NSW GOVERNMENT Department of Industry

OUT18/4263

Mr Stephen O'Donoghue
Planning Services, Resource and Energy Assessments
NSW Department of Planning and Environment

By email: Stephen.o'donoghue@planning.nsw.gov.au

Dear Mr O'Donoghue

Cadia Hill Tailings Modification

I refer to the email of 29 March 2018 to the Department of Industry in respect to the above matter. Comment has been sought from relevant branches of Department of Primary Industries and Lands & Water.

Any further referrals to Department of Industry can be sent by email to landuse.enquiries@dpi.nsw.gov.au.

The department has reviewed the modification application and provides the following recommended conditions of consent. Detailed comments are provided in Attachment A.

Recommended Condition of Consent

- The proponent must update the Water Management Plan in consultation with DoI Water to ensure adequate groundwater monitoring is in place. The monitoring is to include the following and is to be implemented prior to tailings deposition in the pit:
    - Deep monitoring bore/s should be constructed to establish the baseline hydrodynamics of the groundwater at or near the base of the pit and continually monitored during and after the pit in-fill.
    - Baseline groundwater quality (metals and non-metals) at the bottom of the pit must be established; and continually monitored against the water quality (metals and non-metals) of the tailings during and after the pit in-fill. Baseline samples of the tailings material would support the identification of potential contaminants of concern.
    - Develop a contingency plan.
    - Prepare a report which includes the baseline groundwater quality and level data, and an assessment to verify the hydraulic gradient towards the areas of historical and current mining during the pit infill. A revised assessment would be required on completion of the pit infill.

Yours sincerely

Alison Collaros
Principal Policy Officer, Cabinet & Legislation Services
NSW Department of Industry – Lands & Water
5 April 2018

ATTACHMENT A – Detailed Comments

Groundwater Comments

- Based on the presence of fault shatter zones and associated fractures within the disused Cadia Hill Pit and groundwater inflows, it is understood there is groundwater connectivity with the Cadia Hill Pit. Placing tailings into the pit therefore poses a risk of groundwater contamination. To fulfil the NSW Aquifer Interference Policy requirement "*any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity*" the baseline groundwater quality (metals and non-metals) at the bottom of the pit must be established and continually monitored against the water quality (metals and non-metals) of the tailings during and after the pit in-fill.
- The Model simulation reports very low hydraulic conductivity of the whole bulk Ordovician rock which is acknowledged for the purpose of accounting for the measured inflows into both the Cadia Hill Pit and Cadia East workings. However it seems inappropriate to apply the same low hydraulic value to the areas of groundwater inflow through the fault shatter zone and associated fractures. The pit is intersected by numerous faults and fractures (some 20 metres wide shatter zone) which may form preferred pathways over time for the tailing leachates to migrate into adjoining groundwater systems; given the pit will be placed with aqueous material (approx. 200 meters thick in one year, to approx. 420 m AHD) which may create adequate hydraulic head to push the leachates into the groundwater system.
- The groundwater monitoring network, although adequate spatially, is inadequate in monitoring the deeper aquifer systems near the pit bottom. There are no details of any deep monitoring bores to establish the hydraulic head at or near the bottom of the pit or within the vertical zone of the proposed tailings fill in the pit. Observations from existing bores deem the pit to be a groundwater sink. It is acknowledged that this assumption applies when the pit fills up with water to the modelled equilibrium level at 670 m AHD. However, the probable existence of another groundwater level near the base of the pit indicates there may be another groundwater system at depth. Deep monitoring bores needs to be established to verify this.
- CVO has acknowledged the need to carry out groundwater monitoring (hydrodynamics + water quality) during the in-pit deposition of tailings at Cadia Hill open pit.

