Pilbara Iron Ore & Infrastructure Project:
East-West Railway and Mine Sites (Stage B)
(Assessment No. 1520)

Response to Submissions
(Additional Studies and Project Variation)
August 2005

by

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1 INTRODUCTION

The public submission period for the Pilbara Iron Ore and Infrastructure Project: Stage B East-West Railway and Mine Sites Public Environmental Review (PER) commenced on 17 January 2005 for a period of eight weeks, ending on 14 March 2005. Late submissions were accepted by the EPA until the 30 March 2005.

Fifteen submissions were received by the Environmental Protection Authority (EPA). Submissions were made by State and Local Government, organisations and individuals.

The issues raised within the submissions have been classified as biophysical, pollution, social or other issues (Sections 5-8). They have been further sorted into various subcategories for ease of response. A summary of the topic areas covered by each submission is given in Section 9 and revised proponent commitments in Section 9.

This report also includes details of the refined project as a result of further investigations and studies; all completed since the release of the Public Environmental Review (see Section 3 and appendices). Section 4 details an offset package that have been determined with input from government agencies.

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2 OVERVIEW OF SUBMISSIONS

A total of fifteen submissions were received. Of these, two submissions generally supported the Project while three submissions opposed the Project (see section 9). The remainder, while raising some issues of concern, can be regarded as neutral.

The submissions covered a wide range of issues. Some issues received attention in more than one submission or were the subject of significant commentary within individual submissions. These issues included:

- Fortescue Marsh: some submissions expressed concern about possible impacts on Fortescue Marsh, mainly through the reduction of water availability by either reducing surface flows in the catchment or extraction of groundwater. These concerns are addressed in section 5.2 and the expected impact on Fortescue Marsh is negligible;
- Sheet flow and mulga woodlands: some submissions formed the view that the proposed railway line and mining operations may interrupt and redirect sheet flow from significant rainfall events. This sheet flow is believed important to the health of mulga woodland vegetation. FMG’s proposed management approaches are described in the Stage B PER (see section 5.4), were generally supported and further work in this area was encouraged;
- Rail route selection: some submissions were critical of the rail route selection and the likely impact on mulga woodland vegetation. Significant project reviews and additional studies has resulted in a new proposed rail alignment similar to route 3 (further detail is outlined in section 5.4);
- Groundwater: there were concerns that the expected groundwater requirements may not be met as anticipated or that groundwater extraction may result in adverse environmental impacts. Responses to each of these issues are included (section 5.5), as are the results of further hydrogeological investigations completed subsequent to the release of the Stage B PER (section 3.0);
- Vegetation: there were concerns about the overall extent of clearing and, in particular, clearing of mulga woodland vegetation and vegetation communities of conservation significance. Responses to these concerns are outlined in sections 5.6 and 5.18;
- Weeds: the potential for the rail and mining operations to spread environmental weeds, in particular ruby dock, was raised. FMG’s commitments in this regard are reiterated in section 5.7;

- Fauna: one submission raised a number of issues in relation to the extent and methodology of the fauna survey work presented in the PER. Responses to each of the issues raised are provided in section 5.8;
- Rehabilitation and Project closure: some submissions felt there was insufficient information presented in respect of rehabilitation and Project closure. FMG's commitments in this regard are reiterated in section 5.18;
- Dust: issues related to dust were raised in more than one submission but largely related to the Stage A PER proposal. The issues and FMG's responses are found in section 6.2;
- Workforce and accommodation: FMG has provided some additional information in response to matters raised in the submissions (see section 7.2); and
- Assessment under the *Environmental Protection Act (1986)*: a variety of issues were raised in submissions about how the Stage B Project is assessed under the Act. These issues included the cumulative effects of the Stage B Project when considered together with Stage A, the exclusion within the Stage B proposal of an impact assessment for the power supply, consideration of the potential sterilisation of mineral resources by the railway line, and the staging of the completion of various topic-specific Environmental Management Plans after the PER has been assessed. Responses to each of these issues are given in section 8.1.
- Other issues were raised and each has been addressed in sections 5-8. As a result of the submissions, some minor changes to the proposed Proponent Commitments have been made (see section 10).

3 ADDITIONAL STUDIES AND INFORMATION

3.1 Additional Information

Since the PER was released in January 2005 additional studies have been undertaken in the areas in which FMG has mining leases. This additional work has helped to refine FMG's resources and has resulted in changes to the scope of the Stage B project. These changes have arisen as a result of the discovery of the Cloud Break deposit and a review of the financial and environmental components of the project. The Cloud Break deposit was discovered after the Stage B deposits and as such was not included in the Stage B assessment. Cloud Break has recently been referred to the EPA as a separate project.

FMG has decided to remove from the mining schedule the Mt Lewin and Mt Nicholas ore bodies. FMG have also reviewed their proposed choice of railway alignment in light of the decision to no longer extend the North – South railway (Stage A) to the Mindy Mindy mine. This review has resulted in a new alignment being sought; crossing the Chichester Ranges further east than originally planned (this is outlined further in the Section 3.4). These actions will reduce the area of disturbance for the project by 4 932ha.

3.2 Hydrogeology

FMG has engaged Aquaterra to undertake hydrogeological studies for its proposed new iron-ore mining Project in the Pilbara. In January 2005 FMG submitted a Public Environmental Review (PER) Report for the Stage B Project, which included a summary of the current hydrogeology of the Project area and identified potential environmental impacts. Within the Stage B PER report FMG committed to undertake additional work to justify some of the assumptions used in the report to determine the environmental impacts. This commitment included additional hydrogeological investigations consisting of:

- the drilling of 12 additional exploration bores within the borefield;
- construction of five trial water supply bores in the borefield;
- test pumping of the five water supply bores;
- drilling of three trial dewatering bores at the proposed Christmas Creek pit; and
- drilling of an environmental test bore close to the Fortescue Marsh.

In addition FMG has decided to undertake down-hole geophysical studies to determine the extent of saline groundwater.

A total of 48 additional exploration bores were drilled in the water supply borefield and five of them converted to trial water supply bores. Monitoring bores were installed at each trial bore and test pumping undertaken. Down-hole geophysics, consisting of fluid temperature and conductivity logging was undertaken in the five trial bores.

Three trial dewatering bores were constructed at Christmas Creek and associated monitoring bores were installed. The trial bores were also test pumped and geophysically logged.

The results of the investigation of the borefield showed that yields of up to 15 L/S could be obtained from the trial water supply bores. The test pumping analysis showed that the assumptions of aquifer properties for the borefield used in the impact assessment for the Stage B PER were conservative, but acceptable. The geophysics survey indicated no saline water was present.

The investigations at Christmas Creek showed that the aquifer properties assumed in the Stage B PER report were again conservative but reasonable. There was no upconing of saline water during the test pumping at Christmas Creek and the geophysical logging did not show the presence of saline water in the fluid column.

The environmental bore has been installed and geophysically logged. As expected the results show the presence of saline water at depth. Planning has been undertaken to ensure correct disposal of any saline water abstracted during the test pumping and the results will be made to the available DoE shortly.

A full report detailing the additional hydrogeological work carried out is located in Appendix A.

3.3 Stygofauna

A total of 28 bores and wells within and adjacent to Fortescue Metal Group (FMG) tenements were sampled between the 11 and 14 March 2005 by experienced Stygofauna Consultants. Of the 28 sites sampled, 14 (50%) yielded Stygofauna. Seven of these were within FMG tenements and four of these were within the 30 year drawdown contour of Mt Lewin and Mt Nicholas. Figures 2 and 3 show stygofauna sampling locations overlaid on 5 year and 30 year drawdown contours.

Twenty-one species of Stygofauna from 12 orders of invertebrate were collected. Some taxa could only be identified to Order (Ostracoda) or Family (Parabathynellida) and have been sent to taxonomic experts. The total species list could be expected to increase after material has been returned. The complete results from the survey are located in Appendix B.

There were three sites that yielded Stygofauna taxa considered as being “important”, however these were sampled outside of FMG tenements and also away from the influence of the predicted drawdowns areas for the Project, these sites included;

- FMG13 yielded a marine origin polychaete worm from the Family Neridae;
- FMG01 yielded a Spelaeogriphacea (probably a Mangakurta kutjarra – one specimen in poor condition); and
- FMG15 yielded an undescribed species of Parabathynellidae (Syncarid).

Several bores were found to be anoxic (low dissolved oxygen) or have a negative oxygen reduction potential; this is likely the result of deceased vertebrates. These bores were found to have no Stygofauna or Stygofauna that tolerate these low oxygen environments like Oligochaete and Nematoda. FMG have since capped these bores and will carry out purging to return these bores to a more oxygen enriched and productive system.

Mt Nicholas

One bore (FMG04) that yielded Stygofauna was within the 30 year predicted groundwater drawdown for Mt Nicholas. The two taxa found (Nematoda & Phreodrilus peniculus) are common throughout the Pilbara and the latter was also found at FMG13, FMG14 & FMG28.

Mt Lewin

Three of the 4 bores within the 30 year predicted groundwater drawdown for Mt Lewin yielded Stygofauna, however none considered of significance:

- FMG07 yielded Enchytraeidae PST1, which is also found outside the drawdown area at FMG01, FMG06 and FMG16;
- FMG08 (Oribatidae group4), has been previously found within the Robe River Basin and the Sandy Desert Basin (PBS survey); and
- FMG10 is yet to be identified past Order level but morphologically appears to be the same as what was found at FMG15. This specimen is currently at the Western Australian Museum (WAM) being identified.

Christmas Creek

No bores within the 30-year predicted drawdown for Christmas Creek yielded Stygofauna. All three (FMG17, FMG18 & FMG19) were contaminated. It has been recommended that these bores be purged and capped where necessary or alternative monitoring bores be found. If the water quality is improved these bores do have the potential to yield Stygofauna in the future.

Mindy Mindy

No bores in the immediate vicinity of the mine yielded stygofauna. One bore at Mindy Mindy had no casing (FMG23) and as such the turbidity at this site was in excess of the maximum reading of 600ntu. If these bores are to be used for on-going monitoring, it has been recommended that they be cased.

Summary

There were no Stygofauna of significance found within the predicted drawdown curves for the FMG Stage B Project. On the basis of this information it is not likely that the Project will cause unacceptable impacts on Stygofauna. It is proposed that FMG continue its Stygofauna monitoring program as proposed in its Stygofauna Management Plan. After two years the results will be reviewed and a long term management strategy developed in consultation with CALM.

3.4 Rail Alignments

FMG's preferred rail alignment, which was outlined in the PER, was chosen because it met a number of criteria established to meet company policies, such as the open access rail as agreed in the State Agreement. With the decision to no longer extend the North – South Rail to the Mindy Mindy mine, one of the key constraining factors affecting the choice of rail has been removed. This factor, a second crossing of the Chichester Ranges, would have resulted in higher disturbance levels and was economically unfeasible.

FMG has since reviewed the alternative rail routes that were proposed as part of the Stage B PER. To address concerns raised by CALM regarding the clearing of mulga due to the location of the rail, FMG have decided to propose Route 3 as their preferred route.

The EPA Services Unit has requested that FMG provide further information on the seven railway alternatives provided in the Stage B PER. FMG have prepared a table that examines the seven rail options, analysing all routes taking into account environmental, engineering, resource, access and economic issues. This is provided in Appendix C. The information contained in the Table 1 below has also been requested by the EPA SU.

Table 1: Vegetation and Mulga Disturbance by Railway Alternatives

Route	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Length (km)	125 (from "start point")[1]	120 (from "start point")	111 (from "start point")	109 (from "start point")	131 (from "start point")	118 (from "start point)	113 (from "start point")
Disturbance[2] (Ha)	514	491	483	482	714	679	574
Mulga Disturbance (ha)	241	174	125	66	67	104	316

[1] Start point is at (704325mE, 7577190mN).

[2] This area is based on a 40 m corridor along the full length of each route, including rail loops and spur lines as shown in Figure 1. This area is based on a 10 m corridor along each conveyor route, including an access road. It does not include the area of rail sidings or loops required in every case at Christmas Creek, and either at Cloud Break or the rail route to which a conveyor would carry ore from Cloud Break. Note that haul roads would result in additional disturbance 5-10 times larger, due to the much greater width of a haul road.

4 OFFSETS

4.1 MULGA VEGETATION COMMUNITIES

For the Stage B Project, 36.4 km^2 of land systems containing Mulga will be impacted by the proposed construction corridor for the East-West railway, the mines and associated infrastructure. To place this into a regional context, the Chichester footslopes Mulga woodland can be considered as a management unit. That is, the Chichester footslopes contain 1 641km^2 of land systems dominated by Mulga. Therefore the disturbance of Mulga resulting from the Stage B Project as a proportion of the total Chichester footslopes is 2.1%, which can be considered to be a relatively small proportion of the total management unit.

In order to mitigate this impact on the Mulga woodlands, offsets will be considered in consultation with CALM. Further information on these offsets is provided below.

FMG has also ensured that the proposed offsets for the Stage B Project are linked with the offsets proposed for the Stage A Project.

Proposed Offsets

Extension of Weed Management Program to Improve Existing Environment Outside Project Area

FMG has committed to the management of weeds within the proposed Project areas as discussed in Section 6.3.4 (page 126) of the Stage B PER. Weed control measures will be implemented to ensure that new weed species are not introduced and that weed species identified within the development areas are not spread during the construction and operation of the Project.

While the above management of the introduction and spread of weeds is a normal Project requirement, as an offset FMG will extend its weed management program. The Weed Hygiene and Management Plan will be extended in consultation with CALM, to focus not only on the introduction and spread of weeds, but reducing (and if possible eradicating) weed infestations, not only within the Project area but also in adjacent areas selected collaboratively with CALM and Department of Agriculture. This will occur for the duration of the Stage B Project and will focus in particular on environmental weeds such as Ruby Dock.

Design and commencement of the Weed Extension Program should occur prior to construction of the project.

Research – Mulga (or other poorly known taxa)

As stated in the Stage B PER (Section 6.3.1.2, page 125), offsets will be considered such as research into the ecology and/or taxonomy of Mulga (or some other poorly known taxa) in the East Pilbara in consultation with CALM and academic experts. Offsets may include research for management and resolution of outstanding taxonomic issues identified in biological survey documents. FMG will strongly support and encourage partnerships with third party users of its infrastructure and other companies in the Pilbara.

FMG will develop an integrated research program aimed at further understanding and protecting the conservation values of the Chichester footslopes Mulga woodlands. This will include the research Project committed to in Stage A (a research Project at PhD thesis level or equivalent) plus the following additional research Projects:

- Three additional research Projects at PhD thesis level or equivalent will be conducted consecutively for a period of nine years.
- Three additional research Projects at honours thesis level or equivalent will be conducted consecutively for a period of three to six years (depending on completion time of each Project).

Commencement of the research program will occur once construction is complete and will be reviewed every three years, in consultation between FMG, CALM and Academic Advisors. The scope of research to be undertaken will be developed in collaboration with CALM through the following process:

- Desktop review of all current research in the Pilbara area, relevant to impacts of FMG's Stage B Project, concerning Mulga (or some other poorly known taxa).
- Discussions with CALM regarding research that requires further work or possible new areas of research.
- Consultation with CALM to select appropriate areas of research to be pursued.
- Initiate discussions with Academic Advisors and Experts in the fields of study selected in order to scope the Research Program further.
- Develop a Scoping Document describing the potential methods, timing and deliverables for the Research Program.
- Select a study team or individual to carry out various components of the work, provide adequate resourcing, technical support, academic and/or expert advice and set a start date for the research.

The above process to scope the nine year research effort will commence at the outset of Project construction and be complete within 18 months (well before construction is complete).

Research –Mulga Plant-Water Relationships

As stated within the Stage B PER (Section 6.1.4.2, page 104) FMG will continue to conduct research on sheetflow redistribution systems to improve the current state of knowledge on effective methods for capturing and maintaining sheetflow during rainfall events. This research will be conducted in liaison with CALM.

While the above work is considered by FMG to be a normal part of Environmental Management of its activities, to complement the above research FMG will also conduct an internal research Project, on Mulga plant-water relationships as an offset. This Project will aim to gain further knowledge on the extent of dependence of Mulga on sheet flow for survival. The Project will be ongoing for at least five years and will be scoped and managed internally by FMG personnel with advice from CALM and academic experts in this field.

Funding of a Position within CALM

FMG will commit to the funding of a position within CALM to manage Project implementation and operation (over the operational life of the Stage B Project) focusing on issues pertinent to CALM's management of land affected by the FMG Project.

Prior to employment of the person FMG and CALM must undertake consultation to agree on:

- selection criteria;
- a salary range and on-costs for the person (these are to be fully funded by FMG);
- a position description; and
- key performance indicators.

Final selection of the person, ongoing management and resourcing for equipment, materials and place of work would be the responsibility of CALM. It is proposed that this person would be recruited prior to the commencement of Stage B construction.

4.2 THREATENED FAUNA SPECIES

FMG committed to considering offsets for threatened fauna in the Stage B PER in Section 6.4 (page 131). To further elaborate on this commitment the following information is provided.

Research Project

As stated in the Stage B PER (Section 6.4.1.1, page 131), offsets could include funding towards taxonomic issues, or other relevant research such as CALM's research programme on Mulgara.

In addition to the offset proposed for Stage A (a research Project at PhD level or equivalent) FMG will commit to the following additional research / funding:

- A research Project at PhD level or equivalent, for a period of at least three years; or
- A funding proposal (of similar cost to a PhD Project) which contributes to knowledge/research for a fauna issue relevant to the Stage B Project.

The Research Project / Funding Proposal will be developed in consultation with CALM and Academic Advisors through the following collaborative process:

- Desktop review of all current research in the Pilbara area, relevant to the potential impacts of FMG's Stage B Project, concerning Mulgara or other threatened species.
- Discussions with CALM regarding research that requires further work / funding or possible new areas of research / funding, to better understand and manage the impacts of rail and port infrastructure (similar to infrastructure proposed by FMG in Stage B) on Mulgara or other threatened species.
- Consultation with CALM to select an appropriate area of research / funding to be pursued.

If a PhD Project is proposed the following process would then also be undertaken:

- Initiate discussions with Academic Advisors and Experts in the field of study selected in order to scope the Research Project further.
- Develop a Scoping Document describing the potential methods, timing and deliverables for the Research Project.
- Select a study team or individual to carry out the work, provide adequate resourcing, technical support, academic and/or expert advice and set a start date for the research.

The above process to scope the research / funding will commence at the outset of Project construction and be complete within 18 months (well before construction is complete).

Memorandum of Understanding

Through the above offset package, FMG and CALM will be required to work collaboratively together for the duration of the Stage B Project.

It is FMG’s aim to maintain a good working relationship with CALM. As such, FMG proposes that a “Memorandum of Understanding” will be developed between both organisations which outlines;

- Further details on the operational aspects of each offset;
- A process for agreeing on key inputs and deliverables;
- Key dates and milestones;
- Communication processes and protocols; and
- Responsibilities and accountabilities.

It is proposed that this MOU is developed in collaboration by both parties prior to commencement of Stage B construction, in accordance with FMG's Project timeline. A pre-requisite for the development of the MOU is a firm commitment from CALM to work to the FMG Project timeline, to ensure it is developed prior to Stage B construction. FMG makes no commitment to delay the Project construction, if the MOU is not finalised.

5 BIOPHYSICAL

5.1 Landscape Values

5.1.1

(SUB3)

***Landscape and geoheritage**: there will be a major impact on the so far undeveloped Chichester Range and a full assessment of the landscape and geoheritage values of the area should be carried out taking into account the principles outlined in Sharples (2002). This aspect has been disregarded by the proponent.*

FMG has briefly reviewed the paper by Sharples (2002). While the principles presented are of interest, the *Environmental Protection Act (1986)* and the *Conservation and Land Management Act (1984)* already have the capacity to protect areas of outstanding natural heritage, including unusual or otherwise significant geological formations. While the value of the Pilbara landscape as a whole is acknowledged, no outstanding landscape features have been recognised in the case of FMG's Project. FMG will also adhere to the EPAs objective to ensure that rehabilitation is "consistent with the surrounding landscape".

5.1.2

(SUB6)

***Visual amenity**: visual amenity has not been considered in this proposal. The mine sites located in the slopes of the ranges have the potential to leave a massive visual scar on the landscape adjacent to an area earmarked for conservation. Furthermore the visual impact of a further set of high voltage transmission lines has not been considered. The proponent is requested to address visual amenity.*

FMG acknowledges that there will be a visual impact associated with both the railway and the mine sites. FMG has outlined how these impacts will be addressed within Section 6.12 of the Stage B PER. As stated above, FMG will adhere to the EPAs objective to ensure that rehabilitation is "consistent with the surrounding landscape".

The power transmission lines will be the subject of a separate assessment to be prepared by a third party supplier. The relevant environmental factors for this assessment are yet to be determined.

5.2 Fortescue Marsh

5.2.1

(SUB1)

***Terrestrial fauna**: if the Fortescue Marsh site is an important wetland habitat, then one might have expected a more comprehensive assessment of the area, and more importantly, specific management plans to protect the area.*

FMG are aware that Fortescue Marsh is an important wetland habitat. A risk assessment was commissioned to look at possible risks on the Fortescue Marsh from the Project. The risk assessment was undertaken by a range of expert consultants and FMG personnel, and was carried out in line with applicable standards for risk assessments. In summary the overall residual risk to the Fortescue Marsh system as a result of FMG Project was found to be minimal when control measures were considered. Furthermore the initial uncontrolled risk levels were found to be low in most cases due to the geographical separation of the mining, railway and borefield facilities from the Fortescue Marsh (i.e. the railway is approximately 4km and the mines are approximately 6.5km, away from the Marsh).

As part of its offsets program FMG have committed to working with CALM to assist them in developing a Fortescue Marsh Management Plan. This plan will identify the conservation values of the Fortescue Marsh and surrounding area (such as the Chichester Footslopes Mulga Woodland) and will outline:

- future management objectives;
- opportunities and risks;
- management strategies;
- a proposed monitoring program; and
- areas requiring further research.

5.2.2

(SUB6)

***Potential for reduced period of pooling**: the PER identifies that there is likely to be a reduced period of pooling on the surface of the Fortescue Marsh if ground water levels are reduced below the marsh. There are no management options identified in the PER to ensure that the groundwater level below the marsh is not reduced and, if it is reduced, that there will be no impact on fauna or flora relying on the area.*

There will be cones of depression resulting from dewatering of the pits and as a result of groundwater abstraction from the borefield. However, the numerical groundwater modelling undertaken shows that the cone of depression will not extend to the marsh. Therefore the groundwater level below the Marsh will not be reduced

To verify this finding, FMG has drilled a series of monitoring bores and has started monthly monitoring of water levels in these bores plus station bores and wells. Some of these bores are located between the pits/borefield and the marsh, whilst others are located away from the Project to act as control sites. Furthermore FMG has installed a series of stage boards in the Marsh to record changes in water level.

The water level data will be collated and reported annually to the DoE. The data will be analysed by an experienced and competent hydrogeologist to determine if the cone of depression is extending towards the marsh. If it is found that the cone of depression is extending toward the Marsh then the borefield management plan would be implemented. This plan includes measures to re-inject water into the aquifer to stop the spread of the cone of depression, or, ultimately, moving the borefield to another area further away from the marsh. However, it is not expected that this will be necessary given the pit dewatering required and the distance of the current borefield from the Marsh.

5.2.3

(SUB8)

Effect of open pits*: it is unclear how the open pit areas may impact on the recharge of the Fortescue Marshes. It is totally inadequate to begin bore monitoring now and expect usable results in the short term – we understand that the past 12 months is in no way representative of the rainfall in the Project area. Combination of the open pit areas and the proposed east-west railway line could potentially have a fatal impact on large parts of the Marshes and culverts alone may not avert the problem. Blatant misuse of statistics to quote that with a quarter of the pits open at any one time will only represent approximately 0.1% of the affected Marsh catchment.*

The work undertaken shows that the Fortescue Marsh is a surface water feature. Therefore the pit voids will only affect recharge of the Marsh (i.e. the filling of the Marsh) if surface water that would have otherwise drained to the marsh is not allowed to do so.

As stated in the PER, the potential impact of surface runoff water volume loss to the Fortescue Marshes, due to the proposed pit developments, is assessed as being insignificant. This can be illustrated by a comparison of the area collectively intercepted by the pit developments and not contributing runoff to the marshes and the surface water catchment area to the marshes of approx 31,000 km^2. During the mining phase, assuming that a quarter of the pits could possibly be open at any one time (a conservative estimate, as FMG will minimise its open area), the open pit areas may total around 40 km^2. This open area, which significantly reduces after closure and backfill of the pits, is only 0.1% of the total marsh catchment area. Such a small and temporary catchment area reduction does not represent a significant catchment loss to the marshes in the context of natural seasonal variability of catchment yield to the marshes.

The numerical groundwater modelling undertaken for the PER used a range of rainfall simulations, not just the previous 12 months, to determine the potential impact on the marsh from the dewatering of the pits and abstraction from the borefield.

FMG and its consultants have undertaken data reviews to collate historic data from as many observation bores as could be located. Since completion of the PER, FMG has installed further groundwater monitoring bores in the Project area and commenced monthly monitoring of groundwater levels. Furthermore FMG has installed a series of stage boards in the marsh so that accurate water level data can be obtained. FMG proposes to extend this monitoring network once environmental approval has been obtained.

FMG proposes to update the numerical groundwater model, which its consultants Aquaterra have developed, on a regular basis to ensure that it can continue to be used to predict potential impacts on the environment. Such updates will be undertaken so that the model is regularly calibrated against field data, to ensure that potential impacts on the marsh are identified in a timely manner and to ensure that mitigation measures can be undertaken.

5.2.4

(SUB8)

***Groundwater modelling predictions**: we have concerns over the modelling that has taken place that predicts minimal drawdown on water table and immediate marsh area, as it seems to rely on the current range of variations due to normal rainfall effects and there seems to be little consideration of trends in differing rainfall levels. This is particularly as recent trends have not been normal, with going through some of the driest times in recorded history and hope that the modelling does not rely on the use of latest trends, not just extremely dry periods as we have now.*

The numerical groundwater modelling described in the Stage B PER considered the average long-term rainfall record for Newman rather than any individual year. Since then further modelling work has been undertaken which includes analysis of a range of rainfall scenarios, including sequences of wet and dry years.

Analysis of the model results shows that the drawdowns produced are not especially sensitive to rainfall. Instead, much of the water abstracted from the borefield is coming from water held in storage within the alluvial deposits.

5.2.5

(SUB12)

***Risk assessment**: the Fortescue Marsh risk assessment undertaken by FMG (Appendix N) did not involve external stakeholders (eg CALM, DOE, and Local Government) and this raises doubts about the credibility of the document. The Fortescue Marsh risk assessment needs to be recommissioned with adequate representation from appropriate stakeholders.*

The Fortescue Marsh risk assessment was carried out by consultants and FMG Staff considered as being experts in their field. The workshop was facilitated by an independent risk assessment consultant with extensive experience in risk assessment processes, methodology, including, steps taken to determine the risks are documented in the report (Appendix N of the Stage B PER). This enables third parties to assess the credibility of the risk assessment. Prior to undertaking the risk assessment, it was discussed with representatives of CALM and DoE, and the participation of expert consultants was thought to be acceptable.

5.3 Surface Water

See Section 5.4 for issues relating to sheet flow and related effects on mulga.

5.3.1

(SUB6)

***Impact of clearing**: concerned over the effect clearing will have on potential to negatively affect surface water movement in the affected areas (including increased likelihood of erosion and sedimentation).*

FMG has recognised the potential for clearing and the subsequent establishment of the mines and supporting infrastructure to affect surface water movement and potentially lead to increased erosion and sedimentation. FMG has outlined a number of strategies in Section 6.1 of the Stage B PER to minimise the impacts in each Project area. These include but are not limited to:

- sediment traps;
- rip rap pads to diffuse water flows; and
- diversion of water flows.

5.3.2

(SUB3,8)

***Activities on floodplain**: we note one of the Mount Lewin Mine Pits will be in the western floodplain of the Kondy Creek (p23). This area should not be mined. This is also the case with the Christmas Creek mine. It should be the case for all areas that could be subject to flooding. The Company should not be aiming to mine every area that may contain some ore. There are some areas that should be no go areas to protect the environment.*

FMG are aware that some of the pits will occur on or near floodplains. Any flood waters will be diverted around pits and re-established downstream. This is a standard mine engineering practice and will be done in a manner which minimises environmental impacts. During rehabilitation surface flows will be re-established to resemble as close as possible a “pre-mining” landscape as practicable. FMG will also aim to minimise the amount of land open for mining at any one time.

5.3.3

(SUB2)

***Flows near railway interconnection**: the proposed location of the FMG railway to Mindy Mindy, which is proposed to cross a potential railway connection to the existing railway near Weeli Wolli Creek, and falls within File Notation Area 5145, has the potential to affect surface flows in the area. More detail is required to understand these potential impacts.*

Interaction with the proposed Hope Downs Management Service (HDMS) railway is an operational issue and not relevant to the Stage B PER (the railway to Mindy Mindy that was covered in the Stage A PER has since been removed as part of the project revisions). However, where possible FMG have committed to ensuring that drainage used for the BHP Billiton Iron Ore (BHPBIO) and the proposed HDMS will be replicated in the FMG railway to reduce impacts to surface water flows. FMG will consult with all stakeholders during the design process to ensure acceptable solutions to any operation issues are found.

5.3.4

(SUB2)

***Drainage at Yandi Spur**: the proposed location of the FMG railway to Mindy Mindy would potentially impact the structure of the proposed grade-separated crossing of the Yandi Spur, at which point the proposed line is elevated some 8 metres above the surrounding surface. How and where would this crossing could be impacted, and what implications this may have for drainage in this area is unable to be ascertained from the information provided.*

Interaction with the proposed HDMS railway is not relevant to the Stage B PER (this was covered in the Stage A PER). However FMG will consult with all stakeholders during the design process to ensure an acceptable solution to any operational issues is found.

5.3.5

(SUB2)

Potential back water effects of FMG railway*: has any study been undertaken on the hydrological, surface water flow and associated vegetation impacts that might occur due to potential back water effects of the FMG railway on our proposed railway formation and the possible measures to be undertaken to avoid these risks?*

Interaction with the proposed HDMS railway is not relevant to the Stage B PER. FMG have assessed cumulative impacts with other railways in the Stage A Response to Submissions.

5.3.6

(SUB8,9)

Cumulative effects*: we are concerned that FMG has focused on the impacts of existing railways, and that modelling has failed to take into account the proposed Hope Downs line. We therefore expect that the detailed drainage design for the Project fully consider both the existing BHPBIO railway, as well as the approved Hope Downs railway.*

The interaction of railways is not relevant to the Stage B PER. Cumulative impacts of multiple railways (BHPBIO, HDMS and FMG) have been assessed as part of the Stage A Project. The East-West railway proposed as part of the Stage B Project does not come into close vicinity to any other railway. FMG's detailed drainage design for the Stage A railway will as a minimum replicate drainage structures for both the BHPBIO and HDMS railways where required.

5.4 Sheet flow and Mulga Woodlands

This Section discusses the effects of the operation on sheet flow and the consequent impacts on mulga. It includes commentary on the railway route selection.

5.4.1

(SUB13)

Sources of sheet flow*: the report refers to sheet flow occurring from the fanning out of creeklines, however there is also known to be significant overland flow sheeting from hillsides during storm events. Both the mine sites and rail will interfere with this "hillside" sheet flow. It is important that flow be re-distributed to re-establish overland flow to the maximum extent possible for ALL mulga stands, not just grove/intergrove stands.*

FMG recognises that sheet flow runoff originates from the hill slopes during storm events, as well as from fanning out from creek lines and that the proposed works will potentially interfere with these sheet flow patterns. As detailed in section 6.1 of the Stage B PER, for sheet flow areas FMG has committed to discharging diverted flows over riprap pads to encourage flows to slow and disperse. Downstream from working pits, FMG will conduct selected irrigation of sheet flow dependent vegetation, following significant rainfall events. Additionally, where the railway passes through sheet flow zones, frequently spaced culverts will be installed, and where sheet flow dependent vegetation exists, a downstream sheet flow redistribution system will be established.

5.4.2

(SUB13)

***Vegetation types affected by sheet flow**: the report generally refers to mulga groves. It would be of concern if this refers only to grove/intergrove communities and does not imply that sheet flow is not important in other areas. This would be an unwarranted assumption.*

The focus on mulga groves/intergroves within the PER reflects the results of consultation with stakeholders and the available information from previous investigations into the importance of sheet flow. FMG does not consider sheet flow to be of importance only to mulga communities; however sheet flow tends to occur on subtle slopes (~0.1 to 2 degrees) which are predominantly depositional (i.e. alluvial soils). Mulga woodland with grassy understorey is the typical vegetation of such landforms/soils in the Pilbara. On higher ground and steeper slopes, such as pediments and slopes of hills and ranges, drainage and surface flow is predominantly via channels and drainage lines. Where these channels open out into alluvial fans downslope (with adjoining fans forming a skirt around the base of the ranges called bajada landforms) is usually associated with the transition from Spinifex to mulga communities.

5.4.3

(SUB8)

***Mulga water relations**: there is little information available on the workings of how mulga satisfy their water needs from surface flow sources, and this is felt to be an area that needs extensive study and investigation. It is felt inadequate that such studies takes place during and after such dramatic modifications have taken place in the area.*

FMG has reviewed the available knowledge in this area. The management strategies have been developed using this knowledge and they build on the experience of others elsewhere in the Pilbara. FMG believes that, properly implemented, the strategies offer an expectation that adverse impacts in mulga communities can be minimised. As described in 5.4.4, 5.4.8 and 5.4.35, FMG will install engineering methods to ensure surface flows are maintained.

5.4.4

(SUB3)

Trials required for sheet flow system*: we note also the railway crosses extensive areas of sheet flow and the mulga woodland community is dependent on this sheet flow particularly at Sandy Creek. It is not apparent that the proponents have demonstrated the railway will not restrict the flow of water and therefore affect this plant community. We believe that at the very least trials should be conducted on the sheet flow system proposed in Section 5.4.7 on page 88 of the PER.*

5.4.5

(SUB6)

Further studies of sheet flow system*: it is recommended that FMG conduct further extensive studies into the viability and effectiveness of spreader ditches focusing on those areas outlined in both Appendix F and Section 6.1.4.2, especially in relation to the major issues regarding maintenance of erosion, siltation and damage by livestock. These studies should be undertaken prior to the Project being assessed by the EPA.*

An initial sheet flow field trial has been undertaken and the report was included in Appendix F of the Stage B PER. Culverts will be used to transport water under the railway and therefore in sheet flow zones, the flow will be converted to a point source after which it will be reverted to sheet flow. The purpose of the initial study was to analyse the success of various structures to redistribute water from a point source back into sheet flow. The two main structures tested were a levee bank made from rock and a trench system. The report concluded that the levee showed promise as an effective and cost-effective method for spreading water quickly. The trenches trialled had limited success in evenly redistributing the water across its length and were susceptible to erosion.

FMG is currently preparing to undertake further field testing of the redistribution structures. The purpose of the additional field testing will be to analyse:

- The most effective rock size for levee banks;
- How effective the levee banks are at withstanding erosion/damage under high flow;
- The impact of heavy sediment flows on the levee; and
- The effectiveness of alternative trench structures.

The report from the field testing will be made available to the DoE and CALM.

5.4.6

(SUB8,13)

***Experience to date**: whilst initial trials for redistributing sheet flow are encouraging, there is no operational experience/proven track record to date. Trials have been conducted during a very dry period.*

FMG is currently aiming to improve on the knowledge of sheet flow redistribution and develop best practice engineering solutions. Throughout the design of the trials, FMG has been in contact with a number of industry experts, such as hydrologists and academics, for input into the trial design. The initial trial showed promise in redistributing sheet flow. Additional field testing will be undertaken shortly to test the structures under a range of conditions (particularly varying flows). If additional work is identified during the proposed trial, FMG will undertake further trials to complete all work.

It is acknowledged that the initial trial was undertaken during a dry period. However, an artificial water source was used to supply sufficient water to the trial. The trial to be undertaken in the near future will utilise significantly more water than the first field test. Therefore, the ground conditions will be similar to those experienced during prolonged rain. Observations during this proposed field test will provide information on how the redistribution system is likely to behave during wet periods.

5.4.7

(SUB8,9)

***Effectiveness of culverts**: we are deeply concerned about the potential impacts of the railway and access roads in terms of surface sheet flows and consequences for downstream vegetation, in particular Mulga communities. We remain unconvinced that the proposed system of culverts can handle the maximum amounts of water expected in such an unpredictable climate, and replicate the natural sheet flows in the area, not just facilitate the movement of the same gross amounts of water across the landscape.*

Culverts will be installed under the railway formation at the defined flow channels where they will be designed to safely pass the 20 year ARI (Average Recurrence Interval) flood event. Although these culverts will partially constrict flood flows, they will not prevent runoff draining to the downstream environment. Designing culverts to safely pass the 20 year ARI event is an accepted industry standard.

As stated in the PER (Appendix F), where the railway passes through the sheet flow areas, FMG will install small diameter culverts under the railway formation at regular intervals. In these sheet flow areas, culverts with a minimum 300mm diameter will be used to redistribute the sheet flow. Where higher discharges are predicted, larger sized culverts will be installed to suit. To reduce the potential for impact through the more sensitive grove/intergrove mulga areas, ground and vegetation conditions along the railway route will be visually assessed to determine the required locations and spacings for the culverts. In these more sensitive areas, the culvert spacings would likely be at around 50m to 100m spacings (although installed according to ground conditions, where ever there is a depression), refer also to response 5.4.35.

On the downstream side of the railway sheet flow culverts and access road, FMG will install works to redistribute the runoff. Where grove/intergrove mulga communities are not located in the immediate area downstream from the railway, discharges from the culverts will be directed against a riprap pad where the flows will slow and disperse to the downstream environment. Where grove/intergrove mulga communities are located in the immediate area downstream from the railway, a redistribution system will be constructed. FMG has initiated field trials for the sheet flow redistribution system and additional trials are proposed prior to final design and construction.

5.4.8

(SUB13)

***Harvesting of sheet flow**: the proposal to use water that flows into the mine for process water will result in that quantity of sheet flow being lost to the system below. This may be significant if it reduces recharge of the soil moisture during lesser rainfall events. Provision should be made to redistribute the water as sheet flow for such events, rather than trap it for process water.*

As stated in the PER (Appendix F), where due to the local topography, diversion of upstream surface water runoff around the pit perimeter is not feasible, the external runoff water may be allowed to discharge into the pit area (within engineering safety constraints). In-pit sumps and pumps will be designed to manage any external surface water entering the pit, together with in-pit stormwater volumes. To save on water abstractions from the water supply bores, it is proposed that the in-pit water will be primarily used as process water. However, prior to pumping from the pit, the in-pit water will be treated via sediment ponds.

Where a sheet flow zone containing a grove/intergrove mulga community is located immediately downslope from an open pit area and external surface water runoff is collected in the pit, FMG proposed that some of the collected in-pit water will be used to irrigate this sheet flow zone. However, as sheet flow only occurs following a major rainfall event, then this irrigation system will only be used following such an event. Irrigation will not be applied to grove/intergrove areas that are approved to be cleared by future mining activities.

During the mining process, FMG proposed that the pit areas will be progressively backfilled to an extent dependent on the backfill material available. Upon completion of mining, if sufficient material is available, the pits will be backfilled such that a whole pit area can drain to the downstream environment. Some portions of the pits may be preferentially backfilled during the mining process, to enable upstream (external) surface water runoff to pass through the pit area, rather than be diverted around the pit footprint (within engineering safety constraints).

5.4.9

(SUB12)

Alignment with mulga groves: *it appears that FMG has not understood the processes driving the impacts from water shadowing with regard to the rail embankment, as demonstrated by the statement (5.2.2.3 Preferred Rail Route pg 65) the benefits of route 2 are that it "…affects areas of mulga and mulga groves, but often obliquely, so that water management may not be as difficult". Approaching mulga areas obliquely is the least preferred option and the most difficult in terms of redistributing water downslope. CALM considers that impacts on mulga can be minimised if the rail embankment is constructed perpendicular to the mulga groves.*

FMG believes that engineering options will allow surface runoff to be managed satisfactorily along the length of the preferred rail route. Aligning the rail route perpendicular to mulga groves is not a practical option. If the rail line were parallel to mulga groves, then the ideal position for the rail line may be towards the uphill end of intergrove separations. However, along some kilometres of rail line, the distance from the rail line to the nearest grove downhill is almost sure to vary, and in some cases the rail embankment may lie directly over groves. If the rail line were oblique to mulga groves, it may be possible to release water immediately below each grove, maximising the lateral spreading of surface flow as it travels the intergrove distance, i.e. before it reaches the next grove downhill. The best locations for culverts and the most appropriate designs for distribution works will be determined during final design. Refer also to response 5.4.35.

5.4.10

(SUB12)

***Success of past practices**: CALM strongly disagrees with the statement "While water shadow is a historical issue which has previously impacted Mulga in the Pilbara, it is now accepted that it can be managed with correct hydrological engineering" (E6 Mulga Groves, page xxii). CALM considers it would be more accurate to state, on the evidence available and in relation to water shadow effects on mulga, that hydrological engineering methods to manage water shadow have generally failed in the past, although with a greater appreciation of the issues and impacts on ecological process it may be possible to mitigate impacts with sympathetic hydrological and engineering solutions.*

Comment noted, refer to response 5.4.35.

5.4.11

(SUB12)

***Further investigations**: FMG should continue investigations into culvert and spreader ditch design and commit to undertaking the additional studies as recommended by Mr Muller (Appendix F). This will foster best practice and continuous improvement. FMG must also commit to the regular maintenance of the final structures that are installed to redistribute water. CALM suggests that this maintenance will need to be undertaken at least twice a year.*

Refer to response 5.4.35.

FMG will incorporate the inspections of the culverts and redistribution systems into the rail inspection program. Additionally culverts and redistribution systems will be checked immediately following rainfall events. Two components of the field trial that FMG is currently planning to undertake will be relevant to the maintenance of the structures. The first involves pumping a high volume of water to determine when the structures fail. This will give FMG an indication of the magnitude of storm event that would be required to damage the structures. The second involves investigating the impact of water with a high sediment load on the redistribution structures. This component of the field trial will give FMG an understanding of the likely impact of sediment on the maintenance requirements for the structures. Based on the results of the field trial, FMG will be in a position to provide further information on the maintenance requirements of the structures. The trial report will be made available to CALM and the DoE.

5.4.12

(SUB12)

***Long term solutions**: FMG must investigate long term solutions to eliminate the requirement for ongoing maintenance of the culverts and spreader ditches or their replacements. This is to ensure the solution to water redistribution in mulga communities is sustainable in the long term and the liability of this management/maintenance is not inherited once mining has ceased.*

Refer to response 5.4.11.

5.4.13

(SUB12)

***Culvert installation**: FMG must commit to installing culverts in sheet flow areas as required and to the satisfaction of CALM.*

The design process will involve a number of steps which need to be undertaken before detailed designs for the railway are finalised. It is anticipated that the following steps will be undertaken:

- an initial review of the corridor using GIS technology to determine a preferred alignment;
- traversing the alignment on the ground;
- final route selection;
- detailed design of water management structures; and
- final detailed design.

Designs will be developed by both track designers and specialist hydrologists in consultation with CALM. Final designs will be provided to CALM for comment which will include location of culverts.

5.4.14

(SUB12)

***Design standards**: Appendix F, Recommended Railway Corridor Surface Water Management, Section 4.2.3. Recommendation 1 states that culverts at all defined drainage crossings will be designed with a capacity to safely pass the 20 year average recurrence interval (ARI). CALM questions the adequacy of this standard and believes that it will result in an unacceptably high potential for floods to damage vegetation. The criteria should be reviewed and it is suggested that a 100 year ARI may be more appropriate for environmentally sensitive areas.*

FMG will install culverts under the railway formation at the defined flow channels where they will be designed to safely pass the 20 year ARI (Average Recurrence Interval) flood event. Although these culverts will partially constrict flood flows, they will not prevent runoff draining to the downstream environment. Designing culverts to safely pass the 20 year ARI event is an accepted industry standard.

5.4.15

(SUB13)

Rail route selection*: no consideration was given to rail alternatives until very late in the process. This lack of early environmental consideration is now used to justify the preferred route (route 2) as it has some approvals. It should be noted that route 2 also crosses Hillside Station (not acknowledged in the report) and would cut off the "best grazing land on the lease" referred to. Routes 1 and 5 would still allow access to this land along the railway.*

From the outset of the Project FMG gave due consideration to rail alternatives. For example, Route 1 was considered in late 2003 and discarded due to hydrological issues and unacceptable impacts on Samphire vegetation.

The Samphire Communities fringing the Fortescue Marsh are locally restricted (pers. comm. Mattiske, 2005) and form part of the nationally recognised Marsh values, in the Register of Nationally Important Wetlands. As stated in a paper formulated by CALM for information for Biota prior to its surveys for the Stage B Project:

- The Samphire shrubland on the Fortescue Marsh is the largest ephemeral wetland in the Pilbara and the only feature of this type in the Pilbara bioregion;
- The Marsh supports at least two endemic taxa (*Eremophila spongiocarpa and Halosarcia* sp. Roy Hill (H. Pringle 62)), both confined to the samphire shrublands; and
- The samphire shrubland community of the Fortescue Marsh is unique principally because of the presence of endemics, which are not rare and may dominate some floristic community types.

Early in 2004 FMG assessed a number of other alternative routes and various crossings through the Chichesters. An indicative rail alignment for the preferred FMG Route (2) was given to CALM on the 26 March 2004 for consideration. CALM's continued advice during consultation was to move the route as far up into the footslopes as possible – a request with which FMG has complied with. FMG considers that the determination of evaluation of rail alternatives was carried out early in the process. The evaluation of the seven rail alternatives in consultation with CALM was carried out in late 2004 only after they changed their initial advice given (to move the rail as far upslope as possible) and asked FMG to document in a report the evaluation of several other alternatives not previously raised by CALM.

FMG will continue to consult with the appropriate stakeholders such as Hillside Station during the design phase of the railway. However FMG's railway will not restrict Hillside from accessing the "best grazing" land on the lease.

5.4.16

(SUB13)

***Rail route selection**: it is unclear why Route 1 would be more difficult from a water management point of view (Appendix E, p40, point 1). The report "Water Flow in Mulga Areas etc" indicates that sheet flow re-establishment is easier in the lower, flatter areas, and the potential drainage impacts less. Route 2 requires the greatest management of sheet flow into ALL mulga stands, NOT just grove/intergrove.*

Water management would be more difficult for Route 1 because it is lower in the landscape, and the volume of water that would need to pass through the embankment after any rainfall event would be larger. For any given number of culverts, all would need to be larger diameter for Route 1 than for Route 2. Alternatively, for a similar size of culverts, Route 1 would require more culverts than Route 2. In addition, Route 1 would require an embankment which is several meters higher than Route 2, to protect the rail from the floodwaters near the Marsh. This in turn would require much larger borrow pits. There are also geotechnical considerations associated with locating the railway in the samphires, as the flood and drying cycles of the Marsh would have a significant impact on the stability of the embankments (refer also to response 5.4.15).

5.4.17

(SUB13)

***Rail route selection**: regarding Route 2, if the rail is oblique to the slope (Appendix E, p49, point 7), the area where water cannot be redistributed (without pumping) is increased. From the culvert, it is only possible to redistribute at best on the contour.*

It will be necessary to design or select appropriate water management structures to manage the redistribution of water from the outlet of every culvert. FMG foresees no need for pumping. The alignment of the rail (whether oblique or parallel to Mulga groves) will be selected in final design to minimise impact. However FMG believe an oblique alignment can be adequately managed where required. Refer also to response 5.4.9.

5.4.18

(SUB13)

***Rail route selection**: regarding Route 1, whilst it is correct that areas through mulga will require a significant embankment to allow for culverts, this is equally true for Route 2 (Appendix E, p50). Preferably, fill for such embankments should come from outside the mulga areas, and this would be closer for Route 2 than Route 1, but for this to be a valid point FMG should commit to no borrow pits in mulga areas.*

FMG will choose the locations of borrow pits carefully, and understands the need to avoid areas of mulga. On the other hand, some areas of mulga will be mined. FMG may choose to source fill material from such areas so as to avoid additional impacts.

5.4.19

(SUB8)

***Rail route selection**: though it is admitted throughout the report that that Route 2 selected has the second greatest impact on mulga communities, so much is not known about mulga and the relationship between them and the way they obtain their water needs. It would have to be considered that the actual footprint of negatively affected mulga would be much higher than the reported percentages.*

FMG is not aware of information collected by CALM or any other organisation that shows that the area of impact of linear infrastructure (such as road or rail) on mulga communities is significantly greater than the actual disturbed area. FMG understands the importance of Mulga communities and accepts that potential indirect impact on mulga communities must be managed. At the same time, FMG believes that with careful route selection at the time of final design, the impact of Route 2 could be significantly less than the reported percentages. It may be possible to choose an alignment that passes immediately below groves (within the intergrove areas), for example, to maximise the opportunity for reestablishment of sheet flow in intergrove areas and at the same time to avoid direct impact on trees.

5.4.20

(SUB12)

***Rail route selection**: the PER states that the rail alignment for the Project was constrained by a number of factors including “potential future mine areas” (Evaluation of Alternatives pg xv, 5.2.1 Railway Corridor Alignment pg 58 & Appendix E pg 10). However, the PER does not address or assess the impacts of these future mine areas at a strategic level and thus this constraint does not constitute legitimate justification for the rail route. If FMG consider*

> *this constraint critical for planning purposes then they should have included the potential future mine areas for assessment also.*

The future mining area which constrains the rail alignment is Cloud Break. Although Cloud Break is a separate Project, its location must be considered in planning the best rail alignment. As stated in the report by Townley and Associates (Stage B PER, Appendix E, Section 3.2.2), in the context of its State Agreement Act, and its stated long term objectives, FMG believes that access to Cloud Break must be taken into account. FMG's objective is to minimise cumulative environmental impacts in the long term and to provide the best possible access to all resources. FMG has recently referred the Cloud Break mining Project to the EPA for assessment. A key component of this assessment (as for any new Project) will be the assessment of the cumulative impacts of Cloud Break and other Projects such as the Hope Downs Project and the Stage B proposal.

5.4.21

(SUB12)

> ***Rail route selection**: there are many errors and misconceptions in the evaluation of alternative rail routes in the document relating to biodiversity and biological and ecological processes that would have been detected if CALM was given the opportunity to review or comment on this document prior to publication.*

FMG does not agree that there are many errors and misconceptions in the Evaluation of Alternative Rail Routes (Stage B PER, Appendix E) relating to biodiversity and biological and ecological processes. The specific examples of these misconceptions raised by CALM are discussed in responses 5.4.27, 5.4.29 and 5.4.30. FMG commenced the evaluation of alternative rail routes early in Project planning. For example, Route 1 was considered in late 2003 and discarded due to hydrological issues and unacceptable impacts on Samphire communities. Early in 2004, FMG assessed a number of other alternative routes and various crossings through the Chichesters. An indicative rail alignment for the preferred FMG Route (2) was given to CALM on the 26 March 2004. At that time CALM advised FMG that the rail should be moved as far up-slope as possible into the footslopes of the Chichester Ranges so that flows could be intercepted in defined creeks, rather than sheet flow areas. FMG followed this advice and ensured that the alignment was in the footslopes as close to the ranges as possible. FMG continued to consult with CALM throughout 2004, and they continued to maintain the position that the rail should be positioned as far up-slope as possible. The additional alternatives proposed by CALM (routes 1, 3, 4, 5, 6 and 7) were not provided to FMG until a consultation meeting held with CALM on the 10 November 2004 and subsequently in correspondence to FMG on the 23 November 2004.

A scope of works for the Evaluation of Alternatives study was provided to CALM on the 19 November 2004. FMG's consultant subsequently included CALM's requests into the report and FMG continued to consult with CALM on a number of occasions during the development of the Evaluation of Alternative Rail Route Report. The draft report was sent to CALM for review on 22 December, 2004, approximately 4 weeks prior to its finalisation and release with the Stage B PER on the 17th of January 2005. No response from CALM was received on the draft document.

5.4.22

(SUB12)

***Rail route selection**: Appendix E would have benefited from the input of a biologist or ecologist with an understanding of Pilbara and/or arid zone ecological processes. An example of the shortcomings in the review document is the identification of several larger land systems as occurring in the Project area, and the suggestion that they are restricted to the region (Appendix E, pg 32). This is not the case and all of the land systems mentioned occur elsewhere throughout the Pilbara and in many cases in the Ashburton and Gascoyne.*

FMG sought advice from Biota, who have significant experience working in the Pilbara. The reference to several of the larger land systems occurring in the Project being restricted to the region is a typographical error. This should read "In addition, whilst larger land systems than those listed below, the following systems are restricted **"<u>in</u>"** the Pilbara region:

- River - major river systems which are restricted to the major rivers in the area.
- Bonney - isolated occurrences in the Pilbara may support distinct vegetation.
- Coolibah - restricted to the Fortescue River floodplains.
- Urandy - restricted to the Fortescue Plains sub-region.
- Marsh - contains Fortescue Marsh samphires and species which are known to be restricted to this area.
- Turee - virtually all on the northern side of the Fortescue Marsh, contains cracking clay vegetation and some mulga."

This means that although they may occur elsewhere, they are isolated from the other occurrences (or different in some way) and therefore likely to support restricted vegetation. Even though land systems can occur across different geographical locations they often contain different vegetation types when there is geographic separation.

FMG believe that the Marsh and Coolabah land systems are restricted to a small area of the Pilbara only and cannot be considered to occur throughout the Pilbara as suggest by this submission.

5.4.23

(SUB12)

Rail route selection*: the information on fire scars in Appendix E is misleading and taken out of context with respect to the accuracy of the mapping and the patchiness of burns within areas identified remotely as having been burnt. This misrepresentation or misunderstanding of the data is evident in several statements as highlighted by the suggestion (Appendix E, pg 37) that areas along alignments 2 and 3 near the Cloud Break deposit were burnt in consecutive years. This is not possible despite the imagery suggesting it happened.*

The fire scar data that FMG used is published data that is publicly available in a GIS format. As such, it was FMG's understanding that the data was accurate. In addition FMG sought verbal reports from Pastoralists regarding fires that had occurred within the region. However, if the data has not been interpreted correctly FMG would be happy to discuss or receive advice on the accuracy of the data, which was provided to FMG by CALM.

5.4.24

(SUB12)

Rail route selection*: CALM does not agree with FMG's argument concerning vegetation condition, specifically in relation to fire and the burn history of Route 2 (Appendix E pg 49, last dot point). Fire does not destroy/degrade communities unless there has been a significant change in some aspect of the fire regime*.

The information relating to the burn history was formulated from the fire scar GIS data provided to FMG (see response 5.4.23). Advice provided to FMG by Biota (Appendix J of the PER) indicated that given the long time to maturity for mulga plants (5-15 years to seed set), fires at frequent intervals may eliminate mulga individuals and thereby change vegetation structure. As such, if an area was noted to have been burnt regularly from the fire scar data, it was considered that it is likely it would have been impacted. The vegetation condition was further assessed based on grazing and weed infestation.

5.4.25

(SUB12)

Rail route selection*: FMG states that cultural heritage is a constraint that was influential in determining the preferred alignment of the rail. FMG has progressed tenure outcomes on its preferred alignment including negotiating site clearance and agreements to protect culturally significant areas prior to receiving*

> *environmental approval for their preferred route. FMG now argues that their preferred route is the most acceptable (e.g. Appendix E, pg 18) because it is not constrained by cultural issues and agreements that have already been made to protect sites of cultural significance along alternate routes.*

As outlined in Section 4.3 and in Townley's report (Stage B PER, Appendix E), during the initial selection of rail routes by FMG in December 2003, an ethnographic cultural heritage constraints survey was conducted over the entire proposed Project footprint south of the northern outwash plains of the Chichester Ranges. This survey focused on identifying any major areas/sites of significance for Aboriginal people. A key focus area was the valley system proposed through the Chichester ranges, which was moved to an alternative valley system (as outlined in the Stage A PER) due to the existence of numerous extensive rock pools and associated cultural heritage material dating back to at least 30,000 years BP. During this survey it was indicated that valley systems to the east of FMG's current Chichester crossing (i.e. the valleys crossed by routes 3, 4, 5, and 6) also had significant potential for substantial cultural heritage sites. This is supported by Appendix I to the PER (Anthropos Australis) which states that "The valleys of the Chichester Range itself contain an abundance of rock engravings. Similar engravings are found elsewhere in the Pilbara, notably on the Burrup Peninsular...There are natural features within the Chichester Range (such as) creeks, springs, claypans, rockholes and rockshelters which the Aboriginal Traditional Owners believe are also the physical manifestations of the ancestral beings." For reasons sensitive to Aboriginal Cultural Heritage, FMG has a strong preference to avoid a second crossing through the Chichester Ranges as would be required by Routes 3, 4, 5 and 6.

5.4.26

(SUB12)

Rail route selection: *FMG acknowledges that "Heritage surveys are ongoing and will be completed prior to commencement of construction." (E5 Social Environment, pg xix). Consequently, how does FMG propose to deal with heritage issues that arise along their preferred route if these issues are significant enough to warrant a change in the alignment or perhaps abandonment of this route?*

Any heritage issues which arise along the preferred route will be dealt with in accordance with agreed cultural heritage protocols for the Project. There is flexibility within the 2 km wide corridor to alter the rail route to avoid areas of cultural heritage concern. It is unlikely that this will result in a significant change or abandonment of the route.

5.4.27

(SUB12)

***Rail route selection**: CALM rejects the suggestion that Route 1 will have the greatest impact on mulga communities (5.2.2.2 Comparison of alternative rail routes, pg 63 and Appendix E, Table 4.8). The reasoning behind the location of this alignment (as proposed by CALM) was for it to be situated below the mulga woodlands and in the samphire and hummock grassland communities fringing the actual bed of the Marsh. The suggestion made by Townley is based on a misunderstanding of the alignment of this route, an over reliance on vegetation descriptions and land system types provided by rangeland mapping and an unfamiliarity with the area (lack of ground truthing).*

It should be noted that each of the rail alignments presented in Appendix E of the PER were 'designed' within a rail computer package. This computer package considered constraints on the alignment of the rail alternatives including grade restrictions, curve limitations, cut and fill requirements and the Commonwealth Department of Environment and Heritage (DeH) flood boundary for the Fortescue Marsh. When designing a railway line a significant constraint is grade and curve and therefore it may not be possible to follow a vegetation boundary.

FMG has positioned Rail Route 1 as close as practicable to the Fortescue Marsh when all design factors (refer to Figure 22 in the Stage B PER for proximity of Rail Route 1 to the Fortescue Marsh). For example, if the rail alignment was positioned closer to the Marsh in the samphire community, the flood and drying cycles of the marsh would have a significant geotechnical impact on the stability of the embankments. In addition advice provided to FMG by Mattiske Consulting, they indicated that vegetation communities within the fringes of the Fortescue Marsh such as samphires should be considered a significant vegetation type and avoided as they are restricted to a fringe bordering the marsh. For this reason, the only practical location for route 1 was out of the Samphire communities and into the Mulga. Refer also to response 5.4.36.

5.4.28

(SUB12)

***Rail route selection**: failure of Appendix E to quantify potential impacts on mulga as a consequence of off-site effects related to changes in surface hydrology. It appears that the estimate for impacted mulga as presented in Table 4.13 is for cleared areas only and therefore direct impacts only. No effort was made to account for the effects of drainage shadowing which may be up to 100m (or more) downslope from the rail. FMG may argue that their proposed rail design and culvert management regimes will preclude such impacts, there is a significant risk that such impacts will still occur. It would have been beneficial to quantify this risk for the PER assessment process,*

> *especially for those vegetation types susceptible to changes in surface hydrological regimes.*

FMG believe that with appropriate management strategies and/or best practice engineering design and monitoring programs these processes can be minimised or mitigated. It is not possible to take into account potential indirect processes such as drainage shadows in the clearing statistics (refer also to Response 5.4.19). Trying to formulate such statistics would be reliant on 'guessing' the extent of potential indirect impacts and no data is available to inform such a guess. FMG believe it is more meaningful to focus on management measures which will minimise and mitigate potential impacts as far as practicable. Refer also to response 0/

5.4.29

(SUB12)

> ***Rail route selection**: the major biological shortcoming of this evaluation of alternative rail routes report is its failure to recognise the significant biogeographical, biological and hence conservation values of the mulga woodlands on the southern slopes of the Chichester Range above the Marsh.*

FMG has outlined the vegetation of conservation significance, as assessed by Biota within the Project area in Section 4.5.2.2, page 34 of the Stage B PER (including the seven types of mulga dominated vegetation of high conservation significance). This information is then provided in full within Appendix J of the PER. It was not necessary to repeat the information verbatim in the Evaluation of Alternatives report (Appendix E, Stage B PER). However, it is recognised within Appendix E, that impact on Mulga is a key environmental issue which should be considered in the evaluation of alternative rail routes along with a number of other key environmental issues. The impact on various mulga containing land systems, by each of the alternative rail routes is assessed thoroughly in the report.

FMG recognises that the mulga woodlands on the southern slopes of the Chichester Range have conservation value. FMG considers that the impact of the Project on Mulga land systems is low in context of the entire Chichester Ranges:

- 0.07% of Chichester Mulga Land Systems disturbed by proposed rail corridor
- 2.1% of Chichester Mulga Land Systems disturbed by proposed mines

It should also be recognised that vegetation studies are not an exact science and can be very subjective. There are a number of issues regarding vegetation classification and assessment of conservation value which often arise. FMG has commissioned a peer review of Biota's Vegetation Study which discusses some of these issues - the review is included as Appendix D to this document. Whilst FMG agrees that the Mulga woodland in the Project area has conservation value, there are a number of issues relating to the subjectivity of vegetation studies which should be considered when assessing the degree of conservation significance of a given vegetation type, as outlined below.

The review highlighted the following critical issues in the science of vegetation classification and determining conservation significance:

- Vegetation classification based on manual grouping through observed similarities in dominant species, structural attributes of vegetation and vegetation condition, is highly a highly subjective approach – that is different botanists are quite likely to interpret patterns and group sites differently resulting in a fundamentally different vegetation classification;

- A critical issue in vegetation assessment relates to choosing appropriate scale and level of abstraction. Typically vegetation can be classified as a hierarchy with broad vegetation types dividable into several subtypes, which further divide into many smaller vegetation units and so on. The greater the number of vegetation units that are defined (or in other words the lower cut-off of the hierarchy) the less distinct they will be in terms of floristics (i.e. plant species composition). Also, the more units defined, the greater likelihood that some of them will be determined to be restricted in distribution within the region. This can lead to subjectivity in vegetation classification and determining conservation significance; and

- With increasing geographic distance apart, it is more likely that vegetation will vary due to stochastic nature of plant species distribution, chance events and environmental differences due to climatic gradients and other factors. In this respect, assessment of significance at a regional scale is somewhat flawed as regional differences within broad types of vegetation are to be expected, between vegetation types of significant distances apart.

These issues, which are common to vegetation studies in general, were reflected in Biota's study for the Stage B PER. In particular, the review highlighted:

- Biota identified 81 vegetation types, which were used as a basis for the assessment of conservation significance. This was considered to be a high number of vegetation types and there appeared to be considerable overlap in composition of dominants. It is likely that at this fine level of abstraction we are seeing subtle, local variation and not always consistent differences between the defined vegetation types. This is reflected by many types being mapped as a mosaic of 2 or more types, showing difficulty in separating them. This is an issue as the 81 types were used to assess conservation significance, and generally the more vegetation types defined in an area, the greater the likelihood that some of them will be found to be restricted and/or of conservation significance; and

- The PATN study conducted as part of the assessment of conservation significance involved a massive regional data set (2000+ sites) but unfortunately the sites were not evenly spread, but rather concentrated spatially around planned mine developments and along rail corridors. Many of the areas from which the 2000+ sites have been sampled appeared to be uplands and few other mulga woodlands appear to have been sampled apart from those further west along the Fortescue Valley (sampled for FMG Stage A and Hope Downs Rail) and at West Angelas. (some 140 km to the south-west). Therefore it is not unexpected that the Mulga sites analysed for the Stage B Project were floristically different from the comparison sites, given the degree of geographical separation.

It is therefore possible that the definition of 81 vegetation types (which is a high number of types and does not necessarily reflect consistent differences in vegetation) has artificially increased the conservation significance assigned to the vegetation mapped. In addition, the PATN comparison with a large dataset of sites some distance from the Project area (often in different physical environments not containing mulga) may have also artificially elevated the level of conservation significance assigned vegetation in the FMG Stage B Project Area (particularly Mulga types). A comparison with Mulga sites within the same area (if data were available) may have well yielded a different result.

The review concluded by commenting that perhaps the most sensible way of determining conservation significance would be to predict the distribution of similar mulga types in the vicinity of the proposed Project using land systems data. This was the approach taken in the Stage B PER to place the impact on Mulga in a regional context by calculating direct impact as a percentage of Mulga land systems in the Chichester Ranges Footslopes (Stage B PER, Section 6.3.1, pg. 124).

5.4.30

(SUB12)

***Rail route selection**: the evaluation of alternative rail routes did not assess the biodiversity or nature conservation values of any of the routes, although they are generally considered high as indicated by Biota in Appendix J. Similarly, the condition of vegetation as assessed qualitatively by Biota (Appendix J, 6.3) was indicative of the perceived biological values of the area with over 50% of community types having moderate or higher conservation significance. As noted by Biota (Appendix J, pg 80), many of these vegetation communities are not represented on the existing conservation estate, a position which reinforces the biodiversity and conservation values of the area. The evaluation of alternative rail routes inadequately addressed such matters.*

FMG has outlined the vegetation of conservation significance, as assessed by Biota within the Project area in Section 4.5.2.2, page 34 of the Stage B PER. This information is then provided in full within Appendix J of the Stage B PER. It was not necessary to repeat the information verbatim in the Evaluation of Alternatives report (Appendix E, Stage B PER).

Within Appendix E, it was not possible to compare and contrast impact on finer scale vegetation units for each rail route, as detailed vegetation mapping has not been conducted for each alternative route. As such, land systems data was a good surrogate to enable a comparison of vegetation impacts and conservation values of each route.

As such, Appendix E makes an assessment of impact on nature conservation values by:

- Assessing the impact on Mulga containing land systems of each route (inherently recognising that Mulga vegetation in the Project area has conservation value, as described in the Stage B PER, to which the report is an Appendix); and

- Assessing the impact on other land systems likely to contain significant vegetation types.

