14 August 2015

Mr Brett Corven
Eurobodalla Shire Council
PO Box 99
MORUYA NSW 2537

Our ref: 31/290400/0 245719
Your ref:

Dear Brett

Proposed Dargues Reef Mine
Comments on Proposed Modification 3 Change to Mining Operations

1 Introduction

Eurobodalla Shire Council (ESC) commissioned Dr Peter Beck of GHD Pty Ltd (GHD) to provide comment on a proposed Modification 3 change to Mining Operations at the Dargues Reef Mine Project (the Project Site), which is currently in the process of being developed. GHD's understand the key changes for Modification 3 involve a change in mine sequence, longer mine life, construction of additional waste rock storage on the surface and, most significantly, the use of a Carbon in Leach process using cyanide, and what is essentially a new Tailings Storage Facility. These are significant changes from the approved project as outlined in the original environmental impact assessment (R.W. Corkery & Co. Pty Limited (RWC, 2010a), Environmental Assessment dated September 2010). The potential environmental impacts of this proposed change in mine operations was outlined in report:

- Unity Mining Pty Ltd (BIM), *Environmental Assessment for the Dargues Reef Gold Project - Modification 3*, July 2015, Ref No. MP10_0054 (Environmental Assessment Report).

2 Background

ESC requested Dr Peter Beck of GHD Pty. Ltd. to provide an independent review and advice regarding the risks to their drinking water supply potentially posed by the proposed modification to the gold mining project within the upper catchment of the Deua River, which supplies approximately 60% of the Eurobodalla's drinking water supply. Eurobodalla Shire Council had previously commenced proceedings in the Land and Environment Court to challenge the decision of the Minister for Planning and Infrastructure to grant a project approval under Part 3A of the Environmental Planning and Assessment Act 1979 ("the EPA Act") to Big Island Mining Pty Ltd, a subsidiary of the publicly listed company, Cortona Resources Ltd. Cortona Resources Ltd. through court action was granted approval for the proposed gold mine. One of the key commitments made by Cortona Resources Ltd. was that no on site procession of gold ore using cyanide would occur on site. Court action was settled in part due to this commitment. The proposed gold mine site is physically located in another Council area; the Eurobodalla drinking water catchments is largely located downstream of the proposed mine. We understand that the mining project was acquired by Unity Mining which is now proposing a number of modifications to the mine infrastructure and ore processing, including on site gold extraction using the carbon in leach process that utilises cyanide. This is a breach of the previous commitment under which Eurobodalla Shire Council agreed to settle the matter.

ESC requested that Dr. Peter Beck of GHD conduct a review of the proposed modifications and provide an opinion on the risk these proposed modifications may pose to the Deua River Catchment.

3 Purpose

ESC sources water from the Deua River catchment to provide the majority of drinking water supply to around 40,000 permanent residents and a seasonal population of up to 100,000. Council's major concern in regard to the proposed development modification is the additional risk posed by proposed use of on-site ore processing using a cyanide based extraction process and deposition of the resultant fine waste stream into the Tailings Storage Facility (TSF). In particular Council seeks the following:

1. Advice on the risks associated with cyanide operations at the site, noting that the gold mine is situated in the upper catchment of the Deua River which supplies approximately 60% of Eurobodalla's water supply. The proposed treatment will be taking place within the environment of and in close proximity to the established development of Majors Creek. The catchment flows past significant dependent agricultural farming lands and established residential properties throughout the Deua River Valley.
2. Advice on the adequacy of proposed processing operations and environmental controls with respect to operational risk (including possible operator error), effluent quality, cyanide leaching from the tailings storage facility, or other components of the project.
3. Advice on the consequences of failure of proposed controls.
4. Advice on the issues relating to extending the approved mine life by four years from 21 August 2018 to 31 August 2022.
5. Advice on increasing the approved maximum ore extraction from 1.2 million tonnes to 1.6 million tonnes over the life of the project.
6. Advice on construction of an enlarged tailings dam to permit storage of additional tailings and construction and use of a waste rock emplacement area, and the influence of cyanide residuals in the tailings material.
7. Advice and discussion on any other relevant matter apparent to you.

4 Cyanide and gold recovery

One key change proposed by Unity Mining is to complete the full gold processing, extraction and waste disposal cycle on site, rather than transport the ore concentrate for processing at an existing off-site facility. The proposed on-site ore processing will utilise cyanide to recover gold from the ore mined at the site in a Carbon in Leach (CIL) Plant. This is a significant change in the proposed site operations and is in breach of the mining company's negotiated agreement with the Eurobodalla community.

The previous proposal would have resulted in the use of mostly benign substances or very small quantities of substances of environmental concern, therefore posing only a relatively limited risk to human health and the environment during and post operation of the mine. The project as approved would not have involved use of large quantities of toxic substances and disposal of waste that contains a range of contaminants and toxic substances on site. The resultant risk during development, operational, care and maintenance, closure and post closure phases would have been able to be managed using relatively simple measures. Also, any failure in infrastructure or management measures would not have posed a significant long term risk due to toxic substances to human health and the environment.

The proposed use of the complete mining, ore processing and gold extraction and waste disposal cycle on site has a significant effect on the potential short, medium and long term risks to human health and the environment. The proposed modification would significantly increase the use of toxic chemicals in operations on the site and result in potential long term risks due to retention of toxic substances in the TSF that would pose a long term risk to human health due to long term leaching or catastrophic failure.

4.1 Summary of cyanide use in gold extraction

Recovery of gold from ore using cyanide is a method that forms water soluble mineral complexes of gold, usually $Na[Au(CN)_2]$. The cyanide process is the most commonly used method for gold extraction from sulphide ores. Due to its toxicity the cyanide based gold recovery process is controversial and its usage is banned in a number of countries and jurisdictions including Germany, Czech Republic, Hungary and Costa Rica, as well the USA states of Montana and Wisconsin and the Argentine provinces of Chubut, Río Negro, Tucumán, Mendoza, La Pampa, Cordoba, San Luis and La Rioja. Turkey has also refused permits for new mines using cyanide. Of these the USA and Turkey are known to have significant gold deposits available for future mining.

The cyanide gold recovery process involves suspending the crushed ore in a cyanide solution that leads to formation of soluble gold complexes and can achieve a separation of up to 96 percent pure gold. Cyanide has been used commercially in gold mining since the 1890s and, despite its toxicity and numerous accidental releases into the environment, remains the most commonly used process due to its effectiveness and low cost. Depending on the nature of the ore further concentration may be required after crushing (by froth flotation or by centrifugal (gravity) concentration) before adding the cyanide. The oxidation-reduction reaction for the dissolution of gold in a cyanide solution is:

$$4\ Au + 8\ NaCN + O_2 + 2\ H_2O \rightarrow 4\ Na[Au(CN)_2] + 4\ NaOH$$

The process oxidises the non-valent Gold (Au) atom to the single valent Au^+ species to facilitate allow formation of the soluble $Au(CN)^-_2$ complex. Aside from sodium cyanide, potassium or calcium cyanide can be utilised, with sodium or calcium cyanide generally the most cost effective.

To limit the risk of forming volatile, toxic hydrogen cyanide during processing, slaked lime (calcium hydroxide) or soda (sodium hydroxide) is added to the extracting solution to ensure that the acidity during processing is maintained over pH 10.5 - strongly alkaline. Lead nitrate can improve gold leaching speed and quantity recovered, particularly in processing partially oxidized ores.

Oxygen is one of the key reagents consumed during the process. Any oxygen deficiency can slow the extraction process rate. Therefore in most ore processing oxygen is added to maximize the dissolved oxygen concentration and maintain optimal extraction conditions.

Once the gold is in solution recovery is required. In order of decreasing economic efficiency, the common processes for recovery of the solubilised gold from solution involve the following steps:

1) **Carbon in pulp / carbon in leach:** Carbon in Pulp (CIP) and Carbon in Leach (CIL) are a simple and cheap process for recovery of gold in the cyanide extraction process. The process uses granular activated carbon to adsorb the gold cyanide complex from solution until it comes to equilibrium with the gold in solution. The carbon particles used are much larger than the ore particles and thus can be separated from the slurry by screening using a wire mesh. The gold can then be recovered from the carbon through an intense cyanide leach cycle. Final gold recovery is then achieved by electrowinning or the Merrill-Crowe process.

    a) **Electrowinning:** Electrowinning, also called electroextraction, is the electrodeposition of metals from solution after extraction from the ore by passing a current from an inert anode through a liquid leach solution containing the metal so that the metal is extracted as it is deposited in an electroplating process onto the cathode; or

    b) **Merrill-Crowe process:** The Merrill–Crowe Process uses filtration (e.g. horizontal leaf type clarifiers) and counter current decantation (CCD) to recover gold from solution. After filtration a very clear solution is achieved. Oxygen is then removed by passing the solution through a vacuum de-aeration column. Zinc dust is added to the clarified, de-aerated solution which precipitates the gold; zinc having a higher affinity for the cyanide ion than gold.

All of the currently available cyanide based gold extraction processes result in various species of cyanide that remain in tails streams produced by CIP and CIL Plants. These remnant cyanide species are potentially toxic, and on some operations the waste streams are processed through a detoxification process prior to tails deposition. This reduces the concentrations of these cyanide compounds, but does not completely eliminate them from the stream. The two main processes used for treatment of cyanide in the tailings stream are the INCO-licenced process or the Caro's acid process. Both processes utilise oxidants to oxidise cyanide to cyanate, which is not as toxic as the cyanide ion, and which can then react to form carbonates and ammonia:

$$CN^- + [O] \rightarrow OCN^-$$
$$OCN^- + 2\,H_2O \rightarrow HCO^-_3 + NH_3$$

The Inco treatment process can typically reduce cyanide concentrations to below 50 mg/L, while the Caro's acid process can reduce cyanide levels to between 10 and 50 mg/L, with the lower concentrations achievable in solution streams rather than slurries. Hydrogen peroxide and alkaline chlorination can also be used, although these are typically less common. For reference, the Australian Drinking Water criterion for Cyanide is 0.08 mg/L, which is more than two orders of magnitude lower than the concentration that can be achieved with either the Inco or Caro's treatment processes. The pristine and modified aquatic ecosystem criteria for Cyanide are 0.004 mg/L and 0.007 mg/L respectively, which is more than three orders of magnitude lower than the concentration that can be achieved with the Inco or Caro's treatment processes.

Over 90 mines worldwide now use an Inco SO2/air detoxification circuit to convert cyanide to the much less toxic cyanate before waste is discharged to a tailings pond. Typically, this process blows compressed air through the tailings while adding sodium metabisulfite (which releases SO2) and lime to maintain the pH at around 8.5, and copper sulphate as a catalyst if there is insufficient copper in the ore extract. This procedure can reduce concentrations of "Weak Acid Dissociable" (WAD) cyanide to below the EU 10 mg/L criteria, which is the treatment level mandated by the EU's Mining Waste Directive. Any remnant free cyanide can then degrade (by UV light) in the tailings dam, while cyanate ions hydrolyse to ammonium. Whilst not a generally applied treatment of gold extraction waste streams for the mining industry, UV treatment of cyanide waste water has been a well-established method for treatment of cyanide containing waste water. These UV based cyanide destruction processes have achieved decreases in waste stream cyanide concentrations of 6,500 to 10,000 mg/L to <2 mg/l in the treated waste stream. When optimised, these processes can achieve cyanide concentrations of 0.2 mg/L after treatment. This is one to two orders of magnitude lower than what can be achieved using the Inco or Caro processes.

4.2 Cyanide and other toxic substances in waste tailings

However, like any industrial process there is remnant cyanide in the tailings that can pose a risk to human health and the environment and hence, requires monitoring and management. The concentrated tailings waste stream also generally contains a wide range of other contaminants of concern including arsenic, mercury, hexavalent chromium, mercury, lead and others. Geochemical and hydrogeochemical studies have shown that residual cyanide and sulphide trapped in the gold-mine tailings can cause persistent release of toxic metals such as arsenic, mercury, hexavalent chromium, lead and others into the groundwater and surface water systems. Therefore, the geochemistry of cyanide and acid generating sulphides in the context of the mine tailings composition and hydrogeochemistry of the tailings facility needs to be fully characterised to inform an assessment of the risk posed to human health and the environment. Even though cyanide extraction is the most commonly utilised process for gold extraction its use remains controversial due to the toxicity of the cyanide itself, as well as its ability to liberate and mobilise other toxic metals from tailings deposits.

While in aqueous solutions cyanide can degrade rapidly in sunlight to less-toxic products, such as cyanates and thiocyanates, these breakdown products may persist for many years. In the absence of sunlight cyanide can also be persistent in the environment and hence pose a long term source of risk to human health and the environment.

While not a common occurrence, there have been several significant incidents as a result of the cyanide extraction process that have impacted the environment and human health including causing fatalities. These incidents have ranged from small scale spill events of process fluids that contain cyanide, to large scale leaks and spills, including complete failure of tailings facilities that contain cyanide. In some circumstances these impacts have affected significant portions of river catchments for multiple decades.

The United Nations Environmental Program has reported 221 significant tailings dam failures which have resulted in discharge waste containing a range of toxic compounds and substances into the environment. Over recent decades there has been an average of two significant incidences involving discharge of waste from TSF's per year and the rate of TSF dam failure has been significantly higher than that for equivalent water storage dams.

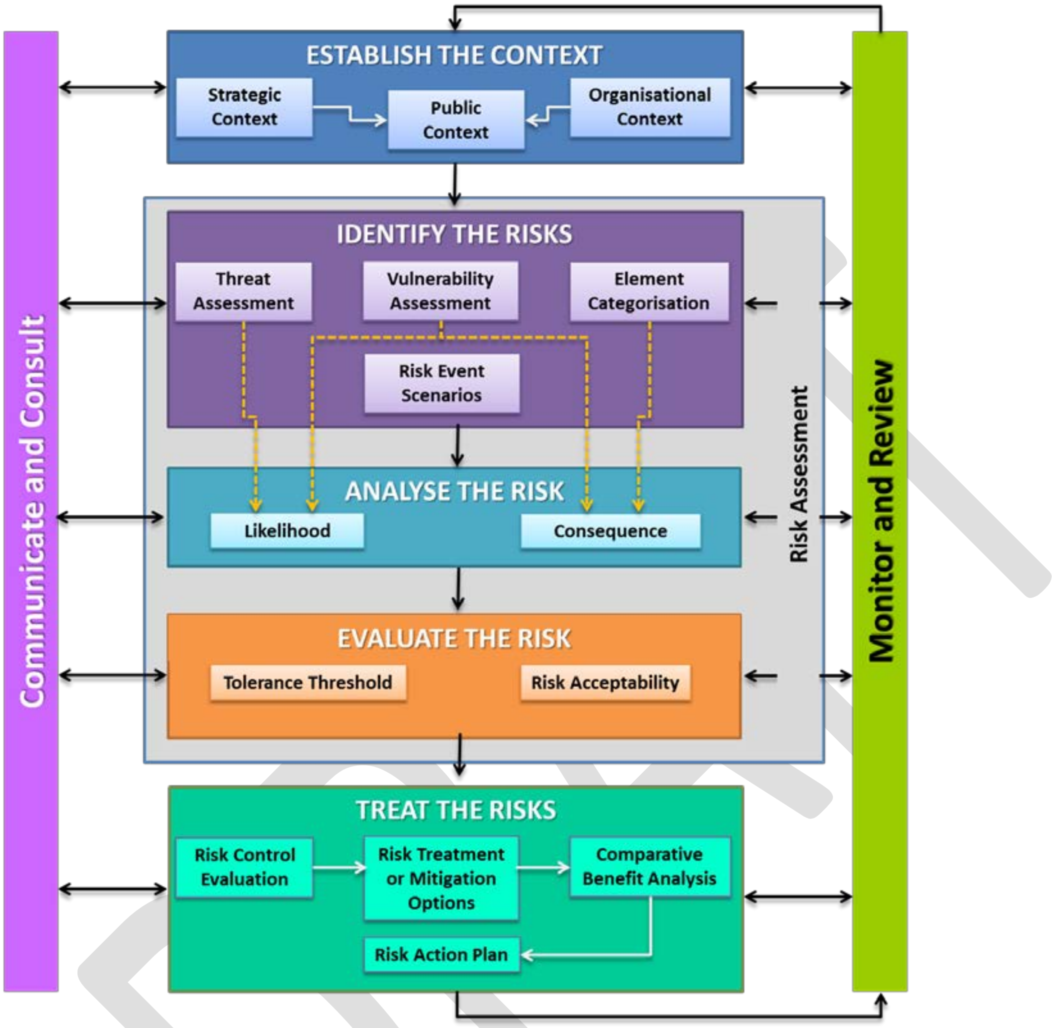
4.3 Alternatives to cyanide

Although cyanide is cheap, effective, and biodegradable, its high toxicity has led to new methods for extracting gold using less toxic reagents. Some viable alternatives to cyanide include thiosulfate ($S_2O_3^{2-}$), thiourea ($SC(NH_2)_2$), iodine/iodide, ammonia, liquid mercury and alpha-cyclodextrin. Challenges include reagent cost and the efficiency of gold recovery. Thiourea has been implemented commercially for ores containing stibnite. The trial and commercial application of the Harber Gold extraction process has demonstrated similar gold recovery rates requiring less time and without the use of cyanide or mercury to liberate the gold from the ore. Due to the ban on use of cyanide in some countries and jurisdictions the commercial viability of alternate gold extraction processes is continually improving as market demand increases.

5 Qualitative risk assessment

To assist in the review, a preliminary qualitative risk assessment approach was adopted. The qualitative risk assessment was used to identify risks associated with the proposed Modification 3 at the site and analyse these and evaluate magnitude and likelihood of these risks occurring. The risk assessment adopted the approach set out in AS/NZS 4360:2004 (refer Diagram 1). The qualitative risk assessment was of a preliminary nature and reliant on the information presented in the environmental assessment report. Where there was a lack of information or relevant consideration, a conservative approach was adopted to evaluate the risk. The method adopted allows for an iterative approach so that the analysis of the risks can be refined as further information becomes available. The risk assessment was also used to identify where further information would be required to inform a refinement of the risk assessment.

