

Advice to decision maker on bauxite mining project

IESC 2023-145: Aurukun Bauxite Project (EPBC 2020/8624) – New Development

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The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) provides independent, expert, scientific advice to the Australian and state government regulators on the potential impacts of coal seam gas and large coal mining proposals on water resources. Additionally, at the request of a relevant New South Wales, Queensland, South Australian or Victorian Minister and with the written agreement of the Australian Government Environment Minister, the IESC can provide advice on any other matter within the expertise of the IESC. The advice is designed to ensure that decisions by regulators on coal seam gas or large coal mining developments or any other matter within the expertise of the IESC are informed by the best available science.

The IESC was requested by the Queensland Department of Environment and Science to provide advice on the Aurukun Bauxite Project Joint Venture's (unincorporated joint venture between Glencore Bauxite Resources Pty Ltd and MDP Bauxite Pty Ltd) Aurukun Bauxite Project in Queensland. This document provides the IESC's advice in response to the requesting agency's questions. These questions are directed at matters specific to the project to be considered during the requesting agency's assessment process. This advice draws upon the available assessment documentation, data and methodologies, together with the expert deliberations of the IESC, and is assessed against the IESC Information Guidelines (IESC 2018).

Summary

The Aurukun Bauxite Project ('the project') is a proposed bauxite mine and associated infrastructure on a greenfield site in western Cape York, Queensland, located 23 km from the township of Aurukun and 600 km from Cairns (Glencore 2023, 04, p. 4-1). The project will mine 15 million tonnes per annum (Mtpa) of run-of-mine (ROM) bauxite, which will be processed onsite into 8 Mtpa of product bauxite (Glencore 2023, 04, p. 4-1).

The project will consist of multiple disturbance areas (approximately 68 km²) mined to a maximum depth of 14 m (Glencore 2023, 04, p. 4-7) that will be progressively mined from the north-western area to the south-eastern area over the 22 years of mine life (Glencore 2023, 04, p. 4-8). The project will include construction of an on-site beneficiation plant, a coastal loading facility and water management infrastructure, including a 19-m high dam across Tapplebang Creek (Glencore 2023, 04, pp. 4-9 – 4-10). This dam will inundate 10 km of the creek (and approximately 4.5 km²), impacting its riparian vegetation which is classified as Regulated Vegetation, a Matter of State Environmental Significance (MSES). There may also be impacts of the dam on food supply, habitat and movement of Estuarine Crocodile (*Crocodylus porosus*), listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and known to occur in the creek.

The project is within the Ward River catchment, with Tapplebang Creek, Coconut Creek and a small tributary of Norman Creek crossing the project area (Glencore 2023, 07, p. 7-2). The catchment supports Darwin Stringybark (*Eucalyptus tetradonta*) woodlands, identified as a groundwater-dependent ecosystem (GDE) (Glencore 2023, 08, p. 8-26) and provides breeding and foraging habitat for EPBC Act-listed species such as Palm Cockatoo (*Probosciger aterrimus*), Red Goshawk (*Erythrotriorchis radiatus*), Black-footed Tree-rat (*Mesembriomys gouldii*), Masked Owl (*Tyto novaehollandiae*) and White-throated Needletail (*Hirundapus caudacutus*) (Glencore 2023, 08, pp. 8-27 – 8-28). Some 6,885 ha of this vegetation will be cleared for the project (Glencore 2023, 04, p. 4-33).

Responses to the questions in the following advice focus on relevant aspects of the hydrology, water quality and ecological features of groundwaters, fresh surface waters and their associated biota but intentionally excludes marine or estuarine aspects.

Key potential impacts from this project are:

- substantial hydrological and ecological impacts collectively due to clearing vegetation and lowering large areas of the catchments of Tapplebang and Coconut creeks, and partly replacing highly permeable soils and shallow aquifer materials with residual fines from mining.
- planned removal of 6,885 ha of vegetation that provides vital breeding and foraging habitat for multiple EPBC Act-listed and migratory species.
- changes to hydrological and sediment regimes and flow volumes due to the proposed damming of Tapplebang Creek which will have downstream impacts on aquatic ecosystems, including wetlands which are used by EPBC Act-listed species (e.g., Largetooth Sawfish (*Pristis pristis*)).
- replacement of a 10-km stretch of seasonally flowing narrow creek with a more permanently inundated lake, completely altering the aquatic and riparian habitats of Tapplebang Creek for at least two decades. Although the planned fishway should enable passage of most fish around the dam, aquatic habitat in the lake-like 10-km dammed stretch will likely be suboptimal for many stream fish species. The dam may also impact movement and habitat use of the Estuarine Crocodile, an EPBC-listed species known to occur in the creek.
- increased sediment, and possibly contaminant, movement to Coconut Creek and Tapplebang Creek, especially during extreme rainfall events.

The IESC has identified key areas in which additional work is required to address the key potential impacts, as detailed in this advice. These are summarised below.