Similarly the qualitative assessment of vegetation condition by Biota was only available for Route 2. As such, it was not possible to conduct a comparison of the condition of vegetation along alternative routes, using a similar system. Townley made an assessment of vegetation condition, using information available, such as weed infestation, grazing history and fire scar history (as requested by CALM in correspondence 23rd November 2004).
The qualitative assessment of vegetation conservation value is also discussed in response 5.4.29.

5.4.31

(SUB12)

Rail route selection and historical weed distribution*: the proponent asserts that elevated areas of the ranges are less likely to be weed infested and that this is a constraint in relocating the alignment north into the Chichester Ranges. This does not take into account that most of the area was grazed by sheep for over 60 years. It also does not take into account that much of the Pilbara was aerial seeded with Buffel grass during the 1950's and 1960's, thereby ensuring that very few areas are free of this environmental weed. Therefore, the proposition that areas higher up the slopes in the Chichester Range are somewhat more "pristine" (free of weeds) than those towards the Marsh because of a lack of access and suitable cattle grazing country is questionable.*

FMG continues to believe that because of the combination of terrain and accessibility, the areas closer to Fortescue Marsh may be less "pristine" than areas of the Chichester Ranges. For example, the Biota (2004) survey identified that there were some obviously heavily grazed areas along Route 2, mainly adjacent to stock watering points, which tended to coincide with heavy Buffel grass infestations. Watering areas for stock generally do not occur higher up in the slopes of the Chichester Ranges. The clayey plains of the Fortescue Valley are highly productive from a pastoral perspective. The dense Mulga vegetation of the clayey plains, and dense Mulga and other vegetation of creeklines, provide both forage and shelter for stock, which tend to concentrate the effects of grazing and trampling in such habitats. In addition, these mesic (moist) environments are more favorable for germination and growth of weed species, which may also be spread by stock movement and/or encouraged by grazing (Biota, 2004).

5.4.32

(SUB12)

Rail route selection: *If FMG receives approval to construct their preferred alignment, or any variation of that alignment that confers a better environmental and conservation outcome. It is recommended that the final rail route selection, design and construction be undertaken in close consultation with and to the satisfaction of CALM. This should involve FMG committing to walking/driving the alignment with CALM and selecting the location of culverts for drainage management. Similarly, a subsequent review of the alignment using GIS technology and orthophotos to confirm the location of culverts must also be undertaken with CALM.*

The design process for the railway will involve a number of steps before detailed designs are finalised. It is anticipated that the following steps will be undertaken:

- an initial review of corridor using GIS technology to determine a preferred alignment;
- traversing the alignment on the ground;
- final route selection;
- design of water management structures; and
- final detailed designs.

Detailed designs will be developed by both track designers and specialist hydrologists in consultation with CALM and other relevant stakeholders. Final designs will be provided to CALM for comment. The final designs will include locations of culverts, rail crossings and borrow pits.

5.4.33

(SUB12)

Rail route selection*: for approval and audit purposes FMG need to provide CALM and DoE with large format final rail design images that include the location and extent of borrow pits, culverts and rail crossings. FMG should be prepared to recoup CALM or its agent for costs incurred during this part of the approval and construction process.*

Refer to response 5.4.32.

FMG has proposed funding of a full time CALM employee as part of its offset package (refer to Section 0).

5.4.34

(SUB12)

Rail route selection*: the proponent must commit to a prescriptive rail EMP that details route selection, access restriction, rail design, borrow pit location and management, access road alignment, weed control and eradication and fire management. This EMP must be developed to the satisfaction of CALM.*

FMG have already committed to developing a comprehensive Environmental Management Plan for both the construction and operational phases of the Project. These plans will include proposed environmental management for all aspects of the railway and will be carried out in consultation with CALM.

5.4.35

(SUB12)

Rail route selection*: CALM does not support Route 2 (Appendix E Figure 22) as this will have a large impact on the mulga woodlands, an impact that will be propagated many tens if not hundreds of metres downslope from the actual disturbance footprint as a result of drainage shadowing and this impact will persist for many decades causing irrevocable change.*

FMG does not believe that Route 2 will have a significant impact downslope of the actual disturbance footprint as a result of drainage shadow (refer also to response 5.4.19 and 5.4.28). As described in the Stage B PER (Section 6.1.4.2, page 102), this potential impact will be carefully managed by FMG through engineering measures, to prevent water shadow.

Culverts will be installed under the railway at all drainage crossings and in the sheet flow areas at frequent intervals of at least 50 m to 100 m or wherever there is a depression. These culverts will be designed with erosion protection works, as appropriate, to neutralise the potential for adverse water flow impacts.

In sheet flow areas, a sheet flow redistribution system will be constructed along the contour, using survey control, to uniformly distribute runoff to the downstream environment. Discharges to the redistribution system from a 300 mm diameter sheet flow culvert, would be relatively small (peak around 60 L/s) due to the culvert's limited flow capacity. Hence flow velocities through the redistribution system would be relatively low and non-erosive.

Prior to entering the system, runoff from the culvert will be discharged to a silt trap that will overflow to the redistribution system. A small riprap pad will be installed directly in-line with the redistribution system inlet, to restrict any potential for flows to breakout of the ditch before lateral redistribution. The final design layout for the redistribution system will be based on field trials that will be completed prior to construction. The operation of the redistribution system will be monitored and maintained with modifications made as considered appropriate to ensure its effectiveness over time. The Surface Water Management Plan will include measures to ensure that:

- sheet flow redistribution system levels are maintained;
- redistribution systems and culverts are maintained in operational order and free from blockage; and
- the redistribution systems are effective for the life of the Project.

FMG have conducted an initial onsite trial into management of surface water via a sheet flow redistribution system. Detail of this system is provided in a report by C Muller (2004) (see attachment to Appendix F, Stage B PER). This trial showed that the redistribution system has considerable promise.

To build on the current level of understanding and the findings of the study, FMG are currently conducting further trials and will refine this system so that it is fully effective and tested prior to construction.

5.4.36 (SUB12) ***Rail route selection**: CALM also does not support route 7 because of implications for surface drainage. CALM favours an alignment from the Christmas Creek mine area that locates the rail on dissected ground and out of mulga as soon as possible CALM recommends routes 4, 5 and 6 or a combination of route 4 joining route 2 towards the western end to be the most environmentally sound. After review of Muller's report (Appendix F, Stage B PER) and based on departmental experience CALM therefore prefer an alignment similar to route 1.*

FMG agrees that route 7 would have unacceptable implications for surface drainage.

FMG believe that route 1, CALM's final prefererence is unacceptable because:

- This route would be significantly more difficult than others from a water management point of view. Being low in the landscape, the resultant embankment required for Route 1 would need to be very high to ensure the rail was above flood levels. This would impede throughflow and require bigger culverts. The embankment would require significant borrow which would be more difficult to source from the proposed mining areas as they are further away. These borrow areas would need to supply a large amount of gravel, increasing overall disturbance and would be very difficult to manage as free draining structures due to their position in the landscape;
- This route has the greatest impact on mulga communities in its current location, or if moved further south into the Samphire communities it will have unacceptable impact on the Samphire (refer to response 5.4.15, 5.4.16, 5.4.27 and 5.4.30 for discussion on the significance of samphire);
- Route 1 impacts the Cowra Land system, a very small land system containing mulga which has only six occurrences and the Marsh Land System which is restricted in the area and contains endemic species;
- Route 1 is cost prohibitive, with a capital cost many orders of magnitude higher than any other route due to the high embankment and significant engineering works that would be required;
- Route 1 would have higher operating costs, as an additional locomotive would be required to gain momentum and speed required for the Chichester Range crossing;
- Route 1 wouild require of the relocation of the proposed railloop at the future Cloud Break Mining Project to the south and on the flats where there is more Mulga groves; and
- Route 1 occurs almost entirely within in the 2015 Pastoral Exclusion Area (refer to response 5.4.39).

FMG believes that routes 4, 5 and 6 (or a combination of route 4 and 2) initially recommended by CALM are unacceptable for the following issues:

- significant Cultural Heritage impacts are likely (refer to response 5.4.25);
- Routes 5 and 6 impact two particularly small non-mulga land systems which may support restricted vegetation (Black and White Springs land systems);
- Route 6 impacts the Bonney land system which has isolated occurrences in the Pilbara and due to isolation of pockets, which may support distinct vegetation;
- Routes 4, 5 and 6 provide inadequate access to future mining operations at Cloud Break (refer to response 5.4.20); and
- Routes 4, 5 and 6 have significantly higher captial and operating costs.

In contrast, FMG's preferred route (3):

- Provides greater likelihood that materials for embankment construction can be sourced from mine areas;
- Has low greenhouse gas emissions;
- Provides best access to FMG's Stage B resources and the Cloud Break Project;
- Provides best access to stranded resources held by other parties;
- Has the low capital costs; and
- Has low operating costs.

While route 3 results in clearing of Mulga, the clearing is small when placed in a regional context as described in the Stage B PER (section 6.3.1, pg. 124):

- 0.07% of Chichester Mulga Land Systems disturbed by proposed rail corridor; and
- 2.1% of Chichester Mulga Land Systems disturbed by proposed mines.

5.4.37

(SUB13)

***Rail route selection**: a route that has not been considered in the comparative evaluation is a combination of route 1 and 5 from the east. Route 1 is low in the landscape, minimising the area of mulga at risk. Route Heading north from Warrie Outcamp along route 5, with a conveyor for the Cloudbreak deposit, would avoid impacts on Mulga to the west of Warrie Outcamp. This would potentially also provide an improved "run-up" to crossing the Chichester Range along route 5.*

A combination of these routes is unacceptable due to the issues associated with route 1 and 5 individually. Refer to Response 5.4.36.

5.4.38

(SUB12)

***Rail route selection**: CALM agrees with Mr Muller's proposition (Appendix F Conclusions) that the flatter the terrain, the quicker and easier water will be redistributed across the landscape and thus there is likely to be less impact from drainage shadowing. Hence, while route 1 as assessed by Townley may have an initially greater footprint, in the longer term, given little shadowing, the area of ultimate impact may be less. FMG should revisit and refine the analysis for an alignment similar to route 1 with EPA and CALM involvement.*

FMG believes route 1 is unacceptable as described in response 5.4.36.

5.4.39

(SUB12)

***Rail route selection**: under the heading of land access issues (Appendix E, pg 11) the proponent's rail option analysis did not recognise "2015 pastoral lease exclusions for conservation reservation proposal" as a constraint to route alignment. The failure to recognise this constraint adds bias to the assessment.*

At the time the report was produced, CALM had not released the *Proposed 2015 Exclusion Area Boundaries*. FMG have recently been provided with the boundaries by CALM. The areas of each of the proposed rail routes which fall within the *Proposed 2015 Exclusion Area* are shown in the following table (Table 2).

Table 2: Area of each rail route occurring within the "Proposed 2015 Exclusion Area"

Rail Route	Area within 2015 ExclusionArea (ha)	% of the 2015 Exclusion Area
1	285.77	0.13
2	116.83	0.05
3	99.49	0.05
4	25.59	0.01
5	28.08	0.01
6	No impact	N/A
7	87.61	0.04

CALM's preferred alignment – route 1 does not recognise this as a constraint, of all the alternatives it is within the greatest area of the *2015 Pastoral Exclusion Area.*

It should also be noted that the 2015 Exclusion Zones have not yet been formally proposed as a conservation reserve. In 2015, when the pastoral leases expire, the exclusion areas will become Vacant Crown Land, and CALM will need to initiate the normal process required to convert the area into a conservation reserve. For this to occur, the Minister for Planning and Infrastructure is required to make a reservation order under part 4 of the *Land Administration Act 1997*. Before the Minister issues such an order, consultation occurs with the Department of Industry and Resources (in terms of its interests with respect to granted tenements, State Agreement Acts and prospectively for minerals, basic raw materials and petroleum). CALM is also required to meet Native Title requirements before the reservation order can be issued by the Minister.

This process can result in significant changes to the boundaries of proposed conservation reserve areas, to take into account other values, such as mineralisation. In some cases, after such consultation, parts of the area (or sometimes the entire area) does not become included in the Conservation Estate, due to the State Government's assessment of values in the area for other land uses.

5.4.40

(SUB8)

Area of affected mulga*: throughout the report there is conflicting reports of the actual % of mulga in the Chichester that will be affected – page xxii refers to 2.7% within the Chichester footslopes unit and page 64 refers to the mulga in the Chichester Range and footslopes as 0.2% of the total mulga in this area. Unless the first reference refers to mine area as well, it is not very clear throughout the report and shows that there is really only limited information available about the current mulga stands and shows that this proposal has seemingly been hastily put together, with promises throughout of continuing research and investigation but we are strong of the belief that this should take place beforehand, not when it is all too late.*

The submission correctly surmises that the reference of 2.7% on page xxii refers to the total expected disturbance for the Project. The figure of 0.2% refers only to disturbance proposed for the east-west rail route. The expected impact on mulga within the Chichester Ranges Footslopes and the Fortescue Marsh Surrounds is summarised in Table 3 below (also on Table 13 of the Stage B PER). Rather than "hastily put together", mulga communities have been identified and mapped in detail. These maps and associated information are shown in Appendix J of the PER. This information has now been updated to reflect the project changes that have been submitted as part of this document.

Table 3: Direct impact on mulga, as a proportion of Chichester Ranges Mulga and Fortescue Marsh Mulga (based on Rangeland Mapping).

<table>
<tr><th colspan="4">*Management Unit Sizes (based on CALM Rangeland Mapping)*</th></tr>
<tr><td colspan="2">Unit</td><td colspan="2">Km^2</td></tr>
<tr><td colspan="2">Chichester Ranges Footslopes</td><td colspan="2">1,641</td></tr>
<tr><td colspan="2">Fortescue Marsh Surrounds</td><td colspan="2">3,204</td></tr>
<tr><th colspan="4">*Direct Impacts on Mulga as a percentage of Management Units*</th></tr>
<tr><td></td><td>Km^2</td><td>% of Chichester Footslope Unit</td><td>% of Fortescue Marsh Unit</td></tr>
<tr><td>Revised Stage B Corridor</td><td>1.2</td><td>0.07</td><td>0.04</td></tr>
<tr><td>Christmas Creek Mine</td><td>35.2</td><td>2.1</td><td>1.1</td></tr>
<tr><td>Total Stage B Project</td><td>36.4</td><td>2.17</td><td>1.14</td></tr>
</table>

5.4.41

(SUB12)

Early detection of impacts: *FMG must provide more detail regarding what monitoring they propose to undertake for the early detection of mulga vegetation impacts and, further, stating what remedial actions they will implement to manage any impacts should they occur. This strategy should be developed in consultation with and the agreement of CALM.*

Vegetation monitoring design must address the enormous variation in vegetation health that occurs as a consequence of natural events, as well as showing any impacts of the FMG Project. The most challenging task in the monitoring will be to differentiate between these impacts. Natural variations in vegetation health can be caused by:

– 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 south-west 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;

– 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;

- 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);

- 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;

- 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 which will differentiate between natural impacts versus water shadow impacts resulting from FMG's Project. To arrive at a suitable methodology the following reasoning has been applied (Table 4).

Table 4: 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
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

METHODOLOGICAL APPROACH	**ISSUES ADDRESSED**	**REASONING**
Transects	Changes to surface hydrology	Surface hydrology impacts can change both across contour, such as might occur in the shadow below a track which 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
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

METHODOLOGICAL APPROACH	ISSUES ADDRESSED	REASONING
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 infra-red 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, the methodology of vegetation health monitoring will use as many control sites as is practical, as well as several potential impact sites. The program will use numerous individual plants of more than one species. Transects will be used wherever possible, preferably in pairs at right angles across and along the contour. Health rating will be the primary measurement taken, complemented by average foliage density measurements.

Data collected to supplement the health information will include canopy size, plant height and stem diameter on large plants. Photographic monitoring using normal colour will record the features of transects, and notes will be taken on aspects of each plant or group of plants to assist in interpretation of results.

FMG will finalise the Monitoring Program to the satisfaction of CALM prior to the commencement of construction. The commitments table located in Section 10 has been updated to include this.

5.4.42

(SUB8)

Borrow pit construction*: concerned over the whole process for borrow pit selection and feel that this information, proposed sites etc should have been made available at the time of considering this proposal. There is not enough information available in the area in which the Project will be conducted to ensure that the borrow pits sites will be selected appropriately considering all the issues associated with surface flows, flora & fauna and rock art/culturally significant areas. The geotechnical studies results should have been available* *for consideration. Want as a priority minimised disturbance to significant vegetation, faunal habitats, surface flows and cultural areas (in no particular order of priority). Not sure what is meant by "the borrow pits will be left as free-draining where practicable" and it is envisioned that they will be rehabilitated after use has expired.*

Final locations of borrow pits will consider significant flora and fauna habitats, cultural heritage areas and surface water flows. As stated in Section 6.4.1.2 (page 131) and also Section 6.3.1.2 (page 125) of the Stage B PER. FMG will conduct further flora and fauna surveys in areas not covered by the previous surveys. A clearing permit system will be developed as part of the Environmental Management System. Key points of the clearing permit are listed as follows:

- ensure minimum amount of land required is cleared by delineation of boundaries prior to clearing;
- ground truthing by Environmental Staff prior to clearing to ensure priority species (flora and fauna) are avoided where practicable.
- ensure aboriginal heritage clearance is received prior to clearing ;
- ensure that topsoil is appropriately stored for future rehabilitation;
- ensure all disturbance is adequately documented; and
- a post clearing inspection is carried out to ensure over clearing has not occurred and procedures have been followed.

Even though FMG will rehabilitate borrow pits after they are no longer used, the material extracted for gravel will generally be greater than that available for rehabilitation (topsoil). As a result of this, the rehabilitated will generally have a slight depression in which water can pool. This pooling can prevent vegetation from re-establishing. Free draining borrow pits are essentially designed so water does not pool in the bottom. FMG will aim to design free draining borrow pits, where possible.

5.5 Groundwater

5.5.1

(SUB6,8)

Capacity of proposed borefield*: there are significant concerns relating to the capacity of the targeted aquifer to supply the large amount of water required for this Project. FMG should provide a full hydrogeological investigation and an environmental impact assessment into the alternative borefields identified in the PER. A very significant water source is essential to this Project and as such the Project should not be assessed until this water source and impacts on its extraction are identified so that the Projects total environmental impact* *can be assessed. It is recommended that FMG commence the further work outlined in the Aquaterra report on pages 41-43 before this Project is assessed by the EPA.*

Since submission of the PER report, FMG has undertaken additional water exploration drilling within the area of the proposed borefield and test pumping has been undertaken on five bores to improve the understanding of the hydrogeology of the area. This data has been used to upgrade the numerical groundwater model and provide more robust estimates of the yield of the borefield. Sensitivity analysis has also been undertaken which shows that, within a range of reasonable estimates of rainfall and aquifer properties, the borefield will be able to supply sufficient water. Section 3.1 details additional hydrogeological work undertaken since the release of the Stage B PER and a supplementary report is included as Appendix A.

FMG have developed a Borefield Management Plan (Appendix G of the Stage B PER) which details a contingency process in event that the proposed borefield has an unacceptable impact.

5.5.2

(SUB6)

***Alternative borefield**: the proposed bore field may not be adequate for the mining proposal. FMG has identified an alternative site to the South East of Fortescue Marsh. If this borefield is utilised there is an understanding that impacts to the marsh could occur. A full hydrogeological report on this location should be provided and not managed at a later date by the North West Region under RIWI or EP Act Part V.*

FMG recognises the importance of an adequate water supply to the Project. Recent investigations carried out since the release of the PER confirms that the proposed borefield is capable of producing a sustainable water supply for the Project. A contingency borefield would only need to be developed in the unlikely event that ongoing monitoring during the operation shows unexpected impacts. Additionally, FMG have developed a Borefield Management Plan which details a contingency hierarchy which will be implemented should the borefield be found to cause unacceptable environmental impacts. FMG have also committed to further investigation into a least one contingency borefield, prior to commissioning of the Project Borefield.

5.5.3

(SUB6,8)

***Potential impact on groundwater dependent vegetation**: the draw down of the water table in the proposed borefield is identified to likely cause stress to E. victrix in the Mt. Lewin Project area (p108). The proponent proposes that, if a major impact is identified by the proposed monitoring program, the proposed borefield management plan will be able to manage the impacts. However, Section 6.2.3.2 outlines the proposed management plan and states that measures are likely only to include monitoring and relocation of the borefield. The proponent should further outline ways to minimise the potential impact to these ecosystems through management techniques or provide complete hydrogeological details of the alternate bore fields that will be required to minimise the impact on the identified ecosystem.*

To ensure impacts are monitored potential impact of phreatophytic vegetation assessed as part of the Stage B PER and found to be low (refer to Stage B PER, Appendix J). FMG has commenced a detailed groundwater monitoring programme, which includes measurements of groundwater levels. The network of monitoring bores will be extended once the Project has received approval. Additionally a vegetation monitoring program has been developed and included in the Borefield Management Plan.

The groundwater monitoring data will be used to continually validate the information used in the numerical groundwater model. If necessary the model will be updated and recalibrated accordingly.

In the unlikely event that the cone of depression from the abstraction is shown to be extending towards communities of phreatohytes and likely to cause unacceptable impacts, then the model will firstly be used to determine if changes to the abstraction regime (e.g. reducing abstraction in some bores and increasing it in others) will mitigate the impact. If that is not possible, then FMG has committed in the PER to undertaking trials in which alternative irrigation methods will be tested. If successful, then these irrigation techniques will be used to prevent stress to susceptible communities.

Ultimately in the unlikely event that ongoing monitoring during the operation of the borefield, predicts unacceptable impacts, a contingency borefield would be developed (refer also to response 5.4.2).

5.5.4 (SUB6) ***Weeli Wolli groundwater system**: the estimated 4% decline in the Weeli Wolli groundwater system (Appendix G) does not include the predicted impact from the proposed Hope Downs Project. As such, the proponent does not identify the total possible cumulative environmental impact of water extraction from the Weeli Wolli system. Both scenarios (HDMS development and non-development) should be modelled to ensure appropriate management practices can be identified.*

FMG understands from the Hope Downs PER that a number of alternatives are being considered to mitigate against the impacts of the Hope Downs Project on flows at the Weeli Wolli Springs. These springs occur upstream of the Mindy Mindy mine.

The proposed mitigations measures out lined in the HDMS PER will not result in a reduction of base flow in the Weeli Wolli Creek. FMG understands that therefore there are no cumulative effects

5.5.5 (SUB8) ***Mindy Mindy**: need to conduct formal investigation and then monitor take from alluvial deposits as proposed for Mindy Mindy.*

FMG recognises that it will need to undertake additional hydrogeological investigations at Mindy Mindy before the DoE will issue abstraction licences. FMG will carry this work prior to the application of any ground water licences. FMG has already commenced monitoring of groundwater levels at Mindy Mindy and will report the data to the DoE annually.

5.5.6 (SUB8) ***Evaporation**: may need to look at creative ways to minimise evaporation, such as use of covers etc, particularly around the beneficiation plant.*

FMG agrees that the expected evaporation losses are substantial. Significant cost savings for can be made if water consumption is reduced and hence FMG is actively seeking to reduce evaporation losses from surface water storage areas by whatever means are available. Measures which FMG are investigating to reduce evaporation include but are not limited to:

- paste thickeners; and
- covers over process ponds.

5.5.7 (SUB8) ***Saline water****: we have concerns over the level of rise of saline water at Christmas Creek Mine site, particularly with the expected 10m of saline water uprising and there are concerns that the saline water at 20m or less below the surface, while it may have no risk of coming into the actual pit, there are concerns about the vegetation community that may have roots down to that level that could be effected. Would like to ensure that there is monitoring bores to ensure that the saline water rise is monitored but that it is kept at a level that will not negatively effect the above lying vegetation. Would like to ensure that in no circumstances is saline water abstracted. Needs to be monitoring systems in place to ensure that this is not the case.*

FMG recognised the risk of saline upconing in the vicinity of the pit at Christmas Creek in the Stage B PER, this issue was investigated and the risk was found to be low. In view of this FMG has already commenced a programme of monitoring from a series of bores drilled between the proposed pit and the Fortescue Marsh. This monitoring consists of monthly water level measurements and field measurements of the salinity of the water in the bores. Furthermore, water quality samples are being taken quarterly from the same bores and tested for a range of analytes. The salinity profile of each bore is planned to be tested using standard geophysical techniques to give FMG further understanding of the saline water in the area. This monitoring will continue throughout the life of the Project and will provide a detailed understanding of the movement of saline water and its potential to impact on vegetation.

FMG has also completed a series of pumping tests to improve its understanding of the likelihood of saline water up-coning. The results will be used to confirm the analysis undertaken for the PER report and is discussed further in Section 3.1.

FMG recognises that abstraction of saline water would be difficult to manage and expensive to its operation and commits to undertake every reasonable step to ensure that saline water is not abstracted during dewatering.

5.6 Vegetation

5.6.1 (SUB12) ***Avoidance of significant vegetation****: the action by FMG to realign the rail between Mt Lewin and Mt Nicholas in an attempt to avoid the mulga community of 'very high significance' described as Fa10 by Biota is commendable, but little appears to have been done to avoid impacts to the other seven mulga community types identified as having 'high significance'.*

FMG rail will no longer extend further than the Christmas Creek mine.

5.6.2

(SUB12)

Extent of impacts: CALM acknowledges that some impacts will only be minor in comparison to the extent of the community type, in other instances it appears that almost all of the community as mapped will be impacted. A case in point is community Fa27 in the Mt Nicholas area. It appears that conceptual pit developments and the mining operations will impact all of this community, although this is hard to verify given the scale of mapping provided in the PER. to clarify the impacts of this Project on the seven significant mulga community types, FMG should submit a matrix documenting the extent of each community within the footprint of the Project area, and the actual area of these communities that will be impacted both by the mining operation and related infrastructure including the rail development. CALM requests that Biota clarify advice on the likely distribution of the abovementioned communities outside the Project area. From information presented in Appendix J (pg 62), it appears that all seven mulga community types are restricted to the greater Fortescue Marsh area.

The impact of the Project on each vegetation type mapped by Biota is documented in a table which is included in the PER as an attachment to Appendix J. While it would be relatively simple to determine the relative proportion of each community mapped within the Project area that is disturbed as a result of the Project, this would not provide a meaningful result as the survey was conducted in areas proposed to be disturbed. A matrix showing this information would simply show that the survey effort has been adequately representative of the areas to be disturbed, but would give no information on the distribution of vegetation communities outside the disturbance area, which is required to adequately assess impact. It is far more meaningful as subsequently suggested by CALM, to attempt to clarify the likely distribution of vegetation communities to be disturbed, outside the Project area and calculate proportions of these representative total communities to be disturbed.

In relation to the specific example given, 59% of community Fa27 surveyed by Biota, would be impacted by the FMG Project – however this figure gives no recognition of the occurrence of Fa27 outside of the Biota survey area.

FMG has predicted the extent of similar mulga communities outside the Project area, within the Chichester Range footslopes, in the Stage B PER using land systems as a vegetation surrogate (Section 6.3.1, pg 124, Stage B PER). This analysis showed that there is approximately 164,100 ha of Mulga containing land systems within the Chichester Ranges footslopes. It is likely that these land systems contain similar mulga communities as within the Project area, because they occur in the same geophysical environment (i.e. the footslopes of the Ranges). When FMG's proposed clearing of Mulga land systems is compared with this total area the impact is relatively small:

- 0.07% of Mulga containing land systems for the East-West rail; and
- 2.1% of Mulga containing land systems for the Mine Sites.

5.6.3 (SUB12) ***Limitation of clearing****: FMG should extend the commitment to minimise clearing to all vegetation types, not just those specific areas identified as having higher conservation significance. FMG must commit to and detail how they will limit the clearing envelope to as narrow a corridor as possible across this landform. FMG should also make use of existing access roads and already disturbed areas adjacent to lay down sites in this area to minimise impacts on the Marsh and its surrounds.*

Clearing for the railway line will typically be limited to a 40 m corridor plus areas for borrow pits and laydown areas (see page 122, Stage B PER). Clearing for mining, while substantial, is required for access to the ore bodies and for establishment of the required infrastructure. The majority of areas disturbed by the Project will require rehabilitation. All rehabilitation will be required to meet completion criteria developed in consultation with, and approved by, the State Government. In addition to maintaining the values of native vegetation wherever possible, FMG will seek to minimise its future rehabilitation liability by minimising clearing to that absolutely necessary. FMG has a strong incentive to limit clearing wherever possible due to the operational costs associated with both clearing and rehabilitation.

5.6.4 (SUB12) ***Use of matrix****: the matrix presented by Biota to assess the conservation significance of vegetation associations is novel and warrants further development and refinement in consultation with CALM. CALM seeks more information in regard to the matrix used to assess the conservation significance of vegetation associations.*

Refer to response 5.4.29.

5.6.5 (SUB8,9) ***Land clearing****: the amount of clearing associated with the proposed new mines is disturbing. We note that up to 1,600 ha will be lost during construction of the railway although no doubt this vastly underestimates matters after hydrological impacts have been taken into consideration. The PER estimates the total clearing associated with the mine sites and railway at over 17,000 hectares. We note that this estimate has not been independently verified and that the areas have not been the subject of multi-year, detailed, and independent surveys.*

FMG will make every effort to limit clearing to that absolutely necessary for the Project. As part of the recent project reviews, the amount of vegetation cleared during construction has fallen to 1 200ha and the total clearing associated with the mine sites and railway is 10 927 ha. Furthermore, FMG will be required to survey and report on areas cleared, and progress towards rehabilitation, in annual reports to the DoIR and DoE.

With regard to “multi-year, detailed and independent surveys”, FMG has conducted detailed investigations into the likely environmental impacts of the Project including vegetation surveys as detailed in Appendix J of the Stage B PER. These are detailed in the Stage B PER with the results of further investigations included in this report. The scope of the studies conducted were outlined in the Project’s scoping document and have been undertaken in a manner consistent with guidelines issued under the *Environmental Protection Act (1986)*, in particular the Environmental Protection Authority (2002) Guide to Preparing an Environmental Scoping Document. EPA, June 2002.

5.6.6 (SUB8) ***Clearing for access roads****: access roads will be constructed to link Project areas – mention of roads and conveyors - want an emphasis on the method that causes the least environmental impact for linking the required areas (mentioned for getting material to crushing and screening and beneficiation and to N/S railway).*

The approach taken to clearing for access roads will be the same as that observed for the rail line and the mining areas. That is, clearing will be limited to what is necessary to establish functional access roads and where required, conveyor corridors.

5.6.7 (SUB3) ***Impacts of railway****: the impacts of the railway on vegetation are such that it can be seen as an environmentally unacceptable Project. It will also have a major impact on Geoheritage values and these have not been considered in the PER.*

See responses 5.1.1 and 5.4.35

5.6.8 (SUB3) ***Vegetation types of conservation significance****: these are outlined on p34-35 and we believe the impact of the Project is too high on these areas and the proponent has not demonstrated how these can be managed satisfactorily.*

Refer to response 5.6.3, the impact on various vegetation types was given in the Stage B PER as attachment to Appendix J.

5.6.9 (SUB6,8) ***Vegetation types of conservation significance****: we note that several vegetation types within the proposed mining areas have been identified as being of restricted occurrence or otherwise significant. A vegetation action plan is required to ensure that such vegetation will not be threatened in the long term.*

As described in the Stage B PER, significant vegetation types will be avoided where possible, refer also to response 5.6.3.

5.7 Weed Management

5.7.1 (SUB12) ***Ruby dock****: FMG must commit to the total eradication of the weed Ruby Dock from all operational areas within all mines and along all infrastructure (including rail) corridors. FMG has indicated they will develop a weed management plan for the Project and this plan needs to be to the satisfaction of CALM.*

FMG acknowledges that ruby dock is a serious environmental weed. Specific consideration of declared and environmental weeds such ruby dock and how it may be controlled has been included in the draft Weed Management Plan. The draft Plan includes provision for baseline surveys of weed infestations, establishment and maintenance of a weed register (locations of infestations, details of control methods used, monitoring results), and reporting on the results achieved. The draft Plan also commits to consultation with relevant stakeholders prior to its implementation, including CALM.

5.7.2 (SUB12) ***Ruby dock****: the proponent must commit to, and require potential contractors to, source ballast and rock armour from quarries free of Ruby Dock. In the long term it may be preferable to develop 'greenfield' quarries if the only operating quarries and sources for ballast have significant Ruby Dock infestations, although this may not be the most favourable option in the short term.*

FMG is aware of the risk of inadvertent transport of ruby dock seed and other weed seed within construction materials, machinery and vehicles. FMG's weed management plan will include procedures for the prevention of introduction of new weed species to Project area, by specific hygiene measures. It will be stipulated in all contracts that ballast must be from "weed free" quarries.

5.7.3 (SUB12) ***Control of new weed outbreaks****: FMG must commit to the effective control and eradication of new out breaks of Ruby Dock (Acetosa vesicaria) and Verano Stylo (Stylosanthes hamata).*

Management of new outbreaks of weeds will be managed in accordance with the draft Weed Management Plan. FMG will aim to control and eradicate new outbreaks of weeds within the Project area. FMG have also committed to reducing existing weed infestations as part of its offset program (refer to Section 4.1.2).

5.8 Terrestrial Fauna

5.8.1 (SUB8) ***Loss of habitat****: concern over the significant disturbance caused by clearing will have on some fauna habitats.*

As described in the Stage B PER fauna habitat reconstruction will be a key component of FMG's Rehabilitation and Revegetation Management Plan, refer also to response 0.

5.8.2 (SUB1) ***Adequacy of survey****: the lack of an adequate range of traps types being used, inappropriate surveying period and the low trapping effort employed for*

> *this series of surveys for the size of the area and the number of biotopes surveyed has yielded an incomplete species list and an inability to assess relative abundance even for common species. No account has been made for temporal variations. Data presented in this report are therefore almost useless as 'baseline' information to assess disturbance impacts at a later date.*

As clearly noted in Biota (2005), trap types used included 20 bucket pit traps, PVC tube pit traps, funnel traps and Elliott traps. This is considered to be a standard range of trap types to employ on a fauna survey for environmental impact assessment. The sampling effort, comprising 36 grids and 2,000 pit nights, was also supplemented by non-systematic methods to detect species other species not sampled by these trapping methods.

Sampling on the scale of this survey on a seasonal and annually ongoing basis would never produce a complete species list. In fact, a complete species is not possible to obtain as the fauna assemblage occurring in any given area is constantly changing. Surveys can only obtain a list of the species that occur in that area at that point in time. However, the data indicates that the number of species recorded (178 vertebrate taxa) is typical for survey of this length in this bioregion, and that the survey was not conducted in an "*inappropriate surveying period*".

Biota recognises that it would be inadvisable to use their data as a baseline to statistically analyse disturbance impacts at a later date. As this submitter would be aware, this would need to be the subject of a specifically designed and power-tested monitoring programme. However, the primary purpose of the survey in question was to provide EPA with data of suitable quality, and based on consistent methodology, to enable a judgement to be made on fauna impacts presented by the Project. We believe that this requirement has been met, in addition to providing a baseline inventory of species occurring within the Project area.

5.8.3 (SUB6) ***Adequacy of survey**: the impact of the loss of vegetation on fauna communities has not been the subject of multi-year, independent studies.*

With regard to "multi-year, detailed and independent surveys", FMG has conducted detailed investigations into the likely environmental impacts of the Project on fauna. These are detailed in the Stage B PER with the results of further investigations into stygofauna included in this report. The scope of the studies conducted were outlined in the Project's scoping document and have been undertaken in a manner consistent with guidelines issued under the *Environmental Protection Act (1986)*, in particular Environmental Protection Authority (2002) Guide to Preparing an Environmental Scoping Document. EPA, June 2002.

5.8.4 (SUB1) ***Identification of major habitat types****: the consultant points out that habitat diversity in the Project area is high. But it is not clear from reading the report how many major habitat types, from a faunal perspective, the consultant believes are in the area and should be surveyed. It is therefore important that the major habitat types are clearly defined and each is adequately surveyed. The methods Section (see Appendix K of PER) should have clearly indicated the surveying effort in each of these biotopes, and the results and discussion Sections should have reported the faunal assemblages in each of these major biotopes. This has not been done.*

There is an extended discussion in Biota (2005) relating to the various habitat types present in the study area. This gives consideration to habitat diversity at the bioregion, sub-bioregion, land system and vegetation type scales. Table 3.3 of Biota (2005) provides the detail of the trapping sites within each of the defined vegetation and landform types and Table 3.4 relates these units to the wider scale land system mapping to enable these to be placed into broader context. As noted in response 0, there is a large amount of detail provided for each fauna species in terms of the habitat type it was recorded from in the annotated lists.

5.8.5 (SUB1) ***Timing of survey****: data for the Abydos Plain in the north-eastern Pilbara and for Ora Banda in the Goldfields clearly indicate that fauna surveys undertaken in June and July are unlikely to catch most of the reptiles, and will catch a lower number of mammals than surveys undertaken in spring or summer. Even data from a March–April survey is likely to be significantly different to that caught in spring or summer. The timing of these surveys was inappropriate.*

Biota’s experience in the Pilbara does not support the statement made by this submission. Data from surveys in June/July, particularly when supplemented with non-trapping techniques, find as many animals as surveys at other times of the year. In support of this statement the survey found 42 species of reptiles and 23 species of non-volant mammals. Surveys of the Hamersley Range Extension to the Hope Downs rail corridor (Biota 2004a) were conducted in April but recorded only 31 species of reptile and 11 species of non-volant mammals while the survey of the Chichester Range addition to the Hope Downs rail corridor was conducted in early May and recorded 47 species of reptile and 11 species of non-volant mammals. Informal discussions with Ric How at the WA Museum and other biological surveyors who have experience in the Pilbara indicate that surveys conducted in June/July are not less likely to capture reptile and mammal species than surveys conducted at other times of the year.

Biota considers trapping is only one component of a biological survey. In fact, non-systematic trapping methods such as microhabitat searching are much more effective during the cooler temperatures of June/July than during the hotter months when reptiles are too quick to be easily caught by hand.

5.8.6 (SUB1) ***Site selection****: the report indicates that systematic sampling was undertaken in areas of potential high biodiversity, and in restricted habitats or habitats thought likely to support rare species, but the authors provided no indication on what basis these judgements made or the criteria that were used.*

The habitat interpretations and judgements were based on the extensive experience of the Biota survey team, in particular Mr Roy Teale and Mr Greg Harold, who have more than 40 years' combined survey experience in the Pilbara region. This has included systematic sampling of hundreds of sites in dozens of habitats throughout the Pilbara. Based on this experience, it is easy to identify habitats that are likely to harbour a distinctive fauna (e.g. cracking clay sites) as well as "new" juxtapositions of habitats that may harbour distinctive species (e.g. mulga over cracking clay, Grevillea/Acacia low shrublands). It was through the identification of such distinctive "new" habitats that a potential new species of *Ctenotus* (*aff. uber johnstoneii)* was identified from *Acacia xiphophylla* over chenopods during the Hope Downs rail corridor surveys.

5.8.7 (SUB1) ***Trapping effort****: a total trapping effort of 1,960 pit-trap night, 400 Elliot trap nights and 70 funnel-trap nights spread across four mine sites, each with more than one biotope and a linear corridor 160 km long that transects multiple biotopes is grossly inadequate to provide an indication of species richness and relative abundance. Such a survey effort would have recorded less than 50% of the reptile species in a biotope, even if the survey was undertaken during the appropriate season.*

A single survey will never record all reptile species that may occur in a study area and this is a well recognised limitation. Consideration must be given to other components of the survey and surveys should not just focus purely on trap efforts. The report outlines a range of supplementary methods used to detect terrestrial vertebrate species in Project area, including searching specific microhabitats and spotlighting. These methods supplement surveys for impact assessment when Project and logistical constraints dictate that a five year seasonal study cannot be completed.

The report also drew on data collected from previous surveys in contiguous areas to supplement the data from this survey. For example, several grids from previous surveys (Weeli Wolli Springs and Hope Downs Rail Corridor) were actually located within or adjacent to the Mindy Mindy orebody. Data collected during previous surveys from habitats that were the same as those in the study area were also used to supplement the current assessment.

It is well recognised that even after 10,000 trap nights species lists are rarely complete due to the rarity of some species and the fact that others are never or almost never caught in traps. It is not clear how many traps nights would be required to achieve this in the Pilbara and there is likely to be no ‘true’ value, as the number of animals trapped will depend in climatic and meteorological conditions as well as stochastic effects. It is considered to be impossible to predict how many trap nights would be required to get a ‘full’ species list.

5.8.8 (SUB1) ***Details of trapping protocols****: no indication is provided in the methods Section on the details of the trapping protocols used (e.g. what were pit-traps made of, were drift fences used, what was the configuration of the trapping arrays). Funnel traps have a propensity to catch reptile species not generally caught in pit-traps, Elliott and wire cage traps. But to be useful, they need to be employed on a similar basis to funnel traps. The token 10 funnel traps used in this survey is inadequate. As a consequence, snakes, pygopods, and even the widely-foraging, fast moving skinks would have been significant under sampled.*

Information on the trapping protocols used is included in Biota (2004a and b) and was not included in this report because it was felt that the few people interested in these details could refer to the earlier reports. The details are provided here:

“Each site was located within a defined habitat with sites…..consisting of a row of 10 pitfall traps, spaced at approximately 10 m intervals and connected with a single length of flywire fence. Pitfall traps alternated between 20 l buckets and 60 cm deep PVC tubes with five of each pit type on each line. The PVC tubes contained inserts that allowed for easy retrieval of all specimens."

It is indicated in this submission that the number of funnel traps used is inadequate and that "As a consequence, snakes, pygopods, and even the widely-foraging, fast moving skinks would have been significantly under sampled". However, as discussed previously Biota used a wide range of sampling techniques to detect species not captured using traditional trapping methods. The tally of six species of pygopodids and nine species of Ctenotus indicates that most species in this group were detected and that these groups would have been adequately sampled.

5.8.9 (SUB1) ***Avifauna surveys****: there is inadequate information contained in the methods to assess the adequacy of the protocols used to assess the avifauna (e.g. were transects used, what was the experience of the observers). I also note that many of the surveys were conducted during the middle of the day when a number of the bird species are likely to be inactive. For some sites, all the surveys were conducted during the middle of the day. A more complete bird species list might have been obtained by undertaking some of these surveys either early in the morning or just before sunset.*

On Page 27 of Appendix K of the PER it states that:

"The avifauna of the FMG Stage B rail corridor and mine areas was sampled using a combination of techniques, which included:

- *unbounded area searches conducted at most of the systematic sampling grids;*
- *unbounded area searches conducted at opportunistic locations containing habitats or microhabitats likely to support previously unrecorded species; and*
- *opportunistic observation of birds recorded while driving around the study area."*

We believe that this information should be more than adequate to assess the protocols used to assess avifauna. The avifauna surveys were conducted by Dr Mike Craig and Mr Roy Teale from Biota. Dr Craig has been observing birds for over 25 years and has conducted numerous surveys of the Pilbara avifauna over the last 12 years. Mr Teale has been observing birds for over 15 years and has conducted a large number of surveys of the

Pilbara avifauna over the last 12 years. Both observers would be able to accurately identify all Pilbara birds by sight and would be able to accurately identify all birds by sound, except for rare or vagrant species. They are familiar with the calls of all Schedule and Priority listed fauna so that should not be any issues with the experience of the observers.

This submission also indicated that "*many of the surveys were conducted during the middle of the day*" and that they had concerns that this may have lead to some birds being missed. During the survey of the Mindy Mindy orebody, in March/April, temperatures were higher and so the order of bird surveys was randomised to ensure that all sites were surveyed early in the morning. During the second trip carried out in June/July ambient temperatures were much lower, and bird activity remained relatively much higher throughout the day, so it was not deemed critical to randomise the order of bird surveys to such an extent. In fact, overnight temperatures were so low that bird activity was often suppressed during the first hour after sunrise (usually the time of greatest activity in warmer temperatures), so surveys in mid-morning often recorded as many, if not more birds, than those conducted early in the morning.

It is further noted in this submission that "*A more complete bird species list might have been obtained by undertaking some of these surveys either early in the morning or just before sunset.*" Due to low ambient temperatures, bird surveys during the middle of the day often recorded as many bird species as those early in the morning. Sites that were considered likely to hold a wide variety of species, or that were most likely to support Schedule or Priority fauna, were surveyed at least once early in the morning. In a survey the size of FMG B, it will be logistically impossible to survey all sites early in the morning and, by continuing surveys into the middle of the day, it is only increasing the chances of detecting more bird species and, therefore, any Schedule or Priority species. Some sites were only surveyed once because they were considered likely to support a specific species that had not been previously recorded. For example, one site (FMNMC001) was surveyed because it was considered likely to support Striated Grass-Wrens, which had not previously recorded in the eastern orebodies and rail corridor, but was unlikely to support any other unrecorded species. Therefore, when Biota's first survey detected this species, the site was not sampled again.

We consider that we recorded all species likely to occur except some rare or vagrant species (e.g. Square-tailed Kite and Grey Falcon). However, these species occur so rarely that even seasonal surveys spread over many years may not be sufficient to detect them.

Therefore, Biota has used their knowledge of these species' habitat preferences to assess the likelihood of their occurrence in the study area.

5.8.10 (SUB1) ***Location of trapping grids**: the report indicates that the location of trapping grids were representative of the range of 'units' within the corridor. This conclusion is not supported by the data presented in Table 3.4 (Appendix K of the PER).*

Based on Biota's extensive experience, it would not be necessary to place trapping grids in all the units in order to adequately sample the fauna of the corridor. Obviously the more grids, the more likely one is to catch species but there are logistical constraints on the number of grids that can be installed and checked as well as ethical constraints so that animals are not sitting in traps too long before they are removed. Given these logistical constraints, it is necessary to place trapping grids in those landscape units that are most likely to contain new species or distinctive faunal elements rather than every landscape unit. Some landscape units may differ only in their position in the landscape or in minor floral component in their understorey from other units and so there is no reason to suppose, based on Biota's experience, that they will contain unique faunal elements. The sampling was representative of the range of units present in the corridor.

5.8.10 (SUB1) ***Use of annotated lists:** annotated lists, although adding considerable bulk to the report, make a very limited contribution to addressing the primary purpose of terrestrial fauna surveys as required by the EPA. Mostly, the annotated lists indicate that the trapping effort was inadequate to catch species likely to be the area. These lists could be deleted with no loss of useful information.*

The annotated lists provide a summation of the habitat preferences of each species within the study area and also provide other fauna specialists reading the document with useful insights into records of any given species. Biota considers annotated lists are an important part of the fauna report. This format has been followed for benchmark regional scale surveys completed by the both the WA Museum and CALM.

5.8.11 (SUB1) ***Adequacy of habitat sampling**: averaged species accumulation curves should have been presented for each of the habitat types sampled so that the reader has an appreciation of how well the habitats were sampled. There is no commentary on the adequacy of the trapping effort in the report.*

Averaged species accumulation curves are a useful measure of sampling adequacy, but they are only one measure of the adequacy of a fauna survey. There are many other non-systematic sampling methods available that do not lend themselves to such evaluation, but significantly affect the adequacy of surveys in documenting the fauna of a given study area.

It is acknowledged that there are species present in the corridor which were not captured in traps and which is why non-systematic means were employed to supplement the trapping component. As already noted in Response 0 and 0 the number of taxa recorded during the survey was comparable to other recent Pilbara surveys of a similar scale, supporting the adequacy of the survey.

5.8.13 (SUB1) ***Overall fauna conservation value****: the comparison is based on surveys undertaken at different times using different trapping efforts. This analysis is both simplistic and inadequate. The web site http://science.calm.wa.gov.au/Projects/pilbaradb/ claims to report on many terrestrial fauna surveys in the Pilbara. It therefore seems apparent that comparative data are available on the faunal assemblages of the Pilbara, but have not been accessed by the consultants.*

The comparison is basic, because the surveys were conducted using different trapping efforts and, to a lesser extent, at different times of the year. However, it adequately conveys the point that the vertebrate communities of the different study areas appears to be roughly comparable in terms of species diversity. Trapping effort will vary from survey to survey depending on the numbers of habitats present in a study area as well as the study area's spatial extent. Logistic and Project timetable constraints also deem that surveys will be conducted at different times of the year, as it is not possible to conduct all surveys at the same time during the optimum times of the year.

The website quoted does not appear to "*report on many terrestrial fauna surveys in the Pilbara.*" as suggested. Biota was instrumental in designing and populating the referred to site and it is a metadata database - no actual data from any Pilbara surveys is actually available on that website or anywhere else on the CALM website as implied above. The data collected in previous surveys from spatially contiguous areas is more relevant, and this was referred to in the report.

5.8.14 (SUB1) ***Threatened Fauna Statutory Framework**: Given the inadequate survey effort, comments under the heading 'Likelihood of occurrence' in relation to Priority Five fauna is not very convincing.*

As far as FMG are aware, there are no "Priority Five" fauna listed under the *Wildlife Conservation Act 1950-1979*; there are only the categories Priority One to Four. It is not exactly clear what this submission is referring to, but it is assumed that they are referring to the likelihood of occurrence sub-sections in Section 6.0 of Appendix K of the Stage B PER. Unless the species was actually recorded, these appraisals are not based on the survey effort at all. The likelihood of these other species occurring is based on the amassed knowledge of the distribution and habitat preferences of species gained through over 15 years of conducting biological surveys in the Pilbara. This was then supplemented by database searches and liaison with relevant specialists. For example, bat roosting sites are quite specific (Dr Kyle Armstrong, pers. comm. and associated publications) so reasonable predictions can be made about how likely a particular species is to roost in the study area based on the geology of the area.

5.8.15 (SUB1) ***Faunal assemblages**: Sections 7.1.1 to 7.1.13 of the PER are only useful to the reader in understanding the faunal assemblages and the possible impact of the proposed disturbance, **IF** the assemblage data are presented in this format, which they are not. This is a very serious shortcoming of this evaluation. It also means the primary objective of this report, from an EPA perspective, has not been achieved. The third paragraph on page 141 suggests the Fortescue Valley could contain faunal assemblages of conservation significance, but no data are provided to support or refute this idea. The next paragraph indicates the cracking clay vegetation types correspond to the most readily identifiable faunal assemblages. Maybe so, but where are the supporting data?*

Biota do not believe that it is necessary to obtain a complete species lists for each site and the relative abundance of species (which is not feasible as discussed above) in order to assess the significance of each habitat type. It is well recognised that different habitats will be important to different groups. For example, among reptiles, sites with extensive *Triodia* will support a much greater species richness and abundance of reptiles than sites that lack this genus. In addition, mulga sites will have a high proportion of species not found in other habitats and creeklines invaded with *Cenchrus* will have a depauperate fauna with mostly generalist species. Similarly with the birds, creeklines will have a high number of species with many unique ones, mulga will have a relatively high number of species also with many unique species, with *Triodia* hilltops will show a depauperate fauna with only a few species favouring that habitat. The results from surveys such as the FMG survey confirm this pattern, even within the limits of short-term studies. Therefore, Biota use their field experience and current theories in the literature to supplement species lists from each habitat to assess impacts of any proposed disturbance. It is believed that this holistic approach makes good use of already available data and is the most prudent way to assess any potential impacts, which we believe we have done adequately.

5.8.16 (SUB1) ***Vouchering of specimens****: One hundred and ninety four specimens were vouchered with the Western Australian Museum. The recently released Australian Code of Practice for the Care and Use of Animals for Scientific Purposes (7th Edition) in Section 5.8 suggests that only the minimum number of specimens should be taken for vouchering purposes, and reasons for their collection should be provided. Some readers could think the number of specimens taken was excessive given there is no justification for this number.*

The survey was conducted over a very large study area, extending over 100 kilometres from east to west, with a total of 36 trapping grids and several other sites where opportunistic collecting was undertaken. Even assuming that collection was only undertaken at trapping grids, the level of vouchering equated to less than 5.4 animals per trapping grid for all species combined. Considering the large number of taxonomic issues that remain to be resolved within the Pilbara's terrestrial vertebrate fauna, and the fact that most sites were several kilometres apart, most zoologists would not consider less than six animals vouchered per grid across all taxa excessive. If it is assumed that a species of each reptile, frog and non-volant mammal that was trapped (which was not the case) was collected, the level of vouchering equates to less than 0.1 animals per species per grid. Even if it is assumed that only half the species that were trapped were vouchered (Biota vouchered slightly more than half the species), the level of vouchering would still be minimal, (that is one animal from every species every five trapping grids). Biota does not consider this to be excessive.

5.8.17 (SUB1) ***Presentation of information****: Section 4.5.3 of the PER is inadequate and fails to provide information in a format that enables the reader to make a reasonable judgement on the extent to which the proposed disturbances will impact on biodiversity value at; a) the genetic, species, and ecosystem levels, and b) ecological functional value at the ecosystem level. Had the information been presented based on habitat types, then this may have been possible.*

Section 4.5.3 of the PER was intended as a summary of the key findings of the fauna studies. The fauna report presented in Appendix K of the Stage B PER provides a more detailed description of the biodiversity values. Section 6 of the fauna report outlines the conservation significance of fauna within the Project area at a species level, whilst Section 7 provides an assessment of habitat conservation significance which utilises the Land System framework and the vegetation types described for the FMG Stage B study area. The assessment of habitat conservation significance is linked to the species that may be present within these habitats.

5.8.18 (SUB1) ***Assessment of impacts on terrestrial fauna****: regarding Section 6.4 of the PER and given the inadequate assessment of the terrestrial fauna data, it is not possible to make a reasonable assessment of the potential impacts of the proposed disturbance on the terrestrial fauna. Any management strategies based on the available information must be considered suspect.*

FMG disagree with this comment, as Section 6.4 deals with both the generic fauna impacts that could be expected to occur for any similar development, and the specific impacts on restricted fauna habitats, and species of conservation significance. FMG draws the reader to the following excerpts from Section 6.4:

“The final design of the rail alignment, mine infrastructure and any related ground disturbing activities will aim to minimise or avoid any impacts on these (significant fauna) habitats where practicable. This particularly applies to the more discrete and isolated habitat units such as cracking clay formations” (pg. 130).

“Spinifex dominated habitat units are particularly susceptible to this type of physical damage (off-road driving) and can take extended periods to recover. Given the reliance of several fauna species of conservation significance on these habitats (including the Schedule 1 species the Mulgara Dasycercus cristicauda), strict on-site management will be implemented to ensure that such activities are controlled." (pg. 130/131)

"The Fortescue Marsh is recognised as providing an important wetland habitat, particularly for inland water birds when in flood…Whilst most birds known to use the Marsh are not true migrants listed under the EPBC Act 1999, there is a single confirmed breeding record for the Great Egret (Egretta alba) from the Fortescue Marsh which is a migratory species listed under the EPBC Act 1999…Any downstream reductions in hydrological input, or increases in sediment loads due to Project-induced scour and erosion, may impact on this regionally important wetland and water bird habitat. However, these risks have been assessed as low in the Stage B PER (see Section 6.1, page 132).

5.8.19 (SUB8) ***Study of fauna losses****: there is a need to ensure that actual and potential losses be studied, particularly in terms of impacts on Federally listed threatened fauna. There needs to be comprehensive consultation with not just CALM, but also Natural Resource Management Authorities (Rangelands NRM Group) and relevant tertiary institutions so that priority areas can be avoided and mutually agreed offsets determined and the necessary research conducted so that there are lessened unknowns when considering future proposals.*

In planning it's offset program FMG will consult with a range of academic advisors, expert consultants, CALM and other relevant regulatory agencies (such as NRM authorities) to identify gaps in the current knowledge.

5.8.20 (SUB8) ***Fauna movement****: need to ensure that studies take place to ensure that embankments are constructed so that they do not act as additional barriers to faunal movement and need to ensure that culverts are maintained and cleared all year round, not just during wet season to ensure that they can be used by small fauna to facilitate movement throughout the affected area. Concern about restrictions to fauna movement due to the effects of the three railway lines – BHPBIO, Hope Downs and FMG railway. Would like to see wherever possible that the distance between the three lines is minimal as possible so as to ensure that the effects of isolated/fragmented habitat is minimised. Also would like to see investigations into mechanisms that may facilitate faunal movement through the respective railway corridors.*

The key mechanisms to allow faunal movement across the FMG railway will be culverts and level crossings. Inspections of culverts and the railway will occur on a regular basis and especially after rainfall to ensure they are maintained and do not become blocked

Impacts as a result of three railways on faunal movement have been assessed as Part of Stage A and are not an element of the Stage B proposal, as there are currently no other railways proposed in the Stage B Project area. FMG have located the Stage A railway as close to the BHPBIO and the proposed HDMS railway as possible. FMG will also replicate and improve on culverts and level crossings of both BHPBIO and HDMS to facilitate faunal movement through the corridors.

5.8.21 (SUB12) ***Vouchering of fauna mortalities****: it is important that FMG recognises that appropriate identification and vouchering must occur for all specimens that may perish as a result of construction of the rail corridor (6.4.6.1 Potential Impacts, pg 134). FMG must forward all monitoring reports to the appropriate authorities, including CALM, to indicate whether there have been deaths of any significant species during construction of the rail corridor. This includes the appropriate identification and vouchering of these species.*

All fauna deaths resulting from the construction and operation of the Project will be recorded and results will be presented in the Annual Environmental Report. If any priority or scheduled fauna are identified, CALM will be informed, and where appropriate photographs will be taken of dead fauna to assist with identification. Vouchering of specimens may not be possible in all cases, however all attempts will be made to correctly identify species. FMG will develop a procedure which details the process to be used for identification of deceased fauna in consultation with CALM. Environmental awareness training will also have a component dedicated to fauna, and educational material provided will assist personnel to identify fauna species.

5.8.22 (SUB12) ***Management plans****: FMG should commit to prepare management plans for specific significant fauna (eg. Mulgara) in the event significant fauna are located during construction.*

Should significant fauna be identified within the Project footprint, FMG will prepare and implement a specific management plan for each species to ensure the potential impacts of the Project are minimised. This will be done in consultation with CALM. This process will form part of the construction and operation EMP's for the Project.

5.9 Stygofauna

5.9.1 (SUB8) ***Sampling frequency****: would like to see quarterly (as opposed to biannually) sampling plan be implemented for the presence of stygofauna in the groundwater in the Project areas for the first two years prior to Project commissioning and if encountered appropriate management actions to ensure that they are not threatened as a result of the take of water from the area. Also strongly support the continuation of stygofauna monitoring throughout the life of the Project.*

FMG are conducting biannual sampling, to look at seasonal (rainfall) variations on stygofauna populations and this sampling frequency is consistent with the approach employed by CALM. The initial background sampling will occur for a period of two years prior to borefield operations. As stygofauna populations have been identified in some of the monitoring bores (see Section 3.2), FMG have committed to preparing a management plan which covers management strategies and a continued sampling program during operations.

5.9.2 (SUB12) ***Likely habitat****: the proponent's statement that the Wittenoom Dolomite in the borefield contains occasional voids (4.4.2 Borefield, pg 30) is indicative of habitat for stygofauna. However, FMG has not identified such habitat under stygofauna management (4.5.4 Stygofauna pg 46). FMG also indicates that there will be significant drawdown in the borefield area and consequently there may be significant impacts on stygofauna inhabiting voids in the Wittenoom Dolomite.*

FMG is currently undertaking stygofauna sampling throughout the Project area, including within the area of the proposed borefield and also more regionally, the results of the sampling are summarised in Section 3.2. The purpose of the stygofauna monitoring programme is to determine if stygofauna are present within the area of the borefield and also more regionally.

Abstraction of groundwater via the borefield will result in a lowering of the groundwater table. However, the field work and numerical groundwater modelling indicates that most of the water will be obtained from the alluvial deposits that overlie the Wittenoom Dolomite. The drawdown within the borefield is not expected to be so great as extend to the dolomite, and it is therefore most unlikely that stygofauna habitats will be dewatered as a result of abstraction from the borefield.

FMG has committed to carry out a biannual monitoring program to detect stygofauna within borefield drawdown areas This initial background sampling will occur for a period of two years prior to borefield operations FMG will, on completion of the first phases of stygofauna monitoring, work with CALM to agree procedures for monitoring the impacts of the borefield abstraction if stygofauna is shown to be present.

5.9.3 (SUB12) ***Likely impacts****: FMG should provide evidence to substantiate the claim that such short-term abstractions will have little impact on stygofauna.*

Typically, it is expected that short-term perturbation as described above would 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. unlikely to lead to extinction of any species) (pers comm. Biota).

5.9.4 (SUB12) ***Commencement of dewatering****: it is the Department's understanding that FMG will not conduct any dewatering until appropriate stygofauna surveys and assessments have been completed. The purpose of these surveys is to identify any stygofauna, to species level, that may occur in the area of proposed impact from dewatering to the EPAs and CALM's satisfaction.*

FMG have recently commenced sampling for stygofauna in line with the Subterranean Fauna Management Plan included as Appendix M in the Stage B PER. FMG have committed to carrying out biannual sampling for a period of two years prior to borefield commencement. A long-term management and sampling plan will be developed in consultation with CALM if stygofauna are potentially impacted by borefield drawdowns. The results of the first round of sampling are discussed in Section 3.2.

5.10 Aboriginal Heritage

5.10.1 (SUB10) ***Approvals under s.18:*** *whilst the PER advises that the proponent is committed to avoiding disturbance of sites in the final design of the Project its advice to us would seem to indicate the contrary. Rather the proponent has* *indicated that it may seek approval under Section 18 of the Aboriginal Heritage Act 1972 to disturb all sites within the Project area whether they will be impacted upon or not.*

FMG has committed to minimising, as far as practicable, any disturbance to any Aboriginal Heritage sites. This process has been agreed within heritage protocols. It is acknowledged that it may not be possible to avoid disturbing all sites. For any site which requires to be disturbed a Section 18 application or applications under the *Aboriginal Heritage Act 1972* will be obtained. If required, this will be preceded by consultation with the traditional owners.

5.10.2 (SUB8) ***Rock art****: would like emphasis placed on the minimisation of negative effect on the rock art of the area.*

Refer to response 5.10.1.

5.11 Fire Management

5.11.1 (SUB12) ***Management plan****: FMG must commit to the development of a Fire Management Plan in consultation with, and agreed to by, CALM and FESA. The Fire Management Plan must be for the whole-of-life of the Project and not only for rail construction as appears to be the suggestion. The Fire Management Plan must also be active over the operational life of the Project including the rail maintenance activities, such as the welding of rail and track grinding.*

As stated in the Stage B PER (section 6.3.5, page 128). FMG will prepare and implement a Fire Management Plan. The plan will include work procedures for welding and grinding work, personnel fire procedures, fire response vehicles on site and bushfire contingency plans. The objective of the management measures will be to reduce the risk of unplanned fires and provide contingency measures to minimise any impact in the event that a fire is started. The Fire Management Plan will be updated on a regular basis and will be implemented for the life of the Project. FMG will consult with CALM and FESA during the development of the management plan.

5.11.2 (SUB12) ***Likely causes of fires****: the Fire Management Plan should acknowledge that the most frequent cause of ignitions along the rail will be from rail grinding and maintenance (welding) operations, and should implement management* *regimes to minimise such ignition sources as well as adequate control, via suppression, of any fires that do eventuate.*

Management of track maintenance and the fire risk associated with track grinding activities will be an important component of fire management. FMG will stipulate to rail maintenance contractors the following:

- spark shields are compulsory; and
- vehicles equipped with fire fighting equipment will be required to follow the track grinder in order to quickly stop any spot fires that may have started.

These requirements will be specified in all track maintenance contracts and have been included in the Fire Management Plan.

5.11.3 (SUB12) ***Natural bushfire events**: CALM seeks clarification on what the proponent means by the statement '…ensure natural bushfire events' under the objective Section of the Bushfire Management Plan.*

This is a typographical error and should read "prevent fires caused by FMG's construction activities and ensure FMG does not increase the frequency of natural bushfire events".

5.11.4 (SUB12) ***Wildfire management**: wildfire management will need to be addressed in the Fire Management Plan and strategies and protocols developed to limit the environmental impact of FMG's response to wildfires (eg firebreak installation). The management of the threat posed by bushfires needs to be discussed with CALM and FESA and the responses developed in agreement with CALM.*

Consideration of wildfires has been incorporated in the Fire Management Plan. It is recognised that wildfires in the Pilbara region have the potential to cover large tracts of land, for the purpose of assisting CALM, local Government and FESA in the control of major bushfires the following will be employed by FMG:

- a coordinated approach to bushfire control will be developed with relevant organisations (including CALM and FESA);
- fire breaks will be constructed as requested, under the supervision of CALM and local authorities, and in consultation with the pastoral lessee where appropriate; and
- suitable materials and equipment (water carts, earth moving machinery etc) will be made available to CALM and other relevant organisations. This equipment will be available for such measures as fire break construction, and the control and

management of bushfires in the surrounding region.

Consultation with CALM and FESA will be carried out prior to the implementation of the fire Management Plan.

5.12 Mining Method

5.12.1 (SUB8) ***Strip mining****: overall we are not supportive of the mining method being used – strip mining is a very high impact for low return form of mining and this is why the proposal has such a massive footprint. Even in the backfilling not only have to go to much effort to ensure that air voids are not left on backfilling, but also concerned about the return of rejects and slurry and the manner in which this will be returned. Need to ensure that it is returned in the right % composition to try as far as practically possible return the soil profile to what is was originally. Or else these additions if mismanaged have the potential to radically alter the soil profile/makeup and as such the organisms that will return to the area (both in soil and on top of soil).*

Strip mining is necessary due to the orebody type, which consists of a relatively shallow ore seam covering a large area. This mining method offers an opportunity to restore most of the pit areas to their original topography. If FMG manages topsoil, overburden and beneficiation rejects correctly, there is a reasonable expectation that many of the ecological values that existed previously can be returned, over time, to these areas. FMG agrees that reconstruction of the soil profile is a likely element in successful rehabilitation.

5.12.2 (SUB8) ***Backfilled pits****: need to ensure that all backfilled pit areas are such that they will drain to the downstream environment. Do not want pits being left with lower elevations that result in water pooling and not being able to drain downstream.*

During the mining process, FMG has proposed that the pit areas will all be progressively backfilled above the watertable. Upon completion of mining, if sufficient material is available, the pits will be backfilled such that a whole pit area can drain to the downstream environment. This would be achieved by backfilling the pit to a level above the lowest elevation on the pit perimeter and then ensuring that the finished pit surface is continuously draining to this area. The backfilled pit surface will be finished with a layer of fine grained material and topsoil prior to rehabilitation such that surface water runoff from the backfilled pit area will drain to the downstream environment. Some portions of the pits may be preferentially backfilled during the mining process, to enable upstream (external) surface water runoff to pass through the pit area, rather than be diverted around the pit footprint (within engineering safety constraints).