Response to key assessment findings

	Proponent Comment/Statement	**CL&W Comment**
1	The slumping of the embankment was fully contained within the Southern Tailings Storage Facility (STSF) that is located immediately downstream. No external environmental impacts arose from the incident (i.e. all tailings and waste rock material in the slumping area were wholly contained within the STSF). (CVO)	Acknowledged Adequately Contained
2	Cadia Valley operations is already approved to transfer tailings storage supernatant water to the Cadia Hill open pit under high rainfall scenarios as may be required for operational water management purposes.(CVO)	Acknowledged
3	The Modification does not propose any increase to the approved rates of mining, ore processing or tailings emplacement at the Cadia Valley Operations.(CVO)	Acknowledged

	Proponent Comment/Statement	CL&W Comment
4	The approved final Cadia Hill and Cadia East subsidence zone void lake would concentrate salts over time due to evaporation from the surface of the waterbody, and oxidation of potentially acid forming Ordovician volcanic material within the Cadia East cave zone.(CVO)	Agree
5	The tailings consists of 40% to 45% water and 55% to 60% solids. (CVO)	Acknowledged
6	The tailings are typically low in sulphur and are non-acid forming as the sulphide mineralization is largely extracted in processing. (CVO)	Acknowledged based on Table 5.11A : Cadia East Tailings Leach Extraction Test Results of dissolved metals. However, no details of non-metal leachates have been provided to verify this statement.
7	The tailings supernatant water that is approved to be transferred to the open pit is typically in the electrical conductivity (salinity) range of 1,500-2,500 microsiemens. This is significantly lower salinity than long term water quality predicted for approved final void. (CVO)	Acknowledge supernatant water approved. However the tailing solids contain source minerals that may leach over time. No details of the full (metal and non-metal) leaching potential was provided.
8	Geotechnical investigations conducted during mining (Newcrest 2006) noted Cadia Hill Open Pit occurs within a low permeability rock mass, and groundwater ingress was generally only evident in localised areas through structures. A number of faults intersect Cadia Hill Open Pit with visual examinations summarised by AGE (2009) indicating the faults are between 0.5 m and 20 m wide and characterised by milled rock and clay gouge infill with fractured wall rocks. During mining, the faults did not produce problematic volumes of groundwater with the clay gouge material expected to retard water movement through the fault plane.(AGE enclosure 1)	Agree in general that the Cadia Open Pit occurs within a low permeability rock mass. However, it is also intersected by numerous faults and fractures (some 20 metres wide shatter zone) which may form preferred pathways over time for the tailing leachates to migrate into adjoining deeper groundwater systems; given the pit will be placed with aqueous material (approx. 200 meters thick in one year, to approx. 420 m AHD) which may create adequate hydraulic head to push the leachates into the groundwater system .
9	It is understood (from Document #1) that AGE has revised the groundwater model twice via transient re-calibration and transient simulation of predictions. During that time, the horizontal hydraulic conductivity of the Ordovician rock mass was reduced from 10-8 m/sec to (5-60)x10-12 m/sec to account for ongoing Cadia Hill inflow of about 0.7 ML/day and Cadia East inflow of about 1.5 ML/day.(HYDROALG)	Agree the bulk of the Ordovician rock mass has very low hydraulic conductivity and the K value has been model simulated for the whole of the rock mass to account for the measured inflows into both the Cadia Hill Pit and Cadia East workings. However, it is known that the inflows are only occurring from the fault and fracture zones and as such it can be assumed to have

