FORTESCUE METALS GROUP LTD

EAST PILBARA IRON ORE PROJECT

HYDROGEOLOGY REPORT FOR THE PUBLIC ENVIRONMENTAL REVIEW

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EXECUTIVE SUMMARY

FMG are proposing a new project consisting of four iron ore mines and associated infrastructure in the eastern Pilbara. Aquaterra has been commissioned to undertake hydrogeological investigations including environmental impact assessment for the Public Environmental Review.

Three of the mines (the Chichester deposits at Christmas Creek, Mt Lewin and Mt Nicholas) are located on the northern flank of the Fortescue Valley in Marra Mamba Iron Formation. The fourth is located to the south, in channel iron deposits. A proposed railway connects the proposed mines to Port Hedland. A water supply will be required for construction of the railway from a series of bores along the route spaced at intervals of 14 km. The ore bodies in each of the pits are mostly above the water table, but some dewatering will be required at each mine. An ore beneficiation process is to be established at Christmas Creek mine. The Chichester Mines will require a supply of approximately 11GL/a primarily for ore beneficiation, but also for dust suppression and domestic use. Some of this water will be obtained fom the dewatering, with the remainder supplied from a borefield. In addition, 0.4 GL/a will be supplied to the Mindy Mindy mine from dewatering bores, for dust suppression, domestic use and ore moisture control (to prevent dust during transportation and whilst at the Port).

Alluvium forms a flat-lying plain across the Fortescue Valley. The alluvium is generally fine-grained, but along creeks, has been shown to contain sands and gravels. The alluvium is underlain by Wittenoom Dolomite in the vicinity of the borefield, and Marra Mamba in the vicinity of the pits. The proposed borefield is located in the alluvial sequence and Wittenoom Dolomite.

The Fortescue Marsh occupies a topographic depression and is an ephemeral surface water feature, approximately 100 km long and 10 km wide, which fills with surface run-off after significant rainfall events. Data suggests that the base of the marsh lies approximately 5 m above the water table reinforcing the concept that the surface water in the Fortescue Marsh forms as a result of rainfall rather than as a result of groundwater discharge. There is evidence of a groundwater catchment divide west of the project area. During flooding events salts deposited during previous drying episodes are redissolved, and the freshwater entering the marsh becomes moderately saline. Further west the Goodiadarrie Hills effectively prevent any western migration of groundwater from the Fortescue Marsh area.

Following a flood event, a portion of the ponded surface water will infiltrate causing water levels to rise beneath the marsh, ultimately to ground (marsh bed) level. Continual evaporation will remove ponded surface water, after which the watertable in the marsh bed sediments will decline to its former position under the combined processed of direct evaporation and radial groundwater flow to the Fortescue valley. It is considered likely that the depth to water beneath the marsh is, or closely approximates, the extinction depth for direct evaporation.

With the above concept, any change in groundwater level beneath the marsh will have no impact on the occurrence of surface water ponding, nor on the rate of seepage from the marsh bed into the water table. It is conceivable however that where the groundwater level is lowered significantly, an increased amount of water would be required to fully saturate the profile, and this could reduce the duration of surface water ponding. However, groundwater modelling indicates that the cone of depression from the dewatering of Christmas Creek and the water supply borefield will not extend as far as the Fortescue Marsh, and therefore that the marsh will not be affected by drawdowns from the dewatering or borefield.

A separate risk assessment was undertaken using the results of modelling undertaken by Aquaterra. A panel of qualified experts identified potential impacts on the Fortescue Marsh. The risk assessment found that impacts from groundwater abstraction are unlikely.

Assessments have been undertaken to determine the impacts of groundwater abstraction, dewatering of the pits, supplies for construction of the railway and storage of rejects from the ore beneficiation process. Analytical techniques have been used to predict the cone of depression from individual railway bores, which will operate at 0.5 ML/d (500 m^3/d) for 30 days. Two numerical groundwater models have been developed and used to predict the extent of the cones of depression from the borefield and pit dewatering. The results of the modelling have been discussed with ecologists employed by FMG, and potential impacts on phreatophytic vegetation and Stygofauna colonies have been identified.

It is considered unlikely that there will be any medium or long-term issues resulting from the railway construction bores. Along the proposed rail corridor vegetation mainly consists of mulga, which is not considered to be phreatophytic. Given the fine-grained nature of the alluvial aquifer underlying the rail route, there are unlikely to be extensive colonies of Stygofauna, they may however locally inhabit gravels along creeks lines.

The larger scale groundwater abstraction from the borefield and dewatering of the proposed pits has the potential to locally impact on phreatophytic vegetation and Stygofauna (if present) along creeks within the resulting cone of depression. However cones of depression for the mines and borefield were assessed in conjunction with detailed vegetation mapping by Biota (2004), and the risk of impacts to phreatophytic vegetation was found to be low. Despite this FMG will implement a Vegetation Monitoring and Management Programme to ensure this low risk is managed. Stygofauna may be present in creek areas impacted by drawdown, however FMG will implement a Stygofauna Management Plan, to manage this risk.

A series of mitigation measures have been developed to reduce the potential impacts of groundwater abstraction on the environment of the project area. These measures include:

- Siting of bores for the railway construction away from creek beds.
- Further development of groundwater impact models.
- Monitoring of regional groundwater levels.
- Monitoring of groundwater levels in the vicinity of operations.
- Monitoring of potentially impacted phreatophytic species and mitigation measures for decline in condition if identified.

A borefield management plan has been developed, which includes contingency plans for alternative supplies in the unlikely event that ongoing monitoring indicates the impacts from the proposed borefield will become unacceptable. FMG will also conduct further work prior to the development of the current borefield (as described in Section 8.2) so a contingency borefield can be developed if further work indicates the current borefield is not preferable.

FMG has commenced additional hydrogeological investigations in the vicinity of the water supply borefield, the proposed pits and the Fortescue Marsh. This involves the drilling of approximately 11 trial water supply bores which will be test pumped for extended periods using a submersible pump. In addition a series of monitoring bores will be installed which will be monitored during the test pumping. The information obtained will be used to provide additional information on the characteristics of the hydrogeology of the region

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APPENDICES

SECTION 1 - INTRODUCTION

Fortescue Metals Group Ltd (FMG) is proposing to mine at four sites in the East Pilbara. These sites are known as Mount Nicholas, Mount Lewin, Christmas Creek and Mindy Mindy. The locations of the proposed mines are shown in Figure 1.1, along with the key features of the project area.

Aquaterra has been asked to undertake hydrogeological investigations within the project area to:

1. determine dewatering requirements for each of the mine sites;
2. locate a potential borefield to provide a water supply for the ore beneficiation plant;
3. investigate the potential impacts of dewatering and the water supply, and
4. determine the impacts of abstraction of water during construction of the railway.

FMG have determined that the total water supply required at Christmas Creek, Mt Lewin and Mt Nicholas is 11 GL/a (30 ML/d), to be derived from a combination of dewatering and the borefield. Most of the water is required for an ore-beneficiation plant. In addition, approximately 0.4 GL/a will be abstracted from dewatering bores at Mindy Mindy (for a mine life of 6 years) and used for dust suppression, domestic purposes and ore moisture control (to prevent dust during transport and at the Port). The total life of the four mines is in excess of 20 years.

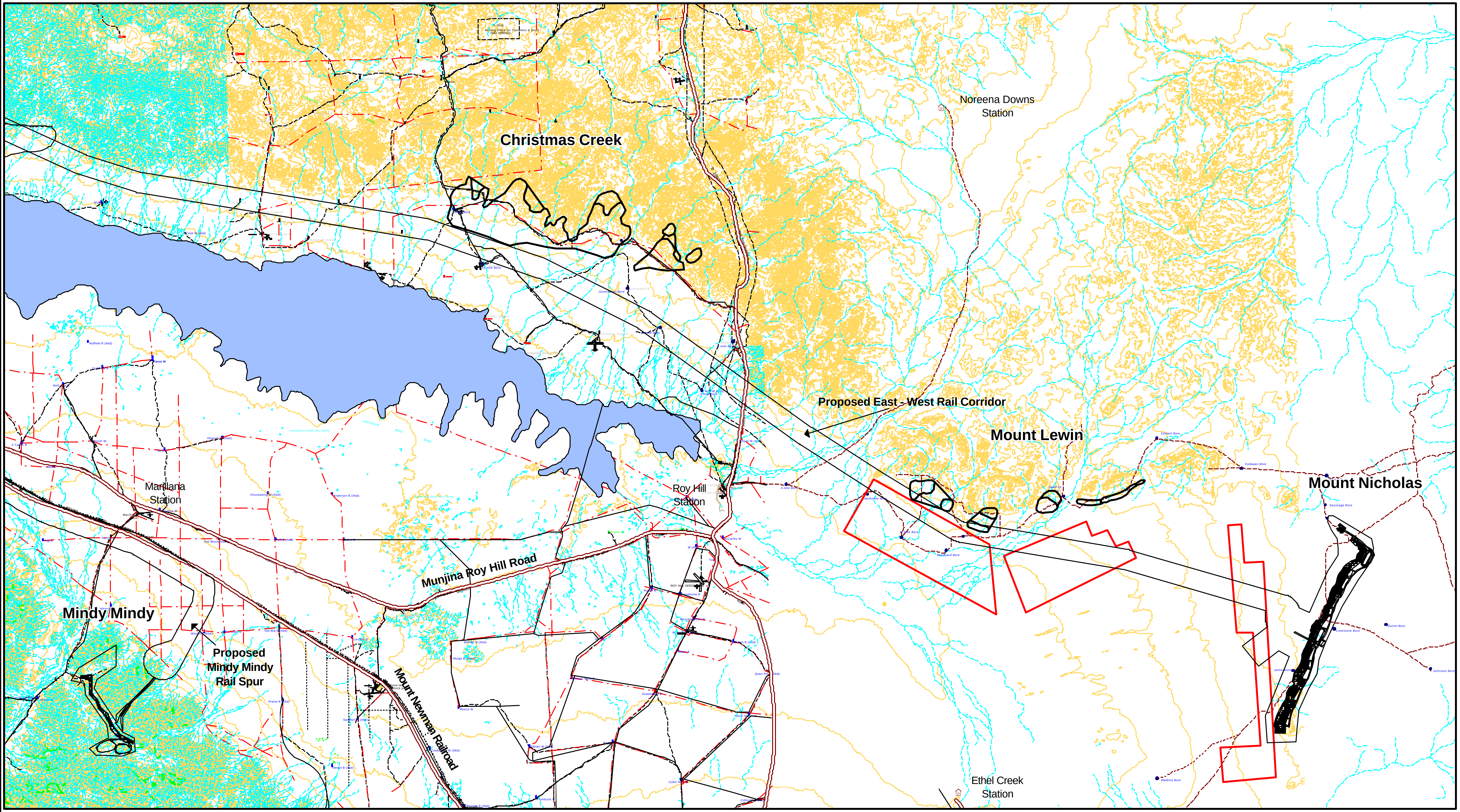
This report is a summary of the first phase of the investigations to date. It includes descriptions of the existing geology, climate and hydrogeology, and then details the methods used to determine the impacts of dewatering and the borefield abstraction on the environment. Key sections of the report contain a non-technical summary.

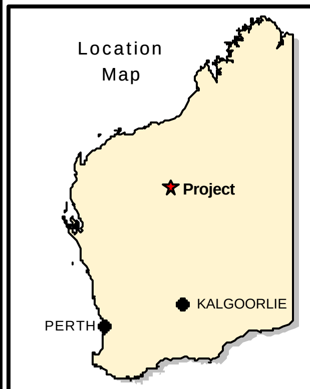
FMG and its consultants, Environ, have produced a Public Environmental Review (PER), which considers all likely environmental impacts from the mining operations on the environment. This report on the hydrogeology of the project area is used within the PER in two ways. Firstly, the complete report forms part of the technical appendix to the PER report where it is designed for those relatively familiar with geological and hydrogeological terms. Secondly, the non-technical summaries have been included in the main body of the PER report.

In any groundwater study it is necessary to make a series of modelling assumptions regarding aquifer recharge, storage and permeability. For this project Aquaterra have used results from the groundwater investigations undertaken as well as knowledge obtained from other projects undertaken in the Pilbara and published data for the area.

However, there is, at this stage, some uncertainty regarding the impacts of the groundwater abstraction on the environment, as there is not a wealth of historical data available for the area. However FMG will conduct further work prior to construction of the borefield (Section 8.2) to reduce this uncertainty and have developed a Borefield Management Plan, which identifies contingency plans, to ensure any impacts are predicted in advance and preventative action can be taken. As part of this plan, six alternative borefield sites have been identified which will be further investigated.

An environmental risk assessment, facilitated by an independent analyst and conducted by a team of qualified experts, was undertaken using the results of modelling conducted by Aquaterra, which identified the potential





Legend

- Fortescue Marsh
- Proposed Borefield

N

0 10 20 km

Fortescue Metals Group Limited

Figure 1.1 Project Location Plan

Author: Aquaterra	Date: 2 November 2004
Drawn By: Barbara Zakrzewska	Revised:
Dwg No.: 1.1	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 350 000

impacts of mining, including groundwater abstraction, on the marsh. The results of the risk assessment are presented under a separate report (minRISK, October 2004), but referred to within this report.

Aquaterra has also been commissioned to undertake a study on the impacts of the mine on the hydrology of the project area. The results of these investigations are in a separate report (Aquaterra, November 2004).

1.1 PREVIOUS EXPERIENCE

Aquaterra is a specialist hydrogeology and hydrology consultancy firm that has extensive experience in water resource investigation, development and management for mining projects

Aquaterra has considerable experience of the geology and hydrogeology of the Pilbara region. Some of our clients operating in similar environments to the FMG project include:

- Hamersley Iron.
- BHP Billiton Iron Ore.
- Robe River Mining.
- Hope Downs.

Investigations have included the assessment and modelling of dewatering requirements and water supply in both channel iron deposits and the Marra Mamba Iron Formation. This experience has enabled Aquaterra to bring considerable relevant expertise and knowledge to the FMG hydrogeology study.

SECTION 2 - THE GEOLOGY OF THE PROJECT AREA

2.1 NON-TECHNICAL SUMMARY OF THE GEOLOGY OF THE PROJECT AREA

2.1.1 Regional Geology

The project lies within the Hamersley Basin where granitoid rocks of the Pilbara Craton (2800 – 3500 million years old), are overlain throughout most of the project area by sedimentary rocks. The lowest of sedimentary group is known as the Fortescue Group, which is itself overlain in parts by the Hamersley Group. These sedimentary formations were originally formed in horizontal layers, but over time, tectonic movement has resulted in folding of the rocks and several major geological faults have developed. Weathering processes have resulted in erosion of some of these rocks into alluvium and colluvium. These eroded rocks include gravels, sands and clays, which have been deposited in the lower lying areas, including ancient river channels.

2.1.2 Mount Nicholas Geology

The iron ore at Mount Nicholas lies within the Hamersley Group, which has been sub-divided into different formations. The lowest formation is the Marra Mamba Iron Formation ("Marra Mamba"), which has been further divided into different members, of which the Nammuldi Member contains the highest ore grades. The Marra Mamba overlies the Jeerinah Formation, which is the top formation in the Fortescue Group.

At Mount Nicholas, the Nammuldi Member dips from southeast to northwest. To the west, it is concealed beneath layers of sands, clays and gravels, which are the weathered remnants of the surrounding rocks, whereas to the east, it has been eroded away and the underlying formations are now exposed at the surface. The iron ore therefore lies in a strip, which runs in a northeast – southwest direction.

Appendix B1 includes 4 typical cross-sections across Mount Nicholas, including a general geological sequence.

2.1.3 Mount Lewin Geology

Geologically, the Mount Lewin mine is similar to that at Mount Nicholas. As with Mount Nicholas the iron ore is located in the Nammuldi Member of the Marra Mamba Iron Formation. However, unlike Mount Nicholas where the Marra Mamba Iron Formation is completely covered by weathered material, there are areas in the northern sections of the Mount Lewin mine where the Marra Mamba outcrops at the surface.

Furthermore, whereas at Mount Nicholas the iron ore is in a strip orientated northeast – southwest, at Mount Lewin the ore lies in a strip that runs approximately southeast - northwest.

Appendix B2 includes 3 general cross-sections across Mount Lewin, including the main geological features.

2.1.4 Christmas Creek Geology

The geology at Christmas Creek is similar to that at Mount Lewin. However there are some subtle differences. As at Mount Lewin, the Marra Mamba Iron Formation at Christmas Creek dips in a southeasterly direction, but the gradient is shallower, so the formation appears at the surface as a broader outcrop than at Mount Lewin. Secondly, the weathered material overlying the southern section of the Christmas Creek mine is generally more coarse-grained than that overlying the southern area of Mount Lewin.

Appendix B3 includes cross-sections, showing the general geology across Christmas Creek.

2.1.5 Mindy Mindy Geology

The geological setting of Mindy Mindy is different to the other three sites. The ore is located in an ancient riverbed associated with the current-day Mindy Mindy Creek. Iron ore mineralisation in such Channel Iron Deposits (CID) results from chemical processes. At Mindy Mindy, this ancient channel passes through the Weeli Wolli Formation of the Hamersley Group for most of its length, with the most northerly section passing through Brockman Iron Formation. Unlike many CID deposits in the Pilbara, where the CID's occurrence is indicated by mesas formed by erosion of the surrounding rocks, the Mindy Mindy deposit lies below the surrounding topography.

Sections across Mindy Mindy are presented in Appendix B4.

2.1.6 Geology of the Water Supply Borefield

The proposed borefield is situated in a 60 km long arc along the foot slopes of Mount Lewin and Mount Nicholas.

The geology of the borefield area consists of gently dipping Marra Mamba Iron Formation, overlain in general by Wittenoom Dolomite and then by a sequence of clays, silts, sands and gravels. The Marra Mamba and dolomite dips gently in two directions; at Mount Lewin it dips in a southerly direction, whereas at Mount Nicholas the dip is to the northwest.

Where present, the surface of the Wittenoom Dolomite is generally weathered to a depth of 5 m, below which it contains occasional minor fracturing.

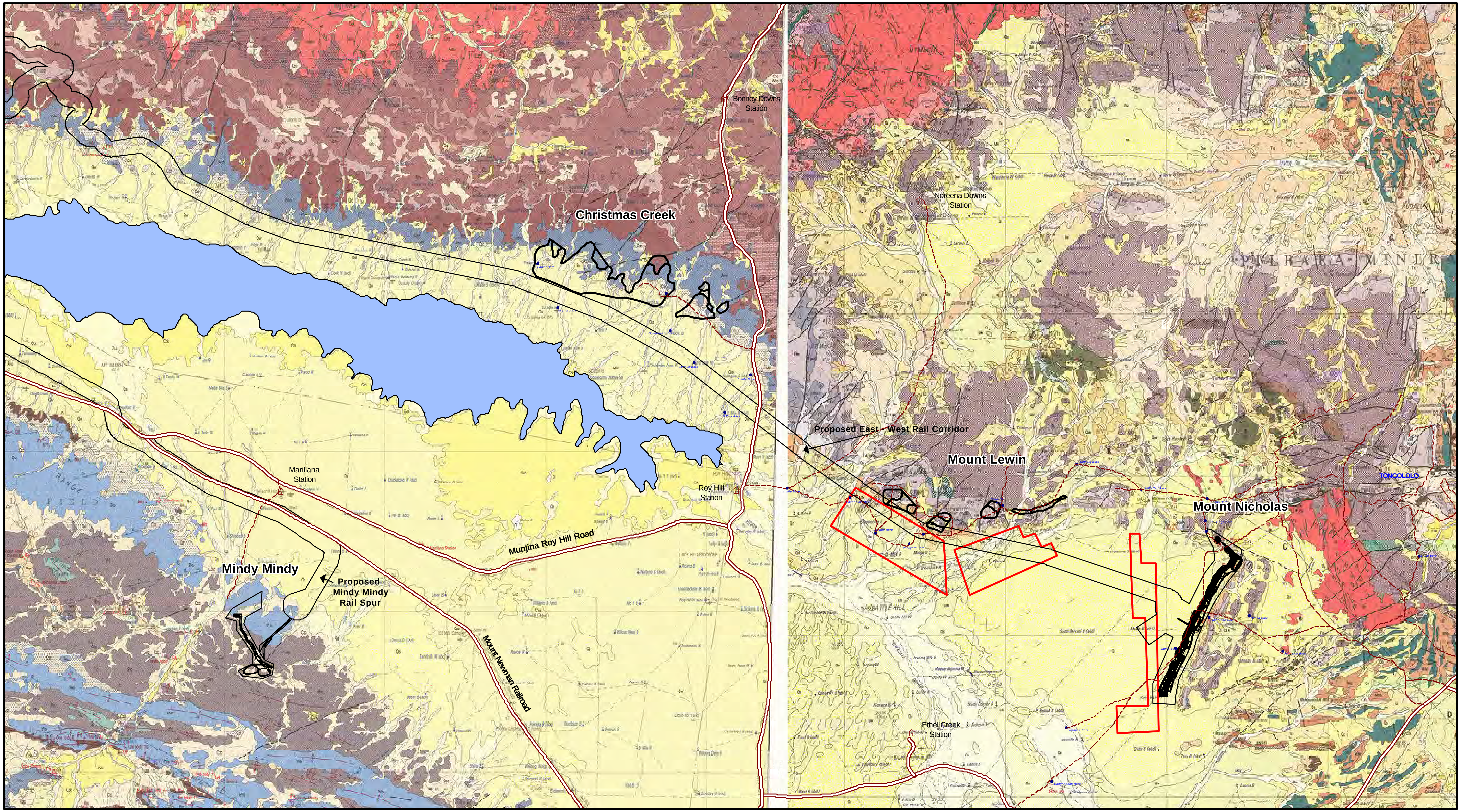
Where the Wittenoom Dolomite is not present the Marra Mamba consists of a weathered saprock, generally 10 m thick. Below this weathered surface, the Marra Mamba was typically represented by unweathered cherts, shales and BIF.

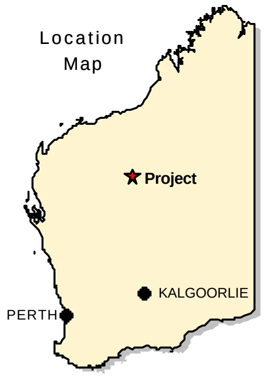
There are several alluvial fans within the northern part of the proposed borefield. Further south there is a series of faults, but it is likely that any voids associated with these features have been in-filled with overlying sediments.

2.2 TECHNICAL REPORT – PROJECT AREA

2.2.1 Regional Geology

The project area lies within the Hamersley Basin within the Pilbara region. A geological map of the area, with the mine locations superimposed is given in Figure 2.1. A summary of local stratigraphy relevant to this study is given in Table 2.1.





Legend

Fortescue Marsh

Proposed Borefield

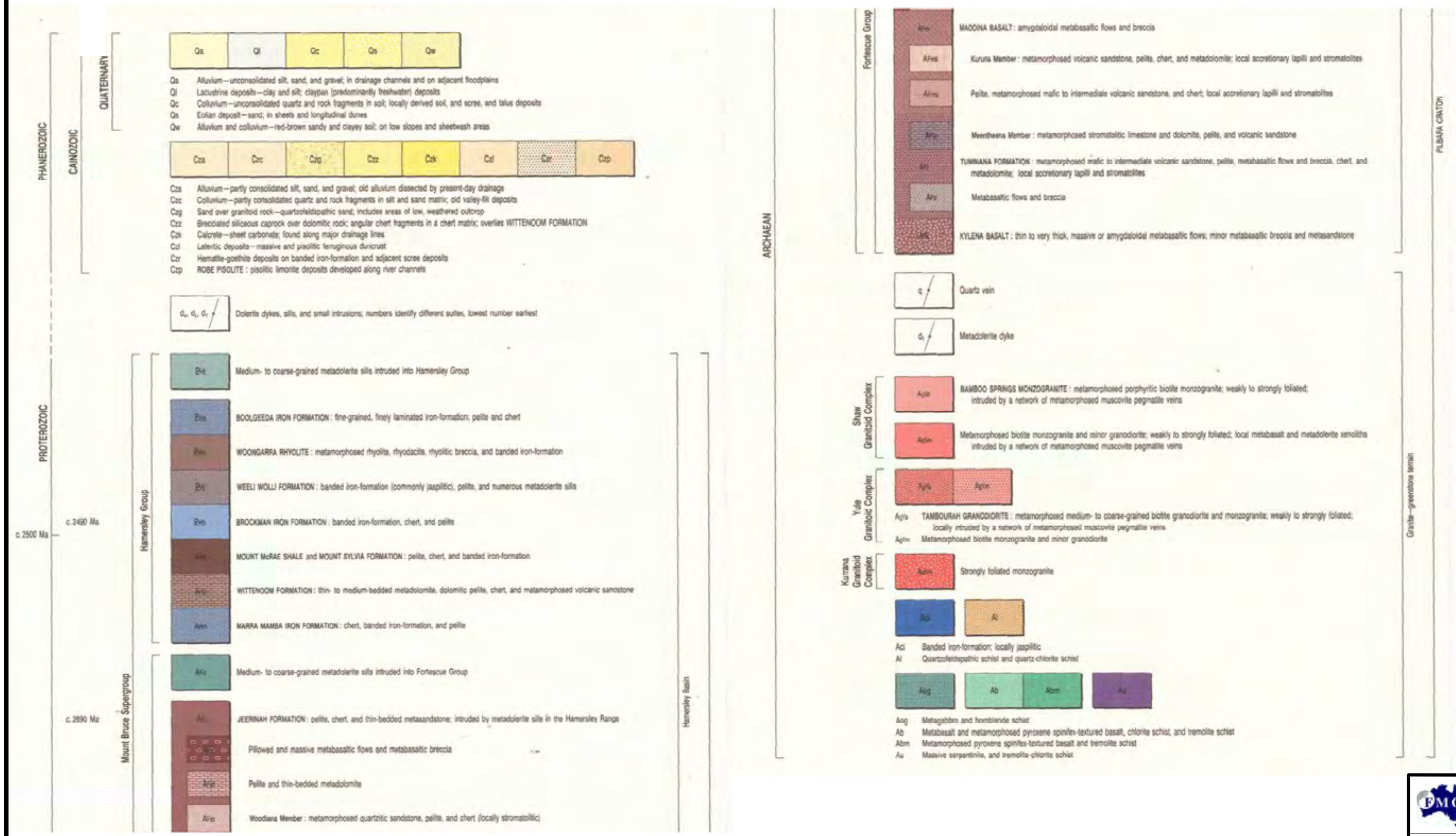
N

0 10 20 km

Fortescue Metals Group Limited

Figure 2.1 Geology of the Project Area

Author: Aquaterra	Date: 2 November 2004
Drawn: Barbara Zakrzewska	Revised:
Dwg No.: 2.1	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 450 000



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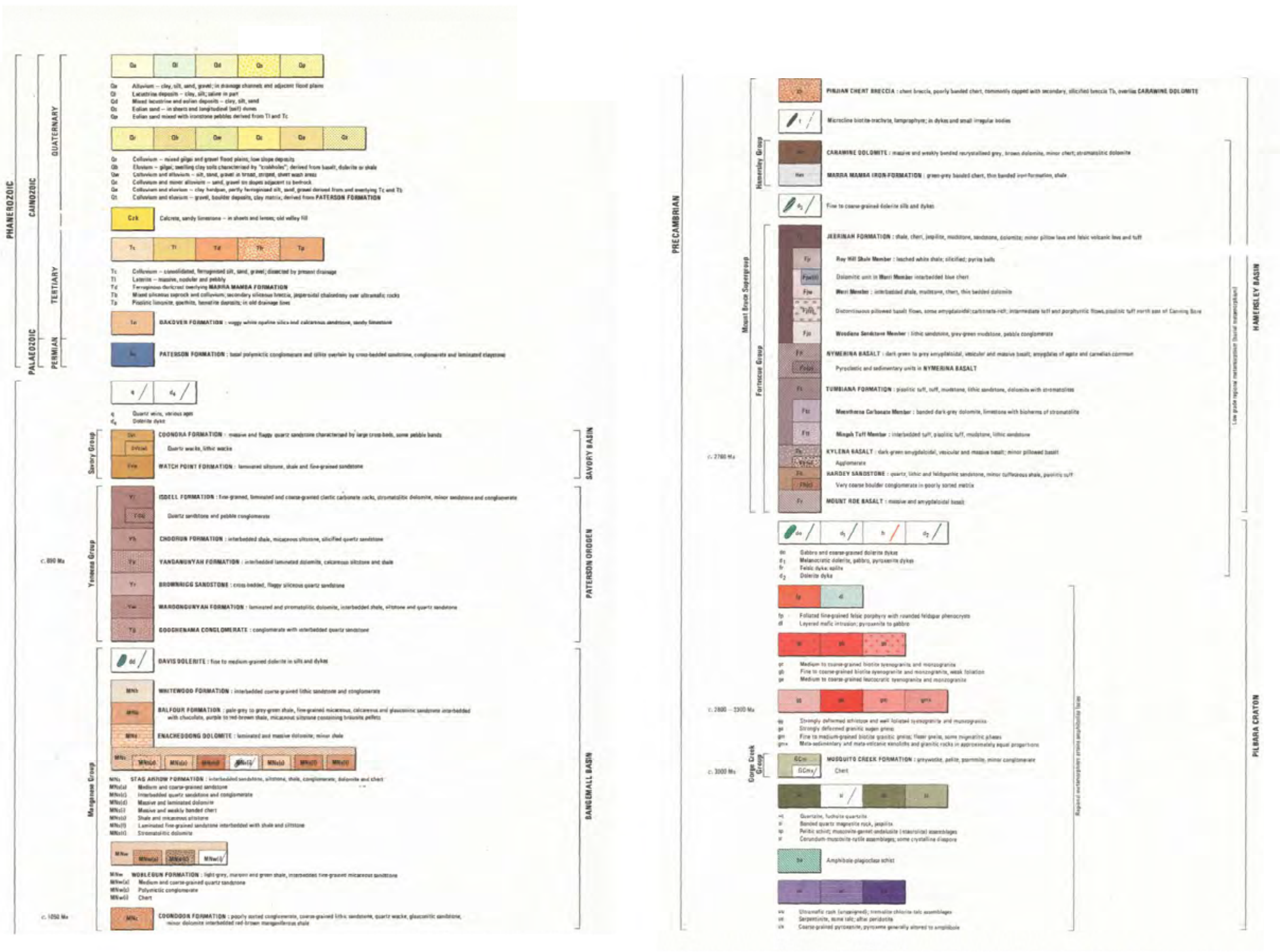
Legend for the Left Portion of Figure 2.1

Author: G. Harvey	Date: 21/10/04
Drawn By: G. Harvey	Revised:
Figure No.: 5b	Wkspc No.: WS0001-3.WOR
Projection: Non Earth	Scale:



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Legend for the Right Portion of Figure 2.1

Author: G. Harvey	Date: 21/10/04
Drawn By: G. Harvey	Revised:
Figure No.: 4b	Wkspc No.: WS0001-3.WOR
Projection: Non Earth	Scale:

Table 2.1
Stratigraphy of the Project Area

Group	Formation	Subdivision	Comments
Quaternary and Tertiary	Alluvium		Clay, silt, sands and gravel.
	Lacustrine Deposits		Clay and silt
	Colluvium and Alluvium		Clay, partly ferruginised silt, sand and gravel
	Ferruginous Duricrust		Overlying the Marra Mamba Iron Formation
	Channel Iron Deposits (CID)		Pisolitic Limonite developed along river channels.
Hamersley Group	Weeli Wolli Formation [1]		BIF [2], pelite and numerous metadolerite sills
	Brockman Iron Formation [1]		BIF, chert and pelite
	Mount McRae Shale [1]		Pelite, chert and BIF
	Wittenoom Dolomite		Thin to medium bodied metadolomite
	Marra Mamba Iron Formation	Mount Newman Member	BIF with thin shale intervals
		MacLeod Member	Shales, chert and BIF
		Nammuldi Member	Chert and iron-formation
Fortescue Group	Jeerinah Formation	Roy Hill Shale Member	Bleached white shale
Pilbara Craton			Granitic Rocks

[1] Only occurs south of the Fortescue River
[2] Banded Iron Formation

The Hamersley basin is underlain throughout by granitoid rocks, approximately 2800 to 3500 million years old, which form the Pilbara Craton. These rocks are mostly concealed by Proterozoic sedimentary rocks of the Fortescue and Hamersley Groups, however they do outcrop, e.g. east of Mount Nicholas.

The Fortescue Group, which is the lower of two sedimentary sequences, rests on weathered granite and metasedimentary rocks of the Pilbara Craton. The Jeerinah Formation is the youngest formation within the Fortescue Group, and is relevant to this project because its surface marks the base of the main ore body. The Jeerinah has been sub-divided into a number of members, of which the Roy Hill Shale is the uppermost; it is composed of bleached and silicified white to grey shale, and was intercepted in several of the bores drilled for the project.

The Hamersley Group conformably overlies the Fortescue Group. The basal Marra Mamba Iron Formation consists of inter-bedded iron-stained chert and shale. Outcrops occur in several areas, including the Christmas Creek and Mount Lewin mine sites. The Nammuldi Member is the lowest unit of the Marra Mamba, and is typically 60 m thick. In the project area, it consists of yellow-brown chert and brown to black iron-formation bands. The Nammuldi Member contains the ore body at the Mount Nicholas, Mount Lewin and Christmas Creek mines. The overlying MacLeod Member comprises thin shales, chert and Banded Iron Formation (BIF). Wittenoom Dolomite, which generally overlies the Marra Mamba, has been eroded in the proposed pits, however it was intercepted in bores in the vicinity of the proposed borefield. To the south of the Fortescue

River, the Wittenoom Dolomite is concealed by the Mount McRae Shale, the Brockman Iron Formation, and the Weeli Wolli Formation. The Mindy Mindy mine is mainly located on the Weeli Wolli Formation, with its most northern extent intercepting the Brockman Iron Formation.

The axis of the Hamersley Basin is marked by the presence of the Fortescue Marsh and Fortescue River systems. The relatively flat Fortescue Plain extends either side of the river. This is underlain by a flat-lying but complex sequence of Quaternary alluvial, colluvial and lacustrine sediments. The sequence has been deposited in a valley incised in the Hamersley Group, which forms the bedrock beneath the Fortescue Plain. The alluvial deposits increase in thickness down gradient towards the Marsh, where a maximum thickness of approximately 100 m has been recorded. Along the ephemeral creeks and riverbeds the alluvial sequence typically comprises of unconsolidated silt, sand and gravel, whereas finer-grained sediments including clays predominate across the adjacent flood plains.

2.2.2 Geology of Mount Nicholas

Mount Nicholas is an extension of the Chichester Range. The “Chichesters” are an outcrop of the Hamersley and Fortescue Groups, which dip gently beneath the Quaternary sequence, towards the northwest. At Mount Nicholas, the strike is in a northeast-southwest direction for most of the proposed mine area (20 km), with the most northerly section veering to the northwest.

The outcrop in the Mount Nicholas area is the Jeerinah Formation of the Fortescue Group. The overlying Marra Mamba has been eroded over much of the area, but remains in a 23 km long strip along the strike, concealed by a Ferruginous Duricrust. At Mount Nicholas, it is the basal Nammuldi Member of the Marra Mamba that contains the ore body.

Geophysical studies have bcated the presence of a series of faults across the Mount Nicholas mine, which typically have a northeast-southwest orientation.

The foot slopes of Mount Nicholas are concealed with a Quaternary alluvial and colluvial sequence, which increases in thickness down the dip slope. This sequence has been shown to consist mainly of fine-grained materials, with occasional lenses of gravel. There are four streambeds crossing the Mount Nicholas mine, associated with faults. Bore logs and hydraulic tests have indicted that the deposits in these features are more coarse-grained than the surrounding deposits. These features are typically 200 m across.

Bore logs are included in Appendix A1 and four sections across Mount Nicholas are included in Appendix B1.

2.2.3 Geology of Mount Lewin

The proposed mine at Mount Lewin will consists of two pits. At the first site, Lewin B and D, the rocks dip gently to the south, whilst to the west, in Lewin C and E, the dip is to the southwest.

At Mount Lewin, the iron ore lies within the Nammuldi Member of the Marra Mamba Iron Formation, which outcrops in a narrow strip (approximately 500 m wide) along the strike. At lower elevations, the Marra Mamba is first concealed below a Tertiary Ferruginous Duricrust, and then below a Quaternary sequence, consisting of mainly clays, but with lenses of gravels. The Quaternary sequence thickens towards the Fortescue River. There are two creeks in the Mount Lewin area, both which flow from northeast to southwest, and are filled in with alluvium. Kondy Creek dissects the Lewin E and C pit on the west from the B and D pit on the east. The Kulkinbah Creek forms the western boundary of Lewin E.

Bore logs for the hanging wall of Mount Lewin are included in Appendix A1 and geological sections across Mount Lewin are given in Appendix B2.

2.2.4 Geology of Christmas Creek

Geologically, Christmas Creek is a similar setting to Lewin E, but with some subtle differences. The main outcrop at Christmas Creek is the Marra Mamba and the underlying Jeerinah Formation, both these formations dip gently to the southwest towards the Fortescue Marsh. The Marra Mamba outcrop is approximately 2 km wide at Christmas Creek. The ore body lies within the Nammuldi Member of the Marra Mamba.

On the lower slopes at Christmas Creek, the Marra Mamba is partially concealed by Cainozoic Deposits of hematite and goethite, which are lithologically similar to the Tertiary Ferruginous Duricrust at Mount Nicholas and Mount Lewin. The overlying sequence includes a number of alluvial deposits associated with present-day creeks, including Christmas Creek. In general, this sequence has been shown to consist of argillaceous material, but does contain more coarse-grained material than at Mount Lewin and Mount Nicholas. The maximum thickness proven during the investigation was 60 m in bore F2.

Appendix A2 includes bore logs from the southern area of the proposed Christmas Creek pits, and Appendix B3 includes four cross sections.

2.2.5 Geology of Mindy Mindy

The proposed Mindy Mindy mine is located in a palaeo-valley within the Weeli Wolli Creek system; which is consistent with a present day drainage channel. The geology of the site is generally typical for the Central Pilbara area. The basement rocks have been eroded forming a palaeo-valley, which is in-filled with channel iron deposits (CID) and alluvium/colluvium. The main valley appears to thin halfway along the site.

Alluvium is absent at the head of the valley (in the south-east). But the depth of alluvium increases down the valley with depths up to approximately 40 m within the main palaeo-valley feature. Greater thicknesses of alluvium occur downstream in the vicinity of the bend in the main valley in the north of the site. Thicknesses of greater than 90 m were recorded to the northwest of the bend.

Scree occurs in the upper part of the valley. The scree is typically 2 to 4 m thick, although greater thicknesses (up to 15 m) are observed halfway down the valley where the valley thins.

A Channel Iron Deposit (CID) has been deposited within the palaeo-valley. The CID is up to 34 m thick. The CID is typically goethitic and limonitic, and is pisolitic in parts. The upper surface of the CID has been weathered forming a Surface Weathered Profile (SWP).

Basement rocks in the area comprise the Brockman Iron Formation and the Weeli Wolli Formation of the Hamersley Group. The Weeli Wolli Formation forms the basement to most of the site. The Weeli Wolli Formation comprises banded iron-formation (BIF) together with shale and dolerite. The Brockman Iron Formation forms the basement in the north of the site; it comprises banded iron formation with shale and chert.

Sections across Mindy Mindy are given in Appendix B4.

2.2.6 Geology of the Water Supply Borefield

The proposed borefield is situated in a 60 km long arc along the foot slopes of Mount Lewin and Mount Nicholas. This area was selected following a geological desk study that indicated the presence of faults and alluvial deposits, and suggested increased permeability.

Geophysical techniques were used to determine the location of these faults and alluvial features, especially outwash fans associated with the ephemeral creeks. Twenty-nine exploratory bores were then drilled in the borefield at sites intercepting these features.

The geology of the borefield area consists of gently-dipping Marra Mamba Iron Formation, overlain in general by Wittenoom Dolomite and then by a Quaternary sequence of colluvium, alluvium and eolian sand. The Marra Mamba and dolomite was shown to dip gently in two directions; south of Mount Lewin it dips in a southerly direction, whereas at Mount Nicholas the dip is generally to the northwest.

Drill logs showed that, where present, the Wittenoom Dolomite was generally weathered to a depth of 5m (eg bore WSE54), below which it contained minor fracturing but was generally fresh. The maximum proven thickness was in excess of 40 m.

Where the Wittenoom Dolomite was not present (eg bore WSE37), the Marra Mamba was often represented by a weathered saprock, which was up to 40 m thick close to drainage systems, but more generally 10 m thick. Below this weathered surface, the Marra Mamba was typically represented by unweathered cherts and shales.

The Quaternary sequence in the borefield area consists of alternating bands of colluvium and alluvium. The uppermost layer within the sequence is generally colluvial sand, except at the base of the slopes where there are extensive surface deposits of colluvium with alluvium, and in drainage channels, which contain alluvial deposits.

There are several faults across the borefield location. These trend northeast–southwest. Alluvial fan development through the northern outcrop of Mt Nicholas can be related to these northeast-southwest trending structural lineaments. These fans are associated with higher yielding groundwater occurrences and increased permeability. Further south, and also associated with lineaments, there are occasional high permeability zones of deeper fractured/karstic, transitionally weathered Wittenoom Dolomite, typically at 80-120 metres depth. Secondary permeability is developed locally, but is uncommon suggesting that any voids have been mostly in-filled with overlying sediments.

SECTION 3 - CLIMATE & HYDROLOGY OF THE PROJECT AREA

3.1 THE CLIMATE OF THE PROJECT AREA

The climate of the Pilbara is classified as arid-tropical, with two distinct seasons, a hot summer from October to April and a mild winter from May to September. There are two main rainfall systems; the northern rainfall system of tropical origin and the southern winter rainfall system. This results in a bi-modal rainfall distribution with a peak occurring between January and March as a result of moist tropical systems followed by significant rainfall occurring between May and June, resulting from cold fronts moving from the south, occasionally extending into the Pilbara. Table 3.1 shows climatic data for Newman, situated approximately 100 km south of the project area, and the nearest station with a long-term record.

Table 3.1
Summary of Climate Data for Newman

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Mean Daily Max Temp	38.8	37.2	35.8	31.6	26.2	22.4	22.2	24.8	29.4	33.6	36.5	38.5	31.3
Mean Daily Min. Temp (°C)	25.3	24.4	22.5	18.5	13.3	9.6	8.0	10.2	23.7	18.0	21.5	24.1	17.3
Mean 9am Rel. Hum. (%)	35.0	41.0	37.0	41.0	49.0	56.0	50.0	43.0	30.0	25.0	24.0	30.0	39.0
Mean 3pm Rel. Hum. (%)	22.0	26.0	23.0	26.0	32.0	34.0	29.0	24.0	17.0	14.0	24.0	19.0	24.0
Mean monthly rainfall (mm)	51.0	80.0	39.0	25.0	23.0	25.0	13.0	11.0	4.0	4.0	10.0	27.0	312.0
Highest monthly rainfall (mm)	226.0	286.0	199.0	212.0	119.0	156.0	64.0	96.0	43.0	23.0	63.0	140.0	286.0
Highest recorded daily rainfall (mm)	142.0	151.0	108.0	72.0	47.0	101.0	29.0	36.0	31.0	17.0	57.0	63.0	151.0
Mean 3pm wind speed (km/hr)	10.1	10.7	8.8	7.7	7.9	8.3	9.3	92.0	20.2	11.0	10.2	9.6	9.4

Record 1965 - 2003

3.2 REGIONAL HYDROLOGY

The hydrology of the region is discussed in more detail in a separate report (Aquaterra, November 2004) but is briefly summarised below.

The proposed FMG mining areas are located in the vicinity of the Fortescue Marsh in the Upper Fortescue River Catchment. In common with other areas in the Pilbara Region, the Fortescue Valley is subjected to localised thunderstorm and cyclonic rainfall events. Due to the low rainfall and brief wet season, most watercourses flow, if it all, for only brief periods. However surface water does remain available all year in some river pools, waterholes and springs.

On the southern and northern flanks of the Fortescue Valley, numerous creeks discharge to the marshes. On the lower less steep valley flanks, rainfall runoff tends to flow overland rather than along defined creek courses. These water courses and sheetflow areas frequently support scrub and mulga woodlands, particularly in the lower lying areas. The Fortescue River and other main channels entering the marshes typically support eucalypt woodland in their floodplains.

The Goodiadarrie Hills, located on the valley floor around 60 km east from the town of Wittenoom, effectively cuts the Fortescue River into two separate river systems. West from the Goodiadarrie Hills, the Lower Fortescue River Catchment drains to the coast, whereas east from the hills the Fortescue Marshes receives drainage from the Upper Fortescue River Catchment. The alluvial outwash fan from the Weeli Wolli Creek system abutting the Goodiadarrie Hills is believed to be partially responsible for this obstruction to the Fortescue River and forming the Fortescue Marsh.

3.2.1 Hydrology of the Fortescue Marsh

The Fortescue Marshes is an extensive intermittent wetland occupying an area around 100 km long by typically 10 km wide located on the floor of the Fortescue Valley. The marsh has an elevation around 400 mRL. To the north, the Chichester Plateau rises to over 500 mRL, whereas to the south the Hamersley Range rises to over 1000 mRL. Following significant rainfall events, runoff from the approx 31,000 $km^{2,}$ upper Fortescue River Catchment drains to the marshes. For the smaller runoff events, isolated pools form on the marshes opposite the main drainage inlets, whereas for the larger events the whole marsh area floods.

Published topographical mapping indicates that bed levels in the Fortescue Marshes predominantly lie between 400 mRL and 405 mRL and that a flood level in the Marsh would need to be around 415 mRL to overspill westwards past the Goodiadarrie Hills. Limited flood level data is available for the marsh. Enquires with BHPBIO indicate that flood levels have never overtopped their marsh railway crossing, although large floods in the early 1970’s are reported to have caused inundation up to the existing railway track level (pers. com. Geoff Liddell, BHPBIO).

On the upstream edge of the marsh, downstream from the Roy Hill Homestead, the Roy Hill streamflow gauging station (S708008) was operating from September 1973 to September 1986. This station was established to monitor streamflows entering the marsh from the upper Fortescue River. At the gauging station, the main flow channel bed level was around 405.5 mRL and during the 13 years of record, the maximum recorded streamflow level was 408.75 mRL (Feb. 1980). The corresponding flood storage level in the downstream marsh would have been less than this gauge level.

Surface water runoff to the marsh is of low salinity and turbidity, though the runoff turbidity increases after periods of flooding. Following a significant flood event that flooded the whole marsh area, the ponded water could be over 5 m deep in the lower elevation marsh areas. Water stored on the marsh slowly dissipates through the processes of seepage and evaporation, and the aerial extent of the marsh decreases, becoming a series of pools, until the surface water completely dries up. During the evaporation process, the water salinity levels increase and as the ponded area recedes, traces of surface salt can be seen.

SECTION 4 - EXISTING HYDROGEOLOGY OF THE PROJECT AREA

4.1 NON-TECHNICAL SUMMARY OF THE EXISTING HYDROGEOLOGY

Following a desk study and literature review the existing hydrogeology of the area has been investigated using a variety of techniques, including:

- The drilling of exploratory bores, using a reverse circulation (RC) drilling rig, to determine the presence of aquifers and groundwater levels.
- Installation of nested piezometers between the Fortescue Marsh and Christmas Creek Mine, to establish information on any potential interconnectedness of aquifers.
- Hydraulic tests to determine the permeability of the relevant geological formations.
- Groundwater sampling and analysis to provide information of the chemistry of the groundwater.
- Geophysical techniques to identify hydrogeological features.

4.1.1 Regional Hydrogeology

In general, the water table throughout the region is a subdued reflection of the topography, so that groundwater levels are generally highest along topographic high points, and lowest in valley locations. However, because groundwater gradients are generally shallower than topography, the depth to the water table is generally least in low-lying areas and greatest along the mountain ridges. As a result, the Nammuldi Member, which dips across the Hamersley Basin, tends to be below the water table where it occurs in low-lying areas, and above the water table at higher elevations.

4.1.2 Mount Nicholas Hydrogeology

Investigations undertaken to date indicate the occurrence of two aquifers within the area of the proposed mine; both drain from east to west, towards the Fortescue River.

The most extensive aquifer is associated with an alluvial sequence that extends southeast from the lower slopes of the hills (below 480 mRL) across to the Fortescue River channel. The alluvial deposits consist of clays, silts, sands and gravels and extend to depths of 70 m. Over most of the area, low permeability clays with occasional sand and gravel lenses dominate the alluvial sequence. In these areas, the permeability is typically low (0.1 m/d). At some locations however, higher proportions of sands and gravels occur within alluvial fans and, in these areas, permeability values of 0.5 m/d have been recorded. Mineralised sections of the Nammuldi Member form a second aquifer.

Geophysical studies indicate the presence of significant faulting across Mount Nicholas. In general, these faults trend in a northeast-southwest orientation. Drilling amongst these faults has indicated that there is little evidence of increased permeability along these features.

Groundwater levels across Mount Nicholas have been measured in mineral bores, and bores drilled for the hydrogeological investigation. The data show that groundwater levels vary from approximately 410 mRL in the lower slopes at the southern end of the deposit, to 485 mRL along the eastern ridge, in the northern-most part of the mine. Contouring of the groundwater levels shows that the water table is generally flat in the southern part of the mine, but there is an east-west hydraulic gradient in the northern sections.

During the hydrogeological investigations, water quality samples were taken from the bores that intercepted the water table. Groundwater in the region was found to be generally fresh, with total dissolved solids (TDS) of typically in the order of 1,000 mg/L.

4.1.3 Mount Lewin Hydrogeology

Bore drilling at, and in the vicinity of, the mine has determined that, as with Mount Nicholas, there are two aquifers to consider. The first is the alluvium, which, as at Mount Nicholas, has been shown to consist mainly of clay and fine-grained material. The second is the mineralised Nammuldi Member. At Mount Lewin, these aquifers dip in a southeasterly direction.

The Mount Lewin mine is bounded on the west by the Kulkinbah Creek and is dissected by the Kondy Creek. Both these creeks flow from northeast to southwest and into the Fortescue River. These creeks have been shown to be closely aligned to geological faults and have extensive alluvial fans associated with them. These fans consist of higher permeability material than the surrounding alluvial clays.

Groundwater levels have been obtained from approximately 40 bores in and around the proposed mine. The data show that groundwater levels in Lewin B are fall from approximately 420 mRL along the northern ridge, to 400 mRL in the southern most portions of the mine. Groundwater levels in Lewin C and Lewin E have a maximum elevation of approximately 440 mRL in the north, falling to approximately 415 mRL in the south.

Water quality analysis showed that water in the ore body and in the alluvium was fresh, with TDS typically 2000 mg/L.

4.1.4 Christmas Creek Hydrogeology

There has been an extensive programme of bore drilling, hydraulic testing and water sampling in the Christmas Creek area to determine the existing hydrogeology. In particular, studies have been undertaken to determine the relationship between the Fortescue Marsh and surrounding aquifers.

The investigation has shown that there are two aquifers in the vicinity of the mine, and a third to the south, close to the Fortescue Marsh. The first is within the alluvial deposits that occur below 450 mRL, and which dip to the southwest, becoming increasingly thicker towards the Fortescue Marsh where the sequence was proven to be 60 m thick. These deposits consist mainly of fine-grained material, with occasional gravel lenses. Hydraulic tests have shown that the alluvium is more permeable that at Mount Nicholas, with values of the order of 1 m/d.

The second aquifer is the Nammuldi Member of the Marra Mamba Iron Formation, which dips in a southwesterly direction to a depth of approximately 100 m. Tests have indicated that permeability values are generally in the order of 3 m/d.

In one bore, (F2), Wittenoom Dolomite was encountered at depth. This formation, which is part of the Hamersley Group, is an aquifer in other parts of the Pilbara.

Measurements have shown that to the north of the rail corridor the water table is generally below the base of the alluvium, but that on, and south of, the proposed railway, the alluvium is partially saturated. Water samples have shown that groundwater in the alluvium is generally fresh with TDS typically 1,600 mg/L. The salinity of water in the alluvium increases towards the Fortescue Marsh, with a maximum value of 5,700 mg/L measured.

In the northern tenements, the Nammuldi Member is above the water table. Measurements in bores in the southern parts of the proposed mine show that the ore is partially or fully saturated with fresh groundwater, but that, below the ore zone, saline water occurs. Drilling to the south of the proposed mine indicates that the Mara Mamba and Jeerinah Formations are saturated with saline water. Measurements of TDS in bores intercepting saline water were typically in the order of 160,000 mg/L.

4.1.5 Fortescue Marsh Hydrogeology

The data available indicate that ponded water in the Fortescue Marsh is a result of rainfall rather than as a result of groundwater discharge. During rainfall events surface water flows into the marsh via the various surrounding creeks. Evaporation from the marsh results in concentration of salts into brine, which seeps into the underlying deposits making them saline. Groundwater in aquifers along the flanks of the Fortescue Valley is fresh due to recharge during rainfall events.

Monitoring of groundwater levels in specially constructed bores (including nested piezometers) close to the Fortescue Marsh indicate that the relatively fresh water in the alluvium and the saline water in the Marra Mamba and Jeerinah Formations have the same potentiometric head.

From the water samples taken, it is evident that the salinity of groundwater in the alluvium, Marra Mamba and Jeerinah formations increases towards the Fortescue Marsh. The highest recorded salinity in the Fortescue Marsh itself was in October, when TDS was 9,000 mg/L, an order of magnitude lower than the saline groundwater in the underlying Marra Mamba and Jeerinah Formations, but similar to values in the alluvium.

The Goodiadarrie Hills are situated approximately 70 Km west of the proposed Christmas Creek pit. As a result there is narrow restriction across the Fortescue Valley, which effectively prevents any westward migration of groundwater.

4.1.6 Mindy Mindy Hydrogeology

The alluvium forms a primary porosity aquifer where saturated. However, the alluvium is generally only saturated in the centre of the valley in the northwest of the site. The alluvium is likely to be in hydraulic continuity with the underlying CID.

A Channel Iron Deposit (CID) has been deposited within the palaeo-valley. The CID is up to 34 m thick. The CID is typically goethitic and limonitic, and is pisolitic in parts. The CID is typically highly porous and vuggy with significant secondary permeability from joints and solution cavities. The upper surface of the CID has been weathered forming a Surface Weathered Profile (SWP). The SWP is likely to have a higher permeability than the unweathered CID due to greater degree of weathering enhancing the secondary porosity.

Basement rocks in the area comprise the Brockman Iron Formation and the Weeli Wolli Formation of the Hamersley Group. The Weeli Wolli Formation forms the basement to most of the site. The Weeli Wolli Formation comprises banded iron-formation (BIF) together with shale and dolerite. The Brockman Iron Formation forms the basement in the north of the site. The Brockman Iron Formation comprises banded iron formation with shale and chert. The Weeli Wolli Formation and Brockman Iron Formation form fractured rock aquifers, with secondary porosity from fractures, ore-mineralisation, weathered horizons, joints and bedding planes. The Weeli Wolli and Brockman Formations are generally considered to form poor aquifers.

The depth to groundwater ranges from approximately 8 m below ground level (mbgl) to 50 mbgl. There is a groundwater divide in the south of the mine. Groundwater levels in the south of the mine at the groundwater divide, have an elevation of approximately 497 mRL falling to approximately 495 mRL to the south and 438 mRL in the northwest. Groundwater flows approximately southeast to northwest north of the divide and northwest to southeast south of the divide.

4.1.7 Hydrogeology of the Water Supply Borefield

The borefield is situated in an arc along the foot slopes of Mount Nicholas and Mount Lewin. The hydrogeology of the borefield therefore reflects the hydrogeology of these two mine sites.

The target aquifers during the exploratory drilling programme were the alluvial deposits, particularly where incised in basement rocks along creek beds, and Wittenoom Dolomite.

The alluvial aquifer is a sequence of clay, silts, sands and gravels, which is typically 50 m thick, and saturated in the basal 20 m. This aquifer is thicker along creek systems, where it extends to 113 m. The alluvium is generally of low permeability, but at some locations, along river creeks, has moderate permeability (0.4 m/d).

The Wittenoom Dolomite was found to be generally weathered to a depth of 5m below which it was poorly fractured, but there were occasional voids, possibly associated with geological faulting. Where the dolomite is absent the alluvium lies on the Marra Mamba Iron Formation, which is generally weathered to a saprock across its surface, to a depth of 10 m.

Groundwater levels throughout the borefield are typically 30 m below ground level, equivalent to 420 mRL. Water levels dip towards the Fortescue River, where they are generally 400 mRL. Water in the alluvial aquifer is typically potable or sub-potable.

4.2 TECHNICAL REPORT – EXISTING HYDROGEOLOGY

4.2.1 Methods Used

Following a desk study and literature review the existing hydrogeology of the area has been investigated using a variety of techniques, including:

1. Geophysical techniques (including aeromagnetic surveys) to locate hydrogeological features, in particular the location of the proposed water supply borefield.

2. The drilling of exploratory bores to determine the presence of aquifers and groundwater levels. Bores were drilled in potential dewatering zones at Mount Nicholas, Mount Lewin and Christmas Creek, and in the proposed water supply borefield area. Additional drilling was undertaken south of Christmas Creek to gain understanding of the relationship between groundwater and the Fortescue Marsh.
3. Hydraulic (falling and raising head) tests to determine the permeability of the relevant geological formations.
4. Groundwater sampling and analysis to provi de information on the chemistry of the groundwater, and in particular aquifers between Christmas Creek and the Fortescue Marsh.
5. Numerical groundwater modelling techniques to simulate existing groundwater systems and enable assessment of the impacts of proposed dewatering and abstraction for the water supply.

4.2.2 Regional Hydrogeology

Regional groundwater levels were obtained from the Department of the Environments AQWABASE system. These data were combined with groundwater measurements from the bores drilled for the project and used to construct regional groundwater contour plots. Figures 4.1 and 4.2 show these contours as meters above reduced level (mRL) and meters below ground level (mbgl).

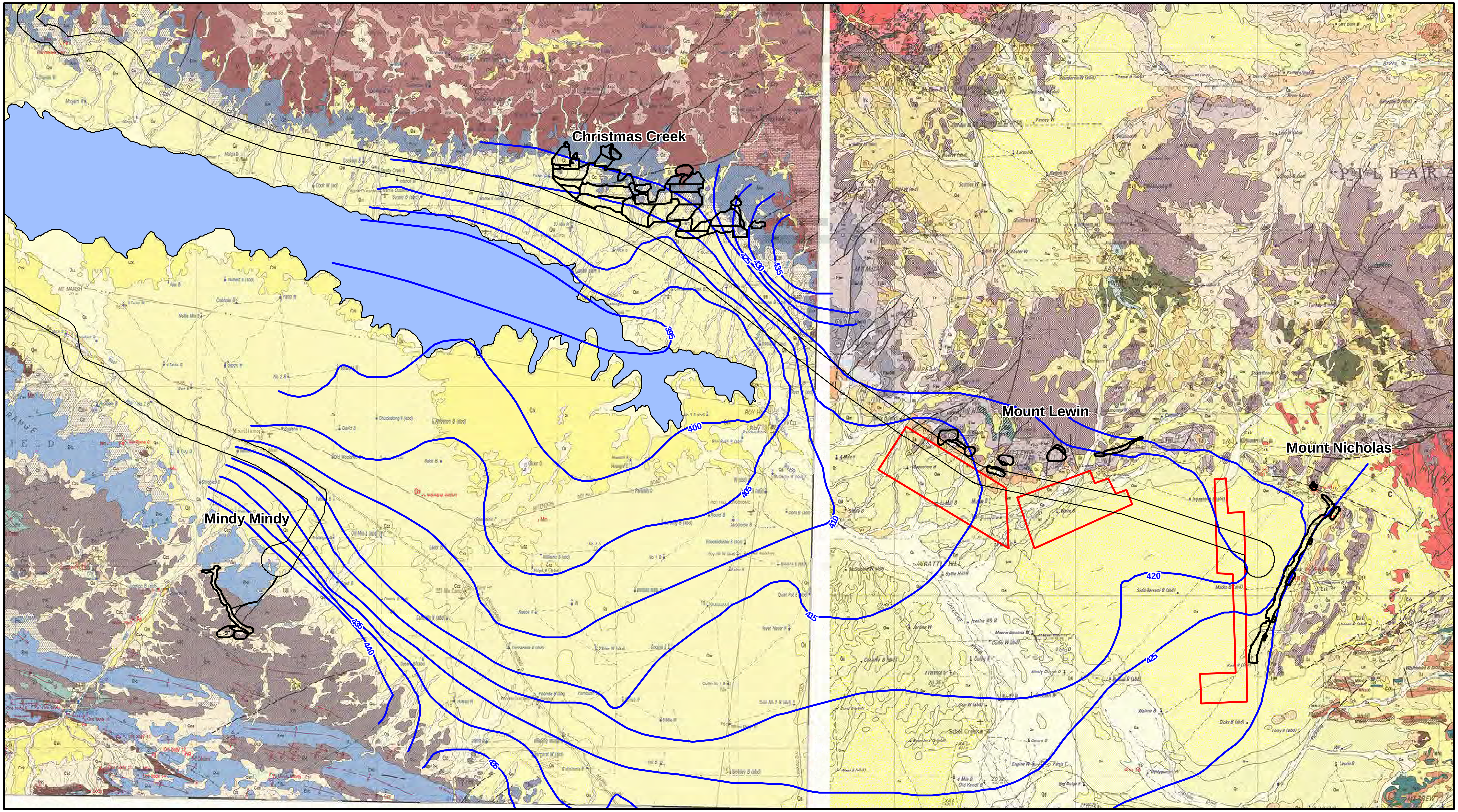
In low-lying areas, particularly along the Fortescue Marsh, Fortescue River and major creek systems, depth to water are typically less than 10 m. At sites on the flanks of the Fortescue Valley groundwater levels are typically at depths of 20 m or more.

Throughout the region groundwater levels are a subdued reflection of topography. Maximum groundwater levels (approximately 500 mRL) were observed along the topographic highs associated with rocks of the Hamersley and Fortescue Groups, whilst groundwater levels were lowest in low-lying areas associated with creeks and the Fortescue Marsh and Fortescue River system. It is important to note that groundwater levels in the vicinity of the Fortescue Marsh are generally below 400 mRL, which, as discussed in Section 3, represents the bed of the marsh. The impact of this is discussed in detail later.

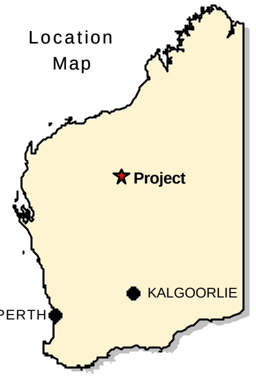
As with the geology, there are two distinctly different hydrogeological regimes within the project area. The first is associated with the three mines located north of the Fortescue River and Marsh (Mount Nicholas, Mount Lewin and Christmas Creek) and the borefield, and the second is associated with the Mindy Mindy area to the south.

In the three mines to the north of the Fortescue River there are two extensive aquifers; an alluvial aquifer within the Quaternary sequence discussed in Section 2, and the upper portion of the Marra Mamba formation where it is either mineralised or weathered. In the borefield the Wittenoom Dolomite was encountered below the alluvium at bore sites west of Mount Nicholas. The Wittenoom Dolomite is an important aquifer in parts of the Pilbara.

Typically the alluvial aquifer is not saturated at the foot slopes (for example WSE026 which intercepted 50 m of alluvium, but where the water table was 55 mbgl). However, in areas along the foot slopes where creeks have incised into basement rocks, the alluvium can be saturated throughout much of its thickness. For example,



Location Map



Legend

Fortescue Marsh

Proposed Borefield

Mine Pit Outline

Groundwater Contour

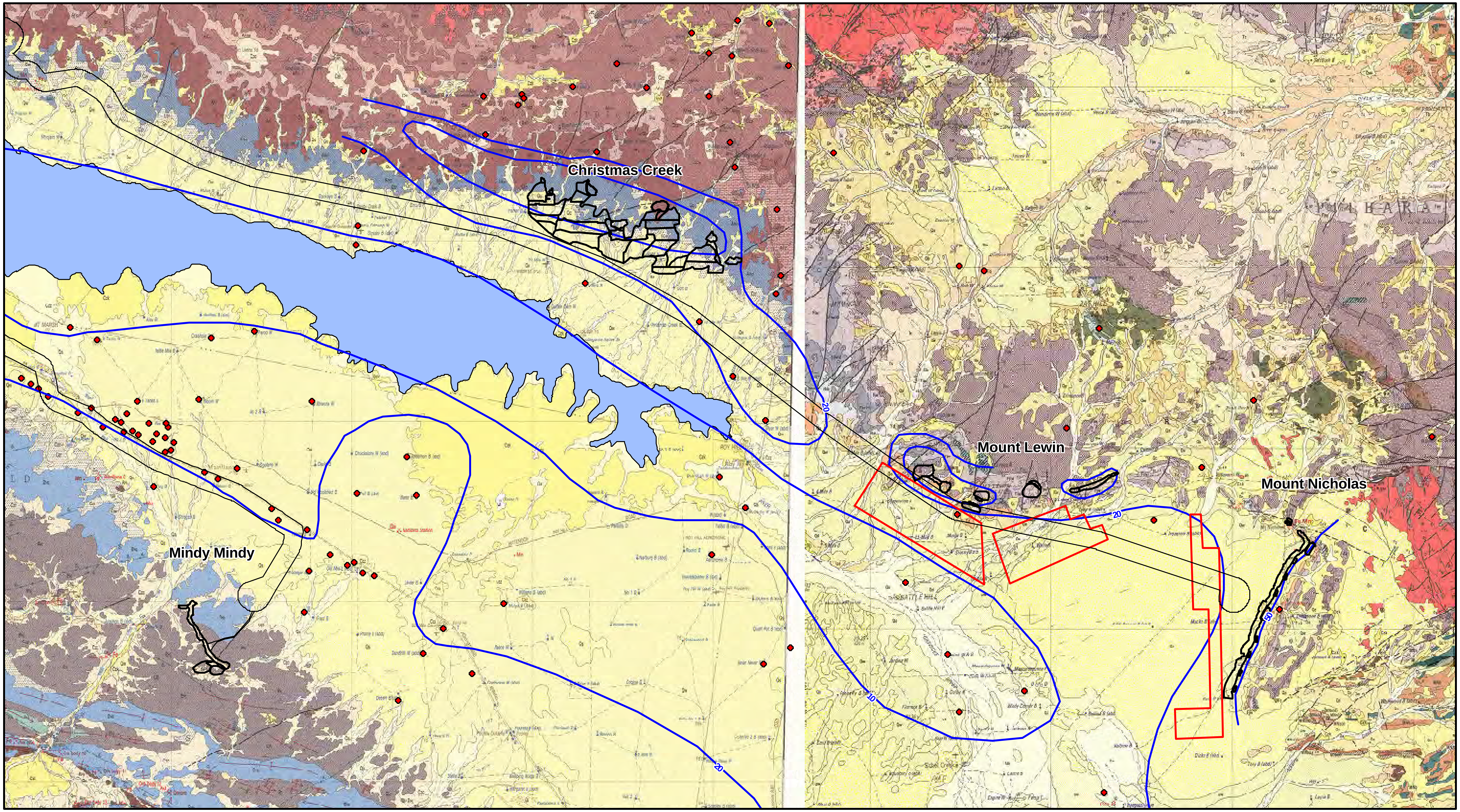
N

0 10 20 km

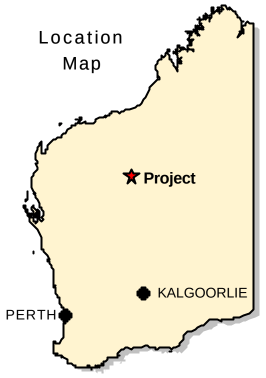
Fortescue Metals Group Limited

Figure 4.1 Regional Groundwater Contour Plan

Author: Aquaterra	Date: 3 November 2004
Drawn By: Barbara Zakrzewska	Revised: 06/01/05
Dwg No.: 12	Report No.: 477-12a
Projection: AMG zone 50	Scale: 1 : 400 000



Location Map



Legend

- Fortescue Marsh
- Proposed Boreholes
- Mine Pit Outline
- Groundwater Contour
- Regional Monitoring Bore

N

0 10 20 km

Fortescue Metals Group Limited

Figure 4.2 Depth to Groundwater Table

Author: Aquaterra	Date: 3 November 2004
Drawn By: Barbara Zakrzewska	Revised: 10/01/05
Dwg No.: 13	Report No.: 477-12b
Projection: AMG zone 50	Scale: 1 : 400 000

bore WSE016, which was drilled close to the channel of an unnamed creek between Mount Nicholas and Mount Lewin, intercepted an alluvial sequence 113 m thick, of which 83 m was saturated. Away from the foot slopes, and towards the marsh, the basal 20 m of alluvium is saturated, for example bore WSE042b.

The Marra Mamba aquifer is typically 20 m thick and is generally saturated, except at higher elevations. Where intercepted, the weathered Marra Mamba (saprock) was typically 10 m thick, but a maximum thickness of 40 m was intercepted in bore WSE028.

The Wittenoom Dolomite was fully saturated where encountered, but generally of low permeability.

Details of the hydrogeology of each mine site are given in the sub-sections below.

4.2.3 Mt Nicholas Hydrogeology

Bores drilled to identify mineral deposits have been used, along with information obtained from bores drilled for the hydrogeological investigation, to provide information on the hydrogeology of the Mount Nicholas area. The depth to groundwater ranges from approximately 25 m below ground level (mbgl) to 100 mbgl. In the nearby creek beds the depth to groundwater ranges from approximately 15-25 mbgl.

These bores have indicated the presence of two aquifers; an extensive aquifer within the Quaternary sequence and a second aquifer associated with the mineralised and/or weathered Nammuldi Member of the Marra Mamba. Both of these aquifers drain from east to west, towards the Fortescue River system.

The most extensive aquifer is associated with alluvial deposits within the Quaternary sequence. This aquifer occurs at elevations below approximately 480 mRL on the foot slopes of Mount Nicholas, and increases in thickness towards the Fortescue River. The alluvial deposits consist of clays, silts, sands and gravels. In general the bore logs indicated that the alluvium is argillaceous, but several bores (eg bore WSE008), indicate the presence of sands and gravels. The alluvium is unsaturated where it occurs at higher elevations (eg bore WSE006) but increases in saturated thickness towards the Fortescue River (eg bore WSE042b, which is 20 km west of Mount Nicholas) where, typically, the basal 20 m are saturated.

There are four distinct alluvial features that cross Mount Nicholas, each associated with east-west draining creeks. Bores drilled to intercept these features showed that alluvial deposits there attained a maximum thickness of 84 m (eg bore WSE007a).

At most sites bore logs indicate that the alluvium, where it occurs, overlies unweathered Marra Mamba Iron Formation, however, several bores (eg WSE011) intercepted a weathered saprock, typically 10 m thick.

The permeability of the alluvial and saprock aquifers was determined from short-term rising and falling head tests on completion of bores drilled for the hydrogeology investigation. In addition further falling head tests were undertaken on mineral bores intercepting the ore body (MN163 and MN010). These tests indicated that the alluvium overlying the Mount Nicholas deposit is generally low permeability (>0.1 m/day), but in alluvial features associated with contemporary creeks, permeability values of 0.3 m/d were obtained (bore WSE008). Falling head tests in the ore body indicated a permeability of 0.3 m/d.

Groundwater levels were measured in 100 mineral bores for the hydrogeology investigation (Appendix D1). These bores are generally located on the lower slopes of Mount Nicholas (bores situated at higher elevations did not intercept groundwater within the main ore zone, where most of the bores terminated). Four sections are included in Appendix B1; they show groundwater levels and stratigraphy across the pit. The data show that groundwater levels are flat in the southern part of the pit (cross-section MN1), where they are typically at 427 mRL. The base of the proposed excavation at Mount Nicholas is 400 mRL, requiring dewatering to a depth of 27 m. Further north, groundwater levels are generally higher, with a maximum recorded figure of 483 mRL (bore MN0217). In northern sections of the proposed Mount Nicholas mine, there is evidence of an east-west hydraulic gradient (Section MN3).

Information has been obtained from the Department of the Environment's AQWABASE database of existing groundwater abstractors near Mount Nicholas. The record indicates that there are 33 station bores within 30 km of the proposed mine, however most of these have been abandoned and only ten are recorded as being operational. The nearest of these is the Johnson Bore which is 8 km east of the proposed mine, other bores include Windy Corner, Walbina, Adrian and Laurie, which are all to the south west of the Mount Nicholas. Of these the Walbina is the closest to the proposed mine, at a distance of 14 km.

Samples taken from bores in the vicinity of Mount Nicholas show that groundwater is generally potable or sub-potable (TDS 360 mg/L to 1600 mg/L). Full results are given in Appendix C.

4.2.4 Mt Lewin Hydrogeology

Groundwater level measurements were undertaken in 161 mineral bores plus 3 bores drilled specifically for the hydrogeology investigation. The data show that groundwater levels across the proposed pit are typically 415 mRL in the southern sections, increasing to, approximately, 427 mRL to the north. Details of groundwater levels are given in Appendix D2 (note the data includes bores drilled east of the proposed pit, eg MN0001, where groundwater levels were higher) and sections, including groundwater levels, are shown in Appendix C2. The footwall of the proposed Mount Lewin pit dips to the south, with the lowest point at 400 mRL, approximately 15 m below the current groundwater table. The depth to groundwater ranges from approximately 35 m below ground level (mbgl) to 100 mbgl. In the nearby creek beds the depth to groundwater ranges from approximately 15 to 25 mbgl.

The drilling programme indicated the presence of two aquifers. The first is an alluvial aquifer and the second consists of mineralised and/or weathered Marra Mamba Iron Formation. The alluvial aquifer occurs below 440 mRL, thickening to the south, where a maximum thickness of 53 m was encountered (bore WSE038). It is generally fine-grained, consisting of clays and silts with occasional sand and gravel lenses.

Kondy Creek, which drains in a northeast-southwest direction, dissects the proposed mine, so that two pits will be constructed. To the east lies the first, Lewin B and D, whilst to the west lies Lewin C and E. Geophysical studies (aeromagnetic surveys) have shown that the creek is aligned along a series of geological faults, and is expected to be associated with higher permeability material.

Marking the West of Mont Lewin, and draining to the southwest, lies the Kulkinbah Creek. Geophysical investigations suggest that this creek is also aligned along a fault, and is therefore believed to be associated with higher permeability material.

Based on the results of drilling investigations in the Mount Nicholas area, these two creeks are likely to be underlain by increased thicknesses of alluvial deposits, which, in turn, are expected to be less argillaceous than the surrounding alluvial deposits.

Short-term hydraulic tests have indicated that the permeability of the alluvium south of Lewin is typically less than 0.1 m/d, however higher permeabilities are expected along creeks. Falling head tests undertaken on 5 mineral bores within the deposit (ML288, ML305, ML173, ML302, ML196) indicate the permeability of the ore to be variable, between 0.01 and 1.5 m/d. This is not surprising given the vuggy nature of the ore deposit.

There are records of 63 station bores within 30 km of Mount Lewin, of which 12 are recorded as being operational. The nearest of these is Eden Holme Bore, 3 km south west of Lewin E.

Water samples taken from bores in the alluvium south of Mount Lewin were found to be sub-potable, with TDS of between 1300 mg/L and 2800 mg/L.

4.2.5 Christmas Creek Hydrogeology

Groundwater levels in the vicinity of the Christmas Creek mine were monitored in 27 bores drilled to determine mineral grade in the northern tenement of the pit (see Appendix D3), plus 21 bores drilled in the southern tenement, specifically for the hydrogeological investigation. In these bores water levels fell from a maximum of 428 mRL in the north to 405 mRL along the southern edge of the proposed pits. At its lowest point, the proposed Christmas Creek pit has an elevation of 380 mRL, approximately 30 m below the existing groundwater table. Further south, and beyond the proposed southern extent of the pit, bores installed for the hydrogeological study showed groundwater levels dipped to below 400 mRL, the base of the Fortescue Marsh. The depth to groundwater ranges from approximately 30m below ground level (mbgl) to 35 mbgl. In the nearby creek beds the depth to groundwater ranges from approximately 20 – 25 mbgl.

The investigation has shown the presence of a fine-grained alluvial aquifer, overlying mineralised Marra Mamba Iron Formation. Further south, borehole F2 intercepted alluvium before penetrating Wittenoom Dolomite, which is an important aquifer in other parts of the Pilbara. Nested piezometers were installed at four locations (F1, F2, F4 and F7), each with one piezometer intercepting the alluvium, with a second intercepting the underlying basement (Marra Mamba or Wittenoom Dolomite). These piezometers show no vertical head gradient between the alluvium and the bedrock.

The alluvial deposits occur at elevations below 450 m, and attain a maximum thickness of 60 m at borehole F2, 2 km south of the proposed pits. Hydraulic tests indicated that the permeability of the alluvium is between 0.1 m/d and 3 m/d, generally higher than that intercepted in the vicinity of Mount Lewin and Mount Nicholas. Hydraulic tests in four mineral bores indicated the permeability of the mineralised Marra Mamba to be variable, but typically 0.5 m/d.

There are 13 operational stock bores within 30 km of the proposed pits (Howard Bore, Dandy Well (b16), Bustler Well (b17), Moxam Well (b5), Cattle Well (b18), Woodenlegs Well (b26), Bookagee Bore (b30), Trig Bore, Parker Bore (r2), Warri West Well, Tabletop Bore (w16), Mulinyary Bore and Quartz Well. Of these Parker Bore lies within the footprint of the proposed pit.

4.2.6 Water Quality Analysis – Christmas Creek

Groundwater samples were taken from 23 bores at various depths from within the alluvial and Marra Mamba formations. Four cross-sections, which include summary results from the water quality analysis, are included in Appendix B3. The analysis shows that there is a trend of increasing salinity (measured as TDS) with depth, and towards the marsh.

The data show that, within the footprint of the pits, water in the alluvium is relatively fresh, with TDS of less than 3000 mg/L (eg bore E23). The underlying ore body also contains relatively fresh water (eg bore E2). Deeper bores, drilled through the ore body into the underlying basement material proved the presence of saline water at depth (eg a sample taken from bore E22 contained TDS of 56,000 at a depth of 93 m). The maximum depth of the proposed pits is 60 m (405 mRL), and the minimum depth between the base of the mine and the saline water is approximately 20 m.

Further south, and outside of the footprint, bores drilled into the alluvium intercepted brackish water with TDS of up to 5,700 mg/L (bore F3A). Deeper bores, intercepting Marra Mamba, contained saline water, with TDS of up to 160,000 mg/L (bore E04).

4.2.7 Hydrogeology of the Fortescue Marsh

Insight into the hydrogeology of the Fortescue Marsh has been obtained from:

- Water samples from the marsh: These showed that it contains sub-potable water (Total Dissolved Solids (TDS) 7,500 mg/L) in spring, but that the water becomes more saline towards summer (TDS 10,000 mg/L in October) as water levels in the marsh decline.
- Nested piezometers installed in the area between Christmas Creek and the marsh: These indicate that, in this area, groundwater levels in both the alluvium and underlying basement material are 8 mbgl. Furthermore, regional water levels recorded in stock bores suggest groundwater levels along the Fortescue Valley are typically 5 m or more below ground level.
- Groundwater samples, taken from bores between Christmas Creek and the marsh: These indicate that the alluvium intercepted contains water with a similar water quality to that in the marsh. For instance, a sample from bore F3B, approximately 2 km from the marsh, was found to have TDS of 5,700 mg/L. However, at greater depths, the Marra Mamba Iron Formation was found to contain much higher salinities (eg bore F4, also 2 km from the marsh, contained water with TDS of 120,000 mg/L).
- Anecdotal evidence suggesting that the marsh completely dries out during sustained dry periods, when salt crystals form on the surface of the bed (Gary Clark, Pers Coms., October 2004). In support of this, during September 2004, occasional, salt deposits were observed on the flanks of the marsh.

- Groundwater levels in the vicinity of the marsh, in the area close to Christmas Creek, are approximately 397 mRL. Unpublished data suggests that groundwater levels along the Mount Newman Railroad, approximately 100 km west of Christmas Creek, are approximately 410 mRL to 415 mRL. These groundwater level data indicate a groundwater catchment divide downstream of Christmas Creek, with the marsh acting as a groundwater discharge point.

The available data set indicate that water levels in the alluvium on the plain are below the bed of the marsh, confirming the surface water in the marsh forms as a result of rainfall rather than as a result of groundwater discharging. During flooding events salts deposited during previous drying episodes are redissolved, and the freshwater entering the marsh becomes moderately saline.

Following a flood event, a portion of the ponded surface water will infiltrate causing water levels to rise beneath the marsh, ultimately to ground (marsh bed) level. Continual evaporation will remove ponded surface water, after which the watertable in the marsh bed sediments will decline to its former position under the combined processed of direct evaporation and radial groundwater flow to the Fortescue valley. It is considered likely that the depth to water beneath the marsh is, or closely approximates, the extinction depth for direct evaporation.

With the above concept, any change in groundwater level beneath the marsh will have no impact on the occurrence of surface water ponding, or on the rate of seepage from the marsh bed into the water table. It is conceivable however that where the groundwater level is lowered significantly, an increased amount of water would be required to fully saturate the profile, and this could reduce the duration of surface water ponding.

The alluvium and, to a lesser extent, Marra Mamba aquifers on the flanks of the valley are recharged with fresh water during rainfall events. Given there is a hydraulic gradient towards the marsh, this water will drain towards the marsh. As a result groundwater both below and close to the marsh is saline, whilst that further away is fresh.

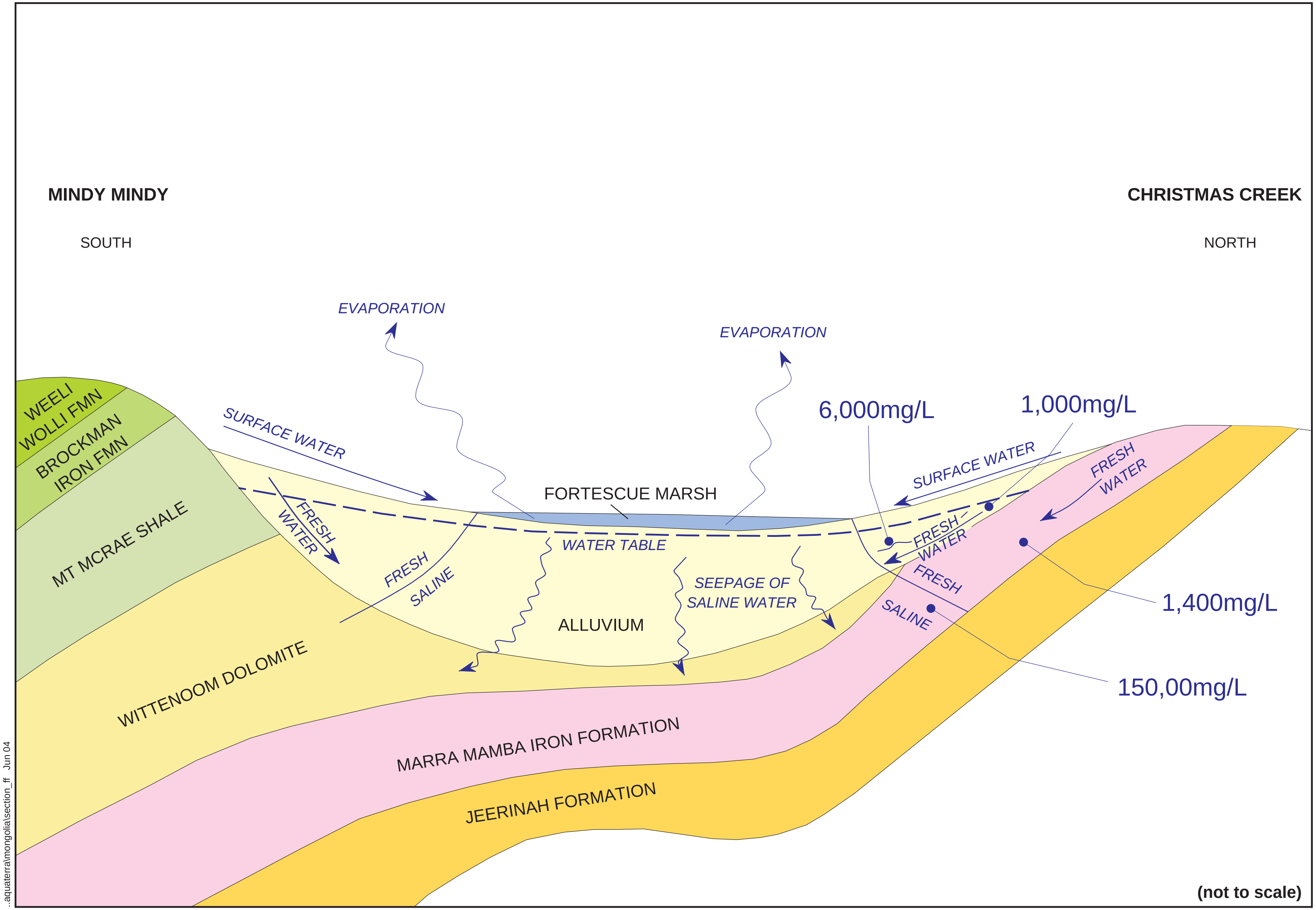
A schematic diagram representing the process is given in Figure 4.3.

Approximately 70 km west of the proposed Christmas Creek pit lies the Goodiadarrie Hills, which consist of siliceous chert, which formed as a result of chemical precipitation within the Fortescue Valley. The hills form a narrow restriction across the Marsh, which prevents any western migration of groundwater away from the Marsh area.

4.2.8 Mindy Mindy Hydrogeology

As described in Section 2, the proposed Mindy Mindy mine is located along an ancient palaeo-channel, which has been in-filled with channel iron deposits and is covered with a veneer of alluvium. After significant rainfall events a creek flows across these alluvial deposits, towards the northwest, and drains into the Weeli Wolli Creek.

Groundwater levels have been obtained from 33 mineral bores drilled into the ore deposit. The depth to groundwater ranges from approximately 8 m below ground level (mbgl) to 50 mbgl. In the creek beds the depth



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Schematic Section Across the Fortescue Marsh

FIGURE 4.3

to groundwater is approximately 25 mbgl. There is a groundwater divide in the south of the mine. Groundwater levels in the south of the mine at the groundwater divide, have an elevation of approximately 497 mRL falling to approximately 495 mRL to the south and 438 mRL in the northwest. Groundwater flows approximately southeast to northwest north of the divide and northwest to southeast south of the divide.

The hydrogeology of the Mindy Mindy mine site is markedly different to that at Christmas Creek, Mount Lewin and Mount Nicholas. Whereas at these three sites the main aquifer is the alluvial deposits, overlying either mineralised or weathered Marra Mamba Iron Formation, the alluvial deposits at Mindy Mindy are mostly unsaturated, and the CID is the main aquifer. The CID itself is saturated only at the northwestern extent of the channel.

The CID is typically highly porous and vuggy with significant secondary permeability from joints and solution cavities. The upper surface of the CID has been weathered forming a Surface Weathered Profile (SWP). The SWP is likely to have a higher permeability than the unweathered CID due to greater degree of weathering enhancing the secondary porosity. Permeability values of 10 m/d are typical for the CID and overlying alluvium in the Pilbara.

The CID is attains widths of the order of 300 m across, and attains a maximum thickness of 34 m. In the northwest extent of the proposed pit the base of the deposit is at a depth of 80 m. Calculations indicate that groundwater flow through the CID aquifer is approximately 0.25 ML/d (250 m^3/d) at this point. This water discharges into sediments underlying the Weeli Wolli Creek, approximately 20 km downstream of the Weeli Wolli Springs.

The CID is underlain by Weeli Wolli Formation along most of its length, however in the northwestern area the Brockman Iron Formation underlies it. The Weeli Wolli and Brockman Iron Formations are generally considered to form poor aquifers however local secondary porosity occurs from fractures, ore-mineralisation, weathered horizons, joints and bedding planes.

4.2.9 Water Supply Borefield Hydrogeology

The proposed borefield is situated at the foot-slopes of Mount Lewin and Mount Nicholas and, therefore, the hydrogeology of the borefield is similar to that at these two mine sites. Wittenoom Dolomite was intercepted in bores drilled west of Mount Nicholas.

There are two potential aquifers, the first an alluvial aquifer, which generally overlies the second, Wittenoom Dolomite. In areas close to the foot slopes of Mount Lewin and Mount Nicholas, the dolomite is absent, and the alluvium overlies Marra Mamba Iron Formation, which is locally weathered to a saprock to a depth of 10 m.

