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9 July 2015

Attn: Peter Corbett
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Springvale Mine Extension Project
IA059800/061b

Hydrological Advice to PAC Review

Dear Peter,

1. Introduction

We have prepared this letter to Springvale Coal Pty Ltd (Centennial) in accordance with our proposal (IA059800/060a, dated 6 July 2015) to provide advice on comments presented by the NSW Office of Environment and Heritage (OEH) within the Planning Assessment Commission (PAC) review (PAC, 2015) of Centennial's Springvale Mine Extension Project.

This letter addresses comments that are relevant to both Angus Place and Springvale.

It is noted that several of the matters raised in PAC (2015) were responded to in Centennial's Response to Agency Comments on the Response to Submissions. Centennial's Response at the time included Jacob's letter of advice (Jacobs, 2014), therefore, where relevant, reference is made to the earlier advice, or is updated if necessary.

2. Proposed Response

2.1 Appropriateness of the AWBM Model

Issue OEH01) *Details are provided on various assumptions about the model, the environment and the parameters in the model, but not all the assumptions are either clearly stated*[1] *or supported by quantitative scientific data…*

[1] *For example no details are provided on the 'suite of in-house programs to generate a continuous time-series' – see Section 3.1.2.2.*

The "*suite of in-house programs to generate a continuous time-series*" is explained in Section 3.1.2.1 and 3.1.2.2 of Jacobs (2015) and refers to the method used for patching daily rainfall and evaporation data. As stated in Jacobs (2015), processing is achieved through disaggregation of accumulated data (segregating two to several days of observed data into individual days) and infilling of missing data (estimating what the daily data might have been when the gauge reader had been absent for an extended period), both through relationships (devised using regression analysis) with neighbouring gauges.

Where the value of some estimated model parameters, such as Land-Use Class Salinity, Average Soil Storage Capacity and Baseflow Index were considered to be potentially uncertain, then the sensitivity of model output to changes in the values of these parameters was assessed through sensitivity analysis. The impact of uncertainty in the values of parameters identified to be sensitive was then further assessed via uncertainty analysis on model predictions. Section 3.3 of Jacobs (2015) presents the results of sensitivity analysis. Section 3.8 presents the results of uncertainty analysis.

From Section 3.3, model output at node #047 (coincident with NSW Office of Water Gauge No. 212054) was assessed with respect to changes in Land-Use Salinity, Average Soil Storage Capacity and Baseflow Index via comparison between the calibration simulation and various sensitivity analysis scenarios.

Sensitivity analysis indicated that modelled median salinity at node #047 was moderately sensitive to assumed value of Land-Use Salinity (20% increase and 20% decrease in the input value of Land-Use Salinity led to a 7.2% increase and 7.2% decrease in model output).

Sensitivity analysis indicated that modelled median salinity was not particularly sensitive to changes in Average Soil Storage Capacity (20% increase and 20% decrease led to a 3.1% increase and 4.1% decrease), however, modelled median flow was moderately sensitive (20% increase and 20% decrease led to a 7.6% decrease and 11.5% increase)

Sensitivity analysis indicated that changes to Baseflow Index led to minor changes in modelled median salinity (20% increase and 20% decrease led to a 2.7% decrease and 3.1% increase) and minor changes in modelled median flow (20% increase and 20% decrease led to increase of 7.7% and decrease of 8.5%).

In summary, sensitivity analysis did not indicate that any of the assumed values for model parameters were highly sensitive.

As stated in RPS (2014) and Jacobs (2015) prediction simulations are presented with respect to both the Proposal and the Null case. The reason this is done in environmental modelling is to accommodate any residual issue with model conceptualisation and / or calibration, whether it is positive or negative, into both the Proposal and the Null cases, thereby allowing evaluation of the impact of the Proposal on an equivalent platform.

Issue OEH02) *It is important to note that there has been NO validation of the AWBM model used in the water quality assessment.*

As presented in Jacobs (2015), the calibration simulation period was set to be from 1 January 1979 through to 30 June 2014, a period of 35 years. It is acknowledged in Jacobs (2015) that the observation dataset for salinity, in particular in the early part of calibration simulation, was not as extensive as that available with respect to flow.

A potential approach to including validation into this type of environmental model would be to exclude a portion of the time-series from the calibration process. Invariably, this has to be a late portion of the calibration time-series. This was not undertaken since the period 2006 to present encompasses the period of greatest stress to the model, namely a significant drought with recovery, the influence of the Springvale Delta Water Transfer Scheme (SDWTS) as well as curtailment of Wallerawang Power Station in 2014. In environmental modelling, periods of greatest change, particularly where they result in a system state that could be encountered during the prediction period, are of greatest value.

The approach instead was to extend the calibration period well into the past, prior to there being a significant dataset by which to make comparisons, however, demonstrating that system behaviour appropriately encapsulated the consequences of the sequential changes to the Coxs River since the commissioning of Lake Wallace and Lake Lyell in 1979. In adopting this approach, a general increase in salinity in storage reservoirs over time (well prior to the introduction of the SDWTS in 2006) is identified. A working hypothesis for this observation is that recirculation of historical discharge from Cooling Tower blowdown as input water supply extracted from Lake Lyell creates a 'semi-closed' circuit.

Issue OEH03) *Jacobs (2015) identified that they derived the data in the report from information "sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report". They expressed a strong caveat in that: "The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report'.*

The reviewer has quoted the General Limitations statement. In consulting, it is general practice to include a Statement of Limitations at the front of a report. From a commercial standpoint, the Consultant, whom is engaged by a Client, need to limit their liability to the information available, however, their work is governed by the requirement to conduct themselves with the usual care and thoroughness of the consulting profession, for the sole purpose described and by reference to applicable standards, guidelines, procedures and practices at the date of issue of the report. Details of project specific assumptions, such as model assumptions, are presented within the main body of the report (RPS, 2014 and Jacobs, 2015).