Diagram 1 AS/NZS 4360:2004 approach to risk management



The risk assessment was conducted using the tailored risk assessment matrix outlined in Table 1. A summary of the preliminary qualitative risk assessment results for each risk evaluated is presented in the relevant sections below.

The outcomes and relevant discussion of the qualitative risk assessment results are presented in Attachment A.

6 Summary of review findings

A review of the Environmental Assessment for Dargues Gold Mine Modification 3 prepared by RW Corkery & Co was undertaken with specific comments presented in Attachment B - Table 2. After review of the relevant information and with consideration of the qualitative risk assessment outcomes, responses to the specific issues raised by Council(s) are addressed below:

6.1.1 Advice on the risks associated with cyanide operations at the site

The proposed use of a CIL Plant that utilises cyanide as the primary leach agent to extract the gold from the ore significantly increases the risk profile with respect to short, medium and long term risk to human health and the environment. ToxConsult (Environmental Assessment Report Appendix 3) provide a detailed discussion of the toxicity profile for cyanide and set out the potential risks to human and selected ecological receptors that may be susceptible to cyanide exposure.

Accidental releases of cyanide at gold mines have occurred at all stages of its uses at a number of sites around the world, even over recent years. The impacts from these releases have varied from localised animal deaths to mass death of aquatic fauna in river systems. Some of these accidents have also resulted in fatalities in communities living near the mine or impacting the quality of the natural resources on which they rely.

Clearly any cyanide release from the proposed Dargues Mine site presents a risk to the downstream catchments. The degree of the risk will depend on the amount of cyanide released. If the release is small (10s of litres) then the impacts would be localised and short lived and not likely to present a risk to drinking water quality or communities and beneficial uses of the land and water downstream of the site. The most significant consequence of a small scale cyanide release would probably be community concerns and reputational damage due to perception. However, a large scale cyanide release could potentially lead to a significant impact on water quality and large scale extermination of aquatic fauna, and potentially pose a health risk to residents, their livestock and pets and other beneficial uses of land and water in the catchment that rely on the water. Cyanide exposure in the environment can occur through ingestion of and dermal contact with dissolved cyanide and inhalation of hydrogen cyanide. A large scale release would also likely have significant reputational and economic impact on the agricultural, tourism and fishing industries of the area.

Over the lifecycle of the mine there are a number of relevant risk dimensions that need to be characterised to develop and implement appropriate management, monitoring and mitigation measures. These are briefly summarised below, with further information presented in Attachment A.

1. **Development and construction phase:** As cyanide would not be present on site during construction the revised risk profile due the proposed modification would not vary significantly from the risk posed by the project as currently approved. However, there is clearly still a risk to water quality from other activities. Some impacts to water quality have already occurred during the construction phase resulting in fines being issued by NSW EPA.
2. **Operational phase:** Cyanide will be present on the site at a number of locations during this phase, including:
    a. **Transport to the site:** Cyanide is generally transported in solid sodium cyanide form in isotainers. The most significant risk during this stage would be a train or road accident that results in release of cyanide into the environment. If such an accident occurs in the drinking water catchment there is a risk that any spills could impact water quality. Although rare these types of releases have occurred.

       Security is also a risk during this stage as any theft or deliberate sabotage could result in the release of cyanide. These incidences have been rare but have occurred in recent years.

Due to the high mass of cyanide in any single load the impact of a catastrophic failure of a single isotainer could be significant.

A transport risk assessment or emergency response measures for the project had not been completed at the time the application for Modification 3 had been lodged. Therefore there is inadequate information in the proposed modification documentation to demonstrate the risk was adequately considered and appropriate response and mitigation measures established;

b. **Storage stage:** Cyanide once delivered to site will be dissolved and stored in on site bunded storage tanks until required in the gold extraction process. The proposed bund around the storage tank would not be sufficient to contain a multi-tank breach. Therefore the proposed primary containment proposed would not be sufficient to prevent release into the environment around the storage facility in the event of any failure that would result in the release of more than a single tank volume.

   No details of any emergency response procedures or any monitoring, mitigation, clean-up or validation plans had been completed at the time the application for Modification 3 had been lodged. Therefore there is inadequate information in the proposed modification documentation to demonstrate the risk was adequately considered and appropriate response and mitigation measures established;

c. **Extraction stage:** Cyanide will be transferred from the storage tanks to the CIL Plant where it is used to extract the gold from the ore. There is no detail on the transfer system design, inspection regime, leak detection and there is no information on whether any spills or leaks will be captured in a primary containment system.

   The proposed bund around the CIL tanks would not be sufficient to contain a multi-tank breach. Therefore the proposed primary containment proposed would not be sufficient to prevent release into the environment around the storage facility in the event of any failure that would result in the release of more than a single tank volume.

   No details of any emergency response procedures or any monitoring, mitigation, clean-up or validation plans had been completed at the time the application for Modification 3 had been lodged. Therefore there is inadequate information in the proposed modification documentation to demonstrate the risk was adequately considered and appropriate response and mitigation measures established;

d. **Cyanide destruction stage:** Cyanide is transferred into the destruction plant for treatment. There is insufficient information to establish whether the destruction plant is within the CIL Plant bund or not, and there are no details of the transfer infrastructure. Therefore the adequacy of any proposed primary containment cannot be assessed. Therefore there is inadequate information in the proposed modification documentation to demonstrate the risk was adequately considered and appropriate response and mitigation measures established;

e. **Transfer stage:** Once treated the residual cyanide along with the concentrated waste tailings are transferred to the TSF. There is no detail on the transfer system design, inspection regime, leak detection and the proposed primary containment proposed would not be sufficient to prevent release into the environment around the transfer infrastructure. Therefore there is inadequate information in the proposed modification documentation to demonstrate the risk was adequately considered and appropriate response and mitigation measures established;

3. **<u>Waste disposal and storage phase:</u>** Residual cyanide will be deposited in the TSF for long term storage and some potential further degradation. The containment of the cyanide in the TSF during the operational, closure and post closure phases is reliant on the design adequacy of the TSF, and the TSF being correctly installed managed and operated. The ongoing containment of cyanide and other toxic metals in the TSF is also reliant on the long term (centuries) integrity and stability of the TSF. In general the TSF's represent the most significant risk at gold mines as they hold the largest mass of cyanide for the longest period and have a track record of leaks and some catastrophic failures that lead to discharge of large masses of cyanide to the environment. Therefore the TSF is considered to present the most significant risk that will be present for the short (months-years), medium (years-decade) and particularly the long term (decades-centuries);

Therefore the proposed use of cyanide would significantly increase the potential risk profile of the site to the downstream catchment due the proposed use of cyanide in the CIL Plant. The environmental assessment report for the modification suggests that the proposed primary containment for critical infrastructure would not be sufficient to contain any spill greater than a single failure event. Further, there is insufficient information in the report to allow for an assessment of potential risks and the relevant response measures proposed. Once the relevant detailed analysis is undertaken and the relevant detailed management, monitoring, response and mitigation plans are provided, a further independent review and re-evaluation of the qualitative risk assessment should be undertaken.

6.1.2 Advice on the adequacy of proposed processing operations and environmental controls

The environmental assessment report does not provide sufficient information to assess the adequacy of proposed processing and environmental controls. As noted, the proponent proposes to only construct primary containment infrastructure that would only contain a single failure event. Also the proponent contends that detailed management, monitoring, response and mitigation plans would only be provided after approval for Modification 3 was granted. This hinders the ability of an independent reviewer to assess the adequacy of the risk assessment undertaken by the proponent and evaluate whether the proponent's management, monitoring, response and mitigation plans adequately address the relevant risks identified. As indicated in Section 6.1.1 the risk profile of the site has increased significantly.

The environmental assessment report places a significant burden on inspections and observations of critical elements of the mines operational and waste storage infrastructure on staff at the site. The reports provides no details on the minimum training, procedures and experience of these operators to fulfil these inspection and observation tasks. This places a high degree of reliance on the staff at the site to prevent, respond to and manage incidents involving cyanide. The proposed plant does not appear to have sufficient redundancy to deal with foreseeable human error. Cyanide release incidents from mining activities almost invariably involve some element of human error. These errors can be due to a range of factors. These aspects were not adequately addressed in the report provided to support the application for Modification 3.

The report lacks detail on the effectiveness of treatment of the proposed waste tailings effluent meet quality performance criteria for discharge into the TSF. The report suggests that the plant will comply with an effluent limit of 20 mg/L of WAD Cyanide 90% of the time and no more than 30 mg/L at any time.

This translates to an average discharge concentration of 21 mg/L WAD Cyanide into the TSF over the life of the project. For comparison the European Union Mining Directive set an effluent limit for WAD Cyanide of 10 mg/L, which is achievable with the treatment process proposed by the proponent. In fact the proponent acknowledges that the proposed treatment technology for cyanide can achieve effluent concentration well below the criteria cited but indicates that due to economic considerations the treatment plant would be operated to comply with the adopted criteria to maximise the economic return from the site. For context, the Australian Drinking Water criteria for Cyanide is 0.08 mg/L, which is 260 times less than the adopted performance criteria and is more than two orders of magnitude below the concentration that can be achieved with either the Inco or Caro's treatment processes when operated under optimal conditions. The pristine and modified aquatic ecosystem criteria for Cyanide are 0.004 mg/L and 0.007 mg/L respectively, which is 5250 times less than the adopted criteria and more than three orders of magnitude lower than the concentration that can be achieved with the Inco or Caro's treatment processes. Based on the information in the report if the plant complies with the adopted effluent criteria and only places the stated 180,000 tonnes of contracted waste tailings into the TSF, nearly 4 tonnes of cyanide waste would be placed into long term storage.

Review of the revised TSF and associated dam shows that some substantial revision of the facility over the approved design has occurred. The report is confusing in regard to some critical design elements of the TSF, particularly in relation the proposed clay liner and cap material specifications. The risk assessment of the TSF was also only confined to the operational phase of the mine and did not consider a potential catastrophic failure of the facility. In terms of the design and management approach used, the TSF would not be compliant with minimum requirements of a landfill facility that could accept the concentrated tailings waste. The concentrated tailings stream exceeds the concentration criteria for non-controlled aqueous liquid wastes.

Key concerns in terms of the TSF design to prevent leaks (excluding catastrophic failure) is the use of a simple liner system that achieves a permeability of 10^{-9} m/s over 900 mm for the total liner system. In NSW the minimum requirement for landfills not located in areas where the landfill poses a risk to surface and / or groundwater quality is a 900 mm compacted clay liner with a maximum permeability of 10^{-9} m/s. As the TSF is located in a drinking water catchment, and poses a risk to both surface and groundwater quality, the minimum liner requirement would be 900 mm compacted clay liner with a maximum permeability of 10^{-9} m/s plus a flexible membrane liner (FML) of minimum co-efficient of permeability of 10^{-14} m/s. The FML must have a minimum thickness of 1.5mm and be designed such that its durability will ensure that it maintains this permeability for a period at least equivalent to the reactive life of the waste contained in storage. The information in the report suggests that the proponent does not intend to construct the TSF to a standard of that required of a landfill. Consequently the risk of leakage from the TSF is higher than that acceptable for a landfill in a similar geological setting. As the TSF stores toxic cyanide that may be subject to some degree of degradation over time, and toxic heavy metals which do not degrade over time, the liner would have to maintain its integrity over a long period (in the order of centuries). The proponent proposes to use a High-Density Polyethylene (HDPE) liner over compacted clay to manage risk of leakage from the TSF. The durability of HDPE in maintaining its integrity varies depending on the quality of the installation, the level of protection applied and geochemical conditions in the zone adjoining the liner. Research suggests that HDPE when installed and protected correctly maintains its integrity for between 30 to 300 years. So even under ideal conditions the HDPE liner is likely to fail while toxic heavy metals remain in the TSF. The TSF will also receive around 5000 tonnes of excess sodium from the approved facility. Sodium can substitute into the clay minerals (particularly Kaolinite) to form Sodium-Montmorillonite, a highly dispersive clay mineral. This substitution would lead to erosion of the clay liner integrity. The report does not appear to have considered these aspects and associated risks, probably in part due to focusing assessment of the TSF performance to only the operational phase of the mine.

Based on experience and with due regard to the issues discussed above it will not be a matter of if the TSF will leak, but when the TSF will leak. The level of impact as a result of the TSF leakage will depend on the rate of liner degradation and the geochemical conditions within the TSF waste at that time.

The environmental assessment did not consider the risk of long term leachate discharge from the TSF into the environment and this risk was therefore not adequately addressed. The scale of any impact would be dependent on the composition of the leachate, the quantity of leachate leaking from the TSF and the streamflow at the time and point of discharge, as well as the distance to the nearest groundwater user.

There is currently insufficient information to address this aspect of Council's concerns in detail with any degree of confidence due the lack of relevant information included in the environmental assessment report that supports the application for Modification 3.

6.1.3 Advice on the consequences of failure of proposed controls

This aspect was considered in the preliminary qualitative risk assessment undertaken for cyanide, with the results set out in Section 6.1.1. The consequences of control failures will depend on where in the mining operations the failure occurs. By far the most significant consequence would result from a catastrophic failure of the TSF dam. TSF dam failure rates are estimated at 1 in 1000 probability, which suggests that the risk of the TSF dam at the site failing during the operational life of the mine may be around 1:200 based on industry statistics. Therefore the risk falls into the "could occur" category. The consequence of such a failure could be that several thousand to tens of thousands of tonnes of waste tailings are released into the catchment. As the concentrated tailings are to be co-disposed with the flotation tailings these would be entrained in the tailings mass released into the catchment. As the concentrated tailings are finer than the flotation tailings they would travel further and concentrate at the leading edge deposition. Most tailings dam failures tend to coincide with significant weather events and therefore the failure could occur in a period of active streamflow that would allow the tailings to migrate considerable distances down gradient of the site. This could result in the concentrated waste tailings being collected in a particular part of the catchment impacting aquatic and terrestrial flora and fauna and affect the livelihood and health of the community in the catchments downstream of the site.

6.1.4 Advice on the issues relating to extending the approved mine life by four years from 21 August 2018 to 31 August 2022

In terms of the longer proposed mine life, the risk would remain similar with respect to cyanide use in the context of the proposal as set out in the environmental assessment report. Clearly the longer mine life intends to allow for the delay in commencing mining in accordance with the approved development and for recovery of the revised ore reserves identified. Also the report indicates that the proponent intends to identify further gold deposits at the site and in the area. The longer mine life could assist in these endeavours as the site would provide revenue to fund this exploration and a base for logistical support.

The longer mine life may raise the risk profile of the site slightly over that of the approved mine but this incremental increase is insignificant in the context of the significant risk increase due the proposed use of a CIL Plant with cyanide leach for gold extraction from the ore.

6.1.5 Advice on increasing the approved maximum ore extraction from 1.2 million tonnes to 1.6 million tonnes over the life of the project

The increase in ore extraction would in itself not significantly affect the risk profile of the site if it occurred within the context of the mine operations as approved. If the extra ore were mined in the context of the approved mine operations then an additional volume of about 400,000t of relatively benign flotation tailings would be deposited in the TSF. However, the Modification 3 application also includes the proposed use of a CIL Plant using cyanide leach for gold extraction from the ore. This change, if approved, would result in some 180,000 tonnes of concentrated waste tailings that contain a range of toxic substances being stored in the TSF.

Similar to the proposed longer mine life, the proposed increase in the ore reserve to be mined may raise the risk profile of the site slightly over that of the approved mine but this incremental increase is insignificant in the context of the significant risk increase due the proposed use of a CIL Plant with cyanide leach for gold extraction from the ore.

6.1.6 Advice on construction of an enlarged tailings dam

The environmental assessment report that supports the application for Modification 3 describes the TSF and associated dam. When assessed in detail the proposed TSF as described in the report is effectively a new design, rather than a modification of the approved design. The proposed TSF is an entirely different tailings dam type, will store a significantly greater volume of tailings, has a different liner design and will present a significantly higher hazard over a longer period.

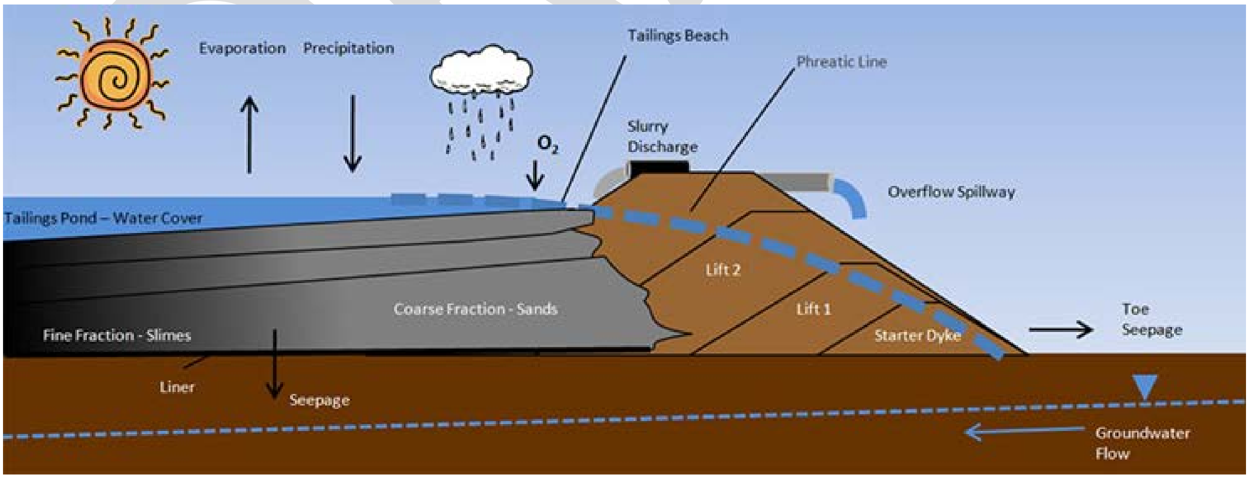


Figure 1: Upstream tailings dam construction method

The TSF dam as approved is based on the Upstream Construction Method (UCM). As illustrated in Figure 1 the UCM method utilises a starter dyke at the toe of the dam and subsequent lifts to increase the height of the dam are placed up-gradient of the starter dyke. The approved TSF dam has an embankment volume of 172,000 m^3 and a clay liner that achieves a permeability of $1x10^{-8}$ over 600 mm. The TSF as approved was only storing relatively benign flotation tailings solids that were not chemically modified, did not contained toxic compounds and had element concentrations around the background levels normally found in rock.

