the effect of a discharge at the edge of a defined initial "near field" mixing zone, if the discharge volume from the licensed discharge point would dominate flows in system under most conditions then the dilution effects within a near field mixing zone may be relatively minimal. EPA would therefore examine the pollutant concentrations at the point of discharge relative to ANZECC trigger values.
- EPA application of mixing zones is developed based on the guidance on mixing zones from ANZECC as well as requirements under the *Protection of the Environment Operations Act 1997*.
 - Where a mixing zone is permitted, every effort should be made to reduce the amount and concentration of liquid waste by applying the waste hierarchy: avoid, reduce, reuse, recycle, treat, dispose.
 - Effective discharge controls that consider the level of waste treatment, the concentration and the total mass of pollutants, and the in situ dilution, should ensure that the area of a mixing zone is small and the designated values and uses of the water body as a whole are not prejudiced.
 - A principle of continual improvement applies where efforts should be made to reduce the size of mixing zones over time.
- Appendix 3 (for both projects) states that "Where dilution is insufficient, the mixing zone criteria are not met in that the mixing zone extends from bank to bank. In this circumstance ANZECC recommends performing a "biological effects assessment" (e.g. Direct Toxicity Assessment)." This is an incorrect interpretation of the ANZECC

guidelines. The ANZECC guidelines do not link direct toxicity assessment with a mixing zone that extends from bank to bank. The ANZECC guidelines state (in Volume 2, Appendix 1) that: *"The mixing zone must be as small as practical in accordance with the waste management hierarchy, and either alone, or in combination with other mixing zones, should not occupy a significant proportion of the receiving waters. The overall integrity of the ecosystem should not be compromised; for example, the entire width of a stream should not be occluded by the zone."*

- Overall, the dilution assessment in Appendix 3 for both projects does not adequately consider the above guidance and EPA policy on mixing zones. These inadequacies include that:
 - available initial near-field mixing is not defined in order for EPA to incorporate an appropriate dilution factor into licence limits;
 - and the extent and configuration of the mixing zone does not allow ANZECC trigger values to be achieved at the edge of any near field mixing zone.
- A substantial proportion of the time it appears that discharge volumes from licensed discharge points would dominate flows in the system and therefore it is unlikely that significant near-field dilution would be available under most circumstances (appropriate near-field mixing zone modelling would be required to establish available near-field mixing under worst-case and other scenarios).
- Taking into account the very low median salinity at the upstream Kangaroo Creek site and low median conductivity levels in the upper parts of the Coxs River catchment (50 – 200 $\mu\text{S}/\text{cm}$); the lack of appropriate information on a near-field mixing; and the principle of not polluting up to environmental limits, then a value of 350 $\mu\text{S}/\text{cm}$ (ANZECC 2000 default trigger value), applied at the point of discharge may be an appropriate value to guide management options for slightly to moderately disturbed ecosystem at this stage.

Selective application of site-specific trigger values

- The RPS report has selectively adopted a site-specific trigger value when it is less stringent than the ANZECC default trigger value and has adopted the ANZECC default trigger value when the site-specific trigger value is more stringent. This is an unacceptable approach.
- If appropriate data is available to derive site-specific trigger values (as set out in the ANZECC guidelines) and an agreed suitable reference site is available (consistent with the ANZECC guidance on reference sites), then site-specific trigger values are preferred over the default trigger values for physical and chemical stressors such as salinity. Toxicants are usually compared with a single default trigger value, less commonly with a background or reference distribution as the default values are prepared by analysis of a comprehensive set of available ecotoxicological data. For naturally occurring metals and some non-metallic inorganics, however, site specific trigger values can be developed using a similar methodology to the physical and chemical stressors.
- Note that "physical and chemical stressors" referred to above relates to the ANZECC guideline grouping of water quality indicators. The ANZECC guidelines state that: *"toxicants and 'physical and chemical stressors' are subcategories of the same class of potentially hazardous indicators, however, the treatment of these groups for guideline purposes is different."*

Suitability of reference sites and data used to define site specific trigger values

- The ANZECC guidelines advise that a minimum of two years of contiguous monthly data at a reference site is required before a valid trigger value can be established. Until this minimum data requirement has been established, comparison of the test site median should be made with reference to the default guideline values identified in Section 3.3 of the ANZECC guidelines.
- The data presented in Appendix 3 for both projects does not indicate the timeframe over which the samples are collected. While for most indicators there is more than 24 samples (which would be needed if 2 years of monthly was available), it is not clear if appropriate seasonal sampling has been conducted. (Note that OEH Water Science may be able to provide further advice on the suitability of the data for considering site specific trigger values.)
- The Kangaroo Creek upstream site may be an acceptable reference site for the assessment of site specific trigger values, in particular, salinity values appear consistent with values recorded at other upstream sites in the catchment, however, WTAU cannot determine its suitability as a reference site without further information, for example, the metals data are highly elevated compared to the default trigger value and the mix of ions making up salinity may be different. (Note that OEH Water Science may be able to provide further advice on this aspect.)
- An inappropriate reference site appears to have been used in the derivation of site specific trigger values for the scenario that considers Sawyers Creek as a discharge into Coxs River (Springvale Appendix 3). This is discussed further below.