The full excerpt of the General Limitations statement in Jacobs (2015) is reproduced below for completeness.

"***Important note about your report***

The sole purpose of this report and the associated services performed by Jacobs is to undertake and report on additional simulations of the Regional Water Quality Impact Assessment Model that is being used to assess potential impacts to flow and quality (salinity) in the Coxs River catchment of various water management strategy options in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed *or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.*

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party."

Issue OEH04) *It is notable that OEH was not approached to provide any data for this area and that Jacobs (2015) do not appear to have been provided with daily discharge data from Centennial for their LDPs in the Upper Coxs River catchment over the period of model calibration. This is concerning because Centennial were required under conditions of their EPLs to collect daily discharge data to ensure they did not exceed EPL limits but do not appear to have provided this data to inform the work of Jacobs (2015). The EPA previously requested that Centennial supply daily flow data from their LDPs in the Upper Coxs River for such an assessment, but the company declined to supply it. Questions are therefore raised as to why such data have not been supplied to either Government or the developers of the hydrological model to provide the best assessment possible for the current proposal*.

Following from Jacobs (2014), information from third parties in the Coxs River was requested and some has been received from EnergyAustralia, in particular time-series observation in Lake Lyell. A request for other data, such as historical monitoring in Sawyers Swamp Creek and daily demand data at Mount Piper Power Station, has been declined at this stage.

All data available to Centennial was provided to RPS and Jacobs. As stated in Jacobs (2014) in response to OEH's comments in the Response to Submissions on the same matter, details of mine water discharge used in model simulation was presented in Section 3.1.2 of RPS (2014). Equivalent sections in Jacobs (2015) are Section 3.1.2.6 and 3.1.2.7. As noted in RPS (2014), Section 3.1.2, local LDPs were assumed to be represented by catchment runoff through sediment retention structures without attenuation of flow or salinity. Whilst not explicitly stated in RPS (2014), the statement "*It is noted that there is no assumed groundwater discharge from the Western Coal Services site and the recent inflow from 2011 may reflect changes in the catchment due to expansion of the Ash Placement Area at Mt Piper Power Station insofar dislocation of water previously stored within Huon Gully / Dam.*" was meant to imply that surface inputs were assumed to be represented by catchment runoff, with associated Land-Use Class set to 'Disturbed', as appropriate.

Jacobs are not privy to the correspondence between Centennial and OEH, however, it is presumed, at the time, that referral was made to already presented information rather than potentially referring to documents or data that had not been presented. In a similar way, it is understood that it was judged to not be appropriate, at that stage, to approach the regulator for information.

The daily discharge at each LDP, as available, was presented in the EIS. As is explained in response to Query OEH08 below, there was an error identified in the flow gauge at Angus Place LDP001, which has since been corrected. i.e. anomalous readings at ~20ML/d. Figure 3.3 of Jacobs (2015) presents the assumed discharge and salinity at Angus Place LDP001. As discussed in Jacobs (2015), the historical record was used, to the extent available, and that record was used to synthesize the early period, where no data was available.

Centennial are required to maintain records of daily discharge as per their EPLs and it is understood that this is now in order. As noted in Jacobs (2015), prior to August 2012, responsibility for Springvale

LDP009, then Delta Electricity/EnergyAustralia LDP020, vested with Delta Electricity, prior to its acquisition by EnergyAustralia.

Issue OEH05) *It is clear from the material presented in Jacobs (2015) that the model is poorly calibrated. Figures 3.5, 3.8, 3.9, 3.10, 3.12, 3.16 (salinity), 3.17, 3.20, 3.28, 3.30, 3.32 identify significant underestimation or overestimation of salinity, flow or both salinity and flow are various points (nodes) in the Upper Coxs River catchment. Figures 3.11, 3.14, 3.18, 3.26 and 3.29 potentially exhibit the worst calibrations of all those presented, where real data on flow/conductivity is very poorly matched to model predictions. This is actually identified by the authors (Jacobs 2015) themselves in places where they state:*

- *From Figure 3.14, the water quality model does not encapsulate observed distribution of salinity particularly well (p18)*
- *From Figure 3.17, the modelled fit to observed fit in Lake Wallace has deteriorated in the current version of the water quality model compared to the previous version (p20)*
- *Figure 3.13 indicates the fit of the calibration model to observed data was not particularly close, with the model under-estimating salinity. (p58).*

Figure 3.15 from Jacobs (2015) is reproduced here, as Figure 1, for the purpose of discussion. It is noted that the salinity and flow time-series in Figure 1 have been separated for clarity.

