Subterranean Ecology

Scientific Environmental Services

Goldsworthy Iron Ore Mining Operations
Cundaline and Callawa Mining Operations
Stygofauna Assessment

Prepared for *BHP Billiton Iron Ore*

October 2008

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Stygofauna Assessment

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Project No. 61

Prepared for BHP Billiton Iron Ore

Prepared by: Subterranean Ecology

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COVER: Syncarid crustacean (Parabathynellidae sp.) from Callawa groundwaters. Body length approximately 1.5 mm. Photo Kate Muirhead. Copyright Subterranean Ecology Pty Ltd.

LIMITATIONS: This survey was limited to the requirements specified by the client and the extent of information made available to the consultant at the time of undertaking the work. Determination of pit and out-of-pit sites was based on information provided by BHP Billiton Iron Ore. Information not made available to this study, or which subsequently becomes available may alter the conclusions made herein.

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EXECUTIVE SUMMARY

BHP Billiton Iron Ore Pty Ltd (BHPBIO) operates the Goldsworthy Iron Ore Mining Operations which are located approximately 200 kilometres (km) east of Port Hedland in the north of the Pilbara Region of Western Australia .

BHPBIO is planning on extending the mine life of Goldsworthy Iron Ore Mining Operations by mining the Callawa and Cundaline Deposits.

This report documents the results of a stygofauna survey conducted between December 2007 and April 2008. It also assesses the potential impacts of the planned Callawa and Cundaline satellite mining operations on the groundwater fauna.

Principle findings and context were:

- Callawa and Cundaline deposits occur on discrete elevated ridge systems composed of Nimingarra Iron Formation within the De Grey River catchment. The ridge systems are separated from each other by Eel Creek which forms an alluvial valley approximately 1 km wide.
- The sampling effort for this survey comprised 89 sample events from 60 holes involving three separate rounds of sampling.
- All holes that could be found which contained water were sampled, but the number of samples that could be obtained was limited by the number of holes that intersected water, especially at Cundaline Ridge where there were few holes containing water. Considering the limitations of survey, the sampling effort is considered adequate to enable an assessment of stygofauna in relation to the planned Callawa and Cundaline mining operations.
- No stygofauna were detected in the bores sampled on the Cundaline Ridge. This may be a consequence of limited groundwater habitat intersected at the depths of drilled bores in this location. The apparent absence at Cundaline Ridge is consistent with the apparent absence of stygofauna on nearby Nimingarra and Sunrise Hill deposits which have been sampled repeatedly over several years from 2005 to 2007 by Biota and more recently by Subterranean Ecology. The results suggest that stygofauna may not be present in the more north-western ranges of the Goldsworthy mining area, which are located at a further distance from the De Grey River than Callawa and Yarrie ridges.
- At Callawa Ridge, five morpho-species of stygofauna were detected, including one worm (Phreodrilidae sp. 1), and four crustaceans: Paramelitidae sp. 1, *Metacyclops* sp. 1 (Copepoda), Bathynellidae sp. 1 and Parabathynellidae sp. 1 (Syncarida). Morphological evidence suggests that four of these species have distributions recorded outside of the proposed pit at Callawa Ridge, including three species collected on a nearby Yarrie Ridge.
- *Metacyclops* n. sp. 1 has, to date, only been collected from one bore located inside the proposed pit at Callawa Ridge. However, the same putative morpho-species has also been collected from Quarry 8 located

approximately 215 km south-west of Yarrie Mine. As a result and for present purposes, the two widely separate records suggest that the conservation status of *Metacyclops* n. sp. 1 is not necessarily dependent on its occurrence inside the proposed pit on Callawa ridge.

- Study of potential hydrogeological impacts of the proposed mining conducted by Aquaterra indicates that mining at the Cundaline deposit will not penetrate the natural groundwater table and no dewatering will be required. In the case of Callawa deposit, Aquaterra concludes that mining will intercept the natural groundwater table and dewatering will be required. Aquaterra anticipates that the impact of dewatering will extend to a distance of less than 500 metres from the pits, but backfilling of pits is likely to result in the water table recovering to pre-mining levels.
- The other members of the stygofauna community at Callawa have been collected outside of the proposed pit. Although some members of the community may have only been collected, to date, from within the predicted zone of dewatering influence (after Aquaterra 2008), the conservation risk to the Callawa Ridge stygofauna community is likely to be low given: (1) the probable wider distribution of the community throughout the Callawa Ridge aquifer; (2) the localised zone of dewatering influence (< 500 m) in relation to the wider extent of the Callawa Ridge aquifer (after Aquaterra 2008); (3) the short mine life with backfilling of pits to above the watertable, and predicted recovery of water levels and water quality after cessation of mining (Aquaterra 2008); (4) operational experience at Yarrie Pit demonstrating localised zone of dewatering influence (Aquaterra 2008) and persistence of the stygofauna community in the Yarrie Ridge aquifer after cessation of mining.
- The diversity, distributions and conservation status of stygofauna in the Pilbara is a new field of knowledge which is building slowly, as a result of surveys and studies associated with mining and other developments. On present knowledge the five morpho-species collected at Callawa have distributions which extend beyond the proposed pits.
- Within its limitations, the survey did not demonstrate any conservation issue for stygofauna associated with mining the Cundaline or Callawa deposits as proposed.

1 INTRODUCTION

BHP Billiton Iron Ore Pty Ltd (BHPBIO) operates the Goldsworthy Iron Ore Mining Operations (herein referred to as the Goldsworthy Operations) which are located approximately 200 kilometres (km) east of Port Hedland in the north of the Pilbara Region of Western Australia (Figure 1).

The iron ore deposits in this area have been progressively mined since the mid 1960's. Current mining operations are centred at Yarrie, with some mining still taking place at the Nimingarra, Cattle Gorge and Sunrise Hill deposits (Figure 2).

The approved mining areas at Goldsworthy are drawing towards the end of their mine life. However, BHPBIO has identified approximately 9.6 million tonnes of additional iron ore at the planned Callawa and Cundaline mining operations that would enable it to extend the mine life by up to five years (Figures 3 and 4). Mining at the Cundaline and Callawa deposits would use conventional open pit mining methods.

Aquaterra (2008) has conducted a groundwater assessment for the planned Callawa and Cundaline mining operations. The hydrological investigations indicate that the local water table in vicinity of the Cundaline deposit occurs at between 120 and 140 metres (m) AHD (Australian Height Datum). The proposed Cundaline pits would not extend below the watertable (ie. the deepest of the proposed pits extends to 150 m AHD).

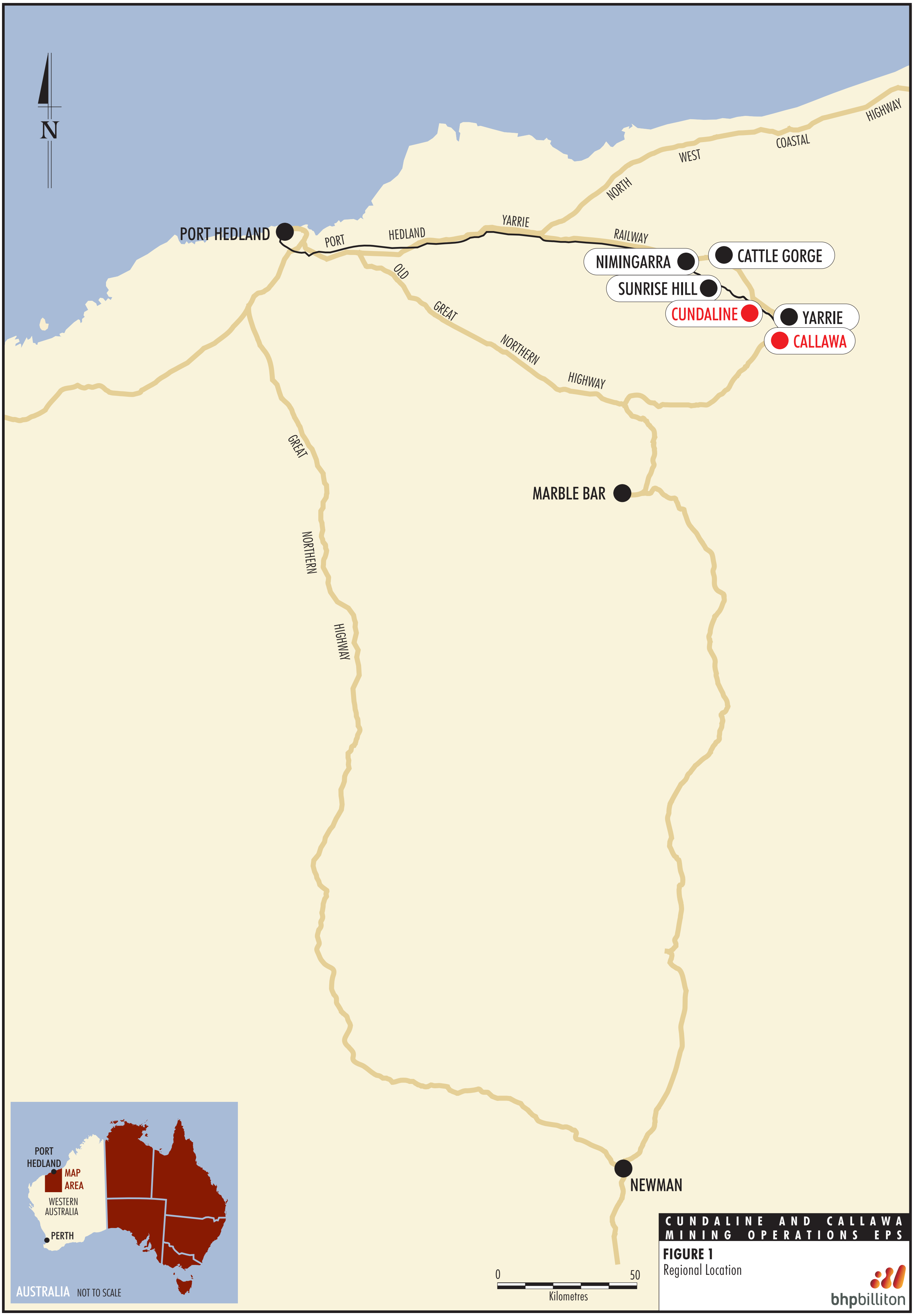
The local water table in the vicinity of the Callawa deposit occurs between 163 and 227 m AHD. The proposed pits would extend up to 50 m below the water table, which will necessitate some mine dewatering to enable mining of the lower benches.

This report documents the results of a stygofauna survey conducted from December 2007 to April 2008 at Callawa and Cundaline ridges.

The objectives of this survey were to:

1. Document the stygofauna morphospecies[1] and communities present within the proposed mine pits at Callawa and Cundaline ridges, and surrounding out-of-pit zones located outside of the proposed mine pits.
2. Assess the conservation status of morpho-species in relation to the proposed pits and mine layout at the planned Callawa and Cundaline mining operations.
3. Assess the potential impacts from mining below the water table for the planned Callawa mining operation.

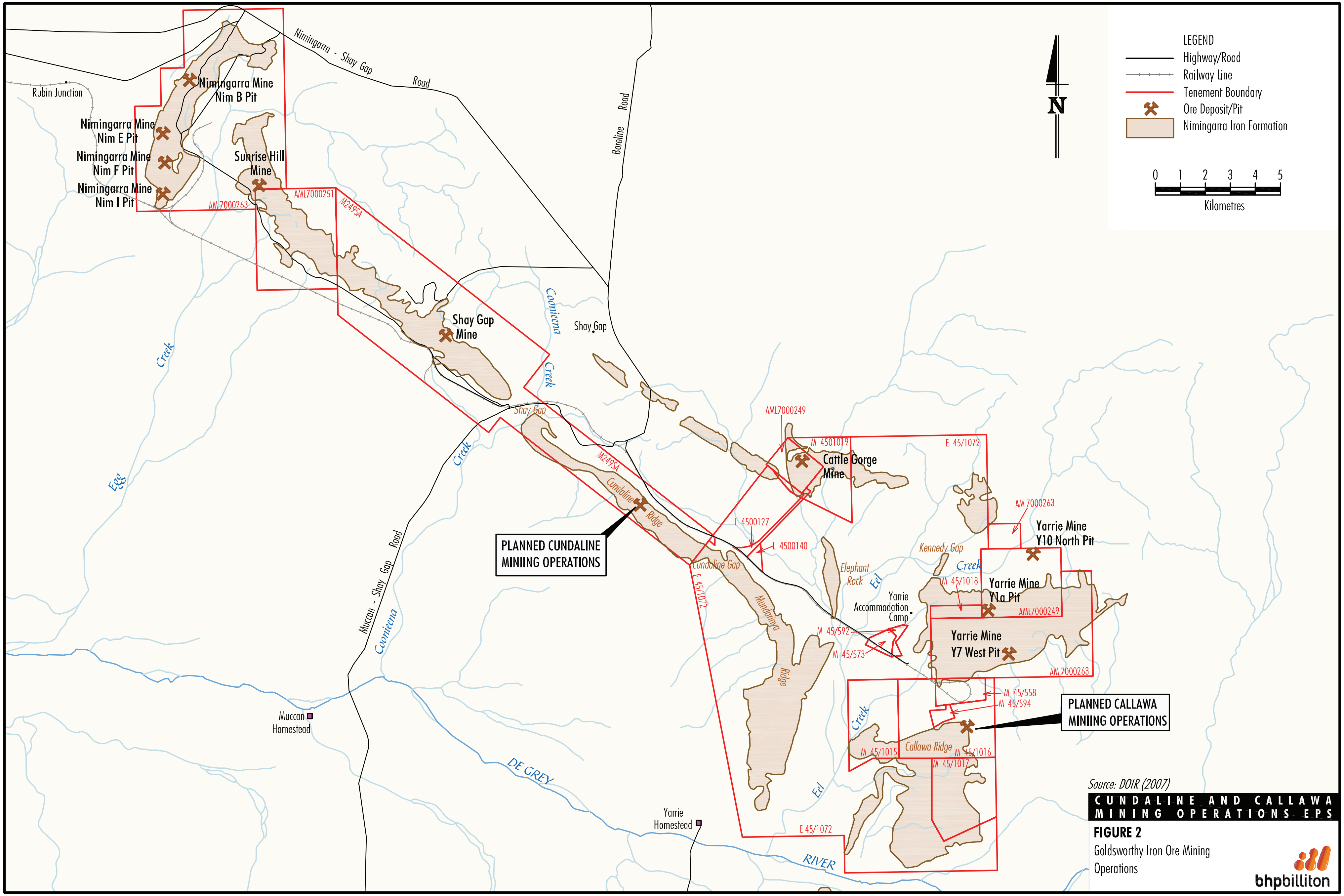
[1] Morphospecies are a group of biological organisms that differs in some morphological respect from all other groups.



CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 1
Regional Location

BHP-07-16 BS Stygo_001C



Source: DOIR (2007)

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 2
Goldsworthy Iron Ore Mining Operations

bhpbilliton

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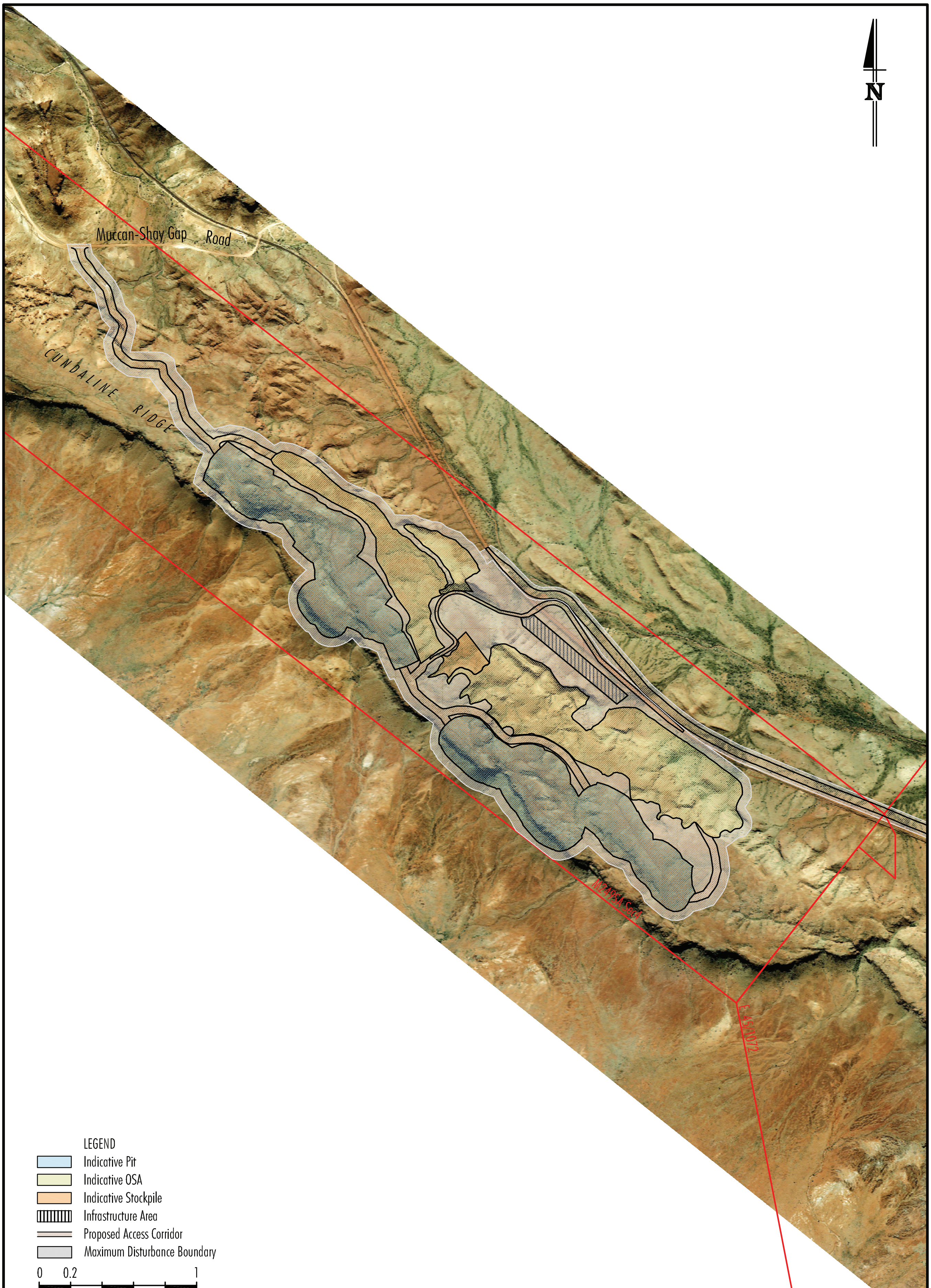

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 3

Planned Cundaline Mining Operations Conceptual General Arrangement

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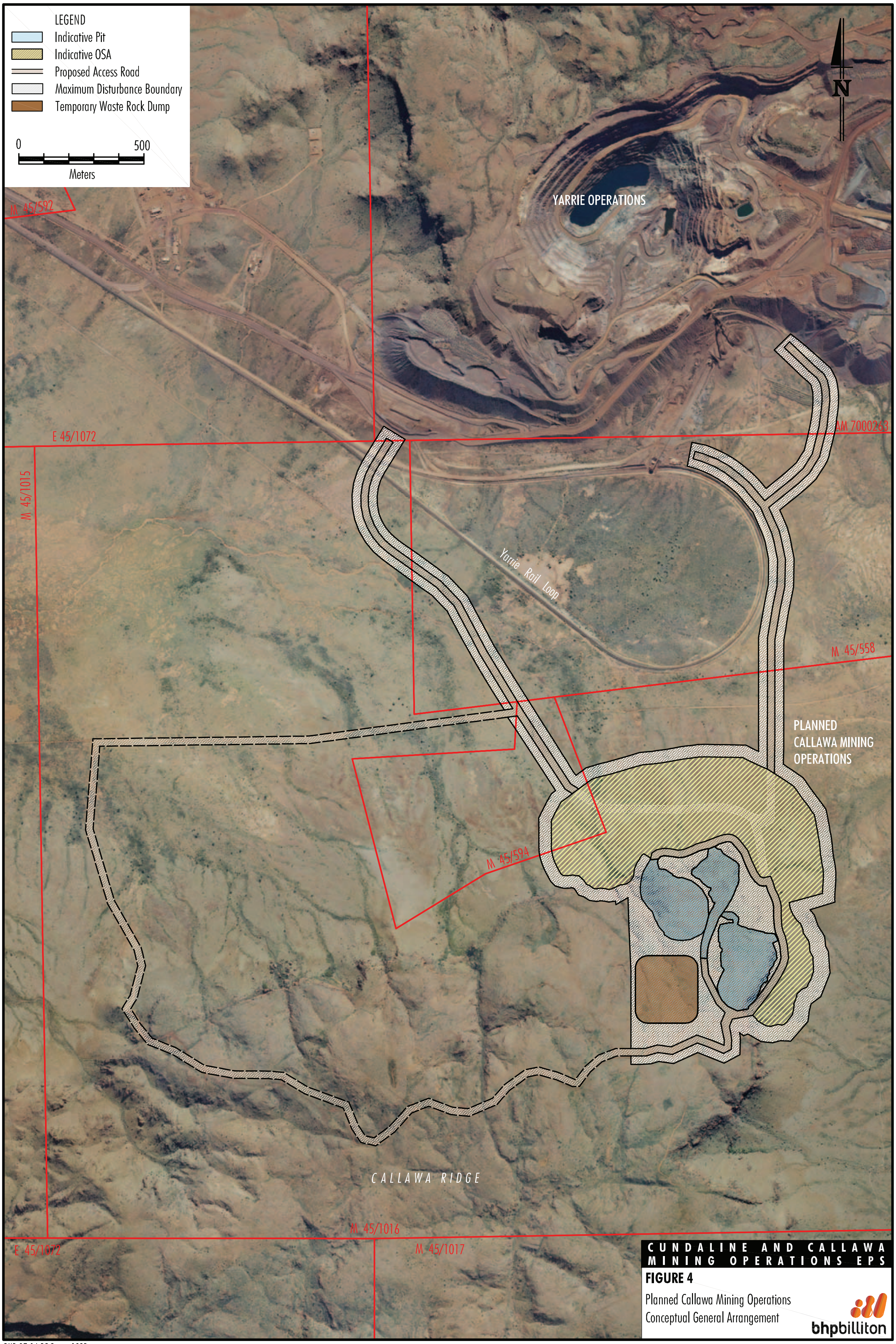


CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 4

Planned Callawa Mining Operations Conceptual General Arrangement

bhpbilliton

BHP-07-16 BS Stygo_103D

1.1 Stygofauna

The term stygofauna refers to aquatic subterranean fauna. In relation to subterranean fauna and short range endemism the EPA supplementary Guidance Statement 54a (EPA, 2007) states:

"Subterranean fauna are an important issue in EIA because a high proportion of subterranean species have geographically restricted ranges. It is also becoming apparent that subterranean habitats contain far more species than previously recognized and, in fact, contain a significant proportion of global biodiversity (Gibert & Deharveng, 2002)."

"While many of the species occupying shallow groundwater are widespread (Halse et al., 2002), and the same is probably true of many terrestrial species in shallow subterranean habitats, species that occupy deeper subterranean habitats and never come to the surface tend to have localized distributions and to be short range endemics. Harvey (2002) defined short range endemism as having a range < 10,000 km^2, while Eberhard et al. (2007) suggested < 1000 km^2 constitutes a more appropriate range criterion. Ranges are difficult to determine precisely, however, and the characteristic that makes short range endemics vulnerable to extinction is being confined to highly restricted habitats or individual geological features. Examples of such vulnerable fauna are troglofauna in Channel Iron Deposit in mesas of the Pilbara and stygofaunal beetles."

1.2 Regional Location

The Goldsworthy operations are located within the catchment of the De Grey River. The De Grey River represents the most northern river system in the Pilbara before the expanse of the Great Sandy Desert begins (Figure 1).

1.3 Local Topography and Proposed Mine Layout

Both the Callawa and Cundaline deposits occur in elevated range-like landforms rising about 150 m above the surrounding plains. The ranges are composed of Archaean age Nimingarra Iron Formation and the surrounding lowland plains and creek drainages contain Quaternary alluvium. The Callawa Ridge is a block-shaped landform of about 5 km x 4.8 km and comprises an area of around 1,800 hectares (ha) (Figures 2 and 4). The Cundaline Ridge is a narrow and elongated ridge-like landform that joins Mundarmya Ridge to form an arc over 20 km long with a maximum width of approximately 3 km and covers an area of around 2,100 ha (Figures 2 and 3). The Callawa Ridge is 1 km to the east of the most southern point of the Cundaline-Mundarmya range. Separating the two ranges is Eel Creek, which forms an alluvial valley. The distance between the proposed pit areas on Callawa Ridge and Cundaline Ridge is approximately 13 km.

1.4 Local Geology and Groundwater

A review of the local geology was undertaken by BHPBIO to assist with the characterisation of the troglofauna habitat (Attachment 1).

In summary, the Cundaline and Callawa deposits occur in the steeply dipping Nimingarra Iron Formation of the Gorge Creek Group. The formation forms a prominent, generally south-east trending ridge extending from Nimingarra through to the Callawa Ridge (Attachment 1). Basalts of the Coonieena Formation and granitoids of the Muccan Granitoid complex occur on either side of the ridges. Faulting occurs throughout the ridges, with east to west trending faults offsetting the strata. Dolerite sills are located in the northern sections of the deposits (Attachment 1).

The Cundaline deposit comprises a series of narrow lode-style orebodies over a strike length of approximately 9 km. There are four small lode deposits contained within the Lower and Middle Banded Iron Formation (BIF) units of the Nimingarra Iron Formation, which dips steeply to the north-east. Several localised faults are noted throughout the deposits with a variety of orientations which offset stratigraphy and associated mineralisation. Examination of bore logs and geological mapping suggests there are minor variations between the composition and structure of the strata along strike, due to depositional variations and faulting and folding. However, these differences are minor, with the main variation being the depth of mineralisation and the extent of hardcap development (Attachment 1).

The Callawa deposit contains only one identified lode ore deposit on the north-east corner. This deposit is situated in the Lower or Middle member of the Nimingarra Iron Formation which dips shallowly to the west. This deposit contains post-mineralisation dolerite dykes that cross-cut the mineralisation but have little offset. There are no other structural disruptions throughout the deposit to indicate faulting (Attachment 1).

As previously described in Section 1.1, Aquaterra (2008) has investigated the hydrology associated with the Cundaline and Callawa deposits. A summary of the key findings are provided below.

Water level information for the Cundaline ridge obtained from recent mineral exploration drilling indicates that water levels range from approximately 118 m AHD to approximately 141 m AHD. This information indicates that mining at the Cundaline deposit will not go below the natural water table and no dewatering would be required (Aquaterra, 2008).

Water level information for the Callawa ridge indicates that the groundwater levels range from approximately 163 m AHD to approximately 227 m AHD. This information indicates that all three of the planned pits at Callawa would be mined below the water table (Figure 4) (Aquaterra, 2008).

Dewatering for mining of the Callawa deposit is not expected to impact on regional groundwater levels beneath the plain adjacent to the mined ridge (Aquaterra, 2008).

Backfilling of the Callawa pits is likely to result in the water table recovering to pre-mining levels. That is, there will be no impact on groundwater flows or quality once mining (dewatering) has been completed (Aquaterra, 2008).

Review of the existing Goldsworthy borefields (both dewatering and water supply) concluded that there have been no significant impacts observed on regional groundwater levels or surface water/groundwater quality as a result of dewatering or dewatering discharge to date (Aquaterra, 2008).

1.5 Previous Subterranean Faunal Studies

Surveys of the Pilbara by the Western Australia Department of Environment and Conservation (DEC) and Western Australian Museum have revealed the Pilbara as one of the world's biodiversity hotspots for stygofauna (Eberhard *et al*. 2005; Humphreys 2000, 2001). In the Pilbara, stygofauna occupy groundwater across a diverse range of geologic/geomorphic settings, including karstic carbonate rocks, fractured rock aquifers, and porous unconsolidated sediments (e.g. alluvium). They may be found in deep groundwater habitats tens to hundreds of metres below the surface, in addition to shallow groundwater habitats including springs and spring-brooks where groundwater discharges to the surface, and may also inhabit hyporheic and parafluvial settings (saturated sediments beneath and alongside surface water courses) (Eberhard et al. 2005). Important habitat requirements for stygofauna are the presence of permanent groundwater in association with secondary porosity within the inundated geological formation. Stygofauna are found in oxygenated groundwater ranging from fresh to brackish, but they may occur in salinities up to seawater (Humphreys 1999).

No previous sampling of stygofauna has been done at Callawa or Cundaline ridges. However, a stygofauna survey within the Goldsworthy operations area as part of the BHPBIO Regional stygofauna monitoring between 2005 and 2007 (Biota 2008) sampled bores at Nimingara A, B, 1, Sunrise Hill, Shay Gap and Yarrie Ridge. Only one stygofauna group (Bathynellacea) was detected from two bores in the south-eastern part of Goldsworthy operations in the vicinity of the inactive Yarrie pit (Biota 2008). Water parameters measured for each site were comparable among the areas and did not provide an explanation of the apparent absence of stygofauna in the north-western region of Goldsworthy operations.