A programme of exploratory drilling, resulting in the construction and testing of 29 bores, has shown that throughout most of the borefield the alluvium is 50 m thick, however, the sequence is markedly thicker at discrete locations associated with creeks draining across the Mount Lewin and Mount Nicholas mines. In bores intercepting these alluvial features, the alluvium attained a maximum thickness of 113 m (bore WSE016).

The alluvium is generally fine-grained, consisting of clays, silts and occasional sands and gravels. However several bores drilled close to creeks (eg bore WSE011) intercepted sands and gravel lenses. Hydraulic tests conducted on these bores indicated permeability values of up to 0.4 m/d.

Six bores were drilled west of Mount Nicholas to intercept a series of faults. The thickness of the alluvial sequence in these bores varied from 48 m to 55 m, suggesting little variation in bedrock topography. The permeability of the alluvium at these locations were typically less than <0.1 m/d.

Generally the alluvium overlays Wittenoom Dolomite, which is typically weathered to a depth of 5 m. The dolomite contains occasional minor fracturing associated with moderate water yielding zones (eg bore WSE38).

Where the dolomite is absent the Marra Mamba typically includes a weathered surface. Borehole WSE028 intercepted saprock 40 m thick and bore WSE016 intercepted a solution feature in the saprock at depth. In general however the saprock yielded minor quantities of water.

Groundwater levels along the borefield vary between 410 mRL and 420 mRL, and are typically 30 mbgl. Groundwater contours indicate that the water table dips gently towards the Fortescue River. Borehole WSE42b, drilled 20 km west of Mount Nicholas, 20 km south of Mount Lewin, and approximately 8 km from the Fortescue River channel, showed the water table was at a depth of 8 m.

Water samples taken from bores drilled for the investigation showed that the water is fresh in the vicinity of Mount Nicholas (TDS ranged from 670 mg/L to 1,600 mg/L), and sub-potable in the vicinity of Mount Lewin (TDS typically 1,300 to 2,800 mg/L).

SECTION 5 - PROJECT OUTLINE

5.1 OVERVIEW

Previous sections of this report have described the existing environment, including the geology, climate, hydrology and hydrogeology. This section briefly describes the project, in particular those aspects that could potentially impact upon the hydrogeology of the region.

The proposed project involves the following key elements that have the potential to impact upon the existing hydrogeology:

- Construction of a railway (the East - West Railway), requiring a temporary water supply
- Operation of the ore beneficiation process, requiring a water supply
- The requirement for a temporary construction camp and permanent mine camp, requiring potable water and effluent discharge
- Excavation of the four mines, requiring dewatering
- Closure of the four mines

Abstraction of groundwater will result in the lowering of the groundwater table in the vicinity, known as a cone of depression. The shape of this depression is dependent upon the rate of abstraction, the location of the bores, and the hydraulic properties of the aquifer(s). Lowering of the water table has the potential to impact on the ability of vegetation to obtain sufficient water, and can affect surface water features such as pools and lakes.

5.2 CONSTRUCTION OF THE EAST- WEST RAILWAY

A railway will be constructed to transport iron ore from the mines to Port Hedland. The railway is being constructed in two phases. The first phase (Stage A) is the North - South Railway from Mindy Mindy to the port (the Stage A railway is subject to a separate report). The second phase “Stage B” (the East – West Railway) will involve the construction of a spur from the Stage A route, in an easterly direction towards Mount Nicholas, between the Chichester Ranges and the Fortescue Marsh. The route of the proposed East - West Rail Corridor is shown on Figure 1.1. The total length of the East – West Railway is 160 km, and for most of its length it is underlain by Quaternary deposits (Figure 2.1)

Construction of the East - West Railway will require a temporary water supply to condition fill (transition and sub-ballast) material for compaction and for dust suppression. It is proposed that bores will be constructed at 14 km spacings and used to fill road tankers that will then truck the water to the construction site. Based upon Aquaterra’s previous experience on similar projects, a total water demand of 1 ML/d (1000 m^3/d) at each supply point along the railway alignment is estimated. On average, once constructed, each bore will be used for a total of 4-5 weeks.

5.3 ORE BENEFICIATION PROCESS

Studies are being undertaken by FMG to identify possible ways to reduce the overall water requirement, however, the latest information provided is that the ore beneficiation process requires a total water supply of 11 GL/a (equivalent to 30.1 Ml/d). This water will be obtained from three sources; the borefield, dewatering from the pits, and direct rainfall collected within the pits after large rainfall events. Ore processing will take place for the full lifetime of the Chichester Mines, which is 16 years.

The proportion of water from dewatering and the borefield will change during the life of the project. Initially, dewatering of the pits will not be required, as mining will take place above the water table, and the borefield will provide the main water supply, supplemented with any rainfall stored in the pits. Later, as mining extends into saturated ore, water produced from the dewatering system will replace some of the borefield supply. It is envisaged that approximately 70 bores will be required to provide the necessary water supply. As with the East – West Railway bores, but at increased scale, there will be a cone of depression resulting from abstraction from the borefield.

For the first two years of the project rejects from the process plant will be stored to the north of the Christmas Creek pit until being transported back to the pits for backfill. After the first two years all rejects will be deposited directly into the pit. These rejects will be wet from the process, and depending upon storage method, water within the rejects has the potential to seep back into the ground.

5.4 WATER SUPPLY FOR THE TEMPORARY AND PERMANENT CAMPS

Temporary personnel camps will be required during construction of the East West Railway and permanent camps will be required during the lifetime of the mining operations. At the Chichester mines these camps will be located close to the process plant. The temporary camps will be required to house up to 800 people, whilst the permanent camp will provide accommodation for 500. The temporary camps will be supplied with bore water obtained from the East-West Railway supply bores. Total demand is expected to be 0.4 ML/d (400 m^3/d), equivalent to 500 litres per head per day.

Water demand from the permanent camp at Christmas Creek is anticipated to be 0.25 ML/d (250 m^3/d), and will be obtained from the water supply borefield. The 0.25 ML/d (250 m^3/d) allowance is included within the 11 GL/a requirements for the process plant discussed above.

Only very limited permanent camp accommodation will be required at Mindy Mindy. Water demand at the Mindy Mindy camp for potable purposes will be very low. Potable water at Mindy Mindy will be supplied from dewatering water. If water from the deposit is not suitable for potable purposes, then potable water will be provided from bores drilled into the nearby alluvial deposits.

Effluent from the camps will be treated in a packaged sewage treatment plant and, once treated, will be used for irrigation by means of sprinklers. Effluent will therefore not impact on the hydrogeology of the project area.

5.5 MINE DEWATERING REQUIREMENTS

The proposed schedule of mining in each pit it set out below:

- Mount Nicholas will be mined along the ore body fom a central location and the Northern end of the orebody. Two faces will progress in a southerly direction along the ore body. Its life will be 4 years.
- Mount Lewin will be mined from north to south opening up multiple pits across the deposit. Its life will be 4 years
- Christmas Creek will be mined from north to south opening up multiple faces across the deposit. Its life will be 8 years

- Mindy Mindy will be mined opening a face one third of the way along the deposit (at the southeastern end) working to the northwest for 4 years, then coming back to the southestern end working northeast for the remaining 2 years. Its life will be 6 years.

Initially, dewatering will not be required in the pits as all excavations will be above the water table. However as the pits are deepened, they will extend below the current water table. During mining operations the lowest part of each of the mines will be at the following elevations:

- Mount Nicholas – 400 mRL
- Mount Lewin – 400 mRL
- Christmas Creek – 380 mRL
- Mindy Mindy – 420 mRL

The water abstracted during dewatering operations will be piped for use in the ore beneficiation process, subject to acceptable water quality. Abstraction will result in lowering of groundwater levels within and around the pits, and at Mount Nicholas and Mount Lewin; water level drawdowns may also extend into the nearby water supply borefield.

5.6 MINE CLOSURE PLAN

In semi-arid areas, such as the Pilbara, where pits are excavated below the water table, mine closure plans are required to prevent saline water forming in abandoned pits and potentially contaminating otherwise fresh aquifers.

During mining, waste material, including rejects and overburden, will be placed into worked parts of each of the mines. Then, on completion of mining, all pits will be backfilled with waste material to a level above the original groundwater table.

The nature of the backfilling material will vary between the mine sites. At Mindy Mindy, Mount Nicholas and Mount Lewin, it will consist of waste rock, and be highly permeable. At Christmas Creek rejects from the ore-beneficiation process, in the form of slurry, will be pumped and discharged into the pit along with waste rock. This slurry will tend to have a low permeability.

SECTION 6 - IMPACT ASSESSMENT

6.1 APPROACH TO IMPACT ASSESSMENT

Initially the cones of depression resulting from groundwater abstraction have been determined using two techniques:

- For temporary abstraction required for construction of the East – West Railway, a lump parameter model has been used to determine the extent of the cones of depression.
- For long-term abstraction, from both the borefield and mine dewatering, numerical models have been developed which first simulate the existing hydrogeology, and are then used to determine potential impacts.

The results of this analysis have then been discussed with ecologists at Environ and Biota to determine the potential impacts of these drawdowns on the ecology of the project area.

Mitigation measures to reduce the potential impacts are discussed in Section 7.

6.2 IMPACTS OF THE EAST – WEST RAILWAY

The East – West Railway corridor is approximately 160 km long. The route lies between the Fortescue Marsh and Chichester Range, where the surface rocks consist of alluvium. The temporary water supply required during construction will be provided by a series of bores. To provide a more reliable supply the bores will be in pairs, each pair 14 Km from the next pair. These bores will be drilled into the alluvial aquifer and Marra Mamba, which extends along the Fortescue River Basin. Water sampling in the vicinity of Christmas Creek shows that the water in the alluvium and Marra Mamba is not saline along the northern part of the proposed rail corridor.

6.2.1 Aquifer Characterisation

As discussed in Section 4, the alluvial aquifer along the Fortescue Marsh has been investigated in the vicinity of Christmas Creek. Based on the results of this work the following assumptions have been made regarding each of the proposed railway bores:

i. Unconfined conditions

ii. Nominal aquifer saturated thickness of 60 (Alluvium and Marra Mamba)

iii. Specific yield of 0.1

iv. Hydraulic conductivity of 0.5 m/d

v. A pumping rate of 0.5 ML/d (500 m^3/d) for 30 days

6.2.2 Analytical Results

The analysis indicates that the likely radial extent of the cone of depression as a result of abstraction at each of the railway bores is likely to be less than 250m. Drawdowns in excess of 2 m are predicted to be confined within 100 m of each bore. Groundwater levels will recover to 2m of the original level within 6 weeks after cessation of pumping.

6.2.3 Impact Assessment

At its closest point the railway is more than 4 km from the Fortescue Marsh. The modelling results indicate that drawdowns from each bore are unlikely to extend for more than 250 m. Furthermore, as discussed in Section 4.2.7, the available data suggests that the water in the marsh is a result of surface run-off, and does not represent a groundwater discharge point. It is unlikely therefore that abstraction from the railway bores will impact upon the marsh.

Vegetation along the rail corridor is categorised into four types. The westernmost 28 km, on low stony hills of the Chichester Range, consists of shrublands and Spinifex hummock grasslands. The easternmost 26 km communities consist of Spinifex hummock grassland on sandplain of the Fortescue Valley. The area in between consists of Mulga woodlands, and grasslands on the alluvial plains of the Fortescue Valley. Along the creeks that cross the rail corridor in the Mount Lewin and Mount Nicholas areas FMG have determined that the potential for groundwater dependent (phreatophytic) species is low. This was based on vegetation mapping conducted by Biota (2004), which classified the vegetation types along these creeks as dominated by Acacia species.

Existing groundwater levels along the route of the East-West Railway are typically 10 mbgl to 20 mbgl (Figure 4.2), deeper than Acacia and Spinifex roots generally penetrate and it is not expected that the drawdown described above would have any effect on non-phreatophytic vegetation. Despite this, FMG will locate bores at least 100 m away from creek lines.

Given the generally fine-grained nature of the alluvial aquifer, it is unlikely that there are significant numbers of Stygofauna. Studies elsewhere in the Pilbara have shown that Stygofauna populations can tolerate significant short-medium term fluctuations in groundwater levels (Biota, Pers. Coms., November 2004). Typically, it is expected that short-term perturbation as described above would probably have a local population level impact on Stygofauna (if present), but would be unlikely to have a significant effect at the taxon or conservation status level (i.e. lead to extinction of any species).

6.3 IMPACTS FROM THE BOREFIELD AND DEWATERING - MODELLING APPROACH

The existing hydrogeology of the four mines and the borefield have been simulated in two numerical groundwater models. The first model includes those features north of the Fortescue Valley, i.e. the borefield, Christmas Creek, Mount Nicholas and Mount Lewin. The second model represents Mindy Mindy, which lies south of the Fortescue Valley.

6.3.1 Assumptions Made

In the course of any groundwater modelling it is necessary to make a series of assumptions based on local and regional data. These assumptions include:

- Estimates of recharge to each of the different aquifers
- The groundwater recharge mechanisms
- The permeability and storage coefficients of the different aquifers

For this particular project Aquaterra have used results from the groundwater investigations undertaken, knowledge obtained from other work undertaken in the Pilbara and published data for the area. Aquaterra has extensive experience in the Pilbara on which to base these assumptions as outlined Section 1.1.

6.4 THE "NORTH" MODEL

Appendix E includes details of the North Model; however a summary of the approach is included below.

6.4.1 Conceptual Model

Figure 6.1 is a schematic diagram illustrating the conceptual hydrogeology of the model. In the model sedimentary rocks of the Hamersley Group and Fortescue Group outcrop along the northeast and southwest boundaries of the model where they form the Chichester Range and Hamersley Range. These rocks typically have a low permeability, which is enhanced where they are mineralised, fractured or weathered. The two ranges are groundwater watersheds and represent no-flow boundaries in the model.

Incised within these rocks is the Fortescue Valley, in-filled with a sequence of Quaternary deposits, which is up to 60 m thick. This extensive Quaternary sequence includes an alluvial aquifer, which is generally fine-grained but, along creeks, contains sands and gravel deposits. The hydraulic heads in both the alluvium and underlying basement rocks are equal.

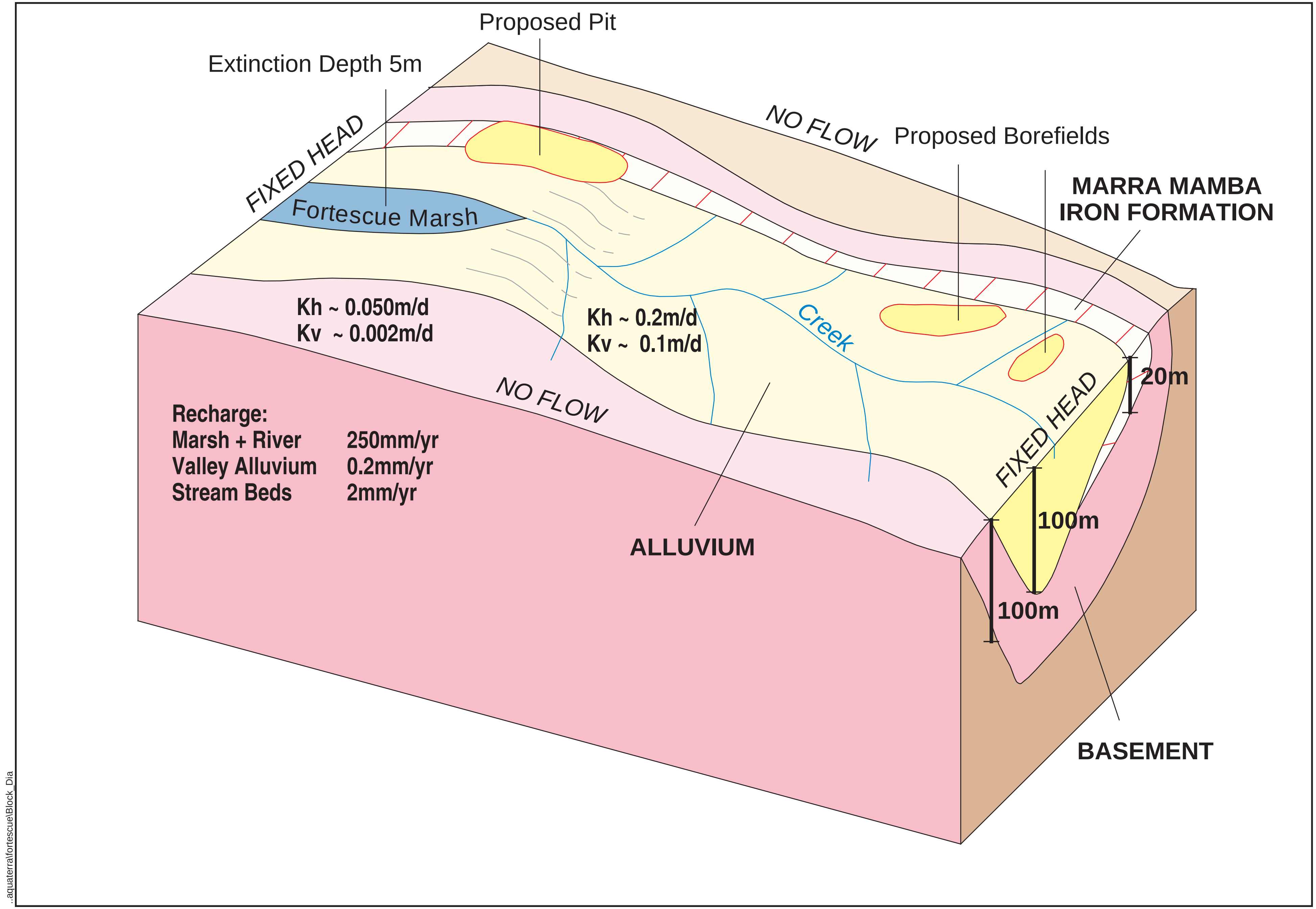
The bed of the Fortescue Marsh is at an elevation of approximately 400 mRL. The marsh is a surface water feature along the base of the valley, where flood waters pond after run-off from significant rainfall events. Evaporation and downward seepage result in the marsh drying out and elevation of the groundwater table to surface. Evaporation from the shallow water table then occurs, with capillary action limiting this depth to 5 mbgl. Groundwater flow is towards the Fortescue Valley, but groundwater does not appear at the surface as a surface water discharge.

Groundwater contours across the region are a subdued reflection of topography, ranging from more than 500 mRL along the Chichester Range and Hamersley Range, to less than 395 mRL along the floor of the valley.

There is limited groundwater flow from the southeast, which is represented in the model as a fixed head boundary, but with a very shallow hydraulic gradient. The northwest of the model is also represented as a fixed head across the alluvial plain downstream of the marsh area of interest.

Aquifers are recharged directly after extreme rainfall events of more than 150 mm per month. Direct recharge of rainfall in arid environments is minimal, indirect recharge, however, may locally be significant with infiltration of run-off (streamflow) along drainage courses and the marsh. Recharge occurs preferentially along creeks and from the Fortescue Marsh.

The study area is arid with high summer temperatures, high mean evaporative demand (2480 mm/yr), and low mean annual rainfall (310 mm/yr). The literature suggests that in the Northern Territory, for example, this hydrogeological situation is likely to experience a mean groundwater recharge of 0.1 to 2 mm/yr (Harrington, Cook, and Herczeg, 2002). In the model therefore recharge along the creeks is 2 mm/year, elsewhere, along



Schmatic diagram illustrating the conceptual north model

FIGURE 6.1

aquaterra

the alluvial plain, recharge is 0.2 mm/year (0.06% of mean annual rainfall (MAR)) and, across the Marra Mamba outcrop, is 0.1 mm/year (0.03 % of MAR).

Seepage from the marsh results in recharge estimated to be 250 mm/a, however this is then balanced by evaporation from the shallow water table.

The main aquifer consists of an alluvial sequence, underlain in part by weathered Marra Mamba in the pits. This alluvial aquifer typically has a bulk horizontal permeability of 0.2 m/d, vertical permeability of 0.1 m/d, storage coefficient of $5*10^{-4}$ and specific yield of 5%. It attains a maximum saturated thickness of 55 m close to the marsh. The Marra Mamba has a bulk permeability of 0.5 m/d.

These horizontal permeability values quoted for the alluvium are consistent with the results of the short hydraulic tests undertaken in the location of the potential borefield, and in the vicinity of Christmas Creek. Values of storage coefficient and specific yield used are consistent with those expected for a generally fine-grained material. The modelled saturated thickness of the alluvium matches the results of the drilling programme undertaken so far.

The aquifer parameters used for the Marra Mamba are consistent with the short hydraulic tests undertaken in a number bores within the proposed Mount Lewin and Christmas Creek pits and work undertaken by Aquaterra for other clients in similar hydrogeological settings in the Pilbara (including several studies undertaken on the permeability of the Marra Mamba in proposed iron ore mines south of the Fortescue River).

Aquaterra has undertaken hydraulic testing on the permeability of the Wittenoom Formation in the vicinity of the Weeli Wolli Spring, where the formation was found to be more permeable than that intercepted in the Mount Nicholas and Mount Lewin areas. As a result, the basement rocks within the model, have been assigned a lower horizontal permeability of 0.05 m/d, a vertical permeability of 0.002 m/d and a nominal thickness of 100 m. Specific yield is 5% and storage coefficient $5x10^{-4}$.

Dewatering is required to lower groundwater levels below the base of each of the proposed pits (alluvium and Marra Mamba) and a water supply is required from the borefield (alluvium and Wittenoom Dolomite). The combined output is 11 GL/a.

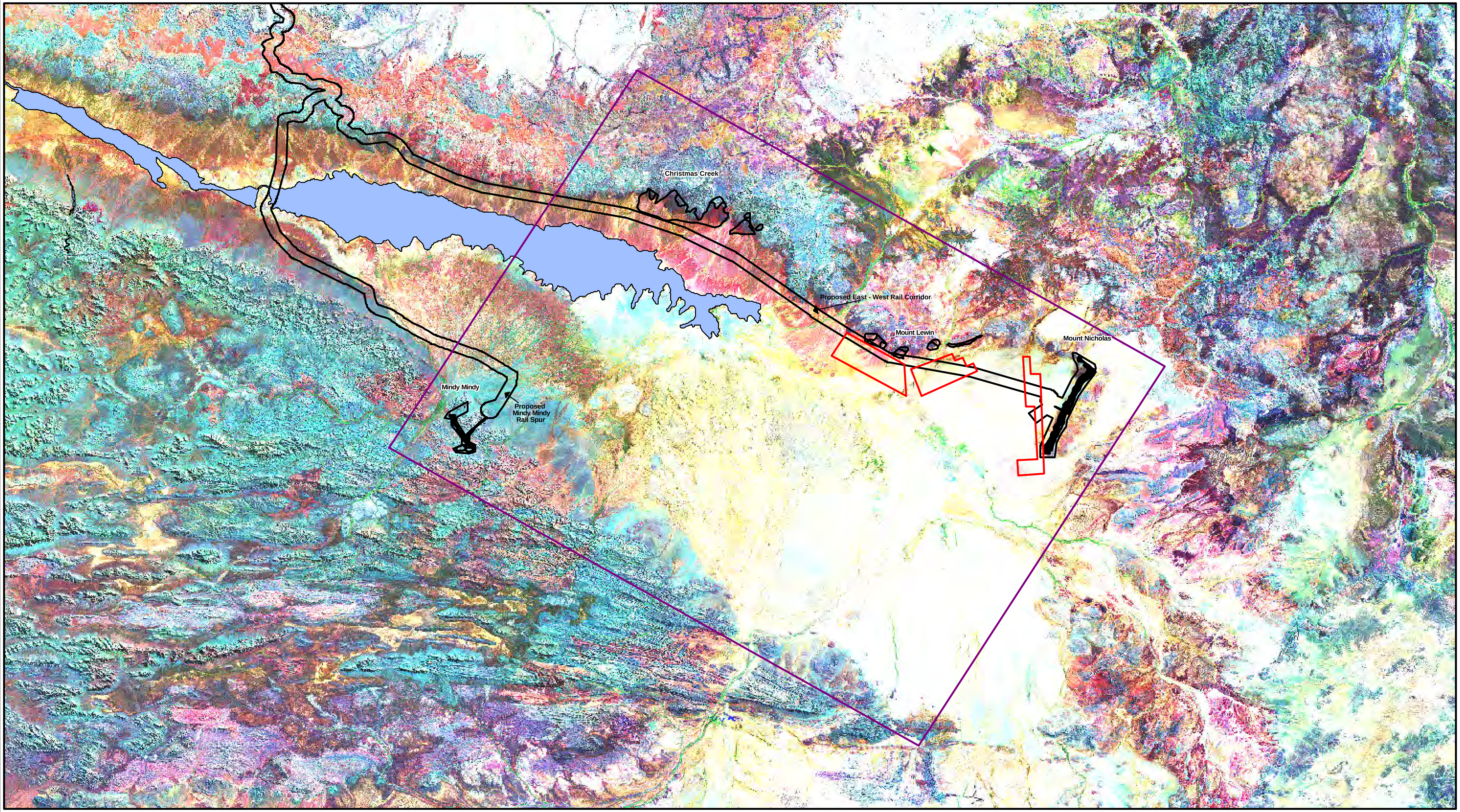
Model Geometry

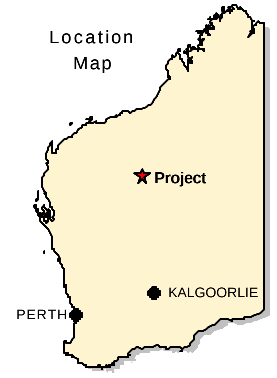
Figure 6.2 shows the area represented by the North Model, which includes the following features:

1. The Chichester Range which forms a north eastern boundary of the model.
2. The Hamersley Range which forms the south west boundary of the model.
3. The Mount Nicholas, Mount Lewin and Christmas Creek mines.
4. The water supply borefield.

There are three layers within the model:

- Layer 1: Alluvium.
- Layer 2: Mineralised Marra Mamba.
- Layer 3: Bedrock.





Legend

- Fortescue Marsh
- Proposed Borefield
- Model Extent

N

0 10 20 km

Fortescue Metals Group Limited

Figure 6.2 Model Boundaries

Author: Aquaterra	Date: 10 November 2004
Drawn: Barbara Zakrzewska	Revised:
Dwg No.: 6.2	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 700 000

6.4.3 Potential Impacts from Dewatering of the Chichester Mines and the Water Supply Borefield

Groundwater levels have been modelled for sixteen years, the life of the Chichester mines, assuming a total annual requirement of 11 GL/a from a combination of dewatering water and the borefield supply. (For modelling purposes surface water storage within the pits is not considered to provide a reliable supply of water for the ore beneficiation process because of the annual variation in rainfall in the Pilbara).

Maps showing predicted groundwater drawdowns during the life of the project are presented in Figures 6.3 (five years), 6.4 (sixteen years) and 6.5 (thirty years, i.e. 14 years after cessation of abstraction for the water supply borefield). Key features of the maps are:

- There is a cone of depression resulting from abstraction from the water supply borefield.
- In Mount Lewin and Mount Nicholas water levels are drawn down below the base of the pits (400 mRL) due to the cone of depression from the borefield.
- Groundwater levels in the southern extent of the Christmas Creek pits are reduced to a level of 380 mRL, which equates to the base of the pit.
- Groundwater levels are drawn down by 1 m at a distance approximately half way between the Fortescue Marsh and the proposed Christmas Creek pits.
- Groundwater levels will be reduced in station bores in the vicinity of the proposed pits and water supply borefield.

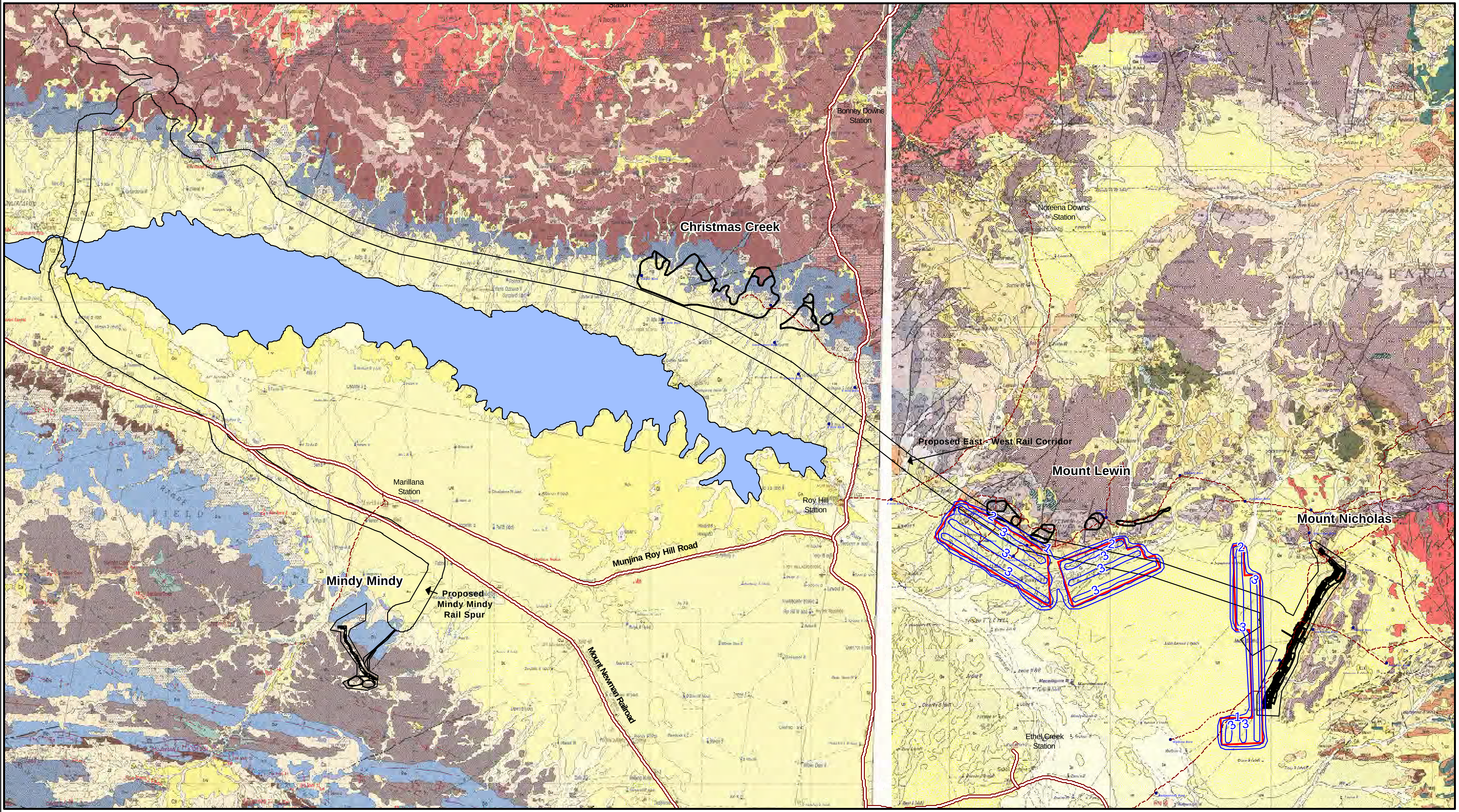
6.4.4 Potential Impacts on Vegetation

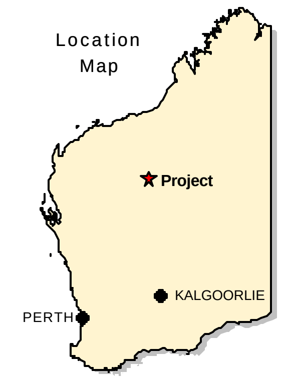
Away from the major creeks, the vegetation of the area consists mainly of mulga and Spinifex hummock grasslands. These communities typically source their water requirements from the soil zone and are not therefore expected to be significantly affected by groundwater drawdowns.

Along the creeks, there is the potential for phreatophytic vegetation woodland communities (including those containing River Red Gums *Eucalyptus camaldulensis*; Cadjeput *Melaleuca argentea*; and Coolibahs *Eucalyptus victrix)*, which may act as a phreatophyte along creek systems. FMG identified vegetation types within the cones of depression that will result from mine dewatering and from the borefield abstraction, using a combination of vegetation mapping by Biota and the Pilbara Rangelands Project Rangeland Mapping (Agriculture WA, 2002). Biota (2004) conducted a review of the vegetation types identified and the groundwater conditions and found the risks to such vegetation from groundwater drawdown to be low. The Biota report is attached (Appendix G) and their findings summarised below.

Mount Nicholas

The vegetation types within the cone of depression at Mount Nicholas are dominated by stony plain, spinifex grasslands and mulga (Agriculture WA, 2002). There are no phreatophytic species known to exist in this area, which has no creek line vegetation present.





Legend

- Fortescue Marsh
- Proposed Borefield
- Pit Outlines
- Drawdown Contour

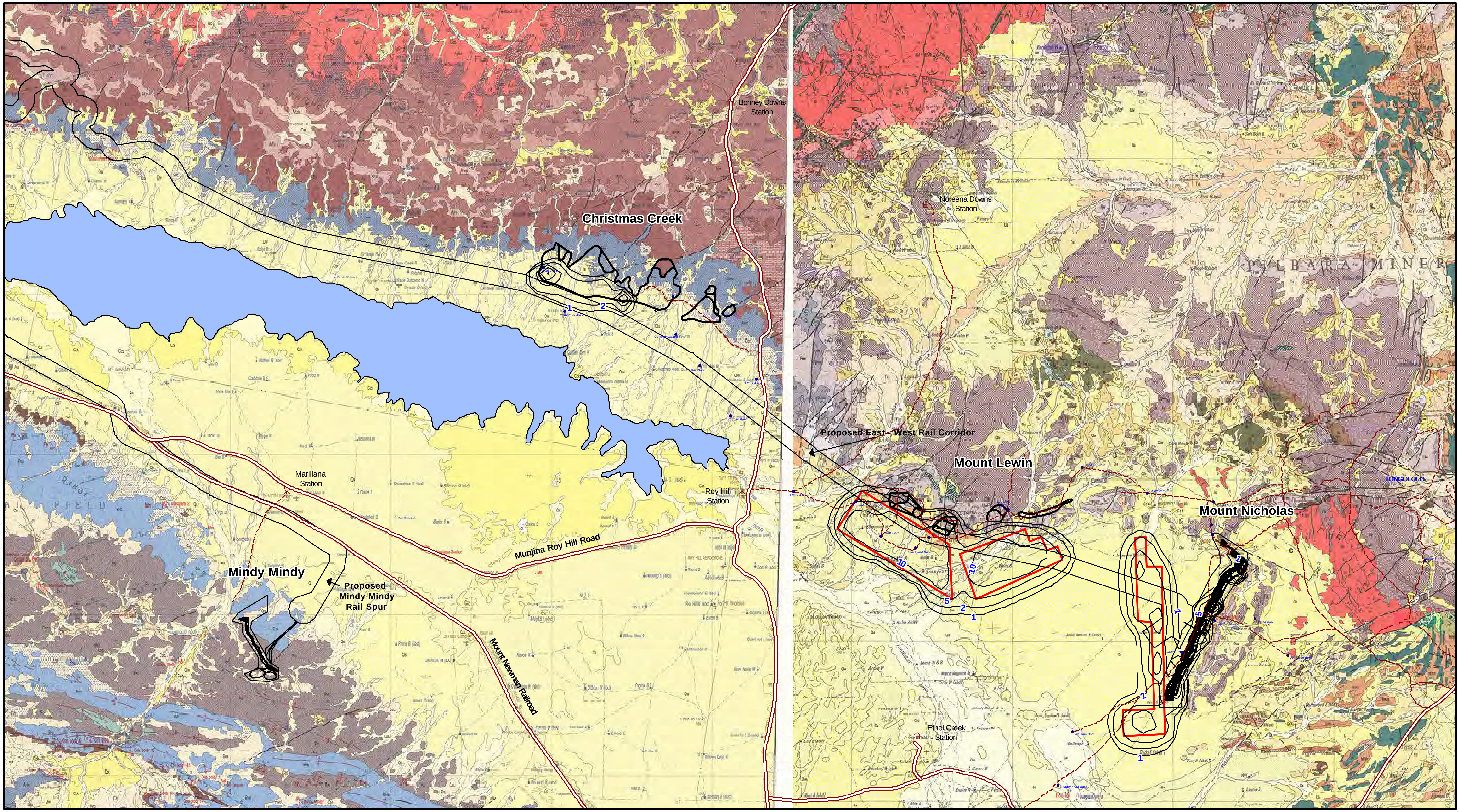
N

0 10 20 km

Fortescue Metals Group Limited

Figure 6.3. Cone of Depression after 5 years

Author: Aquaterra	Date: 2 November 2004
Drawn: Barbara Zakrzewska	Revised:
Dwg No.: 19a	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 450 000



Legend

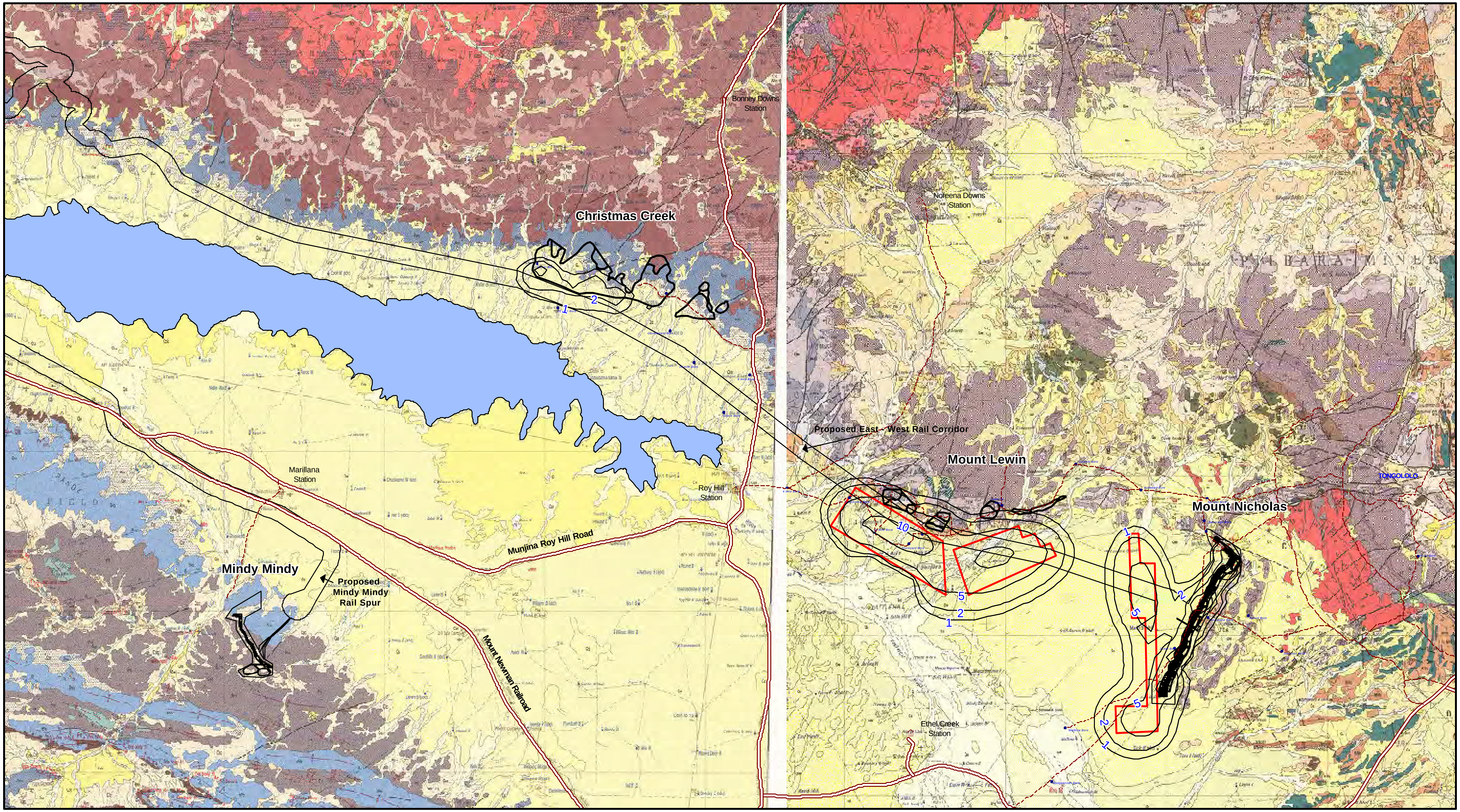
Fortescue Marsh

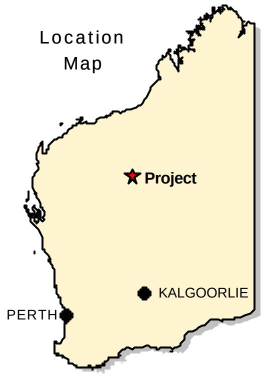
Proposed Borefield

Fortescue Metals Group Limited

Figure 6.4 Cone of Depression after 16 years

Author: Aquaterra	Date: 2 November 2004
Drawn By: Barbara Zakrzewska	Revised:
Dwg No.: 6.4	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 450 000





Legend

- Fortescue Marsh
- Proposed Borefield

N

0 10 20 km

Fortescue Metals Group Limited

Figure 6.5 Cone of Depression after 30 years

Author: Aquaterra	Date: 2 November 2004
Drawn By: Barbara Zakrzewska	Revised:
Dwg No.: 6.5	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 450 000

Mount Lewin

At Mount Lewin the majority of vegetation types within creeks are dominated by Acacia species, which are not known to be phreatophytic. They are unlikely to have any dependence on the water table, since the depth to groundwater is approximately 15 - 25 mbgl. However, in the small defined channel in the centre of the main creek at Mt Lewin a vegetation type which is sensitive to changes in groundwater level was identified. The vegetation consists of: *"Eucalyptus victrix* open woodland over *Acacia coriacea* subsp. *pendens, A. aneura, Atalaya hemiglauca* low woodland over *Cenchrus ciliaris* tussock grassland (Biota, 2004). This vegetation is potentially sensitive to groundwater level changes, especially in the area that will be affected by the Mount Lewin component of the Stage B proposal. The predicted water level drawdown predicted for this area ranges between 1 and 5 m, with the current groundwater level at approximately 15 - 25 m below the surface. The current level of groundwater dependence is likely to be low to moderate, dependent on the rooting depth of the *E. victrix* associated with this creek. It is expected that the *E.victrix* within the area of 1 - 2 m of drawdown would be unaffected by the proposal, but some of the individual trees in the area of 2 - 5m drawdown may be stressed. As a result Biota (2004) have suggested that a properly designed monitoring and management programme be implemented.

The Department of Agriculture WA (2002) identified "Flood plains with weakly gilgaied clay soils supporting coolibah woodlands (*E. Victrix*) with tussock grass understorey" in the Fortescue flood plain, which is an area where drawdown is predicted. However, in floodplain areas, E. *Victrix* (coolibah) is not phreatophytic.

Christmas Creek

At Christmas Creek the majority of vegetation types within creeks are dominated by Acacia species, not known to be phreatophytic. The Acacias in the creek areas are unlikely to have any dependence on the water table, due to the depth to groundwater of approximately 20 - 25 mbgl. The only vegetation type in this mine area that may contain phreatophytic species is " *Eucalyptus victrix* open woodland over *Acacia coriacea* subsp. *pendens*, *A. aneura, Atalaya hemiglauca* low woodland over *Cenchrus ciliaris* tussock grassland" (Biota, 2004). This species was associated with the main tributary of Christmas Creek, at the fringe of the cone of depression. *Eucalyptus victrix* is a phreatophytic species, but the extent to which it is phreatophytic is dependent on the local groundwater conditions prevailing (Biota 2002). Current groundwater levels in this area are at approximately 20 – 25 m below surface, and this is likely to be at the limit of eucalypt rooting depth. Some of the *E. victrix* may therefore utilise groundwater for a component of their ecological water requirements. However, modelling indicates that drawdowns of only around 1 m are likely to occur in the area of this vegetation type. This low drawdown is likely to be within the typical seasonal and long-term variations in water table depth that the trees experience under natural conditions. Therefore it is unlikely that any significant impact would arise from this level of change (Biota 2004).

Mindy Mindy

Only a single groundwater dependent vegetation type occurs in the area that will be affected by dewatering at this site. Based on rangelands mapping, this type is "Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands." This vegetation type is likely to have a moderate level of groundwater dependence and is likely to include eucalypts, which rely on groundwater for their ecological water requirements. However, groundwater modelling indicates that a drawdown of only 0.5 m is likely to arise from the implementation of the proposed development. Similar to Christmas Creek, this is likely to be within the seasonal and long-term fluctuation range that the tree species in this riverine vegetation type would experience under normal conditions (Biota 2004).

6.4.5 Potential Impacts on Stygofauna

Any saturated gravel deposits along the Fortescue River and other creeks have the potential to support Stygofauna. These deposits may be dewatered by abstraction from the borefield. There is therefore potential for Stygofauna communities to be affected by the borefield abstraction. FMG have developed a Stygofauna Management Plan, to manage this risk. The plan has been included separately within the PER.

6.4.6 Potential for Saline Water Upconing at Christmas Creek

As discussed in Section 4.2.6, saline water underlies the Christmas Creek pit. When an aquifer contains an underlying layer of saline water, and is pumped buy a well penetrating only the upper freshwater portion of the aquifer, a local rise of the interface below the bore occurs. This phenomenon, known as upconing, is illustrated in Figure 6.6. Here the interface is horizontal at the start of pumping ($t = t_0$). With continued pumping the interface rises to successively higher levels. Once it reaches above a critical level it can reach the base of the bore, resulting in abstraction of saline water. At Christmas Creek saline water cannot be used in the ore beneficiation process plant.

An approximate analytical solution for upconing directly beneath the Christmas Creek pit is given by:

$$z = \frac{Q}{2P\ d\ K\ (Dr/r_f)} \qquad \textit{Equation 1.}$$

Where $\Delta\rho = \rho_s - \rho_f$,

K = hydraulic conductivity and all other quantities are shown in the figure.

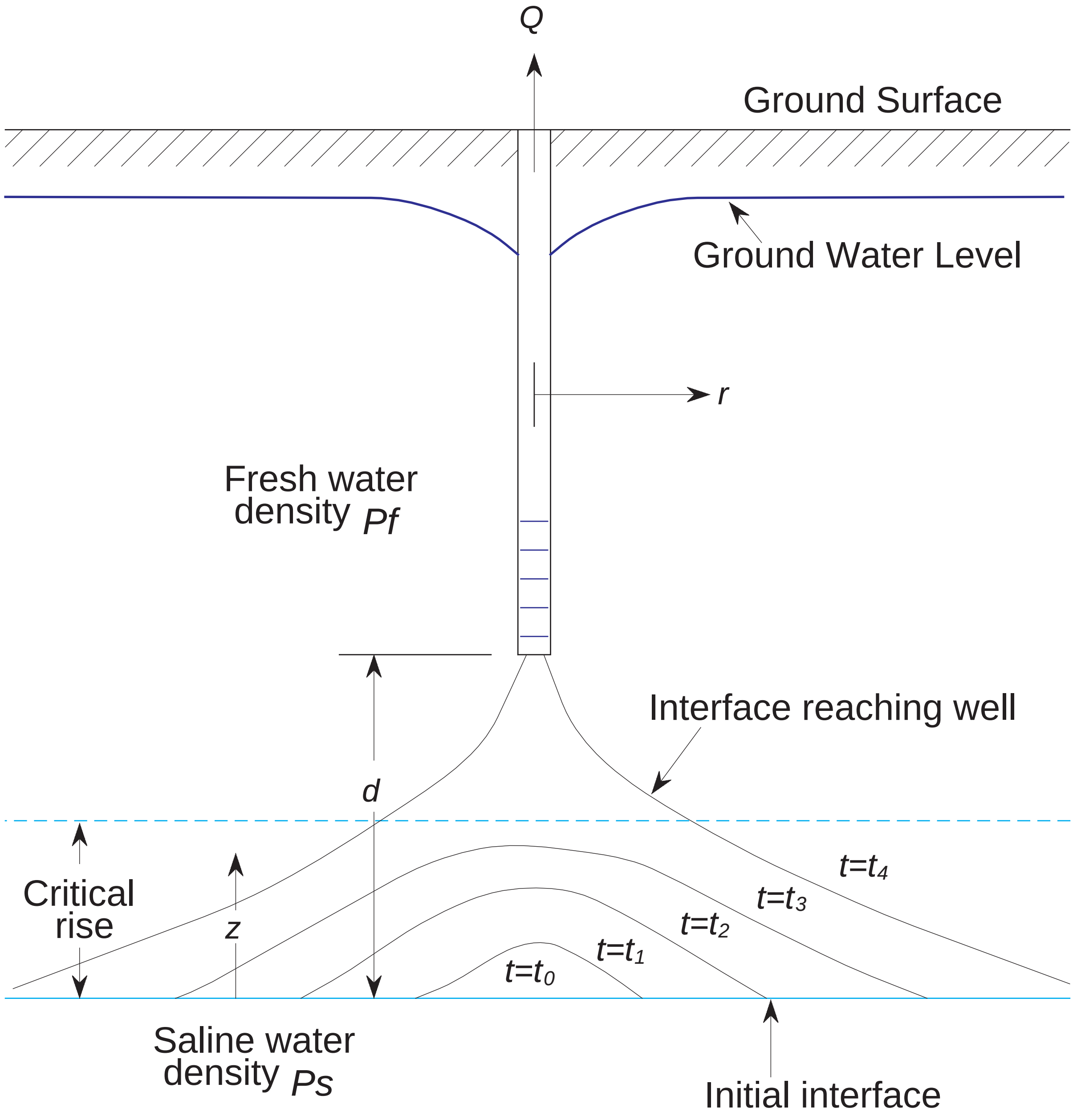
This equation has been used to determine the potential for upconing at two sites, represented by bores E19 and F6.

The saline water underlying the southern extent of the Christmas Creek pits has a TDS of between 16,000 mg/L (bore E19) to 160,000 mg/L (bore F6). This is equivalent to ρ_s of between 1.016 and 1.16. The depth to saline water in these bores is 88 m and 90 m respectively, and the depth of the pit on completion will be 60 m (d = 28 m and 30 m respectively). Discharge (Q) from dewatering bores is estimated to be 1 ML/d (1,000 m^3/d). Hydraulic conductivity of the Marra Mamba is assumed to be 0.5 m/d

Substituting these values in Equation 1, gives:

<u>Bore E19</u>

$$z = \frac{1000}{2P\ *28*\ 0.5*(1.016/1)} = 11.2\ m$$



..aquaterra\fortescue\diag1

Diagram of upconing of underlying water to a pumping bore

aquaterra

FIGURE 6.6

Bore F6

$$z = \frac{1000}{2\pi * 30 * 0.5 * (1.16/1)} = 9.2 \text{ m}$$

From this analysis it is apparent that the extent of upconing of saline water is likely to be in the order of 10 m, this compares to thickness (d) of approximately 30 m, indicating that there is little risk of saline water upconing into the pit.

6.4.7 Potential Impacts on the Fortescue Marsh

The potential impacts on the marsh from the dewatering and borefield water supply have been assessed based on the conceptual model for the marsh discussed in Section 4.2.7 and presented in Figure 4.3.

There are two potential impacts that need to be considered. They are:

1. Will surface water in the marsh will form less frequently than it does at present, and
2. Will the marsh dry out more quickly than at present?

As stated in Section 4.2.7 the available data indicates that surface water in the marsh is a result of run-off after rainfall. Evaporation from the water table acts as a control, and results in groundwater levels being maintained 5 m below the base of the marsh (except during periods when surface water in the marsh is draining into the underlying aquifer). Therefore, changes in the hydrogeological regime will not result in the marsh being filled less frequently than at present.

Figure 4.3 shows the water table as being below the marsh (i.e. there is an unsaturated layer below the bed of the marsh). The volume of water draining from the marsh into this unsaturated layer is limited by the available storage within that unsaturated zone. If drawdowns from the dewatering and/or water supply borefield were to extend below the marsh, then the available storage would increase. This would result in more seepage from the marsh, and the marsh becoming drier more quickly than at present.

The groundwater modelling indicates that the cone of depression from the dewatering of Christmas Creek will not extend as far as the Fortescue Marsh, and therefore that, irrespective of whether the alluvium below the marsh becomes saturated or not, the marsh will not be affected by drawdowns from the dewatering or borefield.

Given the limited available data and importance of the marsh, a risk assessment was undertaken which, in part, considered the potential impacts on the marsh from changes in groundwater levels. The results are included in a separate report (minRISK, October 2004), however a summary of the potential risks is provided below.

6.4.8 Fortescue Marsh Risk Assessment

The potential impacts on to the marsh from pit dewatering, the borefield supply, saline water and the discharge from Mindy Mindy were listed and the risks assessed using a model based on AS/NZS 4360: 1999 "Risk Management" and utilising risk criteria specifically developed from the guidelines within HB 203: 2000 "Environmental Risk Management".

Potential Impacts

For the purposes of the risk assessment the marsh was defined as the area within the Australian Nature Conservation Agency (ANCA) boundary. A list of potential impacts on the marsh was developed and impacts and likelihoods estimated; the results are summarised below. Except where the consequences were considered to be insignificant, mitigation measures were developed. These are discussed in Section 7.

Table 6.1
Inherent Risks to the Fortescue Marsh (minRISK, October 2004)

Activity	Issue	Impact	Consequence	Likelihood	Inherent Risk Rating	Inherent Risk Score
Borefield operation	Groundwater	Drawdown affecting water levels in the marsh and therefore vegetation.	Minor (2)	Unlikely (D)	**L**	**21**
Borefield operation	Groundwater	Drawdown affecting vegetation in Fortescue River and increasing sedimentation within marsh.	Minor (2)	Possible (C)	**M**	**18**
Borefield operation	Groundwater	Drawdown affecting Stygofauna.	Insignificant (1)	Rare (E)	**L**	**25**
Borefield operation	Groundwater	Drawdown affecting yields from stock bores within marsh boundary.	Insignificant (1)	Rare (E)	**L**	**25**
Borefield operation	Groundwater	Drawdown impacting on the drying cycle of the marsh.	Minor (2)	Possible (C)	**M**	**18**
Mine Dewatering	Groundwater	Drawdown affecting water levels in the marsh and therefore vegetation.	Minor (2)	Unlikely (D)	**L**	**21**
Mine Dewatering	Groundwater	Drawdown affecting Stygofauna.	Insignificant (1)	Rare (E)	**L**	**25**
Mine Dewatering	Groundwater	Drawdown affecting yields from stock bores within marsh boundary.	Insignificant (1)	Rare (E)	**L**	**25**
Mine Dewatering	Groundwater	Aquifer drawdown impacting drying cycle.	Minor (2)	Possible (C)	**M**	**18**
Mine Dewatering	Groundwater discharge	Effect of disposal of saline water produced during pit dewatering	Insignificant (1)	Rare (E)	**L**	**25**
Mine Dewatering	Groundwater discharge	Flora loss from pipeline failure releasing saline water	Insignificant (1)	Rare (E)	**L**	**25**
Mine Dewatering	Groundwater discharge	Introduction of an artificial semi-permanent source of surface water at Mindy Mindy	Insignificant (1)	Rare (E)	**L**	**25**

6.4.9 Impacts on Station Bores

Where the cones of depression from the water supply borefield and dewatering extend to station bores, there is the potential that yields from those bores will be reduced. Furthermore, there is a very low, risk of saline water upconing in the proposed Christmas Creek pits. If this occurred and was not effectively managed, it could then contaminate station bores nearby. However, FMG has stated that it will put measures in place to manage this risk.

6.5 IMPACTS OF MINDY MINDY DEWATERING

6.5.1 Summary of the South Model

Conceptual Model

In the conceptual model of Mindy Mindy the CID aquifer, up to 34 m thick, is found within the palaeo-channel. The direction of the palaeo-channel approximately mimics the present day drainage channel. The CID has a hydraulic conductivity of 10 m/day and a specific yield of 0.03.

Valley-fill deposits are absent at the head of the valley (in the south-east). However, the depth of valley-fill increases down the valley, where they overlie the CID. The valley-fill deposits are up to 46 metes thick within the main valley feature, and greater than 90 metres in the tributary valley in the north of the area. The valley-fill deposits have a hydraulic conductivity of 10 m/d and a specific yield of 0.2. The valley-fill deposits are only saturated in the northwest of the area.

The bedrock underlying and adjacent to the palaeo-channel is considered to be relatively impermeable. The bedrock comprises Weeli Wolli Formation in the south and west of the area, and Brockman Iron Formation in the north. The Weeli Wolli Formation has a hydraulic conductivity of 0.1 m/day and specific yield of 0.001. The Brockman Iron Formation has a hydraulic conductivity of 0.01 m/day and specific yield of 0.001.

The aquifer parameters used in the model are consistent with values used by Aquaterra in CID deposits in other parts of the Pilbara. The alluvium overlying the CID in Mindy Mindy is likely to be more coarse-grained than that in the Fortescue Plain, hence a higher value of permeability has been used. Work undertaken by Aquaterra elsewhere in tributaries of the Weeli Wolli Creek has indicated a range of permeability values for the CID of between 2 m/d and 20 m/d. Adopted values for the Weeli Wolli Formation and Brockman Iron Formation in the model are the same as those adopted by Aquaterra elsewhere in the Pilbara (except where specific testing work has indicated an alternative value).

Recharge to the system is estimated to be equivalent to approximately 1% of annual rainfall to the entire catchment.

The pit will be mined from southeast to northwest over a six-year period. For the first four years the CID will be above the water table, hence dewatering will only be required in the final two years.

Model Geometry

A two layer groundwater model was developed, as detailed below:

- Layer 1: CID/Valley fill deposits within the palaeo-channel and surrounding bedrock
- Layer 2: Bedrock

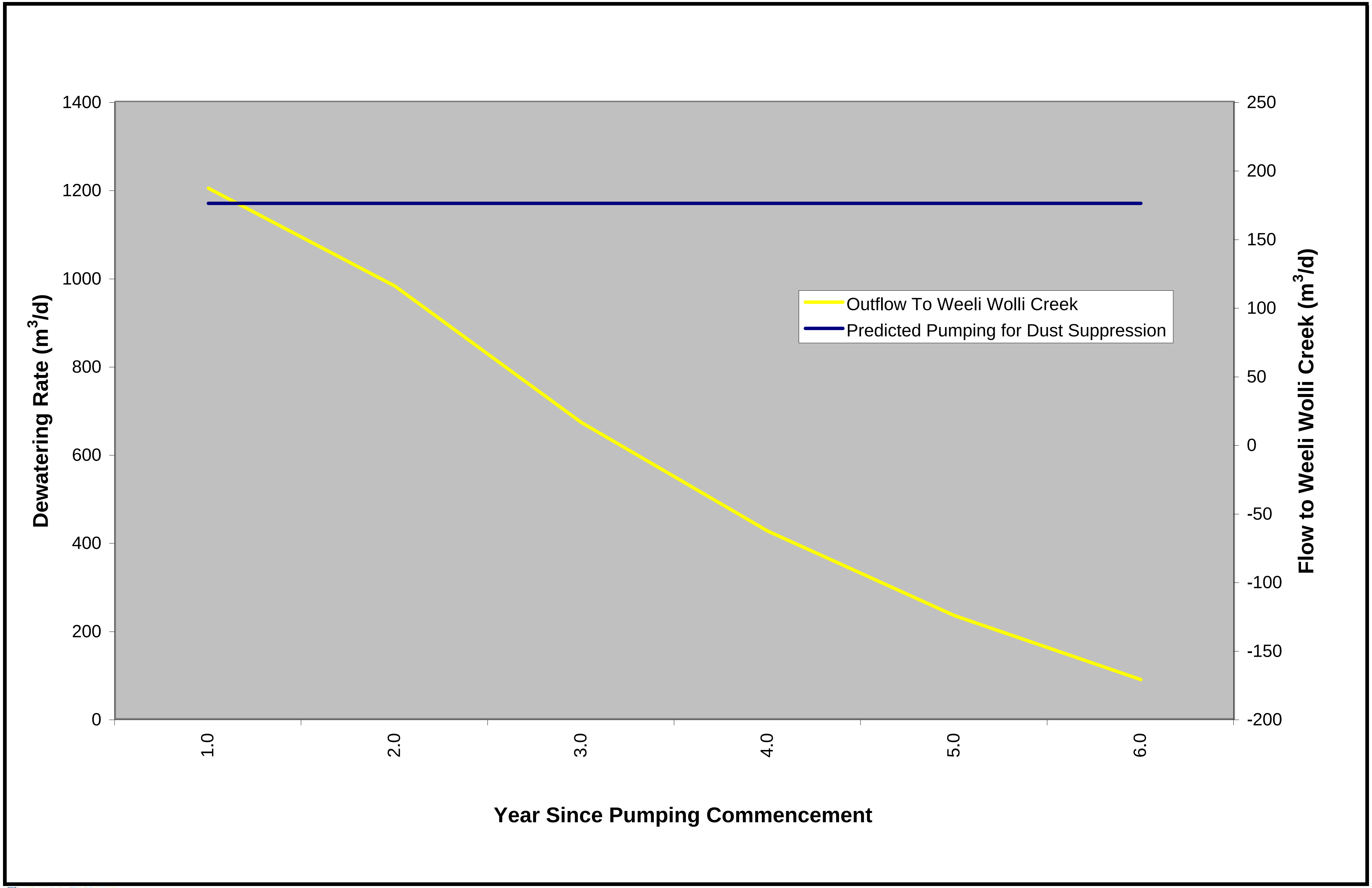
A general head boundary was assigned to the downstream and upstream ends of the aquifer to simulate groundwater outflow and groundwater inflow respectively. No-flow boundaries were assigned to the other boundaries.

Model Outputs

Dewatering is only required for the northern-most 3 kilometres of the pit. Figure 6.7 shows the abstraction required for dust suppression and the camp supply, which averages 1.19 ML/d. The graph also shows the net change in flow into/out of the Weeli Wolli Creek channel as a result of the dewatering.

6.5.2 Assessment of the Impacts from Dewatering

As discussed in Section 4.2.8, groundwater flow occurs through the CID in a northwest direction within the Mindy Mindy palaeo-channel. This flow has been estimated to be 0.2 ML/d (200 m^3/d). Further downstream,



aquaterra

Mindy Mindy Predicted Pumping Rates and Flow Rates to Weeli Wolli Creek

Figure 6.7

F:\jobs\477\6000\PER Reports\[396_Figures.xls]Figure 3 revb this water currently discharges into the sediments that in-fill the Weeli Wolli Creek. Throughflow in the Weeli Wolli Creek discharges into the sediments of the Fortescue Valley.

The aquifer throughflow in the Weeli Wolli channel has been estimated the form of Darcy Equation:

$Q = KiA$ *Equation 2*

Where Q = outflow

K = permeability

i = hydraulic gradient

A = cross sectional area

The following, estimated, parameters were used:

- Hydraulic gradient 0.02 (based on regional bore data).
- Permeability 10 m/d.
- Cross-sectional area 50,000 m^2 (calculation based on a saturated thickness of 50 m and width of 1.5 km, treated as a trapezoid shape with base 500 m.

Giving an estimated throughflow of = 10 ML/d (10,000 m^3/d).

Most of the water abstracted will be used for dust suppression, with the remainder used for a potable supply for the camp. As a result of the abstraction, throughflow to the Weeli Wolli system will decline by 0.4 ML/d (400 m^3/d). This is equivalent to 4% of the estimated total through flow of the Weeli Wolli groundwater system. It is not anticipated that such a change will have a noticeable effect on vegetation along the Weeli Wolli Creek or downstream in the Fortescue Valley.

Based on work in other parts of the Pilbara, groundwater in the CID is expected to have a salinity of between 1,000 and 2,000 mg/L as TDS. It is expected that the discharged water will soak into the ground relatively quickly, reducing the possibility of evaporation and a pool of saline water forming.

6.5.3 Impact on Weeli Wolli Springs

The Weeli Wolli Springs are an important feature of the Weeli Wolli Creek system. They are located approximately 20 km upstream from the proposed Mindy Mindy mine and will not be affected by the proposed dewatering.

6.6 MINE CLOSURE PLAN

As stated in Section 5, the mine closure plan involves the backfilling of waste material into the pits. At Christmas Creek this will consist of wet rejects from the ore beneficiation process and waste rock, including overburden. At the other proposed mines the backfill will consist of waste rock only.

The rejects from the ore beneficiation process will be low permeability material, which, if placed along the hanging wall, will have the potential to partially “blind” the hanging wall material (alluvium and Marra Mamba) and reduce groundwater flow. This has the potential to result in “backing-up” of water in the pits, forcing groundwater levels towards the surface. The hydrogeology of the marsh suggests that capillary action resulting from evaporation at the surface can occur to a depth of 5 m in the project area. It is concluded therefore that if such backing-up of groundwater did occur, evaporation from the resulting shallow water table would prevent this water appearing at the ground surface as a pool. Whilst evaporation of the groundwater would result in increased salinity, constant groundwater throughflow would maintain this at relatively low levels.

6.7 REJECT STORAGE

For the first two years of mining rejects will be stored in the reject storage facility (RSF) immediately north of Christmas Creek in an area underlain by Jeerinah Formation. The area of the RSF is approximately 780,000 m^2. Some of the rejects will contain water from the ore beneficiation process. The volume of water discharged with the rejects has been estimated at approximately 640 m^3/day, which, spread over an area of 780,000 m^2 is equal to 0.8 mm per day. Potential evaporation within the project area is estimated to be 25 m/annum, which is equivalent to approximately 7 mm/day.

This analysis suggests that there is unlikely to be any seepage from the rejects into the Jeerinah Formation. However, even if there were, it is considered unlikely that there would be any impacts on the environment.

6.8 EXCESS DEWATERING

There is a need to consider the consequences of intercepting greater amounts of water during the mining process than predicted. Other mining operations in fractured rock in the Pilbara, have intercepted more water than anticipated and the permeability of the Marra Mamba in other parts of the Pilbara is known to be highly variable. It is possible (whilst thought unlikely) that higher rates of dewatering than those predicted from the modelling could be required.

6.8.1 Management Strategies

The water requirements from the ore beneficiation plant are large in comparison to the predicted dewatering requirements, but in the unlikely event that the rate of dewatering were to exceed the water requirements, initially, the abstraction from the borefield would be reduced accordingly. It would then be necessary to store and/or discharge the excess water. There are several possible disposal mechanisms including:

- using the water to irrigate any vegetation affected by the cone of depression;
- piping the water to one of the many creeks in the area;
- discharging into one of the worked pits; or
- allowing the water to soak away into the Marra Mamba at a point away from the unworked pits.

The mechanism chosen would depend upon a number of factors, including the volume of water to be discharged, the location of the excess water and whether there are any worked pits in the vicinity. The management strategy would be chosen in consultation with the DoE, based on information available at the time. If management involved a discharge to the environment then prior to such a discharge, a suitable monitoring programme would be developed to the satisfaction of the DoE.

SECTION 7 - MITIGATION MEASURES

7.1 INTRODUCTION

The previous section discussed the potential environmental impacts from the project. This section of the report discusses possible mitigation measures to reduce those impacts.

7.2 IMPACTS FROM THE EAST – WEST RAILWAY

In Section 6.2 it was shown that there was unlikely to be any long-term impact on vegetation from the temporary abstraction of water for the construction of the railway except where bores are situated close to phreatophytic species, such as may exist, along creek lines. Furthermore, the most likely habitats for Stygofauna are within coarse-grained alluvial deposits within these same creeks.

- It is proposed that the temporary bores be constructed more than 100 m from any creek to mitigate against potential impacts on Stygofauna and phreatophytic vegetation

7.3 IMPACTS TO THE FORTESCUE MARSH

The potential impacts to the Fortescue Marsh were discussed in Section 6.4.7. A series of management and mitigation measures were developed as part of the Risk Assessment. The results are presented in Table 7.1 below.

Table 7.1
Mitigation Measures to Manage Impacts on the Fortescue Marsh

Potential Impact	Mitigation Measure	Residual Risk	Residual Risk Number
Drawdown from the borefield affecting water levels in the marsh and therefore vegetation.	Installation of groundwater monitoring bores between the borefield and the marsh. Monitoring & measurement of those bores Development of and annual calibration of a groundwater impact model. Third party hydrological reports. Timely development of contingency plans for an alternative abstraction borefield if the model and/or monitoring data predict an impact.	L	23
Drawdown from the borefield affecting vegetation in Fortescue River and increasing sedimentation within marsh.	Installation of groundwater monitoring bores between the borefield and the Fortescue River. Monitoring & measurement of those bores Development of and annual calibration of a groundwater impact model. Third party hydrological reports. Timely development of contingency plans for an alternative abstraction borefield if the model and/or monitoring data predict an impact.	L	23
Drawdown from the borefield affecting Stygofauna.	Not required – initial risk considered insignificant Stygofauna Management Plan (see Section 7.5)	L	25
Drawdown from the borefield affecting yields from stock bores within marsh boundary.	Not required - Groundwater modelling study shows negligible impact on water table around boundary areas	L	25
Drawdown from the borefield impacting on the drying cycle of the marsh.	Installation of groundwater monitoring bores between the borefield and the marsh. Monitoring & measurement of those bores Development of and annual calibration of a groundwater impact model. Third party hydrological reports. Timely development of contingency plans for an alternative abstraction	L	21

Potential Impact	Mitigation Measure	Residual Risk	Residual Risk Number
	borefield if the model and/or monitoring data predict an impact.		
Drawdown from dewatering affecting water levels in the marsh and therefore vegetation.	Installation of groundwater monitoring bores between the pits and the marsh. Monitoring & measurement of those bores Development of and annual calibration of a groundwater impact model. Third party hydrological reports. Timely development of contingency plans for an alternative abstraction borefield if the model and/or monitoring data predict an impact.	L	23
Drawdown from the dewatering affecting Stygofauna.	Not required – initial risk considered insignificant. Stygofauna Management Plan (See Section 7.5).	L	25
Drawdown from the dewatering affecting yields from stock bores within marsh boundary.	Not required - Groundwater modelling study shows negligible impact on water table around boundary areas	L	25
Drawdown from the dewatering impacting on the drying cycle of the marsh.	Installation of groundwater monitoring bores between the pits and the marsh. Monitoring & measurement of those bores Development of and annual calibration of a groundwater impact model. Third party hydrological reports. Timely development of contingency plans for an alternative abstraction borefield if the model and/or monitoring data predict an impact.	L	21
Effect of disposal of saline water produced during pit dewatering	Regular sampling from the dewatering bores. Installation of deeper water quality monitoring bores. Mixing of saline water with fresh water for use in the ore-beneficiation process. Third party hydrological reports. Develop contingency plans for aquifer recharge.	L	25
Flora loss from pipeline failure releasing saline water	Bunding, pipeline pressure monitoring and inspections	L	25
Introduction of artificial permanent source of surface water downstream of the Mindy Mindy dewatering discharge.	Small catchments and settling sumps, diversion to natural water courses	L	25

7.4 IMPACTS ON PHREATOPHYTIC VEGETATION

FMG have stated that they will develop a Vegetation Monitoring and Management Programme as part of the Borefield Management Plan (see Section 7.8 below) to ensure the vegetation impacts and associated groundwater abstraction is adequately managed. This plan will be based on the vegetation that might be affected by groundwater drawdown, as described in Section 6.4.4. Possible measures to be included in this plan are as follows:

- The construction of groundwater monitoring bores and monitoring of water levels in the alluvial and basement aquifers along creeks where vegetation might be effected, prior to commencement of abstraction.

- Sampling of groundwater in the vicinity of Christmas Creek to monitor changes in salinity in the alluvial aquifer.
- Development of improved numerical groundwater models and annual calibration of these models, so that future drawdowns for the life of the project can be identified in a timely manner before potential impacts occur.
- Assessment of vegetation condition, in those areas where groundwater levels have declined as a result of groundwater abstraction.
- If groundwater monitoring and vegetation condition assessments indicate a decline in tree condition due to drawdown, irrigation systems will be considered to support selected communities.

The results of the plan will be reported in the Annual Environmental Report, which is submitted to the Department of Environment (DoE) and the Department of Industry and Resources (DoIR). Results will also be submitted to the Environmental Protection Authority and Department of Conservation and Land Management. FMG have stated that they will also make the results of the sampling programme publicly available if required.

7.5 IMPACTS FROM THE BOREFIELD AND DEWATERING ON STYGOFAUNA

FMG has developed a subterranean fauna management (FMG, November 2004), which is being submitted as part of the PER. The plan includes a commitment to monitoring of groundwater levels for two years prior to the commencement of operations, and a long-term plan will be developed if Stygofauna are located.

7.6 IMPACTS ON STATION BORES

As described in Section 4.2.2 information on the location and status of station bores was obtained from the DoE's AQWABASE system. Before commencement of mining it is proposed that a more detailed survey of station bores be undertaken. This will involve water level dipping and status assessment. The groundwater models will then be used to identify bores currently used, which may be affected by the project.

- Possible mitigation measured include deepening of affected bores or, where this is not possible, provision of an alternative piped supply from the dewatering bores or water supply borefield.
- Water quality samples will be taken from those bores in the vicinity of Christmas Creek prior to commencement of the project. The results will be used to determine if these bores are becoming more saline as a result of the dewatering of Christmas Creek. If this occurs FMG will make alternative water supplies available to the pastoral leasee.

7.7 IMPACTS FROM MINE CLOSURE

As discussed in Section 6.6, there is the potential for evaporation from shallow groundwater in the Christmas Creek pits if rejects from the ore-beneficiation process blind the hanging wall material.

- To reduce the likelihood of this it is proposed that rejects will be disposed of above the existing water table.

7.8 BOREFIELD MANAGEMENT PLAN

Appendix H includes a draft Borefield Management Plan, which includes monitoring strategies, data collection systems, impact modelling and annual reporting proposals. It also includes a Borefield Contingency Plan. The Borefield Contingency Plan describes potential alternative locations for the borefield and describes the process which would lead to the development of such an alternative site.

SECTION 8 - CONCLUSIONS AND PROPOSED FURTHER WORK

8.1 CONCLUSIONS

The key conclusions are:

1. The Fortescue Marsh is a surface water feature, which fills after large rainfall events. The frequency of the marsh filling up is dependent on rainfall and is not affected by the hydrogeology of the project area.
2. After floods, the marsh then dries out as a result of evaporation and seepage into the unsaturated alluvium below. Once the marsh has dried out evaporation from the shallow groundwater occurs, resulting in the water table reducing to 5 mbgl. It is not predicted that dewatering or the water supply borefield will affect groundwater levels in the vicinity of the marsh.
3. A risk assessment has been undertaken on the marsh using the results of Aquaterra modelling. The risk assessment was conducted by a team of expert consultants and found that changes to the hydrogeology of the project area are unlikely to impact on the marsh. A series of monitoring and mitigation measures have been developed to accommodate potential impacts.
4. There is saline water at depth in the aquifers between Christmas Creek and the marsh. This saline water is below the base of the proposed pit. Calculations suggest that it is unlikely to upcone into the dewatering bores.
5. It is not predicted that there will be any long-term impacts on the environment resulting from abstraction during construction of the railway, where bores are sited more than 100 m from creeks.
6. There is some potential for impact to individual trees, which are possibly phreatophytic, occurring locally in areas that will be impacted by the drawdowns associated with the water supply borefield and dewatering at the mines. FMG will implement a Groundwater Monitoring and Management plan which will further consider possible impacts to phreatophytic vegetation and monitor vegetation condition and groundwater levels where appropriate.
7. Stygofauna may be affected by dewatering and the water supply borefield. A Stygofauna Management Plan has been developed by FMG.
8. There are station bores that will be affected by the drawdowns associated with the dewatering and water supply borefield. Mitigation measures include bore deepening and the provision of alternative supplies.
9. It is proposed that rejects from the ore beneficiation process be disposed of above the water table to reduce the likelihood of the blinding of the hanging wall at Christmas Creek with low permeability material.

8.2 PROPOSED FURTHER WORK

Whilst sufficient data has been obtained for this study to be able to undertake a preliminary assessment of the potential impacts of the project, it is recognised there is a need for further work, prior to licensing and borefield development. The following sections outline the work that is proposed.

8.2.1 Borefield

Further work is proposed to improve upon the environmental impact assessment resulting from the borefield. The work proposed consists of:

- The drilling of more exploratory bores in the area south of Mount Lewin on existing FMG tenements. Information obtained from these bores will be used to more accurately map the thickness of the alluvial deposits in this area and the topography of the basement material. This information will be used to more accurately define the layers in the north numerical groundwater model.
- The drilling of trial water supply bores and monitoring bores in the location of the borefield. The trial bores will intercept the alluvium and underlying formation (Marra Mamba or Wittenoom Dolomite). Each bore will be drilled at 250 mm diameter and lined with 155 mm PVC screen and casing. A filter pack will then be installed. The monitoring bores will be drilled as nested piezometers, intercepting both the alluvium and basement rocks and completed with 50 mm PVC screen and casing and a gravel pack. Drilling of these bores is due to start in early December 2004.
- Test pumping of the trial bores to more accurately determine hydraulic parameters. Test pumping will be undertaken using submersible pumps. The data from the test pumping analysis will be used to provide improved estimates of the aquifer parameters for the alluvium and basement materials. This information will be used to improve the assumptions within the north numerical groundwater model.
- Monitoring of water levels in the station bores within the predicted cone of depression, to provide improved understanding of regional groundwater levels. The groundwater model will be updated to reflect this improved information.

8.2.2 Dewatering Requirements

Further work is proposed to improve the assessments of dewatering requirements in each of the pits. This will involve the drilling of trial water bores in the hanging wall material of Mount Nicholas, Mount Lewin, Christmas Creek and Mindy Mindy. These bores will be completed to the same specification as the bores described in Section 8.2.1 above. Monitoring bores will be drilled to penetrate the hanging wall material.

Each trial bore will be test pumped using a submersible pump. The analysis of the data will provide improved estimates of the hydraulic characteristics of the saturated material. This work is expected to be completed in January 2005.

The results of these investigations will be used to improve the north numerical groundwater model, providing more robust estimates of dewatering requirements.

8.2.3 Groundwater Modelling

The modelling studies require additional work as recommended in Groundwater Flow Modelling Guideline (MDBC, 2000), including:

1. Model sensitivity assessment, and
2. Uncertainty analyses.

The current models will be refined as more field data becomes available. Model features that are identified for refinement include:

1. Water table elevations, with data from new bores and surveys for existing regional bores;
2. Evapotranspiration, including aerial zonation and rooting depths of major vegetation types;
3. Recharge, including aerial zonation of major recharge zones; and
4. Stratigraphic elevations, including alluvial and basement thickness.

Other potentially important issues for the model development, calibration, and predictions, are also being considered. These include:

1. Examination and refinement of the whole-of-model water budget to ensure that the water budget is consistent with (a) the catchment water balance, and (b) the estimated regional inflows/outflows connecting the current study area with neighbouring aquifers, and
2. Examination of the historical rainfall for the region and the assessment of impacts of rainfall variability on (a) water supply, and (b) water table drawdown.

8.2.4 Borefield Contingency Plan

FMG is currently seeking access to five of the proposed contingency borefields. Once access has been obtained (either by tenure or agreement with existing tenement owners), geophysical investigations and exploratory drilling will commence. It is envisaged that the first drilling programme will commence in January 2005. This will allow FMG to develop a contingency borefield should there be some difficulties, environmental or other, developing the borefield mentioned above.

FMG is currently undertaking geophysical studies on the sixth borefield site (the Fortescue Borefield), to determine if groundwater quality in the Wittenoom Dolomite can be interpreted remotely. If the results of this investigation prove encouraging, then a programme of exploratory drilling and testing will commence.

It is anticipated that numerical groundwater models will be produced for the most prospective sites.

SECTION 9 - REFERENCES

Agriculture WA (2002) Pilbara Rangelands Project, Rangeland Survey

Aquaterra, East Pilbara Iron Ore Project – Surface Hydrology, November 2004

Biota, Review of Phreatophytic Vegetation Potentially Occurring in FMG Project Area, December 2004

Biota, Vegetation mapping produced for FMG's Stage B Project, November 2004

FMG, Subterranean Fauna Management Plan, November 2004

Harrington, Cook, and Herczeg, 2002 Spatial and temporal variability of groundwater recharge in central Australia: a tracer approach. Ground Water. Vol. 40 (5): 518-528.