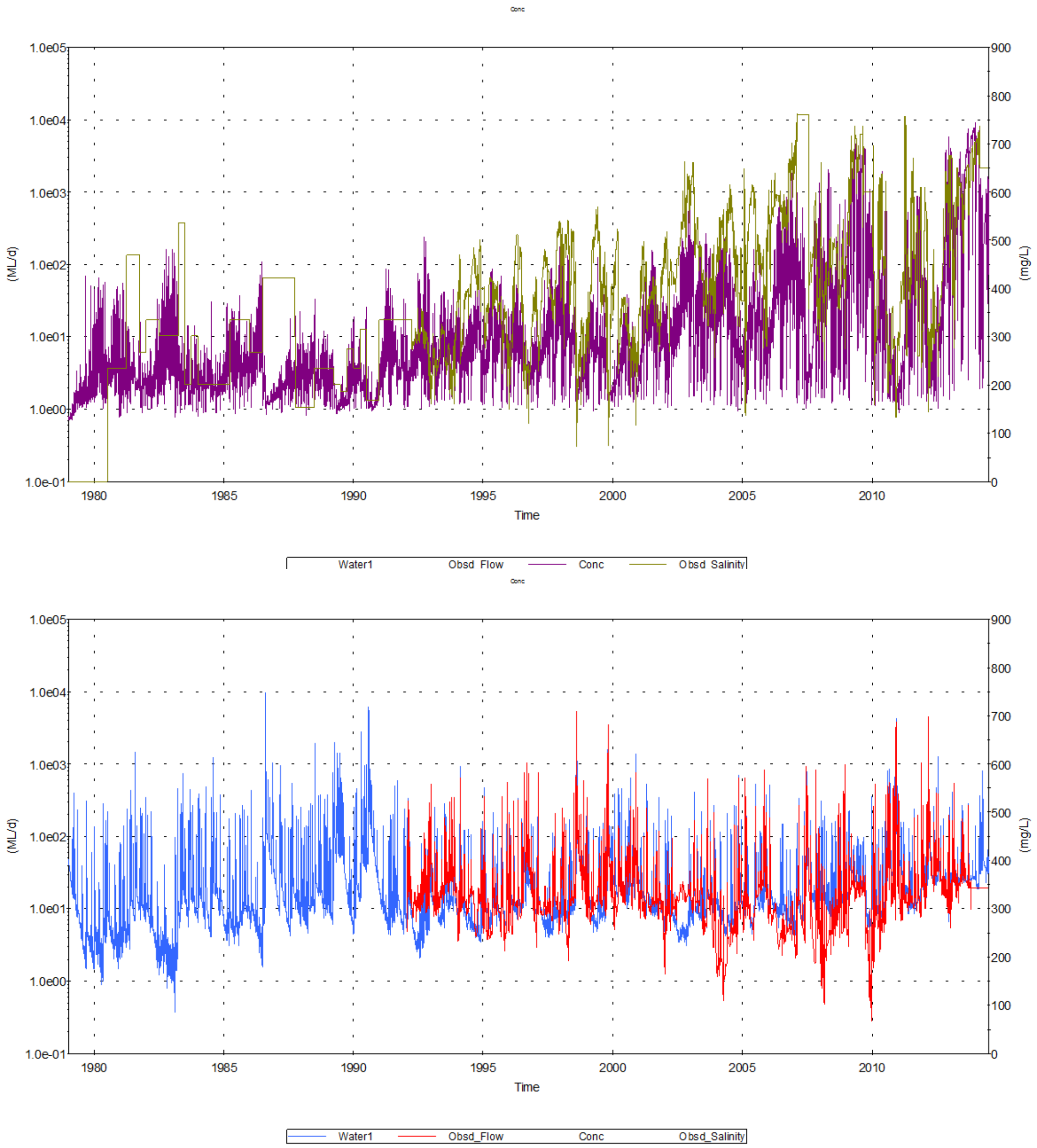

Figure 1 : Calibration Time-Series Chart at #047 (Coxs River above Lake Wallace, NSW Office of Water Gauge No. 212054)

This node (#047) corresponds with NSW Office of Water Gauge No. 212054 and is located upstream of Lake Wallace and is the outlet from the Upper Coxs River catchment. From Figure 1, it is demonstrated that there is an acceptable match between observed and modelled flow and salinity.

Kangaroo Creek

Figure 3.5 of Jacobs (2015) is reproduced below, as Figure 2. It is noted that the salinity time-series in Figure 2 has again been separated for clarity.

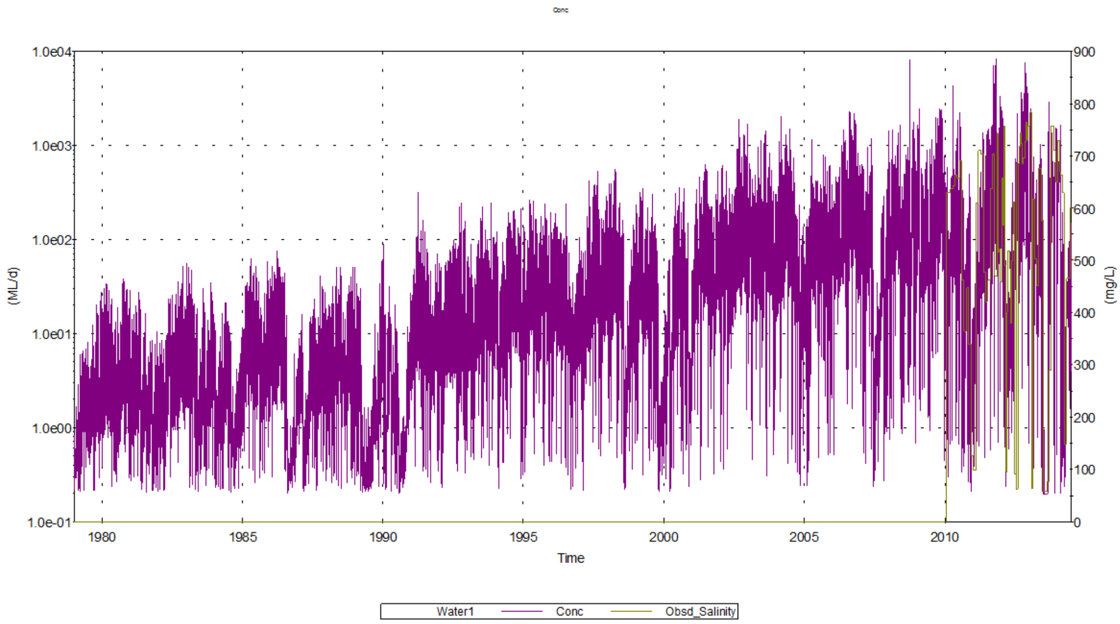

Figure 2 : Calibration Time-Series Chart at #011 (Kangaroo Creek, downstream of Angus Place LDP001)

From Figure 2, there is an adequate fit to observed salinity, highlighting that the frequency of historical sampling presented in Figure 2 (Figure 3.5 of Jacobs (2015)) is not the same as model output, which is daily. Figure 3.6 of Jacobs (2015) presents a cumulative distribution plot, where direct comparison is made between model output on a particular day and observation data (69 samples) and as noted in Jacobs (2015), the model is slightly under-predicting median salinity, however, the shape of the distribution is appropriately captured by the model.