5.13 Site Water Management

5.13.1 (SUB8) ***Excess water from dewatering****: we are concerned about the management of excess water obtained from dewatering and are supportive of the Department of Environment being involved in the development of a suitable monitoring program. However we would like to see the program include provisions for management of sediment/turbidity & dissolved salts levels of such intercepted water and ensure that whatever disposal option is chosen that has minimal negative effect on the environment into which it is being discharged.*

The water requirements for the ore beneficiation plant far exceed the pit dewatering requirements and the work undertaken to date suggests that the abstracted water from the dewatering will be suitable for use in the beneficiation plant. Therefore it is envisaged that all the water from the dewatering will be used, thus negating the need to discharge it back to the environment.

5.13.2 (SUB12) ***Excess water from dewatering****: FMG suggests that one possible method to dispose of any excess water from dewatering operations will be to irrigate vegetation affected by the cone of depression (6.2.9.2 Management Strategies pg 116). This method of disposal is not best practice in this environment, carries risk and is contrary to the principles of sustainable development, and is therefore unacceptable. FMG should dispose of excess water through re-injection, following the development of a comprehensive water management budget.*

Refer to response 5.13.1. FMG have also committed to the development of a Water Use Management Plan (Appendix E page E8 of the Stage B PER).

5.13.3 (SUB8) ***Drainage control****: would like to see adequate provisions for bunding and onsite drainage works to protect nearby waterways from runoff that may result from ore moisture control, dust suppression activities generated onsite and runoff from all other site infrastructure including overburden placement. Sumps must be capable of withstanding flood events.*

As stated in the PER (Appendix F), FMG will bund the proposed plant sites as appropriate to prevent external surface water runoff entering the infrastructure area and to retain internal drainage. The internal drainage will be collected and reused in the process water circuit. It has been assessed that the process plants will have no impact on the surface water quality in the downstream environment, due to external surface waters being diverted around the sites and internal drainage water being retained.

Ore stockpiles will be established at the process plants and at the train loading facilities in the rail corridor. FMG will similarly bund these stockpile areas, to contain internal drainage and protect from any external surface water runoff. Water collected from within the bunded areas will be returned to the process water circuit. As with the process plants, it is assessed that the stockpiles will have no impact on the surface water runoff quality in the downstream environment, due to the perimeter bunding and retaining of the internal drainage waters.

FMG propose to construct surface water protection bunding around the waste area perimeters, as appropriate. These protection works, comprising a combination of earth bunds and diversion channels, will prevent external surface water from entering the sediment prone waste areas. Upstream surface water flows will be diverted around the waste areas, where feasible and directed into defined surface water pathways either adjacent or downstream from the waste areas. Where appropriate, riprap pads will be provided in key areas along the edges of the diversion bunding to slow and redistribute runoff. Within the waste areas, surface water runoff will be drained from the waste area top surface and batters to the downslope sides and then directed through sediment basins, to reduce sediment loadings and turbidity, prior to discharging to the downstream environment.

All surface water collection sumps will be designed for flood events.

5.13.4 (SUB8) ***Water supply dams**: mentions that water drawn from dewatering bores will be pumped to dams that supply the beneficiation plant – there are no details supplied about these and concerned what scale these dams will be and bunding provisions in readiness for flood events (spill of heavy sediment load water) but also impact these may have on diverting surface flows in the immediate area.*

Water from the borefields will be pumped to a 'process water pond' located adjacent to the beneficiation plant. The pond will then supply the beneficiation plant with a constant water supply. The footprint of this pond is likely to be around 80m x 120m and has been included in the processing plant footprint as shown Figure 25 of the Stage B PER. The process water pond will not have any additional impact on surface water flows for the area as water will already be diverted around the Beneficiation Plant. Surface water from around the beneficiation plant and workshops originating from direct rainfall will be diverted into the process water pond and reused.

There will be a sufficient freeboard on the dam to allow for most large rainfall events. However, an overflow spillway and collection area will be included in the design to allow for events where a sufficiently large rainfall event could result in the dam overtopping.

5.14 Power Supply

5.14.1 (SUB8) ***Impacts associated with power supply**: the proponent does not discuss the potential environmental impacts and management of the power supply options in sufficient detail. The impacts from clearing for infrastructure footprints such as access tracks and high voltage transmission towers or a gas pipeline corridor are not considered. Power generation is an integral part of this Project and should be addressed within this document.*

As stated in the Stage B PER (Section 5.3.10, page 80) the power requirements for the mining, processing and support facilities will be provided and maintained by an external provider. These providers will submit separate environmental proposals and consultation with regulatory bodies and interest groups will occur during the assessment process.

5.14.2 (SUB12) ***Impacts of corridor establishment**: whatever option (transmission lines or gas pipeline) is chosen by the proponent, FMG and its supplier will need to carefully consider the impacts on mulga communities and other significant conservation values of the area. For example, if transmission lines are selected as the power supply option then consideration will need to be given to assessing the likelihood of waterbird collisions together with clearing, fire risks and changes in surface hydrological regime associated with access tracks.*

5.14.3 (SUB12) ***Burial of transmission lines**: if power transmission lines are utilised, then such lines along the rail alignment in the vicinity of the Fortescue Marsh and for the mines must either be buried or equipped with deflectors. The burying of transmission lines or equipping them with deflectors is required to prevent collisions and mortalities among the large waterbird population that utilises the Marsh when surface water is present.*

If a transmission line is selected to provide power, it will be provided by an experienced provider, familiar with conditions experienced in the Pilbara and transmission lines near wetlands. Where possible it is proposed that the transmission line will be adjacent to and within the PER rail corridor, and utilising existing access roads.

As stated in the Stage B PER (Section 5.3.10, page 80) the power requirements for the mining, processing and support facilities will be provided and maintained by an external provider. These providers will submit separate environmental proposals and consultation with regulatory bodies and interest groups will occur during the assessment process.

5.14.4 (SUB12) ***Power and communications for railway**: FMG must document how they will distribute power and communications along the rail corridor.*

Communications along the corridor will be provided by either a fibre optic or microwave system. In most cases power along the rail way line will be provided by solar batteries. The exception to the use of solar power will be if microwave system is installed, the microwave towers will be provided with their own diesel generating capacity.

5.14.5 (SUB8) ***Renewable energy**: would like to see renewable energy sources promoted throughout the Project to help meet energy needs (as opposed to use of fossil fuels), though we appreciate emphasis on energy efficient technology, we would also like to see the promotion of renewable energy sources throughout the Project.*

FMG will promote the use of renewable energy sources where possible (e.g. solar panels for power) although these will not be able to replace the use of fossil fuels such as diesel for the Project. Wherever possible, FMG will select the most energy efficient technology available.

Once operational, FMG has committed to monitor greenhouse gas emissions and continue to look for ways to improve energy efficiency and reduce greenhouse gas emissions as part of continual improvement.

5.14.6 (SUB12) ***Solar power**: CALM recommends that FMG utilises solar for the primary source of power for signalling and communication facilities.*

At this stage the assessment for primary power for signalling and communications is dependant upon on the selection of communications system (refer to response 5.14.4).

5.14.7 (SUB6) *While the proponent does identify the associated greenhouse gas emissions, they do not discuss the potential impacts resulting from power generation such as NOx, SOx, particulates and VOCs. This is of specific concern if the power is to be supplied from Newman where cumulative impacts may occur.*

It is likely that FMG will purchase its electricity requirements from external providers and the PER recognises that these external providers may be required to obtain separate environmental approvals for any new infrastructure or power plants. Such approvals are likely to include cumulative impact modelling of the atmospheric emissions from the power station if the power is supplied from Newman and new plant is required.

5.15 Future Ore Processing

5.15.1 (SUB8,15) ***Future increases in rate and mining and processing**: concerned in terms of the approval for future use of the facilities whether there are any avenues for appeal/setting of conditions. FMG are looking at transporting 45Mtpa, but the railway will have a capacity to transport 100Mtpa, want clarification that if approval is given does that just cover the 45Mtpa or the future anticipated 100Mtpa and what are the options available to set conditions for third party users that come after the event to use the railway.*

FMG is currently seeking environmental approval for mining, processing and transport of 45 Mtpa ore. Any proposal to significantly expand the development above 45 Mtpa by FMG or a third party would require separate environmental assessment and approval in accordance with Section 45 of the *Environmental Protection Act (1986)*.

5.15.2 (SUB6) ***Reprocessing waste steams**: the PER discusses reprocessing waste streams to obtain manganese. The environmental aspects of this operation were not discussed in any other area of the PER. While the proponent previously stated that “this process will not have any incremental adverse environmental impacts” the statement was not backed up with any supporting documentation. The proponent is requested to provide more information on this process if it is to form part of the Project.*

Although the PER mentions the possibility of reprocessing the waste for manganese, this will not form part of the Stage B proposal. In the event that FMG decides to pursue manganese reprocessing option, separate approvals would be applied for.

5.16 Other Infrastructure

5.16.1 (SUB8) ***Mindy Mindy airstrip**: we support the notion that companies share infrastructure and facilities. To avoid unnecessary clearing, a shared usage arrangement should be brokered.*

As stated in Section 5.5.6 (page 92) of the Stage B PER, FMG will utilise the existing Hammersley Iron (HI) or BHPBIO airstrips if access to these facilities can be agreed.

However, if an agreement is not reached FMG will construct a new airstrip adjacent to the proposed mine camp (within the current proposed infrastructure footprint).

5.16.2 (SUB12) ***Road design**: FMG states that unsealed roads will be built to all mine sites to facilitate access (5.5.6 Access and Stock Management page 92) and it is assumed that these roads will be of all-weather gravel type construction. In respect to the access roads for sites on the foot of the Chichester Range, road design and construction, especially through mulga areas, will need to be sympathetic to issues of drainage shadow as per the rail line. The location and design of mine access roads together with rail access maintenance tracks must be undertaken in consultation with and to the satisfaction of CALM.*

The final design and location of any roads will take into consideration local conditions. This will include avoiding areas of significant vegetation where practicable. In areas of sheet flow the design of the road will aim to minimise potential affects from drainage shadow. The design and locations of access roads will be undertaken in consultation with CALM.

The rail maintenance track will follow the rail alignment for the majority of the length. In areas of sheet flow the maintenance track will be located downslope of the rail line to reduce sediment loading of water flowing through culverts. Water from the culverts under the rail will flow across stabilised areas of the track and then into the redistribution system.

5.17 Waste Management

5.17.1 (SUB8) ***Waste minimisation and recycling**: for the accommodation camps there has been little attention afforded to waste generation and management and particular emphasis on recycling. Would like to see that attention and emphasis to waste minimisation/recycling is actively encouraged throughout and that waste generated will be properly disposed of at a licensed premise.*

In line with best practice waste management principles, FMG will implement the following management hierarchy for the life of the Project:

- Avoidance – reduce the amount of waste generated at the site;
- Re-use – reuse wastes without substantially changing their form (e.g. reuse of printer cartridges);
- Recycling – treating waste that is no longer usable in its present form and using it to produce new products (e.g. segregation and storage of scrap metal, aluminium cans for periodic transportation to recycling facilities);

- Energy recovery from waste – adopt management practices that recover and use energy generated from waste (e.g. refining of waste oil for reuse for power generation); and
- Treatment and or/disposal – adopt management practices that reduce the potential for environmental harm by disposing of wastes at licensed facilities only.

As stated in the Stage B PER (Section 6.9.4.2, p157), FMG will also implement a Waste Management Plan for the life of the Project. The Plan will detail all aspects of waste disposal and management.

Successful recycling is already actively occurring at all FMG's exploration camps in the Pilbara.

5.18 Land Rehabilitation and Project Closure

5.18.1
(SUB1)

***EPA objective**: the EPA objective for this Project (Section 6.12) is inadequate. Surely, the public has a right to expect the EPA require the proponent to endeavour to establish near-natural, functional ecosystems as one of its primary rehabilitation objectives. A 'functional landform' is meaningless and enables the proponent to do almost anything. A barren carpark is a functional landform, but in most circumstances is not a reasonable outcome for a rehabilitated site in the Project area.*

It is FMG's intention to aim for the establishment of functional ecosystems in those areas where it undertakes rehabilitation. In areas where the original landforms experience minimal disturbance, or, if disturbed, they are restored to a form approximating the original topography, FMG agrees that it is a reasonable expectation that the public should see, over time, a return of the pre-existing ecological values in those areas. Where the final landform differs from the pre-mining landform, FMG will aim to ensure it is a functioning landform. Rather than a "barren carpark", FMG understands this to mean the establishment of a landform that has ecological values consistent with those occurring in the surrounding areas, to the extent that this is possible.

5.18.2 (SUB8) ***Extent and design of overburden landforms****: concerned over the footprint of the area that will have overburden placed on it and there needs to be strict licensing conditions over the design/form and height of such imposed features. Need to ensure that they are rehabilitated in a timely manner and using indigenous seed from the area. These will form significant barriers to not only surface water movement, but also faunal movement.*

The overburden placement areas will only be utilised for a short amount of time until the material can be used to back fill the mine voids. The estimated footprint for overburden placement areas is indicated in Table 5.

Table 5: Indicative footprint of overburden placement areas.

Mining Area	Footprint (ha)	Overburden Disposal (Mt)
Christmas Creek	388	112
Mindy Mindy	200	40

As stated in Section 5.3.1.2 (page 69) of the Stage B PER, the final design, and therefore the height of the overburden storage areas, will be integrated into the surrounding landscape, using industry best practice. DoE and DoIR will be consulted during the design and rehabilitation of these landforms.

The rehabilitation of overburden landforms will occur progressively and will be competed soon after they are no longer required. Topsoil and vegetative material removed from the footprint will be returned during rehabilitation, it is anticipated that these sources will have an adequate seed bank to allow natural revegetation. In the event that vegetative growth in rehabilitation areas is unsatisfactory, FMG will collect seeds indigenous to the area to supplement revegetation from soil seed banks.

Overburden placement areas will be bunded and upstream flows will be diverted to either rejoin downstream drainage lines or dispersed to mimic sheet flow. It is not expected that the overburden placement areas will form a barrier to faunal movement.

5.18.3 (SUB14) ***Mining method:*** *strip mining and progressive backfilling of the pits along with direct return of topsoil, where available, is highly recommended. Backfilling and progressive rehabilitation of the site will not only reduce the liability to the State and minimise environmental impacts, but may also reduce the long term responsibilities of FMG.*

FMG agree that progressive backfilling of pits has the potential to reduce “environmental liability”. Research and Development programs are also being established by FMG to develop best practice rehabilitation techniques and also closure criteria for rehabilitated landforms.

5.18.4 (SUB8) ***Bench heights on overburden landforms****: Concerned about bench heights being proposed and ability for faunal/surface water movement between such imposed boundaries (Mt Nicholas 6m).*

The overburden landforms will be rehabilitated such that surface water is shed from the surface to sediment basins prior to discharge to the downstream environment. Surface water originating above the overburden landform will be directed around it. It is most unlikely that the rehabilitated landforms would form a barrier for the movement of fauna, as the structures will not prevent movement of fauna around or over them.

5.18.5 (SUB12) ***Borrow pit rehabilitation****: FMG should commit that the final borrow pit landform permits drainage by ensuring that borrow pits are designed and constructed so that water drains out rather than collects within. The proponent must include a commitment to no ponding within the borrow pits. CALM recommends FMG develops, in consultation with and agreed to by CALM, a Borrow Pit Environmental Management Plan.*

FMG will adopt best practice environmental management to rehabilitate borrow pits used in the Project. This will include incorporating any previous experience of borrow pit rehabilitation within the Pilbara. The final rehabilitation technique that is adopted will be case specific for each borrow pit. Where practicable FMG will aim to minimise the 'bowl' effect within the borrow pits by preferentially excavating shallower borrow pits while aiming to minimise the footprint area of the pit. Depth and footprint of borrow pits will be balanced with one another for the best environmental outcome. In addition, wherever practicable, oversized screened material excavated from an embankment prior to culvert construction will be returned to and spread onto the base of the borrow pits after the bases have been ripped. Surface water will be diverted around the pits to minimise the potential for water to pond within the borrow pits.

FMG has developed a draft Borrow Pit Rehabilitation Procedure. Rehabilitation outlined in this procedure includes tapering borrow pit batters to shallow angles and respreading vegetation into the borrow pits (to reduce batter erosion and promote revegetation). Completion criteria that are developed in consultation with relevant stakeholders and included within the Rehabilitation and Revegetation Management Plan (Stage B PER, Appendix D) will be applicable to all borrow pit rehabilitation. FMG will monitor the success of rehabilitation of the borrow pits and implement corrective actions if necessary.

5.18.6 (SUB12) ***Disposal of unsuitable or excess material in borrow pits****: in instances where there is an excess of material extracted from the rail corridor, due to it being geotechnically unsuitable for use in the rail formation, this material should either be disposed of in an exhausted borrow pit, or dumped in abandoned BHP Billiton borrow pits. Preferably, the receiving borrow pit for such material would be the same type of habitat as the original, thereby facilitating rehabilitation and the development of an appropriate self sustaining community. However, where this is not possible and the material is deposited in a borrow pit of a different habitat type or is weed infested, such material should be buried or covered.*

Initially, FMG will aim to balance the cut and fill requirements within the footprint of the railway. However, if there is additional material, FMG will use abandoned borrow pits where practicable to dispose of excess material extracted from the rail corridor in the manner mentioned above. Use of BHPBIO borrow pits will depend on whether BHPBIO grants permission for their use. Details of disposal for excess materials will be agreed in consultation with CALM.

5.18.7 (SUB8) ***Seed collection****: would like to see seed collection from the affected area take place prior to soil removal activities and use of local seed incorporated into the Rehabilitation and Revegetation Management Plan for the affected mining areas.*

As stated in Appendix D of the Stage B PER, Section 5.5.3 (p17), seed collection will be undertaken if the establishment of native vegetation from the topsoil and stored vegetative material is unsatisfactory. It will not always be possible to collect seeds from disturbance areas prior to topsoil removal. However, seed collection, if necessary, will occur in the general vicinity of the proposed revegetation areas.

5.18.8 (SUB12) ***Use of provenance seed****: the commitment to use provenance seed in rehabilitation should be reinforced and implemented as standard operating procedure.*

Use of provenance seed for areas where establishment of vegetation is not satisfactory has been incorporated into the Revegetation and Rehabilitation Management Plan. This will be the primary document for any persons undertaking rehabilitation. Additional work procedures may also be developed based on results of research and development.

5.18.9 (SUB12) ***Monitoring****: the Draft EMP refers to monitoring vegetation health and rehabilitation success (eg. Item 15 pg E12, Appendix B). The monitoring that the proponent proposes needs to be rigorous to assess and document change with a high degree of confidence. FMG will need to commit to a rigorous monitoring methodology including, but not limited to, fixed photo points and a quadrat-based monitoring regime that includes attributes such as vegetation cover and species presence/abundance.*

Section 5.7 of the Rehabilitation and Revegetation Management Plan (Appendix D of the Stage B PER) relates to maintenance. Within this Section it is stated:

Rehabilitated areas need to be monitored and managed after the initial rehabilitation. FMG's primary tool for maintenance of the rehabilitated area will be monitoring of the sites to identify area that require additional works. If any rehabilitation areas are identified that are considered to be unsatisfactory then maintenance may include, but not be limited to:

- replanting failed or unsatisfactory areas;
- repairing any erosion problems;
- fire management; and
- pest and weed control.

The monitoring technique that is selected is likely to be a combination of methods and will be based on specific completion criteria that will be developed in consultation with regulators.

Monitoring may include but not be limited to, photographic monitoring, transects and standard plot areas. It is anticipated that monitoring in rehabilitation areas will initially be undertaken annually. If the monitoring results indicate that an area is stabilising, the monitoring frequency may be extended.

5.18.10 (SUB12) ***Monitoring**: FMG's monitoring programs will need to set appropriate time frames for ongoing monitoring of success criteria and weed control.*

See response 5.18.9 for information regarding FMG's monitoring program.

5.18.11 (SUB1) ***Monitoring**: regarding Section 6.12.4, monitoring what, for what purposes, against what baseline data. Before the EPA approves this development it must insist that a Rehabilitation Plan is prepared that commits the proponent to re-establishing near-natural, functional ecosystems on the disturbed lands that are not to be used for pastoral or another specific purpose before it is given closure. Quality baseline data must be provided before the Project is approved. These data, along with the methods and a detailed explanation of how they will be used during the monitoring program must be made available for public comment prior to their approval. The tools to enable this assessment are now available.*

As stated in Section 6.12.4 (page 167) of the stage B and also in the Revegetation and Rehabilitation Management Plan (Appendix D of Stage B PER) FMG will carry out monitoring to assess the effectiveness of rehabilitation and remedial works. The monitoring technique that is selected is likely to be a combination of methods and will be based on specific completion criteria that will be developed in consultation with regulators. Monitoring may include but not be limited to, photographic monitoring, transects and standard plot areas. It is anticipated that monitoring in rehabilitation areas will initially be undertaken annually. If the monitoring results indicate that an area is stabilising, the monitoring frequency may be extended

5.18.12 (SUB1) ***Conceptual Closure Plan**: regarding Appendix Q of the PER, second paragraph pp. 2 'Commitment – FMG will develop a comprehensive Life-of Mine Closure Plan within two years of mining activities which will include the following: ….. stakeholders consultation program'… and first paragraph under Section 6 …. 'FMG recognised that stakeholder involvement is critical in developing and implementing mine closure'. Given FMG's unwillingness to provide basic information about what they intended to do during the fauna*

> *surveys as part of the public review of the Scoping Document, FMG clearly should not be trusted to develop a satisfactory closure plan involving stakeholders at some later stage. This could involve another round of token consultations. The closure plan must be prepared prior to EPA approval for this development.*

FMG reiterates its commitment to consult during the preparation of the Life-of-Mine Closure Plan. Indeed, it will not be possible to produce a viable Plan without consulting the range of stakeholders with an interest in our Project. Furthermore, the Plan will require approval under both the *Environmental Protection Act (1986)* and the *Mining Act (1978)*.

In respect of the timing of the Plan, it is of limited value to attempt to produce a detailed Closure Plan before operations have commenced. FMG has outlined, in conceptual terms, the form the final landforms will take and the PER will be assessed on this basis. Details of how rehabilitation and revegetation will be carried out have been provided in the Rehabilitation and Revegetation Management Plan (Appendix D of Stage B PER).

5.18.13 (SUB12) ***Closure Plan consultation****: CALM should be consulted on and agree to the Sections of FMG's Life-of-Mine Closure Plan, with particular regard to the aspects of the Project in proximity to the proposed Fortescue Marsh conservation reserve.*

FMG agrees to consult with CALM on the relevant Sections of the Life-of-Mine Closure Plan.

5.18.14 (SUB14) ***Time frame for Closure Plan****: a two year time frame is considered satisfactory for the completion of a rehabilitation and closure plan. However it is suggested that rehabilitation plan objectives and commitments are integrated into short term mine planning to ensure an interactive closure system. A regular review would be beneficial in regards to producing a closure plan which is a "living document", however this may not be suitable for short term planning.*

FMG considers it essential to integrate rehabilitation plan objectives and commitments into short term mine planning. To do otherwise is likely to result in a cost penalty to FMG through rehandling of materials and a prolonged rehabilitation schedule and monitoring program. Should the Project be successful in receiving final approval and funding, this issue will feature strongly in the early planning.

5.18.15 (SUB1) ***Completion criteria****: Section 2 in the 'Objectives' column in Section 11 Completion Criteria (Appendix Q of the PER) indicates that the objective will be to rehabilitate the areas so that it contains a self-sustaining ecosystem similar to the surrounding environment in terms of flora and fauna species composition and fauna habitat. For fauna, the proponent does not have sufficient quality baseline data against which to measure this. The proponent must commit to producing these data before this Project is approved. We have developed a Rehabilitation Index that assesses rehabilitation success by comparing the reptile assemblage in the rehabilitated area with that in the adjacent undisturbed area.*

FMG is aware of various national and international research and methodologies that exists relating to the assessment of mine rehabilitation success in terms of fauna re-establishment. As rehabilitation planning proceeds, methodologies suitable for this Project will be determined. FMG will be actively carrying out investigations to determine suitable closure criteria for rehabilitated areas.

5.18.16 (SUB12) ***Contingency plans for revegetation not meeting criteria****: the Rehabilitation Plan does not demonstrate an ongoing commitment to monitoring and follow up work if monitoring shows that rehabilitation has not met desired standards (Appendix D pg 19). FMG must include in the Rehabilitation Plan an ongoing commitment to monitoring and remedial work if monitoring shows that rehabilitation has not met desired standards.*

Refer to response 5.18.9.

5.18.17 (SUB1) ***Post closure pit water quality****: the PER does not address the issue of water salinity increase post mining.*

Work undertaken by FMG shows that there will be sufficient backfill to infill the pits to approximately the original ground level. FMG has committed to ensuring that all pits are backfilled to above the water table. That being the case there will not be water ponding in the pits, and therefore evaporation increasing the salinity within the pits will not occur.

6 POLLUTION

6.1 Greenhouse Gas Emissions

6.1.1 (SUB6) ***Low grade of ore**: on processing, the low grade of ore proposed to be mined will contribute more significantly to greenhouse emissions than any other iron ore mine site in Western Australia.*

The PER estimated that the FMG Project (mines, railway and port) would emit approximately 14.3 kgCO2e/t of ore shipped and that this is similar to that estimated for the Hope Downs Iron Ore Project (13.6 kgCO2e/t of ore shipped) although comparisons between Projects are difficult due to the general lack of directly comparable information. The PER stated that it was likely that the FMG estimated greenhouse gas emissions were overestimated as it did not include offsets that would arise as a result of the progressive rehabilitation of cleared areas.

The FMG Project will have a lower stripping ratio than most other Pilbara iron ore mines which results in lower energy requirements and decreased greenhouse gas emission. These savings are somewhat offset by the requirement to beneficiate the ore. Therefore, while the lower grade ore will require beneficiation to bring it to market specifications, the overall energy efficiency of the Project remains comparable to other operations.

6.1.2 (SUB8) ***Emissions from material movement**: would like to see emphasis on access road construction and material movement between sites that has the least greenhouse gas emissions.*

FMG is committed to achieving the best engineering design for its Project that considers (amongst other things), environmental, engineering and economic aspects. Greenhouse gas emissions are intrinsically linked to energy/fuel consumption and efficiency which themselves are linked to the economics of the Project. FMG will consider all of these aspects when evaluating and selecting the method(s) and routes for the movement of ore between sites.

6.1.3 (SUB8) ***Best practice**: though FMG should be commended for a comparatively lower kgCO_2e/t for ore shipped, it would however be good to see a commitment to best practice in ensuring that throughout greenhouse gas emissions are minimised. This may include but not be limited to: all equipment using low sulphur diesel, looking at biodiesel usage opportunities and also looking at opportunities associated with the train/locomotive technology used (preference towards technology that encourages energy/fuel efficiency).*

FMG will consider the environmental, engineering and economic issues when selecting equipment and energy sources for its Project. FMG will also have a regular review process to ensure that there is a process of re-evaluation and continuous improvement.

FMG will commit to minimising greenhouse gas emissions. This will primarily be achieved by looking to maximise the overall energy efficiency of the Project including type of locomotive used and their operational regimes.

6.2 Dust

6.2.1. (SUB8,15) ***Dust from Marra Mamba ore**: Marra Mamba ore type is extremely dusty material, to the extent that fines resemble a talc powder. Would need to ensure that during transport and activities at the port facilities that the appropriate level of moisture is added so as to prevent generation of excess dust.*

FMG is committed to working with the community to manage its potential dust impacts on local communities. FMG’s Project will be designed with a large number of engineering solutions to reduce dust emissions. FMG will develop and implement a comprehensive dust management plan that will include ambient monitoring programmes and continuous improvement programmes to further reduce dust emissions where practicable. The dust management plan will include a real-time dust monitoring network that is proposed to be installed at sensitive receptors to evaluate dust contributions from FMG operations and to enable measurement of dust mitigation measures.

FMG is prepared to coordinate its dust monitoring and management activities with existing and future port users.

6.2.2 (SUB8,15)

***Dust management at port**: with majority of ore type being Marra Mamba, emphasis needs to be placed on full enclosure of conveyors and load out facilities at the port and also the use of extractive methods and processes so as to ensure dust generation at the port, during load out is minimised throughout. Concerned also on the effects of dust deposition, on the mangroves that will be in the immediate vicinity of the port facilities.*

Dust management at the Port has not been assessed as part of Stage B. However, as detailed in the Stage A PER (Section 7.3.9, p188), FMG has committed to implement a wide range of control measures to reduce dust emission from its proposed port operations, including:

- a dust extraction system for the car dumping facility will be installed, which will include an induced draught at the dumping point and wet scrubbing;
- conveyor transfer points will be totally enclosed, with water sprays jets at each loading point to wet the surface of the ore;
- allowance has been made if necessary for future installation of insertable dry, reverse pulse gas filters at the transfer points in the unlikely event that the use of water sprays proves to be inadequate for dust control;
- dust emitted from the belt conveyors will be controlled through proper maintenance of belt scrapers to dislodge material sticking to the belt;
- conveyors from the car dumper to the screening building and out to the shiploader will be covered;
- automated stackers to minimise the drop heights to stockpiles and the stacker booms will be fitted with spray heads to minimise the emissions of dust;
- the fines stockpiles will be protected from prevailing winds by the coarse stockpiles where practicable and the stockpile area will be fitted out with a fixed water cannon based spray system to reduce the likelihood of dust from wind erosion; and
- the feasibility of planting a vegetation shelter belt along the western side of the stockpiles will be investigated.

Studies have indicated that iron ore dust in particular does not appear to cause any significant damage to mangrove health (Paling et. al. 2003).

5.2.3 (SUB15) ***Dust monitoring**: the Town of Port Hedland would like to see the establishment of an independent, interagency dust monitoring taskforce to be based in Port Hedland that would enable community involvement and independency for dust monitoring across the north of the state as another positive initiative that would act to constructively address the issue of dust and increasing dust levels in Port Hedland.*

FMG is of the understanding that the PHPA, DoE, DoIR and other industries are working together regarding cumulative dust impacts within Port Hedland and will be establishing an independent dust monitoring taskforce. As mentioned in the Stage A PER FMG is committed to working with the community, existing and future port users to manage its potential dust impacts on local communities.

6.3 Acid-Generating Material

6.3.1 (SUB8) ***Acid-generating material**: we would like to see a process in place that if acid-generating materials are encountered, that the Department of Environment be involved in the development of a management plan in conjunction with FMG. There needs to be heightened efforts and attention to ensure that this does not have the potential to negatively affect waterways and surrounding vegetation (particularly mulga).*

Geochemical characterisation was carried out on all rock types for all the mines for Acid Forming Potential. In brief, assuming that the black shales remain undisturbed insitu, no geochemical concerns are foreseen for the overburden to be produced during open-pit mining. However, if acid generating materials are encountered, FMG will develop a robust management plan in consultation with the DoE and DoIR.

6.4 Asbestos

6.4.1 (SUB8,15) ***Availability of test results**: concern over presence of asbestos in ore to be mined and would like to see results of testing of ore samples publicly available so that assurance can be passed on in terms of presence of asbestos in the ores coming to the port.*

Although the Hamersley Range geological sequence is noted for occurrence of asbestiform (or asbestos) minerals, there has been no identification of such minerals in all of the FMG active exploration Projects to date.

Crocidolite (or riebeckite) is the most common asbestiform mineral recognised in the Hamersley region. These are fibrous members of the amphibole group, which are common rock forming minerals in igneous or metamorphic terrains. It is postulated that there is no recognised asbestiform minerals within the FMG Project areas as there have been unsuitable geological conditions for the formation of crocidolite or riebeckite (unsuitable rock geochemistry or metamorphic conditions). In conjunction with the potential non-occurrence of asbestiform minerals, the processes of iron enrichment can act to replace these minerals with iron, therefore destroying their fibrous nature. As FMG is targeting the iron-enriched areas, the possibility of intersecting these minerals is again reduced. The occurrence of asbestiform minerals within the Project areas is therefore considered to be very low. This is supported by current drilling statistics.

Nonetheless, FMG will test for the presence of asbestiform minerals as a matter of course. The results will be available to interested parties.

6.4.2 (SUB8)

***Definition of unacceptable concentrations**: fully supportive of continued testing for presence of asbestos in its ore throughout the life of the Project and support the decision not to mine a particular area if concentrations of asbestiform minerals are unacceptable – however concern over the term “unacceptable” and want measures to ensure that this level is in compliance with WHO and Australian Standards for allowable exposure concentrations.*

As stated in the response to 0, FMG have not intersected any fibrous material in any exploration drilling to date. If any asbestos bearing materials are found, FMG will carry out sampling as per relevant standards and will be required to develop a management plan. The following regulations of the Mines Safety and Inspection Regulations (1995) are relevant for asbestos on mine sites and FMG will comply with these regulations:

(9.33) .Control of contaminant asbestos

1. *If any contaminant asbestos occurs at a mine, the manager of the mine must ensure that:*
    - *a) such action is taken as is necessary to protect the health of employees at the mine from the effects of the asbestos; and*
    - *b) the district inspector is notified in writing of that occurrence.*

2. *If in the course of any mining operation at a mine it is necessary to assess exposure to airborne asbestos fibres, the manager of the mine must ensure that the assessment is carried out using the method specified in the Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Dust [NOHSC:3003(1988)] published by Worksafe Australia.*

3. *(3) For the purposes of subregulation (2), a countable fibre is taken to be defined in the document referred to in that subregulation as any object having a maximum width of 1 micrometre or less and a length exceeding 5 micrometers.*

Unacceptable concentrations of asbestos will depend on the species of asbestos. The National Occupational Health and Safety Commission (1995) have specified that the air breathed by a worker throughout a working shift should not exceed the occupational exposure standards shown in Table 6.

Table 6: Asbestos exposure standards

Asbestos Variety	**Exposure Standard**[a]
Chrysotile (white asbestos)	0.1 f/mL
Crocidolite (blue asbestos)	0.1 f/mL
Amosite (brown asbestos)	0.1 f/mL
Other forms or mixtures	0.1 f/mL

[a] Expressed in terms of the average number of fibres per millilitre (f/mL) of air breathed. The standards are defined in terms of a time-weighted average over the working shift, and apply over an eight-hour day for a five-day working week.

Throughout mining operations, FMG will be obliged to measure dust levels and mineralogy to ensure compliance with exposure standards.

6.4.3 (SUB15) ***Asbestos Management Plan****: the Town of Port Hedland would like to be involved of the development of the asbestos management plan.*

FMG have not intersected any fibrous material in any exploration drilling to date. If any asbestos bearing materials are found, FMG will carry out sampling as per relevant standards and will be required to develop a management plan. Consultation will be carried out with relevant stakeholders during the development of this plan (if required).

6.5 Hydrocarbon Management

6.5.1 (SUB12) ***Spill management plan**: FMG has not included a commitment to develop and implement a management plan for spill and hydrocarbon contamination in the Upper Fortescue River catchment including the Fortescue Marsh (Table 23 Environmental Commitments pg 198). This plan should principally address rail accidents/derailments. Given the significance of Fortescue Marsh, the proponent should commit to developing a management plan to address hydrocarbon spills.*

FMG has committed to "Maintaining or improving the quality of surface water to ensure that existing and potential users, including ecosystem maintenance are protected, consistent with the Australian and New Zealand Water Quality Guidelines (ANZECC, 2000). Monitoring of surface water on a regular basis at the marsh will ensure that water quality is maintained.

As stated in Section 7.3.6 of the PER (page 172), FMG has also committed to the development of a Hydrocarbon Management Plan, which will include spill prevention and clean up procedures, for both construction and operations. The plan will also include a Section on rail derailments and accidents involving hydrocarbons. In general, the plan will require all hydrocarbons to be stored, transported and handled in accordance with appropriate legislation and standards including:

- Australian Standard 1940 Storage and Handling of Flammable Goods;
- Australian Code for the Transport of Dangerous Goods by Road and Rail;
- Traffic Act 1974; and
- Dangerous Goods (Transport) (Road and Rail) Regulations.

Regular audits will ensure that the plan is adhered to by all personnel (including third parties). Additionally, an Emergency Response Plan will be developed prior to Construction, which will detail procedures to be followed in the event of a Rail Crash/Hydrocarbon spill. This issue has also been included in the Construction EMP (Appendix E of the Stage A PER).

6.6 Light Overspill and Noise

6.6.1 (SUB12) ***Management of impacts****: FMG will need to implement design strategies and engineering solutions to limit the effects of light overspill. Similarly, the effect of noise on waterbird populations, particularly breeding populations, will also need to be managed. FMG should liaise with CALM over the monitoring of impacts and management solutions to mitigate any impacts from light overspill and noise.*

FMG has addressed the issue of Light Overspill in Section 6.4.5 (page 134) of the PER. Specifically FMG has committed to managing this impact though a Management Plan, which will include measures such as limited lighting at night directed inwardly at operations, light shielding and selection of lighting that minimizes overspill and insect attraction (see PER Table 20, page 175). FMG will finalise this plan in consultation with CALM prior to construction commences.

FMG has also addressed the issue of Noise impact on water bird populations in Section 6.4.4 (page 134) and Section 6.7.1.1 (page 146). FMG will develop a Noise and Vibration Management Plan and as part of this plan, monitor the effects of blasting on birds and other fauna using the Fortescue Marsh. FMG will finalise this plan in consultation with CALM prior to construction commences.

7 SOCIAL

FMG has chosen to undertake a socio-economic assessment for the Project which is not required under the Environmental Assessment process. Many of the concerns raised are currently being worked on by FMG through their consultation process, which includes consultation with local shires, government departments and participation in the Development Commissions' taskforces. While workforce numbers, peaks and troughs, accommodation, FIFO issues etc. are of great importance to the local community and FMG, there is no requirement under the Environmental Assessment process to address these issues in the Public Environmental Review document.

7.1 Existing Social Environment

7.1.1
(SUB7)

***Census data**: the information on pages 46, 47 and 48, and Tables 4 and 5 in particular, relies on Census data and in cases is dated. It would be preferable for the proponent to use ABS estimated resident population.*

As suggested FMG has further researched information regarding ABS estimated resident population, which is displayed in Table 7 below. The Total Population figures for Newman were more than had been reported in the PER and figures for Port Hedland do not vary significantly. It is important to note that the figures in the table below are the estimated resident population (ERP) based on Census data.

Table 7: Australian Bureau of Statistics - National Regional Profile

East Pilbara (S) ABS cat. no. 1379.0.55.001							
		1999	**2000**	**2001**	**2002**	**2003**	**2004**
POPULATION - at 30 June							
Total - all persons	no.	6,518	6,153	5,843	5,765	5,675	5,535
Proportion of total population							
Aged 14 years and younger	%	27.8	27.7	26.9	26.5	25.3	
Aged 15 years to 44 years	%	52.7	52.0	51.5	51.2	51.5	
Aged 45 years to 64 years	%	17.0	17.9	19.1	19.8	20.4	
Aged 65 years and over	%	2.5	2.4	2.4	2.6	2.9	

Table 7: Australian Bureau of Statistics - National Regional Profile
(Continued)

Port Hedland (T) ABS cat. no. 1379.0.55.001

POPULATION - at 30 June		**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Total - all persons	no.	12,935	12,755	12,615	12,713	12,770	12,487
Proportion of total population							
Aged 14 years and younger	%	26.4	26.4	26.6	26.3	26.3	
Aged 15 years to 44 years	%	53.2	52.8	52.2	51.7	51.2	
Aged 45 years to 64 years	%	17.8	18.3	18.8	19.4	19.8	
Aged 65 years and over	%	2.5	2.4	2.4	2.6	2.7	

Population figures are the estimated resident population (ERP) for the selected region as at 30 June for the year shown.

7.1.2 (SUB7) ***Pilbara population levels**: ABS Estimated resident population shows that the population of the Pilbara has been in decline since 1998.*

FMG acknowledge that there has been a decline in population again in late 1990s as world demand for resources slowed in the wake of the Asian financial crisis (refer to Section 4.6.1. of the Stage B PER). The Census data for 2001 does not clearly show to what extent the current investment cycle has reversed the decline in resident population.

7.1.3 (SUB7) ***Population growth**: estimated resident population data shows that the average annual growth rates over the last 5 years are 1.4% for the State and Perth metro area, -0.9% for the Pilbara -0.3% for Port Hedland and -2.8% for the Shire of East Pilbara.*

Comment noted.

7.1.4 (SUB7) ***Identification of social impacts**: the Section on regional development (p48) ignores the impact of technological change in the resources sector on the region, the potential for social dislocation caused by the influx of construction workforces and in cases operational workforces.*

Comments noted.

7.1.5 (SUB7) ***Fly in / fly out****: on p49 it is noted that FIFO is of concern to the Pilbara Development Commission. Whilst the Commission is not generally supportive of fly-in fly-out arrangements for operational workforces it makes judgements on a case by case basis.*

Comment noted.

7.1.6 (SUB7) ***Cultural and recreational facilities****: whilst the region's main towns do contain cultural and recreational facilities (see p49), local government authorities in the region would argue that many of the facilities are now reaching the end of their economic life and would have difficulty in coping with any increase in demands.*

FMG is aware that some facilities in the region are reaching the end of their economic life. While these issues are of concern to FMG, they are regional issues and would need to be addressed at a regional level. FMG will continue consulting with Local Shire Councils and Government Departments on many issues including facilities upgrades.

7.2 Workforce and Accommodation

7.2.1 (SUB7) ***Construction workforce****: it is unclear from Section 5.5.5 of the report as to how many construction workers will be domiciled adjacent to minesite and for what duration and when the number of workers will reach a peak. Given that the construction camp will be within commuting distance from Newman consideration needs to be given on how the socio-economic impacts on the town will be managed during the construction phase.*

It is anticipated that 380 workers for the mine site construction will be housed in the on site construction camp. The construction camp will be located near the Christmas Creek mine site which is approximately two hour drive from Newman. FMG believe that this two hour drive will restrict workers from travelling to the town of Newman, especially after a twelve hour shift. The socio-economic impacts to the town of Newman will be minimal from the construction workforce, who will be flown in and out of the site.

7.2.2 (SUB7) ***Impacts on recreational facilities****: consideration will also need to be given to the potential environmental and social impact of construction workers on surrounding tourism and recreational areas, and in particular the area's many waterholes.*

As the construction workforce will be FIFO out from site the number of personal vehicles will be minimal which will reduce the environmental and social impacts of construction workers on surrounding tourism and recreational areas.

7.2.3 (SUB7) ***Contractor accommodation****: the fact that the operational work force is to commute from Newman on a daily basis raises the issue as to why permanent contractor accommodation is required on site. Why can't the contractors, even if they are employed on FIFO basis, be accommodated at motel/hotel accommodation in Newman?*

FMG cannot enforce the non-FIFO policy on contractors, hence the on site camp. FMG has committed to a non FIFO out workforce to support local communities as this has been an issue for most regional towns in the Pilbara. FMG has experienced during their exploration activities and consultation that accommodation at local motel/hotels, caravans parks etc. in Newman is very limited and at times unavailable due to limited rooms. (Refer to Newspaper article in Sunday Times 20/3/2005 Critical home Shortage - Hotel accommodation is at a premium, with a two week waiting period for some rooms).

7.2.4 (SUB7) ***FIFO during construction****: the intent for contractors employed at the mine to be based on a FIFO arrangement via Newman is noted and it is assumed that the construction workforce will be based on a similar arrangement. However, it is our understanding that RPT flights into and out of Newman are currently operating at near capacity.*

FMG is aware of the issues relating the flights into and out of Newman and have held discussions with Qantas regarding availability of flights. Refer also to response 7.2.3.

7.2.5 (SUB7) ***Use of charter aircraft**: we would not like to see FMG or its construction contractor use charter aircraft to bring employees into Newman as this would be of little benefit to the community. It would much preferable for an increase in the number of RPT flights into Newman or alternatively the use of larger aircraft for RPT services. Increased RPT air service capacity into Newman could provide a range of social and economic benefits to the wider community.*

It is not FMG's preference to use charter aircraft to bring employees into Newman from Perth. All options, however, will need to be considered by the company and it's contractors before a final decision can be made. FMG is aware of the issues relating the flights into and out of Newman and have held discussions with Qantas regarding availability of flights. Further discussion with Qantas regarding construction workforce FIFO requirements will need to be held with FMG and the construction workforce contractor(s).

7.2.6 (SUB7) ***Accommodation in Newman**: the PER is unclear as to how many personnel are to be domiciled in Newman. Based on the overall employment figure for the Project of 500 it could be expected to be 300-350.*

Although the number of anticipated personnel to be housed in Newman has not been recorded in the PER, FMG has advised throughout its consultation through community presentations and the Central Pilbara Coordinating Taskforce meetings the anticipated workforce numbers and accommodation requirements (see Table 8 below).

Table 8: Anticipated workforce numbers.

Project Component	Construction	Operations
Rail	1000	140
Port	500	70
Mine	800	380
Processing	(included above)	120

Construction workforces will be accommodated in temporary camps along the rail line (progressively moving), Port Hedland, and mine site camps. The potential housing needs in the local communities for operations are:

- Newman 120,
- Port Hedland 210.

7.2.7 (SUB7) ***Accommodation availability in Newman**: given the current state of the real estate market in Newman and given BHP Billiton Iron Ore's expansion plans it is unlikely that any significant number of existing residences will be available for employees.*

FMG is aware of the shortage of housing in Newman and has been working with Local Shires, Real Estate Agents and have been participating in the Pilbara Development Commission Central Pilbara Coordinating Taskforce to assist in addressing these issues from an industry perspective. FMG has also been consulting with Landcorp and their consultants and the Shire of East Pilbara in regards to these issues, the number of anticipated houses and types of housing required by FMG.

7.2.8 (SUB7) ***Residential land in Newman**: a major constraint to development of new housing is the current lack of available residential land in the town.*

FMG is working with Landcorp and the Local Council to address these issues. It is our understanding through consultation that:

- There is suitable land zoned under the current town planning scheme; and
- There is suitable land to develop approximately 150 - 200 lots or four potential sites.

7.2.9 (SUB7) ***Housing supply and demand**: the issue of housing supply and demand needs to be more thoroughly examined by the proponent and an accommodation plan and strategy put in place.*

FMG has prepared an in house accommodation plan and strategy and is consulting with stakeholders including Local Council, Landcorp, financiers, and local builders to address these issues.

7.2.10 (SUB7) ***Social infrastructure in Newman****: we are concerned that the proponent has failed to assess and address the wider impact of the development on the social and physical infrastructure Newman and in particular, what will be the impacts of the Project be upon childcare facilities, educational facilities, health facilities, recreation services, police/law and order services and local government services.*

FMG will be addressing the above issues under their Community Development Plan and will continue consulting with Government Agencies, Local Shires and community members throughout the life of the Project in regards concerns regarding the social and physical infrastructure in the Pilbara.

7.3 Other Issues

7.3.1 (SUB7) ***Training opportunities for Aboriginal people****: whilst the document discusses training, specific consideration also needs to be given to the employment opportunities the Project can offer to local Aboriginal people. The Commission believes that a strategy needs to be developed to determine what Aboriginal employment opportunities exist and how these can be maximised in the longer term.*

Section 6.14.1.2 (page 180) of the Stage B PER, states that FMG will develop a Vocational Training and Education Centre (VTEC) aimed at providing meaningful training opportunities for indigenous people who would like to work for FMG with guaranteed employment on completion. FMG is committed to local employment, which includes indigenous employment and is talking with indigenous communities in regards to employment options.

7.3.2 (SUB7) ***Local suppliers****: we strongly argues that for local businesses and contractors to benefit from the Project, Fortescue Metals Group needs to conduct a concerted awareness campaign among local businesses to advise them of supply requirements and procedures.*

Section 6.14.1.2 (page 180) of the Stage B PER states that FMG will maintain a focus on regional capacity building through using local suppliers and establishing partnerships with local businesses where commercially practicable. FMG will address the issue of local procurement of goods and services under their Community Development Plan which will include an awareness campaign among local businesses.

8 OTHER

8.1 Assessment under the Environmental Protection Act (1986)

8.1.1 (SUB11) ***Definition of Project scope****: Section 4A of the Environmental Protection Act 1986 states that the object of the Act is to protect the environment. This object is achieved by having regard to a number of principles, the first of which is the precautionary principle.*

We believes that the FMG Stage B PER has been submitted at a point where the Project scope is not defined to the extent necessary to allow an understanding of the proposed operations and significant areas of impact, an evaluation of the likely environmental impacts arising from these operations at those areas, and an assessment of the options available to mitigate those impacts.

Instead, in many cases the reader is merely advised that evaluation of alternatives is ongoing and that some option will be selected at a later date. Examples include:

- *Location of borrow pits (Section 5.4.2)*
- *Transport of ore from mine to beneficiation plant (Section 5.3.4)*
- *Quarry requirements for railway ballast (Section 5.4.6)*
- *Detailed surveying of Project areas (Table 10)*
- *Detailed surveying of rail route, special construction techniques and mitigation measures (Table 11)*
- *Groundwater investigations (Section 6.2.13) and*
- *Hydrological impacts of open pits (Section 6.1).*

FMG disagrees that the Project cannot be assessed because of lack of information. In both of the PERs produced by FMG, the proposed activities have been clearly identified and the likely environmental impacts discussed. This has been supported with environmental investigations that have been conducted to better understand these likely impacts. We note that the precautionary principle requires that “decision-making is guided by:

> (a) a careful evaluation to avoid serious or irreversible damage to the environment wherever possible; and

> (b) an assessment of the risk-weighted consequences of the options." (Environmental Protection Authority, 2004).

FMG believes there is sufficient information within the Stage B PER to assess the Project but we acknowledge it is necessary to gather further detailed information. This information is required not for the assessment but for ensuring the Project can be implemented in the manner we have proposed.

8.1.2 (SUB10) ***Available information****: the rail lines exact location is not defined and accordingly it is difficult to assess the proposal in any meaningful way. Also, the exact location of each mine is not delineated in the PER. Rather zones of "indicative mineralisation" are identified within which mining is proposed to be undertaken.*

While the exact location of the rail line has not been defined, the corridor in which it will occur has been assessed. As the corridor is far more substantial that the actual rail line will be, this means that much of the area assessed will not be directly disturbed. The assessment of a 2km wide corridor allows flexibility in the final design to avoid environmental and cultural heritage constraints and also provides more information than if a smaller corridor was surveyed.

The exact location of the mines and their associated infrastructure were displayed in Figures 30-33 of the Stage B PER.

8.1.3 (SUB11) ***Risk mitigation****: we note that FMG has no track record of delivering resource Projects in the Pilbara, the scale of the Project and its environmental footprint is very large, and the Project intersects some sensitive areas of the Pilbara, such as the Chichester Ranges.*

These factors increase the environmental risks associated with delivery of the proposed Project. In these circumstances, it seems likely that environmental risk mitigation is best achieved through stringent and rigorous assessment before the Project commences, which in the present case is not possible due to the deficiencies inherent in the FMG PER.

FMG acknowledges the scale of the Project is large. However, FMG has conducted a through environmental impact assessment and considers that the Stage B PER, together with the additional information presented in this report, provides a sufficient basis on which to judge the risks and assess the Project. Furthermore, should Project approval be received, it is FMG's expectation that a suite of binding environmental conditions will be placed on our operations by the Minister for the Environment. The Project Team of FMG personnel and contractors involved in the FMG Project, have extensive experience in similar Projects in the Pilbara for other companies.

8.1.4 (SUB6) ***Cumulative effects****: Part A and Part B of the FMG Project need to be considered together. The PER is only reviewing Stage B of the proposal. It is a public stand-alone document and as such should identify all the impacts of the entire proposed Project.*

8.1.5 (SUB10) ***Cumulative effects****: clearly the works defined in Stages A and B constitutes a single Project and as such will present common and overlapping areas of environmental concern. Whilst the public comment periods for the Stage A and B PER's do not overlap Section 1.6.2 of the PER advises that "the EPA will be assessing both Projects concurrently". If the DoE is to assess both PER documents concurrently the public should similarly be able to assess and provide comments on the PER's concurrently.*

Whilst the Minister for the Environment encouraged the two Projects to be assessed concurrently where possible, she also recognised that there may be practical constraints in doing so. The Minister did not stipulate that the public comment periods for both Projects must overlap.

Whilst the public comment period for the two Projects did not overlap, both Projects are undergoing various stages of the Environmental Impact Assessment process concurrently.

Although the two Stages are closely linked, their environmental impacts and geographical separation of the two Projects are sufficiently distinct for them to be assessed in two stages (as supported by the Minister's approval for the Project to be separated into Stage A and B).

In order to ensure that the interrelationships between the two Projects are clearly articulated and well understood, FMG has written a dedicated Section on this topic in both the Stage A and Stage B PERs (Sections 1.5 and 1.6 respectively). This ensured that during the public comment period for each PER, there is an opportunity for stakeholders to comment on the interrelationships between the Projects, as has been demonstrated throughout this document.

8.1.6
(SUB11)

Cumulative effects: the FMG Project has been arbitrarily separated into Stage A and Stage B PER's, notwithstanding that the two parts are inseparable components of an integrated whole, with operations unable to be commenced unless both are approved.

Additionally, a number of aspects of the Project that may have environmental impacts (such as power supply (Section 5.3.10) and quarries (Section 5.4.6)) are effectively "carved out" out of the application by the statement that they will be undertaken by an external (though as yet unidentified) party.
We are concerned that the approach of carving out individual Sections of the Project, particularly through the artifice of a conjectural third party supplier, might tend to have the effect of failing to adequately capture the cumulative environmental impacts of the Project. This issue is not addressed at all in the Stage B PER.

Refer to 8.1.5 regarding separation of the two stages of the Project

FMG is an iron ore mining and processing company and does not own or operate power stations. Therefore power supplies depend on a third party, and as stated in Section 5.3.10 of the Stage B PER, Alinta and the Goldfields Gas Transmission Company are two parties that are being considered to provide this service.

Similarly it is expected that quarrying and excavation of borrow material, particularly for construction of the railway, will be contracted out. Any development of a borrow pit or quarry by a third party will need to take into account the environmental management measures and commitments made for this Project. Management of borrow pits and quarries is outlined in Section 5.4.2 of the Stage B PER.

The key environmental issue relating to power supply is Greenhouse Gas emissions, which has been considered for the Stage B Project in Section 6.8 of the Stage B PER. Other air emissions that may occur during power generation are not considered a key issue, as the current best-practice technology used for power stations result in very low levels of air emissions in order to comply with stringent Australian and International air quality guidelines. Whilst clearing impacts of a new power station (if required) and gas pipeline and transmission corridors have not been included in final clearing estimates for the Project, the locations of these can have some flexibility to allow them to be located in already disturbed areas or adjacent to existing infrastructure, thus minimising the impact on native vegetation. These more minor issues would be included as part of any assessment for the development of power supplies.

The estimated clearing for the Project included areas for borrow pits, quarries and other areas of temporary disturbance. However, in practice it is expected actual clearing from borrow pits and quarries will be less than the estimate provided, as these will be preferably located in areas designated for pit and overburden stockpile locations, and overburden will be used where practicable in site preparation works to minimise the need for additional borrow pits. Proposed management of borrow pits and quarries is outlined in Section 5.4.2 of the Stage B PER

8.1.7 (SUB10) ***Ongoing and future studies****: we note that a number of studies related to the PER are either ongoing or have not been undertaken. For example, further hydrogeological work is required to confirm or otherwise the numerical hydrogeological assumptions made in the Stage B PER. Documents either incomplete or are yet to be prepared include:*

- *Sustainability Strategy – to be prepared.*
- *Environmental Management System - to be prepared.*
- *(Construction) Environmental Management Plan (Appendix B) - draft.*
- *(Operation) Environmental Management Plan - to be prepared.*
- *Project Closure Plan (Appendix Q) – draft.*
- *Rehabilitation and Revegetation Management Plan (Appendix D) – draft.*
- *Weed Hygiene and Management Plan – to be prepared.*
- *Fire Management Plan – to be prepared.*
- *Borefield Management Plan – to be prepared.*
- *(Construction) Dust Management Plan – to be prepared.*
- *(Operation) Dust Management Plan – to be prepared.*
- *Greenhouse Gas Management Plan – to be prepared.*
- *Waste Management Plan - to be prepared.*
- *(Construction) Noise and Vibration Management Plan - to be prepared.*
- *(Operation) Noise and Vibration Management Plan - to be prepared.*
- *Cultural Heritage Management Plan - to be prepared.*

It is common practice during the EIA Process that the proponent makes a series of commitments (such as the plans indicated above), which must be completed in consultation with nominated advisory agencies, within specified timeframes. Proponent commitments will be included in Ministerial Conditions issued by the Minister for the Environment. FMG is legally obliged to complete all commitments prior to the timeframes nominated. Each and every Environmental Management Plan listed in the Project commitments will have to be completed to the satisfaction of the Department of Environment Audit Branch, in most cases before construction can commence.

The results of further studies requested of FMG by the EPA are included in Section 3 of this report. This includes the following information:

- additional stygofauna sampling; and
- additional hydrological information.

8.1.8 (SUB10) ***Geotechnical studies****: our understanding is that the proponent has not undertaken any geotechnical studies but that it is in the process of applying for an environmental licence to undertake such investigations. Clearly such work should have been undertaken and assessed prior to the submission of the PER.*

Geotechnical Studies form part of the detailed feasibility study required for the railway and are not required for the assessment of the Stage B PER. Geotechnical studies will enable a final route and borrow pits to be selected within the proposed 2km wide corridor. The 2km wide rail corridor has already been subjected to a detailed impact assessment. FMG has committed to completing flora and fauna surveys in areas not adequately surveyed (such as borrow pits).

8.1.9 (SUB12) ***Assessment of impacts from quarrying****: any quarry sites that FMG requires for ballast during railway construction (5.4.2 Borrow Pits and Quarries page 84) should be assessed as part of this PER as they are integral to the construction aspects of the Project. This is not currently the process as the quarry sites have not yet been identified and, as stated, a third party who will be responsible for obtaining the necessary approvals may manage these sites. This staged approach to the approval process places an element of risk on the Government in determining the environmental acceptability of this Project as all the information is not presented and assessed in parallel.*

FMG has committed to ensuring that ballast and quarry sites not provided by a third party will be managed in consultation with CALM. Biological surveys will be conducted on these facilities to ensure that species and vegetation of conservation significance are avoided. If construction materials such as ballast and rip rap are sourced from a third party, then the approval process will be conducted separately to FMG's Stage A and B proposals. FMG is committed to ensuring that all aspects of its Project are carried out in an environmentally responsible manner.

8.1.10
(SUB11)

***Timing of application**: at Section 5.3.12 (Mine Scheduling) it is stated that "Christmas Creek will be mined for the first 8 years of production. The other three mining areas will be mined in combination over the following 12 year period, in order to produce the grade required by customers at that time". We understand that standard EPA conditions require that approved Projects must be substantially commenced within five years of the date of approval.*

As the proposed Chichester Ranges mines will share infrastructure such as the beneficiation plant (Section 5.3.5) and rail spur, and blending of product from these mines will occur, it seems reasonable to consider that they are interconnected in such a way that they should be considered as a whole, where commencement of one part of the operations amounts to commencement of the whole.

However, Mindy Mindy is located a significant distance from the other mine sites, will not utilize any other item of infrastructure the subject of the Stage B PER, and its production will not be blended with ore from the other mine sites. Accordingly, commencement at Christmas Creek cannot be considered to amount to commencement at Mindy Mindy.

As FMG has no intention of commencing operations at Mindy Mindy within a reasonable time frame, it has not carried out sufficient work to allow it to adequately describe the operations it proposes to undertake at this location. The FMG PER, to the extent it deals with proposed operations at Mindy Mindy, has been submitted prematurely.

While mining operations at Mindy Mindy are staged to commence after the commencement of mining at Christmas Creek, the ore at Mindy Mindy forms part of the overall reserve and, as such, should be included in this assessment. The blending of ore from different minesites such as Mindy Mindy is likely to be required to meet customer requirements.

8.1.11
(SUB11)

***Project proponent**: at Section 1.4 of the PER it is stated that "The Proponent and owner of the Pilbara Iron Ore and Infrastructure Project is Fortescue Metals Group Limited".*

We understand that the proposed Mindy Mindy mining operations are on

> *ground held under exploration licences by Pilbara Iron Ore Pty Ltd (E47/1191,1192,1156 and 1157) and by Mr Derek Ammon (E47/1140). It is difficult to reconcile the statement quoted above with these facts.*
>
> *We further note that any environmental conditions imposed upon the Project proponent (in this case FMG Limited) attach to it, not the registered tenement holders.*
>
> *Consequently, it is appropriate that the registered tenement holders be included as Project proponents, in order to ensure that the imposition of conditions will bind all relevant parties.*

Pilbara Iron Ore Pty Ltd is a 50/50 joint venture between Consolidated Minerals and FMG, this relationship is outlined on Page xi of the Stage B PER. This is the joint venture company which holds all tenements at Mindy Mindy apart from E47/1140. Tenement E47/1140 is registered in the name of Derek Ammon. However Consolidated Minerals has a Joint Venture agreement with Ammon. This agreement states that Consolidated Minerals can act on behalf of Ammon's tenement. Essentially FMG is acting on Consolidated Minerals behalf with their permission.

FMG is obligated to ensure that all environmental conditions are fulfilled by all parties involved in the Project.

8.1.12 (SUB10)

> ***Tenure**: It would appear that there is currently no tenure for the Project but that a number of possible scenarios exist. For example, Section 3.2 states that "If Project tenure is issued under the Mining Act 1978, approvals from the Department of Industry and Resources will be required once formal approvals under the Environmental Protection Act have been obtained" (emphasis added).*

FMG has recently finalised a State Agreement for the port and rail facilities covered by the Stage A PER, and is still in negotiations for a separate State Agreement Act for the mining operations. Tenure issued under the *Mining Act (1978)* is also being sought for the mining areas. Hence, FMG are obliged to seek approval from the DoIR before the Project can commence.

8.1.13 (SUB10) ***Project constraints****: Section 1.6.2 of the PER identifies the gaining of environmental approvals and appropriate tenure as "constraints to the Project timing". This suggests the proponent views the gaining of the legal authorities to operate the Project as an impediment.*

FMG does not view these approval processes as impediments and is committed to meeting all legal requirements. FMG will finalise all Environmental Approvals and gain appropriate tenure prior to construction of the Project commencing. This process however involves extensive consultation with the local community, regulators and other interested parties which takes time and can result in delays in Projected Project timings if key stakeholders require an extended period of consultation. For this reason, FMG has commenced the Environmental Approvals Process early in the Project planning stage.

FMG is pursing two State Agreements, one for the rail and port facilities and one for the mining operations. This process is also a lengthy one. The State Agreement for the port and rail authorities has recently been finalised by the WA State Government and the State Agreement for the mining operations is still in the negotiation process.

8.1.14 (SUB4,5) ***Consideration of economic issues****: under the Environmental Protection Act definition of 'environment', consideration of economic factors is required. Impacts on sterilisation of mineral resources have not been considered in the PER.*

Not only is it unreasonable to require FMG to assess the economic consequences of the Project on the exploitation of "unknown" mineral resources, but such an assessment falls out of the scope of, and is not anticipated by the EPA position statements. If FMG's Project is approved and constructed and mineral resources are discovered at or in the vicinity of the Project, any potential landuse conflict will be addressed through the procedures under the *Mining Act 1978.* Refer to Appendix E of this document for further information.

8.1.15 (SUB10) ***Project feasibility studies****: our understanding is that the proponent has not yet undertaken a feasibility study of the Project. We submit that this is a necessary precondition to any approval of Project of this scale.*

FMG is currently undertaking a bankable feasibility study which will be completed in the first half of 2005. While commencement of construction would be dependant on a satisfactory feasibility study, all indications to date show that FMG's proposal is both economic and technically feasible. The preparation of an environmental impact assessment forms part of the feasibility study, as is standard industry practice.

8.1.16 (SUB15) ***Decision-making authorities****: the Town of Port Hedland would also like to be officially recorded as a decision-making authority (DMA) involved in the Project approvals (currently not listed with DMAs as listed on p10 of the PER document).*

FMG agree with this statement and will continue to consult with the Town of Port Hedland as one of the key decision making authorities.

8.1.17 (SUB15) ***Department of Environment office:*** *the Town of Port Hedland feels that it would be valuable that a Department of Environment office be sited in Port Hedland (with associated staff), this would assist substantially with dust monitoring and enforcement/regulation of license and operating conditions.*

The submitter may wish to raise this issue with the State Government.

8.2 Consistency with EPA Guidelines

8.2.1 (SUB1) ***Adequacy of terrestrial fauna survey****: the terrestrial fauna survey for Stage B of this Project is inadequate to meet the requirements of EPAs Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection (2002) and EPA draft Guidelines Terrestrial fauna surveys for environmental impact assessment in Western Australia (2003).*

As EPA Guidance Statement No 56 forms a more detailed and fauna-specific response to EPA Position Statement No. 3, we will address that in response to the above comment. We note that submitter to the draft Guidelines issued in 2003, when these were in fact published as final by EPA in June 2004.

The specifically stated objectives of Guidance Statement 56 are to ensure:

– *There is clarity for proponents on the scale of fauna and faunal assemblage survey appropriate for different areas;* - The survey work was consistent with the level of investigation indicated Appendix 2 of Guidance 56 – a ‘Level 2’ survey (based on ‘Scale and Nature of Impact’ – High and ‘Bioregion’ - Group 2);

– *the fauna and faunal assemblage survey, analysis, interpretation and reporting undertaken for EIA is of a suitable quality and of consistent methodology to enable the EPA to judge the impacts of proposals on fauna and faunal assemblages;* - Met by this survey (see Response 0)

– *the environment, in particular significant fauna and faunal assemblages, is identified and protected through best practice in the conduct and reporting of fauna and faunal assemblage surveys for EIA* – met by this survey both in supplying data to the proponent which will be used in refining Project design to avoid or minimise fauna and fauna habitat impacts, and also by providing EPA with adequate data to evaluate the proposal's impacts;

– *Western Australia's knowledge base of fauna and faunal assemblages and biogeography are developed and enhanced over time at both the local and regional scale to the benefit of future decision making* - Met by this survey given the vouchering of specimens for further research at the WA Museum, and the collection of almost 9,000 individual fauna records across 178 taxa in a part of the Pilbara where limited historical survey work has been completed ;and

– *survey data are capable of underpinning long-term observation and measurement for later compliance and audit purposes (especially as this pertains to completion criteria for Projects)* - Met by this survey (see Response 5.8.2).