The Ord Ranges are relatively close to Goldsworthy operations (approximately 110 km to the west) and are also situated in the Nimingarra Iron Formation within the De Grey River Basin. Hancock *et al.* (2007) found a relatively diverse stygofauna community in the Ord Ranges.

BHPBIO is conducting a regional subterranean fauna sampling program on its tenements in the Pilbara. The program has so far included sampling at:

- Area C, located approximately 300 km south of Callawa and Cundaline ridges.
- Orebody 18, 23, 24, and 25 located approximately 330 km south of Callawa and Cundaline ridges.
- Opthalmia Dam, located approximately 330 km south of Callawa and Cundaline ridges.
- Quarry 8, located approximately 95 km north of Area C.
- Yandi-Marillana Creek, located approximately 30 km north of Area C.

- Boundary Ridge, located approximately 15 km west of Area C.

The stygofauna results from the numerous BHPBIO survey projects are variable with little or no stygofauna detected (e.g. Jimblebar [Biota 2008] and Mining Area C [Biota 2008; Subterranean Ecology 2008b]) to relatively diverse stygal communities in other areas (e.g. Marillana, Orebody 23/25 and Opthalmia Dam [Biota 2008], and Quarry 8 [Subterranean Ecology 2008c]). Numerous other areas were found to possess intermediate levels of stygofauna diversity (e.g. Whaleback, [Biota 2008], Boundary Ridge [Subterranean Ecology unpublished data]).

2 METHODOLOGY

The sampling methods used for the survey of stygofauna at Goldsworthy operations were consistent with the Western Australia Environmental Protection Authority (EPA) Guidance Statement No. 54 and 54A (EPA 2003, 2007) and the Department of Environment and Conservation Pilbara Regional Stygofauna Survey (Eberhard *et al.* 2004).

2.1 Sampling Approach

Stygofauna sampling was undertaken in bores within the Callawa and Cundaline ranges, and surrounding areas (Figure 5). The number of samples outside of the planned pit area was constrained by the occurrence of relatively few bores outside the proposed mine pits because the bores are drilled to define the area of iron ore that is economically viable to recover and rarely extend far beyond the pit. This is a general problem with sampling at most mine sites. In addition, for this survey, many holes drilled did not intersect water, thereby further limiting the number of holes available. Groundwater levels were recorded and are provided in Attachment 2.

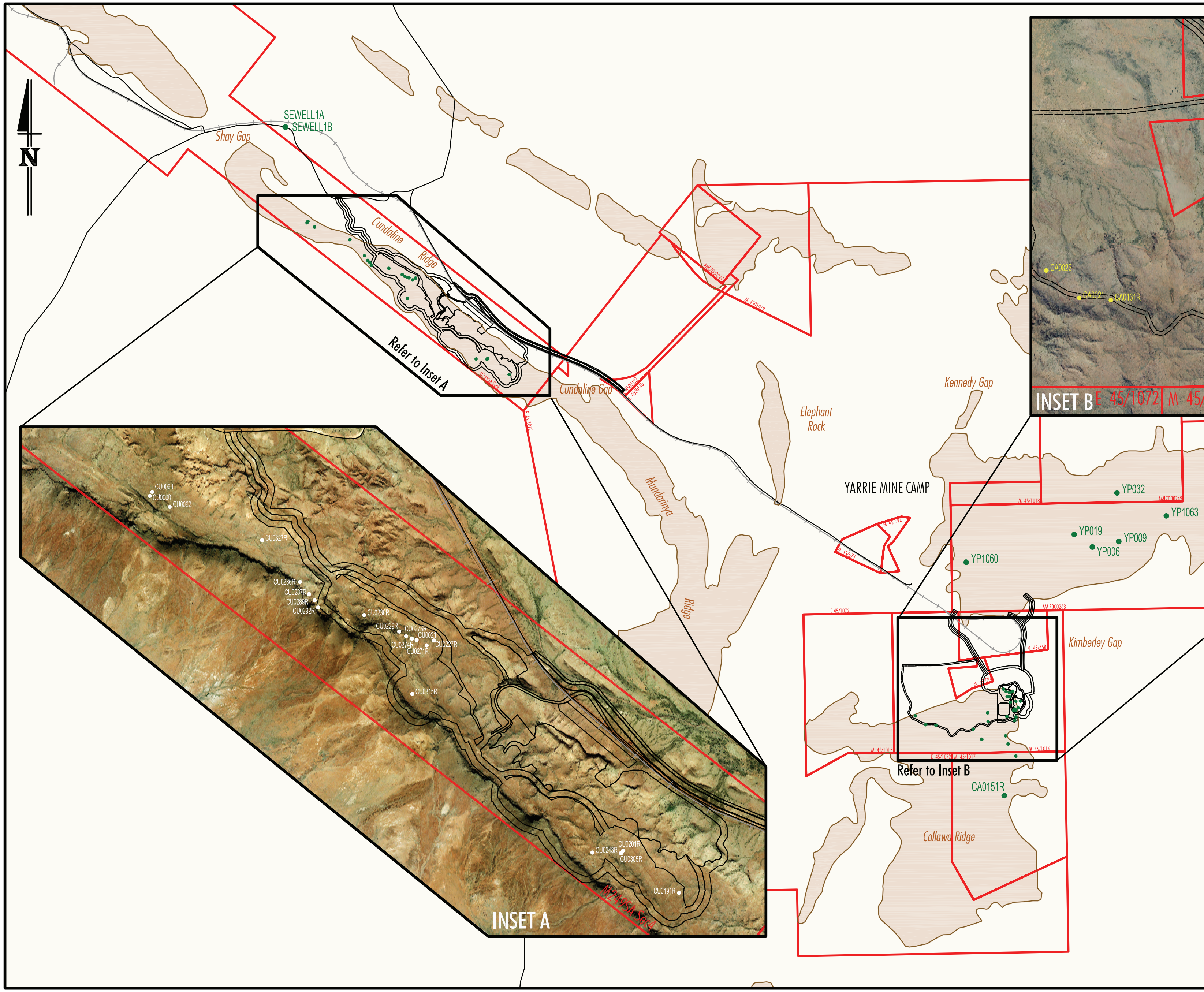
Holes that were not within the respective pit areas were classified as Callawa out-of-pit and Cundaline out-of-pit bores.

2.2 Sampling Effort

The total sampling effort conducted from December 2007 to April 2008 consisted of 89 sample events from 60 holes involving three rounds of sampling (December 2007, February 2008 and April 2008) (Table 1 and Attachment 3).

Overall, 35 samples were collected from inside proposed pits and 44 were collected from outside the proposed pits. On Callawa Ridge, 17 samples were obtained from inside the proposed pit shell and 31 out-of-pit samples were obtained from outside the pit (Table 1 and Attachment 3). On Cundaline Ridge most holes did not have water so there were few suitable holes available for stygofauna sampling, but 18 samples were obtained from inside the proposed pit shells and 13 samples were collected from outside the pit (Table 1 and Attachment 3).

To increase the out-of-pit survey effort, additional bores outside of Callawa and Cundaline ridges, but within Goldsworthy operations, were sampled. These sites were Salt Well, Shay Gap, and Yarrie Ridge (Figure 5). All the sites sampled at Callawa and Cundaline ridges for each round are listed in Attachment 3.



CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 5

Sygofauna Sampling Sites

BHP-07-16 BS Stygo_101D

Table 1: Stygofauna Sampling Effort

		Number of holes sampled	Number of samples taken
CALLAWA RIDGE	PIT	14	17
	OUT-OF-PIT	14	31
CUNDALINE RIDGE	PIT	12	18
	OUT-OF-PIT	10	13
ADDITIONAL SITES	YARRIE RIDGE	7	7
	SALT WELL	1	1
	SHAY GAP	2	2
	Total number	**60**	**89**

2.3 Sampling Method

Suitable boreholes were sampled for stygofauna using a plankton net of an appropriate diameter (45 millimetres [mm] to 300 mm) to match the bore/well size. The net (125 micrometres [µm] mesh), with a weighted vial attached, was lowered into the bore and then hauled up through the water column. Each bore was sampled with six hauls prior to the haul sample being transferred to a labelled vial and preserved in 100% alcohol. Samples with large quantities of sediment were elutriated prior to preservation. To minimise the possibility of faunal contamination between sites, the nets were thoroughly rinsed in water and air-dried. Between sample areas the nets were treated with Decon 90 solution.

2.4 Sample Sorting and Species Identification

All invertebrates collected were sorted and identified under a dissecting microscope using relevant available taxonomic resources. All specimens of each morpho-species were assigned a separate labelled vial and specimen tracking code. All associated and relevant morpho-species data and site data were recorded and analysed in an Excel spreadsheet.

Material was identified by Mr N. Stevens, Dr Stefan Eberhard, D. Cale and Dr T. Moulds. When necessary, identifications were confirmed by the specialist taxonomist Dr T. Karanovic (University of Tasmania) (Copepoda). At the conclusion of the study, most specimens will be lodged at the Western Australian Museum. Subterranean Ecology will retain a voucher collection for future reference purposes.

2.5 Water Quality and Depth to Water

Water samples were collected with a bailer prior to stygofauna net hauling, and water quality parameters (temperature, conductivity, pH) measured in the field with TPS 90FLMV water quality meter.

Depth to water in bores was estimated in the field by counting the number of revolutions of the line reel during net hauling. The number of revolutions was then multiplied by 0.63, the calculated average circumference of the line on the reel (i.e. $2\pi r$ where r [radius] was averaged as 0.1 m).

3 RESULTS

3.1 Species Richness, Abundance and Distribution

No stygofauna were collected from Cundaline Ridge or the Shay Gap Borefield, but stygofauna were detected at Callawa Ridge, Yarrie Ridge, and Salt Well, comprising a total of twelve species (Table 2 and Attachment 4). At Callawa Ridge, five morpho-species of stygofauna were detected, including one worm (Phreodrilidae sp. 1), and four crustaceans: Parabathynellidae sp. 1 (Syncarida) (Plate 1), Bathynellidae sp. 1 (Plate 2), Paramelitidae sp. 1 (Plate 3) and *Metacyclops* n. sp.1 (Copepoda). Morphological evidence suggests that four of these species have distributions recorded outside of the proposed pit at Callawa Ridge, including three species collected on a nearby ridge at Yarrie Mine.

Metacyclops n. sp. 1 has, to date, only been collected from one bore located inside the proposed pit at Callawa Ridge. However, the same putative morpho-species has also been collected from Quarry 8 located approximately 215 km south-west of Yarrie (Subterranean Ecology 2008c).

The Salt Well out-of-pit site yielded seven taxa, which was the highest number of species collected from any one site sampled. Six of the seven species found in the Salt Well out-of-pit site were not collected from any of the other sites, with the exception of Paramelitidae sp. 2, which was also found at the Yarrie Ridge site (Tables 2 and 3; Attachment 4).

Table 2: List of Stygofauna Taxa Found with the Number of Specimens Collected Accompanied by the Number of Samples Taken (>1 and in parenthesis)

Higher taxonomic level		Taxa	Callawa Ridge		Yarrie Ridge	
			Pit	Out-of-pit	Pit	Salt Well
Amphipoda	Crangonyctoid	Paramelitidae SP01	80 (2)	3 (2)	-	-
		Paramelitidae SP02	-	-	1	26 (2)
Copepoda	Cyclopoida					
	Cyclopidae	*Diacyclops scanloni*, Karanovic	-	-	-	65
		Metacyclops SP01	36	-	-	-
	Harpacticoida					
	Ectinosomatidae	*Rangabradya* SP01, n.sp.	-	-	-	4
	Ameiridae	*Stygonitocrella trispinosa*, Karanovic	-	-	-	3
	Parastenocarididae	*Parastenocaris jane*, Karanovic	-	-	-	2
	Canthocamptidae	*Elaphoidella humphreysi*, Karanovic	-	-	-	9 (2)
Syncarida	Bathynellacea	Bathynellidae SP01	1,181(9)	524 (12)	25	-
		Parabathynellidae: *? Notobathynella* SP01	201 (3)	282 (4)	110	-
Isopoda		Microcerberidae SP01	-	-	-	1
Oligochaeta	Microdrili	Phreodrilidae SP01	9	1	28	-
		Enchytraeidae SP01	-	-	1	-
Stygofauna taxon total		***13***	***5***	***4***	***5***	***7***

Note: Shaded taxa are known from out-of-pit sites.

Photo Kate Muirhead. Copyright Subterranean Ecology Pty Ltd.
Body length approximately 1.5 mm.
Plate 1. Syncarid crustacean (Parabathynellidae sp.) from Callawa groundwaters.

Photo Kate Muirhead. Copyright Subterranean Ecology Pty Ltd.
Plate 2. Syncarid crustacean (Bathynellidae: ? *Notobathynella* sp.) from Callawa groundwaters.

Photo Kate Muirhead. Copyright Subterranean Ecology Pty Ltd.
Plate 3. Amphipod crustacean (Parameltidae sp.) from Callawa groundwaters.

Table 3: Number of Stygofauna Taxa Shared Among Sites.

		Callawa Ridge		Additional Sites	
		Pit	Out-of-pit	Yarrie Ridge	Salt Well
Callawa Ridge	Pit	**-**	4	3	0
	Out-of-pit	4	-	3	0
Additional Sites	Yarrie Ridge	3	3	**-**	1
	Salt Well	0	0	1	**-**

Note: Numbers of species confined to only one site are in bold.

3.2 Water Physio-chemistry

There were only minor variations in water temperature and pH measured between Callawa and Cundaline ridges during both sample periods (Table 4). Ranges for both parameters broadly overlapped between areas for each sample round. Conductivity did not vary much within each area between sample rounds, although there were fewer samples taken for Cundaline Ridge in April compared to February (Table 4). However, on average, sites within Callawa Ridge had lower levels of conductivity than sites at Cundaline Ridge where the maximum value was nearly four times greater than the maximum at Callawa Ridge. The water quality values measured at Yarrie Mine in (April 2008 also fell within the ranges measured at Callawa and Cundaline ridges (Table 4).