- Conceptualisation, quantification of processes and subsequent impact assessment modelling in the unsaturated and saturated zones should be developed further and integrated for baseline, mining and post-mining conditions.

- The period of monitoring of groundwater levels should be extended, and additional analysis of groundwater level recession completed. Further characterisation of project site hydraulic properties of bauxite and the underlying weathered Bulimba Formation aquifer are required together with characterisation of the mechanical consolidated backfill material.
- Measurement of flows in Tapplebang Creek and Coconut Creek over the wet and dry seasons to provide baseline information on year-to-year variability in baseflows to constrain the pre-mining water balance and to inform potential changes to enhanced recharge rates associated with mining and the construction of Tapplebang Dam.
- Collection of further baseline information on year-to-year variability and timing of ecologically important flow components to be able to assess downstream impacts of Tapplebang Dam.
- Assessment of the value of selecting an alternative downstream release strategy from Tapplebang Dam that is higher than 5.1 ML/d during the wet season (up to 100 ML/d or higher) to better preserve ecologically important flow components.
- Consideration of climate-change scenarios in groundwater modelling, surface-water flow modelling, flood modelling and water-balance modelling assessments, to evaluate changes in rainfall amounts, flow regime, infiltration rates and occurrence of extreme events over the life of mine (LOM) and inform identification of all possible impacts of the project.
- Development of one or more impact pathway diagrams (IPDs) derived from an evidence-based ecohydrological conceptualisation to illustrate the collective and interacting impacts that may arise from this project. These IPDs should link predicted drawdown, mounding and other potential impacts to ecological values such as GDEs, riparian vegetation and aquatic biota and ecosystems, especially those supporting EPBC Act-listed species or classified as MSES.
- Collection of more baseline data from Tapplebang Creek on turtles, fish and invertebrates to complement the current data from 3-5 sites collected in 2018, enabling more robust assessment of the impacts of the dam and recovery after it is removed.

Context

The project is a proposed bauxite mine and associated infrastructure on a greenfield site and will consist of multiple disturbance areas (68 km²) stripped to maximum depths of 14 m (Glencore 2023, 04, p. 4-7), an on-site beneficiation plant, transport corridor, coastal loading facility, creek crossings and a dam. The project is located 23 km north-east of the township of Aurukun, Queensland, on the western side of Cape York, where it will produce 15 Mtpa of ROM bauxite over 22 years. Other mining projects surrounding the proposed project include Rio Tinto's lease for Amrun and Andoom Bauxite Mines, Urquhart Point Bauxite Project, Hey Point Mine, East Weipa Mine and Bauxite Hills Mine (Glencore 2023, 04, Figure 4-7, p. 48).

The project area covers approximately 23,100 ha with a disturbance area of approximately 6,885 ha (Glencore 2023, 04, p. 4-1) that will be cleared for mining (Glencore 2023, 04, p. 4-7), an on-site beneficiation plant and a water storage dam on Tapplebang Creek (Glencore 2023, 08, p. 8-19). The proposed project requires 10.5 gigalitres (GL) per annum of freshwater for operations, which the proponent plans to secure by constructing a 19-m high dam (and fishway) on Tapplebang Creek (Glencore 2023, 07, p. 7-28). The dam will fill at the beginning of each wet season. During the filling period, the proponent plans to release up to 5.1 megalitres per day (ML/d) to provide low flows in Tapplebang Creek downstream (WRM 2023, p. 26).

The project area is within the catchments of Coconut Creek and Tapplebang Creek, which are third-order, channelised streams with highly variable flows (Glencore 2023, 07, p. 7-3). Highly seasonal rainfall results in high flows during the wet season and minimal or zero flows during the dry season (WRM 2023,

p. 12). The woodlands within the project have been identified as mostly Darwin Stringybark (*Eucalyptus tetradonta*) woodlands. Recent research confirms these woodlands as being a GDE that accesses the groundwater during the wet season when the water table is closest to the surface (Glencore 2023, 08, p. 8-26). These woodlands are breeding and foraging habitat for EPBC Act-listed species such as Palm Cockatoo, Red Goshawk, Black-footed Tree-rat, Masked Owl, White-throated Needletail and migratory species (Glencore 2023, 08, pp. 8-27 – 8-28).

Response to questions

The IESC's advice in response to the requesting agency's specific questions is provided below.

Water resources and assets

Question 1: Advice is sought on whether the proponent has adequately characterised surface and groundwater resources and related assets to allow for assessment of the project's impacts on surface and groundwater resources. In particular, in relation to groundwater, has the proponent:

- a. Provided suitable justification to support the hydrogeological conceptual and numerical model in relation to:
 - i. The groundwater and surface water interaction regime for predevelopment, during mining and post mining.
 - ii. Adequacy of the hydraulic parameters and other baseline (particularly monitoring) data to inform the groundwater conceptual and numerical model.
 - iii. Adequacy of the numerical model report (Appendix D to Appendix F – Groundwater Report) to appropriately assess the validity of the numerical groundwater model assumptions and outputs.
 - iv. Adequacy of the numerical model outputs in relation to groundwater/surface water interactions, drawdown and mounding during mining operations, sensitivity analysis and uncertainty analysis.
- b. Adequacy of the project water balance in relation to seepage losses (Fines Containment Area, open cut pits, in-pit fines backfill areas, Tapplebang Dam) to groundwater and evaporative losses.

