

;2 June 2022

## Technical memorandum

Dear Kate,

The following document outlines the outcome of drone surveys undertaken over identified potential groundwater dependent ecosystems (GDEs) near the Fountain Head Gold Project.

### 1. Background

The Fountain Head Gold Project (FHGP) leases are located on Ban Ban Springs Station, approximately 170 km south of Darwin in the Northern Territory, and approximately 13 km east of the Stuart Highway. Ban Ban Springs Station is an operating cattle station on pastoral lease (PL) 1111. The existing Fountain Head open pit has filled over time with ground water inflows, surface water runoff and rainfall since mining ceased in August 2009. The Project involves recommencing mining of the Fountain Head pit and will include the following activities:

- Dewatering of existing open pit.
- Expansion of existing open pit.
- Construction of crushing facilities and gold processing plant.
- Construction of supporting infrastructure (i.e., workshops, power station, roads, offices etc.).
- Construction and progressive rehabilitation of the integrated waste landform (IWL).
- Construction of surface water management features i.e., sediment and runoff dams and diversions.
- Ongoing dewatering of the evaporation pond.

The pit currently contains approximately 2064 ML of water that will need to be partially removed prior to the expansion of the pit. Expansion of the Fountain Head open pit will be based on conventional drill and blast mining techniques. The expansion will involve a cutback of the existing open pit void, along with an extension to the existing void in a northward direction.

During the environmental impact assessment process, potential groundwater dependent ecosystems (GDEs) were identified to the north of The Project which may be affected by dewatering activities. ERIAS is currently undertaking hydrological modelling that will determine the extent of drawdown associated with dewatering.

## 2. Scope

Aquatic Ecology Services was engaged by ERIAS to characterise the environmental values of identified GDEs near the FHGP. A remote survey via drone was conducted in two areas north of the FHGP that have been identified by ERIAS through the GDE Atlas as potential GDEs. This document outlines the outcome of drone surveys undertaken over identified potential groundwater dependent ecosystems. The study aimed to understand the likelihood that each identified potential GDE was actually dependent of groundwater.

## 3. Study Area

Two potential GDEs have been identified by ERIAS through the GDE Atlas (Kate Sinai, ERIAS *pers comm*): a billabong north-east of the Project Area (high potential aquatic GDE) and an unnamed creek north of the Project Area (low potential terrestrial GDE). Results of a GDE Atlas search are confirmed in Appendix A.

In addition to the two nominated areas for survey, the flight area was extended to identify any additional surface water bodies that may be included in surveys during the late-dry season.

Late-dry season surveys can be used to demonstrate where water remains long after the wet season rain and overland flow has ceased. The initial survey will assist with scoping for future monitoring if required, which would establish the baseline condition of any GDEs affected by drawdown.

## 4. Methods

Using flight automation, drone photogrammetry was completed at two sites identified as potential GDEs. At the Unnamed Creek, the length of the creek identified through the GDE Atlas was photographed, including the riparian fringe. The identified billabong was also flown, including surrounding vegetation.

Orthophotographs were stitched to create orthomosaic imagery, a high-resolution and geographically rectified representation of the prevailing environment at the time of the survey. Automated flight surveys record drone position in three dimensions (latitude, longitude and altitude) when aerial photographs are taken. This means that when future surveys are required, drones can be sent back to the exact location of previous photographs. Photogrammetry records visual data in real time and assist with data interpretation, especially where long-term data sets are used. It is anticipated that imagery from this survey will be compared to a late-dry season survey of the same areas to understand changes to surface water availability and vegetation condition.

Outside of the two areas nominated for survey, the surrounding area was flown for a distance of 2km to look for surface water features that had the potential to persist perennially. Where these were identified, photogrammetry was also completed

In addition to photogrammetry surveys, drones were used to take footage of creeks and fauna accessing water to assist with characterisation.

## 5. Results

Drone surveys were completed in late April 2022. The following sections present the observations made during those surveys. The location of all photos can be found in Appendix B.

### 5.1 Unnamed Creek

Drone surveys were completed on 27<sup>th</sup> April 2022. A total of 4.2km was surveyed by from Ban Ban Springs Road crossing to the Billabong inflow. A section of approximately 200m towards the centre of the unnamed creek was not able to be processed into an orthomosaic layer due to file corruption, and the result of the survey is presented in Figure 1. The creek was characterised by an incised, meandering channel. Standing water was present along the length of the creek in the form of isolated pools, and flow was not observed. The riparian zone of the creek was narrow and discontinuous and was obviously disturbed by cattle grazing and wallowing of livestock (Photo 1).