The TSF dam proposed under Modification 3 is to be based on a Downstream Construction Method (DCM). As illustrated in Figure 2 the DCM method utilises a starter dyke at the up-stream end of the dam and subsequent lifts to increase the height of the dam are placed down-gradient of the starter dyke. The new TSF dam proposed in Modification 3 has an embankment volume of 670,000 m^3. This is a fourfold increase in embankment volume. Also Modification 3 proposed a single composite clay and HDPE liner that achieves a permeability of $1x10^{-9}$ over 900mm or equivalent. Modification 3 proposes to place concentrated waste tailings in the TSF in addition to the flotation tailings using the co-disposal method. This would effectively place concentrated, chemically altered fine ore material that contains toxic compounds and substances into the TSF along with the flotation tailings and generate leachate that would likely contain a range of toxic heavy metals and is potentially chemically aggressive to the liner. Based on preliminary evaluation the TSF could store around 15 to 20 ML of potentially toxic leachate during the operational life of the mine and up to 200 ML of potentially toxic leachate in the long term after closure of the mine is completed. Therefore the proposed TSF would be a storage facility for waste liquid and solid waste tailings, chemicals and toxic compounds that remain geochemically active for a long period (decades to centuries). The proposed TSF has almost double the footprint of the approved TSF, 16 ha as opposed to 9 ha, stores around 35% more tailings and would contain leachate with toxic metals.

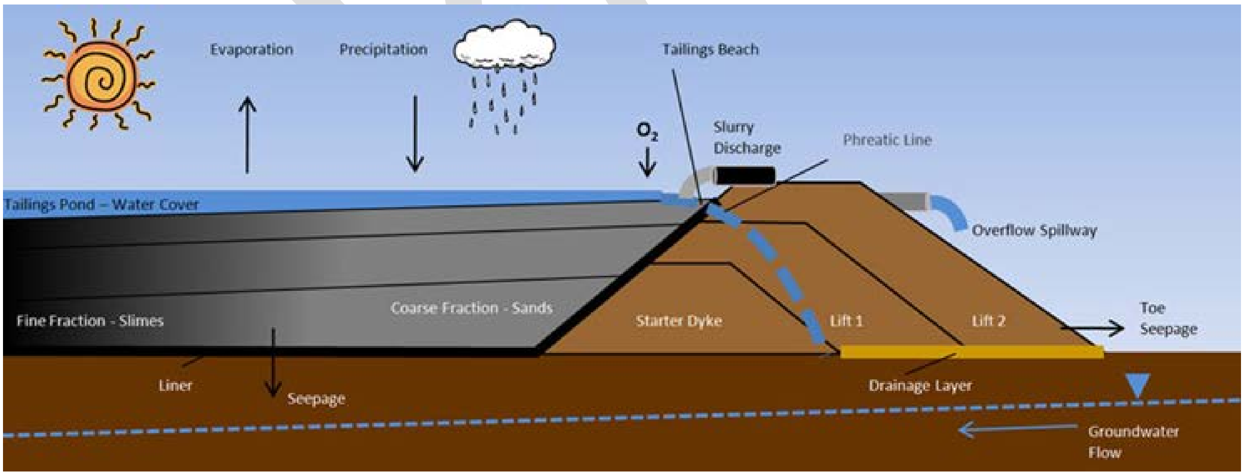


Figure 2: Downstream tailings dam construction method

Therefore the TSF proposed in Modification 3 is effectively a new piece of infrastructure that apart from location has very little similarity to the approved TSF.

As noted above, the environmental assessment report that supports the proposed Modification 3 does not consider the risk of a catastrophic failure of the TSF dam and also under-estimates the potential for leakage of the TSF. Therefore the report presents the potential risk profile of the site in a highly optimistic light and deals with the risk of either event by simply assuming that all engineering design is adequate and that the TSF will be constructed, maintained and operated for the entire lifecycle of the TSF. Further the risk assessment only considered the period of the operational mine life and not the entire lifecycle of the TSF.

The TSF as proposed under Modification 3 presents a significant long term hazard to the downstream catchment aquatic and terrestrial ecosystem, human health, agriculture, tourism and fishing industries that has to be monitored, managed and if necessary mitigated or cleaned up.

Modification 3 proposes co-disposal of the flotation and concentrated waste tailings leading to interlayering and mixing of the two waste streams. The consequence is that the co-disposal leads to a waste volume of 1,222,000 tonnes instead of 180,000. This is contrary to NSW EPA policy that dilution is not an acceptable solution to pollution. Also the TSF as proposed in Modification 3 would not meet the requirements of a landfill that would contain similar type waste.

The co-disposal as proposed in Modification 3 should be avoided, particularly as the environmental assessment did not consider all relevant plausible risk scenarios that could be realised over the full lifecycle of the TSF. As a minimum co-disposal should be avoided even if the CIL Plant using cyanide extraction was permissible. An example of a simple and practical alternative would be that the flotation tailings and concentrated waste tailings are kept separate. The flotation tailings are then disposed in a TSF as approved. The concentrated tailings are separated into a liquid and solid waste stream. The liquid waste stream should then be treated and the water recycled on site. The solid waste stream could then be treated and disposed of either:

- Into a purpose-built, suitably located, engineered (double composite liner and drain layer or equivalent) and constructed waste disposal facility, such as a dedicated well-engineered and constructed encapsulation cell. The design and construction should be independently verified; or
- Cement stabilisation of the solid concentrated waste stream in a dedicated part of the paste fill plant and placement into bulka-bags to set with subsequent disposal into the underground mine workings where they are then entombed in the paste fill. A preliminary assessment suggests that the daily production rate of solid concentrated tailings waste that requires stabilisation would be around 20 to 40 m^3.

This would ensure that the concentrated waste volume generated is minimised, each waste is appropriately handled, treated, recycled and where necessary disposed into a suitable dedicated facility. This would also limit future monitoring, management and if necessary mitigation costs. Also the dedicated waste cell approach would allow future recycling or reuse of the waste if suitable technologies emerge or economic circumstances permit. This approach is commonly practiced and the relevant regulatory, engineering, construction and verification processes are well established. The documentation that supports Modification 3 does not appear to have considered these types of relatively simple and practical options to deal with the concentrated waste tailings.

The TSF as proposed in Modification 3 would represent a significant long term hazard that will need long term monitoring, management and if necessary mitigation. This represents a long term environmental liability that requires resources and funding devoted to the task. This aspect does not appear to have been considered by the proponent.

6.1.7 Advice in regard to consequence of leachate discharge into the river catchment from the TSF

The environmental assessment report acknowledges that leakage of leachate from the TSF would occur. Under ideal conditions with all engineered systems perfectly installed and all seepage collection systems operating under ideal conditions the proposed TSF would discharge 0.9 ML of leachate per year. This rate would increase to 6 ML per year once the seepage management systems are not operational. The report did not consider the risk posed to or potential impacts this leachate discharge would have on the down-steam catchment. The proponent's risk assessment that accompanied the application for the proposed Modification 3 only considered the risk posed by discharge from the TSF via the emergency spillway during a storm event and then only considered cyanide. This is a significant data gap in understanding the potential risk to the drinking water quality and environment from the proposed Modification 3.

A basic assessment of the data from relevant stream gauges should have been undertaken to demonstrate the long term leachate discharge from the TSF was adequately considered. A preliminary assessment was undertaken using the data from two monitoring points (stream gauges, 217002 (Deua River at Wamban) and gauge 218008 (Tuross River at Eurobodalla) to assess mean flow conditions in the catchment potentially impacted by the proposed Modification 3. The preliminary assessment utilised the following flow regimes:

- Mean Daily Minimum Flow: 43 ML/day
- Mean Daily Base-flow: 397 ML/day; and
- Mean Daily Flow: 793 ML/day

Based on the proponents estimates leachate discharge rates of 0.187 L/sec and the concentrated waste tailings stream contaminant concentrations it is possible for the chromium concentrations to exceed the drinking water criteria (at gauge station 217002) under daily minimum flow conditions and the ANZECC 99% protection criteria under the following circumstances:

- Mean Daily Minimum Flow, cyanide, arsenic, cadmium, chromium, copper, mercury and lead;
- Mean Daily Base-Flow, arsenic, chromium, copper and lead;
- Mean Daily Flow, arsenic, chromium, copper and lead.

Considering that the performance of the liner may deteriorate over time a preliminary evaluation was conducted that increased the defects in the HDPE liner and increase the permeability of the clay liner to reflect potential weathering effects due to leachate leaks. This analysis indicated that leachate discharge volume may increase to around 4L/s with peak discharge as high as 20 L/s as the liner ages. Using this leachate discharge the impacts in the catchment down-gradient of the site at gauge station 217002 could be as follows with respect to drinking water:

- Mean Daily Minimum Flow, cyanide, arsenic, cadmium, chromium, copper and mercury;
- Mean Daily Base-Flow, arsenic, chromium and copper;

- Mean Daily Flow, arsenic, chromium and copper.

The preliminary assessment indicated that that the ANZECC 99% and 95% protection criteria would be exceeded for cyanide, arsenic, cadmium, chromium, copper and mercury for all flow conditions considered.

While this was a preliminary analysis based on limited data the results highlight that without a detailed consideration of the potential leachate discharge from the TSF in the short, medium and long term the risk to the down-gradient catchment cannot be adequately considered, and until such an assessment is provided, the application for Modification 3 should be not be further considered.

6.2 Advice and discussion on any other relevant matter apparent to you

The review has highlighted a number of key information and knowledge gaps that should be addressed before the human health, environmental, social and economic risks can be sufficiently understood, and a transparent, robust and independent review of the proposal can be made. The key information and knowledge gaps fall into the following categories:

1. Waste tailings composition
2. Risk assessment limitations
3. Sustainability principles

6.2.1 Waste tailings

The report appears to focus on cyanide as the only primary contaminant of concerning associated with the disposal of waste tailings into the TSF. Table 9 and 10 present the chemical composition of the flotation and concentrated waste tailings streams. This information was utilised to compile the analysis of the waste streams and the various contaminant masses to be disposed of into the TSF and is presented in Table 3. The concentrated waste tailings contain a range of other contaminants and toxic compounds that need to be considered. The most significant of these is briefly outlined below:

1. **Aluminium:** While common in soil and rock, aluminium concentrations in natural near surface waters is very low due to the low solubility of most aluminium species at neutral or near neutral pH. However, aluminium species are soluble at acid and alkaline pH (refer to Figure 3), mobilising into solution. Therefor the proposed Modification could lead to increased mobilisation of aluminium into the environment.
2. **Arsenic:** The co-disposal of flotation and concentrated waste tailings will lead to an almost 800% increase in arsenic mass stored in the TSF, which will store 16 tonnes of arsenic instead of 1.8 tonnes as would occur in the approved TSF. Further the processing of the tailings in the CIL Plant will lead to considerable mobilisation of arsenic from a relatively low solubility sulphide mineral form to dissolved and more easily mobilised arsenic species that are considerably more mobile in the environment than would occur if the TSF would be operated as approved. The likely impact of the proposed ore processing on arsenic speciation and mobility is illustrated in Figure 4, which demonstrates that the ore processing will liberate arsenic into solution as arsenate species that will then accumulate in the TSF in either solution or sorbed form where they can pose a long term risk

through discharge or release into solution and discharge into the environment. Arsenic in solution is a common long term risk factor at many former and current gold mines.

3. **Cadmium:** The co-disposal of flotation and concentrated waste tailings will lead to more than doubling the cadmium mass stored in the TSF, which will store 200 kilograms of the highly toxic metal. Further cadmium has a similar geochemical behaviour to gold and thus the processing of the tailings in the CIL Plant will lead to considerable mobilisation of cadmium. Cadmium cyanide ($Cd(CN)_2$ is a toxic mobile anion species that unlike most metal cyanide complexes has a high solubility (220 mg/L). Therefore the proposed Modification would likely lead to the presence of potentially high concentrations of toxic cadmium that would be considerably more mobile in the environment than the cadmium present in unprocessed ore.

4. **Chromium:** The co-disposal of flotation and concentrated waste tailings will lead to an almost 80% increase in chromium mass stored in the TSF, which will store 255 tonnes of chromium instead of 140 tonnes as would occur in the approved TSF. Furthermore the processing of ore on site using the proposed CIL Plant with cyanide would result in gold extraction occurring at alkaline pH and under oxidising conditions. The data in the environmental assessment report indicated that manganese is present during the extraction process. This could result in the oxidation of low toxicity trivalent chromium naturally present in the ore to the highly toxic hexavalent chromium species (refer to Figure 5) by the following reaction:

$$2Cr^{3+} + 2MnO_4^{-} + 3H_2O \rightarrow Cr_2O_7^{2-} + 2MnO_2 + 6H^{+}$$

$$Cr^{3+} + MnO_4^{-} + 2H_2O \rightarrow HCrO_4^{-} + 2MnO_2 + 3H^{+}$$

$$2Cr^{3+} + 3H_2O + 3MnO_2 \rightarrow Cr_2O_7^{2-} + 3Mn^{2+} + 2H^{+}$$

Hexavalent chromium in solution forms highly soluble anions ($HCrO_4^{-}$, CrO_4^{2-}, CrO_2^{-}, $Cr_2O_7^{2-}$) that are mobile in the environment. The proposed Modification 3 could therefore lead to converting a relatively benign form of naturally occurring chromium (trivalent) present in the ore and concentrating and oxidising this chromium to the highly toxic hexavalent forms that would then be deposited into the TSF.

5. **Lead:** The co-disposal of flotation and concentrated waste tailings will lead to an almost 200% increase in lead mass stored in the TSF, which will store 16 tonnes of lead instead of 5.5 tonnes as would occur in the approved TSF. Lead concentrations in natural near surface waters are very low due to the low solubility of most lead species at near neutral and slightly alkaline pH. However, lead species are soluble at acid and highly alkaline pH (refer to Figure 3), mobilising into solution and mobile in the environment. The proposed modification would therefore potentially significantly increase the lead mass stored in the solid phase within the TSF that could be mobilised into the environment should geochemical conditions within the TSF change.

6. **Mercury:** The co-disposal of flotation and concentrated waste tailings will lead to an almost 220% increase in mercury mass stored in the TSF, which will store 300 kilograms of mercury instead of 100 kilograms as would occur in the approved TSF. Further, mercury has a geochemical behaviour that allows formation of highly toxic mercury cyanide complexes as follows:

$HgO + 2\ HCN \rightarrow Hg(CN)_2 + H_2O$; or disproportionation of mercury

$Hg_2(NO_3)_2 + 2\ NaCN \rightarrow Hg + Hg(CN)_2 + 2\ NaNO_3$

Mercury cyanide is highly soluble in water (930 mg/L). Also the solubility of mercury cyanide increases significantly at higher temperature (5390 mg/L at 100^{o}C), leading to increased mercury mobilisation under the proposed CIL Plant operating temperatures. Therefore the proposed Modification 3 would likely lead to the presence of potentially high concentrations of toxic mercury that would be considerably more mobile in the environment than the mercury present in the TSF as approved.

7. **Salinity:** The co-disposal of flotation and concentrated waste tailings will lead to a significant increase in salinity within the TSF. Salinity increases the ionic strength of the solutions stored in the TSF, which leads to decreased sorption of solutes. This mechanism would facilitate an increased mass of contaminants, including toxic compounds, in solution. Therefore the proposed Modification 3 would likely lead to the presence of higher concentrations and greater mobility of toxic compounds that can mobilise into the environment.
8. **Selenium:** The co-disposal of flotation and concentrated waste tailings will lead to an almost 7500% increase in selenium mass stored in the TSF, which will store 4.1 tonnes of selenium instead of 0.1 tonnes as would occur in the approved TSF. Alkaline and oxidising conditions such as those that would occur in the CIL Plant process favour the formation of selenates. Because selenites and selenates are soluble in water they are more mobile in the environment than reduced forms such as elemental selenium and selenides. Therefore the proposed Modification 3 would likely lead to the presence of potentially high concentrations of selenium that would be considerably more mobile in the environment than the selenium present in the TSF as approved.
9. **Sulphur:** The co-disposal of flotation and concentrated waste tailings will lead to an almost 23,000% increase in sulphur mass stored in the TSF, which will store 53,000 tonnes of sulphur instead of 234 tonnes as would occur in the approved TSF. The source of sulphur is from the sulphide minerals associated with the ore as well as from the discharge of sodium metabisulphite from the cyanide treatment process. The environmental assessment report indicates that sulphur will be disposed as sulphate and sulphide. Sulphide oxidation leads to generation of sulphuric acid in solution, which would cause acid pH. The proponent's testing suggests that the co-deposited tailings will have acid generation potential. As shown in Figure 3 most heavy metal species have significantly increased solubility in acidic conditions. Therefore the proposed modification could lead to significantly enhanced contaminant mobility in the environment than would occur with the TSF as approved.