Groundwater

1. The proposed mining will take place predominantly in the unsaturated zone and through the zone of groundwater fluctuation. It will fundamentally alter the shallow hydrological regime across the mine site, changing the timing and quantities of infiltration of rainfall, recharge processes and the availability of water to support vegetation whether from the unsaturated or saturated zone. The conceptual model presents insufficient information about the pre-existing shallow hydrological and hydrogeological processes and how the mining and closure phases of the project will change them.
2. The simulation of shallow hydrological and hydrogeological processes to predict project impacts on water resources is disjointed, being represented by a surface water model, a mine water balance model (WBM), a recharge spreadsheet and a saturated zone groundwater model. The links from hydrological process changes to impacts on vegetation and other ecological receptors (including MNES / MSES) are insufficiently developed. This fragmented approach is unlikely to capture the complexity and interactions between processes or allow detailed assessment of project impacts.
3. The collection of groundwater baseline data is inadequate. Additional data should be collected as described below.

- a. The temporal variability of groundwater levels within and around areas of proposed mining has been monitored for a 22-month period revealing significant differences in response to wet season rainfall and the subsequent recession of groundwater levels. The monitoring period should be extended to improve the characterisation and to document the range of seasonal behaviours during drier and wetter than average years. Further interpretation of the hydrographs, particularly the hydrograph recessions, may add detail to the conceptual hydrogeological model such as changes in hydraulic properties with depth, rooting depth of vegetation or by constraining hydraulic conductivity.
 - b. At the project site, the hydraulic properties of the bauxite and underlying weathered Bulimba require further characterisation. Sources of information on hydraulic conductivity are quoted from other studies that encompass 4 orders of magnitude, and from site slug and falling head tests and trench tests. Conceptualisation would be enhanced by further site-specific measurements using pumping tests to provide more reliable information.
 - c. The hydraulic properties of the backfill material will strongly influence future hydrological processes in mined areas and need to be adequately characterised either by test samples or using information from sites with bauxite fines that use accelerated mechanical consolidation (REE 2023a).
 - d. Monitoring of flows in Tapplebang and Coconut creeks needs to be extended over multiple wet and dry seasons, preferably using fixed gauges to provide a temporal record complemented by spot gauging at other locations (see also Paragraph 8). This will inform both the contribution of groundwater during dry season baseflow recession, will frame the runoff component of flow during the wet season and large events, and help understanding of where flows are accreted along the creek. This information is fundamental to informing and constraining components of the pre-mining water balance.
4. Evapotranspiration is likely a key part of the water balance with vegetation drawing on water in unsaturated and saturated zones during the dry season. Vegetation groundwater use (Doody et al., 2019) pre- and post-mining requires further explanation and justification within the conceptualisation.
 5. The conceptualisation and quantification of the unsaturated and saturated zones should be integrated and improved. This should be done for baseline, mining and post-mining conditions. Variability due to seasonality and extreme climate events should be addressed.
 - a. Develop and present integrated conceptual models, including conceptual diagrams that explain the interactions of hydrological processes of rainfall, runoff, infiltration, recharge, evapotranspiration and flow in the unsaturated and saturated zones. Conceptual diagrams should include pre-mining, operational and closure conditions and consider spatial transitions from mined impacted areas through to undisturbed native vegetation.
 - b. Based on the integrated conceptual models, develop and justify ranges for model parameters and inputs such as recharge rates, hydraulic conductivity and storage. This could involve unsaturated-saturated zone numerical simulations of hydrological interactions for representative cross-sections. Particular attention should be paid to the properties of the infill under unsaturated and saturated conditions, and how the water table interacts seasonally with mining areas, with variations in the saturated thickness and rates of infiltration. Assumptions should be fully documented.
 - c. The change in the elevation of the landform within the mining areas, combined with the reduced hydraulic conductivity of the backfilled material will likely result in greater areas of where the water table is near to or above the ground surface. This is likely to compromise the success of revegetation of species that cannot tolerate waterlogged conditions.

6. Once the conceptualisation has been improved, the groundwater numerical model should be revised:
 - a. explicitly simulating flow from creeks and the dam to the groundwater, which has been assumed without justification in the current model to be negligible;
 - b. constraining calibration by measured seasonal baseflow, and providing greater detail on the adequacy of the model calibration by season;
 - c. providing much greater detail of reporting of baseline conditions and mining impacts, for example, plots of water balance components over time, drawdown/mounding maps for specific years, depth-to-water maps highlighting waterlogged areas for specific years; and
 - d. conducting an uncertainty analysis for each Quantity of Interest following the approach of Peeters and Middlemis (2023). The limited sensitivity analysis presented in AGE (2023, Appendix D, pp. 22 – 28) is not adequate as a predictive uncertainty analysis.