*Photo 1 – Several wallows and cattle tracks present in the riparian grassland adjacent to the Unnamed Creek*

Riparian vegetation was dominated by an understorey of native and pasture grasses, broad leaf tea-tree (*Melaleuca viridiflora*), ear-pod wattle (*Acacia auriculiformis*) and northern swamp mahogany (*Lophostemon grandiflorus*) with mix of other dry scrub and sclerophyllous shrub species. These species are considered shallow-rooted and would be resilient against drying of surface and pore water (Boland 1990; Skull and Congdon 2008). These tree species can be reliant on overland flow, creek flows and soil saturation during the wet season. Bamboo (*Bambusa arnhemica*) was also common but growing sparsely

on the banks of the unnamed Creek (Photo 2). The species is naturalised in the NT and is associated with the riparian zone of ephemeral creeks, and able to withstand low soil moisture for prolonged periods (Franklin 2004).

Vegetation density was greatest at the eastern end of the creek, close to the inflow of the billabong. There was no notable change in species, although at the downstream (eastern) part of the creek, and vegetation was dominated by broad-leaf tea tree.

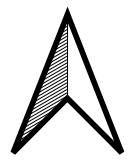
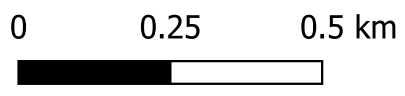


*Photo 2 – Bamboo growing on edges of the Unnamed Creek*

Fish were observed in the standing pool at the Ban Ban Springs Road crossing of the Unnamed Creek in April 2022. Previous sampling by ERIAS (2020) also captured several species of fish at the site that are well suited to migration and occupation of ephemeral creeks during the wet season and can withstand the harsh conditions of dry season standing pools (Pusey *et al.* 2004).



Fountain Head Gold Project Groundwater Dependent Ecosystem Survey  
Figure 1 - Unnamed Creek mapped using drone photogrammetry, April 2022



Base layer imagery source: Google Satellite <https://mt1.google.com/vt/lyrs=y&x={x}&y={y}&z={z}> EPSG:3857 - WGS 84 / Pseudo-Mercator - Projected

## 5.2 Billabong

An area of 33 hectares was surveyed by drone to map the extent of surface water and associated riparian vegetation at the billabong located north-east of the FHGP (Figure 2). The billabong covered approximately 1.3 hectares of the survey area and was divided into two main pools. The two pools were connected by a narrow channel that was flowing slowly from the southern pool to the northern pool. There were two surface water inflows to the billabong, the unnamed creek to the west (surveyed area) and an unnamed creek to the south. A channel on the northern tip of the billabong appeared to head north-east towards the Margaret River. There was no inflow/outflow observable at the time of the survey.

Water in the southern pool was clear and with a mixture of submerged and floating macrophytes and appeared to be around 1-2m deep. The billabong showed signs of being accessed by livestock, and pugging along banks associated with cattle or other hard-hoofed animals was evident (Photo 3). Wallows, cattle pads, and tracks were also observed surrounding the billabong. The Northern pool was turbid, with steeper banks than the southern pool and fringed by floating macrophytes. Due to low water clarity the depth of the northern pool could not be determined, but the wetted banks indicated that the water level had dropped recently by around 0.5m (Photo 4).



*Photo 3 – Cattle tracks (pugging) on banks of the billabong*

Vegetation surrounding the billabong was dominated by broad leaf tea-tree. There were narrow, dense stands of vegetation along the banks of the northern pool (Photo 4), which were taller than the same trees growing along the Unnamed Creek, but vegetation was not continuous around the entirety of the billabong. The composition of riparian vegetation was similar to the Unnamed Creek but did not contain any bamboo. The understorey of the riparian zone was also a mix of pasture grasses and broad areas of bare ground that were potentially covered by surface water until a short time earlier (including the area of bare ground separating the two pools).

As the billabong was inaccessible, fish and other aquatic fauna could not be directly observed from the bank. Besides cattle, several water birds and wallabies were seen accessing the billabong during the drone survey.



*Photo 4 – Riparian vegetation along the northern pool of the billabong*



Fountain Head Gold Project Groundwater Dependent Ecosystem Survey  
Figure 2 - Billabong mapped using drone photogrammetry, April 2022

### 5.3 Additional Identified Areas and Observations

To the north-east of the billabong a channel and wetland area that appeared to be fed by outflow from the billabong was observed. At the time of the survey there was no discernible flow from the billabong, but the channel was incised, indicating flow occurs in the wet season. The channel was a series of isolated pools at the time of the survey and appeared to be drying rapidly. The channel was largely surrounded by grass, with only a small number of trees along the edges. Water was observed flowing north of the wetland but was not in a defined channel and appeared to be overland flow into a dense forest. Vegetation surrounding and within the wetland was a mixture of pasture grasses and broad leaf tea tree. Sedges were also present, but could not be identified. Cattle and buffalo were observed along edges of the wetland and in the surrounding vegetation. Cattle tracks were common along the channel and surrounding the wetland.

Due to drone flying guidelines (maintaining line of sight), water could not be followed further north.