The detailed requirements of Guidance 56, including the use of zoologists experienced in the region, consideration of short range endemics, statements of limitations and many other specific matters, were all met by the survey and the subsequent reporting.

8.2.2 (SUB1) ***Scoping document****: had the scoping document contained adequate and appropriate information, and the survey work not been undertaken prior to receiving feedback from the public, then this situation (inadequacy of terrestrial fauna survey) could have been avoided.*

The scoping document for this Project was prepared in accordance with the relevant guideline (Environmental Protection Authority, 2002). An outline of the proposed studies and investigations were included in the scoping document as per Section of the guideline. Input was received in developing the scopes for the studies from representatives of the Departments of Conservation and Land Management, and Environment.

8.3 Proponent Commitments

8.3.1 (SUB6) ***Proponent commitments**: commitments No. 1 and 2 are not auditable by the Department of Environment (DoE). These commitments should be deleted. Alternatively the proponent may include another table highlighting commitments FMG has made but indicating that these commitments will not be audited by the DoE. Commitments 4 and 5 should list those aspects of the Project that will require specific management strategies. Consideration should be given by FMG to plans that they can "Prepare and make publicly available". For example the Waste Management Plan.*

FMG has deleted Commitments 1 and 2. However, it is the intention of FMG to still carry out these commitments. Commitments 4 and 5 have been amended to list proposed management strategies. An updated table of commitments is included in Section 10.

8.3.2 (SUB2) ***Stakeholder consultation**: no contact or stakeholder consultation was undertaken with us, notwithstanding the potential impact on our proposed Project. No details of our File Notation Areas are given in the Stage B PER, other than in Figure 1, and then at a scale where no adequate assessment of the potential impacts of the FMG proposals on the our proposals can be made.*

FMG has attempted consult with all stakeholders, with varying levels of success. This submitter has been provided with GIS information on FMG's proposed railway and hence is able to make an informed assessment of the potential impacts of FMG Project has on its proposals.

A File Notation Area is simply a "flag" or "notation" created by the Department of Industry and Resources (DOIR) to record a proposed use of crown land. Functionally, any proposed land transaction or proposed alienation from the Crown or other proposed changes in land which come to the attention of DOIR are notated by DOIR into its TENGRAPH® database and are thereafter referred to as "file notation areas". An FNA is therefore simply a notation made by DOIR into its TENGRAPH® database.

An FNA does not provide any tenure or security for an intended land use. In other words, the FNA does not and cannot create any legal standing for the land use to occur and therefore does not preclude the EPA from granting approval for another proposal in the area.

8.3.3 (SUB11) ***Stakeholder consultation**: FMG has not consulted with us (BHPBIO) in relation to relevant aspects of the Project.*

FMG has attempted to consult with all stakeholders with varying levels of success. FMG would be happy to discuss relevant aspects of their Project with BHPBIO.

8.3.4 (SUB14) ***Action arising from consultation**: the consultation program undertaken by FMG was comprehensive however in some cases the results of the consultation and any action taken by FMG to address issues raised by stakeholders is unclear, for example it is not specified whether the concerns of the pastoralist in relation to movement of fencing have been addressed.*

Refer to Section 5.5.6 Access & Stock Management, FMG will liaise with the affected land holders regarding impacts on land access and land use to reach an appropriate outcome. Management measures may include additional fencing and gates, cattle crossings and land use agreements. It is not a requirement of the EIA process to have finalised land tenure issues and land access agreements with pastoralists or other stakehodlers. This will be finalsied in the detailed plan stages. Consultation is to understand the issues to ensure that they are addressed prior to finalising any agreement

8.4 Site Environmental Management

8.4.1 (SUB12) ***Environmental controls in contractor conditions**: the proponent should apply some form of penalty to contractors in breach of environmental conditions and should also consider incentives for good performance.*

All contractors will be required to comply with the Project's environmental requirements, or risk facing contract penalties. Contracts specify that should contractors cause disturbance of ground beyond the limit of the defined work area, they will be responsible for the rectification and rehabilitation of the area at their cost.

8.4.2 (SUB12) ***Environmental accountability**: require details as to how the environmental accountability will operate we need details as to how the environmental accountability will operate on-site to ensure that there is adequate on-ground environmental management and supervision.*

FMG will implement and operate an Environmental Management System (EMS) consistent with the ISO 14001 international standard. The Environmental Management Plan (EMP) will include a Section on environmental accountability across FMG and its contractors. This will be reinforced through awareness training for all personnel.

8.4.3 (SUB12) ***Detailed planning for construction phase****: the current Construction Phase EMP broadly covers the majority of environmental issues at a general level, accordingly the plan will require much greater detail prior to construction commencing. CALM (through its Pilbara Region) should be consulted by FMG during the development of the subsequent detailed EMP.*

FMG agrees further detailed planning is required and that consultation with CALM should occur in this regard. FMG have committed to the development of a number of management plans, which will form the detailed part of the Construction EMP.

8.5 Land Use Planning

8.5.1 (SUB1) ***Lease exclusion zones****: The release of the EPA Bulletin for the proposal should be delayed until CALM has finalised the pastoral Lease Exclusion Zones in the FMG proposed Project area. Without this happening the agencies and the community are not adequately informed about all the environmental impacts of the Project on the area.*

The proposed 2015 Lease Exclusion Area has now been released by CALM. Figure 4 shows the proposed conservation estate in relation to FMG's proposed Project area.

8.5.2 (SUB12) ***Conservation reserve boundaries****: FMG suggests that the Mindy Mindy mine area is within the bounds of a conservation reserve proposal (6.13.1 Regional Context pg 168). This suggestion is incorrect. The reserve proposal that FMG is referring to is an historical proposal that was put forward jointly by CALM and the then Department of Resources Development.*

At the time the PER went to print, CALM had not released the Proposed 2015 Pastoral Exclusion Area boundaries, and FMG were using historical boundaries obtained from the Department of Land Information and the Tengraph database as a guide. FMG have since received the correct boundary from CALM and this is shown in Figure 4 in relation to FMG's Project.

8.5.3 (SUB12) ***Conservation area management strategies****: FMG should revisit the management strategies listed in Table 20 of the PER to be adopted in conservation areas in consultation with and in agreement with CALM.*

FMG is willing to re-visit the management strategies listed in Table 20 and finalise this in agreement with CALM. FMG has amended the commitment table to ensure this occurs prior to commencement of construction.

8.5.4 (SUB12) ***Fencing affecting conservation areas****: given the conservation values of the Fortescue Marsh and the future inclusion of this area in a conservation reserve (2015), any proposal for fencing in the Fortescue Marsh area should be in consultation with CALM.*

FMG will consult with CALM for any proposal for fencing around the Fortescue Marsh

8.5.5 (SUB12) ***Fencing types****: as is standard practice throughout the Pilbara in relation to fences at mining operations, barbed wire is not to be used. FMG should adopt a similar policy for all its fences. This protocol has been adopted to limit the entanglement of Ghost Bats in fences, particularly station fences used for livestock management. Ghost bats are likely to forage in the Project area, as they are known from Marillana to the south and Nullagine to the north.*

Any proposal to fence any part of FMG's proposal will be done in consultation with CALM and relevant Pastoral Lease holders. Barbed wire will not be utilised in any fence constructed by FMG.

8.5.6 (SUB12) ***Future ownership of rail asset****: CALM notes the assertion that the rail should be seen as a State asset (6.12.2 Rail Decommissioning, pg 166). FMG has not addressed the implications of labelling the rail as a State asset. FMG should commit to a decommissioning plan addressing the future liability of the railway, unless the Government accepts it as a State asset.*

FMG acknowledges this point and agrees to explore this issue as part of the closure planning process.

8.6 Offsets

8.6.1 (SUB12) ***Offset package**: in the event that the proposed preferred route is approved, an offset package should include but not necessarily be limited to:*

- *funding to CALM to facilitate early acquisition of 2015 Fortescue Marsh conservation reserve areas as well as additional adjoining areas;*
- *fencing of the conservation reserve;*
- *funding a position within CALM to manage Project implementation and operation (over the life of the Project) for the area proposed for CALM management;*
- *research including funding for management and resolution of outstanding taxonomic issues identified in the biological survey documents;*
- *a Fortescue Marsh Management Plan; and*
- *land purchases for conservation.*

Section 4 of this report details proposed offsets for the Project.

8.6.2 (SUB12) ***Offset package**: CALM notes that FMG has suggested several options as possible offsets (PER 6.3.1.2 Management Strategies page125, Appendix D 6 Research and Development pg 19). CALM considers most of these suggestions to be core business activities and best practice in regard to the management of a mining operation (eg rehabilitation, research and development).*

The Draft EPA position statement No. 9 “Environmental Offsets” (pg 9) states the following;

“Primary Offsets are at least one activity selected to counterbalance the environmental impact, with the aim of achieving no environmental difference eg: restoration, rehabilitation, reestablishment, sequestration or contributions to an approved ‘bank’, credit trading scheme or trust fund (as deemed appropriate by the EPA).

Secondary Offsets are select complementary activities (as necessary) to help the primary offset meet the offset principles eg. acquiring land for conservation, protection mechanisms, management, education, research, removal of threats, or other activities having a proven environmental benefit".

FMG considers that its proposed offsets meet the intent of draft EPA Guidance Statement No.9

8.7 Potential Sterilisation of Resources

8.7.1
SUB4,5,11

***Land use planning**: FMG proposes that the EPA approve route 2 as the preferred alignment for the east-way rail line.*

Impacts on the mineral resources underlying the proposed rail route have not been assessed in the PER. Some of these areas are considered highly prospective. Despite this, mining is not identified as a potential land use zoning in Section 3.4 of the PER.

Based on the information contained in the PER, it is believed that significant commercial iron ore deposits will be sterilized by the proposed FMG east-west rail line.

FMG should be required to prepare a supplementary PER which addresses this matter. The supplementary PER should be made available for public comment.

Refer to response 8.1.14.

8.8 Sustainability

8.8.1
(SUB3)

***Staged development:** There is an alternative to the no development option - staged development. Currently the government allows companies to sit on leases with known resources eg bauxite resources in the Kimberley for many years without developing them until they have exhausted current mine areas. The converse should also be put into practice, that is, the government allowing development in a timely sustainable way which by definition would also be more environmentally appropriate. This proposal will result in massive clearing totalling 17,107 ha. The proposal should be at least scaled back to one mine and revegetation started and the environmental impact can be truly assessed.*

> *The government must strategically plan for any future developments. The iron ore resource will then last well into this century and there will not be a non sustainable boom for say twenty years with all the negative outcomes for the environment as well as the undoubtable social ones.*

FMG considers that the mining proposal does represent a staged proposal with mining to occur over more than twenty years and rehabilitation occurring progressively during that time. The mine is being developed to meet increasing global demand for iron ore. Were FMG to produce and supply iron ore at a lower rate, an additional supply would need to be sought from elsewhere.

Exploration will continue during the life of the mine and reserves may be expanded to give the operations a longer life.

8.8.2

(SUB3)

Core objectives*, the proposal does not appear to meet the core objectives of the National Strategy for Ecologically Sustainable Development (NSESD) e.g.*

- *Enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations (see comments 2.3). This Project seems to be all about getting in and shipping out as much ore now rather than working on a staged development with the appropriate amount of infrastructure.*
- *To provide for equity between generations. Future generations will have taken from them environmental and natural heritage assets for the short term gain of the current generation should this proposal proceed in its current form.*

Whilst it can be argued that mining in itself is not sustainable as it involves extracting minerals and using fuel resources that will one day be depleted, it can equally be argued that it is possible to:

1. design, construct, operate and decommission the Project in a way which meets the core objectives of the National Strategy for Ecologically Sustainable Development (ESD); and
2. provide long-term benefits that are sustainable even within the context of a mining Project. This includes making changes to operations to secure future benefits, being innovative in improving environmental, social and economic outcomes and in working together with the community to meet a common goal.

- *Enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations*: Resource Projects are the main economic and employment generators in the Pilbara region. FMG will maintain a focus on regional capacity building in the Pilbara through offering local employment opportunities; implementing education and training programmes for the local workforce; using local suppliers and establishing partnerships with local businesses where commercially practicable, to contribute to the long-term economic development and sustainability of the Pilbara region. The Project as a whole will see mining and export of iron ore over 20 years or more. Further exploration may lead to an extension of FMG's known resource and thus an extension of the life of the Project and benefits for the community.

- The education, training and local business development benefits will extend well beyond FMG's Project life and will have run-on benefits to many areas such as tourism and pastoral activities not directly associated with the Project.

- *To provide for equity between generations:* FMG will make every effort to minimise the potential environmental and social impacts of the Project to ensure future generations are not disadvantaged by construction of the four mines and east-west railway. This includes such measures as developing (through specific research programmes and on-site trials) and implementing 'best-practice' environmental management measures; progressive rehabilitation throughout the life of the mine to re-instate as far as practicable pre-mining contours and vegetation communities; and providing support to the local communities through training, employment and local business opportunities as outlined above. Thus future generations will receive a legacy of environmental understanding and social benefit extending many generations into the future.

- *To protect biological diversity and maintain essential ecological processes and life support systems:* FMG has undertaken surveys of flora, vegetation and fauna across the habitats represented within the Project area and has avoided areas of ecological significance where practicable. However, the Project is constrained to some extent by the location of the ore bodies which occur in, and on the edge of the Chichester Ranges. The mines and east-west railway route cover approximately 2.7% of the Mulga communities in the Chichester Footslope Unit and 1.4% of the Mulga communities in the Fortescue Marsh Surrounds Unit (as defined in Section 6.3.1 of the Stage B PER).

FMG recognises the importance of the Chichester Ranges and the mulga shrublands and has developed management measures to minimise the impacts of the Project on these features. FMG have considered offsets to the disturbance of Mulga groves, as such further information is provided in Section 4.1.

8.8.3
(SUB4,5)

Impact on future resources*: the proposed rail route 2 could sterilise other mineral resources. This is inconsistent with the principles of sustainability outlined in a number of guidance documents.*

Refer to response 8.1.14 and also Appendix E of this document.

9 SUMMARY TABLES OF SUBMISSIONS

MATRIX IDENTIFYING ISSUES RAISED BY GENERAL PUBLIC AND CONSERVATION GROUPS TENDERING SUBMISSIONS TO DEVELOPMENT PROPOSAL

NOTE: ISSUES NOT TO BE IDENTIFIED WITH NAMES OF SUBMITTERS

🟦 **= PRO DEVELOPMENT**
⬜ **= ANTI DEVELOPMENT**
🟨 **= NEUTRAL**

SECTION	ISSUES	SUBMISSION NUMBER														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	BIOPHYSICAL															
5.1	Landscape values			X			X									
5.2	Fortescue Marsh	X					X		X	X			X			
5.3	Surface water (exc. sheet flow/ mulga woodlands)		X	X			X		X	X						
5.4	Sheet flow and mulga woodlands (inc. rail route selection)			X			X		X	X			X	X		

SECTION	ISSUES	SUBMISSION NUMBER														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5.5	Groundwater						X		X							
5.6	Vegetation			X			X		X	X			X			
5.7	Weed management												X			
5.8	Terrestrial fauna	X							X				X			
5.9	Stygofauna								X				X			
5.10	Aboriginal heritage								X		X					
5.11	Fire management												X			
5.12	Mining method								X							
5.13	Site water management								X				X			
5.14	Power supply						X		X				X			
5.15	Further ore processing						X		X							X
5.16	Other infrastructure								X				X			
5.17	Waste management								X							
5.18	Land rehabilitation and Project closure	X							X				X		X	

SECTION	**ISSUES**	**SUBMISSION NUMBER**														
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
	POLLUTION															
6.1	**Greenhouse gas emissions**						**X**		**X**							
6.2	**Dust**								**X**							**X**
6.3	**Acid-generating material**								**X**							
6.4	**Asbestos**								**X**							**X**
6.5	**Hydrocarbon management**												**X**			
6.6	**Light overspill and noise**												**X**			
	SOCIAL															
7.1	**Existing social environment**							**X**								
7.2	**Workforce and accommodation**							**X**								
7.3	**Other issues**							**X**								
	OTHER															
8.1	**Various issues related to assessment under the Environmental Protection Act (86)**				**X**	**X**	**X**				**X**	**X**	**X**			**X**

SECTION	ISSUES	SUBMISSION NUMBER														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8.2	Consistency with EPA guidelines	X														
8.3	Proponent commitments		X				X					X			X	
8.4	Site environmental management												X			
8.5	Land use planning	X											X			
8.6	Offsets												X			
8.7	Potential sterilisation of resources				X	X						X				
8.8	Sustainability			X	X	X										

10 REVISED TABLE OF COMMITMENTS

Topic	Objectives	Actions	Timing	Advice from
Sustainability Strategy	To ensure as far as practicable, that the proposal meets, or is consistent with, the sustainability principles in the National Strategy for Ecologically Sustainable Development.	1. Develop and implement a Project Sustainability Strategy which addresses contribution to global impacts such as greenhouse gas emissions and focuses on managing impacts across the triple bottom line of Social Capital, Economic Wealth and Environmental Assets.	Prior to the start of construction.	DoE
Environmental Management System (EMS)	Be proactive in managing environmental issues, and promoting environmental excellence during construction and operation of the Project.	2. Prepare and implement an EMS that is consistent with the ISO 14001 standard.	Prior to the start of construction.	DoE
		3. Integrate the EMS with Quality, Health & Safety and other business, systems.	Prior to the start of construction.	DoE DoIR
Environmental Management Plan (EMP)	To minimise the environmental impacts associated with the Project.	4. Prepare and implement an EMP as part of the EMS, containing specific environmental management strategies for the construction of the Project *(refer to Appendix B for draft)*.	Prior to the start of construction.	DoE DoIR
	To provide a mechanism for monitoring environmental parameters, impacts, compliance with legal requirements, feedback, reporting and continual improvement.	5. Prepare and implement an EMP as part of the EMS, containing specific environmental management strategies for the operation of the Project.	Prior to commissioning.	DoE DoIR
		6. The Proponent will ensure that all personnel and contractors comply with the requirements of the EMPs and be made aware of their obligations through an environmental awareness training programme.	During construction and operations.	DoE DoIR

Topic	**Objectives**	**Actions**	**Timing**	**Advice from**
Project Closure Plan	To ensure, as far as practicable, that decommissioning and rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and meets other environmental objectives including biodiversity.	7. Develop a comprehensive Project Closure Plan which includes Closure Criteria to be agreed with the regulators *(refer to Appendix Q for draft)*.	Within two years of commencement of mining.	DoIR DoE
		8. Review the Project Closure Plan regularly during the operational life of the Project.	At least every two years during the operational life of the Project.	DoIR DoE
		9. Submit a final Project Closure Plan to the regulators for approval, no later than two years prior to the planned closure of operations.	Two years prior to the planned closure of operations.	DoIR DoE
Terrestrial Flora and Vegetation	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities. Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act* 1950.	10. Design infrastructure to avoid declared rare and priority flora and species of conservation significance, and minimise disturbance to flora and vegetation communities.	During the design phase.	CALM
		11. Prepare and implement a Rehabilitation and Revegetation Management Plan, to address the impact of vegetation clearing *(refer to Appendix D)*.	As part of the PER. Review prior to commencement of construction.	CALM DoE
		12. Complete revegetation and rehabilitation activities in accordance with agreed closure criteria to be developed as part of the Closure Plan.	During progressive rehabilitation activities throughout the life of the Project and on closure.	DoIR DoE

Topic	**Objectives**	**Actions**	**Timing**	**Advice from**
Weed Hygiene and Management Plan	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	13. Prepare a Weed Hygiene and Management Plan that contains procedures to minimise the introduction and spread of weeds, including: • identifying target weeds; • hygiene inspection and washdown procedures for all mobile plant and equipment. • control measures that may be necessary for some species; • monitoring and any follow-up control including reporting to relevant authorities.	Prior to construction.	CALM APB
		14. Implement the approved Weed Hygiene and Management Plan.	During construction, operations, and decommissioning.	CALM APB
		15. Ensure sites (including temporary construction camps) have contained wash down facilities.	During construction and operations.	
Fire Management Plan	Reduce the risk of unplanned fires and provide contingency measures to minimise any impacts in the event that a fire is started.	16. Prepare a Fire Management Plan to include: • installation of necessary fire breaks; • safe work procedures for all welding and grinding work; • personal fire hazard procedures; • vehicle fire hazard procedures; • emergency fire response procedures; and • bushfire contingency plans.	Prior to construction.	CALM FESA
		17. Implement the approved Fire Management Plan.	During construction and operations.	CALM FESA

Topic	**Objectives**	**Actions**	**Timing**	**Advice from**
Terrestrial Fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the Wildlife Conservation Act 1950,	18. Design infrastructure to avoid specially protected (threatened) fauna habitats, other significant fauna habitats, and minimise disturbance to fauna habitats in general.	During the design phase.	CALM
Water Supply	Maintain (sufficient) quality of groundwater so that existing potential uses, including ecosystems maintenance are protected.	19. FMG will conduct further hydrogeological work (including pump testing) as outlined in Section 6.2.13, to confirm the numerical hydrogeological modelling assumptions made for this PER, and submit the results of this work to the EPA for review.	Prior to finalisation of the EPA Report and Recommendations.	DoE (WRC)
		20. Prepare a Borefield Management Plan *(refer to Appendix G)*.	As part of PER. Review prior to development of the borefield.	DoE (WRC) DoIR
		21. Implement the Borefield Management Plan, including the groundwater and vegetation monitoring programmes.	During construction, operations and post-closure.	DoE (WRC) DoIR
		22. Develop a contingency plan for timely development of an alternative water supply borefield if the groundwater impacts model and/or vegetation conditions assessment predict an adverse impact on phreatophytic vegetation.	During operations.	DoE (WRC)

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FIGURES

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Appendix A

Additional Hydrogeological Drilling and Testing Programme

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FORTESCUE METALS GROUP

REPORT ON ADDITIONAL HYDROGEOLOGY DRILLING, TEST PUMPING AND GEOPHYSICAL LOGGING AT MOUNT LEWIN AND CHRISTMAS CREEK

APRIL 2005

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SECTION 1 - INTRODUCTION

Fortescue Metals Group (FMG) is proposing to commence iron ore mining at several pits in the Pilbara. The pits are known as Mount Nicholas, Mount Lewin, Christmas Creek and Mindy Mindy. FMG has engaged Aquaterra to undertake hydrogeological investigations for the project.

In January 2005, FMG submitted a Public Environmental Review (PER) report for public consultation. The PER report included a review of the hydrogeology of the project area. The report considered the current hydrogeology of the region and possible impacts resulting from dewatering of the pits, abstraction from a proposed borefield and temporary groundwater abstraction during the construction of the Stage B railway.

In preparation of the PER report FMG undertook an extensive groundwater exploration programme. This included the drilling of 26 exploration bores in the area of the proposed borefield and additional bores in the vicinity of the mines. The bores were airlifted and the data analysed to determine aquifer properties. The results were incorporated into two numerical groundwater models that represent the hydrogeology of the project area (one model represents the area around Mindy Mindy whilst the second model represented Mount Nicholas, Mount Lewin, the borefield and Christmas Creek).

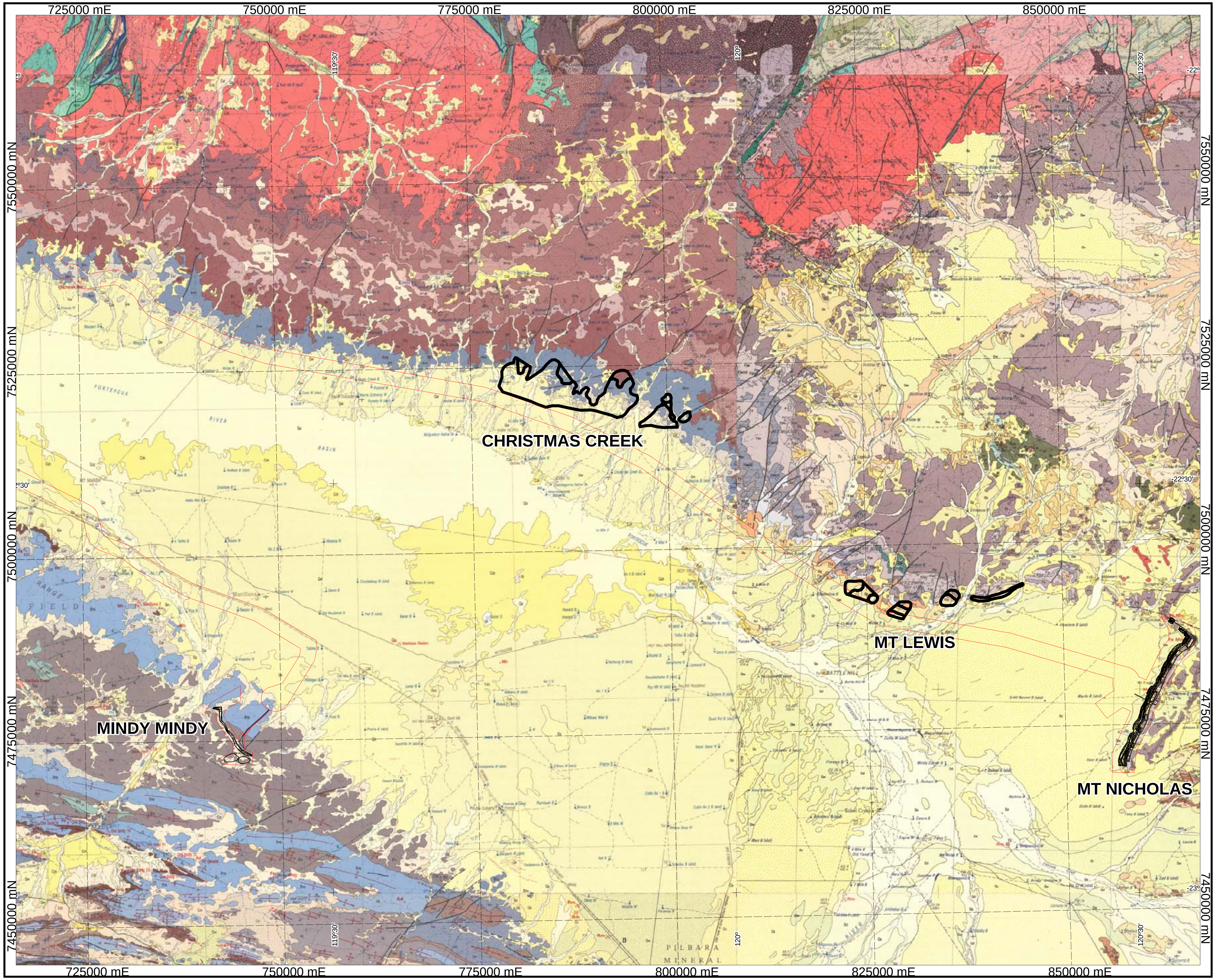
In the Stage B PER (section 6.2.13, pg 119) FMG committed to undertake additional work to confirm some of the assumption made in the numerical models. The following is an extract the Stage B PER:

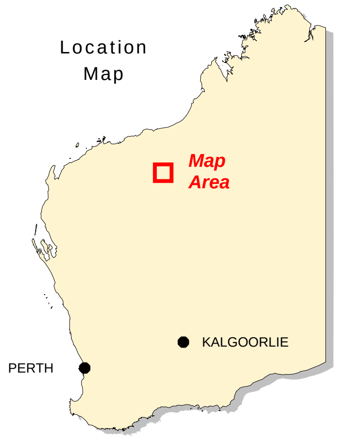
> ***"Further Work***
>
> *In the course of any groundwater modelling it is necessary to make a series of assumptions based on local and regional data. These assumptions include:*
>
> - *Estimates of recharge to each of the different aquifers*
> - *The recharge mechanisms*
> - *The permeability and storage coefficients of the different aquifers*
>
> *For this project Aquaterra have used results from the groundwater investigations undertaken, knowledge obtained from other work in the Pilbara and published data for the area. FMG also discussed the assumptions made with other hydrogeologists with experience in the study area and on this basis the assumptions were found to be reasonable.*
>
> *However, to further verify the findings to date, FMG propose to conduct additional work. The work program is designed to confirm the assumptions in the numerical groundwater models and validate the results presented in this PER. This includes the drilling of trial water supply bores in the location of the proposed borefield, and trial dewatering bores in the proposed Christmas Creek and Mount Lewin pits. Furthermore a temporary abstraction bore is to be installed close to the Fortescue Marsh to confirm that the marsh will not be affected by changes to the hydrogeology of the project area. Details of the proposed further work are given below. It is expected that all of this work will be completed by the end of the first Quarter 2005. FMG proposes to submit the results of this work to the EPA for review prior to its decision on the project.*
>
> ***Water Supply Borefield***
>
> *Work that has commenced already consists of the drilling of approximately 12 additional exploratory bores in the area south of Mount Lewin on existing FMG tenements. Information*

> *obtained from these bores will be used to verify the thickness of the alluvial deposits in this area and the topography of the basement material. In addition 5 trial water supply bores and 10 monitoring bores will be drilled in the location of the borefield. The trial bores will intercept the alluvium and underlying formation (Marra Mamba or Wittenoom Dolomite). Each of the trial bores will be test pumped for an extended period of time using a submersible pump. The results will be analysed to verify aquifer parameters. This information will be used to validate the assumptions within the numerical groundwater model and to confirm the extent of the cone of depression from the borefield abstraction.*
>
> *FMG also proposes to measure groundwater levels in station bores within the predicted cone of depression, to provide improved understanding of regional groundwater levels.*
>
> ***Dewatering Requirements***
>
> *Further work is proposed to verify the assessment of dewatering requirements. This will involve the drilling of trial water bores in the hanging wall material of the proposed Mount Lewin and Christmas Creek pits. Monitoring bores will also be drilled to penetrate the hanging wall material. Each trial dewatering bore will be test pumped using a submersible pump. The results of this investigation will be used to improve the numerical groundwater model, providing more accurate estimates of both the dewatering requirements for the Chichester Mines and the extent of the cone of depression.*
>
> ***Fortescue Marsh***
>
> *FMG proposes to install a temporary abstraction bore close to the Fortescue Marsh. This bore will be test pumped for an extended period of time and the impacts on nearby monitoring bores already installed in the area will be measured. The results will provide additional information on the hydrogeology of the Fortescue Marsh and, in particular, any impacts on the marsh from groundwater abstraction resulting from either dewatering of the proposed pits or abstraction from the water supply borefield.”*

This report describes the results of the drilling and testing work undertaken. It should be noted that FMG has also commenced its groundwater monitoring programme and the results will be made available to the Department of Environment in the Annual Environmental Report.

Figure 1.1 shows the location of the four pits overlain on the geology maps of the area.





LEGEND

▭ Mine pit outlines

N

10 0 10 20 30

Kilometres

Scale: 1:500 000

aquaterra
water resource and environmental solutions

Aquaterra Consulting Pty Ltd
Suite 4, 125 Melville Parade
COMO WA 6152

FIGURE 1.1
GENERAL LOCATION PLAN

Author:	A BALL	Date:	21/04/2005
Drawn:	Meridian GIS	Revised:	.
Fig No.:	1.1	Report No.:	.
Projection:	Lat/Long GDA94	Scale:	1 : 500 000

SECTION 2 - OUTLINE OF THE WORK UNDERTAKEN

2.1 SCOPE OF WORK

The scope of work is set out in the Introduction of this report. To meet this scope of work a detailed program to further investigate the sustainability and potential impacts of the Mt Lewin Borefield has been conducted. In order to further investigate the impacts of mine site dewatering, further investigation was also conducted at Christmas Creek. The Christmas Creek pit is closer to the Fortescue Marsh than the other pits, and therefore, whilst the risk of environmental impact from the dewatering of Christmas Creek is small, it is greater than that from any of the other pits. Focussing the testing programme on the proposed Christmas Creek pit is therefore appropriate.

Since the PER Report, FMG has also decided to undertake further investigations into the risk of saline water upconing into the Christmas Creek pit and the risk of saline water contaminating the borefield. Therefore, FMG decided to undertake down-hole geophysical investigations at nine bores within both the area of the proposed borefield and the area between Christmas Creek and the Fortescue Marsh.

The programme of work described in this report therefore consisted of:

Mount Lewin Borefield

- Drilling an additional 48 exploration bores in the proposed borefield, in the area south of Mount Lewin.
- Installing five trial water supply bores in the borefield.
- Test pumping of these five bores to determine aquifer parameters for the alluvium and basement aquifers and to determine potential yields from individual bores.
- Down-hole geophysical logging of these bores using a conductivity probe to determine if saline water is present and at what depth.

Christmas Creek

- Installation of three trial dewatering bores in the hanging wall material at Christmas Creek.
- Test pumping of these bores to determine hydraulic properties of the hanging wall material and likely abstraction rates from individual bores.
- Down-hole geophysical logging of these three dewatering bores using a conductivity probe to determine if saline water is present and at what depth.
- Installation of a trial environmental test bore (F02T), close to the Fortescue Marsh.
- Down-hole geophysical logging of this environmental bore (F02T) at Christmas Creek to determine the depth of saline water.

The studies undertaken on the borefield are described in Section 3 of this report, whilst the work undertaken at Christmas Creek is described in Section 4.

SECTION 3 - RESULTS OF THE BOREFIELD PROGRAMME

3.1 DRILLING PROGRAMME

3.1.1 Drill Logs and Bore Locations

The drilling programme included the construction of 48 exploration bores. Construction logs for each bore are provided in Appendix A and a plan showing the location of each bore, overlaying the geology map, is shown in Figure 3.1. Most of the bores were drilled using reverse circulation (RC), however some were drilled using direct circulation, which tended to result in the bores staying open for longer.

Two areas were identified for exploration drilling. The first was along the course of the Kondy Creek where FMG has an extensive tenement. The second was to the west, at Kulkinbah Creek, where FMG currently has a small strip tenement.

3.1.2 Geological Interpretation

The stratigraphy of the area was as expected and as modelled in the numerical groundwater model described in the PER report. That is it consisted of a sequence of alluvial deposits that were found to overly Marra Mamba or Wittenoom Dolomite.

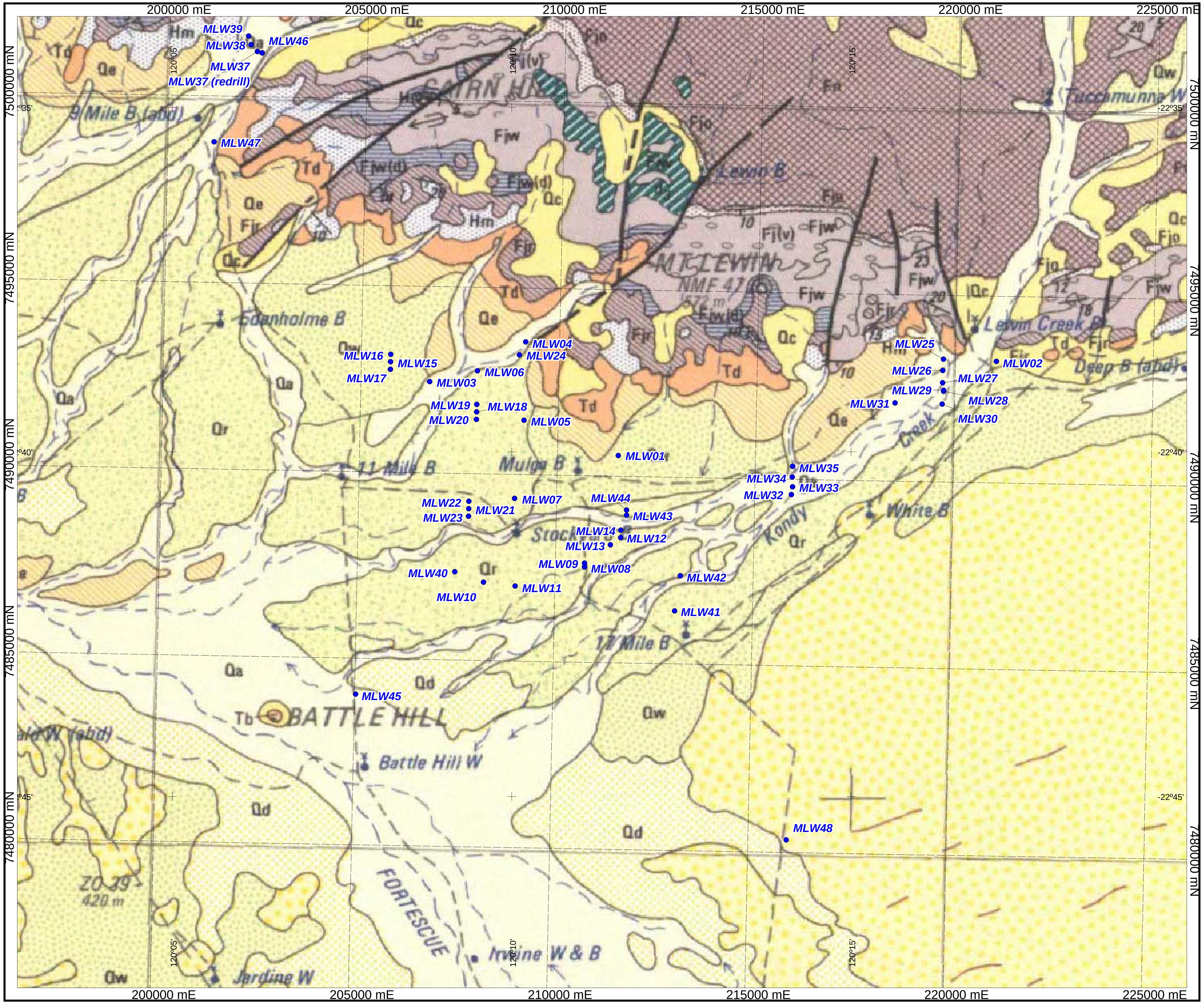
Kondy Creek

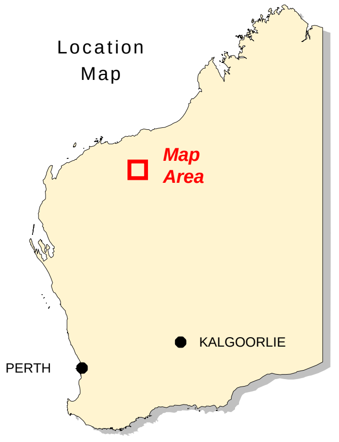
The alluvial deposits were generally found to consist of a series of silts, clays, sands and gravels. However, in many of the bores a calcrete deposit was intercepted. This deposit is believed to be associated with a paleo water level in the Fortescue Marsh; its thickness is variable with a maximum of approximately 31m, and an average thickness (where present) of 10m. The base of the calcrete was found to be, generally, around 380mRL, however this varied from 354mRL to 401mRL. This calcrete is believed to be an extension of calcrete deposits shown on the geology map at ground surface around the edge of the Marsh, particularly on the southern flank of the Fortescue Valley.

In bore MLW11 approximately 15m of sand was intercepted at a depth of approximately 50m and at MLW35 in excess of 50m of sand was intercepted below 360mRL. These sands are probably associated with a paleo channel, however, in spite of the fact that there were several other bores drilled in the vicinity, the width and course of this paleo channel has not yet been determined.

The alluvial sequence is underlain by Wittenoom Dolomite, except in the north of the exploration area where the alluvium overlies Marra Mamba. As at Mount Nicholas, the dolomite and Marra Mamba is generally of low permeability, however, in several bores, the dolomite was found to be cavernous at depth and a surface weathered profile was encountered.

On completion of drilling, each exploration bore was airlift tested to confirm its yield. In general the yields from the bores drilled at Kondy Creek were much higher than those drilled in the area west of Mount Nicholas during the first phase of exploration drilling in July to October 2004, and described in the PER report. Typically RC bores drilled in the Kondy Creek area yielded between 3 and 7 L/S, and in many cases it was felt that the rate of abstraction was constrained by the airlift capacity of the drill rig rather than the hydraulic yield of the bores.





LEGEND

● Bores

N

2 0 2 4 6

Kilometres

Scale: 1:100 000

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FIGURE 3.1
EXPLORATION BORES - MT LEWIN

Author:	A BALL	Date:	20/04/2005
Drawn:	Meridian GIS	Revised:	.
Fig No.:	3.1	Report No.:	.
Projection:	Lat/Long GDA94	Scale:	1 : 100 000

Kulkinbah Creek

At Kulkinbah Creek, five additional bores were drilled (MLW37 to MLW39, MLW46 and MLW47)) at the point where the Kulkinbah Creek courses over the Marra Mamba and then alluvial deposits. In each bore the alluvial deposits consisted of silts overlying calcareous sediments. These alluvial deposits were found to overlay weathered Marra Mamba in bores MLW37, MLW38, MLW46 and MLW47 and scree in MLW39. In each bore the Marra Mamba overlays Roy Hill Shale.

Yields from the five RC bores drilled at Kulkinbah Creek were less than 1L/S

3.2 TRIAL BORE CONSTRUCTION

Within the scope of works FMG had committed to installing five trial water supply bores within the borefield.

The five sites selected for installation of the trial bores were close to exploration bores which had been shown to have high yields. These were MLW06, MLW11, MLW22, MLW29 and MLW44. In each case a trial bore was constructed close to the exploration bore (typically 20m away) and the trial bore was given the suffix T (i.e. MLW06T). The original exploration bore was then converted to an observation bore, and nested piezometers installed at various depths to monitor water levels in the different lithological layers.

Each trial bore was drilled at 10inch diameter using a mud-rotary drilling rig. Mild steel casing was installed at the surface of each bore, which was then lined with 155mm PVC screen and casing. Graded gravel pack was used to backfill the annulus and a cement seal installed at the surface. Construction diagrams for each of the bores are given in Appendix B and summary construction details are provided in Table 3.1. Details of the lithology intercepted are given in Section 3.4.

3.3 MONITORING BORE CONSTRUCTION

As stated in Section 3.2, the original exploration bore was converted to a monitoring bore. Initially each bore was cleaned out using the RC rig and nested piezometers were installed at various depths coincident with changes in lithology. A maximum of two piezometers was installed in each exploration bore, separated by a layer of bentonite. In some instances an additional monitoring bore was installed in a specially drilled RC bore to provide additional data. Summary construction details for the monitoring bores are given in Table 3.1.

3.4 TEST PUMPING

The test pumping consisted of constant rate tests and recovery tests on each of the five bores. In addition, step tests were undertaken on two bores (MLW11 and MLW22).

The analysis of the data is complex because of the multi-layered nature of the aquifers, particularly the alluvial deposits, which, as discussed earlier, consist of alternating layers of silts, sands, clays, gravels and calcrete. This means that the water levels in the pumping and monitoring bores do not change at a uniform rate instead, for example, as high permeability layers in the alluvium are dewatered the rate of decrease of water levels will tend to increase. The results and analysis are described in the following sub-sections in some detail, which is designed to help with interpretation of the data. A summary of the results is presented in a series of tables in Section 3.4.6.

Monitoring bores are named after the adjacent trial bore, with the numeric suffix indicating the total depth of the bore (e.g. MLW06-33 indicates the bore is 33 m deep).

The entire test pumping data is presented in Appendix C.

3.4.1 MLW6T

Construction Data

The test well was constructed with slotted casing (screened) from 55m to 85m throughout the calcrete unit plus chert, jaspilite and BIF. Water levels were monitored in three observation wells:

- MLW6-33 is cased from 0-21 m and screened from 21m to 33 m through alluvial deposits (12m);
- MLW6-61 is cased from 0 – 49 m and screened from 49 to 61 m through the base of a marl formation (8m) and top of calcrete (4m); and
- MLW6-107 is cased to 101.2 m and screened from 101.2 to 107.2 m through Marra Mamba, which mostly consists of shale (6m).

Constant Rate Test Analysis

The initial water level was similar in all four bores at approximately 17mbgl (metres below ground level). A maximum drawdown of approximately 18m was recorded in the test well and water levels remained within the alluvial sediments for the duration of the test. A marl band (34-57mbgl) is located between the upper layers of the alluvium and the calcrete and is likely to represent an aquitard.

MLW06T

Water levels in the test well dropped approximately 14m in the first two minutes and then the drawdown became steadier, reaching a maximum drawdown of approximately 18m after 48 hours. Irregularities in the water levels recorded are evident which appear to be associated with pumping rate changes. A transmissivity of approximately 130m^2/d has been derived from analysis of the test pumping data (Cooper-Jacob.

Alluvial Well (MLW6-33)

Water levels in the alluvium dropped by approximately 10cm within the first 24 hours but there was little change from 24-48 hours. There is no screened interval overlap between the test well and this observation well. A 23m band of marl separates the upper alluvium and calcrete units. The water level monitoring results from this well indicate that at this location the marl deposits are acting as an aquitard, reducing vertical flow between the upper alluvium and the calcrete.

Bottom of Marl/Top of Calcrete Well (MLW6-61)

Water levels declined by approximately 1.5m during the 48hour test. There is a 6m screened interval overlap between the test well and this observation well. A transmissivity of approximately 280m^2/d has been derived from analysis of the test pumping data (Theis and Cooper-Jacob). A storativity estimate of 9 x 10^{-4} was calculated.

Marra Mamba Shale Well (MLW6-107)

Water levels declined by approximately 1.5m during the 48 hour test. There is no screened interval overlap between the test well and this observation well. A transmissivity of approximately 280m^2/d was derived from analysis of the test pumping data (Theis and Cooper-Jacob) and a storativity estimate of 7 x 10^{-4} determined. This result suggests that the Marra Mamba and calcrete deposits are in hydraulic continuity.

Recovery Test Analysis

Recovery water levels were recorded in the test well only. Water levels recovered to within 0.73m of initial levels within 30 seconds and then dropped again to record an approximate drawdown of 1.5m after 90 seconds, after which time a steady recovery was evident. A transmissivity of approximately 190m^2/d was derived from analysis of the recovery test data.

Summary

A transmissivity value of approximately 130m^2/d was derived for the calcrete from the constant rate test undertaken on the test well whilst recovery data provided a transmissivity value of approximately 190m^2/d. None of the other observation wells was only screened within the calcrete. The well within the alluvium was impacted by 10cm suggesting the marl does limit hydraulic continuity between the calcrete and alluvium to some degree at this location. The other two monitoring wells recorded drawdown of approximately 1.5m and provide transmissivity and storage values of 280m^2/d and 7-9x10^{-4}, respectively. The fact that the bore screened only in the Marra Mamba is impacted to the same extent as the bore in the calcrete (although only partially penetrating) suggests that there is hydraulic continuity between the calcrete and underlying Marra Mamba at this location.

3.4.2 MLW11T

Bore Construction Details

The test well is screened from 12m to 60m from the base of the upper alluvium (2m) through the calcrete unit (44m) and top of the sand unit (2m). Water levels were monitored in two observation wells:

- MLW11-19 which is cased from 0m to 13.1m and screened from 13.1m to 19.1m though the base of the upper alluvium (1m) and top of the calcrete (5m), and
- MLW11-60, which is cased from 0m to 54.3m and screened from 54.3m to 60.3m through the base of calcrete (4m) to the top of the sand (2m).

Constant Rate Test Analysis

The initial water level was similar in all three bores at approximately 8m below ground level. A maximum drawdown of approximately 12m was recorded in the test well. Water levels in the test well went from within the alluvium to below the top of the calcrete in less than 30 seconds. Water levels in the observation wells remained within the upper alluvium for the duration of the test.

The step test analysis suggests that the test well is 97% efficient at a discharge rate of 1,296m^2/d (the rate the constant rate test was undertaken).

Test Well (MLW11T)

Water levels in the test well dropped approximately 11m in the first three minutes (dropping below the top of the calcrete within 30 seconds) and then declined at a steady rate until approximately 180 minutes, when a drawdown of approximately 12m was recorded. Water levels remained relatively stable between 180 and 1,000 minutes. After approximately 1,000 minutes, water levels in the test well appear to recover; this is, indicative of recharge (either interception of a more permeable medium or recirculation of the discharged water). Using the Cooper-Jacob method, a transmissivity of approximately 400m^2/d has been derived from the data for the period 3-180 minutes corresponding to the calcrete aquifer, however it is possible that this result is affected by leakage from the overlying alluvium.

Base of Alluvial/Top of Calcrete Well (MLW11-19)

Water levels remained within the upper alluvium for the duration of the test, declining by approximately 1.2m during the 34 hour test. After approximately 200 minutes, the water levels appear to start to stabilise and ultimately recover after 1,800 minutes, which is believed to be due to recirculation. There is a 6m screened interval overlap between the test well and this observation well (at the top of the test well). A transmissivity of approximately 520m^2/d has been derived from analysis of the test pumping data (Theis and Cooper-Jacob) and a storativity estimate of 3 x 10^{-3} determined.

Bottom of Calcrete/Top of Sand (MLW11-60)

Water levels remain within the upper alluvium for the duration of the test. Water levels declined by approximately 1.6m during the 34 hour test. After approximately 500 minutes, the water levels appear to start to stabilise and ultimately recover after 1,800 minutes, which is believed to be due to recirculation. There is a 6m screened interval overlap between the test well and this observation well (at the base of the test well). A transmissivity of approximately 520m^2/d has been derived from analysis of the test pumping data (Theis and Cooper-Jacob) and a lower storativity estimate of 7 x 10^{-4} determined for this observation well.

MLW11T Recovery Test

Recovery water levels were recorded in the test well only. A relatively steady water level recovery was evident after approximately one minute. A transmissivity value of approximately 700m^2/d has been derived from analysis of the recovery test data.

MLW11T Summary

A transmissivity value of approximately 400m^2/d was derived for the calcrete from the test well although it is possible that this figure is affected by leakage from the overlying alluvial deposits. The recovery data from the test well provided a transmissivity value, for the calcrete, of approximately 700m^2/d.

Water levels were monitored in two observation wells, one screened in the top of the calcrete and one in the base of the calcrete. Both observation wells returned transmissivity values of approximately 520m^2/d although the storativity values were quite different. The observation well screened in the base of the upper alluvium/top of the calcrete returned a storativity of 3 x 10^{-3} while the observation well screened in the base of the calcrete/top of the sand returned a storativity of 7 x 10^{-4}.

3.4.3 MLW22T

Bore Construction Details

The test well is cased from 0m to 12.2m and screened from 12.2m to 66.2m through the base of the upper alluvium (17m), calcrete unit and clays chert and BIF (37m). Water levels were monitored in two observation wells both screened in the base of the alluvium and the top of the calcrete:

- MLW22-33 which is cased from 0m to 21.7m and screened from 21.7m to 33.7m through the base of the upper alluvium (8m) and top of the calcrete (4m), and
- MLW22-34, which is cased from 0m to 28.3m and screened from 28.3m to 34.3m thorough the base of calcrete (1m) and top of the sand (5m).

Constant Rate Test Analysis

The initial water level was similar in all three bores at approximately 8-9m below ground level. A maximum drawdown of approximately 16m was recorded in the test well. Water levels within all three bores remained within the upper alluvium.

The step test analysis suggests that the test well is 69% efficient at 1,296m^2/d; the rate the constant rate test was undertaken.

Test Well (MLW22T)

Water levels in the test well dropped approximately 14m in the first 2.5 minutes and then declined at a steady rate until approximately 60 minutes, when a drawdown of 16.35 m was recorded. Water levels in the test well appeared to recover after approximately 60 minutes, which may be indicative of recharge (most likely recirculation of the discharge water). The water level remained within the alluvium for the duration of the test. A transmissivity value of approximately 180m^2/d has been derived from the test data using Cooper-Jacob analysis.

Base of Alluvial/Top of Calcrete Well (MLW22-33)

Water levels remained within the upper alluvium for the duration of the test declining by approximately 3.5m during the 36 hour test. A steady decline in water levels occurred from the start of monitoring to approximately 1,000 minutes, after which time water levels stabilised. There is a 12m screened interval overlap between the test well and this observation well (towards the top of the test well). A transmissivity of approximately 160m^2/d was derived from analysis of the test pumping data (Theis and Cooper-Jacob). A storativity estimate of 2×10^{-3} was derived.

Base of Alluvial/Top of Calcrete Well (MLW22-34)

Water levels remained within the upper alluvium for the duration of the test, declining by approximately 1.5m during the 34 hour test. A steady decline in water levels is evident in the data from the start of monitoring to approximately 1,000 minutes, after which time water levels stabilised. There is a 6m screened interval overlap between the test well and this observation well (towards the top of the test well). A transmissivity of approximately 350m^2/d has been derived from analysis of the test pumping data (Theis and Cooper-Jacob) and a storativity estimate of 7×10^{-3} was calculated.

MLW22T Recovery Test

Recovery water levels were recorded in the test well only. A relatively steady water level recovery was evident after approximately one minute. A transmissivity of approximately 340m^2/d was derived from analysis of the recovery test data.

MLW22T Summary

A transmissivity value of approximately 180m^2/d was derived for the calcrete from the test well. While recovery data from the test well provided a transmissivity value for the calcrete of approximately 340m^2/d. Water levels were monitored in two observation wells, both screened in the base of the upper alluvium and the top of the calcrete. Analysis of data from one of the observation wells returned a transmissivity value of approximately 160m^2/d and a storativity of 2 x 10^{-3} (12m screened interval). While the second observation well returned a transmissivity value of approximately 350m^2/d and a storativity of 7 x 10^{-3} (6m screened interval).

3.4.4 MLW29T

Bore Construction Details

The test well is cased from 0m to 38m and screened from 38m to 68m. The screened section of the bore intercepts the base of the upper alluvium (12m), alluvium with minor calcrete unit (9m) and weathered dolomite (9m).

Water levels were monitoring in two observation wells:

- MLW29-29, which is cased from 0m to 21.9m and screened from 21.9m to 29.9m in the alluvium overlying the calcrete only (8m), and
- MLW29-67, which is cased from 0m to 47.3m and screened from 47.3m to 67.3m in the base of alluvium (3m), alluvium with minor calcrete unit (9m) and weathered dolomite (8m).

Constant Rate Test Analysis

The initial water level was similar in all three bores at approximately 19m below ground level. A maximum drawdown of approximately 7.5m was recorded in the test well. Water levels within all three bores remained within the alluvium overlying the calcrete.

Test Well (MLW29T)

Water levels in the test well dropped approximately 4m in the first 2 minutes and then declined at a steady rate until approximately 70 minutes (drawdown approximately 5m), when the rate of decline in water level increased for the remainder of the test (a final drawdown of approximately 7.5m was recorded). The water level remained within the alluvium for the duration of the test. The increase in the rate of water level decline evident at approximately 70 minutes corresponds to the water level reaching approximately 24.5mbgl (5m drawdown). This increase in drawdown is possibly the result of dewatering of a water-bearing horizon within the alluvium. Transmissivity values of approximately 540m^2/d (early-time data using Cooper-Jacob) and 150m^2/d (late-time data using Cooper-Jacob and Theis) were derived from the test data.

Alluvium Well (MLW29-29)

Water levels remained within the upper alluvium for the duration of the test, declining by approximately 0.7m during the 72 hour test. From the data, water level decline was obvious after approximately 100 minutes and continues until the end of the test, although there is a marked drop in water level (0.17m) at approximately 1,000 minutes. There is no overlap between the screened sections of the test well and this observation well, although both are screened within the upper alluvium. A transmissivity of approximately 580m^2/d was derived from analysis of the test pumping data (Theis and Cooper-Jacob). However, calculated values of storativity before and after the marked water level drop (at approximately 1,000 minutes) are quite different, at 1 x 10^{-1} and 7 x 10^{-2} respectively.

Base of Alluvium/Alluvium with minor Calcrete/Weathered Dolomite Well (MLW29-67)

Water levels remained within the upper alluvium for the duration of the test declining by approximately 0.5m during the 72 hour test. From the data, a steady decline in water levels was evident from the start of monitoring to approximately 70 minutes, after which time water levels stabilised and then recovered. The entire 20m screened interval of this observation well overlaps with the test well. A transmissivity of approximately 1,170m^2/d was derived from analysis of the test pumping data (Theis and Cooper-Jacob) and a storativity estimate of 8 x 10^{-4} was calculated.

MLW29T Recovery Test

Recovery water levels were recorded in the test well only. A relatively steady water level recovery was evident after approximately one minute. A transmissivity of approximately 1,260m^2/d was derived from analysis of the recovery test data.

MLW29T Summary

This test evaluated the aquifer parameters of the upper alluvium, minor calcrete bands and weathered dolomite. Transmissivity values of approximately 540m^2/d (early data) and 150m^2/d (late data) were derived from the test well. The lower transmissivity of the late time data may be the result of the dewatering of a water-bearing horizon within the alluvium. Recovery data from the test well provided a much higher transmissivity value of approximately 1,260m^2/d, suggesting that the well has a low efficiency (approximately 40%). Water levels were monitored in two observation wells, one screened within the upper alluvium only and the other with a construction very similar to that of the test well, with slotting in the alluvium, calcrete and weathered dolomite. The observation well, which is screened only in the alluvium, returned a transmissivity value of approximately 580m^2/d and a storativity of 1 x 10^{-1} (early data) and 7 x 10^{-2} (late data). The observation well with the design similar to that of the test well returned a transmissivity value of approximately 1,170m^2/d and a storativity of 8 x 10^{-4}.

3.4.5 MLW44T

Bore Construction Details

The test well is cased from 0m to 38m and screened from 38m to 80m through marl (14m), weathered dolomite (20m) and BIF (8m). Water levels were monitoring in two observation wells:

- MLW44-36 screened from 23.6m to 35.6m through the alluvium (6m) and calcrete (6m) and
- MLW44-79 is screened from 61.1m to 79.9m through weathered dolomite (11m) and BIF (7m).

Constant Rate Test Analysis

The initial water level was similar in all three bores at approximately 10.5m below ground level. A maximum drawdown of approximately 4.0m was recorded in the test well. Water levels within all three bores remained within the upper alluvium.

Test Well *(MLW44T)*

A consistent pumping rate was not established until 4 minutes into the test, after which time a steady decline in water level was evident. Water levels in the test well had dropped by approximately 4.0m by the end of the test after 44 hours. There was a slight increase in the rate of water level decline after 2,000 minutes due to an increase in pumping rate. A transmissivity value of approximately 570m^2/d was calculated from the test data.

Alluvium/Calcrete Well (MLW44-36)

Water levels remained within the upper alluvium for the duration of the test, declining by approximately 2m during the 44 hour test. A steady water level decline was evident from 20-2,000 minutes. There is no screened interval overlap between the test well and this observation well so this observation well is isolated from the units from which abstraction is being taken (weathered dolomite and BIF) by a 16m marl horizon (although the test well is screened in most of the marl band). A transmissivity of approximately 1,000m^2/d and storativity of 2 x 10^{-7} was derived from the test data but the validity of these values is uncertain as no abstraction is occurring from the units being monitored. However, the fact that almost 2m of drawdown was evident indicates that there is some degree of hydraulic continuity between the alluvium, calcrete, marl, weathered dolomite and BIF.

Weathered Dolomite/BIF Well (MLW44-79)

Water levels remained within the alluvium for the duration of the test and the maximum drawdown was 1.5m during the 44 hour test. A steady water level decline was evident from 20-2,000 minutes. The entire 18m screened interval of this observation well overlaps with the test well. A transmissivity of approximately 590m^2/d was derived from analysis of the test pumping data (Theis and Cooper-Jacob) and a storativity value of 3 x 10^{-3} was calculated.

MLW44T Recovery Test

Recovery water levels were recorded in the test well only. A relatively steady water level recovery was evident after approximately one minute and a transmissivity of approximately 700m^2/d was derived from analysis of the recovery test data.

MLW44T Summary

This test evaluates the aquifer parameters of the marl, weathered dolomite and BIF. A transmissivity value of approximately 570m^2/d was derived from the test well. Recovery data from the test well provided a slightly higher transmissivity value of approximately 700m^2/d. Water levels were monitored in two observation wells, one screened within the alluvium and calcrete only and the other with a construction similar to that of the test well, with screened section in the weathered dolomite and BIF but not in the marl. Approximately 2m of drawdown was evident in the observation well screened in the alluvium and calcrete only suggesting some hydraulic continuity between these horizons and the underlying weathered dolomite and BIF. Transmissivity and storativity values were estimated to be 1,000m^2/d and 2 x 10^{-7}, respectively, but the validity of these values is uncertain as no abstraction was occurring from the units being monitored. The observation well with the design similar to that of the test well returned a transmissivity value of approximately 590m^2/d and a storativity of 3 x 10^{-3}.

3.4.6 Summary of Test Pumping Analysis

The results of the test pumping analysis are summarised in Tables 3.1 to 3.4 below.

Table 3.1
Summary of Well Details

Well	Easting	Northing	Distance from Test Well (m)	Total Depth (m)	Screened Interval (mbgl)	Unit
MLW6T	207800	7492600	-	87	55-85	Calcrete
MLW6-33	*207829.8*	*7492600*	29.8	33	21-33	Alluvium
MLW6-61	*207829.8*	*7492600*	29.8	61	49-61	Base of Marl/Top of Calcrete
MLW6-107	*207827.75*	*7492600*	27.75	112	101.2-107.2	Marra Mamba Shale
MLW11T	208860	7486850	-	67	12-60	Calcrete/Sand
MLW11-19	*208877.3*	*7486850*	17.3	94	13.1-19.1	Top of Calcrete
MLW11-60	*208878.9*	*7486850*	18.9	66	54.3-60.3	Base of Alluvium/Calcrete/Sand
MLW22T	207650	7489100	-	70	12.2-66.2	Alluvium/Calcrete
MLW22-33	*207674.15*	*7489100*	24.15	130	21.7-33.7	Base of Alluvium/Top of Calcrete
MLW22-34	*207696.1*	*7489100*	46.1	46	28.3-34.3	Base of Alluvium/Top of Calcrete
MLW29T	219580	7492300	-	69	38-68	Alluvium/Minor Calcrete/Weathered Dolomite
MLW29-29	*219611.1*	*7492300*	31.1	30	21.1-29.1	Alluvium
MLW29-67	*219611.5*	*7492300*	31.5	70	47.3-67.3	Alluvium/Minor Calcrete/Weathered Dolomite
MLW44T	211635	7488940	-	86	38-80	Marl/Weathered Dolomite/BIF
MLW44-36	*211646.6*	*7488940*	11.6	80	23.6-35.6	Alluvium/Calcrete
MLW44-79	*211651.1*	*7488940*	16.1	80	61.1-79.1	Weathered Dolomite/BIF

Co-ordinates in italics = inferred values based on distance from test bore

Table 3.2
Summary of Pumping Test Schedules

Test Well	Test Date	Test Duration (mins)		Discharge Rate (m^3/d)	Observation Well	SWL (mbgl)*[1]	Maximum Drawdown (m)*[2]
		Constant rate	Recovery				
MLW6T	24/3/05	2,880	60	690	MLW6T	17.23	17.95
					MLW6-33	17.38	17.50
					MLW6-61	17.59	19.04
					MLW6-107	17.13	18.64
MLW11T	6/3/05	2,040	60	1,296	MLW11T	8.16	12.17
					MLW11-19	8.35	1.27
					MLW11-60	8.33	1.65
MLW22T	9/3/05	2,190	60	1,296	MLW22T	8.14	16.35
					MLW22-33	8.45	3.67
					MLW22-34	9.07	1.47
MLW29T	20/03/05	4,320	60	1,296	MLW29T	19.42	7.63
					MLW29-29	19.34	0.69
					MLW29-67	19.27	0.49
MLW44T	11/03/05	2,640	60	1,296	MLW44T	10.42	4.00
					MLW44-36	10.61	1.98
					MLW44-79	10.63	1.51

*[1] Static water level at start of constant rate test

*[4] Maximum drawdown during constant rate test

Table 3.3
Apparent Well Efficiency[1]

Well	Date Undertaken	Steps (L/S)	Apparent Well Efficiency (%)
MLW11T	06/03/05	6	99
		9	98
		12	98
		15	97
MLW22T	06/03/05	6	84
		9	78
		12	73
		15	69

[1] Apparent well efficiency representing the total additional drawdown created by hydraulic losses within the well and by non-laminar flow within the aquifer immediately surrounding the well.

Table 3.4
Summary Pumping Test Results

Test Well	Observation Well	Constant Rate Test Transmissivity (m^2/d)	Recovery Test Transmissivity (m^2/d)	Storativity Estimate
MLW6T	MLW6T	130	190	-
	MLW6-33	-	-	-
	MLW6-61	280[b]	-	9 x 10^{-4} [b]
	MLW6-107	280[c]	-	7 x 10^{-4} [c]
MLW11T	MLW11T	400[d]	700	-
	MLW11-19	520[b]	-	3 x 10^{-3} [b]
	MLW11-60	520[b]	-	7 X 10^{-4} [b]
MLW22T	MLW22T	180	340	-
	MLW22-33	160[b]	-	2 x 10^{-3} [b]
	MLW22-34	350[b]	-	7 x 10^{-3} [b]
MLW29T	MLW29T	540 (early) 150 (late)	1,260	-
	MLW29-29	580[b]	-	1 x 10^{-1} (early) 7 x 10^{-2} (late)
	MLW29-67	1,170	-	8 x 10^{-4}
MLW44T	MLW44T	570	700	-
	MLW44-36	1,000[c]	-	2 x 10^{-7} [c]
	MLW44-79	590	-	3 x 10^{-3}

Note: a. Not corrected for apparent well efficiency as no step test undertaken.
b. Derived from observation wells with screened section not fully penetrating aquifer unit.
c. Derived from observation wells with screened section not in aquifer unit.
d. May be impacted by release of water from storage as water level within calcrete unit.

The test pumping data and analysis suggests that, as expected, the aquifer units within the borefield comprise of a complex layering of shallow alluvial deposits, calcrete, sands, marls, dolomite and BIF.

The results indicate that at some locations (e.g. MLW11T) the clays and marls act as an aquitard, limiting vertical flow between the layers, whilst at others (e.g. MLW44T) the clays and marls are more permeable. The data also suggests that the BIF, dolomite and calcrete are in hydraulic continuity.

The fact that recirculation of the discharged water occurred after a short period of time in two bores (e.g. MLW22T) suggests that direct recharge of the calcrete is likely to occur after significant rainfall events.

Values of transmissivity for the alluvial and calcrete deposits range from 130 m^2/d to 1170 m^2/d. Values of permeability (K) have been estimated to be in the range of 3m/d to 20m/d, with an average of approximately 10m/d. Values of storativity were typically of the order of 3×10^{-3}.

The results need to be considered carefully, in particular it is important to note that the test pumping was undertaken on the highest yielding bores drilled during the exploration drilling programme and thus results will be biased toward higher transmissivity values rather than average values. Of the 48 RC bores drilled, the average yield was 4 L/S, whereas the average yield of the five bores converted to trial production bores was 8 L/S.

The test pumping analyses suggest that the values of K and storativity assumed in the model (0.2 m^2/d and 5×10^{-4}) are conservative, and the potential yield of each of the bores modelled in the PER report may have been underestimated.