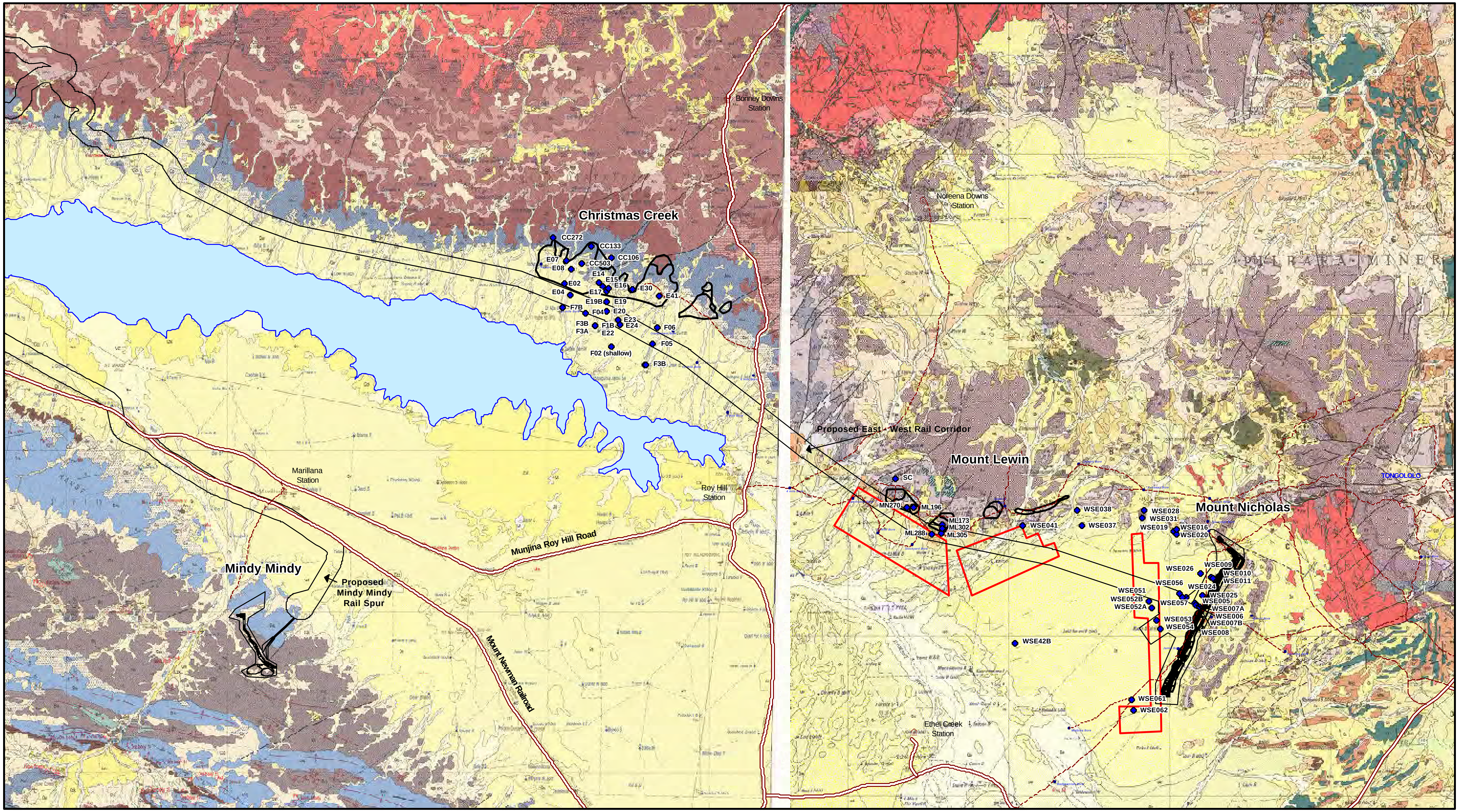
Hope Downs, Hope Downs Iron Ore Project, Public Environmental Review, August 2000

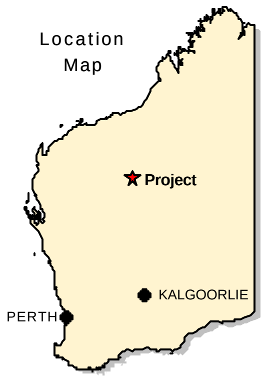
MinRISK, Risk Assessment Impact Of Mine Water Demands On The Fortescue Marsh Ecosystem Findings And Recommendations, October 2004

APPENDIX A

BORE LOGS FROM THE HYDROGEOLOGICAL INVESTIGATION

Figure Showing Location of Hydrogeology Bores





Legend

Fortescue Marsh

Proposed Borefield

Exploration Bore

N

0 10 20 km

Fortescue Metals Group Limited

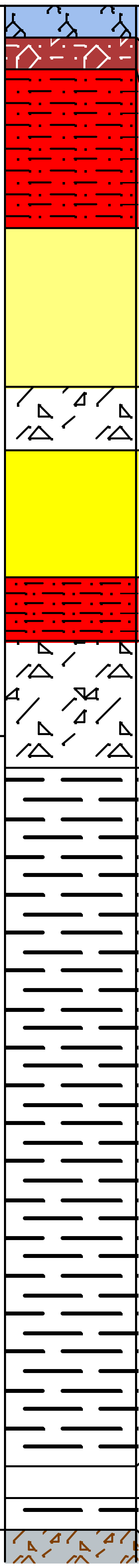
Figure A1 Exploration Bore Locations

Author: Aquaterra	Date: 26 November 2004
Drawn: Barbara Zakrzewska	Revised:
Dwg No.: B1	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 450 000

A1: Mount Nicholas/Mount Lewin and Borefield Area

aquaterra	COMPOSITE WELL LOG		Well No: WSE 5	
Suite 4, 125 Melville Parade *Como* *WA 6152* *Australia* *Tel: (+61) (08) 9368 4044* *Fax: (+61) (08) 9368 4055*	**Client:** Fortescue Metals Group	**Project:** Mt Nicholas groundwater RC exploration		
	Commenced: 14/7/2004 **Completed:** 15/7/2004 **Drilled:** Connector **Logged By:** P.Costello	**Method:** RC (0-106) **Fluid:** **Bit Record:** 5 3/8"		**Area:** Mt Nicholas **East:** 244400m(AMG) **North:** 7483150m(AMG) **Elevation:**
	Static Water Level: 43.15 mbgl	**Date:** 15/7/2004 (12.45pm)		

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0 – -10 – -20 – -30 – -40	Tertiary alluvium; Puggy clays (lacustrine?).		TOPSOIL: Brown gritty clays.			
			GRAVELLY SILTS & CLAYS: Red-Brown gritty clays limonitic gravels and sands.			
			CLAY WITH SAND: Orange-brown clays and 1-3mm moderately sorted, subrounded sands.			
			GRAVEL AND SAND: Orange-brown gravel up to 2cm and poorly sorted, well rounded quartz sands; up to 30% clay.			
			CLAY WITH GRAVEL: as previous; with 60% red-brown gritty clays.			
			CLAYEY SILT: Red- brown gritty clays.			
			CLAY AND SAND: Red -brown gritty clays; 30% sub-round quartz & limonite; 0.5 - 5mm; poorly sorted.			
			CLAY WITH GRAVEL: Red-brown-cream clays; 30-50% sand & gravel; 0.5- 1.5cm; subangular; poorly sorted.			
			CLAY 2: Yellow- brown-cream puggy clays.			
			SILCRETE: Cream silcrete and green clays.			
			CLAY 2: Pale turquoise-yellow clays.			
			CLAY AND GRAVEL: Pale Yellow-green-brown puggy	48-54m: Puggy clays (lacustrine?) and		



Depth scale: -50, -60, -70, -80, -90, -100

Lithology	Comments	Construction
clays & dark brown limonitic sand-gravel;1- 6mm; poorly sorted.	limonitic sands.	Open hole (0-106mbgl)
CLAY 2: Pale green-cream puggy clays.		
CLAY WITH GRAVEL: Pale olive green clays with limonitic sand and gravel; 1- 6mm; subangular; moderately sorted.		
SILCRETE: Cream clays and cream silcrete.	54-61m: Cream clays and silcrete.	
FERRICRETE: Pale brown clays and dark red -brown hard ferricrete.	61-63m: Brown clays and ferricrete.	
CLAY AND SAND: Pale brown- cream clays and quartz- limonite sand; subangular; 1- 3mm; well sorted.	damp samples to 63m	
FERRICRETE: Pale brown clays and dark red -brown hard ferricrete fragments up to 5mm..	63-77m: Brown-grey clays with poorly sorted, limonitic sands.	
CLAY 3: Dark grey- brown puggy clays.		
CLAY WITH SAND: Grey- brown clays and 30% dark brown limonitic sub-round sand; 1- 5mm;poorly sorted.	damp samples to 72m	
DOLOMITE AND CLAYS: Grey clays and Grey-pale red brown fresh hard Dolomite; chips up to 2cm.	77-88m: Dolomite with clays.	
DOLOMITE: Fresh green-brown fine grained hard, silicified Dolomite; broken.	damp sample; fast pen. to 80m.	
DOLOMITE AND CLAYS: Grey clays and fresh green-brown fine grained hard, silicified Dolomite; broken.	high outside water circ. and broken ground.	
CHERT: Pale grey blocky chert and grey clays.	88-92m: Grey Chert.	
DOLOMITIC SILTSTONE: Pale grey, mottled fresh broken dolomite and grey laminated siltstone.	damp samples to 92m; high inside and outside water flow at rod change; inceased pen. rate to E.O.H.	
DOLOMITE: Pale yellow-brown Dolomite.	92-94m:Dolomite and dolomitic siltstone.	
DOLOMITIC SILTSTONE: Grey, blocky, well laminated siltstone.	94-96m: Dolomite. low water flow at rod change. 96-106m: Dolomitic siltstone. EOH at 106mbgl	

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COMPOSITE WELL LOG

Well No: WSE 6

Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced: 15/7/2004	**Method:** RC (0-77)		**Area:** Mt Nicholas
Completed: 15/7/2004	**Fluid:**		**East:** 244600m(AMG)
Drilled: Connector	**Bit Record:** 4"		**North:** 7483000m(AMG)
Logged By: P.Costello	5.5"		**Elevation:**

Static Water Level: **Date:**

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Alluvium (Tertiary)		CLAY AND GRAVEL: Dark red-brown clays and limonitic,quartzose sand to gravel.			
			CLAYEY SAND: Red-Brown gritty clays and poorly sorted quartz sand; 0.5- 5mm.			
			CLAY WITH GRAVEL: Red-brown indurated clays and limonitic gravel.			
-10			CLAY AND SILT: Red-brown gritty clays.			
			CLAY 2: Brown puggy clays; 10% limonitic sand, 1-3mm; mod. sorted from 12- 13m.			
			CLAY WITH GRAVEL: Red- brown gritty clays; 20% limonitic sand, 0.1- 5mm; poorly sorted.			
-20	Alluvium - puggy clays		CLAY 2: Pale yellow-cream-brown puggy clays; 30% limonitic-quartzose sand -gravel; subrounded, (1 - 4mm) from 24-26m.			
-30			CLAYEY SAND: Maroon-brown sandy clays.			4" open hole (0-77mbgl)
			CLAY 2: Yellow-brown-turquoise puggy clays; minor brown, well rounded limonitic sand t/out averaging 2mm from 37- 47m.			
-40				damp to 47m		
			SAPROLITIC CLAY: Olive green brown- white clays.	47-49m: Saprolitic clays		
-50	Dolomite with dolomitic siltstone		DOLOMITE: Pale green-maroon fresh Dolomite; broken, chips up to 2.5cm.			
			DOLOMITIC SILTSTONE: Maroon dolomitic siltstone; 64- 66m brown- pink dolomite(silicified).			
-60				wet sample at rod change.		
-70			DOLOMITE: Pale maroon dolomite; 30% dark green siltstone from 71- 76m.	wet sample at rod change. Dry hole (no water airlifted) 77 m EOH		

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COMPOSITE WELL LOG

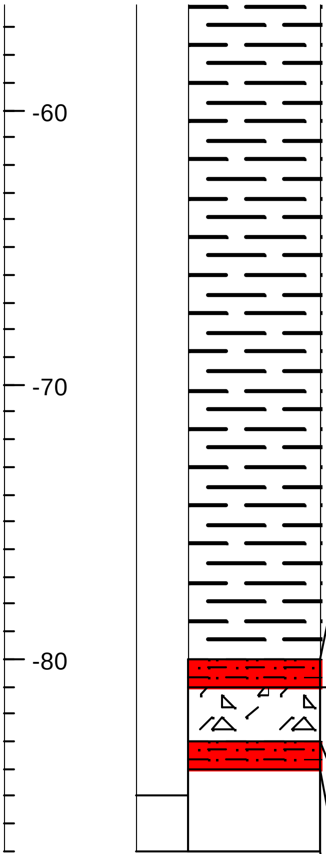
Well No: WSE7a

Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC drilling

Commenced:	15/7/2004	**Method:**	RC (0-87)	**Area:**	Mt Nicholas
Completed:	16/7/2004	**Fluid:**		**East:**	244800m(AMG)
Drilled:	Connector	**Bit Record:**	4"	**North:**	7482850m(AMG)
Logged By:	P.Costello		5.5"	**Elevation:**	

Static Water Level: **Date:**

Depth (mbgl)	Geology	Lithological Description	Field Notes	Well Completion Notes
0	Colluvium	COLLUVIUM: Red-brown clays,chert and gravel.	Angled hole; Azimuth 145 degrees, inclination - 70 degrees.	
	Colluvium	CLAY AND SAND: Yellow- brown clays and 0.5- 4mm rounded quartz sand.		
	Colluvium	CLAY AND GRAVEL: Orange- brown clays and sand- gravel composed of quartz, chert and limonite; poorly sorted.	Hole abandoned due to highly broken chert in puggy clays.	
		GRAVEL AND SAND: Orange-brown gravel up to 2cm and poorly sorted, well rounded quartz sands; up to 30% clay.		
-10		CLAY AND SAND: Red- brown clays; partially indurated; minor dark brown limonitic sand averaging 3mm.		
-20		CLAY: Red- brown puggy clays.		
		CLAY WITH SAND: Red -brown and pale turquoise puggy clays; 15% dark brown limonitic and quartzose sand; 0.5- 3mm, poorly sorted; from 29- 31m.		
-30				4" open hole (0-87mbgl)
		CLAY AND SAND: as above; 50% sand.		
		SAND: Sand as above.		
		CLAYEY SANDY SILT: Dark red-brown silty clays and 10% 0.5- 5mm quartz and limonite sand.		
-40		CLAY AND SAND: Yellow-brown clays & limonitic sand up to 4mm.		
		CLAY AND SAND: Dark brown clays with quartz and limonite sand- gravel; rounded; 0.5- 10mm; poorly sorted.		
	Alluvium	CLAY 2: Yellow-brown puggy clays.		
	Alluvium	CLAY WITH SAND: Pale olive green clays with 20% limonitic sand; 1mm- 5mm, mod. rounded; 10% mod rounded, well sorted 1- 2mm quartz sand.	damp to 50m	
-50		CLAY 2: Pale olive-green-brown puggy clays; 5% quartz and limonite sand; 1- 3mm; well rounded and sorted from 59 -80m		



Lithology	Comments
	wet outside return at rod change (minor).
	wet outside return at rod change (minor).
	damp samples to 86m. Water & foam injected,
CLAY AND SAND: Pale olive-green-brown puggy clays; 50% quartz sand; 1- 3mm; well rounded and sorted.	85-87m: Chert and saprolitic clays.
CLAY WITH GRAVEL: Pale olive-green-brown puggy clays; 20% limonitic sand- gravel; 1- 10mm; well rounded and poorly sorted.	wet outside return at rod change (minor).
CLAY AND SAND: Cream clay ; 60% 1-2mm well rounded and sorted quartz sand.	wet outside return (minor)).
CHERT AND CLAYS: Yellow- brown puggy clays and up to 30% green angular broken chert fragments up to 2.5cm.	EOH at 87mbgl

COMPOSITE WELL LOG

Well No: WSE 7b

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Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC drilling

Commenced: 16/7/2004	**Method:** RC (0-142)	**Area:** Mt Nicholas
Completed: 17/7/2004	**Fluid:**	**East:** 244785m(AMG)
Drilled: Connector	**Bit Record:** 4"	**North:** 7482851m(AMG)
Logged By: P.Costello	5.5"	**Elevation:**

Static Water Level: 55.8 mbgl **Date:** 17/7/2004; 12.00am

Depth (mbgl)	Geology	Lithological Description	Field Notes	Well Completion Notes
0	Colluvium	COLLUVIUM: Red- orange- brown clays and quartz, chert and limonitic sand- gravel.		
		CLAY AND SAND: orange-brown gritty clays and subround, mod. sorted quartz and limonitic sand; 1-4mm.		
-10		CLAY WITH SAND: Red- brown gritty clays and 10% limonitic sand up to 5mm.		
		CLAY WITH SAND: Red- brown clays; partially indurated; minor dark brown limonitic sand averaging 3mm.		
-20		CLAY: Red- brown puggy clays; 21-22m 10% limonitic sands up 4mm; mod. sorted; 27- 30m up to 15% 0.5 - 5mm, poorly sorted, subangular limonite and quartz sand.		
-30		CLAY WITH SAND: Cream- pale turquoise puggy clays; minor brown limonitic and quartzose sand; 0.5-5mm, poorly sorted.		
		CLAY AND GRAVEL: Cream- maroon brown clays and quartz, chert, limonite sand -gravel; 1- 10mm; rounded to subangular; poorly sorted.		
-40		CLAY 2: Yellow- brown-turquoise, hard puggy clays.		
		CLAY WITH SAND: Yellow- brown-turquoise, hard puggy clays and minor 1-3mm rounded limonite sand t/out..		
-50	Alluvium	CLAY WITH SAND: Olive-green-brown puggy clays; 15-30% 1-4mm rounded limonitic sand. 52 to 64m; 2% sand.		
-60				4" open hole (0-142mbgl)
			damp sample	
		CLAY WITH SAND: Cream-pale olive green clays; minor limonitic sand; average 1-2mm; well sorted; 70-		

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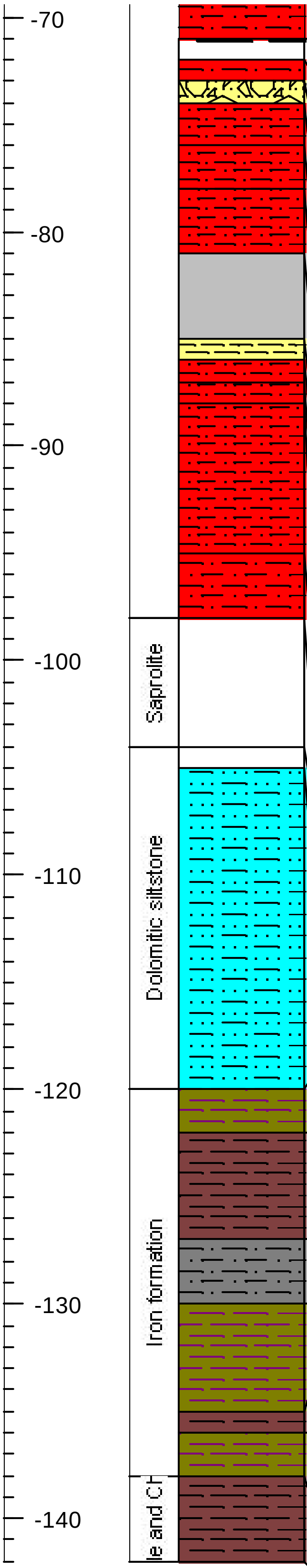
COMPOSITE WELL LOG

Well No: WSE 7b

Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC drilling



Lithology description	Comments
71m- minor dark grey chert.	damp samples to 71m
CLAY 2: Pale green- brown puggy clays.	
CLAY WITH SAND: Pale green-brown puggy clays; 40% quartz sand; 1- 2mm; well rounded and sorted.	
SAND AND GRAVEL: Cream- pale grey well rounded; 1- 20mm; poorly sorted chert and quartz sand- gravel.	damp samples to 78m
CLAY AND SAND: Cream clays and pale grey well rounded; 1- 2mm; poorly sorted chert and quartz sand.	
CLAY AND SAND: Yellow-olive green gritty clay ; 40% 1-2mm well rounded and sorted quartz sand.	
CLAY AND SAND: Cream-yellow-brown clays; 50% quartz sand as above.	
CLAY AND SILT: Brown gritty clays; 50% 1-3mm mod sorted and rounded quartz sand from 84-85m.	damp samples to 112m
CLAY: Cream clay.	
CLAY AND SAND: Pale brown clays and 1-3mm mod. sorted , rounded quartz sand.	
CLAY AND SAND: Dark olive- green-brown clays and 1-2mm. well sorted and rounded quartz and limonite sand.	outside circ. water return.
CLAY AND SAND: Dark olive- green-brown clays and 1- 7mm moderately sorted and rounded limonitic sand.	fast penetration to E.O.H.
CLAY WITH SAND: Dark grey- brown clays; 25% yellow-brown-dark grey goethitic/manganiferous fragments and subangular 1- 4mm , poorly sorted limonitic sand.	
CLAY 3: Dark grey-brown clays.	
DOLOMITE AND CLAYS: Dark grey-brown saprolitic clays and blocky cream-brown weakly laminated dolomite/dolomitic siltstone.	
DOLOMITIC SILTSTONE: Olive green saprolitic clays and broken weakly laminated, pale grey dolomitic siltstone.	wet samples to E.O.H. broken, cavernous.
SHALE AND IRON FORMATION: Red- brown clays and green well laminated hematitic shale/siltstone.	
SHALE AND CHERT: Orange- brown clays and dark green-grey shale and pale grey chert; strongly laminated; Highly broken; iron stained.	
SHALE: Orange- brown clays and green strongly laminated shale.	
SHALE AND IRON FORMATION: Dark grey- brown hematitic shale.	
SHALE AND CHERT: Grey, broken shale pale grey cherty bands.	
SHALE AND IRON FORMATION: Grey- green chert with minor hematitic laminae t/out; highly broken from 137-138m with chips up to 2.5cm.	EOH at 142mbgl
SHALE AND CHERT: Maroon-grey shale and pale grey chert; highly broken.	

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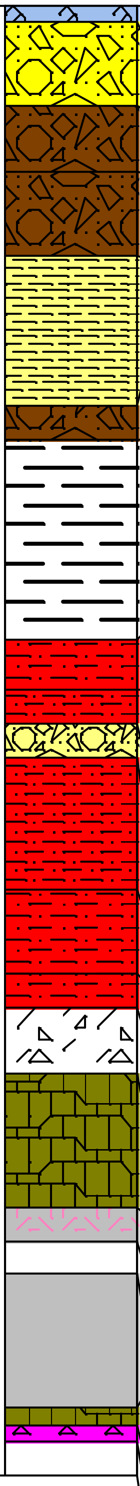
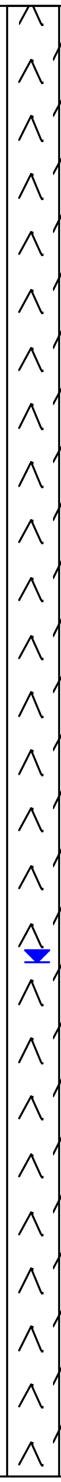
COMPOSITE WELL LOG

Well No: WSE 8

Client: Fortescue Metals Group
Project: Mt Nicholas groundwater RC exploration

Commenced:	13/7/2004	**Method:**	RC (0-88)	**Area:**	Mt Nicholas
Completed:	14/7/2004	**Fluid:**		**East:**	245000m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7482700m(AMG)
Logged By:	P.Costello			**Elevation:**	

Static Water Level: 57.23 mbgl
Date: 15/7/2004; 12.30pm

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			TOPSOIL: Brown gritty clays.			
			COLLUVIUM: Red-Brown gritty clays,limonitic gravels and cherty fragments.			
			ALLUVIUM: Dark red-brown clays and 1-3mm moderately sorted, subround sands.			
-10			ALLUVIUM: Dark red-brown clays, gravel up to 10mm and poorly sorted, well rounded limonitic sands from 1-9mm.			
			CLAY: Red-brown gritty clays.	water in first sample from overnight.		
-20			ALLUVIUM: Brown limonitic gravel up to 7mm and subround limonitic & quartz sand >0.5mm (poorly sorted).			
-30			CLAY 2: Pale yellow-cream-brown puggy clays. Dark brown limonitic gravel up to 1.5cm in sandy clay from 32-33m. 15% limonitic sand -gravel (<0.5 - 6mm) poorly sorted, from 36 -37m.			Open hole (0-88mbgl)
-40			CLAY WITH SAND: Yellow-brown gritty clays; 5% rounded quartz up to 2mm; moderately sorted.			
			CLAY AND SAND: Yellow gritty clays & poorly sorted 0.5- 3mm subrounded quartz sand; some limonitic up to 5mm.			
-50			SAND AND GRAVEL: Quartz & limonitic sand- gravel; rounded, 0.5- 10mm, poorly sorted; 10% yellow clays.			
			CLAY AND SAND: Yellow-white clays & rounded 0.5-3mm, moderately sorted milky sand. 48-50m limonitic sand & 10% limonitic rounded gravel up to 7mm.	damp samples to 64m		
			CLAY WITH SAND: Pink -brown clays;10% well sorted & rounded 1-2mm quartz sand.			
-60			CLAY WITH SAND: Yellow-brown clays; minor 1-2mm quartz sand.			
			CLAY WITH GRAVEL: Pale olive green clays with limonitic sand and gravel; 1mm- 1cm, rounded, poorly sorted.	muddy samples to 68m; minor outside water circ. at 70m rod change.		
-70			HEM. SHALES & CLAY: Pale olive-green-brown saprolitic clays and angular maroon-brown hematitic fragments up to 2cm.	damp samples.		
			SAPROLITIC CLAY: Brown clays and dark red -brown hematitic shale fragments up to 1cm.	wet samples to 76m.		
			HEMATITIC SHALES: Dark brown-grey hematitic fragments up to 3cm/ broken.	muddy samples to 84m. no measurable flow during drilling.		
-80			CLAY AND SILT: Dark grey-brown gritty clays.			
			HEM. SHALES & CLAY: Dark grey-brown gritty clays & grey angular fragments of hematitic shale up to 1.5cm.	EOH at 88mbgl		
			CHERT: Brown angular chert fragments.			
			HEMATITIC SHALES: Brown-grey limonitic shale.			

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COMPOSITE WELL LOG

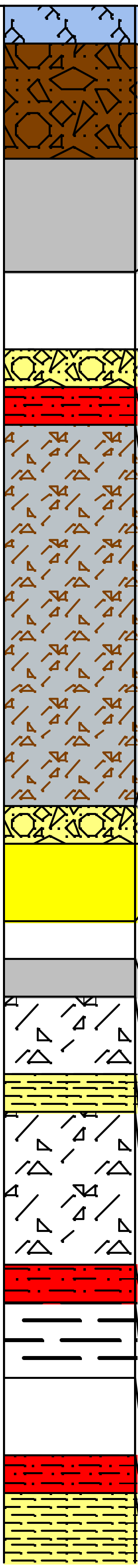
Well No: WSE 9

Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced: 22/7/2004	**Method:** RC (0-76)	**Area:** Mt Nicholas
Completed: 22/7/2004	**Fluid:**	**East:** 246300m(AMG)
Drilled: Connector	**Bit Record:** 4"	**North:** 7486450m(AMG)
Logged By: P.Costello	5.5"	**Elevation:**

Static Water Level: 63.8 mbgl **Date:** 23/7/2004; 7.55am

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Notes
0	Alluvium		TOPSOIL: Brown gritty clays.			4" open hole (0-76mbgl)
			ALLUVIUM: Dark red-brown clays and 1-3mm moderately sorted, subround sands; minor gravel up to 7mm..			
			CLAY AND SILT: Brown silty clays.			
			CLAYS AND GRAVEL: Brown clays and limonitic gravel up to 10mm; poorly sorted, well rounded limonitic and quartz sands from 1- 3mm.			
-10			SAND AND GRAVEL: Poorly sorted sand and gravel; 50% dark brown angular limonitic fragments up to 1.5cm.			
			CLAY AND SAND: Brown clays and 10% limonitic gravel and sand.			
			CLAY AND GRAVEL: Brown clays and rounded to subangular limonitic and quartzose sand-gravel 1-15mm; very poorly sorted.	damp to 21m		
-20			SAND AND GRAVEL: Yellow-red-brown limonitic gravel and quartz sand; rounded; mod sorted; <0.5-12mm.			
			CLAYEY SILT: Brown silty clays; 22- 23m 20% as above.	very damp samples to 26m		
			SILCRETE: Pale green angular silcrete fragments up to 3cm; 30% limonitic sand- gravel; 1-10mm; rounded, poorly sorted.			
			CLAY AND SILT: Yellow-white clays & rounded 0.5-3mm, moderately sorted milky sand. 48- 50m limonitic sand & 10% limonitic rounded gravel up to 7mm.	damp samples to 29m		
-30			CLAY WITH GRAVEL: Dark-brown clays and subround, poorly sorted limonitic sand-gravel; 1-10mm; 30% yellow- pale green-brown angular fragments of silcrete up to 10mm.			
			CLAY: Brown- cream puggy clays.			
			CLAY WITH GRAVEL: Pale cream- brown- turquoise clays with limonitic sand and gravel; 1mm- 1cm, rounded, poorly sorted; minor green silcrete. 10% sand- gravel, 30-32m.			
			CLAY WITH SAND: Pale turquoise- brown puggy clays; 20% quartz and limonite sand; 0.5- 3mm; moderately sorted, subround.			
			CLAY 2: Brown clays and dark red -brown hematitic shale fragments up to 1cm.			
			SILCRETE: Cream clays and pale green silcrete.			
-40			CLAY AND SAND: Cream clays and well rounded, mod. sorted, 0.5-3mm quartz sand.			



aquaterra	COMPOSITE WELL LOG	**Well No:** WSE 9
	Client: Fortescue Metals Group	**Project:** Mt Nicholas groundwater RC exploration

Depth	Unit	Lithology description	Comments
		SILTY CLAY: Dark grey-brown gritty clays & grey angular fragments of hematitic shale up to 1.5cm.	
		CLAY AND GRAVEL: Olive green- brown clays and sub-angular limonitic fragments; 10% limonitic-quartz sand; subround; mod. sorted, 0.5- 2mm. 45-46m ; 20% sand; 10% rounded limonitic gravel up to 12mm.	
		CLAY AND SAND: Green- brown gritty clays; 20% 1-2mm well sorted, rounded quartz sand.	
-50		CLAY WITH GRAVEL: Green- brown gritty clays; 30% 1-10mm poorly sorted, rounded quartz sand.	damp samples to 62m
		CLAY WITH SAND: Grey clays; 5% subround limonitic sand from 1-3mm.	
		SILTY CLAY: Olive-green-brown gritty clays.	
-60		CLAY WITH GRAVEL: Dark grey clays; 30% dark brown-grey manganiferous sand- gravel,1-4mm, rounded; mod. sorted.	
	Dolomite	DOLOMITE AND CLAYS: Grey clays and grey dolomite.	
	Dolomite	DOLOMITE: Pale grey, broken, silicified dolomite; chips up to 2.5cm.	damp samples to 70m; cavity at 68-69m.
-70	Dolomite	DOLOMITIC SILTSTONE: Pale grey, broken dolomite/dolomitic siltstone; weak- moderately laminated.	water flow measured through cyclone at 70m rod change = 0.3 l/s.
			76 m EOH

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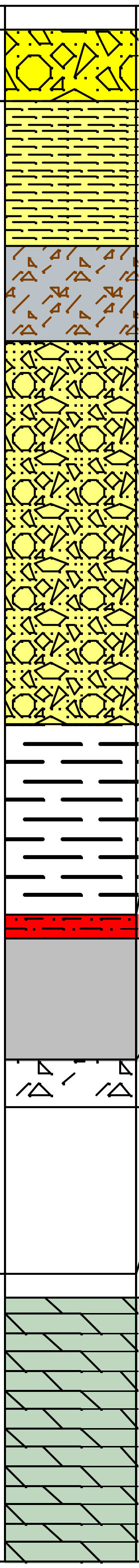
COMPOSITE WELL LOG

Well No: WSE 10

Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced: 22/7/2004	**Method:** RC (0-64)	**Area:** Mt Nicholas
Completed: 23/7/2004	**Fluid:**	**East:** 246540m(AMG)
Drilled: Connector	**Bit Record:** 4"	**North:** 7486350m(AMG)
Logged By: P.Costello	5.5"	**Elevation:**

Static Water Level: 64 mbgl **Date:** 23/7/2004; 7.45am



Depth (mbgl)	Geology	Lithological Description	Field Notes	Well Completion Notes
0	Colluvium	COLLUVIUM: Brown gritty clays; poorly sorted quartz sand,1-4mm,chert fragments up to 1cm.		
	Alluvium	SILTY CLAY: Yellow brown gritty clays.; 0.5- 2mm rounded quartz t/out; 7-8m, 30% pale green angular silcrete/ferricrete.		
-10	Alluvium	CLAY AND GRAVEL: Yellow brown gritty clays and limonitic gravel and silcrete/mudstone; frags up to 1.5cm.		
-20	Alluvium	SAND AND GRAVEL: Dark red-brown clays, gravel up to 10mm and poorly sorted, well rounded limonitic sands from 1- 5mm; 23-24m 50% pale grey chert fragments; 26-28m, 50% cream puggy clays.	damp sample.	4" open hole (0-64mbgl)
-30	Alluvium	CLAY 2: Yellow-brown-turquoise hard puggy clays.		
	Alluvium	CLAY AND SAND: Cream clays and limonitic, quartzose sand-gravel , 0.5- 7mm ,rounded, poorly sorted.		
-40	Alluvium	CLAY AND SILT: Cream-grey clays, gritty/ manganiferous.		
	Alluvium	CLAY WITH GRAVEL: as above with 10% dark grey -browm subangular gravel up to 1.5cm.		
	Alluvium	CLAY WITH SAND: Dark grey clay and 10% 1-2mm subangular manganiferous. sand; mod. sorted; 49-50m 1-10mm poorly sorted limonitic sand-gravel.		
-50	Alluvium	DOLOMITE AND CLAYS: Yellow-brown clays and grey, mod. laminated dolomitic siltstone.		
-60	Dolomite	DOLOMITE: Grey, fresh, broken, dolomite; fragments up to 2cm.		

COMPOSITE WELL LOG

Well No: WSE 11

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Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced: 23/7/2004
Completed: 23/7/2004
Drilled: Connector
Logged By: P.Costello

Method: RC (0-112)
Fluid:
Bit Record: 5 3/8"

Area: Mt Nicholas
East: 246750m(AMG)
North: 7486250m(AMG)
Elevation:

Static Water Level: 61.77 mbgl **Date:** 23/7/2004; 17.30pm

Depth (mbgl)	Geology	Lithological Description	Field Notes	Well Completion Notes
0	Topsoil	TOPSOIL: Red-Brown gritty clays.		
	Colluvium	COLLUVIUM: Yellow-brown gritty clays with rounded sand and angular cherty fragments from 1- 20mm; porly sorted.		
	Alluvium	SAND AND GRAVEL: Yellow-orange-brown subround limonitic sand-gravel; 0.5- 25mm.		
-10		CLAY AND GRAVEL: Orange-brown gritty clays and dark grey angular manganif. shale frags up to 8mm.		
		SAND AND GRAVEL: Yellow-orange-brown subround limonitic sand-gravel; 0.5- 10mm.		
-20		CLAY AND GRAVEL: Dark brown clays and orange-brown limonitic/goethitic gravel-sand, 1-10mm; well rounded, poorly sorted.	damp sample.	
		CLAY 2: Pale turqouise-brown puggy clays.	damp to 24m.	
		CLAY AND SILT: Brown silty clays and 30% limonitic sand-gravel, 0.5- 15mm; poorly sorted.		
		CLAY 2: Pale turqouise-brown puggy clays.		
-30		SAND AND GRAVEL: Silcrete & limonitic sand- gravel; rounded, 0.5- 10mm, poorly sorted.		
-40		CLAY AND SAND: Cream-brown puggy, gritty clays and 1-4mm mod. sorted, rounded limonitic sand; 29-30m gravel up to 2cm.		
		CLAY AND SAND: Grey- brown clays and manganiferous sand as above.		
-50		SAND: Dark grey 0.5- 4mm, well rounded; mod. sorted limonitic, manganiferous sands.		Open hole (0-112mbgl)
		CLAY AND SILT: Brown silty clays.		
		CLAY 2: Dark brown puggy clays.		
		CLAY AND SAND: Brown clays and dark red -brown limonitic sand, 1-3mm, well sorted and rounded.		
-60		GRAVELLY SAND: Yellow- brown limonitic/goethitic sand- gravel, 1-10mm, rounded, poorly sorted.		

aquaterra	COMPOSITE WELL LOG	Well No: WSE 11
	Client: Fortescue Metals Group	**Project:** Mt Nicholas groundwater RC exploration

Depth scale: -70, -80, -90, -100, -110

Unit	Description
	CLAY WITH SAND: Cream-grey- yellow clays and 10% quartz sand; 1-2mm, well sorted, rounded.
	CLAY AND SAND: Cream-yellow puggy clays and 0.5-2mm well rounded; mod. sorted quartz sand
Saprolite	CLAY AND SAND: Dark grey clays and grey manganiferous rounded sand 0.5- 2mm, mod. sorted.
Saprolite	SAPROLITE: Dark grey clays and 10% manganiferous fragments up to 4mm.
Saprolite	SAPROLITE: Olive-green-brown clays.
Saprolite	SAPROLITE: Maroon-brown clays.
Orezone	SHALE AND IRON FORMATION: Maroon clays and dark brown hematitic shales.
Siltstones	DOLOMITIC SILTSTONE: Green-grey laminated, broken dolomitic siltstone; frags up to 2cm.
Siltstones	SILTSTONE: Brown clays and brown siltstone.
Shale	SHALE: Grey-brown -green clays and brown- maroon shale.
Shale and Chert	SHALE AND CHERT: Red-brown clays and shales with grey chert bands.
Shale	SHALE: Maroon clays and dark green-grey strongly laminated shale.

damp to 76m; minor water in outside circ. at 76m rod change; (approx. 1L/sec.)

very damp to 87m; minor water in outside circ. at 82m rod change; (approx. 0.5L/s while drilling)

damp to 93m; outside circ. stopped at 92m.

damp to 112m; minor water in cyclone at 100m rod change; outside return at 106m approx.2 L/s; wet sample at 107m..

minor water through cyclone at 100m rod change.

approx. 2L/s flow through cyclone at 106m rod change.

112 m EOH

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COMPOSITE WELL LOG

Well No: WSE 16

Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced: 26/7/2004
Completed: 27/7/2004
Drilled: Connector
Logged By: P.Costello

Method: RC (0-136)
Fluid:
Bit Record: 4"
5.5"

Area: Mt Nicholas
East: 241800m(AMG)
North: 7492250m(AMG)
Elevation:

Static Water Level: 29.75 mbgl **Date:** 28/7/2004; 7.10am

Depth scale (mbgl): 0, -10, -20, -30, -40, -50, -60, -70

Depth (mbgl)	Lithological Description	Field Notes	Well Completion Notes
	TOPSOIL: Brown gritty clays.		
	CLAY AND SAND: Red-Brown gritty clays,limonitic gravels and cherty fragments.		
	CLAY WITH SAND: Orange-brown gritty clays; 10% limonitic and quartz sand, 1-3mm, mod. sorted, sub rounded.		
	CLAY AND SAND: Brown clays and sand-gravel; 0.5-20mm, very poorly sorted quartz, chert and limonite, rounded - angular.		
	CLAY AND SILT: Red-brown gritty clays.		
	CLAY WITH GRAVEL: Red-brown gritty clays and 30% orange-brown limonitic sand-gravel; 0.5 - 15mm, poorly sorted.		
	CLAY AND GRAVEL: Red-brown gritty clays and 70% orange-brown limonitic sand-gravel; 0.5 - 15mm, poorly sorted.		
	CLAY WITH GRAVEL: Brown gritty clays and and 5% limonitic gravel up to 7mm.	damp samples to 45m.	
	CLAY AND GRAVEL: Brown clays and orange-brown-red limonitic sand- gravel, 1-15mm, poorly sorted, subrounded; 42-43m red-brown gritty clays.		
	CLAY AND SILT: Red-brown gritty clays.	slightly damp samples to 49m.	
	CLAY 2: Red-brown gritty clays and cream-pale turquoise puggy clays.		
	CLAY AND SAND: Cream-turquoise indurated clays and dark red-brown limonitic sand; mod. sorted,1-5mm, subrounded.		
	CLAY 2: Brown- turquoise puggy clays.		4" open hole (0-136mbgl)
	CLAY WITH GRAVEL: Pale olive green clays with limonitic sand and gravel; 1mm- 1cm, rounded, poorly sorted.		
	CLAY WITH SAND: Grey-green clays and 10% cream silcrete sand; 70-73m angular yellow-brown silcrete fragments up to 15mm.		

Depth scale: -80, -90, -100, -110, -120, -130

Unit	Lithology description
Silcrete	SILCRETE: Green clays and green-cream angular silcrete fragments.
Alluvium	CLAY 2: Yellow-brown-grey puggy clays with minor detrital manganiferous nodules up to 3mm.
	CLAY 2: Grey puggy clays.
	LIGNITE: Black carbonaceous clays; powdery; lignite/peat fragments throughout.
	CLAY 2: Pale grey-buff cream clays.
	CLAY WITH SAND: Grey silty clay;30% well rounded and sorted quartz sand; 0.5-2mm.
	CLAY WITH SAND: Grey silty clay; 5% well rounded and sorted quartz sand; 0.5-2mm.
	CLAY: Cream clay.
	CLAY 2: Pale brown-turquoise puggy clays.
Dolomitic siltstone	DOLOMITIC SILTSTONE: Pale green clays and pale green dolomitic siltstone; broken, angular fragments up to 20mm; 114-115m 5% dark green shale.
	DOLOMITIC SILTSTONE: Pale green, massive-weakly laminated dolomitic siltstone; fragments up to 10mm.
	CLAYS AND DOLOMITE: Yellow-brown clays and 20% grey-green broken dolomite.
	DOLOMITIC SILTSTONE: Grey mod. laminated, silicified dolomitic siltstone; fragnents up to 15mm.Minor iron staining on fractures; 127-128m, 50% dark grey siltstone..
	DOLOMITIC SILTSTONE: Pale grey-green massive dolomite/dolomitic siltstone.

inside water return.
damp samples to 84m;
wet sample at 83m.

wet sample.

dry; rods jammed; pull rods and clear inners 2.45pm - 4.30pm.

water injected.
wet samples to 101m.

dry to 106m.

wet sample.

112 m approx. 1 L/s outside return.(finish drilling for 26/7/04)

wet samples to 118m.

wet samples to 124m; (approx. 1L/s through inner circ.at 118m rod change.)

wet samples to 136m; (approx. 0.5L/s through inner circ.at 124m rod change.)

cavernous, broken 125m - 127m.

approx. 1L/s through inner circ.at 130m rod change.

136 m EOH

COMPOSITE WELL LOG

Well No: WSE 19

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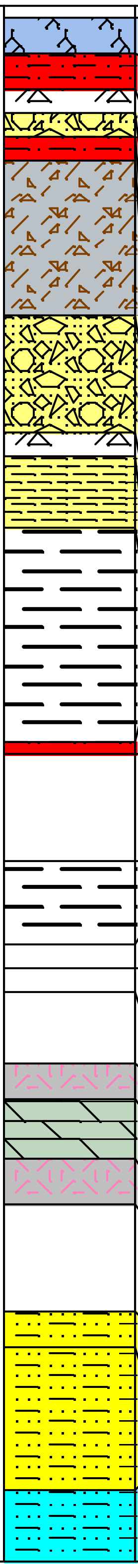
Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced: 25/7/2004	**Method:** RC (0-130)		**Area:** Mt Nicholas
Completed: 26/7/2004	**Fluid:**		**East:** 241500m(AMG)
Drilled: Connector	**Bit Record:** 4"		**North:** 7492000m(AMG)
Logged By: P.Costello	5.5"		**Elevation:**

Static Water Level: 37.25 mbgl **Date:** 26/7/2004; 8.45am

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			TOPSOIL: Brown gritty clays.			
			CLAY WITH SAND: Yellow-brown gritty clays; 20% limonitic sand ,0.5- 4mm, mod. sorted, rounded.			
-10			CLAY WITH GRAVEL: Yellow-brown gritty clays; 20% limonitic sand ,0.5- 4mm, mod. sorted, rounded; up to 15mm cherty gravel.			
			SAND AND GRAVEL: Chert, limonite sand-gravel, 0.5-15mm, poorly sorted.			
-20			CLAY WITH SAND: Red-brown gritty clays and 1-4mm limonitic sand.			
-30			CLAY AND GRAVEL: as above and up to15mm gravel; 30% pale green silcrete/shale from 15-17m.			
			SAND AND GRAVEL: Pale yellow-cream-brown puggy clays. Dark brown limonitic gravel up to 1.5cm in sandy clay from 32-33m. 15% limonitic sand -gravel (<0.5 - 6mm) poorly sorted, from 36 -37m.	damp samples to 39m.		
-40			CLAY WITH GRAVEL: Orange-brown gritty clays; 10% sand-gravel as above.			
			SILTY CLAY: Red-brown silty clays.			
-50			CLAY 2: Pale turquoise-yellow-brown puggy clays.			
-60			CLAY WITH SAND: Grey-green clays; 5% quartz sand; rounded, well sorted,1-2mm.			4" open hole (0-130mbgl)
			SILCRETE: Pale green clays and pale yellow-brown silcrete.			
-70			CLAY 2: Green-brown-turquoise puggy clays.	damp samples to 82m; minor inside flow at 82m rod change.		
-80			CLAY 3: Grey puggy clays.			
			LIGNITE: Black carbonaceous clays with lignite and fine grained pyritic aggregates.	wet samples to 84m.		
			CLAY 3: Grey puggy clays.			
-90			SAPROLITIC CLAY: Cream clays.	0.5 L/s at rod change.(inside flow)		
			DOLOMITE: Buff cream, massive, partially oxidized dolomite.	damp to 100m; approx. 1 L/sec at rod change.(inside flow)		
-100			SAPROLITIC CLAY: Pale green puggy clays.			
			DOLOMITE AND CLAYS: Pale green clays and pale green-pink silicified dolomitic siltstone; mod. laminated; highly broken from 100-102m and 106-107m.	wet samples to 109m; broken from 106 - 108m.		
-110			SILTSTONE: Olive green clays and dark green mod. laminated siltstone.	damp to 111m. wet samples to 130m; 0.5 L/s at rod change and during drilling.		
-120			SILTSTONE: Grey, mod. laminated siltstone; minor hematitic staining on fractures; chips up to 2cm.	1.33 L/s; 1580ppm, ph 8.53		
-130			DOLOMITIC SILTSTONE: pale grey dolomite/dolomitic siltstone; massive, silicified; broken from 128-129m.	1.5 L/s; 1560ppm, ph 8.51 130 m EOH		



COMPOSITE WELL LOG

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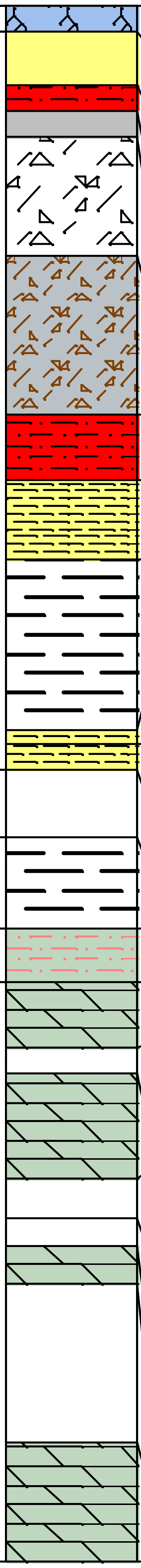
Well No: WSE 20

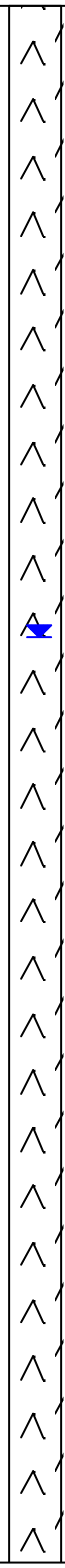
Client: Fortescue Metals Group
Project: Mt Nicholas groundwater RC exploration

Commenced: 25/7/2004	**Method:** RC (0-118)	**Area:** Mt Nicholas	
Completed: 25/7/2004	**Fluid:**	**East:** 241800m(AMG)	
Drilled: Connector	**Bit Record:** 5 3/8"	**North:** 7491650m(AMG)	
Logged By: P.Costello		**Elevation:**	

Static Water Level: 47.92 mbgl
Date: 27/7/2004; 13.14pm

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	ps		TOPSOIL: Brown gritty clays.			
	Alluvium		GRAVEL AND SAND: Red-Brown gritty clays,limonitic gravels and cherty fragments; 1-15mm.			
-10			CLAY WITH SAND: Orange-brown clays; 20%dark brown limonitic 1-5mm sand; mod sorted and rounded.			
			CLAY AND SILT: Orange-brown silty clays.			
			CLAY WITH GRAVEL: Brown clays; up to 40% yellow-brown goethitic/limonitic sand-gravel; 1-20mm; poorly sorted , subrounded.	wet samples to 17m.. damp samples to 37m.		
-20			CLAY AND GRAVEL: Brown clays and yellow-brown limonitic sand-gravel;1-10mm; rounded, mod. sorted.			
-30			CLAY WITH SAND: Brown gritty clays ; minor limonitic sand up to 4mm, well sorted.	fast pen. to 40m.		
			CLAY: Brown indurated clays.			
-40			CLAY 2: Pale olive green-brown-turquoise puggy clays.			
-50			CLAY: Buff cream, powdery clay; minor cream silcrete.			Open hole (0-118mbgl)
			CLAY: Yellow-brown-green puggy clays; 5-10% cream silcrete.			
-60	Silcrete		SILCRETE: Grey-yellow-brown clays and yellow-brown-white silcrete. Manganese dendrites at 59-61m.	damp samples to 77m; 70m outsde circ. at rod change; 76m outsde circ. at rod change-1L/s.		
	aprolitum (lacus		CLAY 2: Yellow-brown-turquoise puggy clays.			
-70			SAPROLITE: Cream-grey clays.			
	Dolomite		DOLOMITE: Cream-pink dolomite; fragments up to 2cm; iron stain on fracture surfaces.			
-80			CLAY AND DOLOMITE: Grey clays and yellow-brown-cream, broken, iron stained dolomite; fragments up to 2.5cm.			
			DOLOMITE: Cream-brown fresh dolomite; massive.	wet sample; approx.1 L/s at rod change (outside); damp to 92m.		
-90			CLAY AND DOLOMITE: Grey clays and yellow-brown-cream, broken, iron stained dolomite; fragments up to 3cm.	wet samples to 97m; 94m rod change - approx. 2 L/s outside circ; 1.5 L/s inside-grey brown; 10% solids (1190 ppm.)		
			CLAY AND DOLOMITE: Olive green clays and yellow-brown-cream, broken, iron stained dolomite; fragments up to 3cm.			
-100			DOLOMITE: Cream-brown broken dolomite; iron stained.	94 m. Broken, difficult drilling to 110m; 97m dry; 100m wet; 106m - 0.5 L/s through inside.		
			CLAY AND DOLOMITE: Cream-pale green clays and yellow-brown-cream, broken, iron stained dolomite; fragments up to 2cm.			
-110			DOLOMITE: Buff cream dolomite; generally massive; fragments averaging 5mm; 116-117m fragments up to 2.5cm.	Fast drilling; 1 L/s through inside circulation. Broken to 117m.(wet) 118 m EOH		





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COMPOSITE WELL LOG

Well No: WSE024

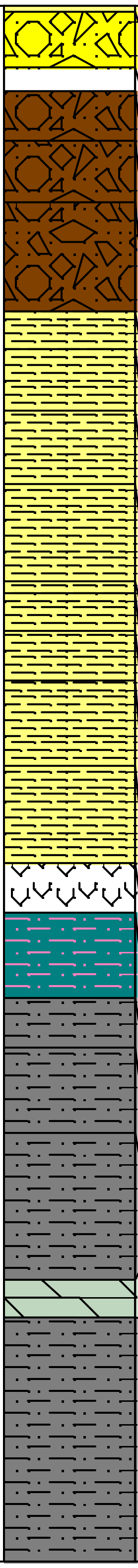
Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced: 13/08/2004	**Method:** RC (0-127)	**Area:** Mt Nicholas
Completed: 13/08/2004	**Fluid:** 1800 cfm 450 psi (Hydco C4)	**East:** 243387m(AMG)
Drilled: Connector	**Bit Record:** 5 3/8"	**North:** 7483843m(AMG)
Logged By: RFToll		**Elevation:**

Static Water Level: 43.46mbgl **Date:** 14/08/2004; 13:30hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Notes

Depth scale: 0, -10, -20, -30, -40, -50, -60, -70, -80, -90, -100, -110, -120

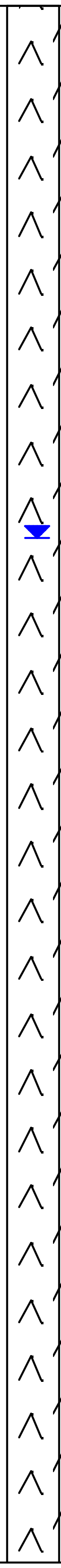


Lithological Description

- SAND: Aeolian desert sands
- COLLUVIUM: Brown ferruginous fragments with fraction of goethetic and poorly consolidated clay
- COLUVIUM: Red-brown clay with minor colluvial and fraction of alluvial fragments
- ALLUVIAL: Red-brown alluvial fragments poorly sorted angular to subrounded to <=2cm
- ALLUVIAL: Red-brown alluvial fragments poorly sorted angular to subrounded to <=2cm with 30% poorly consolidated clay
- ALLUVIAL: Red-brown poorly consolidated clay with 50% alluvials poorly sorted to subrounded <=2cm
- CLAY: Red-brown very finely aggregated clay with minor alluvial fragments
- CLAY: Pink-brown well consoldated clay as dense/brittle fragments
- CLAY: Pink-brown dense/brittle clay/claystone highly ferruginised aggregates <=1.5 cm
- CLAY: Red-brown brittle claystone highly ferruginised aggregates <=4cm
- CLAY: Pale brown-orange poorly consolidated gritty clay - highly ferruginised
- CLAY: Pale brown-cream friable loosely bonded clay
- CLAY: Pale brown -brown moderately consolidated clay with 40% comprising ferruginised hard fragments <=1cm
- CLAY: Cream-grey moderatley consolidated soft clay aggregates <=1.5cm
- CLAY: Cream-grey friable loosely bonded clay-damp in zones. Water intersection 70m
- QUARTZ: Cream-grey slightly oxidised quartz. Samples fine <=2mm with minor cream clay
- SAPROCK: Pale brown-grey highly oxidised saprock(shale?) <=2cm. Samples go wet from 76m
- SHALE: Dark grey-dark brown oxidised claystone with minor hard shale fragments. Samples completely wet
- SHALE: Dark grey-dark brown hard shale fragments <=2cm -wet samples increasing flow
- SHALE: Dark grey-black hard highly oxidised shale. Fracture @ 100m Major fracture/cavity 104-105m
- DOLOMITE: Grey-brown-pink oxidised dolomite and oxidation film on common fractured/pitted surfaces
- SHALE: Dark grey-dark brown hard shale fragments interbedded fractured dolomite. Major cavity 107-108m

Field Notes

- pH 8.52. TDS ppt 1.21. mS 2.46. Temp 28.9C
- Minor wet zone - flows not strong
- 70-77m: Minor Aquifer Main wet part 76-77m
- 83-88.5m: Minor Aquifer Main wet zone 87-88.5m Moderate water intersection
- 100 m Significant water intersection
- 100-101m: Moderate Aquifer
- 104 m Significant water intersection with fracture and cavity 0.5m
- 107 m Major water intersection cavity 1m
- 102-106m: Main Aquifer
- 109-110m: Cavity 1m Main Aquifer
- EOH at 127mbgl



Notes: Open hole (0-127mbgl)

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COMPOSITE WELL LOG

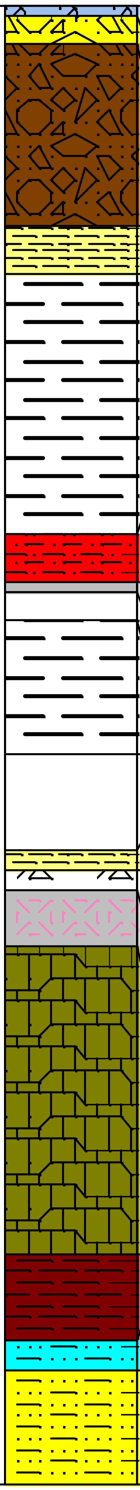
Well No: WSE 25

Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced: 12/7/2004	**Method:** RC (0-154m)		**Area:** Mt Nicholas
Completed: 13/7/2004	**Fluid:**		**East:** 245392m(AMG)
Drilled: Connector	**Bit Record:** 4		**North:** 7484162m(AMG)
Logged By: P.Costello	5.5		**Elevation:**

Static Water Level: 58.75 mbgl **Date:** 13/7/2004

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes



Depth scale: 0, -10, -20, -30, -40, -50, -60, -70, -80, -90, -100, -110, -120, -130, -140, -150

Lithological Description	Field Notes
TOPSOIL: Brown gritty clays.	
COLLUVIUM: Brown gritty clays and cherty fragments.	
ALLUVIUM: Brown clays and up to 10% limonitic sand-gravel.	
CLAY: Brown clays.	
CLAY 2: Cream/green/brown puggy clays.	damp.
CLAY AND SAND: Cream clays and up to 50% subround -rounded, well-poorly sorted 0.5- 5mm quartz sand.	dusty.
CLAY AND SILT: Cream silty clays.	
SILCRETE: Cream-pink clays and cream silcrete.	damp.
CLAY 2: Pale brown-pink puggy clays.	minor outside water return at rod change.
CLAY 3: Grey puggy clays.	
CLAY: Brown clays.	
CLAY WITH GRAVEL: Brown clays and angular limonitic fragments up to 10mm.	water in outside return.(unmeasurable) damp samples to 120m.
SAPROLITIC CLAY: Pale brown-green-yellow saprolitic clays.	
HEM. SHALES & CLAY: Yellow-orange-brown clays and dark red -brown hematitic shale fragments up to 2cm. 10% cream chert from 122 -124m. Dark brown clays from 124-128m.	high water flow at rod change.(unmeasurable) wet samples to 128m.
CHERT & SHALE: Dark grey chert and fresh shale.	dry sample. wet samples to 154m.(rods stuck)
DOLOMITIC SILTSTONE: Pale grey dolomitic silstone/shale.	
SILTSTONE: Dark grey finely laminated siltstone. Fragments up to 2cm from 146 - 147m; 50% pale grey chert from 150 - 154m.	broken 154 m EOH

Well Completion Notes: 4" open hole (0-154mbgl)

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COMPOSITE WELL LOG

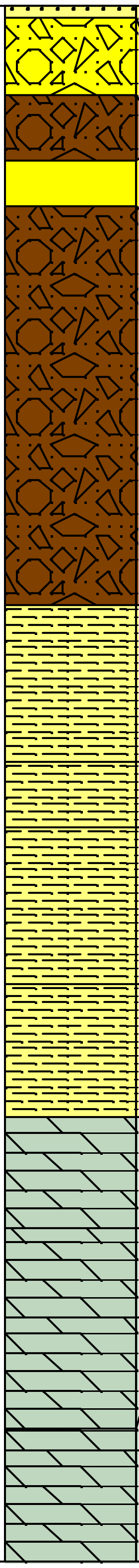
Well No: WSE026

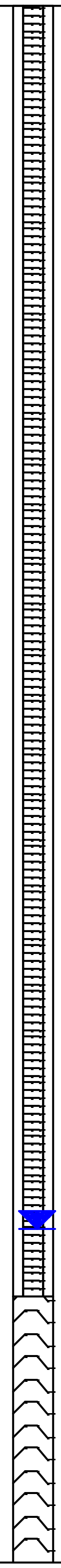
Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater exploration RC drillin

Commenced:	21/08/2004	**Method:**	RC to 70m EOH.	**Area:**	Mt Nicholas
Completed:	21/08/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:**	245044m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches rods	**North:**	7486879m(AMG)
Logged By:	RFToll		5 3/8 inches	**Elevation:**	

Static Water Level: 55mbgl **Date:** 21/08/2004; 13:30hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			SAND: Aeolian desert sands			
			COLLUVIUM: Brown unconsolidated clay with interspersed colluvium			
			ALLUVIUM: Alluvium with minor clayey silt			
			CLAYEY SANDY SILT: Alluvium poorly sorted subangular with minor subrounded fragments <=2cm			
-10			ALLUVIUM: Alluvium with minor clayey silt			
-20						Slotted 50mm PVC (0-58mbgl)
			CLAY: Red brown finely aggregated clay with 5% alluvial fragments			
-30			CLAY: Light brown-grey consolidated clay with highly oxidised/ferruginous chert			
			CLAY: Light brown densely aggregated clay			
-40			CLAY: Light grey-ash consolidated damp clay			
-50			DOLOMITE: Light grey highly oxidised dolomite	slurry only		
			DOLOMITE: Ash-cream-grey slightly oxidised dolomite	pvc blocked at 55 metres No swl measured to this depth estimated 55 metres swl		
-60			DOLOMITE: Pink grey fresh dolomite with Mn alteration	64-65m: Damp to minor wet zone Airlift attempted RC and outside returns failed to create flow No evidence of suitable water zones. No hydraulic testing required		
			DOLOMITE: Brown-grey slightly oxidised dolomite with minor wet/damp zone			Fallback (58-70mbgl)
-70			DOLOMITE: Pink grey dolomite	EOH at 70mbgl		





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COMPOSITE WELL LOG

Well No: WSE028

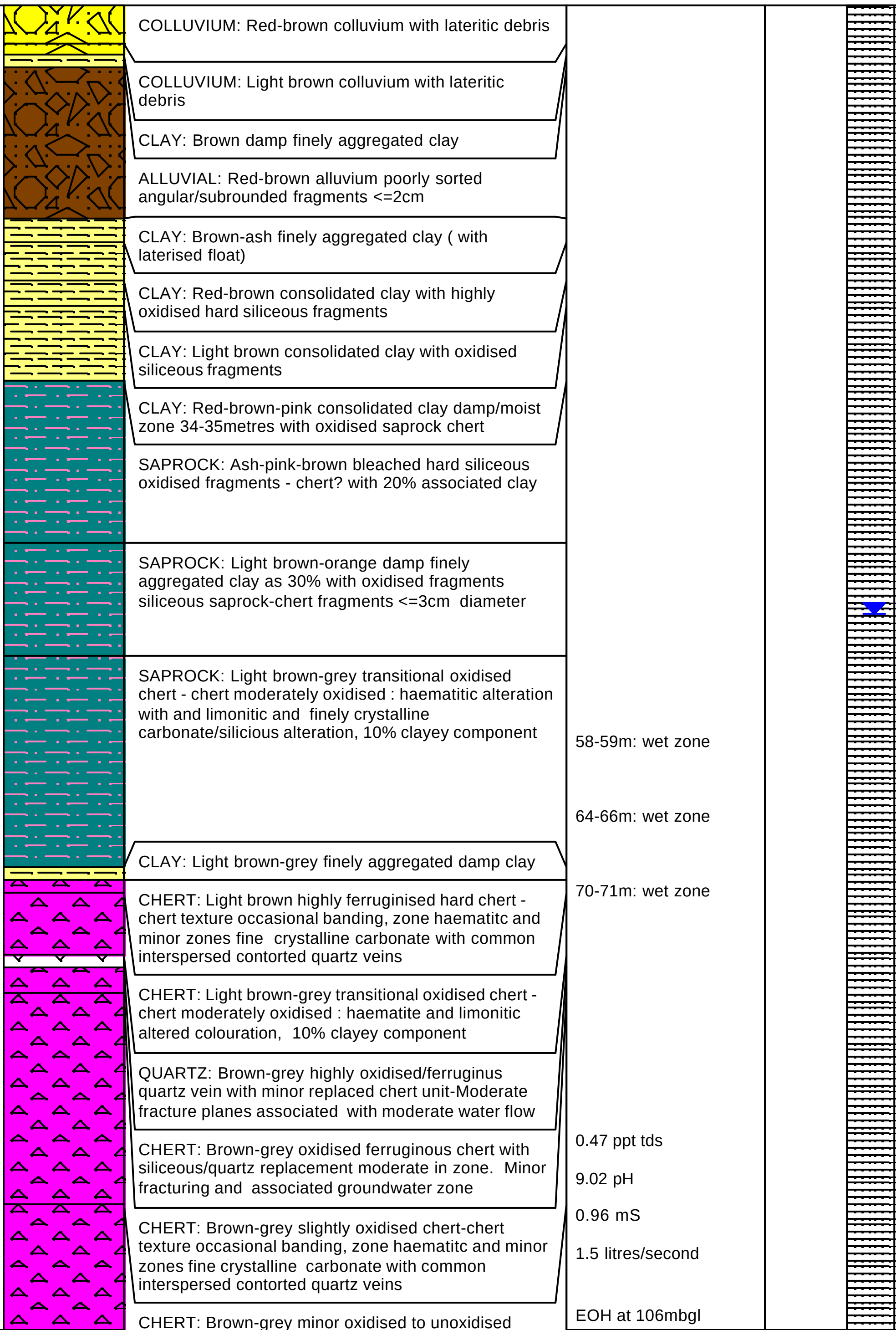
Client: Fortescue Metals Group
Project: Mt Lewin groundwater RC exploration

Commenced: 25/08/2004	**Method:** RC (0-106)		**Area:** Mt Lewin
Completed: 26/08/2004	**Fluid:** 1800 cfm 450 psi (Hydco C4)		**East:** 237680m(AMG)
Drilled: Connector	**Bit Record:** 5 3/8"		**North:** 7494413m(AMG)
Logged By: RFToll			**Elevation:**

Static Water Level: 48.75 mbgl
Date: 25/08/2004; 10:30hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes

Depth scale: 0, -10, -20, -30, -40, -50, -60, -70, -80, -90, -100



Lithological Description	Field Notes
COLLUVIUM: Red-brown colluvium with lateritic debris	
COLLUVIUM: Light brown colluvium with lateritic debris	
CLAY: Brown damp finely aggregated clay	
ALLUVIAL: Red-brown alluvium poorly sorted angular/subrounded fragments <=2cm	
CLAY: Brown-ash finely aggregated clay (with laterised float)	
CLAY: Red-brown consolidated clay with highly oxidised hard siliceous fragments	
CLAY: Light brown consolidated clay with oxidised siliceous fragments	
CLAY: Red-brown-pink consolidated clay damp/moist zone 34-35metres with oxidised saprock chert	
SAPROCK: Ash-pink-brown bleached hard siliceous oxidised fragments - chert? with 20% associated clay	
SAPROCK: Light brown-orange damp finely aggregated clay as 30% with oxidised fragments siliceous saprock-chert fragments <=3cm diameter	
SAPROCK: Light brown-grey transitional oxidised chert - chert moderately oxidised : haematitic alteration with and limonitic and finely crystalline carbonate/silicious alteration, 10% clayey component	58-59m: wet zone 64-66m: wet zone
CLAY: Light brown-grey finely aggregated damp clay	
CHERT: Light brown highly ferruginised hard chert - chert texture occasional banding, zone haematitc and minor zones fine crystalline carbonate with common interspersed contorted quartz veins	70-71m: wet zone
CHERT: Light brown-grey transitional oxidised chert - chert moderately oxidised : haematite and limonitic altered colouration, 10% clayey component	
QUARTZ: Brown-grey highly oxidised/ferruginus quartz vein with minor replaced chert unit-Moderate fracture planes associated with moderate water flow	
CHERT: Brown-grey oxidised ferruginous chert with siliceous/quartz replacement moderate in zone. Minor fracturing and associated groundwater zone	0.47 ppt tds 9.02 pH 0.96 mS
CHERT: Brown-grey slightly oxidised chert-chert texture occasional banding, zone haematitc and minor zones fine crystalline carbonate with common interspersed contorted quartz veins	1.5 litres/second
CHERT: Brown-grey minor oxidised to unoxidised chert - fracture plane associated with clayey broken section 104-105metres- No significant increase water flow	EOH at 106mbgl

Well Completion Notes: 5.5" Slotted PVC casing (0-106mbgl)

COMPOSITE WELL LOG

Well No: WSE031

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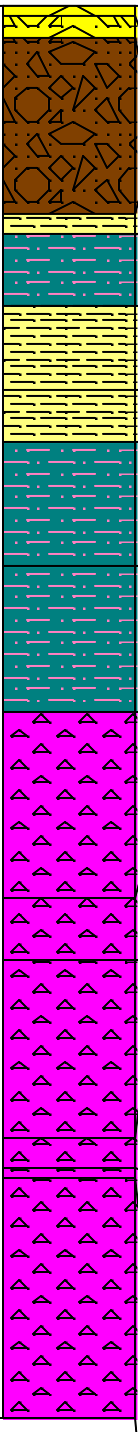
Client: Fortescue Metals Group | **Project:** Mt Lewin groundwater RC exploration

Commenced:	26/08/2004	**Method:**	RC (0-136)	**Area:**	Mt Lewin
Completed:	27/08/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:**	237485m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7493841m(AMG)
Logged By:	RFToll			**Elevation:**	

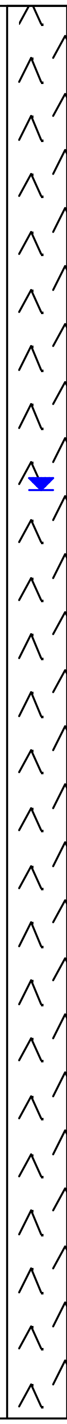
Static Water Level: 46.60 mbgl | **Date:** 29/08/2004; 07:00hrs

Depth (mbgl)	Lithological Description	Field Notes
0	COLLUVIUM: Dark brown sands and gravels	
	COLLUVIUM: Light brown lateritic colluvium	0.48 tds ppt
-10	ALLUVIAL: Red brown alluvial poorly sorted angular-subrounded fragments <=2cm	8.85 pH 0.98 mS
-20	CLAY: Pink brown clay with highly oxidised ferruginous brittle fragments	3.8 litres/second
	SAPROCK: Red-brown-orange consolidated clay with hard ferruginous slightly laterised fragments	
-30	CLAY: Pale brown finely aggregated clay with minor lateritic grit <2mm diameter	
-40	CLAY: Ash-grey finely aggregated bleached clay	
	SAPROCK: Red-brown moist highly ferruginous hard siliceous fragments with associated clay 30% of sample	43-50m: Minor aquifer samples moist slightly wet
-50		
	SAPROCK: Pale brown moderately oxidised saprock/chert slightly ferruginous with trace of bleached debris fragments <2mm diameter	
-60		60-72m: Moderate aquifer samples wet with moderate flows
-70	CHERT: Grey-pale brown slightly oxidised chert with less oxidised zones. Chert appears with strong silica replacement and with slight banded appearance with deformation kinks Occasional fracturing with minor vugh development and Fe/oxidised surfaces	
-80	CHERT: Grey-pale brown moderately oxidised moderately broken section. Increasing water flow. Fracture samples <3cm diameter Limonitic weathered zone 89-91metres.	85-92m: Moderate aquifer smaples wet with moderate flows, samples wet from 80-86 metres
-90	CHERT: Grey-pale brown-dark grey slightly oxidised chert with ferruginous zones and associated Fe stained surfaces and broken from 95-105 metres.	95-105m: Fractured chert moderate/good flows limonitic/Fe stained samples Airlift rate measured at 2 litres/second
-100	CHERT: Grey highly siliceous chert massive texture with oxidised Fe stained surfaces with minor ferruginous grit associated with minor broken sections. Possible minor increase in flow. Good fracture @112-113metres fragments <3cm.	
-110	CHERT: Grey-dark grey slightly oxidised to fresh chert with minor ferruginised grit. Moderate fracturing associated with Fe coated surfaces fragments <=3cm Likely increased water flow	109-113m: Very wet samples with increased fracturing NB good fracture 112-113metres Lost outside return from 113 metres
-120	CHERT: 113-122m: Grey-dark grey slightly oxidised to fresh chert with minor ferruginised grit 122-129.5m: Brown-grey finely fractured moderately oxidized to highly oxidized zones samples <=1cm diameter No outside return 129.5-130m: Dark grey-grey slightly ferruginous <=2.5cm fragments chert No outside return 130-134m: Dark grey-grey-brown slightly oxidized zones associated with moderate fracturing zone 130-133 metres Likely water zone Still no outside return 134-136m: Grey-dark grey much less oxidised chert with only trace ferruginous grit.	122-129m: Moderate oxidised/ferruginous fragments with grit 129.5-134m: Fractured chert fragments <=3cm diameter Fe coated Final airlift rate 3.8L/s
-130		

Graphic Log:



Well Completion Diagram:



Well Completion Notes: Open hole (0-136mbgl); EOH at 136mbgl

COMPOSITE WELL LOG

Well No: WSE037

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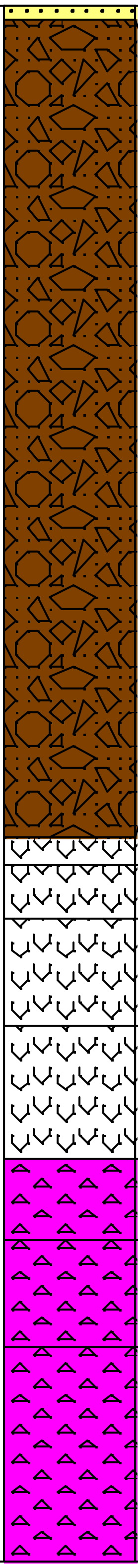
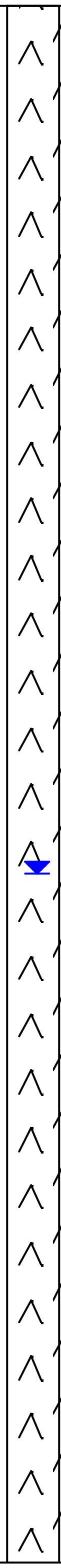
Client: Fortescue Metals Group **Project:** Mt Lewin groundwater RC exploration

Commenced: 24/08/2004	**Method:** RC		**Area:** Mt Lewin
Completed: 25/08/2004	**Fluid:** 1800 cfm 450 psi (Hydco C4)		**East:** 230070m(AMG)
Drilled: Connector	**Bit Record:** 5 3/8"		**North:** 7492263m(AMG)
Logged By: RFToll			**Elevation:**

Static Water Level: 32.35mbgl **Date:** 25/08/2004; 10:30hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			SAND: Red-brown desert sands			
			ALLUVIAL: Red-brown alluvials poorly sorted sub-rounded/angular fragments <=2cm with loosely consolidated clay			
-10						
-20						Open hole (0-58mbgl)
-30			QUARTZ: Light brown damp consolidated clay with 50% highly oxidised /ferruginous quartz			
			QUARTZ: White-opaque quartz slightly oxidised			
			QUARTZ: White-brown highly ferruginous broken quartz reef highly unstable zone Moderate to minor flows in zone	34-37m: Quartz reef ferruginised highly broken minor flow only-approximates depths to water table 0.1 litres/second		
-40			QUARTZ: Grey slightly oxidised chert with 50% consolidated damp clay			
			CHERT: Grey slightly oxidised chert transitional zone	tds ppt 1.71 8.8 pH 3.37 mS		
			CHERT: Grey slightly oxidised chert			
-50			CHERT: Grey-dark grey fresh chert	EOH at 58mbgl		





COMPOSITE WELL LOG

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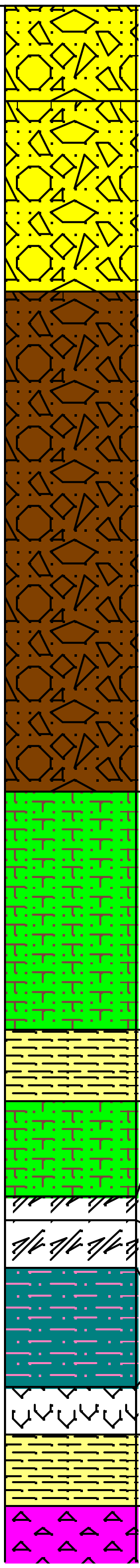
Well No: WSE038

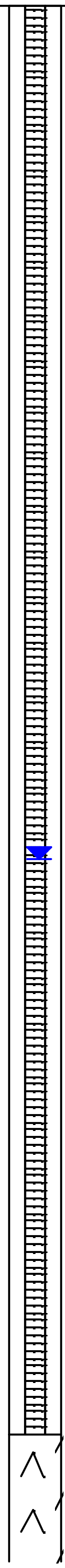
Client: Fortescue Metals Group **Project:** Mt Lewin groundwater RC exploration

Commenced: 23/08/2004	**Method:** RC (0-115)	**Area:** Mt Lewin	
Completed: 24/08/2004	**Fluid:** 1800 cfm 450 psi (Hydco C4)	**East:** 229314m(AMG)	
Drilled: Connector	**Bit Record:** 5 3/8"	**North:** 7494092m(AMG)	
Logged By: RFToll		**Elevation:**	

Static Water Level: 35.85mbgl **Date:** 25/08/2004; 10:30hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Red-brown colluvium			
			COLLUVIUM: Red-brown poorly aggregated clay with 30% colluvium/alluvial fragments			
-10			ALLUVIAL: Red brown poorly sorted angular/subrounded alluvial fragments <=2cm diamteter with poorly consolidated zones clay			pvc 50 mm slotted top cap only - end cap not attached to allow measurements below casing to EOH if required
-20						
-30						(Swelling clays restricted casing to 60 metres installment depth)
			CLAYSTONE: Red-brown brittle ferruginised claystone fragments			
-40						
			CLAY: Brown denseley aggregated brittle clay			
			CLAYSTONE: Light brown finely aggregated clay/claystone brittle fragments <=3cm			
			QUARTZ VEIN: Pale brown highly oxidised ferruginous quartz vein with clayey coated surfaces			
-50			QUARTZ VEIN: Dark grey-green finely aggregated clay damp with oxidised siliceous quartz?saprock?			
			SAPROCK: Red-pink-ash finely aggregated clay with highly oxidised saprock- chert?			
			QUARTZ: Dark grey clayey damp consolidated clay with 50% interspersed highly oxidised broken quartz			
-60			CLAY: Dark grey consolidated damp clay			No endcap on PVC
			CHERT: Dark brown -dark grey consolidted clay + 50% moderately oxidised moist chert fragments Minor			





-70

-80

-90

-100

-110

water flow

CHERT: Ash-grey highly oxidised chert moderately silicified.

CHERT: Dark brown-grey damp consolidated clay with 50% moderately oxidised dark grey silicified chert

DOLOMITE: Pink-grey slightly oxidised dolomite strongly haematitic and manganese stained - Slightly vughy development and oxidation fragment surfaces <=2cm diameter

DOLOMITE: Brown consolidated damp clay with moderately oxidised dolomite strongly haematitic b/w 75-77m

DOLOMITE: Brown-pink-grey slightly oxidised ferruginous dolomite with slight clay development and moderately fractured from 75-77metres

DOLOMITE: Brown-pink-dark grey highly oxidised haematitic dolomite with pervasive ferruginous development. Samples wet 82-83metres, 87-91metres with outside discharge minor flow

CHERT: Pink-grey slightly oxidised chert

DOLOMITE: Dark brown oxidised/ferruginous dolomite fragments finely broken with moderate aquifer development. Samples wet throughout

DOLOMITE: Pink-red haematitic dolomite wet samples

DOLOMITE: Pink-red dolomite slighlty oxidised fractured fragments <=3cm showing oxidised fracture surfaces - minor increase water flow

DOLOMITE: Pink-red dolomite less oxidised to fresh rock

66-69m: Moist clayey chert minor aquifer

82-83m: Clayey dolomite with minor flow

85-87m: Fractured clayey dolomite with moderate flow

87-91m: Moderate flow through zone Dolomitic substrate

94-95m: Finely broken moderate aquifer development

99-102m: Samples wet minor flow increase

EOH at 115mbgl

Open-hole (60-115mbgl)

COMPOSITE WELL LOG

Well No: WSE041

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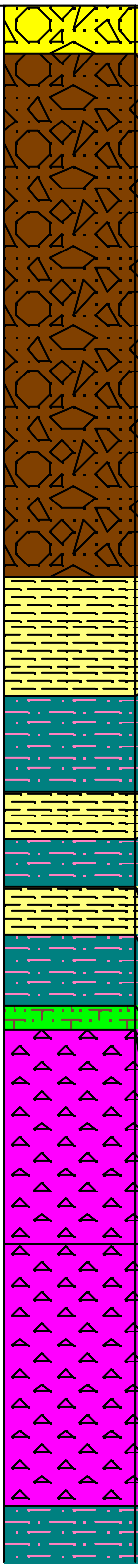
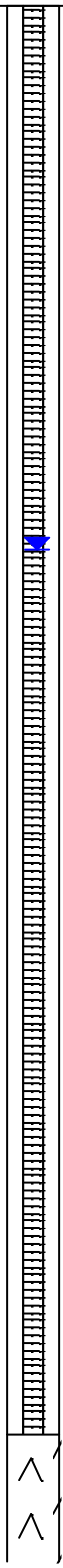
Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced:	22/08/2004	**Method:**	RC (0-120)	**Area:**	Mt Nicholas
Completed:	23/08/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:**	222613m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7492055m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 22.85mbgl **Date:** 24/08/2004; 13:30hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Red brown consolidated silty clay with colluvium			
			ALLUVIUM: Red-brown poorly sorted angular-subrounded fragments <=3cm diamter with 10% poorly consolidated clay	Airlift Yield= 2L/s tds ppt 2.01 8.71 pH		
-10						
-20						
			CLAY: Red brown loosely consolidated clay wit 30% alluvial grit <=2mm diamter	4.03 mS		
-30			SAPROCK: Cream hard/brittle fragments highly bleached slightly oxidised showing banding(Chert) and massive siliceous textures with small quartz inclusions			50 mm slotted PVC (0-60mbgl) top cap only - end cap not attached to allow measurements below casing to EOH if required
			CLAY: Pale brown finely aggregated clay			
			SAPROCK: Light brown-cyan damp/wet finely aggregated clay with 30% ferruginous saprock fragments and minor calcareous soft fragments	35-37m: Damp wet clay minor aquifer		
-40			CLAY: Pale brown-ash finely aggregated clay			
			SAPROCK: Pale brown-ash hard ferruginised/bleached saprock (Chert?)			
			CLAYSTONE: Light brown consolidated clay with interspersed brittle/hard ferruginised claystone/saprock fragments			
-50			CHERT: Grey-pale brown highly ferruinous/oxidised chert with subtle banding showing deformation as microfolding. Quartz/siliceous development aligned with banding. Moderately wet zone 46-47m	46-47m: Wet sample minor flow from outside reture		
			CHERT: Grey-pale green oxidised chert with banding evident as above with increased silicification evident. Some vuggy development associated with siliceous zone and goethetic/haematitic weathered surfaces. Samples are wet throughout zone with moderate outside return flows	52-63m: Samples go damp to wet Minor aquifer		
-60			SAPROCK: Grey-pale brown damp highly clayey with interspersed highly oxidised chert fragments with			





aquaterra	COMPOSITE WELL LOG	Well No: WSE041
	Client: Fortescue Metals Group	**Project:** Mt Nicholas groundwater RC exploration

Depth	Lithology description	Comments	Construction
	zones of white/bleached chert		
	CHERT: Light brown-pale green stiff/consolidated wet clay with high % of highly oxidised chert		
-70	CHERT: Pale grey-green chert with siliceous zones overprinting chert banding with minor ferruginous/moderate oxidation	70-71m: No clay in zone and wet samples	
	CHERT: Pale green-grey oxidised chert as wet samples .Outside return flows developing stronger. Siliceous development in chert most predominantly weathered with haematitic/goethitic/limonitic staining also associated with good vugg development. Moderate fracturing though not extensive Fractured samples to <=3cm	75-77m: Vugh development moderate to good on siliceous/chert with moderate fracturing. Airlift 1.8 litres/second low cycle air pressure 150 psi	
-80	CLAY: Pink-light brown wet/damp consolidated clay with interspersed highly oxidised chert		
	CHERT: Pale green-grey oxidised chert becoming less oxidised to end of zone. Moderate Aquifer with fractured fragments oxidised and ferruginous on fracture surfaces	82-85m: Moderate fracturing with vuggy development in minor zones Moderate aquifer	
-90	CHERT: Cyan-brown wet/damp consolidated clayey highly oxidised chert. Fragments <=1cm		Open-hole (60-120mbgl)
	CHERT: Grey-pale brown oxidised chert with subtle fracturing in zones. Samples all going wet with water flow in cyclone. Main aquifer	94-103m: Subtle fracturing in chert with minor vugh and oxidation of fracturing Moderate aquifer	
-100	CHERT: Pale brown-grey chert mildly oxidised with 30% clay component. Samples damp only		
	CHERT: Brown-dark grey wet oxidised chert with interpersed highly ferruginous debris with minor ironstone fragments <=2mm. Zone becomes much less oxidised	106-113m: Minor aquifer with less fracturing and less oxidation development through the zone	
-110	CLAY: Pale brown-grey damp consolidated clay with interspersed oxidised chert highly oxidised as soft to hard fragments with minor ironstone and ferruginous debris	112-114m: Airlifted 40 minutes periodically testing 20litres/9 seconds as constant flow 2.01 ppt TDS, 8.70 pH, 4.03 mS	
	CHERT: Grey-pale brown slightly oxidised chert- sample fragments ,<=1cm no fracturing Samples becoming fresh		
-120		EOH at 120mbgl	

COMPOSITE WELL LOG

Well No: WSE042B

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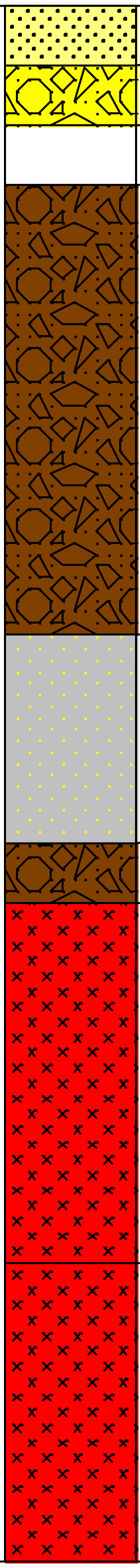
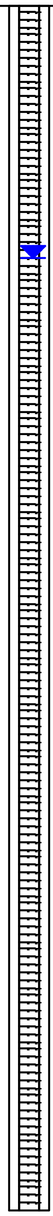
Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced:	01/09/2004	**Method:**	RC to 52m EOH	**Area:** Mt Nicholas
Completed:	01/09/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:** 222325m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches rods	**North:** 7477310m(AMG)
Logged By:	RFToll		5 3/8 inches	**Elevation:**

Static Water Level: 8.38mbgl **Date:** 01/09/2004; 13:30hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			SAND: Aeolian desert sands			
			COLLUVIUM: Brown unconsolidated clay with interspersed colluvium			
				1.17 tds		
			ALLUVIUM: Brown damp consolidated clay with minor lateritic fine debris/grit	8.64 pH		
-10				2.36 mS		
-20			CLAYEY SANDY SILT: Brown highly oxidised saprock with clayey component 10%			Slotted 50mm PVC (0-40mbgl)
			ALLUVIUM: Brown wet moderately broken Fe-stained granitoid unit	28-30m: Moderate yielding oxidised broken section		
-30			GRANODIORITE: Grey-pale brown damp slightly oxidised granitoid with occasional broken sections with minor clayey component 5%			
-40			GRANODIORITE: Grey granitoid (sedimentary textures evident though high grade metamorphism pervasive) less oxidised becoming fresh rock with occasional broken sections with likely association with water	42-52m: Transitional slightly broken granitoid/metamorphosed units (high grade metasediments)		
-50				EOH at 52mbgl		





COMPOSITE WELL LOG

Well No: WSE51

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Client: Fortescue Metals Group
Project: Mt Nicholas groundwater RC exploration

Commenced: 2/08/2004	**Method:** RC (0-70 m)	**Area:** Mt Nicholas
Completed: 2/08/2004	**Fluid:**	**East:** 238775m(AMG)
Drilled: Connector	**Bit Record:** 4 inches	**North:** 7483187m(AMG)
Logged By: RFToll	5.75 inches	**Elevation:**

Static Water Level: 25mbgl
Date: 3/08/2004; 10:00am

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			SAND: Aeolian desert sands			pvc surface end cap 50 mm installed with 50 mm pvc piezometer tubing
			COLLUVIUM: Red-Brown colluvium with minor lateritic debris			
			COLLUVIUM: Red brown clayey colluvium			
-10			ALLUVIUM: Red brown clayey alluvial			50 mm blank PVC piezometer tubing
-20			CLAY: Brown damp finely aggregated clay			
			CLAY: Pink brown ferruginised clay with interspersed lateritic fragments			
-30						
-40			CLAY: Khaki poorly bonded clay interspersed with grey dense clay aggregates			50 slotted PVC piezometer tubing
			CLAY: Pink brown large aggregated dense puggy clay			
			CLAY: Grey - brown to red brown damp clay aggregates (4mm diameter) with highly oxidised black sub angular silicified pisolites(Festone?)			
-50			CALCRETE: Cream soft - brittle weathered calcrete with rare Mn coatings. Damp sample and clayey			
			DOLOMITE: Cream brittle calcrete with zones of pink matix ferruginised calcrete. Visible dolomite xstal faces. Occasional ferruginised crosscutting veinlets. Wet sample @ 52m minore flow	wet zone minor flow- likely associated contact dolomite		
-60			DOLOMITE: Pink - cream dolomite with cream dolomte evident as xtal inset in the pink dolimite massive matrix). Slight weathered surfaces become less to fresh conditions with depth	pH 8.82 TDS ppm 740 mS ppt 1.51 Temp 0.C 24.1		
-70				70 m EOH		

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COMPOSITE WELL LOG

Well No: WSE52A

Client: Fortescue Metals Group
Project: Mt Nicholas groundwater exploration RC drillin

Commenced: 2/08/2004
Completed: 2/08/2004
Drilled: Connector Drilli
Logged By: RFToll

Method: RC to 46m EOH.
Fluid:
Bit Record: 4 inches
5 3/8inches

Area: Mt Nicholas
East: 239119m(AMG)
North: 7482418m(AMG)
Elevation:

Static Water Level: 33.65mbgl
Date: 11/08/2004; 17:00hrs

Depth (mbgl)	Lithological Description	Field Notes
0	SAND: Aeolian desert sands	
	COLLUVIUM: Grey-brown damp consolidated clay	
	COLLUVIUM: Brown clayey colluvium	
-10	ALLUVIAL: Red-brown clay with minor interspersed fine angular lateritic particles	
-20	ALLUVIAL: Red-brown poorly consolidated clay with predominant poorly sorted angular-subrounded lateritic fragments 1cm diameter	
	ALLUVIAL: Red-brown alluvial as highly ferruginous chert angular-poorly sorted with minor jaspilite angular fragments	
-30	ALLUVIAL: Red brown consolidated clay with poorly sorted angular to subrounded ferruginised fragments	
	CLAY: Grey dense clayball with minor red-brown damp gritty unconsolidated clay	wet approximate yield 0.5 litres/second
-40	CLAY: Dark brown damp finely aggregated clay. Swelling clay	Swelling clay 39-45m hole collapsing quickly. Rods completely stuck 43m No rotation Hole abandoned
	CLAY: Dark grey damp clay aggregated with interspersed grit Festone- Swelling clay come in quickly causing hole to collapse- rods completely stuck 43m No rotation	EOH at 46mbgl

Well Completion: Diagram | Notes

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COMPOSITE WELL LOG

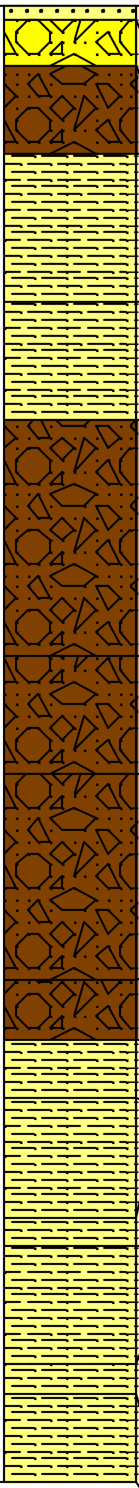
Well No: WSE52B

Client: Fortescue Metals Group
Project: Mt Nicholas groundwater RC exploration

Commenced:	10/08/2004	**Method:**	RC to50m EOH.	**Area:**	Mt Nicholas
Completed:	10/08/2004	**Fluid:**		**East:**	238775m(AMG)
Drilled:	Connector	**Bit Record:**	4 inches	**North:**	7483187m(AMG)
Logged By:	RFToll		5.75 inches	**Elevation:**	

Static Water Level: 33.65mbgl
Date: 11/08/2004; 17:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			SAND: Aeolian desert sands			
			COLLUVIUM: Grey-brown damp consolidated clay			
			ALLUVIUM: Red-brown highly ferruginised chert			
			CLAY: Red-brown clay with minor interspersed fine angular lateritic particles			
-10			CLAY: Red-brown poorly consolidated clay with with angular goethitic/laterised fragments.			
			ALLUVIAL: Red-brown poorly consoldiated clay - damp in zones with interspersed angular ferruginous fragments to 2mm diameter			
-20			ALLUVIAL: Red brown consolidated clay with poorly sorted angular to subrounded ferruginised fragments			
			ALLUVIAL: Brown dense soft/brittle claystone with minor interspersed goethitic ferrruginised angular to subrounded fragments to 5mm diameter			
-30				Hole abandoned due to swelling clay		
			ALLUVIAL: Dark-brown damp finely aggregated clay with minor zone cream soft silcrete			
			CLAY: Pale brown dense clay with zones ash brown brittle claystone slightly ferruginised			
			CLAY: Brown-cyan damp stiff aggregated clay			
-40			CLAY: Red-brown dense soft/brittle claystone slightly Fe cemented with fragmental ferruginous sized particles to 1 cm diameter			
			CLAY: Cream-grey poorly bonded clay. Loss of air pressures. Clays swelling quickly difficult to maintain drilling			
			CLAY: Khaki - grey- brown poorly bonded clay with ferruginous fragments poorly sorted angular to subrounded to 1cm diameter. Weak soft decomposed calcrete?dolomite?@46m	approximate yield 0.5 litres/second		
-50			CLAY: Light brown damp consolidated clay. Hole abandoned due to swelling clay	EOH at 50mbgl		



COMPOSITE WELL LOG

Well No: WSE 53

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Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced: 10/08/2004
Completed: 11/08/2004
Drilled: Connector
Logged By: RFToll

Method: RC (0-106)
Fluid: 1800 cfm 450 psi (Hydco C4)
Bit Record: 5 3/8"

Area: Mt Nicholas
East: 237786m(AMG)
North: 7480866m(AMG)
Elevation:

Static Water Level: 44.4 mbgl **Date:** 11/08/2004; 12.45am

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			SAND: Aeolian desert sands			
			COLLUVIUM: Red-brown colluvium			
			ALLUVIUM: Light brown poorly bonded clay with fragmental ferruginised chert siliceous angular particles			
-10			ALLUVIUM: Red-brown loosely consolidated clay with ferruginous chert fragments			
			CLAY: Khaki damp consolidated clay with fine angular particles ferruginous goethitic fragments to 3mm diameter			
			CLAY: Pale brown poorly consolidated with fine ferrugious angular particles			
-20			CLAY: Red-brown clayey alluvial. Highly ferruginous fragments poorly sorted angular to subrounded to 2-5mm diameter.			
			CLAY: Red-brown finely aggregated clay with minor fine ferruginous particles to 2mm diameter			
			ALLUVIAL: Red-brown highly ferruginous hard ferruginised chert			
-30			ALLUVIAL: Red-brown highly ferruginised alluvials(chert). Fragments subrounded to angular poorly sorted to 2 cm diameter.			
			CLAY: Red-brown finely aggregated clay			
-40			CLAYSTONE: Red-brown brittle/soft ferruginised claystone. Partly laterised			
			CLAYSTONE: Cyan-pale brown brittle claystone			
			CLAY: Dark brown-grey consolidated damp puggy clay			
-50			PISOLITE: Dark brown-black moderately rounded pisolite-goethitic fragments to 5 mm diamter.			Open hole (0-106mbgl)
			DOLOMITE: Dark grey damp oxidised dolomite with component pink Mn impregnated Dolomite			
-60			DOLOMITE: Brown highly oxidised partly decomposed dolomite. Minor film grey-green oxidised precipitate with angular goethitic/limonitic fragments			
			DOLOMITE: Grey-pink fresh to slightly oxidised dolomite Mn impregnated			
			DOLOMITE: Dark-grey with brown clayey component highly oxidised wet dolomite			
-70			DOLOMITE: Grey-pink slightly oxidised dolomite with xstal faces	70-77m: Minor Aquifer Main wet part 76-77m		
			DOLOMITE: Brown highly oxidised dolomite. Haematie-Manganese common on surfaces - more intense on occasional fracture planes			
-80			DOLOMITE: Grey-pink unoxidised dolomite (xstal faces evident)			