*Photo 5 – Channel leading north from billabong*



*Photo 6 – Channel north of billabong leading to wetland area, overland flow north of wetland*

## 6. Conclusions and Recommendations

### 6.1 Unnamed Creek

The survey timing suggests that surface water observed in the Unnamed Creek is the result of wet season rainfall, rather than groundwater baseflows. The lack of surface water flows does not necessarily discount the presence of groundwater baseflows, as these may be present as subsurface flow connecting pools. However, the riparian vegetation observed does not give a strong indication that pore water is perennially present within the root zone of the vegetation. The Unnamed Creek is unlikely to be a terrestrial GDE and its “low potential” as mapped in the GDE Atlas appears to be correct.

It should be noted that the shallow-rooted nature of the vegetation that is present has the potential to be impacted by drawdown that alters availability of alluvial groundwater. Further surveys would be required if drawdown modelling suggests the unnamed creek would be impacted by dewatering at FHGP. A follow-up survey in the late dry season to establish surface and sub-surface water availability including leaf-water potential is required to accurately define the Unnamed Creek as a GDE, but this appears unlikely.

### 6.2 Billabong

The height and density of vegetation surrounding the billabong, along with aquatic vegetation indicates that soil moisture is present for longer than in creeks and is likely to be permanent. The low-lying area in which the billabong is situated indicates that soil is likely to stay saturated by rainfall for a long period of time following the wet season, and may be resulting in slow, subsurface water flow to the billabong, maintaining its surface water height. Water accumulated in the billabong at the time of the survey was likely to be from creek inflows, but appears to be deeper than creeks and may intersect an alluvial aquifer. The intersection of an alluvial aquifer, or groundwater baseflow from the Unnamed Creek would maintain surface water in the billabong and classify the water body as a GDE.

The timing of this survey in the early dry season makes a clear determination of water permanency and its origin difficult. The GDE Atlas determined the billabong as a high potential aquatic GDE, which appears to be correct and could be confirmed through a follow-up drone survey and analysis of surface water remaining later in the dry season. Should water permanency be confirmed, the billabong would be an important refugial area for aquatic species, particularly when below average wet season rainfall occurs.

### 6.3 Northern channel and wetland

Surface water present to the north overflows from the billabong, but was not flowing by the early dry season. It is considered unlikely that surface water present north of the billabong is permanent, and is likely the result of overflow of surface water flows during the wet season that are receding. Should the surface water in the billabong be permanent, water flowing to the downstream wetland and channel to the north should be investigated further. A late dry season survey of the billabong will determine if water is present to the north and if billabong outflow or subsurface connection occurs. Analysis of surface water (if) present to the north would determine if there is connectivity from the billabong.

## 7. References

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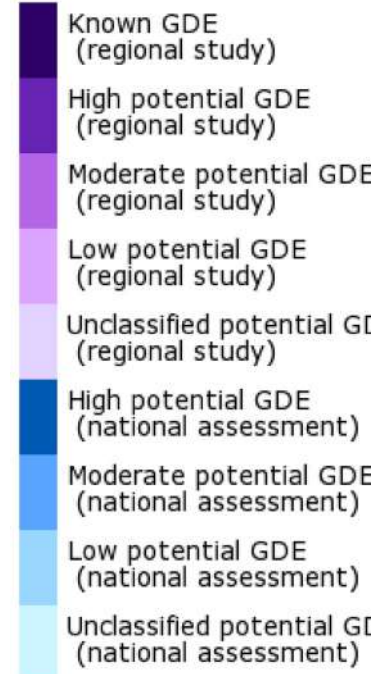
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## Appendix A. GDE Atlas Search Results



## Aquatic GDE



World Imagery

Low Resolution 15m Imagery

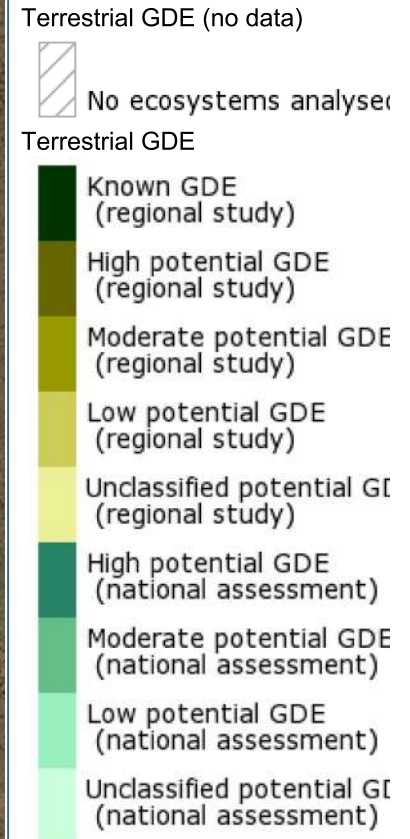


Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: [Click here](#)

Australian Albers GDA94

Date: 16 April, 2022





Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: [Click here](#)

Australian Albers GDA94



## Appendix B. Photo Locations



Photo 6

Photo 5

Photo 4  
Photo 3

Photo 2

Photo 1