



Advice to decision maker on gold mining project

IESC 2024-151: Cadia Continued Operations Project – Expansion

Requesting agency	The New South Wales Mining and Petroleum Gateway Panel
Date of request	16 August 2024
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Advice stage	Gateway Application

The Independent Expert Scientific Committee on Unconventional Gas Development and Large Coal Mining Development (the IESC) provides independent, expert, scientific advice to the Australian and state government regulators on the potential impacts of unconventional 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 unconventional gas or large coal mining developments or any other matters within the expertise of the IESC are informed by the best available science.

The IESC was requested by the New South Wales Mining and Petroleum Gateway Panel to provide advice on the Cadia Holdings Pty Limited Cadia Continued Operations Project in New South Wales, and the request approved in writing by the Australian Government Environment Minister. 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 2024).

Summary

The Cadia Continued Operations Project (the 'project') is a proposed expansion of the existing Cadia Valley Operations (CVO), a polymetallic mining operation located in central New South Wales (Minesoils 2024, p. 6). The project is currently being reviewed by the New South Wales Mining and Petroleum Gateway Panel as it requires a Gateway Certificate due to the project's likely permanent impacts to Biophysical Strategic Agricultural Land (BSAL). The Mining and Petroleum Gateway Panel has requested the IESC's advice as required under the *State Environmental Planning Policy (Resources and Energy) 2021* (SEPP).

The project involves extension of operations to approximately 2050 via continuation of underground (cave) mining, tailings emplacement within existing and additional storages, development of an additional water storage, road realignments, and changed site infrastructure and facilities to enable the extended mining operations (Minesoils 2024, p. 6). This will result in disturbance of up to 1,253 hectares (ha) (Minesoils 2024, p. 10), of which 378 ha are verified BSAL (Minesoils 2024, p. 52). This disturbance occurs in the Gateway Application Area, which refers to the portion of the project area outside the existing CVO boundary.

The provided documentation lacks specific details as the Gateway Certificate assessment occurs prior to project referral and assessment under the New South Wales *Environmental Planning and Assessment Act 1979* (EP&A Act). The Gateway Assessment focuses on impacts to verified BSAL in areas which have not been previously assessed by the Gateway Panel. The IESC acknowledges that additional impact assessment and documentation will be required by the New South Wales EP&A Act, and the proponent indicates that such studies are underway (Minesoils 2024, pp. 10, 62). The IESC previously provided advice on upgrades to the tailings dam embankment for the CVO in August 2023 (IESC 2023).

Key potential impacts from this project are:

- disturbance of up to 1,253 ha outside the existing approved CVO project boundaries;
- emplacement of tailings in existing and proposed storages which could alter the water quality, rate and/or direction of leakage, impacting nearby groundwater-dependent ecosystems (GDEs) (including high-priority ones along waterways listed in the Water Sharing Plan), surface water systems and local groundwater;
- changes to instream habitat and downstream GDEs from construction of the South Water Storage on Cadiangullong Creek, including permanent inundation of a section of the creek, leading to impacts to ecologically important components of its flow and sediment regimes and water quality, and water logging of nearby GDEs;
- modification of surface flows due to different types of cave mining and associated localised fracturing and subsidence;
- increased drawdown from extension of cave mining, reducing groundwater availability to GDEs along Flyers Creek and Cadiangullong Creek; and
- cumulative impacts with the existing CVO project.

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

- An improved understanding of surface water and groundwater resources, surface water-groundwater interactions and GDEs is required, which should include relevant baseline information on water quality, hydrological connectivity and flow regimes.
- Proposed project activities should be finalised and described in more detail so that potential impact pathways to water resources can be determined with greater certainty. Following this, an impact pathway diagram should be developed to refine and communicate understanding of how and where the project may impact water resources
- Site-specific investigations should be conducted to confirm the presence and groundwater-dependence of aquatic, terrestrial and/or subterranean GDEs in and near the project area. This information will guide assessment of likely impact pathways and potential impacts of the project on relevant GDEs.