Surface Water

7. The proponent has assessed the potential for downstream flow impacts due to the operation of Tapplebang Dam (WRM 2023, p. 31). Changes in flows will be greatest at the beginning and end of the wet season, when proposed environmental releases will be limited to up to 5.1 ML/d (Glencore 2023, 07, p. 7-35). For example, this would be instead of potential average flows in January of approximately 500 ML/d (Glencore 2023, 07, p. 7-9). The proponent has chosen the 5.1 ML/d volume based on the Flows to Waterholes environmental flow objective (EFO) from the Cape York Water Plan (CYWP) (State of Queensland 2019; WRM 2023, p. 41). In Paragraphs 8 – 12, the IESC has outlined gaps in key data needed to be able to adequately characterise the surface water resources and assess the possible impacts of these limited environmental releases.
8. The proponent has collected one year of baseline flow data for Coconut and Tapplebang creeks (WRM 2023, p. 12). The IESC recommends that the proponent make better use of these data to calibrate the water resource (“Source”) and flood (“URBS”) models to reduce the uncertainties involved in relying on empirical regional information. The ongoing collection and use of local data to calibrate these models would greatly increase confidence in the analyses of streamflow behaviour (see Paragraph 3d), specifically the year-to-year variability in ecologically important flow components, behaviour of the water supply system, and flood risks. In addition, the validity of the preliminary rating curve should be verified by streamflow gauging, and/or by the development of a local hydrodynamic model of river conditions immediately upstream and downstream of the gauging stations.
9. The Source model used in the surface water flow assessment uses 124 years of climate data to assess impacts across different ranges of flow magnitudes (WRM 2023, p. 27-33); however, the impacts are assessed in terms of average total reductions. This approach masks the impacts on the year-to-year variability of ecologically important flow components, such as the length and duration of low- and high-flow spells, and the duration of zero-flow periods. Of particular potential concern is the impact of Tapplebang Dam on the year-to-year variability of early and late wet season flow pulses, and on the timing of both the onset and cessation of streamflows during the wet season.
10. The proponent has chosen to release environmental flows at 5.1 ML/d until the dam reaches capacity, a value derived from the Flows to Waterholes EFO in the CYWP (WRM 2023, p. 26). However, other flow volumes, durations, timings or step-wise changes to the environmental flow releases may result in fewer impacts to aquatic biota and riparian vegetation downstream of the proposed dam. The IESC recommends the proponent assess a range of environmental flow release scenarios to preserve ecologically important flow components, along with a sensitivity analysis, to justify that the current proposed release volume of 5.1 ML/d is sufficient to minimise impacts to downstream receptors (also see Paragraphs 23 – 25). Given that the annual inflow volumes to the

dam are considerably larger than its storage capacity, changing the release provisions may have little adverse impact on water security whilst greatly reducing environmental impacts.

11. Appropriate models have been selected for estimating baseline flood impacts, and some efforts have been made to ensure consistency with regional empirical information, and between the hydrologic and hydraulic model simulations. Although only a short period of local streamflow observations is available, the records do include the flood response to Tropical Cyclone Trevor; calibrating the runoff-routing flood model (URBS) to this event would thus add confidence to the design flood inundation estimates provided. Once the model has been calibrated, the proponent should incorporate key mine infrastructure, such as the mined areas and the dam structure, into the model to determine any changes to overland flow and the extent of flooding around the dam. The proponent should also provide an assessment of overtopping risks for the dam.
12. Climate-change predictions for Cape York include a possible increase or decrease in seasonal and annual rainfalls, but an increase in rainfall intensities associated with cyclones (Glencore 2023, 12, p. 12-5). Given the expected length of mining operations and the likely increase in the intensity of storm rainfalls, the IESC recommends that the proponent incorporate climate-change scenarios into the water management and flood risk modelling using approaches that are consistent with current national guidelines (Ball et al., 2019).

Question 2: Advice is sought on whether the EIS has identified and assessed the key risks and impacts to water resources and related assets as a result of the proposed project, particularly as a result of the proposed damming of Tapplebang Creek, including to:

- a. groundwater and surface water
- b. groundwater-surface water interactions
- c. water-dependent ecosystems and associated threatened species habitat.

13. The EIS's identification and assessment of the project's risks to water resources should include one or more IPDs, derived from a suitable evidence-based ecohydrological conceptualisation, to illustrate all the potential direct and indirect impact pathways and their interactions during and after mining. Much of the current EIS treats each potential impact (e.g., drawdown, damming of Tapplebang Creek) individually but does not clearly describe their likely collective impacts and how these may vary or interact. As project-related drawdown, mounding, damming and other processes will occur concurrently, the combined effects of these on water resources and water-dependent Commonwealth- and State-listed species in different parts of the project area should be assessed. Drawing up the IPDs will also better integrate the different sections of the EIS, illustrate interacting impact pathways, and help identify and justify where further data, monitoring and mitigation measures are required (see response to Question 5).