Wangcol Creek

There is detailed discussion in Jacobs (2015) of the impact of the assumed seepage from the Brine Conditioned Ash Placement Facility. An interim solution is presented in Jacobs (2015) to investigate the influence of the assumed seepage on fit to observed flow. As stated in Jacobs (2015), "*Review of Figure 3.9 and 3.10 suggests the seepage rate may be overestimated; however, comparison of modelled and observed salinity is reasonable.*". As noted in Section 3.1.2.8 of Jacobs (2015), the assumed seepage rate and concentration was retained in the current version of the water quality model and the impact of this assumption was not significant with respect to predicted salinity in Lake Wallace and Lake Lyell.

Sawyers Swamp Creek

Figure 3.13 of Jacobs (2015) is reproduced in Figure 3 below. The full statement in Jacobs (2015) was "*From Figure 3.14, the water quality model does not encapsulate observed distribution of salinity particularly well. The cause of this discrepancy is not known at this stage and is considered may be due to the assumed location of the Centennial monitoring station.*".

As indicated, the cause for the misfit is alluded to. i.e. the assumed location of the monitoring station may be incorrect. EnergyAustralia was approached for historical monitoring in Sawyers Swamp Creek associated with their Sawyers Swamp Creek Ash Dam and Dry Ash Placement Facility,

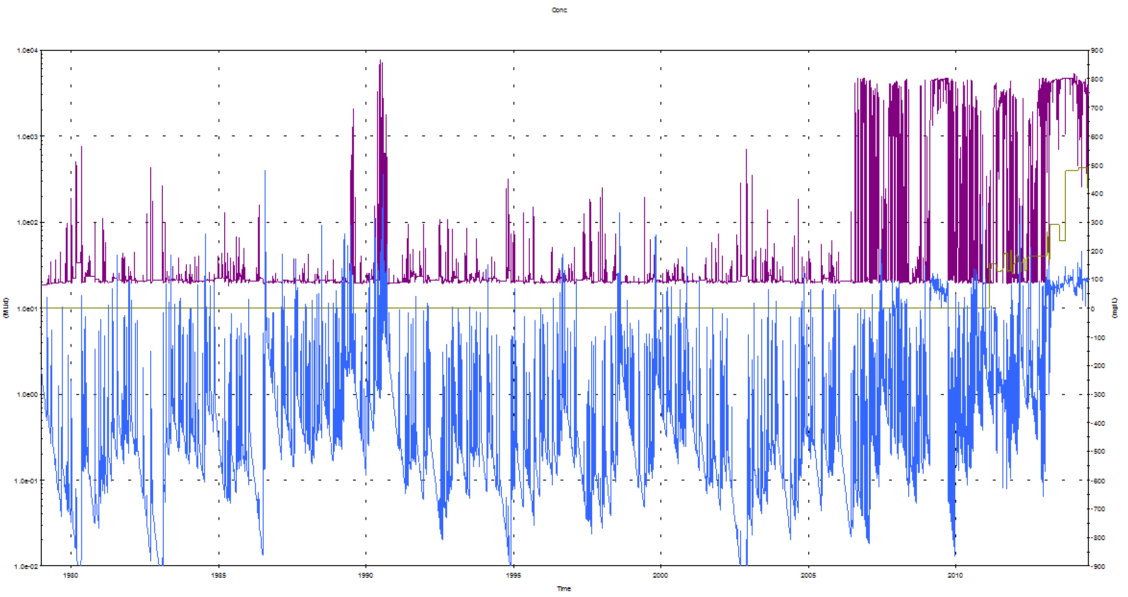

Figure 3 : Calibration Time-Series Chart at #166 (Sawyers Swamp Creek above Coxs River)

however, was declined. It is understood that there is now regular monitoring by Centennial of Sawyers Swamp Creek and that dataset will be used in the next revision of the RWQIAM.

The above, however, does not invalidate the integrity of the presented impacts, which are based on a comparison of the Proposal and the Null Case. This is discussed further in the response provided to Query OEH01 above. Table 3.31 of Jacobs (2015) presents the tabulated daily statistics from the prediction simulation wherein the Null Case has a predicted median salinity of 95mg/L compared to 798mg/L in the Proposal (WS2b and WS2b-S). The full statement in Jacobs (2015) is "*There has been mine water discharge to Sawyers Swamp Creek since 2006, as presented in Jacobs (2014). Figure 3.13 indicates the fit of the calibration model to observed data was not particularly close, with the model under-estimating salinity. Predicted salinity presented in Figure 3.54 is essentially the same as the assumed salinity of mine water discharge of 804mg/L.*"

2.2 Assumptions of the AWBM model

Issue OEH06) *The AWBM can be very sensitive to the choice of baseflow index (BFI) values. In the current model it is stated that the baseflow index has been set at 0.25 for all land-use classes. The reasoning behind setting the BFI constant and indeed to a value of 0.25 has not been justified.*

As presented in the response to Query OEH01, the sensitivity of the calibrated value of Baseflow Index (BFI) was investigated and found to be of minor sensitivity with respect to salinity and flow. As noted in Section 3.2.1 of Jacobs (2015), changes from the previous values of the AWBM pertain to improved fit to flow monitoring data. Improvement to the fit to flow monitoring data was identified by the OEH in their input to the Response to Submissions.