3.5 GEOPHYSICAL LOGGING

During previous investigations at Christmas Creek, it was shown that there was saline water at depth. FMG therefore decided it would be prudent to undertake down-hole geophysical logging of the trial water supply bores to determine if there was evidence of saline water within the proposed borefield.

WestLog Wireline Services were therefore engaged by FMG to undertake down-hole geophysical investigations at each of the bores in April 2005. The logging consisted of fluid conductivity and temperature measurements. It should be noted that the logging was undertaken several weeks after test pumping of the bores, and therefore the fluid column in the bores is likely to have reached equilibrium. Charts showing the variation in conductivity and temperature with depth are presented in Appendix D, however a summary of the results is given below: -

3.5.1 MLW06T

The bore was logged on the 15 April 2005 to a depth of 86m. The temperature log showed the water level to be around 17m btc (below top of casing) and exhibits a standard geothermal response, with the fluid temperature increasing slightly with depth.

The conductivity log shows several features at 35 to 40m, 55 to 60m and below 83m. The response below 83m is “spiky”, which is believed to be due to the probe entering slurry at the base of the bore. The other two features are more likely to represent changes in water conductivity, however the maximum salinity of 200mS/m represents water that is still reasonably fresh and acceptable for the ore-beneficiation plant.

3.5.2 MLW11T

The bore was logged on 15 April 2005 to a depth of 60m. The temperature and conductivity logs show the water level was 7m btc and the temperature log shows a typical geothermal increase with depth.

The conductivity log shows several horizons of increased conductivity at 20 to 25m and 27 to 33m, however the maximum conductivity recorded was 130mS/m, which, although sub-potable, meets the requirement of the processing plant.

3.5.3 MLW22T

This bore was logged on the 13 April 2005 to a depth of 66m. The water level was found to be approximately 6m btc.

There is an increase in conductivity from 30 to 40m (coincident with a layer of gravel and calcrete), which then decreases towards the base of the bore. The maximum conductivity was 200mS/m, which is acceptable for the ore-beneficiation plant.

Two temperature logs were undertaken (the first going down the bore and the second coming up). Both show a typical geothermal gradient.

3.5.4 MLW29T

Bore MLW29T was logged on the 13 April to a depth of 68m. The conductivity log shows low conductivity water (less than 100mS/m) to a depth of 45 m, below which the conductivity increases to a maximum of 180mS/m.

The temperature log shows that the depth to water was approximately 19m btc and a typical geothermal gradient with depth.

3.5.5 MLW44T

The temperature gradient in the water column in this bore shows a slightly unusual response, with a geothermal gradient to 25m, whereafter there is very little increase in temperature with depth. This type of response often suggests fluid movement in the water column resulting in mixing. The bore was logged on the 13 April and this mixing is considered unlikely to be the residual from the test pumping which was undertaken several weeks earlier.

The conductivity log shows the fluid column to be of low conductivity water with possible inflows at 27m, which is coincident with the top of the calcrete and may indicate flow into the bore. The maximum conductivity recorded was 170mS/m.

There is an unusual conductivity response at the base of the bore that is believed to be a result of the probe entering slurry.

3.5.6 Summary of the Geophysical Logging

The logging results show that there is no evidence of saline water within the borefield. The data also suggests a typical geothermal response, except at MLW44T, which may be affected by vertical flow within the fluid column.

SECTION 4 - RESULTS OF THE CHRISTMAS CREEK PROGRAMME

4.1 DRILLING PROGRAMME

The drilling programme at Christmas Creek consisted of the construction of four bores. Three of the bores (E02T, E19T and E41T) were drilled in the hanging wall of the proposed Christmas Creek pit to help determine the dewatering requirements for the pit. The fourth bore (F02T) was drilled close to the boundary of the Fortescue Marsh and is to be used to improve understanding of the aquifer parameters in that area.

The locations of the bores are shown in Figure 4.1 and drill logs, including construction details, for each of the bores are given in Appendix E.

4.1.1 Dewatering Bores

The three dewatering bores were installed along the hanging wall of the pit, and were approximately equally spaced so that there was one bore at the western end (E41T), one at the eastern end (E02T) and one, approximately, in the middle (E19T).

Each bore was drilled at 10 inch diameter using a mud rotary rig and surface casing was installed in the top section of the bore and grouted into place. The bores were completed with 155mm PVC casing and slotted screen and end caps installed at the base. The annulus was packed with graded gravel.

4.1.2 Environmental Bore

A new environmental bore (F02T) was installed to a depth of 100m using air percussion. The bore was completed so the same specification as the dewatering bores.

4.2 TEST PUMPING

Test pumping was undertaken on the three dewatering bores in April 2005. Unfortunately the testing of bore F02T could not be completed for this report because the presence of saline water (see Section 4.3 below) meant that careful disposal of the water, involving the construction of containment pits, was required. It is proposed that this work will be completed in April and a separate report will be issued to the DoE on completion describing the results.

The sections below include details of the analysis and summary tables are provided in 4.2.4. The complete data set is presented in Appendix F.

4.2.1 E02T

Bore Construction

The test well is cased from 0m to 15.9m and screened from 15.9m to 75.9m across alluvium, clay, calcrete and Marra Mamba. Water levels were monitored in nested observation wells: E02-38 and E02-82, approximately 27m from the test well.

Test Pumping Analysis

The initial water level in all of the bores was approximately 22.5m. A maximum drawdown of 18.81m was recorded in the test well at a discharge rate of 7L/S. Water levels were within the alluvium and underlying clay sediments for the duration of the test.

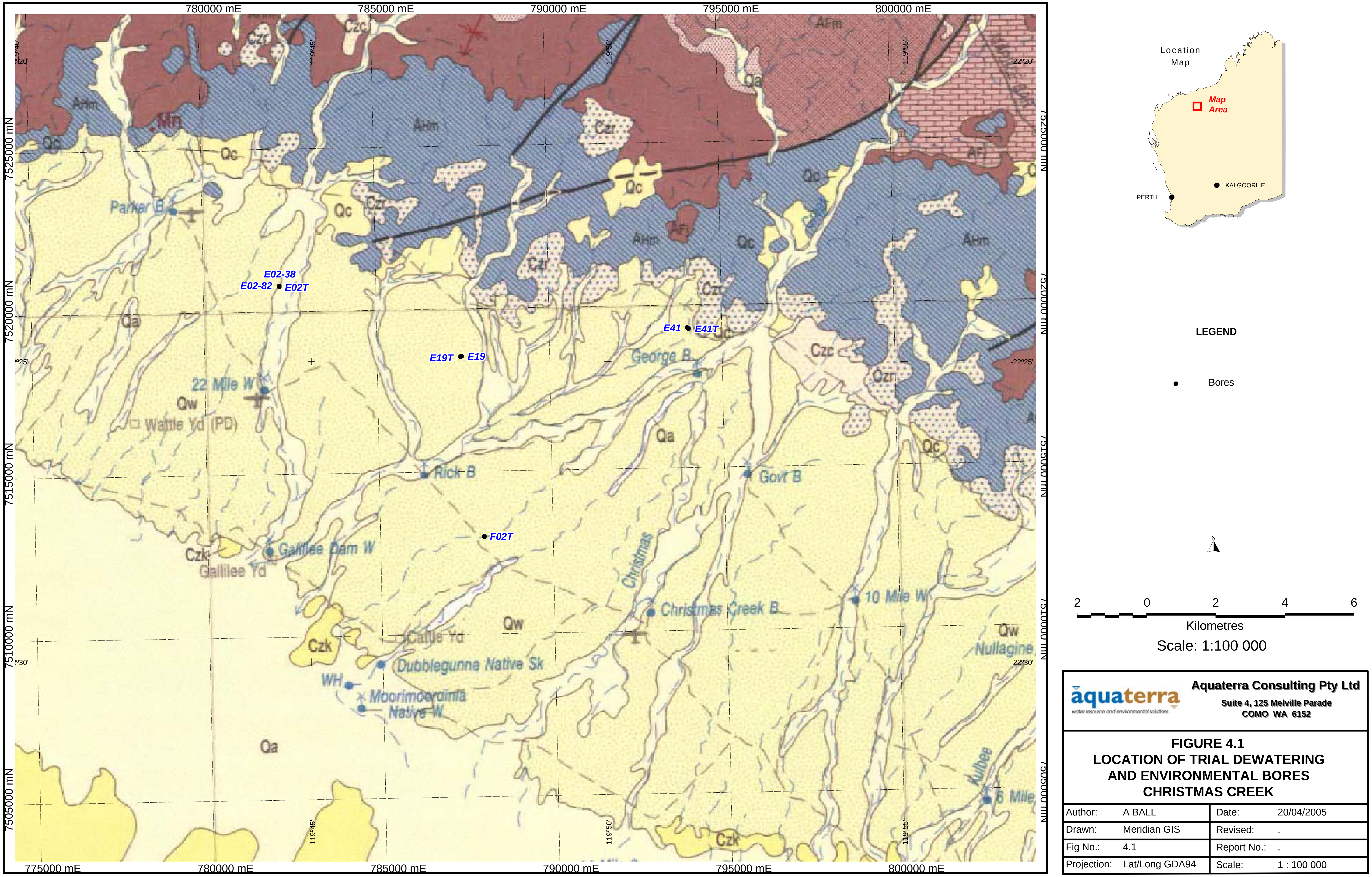

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FIGURE 4.1
LOCATION OF TRIAL DEWATERING AND ENVIRONMENTAL BORES CHRISTMAS CREEK

Author:	A BALL	Date:	20/04/2005
Drawn:	Meridian GIS	Revised:	.
Fig No.:	4.1	Report No.:	.
Projection:	Lat/Long GDA94	Scale:	1 : 100 000

E02T

A maximum drawdown of 18.81m was recorded in the test well after 48 hours. There were two irregularities in the water levels recorded which appear to be associated with pumping rate changes (at 270 minutes and 660 minutes). A transmissivity of approximately 90m^2/d has been derived from analysis of the drawdown data, with a similar value (70m^2/d) obtained from the recovery data. As the test bore is open to all of the saturated sediments, these transmissivity values are bulk parameters for the whole sediment sequence. Screened section permeability values in the range 1.2 m/d-1.5 m/d are derived for the test well.

E02-38

A maximum drawdown of 2.84m was recorded in the shallow observation well after 7 hours pumping after which time water levels stabilised. After 22 hours of pumping the water level recovered slightly to a drawdown of 2.75m at the end of the test. A transmissivity of approximately 40m^2/d has been derived from analysis of the early drawdown data and a storativity estimate of 1.4 x 10^{-3} was calculated.

E02-68

Water levels declined by 2.24m during the 48 hour test. A transmissivity of approximately 95m^2/d was derived from analysis of the early drawdown data with a transmissivity value of 265m^2/d derived from the late time data. A storativity estimate in the range of 3.4x 10^{-4} to 6.0x 10^{-6} was derived.

4.2.2 E19T

Bore Details

The test well is screened across alluvium, clay and Marra Mamba. The water level was also monitored in an observation well, E19-80, approximately 36.4m from the test well.

Test Pumping Analysis

The initial water level in both of the bores was approximately 22m. A maximum drawdown of 18.69m was recorded in the test well. Water levels were within the alluvial sediments for the duration of the test.

E19T

A maximum drawdown of 18.69m was recorded in the test well after 48 hours. A number of irregularities in the water levels recorded are evident which appear to be associated with pumping rate changes (between 1 and 20 minutes, at 150 minutes, 300 minutes and 1020 minutes). A transmissivity of approximately 105m^2/d has been derived from analysis of the drawdown data. A transmissivity value of 260m^2/d was derived from the early recovery data, with a value of 630m^2/d obtained from the late time recovery data. As the test bore is open to all of the saturated sediments, these transmissivity values are bulk parameters for the whole sediment sequence. Screened section mean hydraulic conductivity values in the range 1.9m/d to 6m/d are derived for the test well.

E19-80

A maximum drawdown of 0.66m was recorded in the observation well after 48 hours. A transmissivity of approximately 430m^2/d was derived from analysis of the drawdown data and a storativity estimate of 8.9 x 10^{-3} was calculated.

4.2.3 E41T

Bore Details

The test well is screened across the Marra Mamba. The water level was also monitored in an observation well, E41-70, approximately 52.8m from the test well.

Test Pumping Analysis

The initial water level in both of the bores was approximately 30m. A maximum drawdown of 8.11m was recorded in the test well. Water levels were within the Marra Mamba for the duration of the test.

E41T

A maximum drawdown of 8.11m was recorded in the test well after 48 hours. A number of irregularities in the water levels recorded are evident which appear to be associated with pumping rate changes (at 480 minutes, 960 minutes and 1440 minutes). A transmissivity of approximately 125m^2/d has been derived from analysis of the early drawdown data with a transmissivity value of 30m^2/d derived from the late drawdown data. A transmissivity value of 280m^2/d was derived from the early recovery data, with a value of 900m^2/d obtained from the late time recovery data. Screened section mean hydraulic conductivity values in the range 0.5m/d to 15m/d are derived for the test well.

E41-70

Water levels decline by 0.205m during the 48 hour test. A transmissivity of approximately 1750m^2/d was derived from analysis of the early drawdown data with a transmissivity value of 800m^2/d derived from the late time data. A storativity estimate in the range of 2 x 10^{-3} to 5.2 x 10^{-2} was derived.

4.2.4 Summary of Test Pumping Data

The following tables summarise the test pumping data and analysis.

Table 4.1
Summary of Well Details

Well	Easting	Northing	Radial Distance to Test Well (m)	Total Depth (m)	Screened Interval (mbgl)
E02T	782204	7520769	-	90	16-76
E02-38	782203	7520796	27	82	12-38
E02-82	782203	7520796	27	82	12-82
E19T	787418	7518530	-	66	9-63
E19	787452	7518543	36.4	58	12-58
E41T	794037	7519273	-	70	9-69
E41	793995	7519305	52.8	70	12-70

Table 4.2
Summary of Pumping Test Schedules

Test Well	Test Date*	Test Duration (mins)		Constant Rate Test Discharge (m^3/d)	Observation Well	SWL (mbgl)*[3]	Maximum Drawdown in Well (m) *[4]
		Constant Rate	Recovery				
E02T	30/03/05	2880	2940	604.8	E02T	22.07	18.50
					E02-38	22.50	2.84
					E02-82	22.68	2.24
E19T	01/04/05	2880	2940	691.2	E19T	21.65	18.69
					E19-80	21.83	0.66
E41T	27/03/05	2880	2940	630.7	E41T	29.52	8.11
					E41-70	30.075	0.205

*[1] Start of constant rate test
*[3] Static water level at start of constant rate test
*[4] Maximum drawdown during constant rate test

Table 4.3
Summary Pumping Test Results

Test Well	Observation Well	Transmissivity (m2/d) [1]		Storativity Estimate
		Early	Late	
E02T	E02T	90	70	-
	E02-38	40(early)	-	1 x 10^{-3}
	E02-82	95 (early); 265 (late)	-	$6x10^{-4}$ (early); $3x10^{-6}$ (late)
E19T	E19T	105	260 (early); 630 (late)	-
	E19-80	785 (early); 435 (late)	-	$8x10^{-3}$
E41T	E41T	125 (early); 30 (late)	280 (early); 900 (late)	-
	E41-70	1750 (early); 800 (late)	-	$2x10^{-3}$ (early); $5x10^{-2}$ (late)

As with the Mount Lewin test pumping, the analysis of the Christmas Creek data is made complex by the multi-layered aquifers. In particular, it is likely that the Marra Mamba has a high variation in transmissivity between sites depending upon the amount of mineralisation that has occurred (highly mineralised Marra Mamba is likely to be more permeable than that which is unmineralised).

The data from the testing of E02T and E19T provides data for the full geological sequence and indicates a range of values of K of between 0.5m/d and 10m/d. Data for E41T provides an estimate of K for the Marra Mamba only and gives a range of K from 0.5m/d to 15m/d. This compares to an overall permeability value used in the PER model of 0.5 m/d, suggesting that the assumptions in the PER model are conservative.

During testing of the bores, field measurements of conductivity were taken and these remained below 200mS/m, showing that there was no upconing of saline water during the test pumping.

4.3 GEOPHYSICAL LOGGING

Geophysical logging on each of the bores was completed on the 14 April 2005, shortly after test pumping of the dewatering bores. The results are summarized below and the logs are presented in Appendix G. As with the logging at Mount Lewin, the work consisted of fluid temperature and conductivity logs.

It should be noted that, because three of the bores were test pumped shortly before the logging, the fluid column in the bore may not have reached an state of equilibrium, and the logs may not fully represent the conductivity of the formation fluid. This is not true for F02T, which had not been test, pumped prior to logging.

4.3.1 E19T

The data for this bore show the water level at around 21m btc. The temperature profile shows a typical geothermal gradient. The conductivity log shows the water column to have a generally low conductivity to the base of the bore (63m) but with increased conductivity values (up to 290mS/m) at depth. It is proposed by FMG that the water abstracted during dewatering will be used for ore-beneficiation, and the recorded conductivity data suggests that the water is suitable for the use in the process plant.

4.3.2 E41T

The logs show that the water level in the bore was approximately 30m btc. The temperature log was run twice and shows a normal response on both traces.

The conductivity log shows a number of spikes (e.g. at 32m and 60m). The acuteness of these features suggests that they are not a response to the conductivity of the fluid column, and are likely to be because of the conductivity probe passing through bands of highly conductive iron ore mineral.

4.3.3 E02T

The temperature log for Bore E02T shows a normal geothermal response, whilst the conductivity trace shows increased conductivity at 47m and 75m. The response at 47m is considered to represent an increase in conductivity of the fluid column, however the conductivity measurements are relatively low (200mS/m) and the water is suitable for the ore-beneficiation plant.

4.3.4 F02T

Water quality sampling in existing bores in the vicinity of the Fortescue Marsh (e.g. F01, F03 and F07) has shown that the water column is saline. The conductivity log for F02T is shown on two scales (1-1000mS/m and 1-5000mS/m), and the plot shows that the values exceeded the lower scale. The plots show that the salinity of the water column is around 1000mS/m to a depth of 50m, below which it increases. There is also an inflection in the temperature log at 50 m suggesting that flow is occurring at this point. A second temperature inflection occurs at 60 m, which is possibly associated with an increase in salinity at 57m. The maximum salinity recorded is 4500mS/m at approximately 57.5 m btc, indicating flow. There are several further changes in conductivity below 60m, where the salinity is typically in the range of 1000 to 3500mS/m.

SECTION 5 - SUMMARY AND CONCLUSIONS

5.1 SUMMARY

This report describes the results of the studies FMG set out to undertake in the Stage B PER report. The studies were designed to improve understanding of certain aspects of the hydrogeology of the project area, and confirm the work undertaken in the numerical groundwater modelling for the PER report.

5.1.1 Borefield

Drilling Programme

The additional exploration drilling in the proposed borefield, described in this report, has confirmed the general assumptions used in the numerical groundwater model, in particular that the stratigraphy in the area of the borefield to the south of Mount Lewin consists of an alluvial formation overlying basement material of Marra Mamba or Wittenoom Dolomite.

The drilling has also confirmed the thickness of the alluvial deposits and that, in general, they have the same lithology as at Mount Lewin.

The exploration drilling programme has identified a potentially important calcrete horizon within the alluvial sequence. This calcrete has been shown to extend throughout most of the exploration area, and is potentially an important aquifer unit.

Trial bores have been installed in the borefield and testing has been undertaken on them to determine the potential yield of individual bores. These bores are being monitored on a monthly basis to provide important water level data.

Test Pumping

Test pumping has been undertaken on five bores within the proposed borefield. The analysis of the data is complex because of the multilayered nature of the aquifers. The results suggest that the calcrete is in hydraulic continuity with the underlying deposits, including dolomite and Marra Mamba. The data also suggests that at some locations the calcrete is likely to be rapidly recharged after rainfall, whereas at others the material overlying the calcrete can act as an aquitard. Values of permeability and storativity determined from the test pumping analyses suggest that the assumptions in the PER modelling tend to be conservative.

Geophysical Logging

The geophysical logging undertaken in the borefield shows that in each of the bores the fluid column consisted of sub-potable water, which is acceptable for the ore-beneficiation plant.

5.1.2 Christmas Creek

Drilling Programme

The drilling programme at Christmas Creek has involved the construction of three trial dewatering bores in the hanging wall material. In addition, an environmental test bore has been installed close to the Fortescue Marsh.

Test Pumping

Test pumping of the three dewatering bores has indicated that each bore will typically yield 7L/S. Values of K and storativity derived from the testing suggests that the assumptions used in the PER model are reasonable but conservative. Field measurements showed that there was no upconing of saline water during the test pumping.

The temporary abstraction bore near the Fortescue Marsh has been installed and planning undertaken to ensure the correct disposal of any saline water abstracted. Pump testing is currently being undertaken and will be used to further verify the assumptions in the numerical groundwater model. The results will be made available to the Department of Environment shortly.

Geophysical Logging

Temperature and conductivity logging has been undertaken on each of the four bores drilled at Christmas Creek. The results indicate that there is no saline water present within the groundwater in the hanging wall material. However logging of bore F02T has confirmed the presence of saline water at depth.

5.2 CONCLUSIONS

The results obtained from the programme of drilling, test pumping and geophysical logging have confirmed key assumptions made in the PER. In particular, these studies have confirmed:

- The extent of the alluvial and Wittenoom Dolomite aquifers at Mount Lewin.
- That the aquifer parameters used in the numerical groundwater modelling are appropriate and conservative.
- That there is no evidence of shallow saline water at borefield or at the Christmas Creek pit, although saline water does exist in the alluvial aquifer close to the Marsh.

APPENDIX A

DRILL LOGS FOR THE MOUNT LEWIN EXPLORATION BORES

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WELL LOG

Well No: MLW01

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

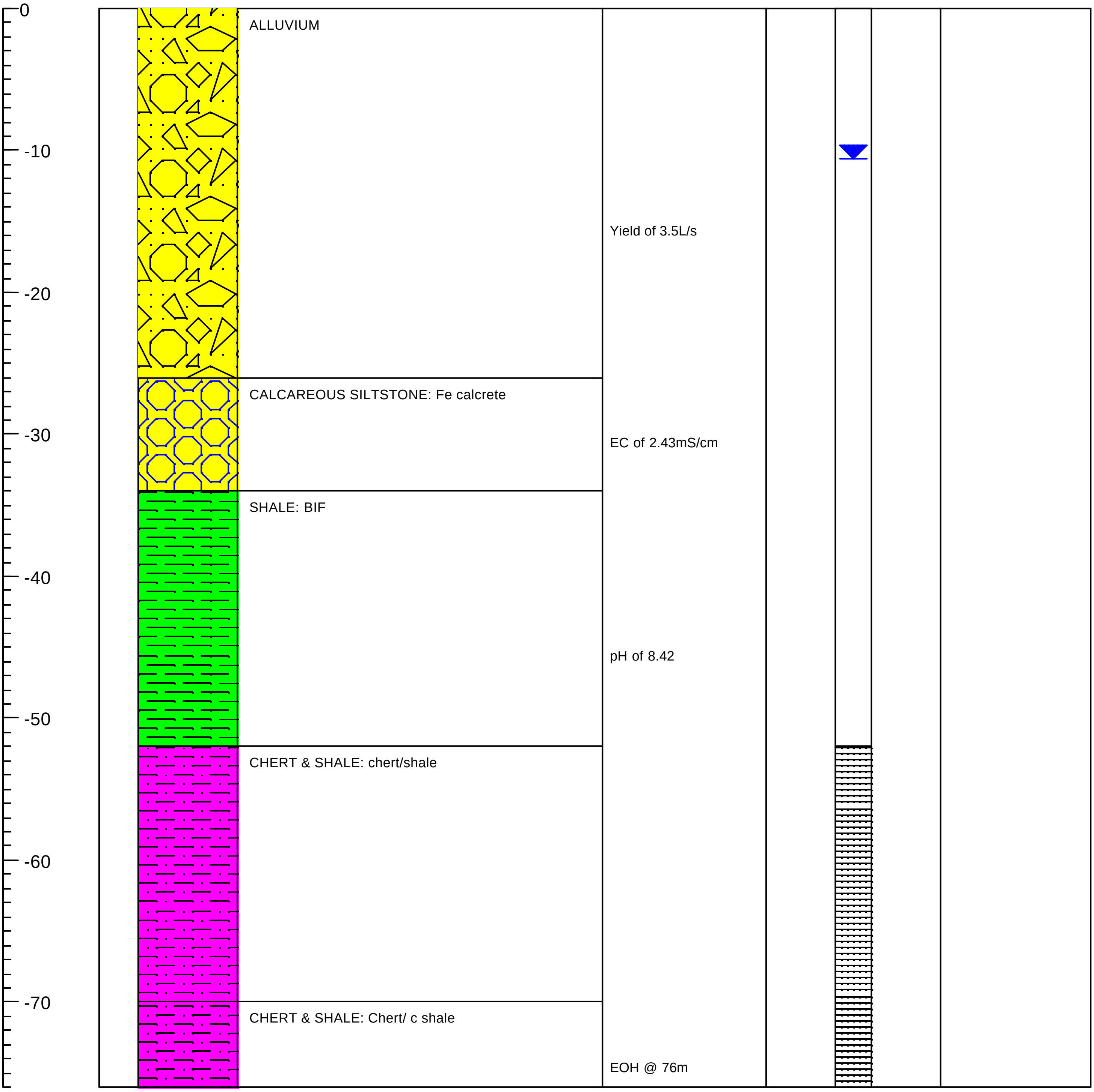
Commenced: 3/12/2004
Completed: 3/12/2004
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 211400m(AMG)
North: 7490400m(AMG)
Elevation: 424 (mRL)

Static Water Level: 10.58 (mbrp)
Date: On completion of drilling

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



ALLUVIUM

CALCAREOUS SILTSTONE: Fe calcrete

SHALE: BIF

CHERT & SHALE: chert/shale

CHERT & SHALE: Chert/ c shale

Yield of 3.5L/s

EC of 2.43mS/cm

pH of 8.42

EOH @ 76m

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WELL LOG

Well No: MLW02

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

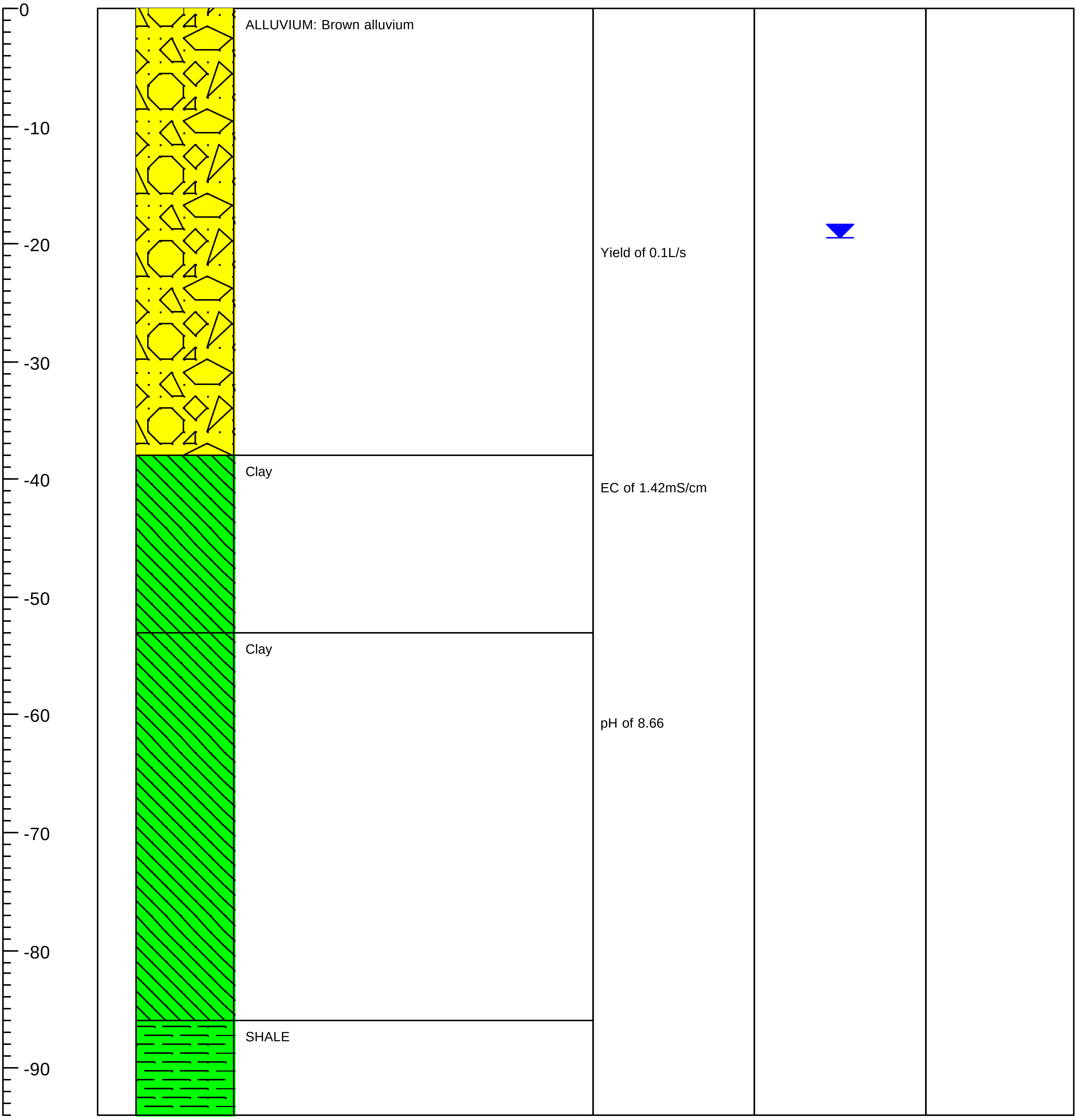
Commenced: 3/12/2004
Completed: 4/12/2004
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 220900m(AMG)
North: 7493100m(AMG)
Elevation: 432 (mRL)

Static Water Level: 19.44 (mbrp)
Date: On completion of drilling

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



ALLUVIUM: Brown alluvium

Clay

Clay

SHALE

Yield of 0.1L/s

EC of 1.42mS/cm

pH of 8.66

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WELL LOG

Well No: MLW03

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

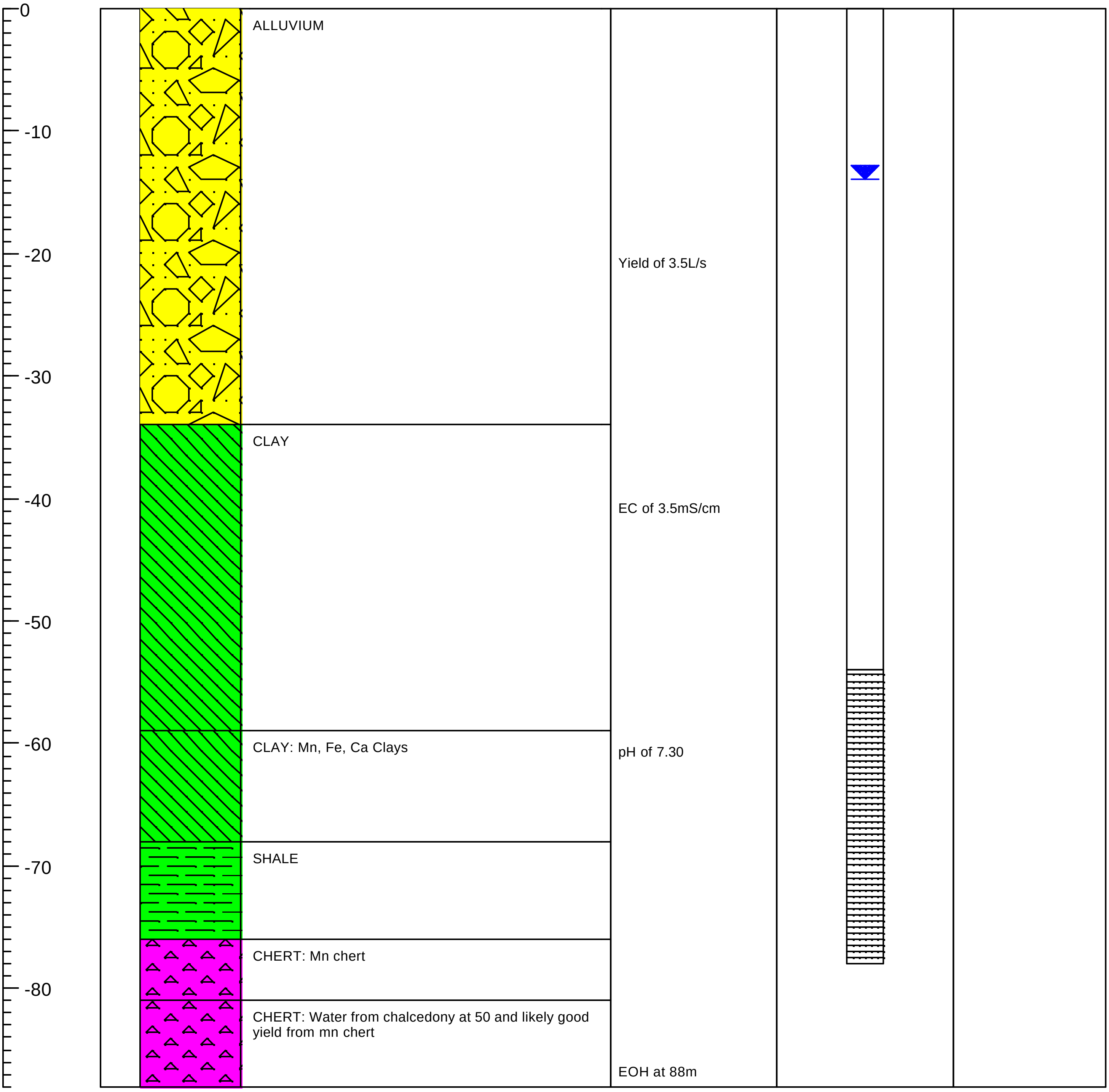
Commenced: 4/12/2004
Completed: 5/12/2004
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 206600m(AMG)
North: 7492288m(AMG)
Elevation: 423 (mRL)

Static Water Level: 13.9 (mbrp)
Date: 5/12/2004

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



ALLUVIUM

CLAY

CLAY: Mn, Fe, Ca Clays

SHALE

CHERT: Mn chert

CHERT: Water from chalcedony at 50 and likely good yield from mn chert

Yield of 3.5L/s

EC of 3.5mS/cm

pH of 7.30

EOH at 88m

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WELL LOG

Well No: MLW05

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

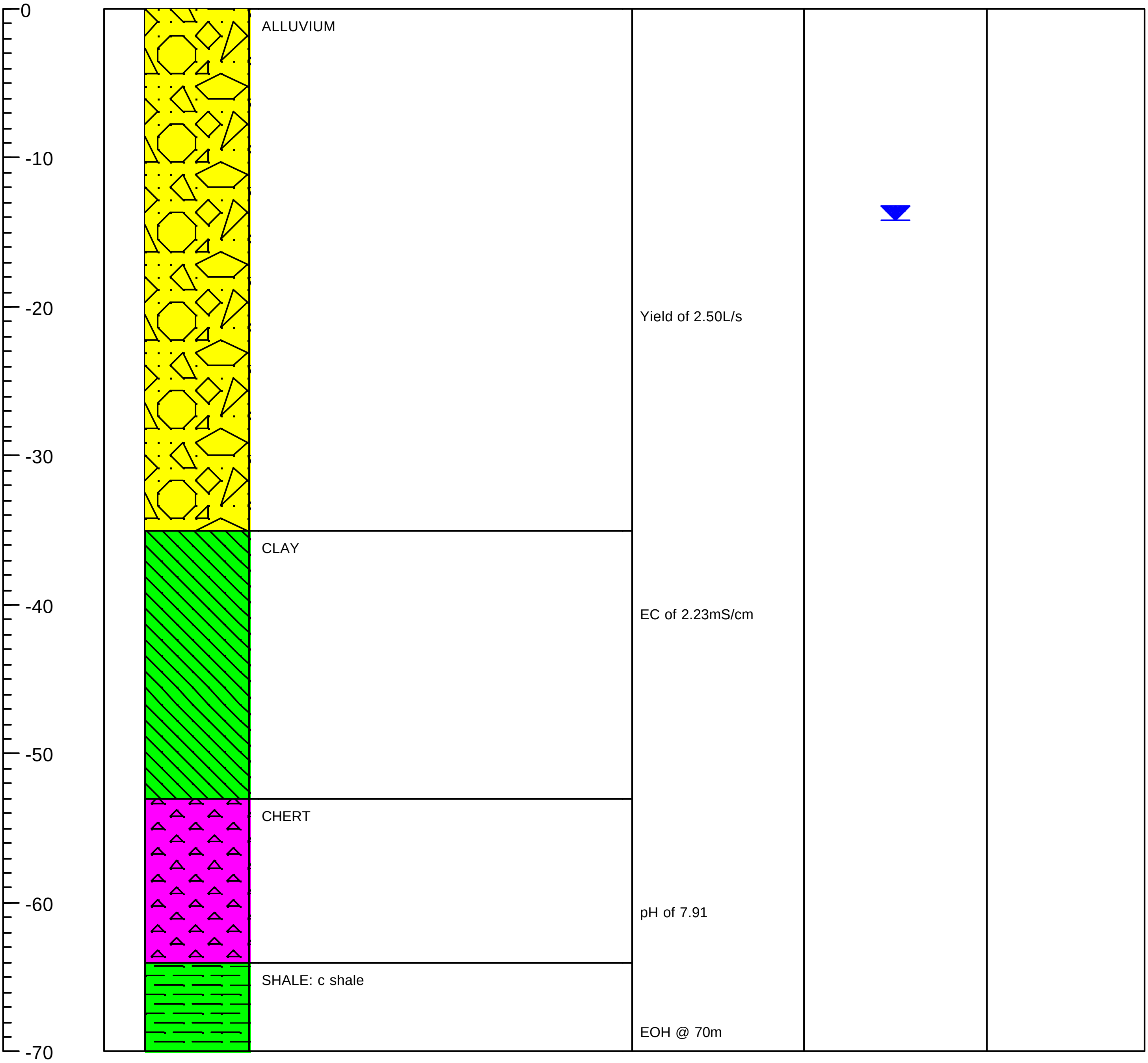
Commenced: 6/12/2005
Completed: 7/12/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 209000m(AMG)
North: 7491300m(AMG)
Elevation: 420 (mRL)

Static Water Level: 14.15 (mbrp)
Date: On completion of hole

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



ALLUVIUM

CLAY

CHERT

SHALE: c shale

Yield of 2.50L/s

EC of 2.23mS/cm

pH of 7.91

EOH @ 70m

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WELL LOG

Well No: MLW06

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

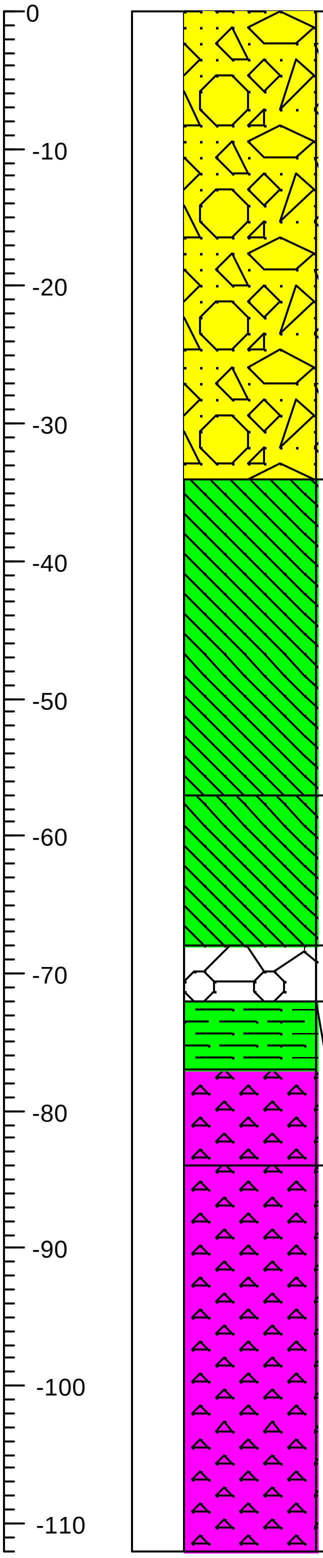
Commenced: 7/12/2004
Completed: 8/12/2004
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 207800m(AMG)
North: 7492600m(AMG)
Elevation: 421 (mRL)

Static Water Level: 16.60 (mbrp)
Date: On completion of drilling

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



ALLUVIUM

CLAY

CLAY: Calcareous clays and chert, water bearing

JASPEROID: Jaspilite high water yield

SHALE: BIF water yielding

CHERT: Chert and jaspilite

CHERT: Chert and c shale silicious, water yields from broken zones

Yield of 7.0L/s

EC of 5.83mS/cm

pH of 7.68

EOH @ 112m

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WELL LOG

Well No: MLW07

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

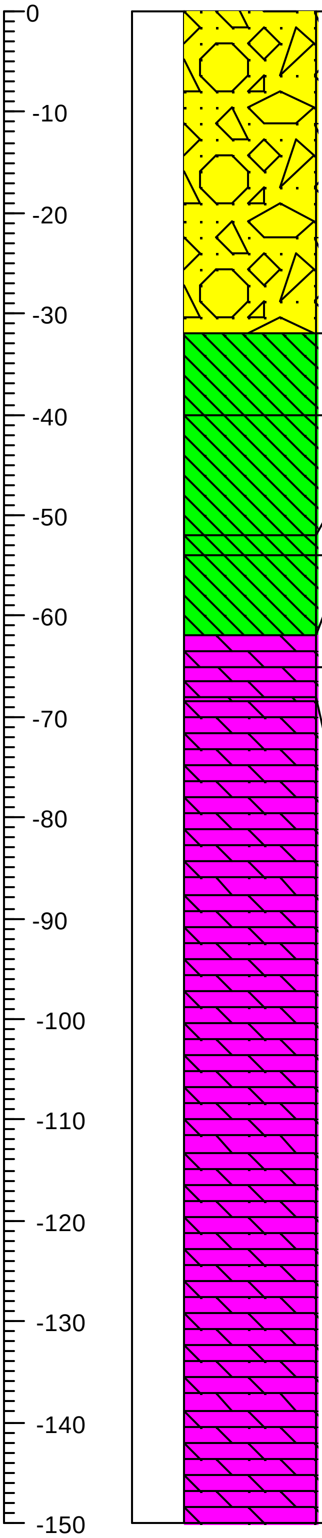
Commenced: 9/12/2004
Completed: 12/12/2004
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 208800m(AMG)
North: 7489200m(AMG)
Elevation: 414 (mRL)

Static Water Level: 11.10 (mbrp)
Date: On completion of drilling

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



Lithological Description

ALLUVIUM

CLAY: Off white marl, partly calcareous, partly non-calcareous (clay)

CLAY: Coloured marl (yellow, brown etc.)

CLAY: weathered coloured marl

CLAY: Marked colour change with dark grey marl

DOLOMITE: Major contact, grey crystaline hard rock, broken, blocky. Weathered, tighter

DOLOMITE: Major contact, grey crystaline hard rock, broken, blocky. Reaction with HCl, therefore interpreted as Wittenoom Dolomite.

DOLOMITE: Fresh dolomite, hard, tight, no evidence of additional water, becoming siliceous and interbedded with hard black shales from 136 to 150m.

Field Notes

Yield of 2.3L/s

EC of 2.39mS/cm

pH of 7.78

EOH @ 150m

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WELL LOG

Well No: MLW08

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

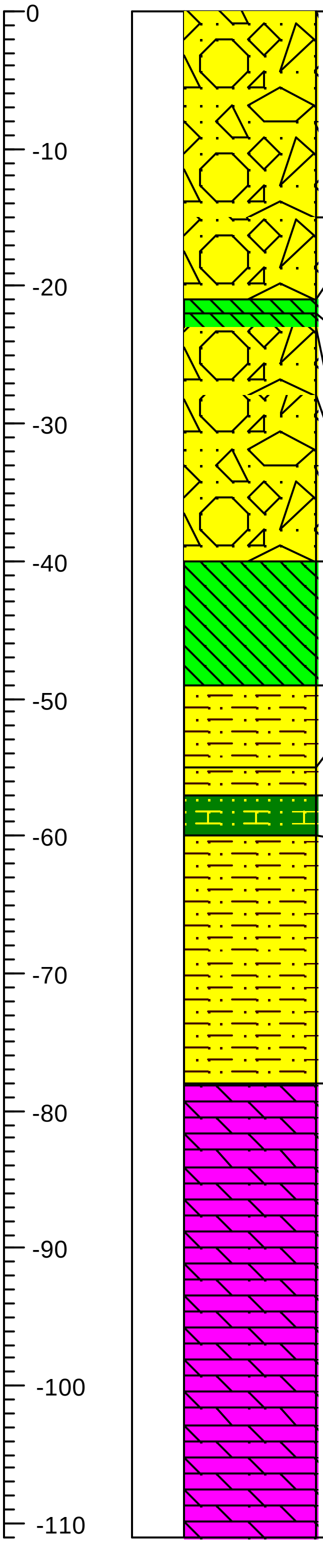
Commenced: 11/12/2004
Completed: 12/12/2004
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 210600m(AMG)
North: 7487400m(AMG)
Elevation:421(mRL)

Static Water Level: 11.71 (mbrp)
Date:

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



Lithological Description	Field Notes
ALLUVIUM: Red brown, fine, silty matrix with rounded clasts	
ALLUVIUM: Buff calcareous layers in red brown siltstone, fewer clasts	
CLAY: Light grey with angular quartz clasts	Yield of 2.2L/s
CLAY: Buff and grey layers, siliceous band, possible water?	
ALLUVIUM: Buff, calcareous with red silt	
ALLUVIUM: Siltstone with silica, ironstone, manganese clasts	
CLAY: Marl. Calcareous, coloured, possible weathered/former water table at 49m	EC of 3.74mS/cm
SILT: Marked colour change to dark grey silt with silica and iron deposition	
SILT: Silt, little silica	
CLAY AND SILT: Silt and clay	
SILT: Silt dark brown and dolomite light grey (silt also slight fizz), dolomite broken with Fe on faces	pH of 7.86
DOLOMITE: Grey becoming fresh, tight	EOH @ 111m

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WELL LOG

Well No: MLW09

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

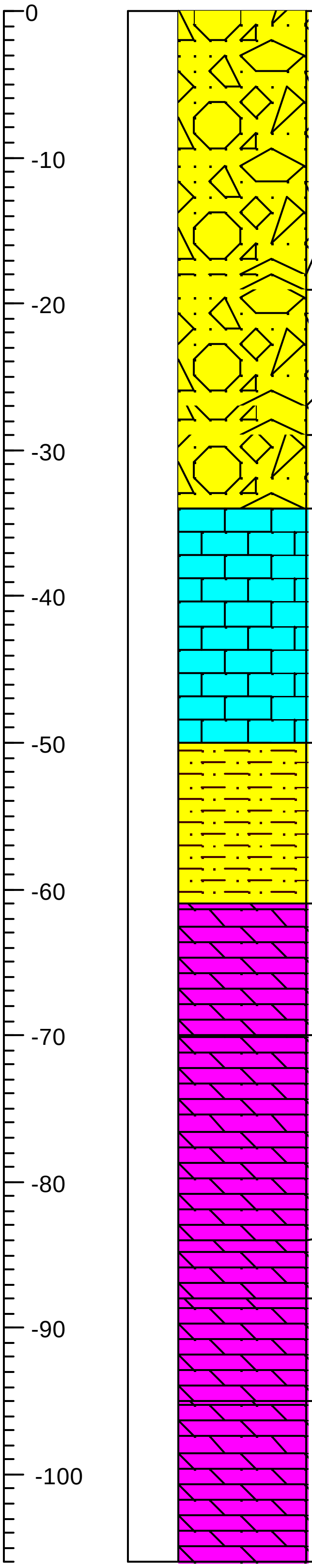
Commenced: 13/12/2004
Completed: 13/12/2004
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 210600m(AMG)
North: 7487500m(AMG)
Elevation: 422(mRL)

Static Water Level: 11.02(mbrp)
Date:

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



Lithological Description	Field Notes
ALLUVIUM: Red brown silt with rounded clasts	
ALLUVIUM: Buff calcareous, clayey	
ALLUVIUM: Red brown silt with fewer clasts	Yield of 2L/s
ALLUVIUM: Buff, calcareous, clayey	
ALLUVIUM: Red brown silt with fewer clasts, major change	
LIMESTONE: White with minor grey on top, fine granular, failry hard (probably equivalent to marble described in other holes), minor vughs, minor yellowish recrystalisation on faces, major change	EC of 3.55mS/cm
SILT: Dark brown, non-calcareous, siliceous and iron rich bands, dark brown, rust, ochre, red.	pH of 7.63
DOLOMITE: Dark grey, blocky with brown crystalisation on faces	
DOLOMITE: Grey, drilling finer, less blocky appearance, minor black (manganese) deposits on faces	
DOLOMITE: dolomite and dark grey to black hard shale bands	
DOLOMITE: Drilling fine, some blocky material but no obvious increase in water	
DOLOMITE: Drilling fine fresh, minor coatings on faces appear to be sealed veining rather than open planes	EOH @ 106m

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WELL LOG

Well No: MLW10

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

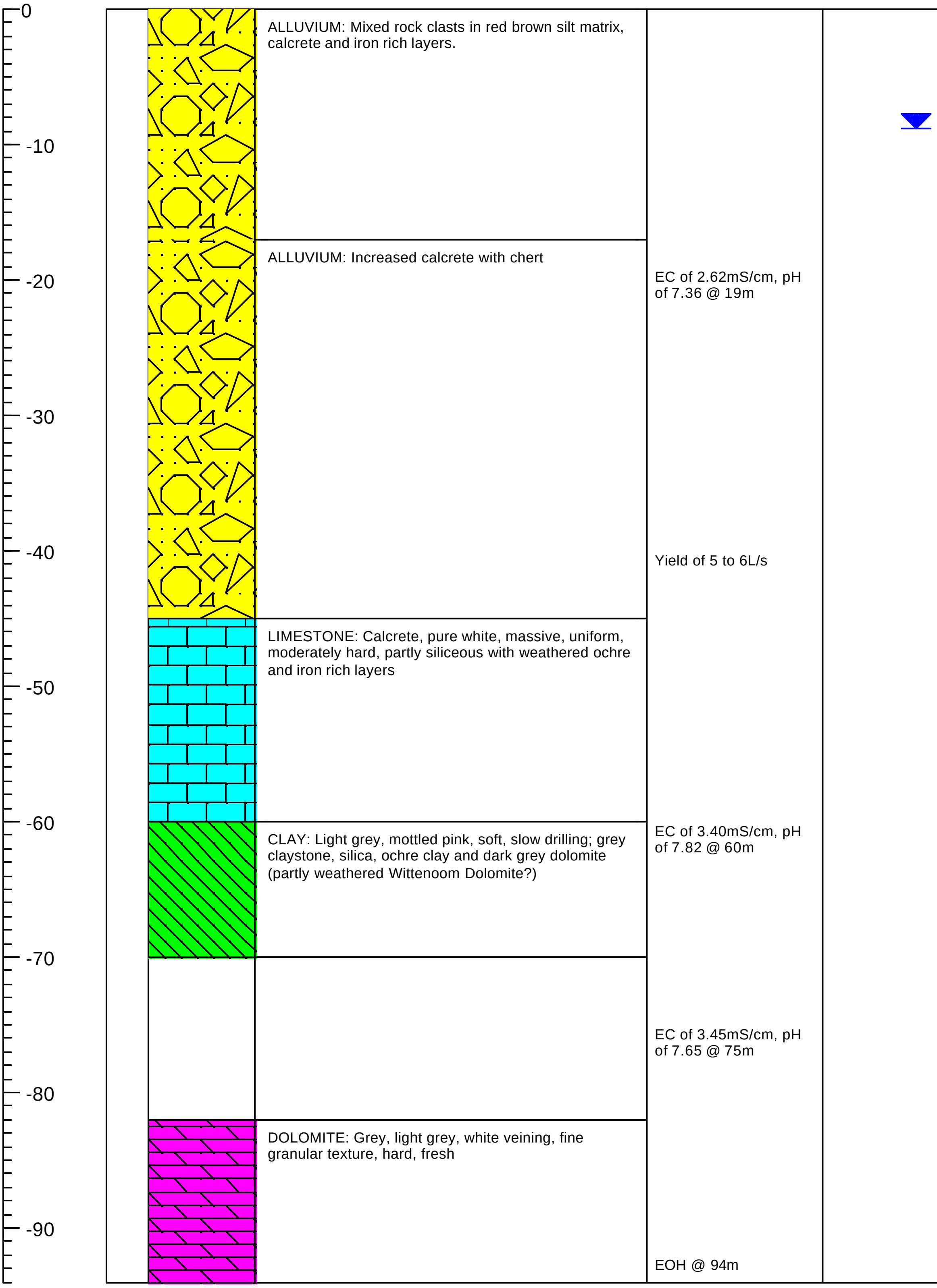
Commenced: 10/01/2005
Completed: 11/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 208060m(AMG)
North: 7486940m(AMG)
Elevation: 420(mRL)

Static Water Level: 8.86(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Mixed rock clasts in red brown silt matrix, calcrete and iron rich layers.

ALLUVIUM: Increased calcrete with chert

LIMESTONE: Calcrete, pure white, massive, uniform, moderately hard, partly siliceous with weathered ochre and iron rich layers

CLAY: Light grey, mottled pink, soft, slow drilling; grey claystone, silica, ochre clay and dark grey dolomite (partly weathered Wittenoom Dolomite?)

DOLOMITE: Grey, light grey, white veining, fine granular texture, hard, fresh

EC of 2.62mS/cm, pH of 7.36 @ 19m

Yield of 5 to 6L/s

EC of 3.40mS/cm, pH of 7.82 @ 60m

EC of 3.45mS/cm, pH of 7.65 @ 75m

EOH @ 94m

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WELL LOG

Well No: MLW11

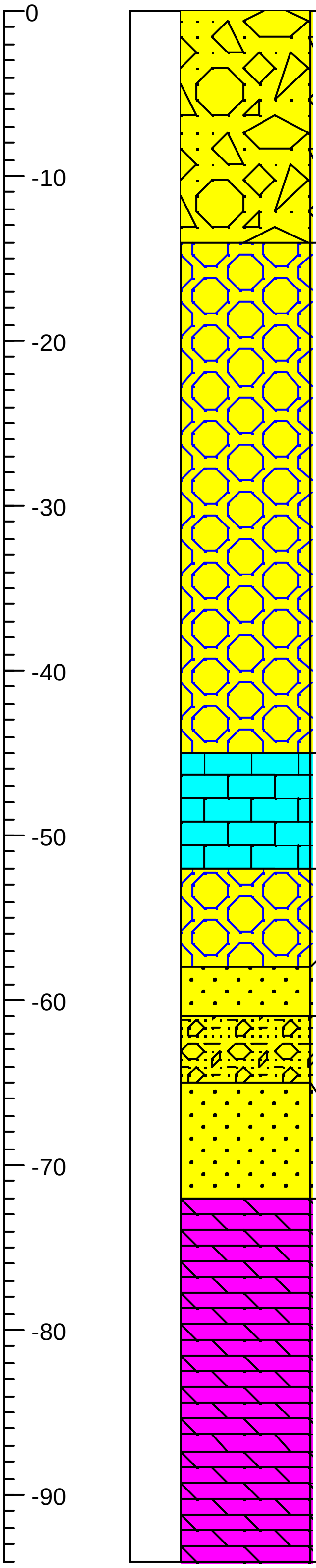
Client: Fortescue Metals Group
Project: Mt Lewin groundwater RC exploration

Commenced: 12/01/2005
Completed: 12/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 208860m(AMG)
North: 7486850m(AMG)
Elevation: 418(mRL)

Static Water Level: 11.00(mbrp)
Date: On completion of drilling



Lithological Description	Field Notes
ALLUVIUM: Red brown silt with rock clasts	
CALCAREOUS SILTSTONE: Off white, hard, rubbly, vughy, minor clayey layers, minor red brown siltstone, rock clasts embedded in calc	Yield of 3L/s, EC of 2.78mS/cm, pH of 7.56 @ 20m
LIMESTONE: Calcrete (limestone?), pure white, hard, uniform, fine grained	
CALCAREOUS SILTSTONE: Siltstone, rock fragments, silica, clay, iron rich rounded pebbles	EC of 2.78mS/cm, pH of 7.60 @ 54m
SAND: Light green, quartz, fine to medium grained, well rounded, moderately sorted, clean	
GRAVEL AND SAND: Sandy gravel, fine light green sand with light grey, coarse quartz pebbles, sub angular, poorly sorted	Yield of 12L/s, EC of 2.95mS/cm, pH of 7.55 @ 63m
SAND: Light green, quartz, fine to medium grained, well rounded, moderately sorted	
DOLOMITE: Dolomitic limestone, grey, dark grey, hard angular chips (samples heavily contaminated with sand)	EC of 3.22, pH of 7.45 @ 94m EOH @ 94m

Well Completion
Diagram
Notes

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WELL LOG

Well No: MLW12

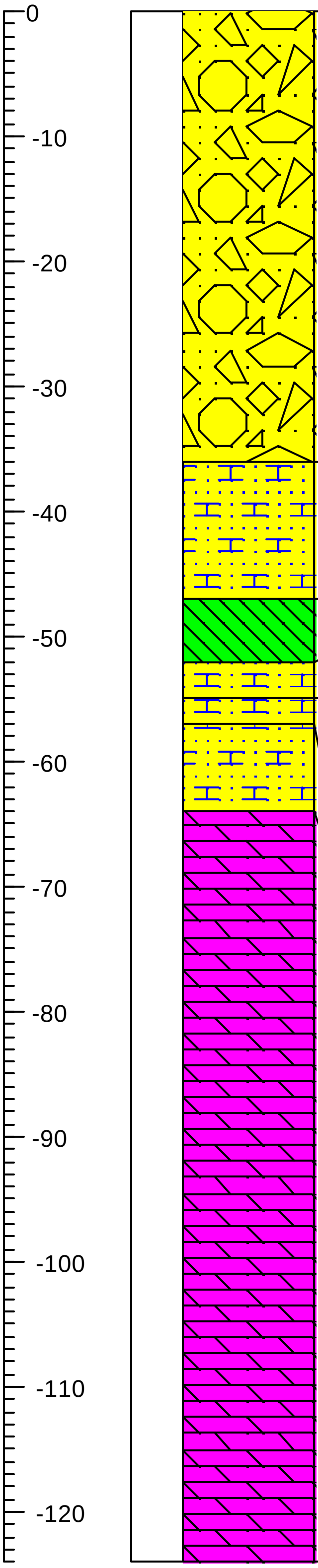
Client: Fortescue Metals Group **Project:** Mt Lewin groundwater RC exploration

Commenced: 13/01/2005
Completed: 13/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 211500m(AMG)
North: 7488200m(AMG)
Elevation: 421(mRL)

Static Water Level: 11.22(mbrp) **Date:** On completion of drilling



Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
			ALLUVIUM: Silty gravel and gravelly silt, red brown		▼	
			CALCAREOUS SANDSTONE: Off white, minor hard chips, mainly drilling as paste			
			CLAY: Grey, minor greenish ochre clay			
			CALCAREOUS SANDSTONE: Off white, firm chips			
			CALCAREOUS SANDSTONE: Off white with abundant dark blackish brown grains (iron, manganese?), fine to medium grained, angular	Yield of <1L/s, EC of 1.22mS/cm, pH of 7.61 @ 57m		
			CALCAREOUS SANDSTONE: Buff, brown, vughy, ochre and yellow brown clay, iron rich grains			
			DOLOMITE: Grey, light grey, dark pink, brown, interbedded layers, fresh	EC of 1.32mS/cm, pH of 8.04 @ 124m EOH @ 124m		

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WELL LOG

Well No: MLW13

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

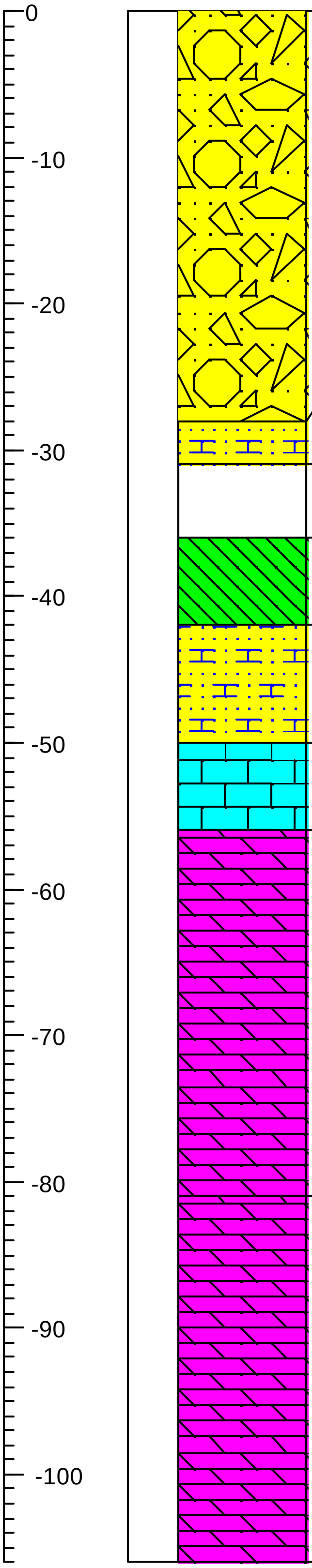
Commenced: 13/01/2005
Completed: 14/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 211500m(AMG)
North: 7488000m(AMG)
Elevation: 421(mRL)

Static Water Level: 10.78(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Silty gravel and silt, red brown, mixed rock clasts

CALCAREOUS SANDSTONE: Buff, calcrete chips and red brown silt

CLAY: Dark grey, gritty (fine black grains, iron or manganese)

CALCAREOUS SANDSTONE: Off white, hard chips and black grains but mainly drilling as paste

LIMESTONE: Calcrete, white, massive, uniform, fresh, minor vughy layers

DOLOMITE: Grey, dark pink, brown, alternating layers, fresh

DOLOMITE: Brown, granular, sacharoidal texture

Yield of 6L/s, EC of 2.15mS/cm, pH of 7.74 @ 50m

EC of 2.54mS/cm, pH of 7.83 @ 70m

EC of 2.62mS/cm, pH of 7.63 @ 102m

EOH @ 106m

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WELL LOG

Well No: MLW14

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

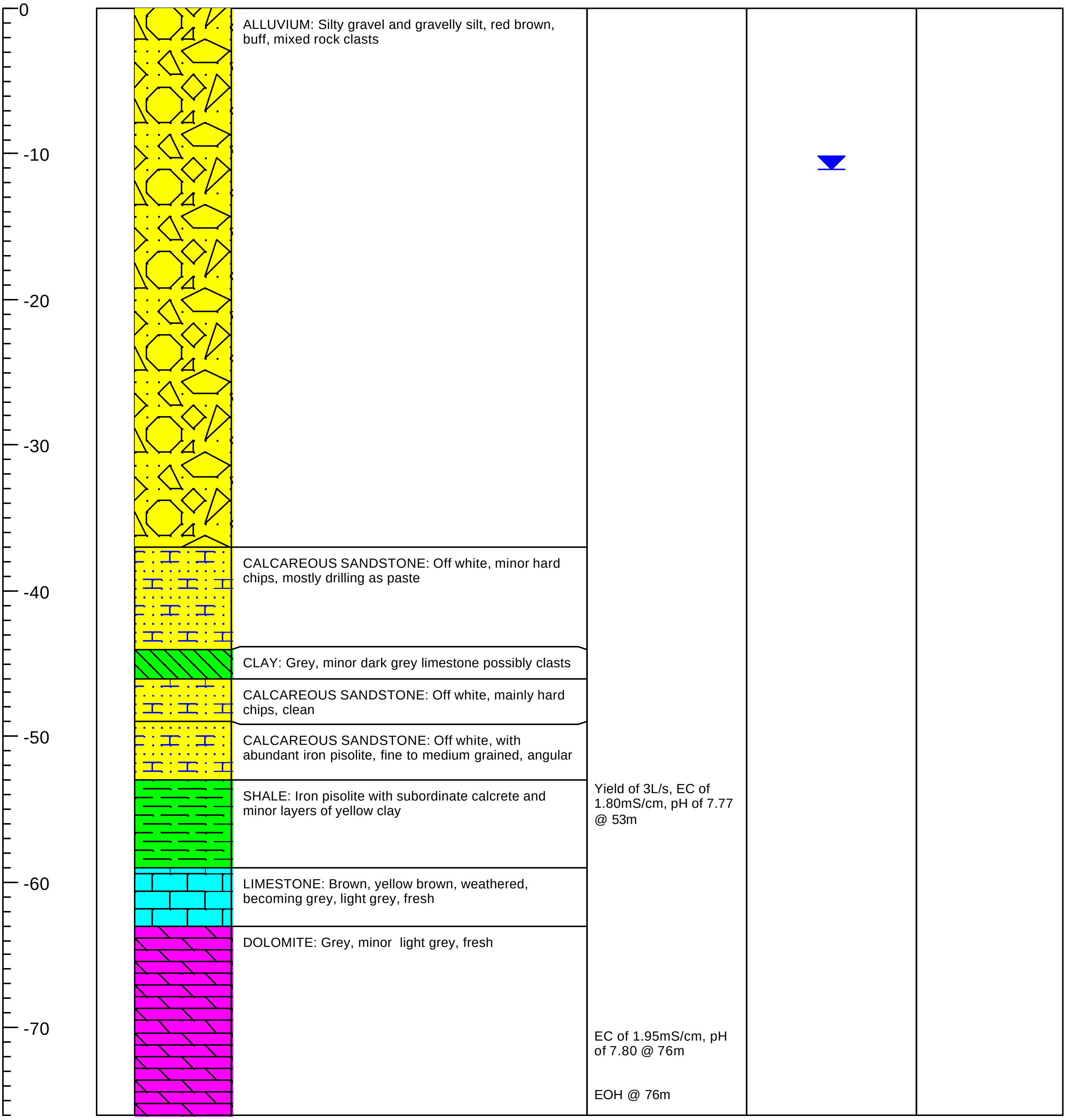
Commenced: 14/01/2005
Completed: 14/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 211500m(AMG)
North: 7488400m(AMG)
Elevation: 421(mRL)

Static Water Level: 11.08(mbrp) **Date:** On completion of drilling

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



ALLUVIUM: Silty gravel and gravelly silt, red brown, buff, mixed rock clasts

CALCAREOUS SANDSTONE: Off white, minor hard chips, mostly drilling as paste

CLAY: Grey, minor dark grey limestone possibly clasts

CALCAREOUS SANDSTONE: Off white, mainly hard chips, clean

CALCAREOUS SANDSTONE: Off white, with abundant iron pisolite, fine to medium grained, angular

SHALE: Iron pisolite with subordinate calcrete and minor layers of yellow clay

Yield of 3L/s, EC of 1.80mS/cm, pH of 7.77 @ 53m

LIMESTONE: Brown, yellow brown, weathered, becoming grey, light grey, fresh

DOLOMITE: Grey, minor light grey, fresh

EC of 1.95mS/cm, pH of 7.80 @ 76m

EOH @ 76m

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WELL LOG

Well No: MLW15

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

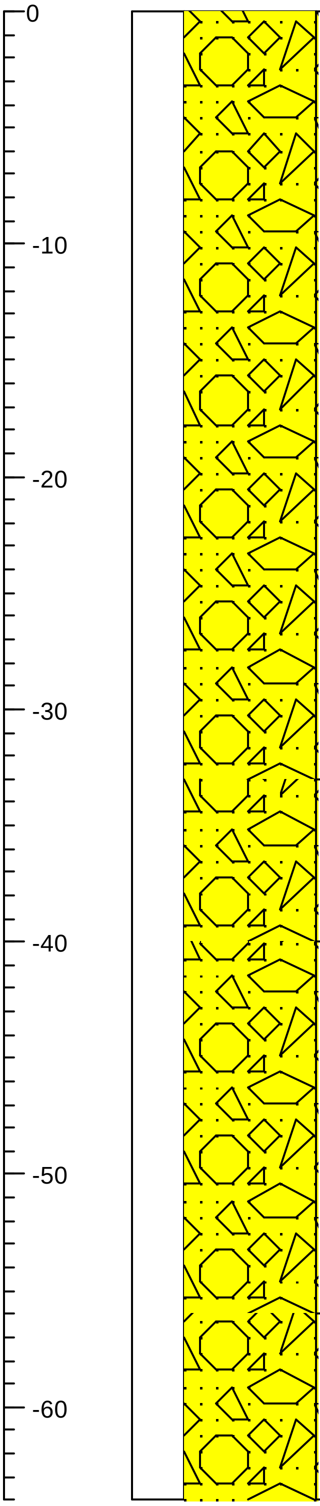
Commenced: 14/01/2005
Completed: 15/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 205600m(AMG)
North: 7492800m(AMG)
Elevation:418(mRL)

Static Water Level: 11.00(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Silty gravel, silt, gravelly silt, red brown, mixed rock clasts

ALLUVIUM: Silty gravel, abundant BIF clasts

ALLUVIUM: Siltstone, minor clasts

ALLUVIUM: Siltstone, minor calcrete

EOH @ 64m

File Ref: F:\jobs\477\3000\3200 test data\Drill logs\Log Plot files\Mt Lewin\MLW15

Well No: MLW15

Sheet 1 of 1

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WELL LOG

Well No: MLW16

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

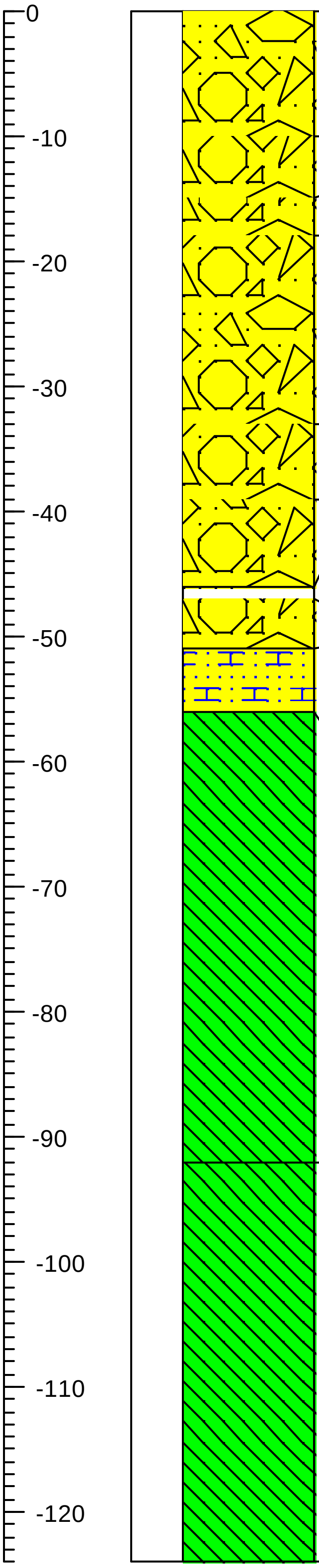
Commenced: 15/01/2005
Completed: 15/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 205600m(AMG)
North: 7493000m(AMG)
Elevation: 418(mRL)

Static Water Level: 11.00(mbrp)
Date: On completion of drilling

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



Lithological Description

ALLUVIUM: Silty gravel, red brown, mixed rock clasts

ALLUVIUM: Gravelly silt

ALLUVIUM: Silt

ALLUVIUM: Siltstone, red brown, hard chips, few clasts

ALLUVIUM: Siltstone, red brown, hard chips, abundant clastic material, mainly BIF, some chert

ALLUVIUM: Siltstone, gravelly, BIF, chert, minor clacrete

BLANK: Cavity?