Depth	Lithology description	Comments
	DOLOMITE: Brown highly oxidised dolomite with occasional fracture surfaces (Mn Hm) Damp zones become wet/flows @ 87metres	83-88.5m: Minor Aquifer Main wet zone 87-88.5 Minor wet zone
-90	DOLOMITE: Grey-pink fresh to slightly oxidised dolomite	pH 8.18 TDS ppt 0.84 mS ppt 1.46
	DOLOMITE: Light brown - grey slightly oxidised dolomite Damp samples become wet @ 97 m	Temp 0.C 27
-100	DOLOMITE: Grey-pink unoxidised dolomite xstal faces evident	93-97m: Minor Aquifer 106 m EOH

aquaterra	# COMPOSITE WELL LOG	**Well No:** WSE 54

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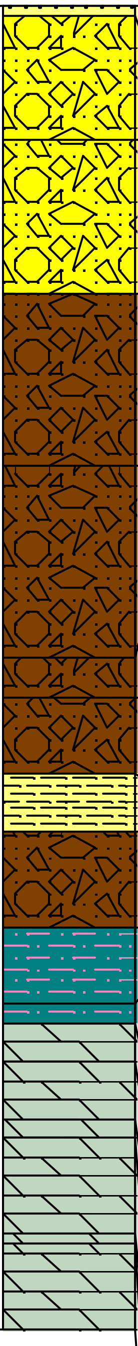
Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced:	11/08/2004	**Method:**	RC to 69m EOH.	**Area:** Mt Nicholas
Completed:	12/08/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:** 240291m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches	**North:** 7479770m(AMG)
Logged By:	RFToll		5 3/8 inches	**Elevation:**

Static Water Level: 43.46mbgl **Date:** 12/08/2004; 13:30hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes

Depth scale: 0, -10, -20, -30, -40, -50, -60



SAND: Aeolian desert sands

COLLUVIUM: Brown ferruginous fragments with fraction of goethetic and poorly consolidated clay

COLLUVIUM: Brown finely aggregated damp clay with particles ferruginous fragements and minor goethite

ALLUVIUM: Brown highly ferruginous fragments poorly sorted - angular to subrounded to 2cm diameter

ALLUVIUM: Red-brown poorly consolidated clay with goethite and highly ferruginous hard fragments to 2mm diameter

ALLUVIUM: Red-brown highly ferruginous hard/brittle fragments poorly sorted - angular to subrounded- 1cm diameter

ALLUVIUM: Red-brown poorly consolidated clay with goethite and highly ferruginous hard fragments to 2mm diameter

CLAY: Dark brown finely aggregated clay

ALLUVIUM: Red-brown damp consolidated clay with hard/brittle subrounded to angular limonite-goethite fragments to 5mm diamter and minor pisolite

SAPROCK: Pale brown limonitic fragments to 2cm diamter. Hole becomes wet (inside sampling)

SAPROCK: Dark grey-brown moderately oxidised dolomite with minor development of soft cream calcrete/silcrete? and minor brittle limonite

DOLOMITE: Grey-brown slighlty oxidised to fresh dolomite xstal faces evident

DOLOMITE: Grey-pink unoxidised dolomite sith minor Mn impregnations

DOLOMITE: Grey-pink slightly oxidised dolomite with pervasive Mn impregnations. Minor fracture development with moderate precipitation on surfaces

DOLOMITE: Grey-brown slighlty oxidised to fresh dolomite xstal faces evident

DOLOMITE: Grey-pink slightly oxidised dolomite with pervasive Mn impregnations. Very weak fracture planes with associated oxidation film

DOLOMITE: Grey-brown slighlty oxidised to fresh dolomite xstal faces evident

Field Notes:

Data from 64mbgl

pH 8.72

TDS ppt 0.500

mS ppt 0.99

Temp 0.C 24.1

Minor wet zone - flows not strong

Minor wet zone - flows not strong
airlift 0.25 litres/second

Minor wet zone - damp samples

EOH at 69mbgl

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COMPOSITE WELL LOG

Well No: WSE056

Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced:	20/08/2004	**Method:**	RC to 76m EOH.	**Area:**	Mt Nicholas
Completed:	21/08/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:**	242466m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches	**North:**	7484355m(AMG)
Logged By:	RFToll		5 3/8 inches	**Elevation:**	

Static Water Level: 55mbgl **Date:** 21/08/2004; 13:30hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			SAND: Aeolian desert sands			
			COLLUVIUM: Brown unconsolidated clay with interspersed colluvium			
			ALLUVIUM: Red-brown poorly sorted alluvium, angular-subrounded, <=2cm			
-10			CLAY: Red brown loosely consolidate clay with lateritic grit			
			ALLUVIAL: Red-brown alluvial -fragments <=2cm diameter poorly sorted with rounded to sub angular fragments			
-20			CLAY: Red-brown moderately bonded clay with 20% alluvial fragments as above			
			ALLUVIAL: Red-brown alluvial -fragments <=2cm diameter poorly sorted with rounded to sub angular fragments			50mm slotted PVC (0-58mbgl) with end cap and top cap
-30			CHERT & SHALE: Pink-grey highly ferruginised hard fragments of chert/shale			
-40			CLAY: Pink-grey very dense clay aggregates <=5cm			
-50			CHERT & SHALE: Brown-cyan highly oxidised limonitic/ferruginised chert/shale with damp zones and 20% clay component	no swl to this depth Estimated 55 metres Blocked at 54 metres		
			SAPROCK: Dark grey-black brittle saprock (chert?) dampe zone with 50% clay component	55-58m: Damp to minor wet zone		
-60			SHALE & CHERT: Dark grey black hard slightly oxidised chert/shale	60-62m: Airlift attempt yielded only mud slurry No significant groundwater yield present		
			DOLOMITE: Grey-brown highly oxidised transitional zone between black sahle and highly oxidised dolomite with 30% clay component Broken framents <=5cm			
			DOLOMITE: Grey-pink slightly oxidised dolomite with xtal faces evident	64-66m: Damp with minor slurry only		
-70			DOLOMITE: Grey-pink unoxidised dolomite with Mn	EOH at 76mbgl		

COMPOSITE WELL LOG

Well No: WSE057

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Client: Fortescue Metals Group | **Project:** Mt Nicholas groundwater RC exploration

Commenced: 14/08/2004	**Method:** RC (0-117)	**Area:** Mt Nicholas
Completed: 15/08/2004	**Fluid:** 1800 cfm 450 psi (Hydco C4)	**East:** 243387m(AMG)
Drilled: Connector	**Bit Record:** 5 3/8"	**North:** 7483843m(AMG)
Logged By: RFToll		**Elevation:**

Static Water Level: 43.46mbgl | **Date:** 14/08/2004; 13:30hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			SAND: Aeolian desert sands			
			COLLUVIUM: Brown unconsolidated clay with interspersed colluvium			
			ALLUVIUM: Red-brown poorly sorted alluvium, angular-subrounded, <=2cm			
-10						
			ALLUVIUM: Red-brown 30% poorly sorted angular-subrounded fragments <=2cm with red-brown finely aggregated clay			
			ALLUVIUM: Red-brown poorly sorted angular-subrounded fragments <=2cm			
-20			ALLUVIUM: Red-brown finely aggregated clay			
			ALLUVIUM: Red-brown finely aggregated clay, 30% alluvial fragments <=2cm			
			CLAY: Red-brown finely aggregated clay			
-30						
			CLAY: Pink-grey well bonded clayballs/aggregates <=2cm brittle/soft			
-40			CLAY: Red-brown ferruginous consolidated clay with pink grey clay as larger aggregates <=5cm			
			CLAY: Red-brown consolidated clay with brittle highly ferruginous fragments <=2cm			
			CHERT & SHALE: Brown-dark grey highly oxidised chert with softer fragments(shale?)			
-50			CLAY: Grey-Ash finely aggregated friable clay			Open hole (0-117mbgl)
			CLAY: Grey-brown damp aggregated clay <=3cm			
			CLAY: Red-brown ferruginous consolidated clay with pink grey clay as larger aggregates <=5cm	54-57m: Fractured chert with moderate water increase approximately 1 l/s		
			CHERT: Grey-brown hard silicified highly ferruginous chert Fractured in zones with asssociated moderate to			

Depth	Lithology	Comments
	high water intersection Fractured fragments to 3cm diameter	
-60	CHERT: Brown-grey-cream highly oxidisied chert with 10% component of carbonate/calcrete soft/brittle fragments <=2mm	
	CHERT: Dark blue-grey oxidised chert-slightly porcellised/carbonate replaces with fractured zone associated with Fe/oxidation coatings on frature planes and development of carbonate precipitate	
	CLAY: Pale brown damp finely aggregated clay	67-73m: Oxidised fractured chert Increase moderately water flow approximately 1.5 l/s
	CLAY: Pale brown-orange finely aggregated clay	
-70	CLAY: Dark grey chert with moderate component of grey-pale brown finely aggregated clay	
	CHERT & SHALE: Dark grey-black highly oxidised ferruginous shale/chert fragments with approximately 30% clay componet	
	CHERT: Grey-dark grey oxidised chert slightly fractured in zones with estimated moderate increase in water flow	
	CLAY: Dark grey-black ferruginous soft large aggregates as damp clayballs <=5cm	
-80	CHERT & SHALE: Grey-dark grey-black oxidised ferruginous zones with minor consolidated clay	
-90	??	
-100		
-110		EOH at 117mbgl

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COMPOSITE WELL LOG

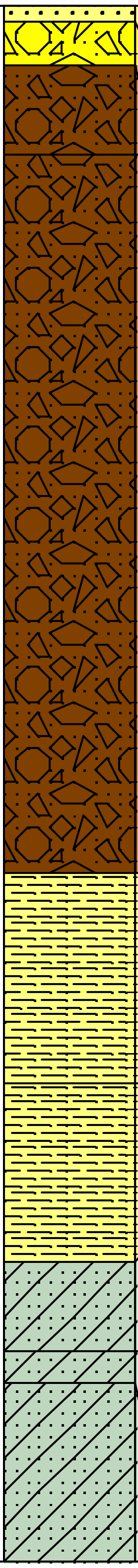
Well No: WSE 61

Client: Fortescue Metals Group **Project:** Mt Nicholas groundwater RC exploration

Commenced: 31/07/2004	**Method:** RC to 52m EOH.	**Area:** Mt Nicholas	
Completed: 1/08/2004	**Fluid:**	**East:** 237049m(AMG)	
Drilled: Connector	**Bit Record:** 4 inches	**North:** 7470865m(AMG)	
Logged By: RFToll	5.75 inches	**Elevation:**	

Static Water Level: 21.4 mbgl **Date:** 2/08/2004; 12.45am

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			SAND: Aeolian desert sands			Piezometer installed 50 mm pvc with bottom and end cap
			COLLUVIUM: Red-Brown gritty clays,limonitic gravels and cherty fragments.			
			ALLUVIUM: Dark red-brown clays			
-10			ALLUVIUM: Dark red-brown clays with angular to poorly rounded debris approximately to 0.5 cm diameter			Blank 50mm PVC (0-36mbgl)
-20						
-30			CLAY: Yellow brown friable clay			
			CLAY: Dark brown damp clays with interspersed silicified highly oxidised dolomitic fragments	pH 8.65		
-40				TDS ppm 1.08		
			METAMORPHICS: Grey-ash slighlty oxidised highly altered silicified sediments with impregnation of quartz veining. Moderate development of ferruginous staining on poor fracturing	mS ppt 2.15		
				Temp 0.C 23.7		Slotted 50mm PVC (36-52mbgl)
			METAMORPHICS: Grey-ash slighlty oxidised highly altered silicified sediments. Fracture intersect with ingresso of minor water flows Higher degree oxidation	wet zone associated fracturing		
-50			METAMORPHICS: Grey ash felsic metamorphosed to moderate - high degree. Rock becoming unoxidised with little fracturing	EOH at 52mbgl		



COMPOSITE WELL LOG

Well No: WSE 62

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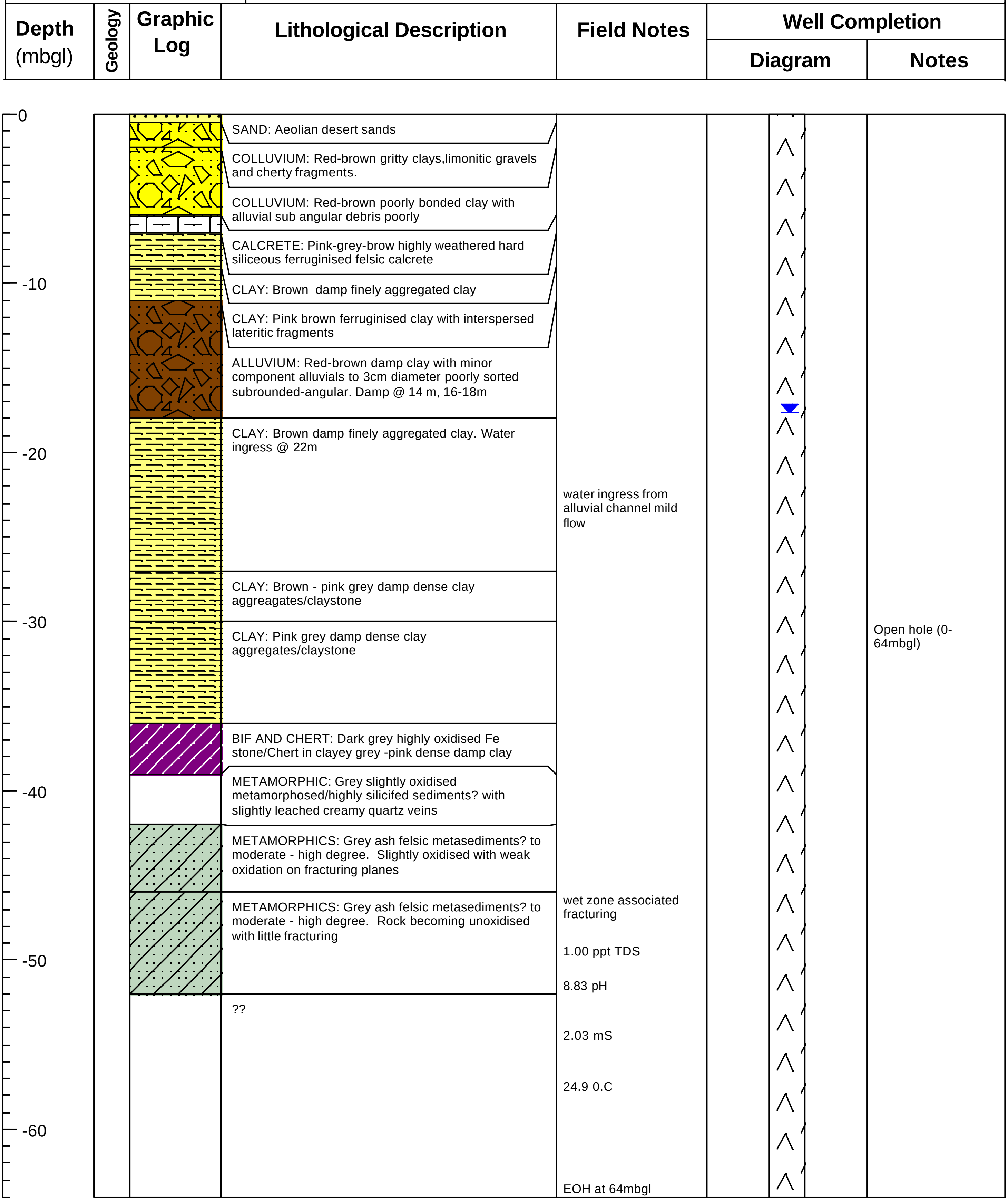
Client: Fortescue Metals Group
Project: Mt Nicholas groundwater RC exploration

Commenced: 1/08/2004	**Method:** RC (0-64)	**Area:** Mt Nicholas	
Completed: 1/08/2004	**Fluid:**	**East:** 237410m(AMG)	
Drilled: Connector	**Bit Record:** 5 3/8"	**North:** 7469608m(AMG)	
Logged By: RFToll		**Elevation:**	

Static Water Level: 17.65 mbgl
Date: 2/08/2004; 12.45am



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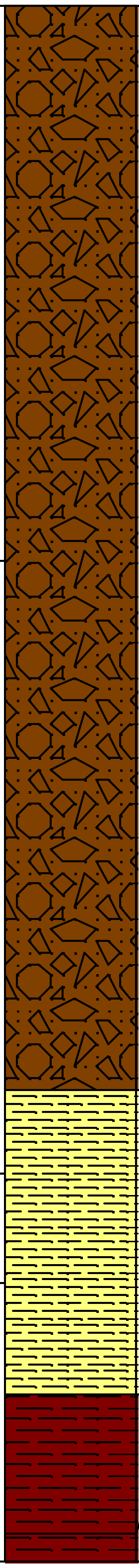
COMPOSITE WELL LOG

Well No: ML173

Client: Fortescue Metals Group		**Project:** Mt Lewin groundwater RC exploration			
Commenced:	29/08/2004	**Method:**	Airlift to 56m EOH.	**Area:**	Mt Lewin
Completed:	29/08/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:**	212600m(AMG)
Drilled:	Connector R3	**Bit Record:**	5 3/8"	**North:**	7491700m(AMG)
Logged By:	RFToll			**Elevation:**	
Static Water Level: 13.65 mbgl		**Date:** 29/08/2004; 07:00hrs			



Depth (mbgl)	Geology	Lithological Description	Field Notes	Well Completion Diagram	Notes
0		ALLUVIAL: Brown alluvium			
-10					
-20	Minor Aquifer				
-30			1ppt tds		
			8.03 pH		
			2.2 mS		
-40	Mod. Aquifer	CLAY: Finely aggregated, bleached clay	40-42m: Airlifted only @ 40metres due to blockages of hammer Minor yield (1/2 hour duration).		
-50		CHERT & SHALE: Grey-light brown consolidated clay with saprock	Airlift yield=0.3L/s		
		CHERT & SHALE: Grey-brown oxidised saprock chert/shale	EOH at 56mbgl		

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COMPOSITE WELL LOG

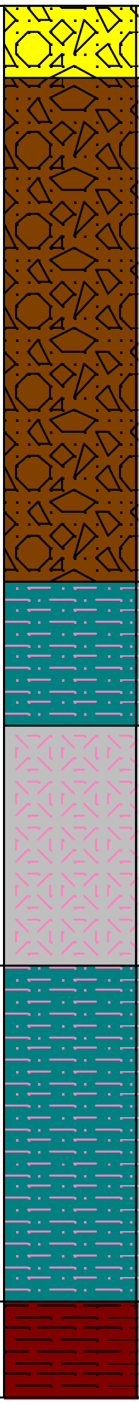
Well No: ML196

Client: Fortescue Metals Group **Project:** Mt Lewin E groundwater RC exploration

Commenced:	9/09/2004	**Method:**	Airlift to 54m EOH.	**Area:**	Mt Lewin
Completed:	9/09/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:**	20900m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7493700m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 20.6 mbgl **Date:** 10/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Brown sandy colluvium.			
-10			ALLUVIAL: Brown-red alluvial sediments fragments <=2cm.			
-20			SAPROCK: Purple-brown clayey gritty debris.			
-30			SAPROLITIC CLAY: Red-brown saprock(chert?) with minor clayey component.			
-40	Moderate Aquifer		SAPROCK: Red-brown-purple shale and chert hard fragments with moderate broken sections includes Fe oxidation surfaces.	TDS=1.1 ppt pH=8.72 E.C.=2.19 mS		
-50			CHERT & SHALE: Black-dark grey chert/shale.	54-58m: possible aquifer, tested at 52 metres: Airlift Yield=3 L/s EOH at 58mbgl		



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COMPOSITE WELL LOG

Well No: ML224

Client: Fortescue Metals Group **Project:** Christmas Creek groundwater exploration

Commenced:	13/10/04	**Method:**	Reverse Circulation to 82m EOH	**Area:**	Mt Lewin
Completed:	14/10/04	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	206599m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches rods	**North:**	7497102m(AMG)
Logged By:	Steve Collett		5 3/8 inches	**Elevation:**	

Static Water Level: **Date:**

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			BIF: Red-brown goethite, BIF, minor amount of haematite.			pvc plain 150 mm collar (0-4mbgl)
			SHALE: Brown goethite rich shale/chert. minor limonite dust.			
-10			SHALE: White to light brown kaolin shales.			
-20						
-30			SHALE: Dark grey carbonaceous shale, pyritic to 10% of sample. Slightly feldspathic and sample damp to 60m depth.	33-60m: Minor yields from transition from ox to fresh carbonaceous and feldsic shale. E.C.=1.5mS/cm TDS=0.75ppt pH=8.7 Airlift Yield=0.5L/s		
-40						
-50						
-60						
-70						
-80			SHALE: Light grey feldspathic shale, fine grained and pyritic, interbedded with thin beds of black carbonaceous shale.			
-90			SHALE: Grey feldspathic shale, trending to higher carbonaceous content.			
-100				EOH at 100mbgl		

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COMPOSITE WELL LOG

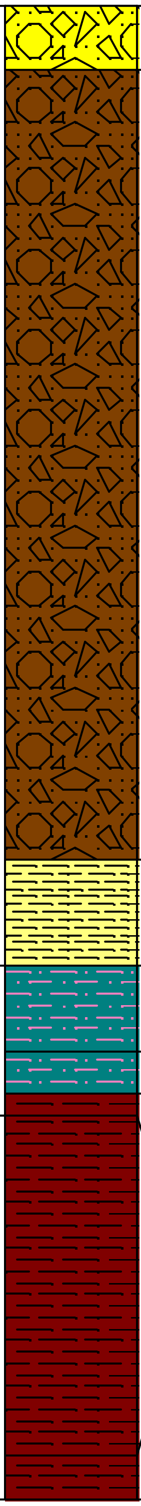
Well No: MN270

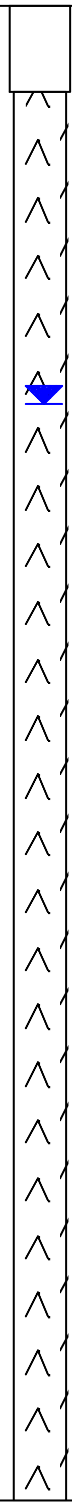
Client: Fortescue Metals Group **Project:** Mt Lewin E groundwater RC exploration

Commenced:	9/09/2004	**Method:**	Airlift to 54m EOH.	**Area:**	Mt Lewin
Completed:	9/09/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:**	20900m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8	**North:**	7493700m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 18.7mbgl **Date:** 10/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Brown colluvium and sandy cover.			T.O.C.: +0.3magl 150mm pvc surface casing (0-4mbgl)
			ALLUVIAL: Brown-red alluvial sediments fragments <=2cm.			
-10						
-20						
-30						Open hole (0-70mbgl)
-40			CLAY: Brown moderately consolidated clays.			
	Moderate aquife		SAPROCK: Brown-dark grey transitional saprock with minor clayey component.			
-50			SAPROCK: Dark grey saprock/chert.			
	Possible aquifer (3.2L/s) tested at 64m		CHERT & SHALE: Black-dark grey chert/shale with minor clayey component.	E.C.=2.34 mS/cm		
			CHERT & SHALE: Brown-dark grey highly oxidised chert, likely aquifer slightly broken/fractured.	TDS=1.15ppt pH=8.77 Airlift Yield=3.2L/s		
-60						
			CHERT & SHALE: Dark grey shale-chert slightly oxidised, possible continuation of broken zones at depth.			
-70				EOH at 70mbgl		





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COMPOSITE WELL LOG

Well No: ML288

Client: Fortescue Metals Group **Project:** Mt Lewin groundwater RC exploration

Commenced:	28/08/2004	**Method:**	RC to 76m EOH.	**Area:**	Mt Lewin
Completed:	28/08/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:**	211400m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7490400m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 9.3 mbgl **Date:** 29/08/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			ALLUVIAL: Red brown alluvial.			
-10						
-20	Minor aquifer					
-30			CLAY: Brown clayey saprock, damp from 18-20m and 24-26m.			
-40	Main aquifer		CHERT & SHALE: Red brown shale, chert.	E.C.=2.36 mS/cm		
-50				TDS=1.18ppt		
				pH=8.6		
-60				Airlift Yield=3.5L/s		
-70			CHERT & SHALE: Dark grey shale, chert. fractured in zones. Wet 46-47m, 58-59m and 64-73m.	70-72m: Flow test 1.5 hours- (Airlift Yield=3.5L/s)		
				EOH at 76mbgl		

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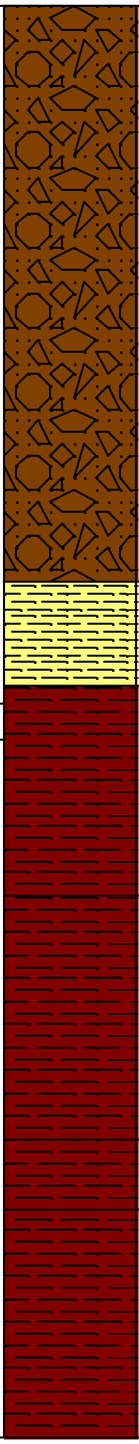
COMPOSITE WELL LOG

Well No: ML302

Client: Fortescue Metals Group
Project: Mt Lewin groundwater RC exploration

Commenced:	29/08/2004	**Method:**	Airlift to 82m EOH.	**Area:**	Mt Lewin
Completed:	29/08/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:**	212600m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7491200m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 13.65 mbgl
Date: 30/08/2004; 07:00hrs



Depth (mbgl)	Lithological Description	Field Notes
0	ALLUVIAL: Red brown alluvial.	
	CLAY: Brown consolidated clay with lateritic debris.	
-40	CHERT & SHALE: Ash-white bleached finely aggregated clay.	40-42m: Airlifted only @ 40metres due to blockages of hammer Minor yield (1/2 hour duration).
		Airlift yield=0.3L/s
-50	CHERT & SHALE: Dark grey-brown oxidised clayey shale & chert.	
	CHERT & SHALE: Red-brown shale chert oxidised.	
-70	CHERT & SHALE: Dark grey to red-brown moderately oxidised chert & shale with wet zones throughout.	
-80		EOH at 82mbgl

Depth scale: 0, -10, -20, -30, -40, -50, -60, -70, -80

Well Completion — Diagram | Notes

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COMPOSITE WELL LOG

Well No: ML305

Client: Fortescue Metals Group **Project:** Mt Lewin groundwater RC exploration

Commenced:	28/08/2004	**Method:**	Airlift to 70m EOH.	**Area:**	Mt Lewin
Completed:	28/08/2004	**Fluid:**	1800 cfm 450 psi (Hydco C4)	**East:**	212600m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8	**North:**	7490600m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 13.65 mbgl **Date:** 29/08/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0 – 39			ALLUVIAL: Red brown alluvial.			Open hole (0-70mbgl)
39 – 50			CLAY: Ash-white finely aggregated bleached clay.	50-54m: Airlifted only 54m due to blockages of hammer. Significant yields and steady over 1 hour.		
50 – 55			CHERT & SHALE: Light grey-light brown consolidated clay with saprock.	Initially: Airlift Yield=8.5L/s		
55 – 70			CHERT & SHALE: Dark grey-brown oxidised saprock chert/shale.	E.C.=2.04 mS/cm TDS=1.04ppt pH=8.3 Airlift Yield=7L/s EOH at 70mbgl		

Depth scale: 0, -10, -20, -30, -40, -50, -60, -70

A2: Christmas Creek Area

COMPOSITE WELL LOG

Well No: E02

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Client: Fortescue Metals Group
Project: Christmas Creek groundwater exploration

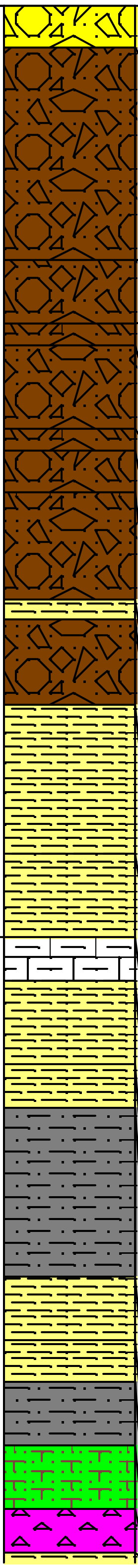
Commenced:	14/09/2004	**Method:**	RC (0-82)	**Area:**	Christmas Creek
Completed:	15/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	782203m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7520796m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 22.5mbgl
Date: 16/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes

Depth axis: 0, -10, -20, -30, -40, -50, -60, -70

Geology: alluvial debris



Lithological Description

COLLUVIUM: Brown colluvium fragments < 3cm with 10% unconsolidated clay.

ALLUVIAL: Brown highly oxidised alluvial comprising chert fragments poorly sorted subangular <2cm diameter + 20% lateritic particles.

ALLUVIAL: Red-brown poorly consolidated clay + 20% lateritic particles.

ALLUVIAL: Brown lateritic hard fragments poorly sorted subangular <2cm diameter.

ALLUVIAL: Brown highly oxidised chert fragments < 2cm diameter 60% + 40% poorly consolidated clay.

ALLUVIAL: Red-brown moderately consolidated clay 60% + 40% highly oxidised alluvials as above.

ALLUVIAL: Brown highly oxidised alluvial poorly sorted subangular <2cm diameter + 30% poorly consolidated clay.

ALLUVIAL: Red-brown aggregated/well bonded clay as 50% of zone + 50% of highly oxidised alluvial fragments wet zone with minor flows.

CLAY: Red-brown damp aggregated/well bonded clay.

ALLUVIAL: Red-brown damp well bonded/aggregated clay as 70% of zone + 20% highly oxidised alluvial fragments subangular < 2 cm diameter + 10% grey limonitic angular fragments < 5cm diameter.

CLAY: Red-brown clay 60% zone with 30-40% dark grey-brown pisolite 2- 4 mm diameter + 10% lateritic particles Wet zone with minor to moderate flows approximately 1 litre/second.

CLAY: Red-brown oxidised poorly sorted subrounded as 70% of zone + 10% pisolite as above + 10% oxidised angular fragments <2mm diameter + 10% red-brown clay.

CALCRETE: Cream-pale brown highly weathered brittle calcrete 90% of zone + 10% brown aggregated clay.

CLAY: Red-brown moderately consolidated clay as 70% of zone + 20% highly oxidised brittle shale subrounded fragments < 1cm diameter + 10% soft calcrete.

CLAY: Red-brown densely aggregated/puggy clay + 5% lateritic particles.

SHALE: Black-dark grey goethitic mineralised Fe shale predominant with minor vugh/oxidised surfaces + 20% brown moderately consolidated clay + 5% lateritic debris Moderater water flows in zone fresh water.

CLAY: Brown-red clay as 60% of zone + 30% Fe shale as above + 10% lateritic debris.

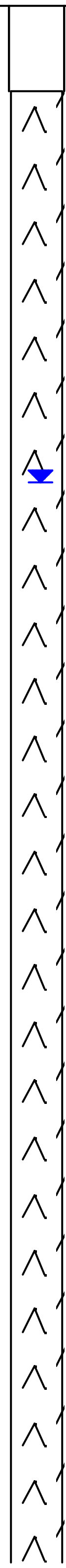
CLAY: Grey very densely aggregated clay/pug predominant + 10% brown consolidated clay.

SHALE: Brown highly oxidised hard shale fragments

Field Notes

Detailed "Field Notes" listed below 82mbgl (EOH) in Lithology column.

Well Completion



150 mm PVC collar (0-4mbgl)

Open hole (4-82mbgl)

-80
-90
-100
-110
-120
-130

angular conchoidal fractured < 0.5cm diameter fragments.

CLAYSTONE: Grey brittle claystone 85% of zone + 15 lateritic debris/particles < 2mm diameter.

CHERT: Brown highly oxidised slightly broken chert as 80% of zone + 20% soft brittle clay/claystone.

EOH at 82mbgl.

CLAY: Grey very densely aggregated/puggy clay.

CHERT: Dark grey-black haematitic chert initially highly oxidised developing to less weathering to depth. Moderate oxidised slightly broken surfaces associated with moderate to good flows. Collar blown at 50 metres and unable to test yield properly. Salinity levels in water strong increase.

09:40 hrs, started airlift

09:50 hrs, 8 cm v-notch weir, 4.5 ppt TDS, 8.37 pH, 8.97 mS

10:25, 7.5 cm v-notch weir, 2.51 ppt TDS, 8.64 pH, 4.98 mS

Collar blown, unable to test yield properly, likely to be 2 l/s+

40-50m: unstable clay swelling -bogging rods.

23-28m: wet/slurry flow only zone with fresh waters

33-40m: wet minor to moderate flows with continuing fresh water 480 ppt TDS

44-46m: calcrete no immediate flow though likely aquifer

51-60m: wet moderate aquifer associated mineralised Fe zone vughy appearances on goethitic shale chips

75-82m: wet moderate to strong flows expected Collar had blown at 50 metres and unable to properly test yield

75-82m: backpressure/flow causing approximately 2 litres/second for 1 hour following drilling completion - unable to conduct recovery or slug test as clays swelling bogging rods

30-60m: water sample taken for upper aquifer fresh water using RC method

75-82m: water sample taken for lower aquifer saline water(swelling clays blocking of upper aquifer during sampling) from inner tube during back pressure with rods at 82 m depth

60-61m: water sampled 0.81 ppt TDS, 8.65 pH, 1.51 mS using RC method

72-78m: water quality - 4.5 ppt TDS, 8.37 pH, 8.97 mS Water sampled for analysis using RC method-lower units higher salinities

81-82m: 3 litres/second bucket test from cyclone

60-80m: severe back pressure during recovery test - flows coming up inner tube for 1.5 hours

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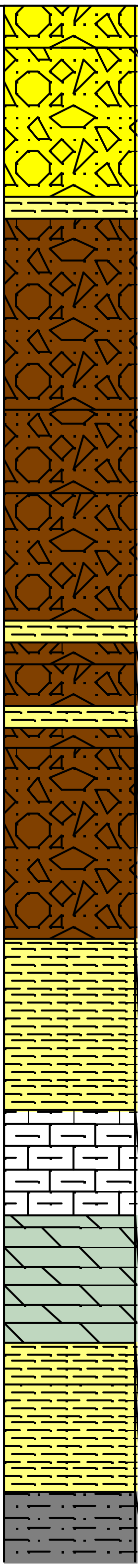
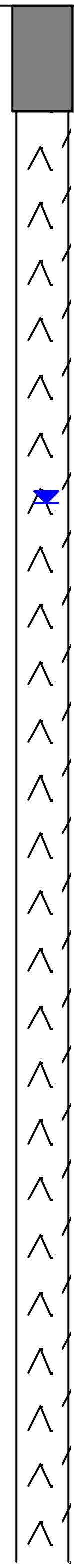
COMPOSITE WELL LOG

Well No: E04

Client: Fortescue Metals Group		**Project:** Christmas Creek groundwater exploration	
Commenced: 15/09/2004	**Method:** RC (0-100)		**Area:** Christmas Creek
Completed: 16/09/2004	**Fluid:** 2000 cfm 700 psi (Hydco C4)		**East:** 782884m(AMG)
Drilled: Connector	**Bit Record:** 5 3/8"		**North:** 7519429m(AMG)
Logged By: RFToll			**Elevation:**
Static Water Level: 23.44 mbgl		**Date:** 17/09/2004; 07:00hrs	

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0 to -70			COLLUVIUM: Brown colluvium fragments < 3cm with 10% unconsolidated clay. COLLUVIUM: Brown colluvium highly oxidised angular fragments < 3cm + 20% unconsolidated clay. CLAY: Red-brown finely aggregated clay. ALLUVIAL: Brown subangular to subrounded poorly sorted chert fragments < 2cm diamter + 20% unconsolidated clay. ALLUVIAL: Brown moderately sorted subangular-subrounded chert fragments < 2cm diameter 80% +10% unconsolidated clay + 10% pisolite <2mm. ALLUVIAL: Brown subangular-subrounded oxidised chert fragments poorly sorted < 3cm diameter + 30% moderately consolidated clay + 10% lateritic debris/pisolites < 2mm diameter. CLAY: Red-brown moderately consolidated clay 40% in zone + brown oxidised poorly sorted subrounded/subangular fragments as 30% in zone + 10% pisolites < 2mm. ALLUVIAL: Red-brown large alluvial fragments chert subangular < 3.5 cm diameter + 10% pisolite <2mm diameter. ALLUVIAL: Red-brown moderately consolidated clay 40% in zone + brown oxidised poorly sorted subrounded/subangular fragments as 30% in zone + 10% pisolites < 2mm. CLAY: Red-brown moderately consolidated clay + 5% lateritic particles. ALLUVIAL: Red-bown moderately consolidated clay 30% in zone + 40% pisolite magnetitc < 3mm diameter + 5% calcrete soft/brittle clayey minor vugginess on surface. Minor water flow as a slurry with TDS at 1500 ppm. ALLUVIAL: Brown highly oxidised alluvial chert fragments subrounded 3 to 5 cm diameter as 70% in zone + 30% pisolite magnetic + 10% moderately aggregated red brown clay. CLAY: Dark brown moderately consolidated clay + 5% lateritic particles. CALCRETE: Grey-cream well bonded wet clayey material saprock with 20% soft/brittle slightly ferruginous calcrete in zone with slightly pitted surfaces/vugh development + 5% oxidised lateritic particles DOLOMITE: Dark grey-brown mottled/replacment textures moderately oxidised dolomite with Mn and sandstone textures with fracturing conchoidal with calcified precipitate on surfaces < 2cm diameter + 5% larger fragments. Moderate flows and water sample taken flow measured 1.8 litres/second. CLAY: Grey-brown well aggregated wet clay + 5% lateritic particles.	Detailed "Field Notes" listed below 100mbgl (EOH) in Lithology column.		150 mm PVC collar (0-5mbgl) Open-hole (5-100mbgl)

Depth scale: 0, -10, -20, -30, -40, -50, -60, -70

Depth	Description	Notes
	CLAY: Brown well aggregated clay + 10% skeletal soft saprock debris.	
	SHALE: Brown highly oxidised Fe rich goethitic shale with minor vughy appearance + up to 10% clay.	
-80	CLAY: Red-brown to grey dense-aggregated clay/pug.	
	SAPROCK & CLAY: Pale brown moderately consolidated clay 70% through zone + 30% saprock.	
	SAPROCK: Grey-brown saprock as 70% through zone + Brown damp moderately aggregated clay 30%.	
-90	CHERT: Red-brown-grey chert moderately oxidised becoming fresher with moderate fracturing as conchoidal with minor fracturing along bedding planes and associated oxidised surfaces. Saline water increase with moderte flows.	
	SHALE: Black carbonaceous unoxidised shale.	EOH at 100mbgl.
-100	airlift 2 litres/second, 4.9 ppt TDS, 8.18 pH, 10.47 mS	
	12:25 flow test, 7.8 ppt TDS, 8.83, 15.34 mS, 2 litres/second	
	12:45 flow test, 20 litres/18 seconds, >10 ppt TDS, 8.27 pH- backpressure causing flow problems	
-110	13:30 hrs >10 ppt TDS	
	13:32 hrs, 20 litres/12 seconds	
	13:40 hrs, 20 litres/13 seconds	
	13:45 hrs 20 litres/13 seconds	
-120	Significant backpressure/flow during airlifting	
	0-44m: alluvial minor wet slurry @ 35metres 1500 ppt TDS	
	44-45m: 1.5 ppt TDS	
	44-52m: damp zone	
-130	50-51m: water sampled for analysis by RC method	
	52-53m: 4.9 ppt TDS, 8.18 pH, 10.47mS initial reading	
	52-53m: 7.8Oppt TDS, 8.83 pH, 15.34mS 2nd reading for lab analysis	
-140	57-63m: wet zone moderate yielding aquifer with flow measure 1 litre/second unstable air cycle imprecise measurement-greater flow likely in dolomite/calcrete	
	89-97m: saline aquifer with moderate flows during drilling - airlift testing only slight increased flow rate 1.7 litres/second- sections creating backpressure and unable to generate outside flow cycle - tested flow with reverse circulation technique	
	93-94m: water sampled for analysis by RC method	
	93-94m: lower aquifer measured at estimated 140 ppt TDS sample taken for lab analysis	

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COMPOSITE WELL LOG

Well No: E07

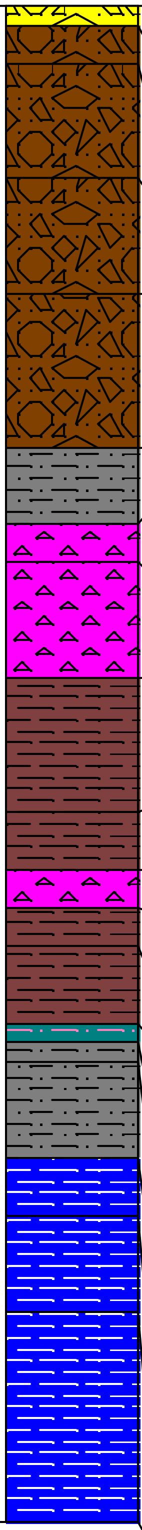
Client: Fortescue Metals Group
Project: Christmas Creek groundwater exploration

Commenced:	27/09/2004	**Method:**	RC (0-79)	**Area:**	Christmas Creek
Completed:	28/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	782411m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7523704m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 30.4 mbgl
Date: 29/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes

Depth scale: 0, -10, -20, -30, -40, -50, -60, -70



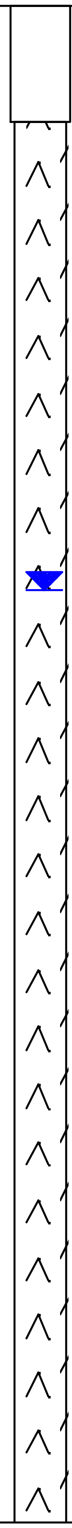
Lithological Description

- COLLUVIUM: Colluvium
- ALLUVIAL: Brown moderately consolidated clay + colluvium debris
- ALLUVIAL: Brown -red alluvial subangular/subrounded with 20% clayey component @ 5-6 metres depth
- ALLUVIAL: Red-brown alluvial compised 80% pisolites(magnetic) + subangular/subrounded fragments <0.5mm diameter
- ALLUVIAL: Red-brown alluvial < 5 mm diameter subrounded/subangular fragments lateritised
- SHALE: Pale brown oxidised as limonitic pervasive staining of shales
- CHERT: Black-pale brown chert slighlty oxidised with haematitic/limonitic
- CHERT: Red-brown haematitic oxidised chert
- SHALE AND CHERT: Brown moderately oxidised chert/shale + 10% quartz presence
- SHALE AND CHERT: Brown-black large fragments broken chert/shale with fractured planes
- CHERT: Red-brown haematitic oxidised chert
- SHALE AND CHERT: Brown-black large fragments broken chert/shale with fractured planes
- SHALE AND CHERT: Pale brown chert/shale highly oxidised surfaces + 10%
- SAPROCK: Pale brown clayey saprock(shale?) + 10% hard black chert particles
- SHALE: Brown highly oxidised shale with clayey surfaces
- SHALE: Black-brown transitional zone, interface between chert/shale, damp to wet with minor haematite staining
- CARBONACEOUS SHALE: Black-brown transitional zone zone interface between chert/shale and carbonaceous shale, damp to wet with minor haematite staining
- CARBONACEOUS SHALE: Black carbonaceous shale unoxidised with occasional broken sections associated with moderate increased water yield (clayey @ 65-66 metres)
- CARBONACEOUS SHALE: Black carbonaceous pyritic shale with moderate broken-fractured planes < 2cm diameter section 74-77 metres

Field Notes

- 0-79m: 09:15 hrs- 20 litres/8 seconds, 1.16 ppt TDS, 8.65 pH, 2.29 mS
- 0-79m: 09:25 hrs 20 litres/9 seconds, 1.19 ppt TDS, 8.63 pH, 2.28 mS
- 0-79m: 09:35 hrs - 20 litres/10 seconds, 1.19 ppt TDS, 8.78 pH, 2.32 mS, 29.1 oC
- 0-79m: 09:45 hrs - 20 litres/10 seconds, 1.16 ppt TDS, 8.71 pH, 2.30 mS
- 0-45m:Water test 1 ppt TDS, 8.43 pH, 1.99 mS
- 50-57m: Minor broken section with minor yield (< 1 litre/second)
- 45-58m: Water test 0.96 ppt TDS, 8.62 pH, 1.93 mS
- 45-58m: airlifted with yield @ 20litres/19 seconds = 1 litre/second
- 60-61m: Minor broken section water yields
- 60-79m: Water test 1.19 ppt TDS, 8.72 pH, 2.37 mS
- 67-77m: Broken slightly with occasional fracture planes evident. Unoxidised carbonaceous shale ie slightly competent rock
- 70-79m: 09:05 hrs- 20 litres/9 seconds, 1.12 ppt TDS, 8.78 pH, 2.25 mS
- EOH at 79mbgl

Well Completion



- 150 mm PVC collar (0-6mbgl)
- Open hole (6-79mbgl)

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COMPOSITE WELL LOG

Well No: E08

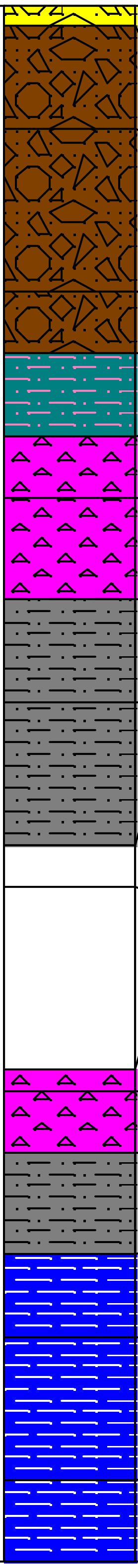
Client: Fortescue Metals Group
Project: Christmas Creek groundwater RC exploration

Commenced:	28/09/2004	**Method:**	RC (0-76)	**Area:**	Christmas Creek
Completed:	29/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	782980
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7522637
Logged By:	RFToll			**Elevation:**	

Static Water Level: 34mbgl
Date: 29/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes

Depth scale (mbgl): 0, -10, -20, -30, -40, -50, -60, -70



Lithological Description

COLLUVIUM: Brown colluvium

ALLUVIAL: Red-brown alluvial moderately sorted fragments subangular with minor subrounded <1 cm diameter

ALLUVIAL: Red-brown poorly sorted subangular/subrounded fragments between 1-3cm diameter

ALLUVIAL: Brown clayey alluvial fragments 70% + black chert debris 30%

SAPROCK: Brown-red clayey saprock 70% + 30% soft grey saprock < 0.5 cm diameter

CHERT: Brown highly oxidised chert/saprock with limonitic casting soft fragments

CHERT: Brown-black highly oxidised chert + weathered limonitic staining

SHALE: Brown highly oxidised shale with strong limonitic staining

SHALE: Brown highly weathered moderately oxidised shale with limonite staining. Wet zone with minor fracturing fragments < 2.5 cm. Degree of Fe enrichment weathered

SHALE & CHERT: Brown-red shale/chert with moderate haematitic stained surfaces fragments < 2cm diameter. Minor Fe enrichment weathered

SHALE & CHERT: Brown shale/chert fragments < 1cm diameter with limonite stained surfaces. Minor broken section @ 46-47metres

CHERT: Black slightly oxidised chert 90% + 10% haematitic surface stained shale debris

CHERT: Red-brown moderately oxidised chert + 10% brittle/hard shale

SHALE: Brown moderately oxidised + minor haematitic stained surfaces

CARBONACEOUS SHALE: Black slightly oxidised carbonaceous shale + minor magnetic effect + very slight silicification

CARBONACEOUS SHALE: Black carbonaceous shale unoxidised fragments between 1-5 cm diameter associated with minor broken zone + silicified pale green appearance + likely contamination ferruginous saprock- No significant increase in yield

CARBONACEOUS SHALE: Black carbonaceous shale unoxidised fragments < 1 cm diameter No fracturing (contamination with ferruginous saprock)

Field Notes

0-64m: Chemistry field test 0.71 ppt TDS, 8.52 pH, 1.41 mS

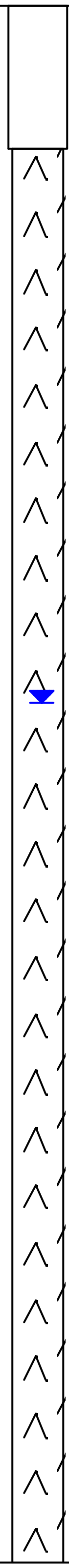
0-76m: Final aiflift test 20 litres/45 seconds = 0.44L/s

Hole collared off at 11 m, still recovering after 24 hr

34-47m: 20 litres/70 seconds flow test
34-47m: Minor aquifer associated with chert shale -with hardcap Fe enriched zone

minor flow - minor Fe concentration 35 - 42 m

62-72m: 20 litres/45 seconds flow test - only minor increase in yield
62-72m: Carbonaceous shale with broken sections- minor yield increase
chemistry field test 0.4 ppt TDS, 8.53 pH, 0.92 mS
chemistry field test 0.66 ppt TDS, 8.48 pH, 1.31 mS
chemistry field test 0.67 ppt TDS, 8.55 pH, 1.32 mS
EOH at 76mbgl



Well Completion Notes

150 mm PVC collar (0-7mbgl)

Likely SWL as hole blocked at 11mbgl

Open hole (7-76mbgl)

aquaterra	COMPOSITE WELL LOG	Well No: E14

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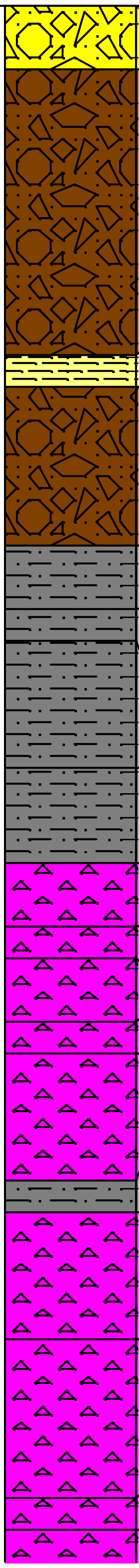
Client: Fortescue Metals Group **Project:** Christmas Creek groundwater RC exploration

Commenced:	26/09/2004	**Method:**	RC (0-76)	**Area:**	Christmas Creek
Completed:	27/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	786449m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8	**North:**	7520987m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 29.15 mbgl **Date:** 28/09/2004; 17:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes

Depth scale: 0, -10, -20, -30, -40



Lithological Description

- COLLUVIUM: Red-brown colluvium-alluvial fragments
- ALLUVIAL: Red-brown alluvial fragments < 2cm diameter poorly sorted, subangular/subrounded
- CLAY: Brown-red unconsolidated clay
- ALLUVIAL: Red-brown chert with strongly oxidised surfaces - fragments < 2cm diameter
- SHALE: Pale brown-grey brittle shale/saprock with minor limonite staining
- SHALE: Dark purple-brown hard shale highly oxidised with strongly weathered haematite staining
- SHALE: Red-brown-pale brown highly oxidised shale with minor limonite staining
- SHALE: Brown-pale brown highly oxidised shale with well developed limonitic staining
- CHERT: Brown-purple highly oxidised chert with minor haematite staining
- CHERT: Black chert + 50% unconsolidated clay
- CHERT: Black chert
- CHERT: Black chert + 50% unconsolidated clay
- CHERT: Brown-black oxidised chert with strong haematite/limonite weathering effects
- SHALE: Black highly oxidised shale wet zone + 30% pink-grey moderately aggregated clay- minor flow
- CHERT: Red-brown highly oxidised chert as haematite weathering with minor shale component- Moderate development of fracturing and wet zone-fragments between 2-4 cm diameter- water field analysis 0.46 ppt TDS
- CHERT: Red-brown highly oxidised chert as haematite weathering with minor shale component -fragments < 1cm diameter- flow < 1litre/second. Minor water intersection @ 46 metres
- CHERT: Brown-black oxidised chert
- CHERT: Pale brown-black shale/chert with minor

Field Notes

after 40 minutres airlifting flows to cyclone discontinued - likely that blockage occurred in hole and unable to airlift further- though slight possibility exists of depletion of groundwater though the measured yields did not show declines but were steady

9m: loss of outside circulation - possibly causing wet samples through pressure and water flow reactions causing difficulties in interpreting true aquifer zones- likely aquifers 42-47 metres, 63-72 metres

59m: 20 litres/12 seconds, 08:25 hrs, 0.71 ppt TDS, 8.66 pH, 1.42 mS

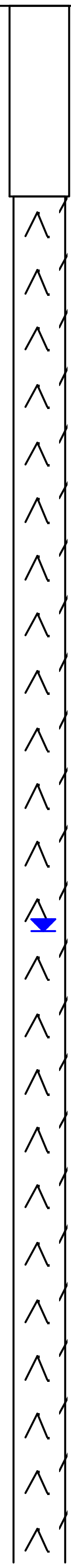
62m: 20 litres/11 seconds, 08:35 hrs, 0.71 ppt TDS, 8.78 pH, 1.43 ppt TDS, 29.6 oC

65m: 20 litres/9 seconds, 08:45 hrs, 0.7 ppt TDS, 8.78 pH, 1.41 pH, 30.5 oC

68m: 20 litres/ 10 seconds, 08:55 hrs, 0.7 ppt TDS, 8.76 pH, 1.42 mS, 31.4 oC

46-47m: Minor groundwater intersection slurry less than 0.5 litres/second

46-50m: 0.46 ppt TDS < 1 litre/second



Well Completion Notes

150 mm PVC collar (0-6mbgl)

Open-hole (0-76mbgl)

Depth	Lithology description	Comments
-50	limonite/clay on surfaces	
	SHALE: Black carbonaceous shale fragments between 1-5 cm- minor oxidation on surfaces	
	SHALE: Black carbonaceous shale weathered soft/brittle fragments with brown clayey surfaces. Moderate water intersection 57-59 metres	57-59m: Moderate groundwater intersection - clayey zone though approaching 1 litre/second flow
-60	SHALE: Black-brown clayey carbonaceous shale (clay as 50%)	
	CLAY: Black carbonaceous clay damp transitional zone	
	SHALE: Black carbonaceous clay with minor broken section associated with moderate increase in flow - fragments between 1-3 cm diameter) Airlifte approximately 2 litres/second	63-72m: Contact interface between upper chert and lower carbonaceous shale moderate broken section with moderate and slight increase salinity to 0.7 ppt TDS, 8.56 pH, 1.41 mS
-70	SHALE: Black carbonaceous shale 1% pyritic with minor broken sections and associated moderate water yield- no significant oxidation- contamination evident in sample	20 litres/? seconds as flows in cyclone stopped - likely blockage in hose and not zone depletion of water
	SHALE: Black carbonaceous shale unoxidised with 20% siliceous alteration veining	
		EOH at 76mbgl

COMPOSITE WELL LOG

Well No: E15

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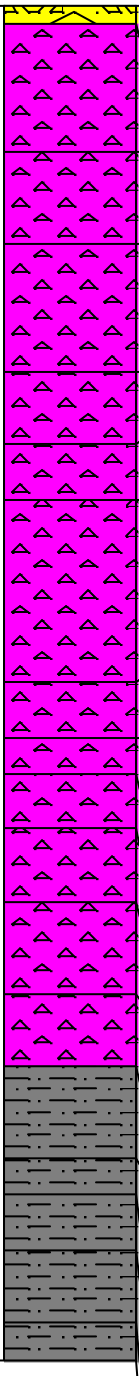
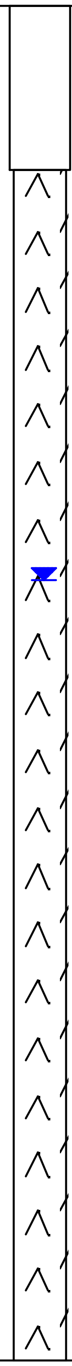
Client: Fortescue Metals Group **Project:** Christmas Creek groundwater RC exploration

Commenced: 22/09/2004	**Method:** RC (0-74)		**Area:** Christmas Creek
Completed: 23/09/2004	**Fluid:** 2000 cfm 700 psi (Hydco C4)		**East:** 787208m(AMG)
Drilled: Connector	**Bit Record:** 5 3/8"		**North:** 7520453m(AMG)
Logged By: RFToll			**Elevation:**

Static Water Level: 31.4 mbgl **Date:** 22/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Brown highly oxidised chert + 30% colluvium			150 mm PVC collar (0-9mbgl)
			CHERT: Brown oxidised chert fragments angular conchoidal fracturing < 2.5 cm diameter			
-10			CHERT: Brown highly oxidised chert 60% + 40% clay poorly consolidated			
			CHERT: Brown oxidised chert fragments < 1 cm diameter	63-65m: Carbonaceous shale interface/contact with wet sample		
-20			CHERT: Brown oxidised with moderate surficial haematite weathering effect	68-70m: Carbonaceous shale moderate broken section with moderate yield		
			CHERT: Pale brown oxidised chert with moderate limonite weathering effects	68-69m: Airlifted outside return method 1.8 litres/second - flow steady		
-30			CHERT: Brown-red oxidised chert with combined haematie/limonite weathering effects	68-69m: 0.58 ppt TDS, 8.79 pH, 1.16 mS, 28 oC		
				35-37m: Minor yield wet sample		
			CHERT: Red-brown oxidised chert with moderate haematite weathering effects			
-40			CHERT: Dark brown-red shale with breaks along bedding - fissile nature - fragments< 3cm diameter long axis	44-47m: Moderate broken section assocated minor water yield		Open hole (9-74mbgl)
				52-54m: Wet sample		
			CHERT: Red-brown chert-moderate fracturing water yield moderate 44-47m	57-58m: Wet sample		
-50			CHERT: Red-brown oxidised chert + 15% soft grey/pale brown saprock/shale + minor clay	68 m; 08:50 20litres/13 seconds, 0.59 ppt TDS, 8.76 pH, 1.16 mS		
			CHERT: Black chert/shale? with moderate broken section 52-54m. Minor yield <1 litre/second	09:05 20 litres/11 seconds, 28 oC, 0.58 ppt TDS, 8.73 pH, 1.17 mS		
			CHERT: Black shale slightly oxidised + 15% soft saprock/shale-minor broken section -uncertain if increased flow as outside return blockage may be wetting samples	09:15, 20 litres/12 seconds, 27.7 oC, 0.59 ppt TDS, 8.75 pH, 1.17 mS		
-60			SHALE: Black carbonaceous shale 70% + brown clayey component 30%	09:25, 20 litres/10 seconds, 27 oC, 0.58 ppt TDS, 8.76 pH, 1.16 mS		
			SHALE: Black carbonaceous shale + 20% ferruginous clayey component-moderate fractured/broken zone with ferruginous development in sample - likely increase flow- outside return lost during this zone	09:35, 20 litres/15 seconds, 27.5 oC, 0.58 ppt TDS, 8.79 pH, 1.16 mS		
-70			SHALE: Black carbonaceous shale -unoxidised with pyritic bands	09:45 20 litres/14 seconds, 31 oC, 0.59 ppt TDS, 8.82 pH, 1.19 mS		
			SHALE: Black carbonaceous unoxidised shale with moderate broken section-fracturing 68-70 metres - predominantly along bedding with minor fracturing across bedding plane- associated with increase in flow	EOH at 74mbgl		
			SHALE: Black carbonaceous shale with minor broken section -no significant increase in flow			





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COMPOSITE WELL LOG

Well No: E16

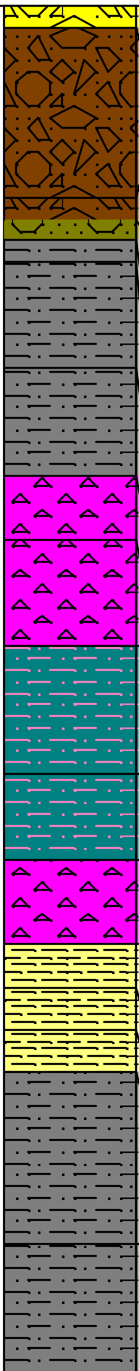
Client: Fortescue Metals Group **Project:** Christmas Creek groundwater RC exploration

Commenced: 22/09/2004	**Method:** RC (0-64)		**Area:** Christmas Creek
Completed: 22/09/2004	**Fluid:** 2000 cfm 700 psi (Hydco C4)		**East:** 787700m(AMG)
Drilled: Connector	**Bit Record:** 5 3/8"		**North:** 7520250m(AMG)
Logged By: RFToll			**Elevation:**

Static Water Level: 30.4 mbgl **Date:** 22/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes

Depth scale: 0, -10, -20, -30, -40, -50, -60



Lithological Description

- COLLUVIUM: Colluvium comprised chert fragments angular < 3cm diameter + 30% river gravels
- ALLUVIUM: Red-brown alluvial poorly sorted subrounded/subangular fragments < 2 cm diameter + 20% poorly consolidated clay
- ALLUVIAL: Red-brown moderately sorted subangular/subrounded fragments < 1.5 cm diameter + 30% unconsolidated clay
- PISOLITE: Red-brown pisolite/alluvial fragments-pisolites < 2cm diameter as 70% of zone with alluvial fragments as above
- SHALE: Black shale highly mineralised with Fe metallic lustre
- SHALE: Red-brown highly oxidised shale with ferruginous content
- SHALE: Black-brown moderately oxidised ferruginised shale mineralised Fe enrichment unweathered
- CHERT: Brown highly ferruginous chert 70% of zone + 30% pale brown moderately aggregated clay
- CHERT: Pale brown limonitic chert
- SAPROCK: Brown-red brown highly oxidised saprock(shale) fragments < 2cm diameter
- SAPROCK: Red-pale brown-brown saprock/shale with varying limonite/haematite development brittle fragments < 1cm diameter
- CHERT: Brown highly ferruginous chert 70% of zone broken section(fragments associated fracture planes < 3cm diameter) with low yielding aquifer
- CLAY: Brown-grey moderately aggregated clay 70% in zone + 30% black/brown highly oxidised weathered shale/saprock
- CLAY: Grey poorly consolidated/loosely bonded clay
- CLAY: Grey wet aggregated clay/claystone
- SHALE: Black-brown moderately oxidised ferruginised shale in transitional weathered zone - oxidation lessens with depth Minor yielding fresh water aquifer
- SHALE: Black carbonaceous unoxidised shale with 3% pyrite mineralisation zones

Field Notes

18-23m: Fe rich shales mineralisation

40-44m: Shale moderate yielding aquifer with fracture planes

50-59m: Transitional oxidised broken shale moderate yielding aquifer

54m: 11:15, 20 litres/26 seconds, 0.51 ppt TDS, 8.50 pH, 1.02 mS

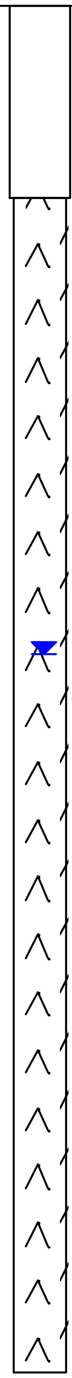
56m: 11:27, 20 litres/33 seconds, 0.52 ppt TDS, 8.73 pH, 1.04 mS, 31.2 oC

58m: 11:37, 20litres/33 seconds, 0.53 ppt TDS, 8.67 pH, 1.04 mS, 31.7oC

60m: 11:47, 20litres/33 seconds, 0.53 ppt TDS, 8.72 pH, 1.05 mS, 30.2 oC

62m: 12:00, 20 litres/30 seconds, 0.54 ppt TDS, 8.74 pH, 1.07 mS, 29.9 oC

EOH at 64mbgl



Well Completion Notes

150 mm PVC collar (0-9mbgl)

Open hole (9-64mbgl)

COMPOSITE WELL LOG

Well No: E17

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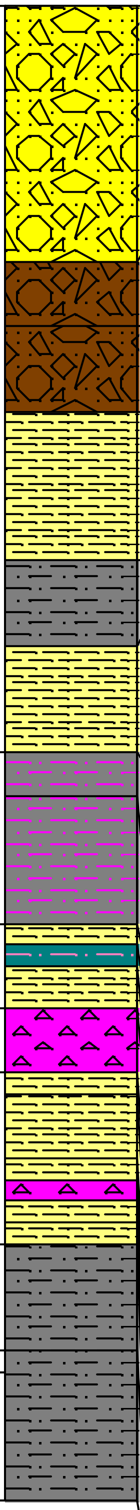
Client: Fortescue Metals Group **Project:** Christmas Creek groundwater RC exploration

Commenced: 20/09/2004	**Method:**	RC (0-70)	**Area:** Christmas Creek	
Completed: 21/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:** 787410m(AMG)	
Drilled: Connector	**Bit Record:**	5 3/8"	**North:** 7519861m(AMG)	
Logged By: RFToll			**Elevation:**	

Static Water Level: 29.03 mbgl **Date:** 22/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes

Depth (mbgl): 0, -10, -20, -30, -40, -50, -60, -70

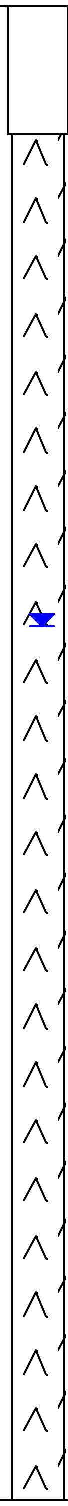


Lithological Description

- COLLUVIUM: Brown alluvial/colluvium fragments < 3cm diameter subrounded/subangular poorly sorted + 20% unconsolidated clay
- ALLUVIAL: Orange-brown alluvial fragments < 2cm diameter poorly sorted, subangular/subrounded as 40% of zone + 60% poorly consolidated clay
- ALLUVIAL: Brown alluvial moderately sorted subrounded fragments < 2cm diameter +60% poorly consolidated clay
- CLAY: Brown finely aggregated clay/alluvial debris 60% + 40% lateritic-magnetic pisolites
- SHALE: Black Fe rich shale with moderate oxidation - no major fracturing evident
- CLAY: Brown-red clayey surficial weathering clayey shale hard Fe rich 80% of zone- fragments of rock in section comprises 80% pisolites and 20% alluvial fragments/magnetite < 1cm diameter + 60% moderately aggregated clay- becomes wet from 35-43 metres
- SAPROCK/SHALE: Brown highly oxidised highly ferruginous saprock- hard fragments (Fe rich shale?) with vughy pitted surfaces common on samples associated with moderate yielding aquifer- fragments between 1-3 cm + 3% magnetite and 5% clayey material
- SAPROCK/SHALE: Brown-red clayey surficial weathering clayey moderately hard shale
- CLAY: Grey-red moderate to well aggregated/clayballs
- SAPROCK: Brown highly oxidised saprock hard fragments (slightly siliceous) fragments<2.5cm
- CLAY: Brown-grey moderate to well aggregated clay
- CHERT: Brown highly oxidised slightly broken fragments with angular conchoidal fractures - fragments b/w 1-3 cm diameter as 70% of zone + 30% clayey component moderately consolidated
- CLAY: Brown-dark purple 60% of zone moderately consoidated clay + 40% saprock(shale)
- CLAY: Brown-purple haematitic clay moderate - well aggregated
- CLAY: Brown finely aggregated clay + 10% ferruginous fragments
- CHERT: Brown highly oxidised slightly broken fragments with angular conchoidal fractures - fragments b/w 1-3 cm diameter as 70% of zone + 30% clayey component moderately consolidated
- CLAY: Red haematitic clay well aggregated

Field Notes

- 35-43m: Minor aquifer
- 47-50m: Minor aquifer 0.6 litres/second flow test outside return method
- 58-63m: Moderate yielding aquifer fracture planes in transitional carbonaceous shale
- 64-70m: 0.96 ppt TDS, 8.56 pH, 1.92 mS
- 64-70m: Flow test outside return method 2.5 litres/second
- 64-70m: Water sample taken for analysis outside return method
- 70 m; 12:15, 20 litres/7 seconds, 0.87 ppt TDS, 8.64 pH, 1.78 mS
- 12:25, 20 litres, 8 seconds, 0.91 ppt TDS,
- 12:36, 20 litres/9 seconds, 0.92 ppt TDS, 8.63 pH, 1.84 mS
- 12:47, 20 litres/8 seconds, 0.96 ppt TDS, 8.56 pH, 1.92 mS yield 2.5 litres/second
- EOH at 70mbgl



Well Completion Notes

- 150 mm PVC collar (0-6mbgl)
- Open hole (6-70mbgl)

CLAY: Brown well aggregated clay
SHALE: Black carbonaceous shale with moderate oxidation -moderate fracturing evident with associated transitionally weathered zone -Moderate increase in yield
SHALE: Black carbonaceous shale unoxidised with 3% pyrite nodules throughout zone

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COMPOSITE WELL LOG

Well No: E19

Client: Fortescue Metals Group **Project:** Christmas Creek groundwater RC exploration

Commenced:	23/09/2004	**Method:**	RC (0-58)	**Area:**	Christmas Creek
Completed:	24/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7518543m(AMG)
Logged By:	RFToll			**Elevation:**	787452m(AMG

Static Water Level: 21.70 mbgl **Date:** 24/09/2004; 17:00hrs

Depth (mbgl)	Lithological Description	Field Notes	Well Completion Notes
0	COLLUVIUM: Brown colluvium with minor alluvial debris with fragments 0.5-5 cm diameter poorly sorted subangular	Upper alluvial sections falling in; unable to stabliise hole, hole discontinued. No hydraulic data gather as hole backreamed to remove gear.	150 mm PVC collar (0-9mbgl)
	ALLUVIAL: Brown alluvial moderately sorted fragments < 1cm diameter + minor clayey coated surfaces		
-10	CLAY: Brown poorly consolidated clay + 10% lateritic debris< 2mm diameter		
	ALLUVIAL: Brown alluvial moderately sorted fragments < 1cm diameter subangular/subrounded		
	ALLUVIAL: Brown moderately sorted alluvial (chert) poorly sorted fragment 0.5-5cm diameter subrounded/subangular		
-20	ALLUVIAL: Brown alluvial moderately sorted fragments < 1cm diameter subangular/subrounded		
	ALLUVIAL: Brown alluvial moderately sorted fragments < 1cm diameter subangular/subrounded + 20% clay on fragment surfaces		
-30	ALLUVIAL: Brown alluvial mix of 80% chert subangular/subrounded 0.5-5 cm diameter + 20% pitted calcrete fragments	28-42m: Minor yields from alluvial wet zones Flow tested 20litres/25 seconds = 0.8 litres/second, 0.40 ppt TDS, 8.42 pH, 0.80 mS -Water sampled for analysis	Open-hole (9-58mbgl)
	ALLUVIAL: Brown alluvial moderately sorted fragments < 1cm diameter subangular/subrounded + 20% clay on fragment surfaces		
-40	ALLUVIAL: Red-brown-black 80% pisolites 2-5 mm diameter, with clay coated surfaces + 20% chert/alluvial fragments < 1cm diameter	40-50m: Likely zone of instability - fallback on hammer when backreaming from 58 metres -	
	ALLUVIAL: Brown highly oxidised moderately sorted 80% pisolite 2-10 mm diameter + oxidised subrounded fragments saprock/shale? < 2cm diameter		
	SHALE/SAPROCK: Brown oxidised shale/saprock 40% + 40% mottled calcrete with pitted surfaces + 20% moderately consolidated clay		
-50	SHALE/SAPROCK: Brown oxidised shale/saprock brittle with moderate clay development on surfaces	49-58m: Minor aquifer - not tested as zone became bogged and drilling required backreaming - several attempts to get through zone failed- hole abandoned	
	CLAY: Brown clay 60% + 40% clayey saprock		
	SHALE: Brown highly oxidised shale with limonitic/goethitic ferruginous weathering		
	SHALE: Brown highly oxidised goethitic shale Fe rich		
	SHALE: Brown-black highly oxidised shale 70% + 25% grey moderately consolidated clay + 5% minor limonitic/ferruginous particles	EOH at 58mbgl	

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COMPOSITE WELL LOG

Well No: E19B

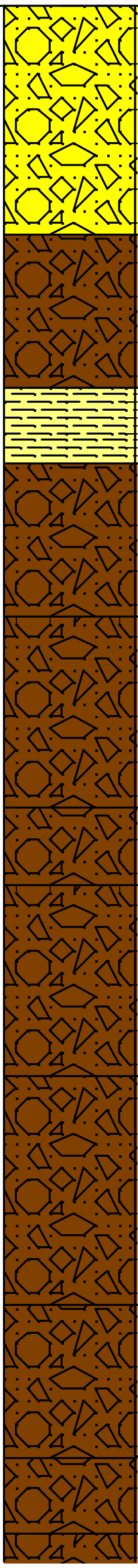
Client: Fortescue Metals Group
Project: Christmas Creek groundwater RC exploration

Commenced: 29/09/2004	**Method:** RC (0-82)		**Area:** Christmas Creek
Completed: 30/09/2004	**Fluid:** 2000 cfm 700 psi (Hydco C4)		**East:** 787422m(AMG)
Drilled: Connector	**Bit Record:** 5 3/8"		**North:** 7518541m(AMG)
Logged By: RFToll			**Elevation:**

Static Water Level: 21.95 mbgl
Date: 24/09/2004; 17:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes

Depth scale: 0, -10, -20, -30, -40



Lithological Description

COLLUVIUM: Brown colluvium with minor alluvial debris with fragments 0.5-5 cm diameter poorly sorted subangular

ALLUVIAL: Brown alluvial moderately sorted fragments < 1cm diameter + minor clayey coated surfaces

CLAY: Brown poorly consolidated clay + 10% lateritic debris< 2mm diameter

ALLUVIAL: Brown alluvial moderately sorted fragments < 1cm diameter subangular/subrounded

ALLUVIAL: Brown moderately sorted alluvial (chert) poorly sorted fragment 0.5-5cm diameter subrounded/subangular

ALLUVIAL: Brown alluvial moderately sorted fragments < 1cm diameter subangular/subrounded

ALLUVIAL: Brown alluvial moderately sorted fragments < 1cm diameter subangular/subrounded + 20% clay on fragment surfaces

ALLUVIAL: Brown alluvial mix of 80% chert subangular/subrounded 0.5-5 cm diameter + 20% pitted calcrete fragments-wet zone with minor yield 0.8 litres/second 0.65 ppt TDS

ALLUVIAL: Brown alluvial moderately sorted fragments < 1cm diameter subangular/subrounded + 20% clay on fragment surfaces

ALLUVIAL: Red-brown-black 80% pisolites 2-5 mm diameter, with clay coated surfaces + 20% chert/alluvial fragments < 1cm diameter

ALLUVIAL: Brown highly oxidised moderately sorted

Field Notes

Alluvial section falling in. Cased to 36 m. Sample contamination, lithology from E19 adopted for 0-46 m.

0-46m: Upper aquifer with 3 litres/second - samples wet from 28 - 33 metres

56-62m: Moderate yielding aquifer wet samples minor increase in flow

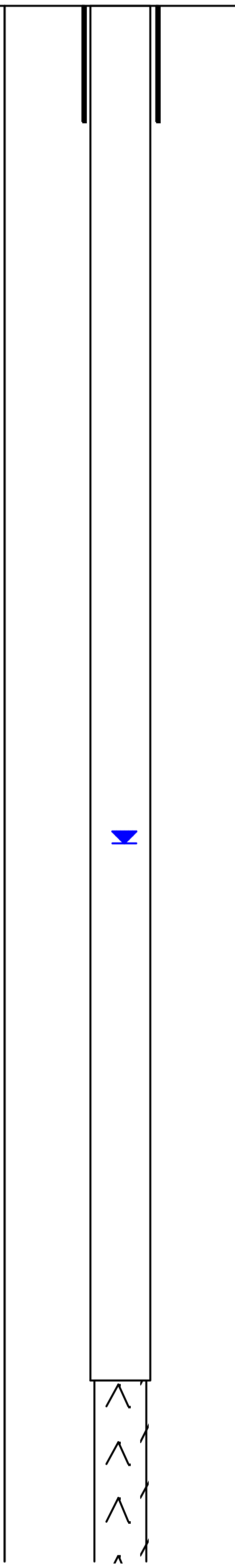
68-82m: Moderate yielding aquifer wet samples moderate increased flow

82 m; 16:00 hrs airlift, 20 litres/10 seconds (some backpressuring/flow disruptions)

16:25 hrs airlift, 20 litres/12 seconds water sample taken for analysis

28-42m: Minor yields from alluvial wet zones Flow tested 20litres/25 seconds = 0.8 litres/second from outside on E19A and water sampled for analysis, 0.40 ppt TDS, 8.42 pH, 0.80 mS - Water sampled for analysis

40-50m: Likely zone of



Well Completion Notes

8" steel collar (0-3mbgl)

150 mm PVC casing (0-36mbgl)

COMPOSITE WELL LOG

Well No: E19B

Client: Fortescue Metals Group

Project: Christmas Creek groundwater RC exploration

Depth	Lithology description	Comments
	80% pisolite 2-10 mm diameter + oxidised subrounded fragments saprock/shale? < 2cm diameter-minor yielding aquifer	instability - fallback on hammer when backreaming from 58 metres -
	SHALE/SAPROCK: Brown oxidised shale/saprock 40% + 40% mottled calcrete with pitted surfaces + 20% moderately consolidated clay	
	SHALE/SAPROCK: Brown oxidised shale/saprock brittle with moderate clay development on surfaces	
	CLAY: Brown clay 60% + 40% clayey saprock	
-50	SHALE: Brown highly oxidised shale with limonitic/goethitic ferruginous weathering	49-58m: Minor aquifer - not tested as zone became bogged and drilling required backreaming - several attempts to get through zone failed- hole abandoned
	SHALE: Brown highly oxidised goethitic shale Fe rich	
	SHALE: Brown-black highly oxidised shale 70% + 25% grey moderately consolidated clay + 5% minor limonitic/ferruginous particles-wet zone	55-56m: Chemistry field test 0.90 ppt TDS, 8.17 pH, 1.79 mS, 35.1 oC
-60	CHERT: Brown-red chert with haematitic/limonite staining-slight increased salinity- wet zone - fragments < 1cm diameter	61-62m: Chemistry field test, 1.95 ppt TDS, 7.87 pH, 3.92 mS, 29.1 oC 64-65m: Chemistry field test, 4.11 ppt TDS, 7.84 pH, 3.92 mS, 32 oC
-70	CHERT: Black red chert with haematite/limonite staining-minor green silicifed 10% and slightly oxidised-samples go wet	65-66m: Chemistry field test 5.07 ppt TDS, 7.78 pH, 10.16 mS, 31.2 oC
	CHERT: Brown clays 80% + Black red chert -20% slightly oxidised as haematite staining- moderate yield increased wetness samples	68-69m: Chemistry field test, 9.098 ppt TDS, 7.67 pH, 19.4 mS 32.9 oC
	CHERT: Black chert moderately broken section fragments to 5cm diameter-likely aquifer though no noticeable increase water flow	75-76m: Chemistry field test, >10 ppt TDS (field dilution estimate @ 24 ppt TDS, 8.82 pH, 52 mS
	CHERT: Black-red chert moderately broken section with fragments between 1-4 cm 50% + 50% red-brown oxidised shale	
-80	SHALE: Grey-black moderately aggregated clay 80% + 20% black carbonaceous shale fragments < 2mm diameter	EOH at 82mbgl
	SHALE: Black clayey carbonaceous shale-no obvious increased flow	

Open-hole (36-82mbgl)

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COMPOSITE WELL LOG

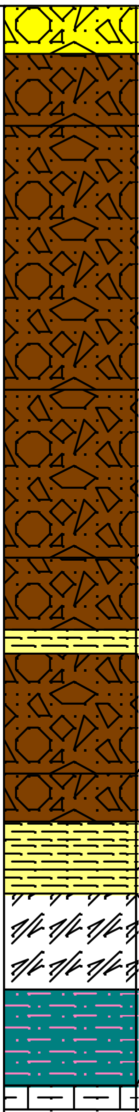
Well No: E20

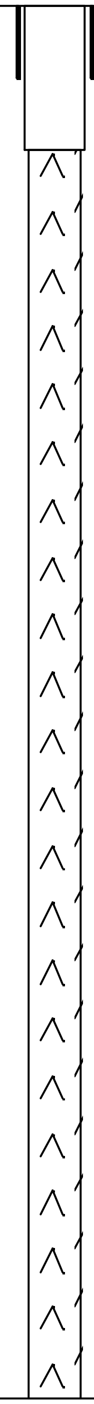
Client: Fortescue Metals Group
Project: Christmas Creek groundwater RC exploration

Commenced:	24/09/2004	**Method:**	RC (0-56)	**Area:**	Christmas Creek
Completed:	26/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7517396m(AMG)
Logged By:	RFToll			**Elevation:**	787392m(AMG

Static Water Level: **Date:**

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Brown colluvium	Upper alluvial sections falling in unable to stabilise formations during drilling- hole discontinued as rod were being restricted		8" steel collar (0-3mbgl)
			ALLUVIAL: Red-brown colluvium 20% + alluvial 60% + 20% unconsolidated clay			150 mm PVC casing (0-6mbgl)
			ALLUVIAL: Red-brown alluvial moderately sorted fragments 90% < 1cm diameter + 10% <2cm diameter	no hydraulic info taken as rod restrictions required backreaming to save gear being stuck in hole		
-10				0-46m: 8 inch conventional drilling to ream out hole for 150 mm pvc collar- 35 metres emplaced initially		
			ALLUVIAL: Red-brown alluvial moderately sorted fragments subangular/subrounded < 1cm diameter + 20% poorly aggregated clay	38 - 40 m; major groundwater intersection -fresh 1.98 ppt TDS, high occurrence of fractured chert, weathered shale fragments to 13 cm diameter resulting from 8" conventional drill ream to 46 metres, quartz vugh samples to 8 cm diameter, brecciated chert in shale matrix minor occurrences		
-20			ALLUVIAL: Red-brown poolry sorted alluvial 70% + 20% poorly aggregated clay + 5% pisolites < 2mm diameter			
			CLAY: Brown poolry aggregated clay			
			ALLUVIAL: Brown poorly sorted alluvial fragments			
-30			ALLUVIAL: Brown-black moderately sorted alluvial fragments < 1cm diameter + 20% pisolites/magnetic	28 - 40 m; minor yields from alluvial wet zones Flow tested 20litres/25 seconds = 0.8 litres/second, 0.40 ppt TDS, 8.42 pH, 0.80 mS -Water sampled for analysis		Open-hole (6-58mbgl)
			CLAY: Brown moderately aggregated clay			
			CLAY: Grey-khaki well aggregated clay			
			QUARTZ VEIN: Quartz vein slight increase in salinity			
-40			SAPROCK: Brown sort/brittle saprock clayey zone	40 - 50 m; likely zone of instability - fallback on hammer when backreaming from 58 metres -		
			CALCRETE: White-grey soft calcrete clayey zone			
			??	minor aquifer -not tested as zone became bogged and drilling required backreaming - several attempts to get through zone failed- hole abandoned		
-50				EOH at 58mbgl		





COMPOSITE WELL LOG

Well No: E22

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Client: Fortescue Metals Group
Project: Christmas Creek groundwater RC exploration

Commenced: 17/09/2004	**Method:** RC (0-99)	**Area:** Christmas Creek
Completed: 18/09/2004	**Fluid:** 2000 cfm 700 psi (Hydco C4)	**East:** 751600m(AMG)
Drilled: Connector	**Bit Record:** 5 3/8"	**North:** 7871590m(AMG)
Logged By: RFToll		**Elevation:**

Static Water Level: 13.95 mbgl
Date: 18/09/2004; 07:00hrs

Depth (mbgl)	Geology	Lithological Description	Field Notes	Well Completion Notes
0	alluvial debris	COLLUVIUM: Brown colluvium angular fragments < 3cm with 10% unconsolidated clay		150 mm PVC collar (0-5mbgl)
		ALLUVIAL: Red-brown highly oxidised ferruginous chert alluvial fragments subrounded/subangular <cm diameter poorly sorted + 30% poorly consolidated clay		
-10		CLAY: Red-brown moderately consolidated clay + 30% alluvial fragments < 1.5 cm diameter		
		CLAY: Red-brown damp moderately consolidated finely aggregated clay + 15% alluvial particles		
		CLAY: Red-brown damp to wet moderate to well consolidated clay as 50% of zone + 50% highly oxidised subangular fragments between 2-5 cm		
-20		CLAY: Red-brown well bonded consolidated clay as 70% of zone + 30% highly oxidised alluvial chert fragments moderately sorted subrounded/subangular < 2cm diameter-Wet zone @ 24-25m		
		CLAY: Red-brown finely aggregated damp clay		
-30		ALLUVIAL: Red-brown damp zone that becomes wet, moderate to well consolidated-Alluvial fragments < 2cm (occasional fragments <5cm @37-38m)	30-31m: 5.06 ppt TDS, 8.70 pH, 10.12 mS, 19.8 oC	
-40		SAPROCK: Grey-pale brown soft clayey saprock	38-39m: 2.80 ppt TDS, 8.47 pH, 5.63 mS, 28.5 oC	
		CALCRETE: Grey-cream calcrete + 20% associated clayey/aqueous gel like water		
		CALCRETE: Grey-cream hard calcrete with well developed vugh associated with cavernous zones common in zone Highly saline groundwater	35-40m: Fresh-mildly saline aquifer	
		CALCIFIED CHERT: Grey-white moderately weathered calcified chert/calcrete replacement. Fragments large extension of cavernous aquifer		
-50		CLAY: Grey-cream moderately weathered consolidated sticky wet clay	43-48m: Upper aquifer mildly saline/fresh water at 4 litres/second	Open hole (5-99m)
		SAPROCK: Pale brown-grey soft clayey saprock	42-51m: Calcrete aquifer saline groundwater >10 ppt TDS	
-60		CHERT/SHALE: Dark grey-brown goethitic/well oxidised fragments < 3 cm diameter- wet zone + 20% limonitic calcrete with moderate vugh on chip surfaces	51-52m: Sampled @ 51 m for water analysis depth - reverse circulation method	

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COMPOSITE WELL LOG

Well No: E22

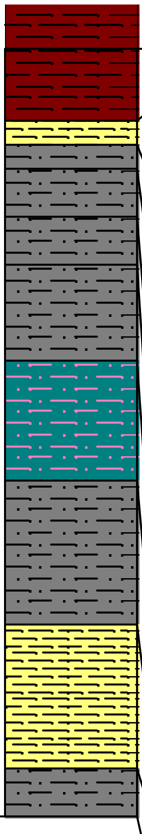
Client: Fortescue Metals Group

Project: Christmas Creek groundwater RC exploration

-70

-80

-90



CHERT/SHALE: Red-brown haematitic/oxidised highly silicified shale/chert with oxidised pitted surfaces

CLAY: Brown limonitic wet moderately aggregated clay

SHALE: Brown limonitic shale fragments between 1-5 cm with pitted oxidised surfaces + 30% associated consolidated clay

SHALE: Dark grey shale/chert moderately oxidised/limonitic moderately weathered surfaces fragments < 1.5cm + 5% as limonitic clayey weathering

SHALE: Dark grey moderately oxidised/limonitic moderately weathered surfaces fragments between 1-5cm + 30% brown wet aggregated clay

SHALE: Dark grey-black slightly oxidised to fresh Fe enriched shale + 2% oxidised surfaces. Wet samples likely good aquifer saline

SAPROCK: Dark grey-black slightly oxidised to fresh zones of Fe enrichment shale with larger weathered fragments between 1-5 cm diameter

SHALE: Dark grey-black slightly oxidised to fresh carbonaceous shale with smaller weathered fragments <0.5 cm diameter. Clayey @ 87-88m and end of zone 90-91m. Wet samples throughout- likely aquifer zone

CLAY: Grey-pale brown well aggregated dense clay with appearance of oxidised small shale particles at end of zone

SHALE: Dark grey-black unoxidised dolomitic shale. Unoxidised and chip fracturing poor to non-existent

57-58m: >10 ppt TDS, 8.27 pH, >20 mS, 28.7 oC

62-69m: Shale/chert aquifer saline groundwater > 10 ppt TDS

92-93m: Sampled for water analysis outside return flow

94-95m: Dilution estimation of saline water ~107,000 ppm TDS

94-95m: Flow test 11 cm V-notch weir 5.5 litres/second combined flow upper and lower aquifer