Groundwater

14. Noting the inadequacies regarding the hydrological and hydrogeological conceptualisation, and the presentation and interpretation of groundwater model outcomes outlined in response to Question 1, impacts to water resources and related assets could be greater than predicted in the EIS, particularly with regard to the following.
 - a. Groundwater elevation in the post-mining rehabilitated landscape (see Paragraphs 5c and 6c), which may affect rehabilitation targets if soils are seasonally waterlogged by shallow groundwater, or surface expressions of groundwater.
 - b. Proposed impacts to baseflow seepage to Coconut and Tapplebang creeks which are not expected (AGE 2023, p. 38) to have a measurable effect on the flow regime in creeks within the

natural year-to-year fluctuations. However, it was noted that differing volumes of baseflow increase and reduction are provided (AGE 2023, p. 33 and 38), which are not always consistent with figures of predicted groundwater seepage (AGE 2023, Figures 33 – 34).

Surface water

15. Due to the lack of calibration of the water resource and flood models as discussed in Question 1 (see Paragraphs 8 – 9 and 11), and inadequacies in modelled scenarios (see Paragraphs 9 and 12), there is uncertainty about the potential impacts of changes to the hydrological regime in Tapplebang Creek associated with changes to ecologically important flow components. Specific issues are outlined below.
 - a. Annual changes in water volume in Tapplebang Dam predicted from the WBM (Glencore 2023, 07, Graph 7-4, p. 7-33) indicate that due to dam filling, high flows can be delayed by at least a month, and during very dry years the dam may not fill until March. This delay in the onset of high flows, as well as a change in the length of the wet season flows (e.g., a later onset and earlier finish as dam levels drop below the weir at the end of the wet season) would be a consistent shift in the hydrological regime over the 22-year LOM.
 - i. This change in the hydrological regime would be most distinct during dry years, where dam storage capacity represents a greater proportion of overall annual flow volume.
 - ii. Due to limited information on the impacts of climate change on surface flows, as highlighted in Paragraph 12, these impacts to flows from the dam may be exacerbated with overall drier conditions and more extreme storm events over the LOM.
 - iii. These changes to the early wet season flows are likely to have impacts on benthic communities, fish and riparian vegetation in Tapplebang Creek that are adapted to the current inherent variability in the hydrological regime.
 - iv. Both changes and delays in flows could impact freshwater flushing of tidal waters in the lower reaches of the Ward River, including into the wetlands that support breeding habitats for EPBC Act-listed species. These systems rely heavily on flow pulses in the hydrological regime to ensure there is no build-up of saline water (C&R 2021, p. 38).
16. The WBM predicts possible passive releases of pit water and in-pit fines emplacement water (REE 2023b, p. 24) when heavy rainfall exceeds the storage capacity of pits and sumps. This water is classed as mine-affected water (MAW). Although the geochemical assessment (RGS 2023) suggests that concentrations of metal contaminants (except selenium) in the MAW will be low, the low pH, low hardness and low dissolved organic carbon (DOC) in the receiving creeks means that any divalent metals released in the untreated MAW will be particularly bioavailable.
17. A key issue is the release of sediment-laden water into the receiving environments. These mine water storages have been designed as 'sediment basins' with capacity to treat a 1:5 AEP 24-h storm event, as per the International Erosion Control Association guidelines (IECA 2008) to allow suspended sediment to settle (REE 2023b, p. 18). Information is limited on the design capacity of these storages, and the pathways of movement of MAW into creeks. The IESC notes that if the design capacity is not sufficient to allow suspended sediment to settle out before water is released, these events will result in increased sediment loads to Coconut and Tapplebang creeks, potentially impacting water quality and increasing sediment deposition downstream. There is also potential for release of this MAW due to operational transfer of water between pits (REE 2023b, p. 30). The WBM outlines a possible scenario where this transfer of water results in water release that continues after rainfall stops. This may result in increased suspended sediment loads to the receiving environment when flows are not large enough to dilute or physically transport the sediment further downstream. The proponent should

provide more information on the potential impacts that may arise from discharges of MAW into Coconut, Norman and Tapplebang creeks.

18. More extreme rainfall events are predicted with climate change (Glencore 2023, 12, p. 12-5), which may result in increased potential for these storages to overflow. The IESC recommends climate-change scenarios be included in the design capacity of MAW storages to limit the potential release of sediment-laden water to downstream environments. Incorporating climate-change scenarios into the WBM, as suggested in Paragraph 12, would inform the design capacity of these mine water storages.
19. Geochemical leachate testing of bauxite ore and pit wall materials showed that selenium (Se) was the only metal/metalloid that exceeded ANZG (2018) water quality guidelines for the protection of aquatic ecosystems (RGS 2023, p. 13). The IESC notes the potential for elevated Se concentrations in initial seepage and runoff, and possible elevated concentrations of Se in potential MAW releases to the receiving environment, including groundwater. Selenium can bioaccumulate in biota, particularly in waters with low pH and low nutrients (ANZG 2018). The proponent should monitor a wider suite of analytes (see Paragraph 38c).
20. Gallium, typically found in bauxite ore (Jaskula 2020), should be measured in additional geochemical testing.
21. The proponent has not discussed potential water quality issues in Tapplebang Dam. Potential issues such as deterioration of water quality by the end of the dry season (WRM 2023, p. 39) should be considered to inform management and monitoring programs related to water quality objectives for dam releases (see Paragraph 38c).