ALLUVIUM: Red brown siltstone with calcrete

CALCAREOUS SANDSTONE: Off white, buff, partly friable, with ochre, yellow, orange clay/claystone, soft, decomposed

CLAY: Greenish yellow, off white, ochre, soft with chert and ironstone bands, thin layers of pisolitic iron

CLAY: Greenish yellow brown, mainly soft with firm layers, abundant fine grained pisolitic iron

Field Notes

Yield of 2.0L/s, EC of 1.76mS/cm, pH of 7.80 @ 42m

Yield of 3.0L/s, EC of 1.88mS/cm, pH of 7.56 @ 71m

Yield of 5.0L/s, EC of 1.82mS/cm, pH of 7.55 @ 94m

Yield of 6.0L/s, EC of 2.18mS/cm, pH of 7.40 @ 124m

EOH @ 124m

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WELL LOG

Well No: MLW17

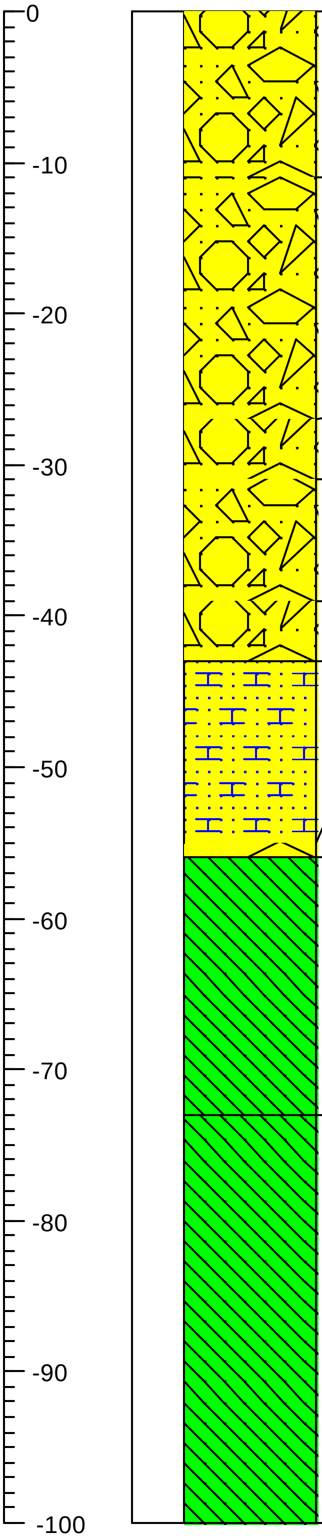
Client: Fortescue Metals Group
Project: Mt Lewin groundwater RC exploration

Commenced: 16/01/2005
Completed: 16/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 205600m(AMG)
North: 7492600m(AMG)
Elevation: 423(mRL)

Static Water Level: 12.75(mbrp)
Date: On completion of drilling



Lithological Description	Field Notes	Well Completion Diagram	Notes
ALLUVIUM: Silty gravel, red brown, mixed rock clasts			
ALLUVIUM: Siltstone, minor clastic material		▼	
ALLUVIUM: Siltstone with increased increased clasts, some BIF and chert			
ALLUVIUM: Siltstone, few clasts			
ALLUVIUM: Siltstone with grey clay, soft, non-calc			
CALCAREOUS SANDSTONE: Calcrete and clay, off white chips of calcrete with layers of light grey clay and siltstone			
ALLUVIUM: Siltstone, minor calcrete			
CLAY: Greenish grey with yellow, light grey, off white, minor calcrete, soft, slow drilling	Yield of 4L/s, EC of 0.75mS/cm, pH of 7.63 @ 56m		
CLAY: Clay with pisolitic iron, overall colour change to grey, greenish grey clay with layers of fine iron grains	EC of 1.90mS/cm, pH of 7.35 @ 82m EC of 2.74mS/cm, pH of 7.36 @ 100m EOH @ 100m		

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WELL LOG

Well No: MLW18

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

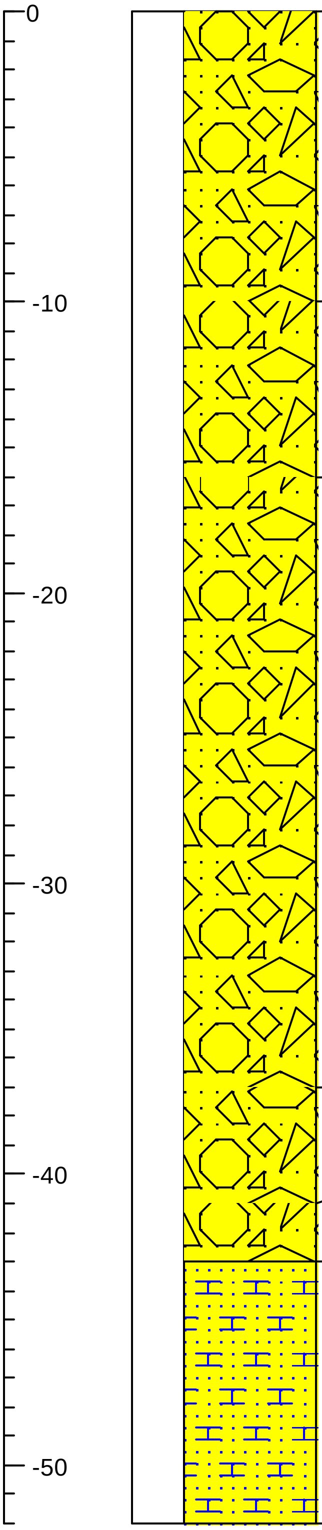
Commenced: 16/01/2005
Completed: 17/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 207800m(AMG)
North: 7491500m(AMG)
Elevation: 426(mRL)

Static Water Level: 15.48(mbrp)
Date: On completion of drilling

Depth (mbgl) | **Geology** | **Graphic Log**



Lithological Description	Field Notes
ALLUVIUM: Silty gravel, red brown, coarse mixed rock fragments	
ALLUVIUM: Gravelly silt, fewer clasts	
ALLUVIUM: Silty gravel, red brown, mixed rock clasts	Muddy discharge in alluvium and calcrete, difficulty clearing hole.
ALLUVIUM: Colour change to buff (poor sample)	
ALLUVIUM: Colour change to grey, evidence of fine grained iron	
CALCAREOUS SANDSTONE: Calcrete, buff, ochre, moderately soft with siltstone, pisolite, rock fragmnets, minor chert	EOH @ 52m

Well Completion

Diagram | **Notes**

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WELL LOG

Well No: MLW19

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

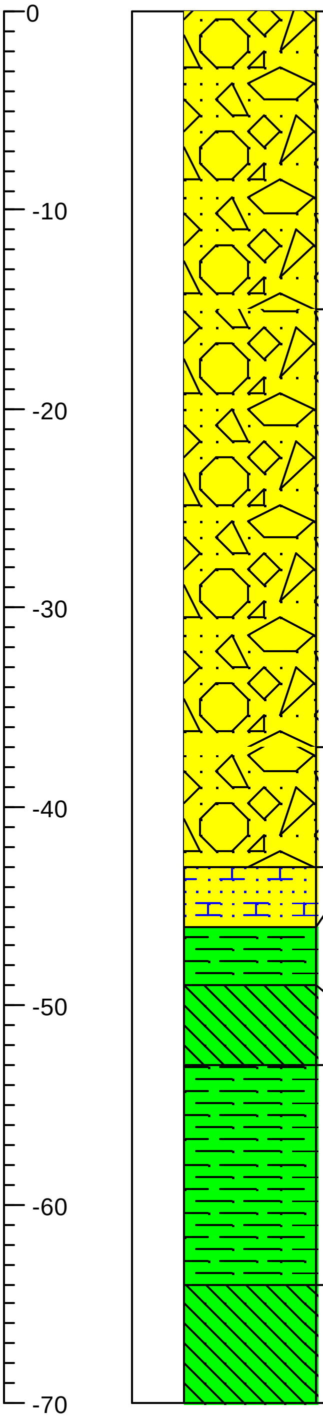
Commenced: 17/01/2005
Completed: 17/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 207800m(AMG)
North: 7491700m(AMG)
Elevation: 425(mRL)

Static Water Level: 15.68(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Silty gravel, red brown, coarse mixed rock clasts

ALLUVIUM: Siltstone, minor mixed rock clasts

ALLUVIUM: Silstone, increased coarse clasts

CALCAREOUS SANDSTONE: Buff, clayey

SHALE: Grey mud, highly weathered Marra Mamba, iron rich, rubble with grey green clay and soft buff calcrete

CLAY: Olive brown mud

SHALE: Marra Mamba? BIF, iron rubble, vughy, with brown and olive green clay

CLAY: Decompossed rock, clay, greenish grey with iron rich layers, granular

Field Notes:

Muddy discharge becoming clearer after 53m, hole blocking off and choking hammer, difficulty removing heavy iron material from hole, no major water on rod change.

Yield of 2L/s, EC of 2.36mS/cm, pH of 7.66 @ 68m

EOH @ 70m

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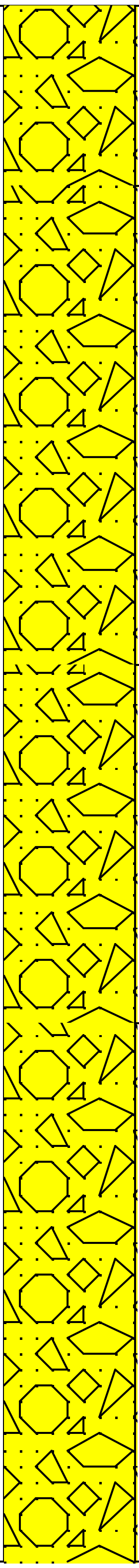
WELL LOG

Well No: MLW20

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

Commenced:	18/01/2005	**Method:**	RC	**Area:**	Mt Lewin
Completed:	18/01/2005	**Fluid:**	Air	**East:**	207800m(AMG)
Drilled:	Connector R3	**Bit Record:**	5 3/8"	**North:**	7491300m(AMG)
Logged By:	S Collett			**Elevation:**	425(mRL)

Static Water Level: 14.47 **Date:** On completion of drilling

Depth (mbgl)	**Geology**	**Graphic Log**	**Lithological Description**	**Field Notes**	**Well Completion**	
					Diagram	**Notes**
0			ALLUVIUM: Silty gravel, red brown, mixed rock clasts			
-10			ALLUVIUM: Silty gravel, buff, light brown, moxed rock clasts	Hole plugging off, large cavity formed, no progress, abandoned hole		
			ALLUVIUM: Silt, red brown, fine, few clasts		▼	
-20			ALLUVIUM: Silty gravel, red brown, coarse, mixed rock clasts	EOH @ 26m		

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WELL LOG

Well No: MLW21

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

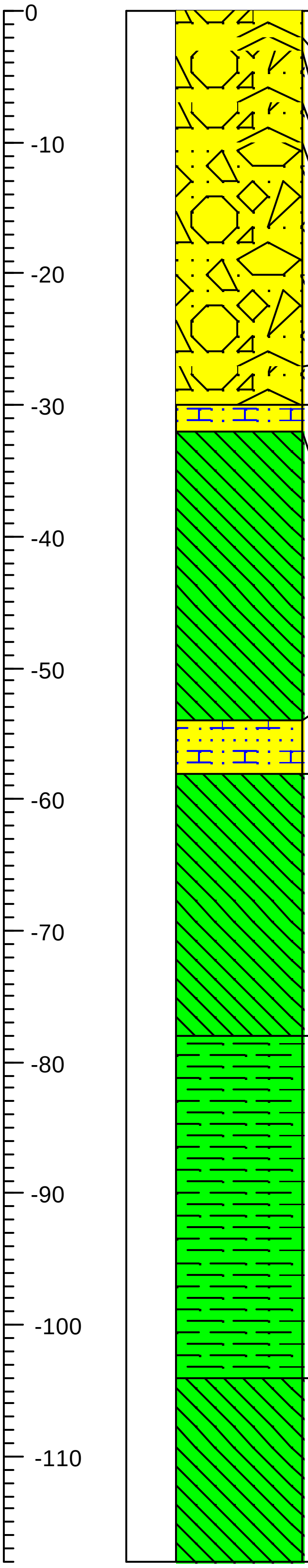
Commenced: 18/01/2005
Completed: 19/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 207650m(AMG)
North: 7488900m(AMG)
Elevation: 425(mRL)

Static Water Level: 9.69(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Silty gravel

ALLUVIUM: Silt

ALLUVIUM: Silty gravel

ALLUVIUM: Silty gravel, partly calcareous,

ALLUVIUM: Silty gravel, abundant chert fragments

ALLUVIUM: Siltstone, minor calcrete

CALCAREOUS SANDSTONE: Off white, moderately firm, partly siliceous

CLAY: Greyish white, minor firm chips, mainly calcareous with non-calcareous grey clay, partly siliceous, minor chert fragments

CALCAREOUS SANDSTONE: Off white, pinkish white and abundant siliceous shale fragments

CLAY: Clay with fine siliceous shale grains, dark grey, (little sample as clay washing out leaving minor grains)

SHALE: Decomposed rock, overall colour change to chocolate brown, medium grained multi-coloured siliceous grains (pink, red, white, clear), clay matrix washing out, abundant calcareous chips

CLAY: Claystone, off white, light grey, with pink and yellow staining, soft, thin bands of chert and oxidised iron

EC of 1.89mS/cm, pH of 7.46 @ 31m

Yield of 1L/s, EC of 2.11mS/cm, pH of 7.61 @ 40m

Yield of 2-3L/s, EC of 1.98mS/cm, pH of 7.38 @ 70m

Yield of 4L/s, EC of 3.15mS/cm, pH of 7.66 @ 97m

EC of 3.15mS/cm, pH of 7.55 @ 114m

Yield of 7L/s, EC of 3.23mS/cm, pH of 7.41 @ 118m

EOH @ 118m

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WELL LOG

Well No: MLW22

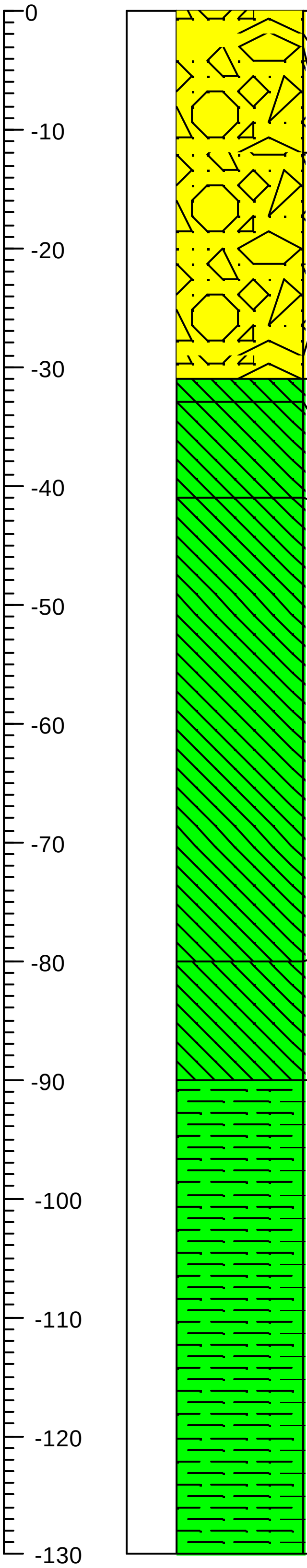
Client: Fortescue Metals Group
Project: Mt Lewin groundwater RC exploration

Commenced: 19/01/2005
Completed: 20/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 207650m(AMG)
North: 7489100m(AMG)
Elevation: 412(mRL)

Static Water Level: 8.53(mbrp)
Date: On completion of drilling



Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
ALLUVIUM: Silty gravel			
ALLUVIUM: Silt			
ALLUVIUM: Silty gravel, buff, light brown			
ALLUVIUM: Silty gravel	Yield of 3L/s, EC of 2.08mS/cm, pH of 7.26 @ 24m		
ALLUVIUM: Silty gravel and calcrete, minor white chips			
CLAY: Red brown, soft			
CLAY: Light grey, soft with angular mixed rock clasts, some large chips of chert up to 25mm, clay partly calcareous, siliceous pebbles at 30m			
CLAY: Clay, light brown, brownish yellow, calcareous, mixed rock clasts (BIF, chert, shale), minor firm chips of calcrete, white, yellow, pink, mottled	Yield of 5L/s, EC of 2.12mS/cm, pH of 7.31 @ 43m		
CLAY: Clay with gritty layers (decompossed rock?), dark chocolate brown overall, yellow brown, buff, soft calcareous, dark red, soft siltstone, minor well rounded clear and orange quartz (inclusions in clay matrix - decomposed or sediment?)			
SHALE: Decomposed rock, buff (no dark brown matrix), cleaner, monotonous unit, clayey, soft, with gritty layers	EC of 2.95mS/cm, pH of 7.58 @ 93m Yield of 10L/s, EC of 3.45mS/cm, pH of 7.29 @ 130m EOH @ 130m		

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WELL LOG

Well No: MLW23

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

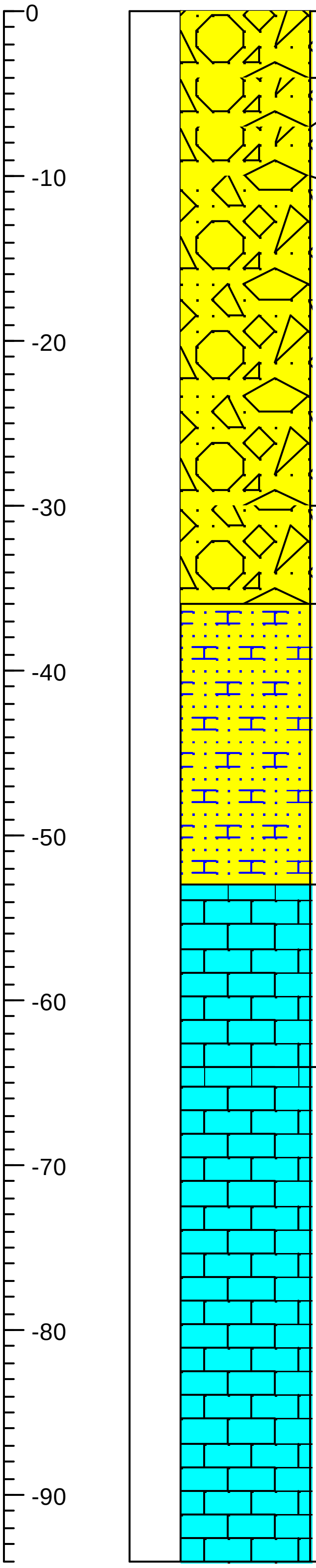
Commenced: 20/01/2005
Completed: 20/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 207650m(AMG)
North: 7488700m(AMG)
Elevation: 415(mRL)

Static Water Level: 7.53 (mbrp)
Date: On completion of drilling

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



Lithological Description	Field Notes
ALLUVIUM: Silty gravel	
ALLUVIUM: Gravelly silt	
ALLUVIUM: Silty gravel, buff, light brown with thin white clay layer	
ALLUVIUM: Silty gravel, red brown, coarse mixed rock fragments, abundant chert, partly lithified	
ALLUVIUM: Silty gravel with minor calcrete	Yield of 3L/s, EC of 2.24mS/cm, pH of 7.72 @ 33m
CALCAREOUS SANDSTONE: Calcrete, off white, buff, light bronwn paste with minor hard chips	
LIMESTONE: Dark grey, hard, granular with abundant calcrete (from above?)	
LIMESTONE: Dark grey, decreasing calcrete	Yield of 4L/s, EC of 2.42mS/cm, pH of 7.84 @ 67m Yield of 4L/s, EC of 2.80mS/cm, pH of 7.82 @ 94m EOH @ 94m

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WELL LOG

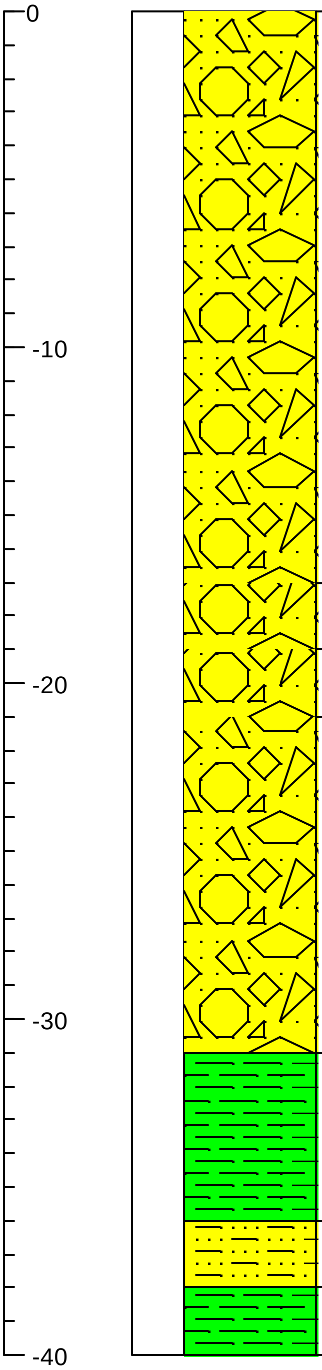
Well No: MLW24

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

Commenced:	21/1/2005	**Method:**	DC	**Area:**	Mt Lewin
Completed:	21/1/2005	**Fluid:**	Air	**East:**	208850m(AMG)
Drilled:	Connector R3	**Bit Record:**	5 3/8"	**North:**	7493050m(AMG)
Logged By:	S Collett			**Elevation:**	432(mRL)

Static Water Level: 20.70(mbrp) **Date:** On completion of drilling

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



ALLUVIUM: Silty gravel, red brown, mixed rock fragments

ALLUVIUM: Silt, minor rock fragments

ALLUVIUM: Silty gravel

ALLUVIUM: Silt, slightly clayey, pinkish red with white calcrete

SHALE: BIF, dark brown iron, chert, broken, vughy. dark yellow oxidised hard clay

SILTSTONE: Red brown

SHALE: BIF, dark brown, iron, chert, broken

EOH @ 40m

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WELL LOG

Well No: MLW25

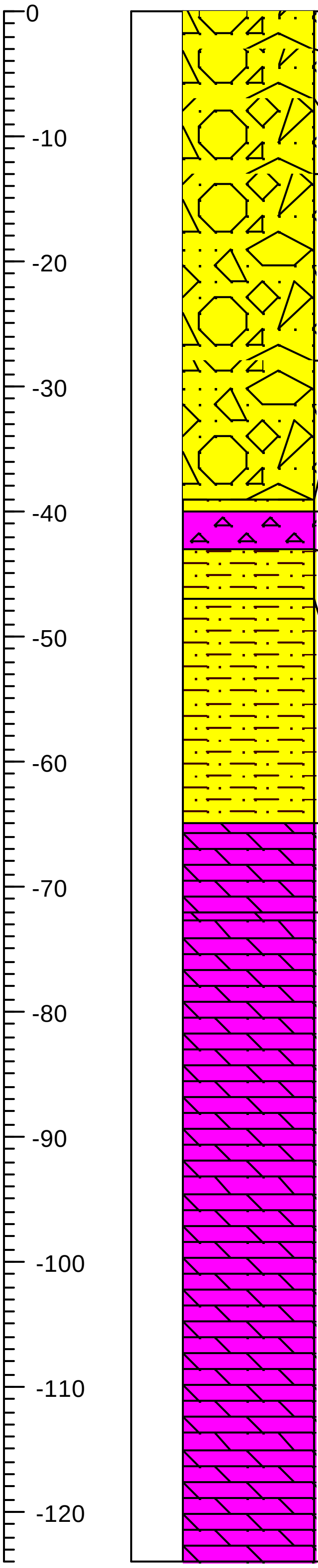
Client: Fortescue Metals Group **Project:** Mt Lewin groundwater RC exploration

Commenced: 21/01/2005
Completed: 22/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 219560m(AMG)
North: 7493130m(AMG)
Elevation: 438(mRL)

Static Water Level: 21.15(mbrp) **Date:** On completion of drilling



Lithological Description	Field Notes	Well Completion Diagram	Notes
ALLUVIUM: Silty gravel, red brown, mixed rock clasts			
ALLUVIUM: Silty gravel, buff, light brown, mixed rock clasts			
ALLUVIUM: Silty gravel			
ALLUVIUM: Silty gravel, red brown, mixed rock clasts		▼	
ALLUVIUM: Gravelly silt, few clasts			
SILT: Ochre with broken ironstone and yellow brown claystone			
CHERT: Chert and siltstone			
SILT: Greyish buff, fine with white limestone and black grains (haematite?), limestone with black flecks (manganese)			
SILT: Colour change to dark chocolate brown, drilling as paste	EC of 1.47mS/cm, pH of 7.92 @ 63m		
DOLOMITE: Meta limestone/dolomite, overall choc brown, chips light grey, crystalline, limestone with pink streaks, fresh			
DOLOMITE: Meta limestone/dolomite, grey, light grey, pink streaks, crystaline, fresh, cleaner sample (no brown silt?)	Yield of 7L/s, EC of 1.96mS/cm, pH of 7.80 @ 82m Yield of 7L/s, EC of 2.09mS/cm, pH of 7.85 @ 106m Yield of 7L/s, EC of 2.12mS/cm, pH of 7.85 @ 124m EOH @ 124m		

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WELL LOG

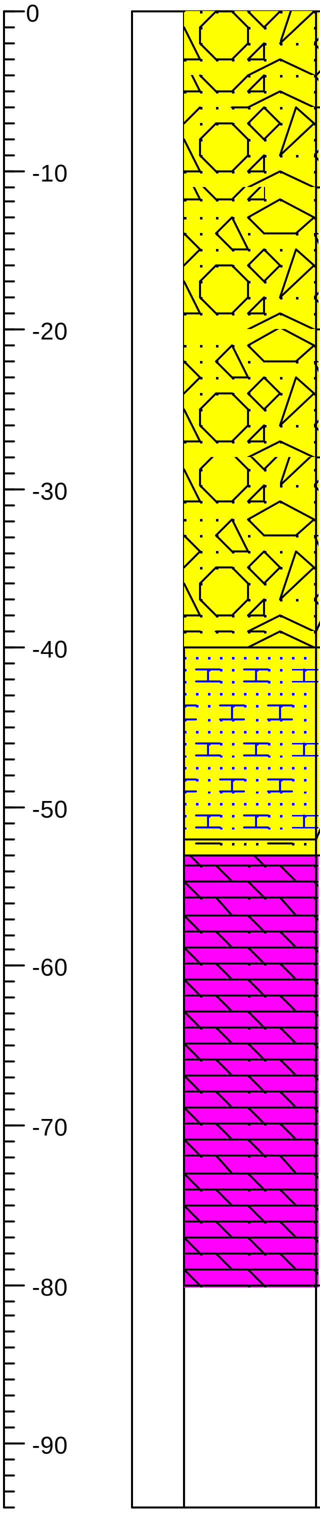
Well No: MLW26

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

Commenced: 22/01/2005	**Method:** DC	**Area:** Mt Lewin	
Completed: 22/01/2005	**Fluid:** Air	**East:** 219550m(AMG)	
Drilled: Connector R3	**Bit Record:** 5 3/8"	**North:** 7492830m(AMG)	
Logged By: S Collett		**Elevation:** 436(mRL)	

Static Water Level:
Date:

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



Lithological Description	Field Notes
ALLUVIUM: Silty gravel	
ALLUVIUM: Silty gravel, buff	
ALLUVIUM: Silty gravel, red brown	
ALLUVIUM: Gravelly silt, red brown, fewer rock fragments	
ALLUVIUM: Silty gravel	
ALLUVIUM: Silty gravel, coarse rock fragments, partly lithified (siltstone)	
ALLUVIUM: Silty gravel, iron pisolite, white calcrete	
CALCAREOUS SANDSTONE: White, yellow, brown, with siltstone, chert, iron pisolite, silty matrix	Yield of 2L/s, EC of 1.31mS/cm, pH of 7.58 @ 42m
SILTSTONE: Red brown with calcrete, iron pisolite	
DOLOMITE: Colour change to dark greenish grey, silicified iron rich shale (baked appearance), white calcrete, brown iron rich vughy layers, dark brown silt, ochre silt, minor grey crystalline limestone/dolomite	Yield of 5L/s, EC of 1.68mS/cm, pH of 7.57 @ 62m
	Yield of 10L/s, EC of 1.78mS/cm, pH of 7.62 @ 82m Yield of 10L/s, EC of 1.82mS/cm, pH of 7.72 @ 94m EOH @ 94m

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WELL LOG

Well No: MLW27

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

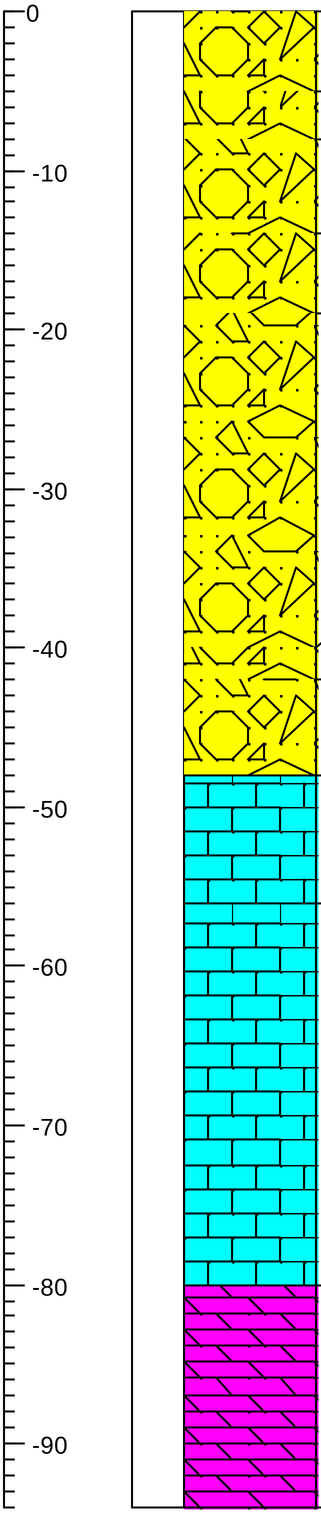
Commenced: 23/01/2005
Completed: 23/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 219550m(AMG)
North: 7492500m(AMG)
Elevation: 425(mRL)

Static Water Level: 19.98(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Silty gravel, red brown, coarse angular mixed rock fragments

ALLUVIUM: Silty gravel, buff, yellow brown

ALLUVIUM: Silty gravel

ALLUVIUM: Siltstone with mixed rock fragments

ALLUVIUM: Silty gravel

▼

ALLUVIUM: Silty gravel, abundant chert

ALLUVIUM: Siltstone and calcrete/limestone, buff paste with hard white chips

LIMESTONE: Calcrete, white, hard chips, fine grained, porcellanous, manganese flecks, ochre/yellow siltstone

LIMESTONE: Overall colour change to dark brown, mixed sample, black siliceous shale, dark red siliceous siltstone, brown iron altered siltstone, vughy, broken, weathered

Yield of 1L/s, EC of 1.68mS/cm, pH of 7.48 @ 58m

Yield of 10L/s, EC of 2.52mS/cm, pH of 7.68 @ 77m

DOLOMITE: Limestone/dolomite, pinkish brown, hard, crystalline, fresh

Yield of 10L/s, EC of 2.53mS/cm, pH of 7.92 @ 94m

EOH @ 94m

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WELL LOG

Well No: MLW28

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

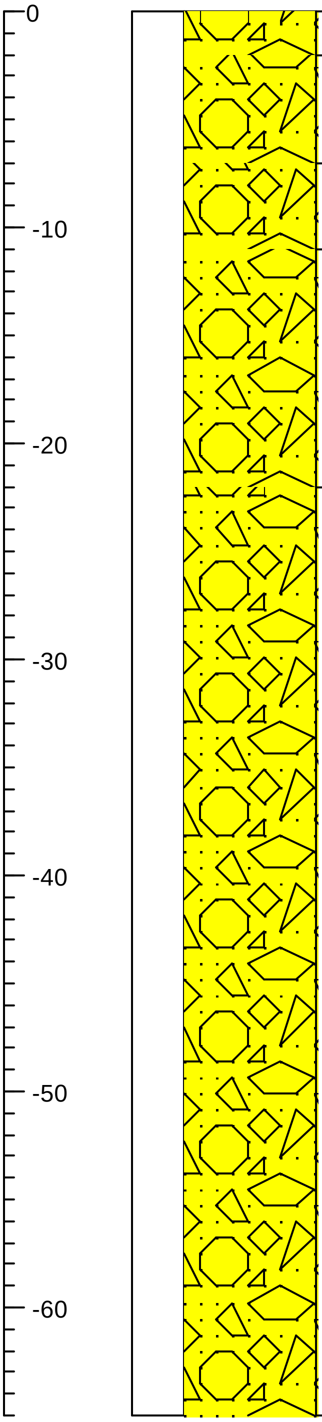
Commenced: 23/01/2005
Completed: 24/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 219580m(AMG)
North: 7492270m(AMG)
Elevation: 417(mRL)

Static Water Level: 19.86(mbrp) **Date:** On completion of drilling

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



ALLUVIUM: Siltstone

ALLUVIUM: Silty gravel

ALLUVIUM: Gravelly silt

ALLUVIUM: Silty gravel

ALLUVIUM: Silty gravel (poor samples due to hole washing out)

Little evidence of water in alluvium (hole collaring off, possibly preventing discharge)

EOH @ 65m

▼

File Ref: F:\jobs\477\3000\3200 test data\Drill logs\Log Plot files\Mt Lewin\MLW28 Well No: MLW28 Sheet 1 of 1

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WELL LOG

Well No: MLW29

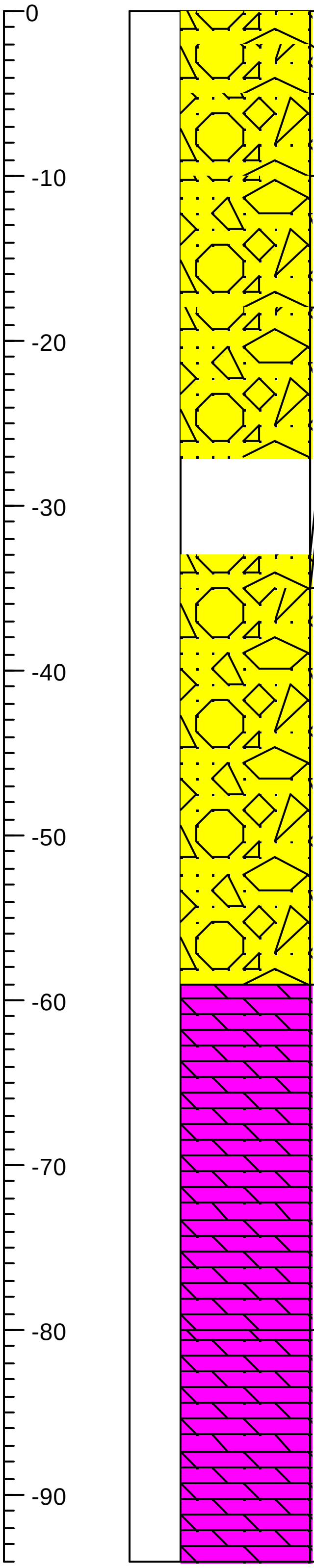
Client: Fortescue Metals Group
Project: Mt Lewin groundwater RC exploration

Commenced: 24/01/2005
Completed: 25/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 219580m(AMG)
North: 7492300m(AMG)
Elevation: 417(mRL)

Static Water Level: 19.78(mbrp)
Date: On completion of drilling



Lithological Description	Field Notes
ALLUVIUM: Siltstone, red brown	
ALLUVIUM: Silty gravel	
ALLUVIUM: Silty gravel, buff	
ALLUVIUM: Gravelly silt, fine grained, few rock fragments	
ALLUVIUM: Gravelly silt	
ALLUVIUM: Gravel, minor silt	
ALLUVIUM: Silty gravel, with minor calcrete from 50-60m	Yield of 5L/s @ 52m
DOLOMITE: Weathered dolomite, colour change to chocolate brown, black shaley dolomite, some pink chips (possibly from broken blocks or pebbles?), yellow, brown, ochre siltstone, possible choc brown silt washing out of sample	Yield of 13L/s, EC of 2.55mS/cm, pH of 7.81 @ 72m
DOLOMITE: Dolomite, pink, pinkish brown, crystalline, hard, fresh	Yield of 13L/s, EC of 2.61mS/cm, pH of 7.85 @ 94m EOH @ 94m

Well Completion

Diagram	Notes
▼	

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WELL LOG

Well No: MLW30

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

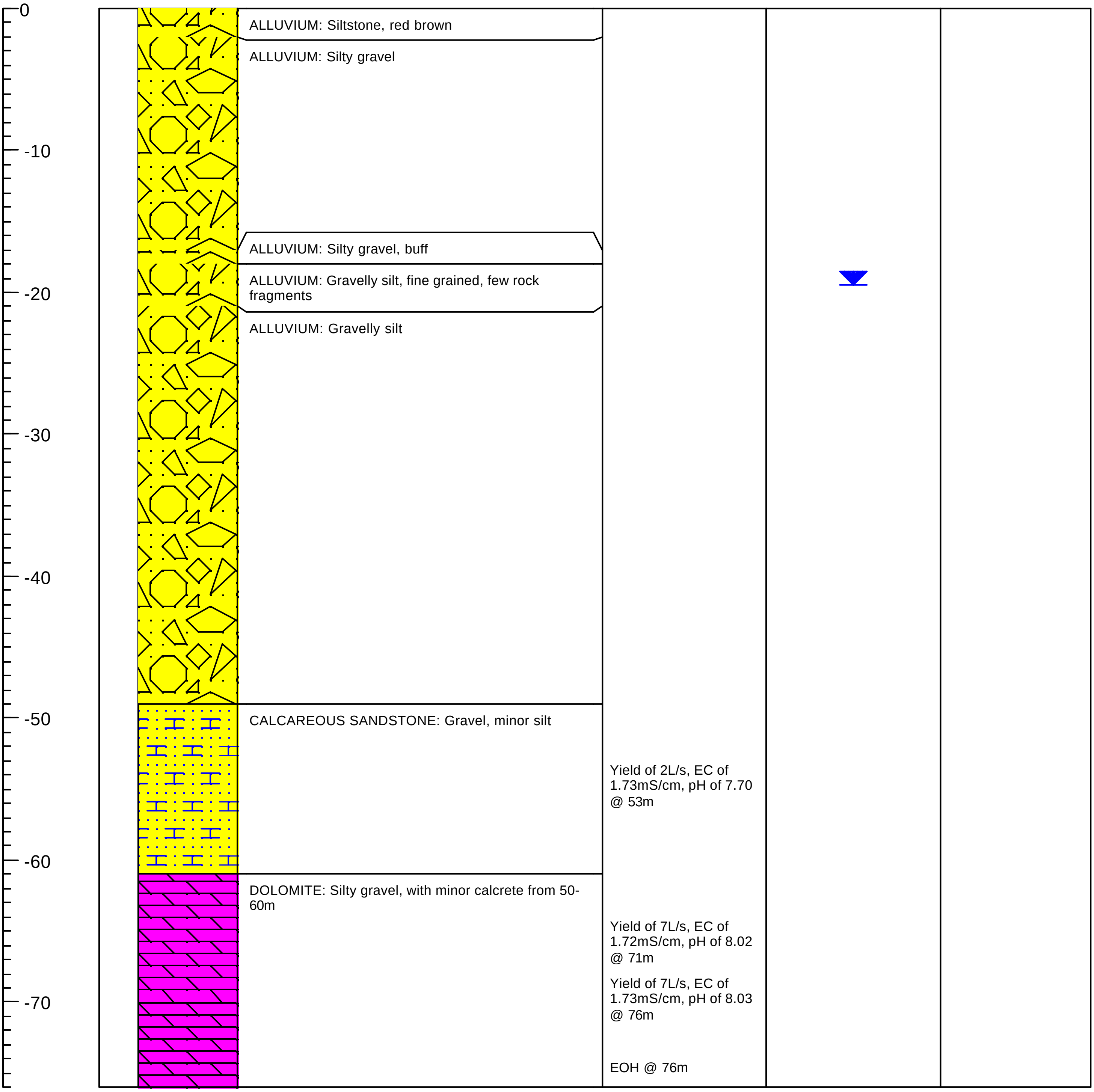
Commenced: 25/01/2005
Completed: 25/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 219550m(AMG)
North: 7491930(AMG)
Elevation: 436(mRL)

Static Water Level: 19.43(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Siltstone, red brown

ALLUVIUM: Silty gravel

ALLUVIUM: Silty gravel, buff

ALLUVIUM: Gravelly silt, fine grained, few rock fragments

ALLUVIUM: Gravelly silt

CALCAREOUS SANDSTONE: Gravel, minor silt

DOLOMITE: Silty gravel, with minor calcrete from 50-60m

Yield of 2L/s, EC of 1.73mS/cm, pH of 7.70 @ 53m

Yield of 7L/s, EC of 1.72mS/cm, pH of 8.02 @ 71m

Yield of 7L/s, EC of 1.73mS/cm, pH of 8.03 @ 76m

EOH @ 76m

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WELL LOG

Well No: MLW31

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

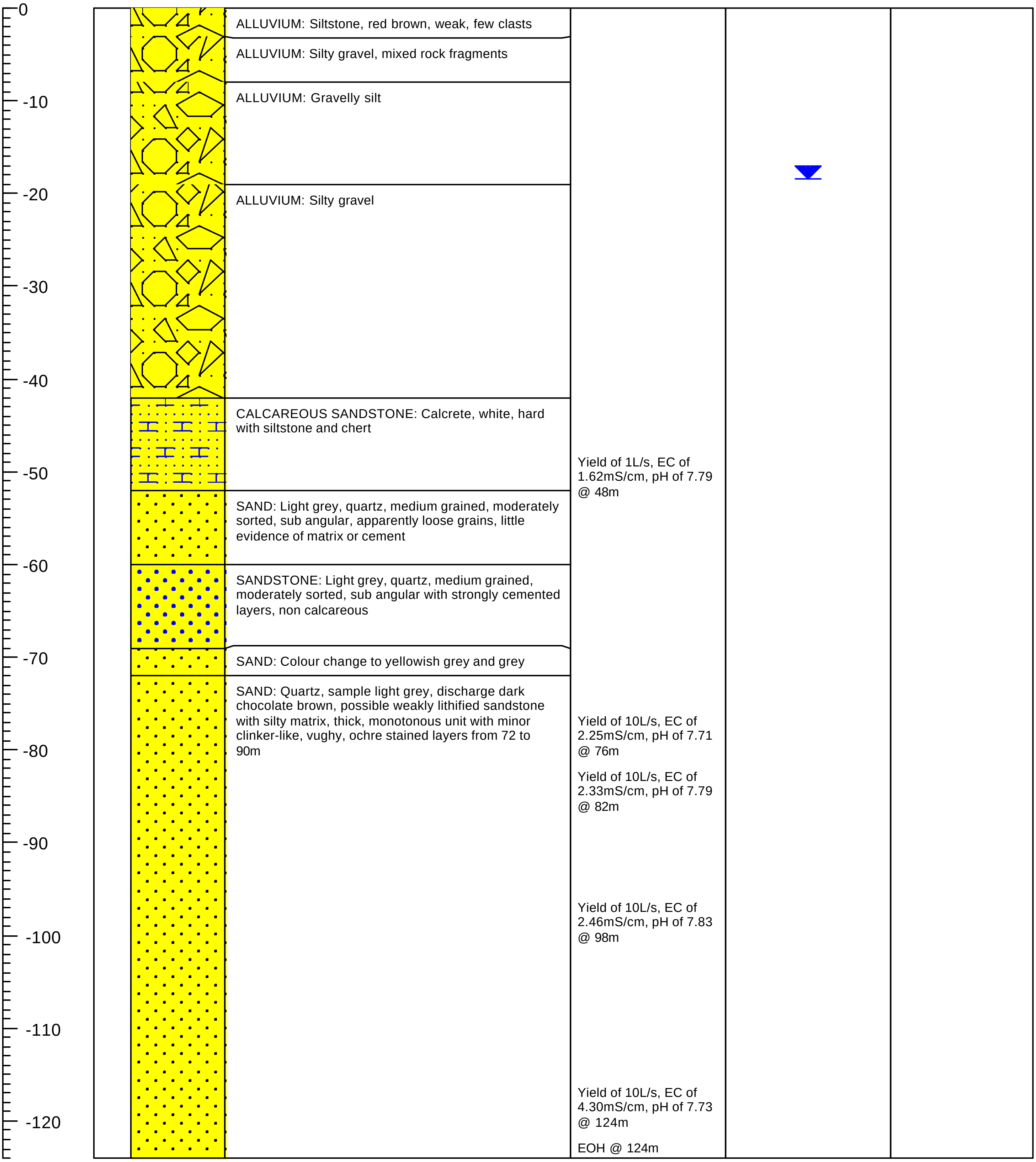
Commenced: 25/01/2005
Completed: 26/01/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 218360m(AMG)
North: 7491940(AMG)
Elevation: 432(mRL)

Static Water Level: 18.38(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Siltstone, red brown, weak, few clasts

ALLUVIUM: Silty gravel, mixed rock fragments

ALLUVIUM: Gravelly silt

ALLUVIUM: Silty gravel

CALCAREOUS SANDSTONE: Calcrete, white, hard with siltstone and chert

SAND: Light grey, quartz, medium grained, moderately sorted, sub angular, apparently loose grains, little evidence of matrix or cement

SANDSTONE: Light grey, quartz, medium grained, moderately sorted, sub angular with strongly cemented layers, non calcareous

SAND: Colour change to yellowish grey and grey

SAND: Quartz, sample light grey, discharge dark chocolate brown, possible weakly lithified sandstone with silty matrix, thick, monotonous unit with minor clinker-like, vughy, ochre stained layers from 72 to 90m

Yield of 1L/s, EC of 1.62mS/cm, pH of 7.79 @ 48m

Yield of 10L/s, EC of 2.25mS/cm, pH of 7.71 @ 76m

Yield of 10L/s, EC of 2.33mS/cm, pH of 7.79 @ 82m

Yield of 10L/s, EC of 2.46mS/cm, pH of 7.83 @ 98m

Yield of 10L/s, EC of 4.30mS/cm, pH of 7.73 @ 124m

EOH @ 124m

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WELL LOG

Well No: MLW32

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

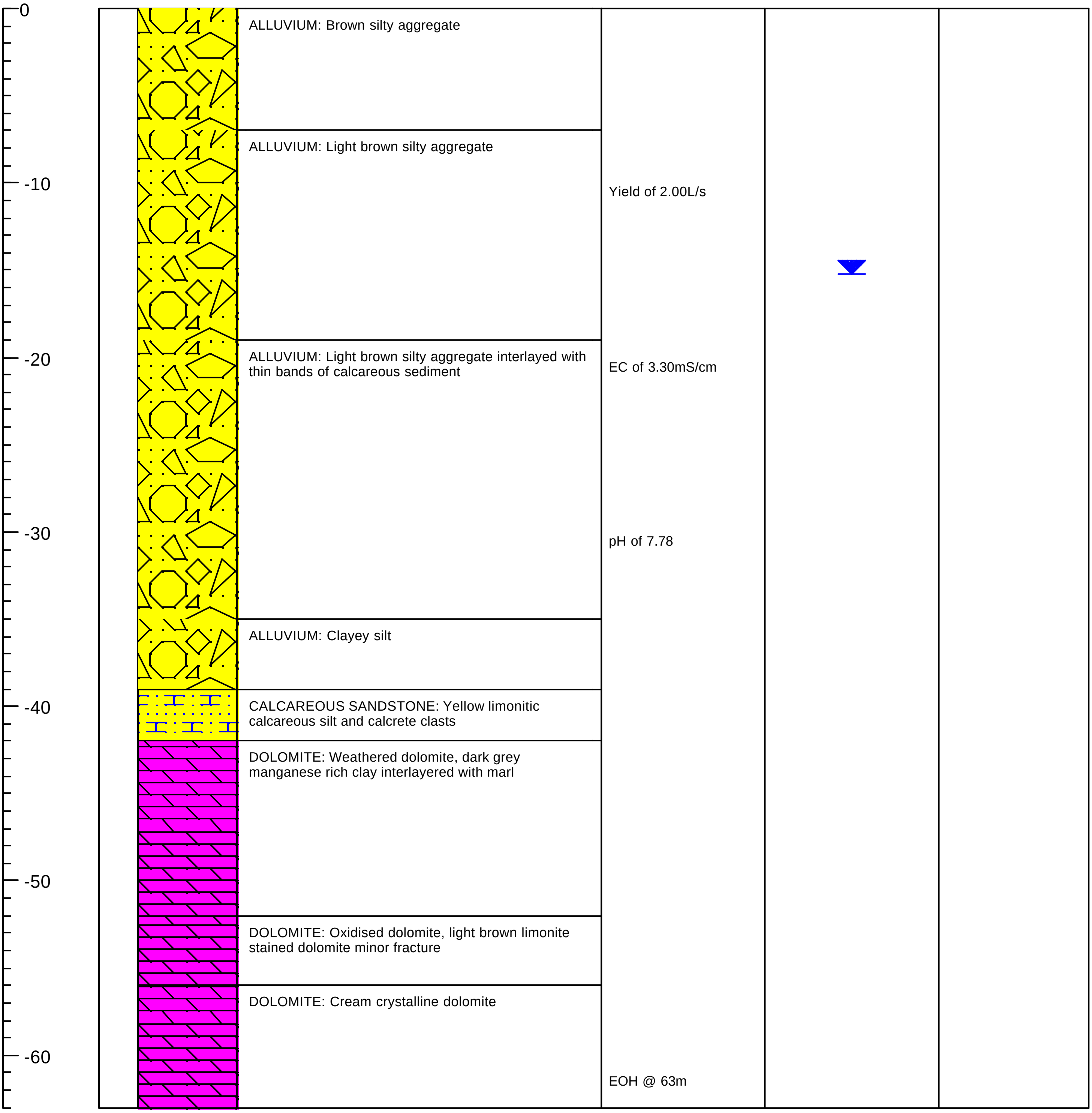
Commenced: 05/02/2005
Completed: 05/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 215787m(AMG)
North: 7489430(AMG)
Elevation: 430(mRL)

Static Water Level: 15.18(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Brown silty aggregate

ALLUVIUM: Light brown silty aggregate

ALLUVIUM: Light brown silty aggregate interlayed with thin bands of calcareous sediment

ALLUVIUM: Clayey silt

CALCAREOUS SANDSTONE: Yellow limonitic calcareous silt and calcrete clasts

DOLOMITE: Weathered dolomite, dark grey manganese rich clay interlayered with marl

DOLOMITE: Oxidised dolomite, light brown limonite stained dolomite minor fracture

DOLOMITE: Cream crystalline dolomite

Yield of 2.00L/s

EC of 3.30mS/cm

pH of 7.78

EOH @ 63m

File Ref: F:\jobs\477\3000\3200 test data\Drill logs\Log Plot files\Mt Lewin\MLW32

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WELL LOG

Well No: MLW33

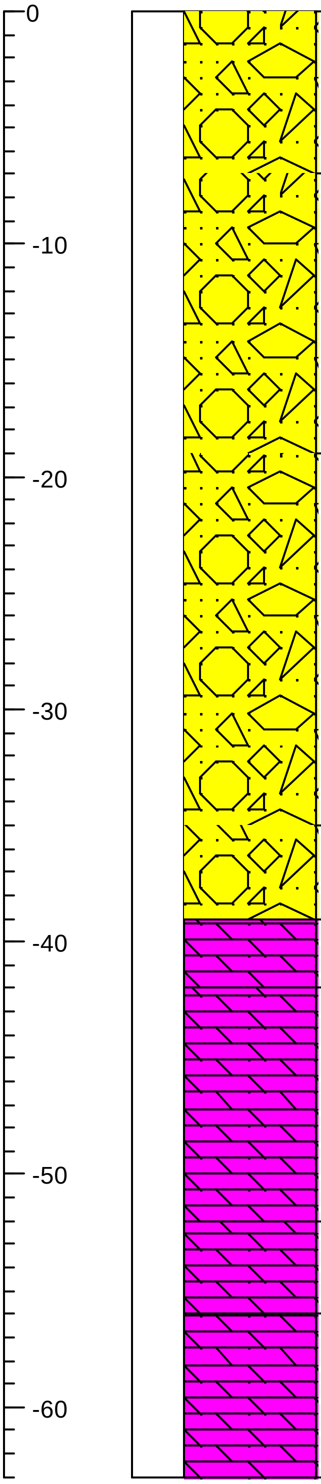
Client: Fortescue Metals Group
Project: Mt Lewin groundwater RC exploration

Commenced: 05/02/2005
Completed: 06/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 215814m(AMG)
North: 7489642(AMG)
Elevation: 430(mRL)

Static Water Level: 13.95(mbrp)
Date: On completion of drilling



Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
			ALLUVIUM: Brown silty aggregate			
			ALLUVIUM: Light brown silty aggregate	Yield of 4.00L/s		
			ALLUVIUM: Light brown silty aggregate interlayed with thin bands of calcareous sediment	EC of 3.11mS/cm pH of 7.80		
			ALLUVIUM: Clayey silt			
			DOLOMITE: Yellow limonitic calcareous silt and calcrete clasts			
			DOLOMITE: Weathered dolomite, dark grey manganese rich clay interlayered with marl			
			DOLOMITE: Oxidised dolomite, light brown limonite stained dolomite minor fracture			
			DOLOMITE: Cream crystalline dolomite			

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WELL LOG

Well No: MLW34

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

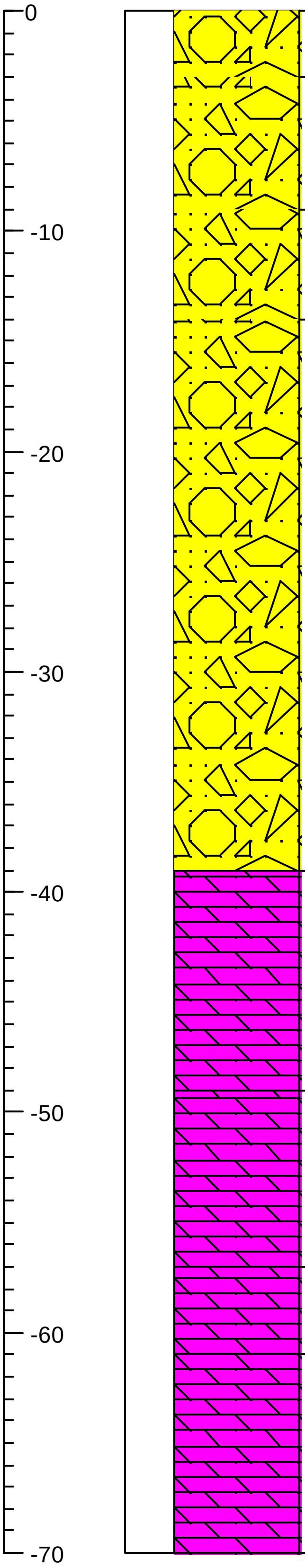
Commenced: 06/02/2005
Completed: 06/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 215801m(AMG)
North: 7489903(AMG)
Elevation: 430(mRL)

Static Water Level: 13.65(mbrp)
Date: On completion of drilling

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



Lithological Description	Field Notes
ALLUVIUM: Brown silty clay, few clasts	
ALLUVIUM: Light brown silty aggregate, mixed rock fragments of shale and chert	
ALLUVIUM: Brown silty aggregate mainly shale	Yield of >7L/s
ALLUVIUM: Brown, silty clay aggregate, aggregate (50%) coarse comprising shale and BIF fragments, very puggy from 27 to 39m	EC of 3.04mS/cm pH of 7.77
DOLOMITE: Weathered dolomite, brown heamatite and ochorous geothite	
DOLOMITE: Weathered dolomite, dark grey manganese clay, hard dessicated concretions broken and vuggy	Main water yielding zone from 49 to 57m associated with manganese layer
DOLOMITE: Weathered dolomite, nodular manganese and contamination	
DOLOMITE: Dolomite, cream crystaline dolomite	EOH @ 70m

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WELL LOG

Well No: MLW35

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

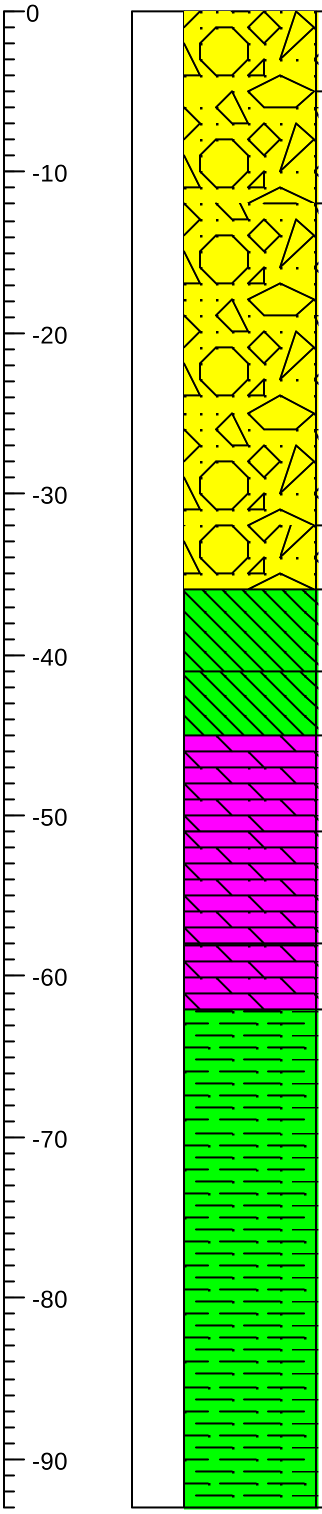
Commenced: 06/02/2005
Completed: 07/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: DC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 215804m(AMG)
North: 7490190(AMG)
Elevation: 430(mRL)

Static Water Level: 14.35(mbrp)
Date: On completion of drilling

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



Lithological Description	Field Notes
ALLUVIUM: Brown silty aggregate	
ALLUVIUM: Light brown silty aggregate	0.5L/s from shallow alluvium
ALLUVIUM: Brown silty aggregate	Yield of 1L/s
ALLUVIUM: Silty clay	
CLAY: Brown pisolitic geothite embedded in clay	
CLAY: Dark grey manganese clay, few clasts of manganese (pyrolusite)	
DOLOMITE: Weathered dolomite, brown clay with few geothite clasts	EC of 2.88mS/cm
DOLOMITE: Weathered dolomite, dark grey manganese rich clay with minor manganese and calcite clasts	
DOLOMITE: Weatherd dolomite, brown geothite, chert and shale rubble	
SHALE: Contamination, very little sample, sketchy evidence, drilling behaviour etc suggests weathered Roy Hill shale	pH of 7.80 EOH @ 93m

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WELL LOG

Well No: MLW36

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

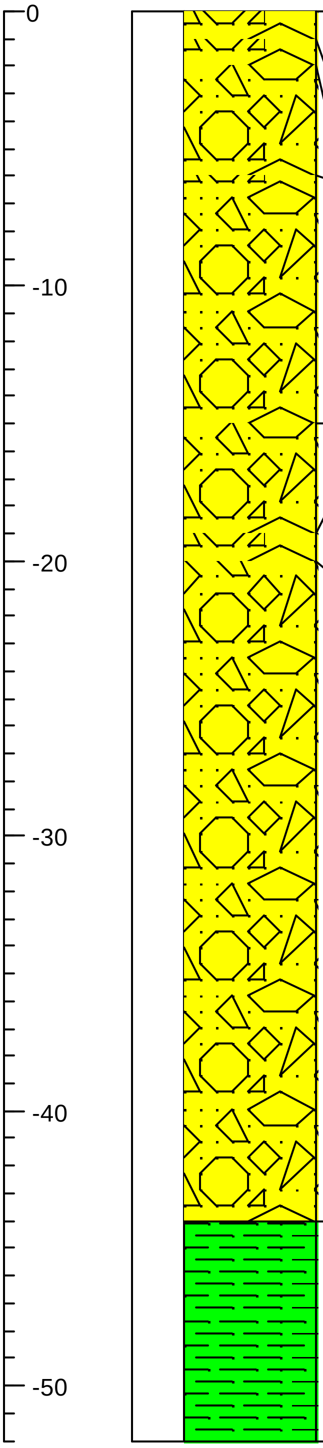
Commenced: 08/02/2005
Completed: 09/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 292250m(AMG)
North: 7500893(AMG)
Elevation: 433(mRL)

Static Water Level: 7.92(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Brown silty clay containing minor amount of pisolites

ALLUVIUM: Brown chert aggregate

ALLUVIUM: Off white earthy calcareous sediment, carbonate replacement of silty gravel

ALLUVIUM: Brown silty sand, very poorly sorted fine to coarse grained, subangular. Minor water yield

ALLUVIUM: Brown clayey aggregate, predominantly haematite 40%, gravel dominant (16-17, 22-23m intervals) minor water yield

ALLUVIUM: Light brown medium grained sands, subrounded, moderately sorted minor water yield

ALLUVIUM: Scree, red brown silty aggregate, predominantly haemitie to 40%, chert and shale rubble

SHALE: Roy Hill Shale, lightly varicoloured weathered shale (kaolin) with slatey cleavage

0.5L/s from shallow alluvium

pH of 7.80

EC of 1.90mS/cm

Yield of 1L/s

EOH @ 52m

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WELL LOG

Well No: MLW37

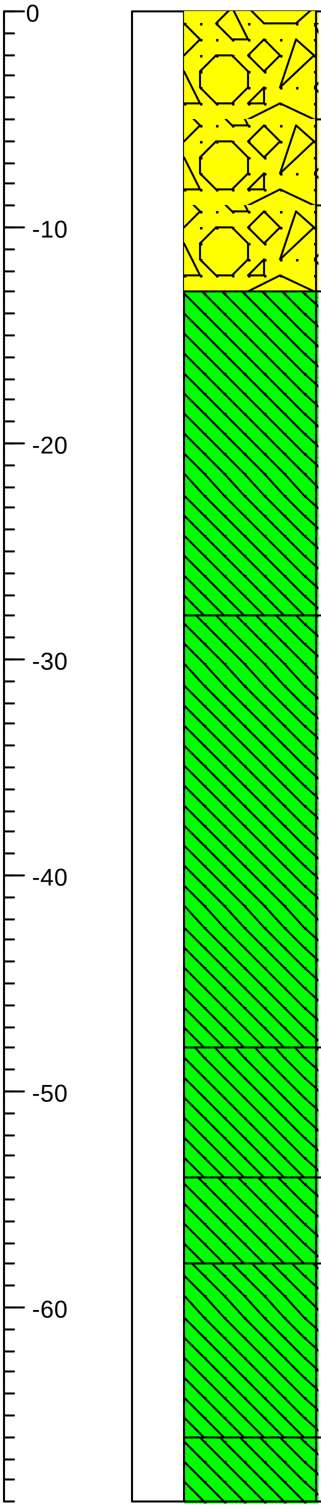
Client: Fortescue Metals Group
Project: Mt Lewin groundwater RC exploration

Commenced: 09/02/2005
Completed: 10/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 202077m(AMG)
North: 7501050(AMG)
Elevation: 433(mRL)

Static Water Level: 7.40(mbrp)
Date: On completion of drilling



Lithological Description
ALLUVIUM: Brown silty aggregate
ALLUVIUM: Light brown earthy calcareous sediment, carbonate replacement, water yielding
ALLUVIUM: Brown silty sand, very poorly sirted pisolitc and mottled
CLAY: Weathered basement? Brown silty clay with mottled clay blebs
CLAY: Weathered basement? Brown stiff plastic clay
CLAY: Weathered basement? Light grey stiff plastic clay
CLAY: Weathered basement? White stiff plastic clay and rubble (contam) Mn stained
CLAY: Weathered basement? Light grey stiff plastic clay
CLAY: Weathered basement? Tan limonitic clay hard at 69m on weldedmgeothite pisolite

Field Notes

Hole abandoned due to swelling clays. Clays very characteristic of Kalgoorlie style paleochannel clays. Worth another hole using an alternative drilling methodology.