12:05 hrs, v-notch weir flow test 10.75 cm = 5.6 litres/second

12:15 hrs, v-notch weir flow test 11 cm = 5.5 litres/second

12:20 hrs, v-notch weir flow test 10.5 cm = 5.2 litres/second

EOH at 99mbgl

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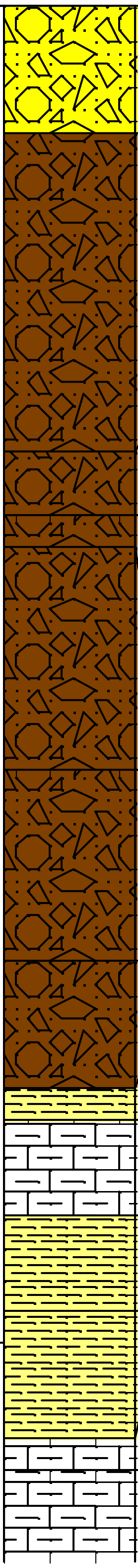
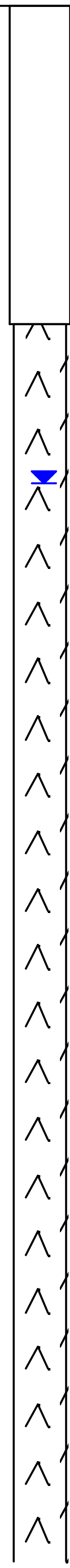
COMPOSITE WELL LOG

Well No: E23

Client: Fortescue Metals Group **Project:** Christmas Creek groundwater RC exploration

Commenced: 19/09/2004	**Method:** RC (0-90)		**Area:** Christmas Creek
Completed: 20/09/2004	**Fluid:** 2000 cfm 700 psi (Hydco C4)		**East:** 788886m(AMG)
Drilled: Connector	**Bit Record:** 5 3/8"		**North:** 7516292m(AMG)
Logged By: RFToll			**Elevation:**

Static Water Level: 15.03 mbgl **Date:** 21/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0, -10, -20, -30, -40	Alluvial debris		COLLUVIUM: Brown colluvium fragments angular < 2.5 cm diameter + 20% unconsolidated clay ALLUVIAL: Red-brown poorly sorted subangular/subrounded alluvial fragments < 2.5 cm diameter ALLUVIAL: Red-brown finely aggregated poorly consolidated clay 70% in zone + 30% alluvial fragments moderately sorted < 2 cm diameter ALLUVIAL: Red-brown poorly sorted subangular/subrounded large alluvial fragments between 1-5 centimetres wet zone + 10% unconsolidated clay ALLUVIAL: Red-brown finely aggregated poorly consolidated clay 70% in zone + 30% alluvial fragments moderately sorted < 2 cm diameter ALLUVIAL: Red-brown moderately consolidated clay 30% in zone + moderately aggregated lateritic fragments moderate water yields < 1 litre/second- varying concentration of regolith components through zone ALLUVIAL: Red-brown damp moderately consolidated clay CLAY: Brown moderately aggregated clay 80% through zone + 20% soft calcrete- wet zone CALCRETE: Brown-grey calcrete 90% through zone- slightly ferruginous + 10% moderately aggregated clay CLAY: Red-brown clay moderately consolidated 80% through zone + alluvial fragments <1 cm diameter CLAY: Grey-brown dense well consolidated clay CALCRETE: Grey hard brittle silcrete/calcrete 80% through zone + 10% wet moderately aggregated clay slurry- Wet zone begins CALCRETE: Grey-cream hard calcrete with vughy pitted surfaces and occasional calcrete accretionary precipitate- Cavity at 50 metres 0.5 metres. -Very wet zone water flow approximately 3 litres/second	Severe back pressure/flow after flow testing - results for recovery tenuous 16-17m: Alluvial minor yielding alluvial water aquifer 2.3 ppt TDS 24-30m: Alluvial minor yielding aquifer < 1 litre/second 12:55, 20 litres/3.5 seconds 24-35m: Water sampled for analysis for upper mildly saline aquifer - using reverse circulation method 35-38m: Calcrete aquifer sampled @ 35 metres- 2.28 ppt TDS, 8.86 pH, 4.61 mS 40-41m: Aquifer tested 1.98 ppt TDS, 8.71 pH , 3.9 mS 46-50m: Calcrete aquifer high yielding 3+ litres/second fresh to mildly saline sampled H20 for analysis @ 35 metres using RC method 49-50m: 2.44 ppt TDS, 8.65 pH, 4.83 mS 50-50.5m: Cavity - groundwater remains mildly saline 50.5-56m: Calcrete with vugh/dissolution textures, precipated finely aggregated calcrete particles on surfaces 50-56m: 3 litres/second yield using outside return flow test- v-notch weir 54-55m: 3.26 ppt TDS, 8.49 pH, 6.54 mS		150 mm PVC collar (0-10mbgl) Open hole (10-90mbgl)

Depth	Lithology description	Water / field data	Remarks
-50	CALCRETE: Cream-grey calcrete with Mn flecks throughout -strong water flows sampled	56-57m: 3.74 ppt TDS, 8.59 pH, 7.62 mS	
	CALCRETE: Cream-grey calcrete 80% through zone + 20% clay slurry	60-61m: 7.16 ppt TDS, 8.44 pH, 14.33 mS	
-60	CLAY: Grey moderate-well bonded clay + 10% calcrete debris	66-68m: Clayey 60% calcrete 30% aquifer	
	CALCRETE: Grey-cream calcrete with vughy/dissolution features with finely aggregated/nodular calcrete particles on surfaces	69-74m: Oxidised shale/goethite/Fe zone highly weathered? saline water aquifer increasing salinities and dominating water quality of flows combined with the mildly saline upper aquifer	
	CLAY: Grey moderate-well bonded clay + 10% calcrete debris		
	CLAY: Brown moderately aggregated clay 60% through zone + calcrete/chert? Highly weathered		
	CALCRETE: Brown moderately aggregated clay 30% through zone + 70% calcrete/chert? Highly weathered	70-71m: >10 ppt TDS, 8.44 pH >20 mS	
-70	CLAY: Brown moderately aggregated clay 60% through zone + calcrete/chert? Highly weathered		
	SHALE: Black hard shale slightly silicifed with goethitic weathered appearance	82-83m: Water sampled for analysis for lower mildly saline aquifer using reverse circulation method	
	CLAY: Brown-grey well aggregated clay 70% though zone + 30% large fragments shale with goethitic weathering appearance- fragments between 1-5 cm diameter. No obvious fracture planes	12:40, 20 litres/3 seconds	
	CLAY: Grey well aggregated dense clay	82 m; 12:35, 20 litres/3.5 seconds	From "Field Notes"
-80	CLAY: Brown well aggregated dense clay	12:46, 20 litres/4 seconds	82-84m Airlift yielded unable to use v-notch as flooded pit and channel- 5.5 litres/second waters saline > 10 ppt TDS ie dominanting flow overcoming upper aquifer salinities- blocked hammer tested from outside return - will have component of upper aquifer water
	SHALE: Brown-grey moderately consolidated clay 50% through zone + 50% moderately weathered shale with small broken fragments - no major fracture planes evident-		
	SHALE: Black shale slightly oxidised becomes nonoxidised Hammer blocking up and hole ended though samples show no evidence of further oxidation-possible Fe enrichment or carbonaceous shale	EOH at 90mbgl	
-90			

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COMPOSITE WELL LOG

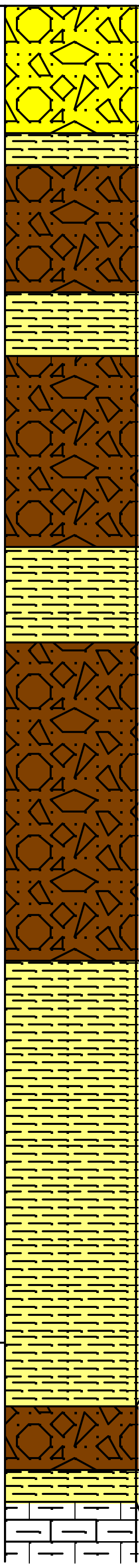
Well No: E24

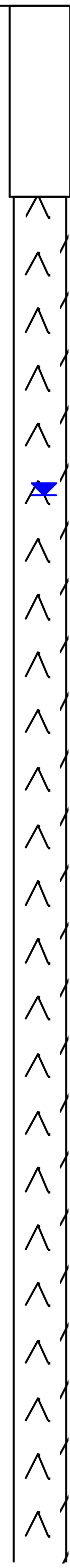
Client: Fortescue Metals Group **Project:** Christmas Creek groundwater RC exploration

Commenced:	18/09/2004	**Method:**	RC (0-106)	**Area:**	Christmas Creek
Completed:	19/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	789150m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7515683m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 15.35 mbgl **Date:** 18/09/2004; 07:00hrs

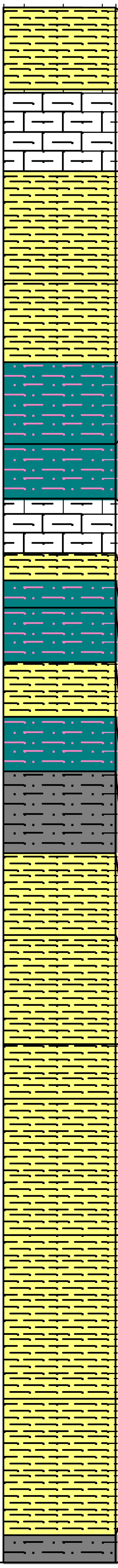
Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	ALLUVIAL		COLLUVIUM: Colluvium angular fragments < 3.5 cm diameter + 20% poorly consolidted clay	98 m; 11:10, v-notch flow test 12.5 cm		150 mm PVC collar (0-6mbgl)
			CLAY: Orange brown poorly consolidated clay + 50% alluvial subangular/sub	11:20, v-notch flow test 13.5 cm		
			ALLUVIAL: Brown alluvial poorly sorted subangular/subrounded + 20% poolry consolidated clay	11:30, v-notch flow test 13 cm		
-10			CLAY: Brown moderately consolidated clay 40% + moderately sorted alluvial fragments			
			ALLUVIAL: Brown alluvial poorly sorted subangular/subrounded + 20% poolry consolidated clay			
			CLAY: Re-brown moderatly consolidated damp clay 60% + alluvial 20-30% poorly sorted fragments			
-20			ALLUVIAL: Red-brown moderately consolidated clay 60% of zone + 40% alluvial <1cm moderately sorted subrounded fragments	52-55m: main aquifer 3.26 ppt TDS, 8.53 pH, 6.45 mS, 29.9 oC		
				64-65m: 3.26 ppt TDS, 8.53 pH, 6.45 mS 26.5 oC		
-30			CLAY: Red-brown well consolidated clay finely aggregated damp in initial zone that becomes increasingly wet @ 40 metres	40-54m: Water sampled for analysis of upper aquifer mildly saline		
				40-41m: 2.08 ppt TDS, 8.48 pH, 3.97 mS		
-40						Open hole (6-106mbgl)
				42-46m: Minor aquifer slurry		
			ALLUVIAL: Grey-cream consoldiated clay + 40% alluvial fragments chert moderately sorted <1cm diameter subangular/subrounded			
			CLAY: Grey highly consolidated/aggregated dense clay/pug			
			CALCRETE: Cream-white calcrete			





	COMPOSITE WELL LOG
	Well No: E24
	Client: Fortescue Metals Group
	Project: Christmas Creek groundwater RC exploration

Depth scale: -50, -60, -70, -80, -90, -100



Lithology:

- CLAY: Grey-cream well aggregated clay 50% of zone + cream calcrete 50% as small fragments with common Mn staining
- CALCRETE: Cream-grey calcrete
- CLAY: Grey-cream well aggregated clay + 20% calcrete debris
- CLAY: Grey-cream well aggregated clay 50% + 50% calcrete debris
- SAPROCK: Brown-cyan highly oxidised saprock 55% + 30% moderately aggregated clay + 15% calcrete debris
- SAPROCK: Brown-cyan highly oxidised saprock 50% + 10% moderately aggregated clay + 40% calcrete debris
- CALCRETE: White-cream calcrete + black goethitic slightly broken saprock fragments < 1cm diameter slighly vuggy chip surfaces with associate oxidation
- CLAY: Brown moderately aggregated clay + 5% goethitic saprock fragments/debris
- SAPROCK: Brown goethitic hard saprock/shale? as 50% of zone + black gossaneous hard fragments < 2mm diameter
- SAPROCK: Brown moderately aggregated clay as 50% + 50% goethitic saprock fragments/debris
- CLAY: Brown well aggregated/dense clay
- SAPROCK: Brown-dark brown hard highly ferruginous fragments saprock < 2.5 cm diameter + 10% moderately aggregated clay
- SHALE: Black-brown hard highly ferruginous shale hard fragments between 1-5 cm diameter
- CLAY: Brown well aggregated/dense clay
- CLAY: Grey-brown aggregated clay
- CLAY: Grey well aggregated dense clay
- CLAY: Black moderately consolidated wet finely aggregated clay
- CLAY: Grey dense well aggregated clay
- CLAY: Grey moderately consolidated clay + 20% black weathered shale fragments <2cm diameter
- SHALE: Black haematitic slightly oxidised clayey shale with small broken section fragmetns < 0.5 cm diameter

Comments:

49-52m: Minor aquifer clayey calcrete

51-52m: Sampled water for analysis using RC method

59-62m: Minor aquifer clayey calcrete

62-65m: Saprock shale + minor calcrete aquifer - Flow Tested 4 litres/second, 3.26 ppt TDS, 8.53 pH, 6.45 mS, 26.5 oC

64-65m: V-notch weir test upper aquifer 4 litres/second RC method and air coming up outside return

70-72m: Main aquifer limonitic no major fractuing sections evident salinity increased > 10 ppt TDS

75-77m: Moderate yielding aquifer shale/chert poorly fractured aquifer increased salinity > 10 ppt TDS

77-80m: Minor aquifer shale limonitic

92-93m: Water samples for analysis for lower aquifer highly saline

50-106m: Collar blown - 6 metres of pvc collar -NB for follow up test production bores unconsolidated alluvial zones difficult to collar - may require collars to depths >12 metres

94-95m: Sampled water for analysis using outside return method

94-95m: V-notch flow 13.5cm = 9 litres/second combined upper and lower aquifer flow

EOH at 106mbgl

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COMPOSITE WELL LOG

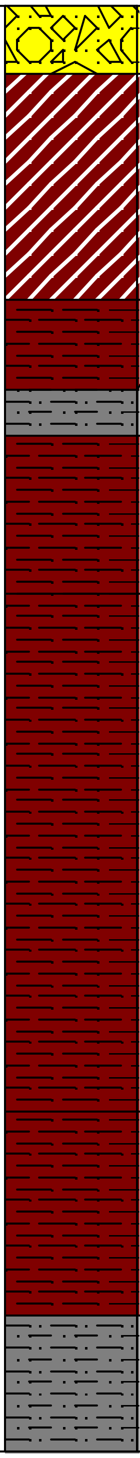
Well No: E30

Client: Fortescue Metals Group **Project:** Christmas Creek groundwater exploration

Commenced:	10/10/04	**Method:**	Reverse Circulation to 82m EOH	**Area:**	Christmas Creek
Completed:	10/10/04	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	790665m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches rods	**North:**	7520085m(AMG)
Logged By:	Steve Collett		5 3/8 inches	**Elevation:**	440mAHD

Static Water Level: 36.28mbgl **Date:** 12/10/04

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0			COLLUVIUM: Brown silty aggregate, aggregate predominantly ironstone			T.O.C.: +0.2magl pvc plain 150 mm collar (0-4mbgl)
			BIF: Brown banded goethite/limonite (goethite 90%)			
-10			CHERT/SHALE: Brown interbedded chert and limonitic shale			
			SHALE: Brown goethite rich kaolin shale, minor thin chert beds			
-20			SHALE/CHERT: Light Brown kaolin shale with minor thin chert beds			
-30			CHERT/SHALE: Brown interbedded chert and limonitic stained kaolin shales, chert broken and water yielding in 40 and 45m zones			
-40				40-45m: Major water bearing zones associated with broken chert beds, pH8.58, EC 0.7 mS, ppt 0.35, yield 0.8 l/s		
-50			CHERT/SHALE: Brown and black interbedded cherts, soft carbonaceous shale and kaolin shale, possible minor water yields from cherts but no measurable increase in yield			
-60			SHALE: Black carbonaceous shale, slightly siliceous, non pyritic	EOH at 64mbgl		



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COMPOSITE WELL LOG

Well No: E41

Client: Fortescue Metals Group
Project: Christmas Creek groundwater exploration

Commenced:	11/10/04	**Method:**	Reverse Circulation to 82m EOH	**Area:**	Christmas Creek
Completed:	11/10/04	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	793995m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches rods	**North:**	7519305m(AMG)
Logged By:	Steve Collett		5 3/8 inches	**Elevation:**	435mAHD

Static Water Level: 29.20mbgl
Date: 12/10/04

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Brown silty aggregate, goethite fragments to 60%, maghaemite pisoliths to 20%			150mm PVC collar (0-4mbgl)
-10			BIF: Brown banded goethite/limonoite (goethite 80%) pisolite infill in voids to 20%			
			BIF: Brown goethite rich BIF, Magnetite 16 to 17m, minor limonite dust			
-20			SHALE/CHERT: Brown banded chert (20%) and goethite rich shale			
-30			BIF: Brown goethite ,minor limonite	31-33m: Moderate water bearing zone in BIF, pH8.45, EC 2.06 mS, ppt 1.03		
			CHERT: Red Brown jaspilite			
-40			SHALE: Brown iron stained kaolin shale, thin chert bedding to 20% of sequence			
-50			CHERT: Dark Grey chert minor shale grading from oxidised to fresh carbonaceous shale at 63m	52-63m: Moderate water bearing zone in chert transition from ox to fresh rock pH 8.7, EC 2.25 mS, ppt 1.13 , yield 1.2 l/s		
-60			SHALE: Black soft carbonaceous shale, with minor thin chert beds			
-70				EOH at 70mbgl		

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COMPOSITE WELL LOG

Well No: F01A

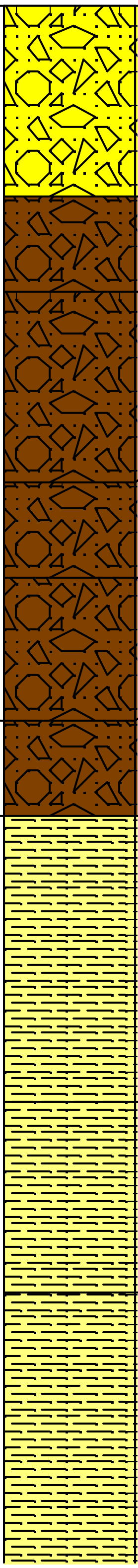
Client: Fortescue Metals Group **Project:** Christmas Creek Piezometer Monitoring Bore

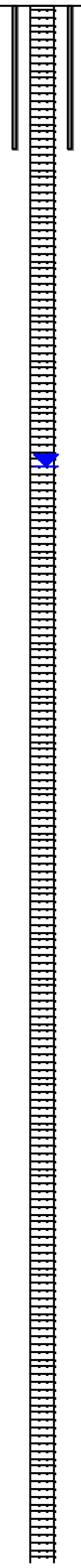
Commenced:	9/09/2004	**Method:**	Airlift to 58m EOH.	**Area:**	Christmas Creek
Completed:	10/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	786013m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7515640m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 9.65 mbgl **Date:** 10/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
			COLLUVIUM: Red-brown highly ferruginised lateritic chert fragments poorly sorted predominantly angular <3cm diamter			150 mm PVC collar (0-3mbgl)
			ALLUVIAL: Red-brown unconsolidated clay as 20% with 80% ferruginous subrounded to angular fragments poorly sorted <3 cm diamter			
			ALLUVIAL: Red-brown damp lateritic ferruginous chert subrounded to angular <1.5cm diameter poorly sorted			
			ALLUVIAL: Red-brown moderately rounded moderately sorted fragments 30% with 70% finely aggregated clay with ferruginous particles <1mm diameter			
			ALLUVIAL: Red-brown consolidated moist clay 70% with 30% alluvial fragments as above			
	inor aquif		ALLUVIAL: Grey-cream highly oxidised hard fragments with similar content ferruginous alluvial chert fragments with 35% brown damp clay, wet zone15-17metres	39-40m: Water sample taken for analysis using RC method		
			CLAY: Brown finely aggregated clay moist clay 80% with 20% ferruginous chert debris	52-54m: Water sample taken for analysis		
			CLAY: Brown finely aggregated clay with ferruginous particles<1mm diamter			Slotted 2.5" PVC (0-58mbgl)
			CLAY: Brown clay moderately consolidated clay, wet zones resulting from higher groundwater zone			

Depth scale: 0, -10, -20, -30





-40

-50

-60

Lithology description	Comments
CLAY: Brown consolidated to dense clay 60% with 40% ferruginised brown fragments and grey claystone	38-42m: Calcrete aquifer with 0.5 metre cavity @ 39 metres
CALCRETE: Grey-light coloured calcrete brittle fragments with minor silcrete on some faces Xstalline development on some chips and evidence of vugh surfaces Cavity 0.5 metres at approximately 39 metres	
QUARTZ: Dark grey-brown oxidised quartz vein with silicified shale, broken section throughout with main groundwater zone/fracture @45 metres +15% minor calcrete samples throughout	40-41m: Airlift 20 litres/7seconds= 2.8 litres/second 40-41m: 2.53 ppt TDS, pH 8.53, initial flow
QUARTZ: Brown highly oxidised siliceous shale, broken fragments <3cm diameter with fracture planes common, quartz slightly bleached with vugh textures	42-47m: Fractured zone quarz oxidised siiceous shale with moderate fracturing chemistry variable but between 4,000-10,000 ppm TDS
CLAY: Grey wet consolidated to dense clay predominates with 10% minor debris/saprock likely basement residual transitional material	51-52m: Field dilution testing estimate 35,000 ppm TDS
SAPROCK: Grey-brown moderately consolidated clay less dense with 20% light brown highly ferruginous highly deformed metapelite, fragments <3cm diameter	field dilution testing estimated 35 ppt TDS, 8.48
METAPELITE: Brown-grey oxidised highly deformed metapelite with 20% moderately consolidated grey clay. Good aquifer, higher salinities and increased flow	52-53m: Airlift 20 litres/3.5 seconds >10 ppt TDS EOH at 58mbgl
	54-58m: Basement aquifer with highly ferruginous zone and associated moderate fracturing Higher salinities >10,000ppm TDS likely >20,000 ppm TDS estimated 35,000 ppm TDS 60-61m: >10 ppt TDS

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COMPOSITE WELL LOG

Well No: F01B

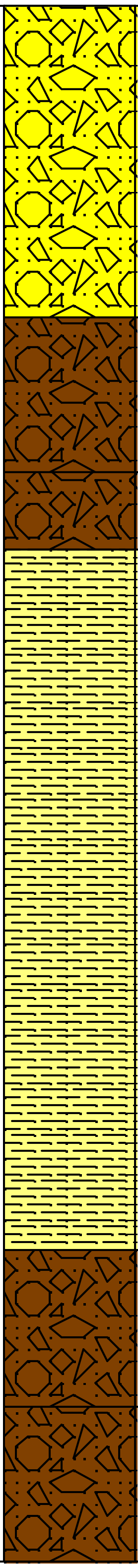
Client: Fortescue Metals Group
Project: Christmas Creek Piezometer Monitoring Bore

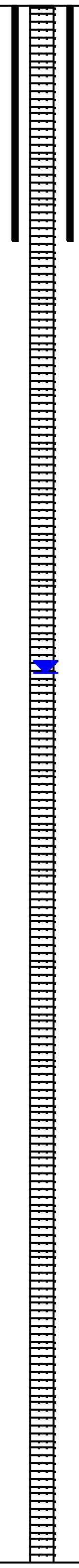
Commenced: 10/09/2004
Completed: 10/09/2004
Drilled: Connector
Logged By: RFToll

Method: Airlift to 20m EOH.
Fluid: 2000 cfm 700 psi (Hydco C4)
Bit Record: 5 3/8"

Area: Christmas Creek
East: 786009m(AMG)
North: 7515646m(AMG)
Elevation:

Static Water Level: 8.46 mbgl
Date: 10/09/2004; 07:00hrs





Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Red-brown highly ferruginised lateritic chert fragments poorly sorted predominantly angular <3cm diamter			150 mm PVC collar (0-3mbgl)
			ALLUVIAL: Red-brown colluvium with 30% poorly aggregated clay			
			ALLUVIAL: Red-brown 80% alluvial fragments <4cm diameter with 20% poorly consolidated clay			
-10			CLAY: Red-brown clay 70% with minor alluvial fragmentals <1cm			2.5" Slotted PVC (0-20mbgl)
			ALLUVIAL: Red-brown moist/damp alluvial fragments highly ferruginous	16-17m: Minor aquifer damp slurry sampled- no TDS		
-20			ALLUVIAL: Red-brown damp moderately consolidated clay with 40% alluvial fragments	19-20m: Water sampled for analysis EOH at 20mbgl		

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COMPOSITE WELL LOG

Well No: F02

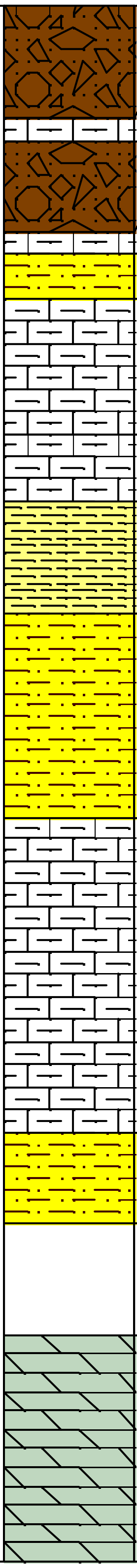
Client: Fortescue Metals Group
Project: Christmas Creek groundwater exploration

Commenced:	11/10/04	**Method:**	Reverse Circulation to 56m EOH	**Area:**	Christmas Creek
Completed:	12/10/04	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	787999m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches rods	**North:**	7512998m(AMG)
Logged By:	Steve Collett		5 3/8 inches	**Elevation:**	411mAHD

Static Water Level: 10.7mbgl
Date: 8/10/04

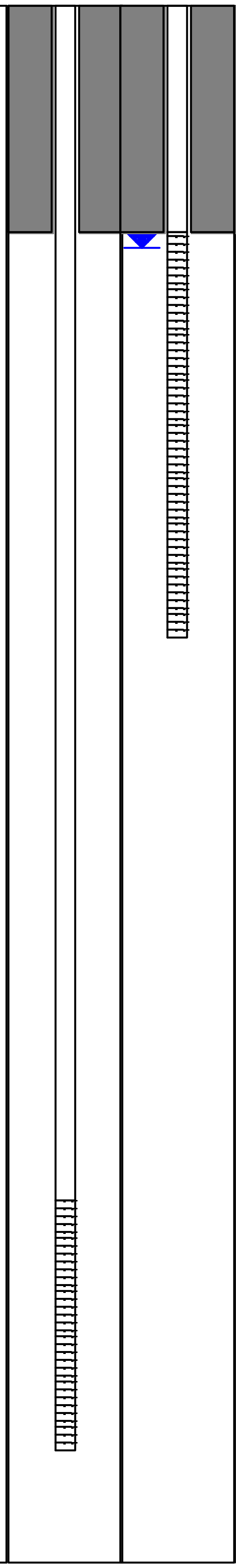
Depth (mbgl)	Lithological Description	Field Notes
0	ALLUVIAL: Brown fine to very coarse agregate, fragments to 60%	
	CALCRETE: White earthy calcrete	
	ALLUVIAL: Brown silty aggregate , aggregate predominatly chert	
-10	CALCRETE: White earthy calcrete	
	SILT: Brown silt minor pisolith content	
	CALCRETE: Light Brown earthy calcareous silt	19-22m: Major yield from calrete and chalcedony pH 8.78, EC 14.06 mS , ppt 7.01, yield intermittant losing air to formation.
-20	CALCRETE: White calcrete and chalcedony Karstic highly water bearing	
	CLAY: Brown silty clay, puggy	
	SILT: Brown silt lucustrine	
-30		
	CALCRETE: White calcrete, 36-40m: pinkish and earthy, 40-46m: earthy + chalcedonic (20%) and karstic, highly water bearing	
-40		40-46m: Major yield from calrete and chalcedony pH 8.4, EC +20000 mS , ppt +10000, yield intermittant losing air to formation.
	CALCRETE: Grey/white calcrete	
-50	SILT: Light brown earthy calcareous silt	
		54-59m: Moderate yield, silcrete pH 7.7 hypersaline.
	SILCRETE: Grey massive silcrete (chalcedony) and brown silcrete vien infilled (secondary opaline infill)	
-60	DOLOMITE: Yellow dolomite, minor fractures in chip samples where potentially interconnected would be water yielding. Moderate water yielding	59-69+m: Moderate aquifer section - hypersaline water pH 7.7 potential for greater yield if encountered faults etc.
		EOH at 69mbgl

Geology | Graphic Log



Well Completion

Diagram



Notes

T.O.C.: +0.7magl

150mm PVC Surface casing (0-10mbgl)

50mm Blank PVC (0-10mbgl)

50mm Slotted PVC (10-28mbgl)

50mm Blank PVC (0-53mbgl)

50mm Slotted PVC (53-64mbgl)

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COMPOSITE WELL LOG

Well No: F03A

Client: Fortescue Metals Group
Project: Christmas Creek Piezometer Monitoring Bore

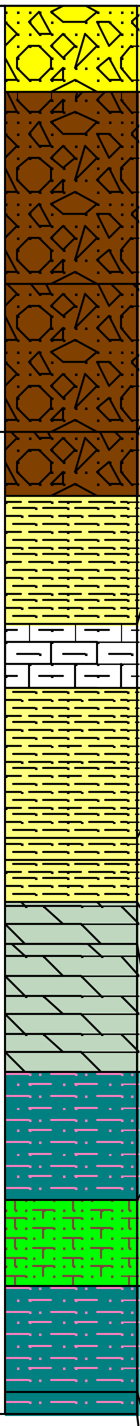
Commenced:	10/09/2004	**Method:**	Airlift to 66m EOH.	**Area:**	Christmas Creek
Completed:	11/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	792255m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7510749m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 11.90 mbgl
Date: 10/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes

Depth (mbgl): 0, -10, -20, -30, -40, -50, -60

Geology: Alluvial



Lithological Description

COLLUVIUM: Red-brown highly ferruginised lateritic chert fragments poorly sorted predominantly angular <3cm diamter

ALLUVIAL: Red-brown alluvial debris fragments <2cm diameter poorly sorted angular

ALLUVIAL: Red-brown clay damp from 13 metres poorly consolidated with component of fine ferruginous particles <1mm diameter 40%

ALLUVIAL: Brown lateritic/ferruginous hard angular fragments reworked texture of possible calcrete with 20-40% clay. Wet zone with only minor flows

CLAY: Brown damp/moist clay to 40% with highly ferruginous silicified fragments

CALCRETE: Cream-brown brittle ferruginous calcrete 20% of sample with mottled surface associated moderate groundwater zone with 80% brown moderately consolidated clay

CLAY: Brown moderately consolidated/dense clay with 10% brittle ferruginised fragmental debris <1cm diameter with less remnant calcrete particles

CLAY: Grey stiff/puggy well aggregated moist clay

CLAY: Grey stiff/dense moist clay/claystone with 10% soft ferruginous fragmentatl debris

DOLOMITE: Grey-cream bleached hard/brittle unoxidised saprock Fragments show little evidence of fracturing

DOLOMITE: Grey soft saprock fragments <1cm diameter with fresh surfaces

SAPROCK: Grey hard slightly silicified shale?/saprock/dolomite? relatively fresh surfaces on fragments <2cm

CLAYSTONE: Grey-brown moderately oxidised fragments (limonitic appearance) brittle 20% <3cm with 80% soft/brittle oxidised saprock and 5% slightly mottled quartz fragments with faint vughy appearance

SAPROCK: Dark brown-orange highly ferruginous throughout brittle/hard saprock. Likely highly weathered proterozoic basement transitional zone. Very wet - aquifer zone though unable to test flow. Fragments broken associated with wet samples and increasing water yield with minor clay lenses to 20%

SAPROCK: Grey-brown dense aggregated clay 70% + 30% highly deformed highly weathered gneissic textured

Field Notes

62-63m: Hole collar blown out difficult to get precise measurement - result was 20 litres/13 seconds- likely larger flow available @ 2.5 litres/second

20-23m: Reworked mottled ferruginous calcrete Minor to moderate flows < 1litre/second

29-32m: Calcrete aquifer moderate flows, Airlifted 1.5 litres/second

39-42m: Well aggregated dense clay

39-40m: Water sampled for analysis

40-41m: 1.38 ppt TDS, 8.76 pH, 7.77 mS initial test

40-41m: 3.38 ppt TDS, 8.88 pH, 7.80 mS next test

45-46m: Airlifted 1.5L/s

51-52m: 3.88 ppt TDS, 8.88 pH, 7.80 mS

field dilution testing estimated 1.38 ppt tds @ 40metres

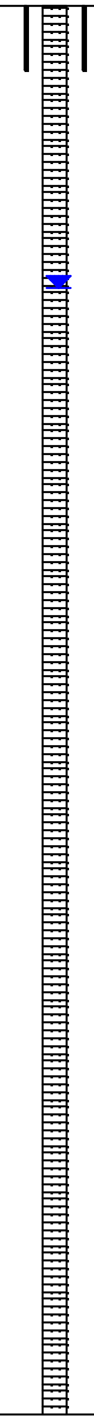
8.76 pH @40 metres

7.77 mS @ 40metres

59-60m: Water sampled for analysis

60-65m: Moderately fractured highly oxidised saprock aquifer, moderate increase in flow, salinity levels increased

EOH at 66mbgl



Well Completion Notes

150 mm PVC collar

Slotted PVC with end cap and top cap

aquaterra	# COMPOSITE WELL LOG	**Well No:** F03B

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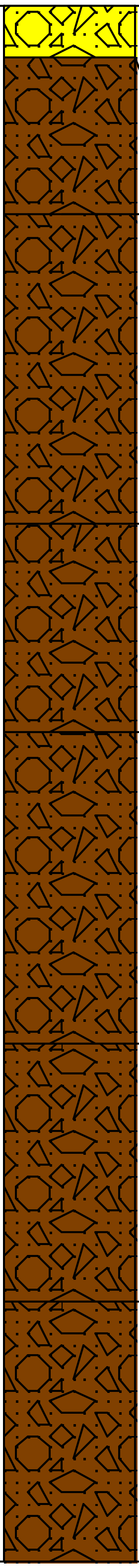
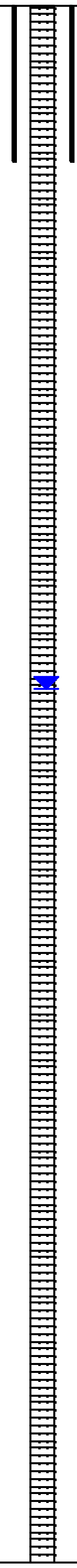
Client: Fortescue Metals Group **Project:** Christmas Creek Piezo installation

Commenced:	12/09/2004	**Method:**	Airlift to 30m EOH.	**Area:**	Christmas Creek
Completed:	12/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	792274m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7510762m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 13.18 mbgl **Date:** 14/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Red-brown highly ferruginised lateritic chert fragments poorly sorted predominantly angular <3cm diamter as 60% + 40% poorly bonded clay			150 mm PVC collar (0-3mbgl)
			ALLUVIAL: Brown highly oxidised colluvium/alluvial with poorly sorted subangular fragments <4cm diameter with 20% poorly bonded clay			
			ALLUVIAL: Red-brown clay 20% in zone + 80% component of highly oxidised poorly sorted subangular fragments < 2cm diameter			
-10			ALLUVIAL: Red-brown clay poorly consolidated 60% of zone + 40% alluvial chert fragments oxidised subangular poorly sorted <2cm diameter			2.5" Slotted PVC with end cap and top cap (0-30mbgl)
			ALLUVIAL: Red-brown moderately consolidated clay as 80% in zone + 20% oxidised/lateritic particles <1mm diameter. Zone goes wet from 15 metres depth			
-20			ALLUVIAL: Brown highly weathered hard silicifed chert fragments. Fragments slightly larger <3cm. Minor aquifer with flow < 1 litres second	20-25m: Minor yield/slurry sampled for analysis 20-25m: 2.6 ppt TDS, 8.88 pH, 5.24 mS		
			ALLUVIAL: Brown damp well consolidated dense clay + 10% lateritic particles/debris	EOH at 30mbgl		
-30						





COMPOSITE WELL LOG

Well No: F04

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Client: Fortescue Metals Group **Project:** Christmas Creek groundwater RC exploration

Commenced:	16/09/2004	**Method:**	RC (0-89)	**Area:**	Christmas Creek
Completed:	17/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	784786m(AHD)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7517193m(AHD)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 13.95 mbgl **Date:** 18/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Brown colluvium fragments < 3cm with 10% unconsolidated clay			
			COLLUVIUM: Brown highly oxidised alluvial/colluvium subangular fragments <3cm diamter			150 mm PVC collar (0-5mbgl)
			ALLUVIUM: Red-brown highly oxidised subrounded/subangular alluvial fragments <3cm + 20% moderately consolidated clay			
-10			CLAY: Red-brown finely aggregated clay + 10% lateritic debris			
			ALLUVIAL: Red-brown alluvial subangular/subrounded fragments <2cm + 30% damp finely aggregated clay			
-20						
			ALLUVIAL: Red-brown alluvial chert fragments subrounded/subangular with 50% moderately consolidated clay - minor aquifer @ 25 metres	25-30m: Alluvial zone with minor wet/slurry zone		
-30				25-40m: Water injection required in alluvial		Open hole (5-89mbgl)
			CLAY: Red-brown moderately aggregated clay + 5% lateritic debris			
-40			CLAY: Dark grey wet aggregated dense puggy clay			
			SAPROCK: Dark grey wet aggregated dense puggy clay as above + soft calcrete particles with minor zone brittle larger chip of calcrete			
			CALCRETE: Cream-pale brown soft-brittle calcrete + 30% associated wet clayey material			
			CALCRETE: Cream-pale brown hard-brittle calcrete + 30 % associated wet clayey calcrete	44-52m: Clayey calcrete minor aquifer Airlifted 20 litres/17 seconds- water sampled >10 ppt TDS, 8.52 pH		
			CLAY: Cream-brown 80% as soft calcrete wet clayey zone with 20% brittle calcrete saprock partilces < 2mm			

COMPOSITE WELL LOG

Well No: F04

Client: Fortescue Metals Group **Project:** Christmas Creek groundwater RC exploration

Depth: -50, -60, -70, -80, -90

Lithology description	Comments
diameter	
CALCRETE: Cream-pale brown calcrete 70% + 20% saprock/soft calcrete + 10% associated clay	53-54m: Sampled water for analysis by RC method >10 ppt TDS, 8.52 pH, >20 mS
CALCRETE: Cream-pale brown calcrete slightly ferruginised + 25% goethitic saprock fragments + minor magnetite	10:20 hrs, 20 litres/17 seconds >10 ppt TDS, 8.52 pH,
CALCRETE: Brown highly oxidised ferruginous/goethitic saprock/shale fragments	52-59m: Calcrete aquifer slightly ferruginous
CALCRETE: Cream-pale brown calcrete slightly ferruginised + 25% goethitic saprock fragments + minor magnetite	60-62m: Shale limonite aquifer
CLAY: Light brown-grey moderately consolidated sticky wet clay + 2% magnetite	62-70m: Clayey limonitic shale + calcrete aquifer
SAPROCK: Wet brown-cream slightly ferruginous calcrete + 40% goethitic saprock brittle fragments <2mm diameter	
SAPROCK: Brown-grey highly ferruginous hard fragments <0.5cm diameter + sticky wet associated clayey material	70-76m: Limonitic clayey shale aquifer
SAPROCK: Brown highly ferruginous hard siliceous shale/chert < 6cm diameter + 30% sticky wet clay	
SHALE: Black hard highly siliceous shale oxidised as limonite and fractured @ 79metres -fragments <3cm diameter larger - larger chips associated with fracture	78-87m: Aquifer chert highly saline aquifer
SHALE: Brown highly ferruginous shale -oxidised as limonite -broken fragments <2cm diameter throughout - fracture @ 79-80 metres <3cm diameter fragments with oxidised planes	Airlifted final @ 5.8 litres/second - water sampled at 82 metres using RC method 11:42 hrs, 20 litres/9 seconds cyclone + v-notch weir 3 litres/second
SHALE: Brown highly ferruginous shale -oxidised as limonite -fragments <1.5cm diameter larger	
DOLOMITE & SHALE: Dark grey hard dolomitic shale with minor 10% oxidised zones as limonite + 1% white quartz veinlet	12:05 hrs flow test v-notch weir 5.6 litres/second
DOLOMITE & SHALE: Dark grey unoxidised shale/dolomite showing boudinage appearance	EOH at 89mbgl
	(92-93m: Water sampled for analsyis by RC method > 10 ppt TDS)

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COMPOSITE WELL LOG

Well No: F05

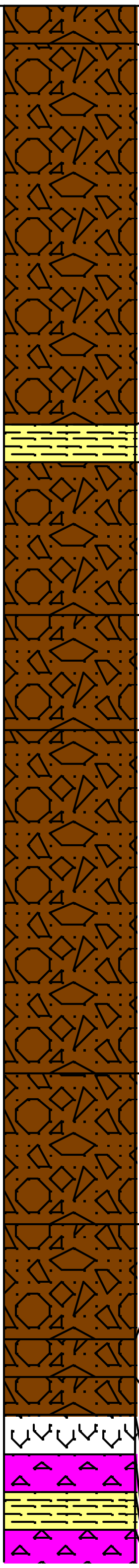
Client: Fortescue Metals Group **Project:** Christmas Creek groundwater RC exploration

Commenced: 1/10/2004	**Method:** RC (0-68)	**Area:** Christmas Creek	
Completed: 2/10/2004	**Fluid:** 2000 cfm 700 psi (Hydco C4)	**East:** 793178m(AMG)	
Drilled: Connector	**Bit Record:** 5 3/8"	**North:** 7513285m(AMG)	
Logged By: RFToll		**Elevation:**	

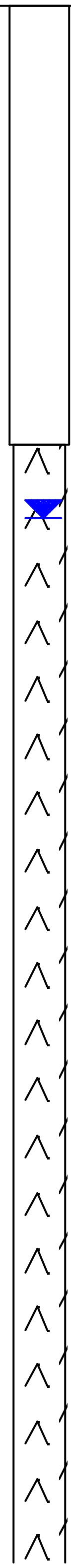
Static Water Level: 13.45 mbgl **Date:** 3/10/2004; 07:00hrs

Depth (mbgl)	Lithological Description	Field Notes	Well Completion Notes
0	ALLUVIAL: Brown surficial clayey colluvium		
	ALLUVIAL: Brown -red unconsolidated poorly sorted alluvial fragments between 1 - 3 cm diameter, subrounded and subangular fragments	Detailed "Field Notes" listed below 68mbgl (EOH) in Lithology column.	150 mm PVC casing to collar off alluvium (0-11.5mbgl)
-10	CLAY: Brown moderately consolidated clay	major aquifer begins at 65 metres - unable to drill deeper due to auxilliary air breakdown, zone blocking bit continuously and severe washout on collar	
	ALLUVIAL: Brown -red unconsolidated poorly sorted alluvial fragments between 1 - 3 cm diameter, subrounded and subangular fragments		
	ALLUVIAL: Red-brown moderately sorted alluvial + 20% brown unconsolidated clay		
-20	ALLUVIAL: Red-brown moderately sorted alluvial with fragments < 0.5 cm diameter subrounded and subangular	22-23m: 0.78 ppt TDS, 8.57 pH, 1.54 mS, 33.1oC	Open hole (0-68mbgl)
	ALLUVIAL: Red-brown poorly sorted alluvial between 1-3 cm diameter (large chert fragments 30-31 metres)	30-31m: 0.66 ppt TDS, 8.63 pH, 1.24 mS, 33.9 oC	
-30	ALLUVIAL: Red-brown moderately sorted alluvial with fragments < 0.5 cm diameter subrounded and subangular		
	ALLUVIAL: Red-brown moderately sorted alluvial with fragments between 1-3 cm diameter subrounded and subangular slight magnetic @ 36 metres		
	ALLUVIAL: Red-brown moderately sorted alluvial with fragments < 0.5 cm diameter subrounded and subangular		
-40	QUARTZ: White quartz with slight ferruginous coated surface + 20% moderately consolidated brown clay- wet zone, no measured increase in salinity	39-40m: 0.81 ppt TDS, 8.45 pH, 1.57 mS, 32 oC	

Graphic Log



Well Completion Diagram



Depth	Lithology description	Comments
	CHERT: Black chert slightly ferruginous surfaces + 20% brown unconsolidated clay	
	CLAY: Brown dense aggregated clay	
	CHERT: Black slightly oxidised chert - fragments to 5 cm diameter	
	SAPROCK: Cream-grey soft saprock/claystone	
	SAPROCK: White-grey soft saprock/claystone	
-50	SAPROCK: Brown soft saprock/claystone	
	SHALE: Dark grey soft claystone/saprock	64 m; 15:00 v-notch weir 12 cm + 2.5 l/second = 10 litres/second
	SAPROCK: Grey-cream soft claystone + 10% soft brown-grey saprock and lateritic debris particles	15:15 hrs, v-notch weir, 12.5 cm + 3 l/sec = 11 litres/second 15:20 hrs, v-notch weir, 12 cm + 3 l/sec = 10 litres/second 15:25 hrs, v-notch weir, 12 cm + 2.5 l/sec = 10.5 litres/second
-60	CLAY: Black chert with clayey surfaces + brown well aggregated/dense clay	15:30 hrs, v-notch weir, 11.5 cm + 2.5 l/sec = 10 litres/second
	CLAY: Light brown clay well aggregated wet with increasing salinity measured > 10 ppt TDS	
	CLAY: Light brown well aggregated clay wet zone with transitional highly weathered hard saprock fragments between 1-3 cm diameter	15:40 hrs, v-notch weir, 12 cm + 2.5 l/sec outside return hose = 10 litres/second
	CHERT: Brown hard saprock with appearance of conchoidal fracturing - small vugh/solution cavity and gossanesous stained chips-fragments < 1.5 cm- major groundwater intersection	EOH at 68mbgl
-70	22-23m: wet zone fresh water -alluvial zone	
	30-31m: wet zone fresh water -alluvial zone - flow tested @ 1 litre/second	
	31-34m: samples wet	
	33-34m: flow test 20 litres/19 seconds	
	47-48m: water sample taken for analysis	
	59-60m: TDS=0.6 ppt	
-80	64-65m: >10 ppt TDS- dilution field test estimates 16 ppt TDS, large flow encountered	
	65-68m: Large groundwater flow immediately beneath clay on intersection of highly weatherd chert-solution fabrics observed on drill cuttings	
	65-68m: water sample taken for analysis using RC method	

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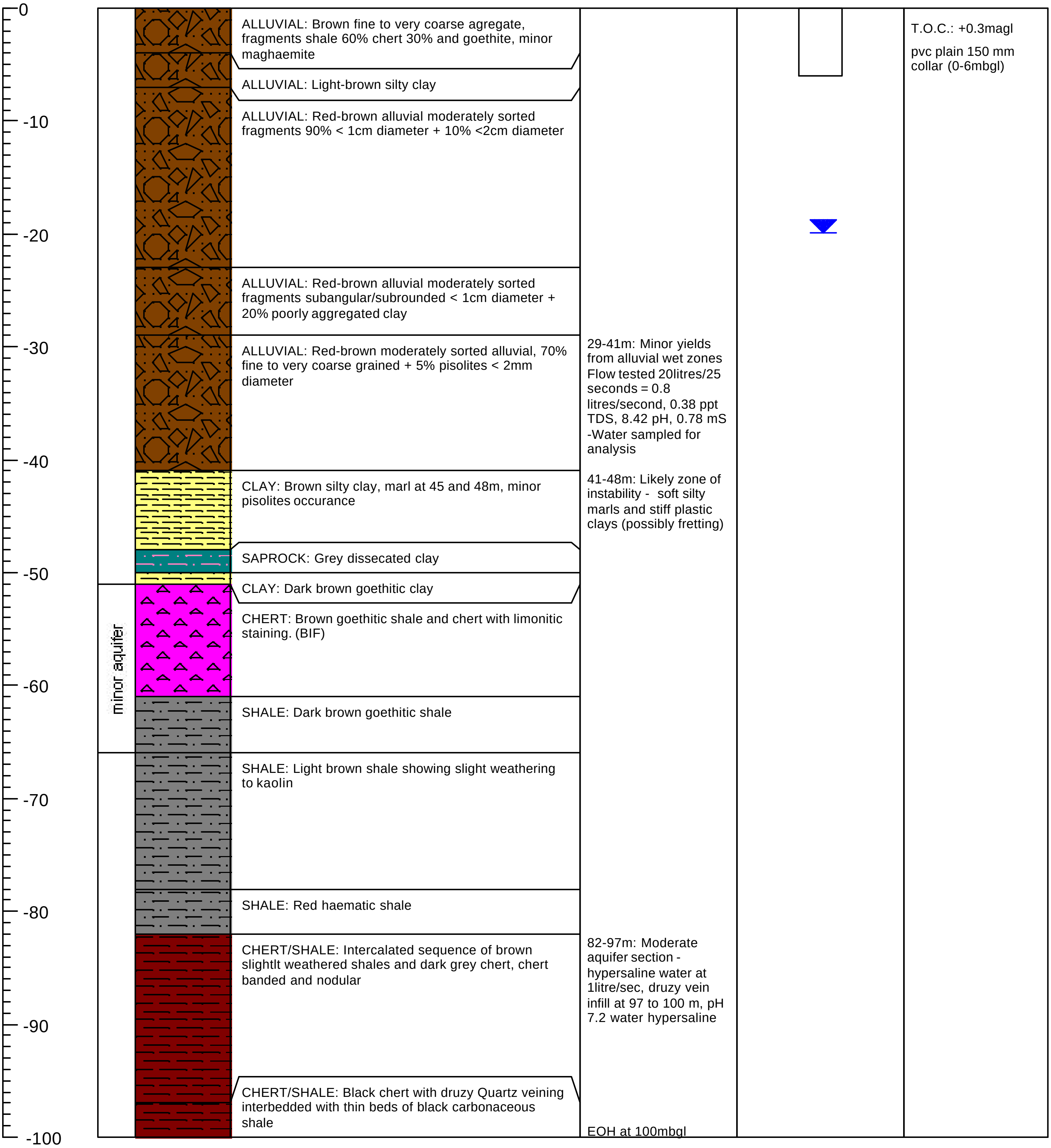
Client: Fortescue Metals Group
Project: Christmas Creek groundwater exploration

Commenced:	5/10/04	**Method:**	Reverse Circulation to 56m EOH	**Area:**	Christmas Creek
Completed:	26/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	793815m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches rods	**North:**	7515344m(AMG)
Logged By:	Steve Collett		5 3/8 inches	**Elevation:**	430mAHD

Static Water Level: 19.93mbgl
Date: 8/10/04

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			ALLUVIAL: Brown fine to very coarse agregate, fragments shale 60% chert 30% and goethite, minor maghaemite			T.O.C.: +0.3magl pvc plain 150 mm collar (0-6mbgl)
			ALLUVIAL: Light-brown silty clay			
-10			ALLUVIAL: Red-brown alluvial moderately sorted fragments 90% < 1cm diameter + 10% <2cm diameter			
-20			ALLUVIAL: Red-brown alluvial moderately sorted fragments subangular/subrounded < 1cm diameter + 20% poorly aggregated clay			
-30			ALLUVIAL: Red-brown moderately sorted alluvial, 70% fine to very coarse grained + 5% pisolites < 2mm diameter	29-41m: Minor yields from alluvial wet zones Flow tested 20litres/25 seconds = 0.8 litres/second, 0.38 ppt TDS, 8.42 pH, 0.78 mS -Water sampled for analysis		
-40			CLAY: Brown silty clay, marl at 45 and 48m, minor pisolites occurance	41-48m: Likely zone of instability - soft silty marls and stiff plastic clays (possibly fretting)		
			SAPROCK: Grey dissecated clay			
-50			CLAY: Dark brown goethitic clay			
	minor aquifer		CHERT: Brown goethitic shale and chert with limonitic staining. (BIF)			
-60	minor aquifer		SHALE: Dark brown goethitic shale			
-70			SHALE: Light brown shale showing slight weathering to kaolin			
-80			SHALE: Red haematic shale			
-90			CHERT/SHALE: Intercalated sequence of brown slightlt weathered shales and dark grey chert, chert banded and nodular	82-97m: Moderate aquifer section - hypersaline water at 1litre/sec, druzy vein infill at 97 to 100 m, pH 7.2 water hypersaline		
-100			CHERT/SHALE: Black chert with druzy Quartz veining interbedded with thin beds of black carbonaceous shale	EOH at 100mbgl		



COMPOSITE WELL LOG

Well No: F7A

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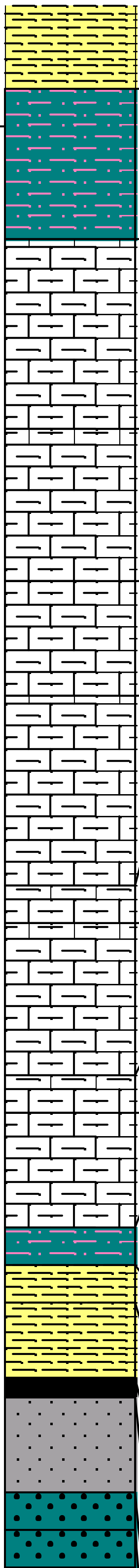
Client: Fortescue Metals Group
Project: Christmas Creek Piezo installation

Commenced:	12/09/2004	**Method:**	Airlift to 82m EOH.	**Area:**	Christmas Creek
Completed:	13/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	782004m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7517844m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 14.05mbgl
Date: 14/09/2004; 07:00hrs

Depth (mbgl)	Geology	Lithological Description	Field Notes	Well Completion Notes
0	Alluvials	COLLUVIUM: Red-brown highly ferruginised lateritic chert fragments poorly sorted predominantly angular <3cm diameter with 30% poorly consolidated clay		T.O.C.: +0.45magl 150 mm PVC collar (0-3mbgl) 2.5" Blank PVC casing with top cap (0-3mbgl)
		ALLUVIAL: Red-brown poorly aggregated clay with 30% highly oxidised alluvials comprising chert fragments poorly sorted subangular <1mm diameter		
		ALLUVIAL: Red-brown highly oxidised alluvial comprises predominantly chert fragments poorly sorted subangular-subrounded <3cm diameter with 30% poorly aggregated clay		
-10		CLAY: Red-brown finely aggregated clay		
		ALLUVIAL: Red-brown finely aggregated clay damp 60% of alluvial highly oxidised chert fragments poolry sorted subrounded-subangular <2cm diameter		
		ALLUVIAL: Red-brown finely aggregated clay damp 60% of alluvial highly oxidised chert fragments poolry sorted subrounded-subangular <2cm diameter. Zone goes damp		
-20		CLAY: Red-brown finely aggregated clay with 20% minor component alluvial chert fragments		2.5" Slotted PVC with end cap (3-82mbgl)
		ALLUVIAL: Red-brown Alluvial 60% of alluvial highly oxidised chert fragments poorly sorted subrounded-subangular <3.5cm diameter with 20%.finely aggregated clay. Zone goes wet minor flow-Difficult drilling conditions blocking bits due to variable alluvial size fractions	25-30m: Alluvial chert with 20% moderate to poorly consolidated clay	
		ALLUVIAL: Red-brown highly oxidised alluvial fragments/shale with mineralisatio in zone with 30% finely aggregated clay	29-30m: Water sampled for analysis	
-30		CLAY: Red brown moderate to well compacted clay with grey dense clay zones and minor 10% lateritic/debris	30-34m: Moderately consolidated brown clay to grey dense aggregated clay	
		CLAY: Red-brown dense to moderately consolidated clay as 80% through zone with periodic zones including 20% highly oxidised siliceous shale/chert fragments <7cm diameter exhibiting calcareous rim. Vitreous texture -possible replacement		
-40				



Depth	Lithology description	Comments
	SAPROCK: Cream-pale brown soft weathered calcareous with pale brown shaley hard fragments with 10% lateritic debris	43-73m: Major Aquifer-Calcrete - Dolomite?Shale? replacement features overprinting original rock by calcrete and calcareous precipitate
	CALCRETE: Cream to pale brown hard calcareous fragments with hard shale fragments with fracturing lost outside return Big water intersection	
-50	CALCRETE: Cream-pale brown calcareous/shale units with manganese veinlets in calcrete with 40% black lateritic debris	
	CALCRETE: Grey-cream vitreous/chert highly siliceous fragments < 6 cm diameter	
-60	CALCRETE: Pale brown ferruginous/limonitic hard fragments (weathered dolomite?) as 60% with 40% calcrete interspersed through zone. Fragments <0.5cm	60-65m: Saprock Aquifer -Moderately fractured highly oxidised saprock aquifer Moderate increase in flow salinity levels increased
	CALCRETE: Pink-cream calcrete brittle to hard fragments 90% through zone with 10% lateritic debris <2mm diameter	
	CALCRETE: Pale brown-cream calcrete with vitreous replacement appearance/porcellenised/siliceous hard fragments as 90% of zone with 10% lateritic debris/particles	
	CALCRETE: Cream-pale brown calcrete as above textures though larger fragments <3cm diameter	
-70	CALCRETE: Cream calcrete fragments <0.5 cm as 90% through zone with 10% hard ferruginous/gossanaeous chips < 0.5 cm diameter	
	SAPROCK: Pale brown soft clayey saprock slight pale green tinge as 90% through zone with 10% lateritic debris/particles <1mm diameter	
	CLAY: Grey-pale brown dense clay 90% through zone with 10% lateritic/particles <1mm diameter	74-76m: Grey-brown dense highly aggregated clay
	CLAY: Grey densely aggregated clay as 70% through zone with 30% black lateritic/gossaneous siliceous particles <2mm diameter	77-77.5m: Cavity
-80	CAVITY: contact zone with calcrete/dolomite with dolerite? associated with this cavity- Major aquifer from 47 to 77.5m	76-78m: Airlift final test only available through reverse circulatio method 20litres/13 seconds-as lost outside return from 47 metres
	METASEDIMENTS: Dark grey slightly oxidised metasediments with some sedimentary layering evidents (greenschist metamorphics) as 90% through zone with 10% lateritc debris/particles	EOH at 82mbgl
	DOLOMITE AND SANDSTONE: Dark grey slightly oxidised dolomite becoming fresher rock condtions	77.5-82m: Mildly weathered dolomite/shale. Moderate yield -aquifer evident- unable to airlift as lost outside return- indicated high yielding aquifer
	DOLOMITE AND SANDSTONE: Dark grey slightly oxidised dolomite as 90% through zone with 10% brittle pale brown/grey shale	79-80m: Water sampled for analysis

COMPOSITE WELL LOG

Well No: F07B

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Client: Fortescue Metals Group **Project:** Christmas Creek Piezometer Monitoring Bore

Commenced:	13/09/2004	**Method:**	Airlift to 27m EOH.	**Area:**	Christmas Creek
Completed:	13/09/2004	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	782004m(AMG)
Drilled:	Connector	**Bit Record:**	5 3/8"	**North:**	7517844m(AMG)
Logged By:	RFToll			**Elevation:**	

Static Water Level: 14.0 mbgl **Date:** 14/09/2004; 07:00hrs

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Red-brown highly ferruginised lateritic chert fragments poorly sorted predominantly angular <3cm diameter with 30% poorly consolidated clay	26-27m: 2.94 ppt TDS, 8.64 pH, 5.88 mS initial test time 1 minutes 3.25 ppt TDS, 8.92 pH, 6.40 mS test time 10 minutes		150 mm PVC collar (0-3mbgl)
			ALLUVIAL: Red-brown highly oxidised alluvials as 80% in zone comprising chert fragments poorly sorted subangular <1mm diameter with 20% poorly aggregated clay	8.1 ppt TDS, 8.61 pH, 16.2 mS test time 15 minutes		
-10			ALLUVIAL: Red-brown highly ferruginised lateritic chert fragments poorly sorted predominantly angular <3cm diameter with 30% poorly consolidated clay	>10 ppt TDS , > 20 mS; test time 30 minutes - indicates only limited available fresh water water sampled for analyis 40 minutes 27m:>2.94ppt TDS 10 minutes test 8.64 pH @ 40 metres at 10 minutes of testing >5.88 mS 10 minutes of testing 20 minutes into test 3.25ppt TDS,8.72 pH, 6.4 mS		Slotted PVC with top cap and end cap (0-27mbgl)
-20			ALLUVIAL: Red-brown highly oxidised alluvials as 80% in zone comprising chert fragments poorly sorted subangular <1mm diameter with 20% poorly aggregated clay	30 minutes into test 8.1 ppt TDS, 8.61 pH, 16.22 mS 40 minutes into test >10.0 ppt TDS Sample taken for lab. (This sample's chemistry to be compared/related to tested water from 80 metres in F7A)		
			ALLUVIAL: Red-brown highly oxidised wet moderater flow in alluvial chert fragments poorly sorted subangular-subrounded <3cm diameter with moderately consolidated clay as 20% wet zone	Airlift final test only available through reverse circulation method 20litres/13 seconds-as lost outside return from 47 metres EOH at 27mbgl		

COMPOSITE WELL LOG

Well No: CC272

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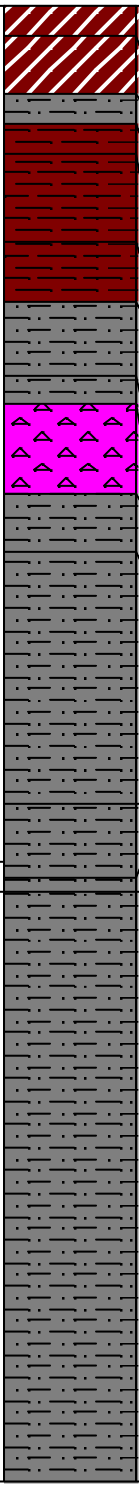
Client: Fortescue Metals Group
Project: Christmas Creek groundwater exploration

Commenced:	9/10/04	**Method:**	Reverse Circulation to 82m EOH	**Area:**	Christmas Creek
Completed:	9/10/04	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	780802m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches rods	**North:**	7526607m(AMG)
Logged By:	Steve Collett		5 3/8 inches	**Elevation:**	483mAHD

Static Water Level: 57.3mbgl
Date: 12/10/04

Depth (mbgl)	Lithological Description	Field Notes	Well Completion Notes
0	BIF: Light brown goethite BIF with maghaemite pisoliths to 20%, minor limonite.		pvc plain 150 mm collar (0-4mbgl)
	BIF: Brown banded goethite/limonite (goethite 80%).		
	SHALE: Brown limonitic shale.		
-10	SHALE/CHERT: Brown banded chert and goethite 50%.		
	SHALE/CHERT: Brown interbedded sequence of thin beds of chert and limonitic kaolin shale.		
-20	CHERT/SHALE: White chert and kaolin shale.		
	SHALE: Red brown varicoloured, weathered shale (kaolin), interbedded with thin beds of siliceous shale and chert, 0.3 m thick making up about 30% of sample.		
-30	SHALE: White kaolin shale.		
	CHERT: Yellow-brown laminated, limonitic chert.		
	SHALE: Light red brown, interbedded chert and kaolin shales.		
-40	SHALE: Red - light brown and brown interbedded cherts and kaolin shales.		
-50	SHALE: White porcelaneous kaolin shale.		
	SHALE: Red-brown shale.	58-60mbgl: Trace water from transition from ox to fresh carbonaceous shale, not enough water for chemical testing.	
-60	SHALE: Black carbonaceous shale, pyrite to 10%. pyrite fine and formed along cleavage planes.		
-70			
-80			
-90			
-100		EOH at 100mbgl	



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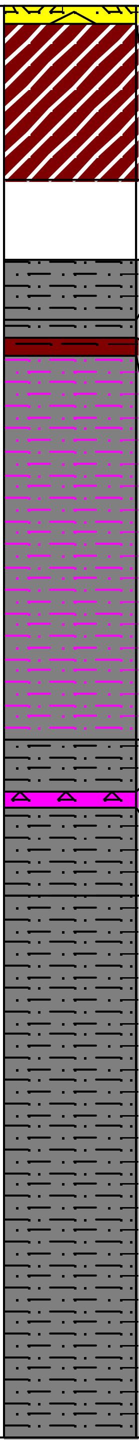
COMPOSITE WELL LOG

Well No: CC133

Client: Fortescue Metals Group
Project: Christmas Creek groundwater exploration

Commenced:	8/10/04	**Method:**	Reverse Circulation to 82m EOH	**Area:**	Christmas Creek
Completed:	8/10/04	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	785602m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches rods	**North:**	7525499m(AMG)
Logged By:	Steve Collett		5 3/8 inches	**Elevation:**	485mAHD

Static Water Level: 53.85mbgl
Date: 12/10/04

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			COLLUVIUM: Red brown goethite-hematite BIF with chert to 10% and minor amount of maghaemite pisoliths.			T.O.C. +0.15magl pvc plain 150 mm collar (0-4mbgl)
			BIF: Brown banded goethite, minor chert/limonoite (shale like).			
-10			JASPILITE: Brown magnetite/ goethite rich chert. Minor limonite dust.			
			SHALE: Tan limonitic kaolin shale.			
			SHALE: Red-brown hematite rich kaolin shale.			
-20			CHERT/SHALE: Brown, dark grey chert interbedded with brown kaolinitic shale.			
			SAPROCK/SHALE: Light to dark brown varicoloured weathered shale (kaolin), interbedded with thin beds of siliceous shale and chert 0.3 m thick, making up about 30% of sample.			
-30						
-40			SHALE: Light grey soft carbonaceous shale.			
			CHERT: Brown laminated chert.			
			SHALE: Red brown kaolin shale hematite stained (slightly water bearing).			
-50			SHALE: Black carbonaceous shale, pyrite rich 61, 64 and 79-82m.	54-57mbgl: Minor yields from transition from ox to fresh carbonaceous shale. E.C. = 1.86mS/cm TDS = 0.91ppt pH = 8.7 Airlift Yield = 0.1L/s		
-60						
-70						
-80				EOH at 82mbgl		

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COMPOSITE WELL LOG

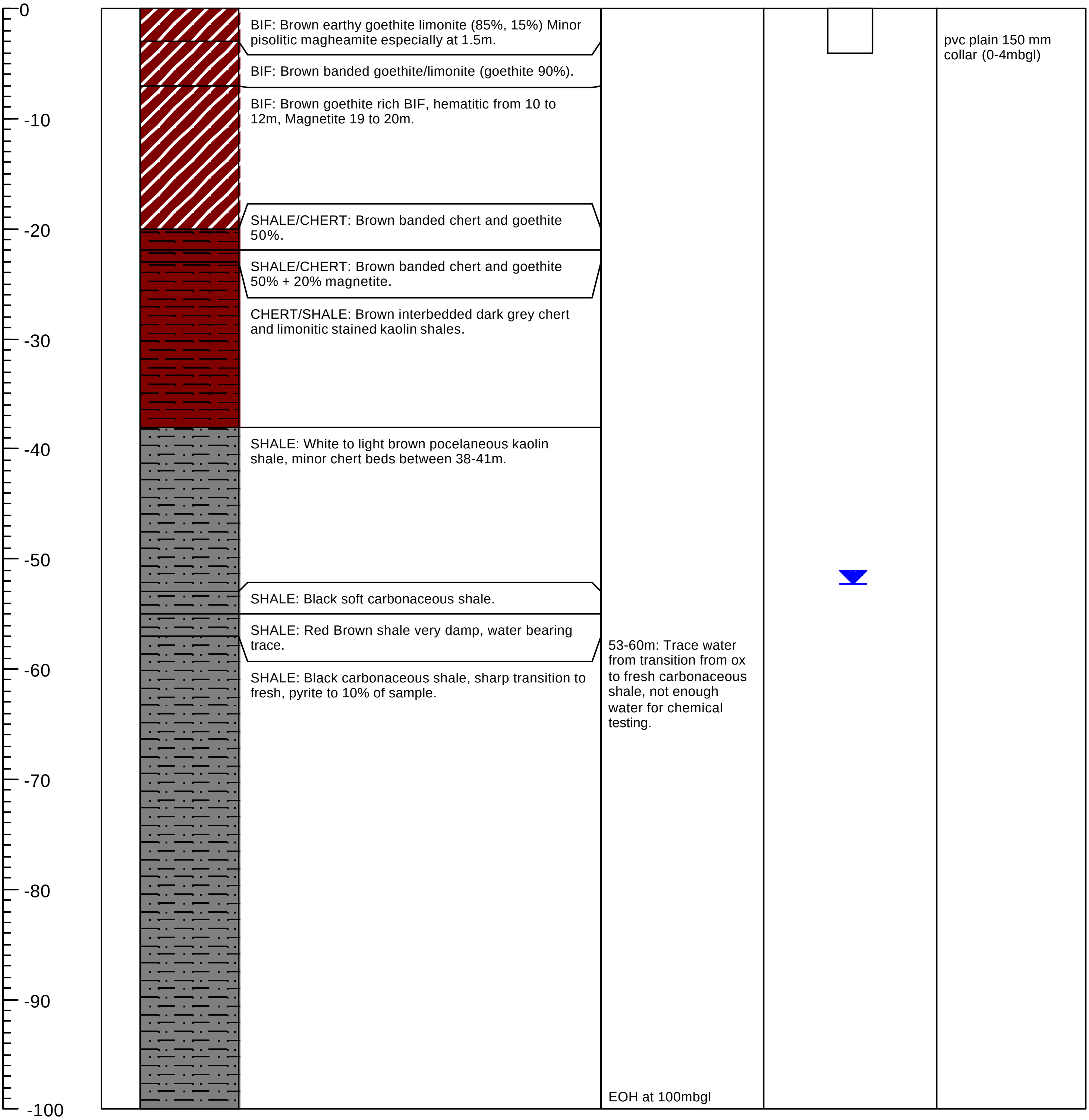
Well No: CC106

Client: Fortescue Metals Group | **Project:** Christmas Creek groundwater exploration

Commenced:	9/10/04	**Method:**	Reverse Circulation to 82m EOH	**Area:**	Christmas Creek
Completed:	10/10/04	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	787997m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches rods	**North:**	7524000m(AMG)
Logged By:	Steve Collett		5 3/8 inches	**Elevation:**	501mAHD

Static Water Level: 52.3mbgl | **Date:** 12/10/04

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes



Lithological Description

BIF: Brown earthy goethite limonite (85%, 15%) Minor pisolitic magheamite especially at 1.5m.

BIF: Brown banded goethite/limonite (goethite 90%).

BIF: Brown goethite rich BIF, hematitic from 10 to 12m, Magnetite 19 to 20m.

SHALE/CHERT: Brown banded chert and goethite 50%.

SHALE/CHERT: Brown banded chert and goethite 50% + 20% magnetite.

CHERT/SHALE: Brown interbedded dark grey chert and limonitic stained kaolin shales.

SHALE: White to light brown pocelaneous kaolin shale, minor chert beds between 38-41m.

SHALE: Black soft carbonaceous shale.

SHALE: Red Brown shale very damp, water bearing trace.

SHALE: Black carbonaceous shale, sharp transition to fresh, pyrite to 10% of sample.

Field Notes

53-60m: Trace water from transition from ox to fresh carbonaceous shale, not enough water for chemical testing.

EOH at 100mbgl

Well Completion Notes

pvc plain 150 mm collar (0-4mbgl)

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COMPOSITE WELL LOG

Well No: CC503

Client: Fortescue Metals Group **Project:** Christmas Creek groundwater exploration

Commenced:	8/10/04	**Method:**	Reverse Circulation to 82m EOH	**Area:**	Christmas Creek
Completed:	9/10/04	**Fluid:**	2000 cfm 700 psi (Hydco C4)	**East:**	784404m(AMG)
Drilled:	Connector R3	**Bit Record:**	4 inches rods	**North:**	7523390m(AMG)
Logged By:	Steve Collett		5 3/8 inches	**Elevation:**	454mAHD

Static Water Level: 35.62mbgl **Date:** 12/10/04

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion: Diagram	Well Completion: Notes
0 – 8			BIF: Light brown limonite goethite, BIF and minor amount of maghemite pisoliths 10%.			T.O.C. +0.35magl pvc plain 150 mm collar (0-4mbgl)
8 – 21			BIF: Brown banded goethite, minor limonite to 20%.			
21 – 23			SHALE: Yellow-brown limonite silt and kaolin shale.			
23 – 29			CHERT: Red-brown predominantly chert and jaspilite, minor thin interbedded kaolin shale.			
29 – 33			BIF: Brown banded goethite /magnetite.			
33 – 58			CHERT/SHALE: Brown weathered sequence of dark grey chert - red jaspilite interbedded with brown kaolinitic shale. Water contributing zones from chert margins, no obvious major zone of contribution.	36-58mbgl: Generally water bearing, small graduations in water yields from intersected chert beds. E.C. = 1.05mS/cm TDS = 0.52ppt pH = 8.66 Airlift Yield = 0.78L/s		
58 – 70			SHALE/CHERT: Dark grey interbedded black, carbonaceous shale with thin chert beds, pyrite to 5% in shale. Very tight and dry.	EOH at 70mbgl		

Depth scale: 0, -10, -20, -30, -40, -50, -60, -70

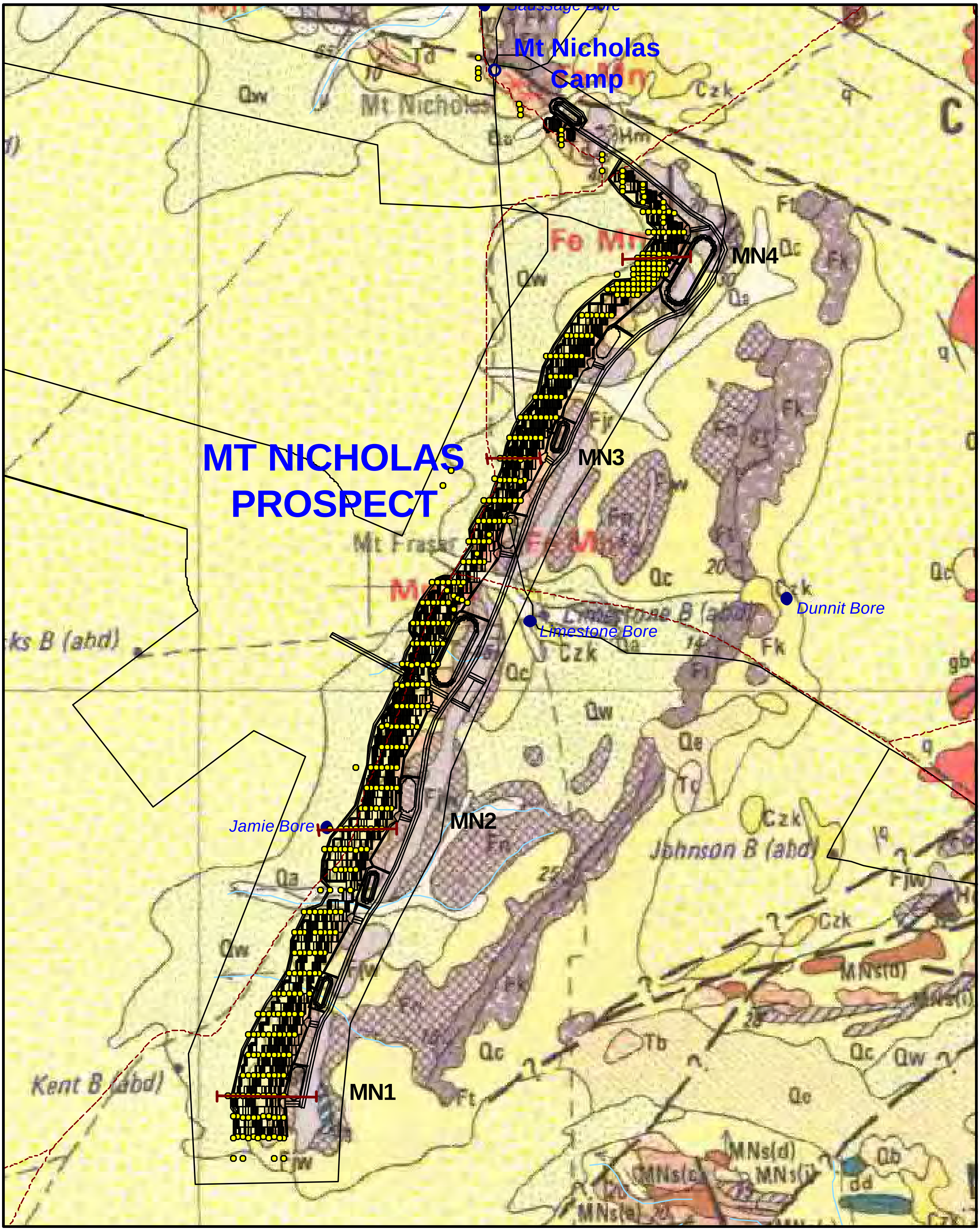
A3: Summary of Airlifting Testing Analysis

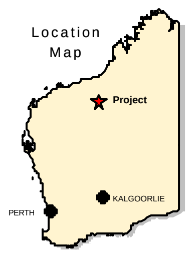
Hole Id	Easting	Northing	Hole Depth (m)	Depth to Water Level (m)	Airlift Yield (L/s)	Minor Aquifer From (m)	Minor Aquifer To (m)	Main Aquifer From (m)	Main Aquifer To (m)	Permeability
WSE061	237049	7470865	52	21.4	0.6			45	46.5	6.27
WSE062	237410	7469608	64	17.65	0.5	42	46	16	18	4.14
WSE053	239786	7480864	106	44.4	0.57	76	77	87	88.5	0.40
WSE054	240291	7479770	69		0.25	48	53			0.04
WSE024	243383	7483847	127	43.35	4	70	74	100	115	0.00
WSE057	242867	7483823	117	40.66	1.5	54	58	104	117	0.00
WSE041	222652	9491938	120	21	2	46	47	69	71	0.12
WSE038	229314	7494092	115	35.85	2	66	83	87	102	0.00
WSE037	230070	7492263	58	32.35	0.1	44	47	64	66	0.01
WSE028	237680	7494413	106	48.75	1.5	58	59	76	79	1.13
WSE031	237485	7493481	136	46.6	3.8	68	109	109	134	0.72
ML288	211400	7490400	76	9.3	3.5	10	40	40	76	0.01
ML305	212600	7490600	70	13.65	7	14	50	50	70	1.82
ML173	212600	7491700	46	19.5	0.1	20	42	42	46	0.02
ML196	209000	7493700	70	20.6	3	22	40	40	58	0.05
MN270	208200	7493600	70	20.2	3.2	22	52	52	70	0.37
WSE42B	222325	7477310	52	8.38	1	28	30	46	48	0.37
E24	7515683	789150	106	15.35	4	42	69	70	80	0.25
E23	7516292	788886	89	15.03	3	24	56	69	86	0.78
E17	7519861	787410	70	29.03	2.5	35	43	58	63	0.50
E16	7520250	787700	64	30.4	0.66	40	44	50	59	0.68
E15	7520453	787028	74	31.4	1.8	35	70			0.96
E14	7520987	786449	76	29.15	2	57	59	63	72	0.55
E07	7523704	782411	79	32.2	1	50	61	67	75	0.77
E19B	7518541	787422	82	21.95	1	28	42			0.85
F05	7513285	793178	68	13.45	1	22	42	65	68	1.18

APPENDIX B

CROSS SECTIONS

B1: Mount Nicholas





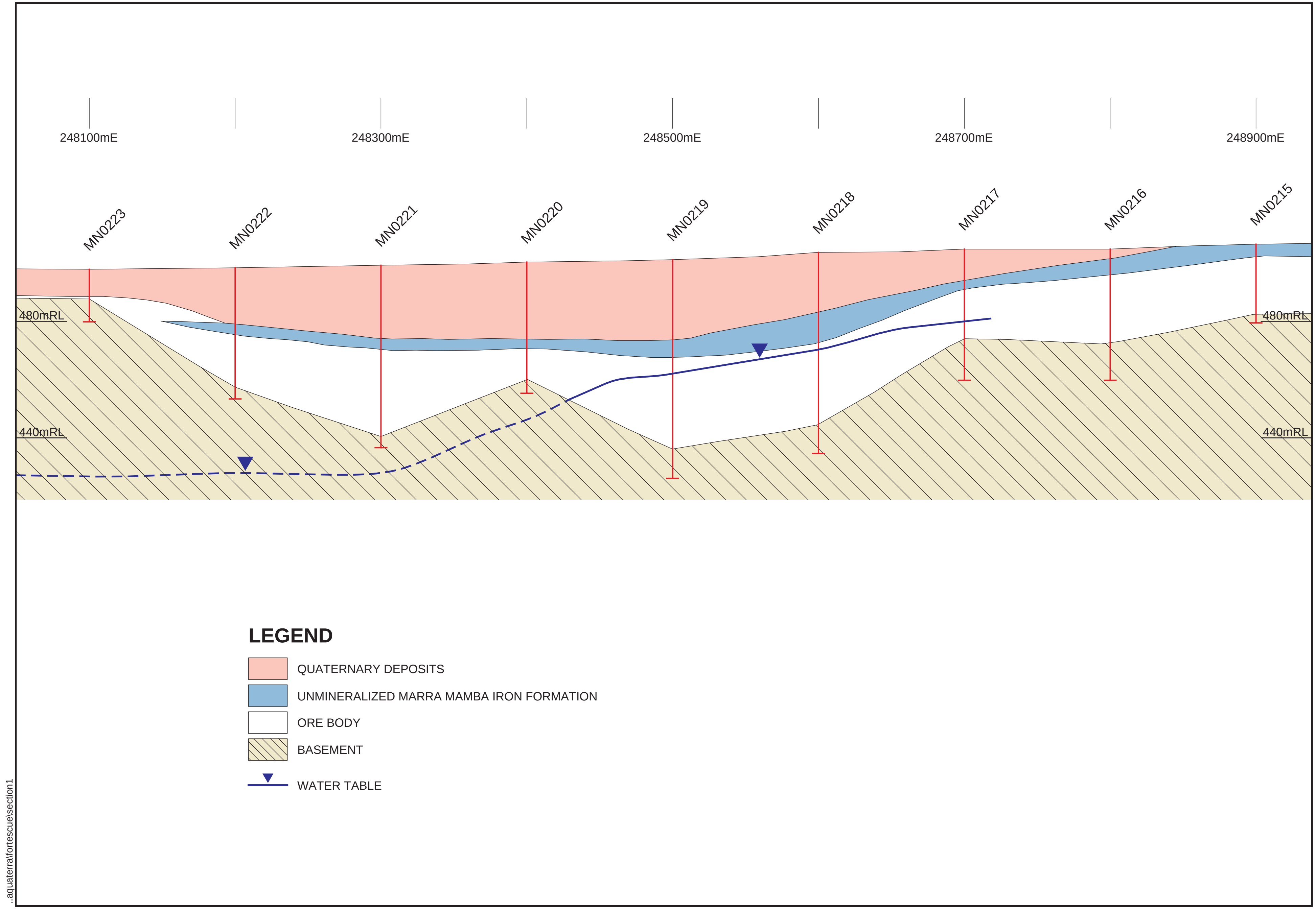
N

0 2 4 km

Fortescue Metals Group Limited

Appendix B1 Plan showing the location of cross sections across MT Nicholas

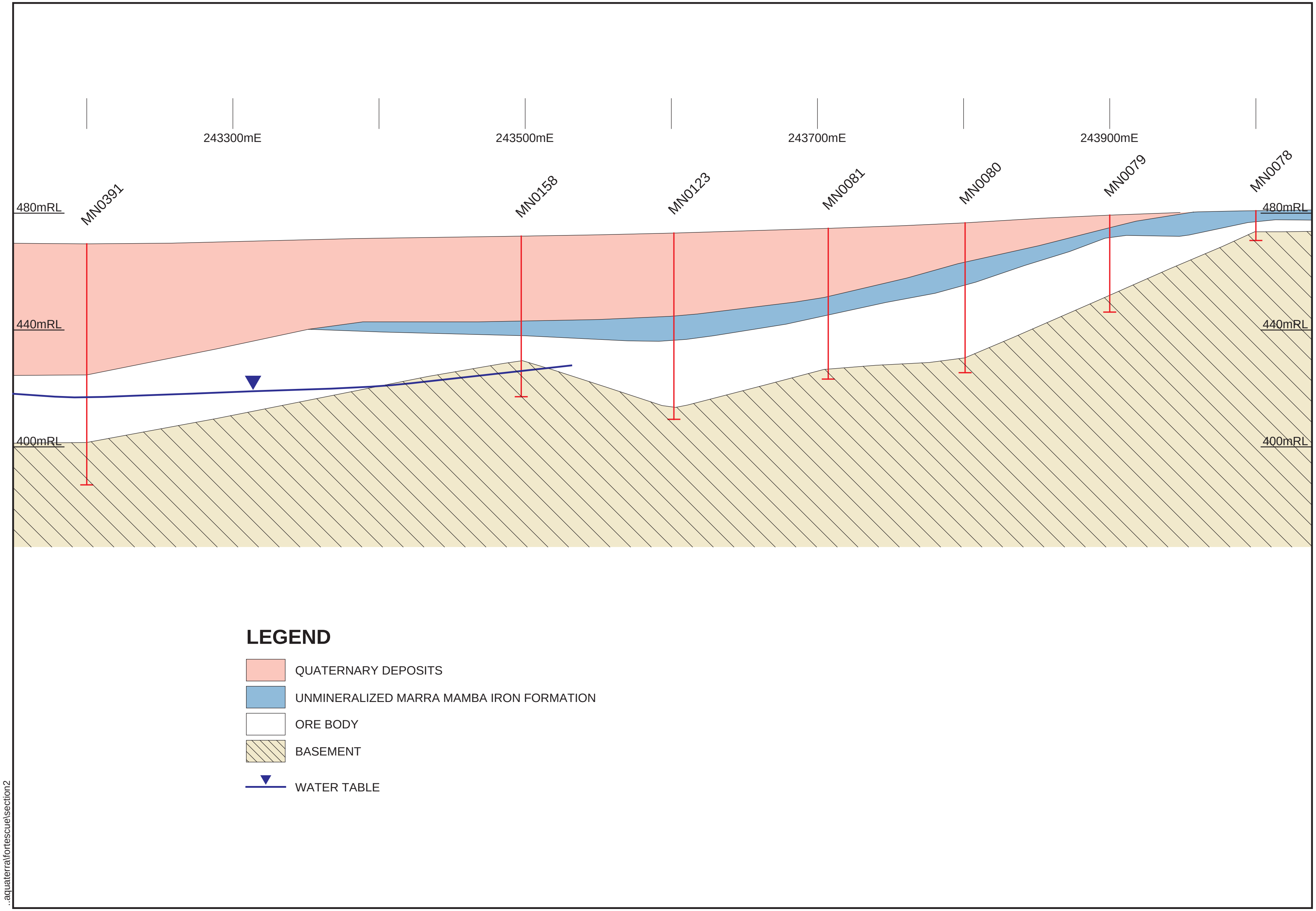
Author: Aquaterra	Date: 10/11/04
Drawn By: Barbara Zakrzewska	Revised:
Dwg No.: Appendix B1	Report No.: 477
Projection: AMG zone 50 (AGD 84)	Scale: 1 : 100 000



aquaterra

Section 1

FIGURE MNN



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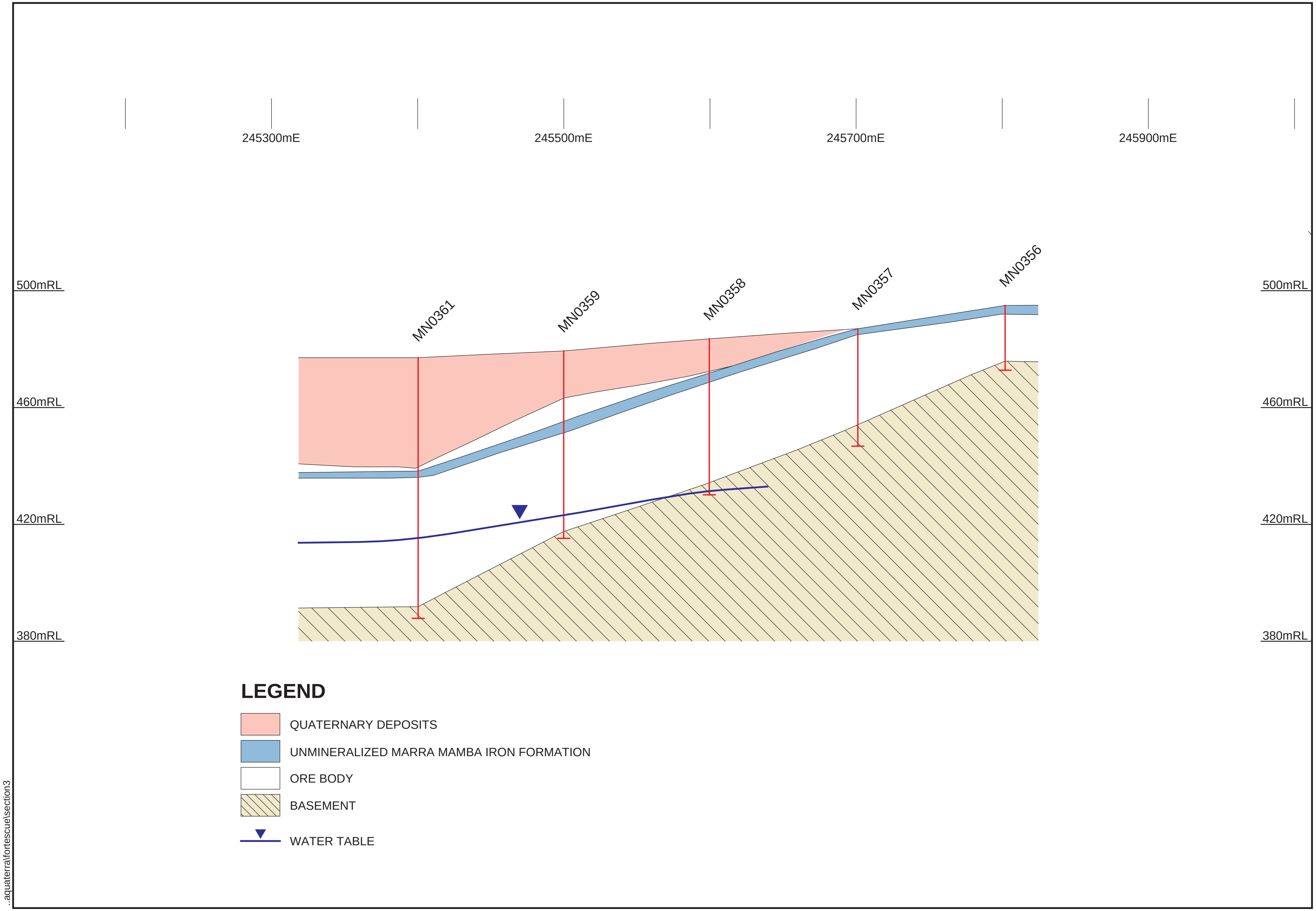
Section 2