Groundwater-surface water interactions

22. The seasonally elevated water table has the potential to intersect with the pits (AGE 2023, p. 31), and this source of inflow has not been accounted for in the Open Cut Pit and In Pit Fines Backfill Areas Water Balance (REE 2023b). In addition, seepage is a large proportion of outflows from the pits (REE 2023b, p. 22). Elevated groundwater levels may limit the amount of infiltration possible, leading to excess water in the pits and a greater potential for pit water and in-pit fines emplacement water to accumulate and overflow to the receiving environment, as discussed in Paragraphs 16 and 17. Any potential mounding of the water table as a result of the project will further exacerbate this issue. The IESC suggests these pit inflows be incorporated into the water balances and that the proponent provide further discussion associated with the potential impacts to the receiving environment.

Aquatic habitats and groundwater-dependent ecosystems (GDEs)

23. The proponent plans to dam Tapplebang Creek and capture 10 GL/yr of water at the beginning of the wet season, releasing up to 5.1 ML/d into the downstream system until the dam has filled. Once the storage capacity is reached, excess water will overtop the dam to flow downstream into the Ward River, until dam levels fall at the onset of the dry season and releases of 5.1 ML/d recommence (WRM 2023, p. 26). The proponent has not provided a detailed discussion about the variability of streamflows (see Paragraph 9) and how the flow-on effect of reduced flows at the beginning of the wet season and altered flows at the start of the dry season could potentially impact aquatic ecosystems and their biota downstream of the project area. For example, seasonal freshwater flushes remove accumulated saline water from the wetlands that are used as breeding habitat for the EPBC Act-listed species Largetooth Sawfish that pup within the wetlands and lagoons during the wet season (C&R 2021, p. 155). Further discussion is needed about the potential impacts to the Largetooth Sawfish resulting from predicted changes to the flow regime and the amounts (and sediment content) of fresh water released downstream into the wetlands.
24. Environmental water releases are to be made via pontoon-mounted pumps on the dam lake that pump water to the Tapplebang Dam pump station for release through a metered valve to a piped

outlet on Tapplebang Creek, located downstream of the spillway (Glencore 2023, 07, p. 7-36). There is no information provided on whether this process of environmental water release may harm or kill fish and other aquatic life (e.g., via transport through the pump infrastructure), alter water quality and/or affect the transport of organic matter, water-borne seeds and other materials. Baseline data on these features of initial flows in Tapplebang Creek are not provided, hampering the proponent's assessment of how these aspects may be affected by the planned environmental water release mechanism.

25. The environmental release process may also alter sediment regimes downstream. As water is to be extracted from the top of the water column (Glencore 2023, 07, p. 7-53), it is likely that most of the entrained sediment will have settled out. Information is needed on how the release of environmental water with depleted sediment loads will alter the sediment regime in Tapplebang Creek downstream of the dam, potentially increasing channel erosion downstream.
26. As part of the proponent's groundwater modelling, mounding is simulated to occur during the dry season around where mining is proposed (AGE 2023, Figure 30, p. 75). The modelled mounding is expected to expand beyond the disturbance areas into areas where field-verified terrestrial GDEs occur (EcoSM 2023, p. 9). This mounding could potentially impact these GDEs through unseasonal waterlogging, especially if they are unaccustomed to having access to water throughout the dry season. Such waterlogging may lead to die-back of vegetation GDEs, as well as other terrestrial vegetation intolerant of prolonged waterlogging yet used as foraging and/or breeding habitat by EPBC Act-listed species such as Palm Cockatoo, Red Goshawk, Black-footed Tree-rat, Masked Owl, White-throated Needletail and several migratory species (EcoSM 2023, p. 165). The IESC recommends that the proponent further assesses the potential impacts of mounding on the condition and persistence of GDEs and other terrestrial vegetation surrounding the mining disturbance area so that the potential extent of vegetation loss can be reliably estimated.
27. The proponent plans to clear some 6,885 ha of vegetation which includes confirmed GDEs (e.g., Darwin Stringybark woodlands) that provide breeding and foraging habitat for species listed by the EPBC Act and the *Nature Conservation Act (1992)* (EcoSM 2023, p. 165). The vegetation in the project area is rated as being in moderate to excellent condition with many tree hollows, which most of these listed species use for breeding (EcoSM 2023, Table G-1, pp. 451 – 465). Removal of a large area of breeding and foraging habitat could potentially reduce populations of this wildlife due to increased competition for food and hollows for breeding. The IESC suggests that the proponent further assesses the potential impacts of clearing (and waterlogging as described in Paragraph 26) on the populations of all listed species, including stresses from increased competition and reduced food availability.
28. The dam across Tapplebang Creek is predicted to inundate 10 km of seasonally flowing narrow creek, replacing it with a more permanently inundated lake that will completely alter the aquatic and riparian habitats of the creek for at least two decades. Although the proponent plans a fishway around the dam, there is little assessment of how native fish diversity and individual species will be impacted by the prolonged and major change from a flowing- to standing-water aquatic habitat along the 10-km dammed stretch. There may also be impacts of the dam on habitat and movement of Estuarine Crocodile, listed under the EPBC Act and recorded from Tapplebang Creek (C&R 2021, p. 58). A full assessment of these impacts, along with species-specific management plans for crocodiles, fish and other aquatic biota, should be provided so that suitable mitigation measures can be proposed, justified and implemented.
29. The inundation of the 10-km stretch of creek will also impact its riparian vegetation (classified as Regulated Vegetation, an MSES) for two decades, and there may also be impacts on riparian vegetation immediately downstream of the dam wall. The proponent should provide more details on the likely loss or impairment of this riparian vegetation and the repercussions for wildlife, some of