Yield of 0.50L/s

EC of 1.70mS/cm

pH of 7.90

Well Completion

Diagram	Notes
▼	

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WELL LOG

Well No: MLW38

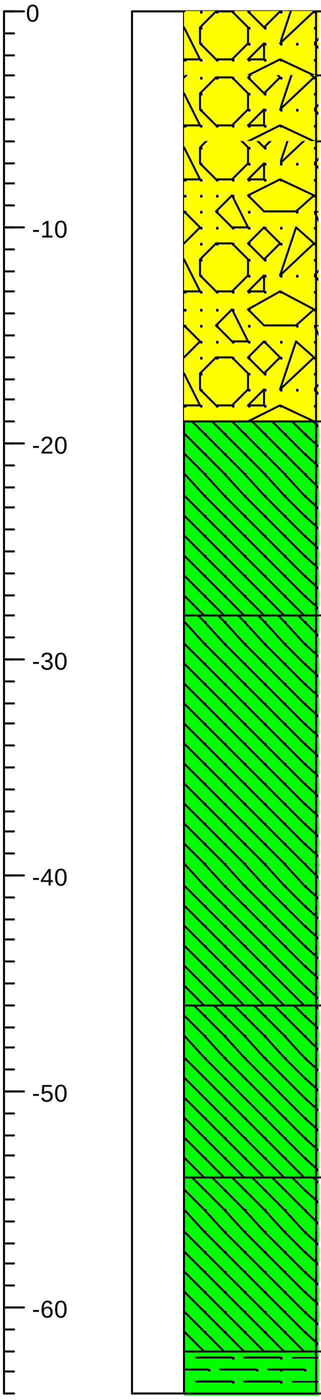
Client: Fortescue Metals Group
Project: Mt Lewin groundwater RC exploration

Commenced: 10/02/2005
Completed: 11/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 201910m(AMG)
North: 7501230m(AMG)
Elevation: 435(mRL)

Static Water Level: 7.9(mbrp)
Date: On completion of drilling



Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
			ALLUVIUM: Brown silty aggregate			
			ALLUVIUM: White earthy calcareous sediment, carbonate replacement			
			ALLUVIUM: Brown silty sand, with pisolites to 10% of sample, sand very fine grain	Hole abandoned due to swelling clays. Clays graded to black carbonaceous shale with no discernable break in oxidised transition.	▼	
			CLAY: Weathered basement? Mottled brown white silt and clay			
			CLAY: Weathered basement? Brown stiff plastic clay with Mn, Fe staining			
			CLAY: Weathered basement? Tan stiff plastic clay with geothite gravel to 20% of sample			
			CLAY: Weathered basement? White stiff plastic clay with kaolin shale			
			SHALE: Roy Hill Shale, black soft carbonaceous shale	EOH @ 64m		

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WELL LOG

Well No: MLW39

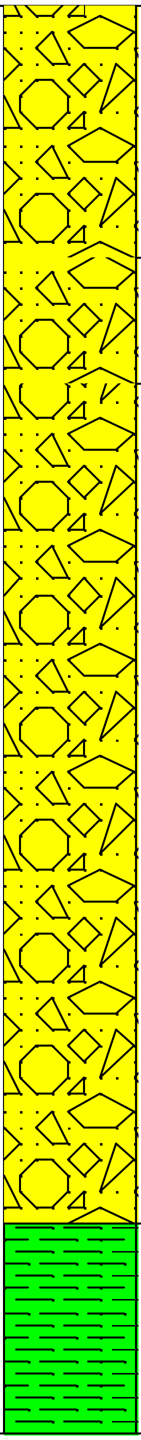
Client: Fortescue Metals Group **Project:** Mt Lewin groundwater RC exploration

Commenced: 11/02/2005
Completed: 11/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 201847m(AMG)
North: 7501460m(AMG)
Elevation: 435(mRL)

Static Water Level: 8.07(mbrp) **Date:** On completion of drilling



Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			ALLUVIUM: Brown silty aggregate of chert and geothite rubble			
			ALLUVIUM: Cream earthy calcareous sediment		▼	
-10 -20			ALLUVIUM: Scree, brown silty aggregate, comprising 60% haematite rubble	Yield of 1L/s EC of 1.56mS/cm pH of 8.01		
-30			SHALE: Roy Hill Shale light varicoloured oxidised shale	EOH @ 34m		

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WELL LOG

Well No: MLW40

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

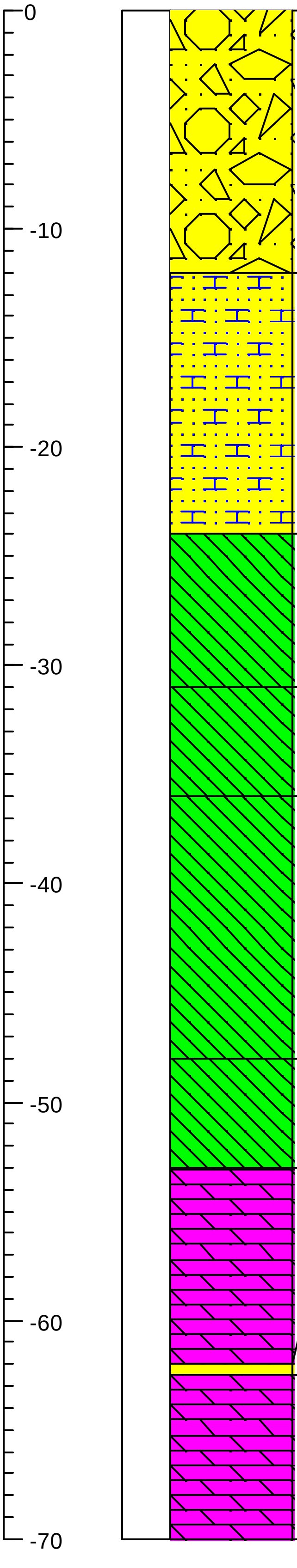
Commenced: 12/02/2005
Completed: 12/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 207329m(AMG)
North: 7487204m(AMG)
Elevation: 425(mRL)

Static Water Level: 8.2(mbrp)
Date: On completion of drilling

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



Lithological Description

ALLUVIUM: Brown silty gravel

CALCAREOUS SANDSTONE: Off white chalky calcrete, hard at 16 and chalcedonic 21-24m with substantial water yield

CLAY: Lucustrine, brown silty clay, fluffy nature

CLAY: Lucustrine, mottled stiff plastic clay with Mn and Fe staining

CLAY: Marl, white marl and earthy chalky calcareous sed with few ironstone clasts, minor increase in water yields

CLAY: Marl, tan marl and ironstone gravel

DOLOMITE: Weathered dolomite, dark grey brown clayey gravel comprising geothite, manganese rich mudstone

SAND: Tan, unconsolidated fine grain sand, angular grain

DOLOMITE: Dolomite, cream crystaline dolomite, massive

Field Notes

Yield of 3L/s

Most water contributed from 21-24m

EC of 3.4mS/cm

pH of 7.8

EOH @ 70m

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WELL LOG

Well No: MLW41

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

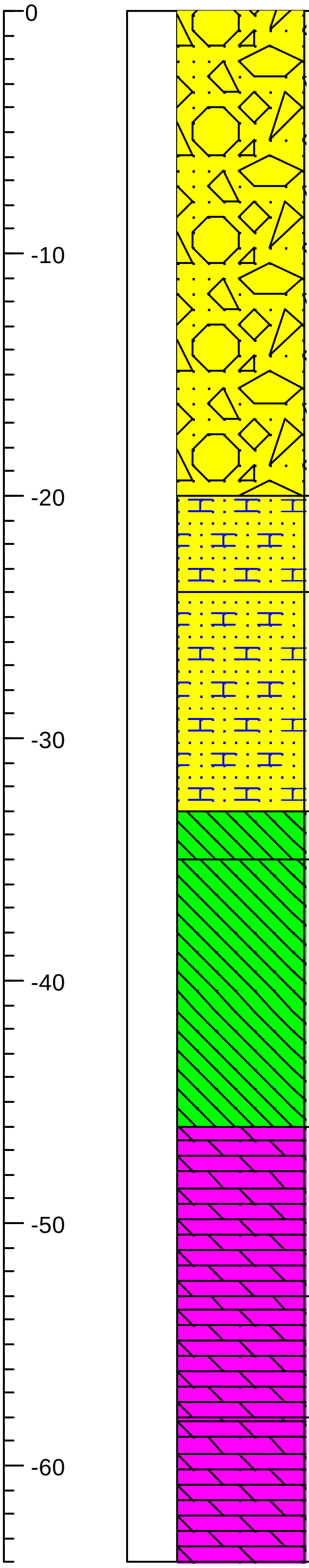
Commenced: 13/02/2005
Completed: 14/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 212899m(AMG)
North: 7486260m(AMG)
Elevation: 426(mRL)

Static Water Level: 9.24(mbrp) **Date:** On completion of drilling

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



ALLUVIUM: Brown silty gravel

CALCAREOUS SANDSTONE: Light red brown earthy

CALCAREOUS SANDSTONE: Off white chalky calcrete chalcedonic 30-33m where water yielding

CLAY: Lucustrine, brown silty clay, fluffy nature

CLAY: Marl, white marl and clayey calcareous sediment

DOLOMITE: Weathered dolomite, light brown and grey geothitic gravel with calcrete, vuggy, probably water yielding

DOLOMITE: Weathered dolomite, dark grey Mn and Fe rich clay and mudstone

DOLOMITE: Crystaline dolomite, massive

Yield of 4L/s

EC of 3.8mS/cm

Converted to a stock bore for Roy Hill, targetting the 30-33m interval, yield of 15L/s from bore.

pH of 7.8

EOH @ 64m

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WELL LOG

Well No: MLW42

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

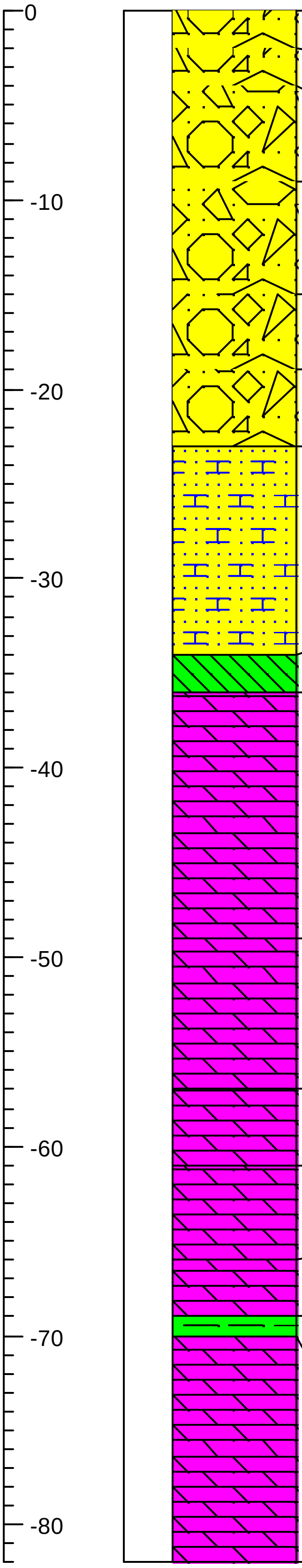
Commenced: 14/02/2005
Completed: 14/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 213023m(AMG)
North: 7487205m(AMG)
Elevation: 427(mRL)

Static Water Level: 11.8(mbrp)
Date: On completion of drilling

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



Lithological Description	Field Notes
ALLUVIUM: Brown silty clay	
ALLUVIUM: Brown aggregate, chert and jaslilite	
ALLUVIUM: Light brown silty gravel	
ALLUVIUM: Brown silty gravel	
ALLUVIUM: Brown gravel, little silt, water yielding	Yield of 2.1L/s
ALLUVIUM: Brown silty clay	
CALCAREOUS SANDSTONE: Lucustrine. Calcrete, chalky calcareous sediment with chalcedony dev in 30-34m interval, water yielding	EC of 2.85mS/cm
CLAY: Lucustrine, brown silty clay	
DOLOMITE: Weathered dolomite, white earthy and chalky marl	
DOLOMITE: Weathered dolomite, dark grey Mn and CaCo rich clays and siltstone, over brown earthy carbonate/siderite	pH of 8.01
DOLOMITE: Weathered dolomite, kahki silty clay	
DOLOMITE: Dolomite, medocratic banded crystalline dolomite, extensively broken along weathered calcite and pyrite veins, brecciated	
DOLOMITE: Dolomite, as above with calcite and pyrite as fresh	
SHALE: BIF, predominantly banded haematite	
DOLOMITE: Dolomite, brecciated extensively pyrite, calcite and Mn veined pyrite to 20% of sample	David's mineral hole regarded as a technical success
	EOH @ 82m

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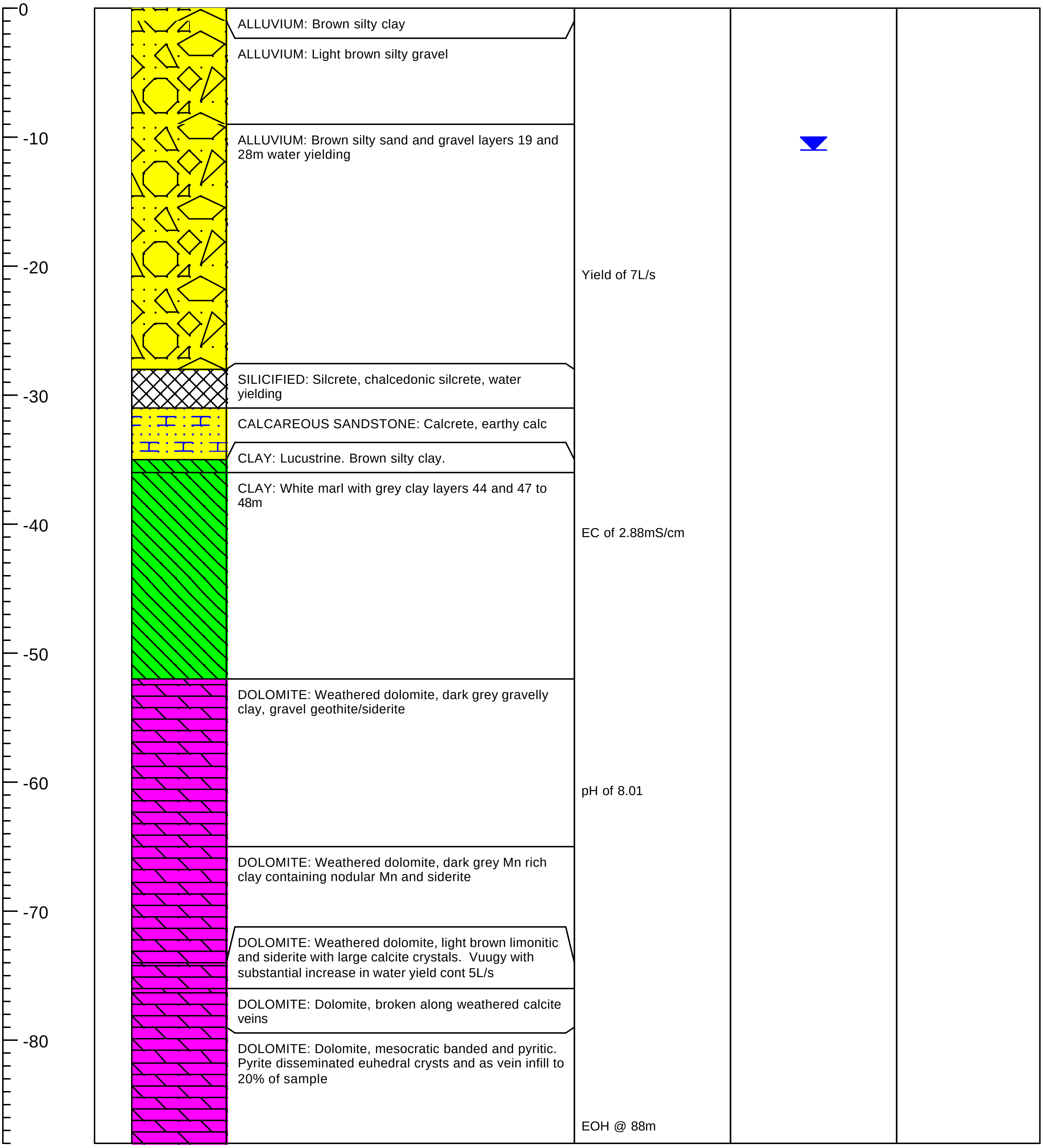
WELL LOG

Well No: MLW43

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

Commenced:	14/02/2005	**Method:**	RC	**Area:**	Mt Lewin
Completed:	15/02/2005	**Fluid:**	Air		211635m(AMG)
Drilled:	Connector R3	**Bit Record:**	5 3/8"	**North:**	7488801m(AMG)
Logged By:	S Collett			**Elevation:**	434(mRL)

Static Water Level: 11(mbrp)
Date: On completion of drilling



Lithological Description	Field Notes
ALLUVIUM: Brown silty clay	
ALLUVIUM: Light brown silty gravel	
ALLUVIUM: Brown silty sand and gravel layers 19 and 28m water yielding	Yield of 7L/s
SILICIFIED: Silcrete, chalcedonic silcrete, water yielding	
CALCAREOUS SANDSTONE: Calcrete, earthy calc	
CLAY: Lucustrine. Brown silty clay.	
CLAY: White marl with grey clay layers 44 and 47 to 48m	EC of 2.88mS/cm
DOLOMITE: Weathered dolomite, dark grey gravelly clay, gravel geothite/siderite	pH of 8.01
DOLOMITE: Weathered dolomite, dark grey Mn rich clay containing nodular Mn and siderite	
DOLOMITE: Weathered dolomite, light brown limonitic and siderite with large calcite crystals. Vuugy with substantial increase in water yield cont 5L/s	
DOLOMITE: Dolomite, broken along weathered calcite veins	
DOLOMITE: Dolomite, mesocratic banded and pyritic. Pyrite disseminated euhedral crysts and as vein infill to 20% of sample	EOH @ 88m

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WELL LOG

Well No: MLW44

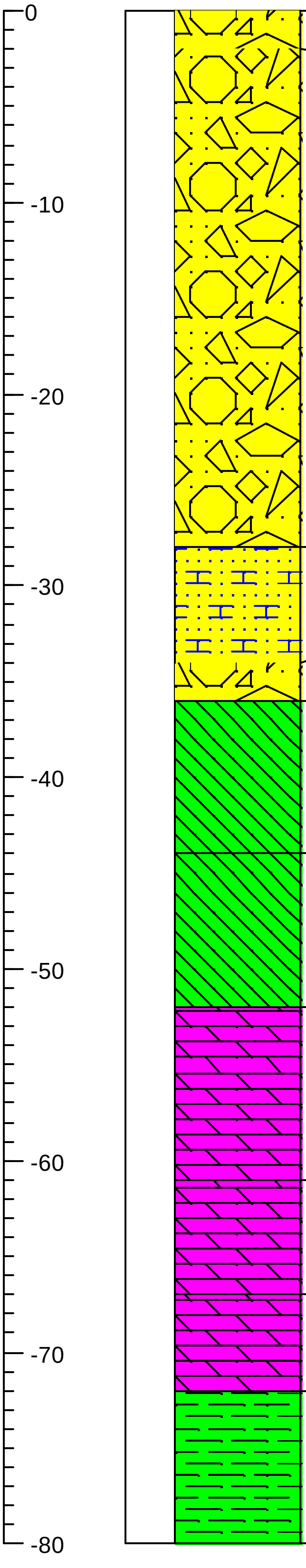
Client: Fortescue Metals Group
Project: Mt Lewin groundwater RC exploration

Commenced: 15/02/2005
Completed: 16/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 211635m(AMG)
North: 7488940m(AMG)
Elevation: 434(mRL)

Static Water Level: 11.05(mbrp)
Date: On completion of drilling



Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
			ALLUVIUM: Brown silty clay			
			ALLUVIUM: Brown silty sands and gravels, wet at 16m	Yield of 20.6L/s		
			CALCAREOUS SANDSTONE: Off white earthy calcrete, silcrete 32m, water yielding			
			ALLUVIUM: Brown silty sand			
			CLAY: White chalky marl	EC of 2.7mS/cm		
			CLAY: Grey clayey marl			
			DOLOMITE: Weathered dolomite, tan gravelly clays geothite and siderite gravel	pH of 7.8		
			DOLOMITE: Weathered dolomite, dark grey Mn rich clay with minor nodular Mn			
			DOLOMITE: Weathered dolomite, dark grey nodular pyrolusite, water yielding			
			SHALE: BIF, banded chert, jaspilite, geothite and heamatite. Cavernous 77-78m extremely broken 78 to 80 where no further drilling possible. Substantial increase in water yield	EOH @ 80m		

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WELL LOG

Well No: MLW45

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

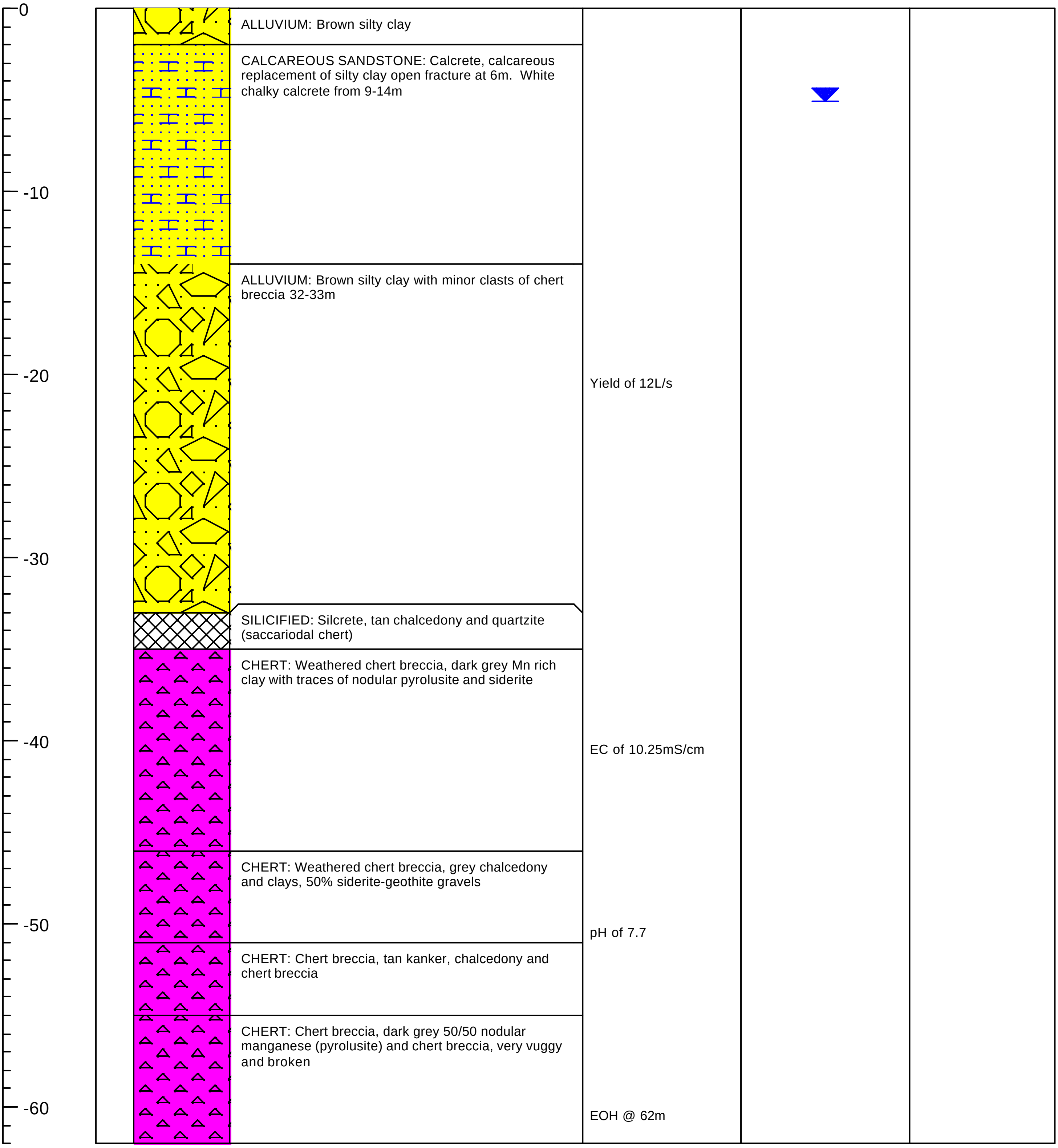
Commenced: 18/02/2005
Completed: 19/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 204888m(AMG)
North: 7483877m(AMG)
Elevation: 421(mRL)

Static Water Level: 5.1(mbrp) **Date:** On completion of drilling

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



Lithological Description	Field Notes
ALLUVIUM: Brown silty clay	
CALCAREOUS SANDSTONE: Calcrete, calcareous replacement of silty clay open fracture at 6m. White chalky calcrete from 9-14m	
ALLUVIUM: Brown silty clay with minor clasts of chert breccia 32-33m	Yield of 12L/s
SILICIFIED: Silcrete, tan chalcedony and quartzite (saccariodal chert)	
CHERT: Weathered chert breccia, dark grey Mn rich clay with traces of nodular pyrolusite and siderite	EC of 10.25mS/cm
CHERT: Weathered chert breccia, grey chalcedony and clays, 50% siderite-geothite gravels	pH of 7.7
CHERT: Chert breccia, tan kanker, chalcedony and chert breccia	
CHERT: Chert breccia, dark grey 50/50 nodular manganese (pyrolusite) and chert breccia, very vuggy and broken	EOH @ 62m

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WELL LOG

Well No: MLW46

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

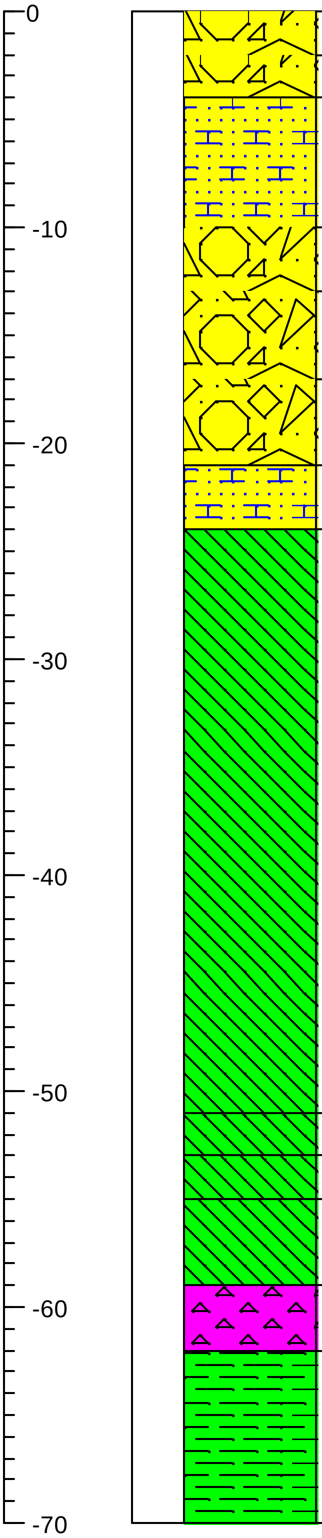
Commenced: 26/02/2005
Completed: 27/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 202196m(AMG)
North: 7501016m(AMG)
Elevation:

Static Water Level:
Date:

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



Lithological Description	Field Notes
ALLUVIUM: Red brown silty clay with gravel	
ALLUVIUM: Red brown slightly clayey gravel, to 2cm	
CALCAREOUS SANDSTONE: Calcrete, off white earthy calcrete (caliche)	
ALLUVIUM: Red brown sandy silt	
ALLUVIUM: Red brown sandy silt with minor calcrete	
ALLUVIUM: Red brown silty clay	Yield of 1L/s
CALCAREOUS SANDSTONE: Calcrete, off white, poorly developed, silty, clayey (dry)	
CLAY: Lacustrine clay, red brown and yellow brown, stiff, dense (Te)	EC of 1.51mS/cm
CLAY: Marl, yellow brown, soft, moist	
CLAY: Marl, off white, soft, moist	
CLAY: Marl, yellow brown, soft moist	
CHERT: Broken (minor aquifer)	pH of 7.82
SHALE: Red brown to red black, weathered, clayey	EOH @ 70m

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WELL LOG

Well No: MLW47

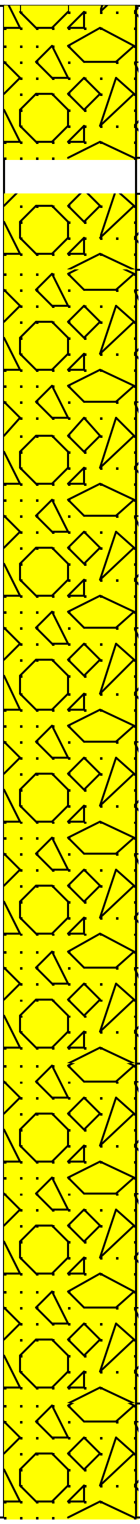
Client: Fortescue Metals Group
Project: Mt Lewin groundwater RC exploration

Commenced: 31/03/2005
Completed: 01/04/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 201030m(AMG)
North: 7498611m(AMG)
Elevation: 426(mRL)

Static Water Level: 11.3(mbrp)
Date: On completion of drilling



Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0			ALLUVIUM: Red brown silty aggregate			
			ALLUVIUM: Red brown silty aggregate, 90% comprising chert rubble			
			ALLUVIUM: Red brown silty pisolitic gravel, magheamite pisoliths with gravel comprising chert and shales, water bearing			
-10				Yield of 1L/s	▼	
-20				EC of 1.58mS/cm		
			ALLUVIUM: Brown gravel, coarse to cobble size, moderately sorted, smaller grain fraction well rounded, comprising chert and shale. 34 to 36m verry coarse to cobble size and unconsolidated. High potential yield.			
-30				pH of 7.8		
			ALLUVIUM: Brown silty sand slightly clayey	EOH @ 40m		
-40						

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WELL LOG

Well No: MLW48

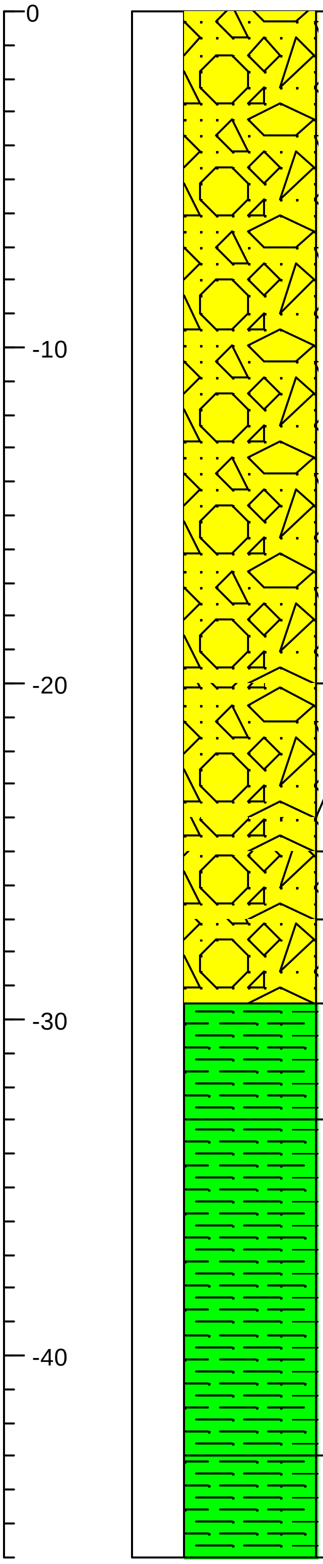
Client: Fortescue Metals Group **Project:** Mt Lewin groundwater RC exploration

Commenced: 01/04/2005
Completed: 02/04/2005
Drilled: Connector R3
Logged By: S Collett

Method: RC
Fluid: Air
Bit Record: 5 3/8"

Area: Mt Lewin
East: 215830m(AMG)
th: 7480180m(AMG)
Elevation: 422(mRL)

Static Water Level: 5.5(mbrp) **Date:** On completion of drilling



Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
			ALLUVIUM: Brown, fine grain silty sand, planer and indurated. Calcareous infill and dentritic Mn coating on horizontal planer surfaces	Yield of 0.5L/s	▼	
			ALLUVIUM: Aolian, light brown fine grain sand, moderately sorted and unconsolidated	EC of 1.5mS/cm		
			ALLUVIUM: Brown poorly sorted silty sand, grains subangular			
			ALLUVIUM: Brown silt, hard and indurated			
			ALLUVIUM: Brown poorly sorted sand, very fine to medium grained subangular grains			
			SHALE: Weathered shale, white dessicated clay	pH of 8.61		
			SHALE: Weathered shale, grey kaolin puggy clay			
			SHALE: Shale (Roy Hill?), black carbonaceous, soft	EOH @ 46m		

APPENDIX B

CONSTRUCTION LOGS FOR THE MOUNT LEWIN TRIAL BORES

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WELL LOG

Well No: MLW06T

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

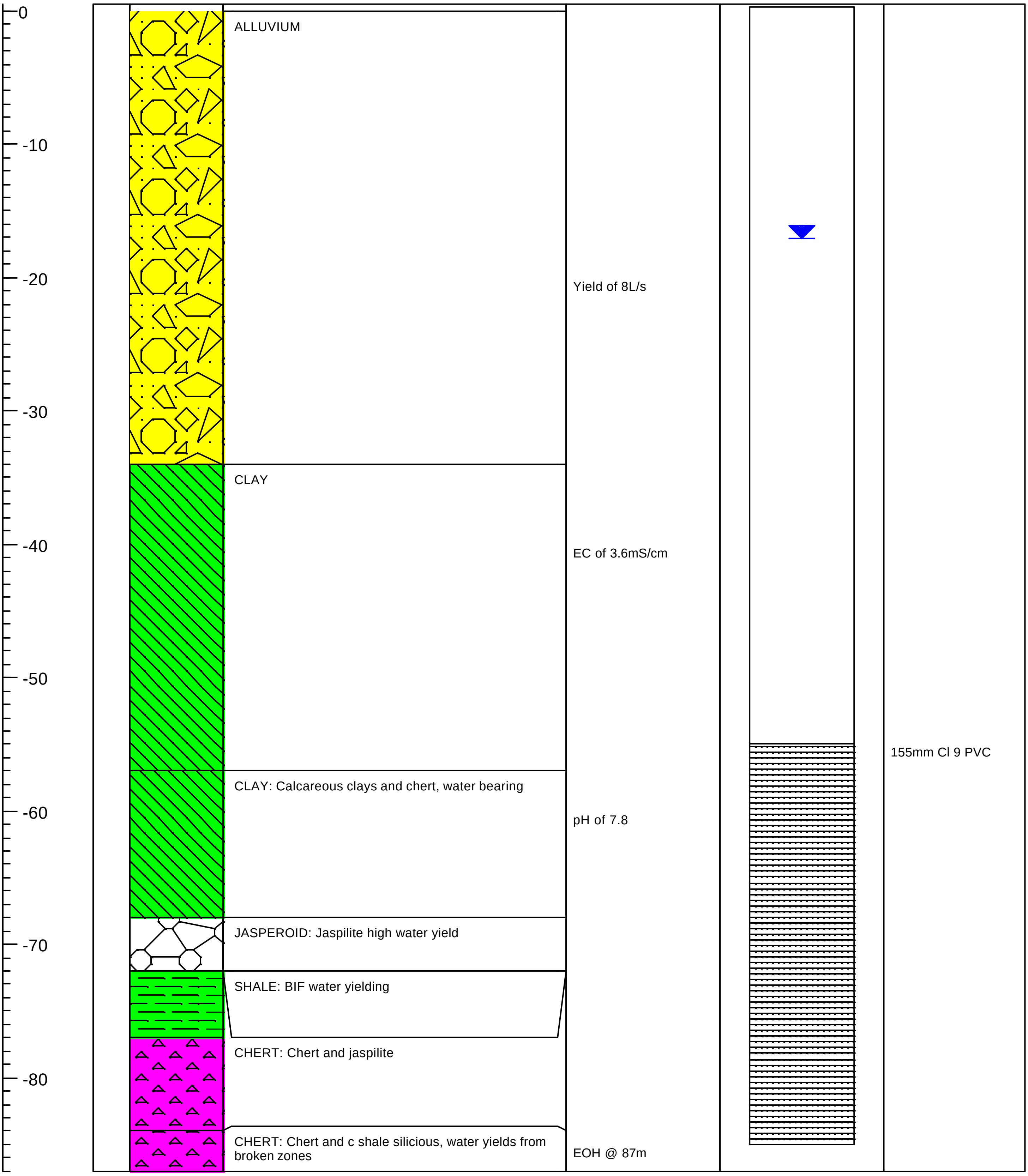
Commenced: 14/12/2004
Completed: 15/12/2004
Drilled: Connector R3
Logged By: S Collett

Method: Mud Rotary
Fluid: Mud
Bit Record: 10 inch

Area: Mt Lewin
East: 207800m(AMG)
North: 7492600m(AMG)
Elevation: 421 (mRL)

Static Water Level: 17.05 (mbrp)
Date: On completion of drilling

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



ALUVIUM

CLAY

CLAY: Calcareous clays and chert, water bearing

JASPEROID: Jaspilite high water yield

SHALE: BIF water yielding

CHERT: Chert and jaspilite

CHERT: Chert and c shale silicious, water yields from broken zones

Yield of 8L/s

EC of 3.6mS/cm

pH of 7.8

EOH @ 87m

155mm Cl 9 PVC

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WELL LOG

Well No: MLW11T

Client: Fortescue Metals Group

Project: Mt Lewin groundwater RC exploration

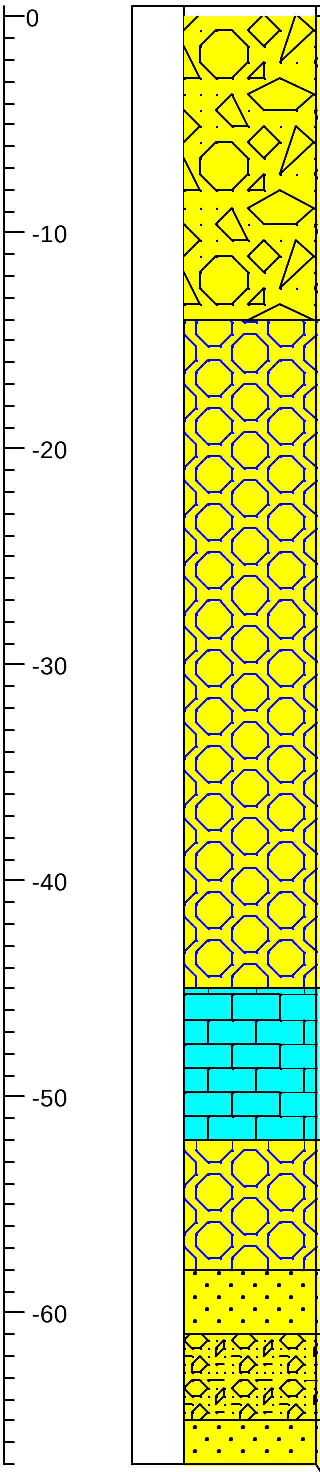
Commenced: 23/02/2005
Completed: 24/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: Air compression and mud rotary
Fluid: Air/mud
Bit Record: 10 inch

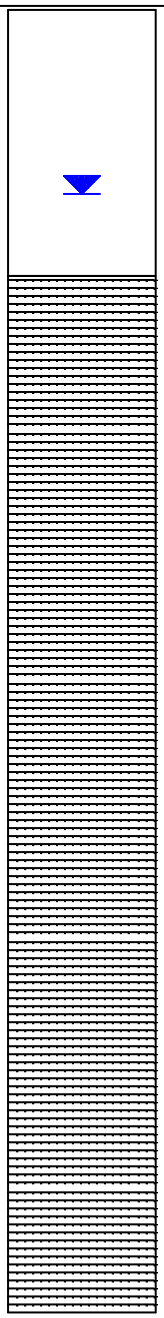
Area: Mt Lewin
East: 208860m(AMG)
North: 7486850m(AMG)
Elevation: 418(mRL)

Static Water Level: 8.16(mbrp)

Date: On completion of drilling



Lithological Description	Field Notes	Notes
ALLUVIUM: Red brown silt with rock clasts		155mm Cl 9 PVC
CALCAREOUS SILTSTONE: Off white, hard, rubbly, vughy, minor clayey layers, minor red brown siltstone, rock clasts embedded in calc	Yield of 8L/s, EC of 2.4mS/cm, pH of 7.8	
LIMESTONE: Calcrete (limestone?), pure white, hard, uniform, fine grained		
CALCAREOUS SILTSTONE: Siltstone, rock fragments, silica, clay, iron rich rounded pebbles		
SAND: Light green, quartz, fine to medium grained, well rounded, moderately sorted, clean		
GRAVEL AND SAND: Sandy gravel, fine light green sand with light grey, coarse quartz pebbles, sub angular, poorly sorted		
SAND: Light green, quartz, fine to medium grained, well rounded, moderately sorted	EOH @ 67m	



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WELL LOG

Well No: MLW22T

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

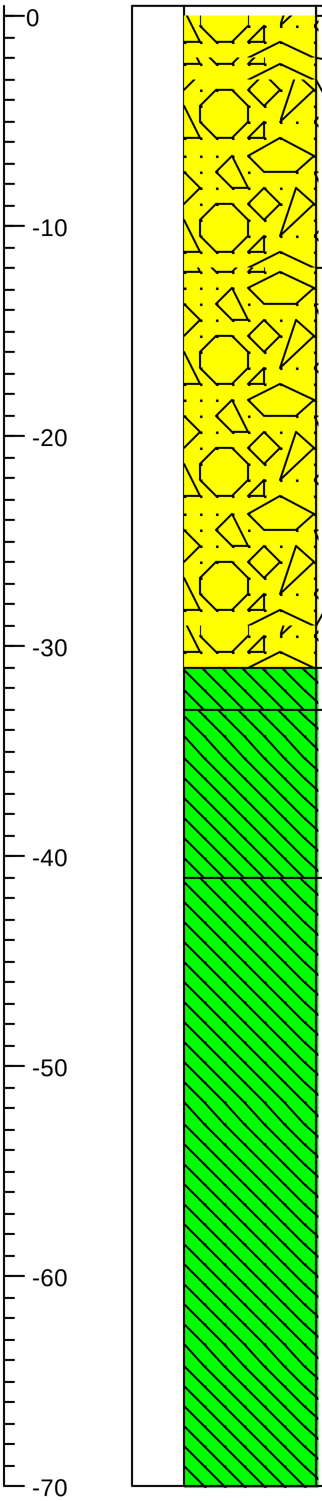
Commenced: 27/02/2005
Completed: 01/03/2005
Drilled: Connector R3
Logged By: S Collett

Method: Mud Rotary
Fluid: Mud
Bit Record: 10 inch

Area: Mt Lewin
East: 207650m(AMG)
North: 7489100m(AMG)
Elevation: 412(mRL)

Static Water Level: 8.14(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Silty gravel

ALLUVIUM: Silt

ALLUVIUM: Silty gravel, buff, light brown

ALLUVIUM: Silty gravel

ALLUVIUM: Silty gravel and calcrete, minor white chips

CLAY: Red brown, soft

CLAY: Light grey, soft with angular mixed rock clasts, some large chips of chert up to 25mm, clay partly calcareous, siliceous pebbles at 30m

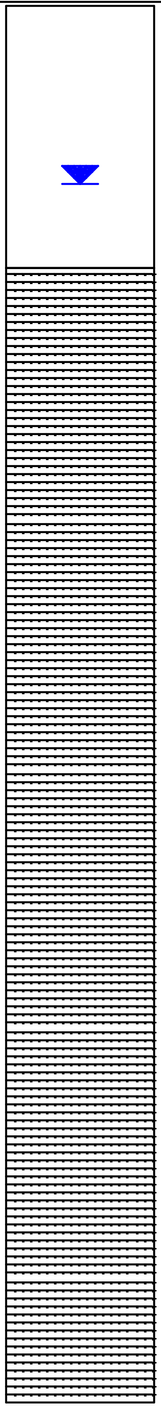
CLAY: Clay, light brown, brownish yellow, calcareous, mixed rock clasts (BIF, chert, shale), minor firm chips of calcrete, white, yellow, pink, mottled

Yield of 8L/s

EC of 2.2L/s

pH of 7.9

EOH @ 70m



155mm Cl 9 PVC

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WELL LOG

Well No: MLW29T

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

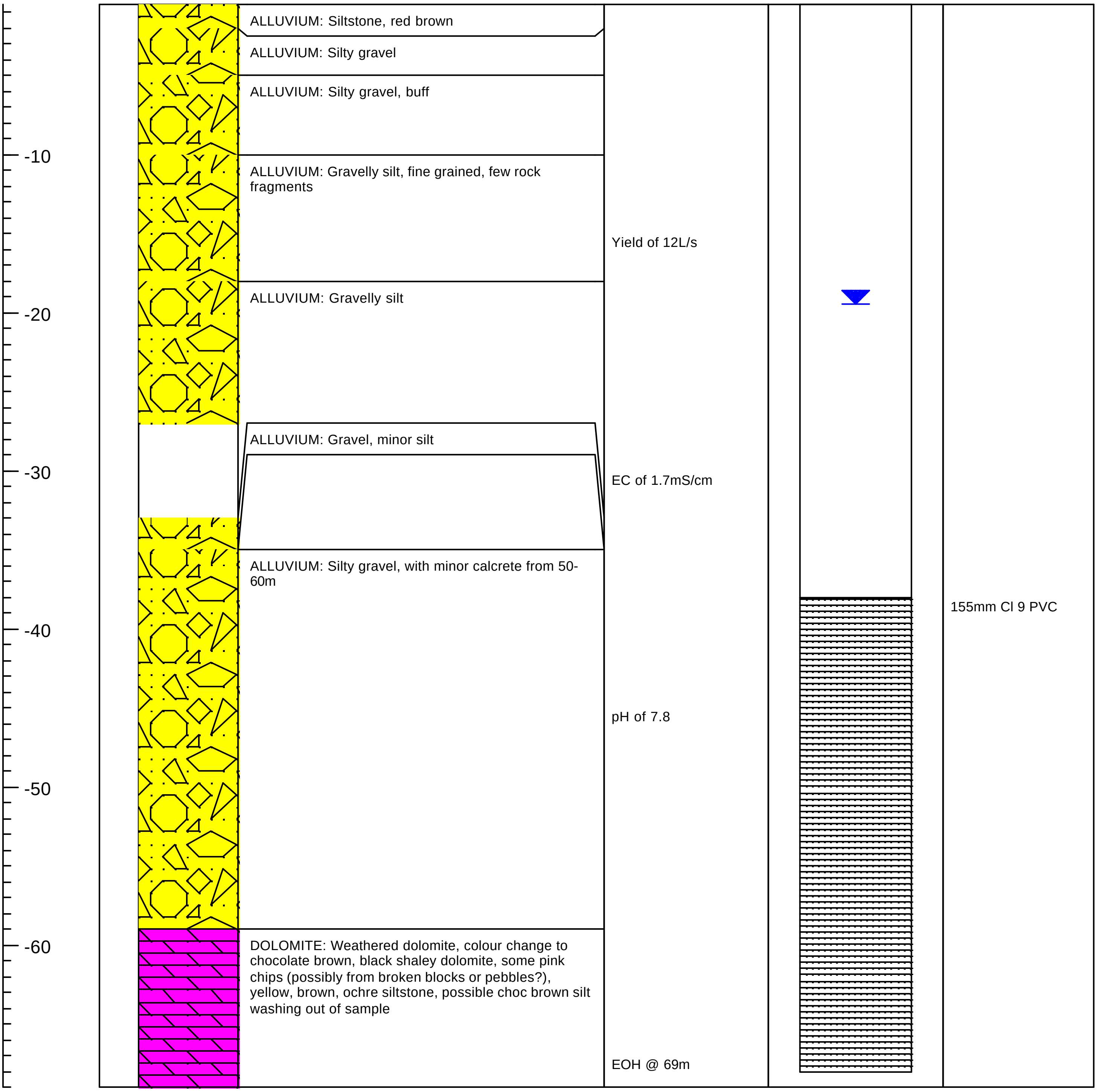
Commenced: 15/02/2005
Completed: 27/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: Mud Rotary
Fluid: Mud
Bit Record: 10 inch

Area: Mt Lewin
East: 219580m(AMG)
North: 7492300m(AMG)
Elevation: 447(mRL)

Static Water Level: 19.43(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Siltstone, red brown

ALLUVIUM: Silty gravel

ALLUVIUM: Silty gravel, buff

ALLUVIUM: Gravelly silt, fine grained, few rock fragments

ALLUVIUM: Gravelly silt

ALLUVIUM: Gravel, minor silt

ALLUVIUM: Silty gravel, with minor calcrete from 50-60m

DOLOMITE: Weathered dolomite, colour change to chocolate brown, black shaley dolomite, some pink chips (possibly from broken blocks or pebbles?), yellow, brown, ochre siltstone, possible choc brown silt washing out of sample

Yield of 12L/s

EC of 1.7mS/cm

pH of 7.8

EOH @ 69m

155mm Cl 9 PVC

File Ref: F:\jobs\477\3000\3200 test data\Drill logs\Log Plot files\Mt Lewin\MLW29T

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WELL LOG

Well No: MLW44T

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

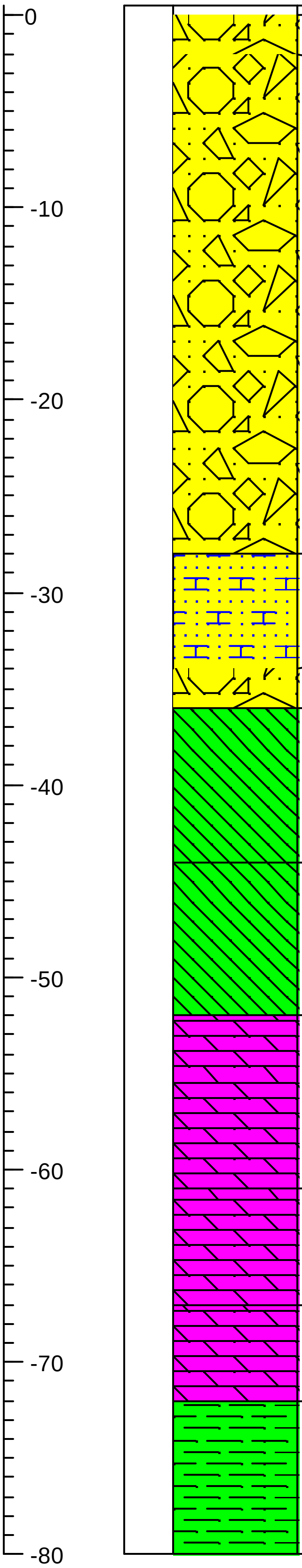
Commenced: 19/02/2005
Completed: 27/02/2005
Drilled: Connector R3
Logged By: S Collett

Method: Rotary Mud
Fluid: Mud
Bit Record: 10 inch

Area: Mt Lewin
East: 211648m(AMG)
North: 7488939m(AMG)
Elevation: 424(mRL)

Static Water Level: 10.42(mbrp)
Date: On completion of drilling

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



ALLUVIUM: Brown silty clay

ALLUVIUM: Brown silty sands and gravels, wet at 16m

CALCAREOUS SANDSTONE: Off white earthy calcrete, silcrete 32m, water yielding

ALLUVIUM: Brown silty sand

CLAY: White chalky marl

CLAY: Grey clayey marl

DOLOMITE: Weathered dolomite, tan gravelly clays geothite and siderite gravel

DOLOMITE: Weathered dolomite, dark grey Mn rich clay with minor nodular Mn

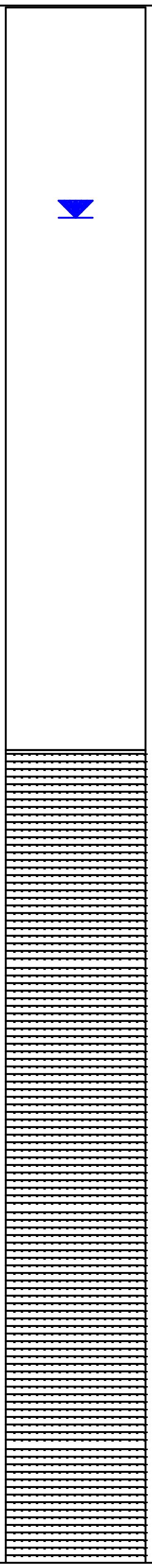
DOLOMITE: Weathered dolomite, dark grey nodular pyrolusite, water yielding

SHALE: BIF, banded chert, jaspilite, geothite and heamatite. Cavernous 77-78m extremely broken 78 to 80 where no further drilling possible. Substantial increase in water yield

Yield of 15L/s

EC of 2mS/cm

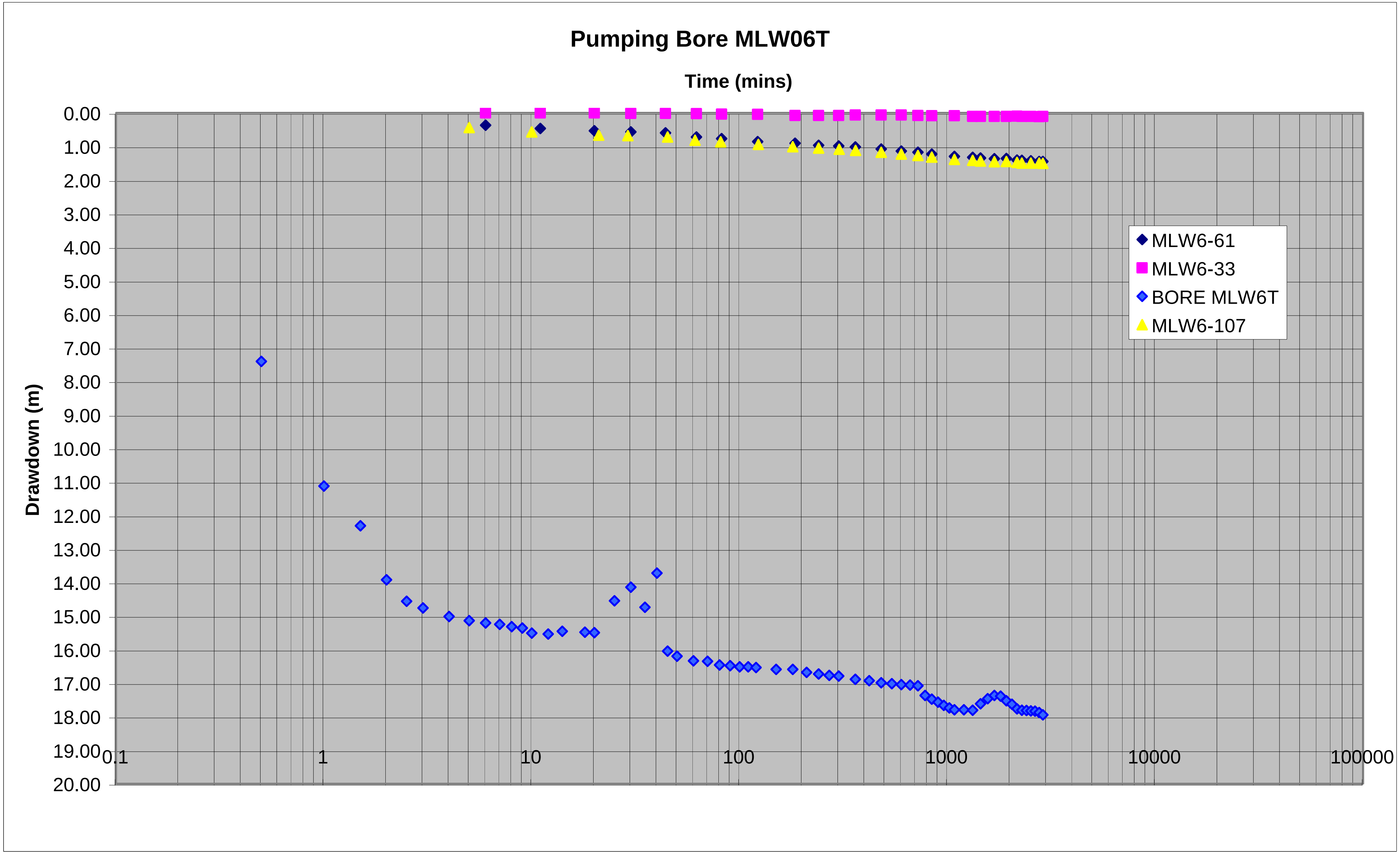
pH of 6.6

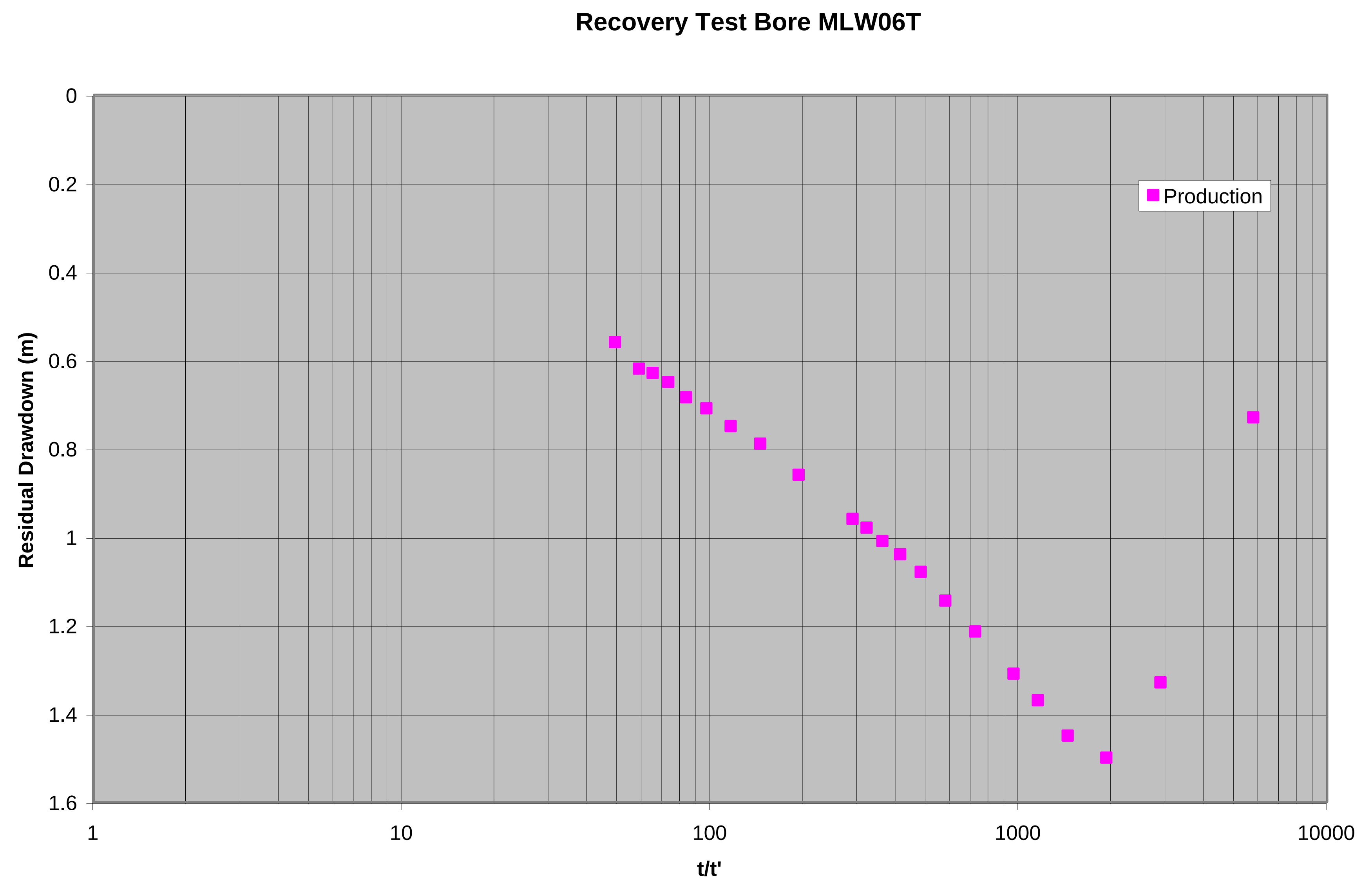


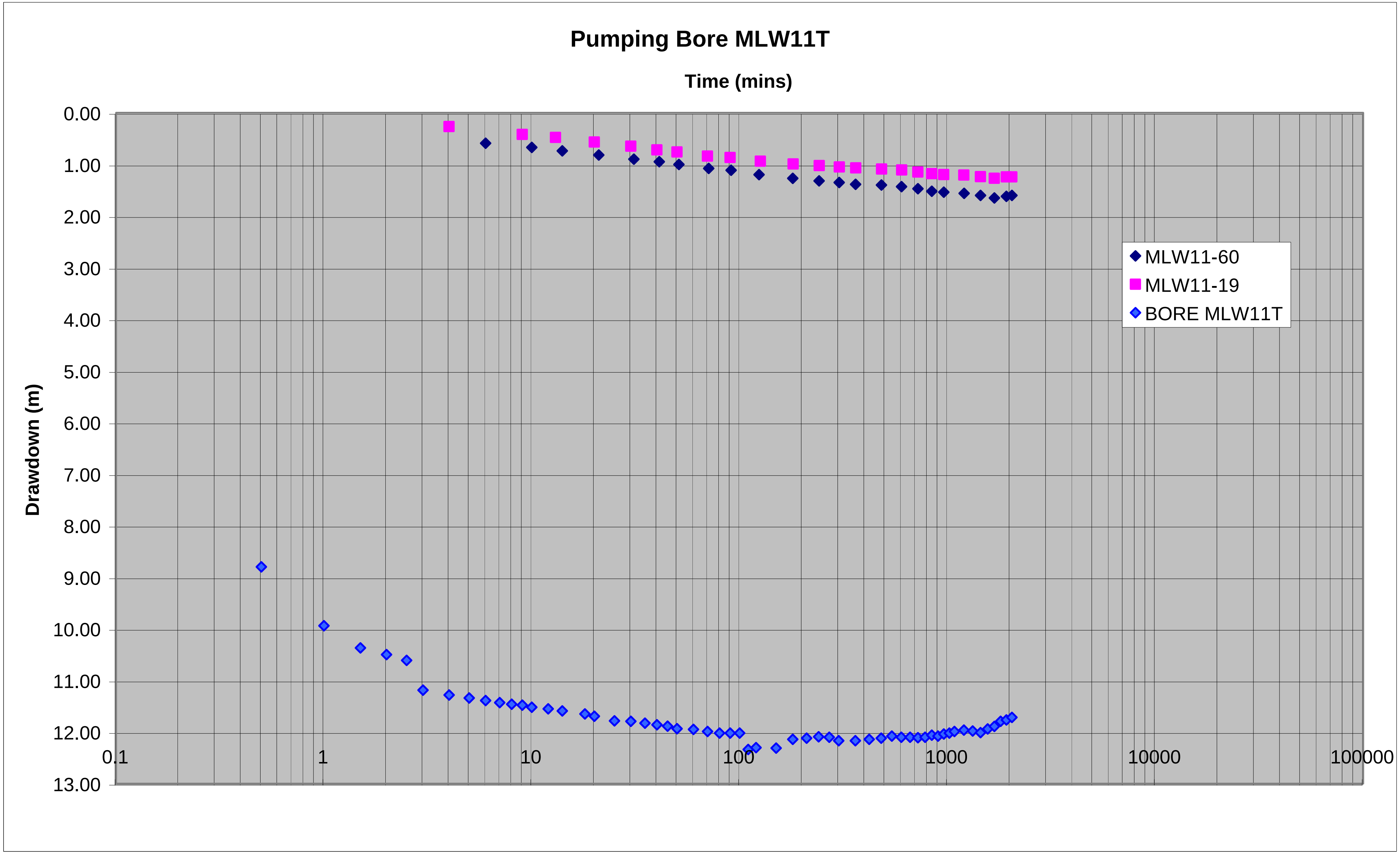
155mm Cl 9 PVC

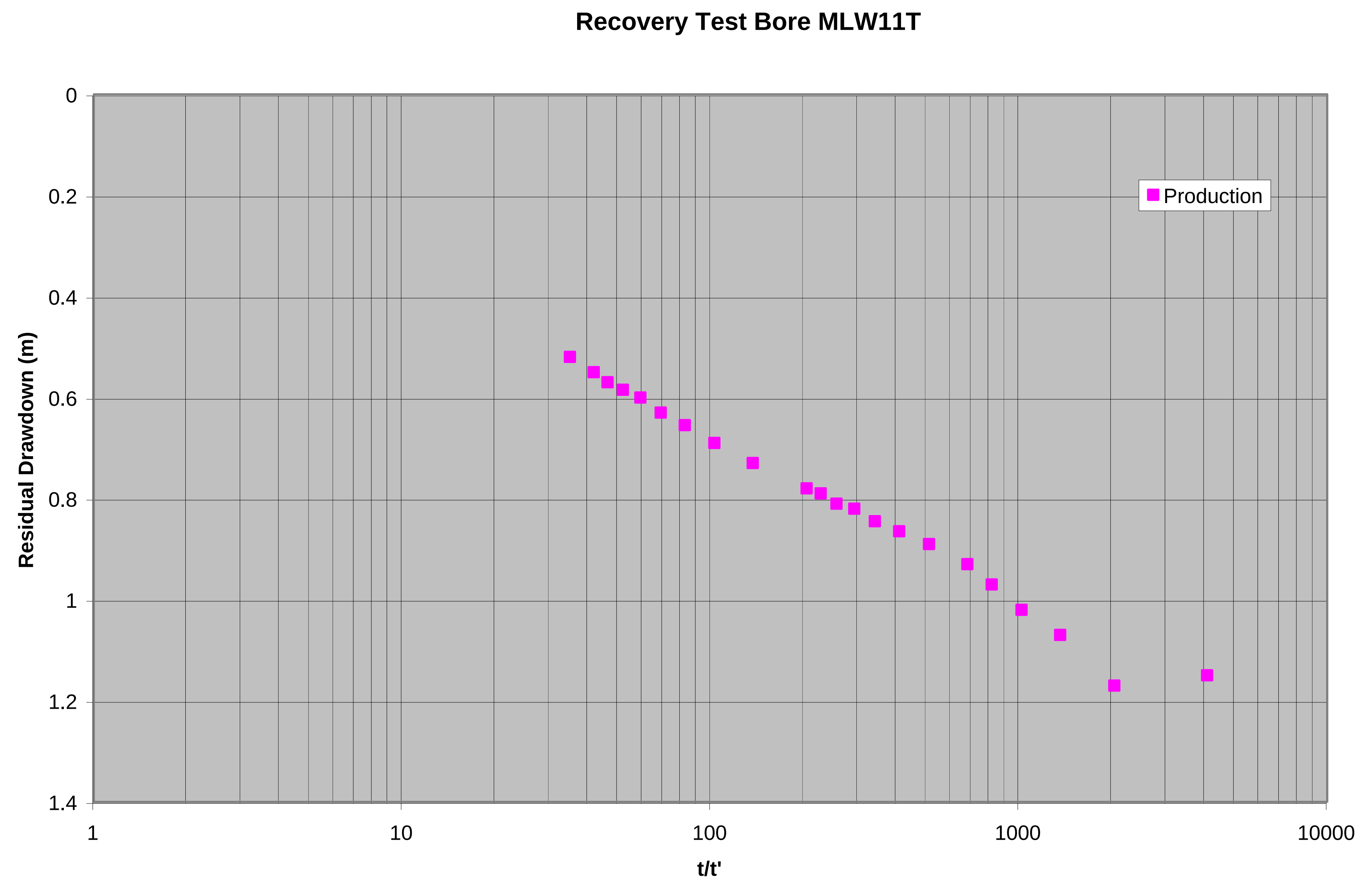
APPENDIX C

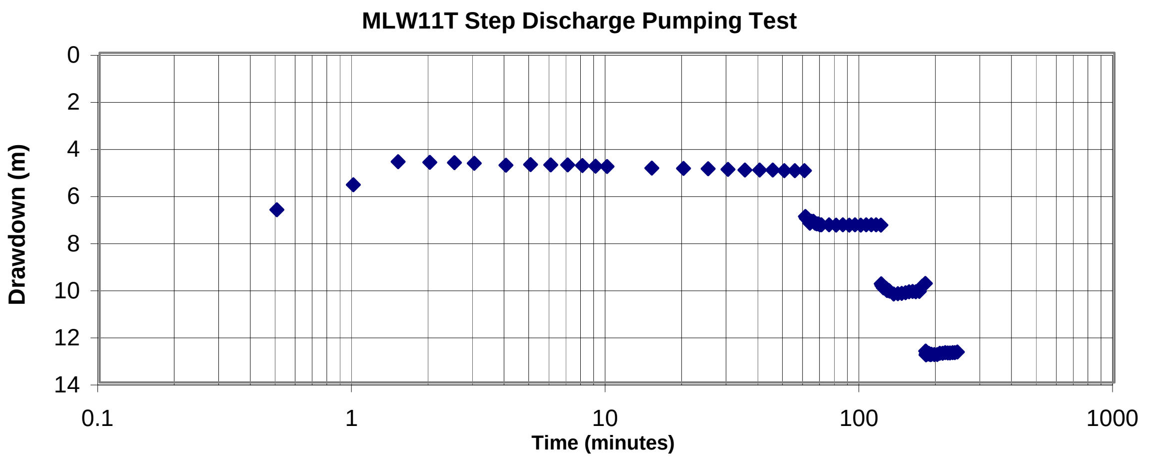
TEST PUMPING DATA FOR THE MOUNT LEWIN TRIAL BORES

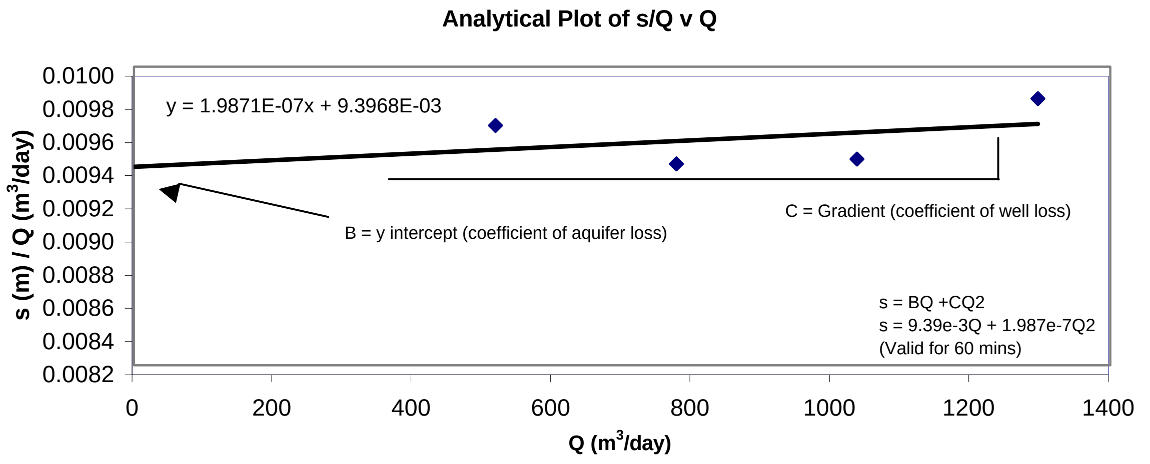

Pumping Bore MLW06T
Time (mins)
Drawdown (m)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
16.00
17.00
18.00
19.00
20.00
0.1
1
10
100
1000
10000
100000
MLW6-61
MLW6-33
BORE MLW6T
MLW6-107