FIGURE MN2



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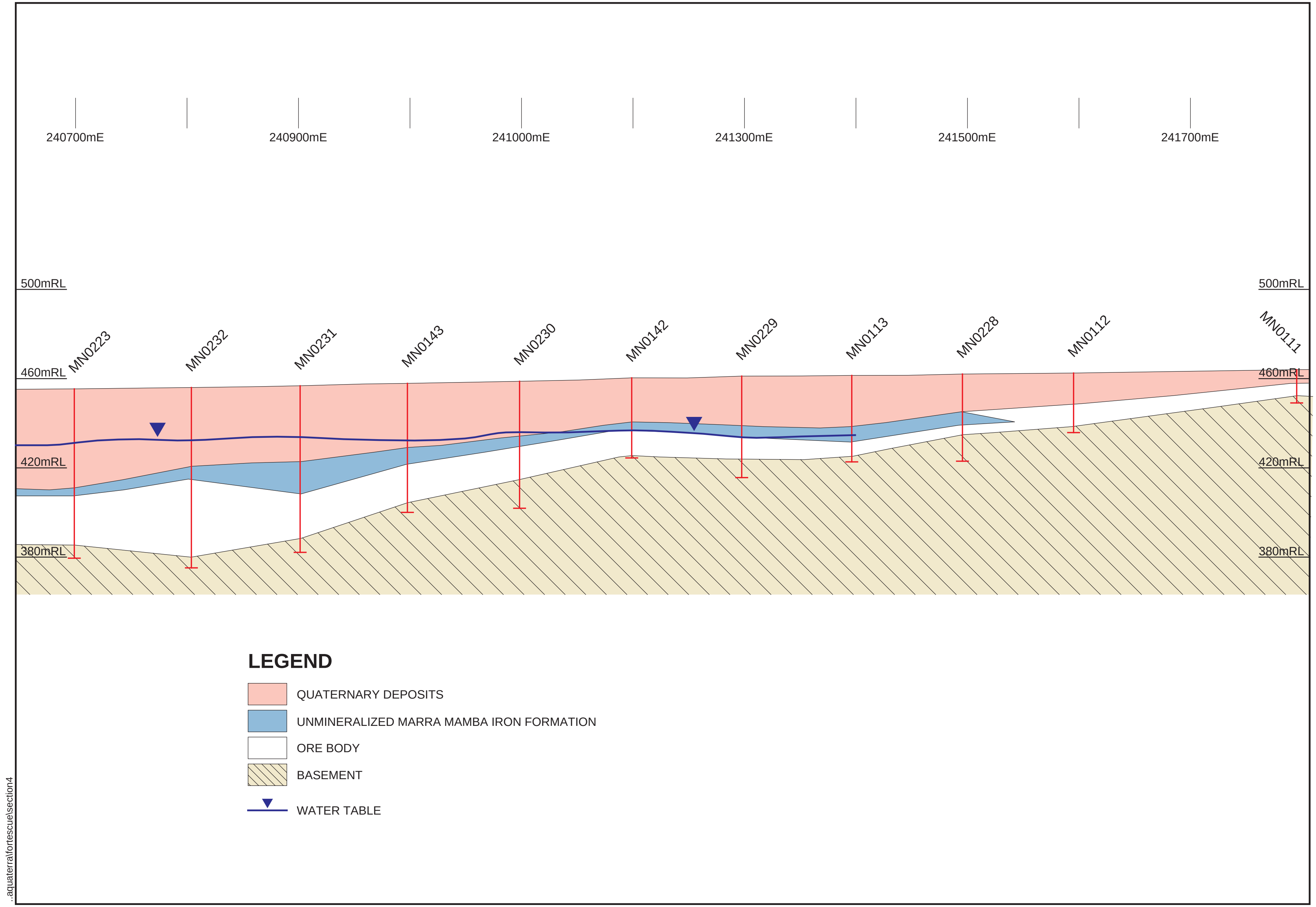
Section 3

FIGURE MN3



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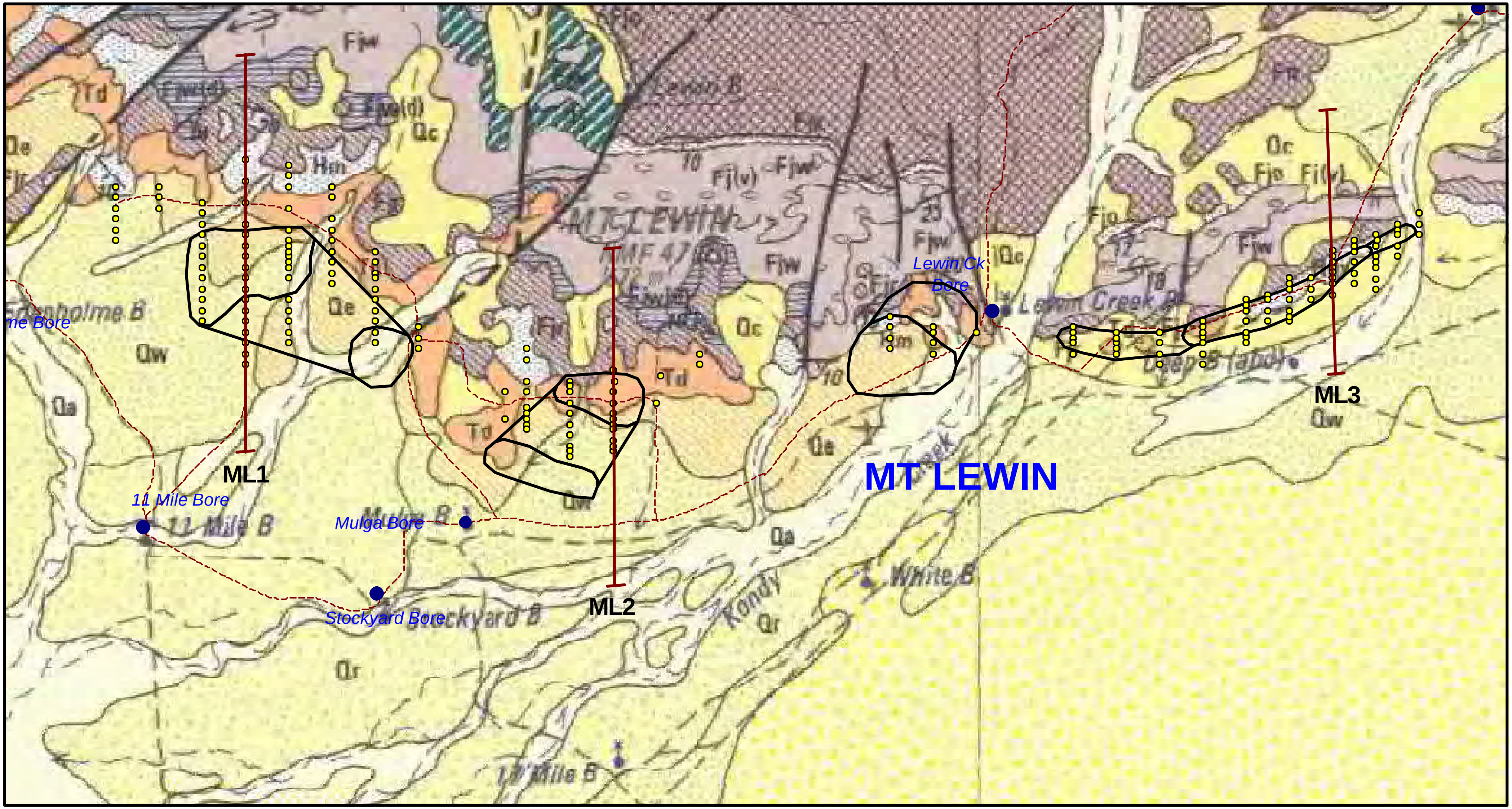
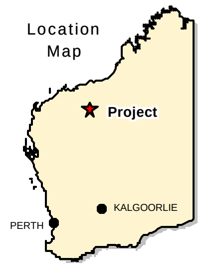
Section 4

FIGURE MN1

B2: Mount Lewin





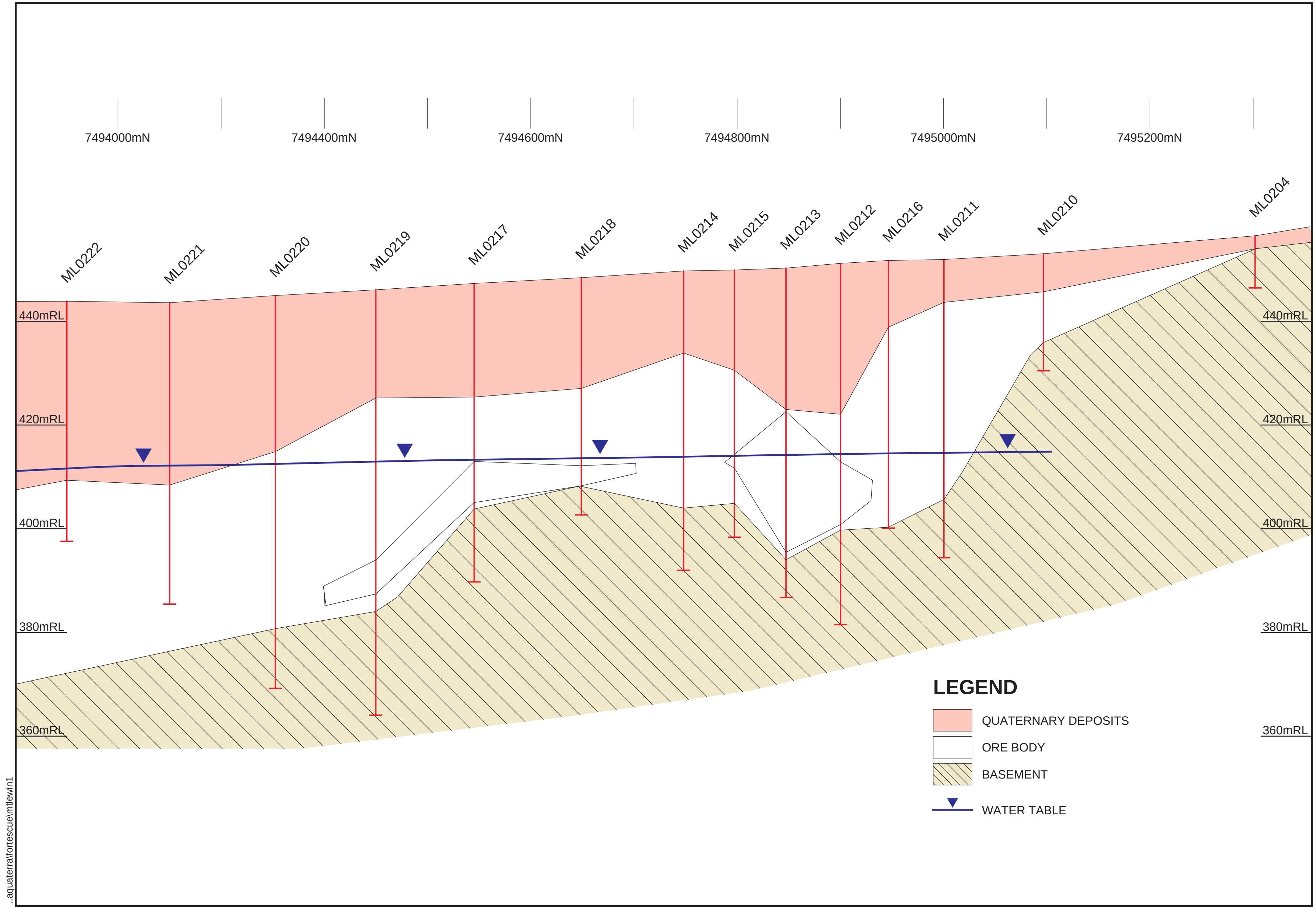
N

0 2 4 km

Fortescue Metals Group Limited

Appendix B2 Plan showing the location of cross sections across MT Lewin

Author: Aquaterra	Date: 9/11/04
Drawn By: Barbara Zakrzewska	Revised:
Dwg No.: Appendix B2	Report No.: 477
Projection: AMG zone 50 (AGD 84)	Scale: 1 : 100 000



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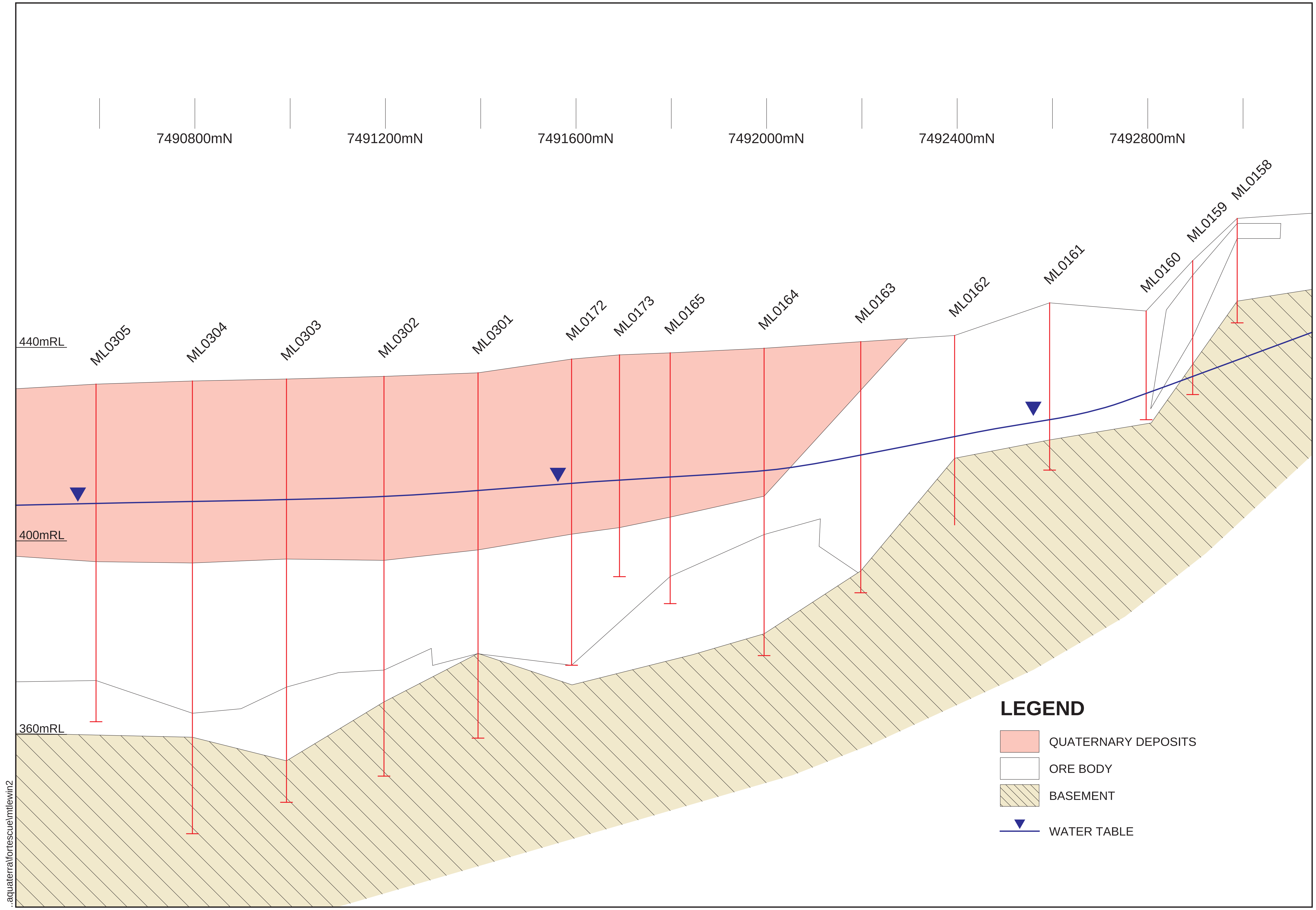
Mt Lewin Section 1

Figure ML1



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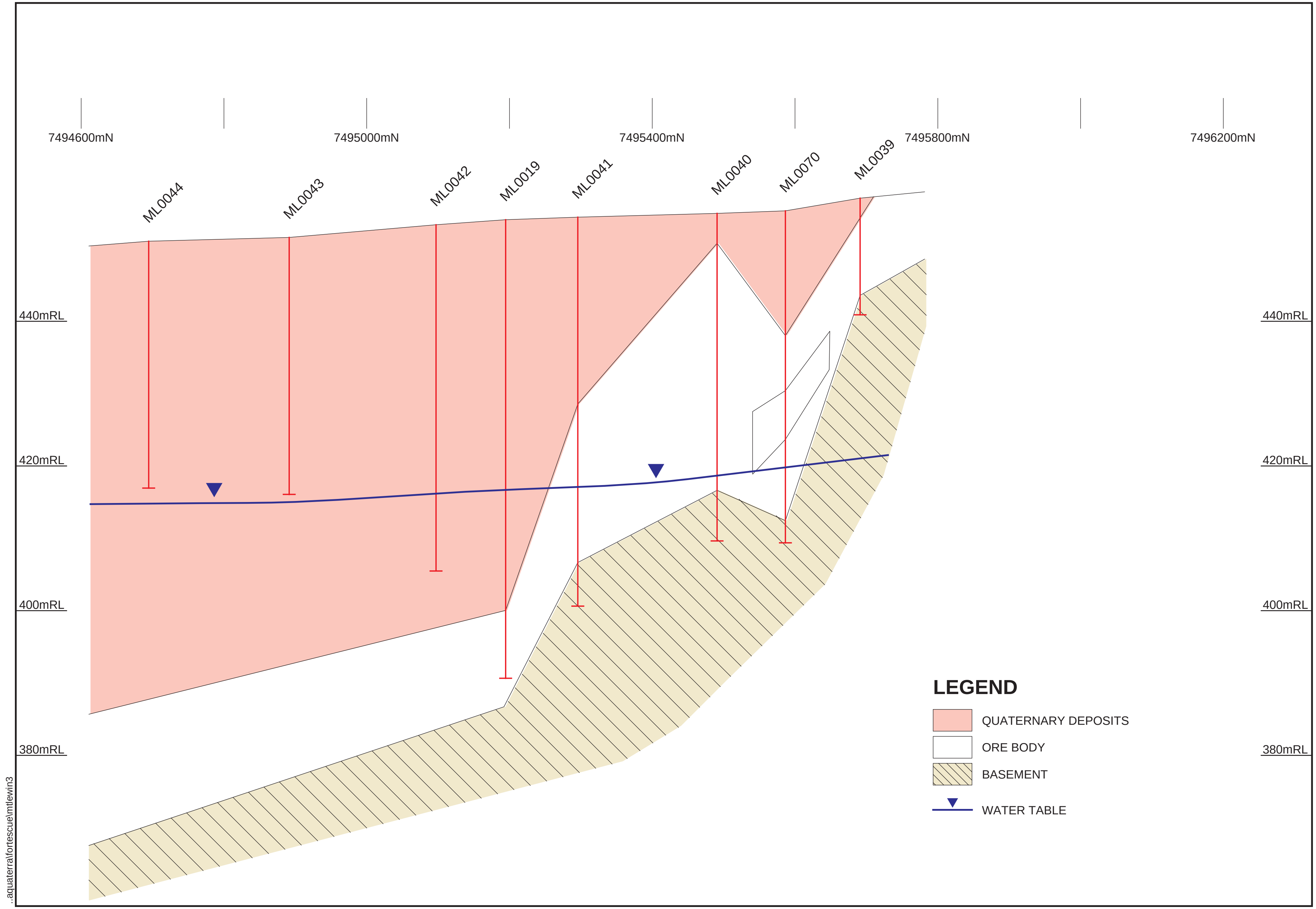
Mt Lewin Section 2

Figure ML2



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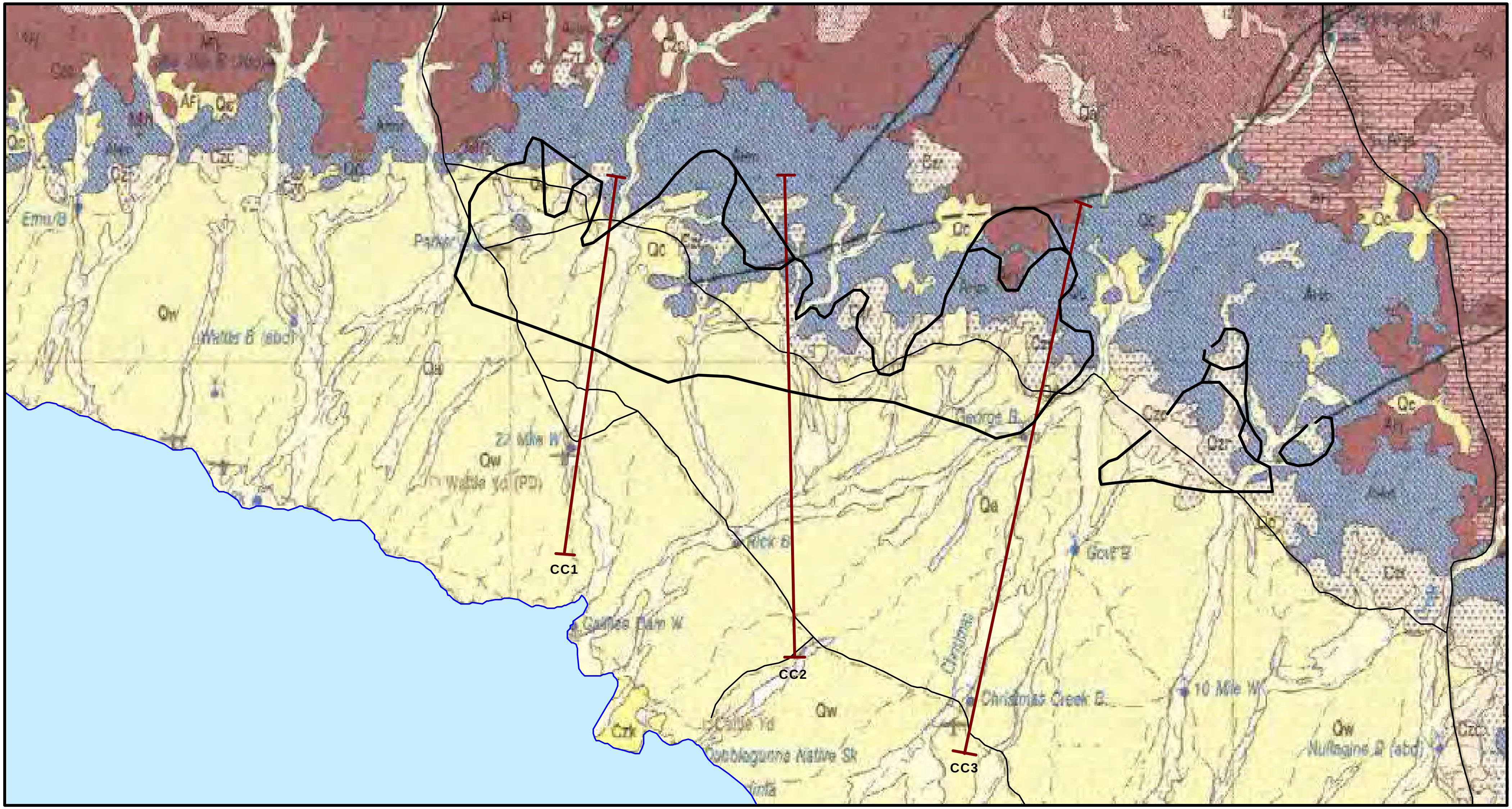
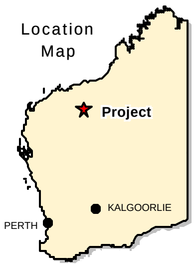
Mt Lewin Section 3

Figure ML3

B3: Christmas Creek





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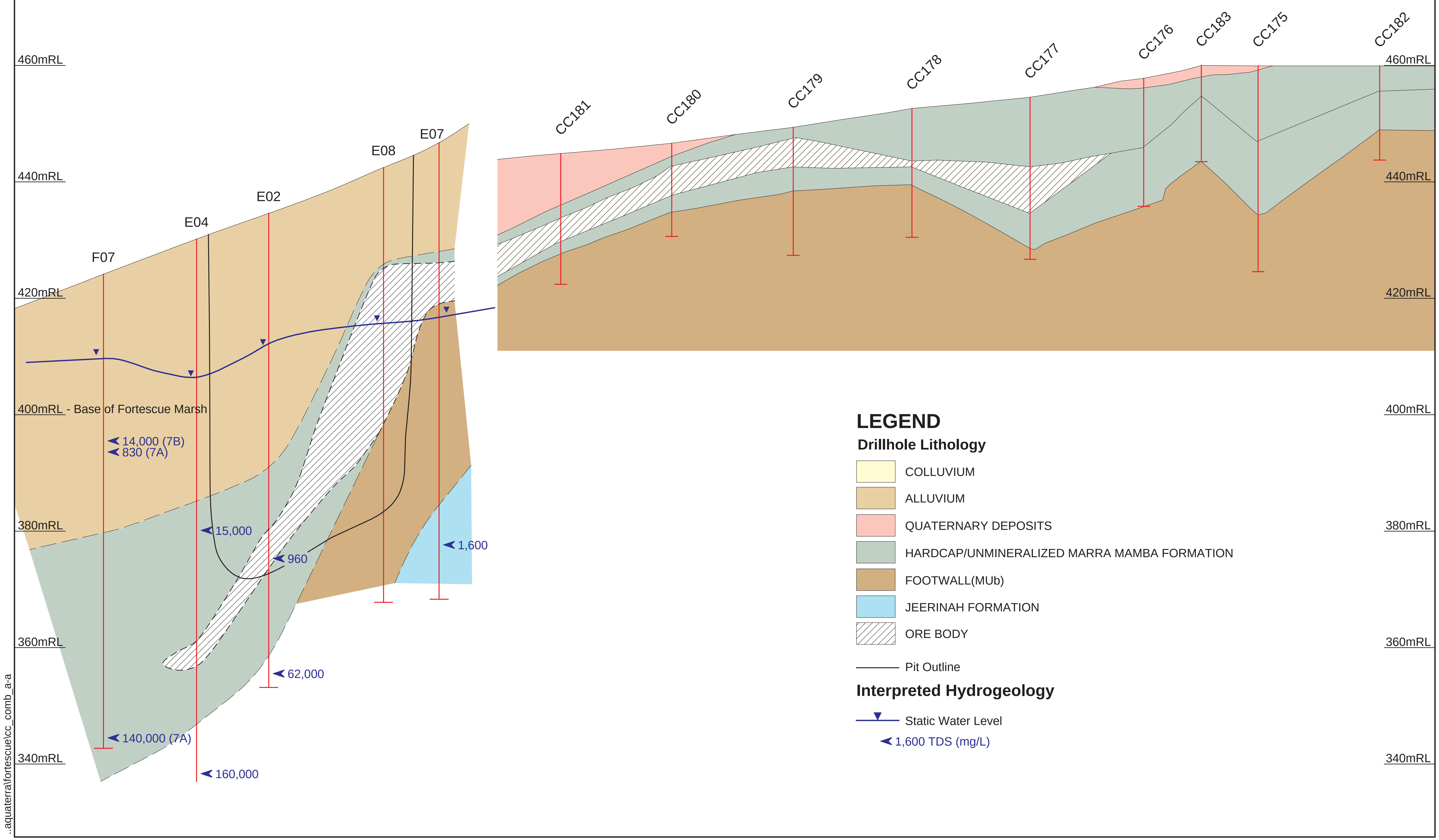
Fortescue Metals Group Limited

Appendix B3 Plan showing the location of cross sections across Christmas Creek

Author: Aquaterra	Date: 15/11/04
Drawn By: Barbara Zakrzewska	Revised:
Dwg No.: Appendix B3	Report No.: 477
Projection: AMG zone 50 (AGD 84)	Scale: 1 : 150 000

SECTION CC1



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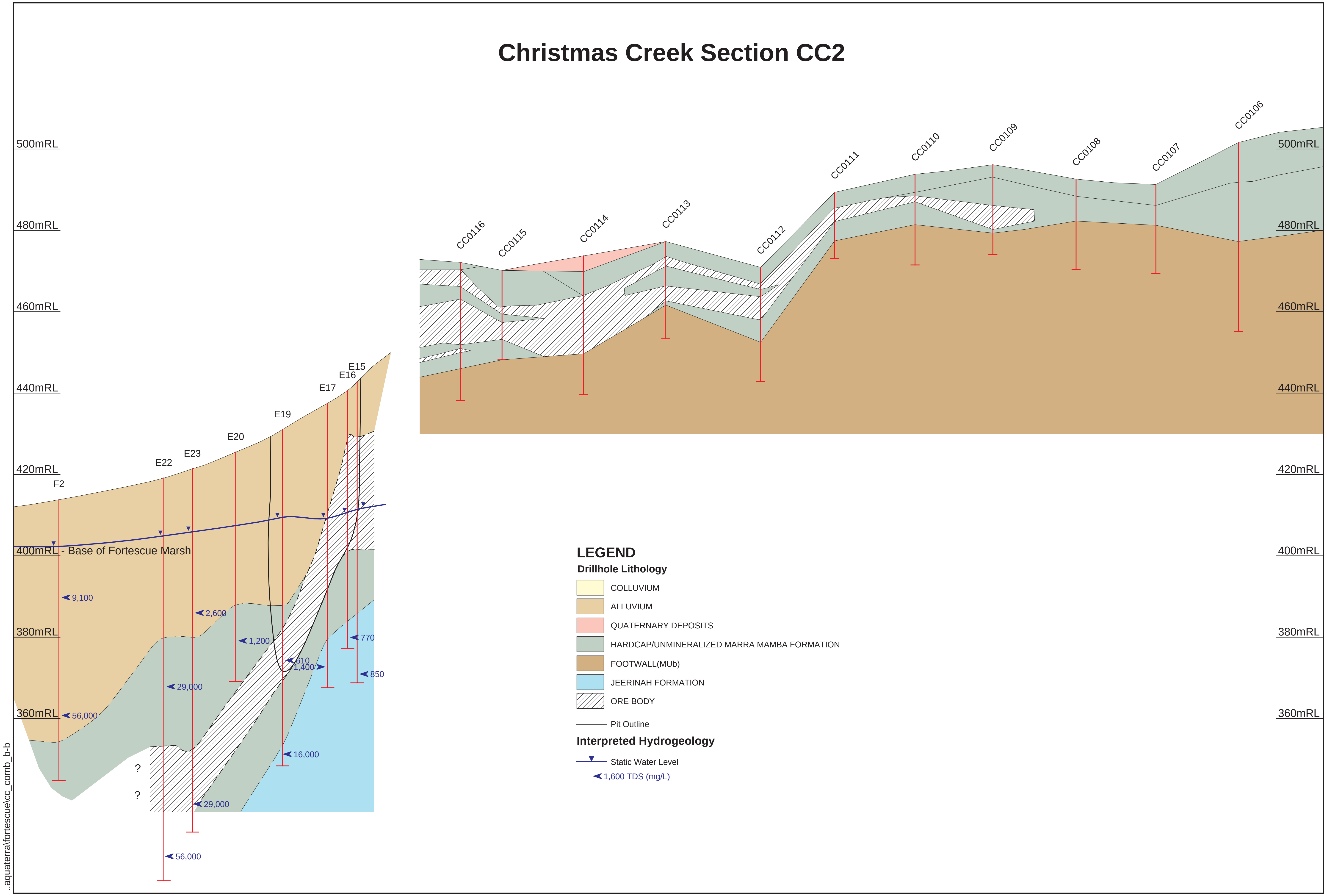
Christmas Creek Hydrogeological Section

APPENDIX B3 FIGURE CC1

Christmas Creek Section CC2



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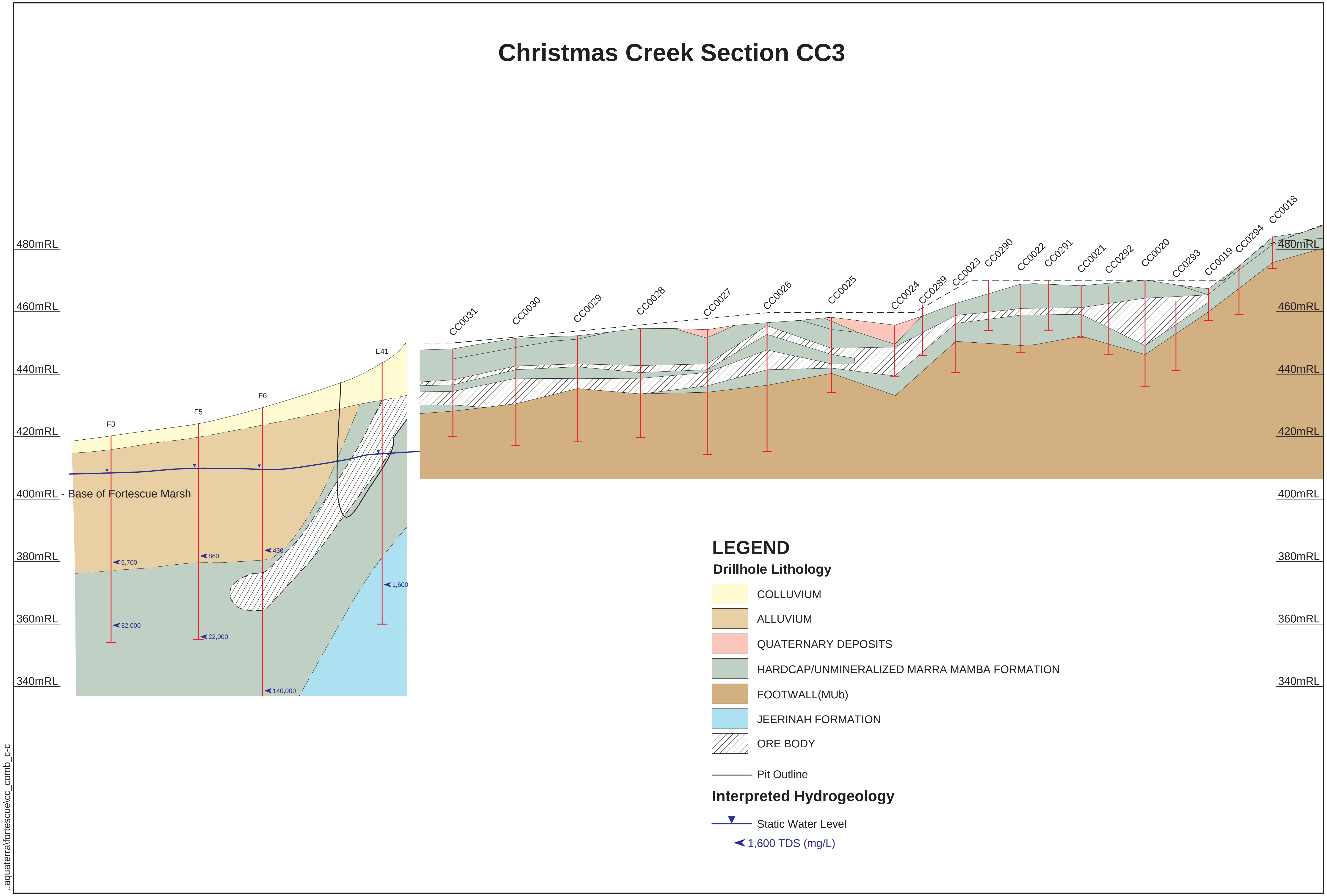
Christmas Creek Hydrogeological Section

APPENDIX B3 FIGURE CC2



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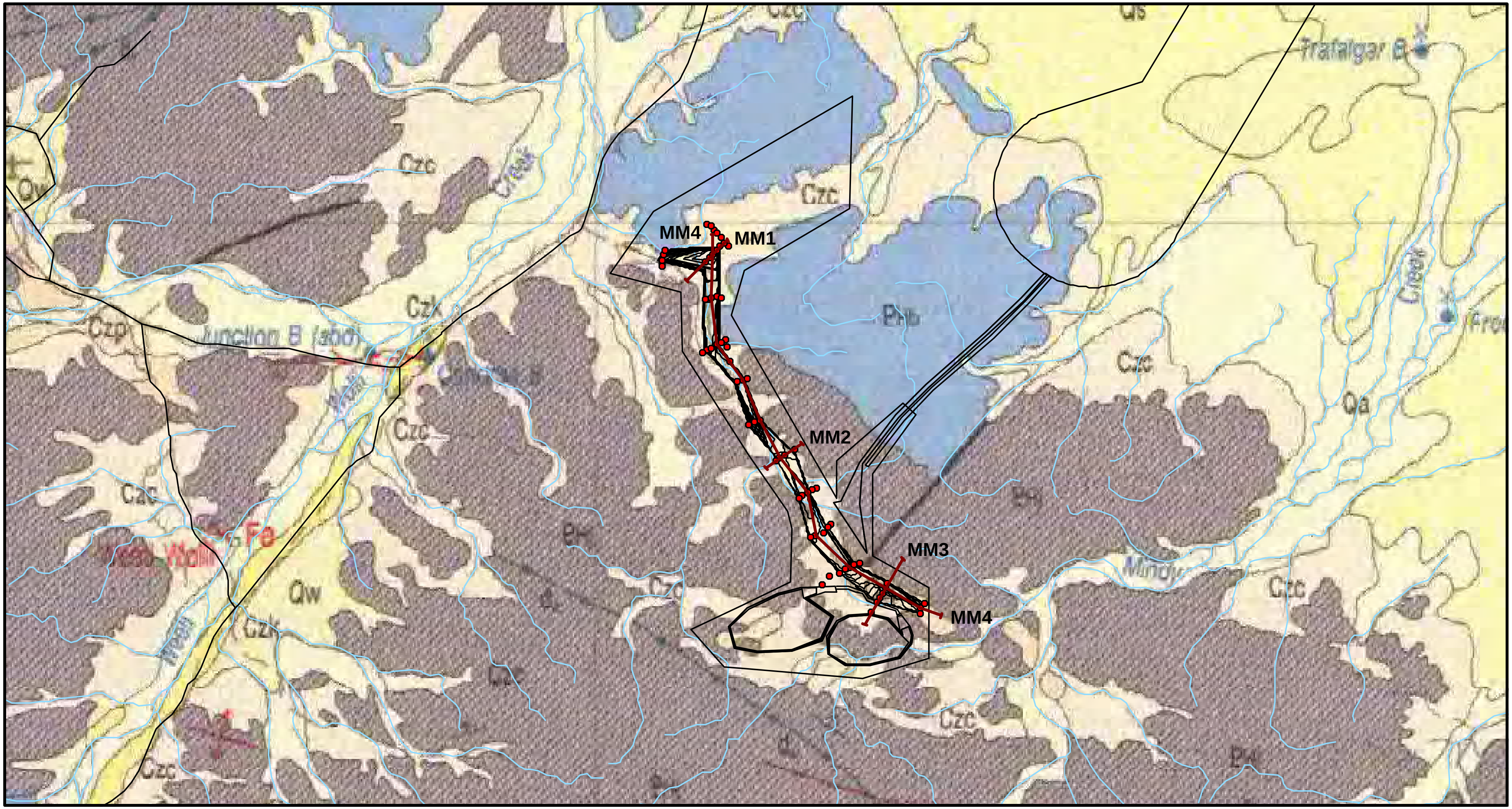
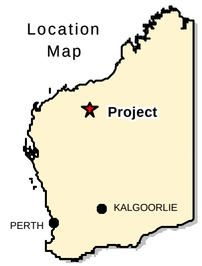
Christmas Creek Hydrogeological Section

APPENDIX B3 FIGURE CC3

B4: Mindy Mindy





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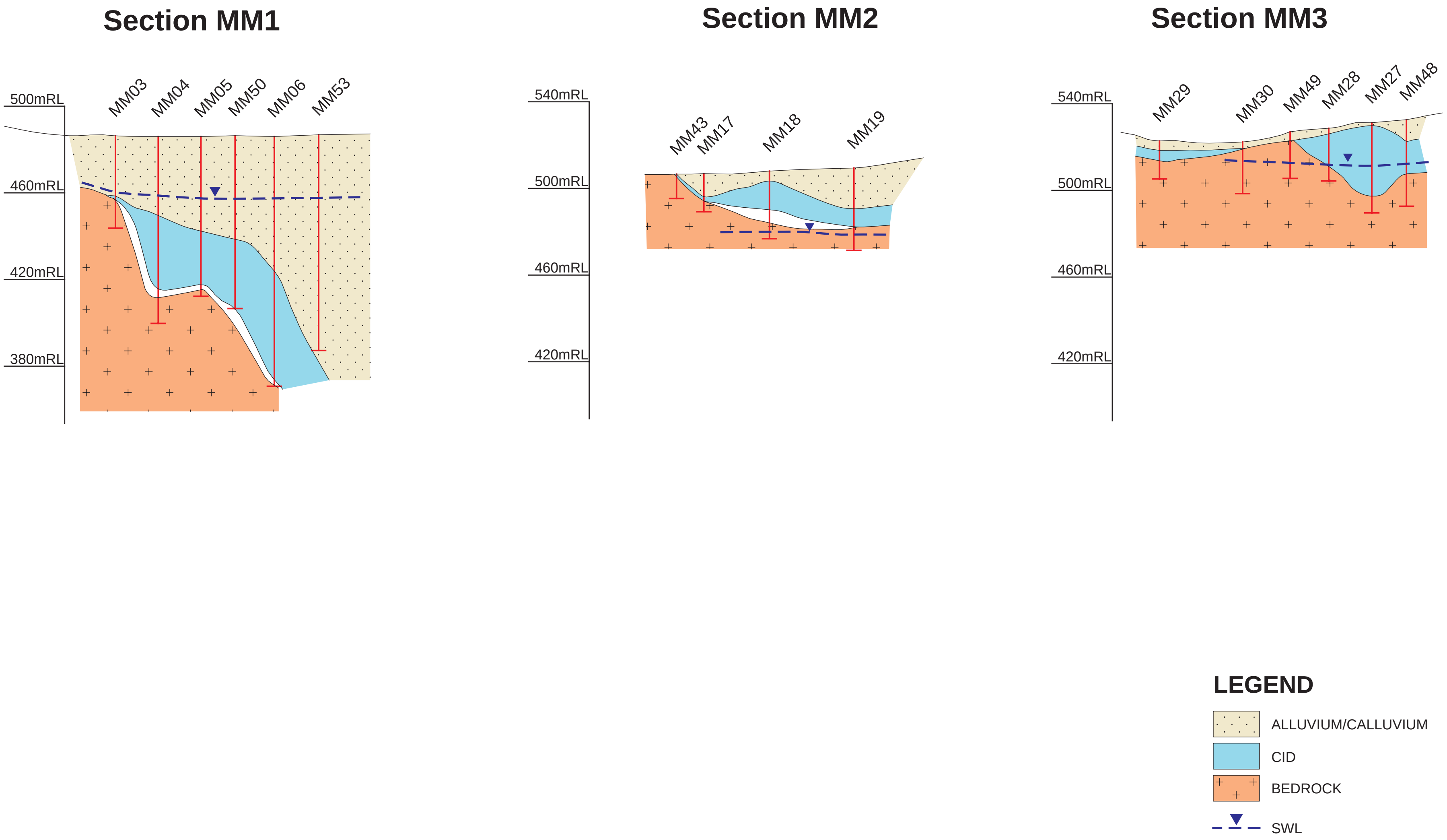
Fortescue Metals Group Limited

Appendix B4 Plan showing the location of cross sections across Mindy Mindy

Author: Aquaterra	Date: 9/11/04
Drawn By: Barbara Zakrzewska	Revised:
Dwg No.: Appendix B4	Report No.: 477
Projection: AMG zone 50 (AGD 84)	Scale: 1 : 100 000

Mindy Mindy Sections



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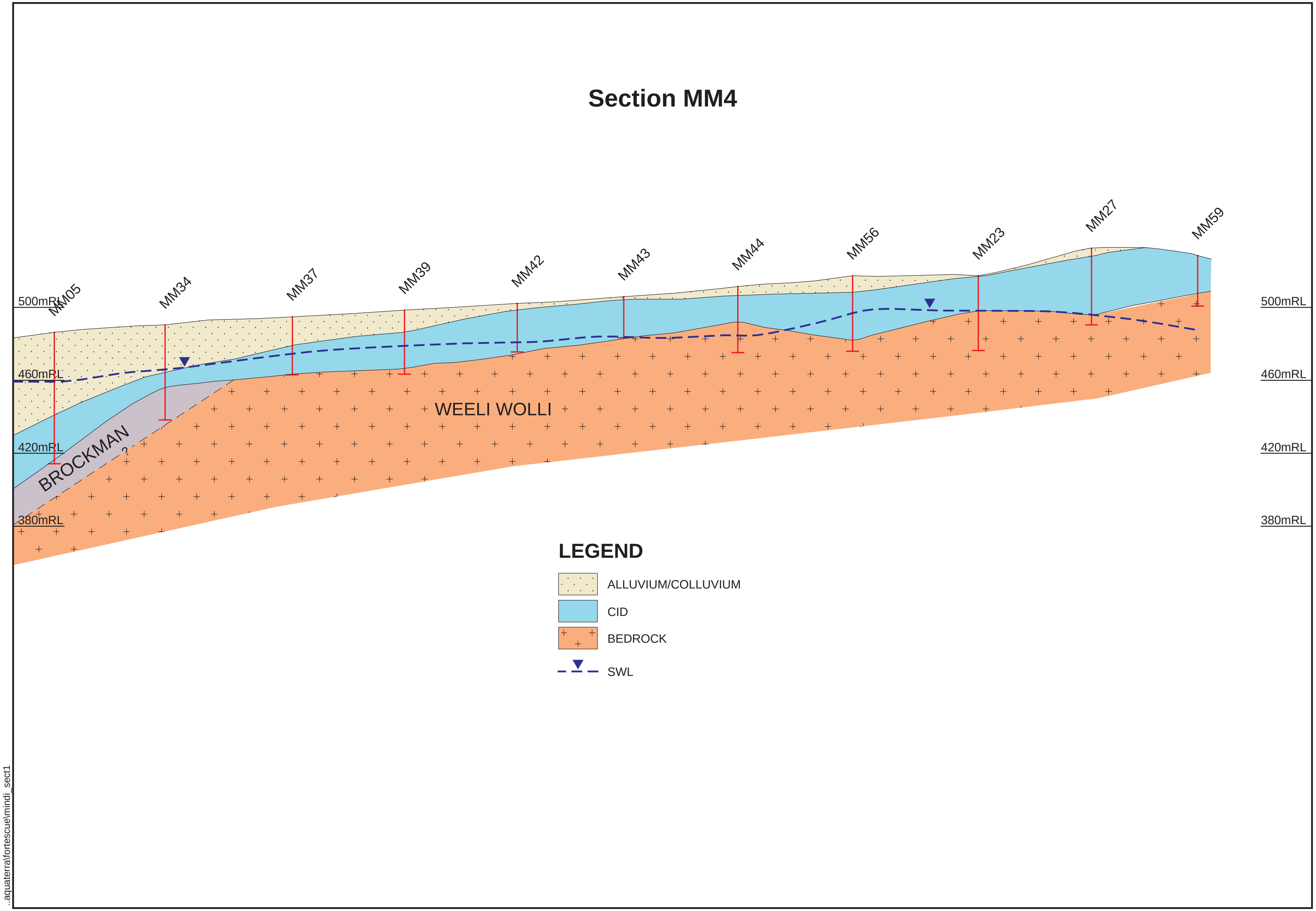
Mindy Mindy Hydrogeological Sections

APPENDIX B4 FIGURES MM1, MM2 & MM3



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Mindy Mindy Hydrogeological Section

APPENDIX B4 FIGURE MM4

APPENDIX C

WATER QUALITY RESULTS

Samples from Bores around the Water Supply Borefield

Your Reference	--	WSE 24	WSE 28	WSE 31	WSE 37	WSE 38	WSE 41	WSE 42B	WSE 51	WSE 53	WSE 54	WSE 57	WSE 61	WSE 62	ML 196	ML224	ML 288	ML 302	ML 305				
Date Sampled:	--	13/08/2004	26/08/2004	27/08/2004	25/08/2004	24/08/2004	23/08/2004	10/09/2004	20/08/2004	11/08/2004	12/08/2004	20/08/2004	1/08/2004	1/08/2004		14/10/2004	28/08/2004		28/08/2004				
PH	pH Units	7.9	8.1	8.1	7.6	7.5	7.9	7	7.6	7.8	7.8	7.8	7.6	7.7	7.8	7.7	7.7	8	7.8				
Electrical Conductivity @ 25oC	?S/cm	2,500	970	1,000	4,100	2,000	4,400	560	1,600	1,600	1,000	2,600	2,200	1,800	2,200	1,500	2,500	2,800	2,200				
Total Dissolved Solids (calc as NaCl)	mg/L	1,600	620	640	2,600	1,300	2,800	360	990	1,000	670	1,700	1,400	1,100	1,400	990	1,600	1,800	1,400				
Iron, Fe (soluble)	mg/L	<0.05	0.15	0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05				
Sodium, Na	mg/L	300	120	130	650	190	710	82	160	170	100	330	250	170	230	120	230	180	190				
Potassium, K	mg/L	28	24	13	54	30	59	16	26	26	22	31	24	30	11	14	20	28	17				
Calcium, Ca	mg/L	89	23	23	96	100	85	7.2	60	66	45	89	82	80	120	97	140	230	110				
Magnesium, Mg	mg/L	88	40	35	98	71	110	9	57	53	32	100	83	61	91	60	110	140	87				
Chloride, Cl	mg/L	470	55	70	920	330	960	65	230	260	120	500	360	290	320	96	400	320	370				
Carbonate, CO3	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1				
Bicarbonate, HCO3	mg/L	300	450	410	250	150	320	160	280	210	240	360	350	260	400	410	310	240	250				
Sulphate, SO4	mg/L	330	29	41	460	290	480	30	150	190	100	340	300	240	410	350	500	900	340				
Nitrate, NO3	mg/L	70	86	90	68	120	57	20	50	58	41	70	6.6	18	9.9	<0.2	16	3.7	29				
Cation/Anion balance	%	-1.62	-3.04	-4.68	2.15	0.11	2.75	-3.12	1.29	0.75	-1.92	-0.7	0.38	-1.91	-1	-4.23	-1.05	-0.4	-1.75				
Sum of Ions (calc.)	mg/L	1,679	827	812	2,596	1,286	2,781	389	1,015	1,039	704	1,820	1,456	1,153	1,591	1,147	1,729	2,044	1,394				

Samples from Bores around Christmas Creek, including the Fortescue Marsh

Standard 1																							
Our Reference:	UNITS	84130-25	84130-26	84130-5	84130-6	84610-13	84610-14	84610-12	84610-11	84130-27	84130-1	84610-18	84610-19	84610-16	84130-10	84130-11	84130-8	84130-9	84130-7	84130-2	84610-6	84610-4	
Your Reference	--	E2 - 60m	E2 - 80m	E04 - 50m	E04 - 94m	E07 70m	E08	E14	E15 70m	E16 - 60m	E 17 - 65 m	E19 58m	E19B 88m	E20 46 m	E22 - 93m	E22 - 51m	E23 - 84m	E23 -35m	E24 - 98m	E24 - 51m	E30	E41 70m	
Date Sampled:	--	15/09/2004	15/09/2004	16/09/2004	16/09/2004	29/09/2004	29/09/2004	28/09/2004	25/09/2004	22/09/2004	21/09/2004	26/09/2004	1/10/2004	26/09/2004	18/09/2004	18/09/2004	21/09/2004	21/09/2004	19/09/2004	19/09/2004	10/10/2004	11/10/2004	
pH	pH Units	8	7.5	7.8	6.6	7.8	7.2	7.6	7.6	8	7.8	6.8	6.6	6.8	7.7	7.8	7.9	7.9	7.6	7.8	7.3	7.8	
Electrical Conductivity @ 25oC	?S/cm	1,500	88,000	18,000	180,000	2,500	1,600	1,600	1,300	1,200	2,200	960	26,000	1,900	80,000	46,000	45,000	4,000	130000	7900	800	2,500	
Total Dissolved Solids (calc as NaCl)	mg/L	960	62,000	15,000	160,000	1,600	1,000	1,000	850	770	1,400	610	16,000	1,200	56000	29,000	29000	2,600	100000	5000	510	1,600	
Iron, Fe (soluble)	mg/L	<0.05	<0.5	<0.05	<0.5	0.05	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.5	<0.05	<0.05	<0.05	<0.5	<0.05	0.1	<0.05	
Sodium, Na	mg/L	160	20,000	2600	50000	190	100	77	71	54	130	70	5,400	170	18000	9800	9800	480	32000	1100	36	260	
Potassium, K	mg/L	15	1,400	140	4300	37	4.2	16	15	15	19	11	220	24	1300	690	680	34	2200	85	12	15	
Calcium, Ca	mg/L	74	470	460	580	150	130	130	96	98	150	45	530	81	350	270	330	130	570	110	52	130	
Magnesium, Mg	mg/L	40	2,100	440	4300	140	49	74	56	59	87	34	650	57	1700	960	890	110	3100	150	33	100	
Chloride, Cl	mg/L	230	33,000	5100	81000	260	200	150	130	120	420	120	8,900	330	30000	15000	15000	960	50000	2100	41	340	
Carbonate, CO3	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Bicarbonate, HCO3	mg/L	190	120	180	110	310	160	260	230	180	220	85	60	95	240	260	260	230	230	240	140	340	
Sulphate, SO4	mg/L	220	12,000	1600	26000	730	380	380	300	270	290	180	2,900	310	9700	4800	5100	310	18000	470	210	560	
Nitrate, NO3	mg/L	16	2.1	11	<0.2	<0.2	7	1.8	2.1	2.4	<0.2	30	17	30	17	17	16	22	8.2	11	7.7	1.6	
Cation/Anion balance	%	-0.44	-2.88	-1.59	-2.92	1.08	-4.19	-0.3	-3.18	1.8	-1.76	-3.68	1.23	-3.08	-3.9	-0.38	-1.03	-0.47	-1.63	-3.02	-5.05	-0.82	
Sum of Ions (calc.)	mg/L	946	68,424	10,573	166,290	1,817	1,030	1,089	900	799	1,318	575	18,677	1,097	61309	32,266	32,456	2,275	106110	4228	532	1,747	

Samples from Bores around Christmas Creek, including the Fortescue Marsh

Standard 1																							
Our Reference:	UNITS	84130-19	84130-20	84130-21	84610-3	84610-5	84610-9	84130-22	84130-23	84130-24	84130-3	84130-4	84610-15	84610-17	84610-1	84610-2	84130-12	84130-13	84130-28	84130-16	84130-17	84610-7	84610-8
Your Reference	--	F1	F1A	F1B	F02 23m	F02 69m	F02 53m	F3A - 40m	F3A - 60m	F3B - 40m	F4 - 54m	F4 - 84m	F05 42m	F05 68m	F06 45m	F06 90m	F7A - 80m	F7A - 30m	F7B - 27m	Fortescue Marsh #1	Fortescue Marsh #2	CC133 80m	CC503 70m
Date Sampled:	--	10/09/2004	10/09/2004	11/09/2004	12/10/2004	12/10/2004	12/10/2004	10/09/2004			17/09/2004	17/09/2004	3/10/2004	3/10/2004	6/10/2004	7/10/2004	13/09/2004	12/09/2004			9/09/2004	8/10/2004	9/10/2004
pH	pH Units	7.9	7.7	7.6	7.9	7.2	7.6	7.9	7.9	7.9	7.9	7.2	7.7	7.7	7.4	6.6	7.5	7.7	8	8.7	8.5	7.5	7.7
Electrical Conductivity @ 25oC	?S/cm	50,000	6,000	6,100	16,000	140,000	80,000	9,100	49,000	9,100	15,000	150,000	1,400	34,000	670	170,000	170,000	1,300	23,000	13,000	13,000	190	1,300
Total Dissolved Solids (calc as NaCl)	mg/L	32,000	3,800	3,800	9,100	110,000	56,000	5,700	32,000	5,700	8900	120,000	860	22,000	430	140,000	140,000	830	14,000	7,500	7,500	120	810
Iron, Fe (soluble)	mg/L	<0.5	<0.05	<0.05	<0.05	<0.5	1.7	<0.05	<0.05	<0.05	<0.05	<0.5	0.1	<0.05	<0.05	1.1	<0.5	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Sodium, Na	mg/L	11000	980	950	2,600	40,000	20,000	1300	10,000	1,400	2200	49000	140	6,800	28	49,000	46000	120	4,700	1,600	1,600	96	61
Potassium, K	mg/L	860	81	83	230	2,700	1,300	110	760	110	190	4200	9.6	360	2	3,400	3600	19	330	230	240	24	20
Calcium, Ca	mg/L	170	74	94	130	570	330	160	340	160	220	530	75	480	79	630	26	84	180	1,000	1,100	140	81
Magnesium, Mg	mg/L	920	110	110	270	3,100	1,600	150	1,200	160	300	4500	36	1,000	16	4,100	3800	30	430	180	180	87	59
Chloride, Cl	mg/L	18000	1500	1500	4,600	52,000	29,000	2500	17,000	2,500	4300	81000	100	12,000	53	75,000	71000	110	7,000	2,400	3,100	140	96
Carbonate, CO3	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	7	3	<1	<1
Bicarbonate, HCO3	mg/L	220	310	310	320	210	260	280	270	300	220	180	320	240	220	140	190	390	340	40	30	350	220
Sulphate, SO4	mg/L	5500	470	480	1,300	20,000	11,000	400	5,400	400	1100	25000	280	3,300	37	25,000	23000	51	2,400	3,800	3,400	550	330
Nitrate, NO3	mg/L	28	3.9	5.4	13	8	7.6	13	10	13	45	12	8.5	9.9	40	0.3	24	88	71	<0.2	<0.2	<0.2	11
Cation/Anion balance	%	-3.2	0.18	0.51	-4.71	5.39	-0.15	-3.09	-2.35	-0.12	-4.06	-3.18	-3.66	-0.01	0.09	-1	-1.6	1.14	0.8	-2.48	-4.54	-5.49	-5.11
Sum of Ions (calc.)	mg/L	36,599	3,530	3,502	9,463	118,290	63,606	4,954	35,029	5,082	8549	164,420	969	24,190	475	157,300	147,640	896	15,417	9,239	9,668	1,387	878

APPENDIX D

GROUNDWATER LEVELS

Table D1
Groundwater Levels at Mount Nicholas

Hole ID	Easting	Northing	Collar Level (mRL)	Dip to SWL	Water Level (mRL)
MN0006	243898.6	7479402.7	473.81	55	418.81
MN0010	244296.4	7480200.2	479.81	57.09	422.72
MN0021	244700	7481801	480.87	62.68	418.19
MN0037	246095	7484199	487.36	45	442.36
MN0042	246998.5	7485801.1	487.02	25	462.02
MN0043	246898.9	7485799.6	485.48	45	440.48
MN0044	246800.1	7485799.4	483.28	51	432.28
MN0047	247398.3	7486599	492.14	18	474.14
MN0048	247300.9	7486598.7	489	33	456
MN0059	249402.8	7489000.5	515.35	34	481.35
MN0062	248798	7489699.5	501.69	36	465.69
MN0106	241796.3	7473801.7	463.34	40	423.34
MN0113	241397.4	7472202.7	463.19	35.52	427.67
MN0118	241598.7	7473800.9	459.8	32.77	427.03
MN0119	242199.8	7475400.1	464.39	33	431.39
MN0120	241393.6	7473003.2	461.34	33.94	427.4
MN0124	243797.1	7479402	472.4	53.94	418.46
MN0125	245099.7	7481683.8	497.24	60.05	437.19
MN0141	240998.9	7471402	456.77	28.58	428.19
MN0142	241199.2	7472201.6	461.3	33.26	428.04
MN0143	240998.3	7472199.5	458.72	35.17	423.55
MN0145	241294.6	7473000.5	460.25	35	425.25
MN0146	241198.2	7473002.1	458.98	31.29	427.69
MN0147	241694.3	7473804.1	461.67	38	423.67
MN0148	241500	7473800	458.83	31.8	427.03
MN0149	241901.1	7474602.4	461.3	34.7	426.6
MN0150	246405.9	7485000.9	488.86	70.66	418.2
MN0154	245598.1	7483401	480.17	62.09	418.08
MN0157	244100	7480199.1	475.92	57.5	418.42
MN0158	243495.6	7478599.4	473.18	49.04	424.14
MN0162	242199.6	7474601.3	463.35	32.18	431.17
MN0163	246699.5	7485799.9	482.15	63.95	418.2
MN0165	246201.5	7485001.8	485.16	67.09	418.07
MN0167	243999.4	7480202.2	474.04	55.76	418.28
MN0168	243703.1	7479401.8	471.54	53.03	418.51
MN0178	248899.9	7488597.2	501.28	71.18	430.1
MN0191	248799.1	7488398.4	502.46	35.03	467.43
MN0211	248599	7487998.4	503.07	75	428.07
MN0212	248499.1	7487998.3	501.35	73	428.35
MN0217	248699.1	7487899.4	505.21	22	483.21
MN0219	248499.4	7487900	501.53	24	477.53
MN0226	240898	7471401.6	456.35	28.17	428.18
MN0227	240798.4	7471400.5	456.04	27.85	428.19
MN0228	241497.1	7472202.9	464.07	36.25	427.82
MN0229	241297.6	7472201	462.31	34.52	427.79
MN0230	241099.1	7472202.9	459.72	22.09	437.63
MN0231	240901.5	7472205.9	457.41	29.45	427.96
MN0232	240804.5	7472206	456.3	29.58	426.72
MN0233	240699.8	7472199.3	455.31	27.55	427.76
MN0234	241100.6	7473001.5	457.71	30.22	427.49
MN0236	241399.3	7473800.9	458.21	31.53	426.68
MN0237	241298.9	7473801.6	457.75	30.98	426.77
MN0238	241997.3	7474602	461.85	24	437.85
MN0239	240999.1	7470999.2	456.06	27.53	428.53
MN0240	240799.8	7470998.3	455.52	27.02	428.5
MN0245	241400	7471800.4	462.8	35.07	427.73
MN0246	241299.6	7471796.9	461.37	23	438.37
MN0247	241199.5	7471797.4	460.06	32.03	428.03
MN0248	241099.4	7471797.6	458.81	30.93	427.88
MN0249	240999.9	7471797.4	459.9	29.83	430.07
MN0250	240899.6	7471798.7	457	28.96	428.04

Table D1 (continued)

Hole ID	Easting	Northing	Collar Level (mRL)	Dip to SWL	Water Level (mRL)
MN0251	249395.9	7489395.8	513.1	32.89	480.21
MN0265	242098.2	7475400.7	463.05	36.79	426.26
MN0273	242400.3	7475797.7	465.29	38.98	426.31
MN0274	242300	7475797	464.37	38.06	426.31
MN0275	242195.1	7475797.9	464.02	30.86	433.16
MN0279	242301.8	7475003.7	466.46	40.1	426.36
MN0281	242104	7474998.2	463	36.62	426.38
MN0284	241999.4	7474197.9	462.2	35.23	426.97
MN0285	241900.1	7474199.4	461.24	34.54	426.7
MN0286	241696.5	7474195.7	460.68	34.05	426.63
MN0290	241700.9	7473397.5	464.55	37.35	427.2
MN0292	241499.9	7473399	460.44	33.01	427.43
MN0293	241397.5	7473398.9	458.61	31.1	427.51
MN0294	241298.2	7473397.6	457.68	30.4	427.28
MN0297	241598.8	7474200.7	460.14	33.41	426.73
MN0301	240799.3	7471799.1	456.28	28.11	428.17
MN0311	241301.6	7472601.6	460.32	32.44	427.88
MN0312	241198.9	7472598.1	459.35	31.8	427.55
MN0313	241100	7472599.5	458.49	30.64	427.85
MN0314	240998.4	7472598.5	457.5	29.84	427.66
MN0323	243208.8	7477396.9	472.08	52.13	419.95
MN0324	243100.4	7477399.6	470.29	50.24	420.05
MN0350	244399.3	7481398.8	477.08	58.94	418.14
MN0354	245799.5	7483799.4	482.26	64.18	418.08
MN0355	245698.1	7483799.3	480.51	62.32	418.19
MN0359	245499.4	7482999.7	480.67	56.78	423.89
MN0361	245401.4	7482997.3	477.6	59.33	418.27
MN0363	244999	7482192.5	480.13	61.73	418.4
MN0365	244799.9	7482196	476.32	58.27	418.05
MN0366	244696.6	7482193.6	475.09	57.02	418.07
MN0380	246300.9	7484598.6	489.16	70.98	418.18
MN0396	241800.2	7474200.2	461.22	46	415.22
MN0405	244200.5	7480597.6	477.48	57.54	419.94
MN0406	244100.6	7480597.4	476.19	51.06	425.13
MN0411	246698	7485396	486.56	67.71	418.85
MN0413	246400.3	7485398.4	484.24	65.98	418.26
MN0414	246500.7	7485398.7	484.17	65.95	418.22
MN0436	243001.5	7477395.1	469.02	48	421.02
MN0437	242894.5	7477399.8	468.03	48	420.03

Table D2
Groundwater Levels at Mount Lewin

Hole ID	Easting	Northing	Collar Level (mRL)	Dip to SWL	Water Level (mRL)
ML0234	206601.21	7494500.13	435.2	23.49	411.71
ML0250	204996.79	7496203.14	438.91	26.74	412.17
ML0256	204201.77	7495800.2	433.84	21.65	412.19
ML0257	204199.72	7495600.11	432.43	20.16	412.27
ML0242	205800.98	7494901.85	433.68	21.12	412.56
ML0221	207396.68	7494099.36	434.66	22.09	412.57
ML0263	206601.35	7492898.23	427.38	14.8	412.58
ML0233	206589.65	7494710.38	435.95	23.32	412.63
ML0262	206597.13	7493303.75	428.77	16.13	412.64
ML0264	206601.74	7492500.18	426.51	13.87	412.64
ML0239	205801.86	7495499.28	437.84	25.19	412.65
ML0243	205801.47	7494698.45	432.22	19.55	412.67
ML0241	205801.7	7495106.24	434.63	21.96	412.67
ML0244	205798.87	7494500.71	430.96	18.28	412.68
ML0259	206600.03	7493902.39	431.94	19.26	412.68
ML0260	206588.85	7493700.72	430.72	18.03	412.69
ML0240	205801.41	7495300.99	436.35	23.65	412.7
ML0235	206593.57	7494101.01	432.94	20.24	412.7
ML0245	205801.42	7494307.7	430.45	17.74	412.71
ML0258	206601.87	7494300.79	434.24	21.52	412.72
ML0232	206617.32	7494894.09	436.96	24.22	412.74
ML0261	206596.68	7493495.55	429.76	17.01	412.75
ML0229	206598.49	7495498.2	440.83	27.97	412.86
ML0273	208995.94	7493395.69	433.68	20.6	413.08
ML0196	208990.88	7493705.43	433.78	20.65	413.13
ML0223	207396.66	7493702.07	432.87	19.61	413.26
ML0194	208997.59	7494092.68	435.64	22.29	413.35
ML0275	208998.8	7492999.16	433.28	19.87	413.41
ML0212	207399.24	7495400.78	442.67	29.22	413.45
ML0211	207399.95	7495597.23	443.42	29.94	413.48
ML0218	207401.13	7494897.93	440.18	26.7	413.48
ML0217	207404.28	7494691.18	438.73	25.25	413.48
ML0214	207400.49	7495098.85	441.36	27.86	413.5
ML0274	208996.67	7493197.98	433.5	19.97	413.53
ML0215	207400.76	7495198.78	441.67	28.13	413.54
ML0267	208197.56	7494202.93	437.28	23.72	413.56
ML0268	208199.54	7494003.97	435.22	21.66	413.56
ML0266	208206.88	7494382.32	438.94	25.37	413.57
ML0193	209002.39	7494297.78	436.92	23.35	413.57
ML0269	208196.75	7493800.66	432.96	19.38	413.58
ML0195	208999.49	7493904.02	434.65	21.07	413.58
ML0216	207400.37	7495497.61	443	29.41	413.59
ML0220	207401.83	7494304.3	436.33	22.74	413.59
ML0270	208191.66	7493602.38	432.3	18.7	413.6
ML0272	208999.79	7493803.06	434.17	20.51	413.66
ML0213	207398.87	7495298.23	442.14	28.42	413.72
ML0265	208214.37	7494589.04	441.2	27.4	413.8
ML0246	205801.38	7494101.91	431.9	17.08	414.82
ML0283	211398.45	7491399.16	429.85	14.35	415.5
ML0282	211405.59	7491599.05	432.4	16.75	415.65
ML0126	233202.5	7493600.7	460.15	44.41	415.74
ML0286	211399.11	7490800.16	427.16	11.38	415.78
ML0287	211400.26	7490598.98	426.4	10.62	415.78
ML0291	211801.09	7491900.86	434.55	18.77	415.78

Table D2 (continued)

Hole ID	Easting	Northing	Collar Level (mRL)	Dip to SWL	Water Level (mRL)
ML0182	213401.77	7491917.45	439.38	23.6	415.78
ML0284	211396.31	7491215.07	428.64	12.82	415.82
ML0288	211400.49	7490399	426.04	10.19	415.85
ML0181	213399.46	7492099.49	440.39	24.51	415.88
ML0290	211396.48	7489994.85	425.78	9.85	415.93
ML0289	211399.19	7490200.92	426.1	10.16	415.94
ML0173	212598.73	7491699.56	435.39	19.43	415.96
ML0285	211396.93	7491000.96	427.88	11.9	415.98
ML0292	211799.38	7491701.45	432.52	16.53	415.99
ML0172	212597.94	7491600.25	434.75	18.76	415.99
ML0163	212596.99	7492202.16	438.27	22.26	416.01
ML0184	213396.04	7491796.89	438.73	22.67	416.06
ML0183	213400.74	7491699.08	438.14	22.05	416.09
ML0156	213397.22	7492201.56	440.52	24.32	416.2
ML0155	213396.05	7492402.7	442.84	26.6	416.24
ML0157	213399.86	7492303.36	440.69	24.43	416.26
ML0162	212599.51	7492398.75	440.24	23.9	416.34
ML0046	226696.38	7494601.55	456.571	38.38	418.191
ML0075	225900.92	7494195.63	452.51	34.25	418.26
ML0049	225898.48	7494098.21	451.447	33.13	418.317
ML0093	227100.84	7494801.22	456.08	37.62	418.46
ML0072	225100.56	7493701.34	449.09	30.6	418.49
ML0089	226299.5	7494905.23	461.04	42.54	418.5
ML0041	227509.45	7495299.7	457.48	38.98	418.5
ML0087	226298.86	7494500.36	456.98	38.43	418.55
ML0085	225497.46	7494302.65	454.76	36.19	418.57
ML0095	227098.91	7495198.89	459.74	41.12	418.62
ML0094	227100	7494990.51	457.7	39.08	418.62
ML0088	226301.73	7494701.7	458.89	40.26	418.63
ML0042	227502.74	7495098.96	456.45	37.82	418.63
ML0048	225900.21	7494297.96	453.64	35	418.64
ML0047	225902.06	7494498.36	455.851	37.2	418.651
ML0045	226699.91	7494801.08	458.031	39.38	418.651
ML0067	224300.33	7493497.81	446	27.34	418.66
ML0086	225495.67	7494101.78	452.64	33.96	418.68
ML0077	226703.17	7494900.64	458.63	39.93	418.7
ML0079	227502.97	7495196.29	457.31	38.61	418.7
ML0066	224300.02	7493699.38	446.99	28.28	418.71
ML0050	225096.07	7494101.41	453.243	34.53	418.713
ML0033	226696.1	7495009.4	460.104	41.39	418.714
ML0110	233697.65	7493200.92	459.52	40.8	418.72
ML0145	221897.76	7493503.45	441.92	23.18	418.74
ML0081	226698.45	7495106.92	461.4	42.66	418.74
ML0135	223500.27	7493302.73	445.25	26.5	418.75
ML0051	224293.51	7493900.15	448.588	29.83	418.758
ML0070	224298.14	7494003.26	451.22	32.43	418.79
ML0103	227899.18	7495299.2	455.62	36.81	418.81
ML0064	233200.75	7494801.15	469.11	50.3	418.81
ML0024	233101.65	7494798.98	468.686	49.87	418.816
ML0062	233096.72	7494000.86	462.85	44.02	418.83
ML0029	233205.56	7494011.15	463.146	44.3	418.846
ML0069	224300.93	7493803.13	447.61	28.76	418.85
ML0078	227520.27	7495591.69	458.38	39.53	418.85

Table D2 (continued)

Hole ID	Easting	Northing	Collar Level (mRL)	Dip to SWL	Water Level (mRL)
ML0022	233500.12	7494797.37	470.082	51.23	418.852
ML0027	233600.74	7494001.17	464.458	45.6	418.858
ML0125	233403.38	7493601.08	460.47	41.61	418.86
ML0128	233395.97	7495196.45	471.75	52.87	418.88
ML0028	233399.93	7493998.38	463.386	44.5	418.886
ML0102	227898.59	7495500.34	456.06	37.17	418.89
ML0124	233608.91	7493603.16	460.8	41.9	418.9
ML0136	222697.75	7493700.44	446.88	27.77	419.11
ML0134	223498.58	7493500.17	447.14	27.99	419.15
ML0137	222697.25	7493499.18	444.13	24.96	419.17
ML0138	222698.37	7493600.99	445.6	26.34	419.26
ML0101	227897.84	7495699.36	456.86	37.55	419.31
ML0144	221897.99	7493703.99	444.16	24.77	419.39
ML0178	209800.54	7494001.43	437	17.58	419.42
ML0277	209798.56	7494101.04	437.39	17.82	419.57
ML0142	221898.11	7493802.66	445.27	25.67	419.6
ML0018	233398.78	7495601.07	473.256	53.58	419.676
ML0154	218495.22	7493597.72	443.96	24.27	419.69
ML0150	219289.16	7493509	439.46	19.77	419.69
ML0293	211800	7491400	435	15.29	419.71
ML0149	219286.24	7493694.29	440.1	20.36	419.74
ML0153	218498.21	7493799.26	447.59	27.84	419.75
ML0146	220099.6	7493898.02	441.31	21.46	419.85
ML0017	233599.74	7495601.49	474.723	54.83	419.893
ML0152	218498.76	7494000.29	450.59	30.31	420.28
ML0016	233796.87	7495600.35	475.14	54.57	420.57
ML0161	212599.25	7492599.82	446.37	25.76	420.61
ML0294	211740	7491200	435	14.36	420.64
ML0013	234193.93	7495604.62	478.125	54.05	424.075
ML0160	212598.86	7492802.52	445.06	17.75	427.31
ML0140	222698.18	7493798.77	448.28	20.97	427.31
ML0226	206599.75	7496301.11	446.86	15.01	431.85
ML0143	221897.64	7493901.44	446.21	12.25	433.96
ML0129	228291.63	7496102.47	457.36	22.79	434.57
ML0012	234100.09	7496400.3	481.544	30.63	450.914
ML0009	234199.96	7496400.44	482.986	31.87	451.116
ML0030	233997.12	7496399.81	481.224	29.8	451.424
ML0003	233999.31	7497201	486.72	35.215	451.505
ML0005	233700.24	7497200.86	487.684	36.15	451.534
ML0004	233898.21	7497200.54	486.751	35.02	451.731
ML0002	234197.83	7497201.76	489.37	37.42	451.95
ML0008	234402.58	7496400.35	485.572	32.99	452.582
ML0001	234398.65	7497204.07	495.666	42.87	452.796
ML0006	233499.27	7497199.12	493.649	39	454.649
ML0295	211800	7491000		13.3	
ML0296	211800	7490800		12.39	
ML0297	211800	7490600		11.52	
ML0298	211800	7490400		10.87	
ML0299	211800	7490200		10.52	
ML0300	211800	7490000		10.35	
ML0301	212600	7491400		17.36	
ML0302	212600	7491200		16.3	
ML0303	212600	7491000		15.18	
ML0304	212600	7490800		14.56	

Table D3
Groundwater Levels at Christmas Creek

Hole ID	Easting	Northing	Collar Level (mRL)	Dip to SWL (m)	Water Level (mRL)
CC0173	783197.7	7522901.3	439.75	11.36	428.39
CC0242	775998.9	7524804.2	434.16	23.36	410.8
CC0234	775992.6	7524703	434.37	23.57	410.8
CC0233	775999.6	7524898.6	434.87	24.08	410.79
CC0231	776793.9	7524198.4	435.16	24.47	410.69
CC0229	776800.5	7524598.7	435.67	24.84	410.83
CC0230	776797.6	7524402.7	435.69	24.98	410.71
CC0264	779192.8	7524113.6	436.9	26.32	410.58
CC0193	780795.2	7524305.8	441.51	26.63	414.88
CC0166	783200.4	7522398	438.21	27.69	410.52
CC0167	783197.6	7522599.7	438.44	27.92	410.52
CC0263	779998.5	7524104.7	439.38	27.95	411.43
CC0201	780005.2	7524307.7	439.03	28.2	410.83
CC0168	795096.1	7518602.9	439.43	28.34	411.09
CC0210	779201	7524498.8	440.47	29.98	410.49
CC0208	779199	7524899.1	443.2	32.69	410.51
CC0160	784000.4	7523396	444.32	32.91	411.41
CC0066	792000.3	7520499.5	441.87	33.03	408.84
CC0055	790395.7	7520201.4	443.34	33.38	409.96
CC0065	792000.6	7520598.6	443.48	33.53	409.95
CC0089	793598.2	7520203.1	445.7	34.93	410.77
CC0087	793597	7520595.7	447.48	37.34	410.14
CC0042	789599.8	7520298	447.63	37.86	409.77
CC0058	791199.5	7520405.9	448.32	38.4	409.92
CC0056	791197.2	7520814	448.42	38.44	409.98
CC0170	784799.9	7524303.6	451.68	39.24	412.44
CC0001	792544.9	7520904	447.41	36.12	411.29

Table D4
Groundwater Levels at Mindy Mindy

Hole ID	Easting	Northing	Collar Level (mRL)	Dip to SWL	Water Level (mRL)
MM034	7478752.940	742287.251	490.360	52.06	438.300
MM031	7479544.558	741401.972	482.572	42.75	439.822
MM001	7479452.703	741382.370	482.943	42.9	440.043
MM032	7479402.438	741375.443	482.914	42.57	440.344
MM002	7479340.069	741392.436	483.016	40.41	442.606
MM010	7479706.479	742612.497	487.277	39.1	448.177
MM011	7478735.537	742221.202	488.873	37.41	451.463
MM009	7479860.961	742471.130	486.771	32.25	454.521
MM050	7479619.365	742389.825	486.227	29.42	456.807
MM005	7479554.028	742318.360	486.232	24.77	461.462
MM016	7476446.269	743090.177	501.628	33.52	468.108
MM007	7480104.376	742209.313	488.032	18.84	469.192
MM012	7478762.531	742389.110	492.344	21.83	470.514
MM035	7478742.677	742486.405	494.638	20.36	474.278
MM036	7477746.375	742127.882	495.391	20.02	475.371
MM037	7477825.098	742285.163	494.090	17.96	476.130
MM004	7479483.023	742250.926	486.328	7.48	478.848
MM018	7475846.978	743652.846	507.594	28.02	479.574
MM042	7476484.273	743182.661	502.081	20.91	481.171
MM019	7475953.915	743824.287	509.755	28.35	481.405
MM038	7477934.455	742473.906	495.906	11.79	484.116
MM044	7475143.566	744075.877	511.432	25.41	486.022
MM020	7475090.245	743979.871	510.770	21.68	489.090
MM027	7473380.174	745508.705	532.092	36.07	496.022
MM047	7473725.809	744760.331	517.254	21.04	496.214
MM025	7473591.078	744475.848	518.578	22.08	496.498
MM026	7473666.152	744658.687	517.711	20.85	496.861
MM046	7473808.387	744935.867	524.547	22.29	502.257
MM024	7473433.502	744329.078	520.569	16.64	503.929
MM021	7475237.668	744237.222	512.986	8.9	504.086

APPENDIX E

SUMMARY REPORT ON THE NORTH MODEL

APPENDIX E – SUMMARY OF MODEL

A groundwater model of a major section of the Fortescue Valley, Marsh and River, including Christmas Creek, Mount Lewin and Mt Nicholas mine sites, was developed using MODFLOW-96 (Harbaugh and McDonald, 1996). The groundwater model also includes the Mindy Mindy mine area, however the Mindy Mindy mine activity will be examined in a separate modelling study.

Main Aims

- Simulation of the effects of mining and water supply on groundwater levels for regional environmental impact assessment.
- Assessment and design of water supply well fields and dewatering schemes.
- Assessment and design of mine-closure plans, notably final void management and salinity assessments for any pit-lakes that may result.

Model Domain and Grid

The model domain includes a rectangular area 120 km wide and 92.5 km long. The domain is rotated 30 degrees clockwise about its north-west corner which is located at –22.1204 Latitude and 119.7059 Longitude. The model domain spans two map zones (zones 50 and 51) and the model coordinates are all based on zone 51 for consistency. In plan the model grid is comprised of 185 rows and 240 columns of uniformly sized cells (each 500m by 500 m). The level of detail provided by this grid is sufficient for regional scale simulations and preliminary mine water supply (feasibility) and drawdown predictions (PER).

Model Layering

The model has 3 layers to represent two major stratigraphic units within which groundwater flow is expected to occur: (Unit 1) a shallow alluvial layer, and (Unit 2) a basement layer of Marra Mamba Iron Formation, Jeerinah Formation, and Wittenoom Dolomite. The upper-most layer (Layer 1) represents the alluvial aquifer which has a thickness that varies from a minimum of about 25 m (along the valley edges and near the mine sites) increasing to 60 m near the middle of the Fortescue Valley and increasing further to about 100 m along the southern edge of the valley where there are large colluvial fans. Alluvial depths were inferred from available drill logs, geologic maps and satellite images.

Layer 1 of the model is also represents outcropping material, including ore, which occurs along sections of the valley edge: notably near the proposed Christmas Creek, Mount Lewin and Mt Nicholas mine sites.

The deeper layers, Layers 2 and 3, were assigned a uniform thicknesses of 20 m and 80 m, respectively. These layers represent basement material (100 m effective thickness) that underlies the alluvium. Layer 2 also represents ore (approx. 20 m thick) where this is known to occur along the valley edges particularly where mining is proposed.

Boundary Conditions

The model's domain-limiting boundaries include no-flow and constant head boundaries. The no-flow boundaries occur mainly along the north and south sides of the valley to approximate the hydraulic (leaky) barrier and groundwater divide associated with the major bedrock outcrops. The northeast corner of the model domain also includes alluvium that appears to be dry (on average) and hence this small area is "inactive". The east and west sides of the model include small sections of no-flow (outcropping) and major sections of constant-head that represent the continuation of the Fortescue Valley aquifer to the east and to the west (respectively). Heads of the constant-head boundaries were extrapolated from available water level measurements.

Hydrologic Balance

The study area is arid with high summer temperatures, high mean evaporative demand (2480 mm/yr), and low mean annual rainfall (310 mm/yr). The literature suggests that in the Northern Territory, for example, this hydrogeological situation is likely to experience a mean groundwater recharge of 0.1 to 2 mm/yr (Harrington, Cook, and Herczeg, 2002).

Evapotranspiration: An evapotranspiration boundary was assigned to zones of low topography and shallow water table (~5 mbgl approx.) where significant groundwater losses are expected to occur via evaporation. The model applies, within these zones, a uniform potential evapotranspiration with an extinction depth of 5m. The extinction depth is based on the following assumptions: (a) that phreatic vegetation can draw groundwater from a maximum depth of 5 mbgl, (b) the water table in the centre of the Fortescue Marsh is located (on average) about 5 mbgl as suggested by trends in the available water level data.

Groundwater Recharge: A number of recharge zones were assigned in the model to represent different rates of average groundwater recharge that were inferred during the model calibration process (for the base-case model). These net recharge zones include: (1) zero net recharge in upland areas, (2) 0.02 mm/yr net recharge in mid-upland areas, (3) 0.2 mm/yr net recharge in the valley areas other than the marshes and riverbeds, (4) 2 mm/yr along foothill streambeds, and (5) 2 mm/yr over the non-flood zones of the Fortescue Marsh and Fortescue River.

A sixth recharge zone was assigned to the model to account for surface water that collects and ponds in the topographic lows of the Fortescue Marsh and Fortescue River. The location of the ponding zones were inferred from aerial photographs and topographic data. It is expected that gross recharge of the order of 250 mm/yr (or more) is likely in the ponding zones given that about 5 m of soil ($S_y \approx 0.05$) is saturated each year as a result of seasonal rainfall-runoff. Hence, whilst the first five recharge zones simulate *net* recharge (i.e. accounting for evaporative losses), the sixth recharge zone simulates *gross* infiltration-recharge (i.e. not accounting for evaporative losses). This distinction is important, because it implies that water table within the ponding zone is unlikely to remain below the plant root-zone because of inputs from seasonal flash flooding and persistent (regional) groundwater inflow. The water table is also unlikely to remain above the plant root-zone for long because of a high evaporative demand (~2500 mm/yr). The two processes combine to result in stable water table elevations in the Fortescue Marsh and parts of the Fortescue River. This natural stability in the water table elevations of the marshes will influence regional groundwater flow patterns and will be a limiting factor for drawdown impacts caused by mine dewatering and abstraction.

Model Calibration - Preliminary

At this stage of the study a base-case model was developed and manually calibrated under steady-state conditions. The steady-state approach assumes that the observed groundwater levels are typical of the system if the effects of climate variation could be averaged-out.

The base-case model includes first-pass estimates of aquifer material properties and hydrological variables. The calibration process involved altering (a) the recharge rates, and (b) the horizontal hydraulic conductivity of the alluvium, until the model simulated water table matched (imperfectly) the interpreted water table. The important parameters of the current model are listed in Table 1. Note that the hydraulic conductivities adopted are within range of limited field tests, and the recharge rates are similar to that estimated for other locations in the Pilbara (eg West Angelas).

The collar elevations for regional bores were not surveyed, and hence the uncertainty on the regional water table is about +/-5 m at bores, and greater than +/-5 m away from bores. Due to this inherent uncertainty, the current approach was to accept a Scaled-RMS of <20%. More importantly, a major calibration target was to ensure that the simulated water table was consistent with (a) the topographic model (so the water-table did not “daylight”), (b) observed water level and extrapolated water level trends, and (c) the conceptual hydrological model for the marsh and river and the hydrogeological model for the valley.