Table 4: Water Quality Parameters Measured During February and April Sample Periods

	Temp (°C)		Conductivity (µS/cm)		pH	
	February	April	February	April	February	April
CALLAWA RIDGE	n=21	n=20	n=21	n=20	n=21	n=20
average	30.63	29.99	238.1	182.46	-	-
range: min	27.1	27	95	53.4	5.08	4.89
max	33.6	32.6	450	319	7.33	7.33
st dev	2.19	1.95	118.37	87.34	-	-
Range for bores with stygofauna	n=13	n=13	n=13	n=13	n=13	n=13
	27.6—33.3	27.1—32.6	114—448	53.4—319	5.08—6.86	4.89—6.52
CUNDALINE RIDGE	n=17	n=0	n=17	n=3	n=17	n=3
average	31.4	-	604.31	530.97	-	-
range: min	29.3	-	162	163.9	4.28	5.7
max	33.7	-	1972	1180	7.83	7.35
st dev	1.13	-	540.38	563.69	-	-
YARRIE RIDGE	n=0	n=0	n=0	n=7	n=0	n=7
average	-	-	-	380.11	-	-
range: min	-	-	-	226.4	-	5.77
max	-	-	-	613	-	7.1
st dev	-	-	-	150.56	-	-
Range for bores with stygofauna	-	-	-	n=3	-	-
	-	-	-	226.4—360	-	5.9—6.84
	n=0	n=0	n=0	n=1	n=0	n=1
SHAY GAP OB1	-	-	-	231	-	6.68
SHAY GAP PB4	-	-	-	390	-	6.38
SALT WELL: stygofauna present			-	255	-	5.96

°C: degrees Celsius

4 DISCUSSION

The number of samples that could be obtained from inside the proposed pit shells was limited, especially on the Cundaline Ridge, by few holes intersecting groundwater. Within the limitations of survey, the sampling effort is considered adequate to enable an assessment of stygofauna in relation to the planned Callawa and Cundaline mining operations.

The stygofauna survey conducted in the Goldsworthy mining area found a moderate diversity of stygofauna on the Callawa Ridge, and an apparent absence of stygofauna on the Cundaline Ridge. The apparent absence cannot be attributed to the range in water quality variables measured during this survey, where only limited groundwater habitat was intersected at the depths of drilled bores on this ridge. The apparent absence at Cundaline Ridge is consistent with the apparent absence of stygofauna on nearby Nimingarra and Sunrise Hill deposits which have been sampled repeatedly over several years from 2005 to 2007 by Biota (2008) and more recently by Subterranean Ecology (unpublished data, 2008a). The results suggest that stygofauna may not be present in the more north-western ranges of the Goldsworthy mining area, which are located at a further distance from the De Grey River than Callawa and Yarrie ridges.

The presence of stygofauna in the near vicinity of the former active mine pit on the Yarrie Range is of some interest as it indicates the persistence of stygofauna at these sites during mining operations, or, recolonisation of these bores after mining operations had ceased.

Only one species from Salt Well reference site was found to be shared with another site. This was not unexpected given that Salt Well is situated in a calcrete-alluvial aquifer of an adjacent creek catchment on the lowland plain, whereas the other sites were located in upland fractured rock aquifers on the ridges. This is consistent with the groundwater contours modelled by Aquaterra (2008) which suggested a low degree of hydraulic connectivity between the Callawa ridge aquifer and the groundwater aquifer that underlies the surrounding valley plain.

Study of potential hydrogeological impacts of the proposed mining conducted by Aquaterra (2008) indicates that mining at the Cundaline deposit will not penetrate the natural water table and no dewatering will be required. In the case of Callawa, Aquaterra concludes that mining will intercept the natural water table and dewatering will be required. Aquaterra anticipates that the impact of dewatering will extend to a distance of 500 metres from the pits, but backfilling of pits is likely to result in the water table recovering to pre-mining levels.

At the Callawa Ridge, *Metacyclops* n. sp. 1 was the only species to be collected solely from inside a proposed pit. The same putative morpho-species has also been collected from Quarry 8 located approximately 215 km southwest of Yarrie, where it was also collected from inside a potential future dewatering zone (Subterranean Ecology 2008b). For present purposes, however, two widely separate records suggest that the conservation status of *Metacyclops* n. sp. 1 is not necessarily dependent on its occurrence inside the proposed Callawa pit.

The other members of the stygofauna community at Callawa have been collected outside of the proposed pit. Although some members of the community may have only been collected, to date, from within the predicted zone of dewatering influence (after Aquaterra 2008), the conservation risk to the Callawa Ridge stygofauna community is likely to be low given: (1) the probable wider distribution of the community throughout the Callawa Ridge aquifer; (2) the localised zone of dewatering influence (< 500 m) in relation to the wider extent of the Callawa Ridge aquifer (after Aquaterra 2008); (3) the short mine life with backfilling of pits to above the watertable, and predicted recovery of water levels and water quality after cessation of mining (Aquaterra 2008); (4) operational experience at Yarrie Pit demonstrating localised zone of dewatering influence (Aquaterra 2008) and persistence of the stygofauna community in the Yarrie Ridge aquifer after cessation of mining.

On present knowledge, the five morpho-species collected at Callawa have distributions which extend beyond the proposed pits. Thus within its limitations, the survey did not demonstrate any conservation issue for stygofauna associated with mining the Cundaline or Callawa deposits as proposed.

5 ACKNOWLEDGEMENTS

We would like to thank Dr Tom Karanovic, University of Tasmania, (Copepods) for identification of copepods.

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ATTACHMENTS

Attachment 1 – Cundaline and Callawa Geological Review

Cundaline and Callawa Geological Review

Prepared by BHP Billiton Iron Ore

22 September 2008

In accordance with Section 3.4 of EPA Guidance Statement No. 54a, BHP Billiton (BHPBIO) has evaluated the geological information at Goldsworthy, in order to facilitate the assessment of the potential occurrence of troglofauna habitat. This review encompasses the Callawa and Cundaline deposits and surrounds. A description of the key findings of the review is provided below.

1. General Geology of the Goldsworthy Area

The Goldsworthy iron ore deposits are located at the northern margin of the Pilbara Craton, which comprises of large granitoid domes and batholiths separated by down-folded sequences of the Pilbara Supergroup sedimentary volcanic and intrusive rocks (Figure 1).

The Goldsworthy area and surrounds comprises a sequence of banded irons, sandstones, siltstones and tuffs as outlined in the stratigraphic column in Table 1 and presented in Figures 2a and 2b. The iron ore mineralisation associated with Cundaline and Callawa is hosted within the Nimingarra Formation, a steeply dipping sequence of banded-iron (BIF), ferruginous chert and shales (Figure 3).

The Nimingarra Formation forms a prominent, semi-continuous fault-offset and folded group of ridges extending from the Callawa Ridge in the south to Nimingarra Ridge in the north, a strike length of approximately 60 km (Figures 2a, 2b and 3). The Cundaline deposits occur in the mid-reach of the north-western trending limb (Figures 2a, 2b and 3).

The Nimingarra Formation consists of Lower, Middle, and Upper Member Banded Iron Formations (BIF) (Figures 4 and 5a to 5e). The Lower Member is characterised by thick bedded white and gray chert with only minor black chert and numerous interbedded shale units. The Middle and Upper Member BIF are typically thin bedded black and jaspilitic chert.

The Nimingarra Formation overlays the granites of the Muccan and Warrawagine batholiths (Table 1; Figures 4 and 5a to 5e).

The Cundaline Formation occurs on the northern side of the Cundaline Ridge, consisting of weathered shale and siltstone (Table 1; Figures 2a and 2b).

The plains between the ridges consist of Quaternary deposits (Table 1; Figures 2a and 2b).

Characteristics of the Nimingarra Banded Iron Formation

Lode ore found within the Nimingarra Formation is restricted mostly to the three hematite BIF units discussed previously, being best developed where structures and cross-cutting dolerite dykes provide a focus for mineralising fluids (Table 1).

The BIF host rock, precursor to ore, consists of finely bedded chert, iron oxides and silicates. The texture of this rock type is fine-grained and dense, with little or no intergranular pore space. Inter-bedded within the iron formation are shale and chert which can form bands up to 40 m thick. The shale and chert are similarly finely bedded and non-porous, however ore-forming weathering processes can alter BIF and other rock types to form voids and cavities. Chert and silica are leached out by meteoric water and may be replaced by iron hydroxides. The resultant rock consists mainly of iron oxides and iron hydroxides (hematite and goethite). Leaching of impurities increases the porosity of the rock and most of these iron ores will be permeable to water to some degree. Often pores are measured in scales of fractions of millimetres although occasionally larger (centimetre scale) voids will occur.

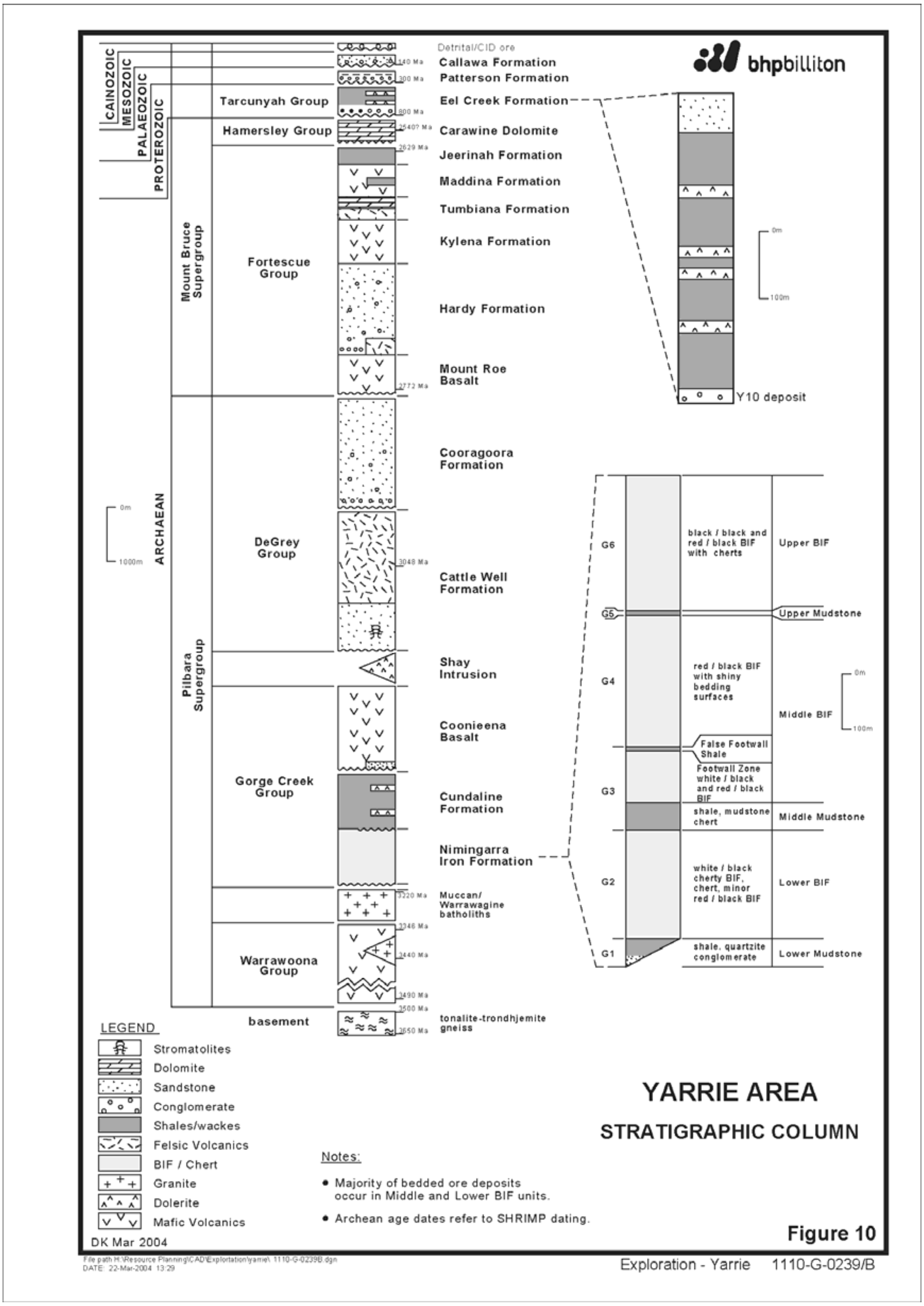

Table 1. Stratigraphy of the Yarrie Area (Kneeshaw, 2008)

Interrogation of the drill hole database shows that cavities extend throughout the Nimingarra Formation to downhole depths of 160 metres (m), however due in part to known weathering processes and also the lack of drilling data at depth in these areas, cavities are more prevalent at shallower depths associated with surficial weathering and development of hardcap (see section titled "Hardcap Zone").

Several deformation and intrusive events have impacted on these rocks, causing folding and faulting at all scales. Faulting introduces discontinuities through which water can access otherwise non-porous rock. Continuous water flow through these faults can produce cavities which are often filled with secondary minerals such as silica or clay. Folding does little to change the porosity of the rocks. Intrusive dolerite dykes also cross-cut the stratigraphy, which creates further conduits through which water can flow.

Larger scale fault lines occur between the ridges as shown on Figure 3. These include the Elephant Rock Fault which defines the eastern edge of the Mundarinya Ridge; the Kennedy Gap Fault which occurs near Eel Creek, and a fault associated with the edge of Callawa Ridge.

Lode Mineralisation in the Cundaline and Callawa area (Figures 3 and 4a to 4e) is dominantly microplaty hematite, with goethite. Crustal hematite ore is also present formed by the near-surface leaching of the BIF).

Hardcap Zone

Continuous weathering over the deposits has resulted in a carapace known as the 'hardcap' zone, which forms a semi-continuous horizon and hosts mineralisation across many of the ridges in the Goldsworthy area. This zone can be extremely variable in texture and is known to contain more frequent voids and cavities (Plate 1). At the base of the hardcap zone there is often an extremely weathered, soft, saprolitic zone several metres thick. This is often seen in outcrop as an undercut where small caves and overhangs occur. While not common, large cavities on a scale of metres are occasionally observed during mining and drilling in this zone.

Plate 1. Example of the Hardcap Zone on the Callawa Ridge

2. Geology of the Callawa and Cundaline Ridges

Cundaline Ridge

The Cundaline deposit comprises a series of narrow lode-style orebodies over a strike length of approximately 9 km. There are four small lode deposits contained within the Lower and Middle BIF units of the Nimingarra Formation, which dips steeply to the north-east (Table 1; Figures 4a to 4e). These deposits are known as the 6 km, 10 km, 13 km and 14 km deposits. Several localised faults are noted throughout the deposits with a variety of orientations which offset stratigraphy and associated mineralisation.

Examination of bore logs and geological mapping suggests there are minor variations between the composition and structure of the strata along strike, due to depositional variations and faulting and folding. However, these differences are minor, with the main variation being the depth of mineralisation and the extent of hardcap development.