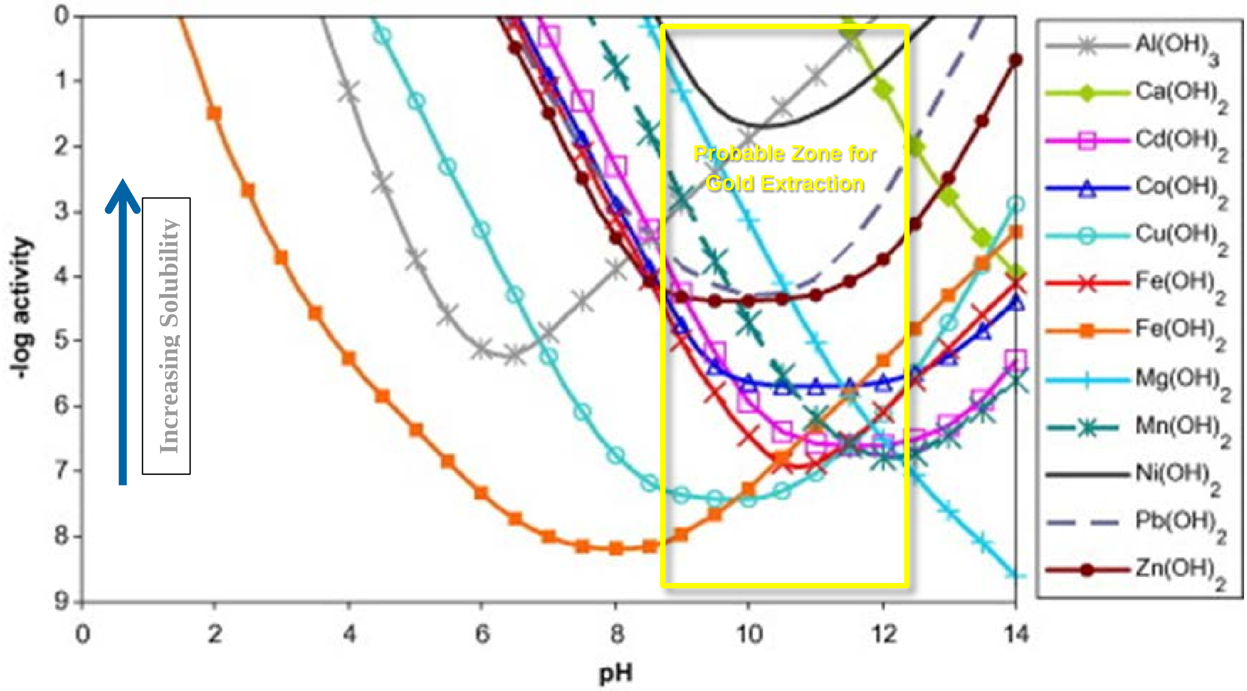


Figure 3: Activity of various metal species with changing pH

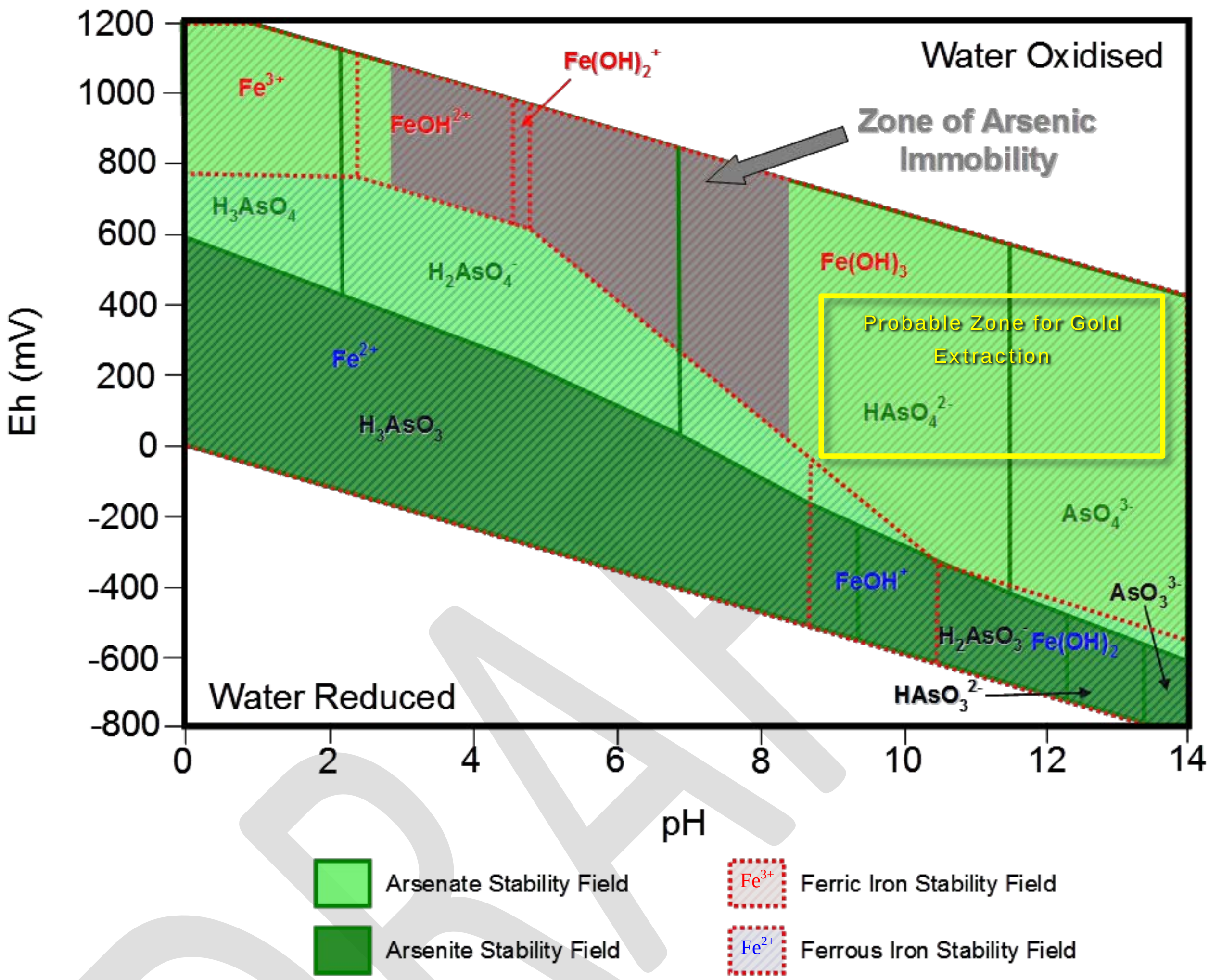


Figure 4: Arsenic stability fields

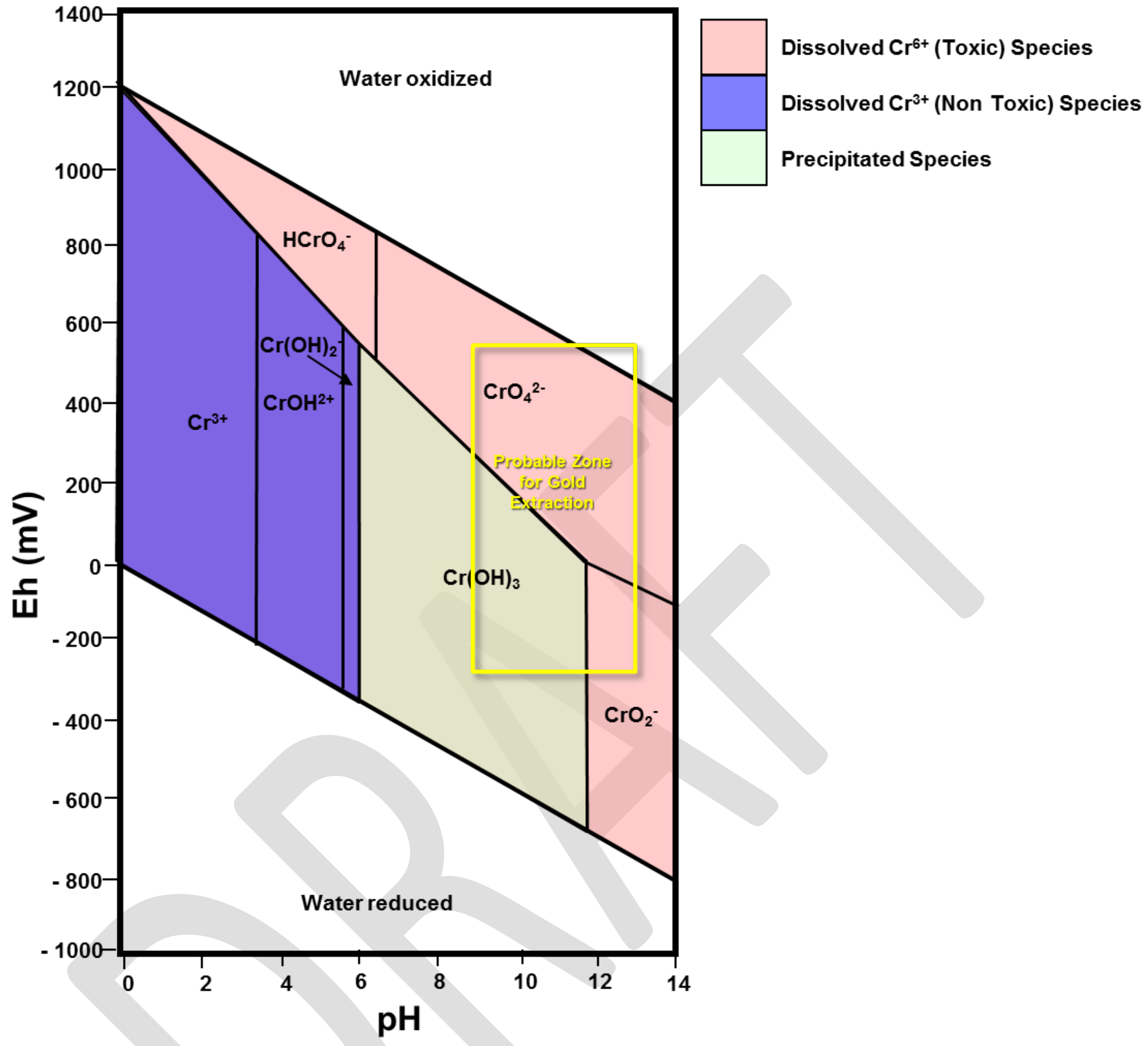


Figure 5: Chromium stability diagram

6.2.2 Risk assessment limitation

The environmental assessment report sets out an evaluation of potential risks to human health and the environment due to the proposed Modification 3. The risk assessment, apart from the toxicological risk posed by cyanide, is simplistic and limited. The risk assessment also does not consider all relevant potential contaminants of concern, risk factors, risk scenarios and risk dimensions. The most relevant risk factors, scenarios and dimensions that should be considered as a minimum are briefly discussed below.

1. **Toxic and harmful substances:** The risk assessment appeared primarily focused on cyanide. The proposed use of a CIL Plant using cyanide to process the ore on site would lead to significant

concentration and geochemical alteration that affects the mobility and toxicity of a range of potential contaminants of concern that could adversely impact human health and environment on site and down-stream catchment. The risk assessment as a minimum needs to consider the potential risks associated with the following additional contaminants of concern:

a. Aluminium: In solution aluminium is toxic to aquatic ecosystems and has a criterion of 0.027 mg/L and 0.055 mg/L for 99% and 95% protection of species respectively. Aluminium is also toxic to humans and has a drinking water criteria of 0.1 mg/L. Aluminium therefore poses a potential risk that needs to be evaluated in the context of the proposed Modification 3 and the environmental setting of the site to demonstrate that this contaminant of concern was adequately considered by the proponent and to demonstrate that the proposed modification does not pose a potentially unacceptable risk to human health and the environment.
b. Arsenic: In solution arsenic is toxic to aquatic ecosystems and has a criterion of 0.0008 mg/L and 0.013 mg/L for 99% and 95% protection of species respectively. Arsenic is also toxic and a probable carcinogen to humans and has a drinking water criteria of 0.01 mg/L. Arsenic therefore poses a potential risk that needs to be evaluated in the context of the proposed Modification 3 and the environmental setting of the site to demonstrate that this contaminant of concern was adequately considered by the proponent and to demonstrate that the proposed modification does not pose a potentially unacceptable risk to human health and the environment.
c. Cadmium: In solution cadmium is highly toxic to aquatic ecosystems and has a criterion of 0.00006 mg/L and 0.0002 mg/L for 99% and 95% protection of species respectively. Cadmium is also highly toxic to humans and has a drinking water criteria of 0.002 mg/L. Cadmium therefore poses a potential risk that needs to be evaluated in the context of the proposed Modification 3 and the environmental setting of the site to demonstrate that this contaminant of concern was adequately considered by the proponent and to demonstrate that the proposed modification does not pose a potentially unacceptable risk to human health and the environment.
d. Chromium: Hexavalent chromium in solution is highly toxic to aquatic ecosystems and has a criterion of 0.0001 mg/L and 0.001 mg/L for 99% and 95% protection of species respectively. Hexavalent chromium is also toxic and a carcinogen to humans and has a drinking water criteria of 0.05 mg/L. Hexavalent chromium therefore poses a potential risk that needs to be evaluated in the context of the proposed Modification 3 and the environmental setting of the site to demonstrate that this contaminant of concern was adequately considered by the proponent and to demonstrate that the proposed modification does not pose a potentially unacceptable risk to human health and the environment.
e. Cyanide: The report clearly notes that under acidic conditions hydrogen cyanide can form and volatilise into the air. The risk assessment only considered risk of hydrogen cyanide emissions during the operational phase of the mine. Although unclear and contradictory in regard to the TSF capping, it would be expected that the TSF is constructed with an impermeable cap. This cap would not allow any hydrogen cyanide to escape into the atmosphere but accumulate under the cap. Therefore a risk scenario of concentrated hydrogen cyanide emissions through a breach (intentional or unintentional) of the cap could occur. This risk scenario was not considered in the proponents risk assessment and should be undertaken before the proposed Modification 3 can be considered.

f. Lead: In solution lead is toxic to aquatic ecosystems and has a criterion of 0.001 mg/L and 0.0034 mg/L for 99% and 95% protection of species respectively. Lead is also toxic to humans and has a drinking water criteria of 5 mg/L. Lead therefore poses a potential risk that needs to be evaluated in the context of the proposed Modification 3 and the environmental setting of the site to demonstrate that this contaminant of concern was adequately considered by the proponent and to demonstrate that the proposed modification does not pose a potentially unacceptable risk to human health and the environment.

g. Mercury: In solution mercury is highly toxic to aquatic ecosystems and has a criterion of 0.00006 mg/L and 0.0006 mg/L for 99% and 95% protection of species respectively. Mercury is also highly toxic and a suspected carcinogen to humans and has a drinking water criteria of 0.003 mg/L. Mercury therefore poses a potential risk that needs to be evaluated in the context of the proposed Modification 3 and the environmental setting of the site to demonstrate that this contaminant of concern was adequately considered by the proponent and to demonstrate that the proposed modification does not pose a potentially unacceptable risk to human health and the environment.

h. Selenium: In solution selenium is toxic to aquatic ecosystems and has a criterion of 0.005 mg/L and 0.0011 mg/L for 99% and 95% protection of species respectively. Selenium is also toxic to humans and has a drinking water criteria of 0.005 mg/L. Selenium therefore poses a potential risk that needs to be evaluated in the context of the proposed Modification 3 and the environmental setting of the site to demonstrate that this contaminant of concern was adequately considered by the proponent and to demonstrate that the proposed modification does not pose a potentially unacceptable risk to human health and the environment.

2. **Monitoring, management and response measures:** The environmental site assessment report does not provide sufficient information to allow for an independent assessment of the adequacy of the proposed monitoring, management and response measures. The proponent contends that this detail is not required to inform the decision as to whether to grant approval of the proposed Modification 3. Given the limitations of the risk assessment as set out in this section and the lack of information there is currently insufficient information to form a view on the risks posed by the proposed modifications and the measures proposed to ensure the mine will operate in a safe and responsible manner that considers all relevant risks.

   Until there is a clear demonstration that all of the relevant risks factors, scenarios and dimensions have been adequately assessed in detail, and appropriately detailed monitoring, management and mitigation plans provided, no decision can be made on whether the proposed Modification 3 can occur on site in a safe and sustainable manner over the full lifecycle of the project.

3. **Catastrophic TSF dam failure:** As noted in previous sections the proposed modified TSF is considered to present the most significant short, medium and long term risk to human health and the environment. The risk assessment undertaken by the proponent did not consider a failure of the TSF dam in the risk evaluation. As this is the risk scenario with the most significant impact on human health and the environment, and could occur, the risk must be considered to inform decision makers before permission for Modification 3 should be granted. The omission of this risk scenario is a significant data gap in the proponent's risk assessment.

4. **Long term leaching from TSF:** The environmental assessment report and associated risk assessment acknowledged that the TSF will leak even if the assumption of perfect design, installation and performance assumed by the proponent would hold. The risk assessment did not include an assessment of the impact of the leachate that leaks from the TSF into the environment. Experience suggests that the rate of leakage from the TSF is likely to be higher than the ideal conditions assumed by the proponent and will increase over time due to the degradation of the HDPE liner and erosion of the clay liner. The proponent's risk assessment did not consider this risk dimension. The long term leakage and consequent leachate discharge into the environment needs to be estimated and the resultant risk evaluated to demonstrate that the new TSF proposed in Modification 3 does not pose an unacceptable risk to human health and the environment.

6.2.3 Sustainability principles

The environmental assessment report notes the proponent seeks a sustainable development on the site. However, the proponent's analysis is limited and focuses mainly on the potentially positive economic and social outcomes of the project and understates the potential environmental impacts. The economic analysis in the report only considered the development, operational and closure phase of the mine lifecycle but did not appear to consider the long term post closure phase. The economic analysis therefore does not appear to take into account the costs associated with monitoring, managing and if necessary, mitigating impacts from the mine in the last and longest stage of the project's lifecycle. This aspect is particularly important in the context of the TSF. The lack of consideration of:

- the long term environmental liability to the local and regional community,
- the potential financial burden on the people of New South Wales, and
- the full lifecycle cost of the project

presents the proposed Modification 3 in a significantly more beneficial economic condition than if these aspects had been fully considered.

The report also does not appear to consider the potential impacts on the local, regional and state economies should there be a significant incident on the site. Again, by not considering this aspect the proponent's report presents the social and economic benefits of the project on an overly positive light.

7 Summation

GHD would like to thank ESC of the opportunity to continue to work on review of the Dargues Reef Mining Project. We trust that the information provided in this letter report and attached Table 1, Table 2 and Table 3 will be sufficient to assist ESC in decision making with regard to potential risks to the drinking water catchment and the environment in which the proposed Modification 3 of the Project Site is located.

Should you have any questions or require any further information please do not hesitate to contact us.