2.2.1 Angus Place discharges

Issue OEH07) *"Continuous flow gauging of Angus Place LDP001 was available from September 2010 onward. In the previous version of the water quality model, there was a simplified assumption as to historical discharge, namely:*

- *2ML/d in January 1979, linearly increasing to 5ML/d in June 2007*
- *2ML/d in July 2007, linearly increasing to 3ML/d in September 2010.*

With respect to salinity, it was assumed in the previous model that salt was 250mg/L in January 1979 and increased linearly to 804mg/L in September 2010.

It is noted that discharge at EnergyAustralia LDP020 and Springvale LDP009 was not updated from the previous version of the model. These discharge locations refer to discharge to Sawyers Swamp Creek when mine water from the Springvale Delta Water Transfer Scheme (SDWTS) was not required at Wallerawang Power Station. Discharge data was reconstructed from historical records, as available, from 2006."

No evidence of whether these assumptions actually match reality have been provided, even though the flow data presumably resides with the client (Centennial Coal) as a requirement under the EPLs for both Angus Place and Springvale.

Reference is made to the response provided to Query OEH04.

Issue OEH08) *It is important to note that in regards to Angus Place the EIS itself identified:*

- *"Angus Place LDP001 has a median flow of 3290 kL/day and a maximum flow of 20,400 kL/day (Table 4.6 RPS Angus Place EIS). Angus Place LDP002 has a median flow of 8 kL/day and a maximum flow of 3620 kL/day (Table 4.6 RPS Angus Place EIS).*
- *Discharge limit on LDP001 recently amended by OEH from 30,000kL/d to 2,000kL/d. As part of the Project Approval, the new LDP is required to have a discharge limit of 30,000kL/d."*

The median and maximum flows and total discharge limits stated in the EIS for Angus Place bear little resemblance to the assumptions used in the AWBM model. In the artificial 'Assumed discharge' (Fig. 3.3 in Jacobs (2015) reproduced above) the maximum discharge identified in the EIS (20.4ML) does not even appear on the scale of the y-axis. The effects these assumptions about LDP001 flow and conductivity have on the model have not been adequately addressed.

As noted in the response to Query OEH04, it was identified following submission of the EIS, that some of the data from Angus Place LDP001 were anomalous. In particular in regard to estimated flow at a maximum of 20.4ML/d. Figure 3.3 of Jacobs (2015) presents the updated historical record, including the assumed discharge where there was no data available. Further detail of Angus Place LDP001 is presented in Section 3.1.2.6 of Jacobs (2015).

2.2.2 Neubecks Creek

Issue OEH09) *As identified earlier, comparison of observed data with modelled data for Neubecks Creek identify a very poor calibration (Figure 3.9 in Jacobs (2015) reproduced below). The model predicts an average of around 3ML/day (median=2.7 in Table 3.5), whereas observed flows are usually 1 ML/day or lower (median=0.7 in Table 3.5). There has been no assessment of how these overestimates of flow affect model predictions downstream of the NOW gauge. It is equally clear that the model overestimates conductivity and there has also been no assessment of how overestimates in conductivity affect model predictions downstream of the NOW gauge (Fig 3.10 reproduced below). Current and historic flows from Centennial's Lamberts Gully LDP (which discharges to Neubecks Creek) do not appear to have been included in the current AWBM assessment.*

Reference is made to the response provided to Query OEH05.

2.2.3 Focus of Calibration Simulation

Issue OEH10) *Jacobs (2015) states:*

- *"The observation dataset for salinity, in particular in the early part of the calibration simulation, was not as extensive as that available with respect to flow. The calibration approach therefore focussed on matching historical salinity in Lake Lyell, as a first priority, and then secondarily at gauging stations and Lake Wallace"*

The reasoning behind calibrating flow and salinity in Lake Lyell some 18-20km distant from LDP009 discharge is not considered sound if the model is supposed to be an assessment of the impact of LDP009 (and other Centennial discharges) on the Upper Coxs River. Daisy-chaining of errors from a point in the river 18-20km downstream including passage through 2 major storages is a significant concern and, as a result, errors in the AWBM could be considerable. This is just one potential reason that could explain the poor level of calibration of the AWBM results with real data in many areas.

The model as it currently stands is being presented as an assessment of the impact of the proposal on the Upper Coxs River, but is potentially ignoring the latest localised effects of the mine on the Upper Coxs River (ie in those areas closest to where the LDP discharges occur). The EPA has previously raised concerns about the lack of appropriate upstream-downstream comparisons for each LDP discharge in the Upper Coxs River catchment to assess its true impact on the environment. This lack of appropriate assessment remains since the node immediately upstream of the LDP discharges is rarely if ever compared to the node immediately downstream of the LDP discharge.

The stated approach to calibration (Section 3.2.2 of Jacobs (2015)) reflected a focus on the impact of the Proposal on Lake Lyell, which is the primary water supply reservoir for the Mount Piper Power Station. As mentioned above, the quality of calibration is considered appropriate for the purpose of impact assessment. It is acknowledged in Jacobs (2015) that the calibrated fit in Lake Wallace has deteriorated from the previous version of the model, with reasons stated in Section 3.2.3 of Jacobs (2015). Comparison of inflow to and outflow from Lake Wallace, with upstream node #047 reproduced as Figure 1 above and node #032 not previously presented in Jacobs (2015), presented in Figure 4 below, indicates that the identified issue in Lake Wallace is not particularly significant.