Model Predictions - Preliminary

After steady-state calibration was achieved, the model was then used predictively to simulate 20 years (2007 to 2027) of mine activity (pit dewatering and bore abstraction). The pre-mining water-table conditions (2007) were approximated by the steady-state heads of the calibrated model. The mining elements that were simulated include scheduled mine pit dewatering at the three sites, and a conceptual well field comprising 70 wells that abstract a total of 30.1 ML/d (11 GL/yr) max. It was assumed that 30% of pumping derives from the alluvial aquifer and 70% from the basement aquifer.

The mine pits at Christmas Creek, Mount Lewin and Mount Nicholas were simulated using the ‘drain package’ of MODFLOW-96. The drains were defined to dewater to specific elevations as per the preliminary mine plans. Since the pits are to be excavated into the hill side from the top down, a large portion of the higher sections of the pits are initially dry (above the water table) and thus significant pit dewatering is only required when the pits actually reach the water table during the second half of the current mine schedule (i.e. 2016-2027).

Preliminary base-case model predictions indicate that the target abstraction rate of the well field (11 GL/yr) can be met but there may be a gradual decline in supply during the last 10-15 years of the mine schedule when the pit dewatering occurs (i.e. the simulation shows some interaction between the pit drawdown and the well field). However, model predictions also show that the pit dewatering is more than sufficient to make-up the shortfall in water provide by the well field, and water supply appears not to be a problem in this mine scenario.

Future Work

The modelling study requires additional work as recommended in Groundwater Flow Modelling Guideline (MDBC, 2000), including:

1. model sensitivity, and
2. uncertainty analyses.

The current base-case model will be refined as more field data becomes available. Model features that are identified for refinement include:

3. Water table elevations, from new bores and surveys for existing regional bores;
4. Evapotranspiration, including aerial zonation and rooting depths of major vegetation types;
5. Recharge, including aerial zonation of major recharge zones; and
6. Stratigraphic elevations, including alluvial and basement thickness.

Other potentially important issues for the model development, calibration, and predictions, are also being considered. These include:

1. Examination and refinement of the whole-of-model water budget to ensure that the water budget is consistent with (a) the catchment water balance, and (b) the estimated regional inflows/outflows connecting the current study area with neighbouring aquifers.
2. Examination of the historical rainfall for the region and the assessment of impacts of rainfall variability on (a) water supply, and (b) water table drawdown.

The above tasks are programmed to commence in December 2004.

Table 1
Model Parameters

Layer 1 Material Properties			
Alluvium	Kh	0.15 to 0.3	m/d
Alluvium	Kv	0.1	m/d
Alluvium	Sy	0.05	
Ore Outcrop	Kh	0.5	m/d
Ore Outcrop	Kv	0.1	m/d
Ore Outcrop	Sy	0.05	
Basement Outcrop	Kh	0.05	m/d
Basement Outcrop	Kv	0.002	m/d
Basement Outcrop	Sy	0.05	
Alluvium Avg Thick		70	m
Alluvium Avg Satd Thick		59	m
Layer 2 Material Properties			
Ore	Kh	0.5	m/d
Ore	Kv	0.002	m/d
Ore	SC	0.00001	
Basement	Kh	0.05	m/d
Basement	Kv	0.002	m/d
Basement	SC	0.00001	
Basement Avg Thick		20	m
Basement Avg Satd Thick		20	m

Layer 3 Material Properties			
Basement	Kh	0.05	m/d
Basement	Kv	0.002	m/d
Basement	SC	0.00004	
Basement Avg Thick		80	m
Basement Avg Satd Thick		80	m
Net Recharge Boundary			
Recharge Upland Areas		0	mm/yr
Recharge Mid-Upland Areas		0.02	mm/yr
Recharge Valley		0.2	mm/yr
Recharge Foothill Streambeds		2	mm/yr
Recharge Marsh and River		2	mm/yr
Gross Recharge Boundary			
Recharge Marsh and River		250	mm/yr
Evapotranspiration Boundary			
Potential EVT Marsh and River		2480	mm/yr
EVT Extinction Depth Marsh and River		5	m

Notes:
Model A2 RUN 5

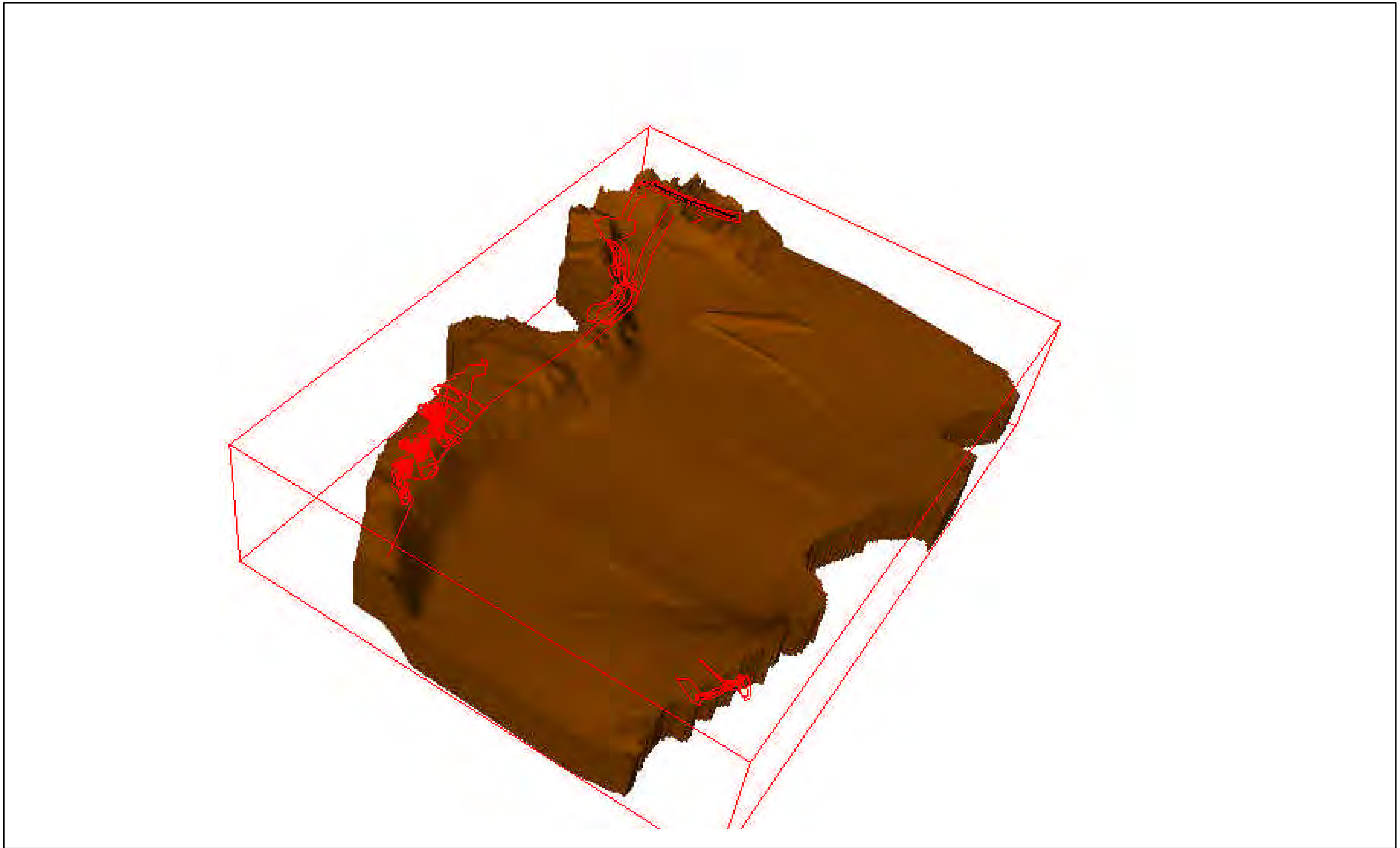
References

User's Documentation for MODFLOW-96, an update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model by Arlen W. Harbaugh and Michael G. McDonald. U.S. GEOLOGICAL SURVEY Open-File Report 96-485. Reston, Virginia 1996.

Harrington, G.A., P.G. Cook, and A.L. Herczeg (2002). Spatial and temporal variability of groundwater recharge in central Australia: a tracer approach. Ground Water. Vol. 40 (5): 518-528.

West Angelas Groundwater Management Project. Prepared for Robe River Iron Ore Associates P/L. Woodward-Clyde (1998).

West Angelas Water Investigations. Robe River Iron Associates. Aquaterra (1999; Doc # 124-B).



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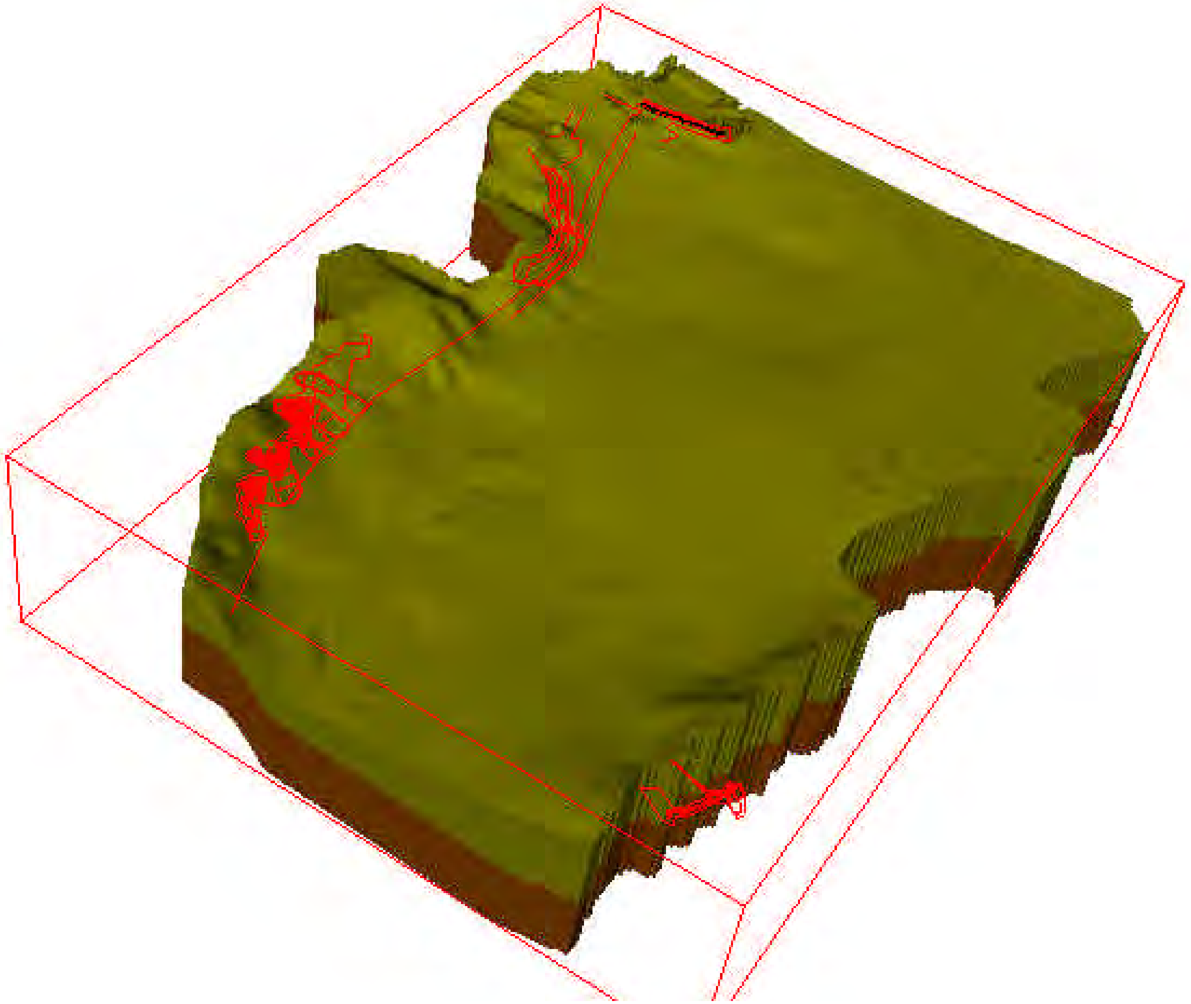
Top of Basement Perspective: Interpreted from Field Data

Figure E1



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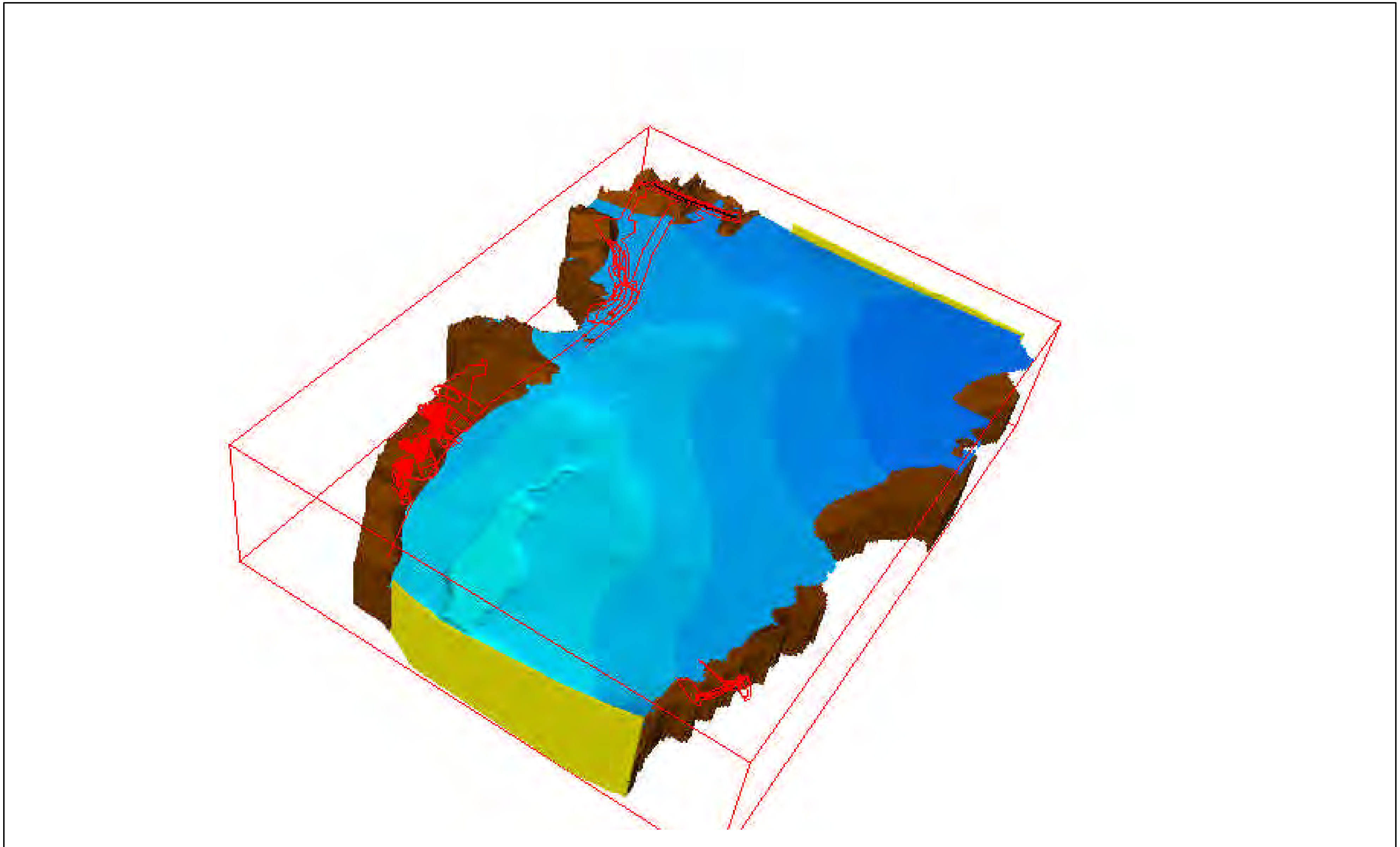
Top of Alluvium Perspective: Interpreted from Field Data

Figure E2



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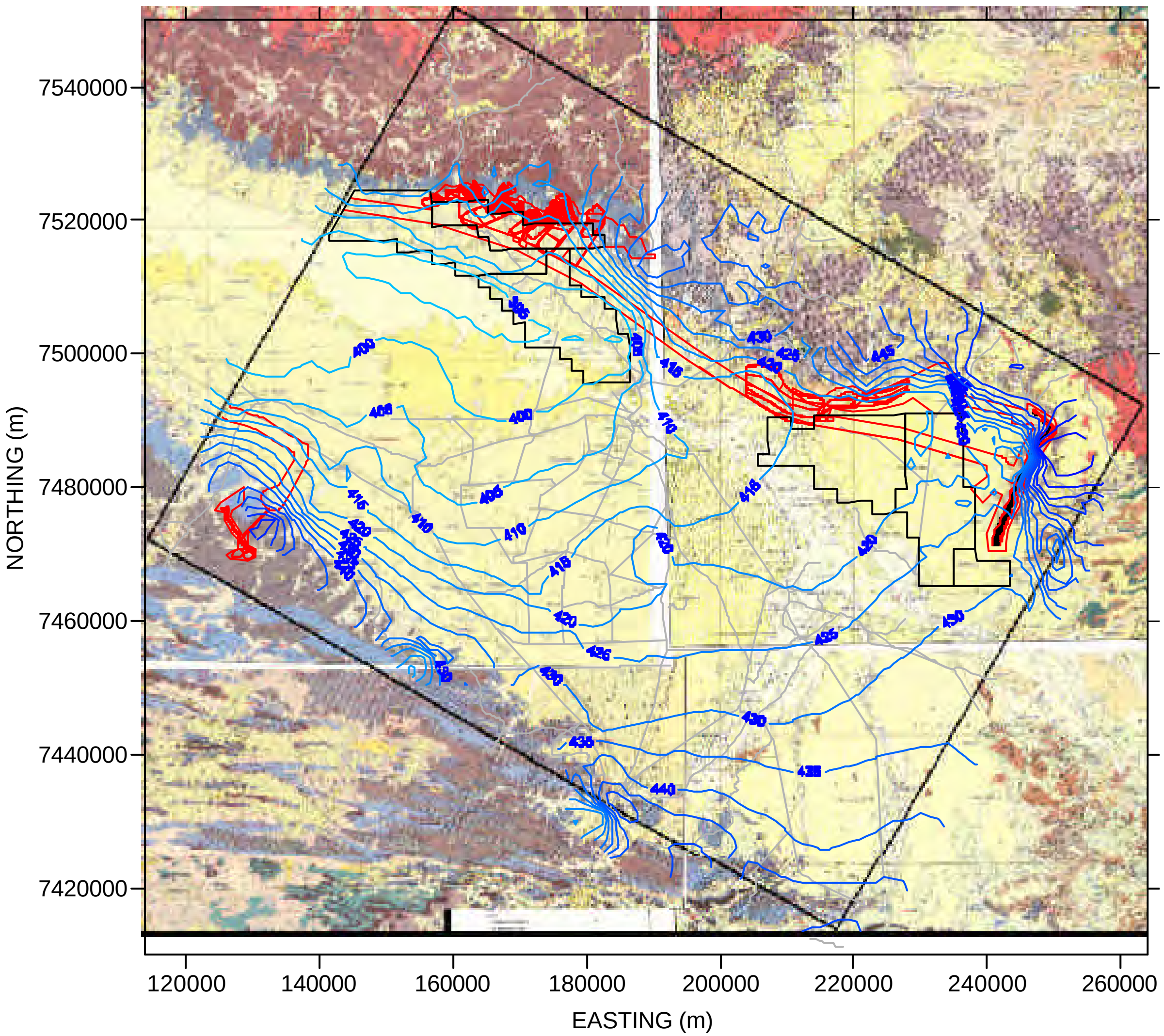
Regional Water Table Perspective: Interpreted from Field Data

Figure E3



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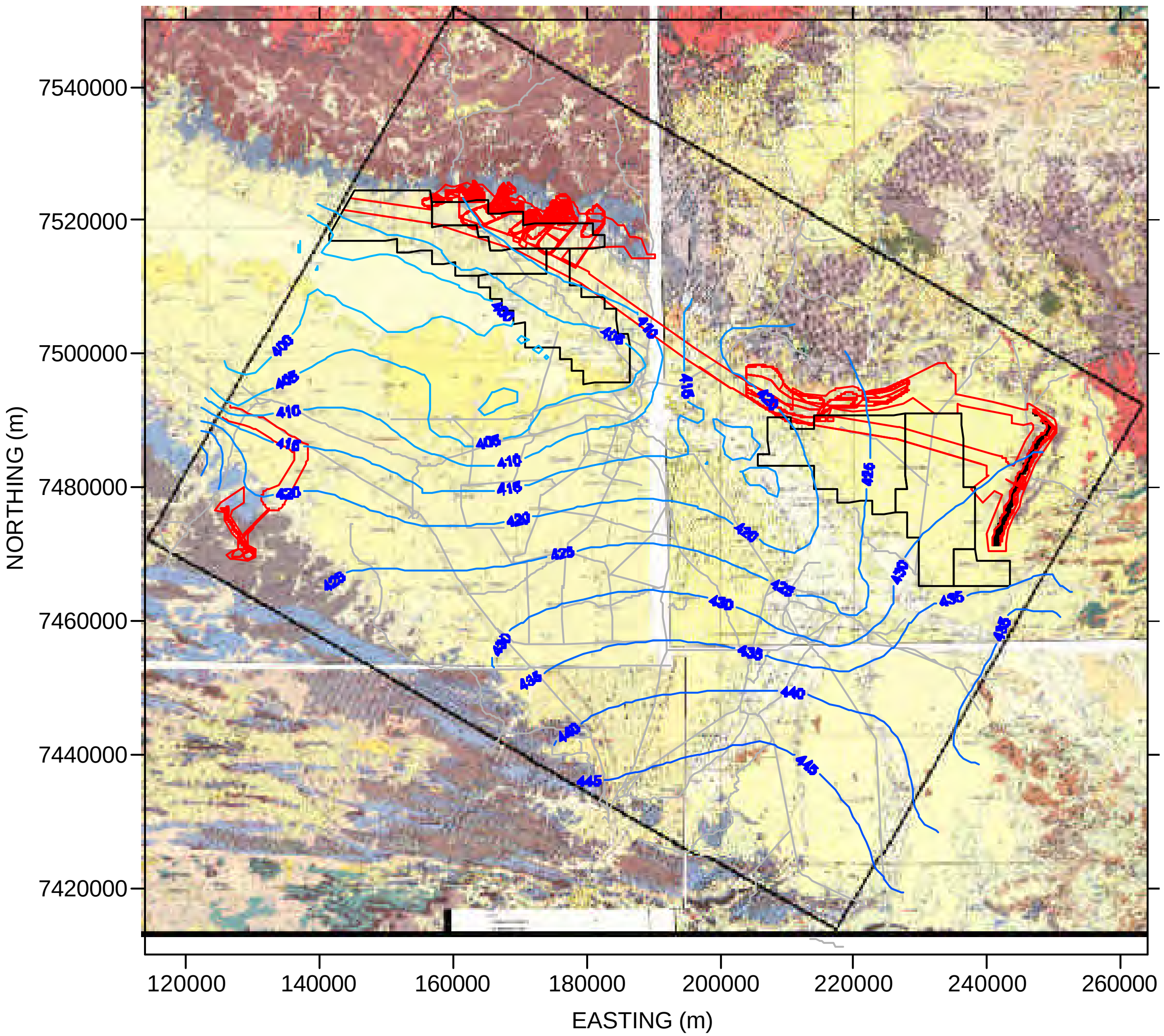
Water Table Contours (mRL): Estimated from Available Field Data

Figure E4



Water Table Contours (mRL): Simulated by the Preliminary Model (A2R7)

Figure E5

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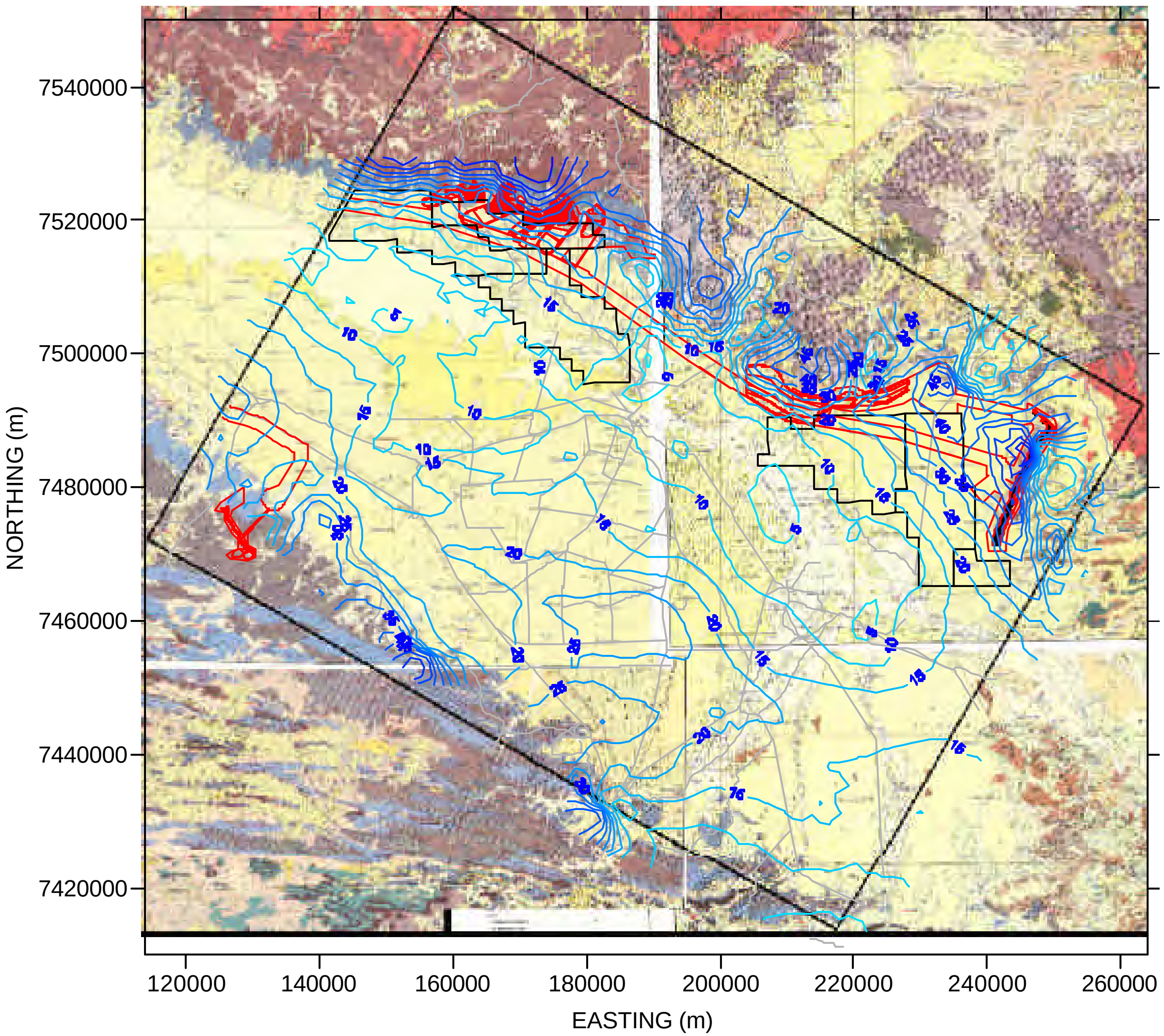

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Water Table Depths Below Ground (mbgl): Estimated from Available Field Data

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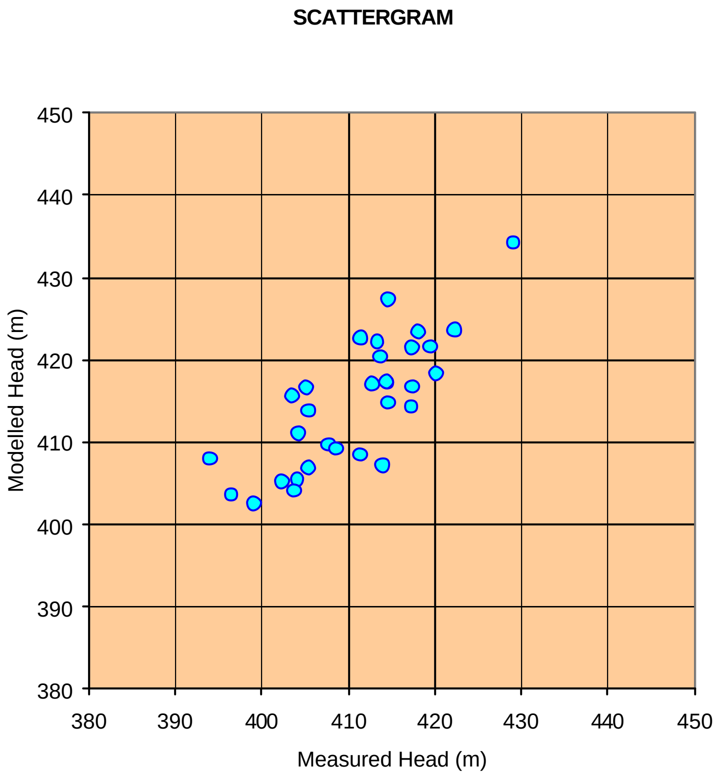
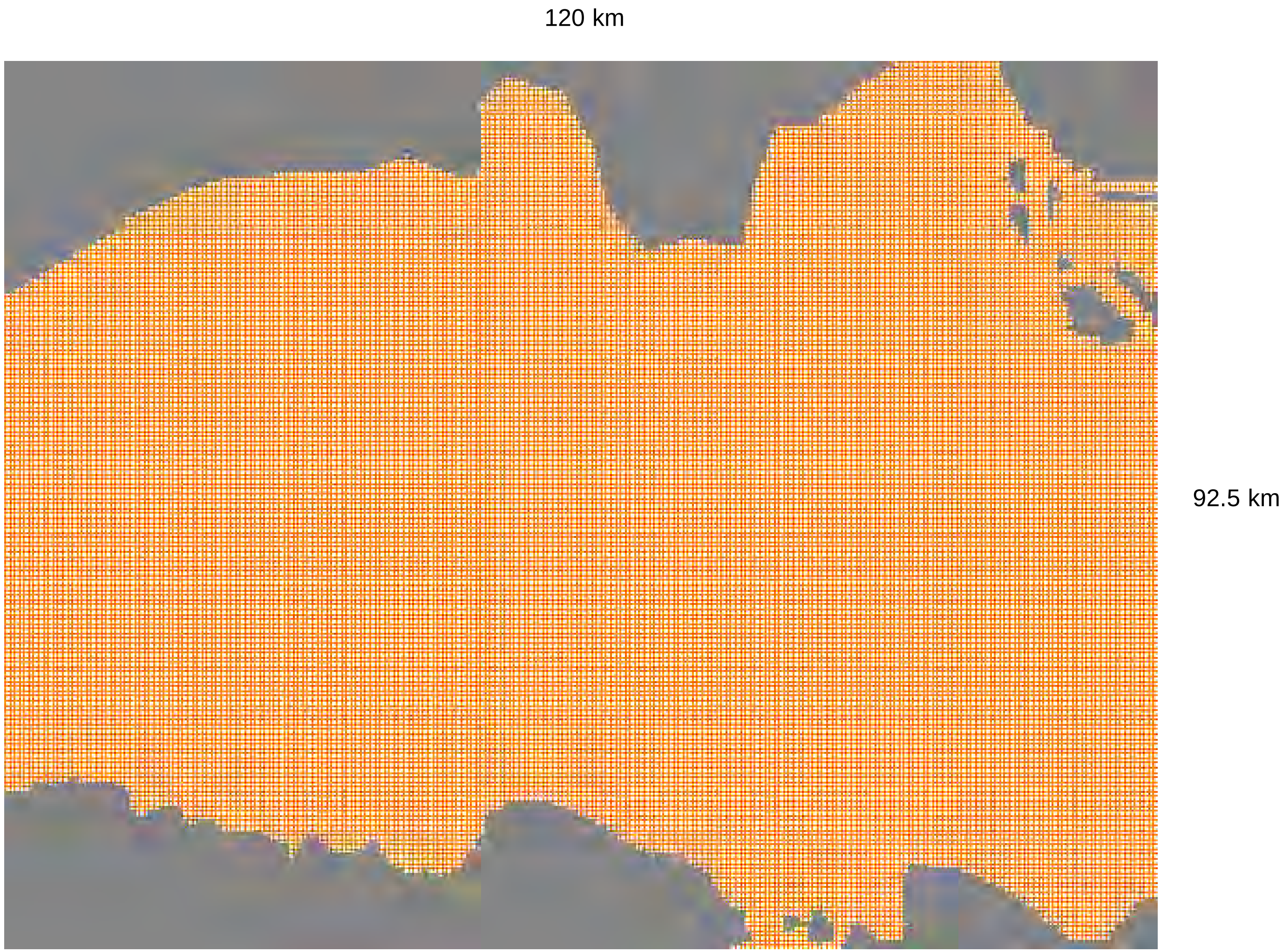
Figure E6

CALIBRATION PARAMETERS		VALUE
Scaled Mean Sum of Residuals	SMSR	-11.52 %
Root Mean Square	RMS	6.39 m
Scaled RMS	SRMS	18.24 %
Root Mean Fraction Square	RMFS	1.57 %
Scaled RMFS	SRMFS	18.41 %
Coefficient of Determination	CD	0.81



Calibration Scatter Diagram

Figure E7



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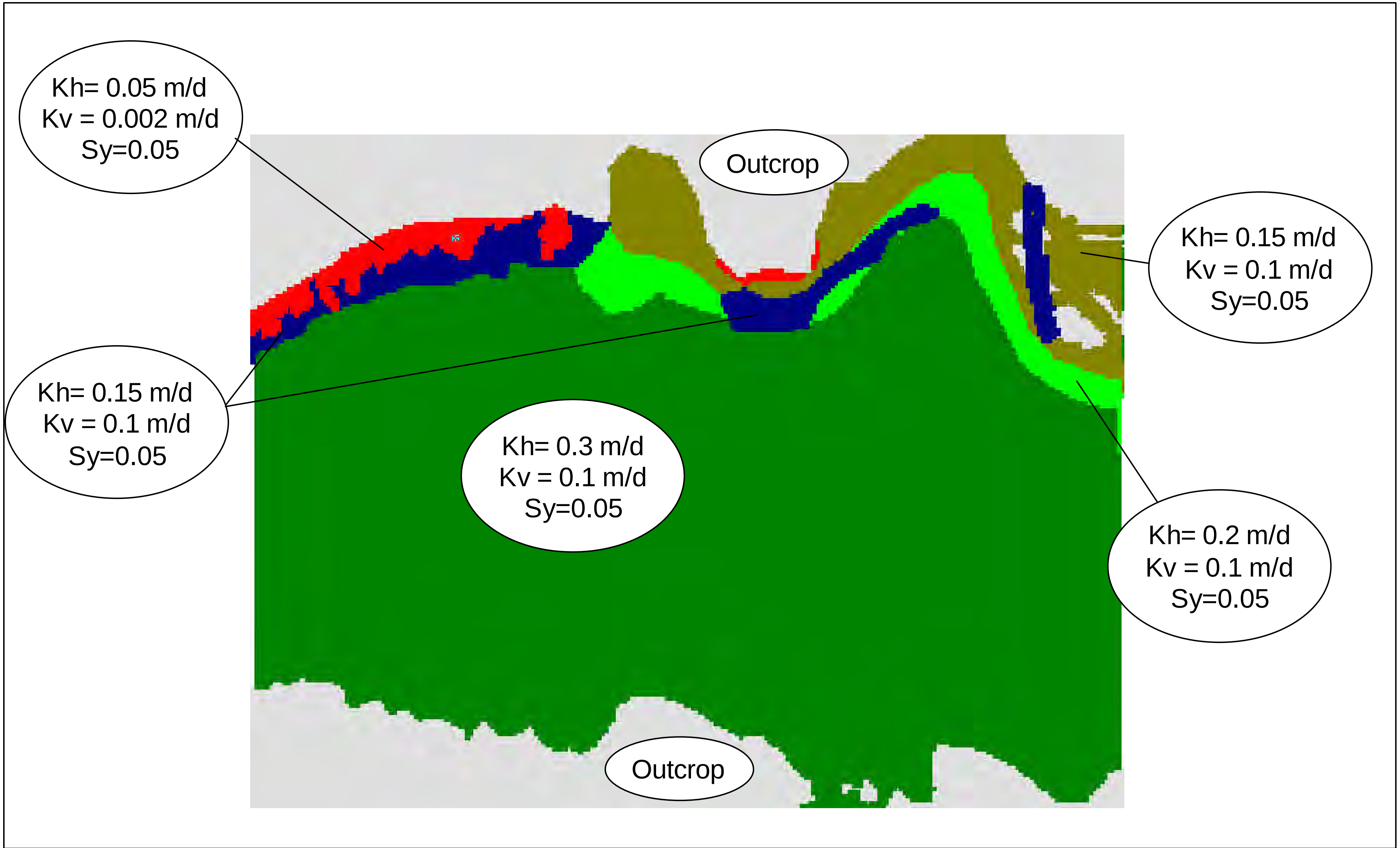
Model Grid (Layer 1)

Figure E8



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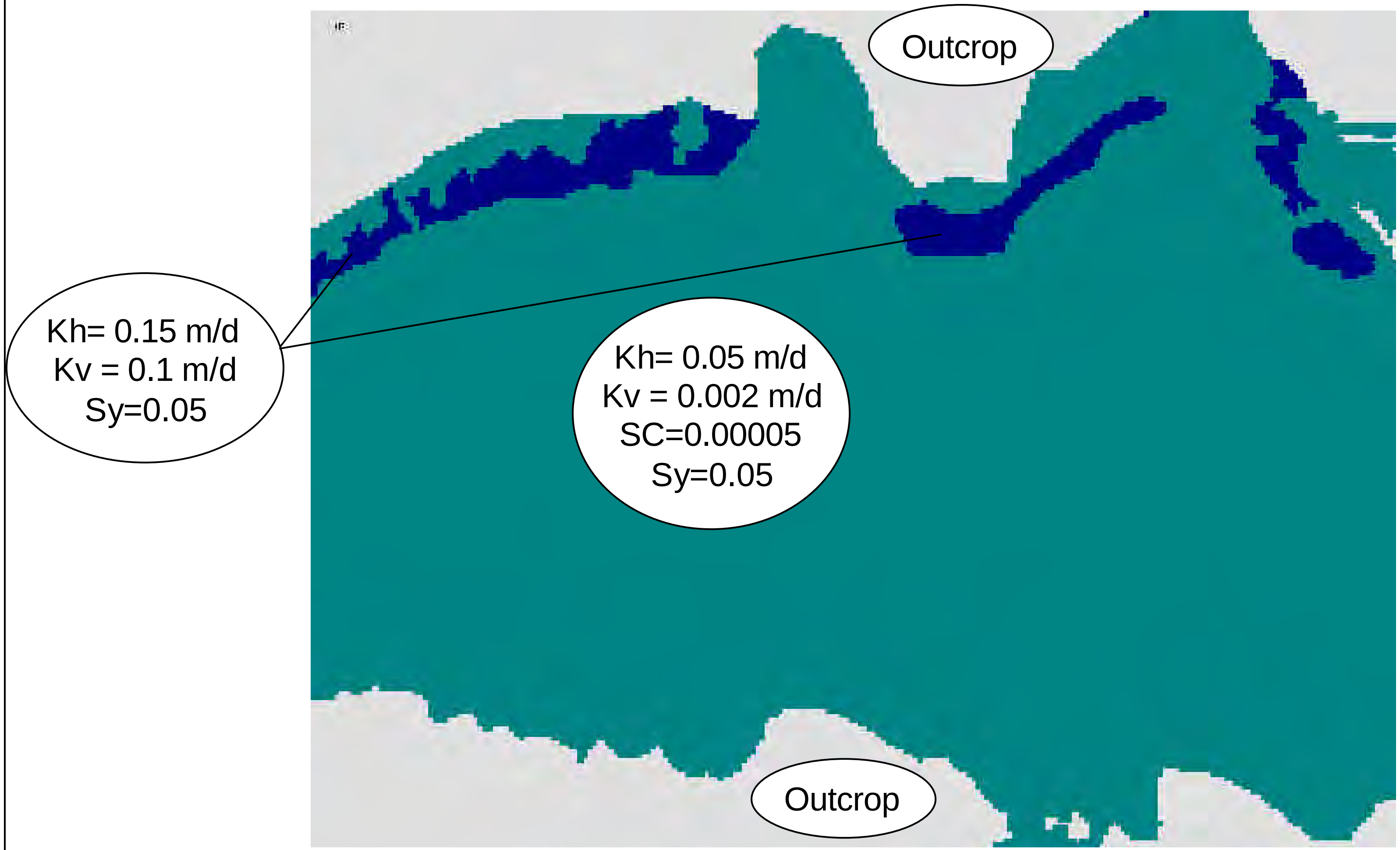
Hydraulic Properties of Alluvium (Layer 1)

Figure E9



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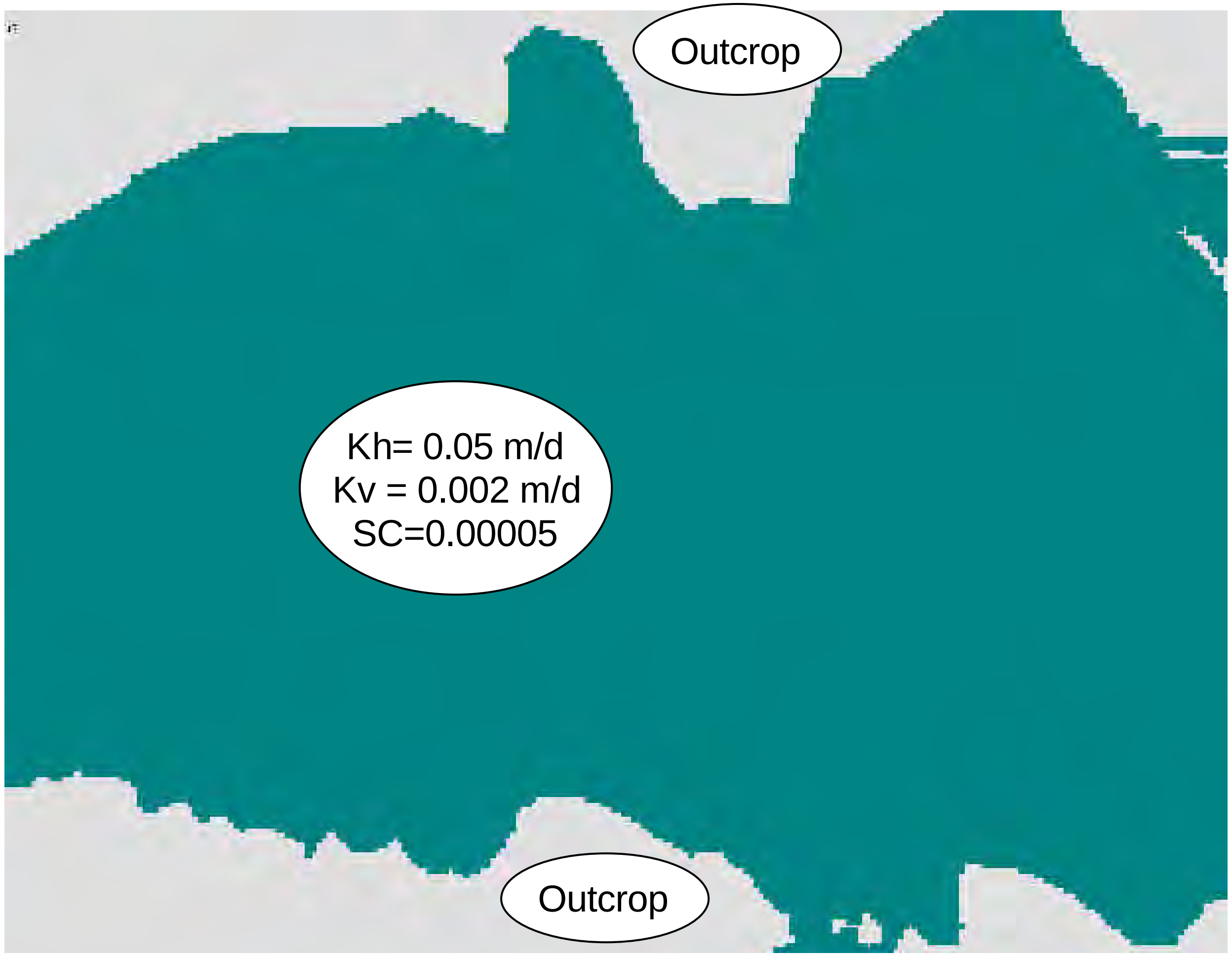
Hydraulic Properties of Basement (Layer 2)

Figure E10



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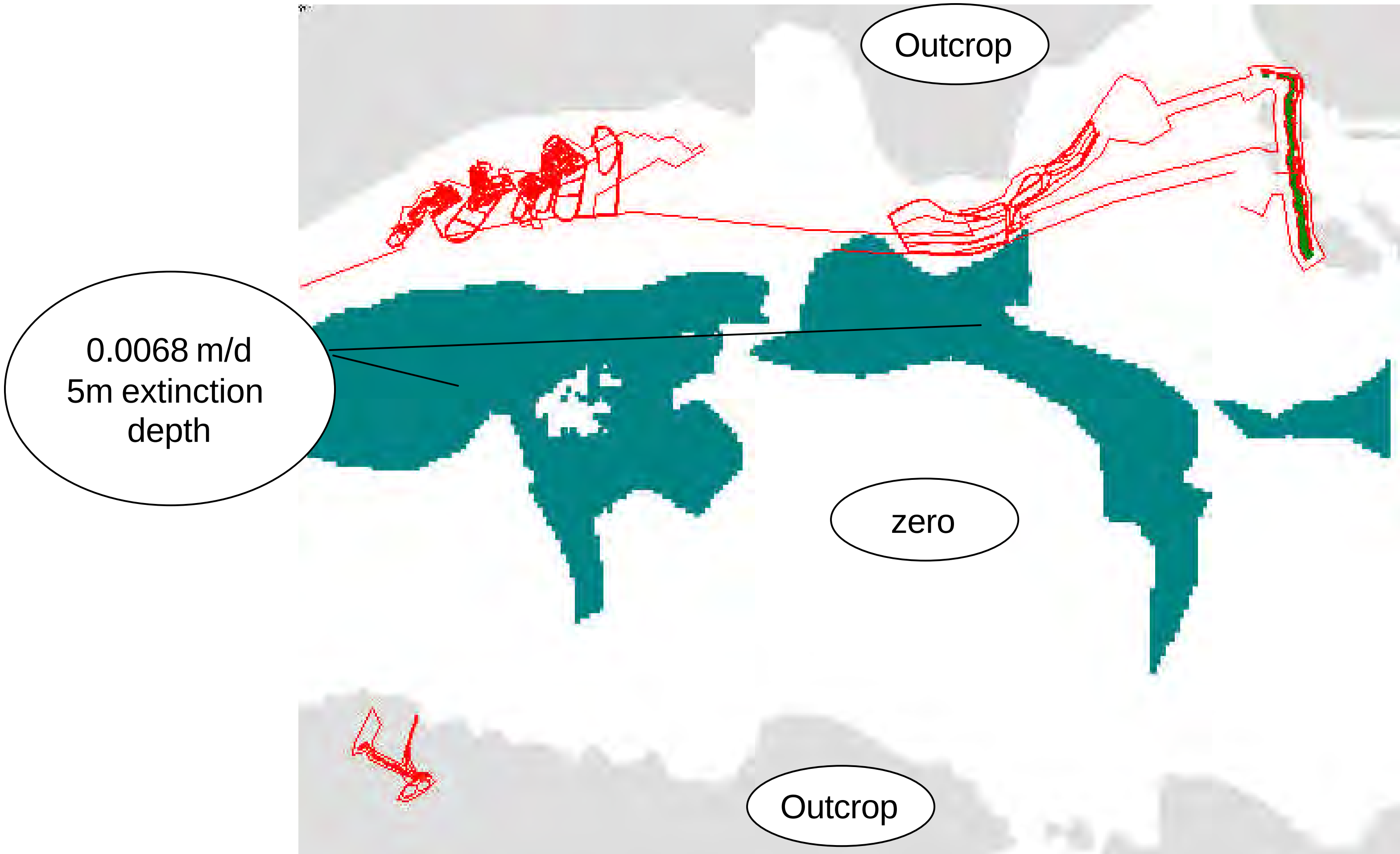
Hydraulic Properties of Basement (Layer 3)

Figure E11



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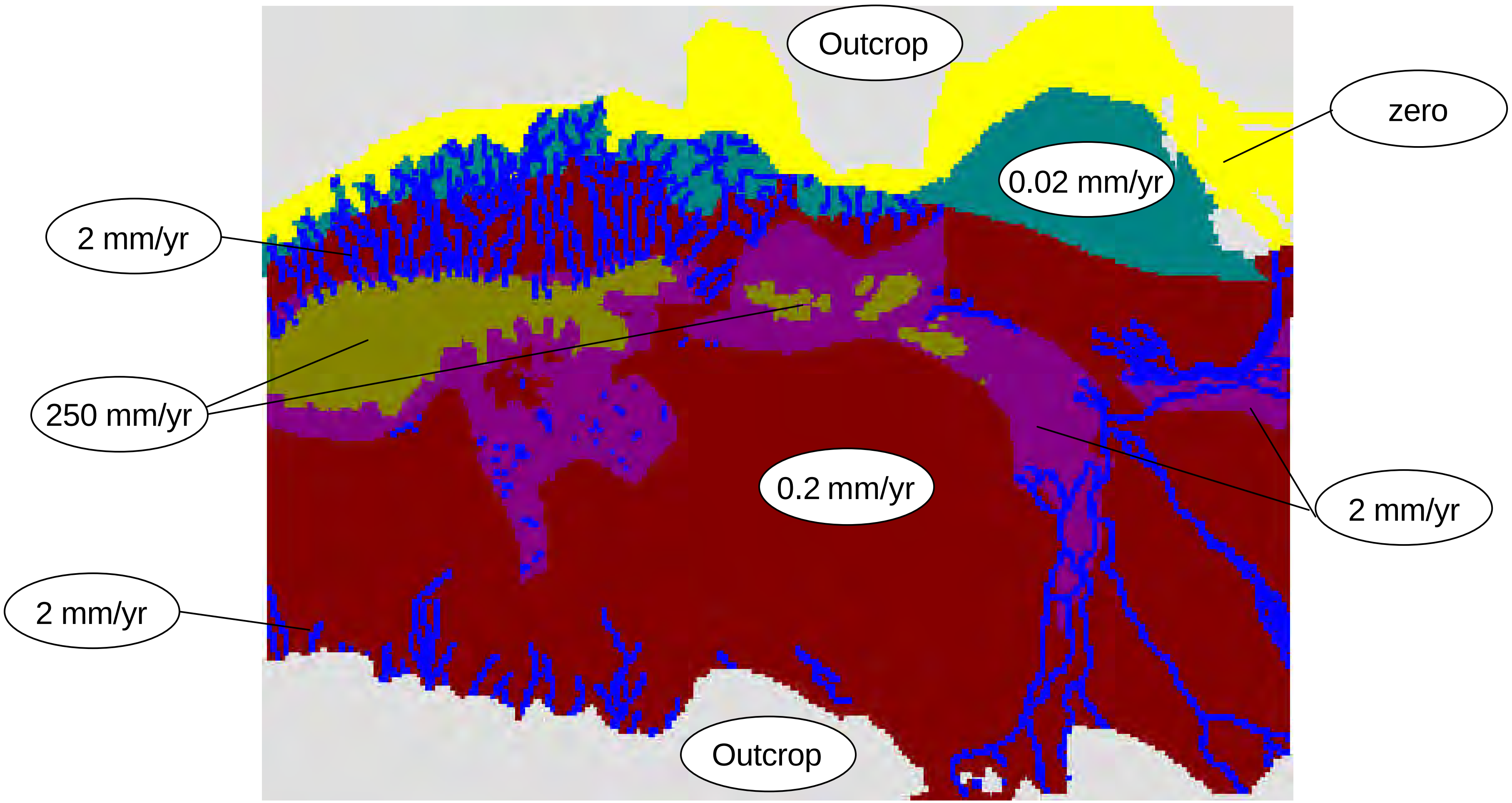
Evaporation Zones (5m extinction depth)

Figure E12



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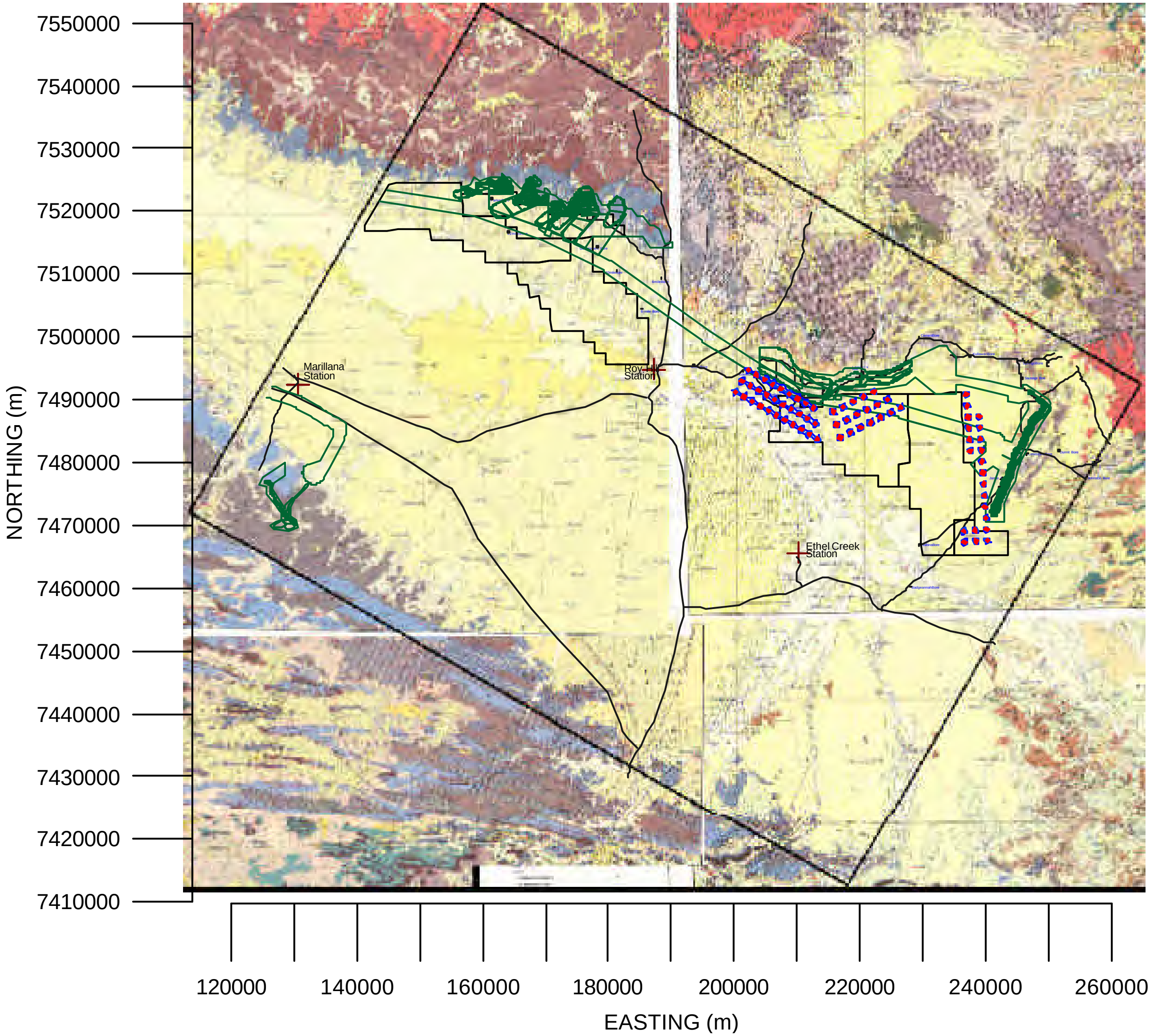
Recharge Zones

Figure E13



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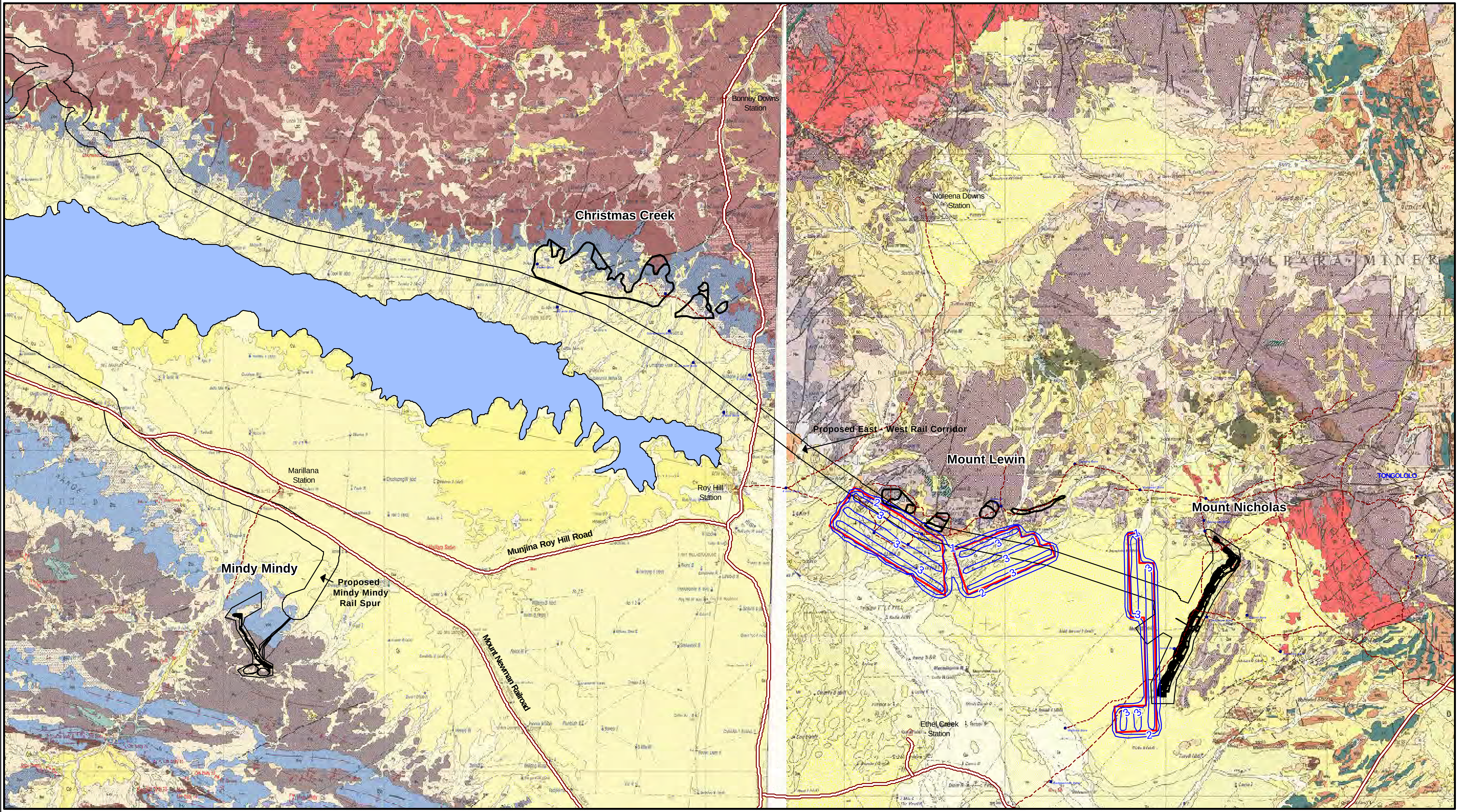
Model Predicted Drawdown after 1 year of Mining (m)

Figure E14



Legend

Fortescue Marsh

Proposed Borefield

Drawdown Contour

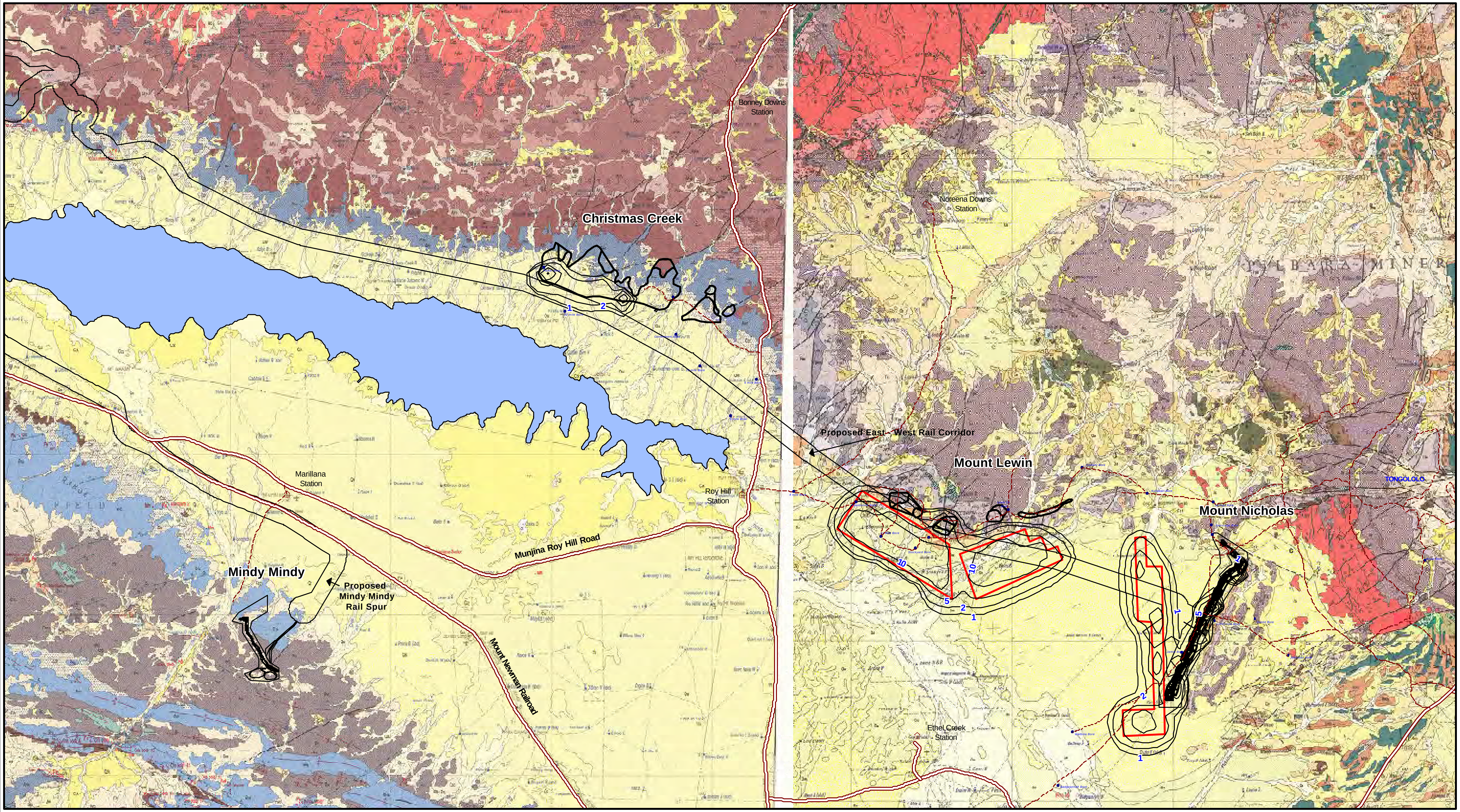
N

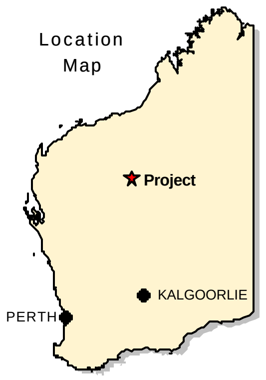
0 10 20 km

Fortescue Metals Group Limited

Figure E15 Cone of Depression after 5 years

Author: Aquaterra	Date: 2 November 2004
Drawn: Barbara Zakrzewska	Revised:
Dwg No.: 6.3	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 450 000





Legend

Fortescue Marsh

Proposed Borefield

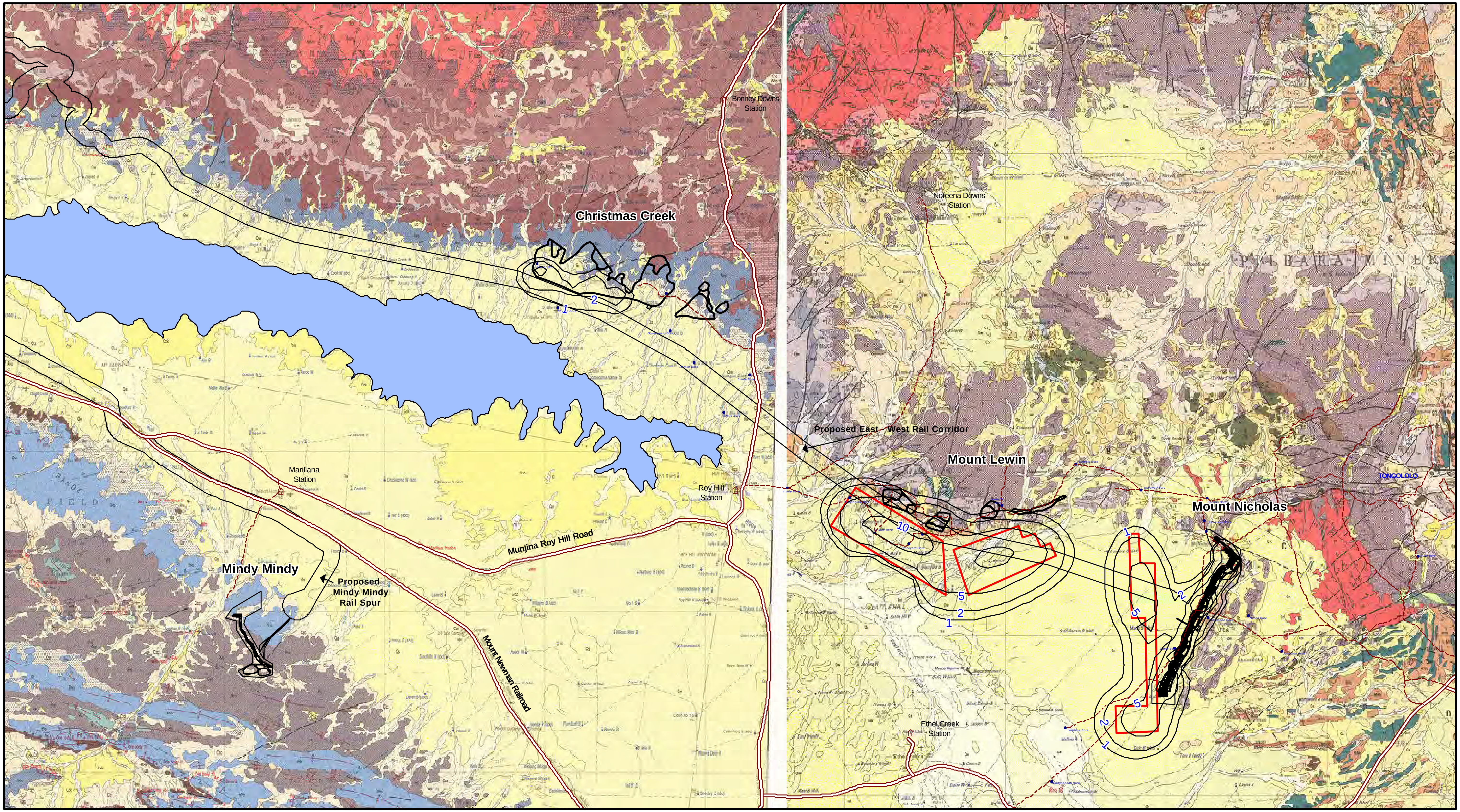
N

0 10 20 km

Fortescue Metals Group Limited

Figure E16 Cone of Depression after 16 years

Author: Aquaterra	Date: 2 November 2004
Drawn By: Barbara Zakrzewska	Revised:
Dwg No.: 6.4	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 450 000



Legend

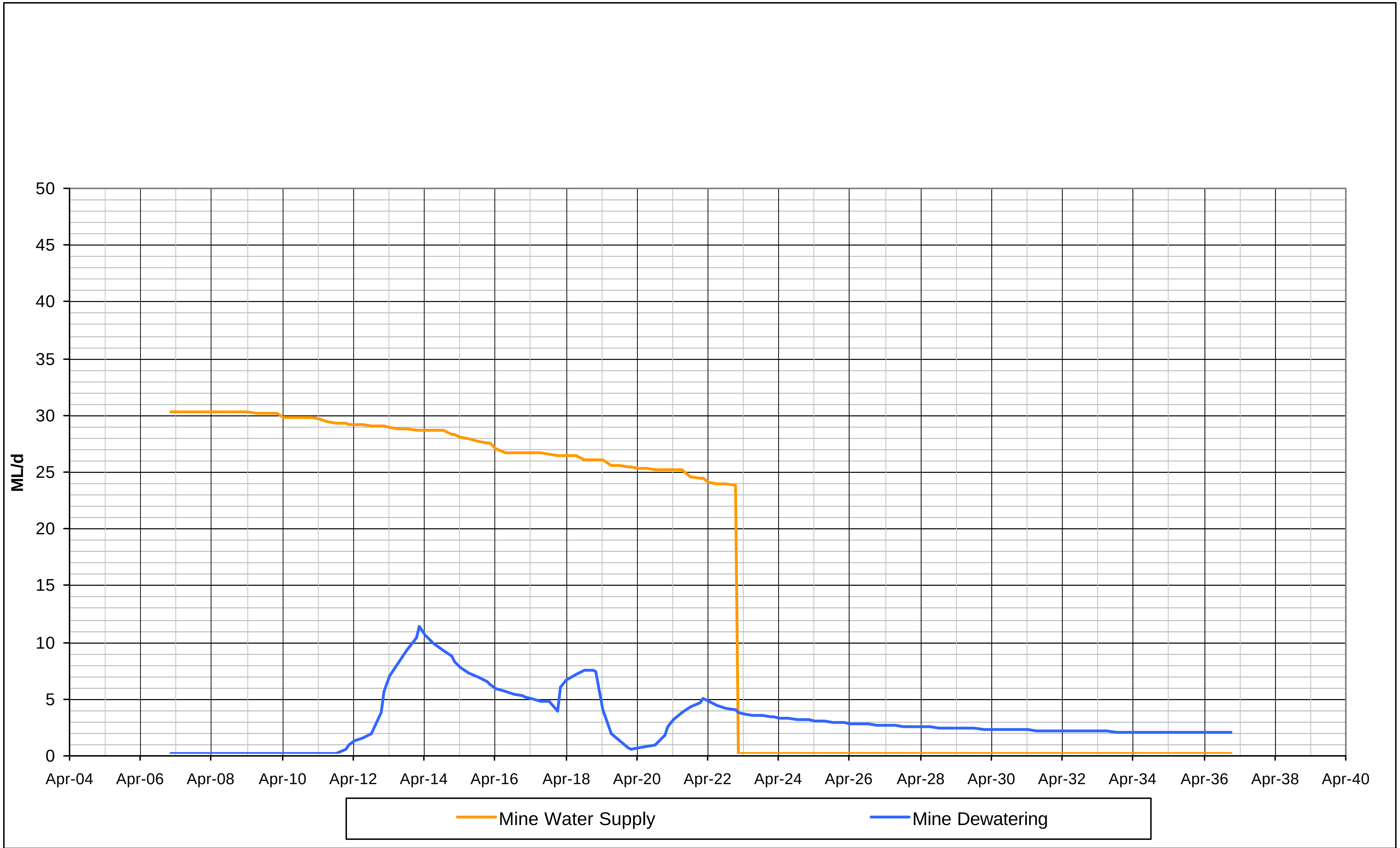
Fortescue Marsh

Proposed Borefield

Fortescue Metals Group Limited

Figure E17 Cone of Depression after 30 years

Author: Aquaterra	Date: 2 November 2004
Drawn By: Barbara Zakrzewska	Revised:
Dwg No.: 6.5	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 450 000



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Model Water Supply Abstraction and Mine Pit Dewatering Rates during Mining

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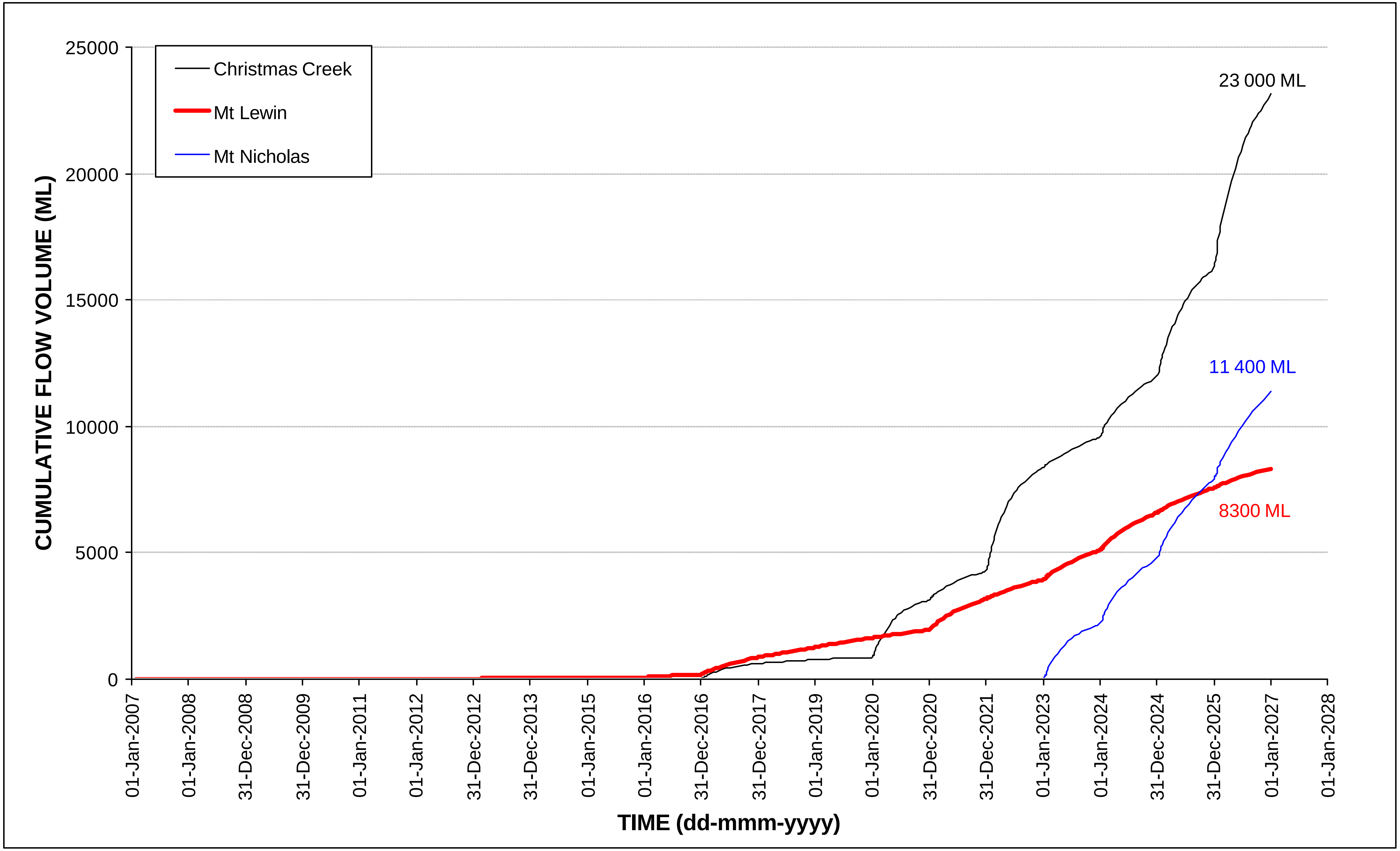
Figure E18



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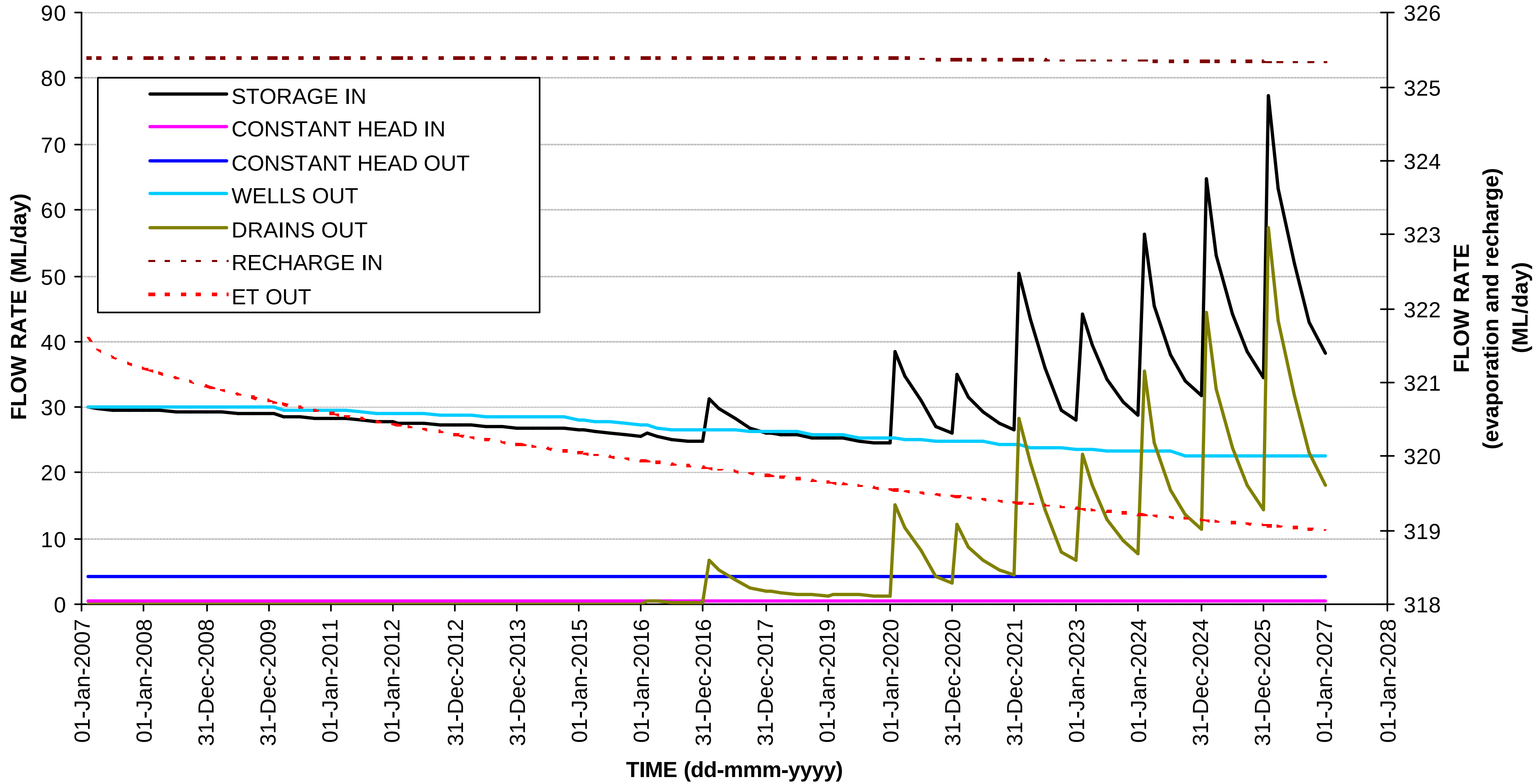
Model Predicted Mine Pit Dewatering Volumes during 20 years of Mining

Figure E19



NOTE: Evapotranspiration and recharge are plotted on the seconday axis.

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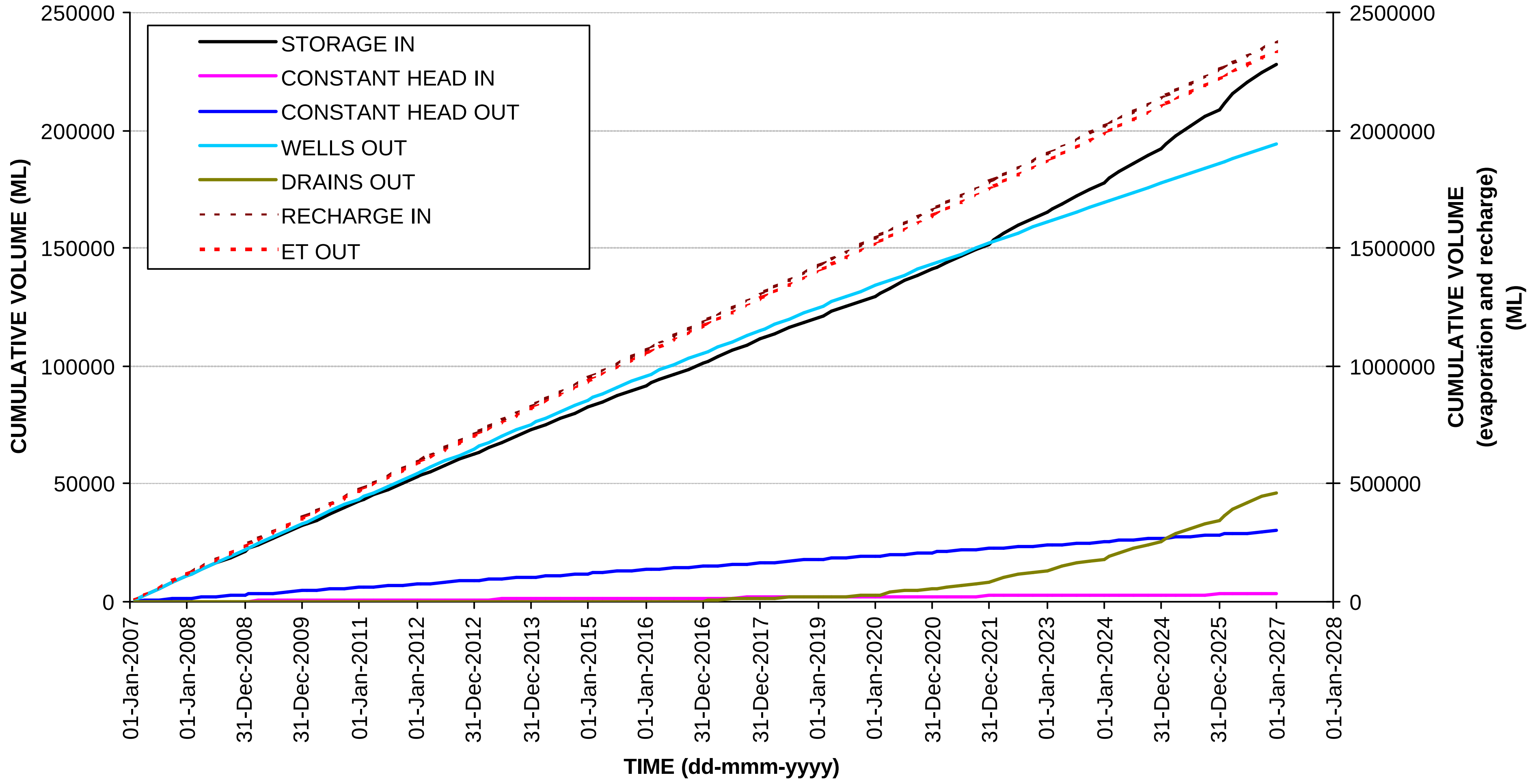
Model Predicted Rates during 20 years of Mining

Figure E20



NOTE: Evapotranspiration and recharge are plotted on the seconday axis.

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Model Predicted Volumes during 20 years of Mining

Figure E21

APPENDIX F

SUMMARY REPORT ON THE MINDY MINDY MODEL

APPENDIX F – SUMMARY REPORT ON THE MINDY MINDY MODEL

1.1 CONCEPTUAL NUMERICAL MODEL

1.1.1 Modelling Objectives

The overall objective of the modelling is to:

- Predict the environmental impact on Weeli Wolli Creek due to dewatering of the nearby Channel Iron Deposit (CID) Mine at Mindy Mindy.
- Assess impacts from the cone of depression on vegetation.
- Figure F1 shows the location of Mindy Mindy Mine in relation to regional features, and the extent of the groundwater model.

1.1.2 Model Set-up

The model has three layers to represent the following formations:

- Alluvials and Basement Outcrop (Layer 1);
- Partially saturated CID and Basement (Layer 2) and
- Basement comprising of the Brockman Iron Formation and the Weeli Wolli Formation (Layer 3).

Layer 1 has been modelled as an unconfined aquifer with varying thickness, ranging from 553 mRL to 440 mRL. The alluvials have been modelled with a horizontal (Kh) and vertical (Kv) hydraulic conductivity of 10 m/d and a Sy of 0.2. The Brockman Iron and Weeli Wolli Formation have been modelled with a Kh of 0.01 and 0.1 m/d respectively with the Kv being an order of magnitude smaller for each unit. Both basement formations have been modelled with a confined storage (Sc) and specific yield (Sy) value of 1.0 e^{-5} and 0.001 respectively.

Layer 2 has been modelled as a confined/unconfined aquifer with varying thickness, ranging in elevation from 503 mRL to 435 mRL. Layers 2 hosts the CID which has been modelled with a Kh and Kv value of 30 m/d. The Sy and Sc have been modelled with values of 0.03 and 3.0 e^{-3} respectively. The Brockman Iron and Weeli Wolli Formations have been modelled with the same properties as layer 1.

Layer 3 represents Basement only and has been modelled under confined/unconfined conditions with varying thickness, ranging in elevation from 500 mRL to 392 mRL. The Basement Formations have the same properties as in Layers 1 and 2.

The flow system is believed to flow in a northeasterly direction, which bends towards the east downstream as the palaeo-valley hosting the CID joins up with Weeli Wolli Creek.

1.1.3 Model Grid and Boundary Conditions

The numerical finite difference groundwater flow modelling package MODLFOW designed by the US Geological Survey (McDonald and Harbaugh, 1988) was used for this work, operating under the PMWin Pro graphical user interface (version 7.0.15, Webtech360 Inc., 2002-2003).

The finite difference grid consists of 202 rows x 218 columns, covering an area of approximately 10 km^2. The grid is uniform and has been meshed with a 25 m by 25 m cell size.

The Well package has been used to represent fixed inflow into the basement layer (layer 3) along the southern boundary. A total Inflow of 22 m^3/d was implemented. Constant head cells have been used for the northwestern boundary and represent a section of the Weeli Wolli Creek. A value of 462 mRL was assigned to the constant head boundary.

1.1.4 Model Features For Recharge and Abstraction Wells

Recharge has been applied to the CID area only in Layer 2 at a rate of 1.15 e^{-4} m/d, equivalent to an annual rainfall recharge rate of 42 mm/year.

The four dewatering bores in the proposed mine pit were simulated using the evapotranspiration (ET) package of Modflow, which is a depth-dependent flux feature. The ET package requires the specification of an ET surface, an extinction depth and maximum ET rate (the ET rate is specified in m/day, and the model multiplies the rate by the cell area to derive the flux rate at any time). The ET feature can represent a dewatering bore by simulating flows at the maximum specified (ET) rate when the water level is higher than the specified ET surface. As water levels fall below the ET surface, the flux decreases linearly from the maximum rate, eventually reaching zero as the water level reaches the specified extinction depth (below the ET surface). The extinction depth represents the "cut-off" water level when the bore will cease pumping all together, and is set a little below the target pit floor level. The ET feature effectively emulates the process of "tuning" long term bore pumping rates to give water levels below the required target dewatering levels, without having to guess the pumping rate for input to the model.

The dewatering wells serve two purposes; firstly they are used to provide a water supply for dust suppression and for the personnel camp and, secondly, to dewater the ore body.

1.2 CALIBRATION

The model was run under steady state conditions to establish initial groundwater levels for the transient dewatering simulation. Simulated groundwater levels were compared to 3 observation bores along a transect through the pit. The transect observation bores used were MM05, MM37 and MM42. Figure F2 presents the steady state water level contours along with the measured head levels. Note that the observed head at MM05 is approximately 5 metres below the modelled level. MM05 has an observed head of 460 mRL and the modelled head is approximately 465 mRL. This is acceptable based on the current data available, which has observed heads ranging from 438 mRL to 478 mRL in this area.