Yours sincerely

Peter Beck
Principal Environmental Scientist
(03) 8687 8643

Attachment A:
Qualitative Risk Assessment

Table 1: Risk assessment matrix

Consequence	Code	Description
Catastrophic		Do Not Undertake
Unacceptable		Urgent Action Required To Lower Risk Before Commencing
Undesirable		Action Required To Manage and Mitigate Risk Before Commencing
Acceptable		Monitor and Manage Risk in Accordance With Approved Management Plan While In Progress
Desirable		No Plan for Monitoring or Management Required While In Progress

	Consequence				
	1 Insignificant	2 Negligible	3 Moderate	4 Significant	5 Catastrophic
Human Health	No discernible effects on health of persons as a result of the incident. Any changes in soil and water quality remain below the health investigation trigger levels	No discernible effects on health of persons as a result of the incident. Minor exceedances of health investigation levels in soil and water but acute and chronic risks remain with acceptable bounds.	No discernible effects on health of persons as a result of the incident. Some exceedances of health investigation levels in soil and water with no acute but potential for chronic risks exceeding acceptable bounds.	Short term effects on human health that require first aid treatment or short hospitalisation (<2 days). Minor discernible long-term effects on health of persons as a result of the incident. Some exceedances of health investigation levels in soil and water with no acute but potential for chronic risks exceeding acceptable bounds.	Short term effects including fatality(s) and hospitalisation of more than 2 days. Discernible long-term effects on health of persons as a result of the incident. Exceedances of health investigation levels in soil and water with both acute and chronic risks exceeding acceptable bounds.
Environment	No discernible effects on health of aquatic flora and fauna as a result of the incident and any associated changes in environmental conditions. Concentrations remain within variance established in the background surveys.	No discernible effects on health of aquatic flora and fauna as a result of the incident. Changes in environmental conditions show slight deviation in variance to that established before the incident occurred but risks to the aquatic and terrestrial flora and fauna health remain in acceptable bounds.	No discernible effects on health of aquatic or terrestrial flora and fauna as a result of the incident. Changes environmental conditions show exceedance of environmental protection criteria but risks to aquatic and terrestrial flora and fauna health remain in acceptable bounds.	Minor discernible effects on health of aquatic and terrestrial flora and fauna as a result of the incident. Changes in environmental conditions show exceedance of environmental protection criteria with risks the aquatic and terrestrial flora and fauna health potentially outside acceptable bounds.	Discernible effects on health of aquatic and terrestrial flora and fauna as a result of the incident. Changes in environmental conditions show exceedance of environmental protection criteria with risks the aquatic flora and fauna health outside acceptable bounds confirmed.
Economic	No measurable loss of productivity of the downstream region as a consequence of the incident.	Minor loss of productivity of the downstream region as a consequence of the incident but these remains within acceptable bounds.	Some losses of productivity of the downstream region as a consequence of the incident and these have a minor negative impact on economic activity but do not affect viability of enterprises.	Losses of productivity of the downstream region and these have a negative impact on economic activity threatening viability of enterprises.	Loss of productivity of the downstream region as a consequence of the incident with negative impact on economic activity and loss of viability of enterprises.
Social	There are only minor concerns from the public in regards the incident and no concerns relate to measurable impacts.	There are only minor concerns from the public in regards the incident and some minor concerns relate to measurable impacts.	Concerns from the public in regards the incident and some concerns relate to the duration and effects of the measurable impacts.	Ongoing concerns from the public in regards to the incident including concerns related to measurable impacts in the long term.	Outrage from the public in regards to the incident including sustained concerns related measurable impacts in the long term.
Reputation	No negative coverage in any form of media	Some minor news items in local press related to the incident but interest is only sporadic. There is no persistent coverage in any form of media.	Some sustained news items in local press related to the incident with sporadic interest from regional media.	Sustained news items in local press related to the incident with periodic interest from regional and state media.	Sustained news items in local, regional and state press related to the incident.
Regulator / Political	No interest form local or state level regulators or politicians.	Minor intermittent interest from local regulator or politicians. No interest from state level regulators or politicians and no sustained interest form any level of regular or politics.	Sustained interest from local regulators and politicians regarding effects. Minor interest from state level regulators and politicians but this is not sustained.	Sustained interest from local regulators and politicians regarding effects. Ongoing periodic interest from state level regulators and politicians.	Sustained interest from local and state regulators and politicians regarding the incident and its effects.

Likelihood

Chance	Probability	Frequency			1 Insignificant	2 Negligible	3 Moderate	4 Significant	5 Catastrophic
Will occur	>1:100	Expected to occur during the lifecycle of the action under expected circumstances	E	Almost Certain					
Could occur	>1:1,000	Foreseeably expected to occur during the lifecycle of the action under expected circumstances	D	Likely					
Might occur	>1:10,000	Expected to occur during the lifecycle of the action / infrastructure under foreseeable circumstances.	C	Possible					
May occur	>1:100,000	Foreseeably expected to occur during the lifecycle of the action / infrastructure under foreseeable circumstances	B	Unlikely					
Occurs in exceptional circumstances	<1:100,000	Not Foreseeably expected to occur during the lifecycle of the action / infrastructure under any foreseeable circumstances	A	Rare					

Qualitative Risk Assessment Results and Discussion

<u>Development and Construction Phase:</u> Low risk as cyanide is not required and would not be present until the site commences ore processing. The results of the risk assessment are presented below and compared to the risk for the approved project.

Result for Cyanide Use during this Phase / Stage of the Project

Risk Dimension	Approved	Modification 3
Human Health		
Environment		
Economic		
Social		
Reputation		
Regulator / Political		

<u>Operational Phase:</u> Cyanide will be present on the site at a number of locations during this phase, including:

Transport to the site: Cyanide is generally transported in solid sodium cyanide form in isotainers. The most significant risk during this stage would be a train or road accident that results in release of cyanide into the environment. Although rare these types of releases have occurred. A transport risk assessment for the project has not been completed at the time the application for Modification 3 had been lodged. Due to the high mass of cyanide in any single load the impact of a catastrophic failure of a single isotainer could be significant. No information or emergency response plan information was provided at the time the application for Modification 3 had been lodged. In the absence of a detailed transport risk assessment and a detailed emergency response plan based on that risk assessment the risks from an incident in the transport phase should be regarded as outlined below and require action and response measures to be understood before granting permission for the proposed Modification 3;

Result for Cyanide Use during Transport Phase / Stage of the Project

Risk Dimension	Approved	Modification 3
Human Health		
Environment		
Economic		
Social		
Reputation		
Regulator / Political		

Storage Stage: Cyanide once delivered to site will be dissolved and stored in on site bunded storage tanks until required in the gold extraction process. The proposed bund around the storage tank would not be sufficient to contain a multi-tank breach. Therefore the proposed primary containment proposed would not be sufficient to prevent release into the environment around the storage facility. No details of any emergency response procedures or any monitoring, mitigation, clean-up or validation plans had been completed at the time the application for Modification 3 had been lodged. Considering these factors the risk assessment results are presented below;

Result for Cyanide Use during this Phase / Stage of the Project

Risk Dimension	Approved	Modification 3
Human Health		
Environment		
Economic		
Social		
Reputation		
Regulator / Political		

Extraction Stage: Cyanide will be transferred from the storage tanks to the CIL Plant where it is used to extract the gold from the ore. There is no detail on the transfer system design, inspection regime, leak detection and there is no information on whether any spills or leaks will be captured in a primary containment system.

The transfer of cyanide for used in the CIL Plant tanks. The proposed bund around the CIL tanks would not be sufficient to contain a multi-tank breach. Therefore the proposed primary containment proposed would not be sufficient to prevent release into the environment around the CIL Plant. No details of any emergency response procedures or any monitoring, mitigation, clean-up or validation plans had been completed at the time the application for Modification 3 had been lodged. Considering these factors the risk assessment results are presented below;

Result for Cyanide Use during this Phase / Stage of the Project

Risk Dimension	**Approved**	**Modification 3**
Human Health		
Environment		
Economic		
Social		
Reputation		
Regulator / Political		

Cyanide Destruction Stage: Cyanide is transferred into the destruction plant for treatment. There is insufficient information to establish whether the destruction plant is within the CIL Plant bund or not nor are there any details of the transfer infrastructure. Therefore the adequacy of any proposed primary containment cannot be assessed. Considering these factors the risk assessment results are presented below;

Result for Cyanide Use during this Phase / Stage of the Project

Risk Dimension	**Approved**	**Modification 3**
Human Health		
Environment		
Economic		
Social		
Reputation		
Regulator / Political		

Transfer Stage: Once treated the residual cyanide along with the concentrated waste tailings are transferred to the TSF. There is no detail on the transfer system design, inspection regime, leak detection and the proposed primary containment proposed would not be sufficient to prevent release into the environment around the transfer infrastructure. Considering these factors the risk assessment results are presented below;

Result for Cyanide Use during this Phase / Stage of the Project

Risk Dimension	**Approved**	**Modification 3**
Human Health		
Environment		
Economic		
Social		
Reputation		
Regulator / Political		

Waste Disposal and Storage Phase: Residual cyanide will be deposited in the TSF for long term storage and some potential further degradation. The containment of the cyanide in the TSF during the operational, closure and post closure phases is reliant on the design adequacy of the TSF and the TSF being correctly installed managed and operated. The ongoing containment of cyanide in the TSF is also reliant on the long term (centuries) integrity and stability of the TSF. In general the TSF's represent the most significant risk at gold mines as they hold the largest mass of cyanide for the longest period and have a track record of leaks and some catastrophic failures that lead to discharge of large masses of cyanide to the environment. Considering these factors the risk assessment results are presented below;

Result for Cyanide Use during this Phase / Stage of the Project

Risk Dimension	Approved	Modification 3
Human Health		
Environment		
Economic		
Social		
Reputation		
Regulator / Political		

Attachment B:

Comments on Environmental Assessment Report

Table 2: Comments on report

Item	Section	Comment / Issue	Significance	Potential Mitigation Options
1.	1.1	This section states "*remove the need for significant truck haulage on public roads*".	While this is a benefit in terms potential road traffic hazard the change proposed would also significantly increase the risk to the local environment due to transport of hazardous substances, particularly cyanide to the site therefore increasing the risk to human health and the environment from exposure to toxicants in the event of a road accident or spill.	Require that a detailed transport risk assessment is prepared to demonstrate that all relevant risks have bene identified and appropriate management and mitigation measures are in place to maintain risks within acceptable bounds.
2.	1.4.3	The section notes further mineralisation in the area including the Chinaman's Ruby Lode, Copper Ridge, Excalibur and Carmine Prospects. The report clearly notes that while not part of the current modification sought further exploration of these prospects is proposed and if viable further modification to the approval would be sought for the exploitation of any viable prospect.	The key consequence is that processing of ore on site could continue beyond the current mine life and result in increases waste rock and tailings storage on the site.	Request that the application for the proposed Modification 3 with respect to on site ore processing using a CIL with cyanide is rejected.
3.	1.4.4	The section indicates that the mine has between about 7 and 10 tonnes of gold reserves which would require between 90 to 140 tonnes of cyanide to effect extraction.	As the cyanide is utilised in liquid form there is the potential for leaks and spills to occur at any stage of the process where the cyanide solution is used.	Request that the proponent provide detailed management and response plans for the proposed Modification 3 operations at the site. This should not represent an onerous task as the proponent is already operating a CIL Plant using cyanide at their Henty Mine.
4.	2.1.1	This section states that the modification aims to reduce the need for duplication of a tailing storage facility and processing facility at different locations. The project as approved was to utilise an existing processing and tailings storage facility to process the ore and extract the gold. Therefore the point seems to contradict the basis of the approved project approach and basis for approval. There was a clear agreement that no ore processing and gold extraction would be undertaken on the site and all processing would occur at an existing facility. The report does not explain why this was changed to require development of a separate off-site process and tailing facility or where this was to be developed.	The report suggests that the project as approved previously would have required the construction of two tailings storage and processing facilities giving the impression of an unnecessary and inefficient requirement that would cause environmental impact at two locations. This was not the case in the in the project plan as previously approved.	The report should be amended to accurately and unbiasedly present the history of the project and the terms and agreements that the approval was granted.
5.	2.1.1	This section suggests that waste rock storage is now proposed for convenience. The project plan as approved was cognisant of the risks of leachate generation and consequent impacts on the environment by any waste rock storage facility. The plan as previously approved was specifically designed to mitigate against this risk. It appears that for convenience of mine operations this risk is now to be reintroduced to the project.	The risk profile of the site to human health and the environment is increased by creation of a waste rock dump in a location convenient to mining operations.	Request a more detailed plan that sets out the short, medium and long term monitoring, management and mitigation measures necessary for the proposed waste dump.
6.	2.1.1	The overarching driver for the proposed modification appears to be the increase in efficiency and profit from the venture at the expense of increased risk to human health and the environment in the surrounding area.	The proposed modification results in an increase in risk to the surrounding environment, particularly through the release of toxicants form transport of toxic substances to the site, storage and handling of toxic substances on site, spills and leaks from process plant, leaks and leachate from tailings storage facility, waste rock leaching and catastrophic failure of the tailings storage facility.	Require that the proponent provide a full and detailed risk assessment that assessed all relevant realistic risk factors, dimensions and scenario and provide detailed plans for the development, operational, closure and post closure phases of the project. These need to demonstrate that the proponent has adequately considered the environmental, social and economic aspects for the full lifecycle of the project.
7.	2.1.2	The section indicates that the modification includes placement of waste rock within the catchment of Spring Creek which increases the risk to water quality in the creek through sediment discharge and leachate.	The key consequence of the modification could be impacts to the catchment that would not be associated with the project as approved. The deposit is associated with sulphide mineral deposits that are likely to be present in the waste rock. Placement of the that material on the surface will result in oxidation of any reduced minerals including sulphide, which can lead to generation of acidic conditions that enhance weathering processes leading to saline leachate that can mobilise heavy metals into the environment.	As per item 5.
8.	2.1.2	The section indicates that the modification includes processing of ore on site using a CIL process that will utilise cyanide to extract the gold from the ore. This increases the risk to the surrounding environment due to use and mobilisation of toxic chemicals in the process and the potential release of toxic heavy metals as part of the ore process.	The key consequence of the modification is the import, storage use and disposal of toxic substances on the site. Cyanide is toxic and its use in ore processing leads to mobilisation of other toxic metals such as aluminium, arsenic, cadmium, chromium, mercury and lead that can be released to the environment and be placed with tailings into the tailings storage facility.	As per Item 6

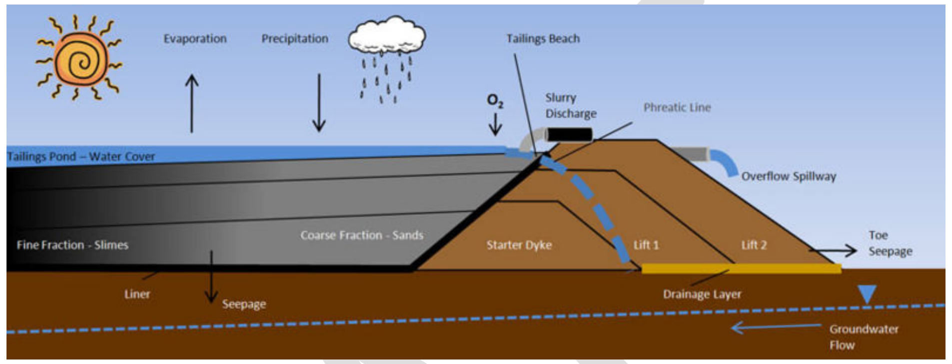
Item	Section	Comment / Issue	Significance	Potential Mitigation Options
9.	21.2	The section indicates that the modification includes what is effectively a new TSF to accommodate extra tailings including those left after completion of the ore processing. This increases the risk profile of the tailings storage facility due to increase in volume and more importantly the introduction of toxic substances for long term storage.	The modification proposes to store larger quantities and toxic substances in the tailings facility in the long term. This can lead to leachate generation that can impact the down-gradient environment. The long term storage of toxic substances can also lead to increased risk to the down-gradient catchment in the event of a catastrophic failure of the tailings dam.	As per Item 6
10.	Figure 4	The legend of the figure is incomplete.	This creates uncertainty as to the extent, location of the proposed modifications compared to the existing project as approved.	Require that the figures are amended to clearly present the information with all features shown on the legend.
11.	Figure 5	The proposed clean water diversions do not appear to divert all potential clean water. The figure clearly shows the that the proposed new access road could act as a 'dam' for runoff from the up-gradient area as the figure shows one culvert for existing natural watercourses, that would then divert into the culvert and enter the 'dirty water' channel and discharge into the sediment dam.	Thus increasing the risk of overtopping of sediment dam for waste rock storage area and consequent impact on down-stream environment.	Require that the proposed layout is amended to keep the "clean" and 'dirty' drainage system is amended to ensure that they remain separated at all times.
12.	2.3.6	This section suggests that material from the Eastern Waste Rock dump is to be used to cap the tailings dam. This material is likely to be granular and will allow infiltration of rainfall into the tailings storage facility after completion of the rehabilitation.	The waste rock is not likely to be suitable for capping of the TSF as its properties are not suitable for impermeable or capillary capping material. The proposed capping with waste rock will thus allow ongoing ingress of rainfall and lead to long term generation of leachate that will present a long term risk to the surrounding environment through leakage and discharge, particularly if the waste rock in the cap generates acid that would further enhance weathering processes and metal mobilisation of heavy metals from the tailings.	As per Item 6
13.	2.4.2	This section provides a preliminary design for the proposed Spring Creek Crossing and shows that only a single culvert is proposed for the crossing. Given the length of the embankment and the size of the up-gradient catchment would this be sufficient?	There is insufficient drainage causing ponding.	Request clarification on the hydrology design of the crossing and its capacity to deal with various rainfall events.
14.	2.5	This section clearly acknowledges that the proponent intends to contravene the public commitment made that no on site cyanide processing would occur as part of the original approval granted. The proposed use of on-site cyanide processing represents a significant increase in the sites risk profile from a scientific, regulatory, social and economic perspective. This section does not appear to consider the aspect of public perception and the significant impact any incident cloud have on the tourism industry in the area due to perception.	Any incident on the site, even if from a scientific perspective not significant could have a significant public image and perception impact that taints the areas image and affect the tourism and fishing industry.	As per Item 6.
15.	2.5	This section only appears to focus on the toxic and contamination risk posed by CN. Table 10 clearly shows that the concentrate tailings to be discharge into the TSF contain a range of other toxic compounds that will be retained on the site in the long term and can and probably will eventually discharge from the TSF.	The full risk posed by the proposed modification, the gold extraction process and TSF cannot be adequately assessed through independent review due to what appears to be inadequate consideration of all relevant contaminants of concern, their fate and transport in the environment, their source, migration and exposure pathways and potential receptors that are exposed.	Require a detailed risk assessment that considers all relevant contaminants of concern, their fate and transport in the environment and the source, pathway and receptor linkages.