The hardcap zone reaches a depth of 30 m in the Cundaline area. Interrogation of the drilling database indicates that vuggy cavities were identified to a depth of 160 m.

Callawa Ridge

The Callawa deposit contains only one identified lode ore deposit on the north-east corner. This deposit is situated in the Lower or Middle member of the Nimingarra Formation which dips shallowly to the west (Table 1; Figure 3). This deposit contains post-mineralisation dolerite dykes that cross-cut mineralisation but have little offset and there are no other structural disruptions throughout the deposit to indicate faulting.

The hardcap zone reaches a depth of 30 m in the Callawa area. Interrogation of the drilling database indicates that vuggy cavities were identified to a depth of 60 m.

3. References

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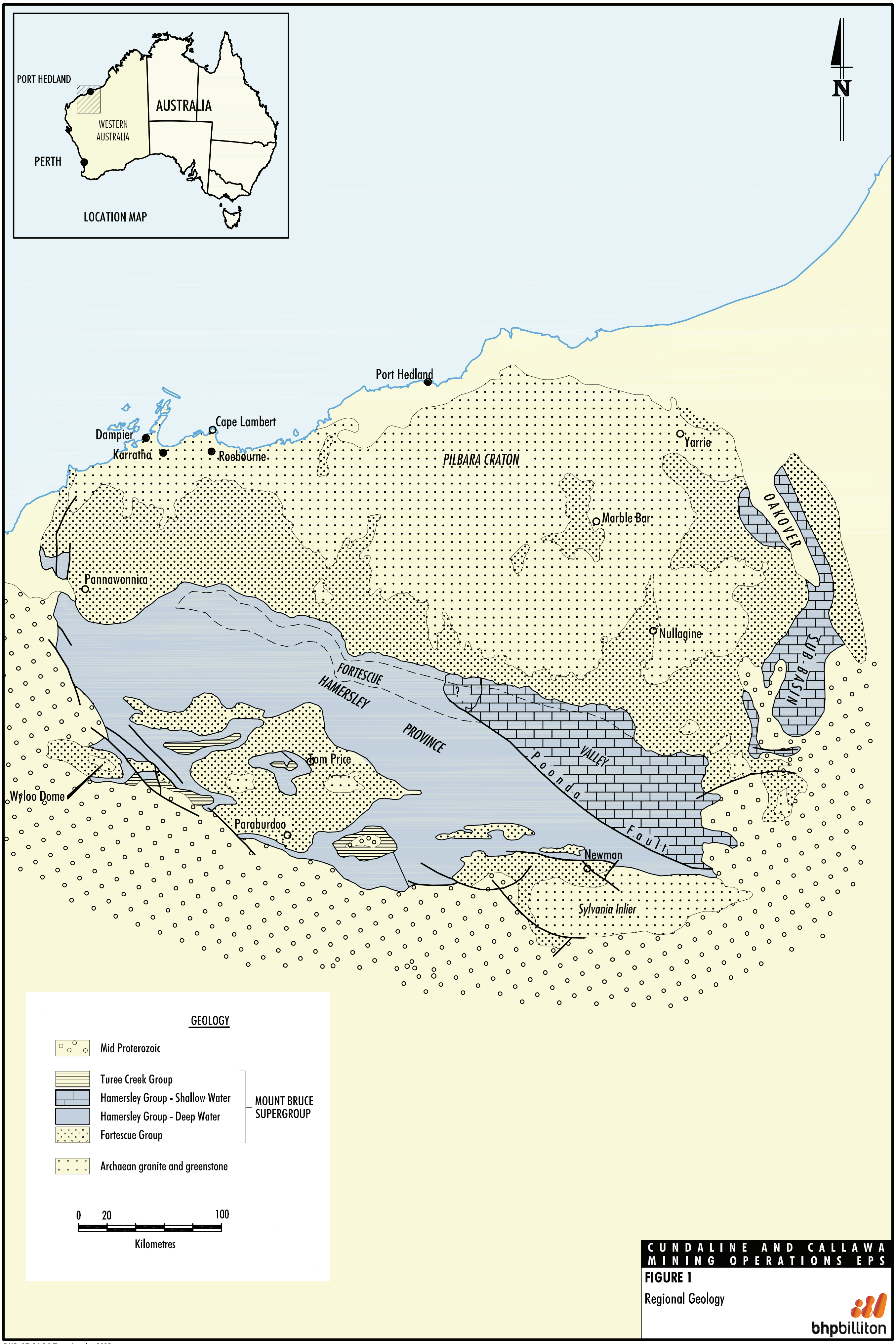


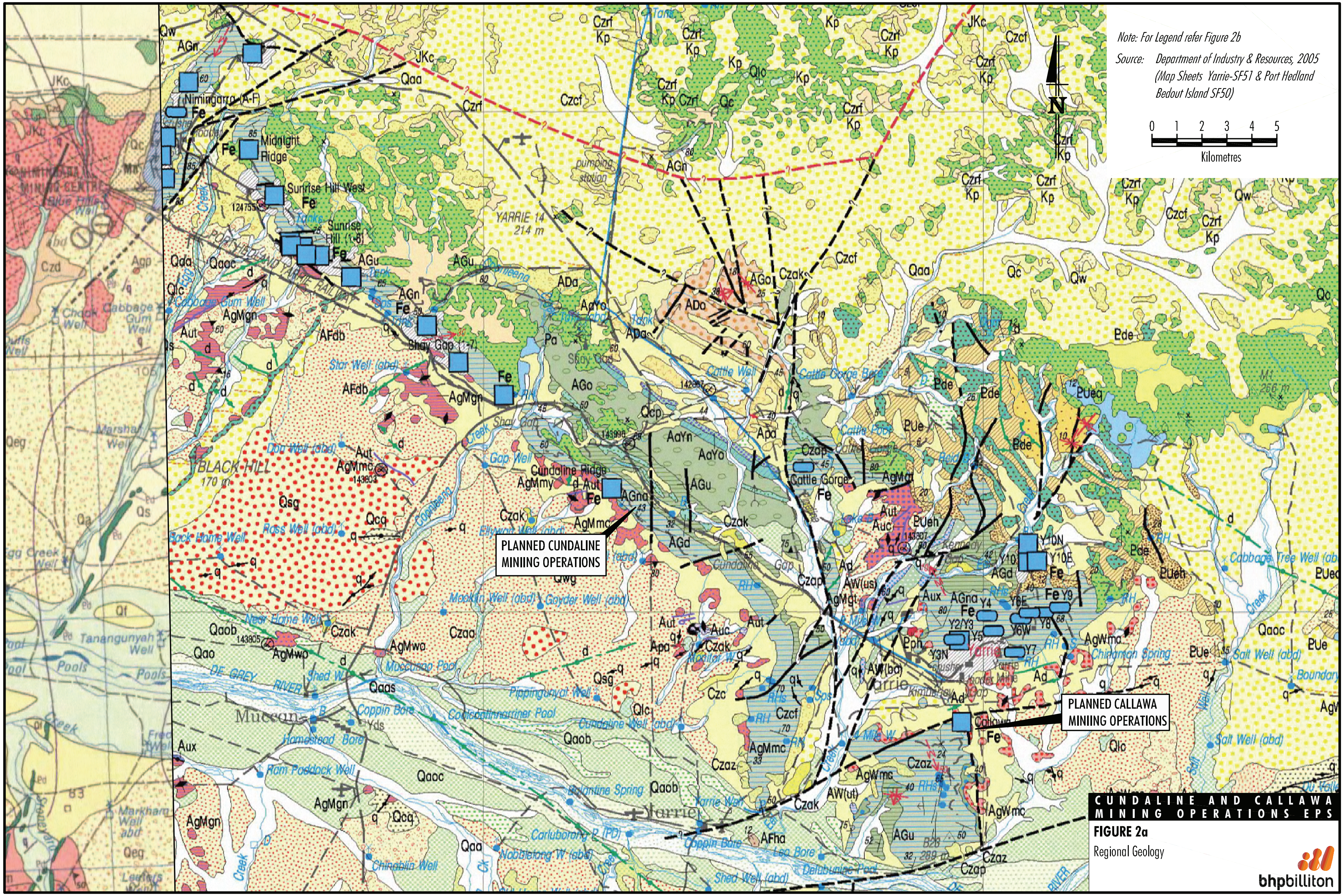
CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 1

Regional Geology

bhpbilliton

BHP-07-16 BS Trog Attach _101B



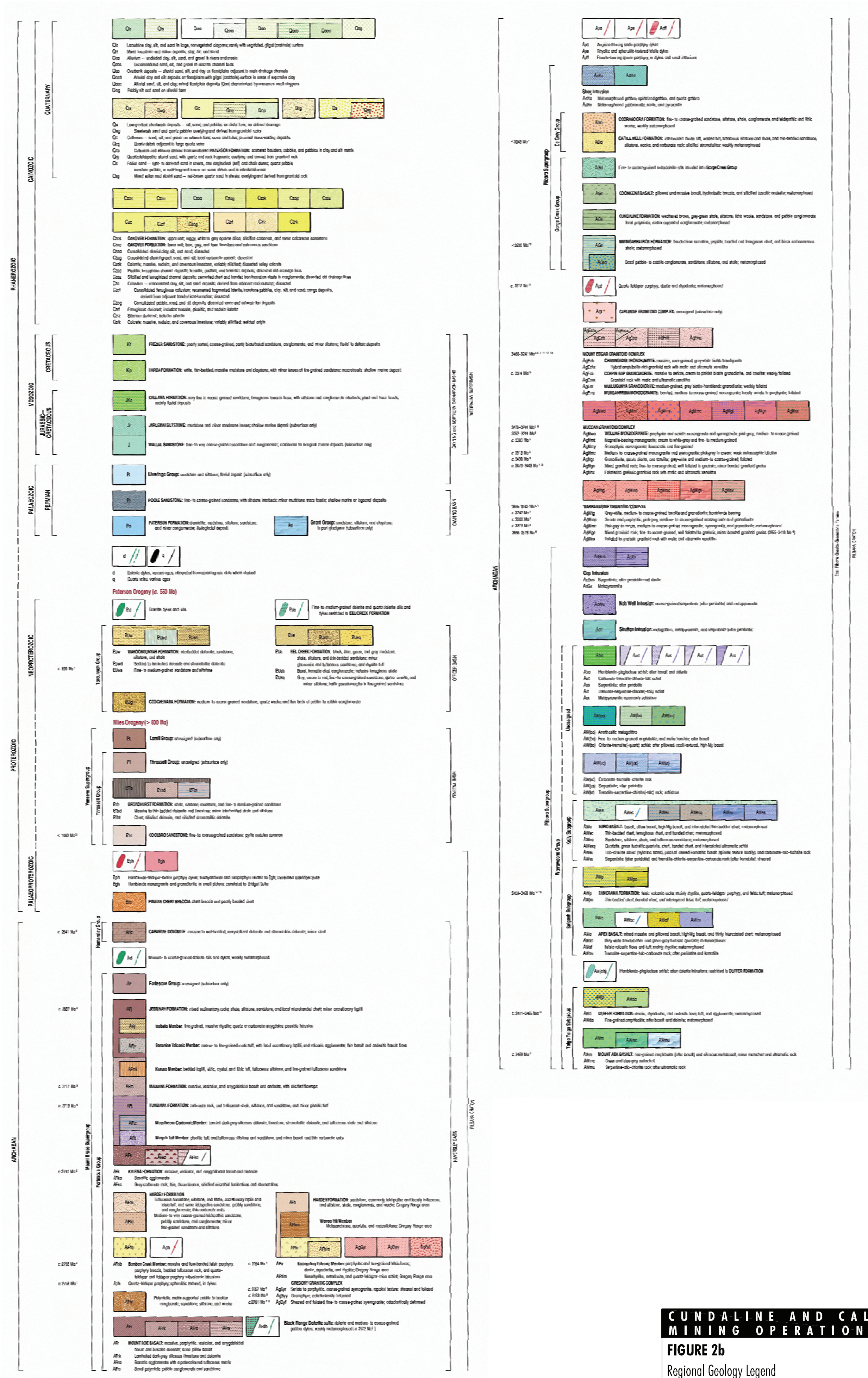
CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 2a