The potential reasons for the misfit in Lake Wallace are stated in Section 3.1.2.5 of Jacobs (2015), "*As indicated in Section 2.3 of RPS (2014a), Cooling Tower blowdown at Wallerawang Power Station was discharged to Lake Wallace (EnergyAustralia LDP001 and LDP021) but the majority was discharged below Lake Wallace (EnergyAustralia LDP004). At Node #086, upstream of Lake Wallace, there was discharge from EnergyAustralia LDP001, based on available record and was extrapolated as required. EnergyAustralia LDP001 was included in the previous model and was not changed in the current model. EnergyAustralia LDP021 is an emergency discharge location and was not included in the model. The available record indicates flow ranging from 0ML/d up to 15ML/d on a sporadic basis, with salinity of ~1000mg/L. This may partially account for observed under-prediction of salinity in Lake Wallace in the water quality model.*"

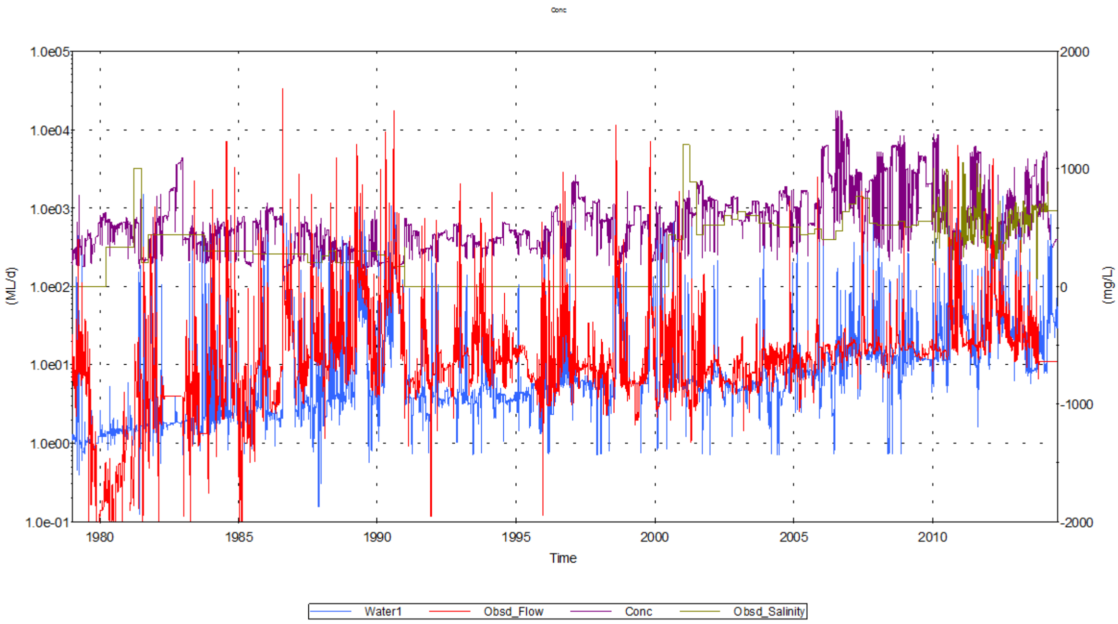

Figure 4 : Calibration Time-Series Chart at #032 (Coxs River below Lake Wallace, NSW Office of Water Gauge No. 212008, AWT_E036, EnergyAustralia WX13, SV_COXS_DOWNSTREAM)

In regard to OEH's comment on localised effects of the mine on the Upper Coxs River, calibration and model predictions in both RPS (2014) and Jacobs (2015) are presented with respect to each tributary.

2.2.4 Evaporation

***Issue OEH11)** Jacobs (2015) state that:*

- *"The evaporation data used in the water quality model was updated from monthly mean daily from BOM Station No. 061089 (Scone SCS) to a spatially distributed historical daily record. Table 3.1 presents the evaporation stations used in the updated model. It is noted that the use of the BOM Station at Scone was an error in the previous version of the RWQIAM. The BOM Station at Bathurst was intended to have been used.*
- *Historic daily evaporation used in the RWQIAM has bene processed by a suite of in-house programs to generate a continuous time-series. The historic input data to this processing is the BOM Rainfall record. Processing is achieved through disaggregation of accumulated and infilling of missing data, both through relationships developed with neighbouring gauges.*
- *This time-series was supplemented from the SILO dataset where required. The SILO dataset is disaggregated and infilled via a gridded approach, where necessary, and adopts long-term averages where no data is available and extrapolation from adjacent sites is infeasible."*

The constant change of evaporation stations in various iterations of the AWBM is not only confusing but inadequately described/summarised. Of the BoM stations identified in Table 3.1 only the last two (Goulburn TAFE and Tarago) are included in the list of BoM stations that actually record evaporation (ie observed data). With the exception of Lithgow and Little Hartley, the majority of the stations in the list are actually many kilometres from the area of LDP discharges in the catchment that is being modelled. No details are provided on the 'in-house programs' and no summary statistics (mean, median, minimum and maximum) of the evaporation data provided by the 'in-house programs' is given.

If Jacobs (2015) are using SILO, as suggested above, then they should be aware that SILO can not only provide patched point datasets for evaporation at existing BoM stations, but also data drill datasets at 0.05^o increments of latitude and longitude. It is likely that the SILO models are much more sophisticated than the AWBM developed in the current report, although both require appropriate validation for any specific catchment. If evaporation data from SILO for the Upper Coxs River catchment (-33.4S, 150.05E) are considered and compared to the evaporation (patched point data) for Scone and Bathurst, it is clear that evaporation is predicted to be much lower in the Upper Coxs River catchment than at either Scone or Bathurst (Table 1)[3]. This is demonstrated (Figure 1) by the evaporation exceedance curve (Cumulative Distribution Function in statistical terms) for SILO evaporation at Bathurst (patched point data), Scone (patched point data) and Upper Coxs River Catchment (Data drill).

No information on the actual evaporation used ('in-house programs') and the effect this has on the AWBM results is possible from what has been provided in Jacobs (2015). It is clear that previous AWBM iterations have used an inappropriately high evaporation rate (based on Bathurst or Scone evaporation) for the Upper Coxs River catchment. Further, the constant changing of evaporation in the various iterations of the model brings into question the comparability/compatibility of the various AWBM results where evaporation sources have been changed. Further, the lack of any validation of AWBM results provides little certainty that the model is either adequate or predicting appropriately in the areas of the Upper Coxs River catchment where the LDPs are located. Indeed, the calibration results suggest that it is not.