Item	Section	Comment / Issue	Significance	Potential Mitigation Options
16.	2.5.1	This section asserts that cyanide is safely used in Gold mining throughout Australia and that the proponent made the commitment not to use on site cyanide processing without a proper understanding of the impacts before making the commitment. The safety aspect is presented out of context. Most Gold mines that still utilise Cyanide are in more remote locations that are generally well outside of significant community drinking water catchments. There certainly have been incidence of cyanide spills and leaks that have impacted the environment in Australia and an Australian Mining company was involved one of the worst incidences involving cyanide (Baia Mare spill)	The report appears to present the cyanide risk out of context and failed to present alternative less toxic extraction processes that would reduce the risk to the environment and allow the proponent to meet their commitment of no cyanide processing on site. Basic research has found that since 2000 there have been a number of notable incidents involving cyanide processing at gold mines including: • 29 Spill and leak incidents that affected the environment, including 2 in Australia; • 4 Transport incidents, including 1 in Australia • 3 Terrorism incidents, including 1 alert of potential attack, 1 unconfirmed and 1 confirmed thefts of cyanide shipments from mine sites for potential use in terrorist attacks. The potential use of cyanide in a terrorist attack is an emerging security issue that poses a potential risk associated with the proposed development. The site is in a populated area close to Australia's capital city. Therefore authorities would have very limited time to respond between a potential theft and attack.	Conduct a full and detailed risk assessment for the use of cyanide that considers each stage of the process from the transport from suppliers location to site, the transfer into storage, storage, transfer from storage to the CIL Plant, use in the CIL Plant and high concentrate leach, destruction and transfer to the TSF as well as long term storage in the TSF. The risk assessment should also consider security issues as the location of the site would provide very little reaction time between a theft or attack and impacts on the community occurring. The security issue does not appear to have been considered by the proponent.
17.	2.5.1	This section suggests a long term future for the mine yet the proposal shows that mining would cease in less than 7 years' time.	The short mine live and limited economic benefit in the context of the potential long term risk and management cost requirements of a tailings storage facility that contains toxic substances was apparently not considered. Further, the cost of clean-up in the event of a catastrophic failure of the tailings facility also does not appear to have been considered.	As per Item 6
18.	2.5.2.6	This section includes description of how cyanide is transported and describes three common methods. The report notes that the transport in bags, crate and locked container method will not be used. But the report does not state what method will be used.	This presents uncertainty on transport method and thus limits the ability assess risk and implement appropriate management measures.	Provide details on the method of transport and conduct a risk assessment to demonstrate that risks are understood and adequate management and response plans are in place.
19.	2.5.2.6	The report suggest that the likely discharge criteria required by NSW EPA will be several orders of magnitude greater than the aquatic ecosystem and drinking water quality criteria.	The discharge of cyanide into the tailings storage facility can lead to mass accumulation in the tailings as not all cyanide will degrade. The residual cyanide and any mobilised heavy metals can thus pose a long term risk to human health and the environment due to leachate discharge and potentially discharge due to catastrophic failure of the tailings dam or erosion over the long term.	As per Item 5 and 6.
20.	2.5.3	The proponent only became a signatory of the cyanide code in January 2015 and has no experience in setting up, operating, monitoring and managing a gold extraction plant in accordance with the cyanide code requirements. The proponents gold extraction operations at their other two mines are not subject to the requirements of the code.	The proponent has not gained experience in operating a mine in accordance with the cyanide code. The first inspection and audit to establish whether the ore extraction plant operations and management would only occur well after the mine is operational. Further if any issues are found at that time considerable loss or discharge of cyanide from the process to the environment could already have occurred.	Require that the proponent prepare detailed monitoring, management, response and mitigation plans based on a full risk assessment. These plans should be independently audited to establish their adequacy with respect to the cyanide code and then conduct verification audits on compliance with these plans on a quarterly basis for the first year of operations with biannual audits thereafter.
21.	2.5.4.1	This section notes that management measures proposed are generic and that further site specific design, management, monitoring measures are necessary but that work on these will not commence until after approval of Modification 3 is received.	The lack of detailed information on the design, operation, management and monitoring measures to be adopted for the project makes assessment risk uncertain. Further the lack of detail makes economic analysis difficult as the true cost of on-site processing can-not be accurately established.	As per Item 5, 6 and 20. Approval for the proposed Modification 3 should be denied until the proponent demonstrates that all relevant issues are understood and appropriate independently verified plans are in place.
22.	2.5.4.2	The section indicates that the Carbon in Leach (CIL) Plant would have 8 tanks but provides no details.	As the capital and operational cost of the CIL Plant would depend on the number of tanks, their size and auxiliary equipment. How was the economic analysis undertaken?	Require the proponent to provide details of all plant to be installed on the site and provide detailed and full economic analysis that covers the full lifecycle of the project.

Item	Section	Comment / Issue	Significance	Potential Mitigation Options
23.	2.5.4.2	This section indicates that the bunding of the CIL Plant would have a capacity of 110% of the largest tank. Therefore the containment is only sufficient to cope with a single failure and has no redundancy or secondary containment.	Given the site is in a drinking water catchment there appears insufficient redundancy in the containment system to deal with a multi-tank failure and therefore if such an incident occurred the spill would not be contained and the cyanide and other process liquids would escape the primary containment and enter the environment and potentially spill into the Drinking Water Catchment.	Require the proponent to increase the capacity of the primary containment so the capacity is sufficient to retail the total volume of all tanks not just 110% of the largest tank. This would provide a greater level of protection to the drinking water catchment in the event of a multi-tank failure.
24.	2.5.4.2	The section provides no details on the design construction materials, monitoring and incident response plan for the bund around the proposed CIL Plant tanks.	The lack of details makes it difficult to establish adequacy of the proposed measures.	Require that the proponent provide these for independent review and verification before any approval for the proposed Modification 3 can be granted.
25.	2.5.4.2	The section refers to the CIL Plant at the Henty Mine for reference but is not clear whether the plant for Dargus Reef Mine will be new or recycled from the Henty or Kangaroo Flat Mine.	The lack of detail on the CIL Plant makes assessment of risk difficult and subject to uncertainty.	As per Item 22 and 24
26.	2.5.4.2	The section provides discharge concentration targets for the detoxification plant that are several orders of magnitude above the aquatic ecosystem and drinking water criteria and provides no detail on the annual and total mass of cyanide to be discharged to the tailings storage facility.	The discharge criteria if met would allow for around 21mg/L cyanide (CN <20mg/L 90% of time and no more than 30 mg/L) to be discharged to the tailings storage facility, which would allow for a substantial mass of cyanide to accumulate in the TSF over the life of the mine even if some degradation in the TSF were to continue.	Require that the discharge limit for cyanide is lower than the proposed less than 20 mg/L 90% of the time and no more than 30 mg/L at any time limits. Treatment technology can achieve significantly better than that and the limits as a minimum should correspond what can be achieved using the best available technology. The EU limit for discharge to TSF's is 10 mg/L and UV oxidation technology can achieve concentrations as low as 0.2 mg/L.
27.	2.5.4.2	The section notes that the sodium meta-bi-sulphide and copper sulphate would also be discharged into the tailings facility thus adding additional contaminant mass to the TSF beyond that considered in the original proposal.	This addition of salt, sulphuric acid and copper to the TSF would present another risk dimension that presents a risk to catchment water quality in the event of a leak, spill or catastrophic failure from the TSF.	As per Item 5 and 6
28.	2.5.4.2	The section indicates that the Elution Circuit (EC) would include use of highly concentrated cyanide solution under pressure. No information on the management, controls and destruction including protection measures with respect to this use of cyanide are provided.	The risk posed by the use of concentrated cyanide solution under pressure in the EC was not available and therefore the risk could not be adequately assessed. This is clearly a part of the process where cyanide spill and leaks can occur and relevant management and protection measures need to be in place.	As per Item 22 and 24
29.	Table 8	The table provides no information on the quantity of each chemical or reagent stored at any one time on the site.	The lack of detail hinders assessment of risk and assessment of adequacy of management measures to be used.	As per Item 5, 6, 22 and 24.
30.	Table 8	The table provides no information on the toxicity of the chemicals and reagents listed. In general the chemicals and reagents to be used as part of the proposed modification are significantly more toxic to the environment and human health than those approved as part of the original proposal approved.	The use of more toxic chemicals and reagent as part of the modification increases the overall risk to human health and the environment. Also the proposed modification would result in the storage of significantly higher masses of toxic substances on site.	As per Item 5 and 6
31.	Table 8	Missing copper sulphate reagent described as part of the cyanide destruction process.	The provision of an incomplete inventory of the chemicals to be stored on site hinders assessment of risk to human health and the environment.	Require that the proponent provide details of all reagents and chemicals to be used on site and include a detailed analysis of the risk these pose to human health and the environment.
32.	2.5.4.4	The section on transport does not appear to include any mention in security for the substance during transport.	The proponent does not appear to have adequately considered security aspects during transport of the cyanide.	As per Item 16
33.	2.5.4.4	The section asserts that Orica as manufacturer and transporter of cyanide have not had a single transport related discharge of cyanide since use of isotainers commenced 20 years ago.	There have been 4 transport related incidents with cyanide deliveries to the mining industry and while not frequent the risk still requires proper analysis, particularly as Orica was considered only a potential supplier for the mine.	As per Item 5, 6 and 18
34.	2.5.4.4	The section notes that an approved route and associated risk assessment does not appear to have been established at the time of the proponents application for the modification.	In the absence of an established route how was the economic analysis undertaken?	As per item 5, 6 and 18
35.	2.5.4.4	The section notes that between 4 and 6 deliveries of a 22t isotainer would be required per year, which amounts to a delivered mass of cyanide of between 88 and 132 tonnes per year.	There appears to be sufficient parameters known to conduct a proper detailed assessment of risk of transport to the site. The locations of manufacturers is known, the routes form the manufacturers location to the site would be known and the road hazards encountered on route and on the site, including transfer to on site storage tanks would be known. Relevant security hazards would also be known. The proponent would have a duty of care to understand the transport risks of a hazardous product they purchase and transport to the site and not just rely on an as yet unknown supplier to be responsible.	As per item 5, 6 and 18
36.	2.5.4.4	The section provides no details as to the capacity of the bund that surrounds the semitrailer parking location.	The risk during delivery and transfer of the cyanide to the tank from the semitrailer needs more assessment to establish sufficient protection is in place to prevent discharge to the environment in the event of an incident.	As per item 5, 6 and 18

Item	Section	Comment / Issue	Significance	Potential Mitigation Options
37.	2.5.4.4	The description on storage of cyanide on site lacks detail. The section indicates that no plan for storage has been developed and sets out only preliminary aspects of what the plan will cover. The proponent appears to seek approval for the proposed Modification 3 before developing plans that will demonstrate that cyanide will be managed in a safe manner on site.	The risk during the storage phase on site can-not be properly assessed due to a lack of detail in the proponent's plans. Also the lack of information would limit the proponent's ability to properly assess the economic benefit achieved by the proposed change.	As per item 5, 6, 18, 22 and 24
38.	2.5.4.4	The proposed bund for the storage facility is 110% capacity of the largest tank and no details of the proposed bund construction materials are provided. The bund would not allow for containment of multiple tank failure. Sodium cyanide is a Group 1 hazardous product and as such the bund should be large enough to contain a full spill of all products stored on the site.	Given the sites position in a sensitive catchment there does not appear to be sufficient redundancy in the proposed plan to contain a multiple tank failure. Therefore in the event of a multi-tank failure or if bund volume is reduced (storm event, storage in bund etc.) during a single tank failure incident cyanide discharge into the environment beyond the primary containment would occur. The proposed bund volume is insufficient to comply with requirements for storage of a Group 1 hazardous product.	As per item 5, 6, 22 and 24
39.	2.5.4.4	The section suggests that rainwater can accumulate in the bund of the storage tank. This would diminish the bunds storage capacity if the spill occurred during or just after a major rainfall event.	The proposed bund capacity may not provide sufficient protection given the position of the site in a sensitive catchment.	As per item 5, 6, 22 and 24
40.	2.5.4.4	The section does not appear to mention monitoring of the bund and tank beyond security with no specific mention of leak detection and bund monitoring to remove accumulated rainwater.	The proposed bund may not be adequately monitored to keep bund capacity at maximum by removal of rainwater and detect potential leaks.	As per item 5, 6, 22 and 24
41.	2.5.4.4	The section provides no details on the equipment specifications, management and monitoring procedures for use of cyanide on site and it appears the proponents intention is only to provide this information after approval for modification 3 is received.	The lack of detail limits the ability to adequately assess risk to human health and the environment during use of cyanide on site.	As per item 5, 6, 22 and 24
42.	2.5.4.4	The section suggests that the bund does not need to contain the contents of the entire tank farm as the tanks are not interconnected in a way to allow all tanks to drain in the event of a single tank failure. CIL tanks are generally interconnected with pumped top to base connection between tanks possible. Given this design there is a risk that the failure of one tank could damage the base connection of and adjacent tank or cause a rupture of the adjacent tank.	The report notes that CIL Plant tanks are interconnected by pumping. The proponent has not identified measures to prevent cyanide leaching solution being pumped into a leaking tank, which would therefore produce a volume greater than the failed tank. Therefore there is a risk that a tank failure could lead to more than one tank draining and thus overtop a bund with a capacity of only 110% of the largest tank. Given the sensitivity of the catchment in which the plant operates the bund was not considered to be adequate.	As per item 5, 6, 22 and 24
43.	2.5.4.4	The proponent considers risk of multiple tank failure negligible and would require external action such as an aircraft crash into the facility. The section provides no definition on how negligible risk is defined or what evidence support the assertion. The section also fails to consider a more obvious action such as sabotage or negligent operation.	The proponent does not appear to consider sufficient safeguards in the usage of cyanide to provide adequate protection of the environment and human health in the event of a significant spill or leak during use of cyanide in the CIL plant.	As per item 5, 6, 22 and 24
44.	2.5.4.4	The proponent suggests that in the event of a multi tank failure the spill be allowed to a discharge the cyanide into the environment beyond the primary containment where while diluted the volume of waste could increase significantly and discharge to the surface soils and groundwater occur as well as potential discharge to the surface water environment.	The suggestion to allow discharge to escape primary spill containment and relay on surface drainage feature to protect spring creek fails to adequately consider risk to human health and the environment and does not appear to consider that Spring Creek is adjacent to the process plant up-steam of the box cut.	As per item 5, 6, 22 and 24

Item	Section	Comment / Issue	Significance	Potential Mitigation Options
45.	2.5.4.4	The proponent refers to the cyanide destruction process which would still leave cyanide concentrations in solution several orders of magnitude above the ecological and drinking water protection criteria.	The reference of destruction overstates the level of cyanide treatment that can be achieved. The limits for discharge presented are orders of magnitude higher than the ecological protection criteria. This limitation of treating cyanide even under ideal conditions is one contributing reason why the use of cyanide in gold mining is banned in numerous countries and jurisdictions including Germany, Czech Republic, Hungary and Costa Rica, as well the US states of Montana and Wisconsin and the Argentine provinces of Chubut, Río Negro, Tucumán, Mendoza, La Pampa, Cordoba, San Luis and La Rioja. Turkey has also refused permits for new mines using cyanide. The European union has also issued a directive that while not banning use of cyanide has set the most stringent criteria for cyanide discharge of 10ppm(mg/L) for any mine commenced after 1 May 2008.	Request that due to the lack of information and inadequate assessment of relevant risk factors, dimensions and scenarios the application for the proposed Modification 3 is rejected until such time that all relevant information and detail has been provided for independent review and verification.
46.	2.5.4.4	The proponent appears to suggest that only WAD CN be monitored.	Cyanide can result in formation of numerous other metal complexes and consequent mobilisation causing accumulation of these in the TSF and thus posing potential risks to human health and environment due to discharge from the facility.	Require that a detailed monitoring plan that considers all relevant contaminants of concern is prepared and independently reviewed and verified before consideration to approving Modification 3 is given.
47.	2.5.4.4	The section suggests that a closure and rehabilitation plan for the processing plant is yet to be developed.	The lack of a plan for closure limits the ability to assess long term residual risk. In WA a closure plan needs to be developed prior to gaining approval for the project. Given the sensitive setting of the process plant it would be important to understand the closure process to assess long term residual risk.	Require that the proponent prepare a detailed and fully costed closure rehabilitation and management plan for the site for independent review and verification before consideration to approval of the proposed Modification 3 is given. This information should be readily available to the proponent as it is an important factor to consider in assessing the projects economics over the lifecycle of the project.
48.	2.5.4.4	The section suggests that a monitoring plan has not been developed and will not be available prior approval of proposed modification 3.	The lack of a monitoring plan limits the ability to assess risk to human health and the environment and establish adequacy of the measures proposed to detect any emerging risk.	As per item 5, 6, 18, 22 and 24
49.	2.5.4.4	The section suggests that an emergency response plan that incorporates changes proposed under modification 3 has not been developed.	The lack of an emergency plan limits the ability to assess adequacy of any response measures in the event of an emergency.	As per item 5, 6, 18, 22 and 24