Discharge from Sawyer Creek to Coxs River (Springvale)

- An inappropriate reference site appears to have been used in the derivation of site specific trigger values for the Discharge from Sawyer Creek to Coxs River.
- The derivation of a trigger value of 1539 $\mu\text{S}/\text{cm}$ is not consistent with the ANZECC guidelines methodology for defining site specific trigger values and the reference site does not appear consistent with the Section 3.1.4 "Defining a reference condition" in the ANZECC guidelines.
- Median conductivity levels in the upper parts of the Coxs River catchment are often in the 50 – 200 $\mu\text{S}/\text{cm}$ range, indicating that 1539 $\mu\text{S}/\text{cm}$ is a significant departure from a suitable reference site and reflects impacts in the catchment.
- The reference sites should be selected based on the best available sites representative of the level of protection for the part of the river in question, in this case slightly to moderately disturbed conditions. An appropriate reference site therefore should be at least only slightly disturbed. Selection of reference sites and application of trigger values should not result in water of lesser quality than that already prevailing.

Other comments

- The GHD report (Appendix 9) states that the conductivity of the upstream Kangaroo Creek site was measured at 820 $\mu\text{S}/\text{cm}$. This is not consistent with data presented in Appendix 3 which indicated median EC of 69 $\mu\text{S}/\text{cm}$ and the site specific trigger value was calculated to be 89 $\mu\text{S}/\text{cm}$.

ATTACHMENT FOUR (DOC14/ 257524-04) – EPA COMMENTS ON THE RESPONSE TO SUBMISSIONS FOR THE SPRINGVALE AND ANGUS PLACE MINE EXTENSION PROJECTS

4A Springvale Colliery, Environment Protection Licence No. 3607 and Salinity

Centennial Coal, and the licensee for EPL 3607, Springvale Coal and Springvale SK Kores/Springvale Coal, has been involved for some time in the EPA's regulatory efforts for the licensee to reduce the salinity of the discharge in the Springvale Delta Water Transfer Scheme (SDWTS). On 2 August 2012 the EPA attached a Special Condition to EPL 3607 requiring the preparation of an Options Study to treat mine water and the options *"must be capable of treating all mine water generated by the premises (ground and surface water) to achieve an electrical conductivity (EC) of 350 microsiemens per centimetre in the treated water, prior to the treated water being discharged to the Cocks River or any of its tributaries"*.

A Options Study was submitted by 30 September 2013, as required. The EPA has since engaged HydroScience to assess the Options presented.

It is important for the Department of Planning and Environment (DPE) to know that even if the Springvale Mine Extension Project was not being proposed, and if the recent circumstances at Angus Place were not occurring, the EPA would still be negotiating with Centennial Coal and its licensee to reduce the salinity of its discharge from Licensed Discharge Point 9 (LDP9). The EPA's current position is a continuation of a regulatory effort to reduce the salinity concentrations of the upper Cocks River. The EPA considers the current limits on LDP9 to be interim until a change in management of the mine water (handling, treatment etc) is implemented.

4B Regional Biodiversity Strategy – Western Projects (Appendix 4)

The Regional Biodiversity Strategy includes a Cocks River Catchment Restoration Program (page 90) which maintains *"is aimed to further enhance the biodiversity values that exist within the Cocks River Catchment and ameliorate the cumulative impacts associated with Centennial projects and the many projects that influences the physical and chemical nature of the Cocks River"*. Further, In this document it is stated that *"the primary impacts from the Angus Place and Springvale Coal projects, specific to instream ecology, are changes to surface hydrology and hydrogeology"* (page 24).

The Strategy provides a list of Centennial's Proposed Protection and Management for Commonwealth Colliery, Bray's Lane, Lidsdale, Wangcol Creek, Lamberts Gully and Angus Place Management Sites. A variety of measures such as riparian restoration, native tree plantings, weed and rabbit control are proposed; however, while these are worthy measures to improve the riparian zone and nearby landscape management, the Cocks River Catchment Restoration Program makes not statements about how any of these relate to an improvement in water quality. They would contribute to streambank stability, reduced sediment laden runoff and keeping nutrients out of the waterways but should not be viewed as measures to compensate for not reducing salinity and certain metals in the upper Cocks River.

4C Closure and Mothballing of Angus Place Colliery – Environment Protection Licence (EPL 467)

The EPA recommends, now that Angus Place has been mothballed indefinitely, that Centennial implements a previous option it once proposed to eliminate the mine water discharge from Angus Place. In September 2011 Centennial Coal proposed to the EPA that it could operate Angus Place as a "nil discharge mine" for groundwater pumped to the

surface from the underground workings. The EPA considered this a serious option to improve the water quality of the upper Cocks River by eliminating this mine water discharge.

On 19 December 2011, following further negotiations with, and importantly agreement by, Centennial Coal, the EPA varied EPL 467 to include a Pollution Reduction Program (PRP), as follows:

"By 30 June 2013, the Licensee must have modified the underground pumping regime at the premise such that no groundwater is discharged through licensed discharge point 1 (LDP1) under normal site operating conditions. After this date, any discharge of groundwater to surface waters from LDP1 will only be permitted in an emergency situation."

On 15 April 2013 Centennial advised it could not meet its PRP because a recent inspection of a bore that was to be used had collapsed. This "nil discharge" outcome never eventuated. However, Centennial did manage its mine water to reduce the volume of discharge from 6-7 Megalitres per day (ML/d) to less than 2 ML/d. The EPA then made the new volume limit 2 ML/d for LDP1.

From this exercise, it is apparent to the EPA that Centennial could now again consider this option, including repairing the collapse bore and then direct mine water from Springvale into the mothballed Angus Place workings. There may be scope for a hybrid option of the partial discharge after treatment to reduce the salinity of Springvale mine water, with the remaining portion directed into the old Angus Place workings for storage until mining at Springvale ends in 2023 at which time the mine water could be transferred back to Springvale for treatment upon the recommencement of mining at Angus Place.

The EPA recommends that DPE requires Centennial to take this option into account for the Springvale Mine Extension Project.