- The likely extent and magnitude of groundwater level and water quality changes from underground mining, tailings deposition and water management infrastructure should be quantified to determine likely impacts to GDEs and surface waters.
- Further information is required regarding proposed avoidance and mitigation of potential impacts once water resources and project components have been adequately defined. This information should be complemented by detailed description of a monitoring program to assess the effectiveness of the avoidance and mitigation strategies and detect any residual impacts.
- An assessment of cumulative impacts is required that explicitly considers the existing CVO project and other relevant land and water uses in and near the project area.

The IESC strongly urges the proponent to draw on existing monitoring and information collected for the current operations to assist preparation of the Environmental Impact Statement.

Context

The Cadia Continued Operations Project (the 'project') is a proposed expansion of the existing Cadia Valley Operations (CVO), located approximately 20 km south-southwest of Orange in central New South Wales. CVO is a polymetallic mining operation which commenced in 1998, with current operations approved by the state (PA 06_2095), covering underground mining at the Cadia East and Ridgeway areas and Cadia Hill Open Pit (now used for tailings storage), and tailings deposition in the North Tailings Storage Facility (NTSF) and South Tailings Storage Facility (STSF) (AGE 2021, p. 8).

The proponent seeks to extend the mine life from 2031 to 25 years after approval is granted (nominally 2050). This will involve extension of underground (cave) mining, extension of the STSF (referred to as the STSFx) and continued use of existing tailings storages, development of the South Water Storage on Cadiangullong Creek, realignment of an unspecified section of Cadiangullong Creek, construction of surface water infrastructure such as drains and reclaim ponds, road realignments, and changes to site infrastructure and facilities (Minesoils 2024, p. 6).

The Gateway Application Area (GAA) refers to land where new mining leases are required for the activities proposed. The GAA totals 2,265 hectares (ha) (Minesoils 2024, p. 41), within which 1,253 ha will be directly disturbed (Minesoils 2024, p. 10). The project is anticipated to directly impact up to 378 ha of Biophysical Strategic Agricultural Land (BSAL) (Minesoils 2024, p. 52). The GAA is within the Lachlan River Catchment, in the Murray-Darling Basin. Cadiangullong Creek is the major watercourse in the GAA, fed by Rodds Creek, flowing generally southward into the Belubula River which then flows west to the Lachlan River (Minesoils 2024, p. 18). Flyers Creek, east of the GAA, has springs and perennial reaches supported by groundwater (Minesoils 2024, p. 57). Within and surrounding the GAA, high-potential terrestrial groundwater-dependent ecosystems (GDEs) and moderate- to high-potential aquatic GDEs are associated with Cadiangullong Creek, Flyers Creek and the Belubula River, and low-potential terrestrial GDEs occur in the Cadia East subsidence zone (Minesoils 2024, Figure 5, p. 17). Some of these GDEs along the Belubula River and Cadiangullong and Flyers creeks are likely to be high-priority ones listed in the Water Sharing Plan.

The GAA is located in the Lachlan Fold Belt of NSW, where the Orange Basalt Aquifer Source associated with Tertiary basalts is considered a highly productive aquifer under the *NSW Aquifer Interference Policy* (AIP). The Lachlan Fold Belt Groundwater Source is considered a less-productive fractured groundwater source in the area. The proponent notes potential discrepancies between regional mapping and site investigations of the extent of the Orange Basalt aquifer (Minesoils 2024, p. 15).

At the Gateway Certificate stage, the proponent must verify whether the proposed site is on BSAL and, where present, assess the likely significance of impacts on BSAL and associated groundwater resources (Minesoils 2024, p. 9). As such, the current documentation is limited in scope, and lacks specific details

that would be required of the Environmental Impact Statement (EIS) once a Gateway Certificate is acquired.