There was a typographic error in "*The historic input data to this processing was the BOM Rainfall record*". This should have read, "*The historic input data to this processing was BOM Evaporation record*".

As presented in Section 3.1.2 of Jacobs (2015), there were several changes during refinement of the RWQIAM, of which evaporation was one. As discussed, refinements were made to address an identified error and then to improve performance through inclusion of greater detail. In the same context of the refinement to the evaporation dataset, the rainfall dataset was upgraded from a manually patched dataset to a more sophisticated and robust approach. Environmental models are, by their nature, refined as more information becomes available.

Section 3.1.2 of Jacobs (2015) documents, in general terms, the refinement to the RWQIAM from RPS (2014). These refinements included correction of the discrepancy in selected evaporation station. This error was noted in Jacob's response to the OEH comments in the Response to Submissions (Jacobs, 2014), where an interim build of the calibration model was presented and it was concluded that there was no significant difference to modelled salinity profile as compared to Figure 3.5 of RPS (2014), although noting that minimum salinity of that interim build required further refinement.

In regard to the discussion on SILO data, the Patched Point Dataset was obtained from the Department of Science, Information Technology and Innovation (DSITI) for the state of NSW. That data includes interpolated Class A Evaporation (variable name '*Evap'* in https://www.longpaddock.qld.gov.au/silo/data_format.html). For stations were there was not direct observation the source code for variable name '*Evap'* was primarily *'25'* (Interpolated from daily observations for that date).

The SILO data was used directly in the model, adopting a Thiessen polygon type weighting to identify which sub-catchments were in closest proximity to a Patched Point Data location. The OEH's comment on which stations were directly observed is correct and the majority of evaporation stations were based on the received SILO data rather than independent processing of the BOM historical record. The relevant section of the RWQIAM report will be amended in the next revision of the model.

Discussion of in-house disaggregation and infilling methods for rainfall and evaporation data is presented in the response to Query OEH01.

2.2.5 Comparison with Real Data

Issue OEH12) *A plot of flows at the NOW 212054 gauge actually identifies a significant increase in flows in the most recent times, potential as a direct results of the LDP009 discharge (Figure 2). This has still not been acknowledged or modelled appropriately in the AWBM assessment. A plot of Conductivity levels (ie an increasing salinization) of Upper Coxs River waters (Figure 3). This most likely a result of the ongoing and increasing mine water discharges in the Upper Coxs River catchment but it too has not been identified or allowed for appropriately in the AWBM model. The failure of the report to address these two issues is considered a major flow in the AWBM assessment.*

This matter was raised by the OEH in the Response to Submissions and responded to in Jacobs (2014). There has been discharge to the Coxs River via Kangaroo Creek for a considerable period and to Sawyers Swamp Creek, intermittently, from 2006, when mine water was not required by Wallerawang Power Station. As presented in Section 3.1.2.7 of Jacobs (2015), discharge data from EnergyAustralia LDP020 / Springvale LDP009 was reconstructed from historical records, as available, from 2006. Accordingly, mine water discharge from Centennial has been included in the model and was included in the previous version of the model.

2.2.6 End of Pipe Targets

Issue OEH13) *No details are actually provided on how the treatment will be undertaken, but Jacobs (2015) note:*

"It is noted that prediction treatment volumes presented here are indicative, being based on simple mass balance. Predicted volumes do not take into account the pre-treatment and other water treatment process requirements and therefore are expected to have an accuracy of +/-15%. Further detail on treatment requirements are contained in the treatment option assessment, presented elsewhere[5]"

[5] It is unclear where this 'elsewhere' is.

The objective for the Jacobs (2015) report is presented in Section 1.1, which was to present outcomes of additional simulations of the RWQIAM. As indicated in the quoted text, further detail on treatment requirements are contained in the treatment option assessment, which is understood to be being prepared by others.

Issue OEH14) *Unfortunately all these assessments are made using a poorly calibrated model which has had no model validation. As discussed earlier the reliability of this model to predict past or future water quality with any degree of accuracy is highly questionable.*

Reference is made to the responses previously provided in regard to the appropriateness of model calibration.

Issues OEH15) What follows are a large number of graphs for the various options, but the most obvious issue is in Figure 3.72 (reproduced below) and 3.73 where predicted future concentrations bear little resemblance to what is currently occurring in the Coxs River at the NOW Gauge 212054 (observed measurements – see Comparison with Real Data section above). Even though the Springvale proposal involves considerably increasing the discharge volumes, the 700, 800 and 900 options modelled into the future suggest that average conductivity at #047 (Coxs River above Lake Wallace, Gauge No. 212054) will fall to approximately 350-570 µS/cm (Table 3.41 of Jacobs (2015)), *despite it currently being approximately 1200 µS/cm[6]. The model therefore suggests a significant reduction in conductivity will occur in the Upper Coxs River at Gauge No. 212054 when the conductivity of discharge under the 700, 800 and 900 µS/cm options is 2-3 times the median concentration predicted by the model. The credibility of this prediction obviously needs further assessment.*

[6] As measured at the NOW gauge. It is emphasised that the model does not appear to adequately account for the recent rise in flow volumes or the increasing trend in conductivity measured at the NOW Gauge 212054 likely to be due in large part to the LDP009 discharge.

Table 3.41 of Jacobs (2015) expresses model output, salinity, in mg/L, not µS/cm.