Regional Geology

bhpbilliton

BHP-07-16 BS Trog Attach _102B

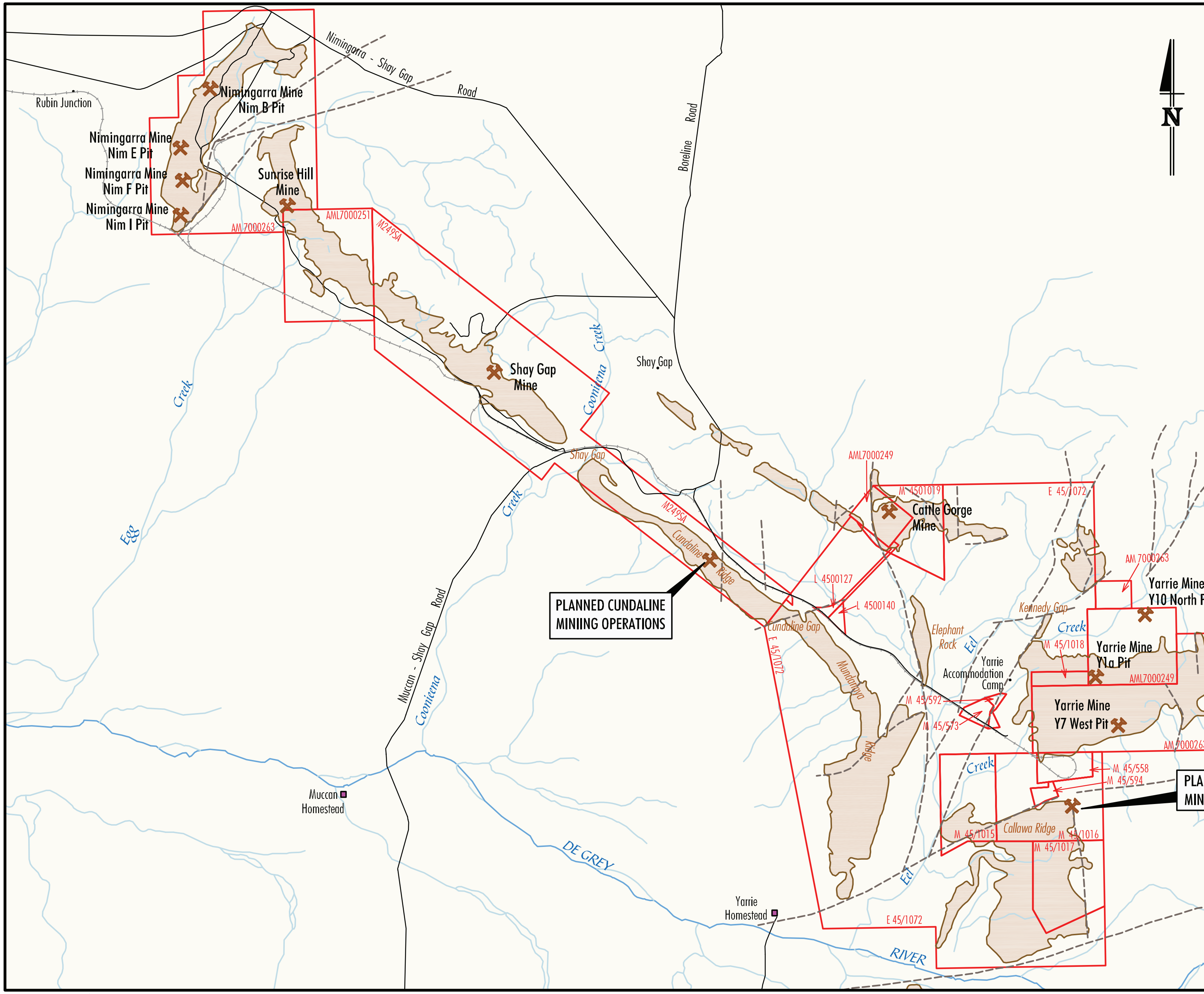


CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 2b

Regional Geology Legend

bhpbilliton



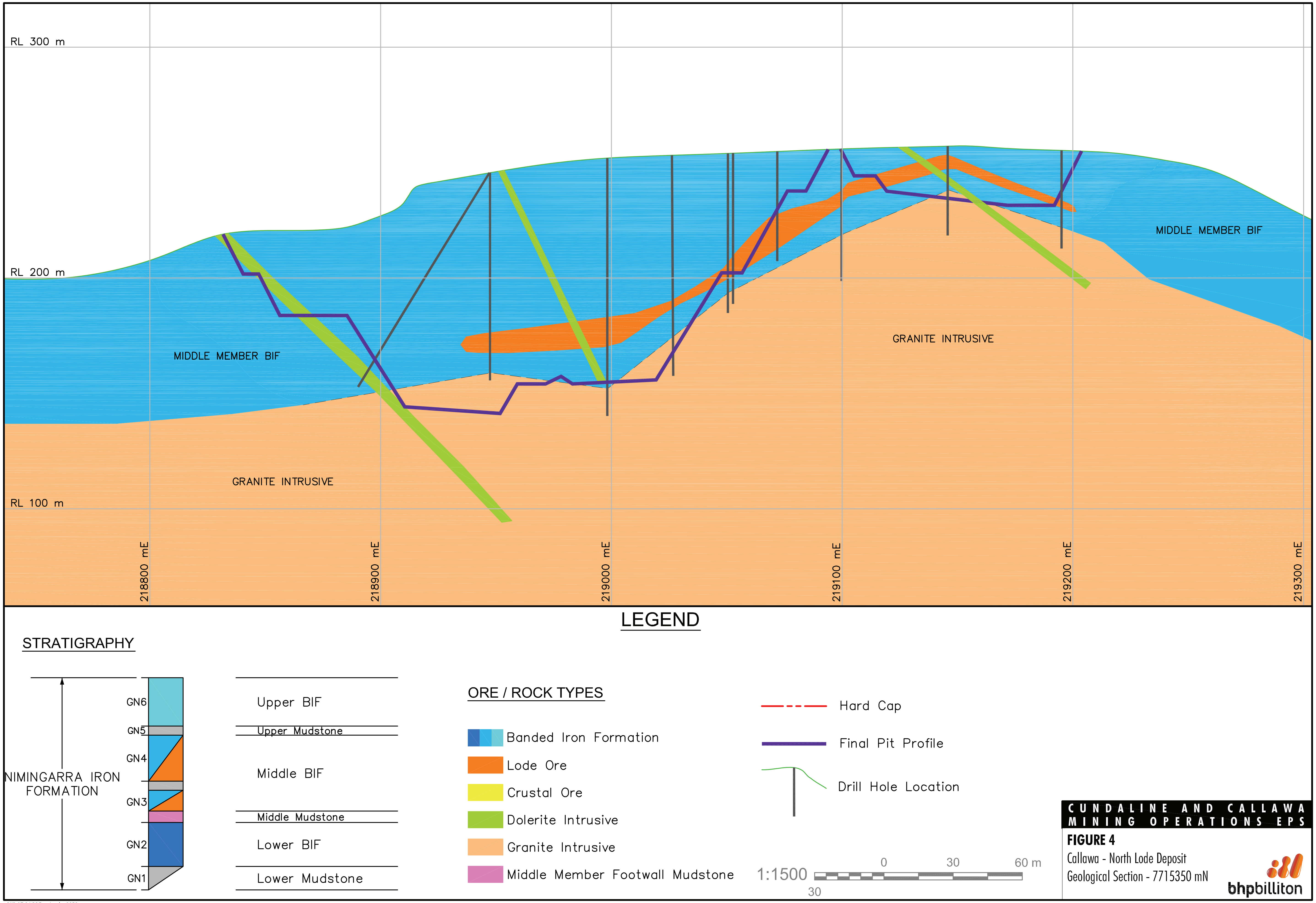
Source: DOIR (2007)

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 3
Goldsworthy Iron Ore Mining Operations

bhpbilliton

BHP-07-16 BS Trog Attach _104B



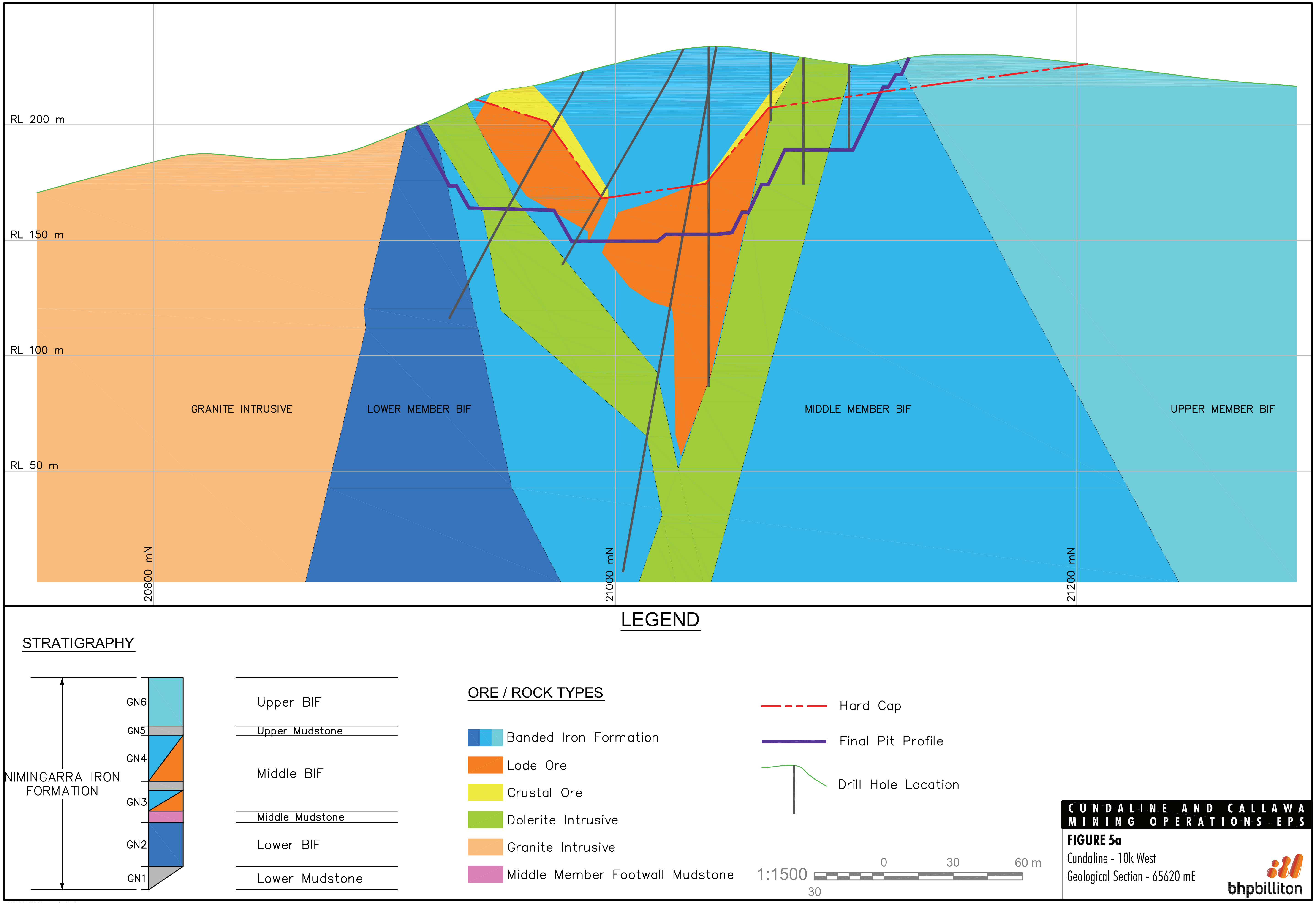
CUNDALINE AND CALLAWA MINING OPERATIONS EPS

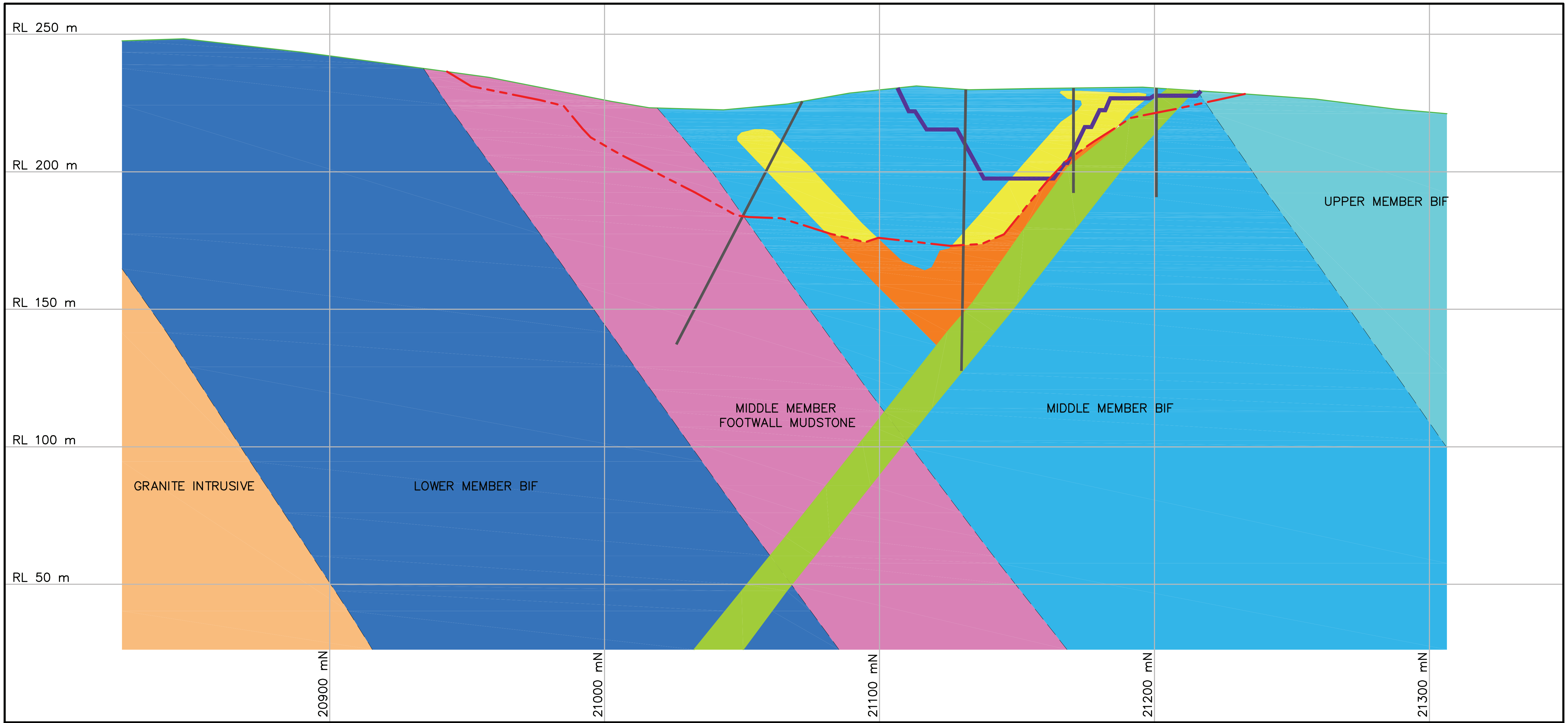
FIGURE 4

Callawa - North Lode Deposit
Geological Section - 7715350 mN

bhpbilliton

BHP-07-16 BS Trog Attach _105C


RL 200 m
RL 150 m
RL 100 m
RL 50 m
GRANITE INTRUSIVE
LOWER MEMBER BIF
MIDDLE MEMBER BIF
UPPER MEMBER BIF
20800 mN
21000 mN
21200 mN
LEGEND
STRATIGRAPHY
NIMINGARRA IRON FORMATION
GN6
GN5
GN4
GN3
GN2
GN1
Upper BIF
Upper Mudstone
Middle BIF
Middle Mudstone
Lower BIF
Lower Mudstone
ORE / ROCK TYPES
Banded Iron Formation
Lode Ore
Crustal Ore
Dolerite Intrusive
Granite Intrusive
Middle Member Footwall Mudstone
Hard Cap
Final Pit Profile
Drill Hole Location
1:1500
30
0
30
60 m
CUNDALINE AND CALLAWA
MINING OPERATIONS EPS
FIGURE 5a
Cundaline - 10k West
Geological Section - 65620 mE
bhpbilliton
BHP-07-16 BS Trog Attach _106C



LEGEND

STRATIGRAPHY

NIMINGARRA IRON FORMATION

GN6	Upper BIF
GN5	Upper Mudstone
GN4	Middle BIF
GN3	Middle Mudstone
GN2	Lower BIF
GN1	Lower Mudstone

ORE / ROCK TYPES

- Banded Iron Formation
- Lode Ore
- Crustal Ore
- Dolerite Intrusive
- Granite Intrusive
- Middle Member Footwall Mudstone