Response to questions

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

Question 1: Have all relevant water resources been adequately defined? If not, what further work is required?

1. The provided documentation presents limited or only high-level descriptions of relevant groundwater, surface water, GDEs and surface water-groundwater interactions within and surrounding the project area. Further work is needed to define the water resources, their distribution and interactions, and to determine if and how these resources and their interactions may be impacted by project activities.
 - a. Groundwater resources have been described with limited detail, particularly the Orange Basalt Aquifer Source, a highly productive aquifer under the NSW AIP (Minesoils 2024, p. 15). Additionally, Quaternary alluvium is mapped along parts of Flyers Creek, Cadiangullong Creek and the Belubula River (Minesoils 2024, Figure 3, p. 13), but the potential presence of alluvial aquifers is not discussed. Further studies should aim to ascertain the extent of these and other relevant aquifers and characterise inter-aquifer connectivity and groundwater-surface water interactions. An assessment of how groundwater levels and water quality have changed due to approved mining operations would assist in understanding and predicting impacts from the project, especially to alluvial aquifers which may support springs, baseflow and/or riparian terrestrial GDEs.
 - b. As groundwater flow likely occurs via fracture networks in fractured rock aquifers, the incidence, orientation, frequency and other characteristics of fractures, including mineral infilling, should be included within the groundwater investigations. This will assist in assessing how proposed mining activities will affect aquifers, such as increased fracturing from cave mining or seepage from tailings storages. Similarly, faults or structural features which could connect or compartmentalise groundwater flow, such as the Warrengong Fault (Minesoils 2024, p. 57), or the Werribee/Cadiangullong Fault (identified in previous hydrogeological investigations – AGE 2021, p. 15), should be investigated and documented (see Murray and Power 2021).
 - c. GDEs have not been adequately characterised. Under the Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources (2020), high-priority GDEs could include groundwater-dependent vegetation along the Belubula River, Cadiangullong Creek and Flyers Creek, and groundwater-fed reaches and springs associated with Flyers Creek (Minesoils 2024, Figure 5, p. 17). Sources of groundwater supporting these GDEs should be identified, and may include the Cobblers Creek Limestone Formation (Minesoils 2024, p. 57) or any perched aquifers that could be present (AGE 2021, p. 19). Further work should aim to characterise GDEs and their groundwater-dependence using methods outlined in Doody *et al.* (2019) and, where present, quantify baseflow components in creeks. Groundwater levels and water quality near mapped GDEs should be measured for a period representative of natural climatic variability before the project commences to provide a baseline against which project impacts can be assessed and then monitored during and for a suitable period after operations.
 - d. Hydrological and sediment regimes and baseline water quality of watercourses in the project area should be described, particularly for Cadiangullong Creek which will be directly impacted by diversions and construction of the South Water Storage. A baseline understanding of the hydrological regime with consideration of ecologically important flow components (e.g. timing, frequency and extent of overbank flows, duration and frequency of low flows) and NSW Water

Quality and River Flow Objectives is needed to assess potential impacts of the dam and to design appropriate managed releases downstream of the storage.

Question 2: Have all potential water resource impact pathways been adequately identified by the Applicant? If not, what further work is required?