As presented in Section 3.5.2 of Jacobs (2015), End of Pipe Targets of 700µS/cm (equivalent to 469mg/L), 800µS/cm (equivalent to 536mg/L) and 900µS/cm (equivalent to 603mg/L), were evaluated in the prediction simulation. For comparison, the assumed salinity of mine water discharge was 1,200µS/cm (804mg/L).

With respect to recent changes to flow and conductivity, the model calibration period was 1 January 1979 to 30 June 2014. As indicated in the response provided to Query OEH12, mine water discharge from Angus Place and Springvale are incorporated into the calibration model and expected discharge, derived from the groundwater model simulation, is used as the basis of the prediction simulation.

2.2.7 Salinity Impacts from LDP009 and other Centennial discharges

Issue OEH16) *Concentrations of individual ions contributing to these measures can vary significantly 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 reliable predictors of toxicity for all water types…*

…It is important to note that there has been little to no toxicity testing of aquatic species endemic to the area or formal Toxicity Identification and Evaluation (TIE) procedures applied the Centennial discharges to determine which components of the discharge are causing the observed toxicity. Electrical conductivity levels in the LDP009 discharge are an order of magnitude greater than natural streams that drain to the Upper Coxs River and it would be unrealistic to suggest that such a large change in conductivity is not affecting the river's ecology…

…The high bicarbonate alkalinity recorded for the mine water suggests that bicarbonate ions could be a series ecological health issue for the LDP discharges. It is clear that none of the scenarios tested by Jacobs (2015) has addressed/considered the issue of toxicity or ionic composition of the mine water discharges.

The potential impact of alkalinity needs to be addressed and is the subject of the Direct Toxicity Assessment; together with on-going correspondence between the EPA and Centennial in regard to this matter.

The RWQIAM, in its current form, is a salt mass balance and flow model. It is understood that the treatment option assessment includes an evaluation of the resultant water type and characteristics.

It is anticipated that a target water quality characteristic will be defined for the purpose of the EPL and, potentially, water treatment options will be tailored to meet these.

Where the water quality characteristics need to be investigated further, incorporating refinement to the Direct Toxicity Assessment, then the RWQIAM may be used as an input.

2.3 Conclusions

Issue OEH17) *There has been no validation of the AWBM model used in the water quality impact assessment.*

The applicability of the Model to the Upper Coxs River catchment rests entirely on an assessment of how well the model has been calibrated to the data that is available in the area.

Reference is made to the response provided to Query OEH02 in regard to this matter.

Issue OEH18) *Based on the data and graphs provided in the Jacobs (2015) report it is clear that the model itself remains poorly calibrated. This is actually stated by the authors (Jacobs 2015) themselves in some sections of their report. Calibration of the model, is particularly poor in areas close to the LDP discharges, flows and water quality (Kangaroo Creek Wangcol Creek, Sawyers Swamp Creek, Lake Wallace). As a result, little faith can currently be placed on the AWBM model, its predictions and the conclusions regarding potential water quality impacts.*

The quality of model calibration is not considered poor. The model presented in both RPS (2014) and Jacobs (2015) included an appropriate level of detail, which is clearly demonstrated by the model's response to stresses applied over a 35 year calibration period.

Further detail is provided in responses presented above.

Issue OEH19) *The AWBM has not used observed flows from the Centennial LDPs in Upper Coxs River Catchment. The AWBM assessment continues to make inappropriate assumptions about the proportion of the flows measured in various parts of the Upper Coxs River that are actually sourced from upstream LDPs.*

It is stated in Jacobs (2014, 2015) that historical observed flows were used for Angus Place LDP001 and EnergyAustralia LDP020/Springvale LDP009 as available. As noted in the response provided to Query OEH03, local LDPs that fed through sediment retention structures were assumed to be represented by catchment runoff, with appropriate assumed Land-Use Class with respect to salinity.

Issue OEH20) *As a result of the continuing confounding of LDP discharges, flows and water quality in the model and assessment, an adequate assessment of the true impact of the LDP discharges is still NOT achieved (particularly that of LDP009).*

As stated in Jacobs (2014) in response to this matter being raised by the OEH at the Response to Submissions stage, it is a requirement that other activities within the catchment are included in the assessment.

As previously stated within this letter, prediction simulations are presented both with regard to the Proposal and the Null Case, which allows direct comparison of impact of the mine extension.

Issue OEH21) *None of the scenarios tested by Jacobs (2015) have addressed/considered the issue of toxicity or ionic composition of the mine water discharges. In addition, no relationship has been drawn between the suggest dilution required (1:37, see GHD 2014) to avoid toxic effects from the discharge and the arbitrary end-of-pipe targets considered by Jacobs (2014).*

Following refinement of treatment options, as relevant, it is anticipated that it will be a requirement of the Water Management Plan to demonstrate that the target water quality characteristic can be achieved, informed by the Direct Toxicity Assessment, extended and/or amended as required.

Issue OEH22) *The AWBM obviously needs to be better calibrated and validated before it should be used to support any decision regarding appropriateness of end-of-pipe targets or acceptability of proposed discharges. It is quite clearly performing poorly when compared to real data in the Upper Coxs River catchment.*

Detailed responses to all aspects of this query are provided in the above.

3. References

Planning Assessment Commission, 2015. *Springvale Mine Extension Project – Review Report*. Sydney, NSW. Reference No. ISBN 978-0-9942315-5-0, dated June 2015.

RPS, 2014. *Regional Water Quality Impact Assessment – Angus Place and Springvale Mine Extension Projects*. Reference No. S187E/021b, dated 10 September 2014.

Jacobs, 2014. *Hydrological Advice to Response to Submissions*. Reference No. IA060400/003c, dated 19 December 2014.

Jacobs, 2015. *Additional Simulations of the Regional Water Quality Impact Assessment Model*. Reference No. IA059800/002c, dated 26 March 2015.

Closing

Should you require additional information then please do not hesitate to contact our office.

Yours sincerely

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