Referring to Figure F3 and/or F4, it is also interesting to note the small flow through rate of 0.2 ML/d (200 m^3/d), predominately from recharge to the CID. The through-flow is small due to the limited extent and saturated thickness of alluvium and CID. During the calibration process, the model was found to be highly sensitive to the head place on the downstream boundary, which represents the appropriate section of Weeli Wolli Creek. A higher head on the boundary increased the model's saturated thickness and thus through-flow and in reality would represent a cyclone or high recharge event. As previously mentioned, a head of 462 mRL was set on the downstream boundary but as indicated by the Weeli Wolli Creek bore YM119, water levels can reach up to 470 mRL during high recharge events. However, this type of scenario was not simulated, as a match to the current measured heads would be very difficult based on the current conceptualisation. High hydraulic heads on the downstream boundary causes the heads at the northern side of the pit to be too high compared to measured values which tends to suggest there is some type of hydraulic discontinuity present between Weeli Wolli Creek and Mindy Mindy mine area. Further field investigations are recommended to further refine the current conceptualisation.

1.3 PREDICTIONS

1.3.1 Dewatering Requirements

Modelling results have indicated that the CID is saturated only in the far northern section of the pit. If we assume the pit base to be equal to the bottom of the CID, the model indicates a maximum saturation of approximately 15 meters. As mentioned above, 4 production bores were assigned to dewater the northern area of the pit. Abstraction from the bores for dust suppression and camp water supplies was simulated over a 6-year period and the abstraction rates and effect on through-flow to Weeli Wolli Creek is shown in Figure F3.

The predicted total maximum dewatering rate for the first few weeks of dewatering starts at approximately 1.1 ML/d but diminishes as the saturated thickness within the pit decreases. The average dewatering rate over the 6-year period is approximately 1.015 ML/d.

The water balance summaries depicted in Figure F4 show that almost all the groundwater being dewatered is coming from aquifer storage. The modelled hydrographs of the 4 conceptual production bores and 3 observation bores shown in Figure F1 are plotted in Figures F5 and F6.

1.3.2 Environmental Impact on Weeli Wolli Creek

Figures F3 and F4 show the effect on flow to Weeli Wolli creek as a result of dewatering. Flow to Weeli Wolli Creek is initially 0.2 ML/d pre dewatering. As abstraction continues, flow to the Weeli Wolli decreases until the flow direction reverses at approximately 2 years into the abstraction period. By the end of the abstraction period, the flow direction is from Weeli Wolli Creek to Mindy Mindy Mine Area with a reversed through-flow rate of approximately 0.2 ML/d. The “Central Pilbara Groundwater Study”, (Aquaterra, January 2001) found that the total predicted groundwater outflow from Weeli Wolli Creek aquifer units to Fortescue Valley is in the order of 7.0 ML/d. Therefore a 0.2 ML/d outflow from Weeli Wolli Creek is quite insignificant compared to the total through-flow of the Weeli Wolli System.

1.3.3 Post Dewatering Recovery

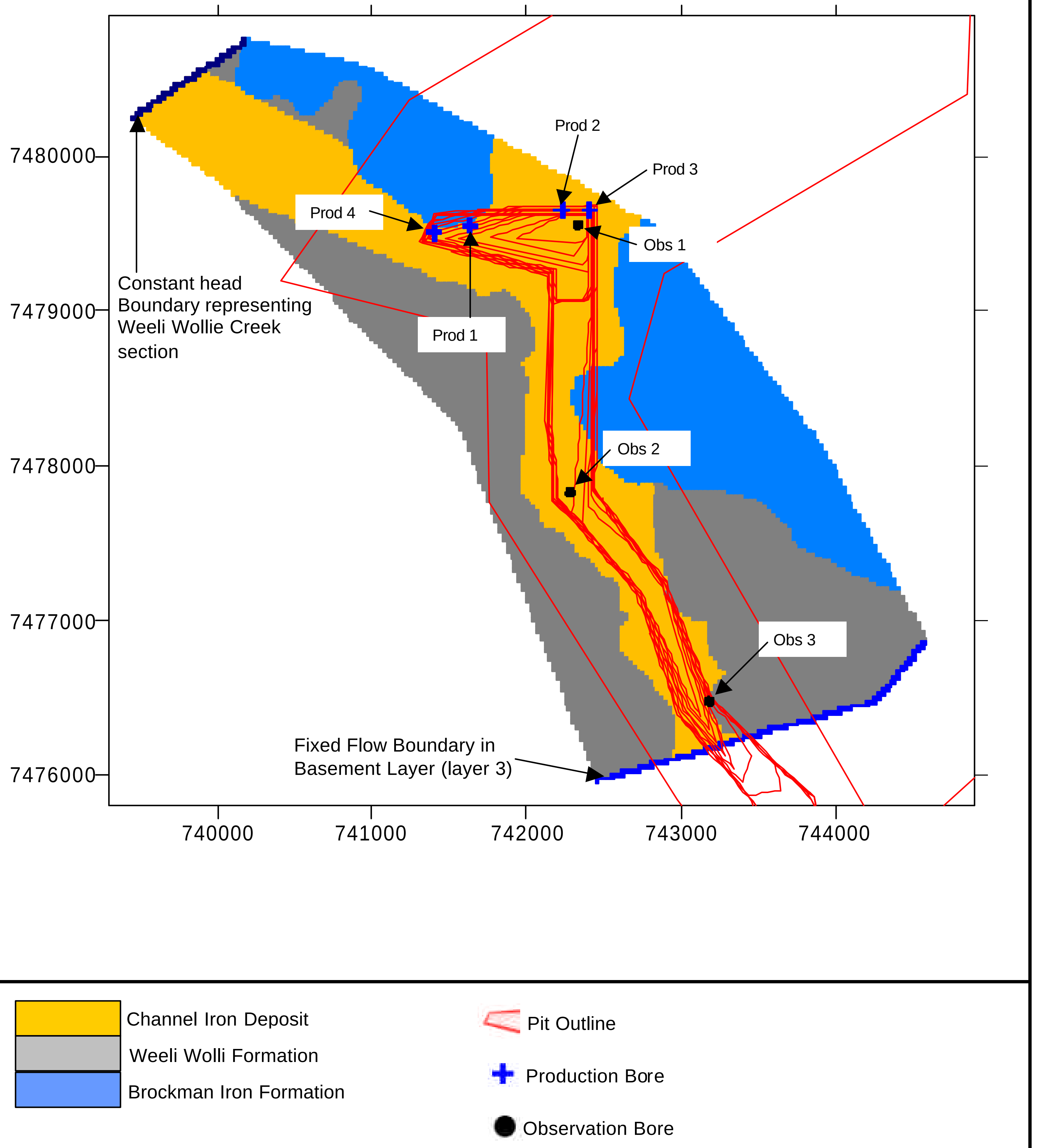
Figure F7 shows the flow to Weeli Wolli Creek and Figures F8 and F9 show the hydrographs post dewatering. Results indicate recovery times in the order of 50 years plus. The slow recovery time is due to the small through-flow rate in the system. To achieve calibration, the model has been simulated with heads at Weeli Wolli Creek being on the low side of the measured range at the only nearby monitoring YM119 bore near Weeli Wolli Creek. However, following a cyclone event, heads at this bore increase by about 4-5 m and the series of wet years since 1998 have shown water levels increasing to around 470 mRL. Such high water levels at Weeli Wolli Creek are not consistent with measured water levels of 465 mRL or lower at the mine area at

Mindy Mindy Creek. Thus, the model was set up conservatively, with low water levels on the boundary representing low recharge, and thus long recovery times result.

1.4 DISCUSSIONS AND CONCLUSIONS

Based on the current conceptualisation, the CID is predominantly above the water table in the Mindy Mindy mine area, apart from the far northern area of the pit. The model suggests there is a maximum saturation thickness of 15 meters from the base of the CID to the water table in this area. The abstraction results in a decrease of the through-flow from Mindy Mindy Creek to Weeli Wolli Creek from an initial rate of 0.2 ML/d pre-dewatering to an outflow rate of –0.2 ML/d at the end of the dewatering period. The "Central Pilbara Groundwater Study", (Aquaterra, January 2001) found that the total groundwater outflow from Weeli Wolli Creek aquifer units to Fortescue Valley is in the order of 7.0 ML/d. Therefore a 0.2 ML/d reduction in outflow from Weeli Wolli System is insignificant compared to the total through-flow.

The recovery time of the Mindy Mindy System is slow with the model suggesting a period of at least 50 years is required before hydraulic heads and through-flow rates reflect pre-mining conditions. The long recovery time is due to the small flow-through rate, which is predominantly dependant on the saturated thickness of the alluvium and CID. Small head values assigned to the outflow boundary were needed to achieve calibration but as a result, directly limits the through-flow rate and thus recovery time. This result suggests the presence of a hydraulic discontinuity between Weeli Wolli Creek and Mindy Mindy mine area. Future field investigations are recommended to further refine the current conceptualisation so more detailed modelling can be done in the future.



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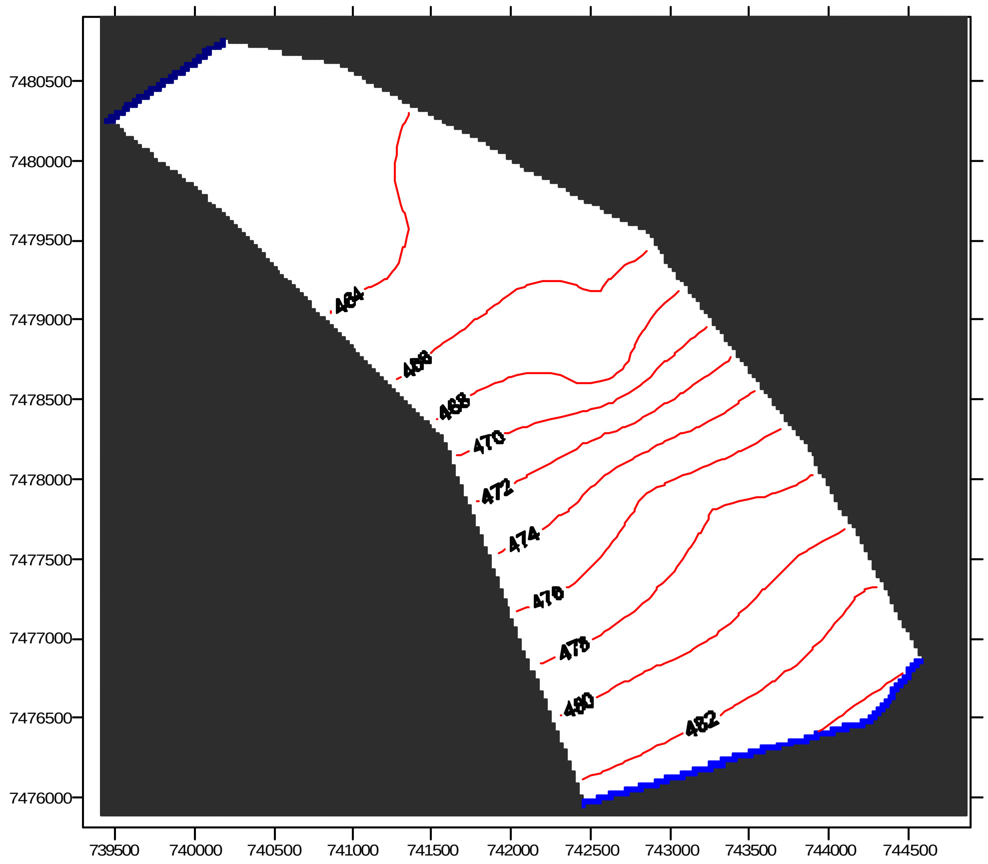
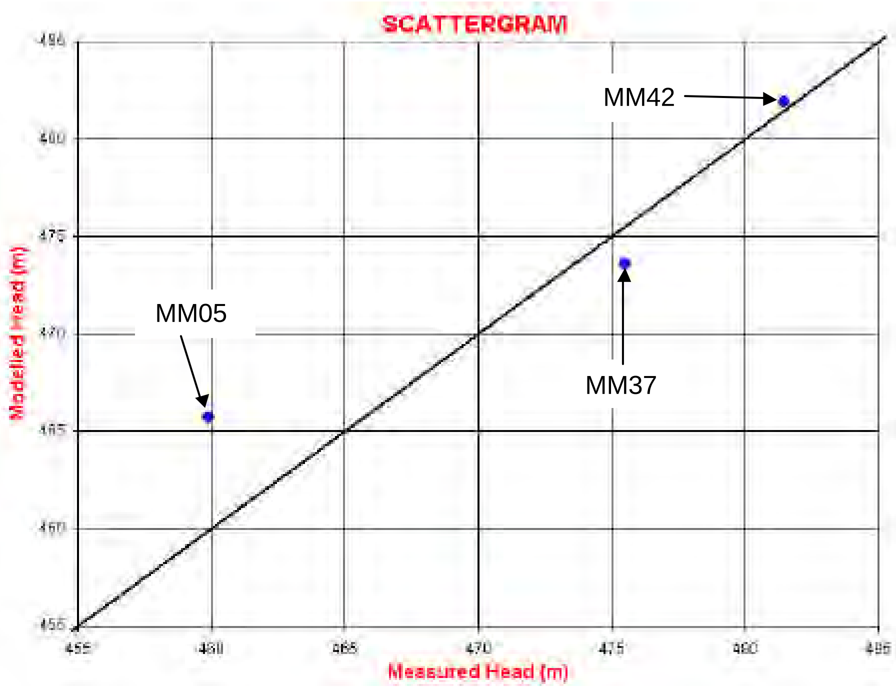
aquaterra

Location Plan and Model Features
Figure F1





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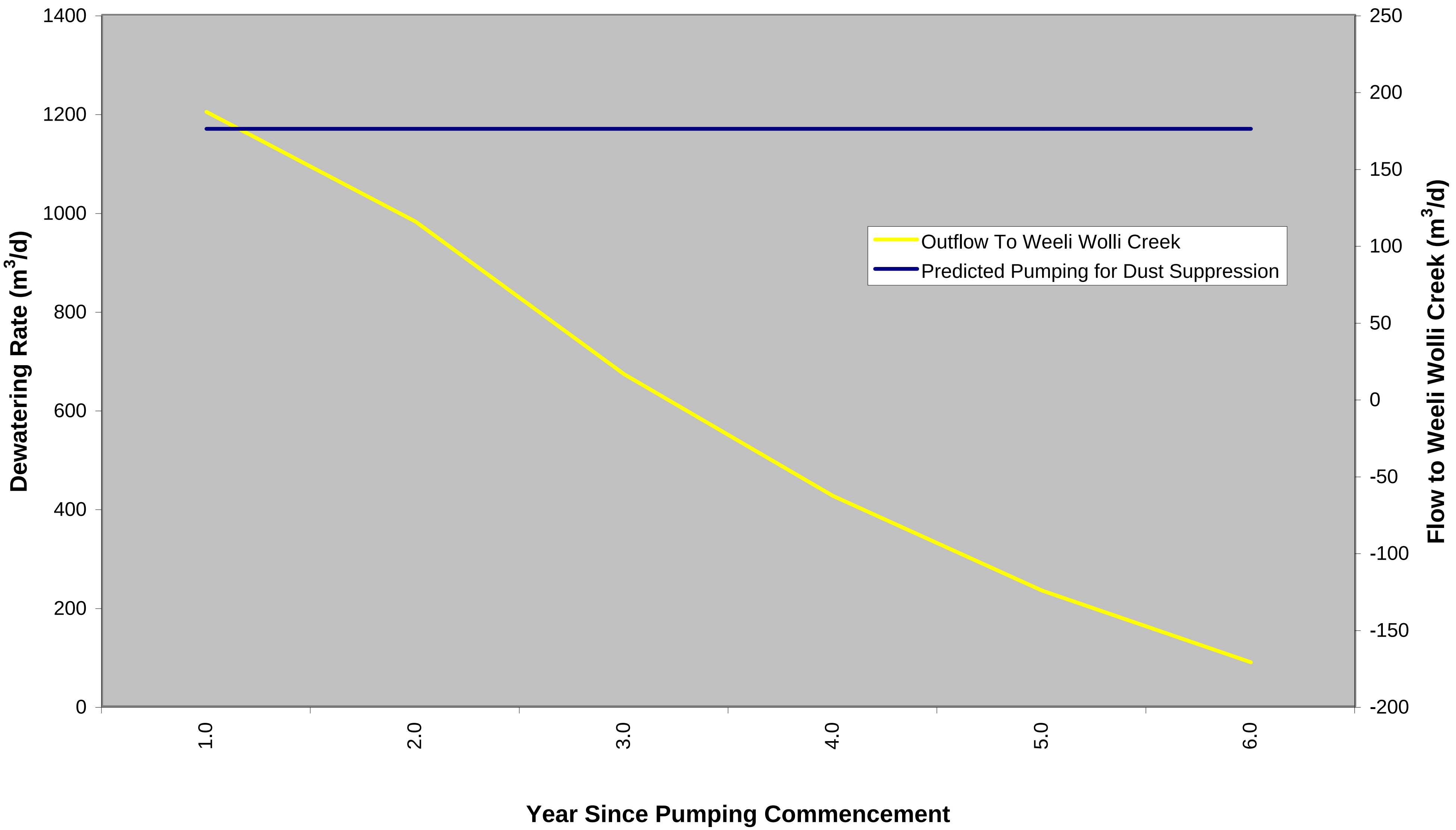
Steady State Calibration
Figure F2



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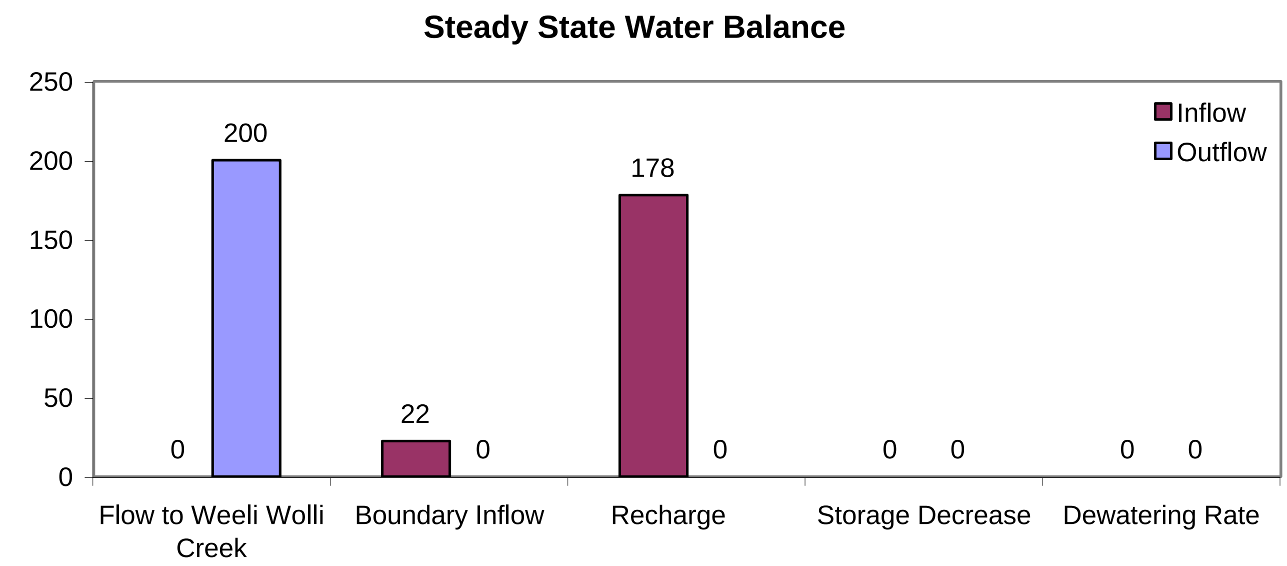
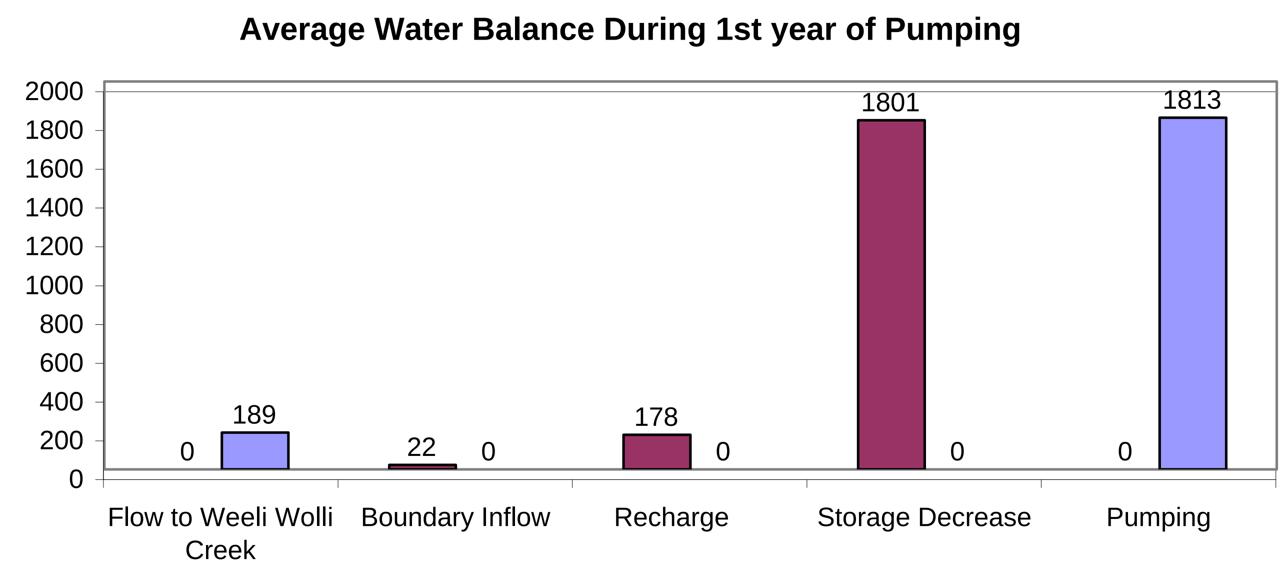
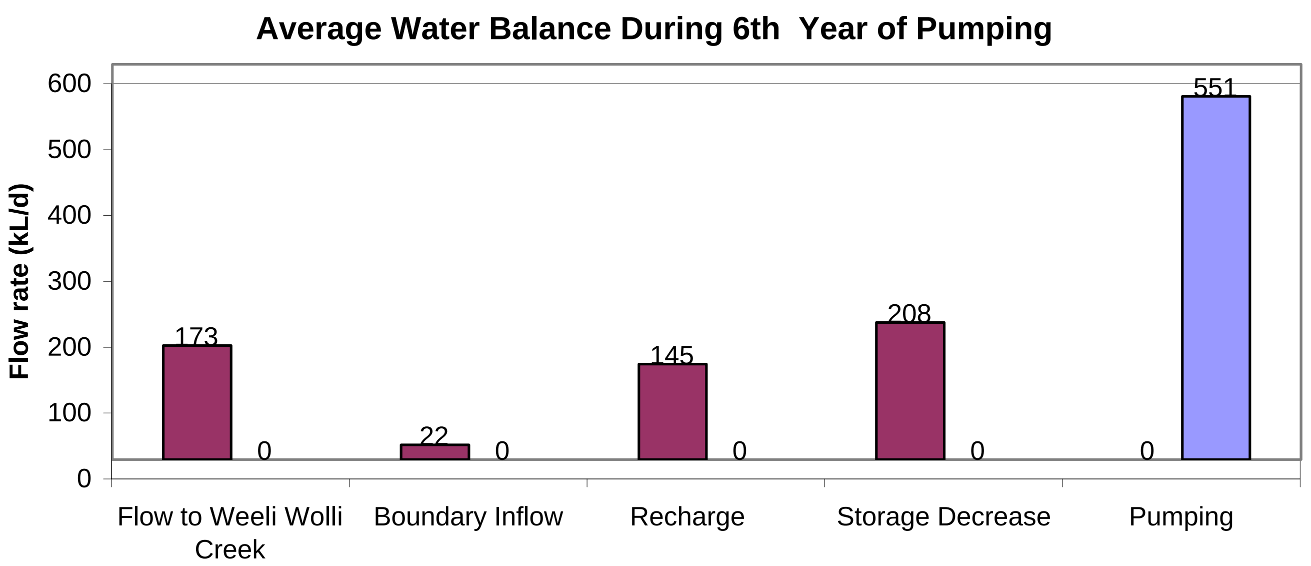
F:\jobs\477\6000\PER Reports\[396_Figures.xls]Figure 3 revb

Mindy Mindy Predicted Pumping Rates and Flow Rates to Weeli Wolli Creek

Figure F3







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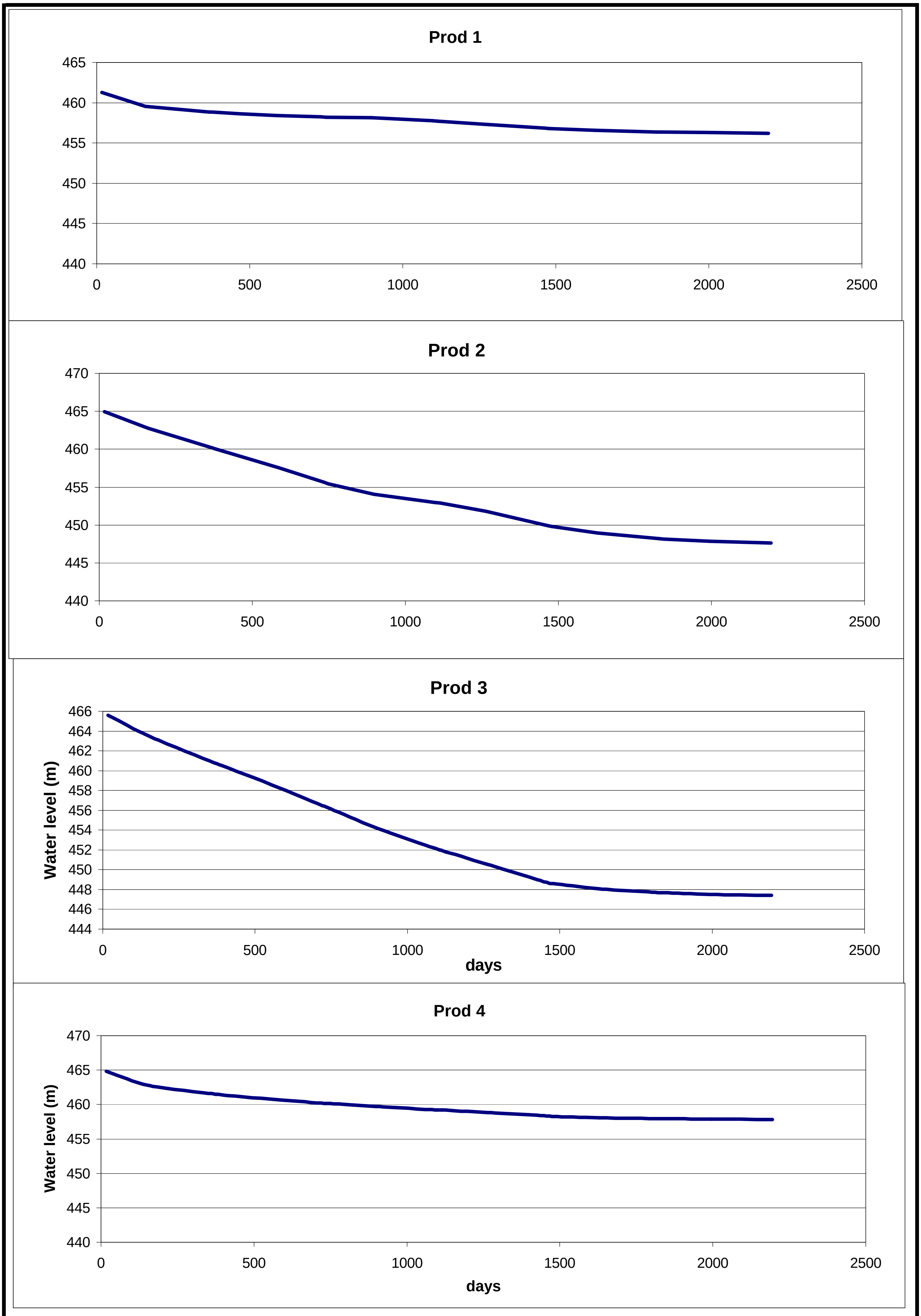
F:\jobs\477\6000\PER Reports\[396_Figures.xls]Figure 4 revb

Average Water Balances Pre and After Pumping

Figure F4



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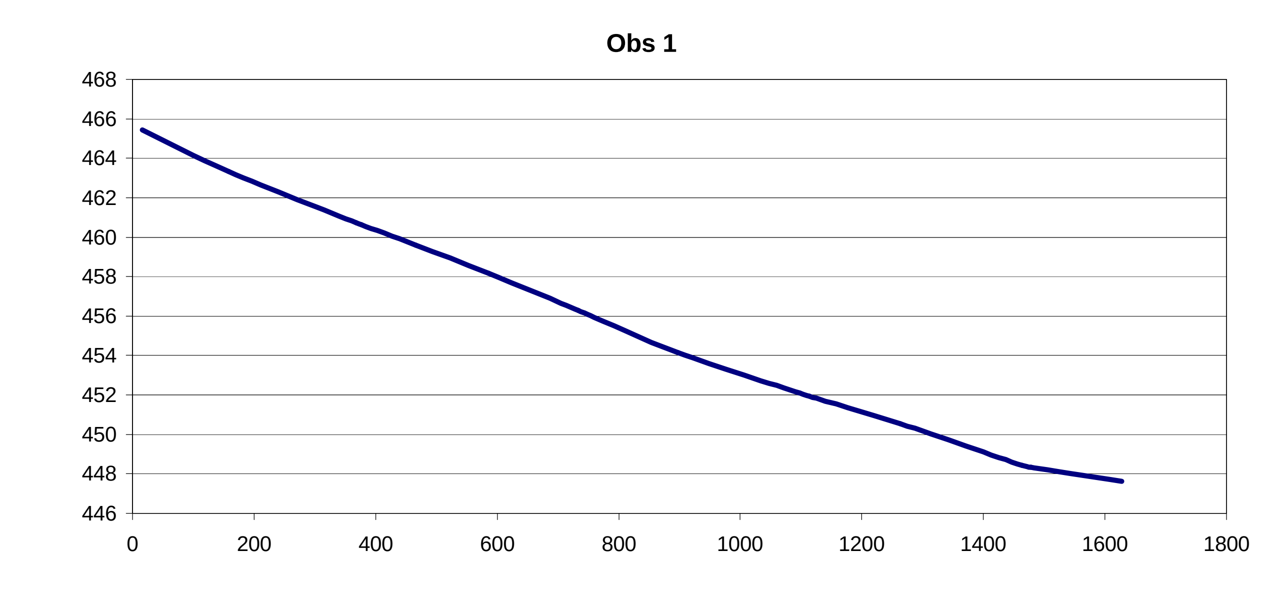
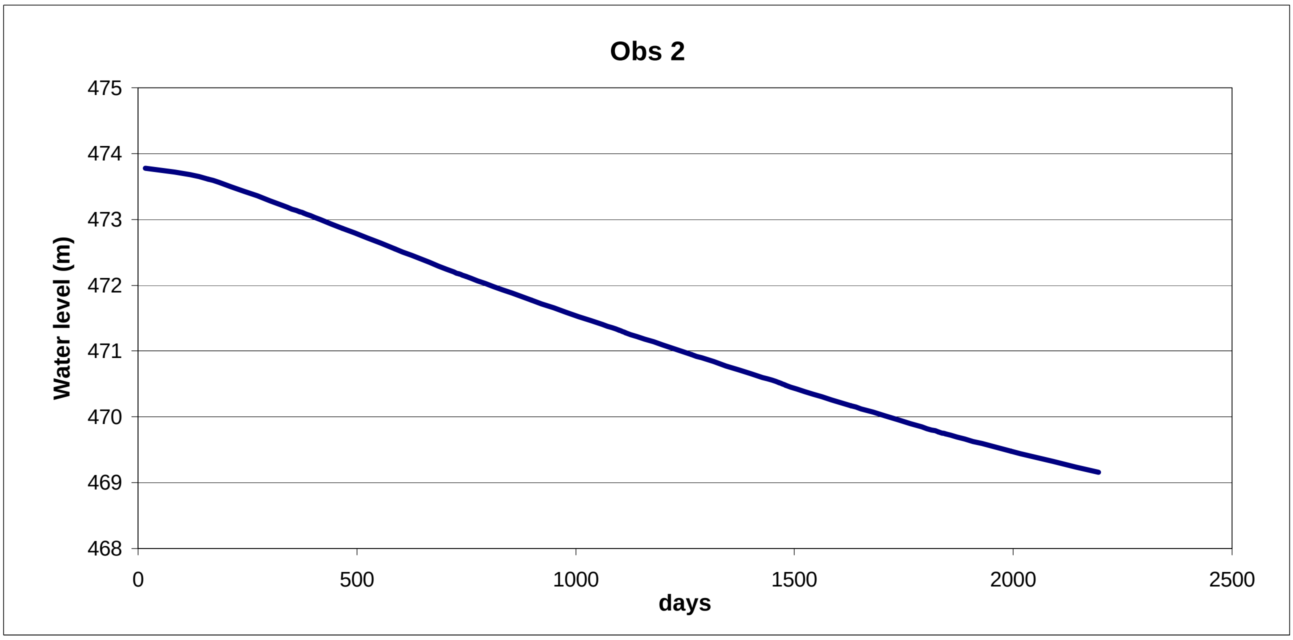
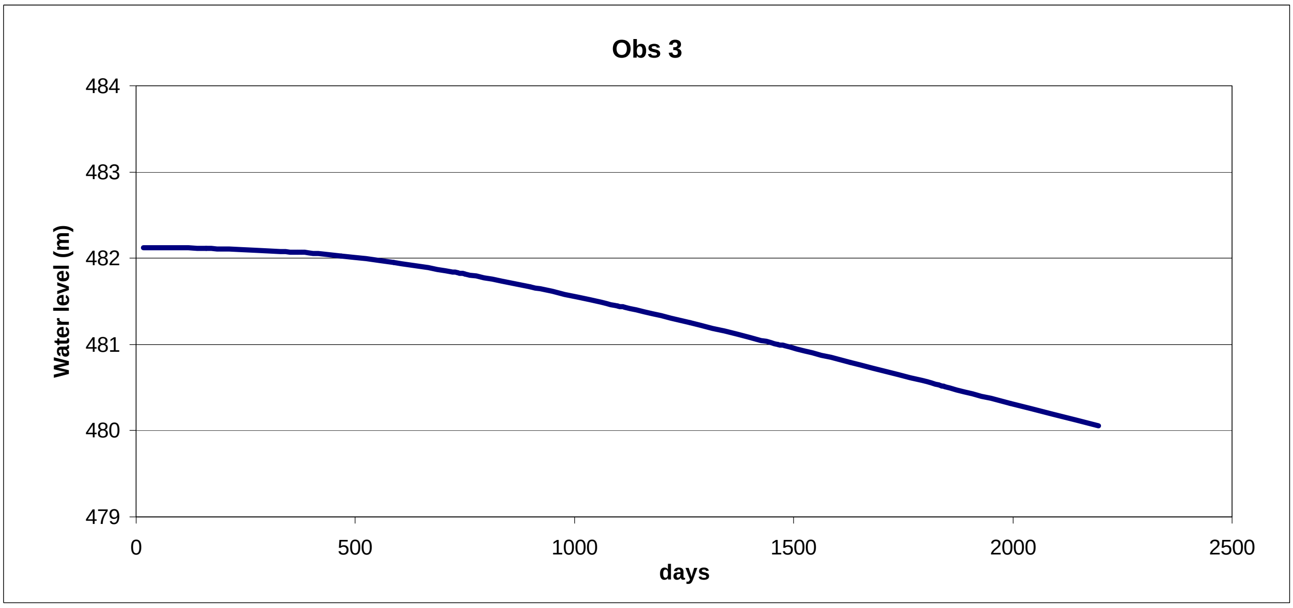
Production Bore Hydrographs During Pumping Period

Figure F5

F:\jobs\477\6000\PER Reports\[396_Figures.xls]DW hydrographs Figs 5 & 6 revb







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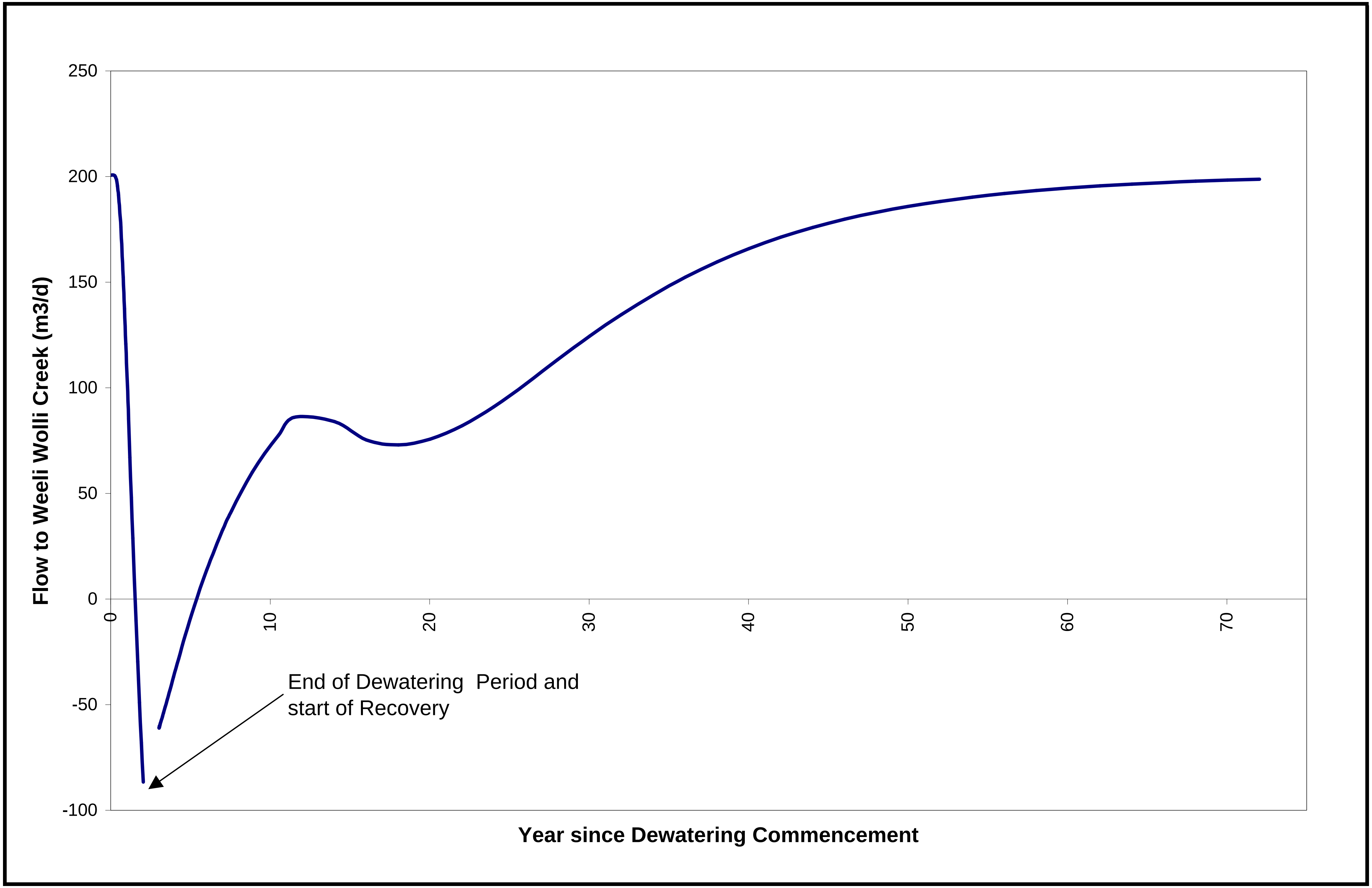
Observation Bore Hydrographs During Pumping Period

Figure F6

F:\jobs\477\6000\PER Reports\[396_Figures.xls]DW hydrographs Figs 5 & 6 revb



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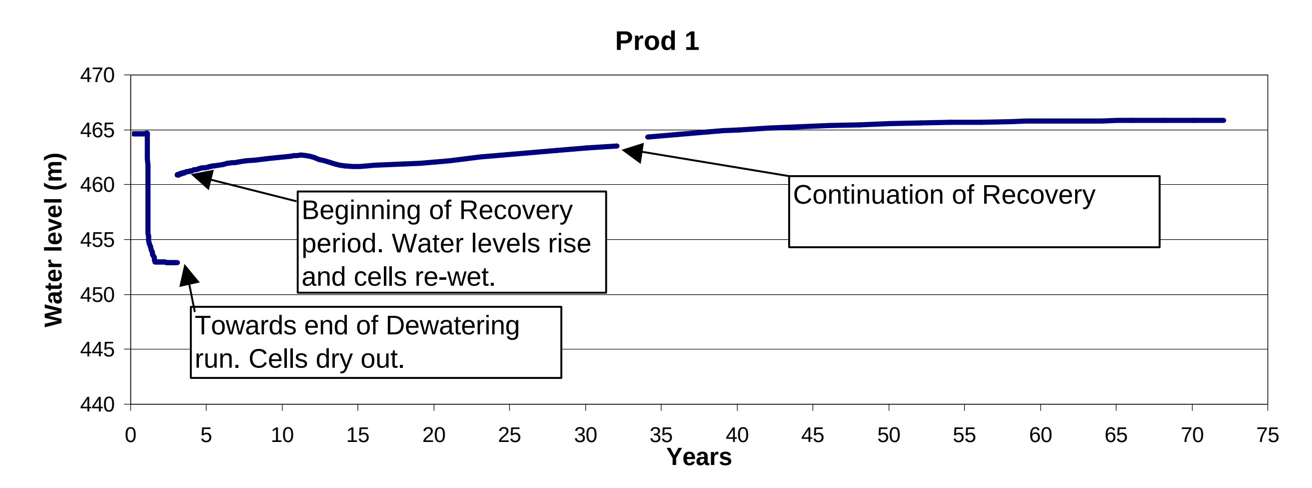
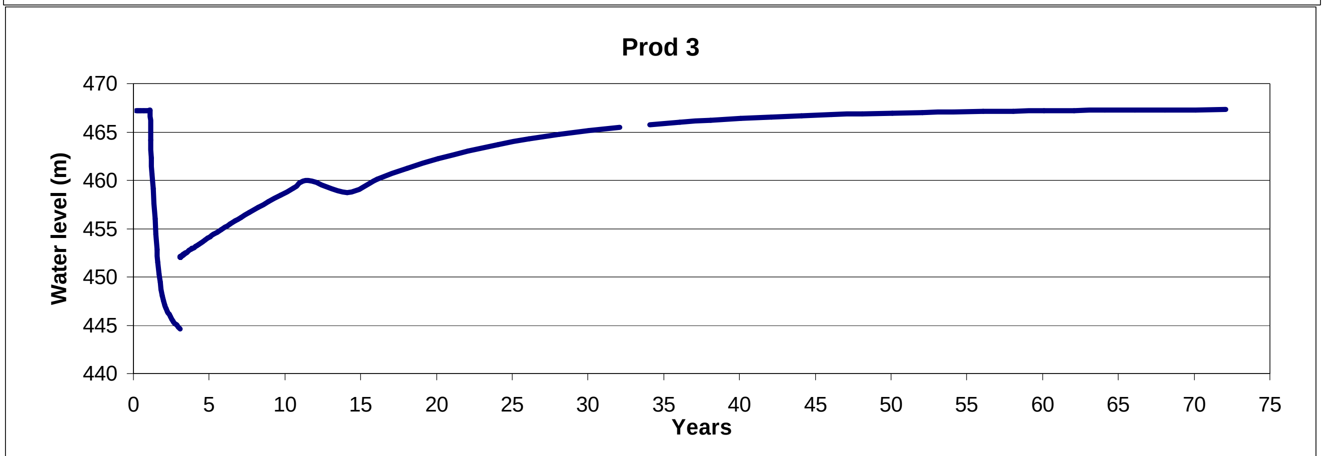
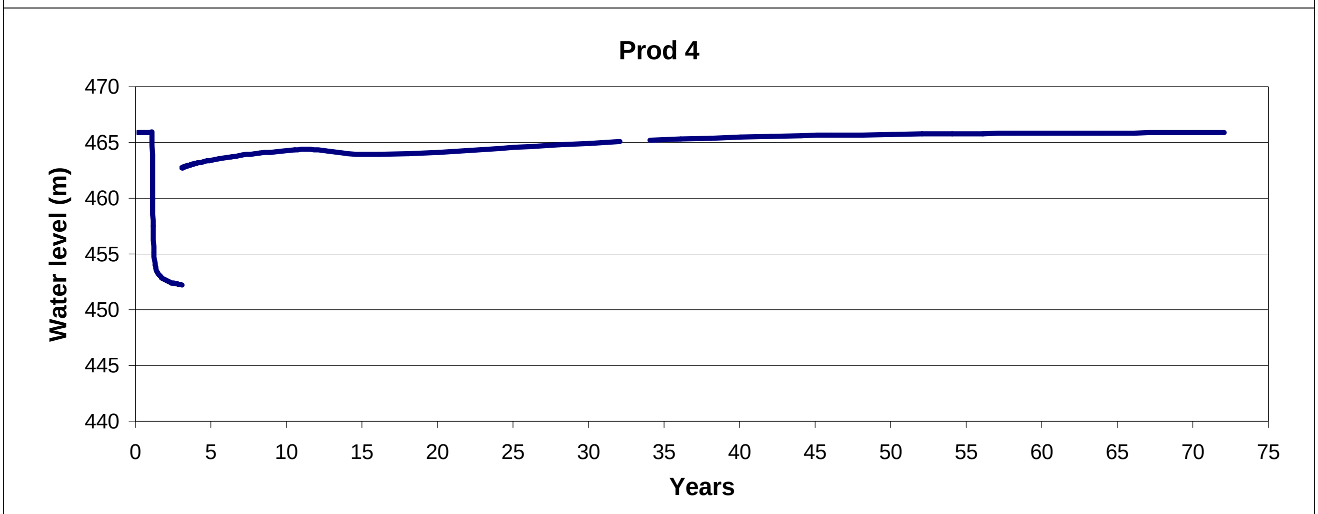
F:\jobs\477\6000\PER Reports\[396_Figures.xls]Figure 7

Mindy Mindy Predicted Recovery Flow Rates To Weeli Wollie Creek

Figure 7







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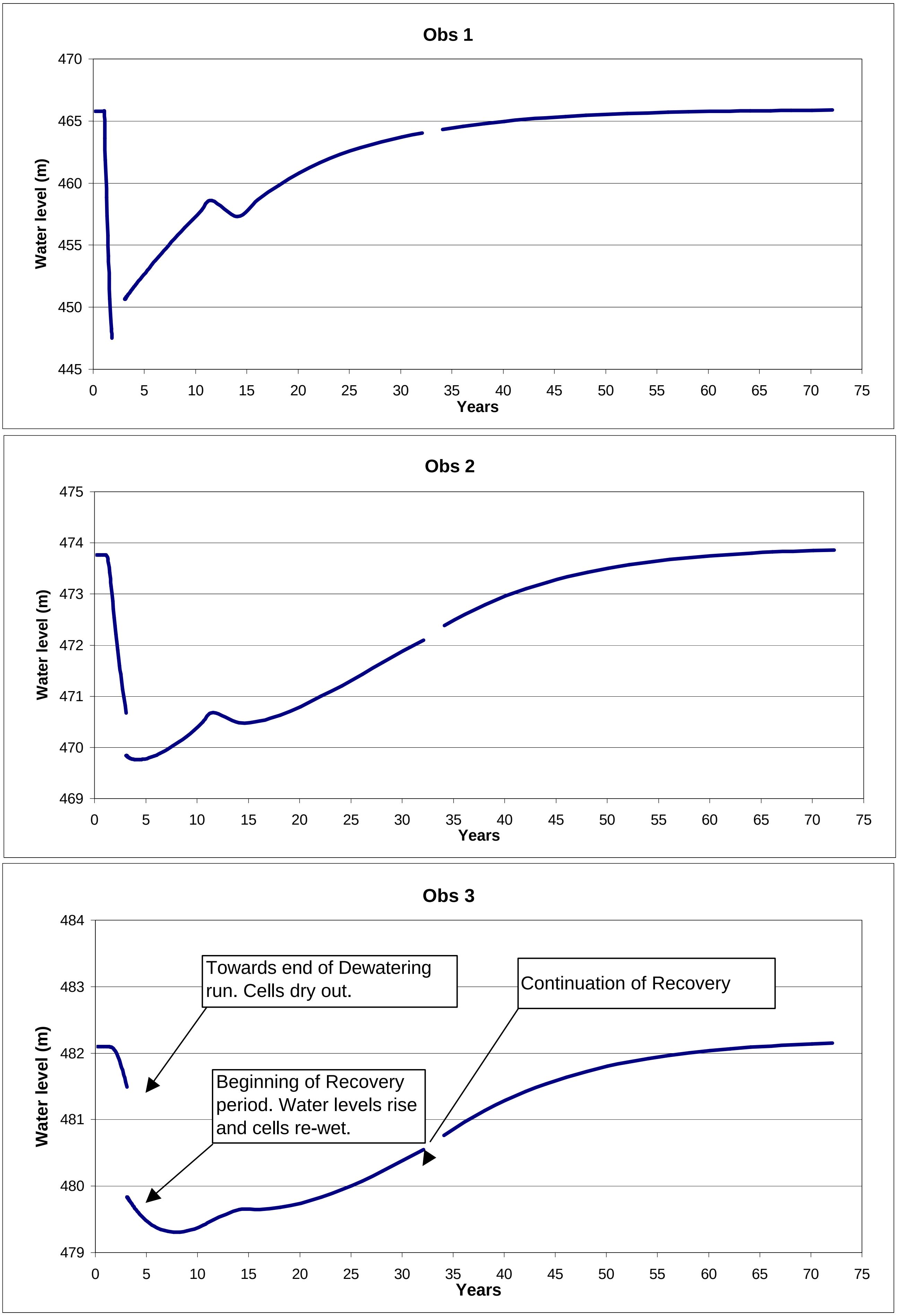
Production Bore Hydrographs During Recovery Period

Figure F8

F:\jobs\477\6000\PER Reports\[396_Figures.xls]Rec hydrographs Figs 8 & 9



Observation Bore Hydrographs During Recovery Period

Figure F9

APPENDIX G

REVIEW OF POTENTIAL PHREATOPHYTIC VEGETATION IN FMG PROJECT AREA
BIOTA, 2004

8 December 2004

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Ms Laura Todd
Environment Manager
Fortescue Metals Group
50 Kings Park Road
West Perth WA 6005

Dear Laura

Potential Impacts on Groundwater Dependent Vegetation

Further to our recent discussions, we provide here an assessment of the potential impacts on groundwater dependent vegetation arising from the proposed Fortescue Metals Group (FMG) Stage B mines and rail proposal.

This assessment has been based on:

- our vegetation type mapping (Biota in prep.);
- rangelands unit mapping (with details as provided by FMG);
- existing groundwater levels and predicted draw-down levels associated with the various components of the Stage B proposal (also provided by FMG); and
- our understanding of recognised phreatophytes (groundwater dependent species) in the region.

I have broken down this assessment by the mine areas comprising the FMG proposal.

Christmas Creek
The only vegetation type in this mine area that may contain phreatophytic species was:

> **Fc4** *Eucalyptus victrix* open woodland over *Acacia coriacea* subsp. *pendens*, *A. aneura, Atalaya hemiglauca* low woodland over **Cenchrus ciliaris* tussock grassland.

This was associated with the main tributary of Christmas Creek itself. *Eucalyptus victrix* is a phreatophytic species, but the extent to which it is phreatophytic is dependent on the local groundwater conditions each individual has become established under (Biota 2002). Current groundwater levels in this area are at approximately 20 – 25 m below surface, and this is likely to be at the limit of eucalypt rooting depth. Some of the *E. victrix* may therefore utilise groundwater for a component of their ecological water requirements. However, modelling indicates that draw downs of only ~1 m are likely to occur in the area of the Fc4 vegetation type. This is likely to be within the typical seasonal and long-term variations in water table depth that the trees experience under natural conditions, and we therefore consider it unlikely that any significant impact would arise from this level of change.

Mindy Mindy
Only a single vegetation type that may be groundwater dependent occurs in the area to be affected by dewatering at this site. Based on rangelands mapping, this is:

> **RGERIV** Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.

This vegetation type is likely to have a moderate level of groundwater dependence and is likely to include eucalypts which rely on groundwater for their ecological water requirements.

However, groundwater modelling indicates that a draw down of only 0.5 m is likely to arise from the implementation of the proposed development. Similar to Christmas Creek, this is likely to be within the seasonal and long-term fluctuation range that the keystone tree species in this riverine vegetation type would experience under normal conditions.

Mt Lewin
There were two vegetation type that are potentially sensitive to groundwater change in the area to be affected by the Mt Lewin component of the Stage B proposal:

> **Fc 4** *Eucalyptus victrix* open woodland over *Acacia coriacea* subsp. *pendens*, *A. aneura, Atalaya hemiglauca* low woodland over **Cenchrus ciliaris* tussock grassland (a unit mapped as part of surveys for the Stage B proposal; Biota in prep.); and
>
> **11** Flood plains with weakly gilgaied clay soils supporting coolibah woodlands with tussock grass understorey (an AgWA rangelands mapping unit).

The former vegetation type occurred within the main creek at Mt Lewin, whilst the floodplain area occurs in the area to be affected by the borefield. Draw down contours predicted for the area of these vegetation types range between 1 and 5 m, with the current groundwater level at ~15 - 25 m below the surface. The current level of groundwater dependence is likely to be low to moderate in the Fc 4 vegetation type, dependent on the rooting depth of the *E. victrix* associated with this creek. We would expect that the extent of this vegetation type within the area of 1-2 m of draw down would be unaffected by the proposal. Some of the creek line eucalypts in the areas where the groundwater will be drawn down by up to 5 m may be stressed and we would suggest that a properly designed monitoring and management programme be implemented. *E. victrix* occurring in the floodplain area are less likely to be strongly groundwater dependent and therefore at low risk of significant impact from groundwater draw down of a few metres. There would, however, be value in including the affected floodplain vegetation as part of an monitoring programme to confirm this assessment.

None of the FMG Stage B development areas include the two most sensitive phreatophytic species in the region, River Red Gum *Eucalyptus camaldulensis* and Cadjeput *Melaleuca argentea*.

Please contact me should you wish to discuss this summary assessment in more detail.

Yours faithfully,

Biota Environmental Sciences Pty Ltd

Garth Humphreys
Ecologist (Director)

References

Biota Environmental Sciences (in prep.). Flora and Vegetation the FMG Stage B Mine and Rail Areas. Unpublished report for Fortescue Metals Group, Perth.

Biota Environmental Sciences (2002). Hope Downs Groundwater Dependent Vegetation Monitoring Programme. Unpublished report for Hope Downs Management Services, Perth.

APPENDIX H

BOREFIELD MANAGEMENT PLAN

APPENDIX H
BOREFIELD MANAGEMENT PLAN

1. INTRODUCTION

Total water requirements for the project are 11.4 GL/a (equivalent to 31.2 ML/d). This water will be obtained from a combination of bores drilled in the water supply borefield, and dewatering bores drilled within the vicinity of the proposed pits at Mount Lewin, Mount Nicholas, Christmas Creek and Mindy Mindy.

Potential impacts from groundwater abstraction may include:

- Stress to potentially phreatophytic vegetation within the cones of depression (although the risk of this is considered low, see Appendix G).
- Although very unlikely increased rate of drying up of the Fortescue Marsh should groundwater be lowered below the marsh (modelling has predicted this will not occur as the cone of depression is predicted to not extend as far as the Marsh).
- Reduction in yields from stock bores as a result of lowering of groundwater levels.
- Changes in groundwater hydrochemistry, including increased salinity.

It is proposed that a detailed Borefield Management Plan be developed which will provide a framework by which those impacts can be measured and predicted. This document is a draft version of that framework. It is intended that it will be finalised in consultation with WRC and CALM.

As part of the monitoring network, a series of environmental triggers will be developed by FMG in consultation with the WRC and CALM. In the event of one of these triggers being exceeded a series of contingency plans will be introduced. These plans may include, deepening of stock bores, changes to the operation of the water supply borefield, or development of an alternative supply borefield.

2. OPERATING RULES

It is proposed that a series of operating rules be developed, these are likely to include:

- FMG will not exceed the maximum draw of 11 GL/a from the water supply borefield.
- Wherever possible water from the dewatering will be used so minimising abstraction from the water supply borefield.
- Direct rainfall into the pit will be used to supplement abstraction from the borefield.
- Given the aerial extent of the proposed water supply borefield, it is expected that it will be possible to manage (to some extent) the cone of depression. That is, it will be possible to reduce abstraction in areas that will be more sensitive to drawdowns.
- There will be an ongoing programme of water minimisation which will be co-ordinated by FMG's Environmental Manager

3. THE WATER SUPPLY

3.1 Water Supply Borefield

The proposed water supply borefield will be located between the proposed Mount Nicholas and Mount Lewin mines. The borefield will intercept the alluvial and Wittenoom Dolomite aquifers. The borefield will consists of approximately 70 bores each, typically, 100m deep. Bores will be drilled at 250 mm nominal diameter and then lined with approximately 150 mm PVC screen and casing, and will be completed with a suitable filter pack.

3.2 Dewatering Bores

Dewatering bores will be installed within the pit outlines. Bores will typically be drilled at 300 mm nominal diameter and lined with 200 mm mild steel screen and casing.

4. THE PROPOSED MONITORING NETWORK

4.1 Abstraction Bores

Production bores will be monitored on a regular basis for abstraction rates (both instantaneous and cumulative and also pumping and rest water levels). Samples will be also taken to monitor hydrochemistry.

4.2 Environmental Bores

A regional groundwater monitoring network will be developed in conjunction with WRC and CALM prior to the start of abstraction. At this stage it is proposed that the borehole monitoring network will consist of a series of approximately 35 bores between the borefield and Fortescue River. These bores will be used to monitor the extent of the cone of depression from the water supply borefield. Additional bores will be drilled between Christmas Creek and the Fortescue Marsh to monitor the impacts of dewatering on the Fortescue Marsh.

Figure H1 shows the draft location of borefield monitoring bores. It is proposed that in the vicinity of the borefield the monitoring bores be installed in transects to aid delineation of the cone of depression. The monitoring bores will be located both within and outside the predicted cone of depression. The monitoring bores located outside the predicted cone of depression will act as controls, aiding with the understanding of seasonal fluctuations in groundwater levels, and helping to measure the drawdown resulting from the borefield abstraction. The monitoring bores will be drilled in nested pairs, intercepting both the alluvial deposits and the underlying basement. The water quality in each of the monitoring bores will be regularly checked for EC and pH to detect any changes.

4.3 Stock Bores

Additional monitoring will be undertaken on stock bores, as agreed with the WRC and station owners. At this stage it is proposed that the following stock bores are monitored, which are shown on Figure H1: -

Table H1
Proposed Stock Bore Sampling Sites

Bore ID	Easting (MGA94)	Northing (MGA94	Total Depth (m)
Kullawarri Well	237604	7496984	24.38
Limestone Bore	246641	7481374	24.3
Hole 64	240925	7472213	N/A
Badgeannah Well	227976	7460257	14.6
22 Bore	238039	7455081	N/A

Bore ID	Easting (MGA94)	Northing (MGA94	Total Depth (m)
17 Mile Well	213263	7485911	N/A
9 Mile Bore	200714	7499738	N/A
Mt Lewin Drillers Bore	212600	7492050	N/A
Old Well	210615	7490400	N/A
Knuckleduster Bore	800884	7482757	11.5

4.4 Rainfall

Rainfall will be monitored daily at two rainfall monitoring stations installed at Mount Nicholas and Christmas Creek. These two stations will provide an indication of spatial variability of rainfall and increased understanding of aquifer recharge.

4.5 Vegetation

The design of the vegetation monitoring programme must address the enormous variation in vegetation health that occurs as a consequence of natural events, as well as the impacts of water table drawdown caused by dewatering and abstraction for the FMG project. The most difficult task in the monitoring will be to differentiate between these impacts.

Variations in vegetation health may be caused by:

1. Variations in rainfall reliability: The Division of National Mapping (1986) shows the study area to have a Rainfall Variability Index of 1.5 to 2.0, the highest level of variability in Australia and exceeded only by a small area south-east of Alice Springs. By comparison the rainfalls of the extreme southwest of Western Australia have a variability of under 0.5 and are therefore highly reliable. It can be expected that there will be considerable variations in rainfall from year to year and therefore vegetation health will also fluctuate;
2. Natural changes in xeric period: Xeric period is the period of time each year (and even between rainfall events) where vegetation is not receiving direct rainfall. In explanation, two rainfalls of 100 mm do not necessarily equal four falls of 50 mm, especially if the interval between falls has increased or decreased. The period of time between rainfall events or rainfall periods is not the same in any given year and so vegetation health (especially in xerophytes [plants not dependent on soil moisture to any great extent] and vadophytes [plants dependent on moisture held within the soil profile but not accessing the water table]) can vary as a result. Provided the drought period is not too long, phreatophytes (species that primarily draw directly on the water table) are generally unaffected. These three physiological groups of plants (called ecotypes) will each behave differently under water stress;
3. Changes to surface hydrology: Much of the vegetation in the study area will be xerophytic and this will persist through most drought periods, with the exception of mulga communities which are partially dependent on seepage from surface water sheetflow. Other vegetation, especially along drainage lines, is dependent on moisture held within the soil profile, even if the roots do not intercept the groundwater table. The moisture held in the soil in this manner is sometimes derived from direct infiltration by rainfall or by infiltration during surface runoff. Any activity that alters the interception (e.g. soil compression), or changes overland flow (eg tracks, mines) will alter the sheet flow characteristics and hence the degree of infiltration at any given point. This

may affect vegetation health by causing "shadows" of decreased health that are not related to changes in groundwater depth;

4. Pest attack may affect vegetation health very quickly if conditions are right for the pest to rapidly increase in population (mostly insects) or influence (eg fungi during longer than usual wet periods);
5. Fire can have a sudden impact, removing all foliage from a plant and sometimes killing it. Conversely, regrowth from epicormic shoots (trunk and branch shoots) can be rapid, dense and extremely healthy after fire, even if the tree is water-stressed. A monitoring programme cannot statistically evaluate this impact, but must record the influence so that numerical data can be compared rationally against real situations;
6. Variability affecting individuals. These lesser, but significant impacts include termite attack which may affect health of individual plants.

Accordingly, the vegetation monitoring programme must have approaches that will differentiate between natural and non-groundwater impacts versus groundwater drawdown impacts. To arrive at a suitable methodology the following reasoning will be applied.

Table H2:
Vegetation Monitoring Programme

Methodological Approach	Issues Addressed	Reasoning
Control sites	Variations in rainfall reliability, natural changes in xeric period	These influences tend to be regional rather than local and establishment of control sites that will not be affected by anthropogenic impacts will be essential
All ecotypes monitored	Variations in rainfall reliability, natural changes in xeric period, changes to surface hydrology	Minor changes to groundwater depth or overland flow will affect vadophytes most, phreatophytes less so and xerophytes the least. Major changes to groundwater depth will affect phreatophytes and vadophytes the most and xerophytes least. It will be important to distinguish between these impacts
Numerous individual plants monitored	Variations in rainfall reliability, natural changes in xeric period, changes to surface hydrology, pest attack, fire	Reduces influence on the data from individual variations in susceptibility to the various potential causes of changes to health, thereby improving statistical reliability. Compensates for the occasional loss of plants through flood damage, insect attack or fire.
More than one species monitored	Variations in rainfall reliability, natural changes in xeric period, changes to surface hydrology, pest attack, fire	Reduces influence on the data from individual variations in susceptibility to the various potential causes of changes to health
Transects	Changes to surface hydrology	Surface hydrology impacts can change both across contour, such as might occur in the shadow below a track that alters overland flow, and along contour if the flow down-gradient is changed in one area compared to another. Transects should therefore be in both directions. Transects along major creek banks are especially useful, as individual trees can be lost during flood events and the transect approach maximises the number of trees monitored

Methodological Approach	Issues Addressed	Reasoning
Vegetation canopy size	Canopy size can vary seasonally and individually	This is not a particularly useful measure of plant health. Measurements can be collected but should be used only as background information
Canopy density	Canopy density (average foliage density - AFD) is directly related to plant health	While an excellent measure of plant health, AFD varies seasonally, with cloud cover, and with time of day as leaves turn to gather the maximum sunlight or to reduce their intra-cellular temperature. This measure can only be used if the measurements are taken at the same time, in the same month, under similar climatic conditions. They are worth recording, but the methodology of survey will need to be precise
Plant height	Growth rate	Depends on plant age and soil conditions. Young plants of phreatophytic species are vadophytic or even xerophytic in the early stages of development and so their responses to impacts will change over time. This information can be recorded but is of limited value unless monitoring recruitment
Stem diameter	Growth rate	Usually only of value on large perennials such as trees. Data are unreliable because of bark decortication (loss after fire) and oval trunks on individuals affected by flooding
Health rating	Overall health status	This method allows for all influences as it measures (albeit subjectively) the overall status of the plants, regardless of the cause of the changes in health. It is critical to compare results with control sites, thereby removing the regional influences caused by climate. This method is largely independent of season and time of day providing there is some degree of consistency in sampling
Photographic monitoring (normal colour)	Overall health status	Photographs are useful, but are greatly influenced by season, climatic conditions (eg overcast) and time of day. They are useful references but are not reliable for health monitoring
Photographic monitoring (infra-red)	Overall health status	More reliable than normal photography because infrared photographs reveal leaf cell stress rather than general visual appearance. Less influenced by season but affected by overcast and time of day. Date and time of photographs must be carefully controlled. Processing is difficult, expensive and has technical problems. This method is not recommended.

Based on the above reasoning, a suitable vegetation health monitoring program will be developed and implemented by FMG prior to the construction of the mines or the borefield.

4.6 Surface Water

A stage recorder will be installed to measure the surface water level in the Fortescue Marsh, so that it can be compared to groundwater levels.

4.7 Stygofauna

FMG has developed a separate Stygofauna Monitoring Plan (FMG, November 2004).

5. MONITORING PROGRAMME

5.1 Draft Monitoring Programme

The draft monitoring programme is set out in the table below.

Table H3
Draft Monitoring Programme

Parameter		Frequency	Monitored By
Abstraction	From the water supply borefield and from dewatering	Monthly with annual total	FMG
Water Use	At the ore beneficiation plant and camps	Monthly	FMG
Water Levels (Production)	Water levels in all production Bores	Monthly	FMG/third party
Water Levels (Environmental Bores)	Water levels in environmental monitoring bores	Monthly	FMG/third party
Vegetation Condition Surveys	Surveys of phreatophytic vegetation.	Annual	FMG/third party
Salinity (EC) and pH	Salinity in water supply bores, dewatering bores, and environmental bores.	Monthly	FMG/third party
Hydrochemistry*	Hydrochemistry in dewatering bores around Christmas Creek, environmental bores and stock bores.	Quarterly	FMG/third party
Rainfall	From a rainfall station installed at Christmas Creek and Mount Nicholas to show regional variability.	Monthly	FMG
Stage Readings	Surface water levels in the Fortescue Marsh	Weekly	FMG/third party

* Analytes include: pH, EC, TDS, Na, Ca, Mg, K, Al, Mn, Fe, Cl, SO_4, CO_3, HCO_3 and NO_3,

6. DATA COLLECTION

As detailed in Table H3, FMG are responsible for monthly groundwater abstraction and water use data. It is the responsibility of FMG for all flow meters to be re-calibrated annually.

FMG are responsible for the collection of all production bore and regional water levels, site rainfall data, pH and EC monitoring and bore water sampling for hydrochemical analyses.

EC and pH meters will be calibrated before each monitoring round and water samples for these readings will be taken when the pump is operational. If a bore is not operational at the time of the monitoring round (but is generally operational), it will be returned to and sampled once it becomes operational.

Water samples will be analysed for a standard hydrochemical suite and will include pH, EC, TDS, Na, Ca, Mg, K, Mn, Al, Fe, Cl, SO_4, CO_3, HCO_3, and NO_3. Analyses will be conducted quarterly from the dewatering, water supply, environmental and station bores. The final quarterly samples will be collected between March and May to allow sufficient time for analyses and reporting. Monthly monitoring of EC will be carried out in the monitoring bores.

6.1 Data Verification & Management

All monthly monitoring data from FMG will be forwarded on a monthly basis to a third party who will verify the data and collate it in a database.

The third party will assess on-going data both numerically and graphically to identify any erroneous readings. Readings that appear erroneous will be remeasured. Should there be any unexpected trends in the ongoing monitoring data, the third party will inform FMG's Environmental Manager immediately.

The third party will report the hydrochemical analysis results to FMG as soon as they are received for verification. If the analyses appear erroneous, the bore(s) in question will be re-sampled. Should there be any unexpected trends in the ongoing monitoring data, the third party will inform FMG's Environmental Manager immediately.

Daily rainfall totals (July to June) will be collated by FMG. This data will be entered into a database for the preparation of the Annual / Triennial Aquifer Review.

All verified data will immediately be forwarded to FMG's Environment Manager.

6.2 Data Review

FMG's Environment Manager will be responsible for reviewing abstraction and water use data each month and all other monitoring data at the end of each year. The nominated monitoring sites and monitoring frequencies will be reassessed in conjunction with WRC, CALM and the station owners, and confirmed as part of this annual review.

7. IMPACT MODELLING

Numerical groundwater simulation models that will be used to predict the cone of depression from the borefield and dewatering will be developed and implemented. This model will be calibrated annually using actual abstraction and water level data. Sensitivity analysis will be undertaken.

The model outputs will be reviewed by ecologists who will comment on the potential impacts of the cone of depression on vegetation.

8. USE OF DATA / REPORTING

FMG will submit a monitoring report to the Water & Rivers Commission (WRC) by the 30th July each year.

The review will detail the results of the monitoring for the previous 12 month period (1st July to 30th June). Once available, three years' of data will be presented graphically and the current year's data will be presented in tabular format. The report text will focus on the current water year; however, comment will be made of any apparent trends over the three-year period.

Every three years a Triennial Aquifer Review will be submitted. This will present and comment on the previous three years' of monitoring data.

The results of impact modelling will be included within the report. This will include potential impacts on vegetation and a summary of the results of the vegetation monitoring programme.

9. ENVIRONMENTAL COMMITMENTS

There are three areas of particular significance with regards to the FMG project and its potential impacts; these are:

1. Potentially phreatophytic vegetation along the creeks
2. Stock bores, and
3. The Fortescue Marsh

Before commencement of abstraction FMG will develop a series of Environmental Commitments. These will consist of a series of trigger events which, if exceeded, will result in the development of a series of mitigation measures. Triggers may include but not be limited to the following: -

- Decreases in the water levels in monitoring bores near the Fortescue Marsh of more than a predetermined level (e.g. 1 m at the ANCA boundary).
- Changes in water quality at stock bores impacted by the borefield, so that water quality became unsuitable for cattle watering.
- Vegetation stress (which may result in vegetation death) in the drawdown areas, which is not observed at the vegetation control sites.

Possible mitigation measures will include:

- Reducing abstraction from bores in areas of the borefield affecting the marsh or phreatophytic vegetation, whilst increasing abstraction from bores in other areas.
- Undertaking trials to determine the effectiveness of irrigation systems on phreatophytic species.
- Lowering pumps in stock bores where yields have declined due to the cone of depression from the borefield supply. Where this is not possible then some bores may need to be deepened.
- Drilling replacement stock bores where existing bores are affected by reduced water quality.
- Providing piped water supplies to replace stock bores.
- The development of an alternative water supply, such that:

  - If the groundwater monitoring programme and impact modelling indicates that the groundwater abstraction will cause a significant impact on the Fortescue Marsh and vegetation sustainability, FMG will implement an alternative water management strategy. FMG will complete water supply investigations and secure tenure for the development of an alternative borefield prior to the commencement of mining.

  - FMG will install and commission an alternative water supply system prior to any unanticipated impacts occurring or as soon as these become apparent based on the monitoring results should the onset of the impacts be very rapid.

9.1 Contingency Plans

As outlined in the previous section FMG will implement an alternative water supply system in the event that a trigger event is predicted to be exceeded.

FMG will complete water supply investigations and secure tenure for the development of an alternative borefield prior to the commencement of mining. Figure H2 shows the location of six potential borefields that have been identified. They are:

- Oakover Borefield
- Tongololo Borefield
- Jigalong Borefield
- Davis Borefield
- Kulkinbah Borefield
- Fortescue Borefield

9.2 Oakover Borefield

The Oakover Borefield site is approximately 60 km east of Mount Nicholas. The site is bounded to the west by the Oakover River, and to the east by Christmas Creek. The confluence of these two drainage systems lies to the north. The land is flat lying, at an elevation of between 400 and 450 mRL.

The geology consists of the Tertiary Oakover Formation, which lies on the Balfour Formation, part of the Manganese Group, a sedimentary sequence which, inturn, overlies rocks of the Hamersley Basin.

The Oakover Formation consists of a distinctive vuggy white opaline silica caprock and calcareous sandstone/sandy limestone. It extends to a depth of 35 m thick. It appears to be a lacustrine-fluvial deposit, modified by chemical precipitation of the calcrete and silica.

The underlying Balfour Formation consists of shale, interbedded with micaceous, calcareous and glauconitic siltstone horizons.

The groundwater catchment for the borefield is estimated to be approximately 400Km^2, rainfall recharge is estimated to be between 4 and 7 ML/d.

9.3 Tongololo Borefield

The Tongololo borefield is situated 40 Km east of Mount Nicholas and close to the Balfour Downs homestead. The site lies within the surface water catchments of the Tongololo Creek and Carrowina Creek. The ground is undulating at elevations of between 450 mRL and 500 mRL.

The geology of the area consists of Tertiary deposits, including a siliceous caprock, overlying the Stag Arrow Formation, a sequence within the Manganese Group. The Stag Arrow Formation consists of interbedded sandstones, shale, conglomerate, dolomite and chert. The target aquifer is the upper-most sandstone formation (mapped as MNs(a)) and consists of medium and coarse-grained sandstones.

Geophysical investigations have indicated a series of northeast-southwest trending faults across the borefield, plus a single northwest-southeast fault. It is anticipated that these faults will be associated with increased permeability.

Rainfall recharge to the groundwater catchment is estimated at 5 to 10 ML/d.

9.4 Jigalong Borefield

The Jigalong Borefield is approximately 12 Km long by 3 Km wide, and lies approximately 12 Km east of Mount Lewin, in the surface water catchment of Jigalong Creek. The area lies at elevations of between approximately 500 mRL and 550 mRL.

The target aquifer is the Lower Formations of the Fortescue Group. There are two faults mapped striking through the borefield shown on the geological map, which may represent increased permeability.

This borefield is relatively small, and is likely to supply a portion of the total water requirements.

9.5 Davis Borefield

The Davis Borefield is the largest of the alternative borefield sites, approximately 400 Km^2, which, at its nearest point, is approximately 40 Km north north east of Mount Nicholas. Elevation varies from approximately 400 mRL to 500 mRL.

The geology consists of Coondon Formation of the Manganese Group and Davis Dolerite. The Coondon Formation mainly consists of poorly sorted conglomerate, and coarse-grained sandstone. There are a series of structures trending northwest – southeast. It is anticipated that these structures indicate the present of secondary permeability.

The groundwater catchment to the borefield is approximately 3000 Km^2 and rainfall recharge is estimated to be between 25 and 50 ML/d.

9.6 Kulkinbah Borefield

This site lies North of Mount Lewin along the Kulkinbah Creek. Geophysical investigations have determined the presence of a significant structural fault with a strike consistent with the present day drainage channel.

To the northwest of this fault the geology consists of Quaternary sediments (mainly sands) overlying Oakover Formation, which in turn overlies Pinjian Chert Breccia and Carawine Dolomite. To the east the geology consists of the Quaternary and Tertiary Formations overlying formations within the Fortescue Group.

The target aquifers are zones in the basement rocks affected by structural faulting, the Oakover Formation and Quaternary deposits.

Rainfall recharge to the groundwater catchment is estimated to be between 10 and 20 ML/d.

9.7 Fortescue Borefield

The Fortescue Borefield lies between the Marra Mamba outcrop to the north of the Fortescue Marsh and the Brockman Iron Formation outcrop to the south. The target aquifer is the Wittenoom Dolomite, which is a major aquifer in other parts of the Pilbara, and is the target aquifer at the proposed Mount Nicholas/Mount Lewin Borefield.

Geophysical investigations are currently under-way to help determine water quality in the dolomite and records have been obtained from two oil exploration bores drilled in the vicinity, which intercepted approximately 500m of Wittenoom Dolomite.

As with the proposed Mount Nicholas/Mount Lewin borefield, a key consideration regarding this proposed site is the potential for impacts on the Fortescue Marsh.

This borefield is likely to have a very large groundwater catchment, and has the potential to supply considerable amounts of water.

9.8 Summary

A summary of the Contingency Planning Process is given on the following page.

10. WATER USE EFFICIENCY

FMG's Environmental Manager will review the water use requirements on a quarterly basis.

Regular checks will be made along the water supply system for leaks etc.

The water balance will be assessed by FMG's Environmental Manager on an annual basis and any improvements to water efficiency will be investigated.

11. REFERENCES

Division of National Mapping (1986). *Atlas of Australian Resources* (Third Series). Vol. 4. Climate.

FMG, Stygofauna management Plan, November 2004.

Pre-Abstraction

Survey of station bores within the project area.

Installation of observation bores along creeks with potentially phreatophytic vegetation.

Weekly monitoring of nested piezometers.

Biannual collection and analysis of water samples from nominated station bores, monitoring bores and the Fortescue Marsh.

Daily rainfall measurements in the project area.

Annual vegetation condition in nominated areas.

Development and calibration of an Impact Assessment Model.

Groundwater Abstraction

Monthly abstraction volumes and pumping water levels at each production bore.

Monthly groundwater levels at each observation bore.

Quarterly collection and analyses of water samples from production bores and nominated observation bores around Christmas Creek.

Weekly stage readings in the Fortescue Marsh (when ponded).

Biannual vegetation condition surveys in nominated areas.

Daily rainfall measurements at the mine site.

Annual Investigations

Collate and analyse all monitoring data.

Plot the drawdown contours and interpret the radius of influence of the groundwater abstraction.

Recalibrate the groundwater model to new data (with abstraction).

Run groundwater model without abstraction.

Assess (from both the radius of influence and the model predictions) whether groundwater abstraction is affecting the natural conditions at the Fortescue Marsh and phreatophytic vegetation along creeks. Quantify effect from model predictions.

Run the newly-calibrated groundwater model to predict the future impact of groundwater abstraction.

Submit a report on investigations and findings.

Trigger

Does the predictive modelling suggest that there will be a significant impact on the marsh and/or phreatophytic vegetation along creeks within the next three years of groundwater abstraction?

No

Continue abstraction

Continue monitoring

Re-assess and Report annually

Yes

Investigate Alternative Supply Options including:

- Oakover Borefield
- Tongololo Borefield
- Davis Borefield
- Kulkinbah Borefield
- Fortescue Borefield

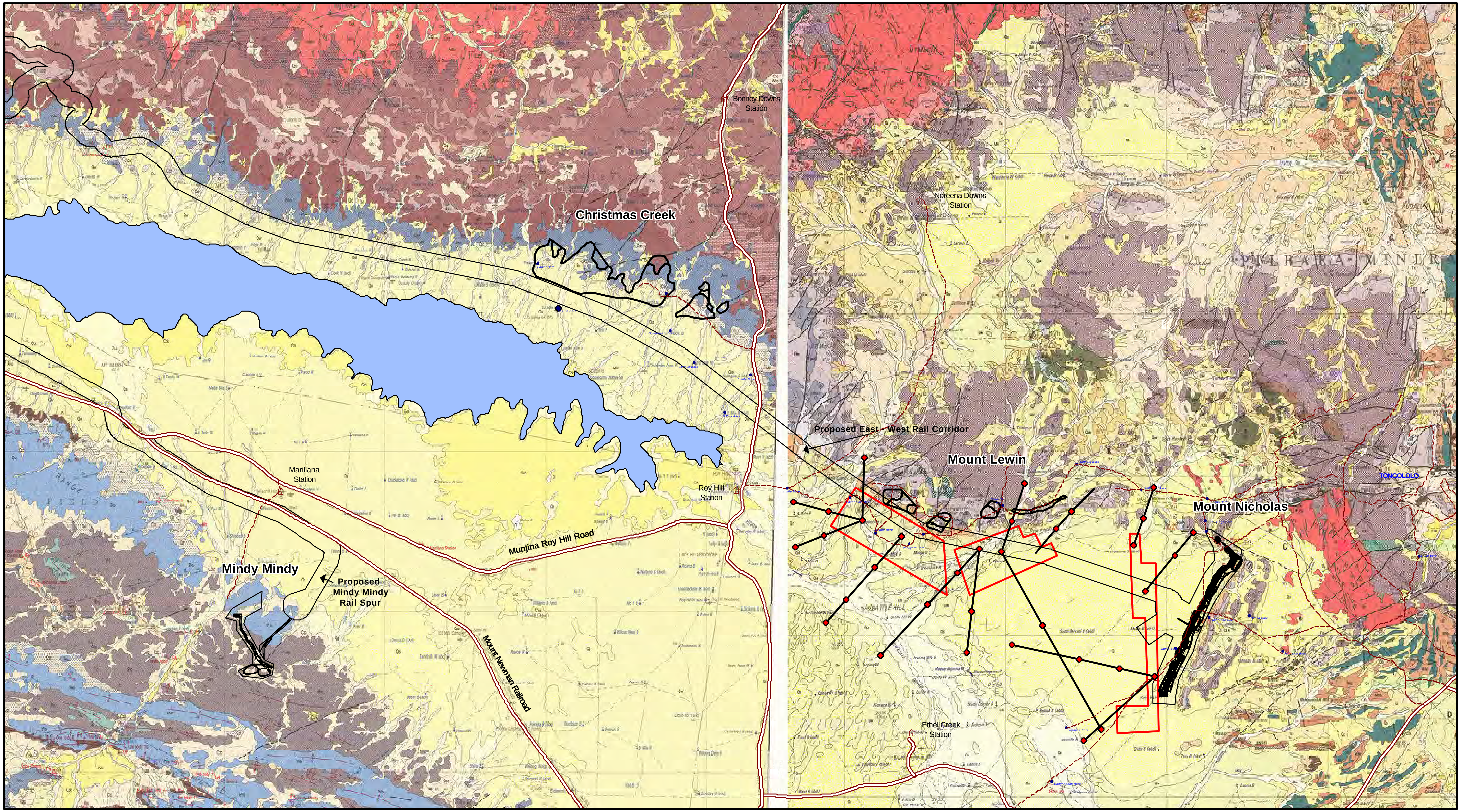
Develop the Preferred Alternative Supply Option and associated monitoring system

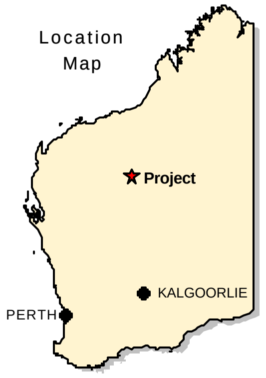
Long-term Water Supply

Commission Alternative Water Supply System

Cease abstraction at mine site borefield

Continued monitoring at the marsh and creeks and reporting of recovery





Legend

Fortescue Marsh

Proposed Borefield

Proposed Borefield Monitoring Bore

Proposed Stock Monitoring Bore

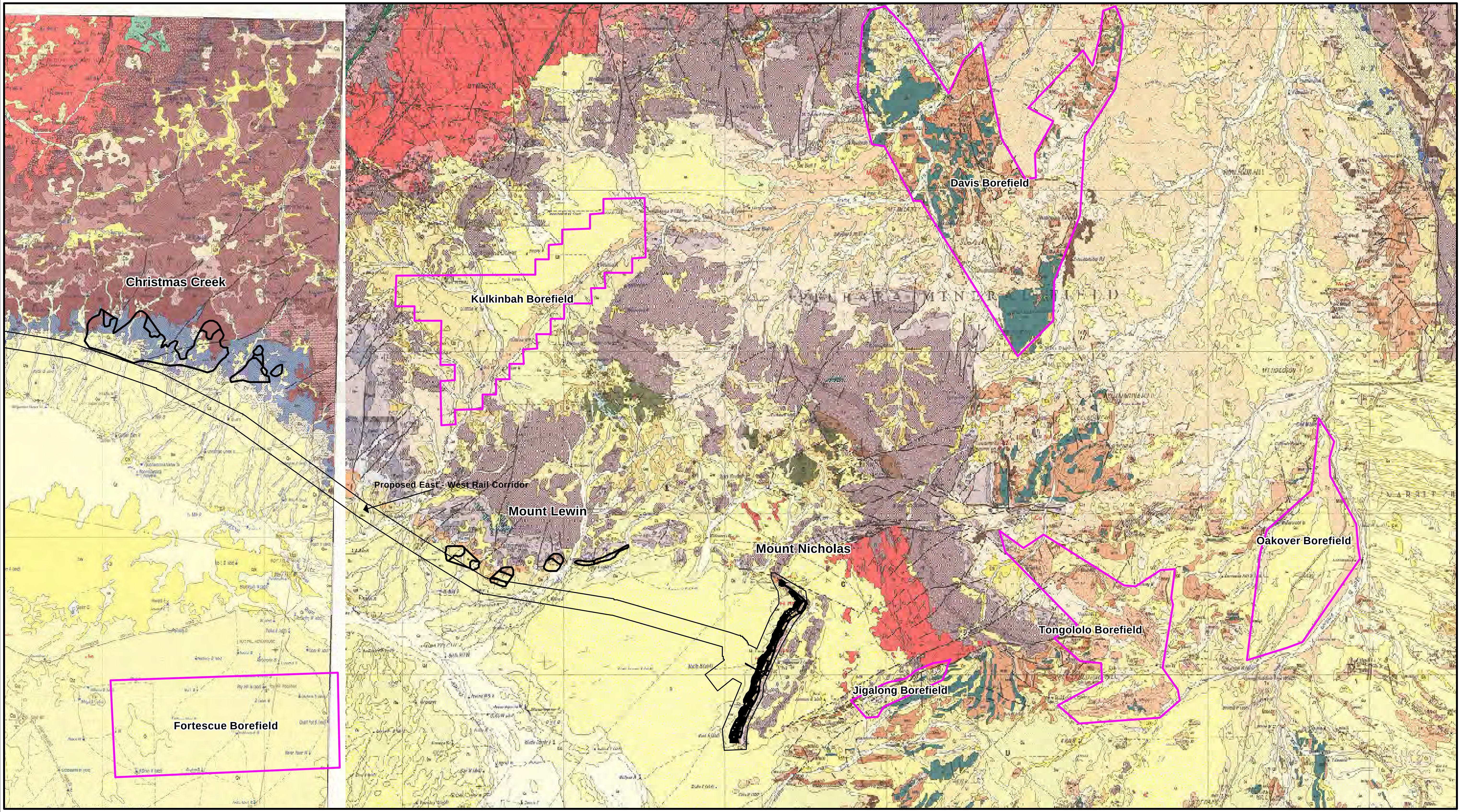
N

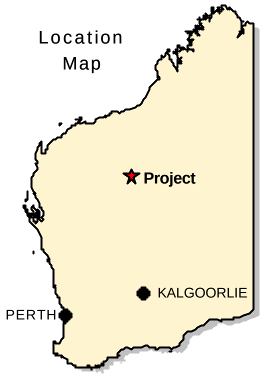
0 10 20 km

Fortescue Metals Group Limited

Figure H1 Proposed Location of Borefield Monitoring Bores (Draft)

Author: Aquaterra	Date: 26 November 2004
Drawn By: Barbara Zakrzewska	Revised:
Dwg No.: H2	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 450 000





Legend

Potential Borefield Sites

N

0 10 20 km

Fortescue Metals Group Limited

Figure H2 Potential Borefield Sites

Author: Aquaterra	Date: 23 November 2004
Drawn: Barbara Zakrzewska	Revised:
Dwg No.: Fig H2	Report No.: 477
Projection: AMG zone 50	Scale: 1 : 450 000