which are EPBC-Act listed, that use it for foraging or breeding habitat. More specific information is also required on its rehabilitation after removal of the dam (Paragraph 38g).

30. The proponent acknowledges that all surface waters in the project area are likely characterised as High Ecological Value (HEV) waters because of the low level of anthropogenic disturbance (C&R 2021, p. 12). However, baseline field-collected data of turtles, fish and invertebrates in Tapplebang Creek are restricted to 3-5 sites sampled in 2018 (C&R 2021, Table 1, p. 16). The proponent should collect at least a year's worth of further field data (see Paragraph 37) to more robustly assess the likely impacts on aquatic biota of damming and inundation of this HEV waterway, and to evaluate recovery once the dam is removed.

Question 3: Advice is sought on the accuracy of the assumptions made in the water supply options analysis and whether the conclusions on unsuitability/unavailability of water supply from the GAB and shallow groundwater aquifers are appropriately supported.

31. The IESC considers the assumptions made about the water supply options from the Great Artesian Basin (GAB) and shallow groundwater aquifers are adequately discussed within the documentation and the conclusions are appropriately supported.
32. The analysis comparing the off-stream storage option and the in-stream storage option on Tapplebang Creek is not appropriately supported by the assumptions and conclusions drawn in the documentation. A comparison has not been undertaken of flow impacts between the two options, and the proponent has based part of their decision on the conclusion that flow impacts from Tapplebang Dam are minor (Glencore 2023, 04, p. 4-35). As outlined in Questions 1 and 2 of this advice (see Paragraphs 8 – 12, and 15), the IESC has noted inadequacies about the proponent's flow assessment methodology and presentation of data, and uncertainty remains about the likelihood of potential impacts relating to reduced early wet season flows.

Cumulative impacts

Question 4: Advice is sought on whether the EIS has sufficiently addressed the cumulative impacts on water resources and related assets (including within and downstream of the project area and nearby extractive projects) and whether the conclusions on cumulative impacts are appropriately supported.

33. Limited discussion is presented on the potential combined impacts on the downstream wetlands due to altered flow (see Paragraphs 15 and 23) and sediment regimes (see Paragraph 25) downstream of the proposed Tapplebang Dam. The IESC suggests more detailed assessment of these combined impacts on the downstream wetlands in the Ward River due to Tapplebang Creek being dammed. The proponent provides only limited explanation of the cumulative effects of how the predicted decrease in flows at the beginning of the wet season from the proposed project's Tapplebang Dam and Rio Tinto's water abstraction from Ward River will affect the amount of freshwater flowing downstream. Further information (see Paragraphs 8 and 9) is needed to properly assess the potential cumulative impacts on downstream environments.
34. Based on currently available information, the IESC agrees with the proponent (AGE 2023, p. 39) that it is unlikely that this project will contribute to cumulative impacts due to groundwater extraction in the Gilbert River Formation (part of the GAB aquifers of the Carpentaria Basin).

Mitigation and management

Question 5: Advice is sought on whether the proposed monitoring, mitigation and management measures are specific enough to adequately identify, mitigate and manage potential impacts from the proposed project on water resources and related assets.