2. Due to the limited documentation provided (consistent with the requirements of a gateway application) and the lack of information, the IESC is not confident that the proponent has adequately identified all potential water resource impact pathways.
3. The proponent presents a qualitative impact assessment (Minesoils 2024, pp. 57-59) which lacks adequate justification for conclusions drawn about residual impacts to water resources, evidenced in the following paragraphs. A more detailed and quantitative approach is needed in future impact assessments for the proposed project, and should include the identified impact pathways described below.
 - a. Extension of underground mining operations and consequent increased extent and duration of groundwater drawdown could impact nearby GDEs and/or other groundwater users. Depending on the magnitude of drawdown, impacts could extend to terrestrial and aquatic GDEs along Cadiangullong and Flyers creeks (Minesoils 2024, Figure 5, p. 17). However, at this stage, the extent of impacts and specific impact pathways to particular GDEs cannot be determined.
 - b. Potential leakage pathways from the STSFx could occur through fractures in the underlying bedrock, affecting groundwater flowpaths, increasing or decreasing groundwater levels, and impacting quality of groundwater that may be used by nearby GDEs. The proponent asserts that the hydrocyclone construction method for the STSFx will preclude infiltration to groundwater, and that consequent reductions in Flyers Creek baseflow will be negligible (Minesoils 2024, p. 58); however, no detail has been provided to support these conclusions.
 - c. Water management infrastructure along Cadiangullong Creek (creek diversion and construction and operation of the South Water Storage) may alter downstream flows, introduce erosion and scour risks, impair water quality and impact in-stream and riparian habitats. Flows are stated to be maintained to 'appropriate flow conditions' (Minesoils 2024, p. 59), which would necessitate a comprehensive understanding and ongoing gauging of the hydrological behaviour of Cadiangullong Creek under a representative range of climate conditions that is not presented in the documents provided. Additionally, the existing Cadiangullong Dam located upstream of the diversion and South Water Storage should be considered when discussing cumulative impacts on flows, sediment regimes, water quality and aquatic and riparian habitats downstream.
 - d. The South Water Storage will increase groundwater heads, recharge and seepage through the dam wall, increasing baseflows in Cadiangullong Creek downstream and potentially waterlogging terrestrial and riparian GDEs along the creek.
 - e. Water management infrastructure to capture seepage and runoff from the STSFx wall, such as drains and reclaim ponds, could result in changes to surface flows (Minesoils 2024, p. 58), loss of catchment area and/or water quality impacts to Rodds Creek, Cadiangullong Creek and associated in-stream and riparian ecosystems. Further information on water infrastructure, locations and the scale of proposed changes is needed to assess these potential impacts and their pathways.
4. Impact pathways described in the documentation largely relate to project components sited in the GAA, outside the existing mining lease. As such, impacts from operations within the broader project are not investigated in detail. These impacts could include increased depressurisation and associated drawdown and subsidence from underground mining, changes to surface flows or interception of

surface flows from subsidence, and increased seepage from compaction and loading as tailings are deposited in existing storages. The extent of these impacts should be quantified once details of the project are finalised, such as volumes of tailings to be deposited in existing storages, or changes in water table as indicated by numerical groundwater modelling.

5. The IESC recommends that, once assessed, all impact pathways are presented as one or more impact pathway diagrams (see Commonwealth of Australia 2024) to illustrate their collective potential impacts and guide the monitoring of the effectiveness of management strategies to minimise or avoid these potential impacts.

Question 3: Is the Applicant's proposed approach to assessing the potential impacts fit for purpose? If not, what further work is required?

6. The proponent states that the 'EIS will address a range of interrelated water resource considerations', and lists the guidelines that will be taken into consideration (Minesoils 2024, pp. 59-61). This high-level list is mostly fit for purpose and covers standard assessments needed to determine potential impacts to surface and groundwaters. However, further work is required and should include the following.
 - a. Proposed assessments of surface and groundwater resources should include characterisation of surface and groundwater interactions to inform assessment of impacts resulting from the project to aquatic and terrestrial GDEs.
 - b. The presence and groundwater-dependence of aquatic, terrestrial and subterranean GDEs should be assessed using established methods (e.g. Doody *et al.* 2019). Once GDEs have been ground-truthed and mapped, the proponent should evaluate potential impact pathways to each of these different GDEs from underground mining works and associated subsidence and drawdown, any alterations to surface flows and/or water quality from additional site infrastructure, and seepage from water and tailings storages.
 - c. Additional details are required for the design and collection of data to inform an understanding of the baseline streamflow regime and water quality over a period sufficiently long to characterise inter- and intra-annual climate variability.
 - d. Ecological surveys should be conducted of instream biota (e.g., invertebrates, fish, frogs, aquatic plants), stygofauna (especially in alluvial aquifers) and riparian vegetation and condition to obtain baseline data against which project impacts can be assessed. Specific details, guided by these surveys, should be used to describe how the effectiveness of mitigation measures will be monitored.
 - e. Geotechnical studies should be conducted to confirm the areal extent of the caving impact zone to the surface, with additional localised fracturing and subsidence expected at Cadia East and Ridgeway underground mining areas. This information is needed because increases in the areal extent of the caving zone could result in additional loss of surface water and groundwater.
 - f. The groundwater modelling approach includes assessing the potential for any impact on alluvial aquifers and surface water (Minesoils 2024, p. 59), but should also identify groundwater flow paths and the potential to impact private bores (Minesoils 2024, Figure 5, p. 17).