Item	Section	Comment / Issue	Significance	Potential Mitigation Options
50.	2.6	The section indicates that a risk assessment for siting of the enlarged TSF containing toxic compounds was not performed. The report only appears to have considered risk from CN during operation of the TSF while the proponent was present and in charge of the site. Mercury is known to be present in the ore and will be concentrated in the tailings after gold extraction.	The lack of a new risk assessment for what is effectively a very different TSF from that previously approved significantly hinders independent assessment of the validity of the location of the TSF and the risk the facility presents to human health and the environment. The TSF risk profile has increased significantly during the development and construction, operational, care and maintenance, close and post closure phases of the project. The risk assessment did not appear to consider all relevant risk dimensions through the TSF lifecycle. The design has been switched from upstream to downstream type of dam  The risk posed by mercury does not appear to have been adequately considered. CN can form the $Hg(CN)_2$ complex which is highly soluble and highly toxic. The fate and transport of this potential cyanide complex does not appear to have been adequately considered if present at the site. The risk posed by hexavalent chromium also needs to be considered given the proposed management and treatment of CN by oxidation and high pH. The risk of a catastrophic failure of the TSF dam was not adequately considered. In the event of a failure the tailings would migrate downstream along the existing stream, particularly in the event of the failure occurring during a storm event. Tailings would grade along migration flow path with the higher risk fine fraction migrating further than the coarse fraction. Subsequent release of the acid from the oxidised sulphide could then release cyanide and other toxic metals into solution and vapour and pose a risk to human health and the environment.	A case specific risk assessment, design management and monitoring requirements evaluation should be conducted with specific reference to or consideration of: • Dep of Primary Industry (2003) Management of Tailings Storage Facilities • Dep of Industry, Tourism and Resources (2007) Tailings management - Leading practice sustainable development program for the mining industry; • Dep of Industry, Tourism and Resources (2008) Risk assessment and management - Leading practice sustainable development program for the mining industry; • Dep of Industry, Tourism and Resources (2008) Cyanide management - Leading practice sustainable development program for the mining industry; • Dep of Primary Industries and Resources (2009) Guidelines for miners: tailings and tailings storage facilities in South Australia • EU Commission (2009) Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities • Dam Safety Committee NSW (2012) Tailings Dams • Dep of Mines and Petroleum (2013) Code of practice – Tailings Storage Facilities in Western Australia, as well as: o Guidelines on the safe design and operating standards for tailing storages; o Guidelines on the Development of an Operating Manual for Tailings Storage
51.	2.6.2	The section suggests that the TSF would receive around 180,000 tonnes of gold concentrate tailings over the projected live of the project. At an approximate discharge concentration of 21 mg/L (~21ppm) this would place up to 3.8 tonnes of CN into the TSF.	The long term fate of the CN in the TSF is uncertain and could pose a long term residual risk to human health and the environment due to leakage and spills from the TSF. The TSF presents a long term risk (decades, centuries) if the proposed modification is granted due to the retained toxic compounds. The report does not assess risk of poor construction practice or long term degradation of the liner.	As per Item 49. Conduct a detailed full lifecycle risk assessment of the TSF that is commensurate with the increased risk profile of what is effectively a new TSF facility that happens to be in the same location as the smaller more benign TSF previously approved.
52.	2.6.3.2	The flotation tailings appear to contain near background concentrations of heavy metals and have minor neutralisation capacity. The risk of mobilising unacceptably high concentrations of toxic metals into the environment was low and was one of the main reasons that locating the TSF in a drinking water catchment was considered to present an acceptable level of risk.	The proposed addition of concentrate tailings will add acid generating material that may mobilise heavy metals from the flotation tailings.	As per item 5, 6, 18, 22 and 24
53.	2.6.3.2	The flotation tailings appear enriched in sodium.	Sodium substitution in clay minerals can lead to formation of Montmorillonite which is dispersive and can lead to erosion of embankments and liners that include clay.	As per item 5, 6, 18, 22 and 24
54.	Table 9 and 10	There are differences in the average abundance concentrations between the two tables.	The discrepancy needs to be addressed.	Request that the proponent clarify the tables and provide justification why the abundance values were different or amend the report as necessary.

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55.	2.6.3.3	The gold concentrate tailing are enriched in heavy metals particularly arsenic, bismuth, boron, cadmium, chromium, cobalt, copper, iron, mercury, molybdenum, lead, nickel, selenium, silver, sulphur and tin.	The gold concentrate tailings added to the TSF will generate acid that can mobilise heavy metals that can then enter the environment posing a potential risk to human health and environment in the medium to long term.	As per item 5, 6, 18, 22 and 24
56.	2.6.4	The proposed modification increases the consequence category of the tailings dam indicating that a failure would result in greater impact and consequences on the environment. This necessitated a redesign of the dam.	The increased risk and consequence will potentially lead to greater impact in that the TSF will retain tailings containing toxic substances in the long term after mining at the site stops.	As per Item 47
57.	Table 11	The table indicates that the emergency spillway capacity during operation of the TSF is to be designed for a 1 in 100,000 year 72 hour event.	This design specification would be very conservative and provide a high level of protection. Although it is uncertain on what data the design would be based.	As per item 5, 6, 22 and 24
58.	Table 11	The table indicates that the emergency spillway post operation of the TSF be designed for a maximum probable flood event.	No details on what a maximum probable flood event is provided so the adequacy cannot be assessed.	Request more information on the hydrological assessment conducted.
59.	2.6.5.2	This section notes the issues in relation to pollution events for which the proponent was fined by NSW EPA.	The proponent has breached environmental standards and causing pollution of surface water quality. This has led the proponent to engage SEEC to develop and improved sediment control plan.	Demonstrates the need for detailed plans and independent verification throughout the process. As per item 5, 6, 18, 22 and 24
60.	2.6.5.3	The section proposes a cut-off trench and includes proposed dimensions. The cut-off trench is to be excavated 2-3m below the base of the TSF dam. No information is provided in regard to the material that the cut-off will the seated into. Also the TSF sits on the edge of a valley with significant elevation drop.	There is a risk that seepage will underflow the cut-off and impact the groundwater and discharge to the surface water environment. Figure 9 does not indicated where the cut off is to be installed and how it is connected into the liner system. The detailed report and drawings in Appendix 7 suggest the intent is to construct the cut off trench on the up-gradient side of the dam wall but provides no indication that the area of the dam or cut off wall location was investigates and no information on what low permeability lithology the cut-off trench was to be keyed into.	Request that a more detailed design based on a through field investigation is provided to show that the proposed cut-off trench will be adequate to minimise underflow and discharge of TSF leachate into the environment in the short, medium and long term.
61.	2.6.5.3	The TSF low permeability liner is to be underlain by a leakage collection drain that is operated while the TSF is operational. The section has limited details on design and management of the leakage collection system.	The potential for leakage is acknowledged and the consequent need to manage the resultant leachate while the TSF is operational. No mention is made on how leakage and resultant leachate is to be managed during the post operational phase.	The proponent should provide a detailed monitoring, management and mitigation plan that dealt with the leachate collection management from the TSF in the short medium and long term, including the closure and post closure phases. This is an important aspect of the environmental liability and economic burden the TSF poses and needs to be well understood up front to allow for a balanced decision on the proposed Modification 3 approval.
62.	2.6.5.3	The section describes the clay and HDPE liner proposed. No information on the design life of the liner, the clay mineralogy and vulnerability to sodium substitution is provided. Also the liner design does not appear to make any allowance for subsidence related impacts on the liner integrity that may be associated with any old unmapped workings that could be present under the proposed TSF facility. To date no investigation that considered the potential presence of old working appears to have been undertaken.	All liners have a design life and this is a critical aspect required to understand the risk of discharge of TSF leachate from the facility. HDPE liners can generally be expected to maintain their integrity for between 30 to 300 years depending on the application, the protection provided and the geochemical conditions. In acidic pH conditions HDPE integrity would be at the low end of that range.	The proponent needs to demonstrate that the liner system has a design that considers all potential stresses and impact to integrity of the liner to demonstrate that the design life is sufficient to main the liner integrity for the duration of the geological and geochemical conditions under which the waste tailing pose a risk. Based on the information in the environmental assessment report the proponent has not undertaken such an assessment.
63.	2.6.5.3	The section notes that down-gradient drain or seepage interception bores would be used if the leakage collection and seepage collection systems failed.	The section provides no information on the likelihood of these measures being required or who and how these would be managed in the long term or how this would affect the project economics. As the liner degrades seepage rates increase as the liner ages. The proponent does not appear to have considered these factors in the design of the TSF or the mitigation measures proposed.	Require the proponents to undertake any relevant investigations and assessment that demonstrated the adequacy of the interception system and outlines the timeframe over which the system is required and what the capital and operational costs are of the system and who will retain liability for its operation over the systems lifecycle. This analysis would also have to be incorporated into the environmental, social and economic assessment for the sustainability evaluation.
64.	2.6.5.3	The section suggests a seepage rate of 0.187L/s from the TSF in the event that the seepage management measures become non-operational. This may also represent post operational conditions.	This could translate to a leachate discharge of around 6 million litres to the environment from the TSF. That is more than 2 Olympic size swimming pools of potentially toxic leachate that could escape the TSF into the environment.	As per Item 47, 61, 62 and 63
65.	2.6.5.4	The section is contradictory it states that the emergency spillway will be designed to handle a 1 in 1000 year AEP event and a 1 in 100000 year AEP event.	This is confusing and it needs clarification. Clearly use of a 1 in 100000 year event design would have a high degree of protection as the likelihood of discharge of potentially toxic tailings would be reduced.	Request that the proponent clarify the emergency spillway design.

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66.	2.6.5.4	The report section only considers a volume discharge to Spring Creek but does not mention the potential impacts of toxicant discharge in such an event and the impact on the Spring Creek and down-gradient streams.	Should discharge occur from the emergency spillway there is a risk of impact due to dissolved toxic heavy metals discharging into Spring Creek.	Conduct a detailed risk assessment that considers all relevant risk factors, dimensions and risk scenarios as not Item 5 and 6.
67.	2.6.5.4	The report does not define the maximum probable flood rainfall event.	The adequacy of the emergency spillway can-not be assessed until this information is available.	Request that the proponent clarify the post closure spillway design, particularly with respect to the flood management capacity.
68.	2.6.6.3	The discharge dilution modelling only considered cyanide.	Cyanide can degrade in the surface water environment and is not likely to accumulate in the catchment into which it discharges. The modelling did not appear to consider other toxic heavy metals in the tailings stream that would not degrade and attenuate and accumulate in the catchment posing a long term risk to water quality.	Require that the proponent conduct a dilution assessment for all relevant contaminants of concern as part of the overall risk and sustainably assessment of the project. This assessment also needs to consider overtopping and leaching scenarios over the entire project lifecycle.
69.	2.6.6.3	The primary risk management method in the event of discharge from the TSF is dilution.	The NSW EPA normally does not accept dilution as the primary risk management approach in the event of a foreseeable contamination event occurring. The other aspect of concern is that while dilution reduced concentration it does not affect the mass discharged into the catchment and thus the mass load to the environment remains unchanged.	Require an alternate approach to dealing with the concentrated tailings by separating the liquid and solid components, treating the liquid and recycling the water and disposing the solid waste tailings into a dedicated waste repository at a suitable location with appropriate design, management and monitoring measures or alternatively to cement stabilise the solids in the a dedicated part of the paste plant and entombing the stabilised waste tailings solids in the mine workings.
70.	2.6.6.3	The section suggests that the minimum dilution rate during the model simulation would be 28.	The minimum dilution rate would not be sufficient to reduce the CN concentrations below to the relevant environmental and drinking water criteria if the TSF contain CN concentrations at the planned plant discharge concentration.	Conduct a detailed risk assessment that considers all relevant risk factors, dimensions and risk scenarios as not Item 5, 6 and 68.
71.	2.6.6.3	The section notes that there were 14 sub-catchments in the hydrologic modelling but only 8 are listed in the report, while 13 sub-catchments are shown on Figure 10.	The lack of clarity crates uncertainty as to what was considered in the modelling and undermines the credibility of the results.	Request the proponent provide revised figures that show all relevant sub-catchments.
72.	2.6.6.4	The management measures of the CN concentration in the supernatant solution appear reasonable over the 65 month but the discussion takes no account of potential extension to mine life.	The proponent has limited discussion to only the minimum expected mine life. In most mining projects further exploration occurs as mining progresses and mine life is extended as additional resource is identified. This was not taken into account in the discussion and risk assessment.	Request clarification in regard to the proponents intentions regarding mine life, exploration activities and extension of mine life in the event further resources are identified.
73.	2.6.6.4	No detailed management plan has been prepared. The proposed measures are summary and generic in nature.	The adequacy of the proposed management measures cannot be assessed until details of the plan become available. The proponent expects to be granted approval on generic information only. This is considered inadequate and the information should be available to allow for a reliable economic analysis as it impacts operational cost and associated uncertainty.	As per Item 5 and 6.
74.	2.6.7	It would appear that the proposed closure plan and closure criteria would largely rely on in the previous closure plan submitted as part of the original approval granted when on site cyanide processing was not proposed. Clearly the short, medium and long term risk profile of the site has substantially changed with the proposal to process ore on site using cyanide.	The lack of a detailed and tailored mine closure plan for the proposed use of cyanide CIL process and tailings hinders assessment on the adequacy of the measures to manage risk to human health and the environment. The existing closure plan as approved would be unlikely to adequately manage and monitor the risks in the context of the modifications the proposed mine operations.	Require that the proponent provide a detailed tailored mine closure plan and costing model for independent review. Require the proponent to provide a bond commensurate to the environmental liability remaining and fund actions should these be required post closure or in the event of company default with clear criteria having to be met to achieve repayment of the bond.
75.	2.6.7	The section indicates that the TSF would be capped with material that would create an impermeable and capillary cap. Section 2.3.6 suggest that waste rock from the eastern waste dump would be used to cap the TSF.	The contradictory statements would have a significant impact on the performance of the TSF Cap. Clearly the use of waste rock rubble would not achieve the objectives as set out in this section.	Provide a derailed rehabilitation plan that provides specific materials sources, design parameters, installation methods and verification and reporting procedures. The waste rock would not be suitable material for construction of either an impermeable or capillary cap. The use of waste rock to cap the TSF should not be allowed and the material should be used to backfill the box cut. The TSF cap should be constructed using appropriate materials. As per Item 49 and 50, this needs to be captured in an appropriate closure plan.
76.	2.6.7	The report provides no information on long term management and monitoring and response requirements for the TSF post closure.	The long term risk posed by the TSF cannot be adequately assessed due to a lack of information. Clearly the long term risk of the TSF is a significant factor in assessment of risk to human health and the environment and presents the largest long term liability (financial, social and environmental) of the project.	As per Item 49 and 50.

Item	Section	Comment / Issue	Significance	Potential Mitigation Options
77.	2.8	The economic analysis appears to only focus on the economic benefit achieved. The section indicates that the increased margin due to the proposed modification would be around $20million. While the projected revenue to government remains unchanged. Also contribution to the state and national revenue would remain unchanged and the local community gains an estimated additional benefit of around $3million.	The lack of a full economic analysis and the minimal gain to the people of NSW would suggest that that the net benefit, particularly when the increased risk and potential increased costs of rehabilitation and potential clean-up cost for even a moderate impact event are considered, would be marginal at best. The economic analysis also does not appear to consider the reputational risk cost of an incident on the local community revenue from industries such as tourism and fishing. Such an analysis would probably indicate that the increased cost due to significant increase in risk profile would not be viable for a limited scale project in an environmental setting such as that of the Dargues Reef Project.	Request that the proponent conduct a detailed, transparent economic analysis of the project that considers the full economic benefit and cost of the project to the shareholder, local, regional, state and national communities.
78.	2.8	The section suggests that the economic analysis of the project is commercially sensitive and thus details are not disclosed.	This hinders independent review that could verify that the economic benefits claimed by the proponent are realistic and defensible, particularly as the economic benefit is one of the key benefits cited as a reason that Modification 3 should be granted.	Request the proponent provide their economic analysis and undertake a full independent economic analysis to verify the claims made by the proponent. This analysis needs to be conducted in accordance with the economic component aspects of sustainable development principles.
79.	2.8	The economic analysis would suggest that the proponents shareholders would reap the majority of the economic benefit of the proposed modification while the only other stakeholder to potentially gain is the local community.	The economic analysis appears to neglect consideration of closure, management, monitoring and incident clean-up impacts. These could become the responsibility of people of the community and this cost could well deliver a negative return to the community while the shareholders could be insulated from such financial loss.	As per Item 74.
80.	2.8	The economic analysis does not provide information as to the gold price used for the economic analysis.	The medium term prediction is a decline in gold price, which would further decrease the project viability	As per Item 74
81.	2.9	The section acknowledges that a final mine closure and rehabilitation plan that is cognisant of the additional risk posed any Modification 3 activities has not been developed.	The risk and how this is to be mitigated in the closure and post closure phases of the project cannot be adequately assessed. The proponent seeks approval of the modification before providing any details on their prosed amendment to the rehabilitation plan.	As per Item 72
82.	2.9.2	The section bullet point 3 is incomplete.	The intent of the bullet point and the intent of the proponent is unclear.	As per Item 72.
83.	2.9.2	This section suggests that the tailings dam cap will utilise waste rock to cap the dam.	The waste rock is not likely to be suitable as a cap for the TSF as it would not be able to meet the proponents objective to capping the TSF with separate impermeable and capillary caps. The proposed use of waste rock in the TSF cap would also result in potentially acid forming waste remaining at the surface allowing discharge of acidic leachate that potentially contains toxic heavy metals into the environment.	As per Tem 72
84.	2.9.2	Not reinstating the box cut would leave behind an excavation that could create a pit lake with potentially impacted water. The report makes no mention of long term management and control of discharge from such a pit lake.	Pit lakes often have poor water quality due to the presence of waste rock and other impacts from exposed rock surfaces subject to weathering. Discharge from a pit lake can pose a risk to water quality in the catchment and impact the environment and human health. The report makes no mention to what the soils excavated from the box cut are to be used for. Reuse of these materials in the order of exaction in reinstating the box cut would represent the lowest risk of impact option. The soils excavated from the box cut should be stored in the order of excavation and then returned to the box cut in the order in which they were present in-situ.	As per Item 72
85.	2.10	The proponent did not consider use of alternatives to cyanide for extraction of gold from the ore.	There are a number of alternatives methods to the use of cyanide that pose a considerably lower risk to human health and the environment. An example that has been applied on a commercial scale is the Harber Process.	Complete a full economic analysis that considers full lifecycle cost and include alternatives methods for gold extraction.
86.	2.10.3	This section indicates that the mine plan was amended from a top down to bottom up approach which created the need to create an increased surface footprint for the mine and disposal of waste rock onto the TSF at the completion of mining.	The change in sequence increases the surface footprint and rehabilitation requirements of the mine and increases the risk of adverse impacts to human health and the environment. The economic assessment is unclear on how the commercial benefit of the change was assessed.	As per Item 72 and 74
87.	2.10.5	The analysis appears to have been based on retaining the creek crossing after mining operations cease.	The inclusion of removal costs in the economic model could affect the commercial viability of this option and needs to be considered.	As per Item 72 and 74