	Proponent Comment/Statement	CL&W Comment
		higher hydraulic conductivity at these particular inflow points.
10	The Cadia Hill pit currently holds about 80 m depth of water.(HYDROALG)	Agree as evidence. The current pit water level is at approximately 300 m AHD. This column of water is deemed to be a combination of groundwater inflow and surface water inflow minus any evaporation losses since the closure of open pit operation in 2012. It can be interpreted that the current groundwater head near the base of the pit (approx. 221 m AHD) would be somewhere between 221 and 300 m AHD. This level will be still lower than the proposed tailing fill level of 420 m AHD. Therefore there is a possibility of outward movement of tailings leachates into the groundwater system.
11	The deepest bore in the existing groundwater monitoring network is at a depth of approximately 200 m. There are 18 bores targeting the Ordovician lithology, with hole depths ranging from 17 m to 136 m, with a median depth of 50 m. Their placement should be examined to ensure they are sufficient to verify the expected ongoing hydraulic gradient towards the areas of historical and current mining. (HYDROALG).	Acknowledged current monitoring infrastructure. NOTE: No details were provided on any deep monitoring bore network if existence. There is no proposal to install adequate deep monitoring bores to add to the existing WQMMP and TARP. Recommendation: *Deep monitoring bore/s should be constructed to establish the baseline hydrodynamics and water quality of the groundwater at or near the base of the pit .*
12	After closure the recovered water level within the Cadia Hill Open Pit and Cadia East subsidence zone combined final void will reach an equilibrium of 670mAHD, which is lower than the groundwater level measured within piezometers in the surrounding rock mass, and means the inward hydraulic gradient towards the pit shell that has developed will remain during deposition of the tailings and continue post mining. (CVO).	Not enough evidence: Points 10 and 11 above, indicates that there could be separate groundwater systems in play for the whole 500 metres depth of the pit. There is no information presented to confirm the hydraulic head of the groundwater at or near the bottom of the pit. All monitoring bores presented are to a maximum depth of 200 metres with majority less than 136 metres. Therefore it is not evidently clear that during the tailings infill into the Cadia Open Pit (420 m AHD) will be lower than the groundwater head at the bottom of

	Proponent Comment/Statement	CL&W Comment
		the pit. Recommendation: *Deep monitoring bore/s should be constructed to establish the baseline hydrodynamics and water quality of the groundwater at or near the base of the pit .*
13	Responses to AIP water quality requirements by AGE: *Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.* • No change due to the Modification. • Groundwater flow is towards Cadia Hill - therefore, there will be no change in the beneficial use category of the water source. • Post mining the Cadia Hill and Cadia East subsidence zone combined final void will remain a permanent sink to groundwater and therefore the flow will be into the void and there will be no change in the beneficial use category of the water source. • Previous predictions that the Cadia Hill and Cadia East subsidence zone combined final void will form an evaporative sink concentrating salts and may include ARD. • Transfer of tailings supernatant water to the open pit is approved.	No baseline groundwater quality information is presented for the groundwater system at or near the base of the pit to compare with the tailings water quality and to comply with the AIP requirements. Further work will be required in the GMMP to monitor water quality of the of the tailing fines and groundwater to ensure the TARP is adequate for monitoring and managing the impacts of this modification. Recommendation: *Deep monitoring bore/s should be constructed to establish the baseline hydrodynamics and water quality of the groundwater at or near the base of the pit.*
14	Groundwater monitoring at the Cadia Valley Operations during the in-pit deposition of tailings at the Cadia Hill open pit would be undertaken in accordance with CHPL's existing Water Management Plan. The current groundwater monitoring programme is extensive (Figure 4 – Enclosure 1). However, CHPL would review, and where necessary revise, the number of groundwater bores proximal to the Cadia Hill open pit, to verify the ongoing hydraulic gradient towards the areas of historical and current mining. Any such monitoring improvements would be documented in a revision to the Water Management Plan. With some minor extensions to the existing environmental monitoring network, the Cadia Valley Operations environmental management and monitoring measures already being applied by CHPL would continue to be applied to minimise the potential impacts on existing environmental values. (CVO)	Acknowledged CVO acknowledges the need to carry out groundwater monitoring (hydrodynamics + water quality) during the in-pit deposition of tailings at Cadia Hill open pit. Recommendation: *Deep monitoring bore/s should be constructed to establish the baseline hydrodynamics and water quality of the groundwater at or near the base of the pit .*

End Attachment A