- Hard Cap
- Final Pit Profile
- Drill Hole Location

1:1500 — 30 0 30 60 m

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

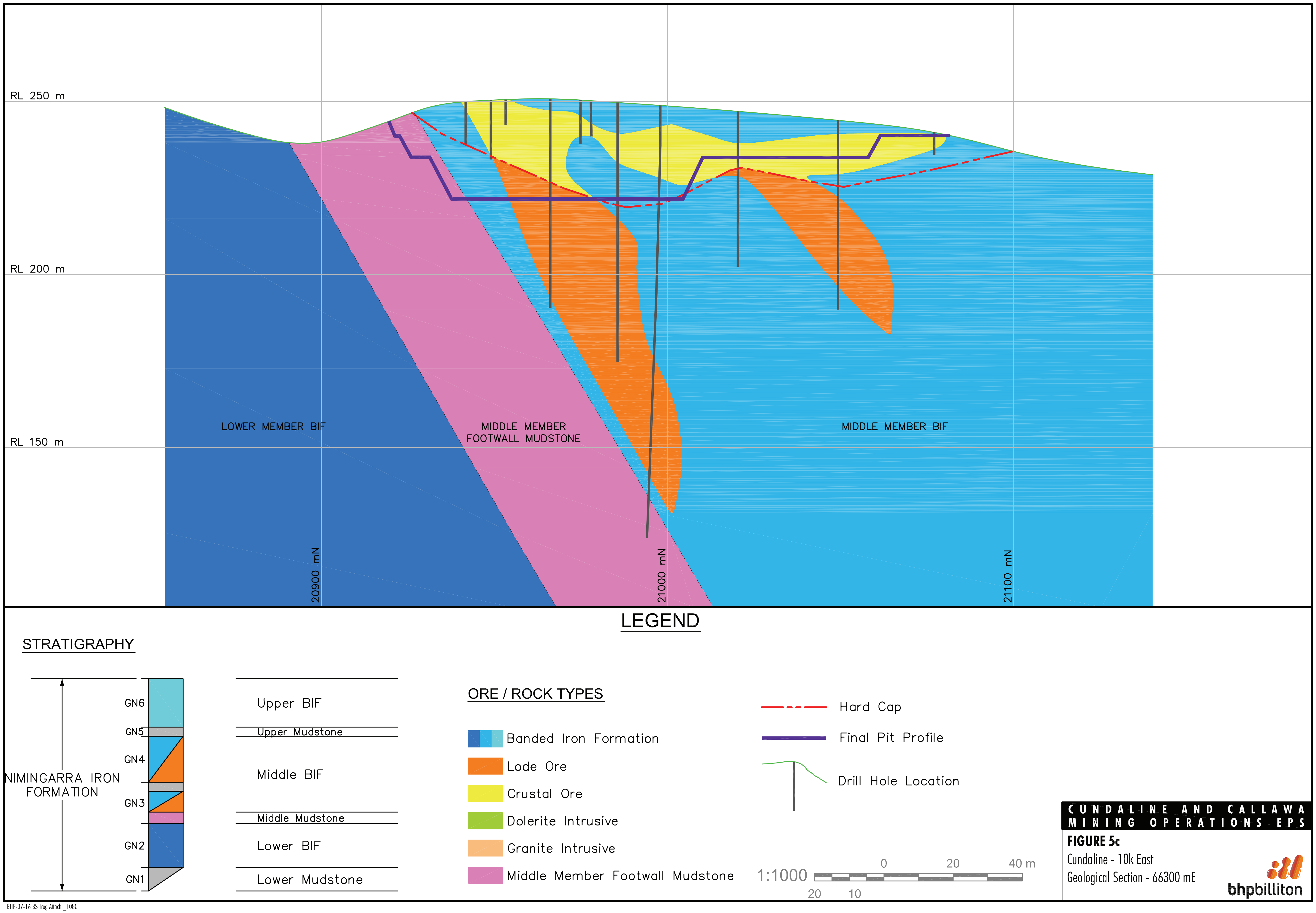
FIGURE 5b

Cundaline - 10k East

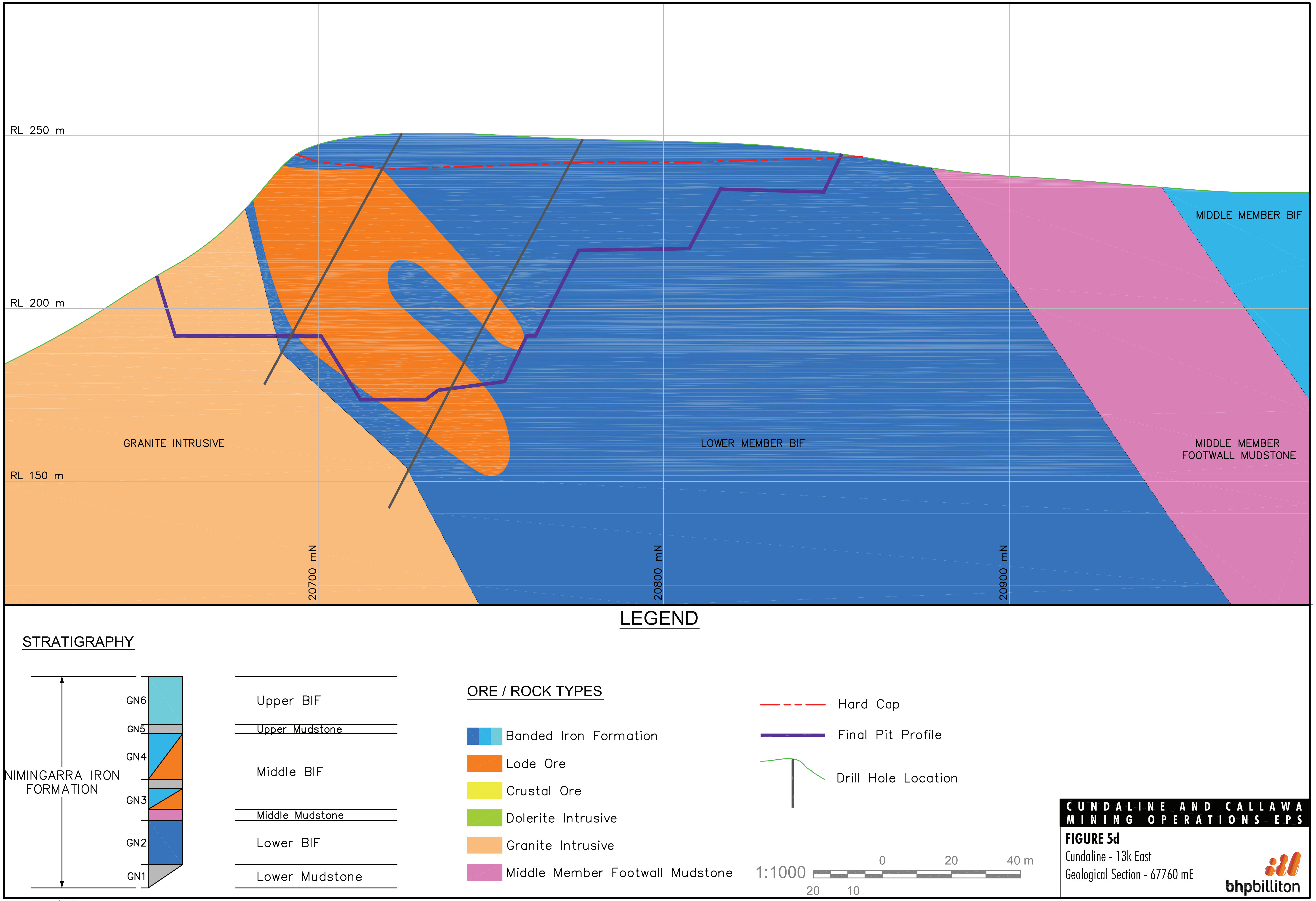
Geological Section - 66000 mE

bhpbilliton

BHP-07-16 BS Trog Attach _107C



RL 250 m
RL 200 m
RL 150 m
LOWER MEMBER BIF
MIDDLE MEMBER FOOTWALL MUDSTONE
MIDDLE MEMBER BIF
20900 mN
21000 mN
21100 mN
LEGEND
STRATIGRAPHY
NIMINGARRA IRON FORMATION
GN6
GN5
GN4
GN3
GN2
GN1
Upper BIF
Upper Mudstone
Middle BIF
Middle Mudstone
Lower BIF
Lower Mudstone
ORE / ROCK TYPES
Banded Iron Formation
Lode Ore
Crustal Ore
Dolerite Intrusive
Granite Intrusive
Middle Member Footwall Mudstone
Hard Cap
Final Pit Profile
Drill Hole Location
1:1000
20 10 0 20 40 m
CUNDALINE AND CALLAWA MINING OPERATIONS EPS
FIGURE 5c
Cundaline - 10k East
Geological Section - 66300 mE
bhpbilliton
BHP-07-16 BS Trog Attach _108C



CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 5d

Cundaline - 13k East

Geological Section - 67760 mE

bhpbilliton

BHP-07-16 BS Trog Attach _109C

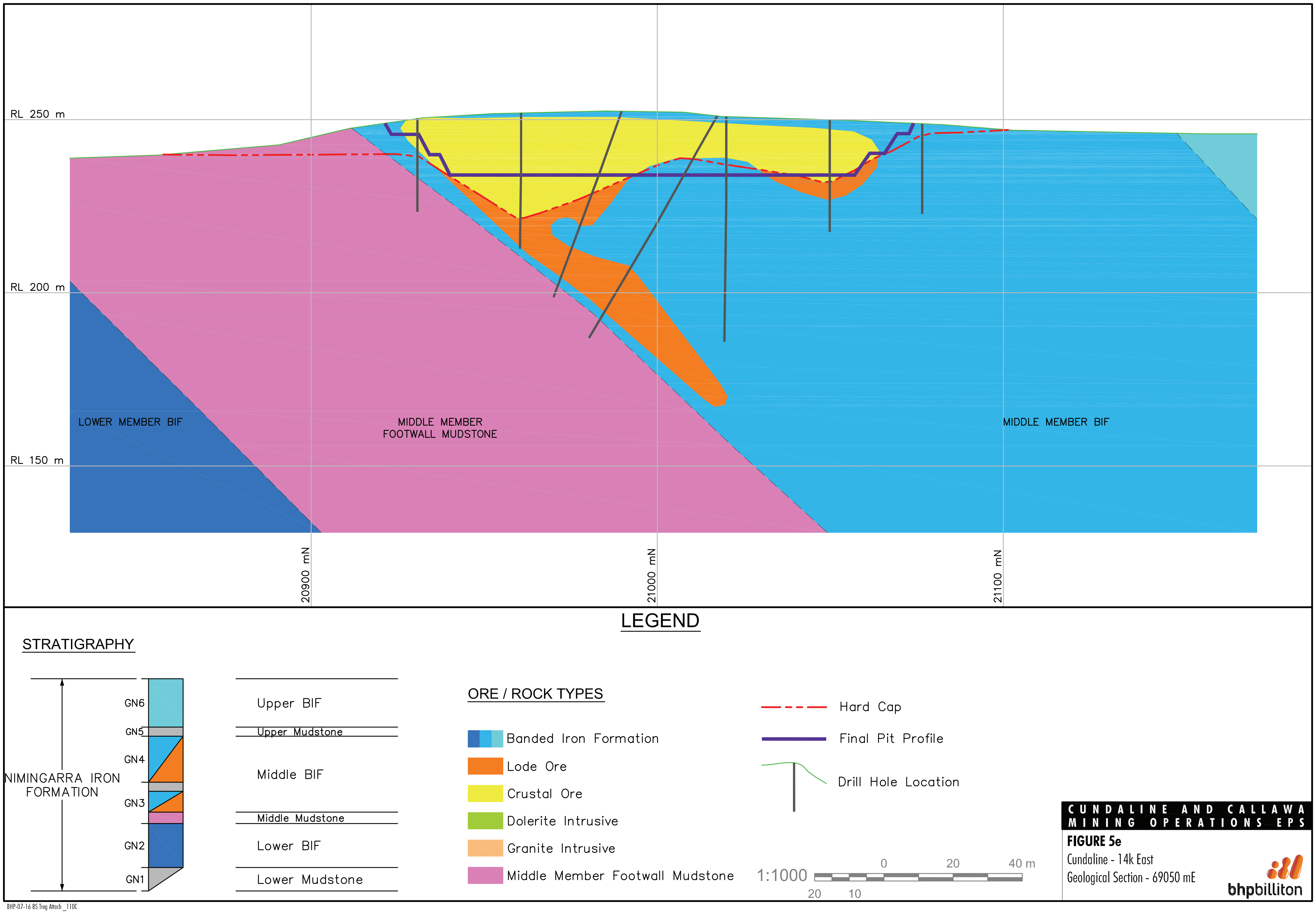


FIGURE 5e
Cundaline - 14k East
Geological Section - 69050 mE

Attachment 2: Groundwater Levels Recorded

Deposit	Hole #	Eastings GDA94	Northings GDA94	Depth (m)	Drill records		Estimated	
				Date sampled	Hole	Water	Hole	Water
Callawa Out-of-pit	CA0006	219308	7714874	29/07/08	138			103
Callawa Out-of-pit	CA0006	219308	7714874	22/02/08	138		186	131
Callawa Out-of-pit	CA0008	218700	7715050	29/07/08	171			87
Callawa Out-of-pit	CA0008	218700	7715050	22/02/08	171		214	98
Callawa Out-of-pit	CA0010	218709	7714849	22/02/08	168		203	98
Callawa Out-of-pit	CA0011	219162	7714346	22/02/08	135		160	124
Callawa Out-of-pit	CA0012	219336	7714073	22/02/08	153		163	99
Callawa Out-of-pit	CA0014	219104	7714529	22/02/08	171		205	104
Callawa Out-of-pit	CA0019	218370	7714681	22/02/08	150		185	101
Callawa Out-of-pit	CA0021	217301	7714782	22/02/08	150		76	63
Callawa Out-of-pit	CA0022	217064	7714980	22/02/08	81		91	75
Callawa Pit	CA0023	219337	7715311	22/02/08	45		48	40
Callawa Pit	CA0069	219437	7715316	22/02/08	75		77	69
Callawa Pit	CA0078	219137	7715411	22/02/08	111		102	88
Callawa Pit	CA0079	219187	7715411	22/02/08	99		116	91
Callawa Out-of-pit	CA0100R	219134	7714963	22/02/08	186		184	109
Callawa Out-of-pit	CA0102R	219338	7714954	22/02/08	144		148	90
Callawa Pit	CA0107	219211	7715284	22/02/08	90		103	86
Callawa Out-of-pit	CA0124R	218568	7714451	29/07/08	150			68
Callawa Out-of-pit	CA0124R	218568	7714451	22/02/08	150		188	76
Callawa Out-of-pit	CA0131	217531	7714767	22/02/08	150		177	75
Cundaline Pit	CU0021	205630	7724869	22/02/08	99		103	94
Cundaline Pit	CU0201R	207411	7723052	22/02/08	114		136	50
Cundaline Out-of-pit	CU0227R	205780	7724864	22/02/08	54		61	51
Cundaline Pit	CU0229R	205480	7724942	22/02/08	114		130	96
Cundaline Pit	CU0236R	205178	7725084	22/02/08	120		196	78
Cundaline Pit	CU0243R	207147	7723036	22/02/08	180	138	204	88
Cundaline Pit	CU0271R	205717	7724822	22/02/08	102		111	96
Cundaline Pit	CU0274R	205590	7724880	22/02/08	102		120	99
Cundaline Out-of-pit	CU0286R	204625	7725370	22/02/08	132		145	118
Cundaline Out-of-pit	CU0287R	204702	7725264	22/02/08	114		126	116
Cundaline Out-of-pit	CU0289R	204751	7725211	22/02/08	138	111	157	105
Cundaline Out-of-pit	CU0292R	204781	7725150	22/02/08	84		98	78
Cundaline Pit	CU0305R	207394	7723030	22/02/08	84		95	95
Cundaline Pit	CU0315R	205593	7724403	22/02/08	126		215	129
Cundaline Out-of-pit	CU0327R	204298	7725729	22/02/08	114		131	99
Shay Gap	OB1	207551	7752183	24/04/08			115	88
Shay Gap	PB4	207727	7152852	24/04/08			119	88
Yarrie Out-of-pit	Salt Well	229721	7718342	24/04/08			9	6
Yarrie Out-of-pit	YP006	221063	7718793	24/04/08			156	100
Yarrie Out-of-pit	YP009	221662	7718916	24/04/08			155	124
Yarrie Out-of-pit	YP019	220655	7719076	24/04/08			168	106
Yarrie Out-of-pit	YP027			24/04/08			154	103
Yarrie Out-of-pit	YP032	221620	7720016	24/04/08			161	104