35. The proponent has provided only high-level information on the proposed monitoring, mitigation and management measures, which is not specific enough to adequately identify, mitigate and manage all potential impacts from the proposed project on water resources and related assets. The IESC suggests additional monitoring and management measures as outlined below.
36. Baseline and continued monitoring of downstream aquatic ecosystems is needed to determine impacts of reduced freshwater flushes and the altered timing of wet season flows (see Paragraph 15a) on biota and habitats, some of which are listed as MSES or by the EPBC Act.
37. As noted in Paragraph 30, baseline field data of turtles, fish and invertebrates in Tapplebang Creek are restricted to 3-5 sites sampled in 2018. Additional pre-dam baseline surveys should be conducted of aquatic and riparian ecosystems at suitable reference sites and sites within and downstream of the 10 km of stream that will be inundated by the dam so that when the dam is removed, the proponent can demonstrate successful recovery of the impacted ecosystems. These additional baseline surveys should be followed by appropriate monitoring so that the proponent can identify changes in the health of these ecosystems during and after mining.
38. The proponent should address the following when developing monitoring, mitigation and management (including rehabilitation) plans.
 - a. Monitoring of vegetation GDEs within and surrounding the project area (especially GDEs within zones of predicted groundwater mounding) to assess the effects of waterlogging of these GDEs (see Paragraph 26). The proponent should investigate and discuss possible measures to mitigate the potential waterlogging conditions from mounding.
 - b. Development of a Groundwater Monitoring Plan before commencement of operations that includes additional monitoring bores where they have predicted drawdown and/or mounding outside of the project area, and monitoring of the full suite of metals/metalloids. The proposed exceedance investigation trigger of five consecutive exceedances (Glencore 2023, 22, p. 22-34) should also be reduced and justified to demonstrate that timely actions to mitigate impacts would occur.
 - c. The proponent mentions that a Receiving Environment Monitoring Program, Water Management System Monitoring Program, Mine Water Monitoring Program and Dam Monitoring Program will be developed (Glencore 2023, 07, p. 7-63). However, no discussion has been provided on when these plans will be developed. The IESC suggests that the proponent develop all the listed programs prior to any operations commencing.
 - i. In addition to parameters outlined in the proposed EA (Glencore 2023, 22, Appendix A, p. 22-39), the proponent should monitor the full suite of total and dissolved metals and metalloids and DOC, to identify any contaminants that may be bioavailable.
 - ii. In addition to turbidity, total suspended solids (TSS) should be monitored to identify sources of turbidity and be able to adapt management measures accordingly.
 - iii. The proponent should provide information on the monitoring frequency and suite of parameters to be monitored within and downstream of Tapplebang Dam. Proposed mitigation and management measures should be outlined if water quality in the dam deteriorates, especially late in the dry season, to limit downstream impacts of poor-quality water being released.
 - d. The proponent has mentioned that a Trigger Action Response Plan (TARP) will be developed as part of the Water Management Plan (Glencore 2023, 07, p. 7-66). This TARP should be developed prior to commencement of operations to ensure adequate and timely responses to any

changes in the surface water systems and aquatic, riparian and water-dependent terrestrial biota and ecosystems in the project area and downstream environments.

- e. The proposed site-specific guideline values should be used to develop trigger values. For the contaminants that did not have sufficient data or limits of reporting to develop guideline values, the proponent should use the ANZG (2018) toxicant guideline values for aquatic ecosystem protection.
- f. Expansion of the existing Rehabilitation Plan to include downstream terrestrial and aquatic ecosystems that may be impacted by the proposed project, including riparian vegetation, wetlands and aquatic biota.
- g. Provision of more detail about the rehabilitation of the riparian zone after removal of Tapplebang Dam, including specific information about which species will be seeded or replanted, what survival success is anticipated, and the time-line and criteria for completion of successful riparian rehabilitation. The proponent acknowledges the lack of information from mines at Gove or Weipa because these mines had little use for riparian species (METS 2023, p. 116). More detail is also needed about how two decades' worth of fine sediment deposition might affect re-vegetation of the previously inundated basin once the dam is removed.
- h. The monitoring and management plans produced for the project should be adaptive. These plans should be able to be continually revised based on new data and information under potential different conditions that may occur during operations.

Question 6: Does the IESC consider that any additional measures are needed to adequately reduce risks and projected levels of impact to water resources and related assets?

39. As discussed in Paragraphs 7 – 9, and 15, Tapplebang Dam will impact on the timing, frequency and duration of flushing flows on the downstream environment. There are also likely to be substantial impacts on the aquatic and riparian biota in the 10 km of creek that will be inundated for 22 years as well as a high risk of impacts of altered flow and sediment regimes immediately downstream of the 19-m high dam. The IESC considers that a comprehensive re-assessment of these risks, informed by more robust field data (e.g., Paragraphs 3d, 8, 36 and 37), is likely to alter the perceived advantages of an in-stream storage compared to an off-stream water storage (Glencore 2023, 04, pp. 4-28 – 4-36), as discussed in Paragraph 32. Accordingly, additional information on the risks to the downstream environment should be included in a re-assessment of the available options to see if an off-stream storage represents a better water supply solution.

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| Date of advice | 14 November 2023 |
| Source documentation provided to the IESC for the formulation of this advice | Glencore 2023. <i>Aurukun Bauxite Project: Environmental Impact Statement</i> . Glencore, July 2023. |
| References cited within the IESC's advice | AGE 2023. <i>Aurukun Bauxite Project Groundwater Impact Assessment</i> . Prepared by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) for Glencore Bauxite Resources Pty Ltd, May 2023. ANZG 2018. <i>Australian and New Zealand guidelines for fresh and marine water quality</i> . Australian and New Zealand Governments and Australian state and territory |

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