Question 4: Have appropriate strategies and measures to avoid, mitigate or reduce, to a practicable extent, the likelihood and significance of impacts to significant water-related resources been proposed? Are there additional strategies, mitigation or off-setting measures that should be considered to address any residual impacts of the project on water resources and related GDEs?

7. Limited information is provided in the Gateway documentation on strategies and measures to avoid, mitigate or reduce the likelihood and significance of potential impacts to significant water-related resources. Future impact assessments describing such strategies and measures should include:
 - a. proposed measures to reduce or mitigate seepage from the STSFx, as well as ongoing monitoring and, if necessary, intervention to ensure leakage and downstream impacts are minimised;
 - b. proposed measures to limit impacts to waterways and associated GDEs during construction of the STSFx, South Water Storage, and road and creek realignments. For example, options should be considered for the relocation of the proposed STSFx reclaim pond to avoid the need to realign Cadiangullong Creek;
 - c. proposed measures to limit impacts to Cadiangullong Creek as a result of the stream diversion, such as replicating and maintaining appropriate stream and riparian habitats and associated ecological processes, and limiting excessive erosion and scour;
 - d. options to offset impacts from clearing and/or reduced groundwater availability and water quality to listed ecological communities potentially present in the project area, such as White Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Native Vegetation (Minesoils 2024, pp. 22-23), that may also include GDEs;
 - e. proposed monitoring programs with appropriate scope and sampling frequency, as well as suitable Trigger Action Response Plans (TARPs) for groundwater and receiving surface water levels and quality;
 - f. information regarding timing and frequency of managed releases (and spills) from the South Water Storage, with consideration of water quality and river flow objectives;
 - g. appropriate mitigation and management measures for GDEs, based on ground-truthed GDE distributions and assessment of potential impact pathways (see Paragraph 6c);
 - h. proposed measures to remediate subsidence impacts in the northeastern area of the GAA should technical studies indicate the potential for this, as briefly indicated (Minesoils 2024, p. 62); and
 - i. a clear description of the proposed mine closure plan, including appropriate measures for restoration of the TSF and the small segment of the stream diversion (if retained).
8. It is essential when preparing the coming EIS that the proponent draws on the existing information, including investigations and environmental monitoring, that has already been collected for and during the current operations.

Date of advice	10 October 2024
Source documentation provided to the IESC for the formulation of this advice	Minesoils Pty Ltd (Minesoils) 2024. <i>Gateway Report – Cadia Continued Operations Project</i> . Prepared for Cadia Holdings Pty Limited. July 2024. (Including Appendices 1-5). Available [online]: Independent Planning Commission - Cadia Continued Operations Project (nsw.gov.au) accessed 3 October 2024.
References cited within the IESC’s advice	Australasian Groundwater and Environmental Consultants (AGE) 2021. <i>Cadia Groundwater Model Update 2021</i> . Prepared for Newcrest Mining. April 2021. Project No. G1383Y. Available [online]: G1383Y Report Cover Apr2021.cdr (caapp.com.au) accessed 17 September 2024.

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