Attachment 3: List of all Sites Sampled at Callawa Ridge, Cundaline Ridge, Salt Well, Shay Gap Borefield and Yarrie

Zone	Hole Information			Stygofauna Sampling		
	Hole #	Eastings (GDA94 Ref. 51)	Northings (GDA94 Ref. 51)	Round 1 Dec. 2007	Round 2 Feb. 2008	Round 3 April 2008
Callawa Out-of-pit	CA0006	219308	7714874	OUT-OF-PIT CA	OUT-OF-PIT CA	
Callawa Out-of-pit	CA0008	218700	7715050	OUT-OF-PIT CA	OUT-OF-PIT CA	
Callawa Out-of-pit	CA0010	218709	7714849	OUT-OF-PIT CA	OUT-OF-PIT CA	
Callawa Out-of-pit	CA0011	219162	7714346	OUT-OF-PIT CA	OUT-OF-PIT CA	
Callawa Out-of-pit	CA0012	219336	7714073	OUT-OF-PIT CA	OUT-OF-PIT CA	
Callawa Out-of-pit	CA0014	219104	7714529	OUT-OF-PIT CA	OUT-OF-PIT CA	
Callawa Out-of-pit	CA0019	218370	7714681	OUT-OF-PIT CA	OUT-OF-PIT CA	
Callawa Out-of-pit	CA0021	217301	7714782	OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0022	217064	7714980	OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Pit	CA0023	219337	7715311	PIT CA	PIT CA	
Callawa Pit	CA0064	219386	7715161	PIT CA		
Callawa Pit	CA0069	219437	7715316	PIT CA	PIT CA	
Callawa Pit	CA0078	219137	7715411	PIT CA	PIT CA	
Callawa Pit	CA0079	219187	7715411	PIT CA		
Callawa Pit	CA0084	219336	7715111	PIT CA		
Callawa Pit	CA0086	219283	7715109	PIT CA		
Callawa Out-of-pit	CA0100R	219134	7714963	OUT-OF-PIT CA	OUT-OF-PIT CA	
Callawa Out-of-pit	CA0102R	219338	7714954	OUT-OF-PIT CA	OUT-OF-PIT CA	
Callawa Pit	CA0107	219211	7715284	PIT CA		
Callawa Pit	CA0113R	219057	7715585	PIT CA		
Callawa Pit	CA0121R	219310	7715137	PIT CA		
Callawa Out-of-pit	CA0124R	218568	7714451	OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0131R	217531	7714767	OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Pit	CA0141R	219268	7715536	PIT CA		
Callawa Pit	CA0143R	219209	7715507	PIT CA		
Callawa Pit	CA0144R	219189	7715506	PIT CA		
Callawa Pit	CA0146R	219116	7715529	PIT CA		
Callawa Out-of-pit	CA0151R	219076	7713178		OUT-OF-PIT CA	
Cundaline Out-of-pit	CU0060	203329	7726112	OUT-OF-PIT CU		
Cundaline Out-of-pit	CU0062	203501	7726017	OUT-OF-PIT CU		
Cundaline Out-of-pit	CU0063	203350	7726146	OUT-OF-PIT CU		
Cundaline Out-of-pit	CU0286R	204625	7725370	OUT-OF-PIT CU		
Cundaline Out-of-pit	CU0287R	204702	7725264	OUT-OF-PIT CU		
Cundaline Out-of-pit	CU0327R	204298	7725729	OUT-OF-PIT CU		
Cundaline Out-of-pit	SEWELL1A	202838	7728273	OUT-OF-PIT CU		
Cundaline Out-of-pit	SEWELL1B	202846	7728269	OUT-OF-PIT CU		
Cundaline Pit East	CU0191R	207894	7722688	PIT EAST		
Cundaline Pit East	CU0201R	207411	7723052	PIT EAST		
Cundaline Pit East	CU0243R	207147	7723036	PIT EAST	PIT EAST	PIT EAST
Cundaline Pit East	CU0305R	207394	7723030	PIT EAST		
Cundaline Pit West	CU0021	205630	7724869	PIT WEST		
Cundaline Pit West	CU0227R	205780	7724864	PIT WEST	PIT WEST	
Cundaline Pit West	CU0229R	205480	7724942	PIT WEST	PIT WEST	
Cundaline Pit West	CU0236R	205178	7725084	PIT WEST	PIT WEST	
Cundaline Pit West	CU0271R	205717	7724822	PIT WEST		

Attachment 3 (Continued): List of all Sites Sampled at Callawa Ridge, Cundaline Ridge, Salt Well, Shay Gap bore-field and Yarrie

Zone	Hole information			Stygofauna Sampling		
	Hole #	Eastings (GDA94 Ref. 51)	Northings (GDA94 Ref. 51)	Round 1 Dec. 2007	Round 2 Feb. 2008	Round 3 April 2008
Cundaline Pit West	CU0274R	205590	7724880	PIT WEST		
Cundaline Pit West	CU0276R	205540	7724901	PIT WEST		
Cundaline Out-of-pit	CU0289R	204751	7725211	OUT-OF-PIT WEST	OUT-OF-PIT WEST	OUT-OF-PIT WEST
Cundaline Out-of-pit	CU0292R	204781	7725150	OUT-OF-PIT WEST	OUT-OF-PIT WEST	
Cundaline Pit West	CU0315R	205593	7724403	PIT WEST	PIT WEST	
Shay Gap Borefield	OB1	207551	7752183			OUT-OF-PIT
Shay Gap Borefield	PB4	207727	7152852			OUT-OF-PIT
Salt Well	Salt Well	229721	7718342			OUT-OF-PIT
Yarrie Out-of-pit	YP006	221063	7718793			OUT-OF-PIT YARRIE
Yarrie Out-of-pit	YP009	221662	7718916			OUT-OF-PIT YARRIE
Yarrie Out-of-pit	YP019	220655	7719076			OUT-OF-PIT YARRIE
Yarrie Out-of-pit	YP027					OUT-OF-PIT YARRIE
Yarrie Out-of-pit	YP032	221620	7720016			OUT-OF-PIT YARRIE
Yarrie Out-of-pit	YP1060	218214	7718448			OUT-OF-PIT YARRIE
Yarrie Out-of-pit	YP1063	227340	7719494			OUT-OF-PIT YARRIE
Total hole and sample number				49	24	16

	Zone	Round 1 Dec. 2007	Round 2 Feb. 2008	Round 3 April 2008	Total
CALLAWA RIDGE	PIT	14	3	0	17
	OUT-OF-PIT	13	14	4	31
	TOTAL	27	17	4	48
CUNDALINE RIDGE	EAST PIT	4	1	1	6
	WEST PIT	8	4	0	12
	OUT-OF-PIT	10	2	1	13
	TOTAL	22	7	2	31
SHAY GAP/ SALT WELL/ YARRIE	OUT-OF-PIT	0	0	10	10

Attachment 4: All Stygofaunal Results

Area	Hole #	Taxon	spmn #	Specimen reference no.	Date
Callawa Out-of-pit	CA0006	Amphipoda; Paramelitidae SP01	2	seLN2301	26/04/08
Callawa Out-of-pit	CA0006	Bathynellidae SP01	30	seLN1651	27/02/08
Callawa Out-of-pit	CA0006	Bathynellidae SP01	65	seLN2302	26/04/08
Callawa Out-of-pit	CA0008	Bathynellidae SP01	2	seFN764	26/02/08
Callawa Out-of-pit	CA0011	Bathynellidae SP01	35	seFN761b	26/02/08
Callawa Out-of-pit	CA0011	Bathynellidae SP01	250	seLN2283	26/04/08
Callawa Out-of-pit	CA0012	Bathynellidae SP01	4	seFN60	26/02/08
Callawa Out-of-pit	CA0012	Bathynellidae SP01	50	seLN2299	26/04/08
Callawa Out-of-pit	CA0014	Bathynellidae SP01	4	seFN762	26/02/08
Callawa Pit	CA0023	Amphipoda; Paramelitidae SP01	42	seLN1376	28/02/08
Callawa Pit	CA0023	Amphipoda; Paramelitidae SP01	38	seLN2278	26/04/08
Callawa Pit	CA0023	Bathynellidae SP01	11	seLN2282	26/04/08
Callawa Pit	CA0023	Cyclopoidea; *Metacyclops* SP01	36	seLN2279	26/04/08
Callawa Pit	CA0069	Bathynellidae SP01	155	seLN1654	28/02/08
Callawa Pit	CA0069	Bathynellidae SP01	600	seLN2274	26/04/08
Callawa Pit	CA0078	Bathynellidae SP01	7	seLN1375	28/02/08
Callawa Pit	CA0078	Oligochaeta; Phreodrilidae SP01	9	seLN1656	28/02/08
Callawa Pit	CA0079	Parabathynellidae: Notobathynella? SP01	1	seLN1371	28/02/08
Callawa Pit	CA0084	Bathynellidae SP01	4	seLN999	16/12/07
Callawa Pit	CA0084	Parabathynellidae: Notobathynella? SP01	45	seLN999	16/12/07
Callawa Pit	CA0086	Parabathynellidae: Notobathynella? SP01	155	seLN1003	16/12/07
Callawa Out-of-pit	CA0100R	Amphipoda ; Paramelitidae SP01	1	seLN1374	28/02/08
Callawa Out-of-pit	CA0100R	Bathynellidae SP01	26	seLN1373	28/02/08
Callawa Out-of-pit	CA0102R	Bathynellidae SP01	45	seLN1525	27/02/08
Callawa Out-of-pit	CA0102R	Bathynellidae SP01	8	seLN2276	26/04/08
Callawa Pit	CA0102R	Parabathynellidae: Notobathynella? SP01	10	seLN2275	26/04/08
Callawa Pit	CA0107R	Bathynellidae SP01	33	seFN775	28/02/08
Callawa Pit	CA0121R	Bathynellidae SP01	50	seLN1010	16/12/07
Callawa Out-of-pit	CA0124R	Bathynellidae SP01	5	seLN1524	27/02/08
Callawa Out-of-pit	CA0124R	Parabathynellidae: Notobathynella? SP01	120	seLN1006	17/12/07
Callawa Out-of-pit	CA0124R	Parabathynellidae: Notobathynella? SP01	40	seLN1524	27/02/08
Callawa Out-of-pit	CA0124R	Parabathynellidae: Notobathynella? SP01	112	seLN2286	25/04/08
Callawa Out-of-pit	CA0124R	Oligochaeta; Phreodrilidae SP01	1	seLN1007	17/12/07
Callawa Pit	CA0141R	Bathynellidae SP01	220	seLN995	16/12/07
Callawa Pit	CA0143R	Bathynellidae SP01	1	seLN994	16/12/07
Salt Well Out-of-pit	Salt Well	Amphipoda; Paramelitidae SP02	25	seLN2307	27/04/08
Salt Well Out-of-pit	Salt Well	Amphipoda; Paramelitidae SP02	1	seLN2310	27/04/08
Salt Well Out-of-pit	Salt Well	Cyclopoidea; *Diacyclops scanloni*, Karanovic	65	seLN2308	27/04/08
Salt Well Out-of-pit	Salt Well	Harpacticoida; *Elaphoidella humphreysi* Karanovic	3	seLN2308	27/04/08
Salt Well Out-of-pit	Salt Well	Harpacticoida; *Rangabradya* SP01	4	seLN2308	27/04/08
Salt Well Out-of-pit	Salt Well	Harpacticoida; *Elaphoidella humphreysi* Karanovic	6	seLN2309	27/04/08

Attachment 4 (Continued): Total Stygofaunal Results

Area	Hole #	Taxon	spmn #	Specimen reference no.	Date
Salt Well Out-of-pit	Salt Well	Harpacticoida; *Stygonitocrella trispinosa* Karanovic	3	seLN2309	27/04/08
Salt Well Out-of-pit	Salt Well	Harpacticoida; *Parastenocaris jane* Karanovic	2	seLN2309	27/04/08
Yarrie Ridge Out-of-pit	YP019	Amphipoda; Paramelitidae SP02	1	seFN827	27/04/08
Yarrie Ridge Out-of-pit	YP1060	Oligochaeta; Enchyraeidae SP01	1	seLN2315	27/04/08
Yarrie Ridge Out-of-pit	YP1063	Bathynellidae SP01	25	seLN2306	27/04/08
Yarrie Ridge Out-of-pit	YP1063	Parabathynellidae: Notobathynella? SP01	110	seLN2305	27/04/08
Yarrie Ridge Out-of-pit	YP1063	Oligochaeta; Phreodrilidae SP01	28	seLN2304	27/04/08