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88.	2.10.7	The section makes a number of assertions that are presented as fact but are not supported by relevant evidence as follows: • The fact that cyanide is commonly used safely and without harming the environment; • The fact that on-site processing is more efficient as it eliminates the need to transport ore; • The fact that proponent investigated a very significant number of off-site processing facilities but none were suitable	The specific issues of concern in regard to these statement of fact are: • There are a number of documented cases over the last two decades of cyanide spills and tailings dam discharge causing harm to the environment. A number of these involved Australian Mining Companies. The UNEP has records of at least 221 serious tailings dam accidents including some at gold mines that resulted in release of toxic substances into the environment; • The report provides no details on the analysis performed to show that the on-site ore processing is more efficient, has a lower impact on the environment and poses a lower risk to human health and the environment in the short, medium and long term. • The report provides no definition of significant number or any details on what sites were approached. Given the very limited number of suitable gold ore processing facilities in NSW and Victoria the claim of significant number of sites being approached maybe questionable.	As per Item 72 and 74
89.	2.10.9	The risk of including concretes within a single TSF is that they are in large facility with the potential for a more significant impact in the event of a failure.	Using separate TSF would result in a smaller facility that contains the more toxic and acid generating materials in a facility that can be more rigorously engineered and located away from the catchment. This would also aid the recovery of the material for reuse should this become viable in the future and thus better align with current waste policy	Require a more detailed assessment of alternate options to the single option presented.
90.	2.10.9	No evidence is presented on the investigation into reuse of the concentrated tailings waste.	The lack of information makes independent review of the claims difficult.	Request the proponent provide evidence of to the relevant investigation and outcomes in the report.
91.	3.2.3.1	The proponent suggests that $100,000 has been spent on community consultation. The report and an independent assessment suggest that the approval of Modification 3 would result in a financial gain to the project of some $20 million. The community consultation budget would therefore represent 0.5% of the projected gain from approval.	Observation only.	None
92.	3.3.3.1	This section suggests that the proposed development is not within a drinking water catchment.	It is understood that the proposed development is at least in part (TSF) within the Eurobodalla Council drinking water catchment. Eurobodalla Council advise that the Drinking Water Catchments Regional Environmental Plan (REP) No.1 is a plan under the Sydney Catchment Management Act. The proponent should note that the Drinking Water Catchments REP NO.1 is not relevant, rather than stating that Drinking Water Catchments REP is not relevant. However, council contends that the aims of the REP should also apply to adjacent catchments, including: 26. Development consent cannot be granted unless neutral or beneficial effect on water quality.	Seek clarification as to extent of drinking water catchment.
93.	Table 21	This table suggests that the proposed Modification 3 would almost double the area of disturbance.	This proposed increase would have a significant impact on the rehabilitation cost but there is insufficient information to understand if and this was accounted for in the economic analysis.	As per Item 72 and 74
94.	4.3.5.2	The assessment of cyanide impacts on species that access the TSF appears to have been limited to birds and bats due to the use of a chain link fence.	While not my area of speciality the assessment appears to have ignored the risk of small non-flight terrestrial species such as snakes, frogs etc. that would not be excluded by a chain link fence. Other species could then prey on the affected species after exposure to in TSF.	The risk assessment should consider a wider range of potential species that may be affected.
95.	4.3.5.2	The risk assessment only appears to have considered risk due to overtopping of the TSF and consequent impacts on downstream water quality.	The TSF could also potentially impact downstream water quality by a number of other mechanisms such as seepage and dam breach.	The risk assessment needs to consider a wide range if risks to downstream water quality than the limited scenario considered in this section of the report.
96.	4.3.5.2	The risk assessment only appeared to consider the risk of cyanide discharge.	The concentrated tailings discharged into the TSF have the potential to generate acid and they contain a range of toxic substances. The risk that these potential contaminants pose needs to be characterised in order to understand the potential consequences on human health and the environment that granting approval for the proposed Modification 3 could cause.	Complete a more comprehensive risk assessment that considers all of the potential contaminants of concern that could be associated with the modified min operations as proposed.

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97.	4.4.3.2	The section states that the tailings stream would be treated to achieve a WAD CN of 20mg/L 90% of the time and no more than 30mg/L at any time. This is used as an indication that risk of groundwater continuation is low.	At the discharge criteria the WAD CN concentration is orders of magnitude greater than applicable environmental and human health criteria.	As per Item 72 and 74
98.	4.4.3.2	The section suggests that impacts to groundwater quality by WAD CN are unlikely as the TSF would be lined and assumed not to leak.	There is insufficient information to allow assessment of risk and adequacy of the claimed design and performance criteria.	As per Item 72 and 74
99.	4.4.3.2	The section contends that aquifers are low permeability and any seepage loss would be confined by the cone of depression due to dewatering. This assumption is contradicted by section 4.4.4.1 which indicates that only one of the three identified aquifers has low permeability. The regolith and particularly the alluvial aquifers are not low permeability.	The assumption of low permeability and long residence time would underestimate the risk posed by leaks from the TSF. Further the regolith and alluvial aquifers may not be affected by the cone of depression due to the low permeability of the fractured rock aquifer. Hence these aquifers could represent preferential flow paths that would allow leachate of the leaks from the TSF to enter the environment through the groundwater pathway. Further the proponent assesses the risk as negligible as… "*The tailings storage facility would be lined and a seepage collection system constructed*". However, the seepage collection system would only be operated during the operations phase, and so the risk following mine closure has been understated as ingress of recharge to the TSF would increase leachate hydraulic head and volume of leachate stored. The assessment also appears to neglect consideration of the post mine closure groundwater recovery and long term groundwater flow conditions. This knowledge gap hinders the realistic assessment of the long term risk posed by the TSF to the groundwater quality and surrounding environment.	Complete a more detailed and comprehensive risk assessment to characterise all relevant risk dimensions.
100	4.4.3.2	The discussion only focuses on HCN and WAD CN.	CN can form persistent complexes and can mobilise other metals (cadmium and mercury) that can impact the environment. The stability of the CN complexes and other contaminant species is highly dependent on the hydrogeochemical environment in the groundwater system in which they occur. Therefore any attenuated CN complexes and other toxic contaminants could remobilise should there be a change in hydrogeochemical conditions.	As per Item 94
101	4.4.4	The proposed modification to the monitoring program would only include WAD CN and limited free CN.	The proposed monitoring program would not be sufficient to detect leachate leakage from the TSF as CN would not be the only contaminant of concern.	Develop a more comprehensive monitoring program that considers all relevant contaminants of concern.
102	4.5.4.4	As noted previously the measures to limit risk to surface water from CN use need further consideration.	CN use on the site significantly increases the risk profile and the report does not include sufficient detail to allow for an independent assessment of the risk posed by the proposed Modification 3.	Provide more detailed information on the proposed measures, detailed assessment of all relevant risks and redesign as necessary to monitor and manage the risk within stakeholder acceptable bounds.
103	4.5.5	The proposed modification to the monitoring program would only include WAD CN and limited free CN.	The proposed monitoring program would not be sufficient to detect leachate leakage from the TSF as CN would not be the only contaminant of concern.	Develop a more comprehensive monitoring program that considers all relevant contaminants of concern.
104	4.10.2.3	The section does not appear to consider the potential for dust to contain toxic compounds when emitted from the TSF.	Dust emission can cause migration of contaminants into the environment and deposition beyond the area subject to exposure control measures. The risk of this exposure scenario and consequent risk does not appear to have been considered	Complete a risk assessment that considers this risk aspect.
105	4.10.4.2	The section does not appear to consider the risk from HCN emissions.	HCN emissions pose a potential hazard as the gas is toxic. The risk posed by this emission and exposure mechanism does not appear to have been considered.	Complete a risk assessment that considers this risk aspect.
106	4.13	The section only appears to focus on the positive socio-economic benefit. The negative impacts such as increased risk to human health and the environment in the medium and long term in particular or the longer term economic and social impacts of managing the site and TSF in particular do not appear to have been considered.	The assessment appears biased and selective which hinders understanding of the socio-economic impacts of the proposed modification.	Conduct a detailed sustainability analysis that considers all relevant environmental, social and economic factors.
107	5.1.2	The statements appear to contradict earlier sections. This section suggest that detailed plans were developed to manage all risks while earlier sections state that such plans would only be developed after the proposed Modification 3 was approved.	The risk assessment is incomplete and did not appear to consider all relevant risk dimensions and contaminants of concern. Therefore scientific uncertainty remains as neither the risk nor the required management measures are adequately understood.	As per Item 94

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108	5.1.3 and 5.1.5	This assessment does not appear to have adequately considered the long term social and economic effects of the TSF which will be a long term repository of salt and toxic compounds left behind in the tailings. The TSF will eventually erode and leak causing impact on the environment.	The full risk, cost and social burden of the project do not appear to have been adequately defined. This hinders full, transparent and independent review of the overall value proposition of the project.	As per item 74, 94 and 101
109	5.2.2	The justifications provided do not mention the TSF and its long term liability management due to leaks of leachate, erosion and failure.	The justification provided is limited and does not appear to take into account all relevant potential negative impacts that may be associated with implementation, operation, and close and long term stewardship of the operations proposed under Modification 3.	As per item 74, 94 and 101
110	5.2.3	As per Item 101.	As per Item 101.	As per item 74, 94 and 101
111	5.2.4	The section appears to limit the discussion to a take one take all proposition. Bullet point 1 suggest by not allowing cyanide based extraction the resource as currently understood could not be fully utilised.	This suggests that underutilisation would result if use of cyanide is not granted. However, the utilisation is dependent on the modified mine extraction plan and longer operating life. The recovery of the currently known resource would not be dependent on the cyanide use but is simply a factor of physical works.	The full recovery of the resource could still occur by granting a conditional modification that approved the revised ore recovery plan and extended mine life, along with granting approval to develop the eastern waste rock dump. The CIL Plan using cyanide would not be required to achieve full utilisation of the resource as defined at this time.
112	5.2.4	The section suggest that the project has marginal economics even when based on the optimistic analysis utilised, which does not appear to consider the full economic and social aspects and is based on limited consideration for the full capital, operational, management and monitoring cost that would be required to minimise risk to human health and the environment.	The project economics are based on optimistic assumptions and a more detailed and representative economic analysis could suggest the project is not viable under current economic and technological conditions leading to a high degree of risk that the project fails and the community has to wear the full burden of cost for management and mitigation of risks.	As per item 74, 94 and 101
113	6	The reference list suggests that not all relevant Australian Guidance was considered. For example the report makes no reference to: Department of Resources, Energy and Tourism (2008) Cyanide Management – Leading Practice Sustainable Development Program for the Mining Industry	Incomplete referencing to relevant guidance increases the risk of the project not being appropriately designed and implemented and consequently increases potential risk above those for projects designed in accordance with all relevant guidance requirements.	Request that the proponent revise the submission to consider all relevant guidance before submitting the application for the proposed Modification 3.

Attachment C:

Summary of Geochemical Impacts

Table 3: Summary of TSF composition and rffects under approved and proposed modified project

Measure		Flotation Tailings	Concentrated Tailings	Approved Capacity	Modified Capacity	Change	Approved Process			Modified Process			
Contaminant of Concern	**Unit**			**Tonnes**	**Tonnes**	**%**	**Toxic**	**Carcinogen**	**Mobility**	**Toxic**	**Carcinogen**	**Mobility**	**Comment**
Contribution / Volume		90%	10%	900000	1220000								The proposed modification would result in mixing for two types of waste to form an interlayered and mixed waste. The two waste streams should be treated separately.
Silver (Ag)	ppm	0.45	2	0.41	0.74	82%	Yes	No	Low	Yes	No	Moderate	The proposed modification would result in extraction of silver from the ore and deposition into the TSF. The process is likely to increase the mobility of silver and thus increases potential risk tot eh environment.
Aluminium (Al)	ppm	82890	17982	74601.0	93207.0	25%	Yes	No	Low	Yes	No	High	The proposed modification would result in the alteration of the geochemical conditions and increase the solubility and mobility of aluminium. The process is likely to increase the mobility of aluminium and thus increases potential risk tot eh environment.
Arsenic (As)	ppm	2	114	1.8	16.1	795%	Yes	No	Low	Yes	No	High	The ore contains significant As which will be deposited in the TSF. As is toxic and under certain geochemical conditions highly mobile. The proposed modification would deposit a significant mass of arsenic into the TSF which poses a long term risk to the environment.
Boron (B)	ppm	10	110	9.0	24.4	171%	Possible	No	Low	Possible	No	Moderate	The proposed medication could lead to increased mobility.
Barium (Ba)	ppm	334	91	300.6	377.8	26%	Possible	No	Low	Possible	No	Moderate	The proposed medication could lead to increased mobility.
Beryllium (Be)	ppm	2.7	0.45	2.4	3.0	24%	Yes	Yes	Low	Yes	Yes	Moderate	The proposed modification would affect the geochemical conditions that could increase mobility and thus increase risk the environment.
Calcium (Ca)	ppm	34711	3662	31239.9	38559.4	23%	No	No	Moderate	No	No	Moderate	None
Cadmium (Cd)	ppm	0.1	0.35	0.09	0.15	69%	Yes	Possible	Low	Yes	Possible	Moderate	Complexation with CN leading to formation of the highly soluble CdCN complex, which is highly toxic. This would significantly increase the risk to the environment due to the proposed modification.
Chloride (Cl)	ppm	130	200	117	167	43%	No	No	High	No	No	High	None
Cobolt (Co)	ppm	4.1	338	3.7	45.7	1140%	Yes	No	Low	Yes	No	Moderate	The proposed medication could lead to increased mobility.
Chromium (Cr)	ppm	159	655	143.1	254.5	78%	Possible	No	Low	Yes	Yes	High	Oxidation of trivalent chromium to toxic hexavalent chromium in presence of manganese. Hexavalent chromium is toxic and a carcinogen
Copper (Cu)	ppm	48	1611	43.2	249.2	477%	Yes	No	Low	Yes	No	Moderate	The proposed medication will lead to a substantial increase in copper mass stored in the TSF. The proposed modification would likely lead to increased copper mobility, which increases the risk posed to the environment.
Cyanide (CN)	ppm	0.0001	21	0.0001	3.7801	4200022%	Yes	No	High	Yes	No	High	The proposed modification will deposit cyanide into the tailings facility where depending on geochemical conditions CN can cause further heavy metal mobilisation and pose a long term risk to the environment.
Fluoride (F)	ppm	976	237	878	1101	25%	Possible	No	High	Possible	No	High	None
Iron (Fe)	ppm	14800	371650	13320	61592	362%	No	No	Low	No	No	Moderate	The proposed modification increases the mass and mobility of iron present in the TSF. Iron could attenuate or mobilise other heavy metals and thus increase the risk profile posed to the environment.
Mercury (Hg)	ppm	0.1	1.46	0.090	0.288	220%	Yes	Possible	Low	Yes	Possible	Moderate	Complexation with CN and mobilisation. HgCN is a toxic and highly soluble species that depending on geochemical conditions can be persistent, posing a long term risk tot eh environment.
Potassion (K)	ppm	19222	5460	17300	21772	26%	No	No	High	No	No	High	None

Measure		Flotation Tailings	Concentrated Tailings	Approved Capacity	Modified Capacity	Change	Approved Process			Modified Process			
Contaminant of Concern	Unit			Tonnes	Tonnes	%	Toxic	Carcinogen	Mobility	Toxic	Carcinogen	Mobility	Comment
Magnesium (Mg)	ppm	6298	3208	5668	7307	29%	No	No	High	No	No	High	None
Manganese (Mn)	ppm	630	178	567	713	26%	Yes	No	Low	Yes	No	Moderate	Magnesium reduction is known to facilitate chromium oxidation to the more mobile and toxic hexavalent state. The proposed modification could therefore significantly increase the risk tot eh environment.
Molybdenum (Mo)	ppm	25	89	23	38	70%	Possible	No	Low	Possible	No	Moderate	The proposed medication could lead to increased mobility.
Sodium (Na)	ppm	30025	5135	27023	33594	24%	Possible	No	High	Possible	No	High	None
Nickel (Ni)	ppm	125	421	113	189	68%	Possible	No	Low	Yes	No	Moderate	Nickel sulphide is toxic and has low drinking water criteria. The addition of significant amounts of sulphides as proposed under the modification application could increase the risk to the environment.
Phospherous (P)	ppm	712	257	641	813	27%	No	No	High	No	No	High	None
Lead (Pb)	ppm	6	76	5.4	15.9	194%	Yes	No	Low	Yes	No	Moderate	The proposed medication could lead to increased mobility, therefor increasing the risk to the environment.
Sulphur (S)	ppm	260	435600	234.0	53428.7	22733%	No	No	High	No	No	High	The proposed modification result in a significant increase in sulphur stored in the TSF. Sulphide and sulphates have a significant effect on the geochemical environment and consequently could significantly increase the risk posed to the environment.
Antimony (Sb)	ppm	3.8	1.4	3.4	4.3	27%	Yes	No	Low	Yes	No	Moderate	The proposed medication could lead to increased mobility, therefor increasing the risk to the environment.
Selenium (Se)	ppm	0.06	33	0.05	4.09	7478%	Possible	No	Low	Possible	No	Moderate	The proposed medication could lead to increased mobility, therefor increasing the risk to the environment.
Tin (Sn)	ppm	3.3	2.3	3.0	3.9	31%	Yes	No	Low	Yes	No	Moderate	The proposed medication could lead to increased mobility, therefor increasing the risk to the environment.
Strontium (Sr)	ppm	370	36	333	411	23%	No	No	Low	No	No	Moderate	None
Thorium (Th)	ppm	12	16	11	15	40%	Possible	Possible	Low	Possible	Possible	Moderate	None
Uranium (U)	ppm	3.13	3.7	2.8	3.9	38%	Yes	Possible	Low	Yes	Possible	Moderate	None
Vanadium (V)	ppm	88	39	79	101	28%	Yes	No	Low	Yes	No	Moderate	None
Zinc (Zn)	ppm	34	22	31	40	31%	Yes	No	Moderate	Yes	No	High	The proposed medication could lead to increased mobility, therefor increasing the risk to the environment.
													None
Salt (estimated)		191885	847253	172696	314054	82%	No	No	High	No	No	High	The proposed medication could lead to increased mobility, therefor increasing the risk to the environment.