Recovery Test Bore MLW06T
Residual Drawdown (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1
10
100
1000
10000
t/t'
Production


Pumping Bore MLW11T
Time (mins)
Drawdown (m)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
0.1
1
10
100
1000
10000
100000
MLW11-60
MLW11-19
BORE MLW11T


Recovery Test Bore MLW11T
Production
Residual Drawdown (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1
10
100
1000
10000
t/t'





$s_{w(n)} = BQ_n + CQ^P{}_n$ (Rorabaugh's equation)

Where, B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
C = Gradient (coefficient of turbulent flow loss or apparent well loss)
s = Drawdown in the borehole
P = Value determined using Rorabaugh's method of superposition

Components of the equation BQ and CQ^2 are termed the aquifer loss and apparent well loss respectively.
They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

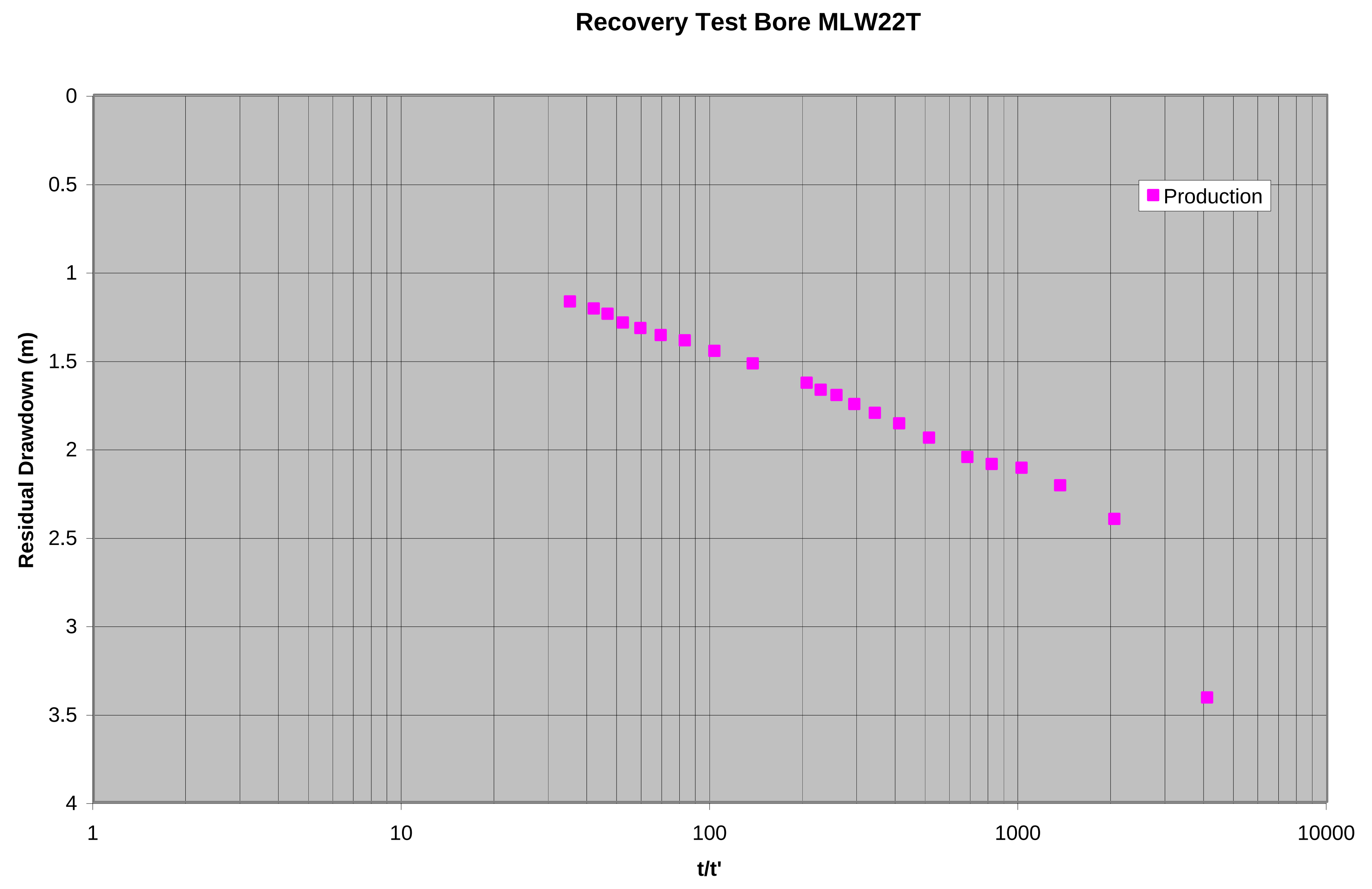
It should be noted:
1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.
2. In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

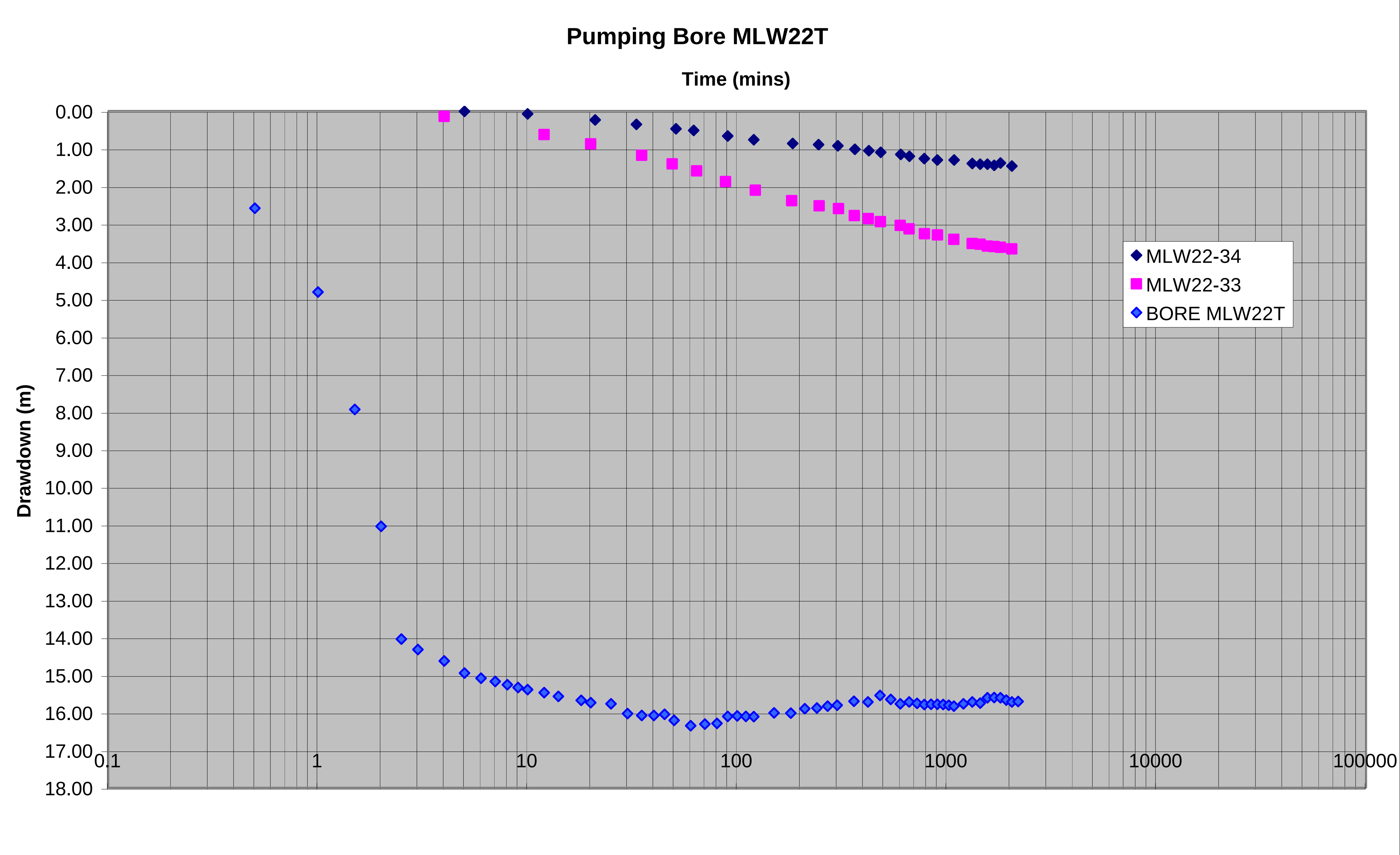
$Ew = (BQ/(BQ + CQ^P) \times 100$

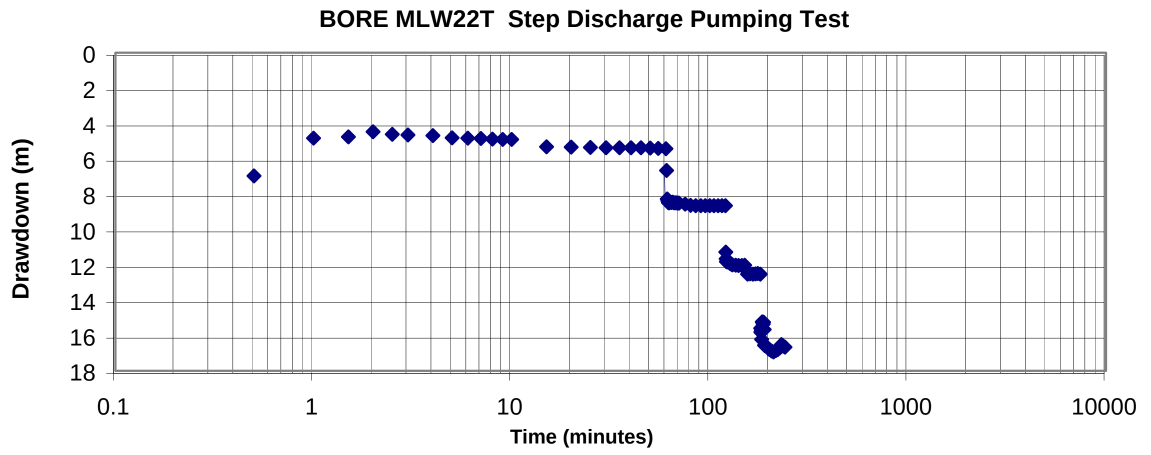
Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow

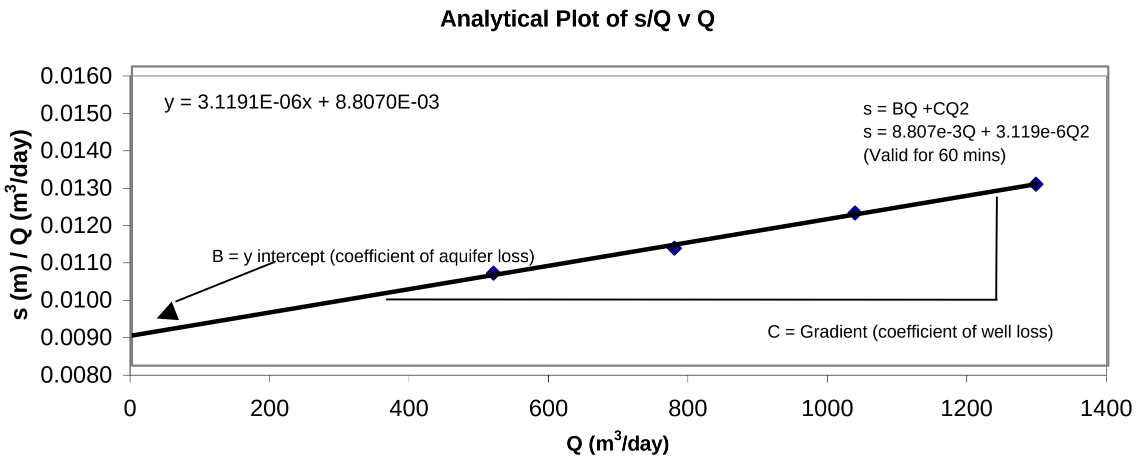
Comparison of Observed and Predicted Drawdowns

Step (100 min steps)	Discharge (L/s)	Discharge (Q) (m^3/d)	Observed Corrected Drawdown (s) (metres)	Predicted Drawdown (metres)	s/Q	Apparent Efficiency (Ew) %
1	6.0	518	5.00	4.92	0.0096	99
2	9.0	778	7.32	7.42	0.0094	98
3	12.0	1037	9.79	9.95	0.0094	98
4	15.0	1296	12.71	12.50	0.0098	97
5						


Recovery Test Bore MLW22T
Residual Drawdown (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
1
10
100
1000
10000
t/t'
Production


Pumping Bore MLW22T
Time (mins)
Drawdown (m)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
16.00
17.00
18.00
0.1
1
10
100
1000
10000
100000
MLW22-34
MLW22-33
BORE MLW22T





$s_{w(n)} = BQ_n + CQ^P{}_n$ (Rorabaugh's equation)

Where, B = Intercept with y axis (coefficient of aquifer loss or laminar flow)
C = Gradient (coefficient of turbulent flow loss or apparent well loss)
s = Drawdown in the borehole
P = Value determined using Rorabaugh's method of superposition

Components of the equation BQ and CQ^2 are termed the aquifer loss and apparent well loss respectively.
They give an indication of the proportion of total drawdown caused by laminar and turbulent flow.

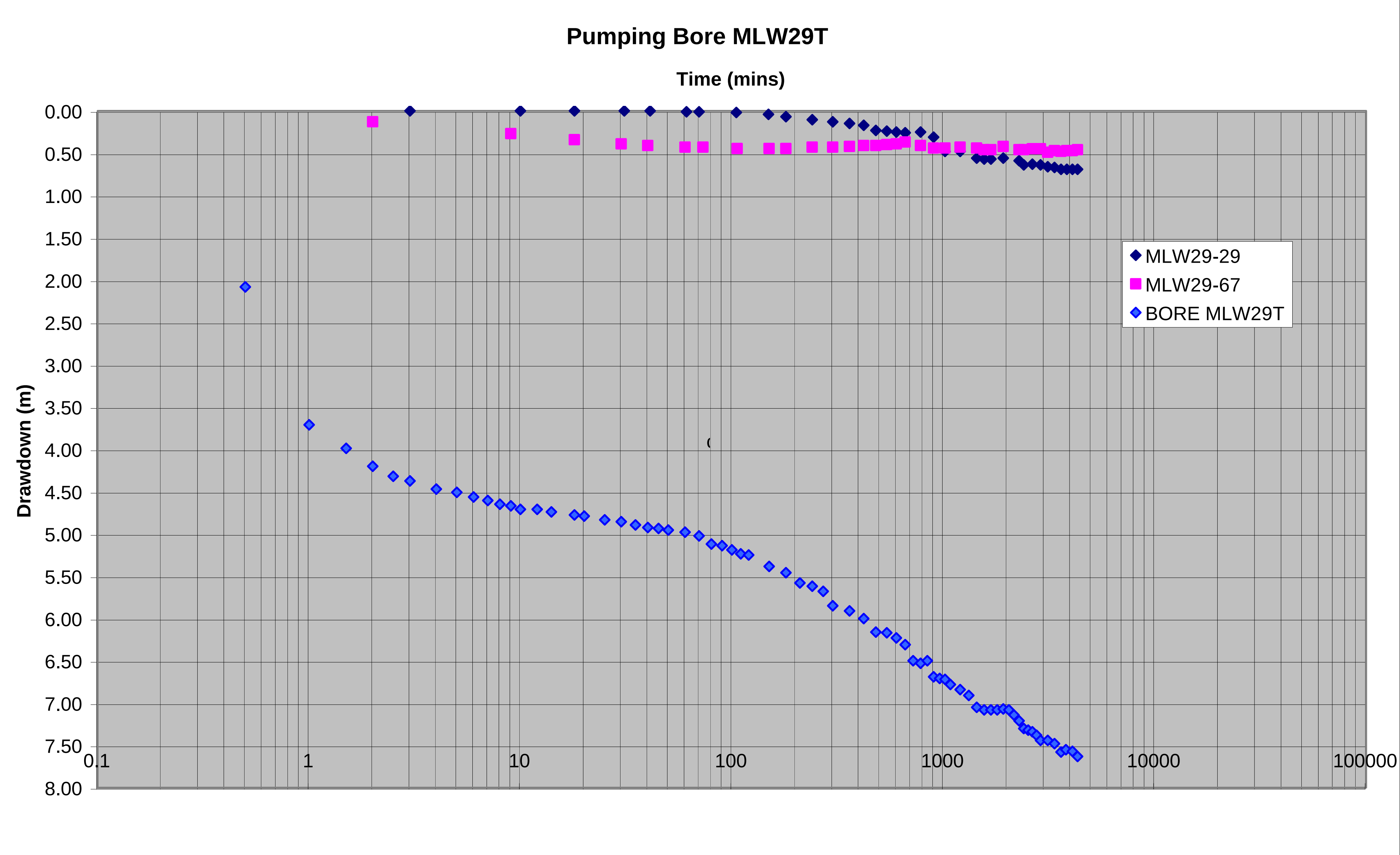
It should be noted:
1. In thin or fissured aquifers large components of well loss are due to high flow velocities in the aquifer rather than inefficient bore design. Therefore, the term "apparent well loss" is better than well loss.
2. In aquifers where the flow horizons are vertically anisotropic, changes in bore performance often relate to changes in the rest water level with respect to the primary aquifer horizons.

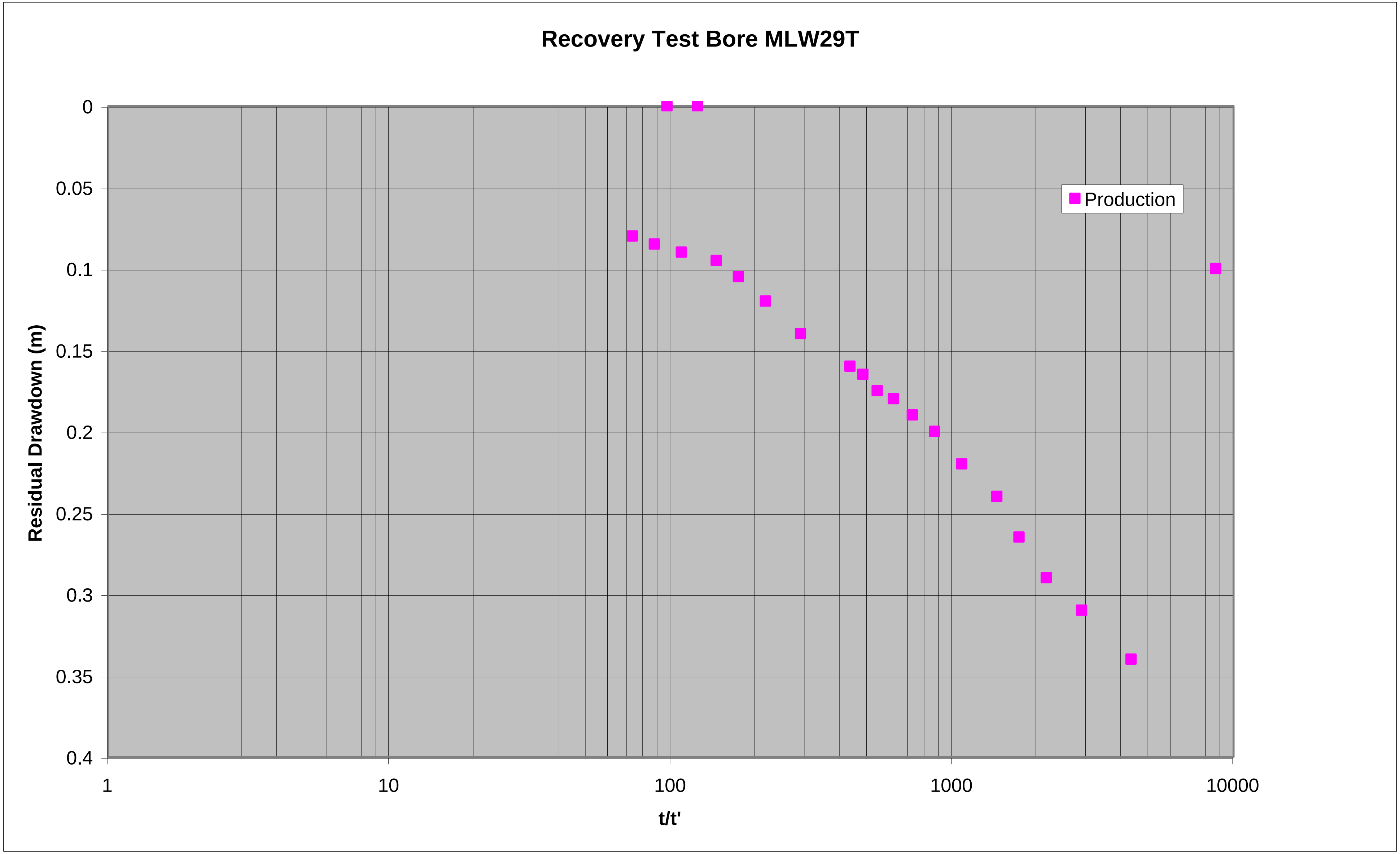
$Ew = (BQ/(BQ + CQ^P) \times 100$

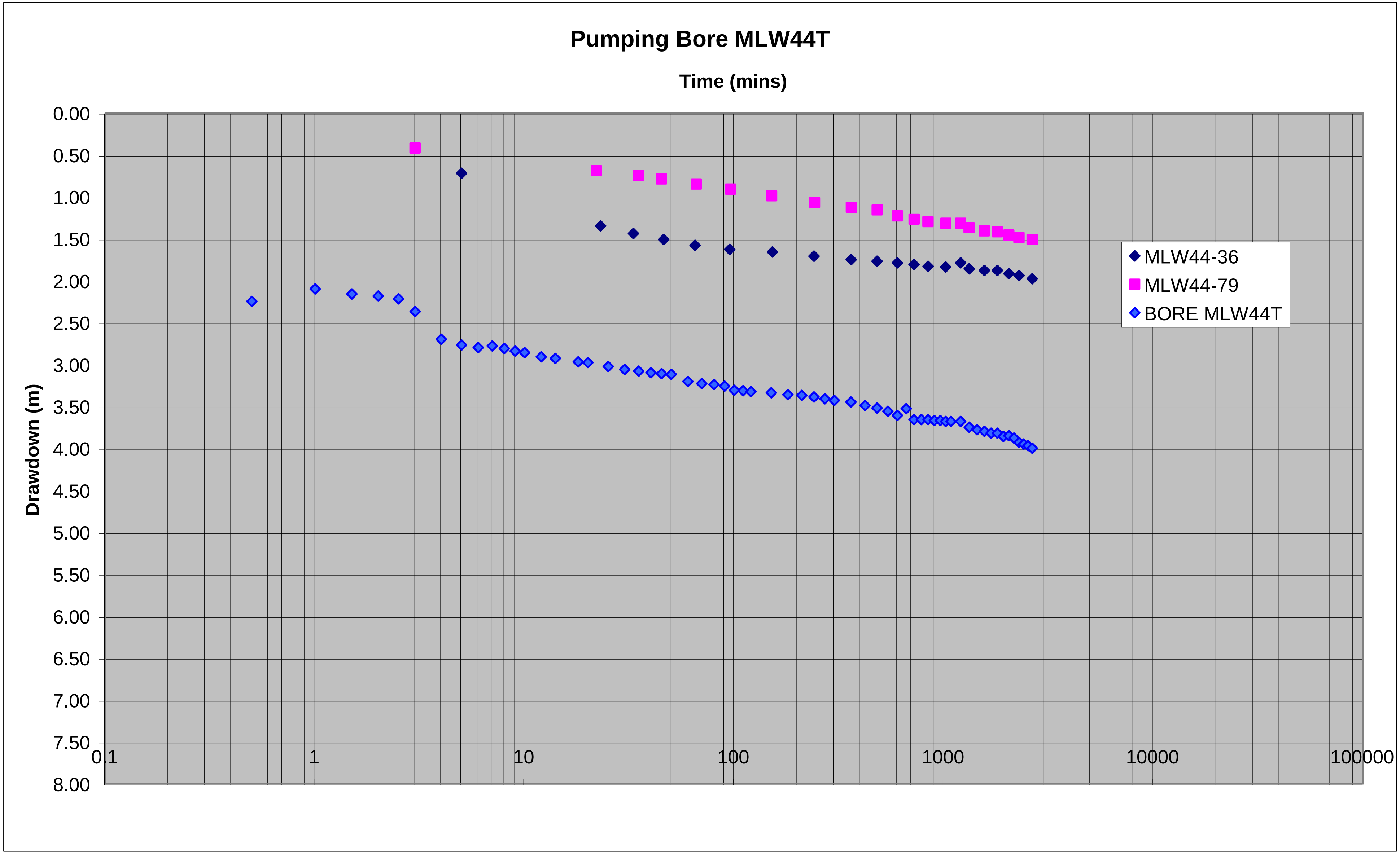
Ew or Well Efficiency represents the proportion of drawdown caused by laminar flow

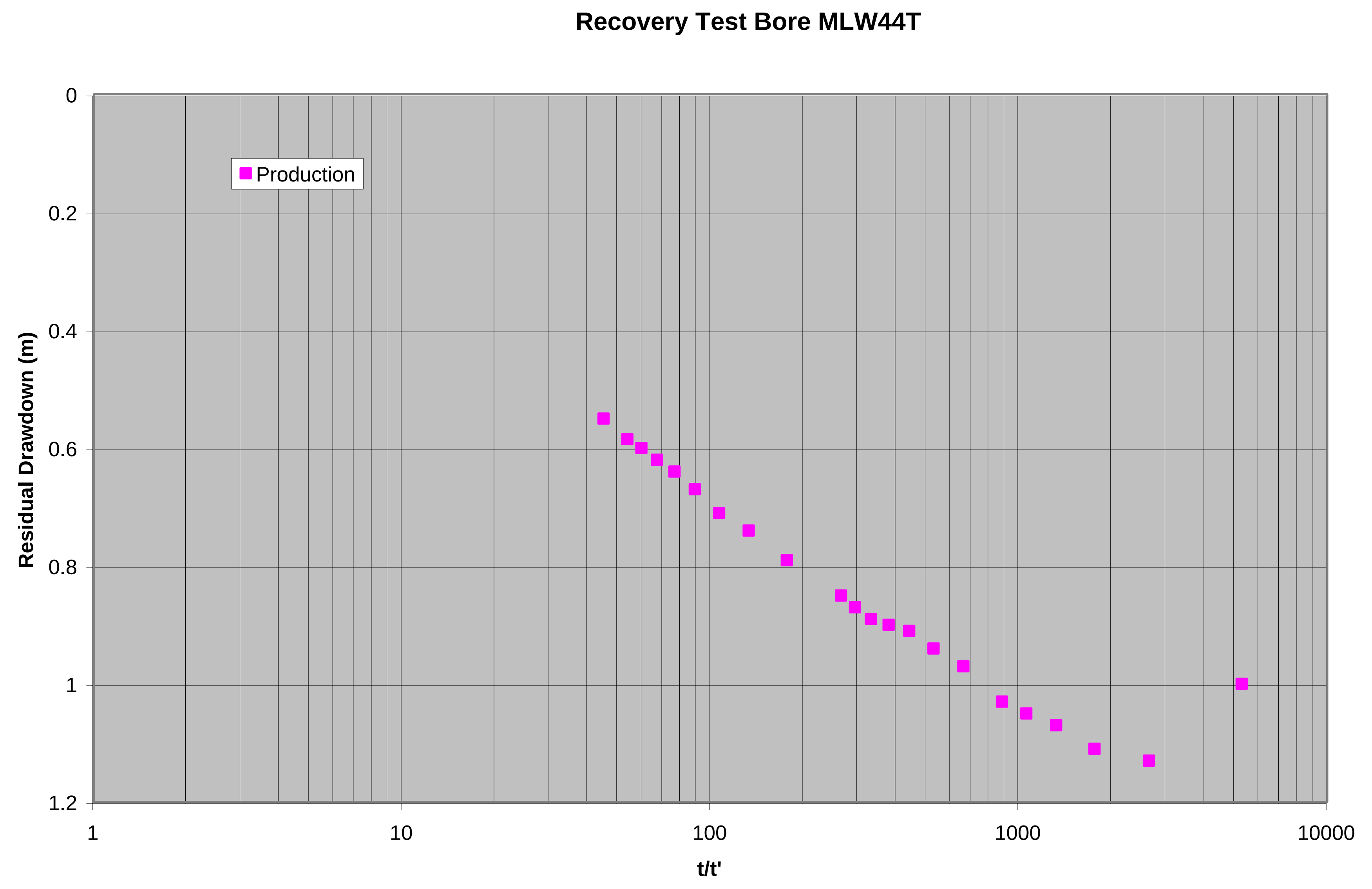
Comparison of Observed and Predicted Drawdowns

Step (100 min steps)	Discharge (L/s)	Discharge (Q) (m^3/d)	Observed Corrected Drawdown (s) (metres)	Predicted Drawdown (metres)	s/Q	Apparent Efficiency (Ew) %
1	6.0	518	5.43	5.40	0.0105	84
2	9.0	778	8.66	8.73	0.0111	78
3	12.0	1037	12.53	12.48	0.0121	73
4	15.0	1296	16.66	16.65	0.0129	69


Pumping Bore MLW29T
Time (mins)
Drawdown (m)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
8.00
0.1
1
10
100
1000
10000
100000
◆ MLW29-29
■ MLW29-67
◆ BORE MLW29T


Recovery Test Bore MLW29T
Residual Drawdown (m)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1
10
100
1000
10000
t/t'
Production


Pumping Bore MLW44T
Time (mins)
Drawdown (m)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
8.00
0.1
1
10
100
1000
10000
100000
◆ MLW44-36
■ MLW44-79
◆ BORE MLW44T


Recovery Test Bore MLW44T
Production
Residual Drawdown (m)
0
0.2
0.4
0.6
0.8
1
1.2
1
10
100
1000
10000
t/t'

APPENDIX D

CONDUCTIVITY AND TEMPERATURE DATA FOR THE MOUNT LEWIN TRIAL BORES

WESTLOG WIRELINE SERVICES

HOLE NO. MLWO6T
LOGGED 15/04/05 at 10:26

COMPANY FORTESCUE METALS
AREA LEWIN
PROSPECT
OPERATOR TONY

DRILLING DATA

PERM DAT GL
ELEV
AZIMUTH
INCLIN
HOLE POS
HOLE DIA
DEPTH

CASING DATA

CASE-TYP PVC
CASE-DTH 86 M
CASE-DIA
CASE-THK

FLUID DATA

FLD TYPE WATER
FLUIDLEV
LOGTYPE TD+5

TOOL: Tmrg--Merged Log
Serial Number: A637
Spacer (cm) : n/a

CHANNEL DATA

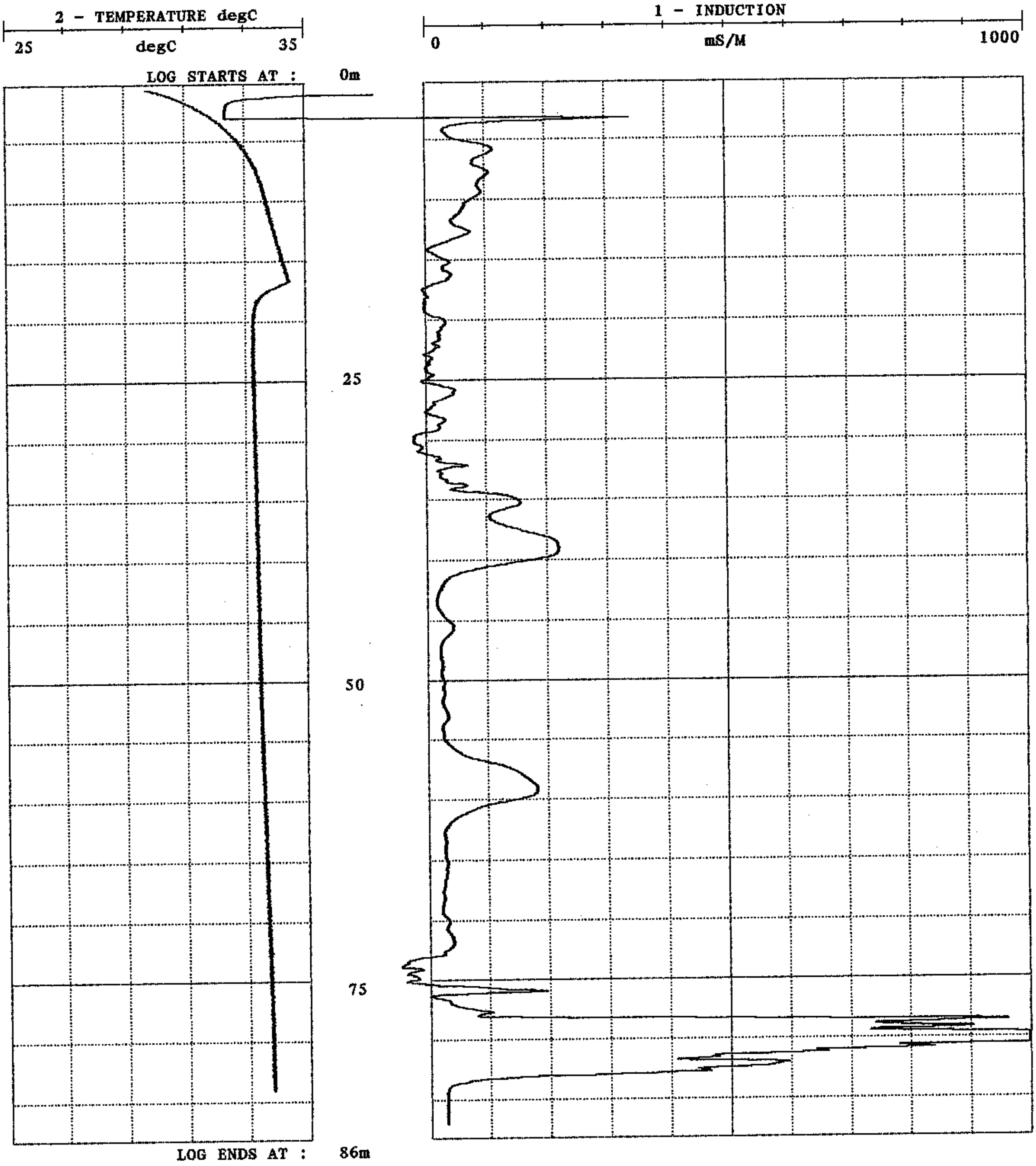
CHANNEL	AMPLITUDE RANGE	CHART AREA	SENSOR OFFSET	FILTER CNST	PLOT TYPE
1 - INDUCTION	0 - 1000	7.0 - 17.0	100	1.0	1
2 - TEMPERATURE de	25.0 - 35.0	0.0 - 5.0	48	1.0	1

CALIBRATION DATA

CHANNEL	units	slope	offset	C1	C2	C3	C4
1 - INDUCTION	mS/M	1.000000	50	0.000	-1.00	INDN	LOK
2 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602

Log No.	FILENAME
1 -	06TI 0
2 -	06TT 0

```
REPLAY of C:\LOGS\Merge Log at 12:36 on 19/04/05
======================================================================================================
                                          SCALE:  1 TO  500
                                                using
                                           DEPTH CORRECTION
======================================================================================================
```



WESTLOG WIRELINE SERVICES

HOLE NO. MLW11T

LOGGED 15/04/05 at 08:07

COMPANY	FORTESCUE METALS
AREA	LEWIN
PROSPECT	
OPERATOR	TONY

DRILLING DATA

PERM DAT	GL
ELEV	
AZIMUTH	
INCLIN	
HOLE POS	
HOLE DIA	
DEPTH	

CASING DATA

CASE-TYP	PVC
CASE-DTH	60 M
CASE-DIA	
CASE-THK	

FLUID DATA

FLD TYPE	WATER
FLUIDLEV	
LOGTYPE	TD+5

TOOL: Tmrg--Merged Log
Serial Number: A637
Spacer (cm) : n/a

CHANNEL DATA

CHANNEL	AMPLITUDE RANGE	CHART AREA	SENSOR OFFSET	FILTER CNST	PLOT TYPE
1 - INDUCTION	0 - 1000	7.0 - 17.0	100	1.0	1
2 - TEMPERATURE de	25.0 - 35.0	0.0 - 5.0	48	1.0	1

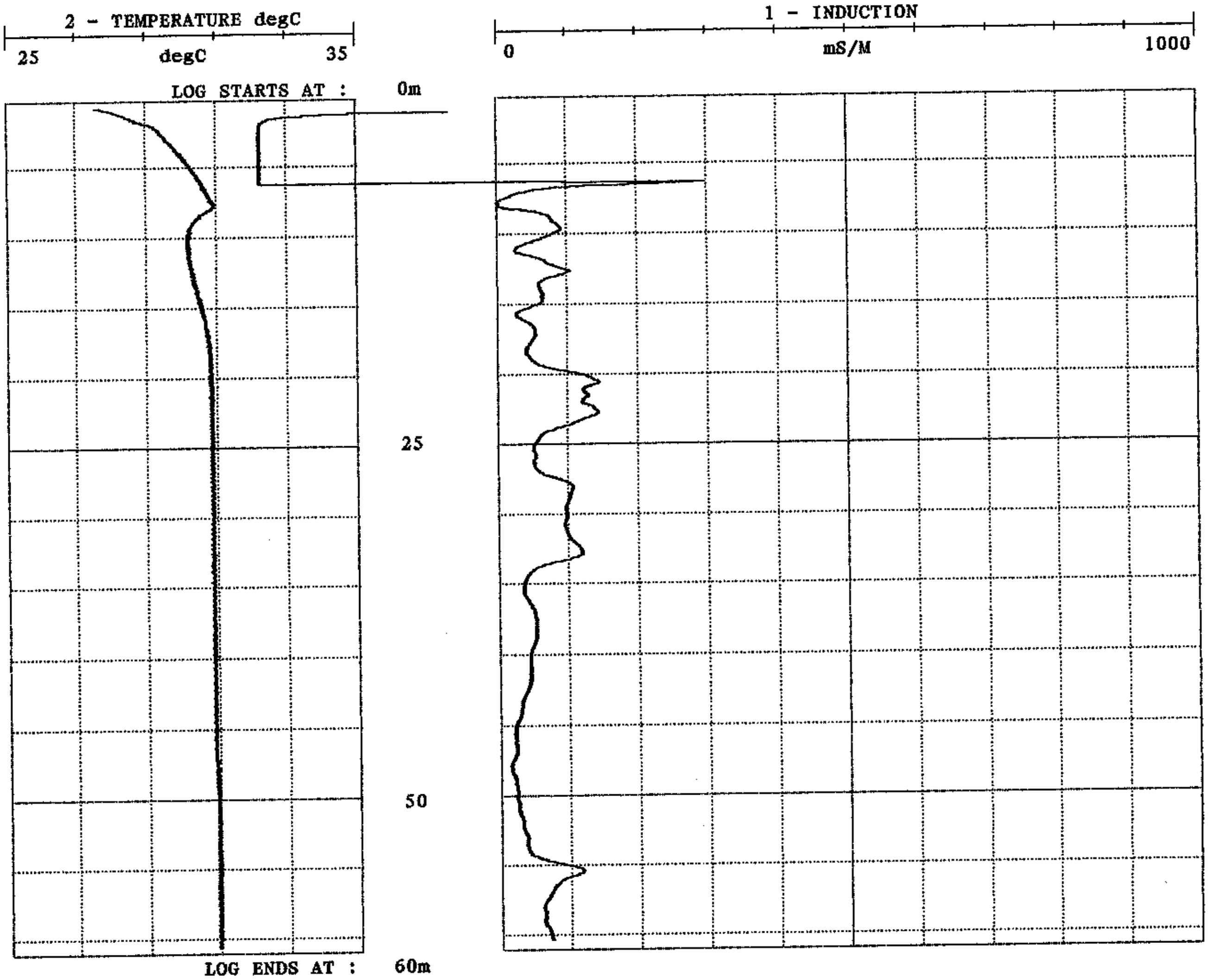
CALIBRATION DATA

CHANNEL	units	slope	offset	C1	C2	C3	C4
1 - INDUCTION	mS/M	1.000000	44	0.000	-1.00	INDN	LOK
2 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602

Log No.	FILENAME	
1 -	11TI	0
2 -	11TT	0

REPLAY of C:\LOGS\Merge Log at 12:24 on 19/04/05

SCALE: 1 TO 500
using
DEPTH CORRECTION



WESTLOG WIRELINE SERVICES

HOLE NO. MLW22T

LOGGED 13/04/05 at

COMPANY	FORTESCUE METALS
AREA	LEWIN
PROSPECT	
OPERATOR	TONY

DRILLING DATA

PERM DAT	GL
ELEV	
AZIMUTH	
INCLIN	
HOLE POS	
HOLE DIA	
DEPTH	

CASING DATA

CASE-TYP	PVC
CASE-DTH	66 M
CASE-DIA	
CASE-THK	

FLUID DATA

FLD TYPE	WATER
FLUIDLEV	
LOGTYPE	TD+5

TOOL: Tmrg--Merged Log
Serial Number: A637
Spacer (cm) : n/a

CHANNEL DATA

CHANNEL	AMPLITUDE RANGE	CHART AREA	SENSOR OFFSET	FILTER CNST	PLOT TYPE
1 - INDUCTION	0 - 1000	7.0 - 17.0	100	1.0	1
2 - TEMPERATURE de	25.0 - 35.0	0.0 - 5.0	48	1.0	1
3 - TEMPERATURE de	25.0 - 35.0	0.0 - 5.0	48	1.0	1

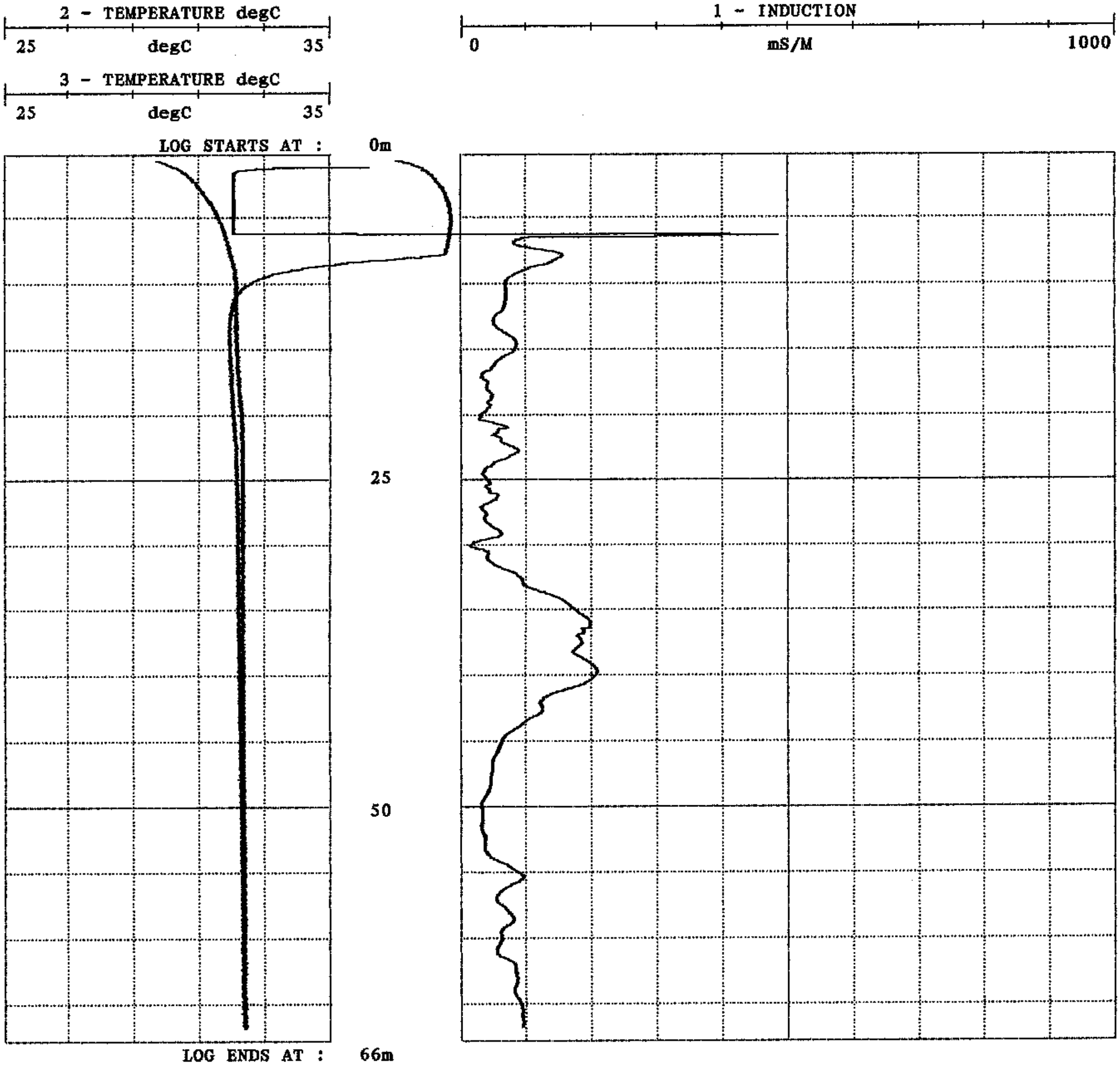
CALIBRATION DATA

CHANNEL	units	slope	offset	C1	C2	C3	C4
1 - INDUCTION	mS/M	1.000000	35	0.000	-1.00	INDN	LOK
2 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602
3 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602

Log No. FILENAME
1 - 22I 0
2 - 22T 0
3 - 22T 2

REPLAY of C:\LOGS\Merge Log at 10:01 on 19/04/05

SCALE: 1 TO 500
using
DEPTH CORRECTION



WESTLOG WIRELINE SERVICES

HOLE NO. MLW29T

LOGGED 13/04/05 at 16:07

COMPANY FORTESCUE METALS
AREA LEWIN
PROSPECT
OPERATOR TONY

DRILLING DATA

PERM DAT GL
ELEV
AZIMUTH
INCLIN
HOLE POS
HOLE DIA
DEPTH

CASING DATA

CASE-TYP PVC
CASE-DTH 60 M
CASE-DIA
CASE-THK

FLUID DATA

FLD TYPE WATER
FLUIDLEV
LOGTYPE TD+5

TOOL: Tmrg--Merged Log
Serial Number: A637
Spacer (cm) : n/a

CHANNEL DATA

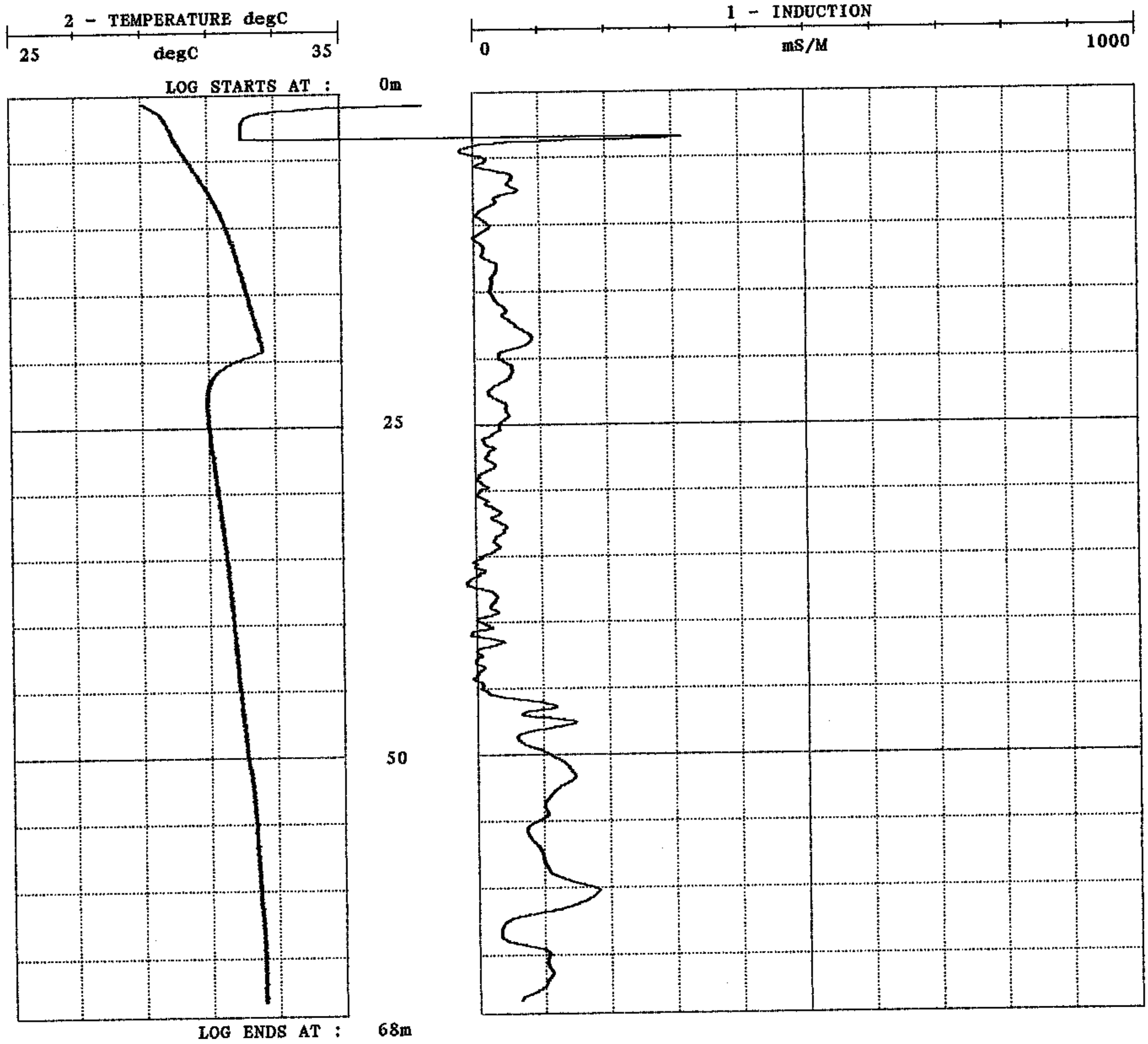
CHANNEL	AMPLITUDE	RANGE	CHART	AREA	SENSOR OFFSET	FILTER CNST	PLOT TYPE
1 - INDUCTION	0 -	1000	7.0 -	17.0	100	1.0	1
2 - TEMPERATURE de	25.0 -	35.0	0.0 -	5.0	48	1.0	1

CALIBRATION DATA

CHANNEL	units	slope	offset	C1	C2	C3	C4
1 - INDUCTION	mS/M	1.000000	32	0.000	-1.00	INDN	LOK
2 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602

Log No.	FILENAME	
1 -	29I	0
2 -	29T	0

```
REPLAY of C:\LOGS\Merge Log at 10:03 on 19/04/05
==================================================================================================
                                             SCALE:  1 TO  500
                                                   using
                                              DEPTH CORRECTION
==================================================================================================
```



WESTLOG WIRELINE SERVICES

HOLE NO. MLW44T

LOGGED 13/04/05 at

COMPANY FORTESCUE METALS
AREA LEWIN
PROSPECT
OPERATOR TONY

DRILLING DATA

PERM DAT GL
ELEV
AZIMUTH
INCLIN
HOLE POS
HOLE DIA
DEPTH

CASING DATA

CASE-TYP PVC
CASE-DTH 80 M
CASE-DIA
CASE-THK

FLUID DATA

FLD TYPE WATER
FLUIDLEV
LOGTYPE TD+5

TOOL: Tmrg--Merged Log
Serial Number: A637
Spacer (cm) : n/a

CHANNEL DATA

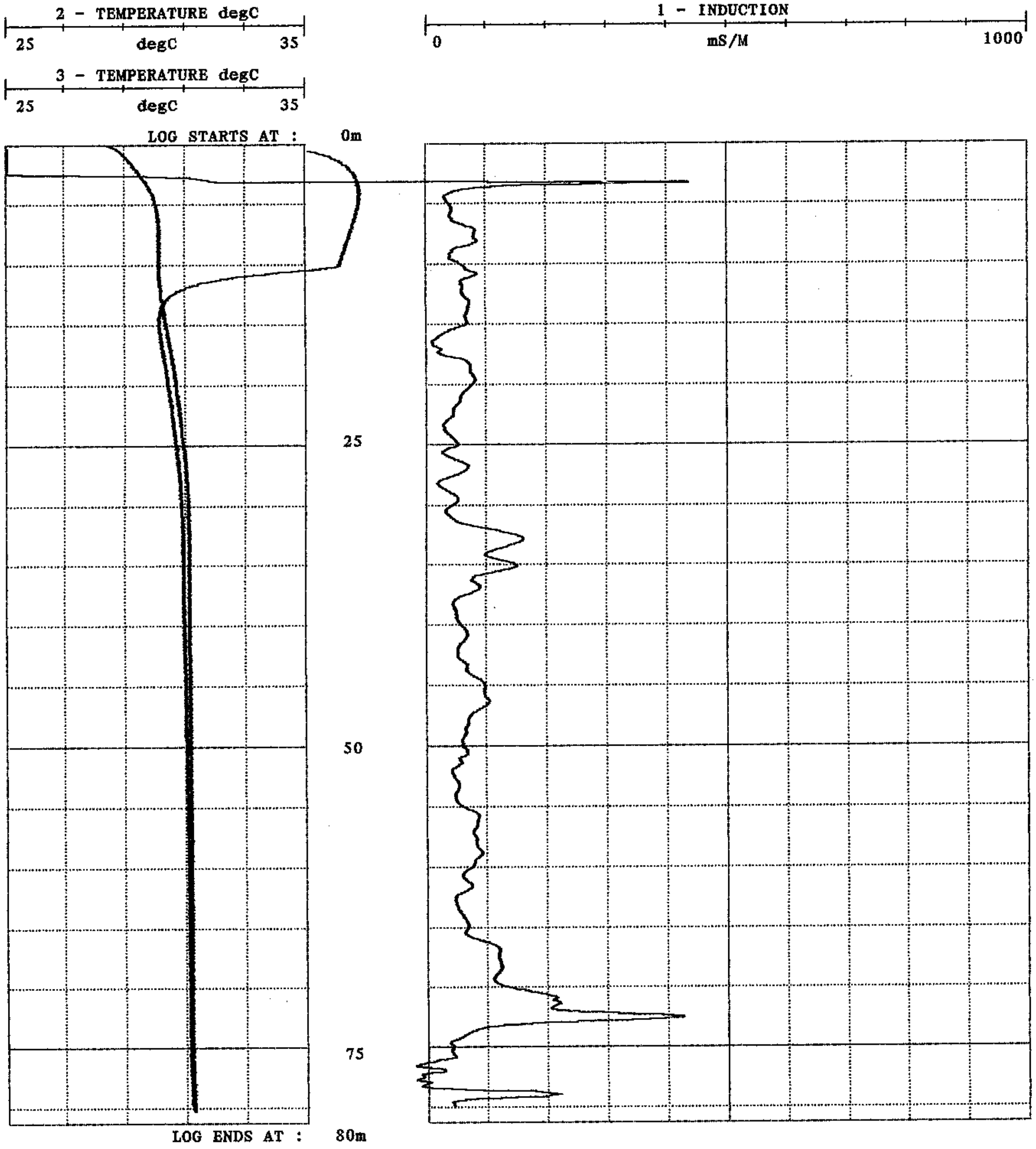
CHANNEL	AMPLITUDE	RANGE	CHART	AREA	SENSOR OFFSET	FILTER CNST	PLOT TYPE
1 - INDUCTION	0 -	1000	7.0 -	17.0	100	1.0	1
2 - TEMPERATURE de	25.0 -	35.0	0.0 -	5.0	48	1.0	1
3 - TEMPERATURE de	25.0 -	35.0	0.0 -	5.0	48	1.0	1

CALIBRATION DATA

CHANNEL	units	slope	offset	C1	C2	C3	C4
1 - INDUCTION	mS/M	1.000000	30	0.000	-1.00	INDN	LOK
2 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602
3 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602

Log No.	FILENAME	
1 -	44I	0
2 -	44T	0
3 -	44T	2

```
REPLAY of C:\LOGS\Merge Log at 09:51 on 19/04/05
============================================================================================
                                         SCALE:  1 TO  500
                                               using
                                          DEPTH CORRECTION
============================================================================================
```



APPENDIX E

DRILL LOGS FOR THE CHRISTMAS CREEK TRIAL BORES

aquaterra

Suite 4, 125 Melville Parade
Como
WA   6152
Australia
Tel: (+61) (08) 9368 4044
Fax: (+61) (08) 9368 4055

WELL LOG

Well No: E02T

Client: Fortescue Metals Group
Project: Christmas Creek groundwater exploration

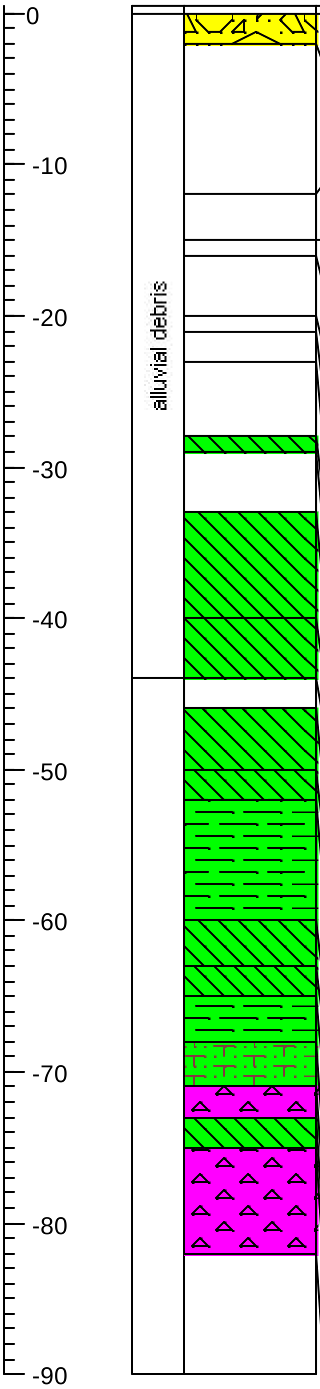
Commenced: 10/03/2005
Completed: 22/03/2005
Drilled: Connector
Logged By: RFToll

Method: Mud Rotary
Fluid: Mud
Bit Record: 10 inch

Area: Christmas Creek
East: 782204m(AMG)
North: 7520769m(AMG)
Elevation: 427

Static Water Level: 22.08mbgl
Date: 22/03/2005

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



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.

ALLUVIAL: Red-brown aggregated/well bonded clay

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

ALLUVIAL: Red-brown damp well bonded/aggregated clay

CLAY: Red-brown clay. Wet zone with minor to moderate flows approximately 1 litre/second.

CLAY: Red-brown oxidised poorly sorted subrounded

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

CLAY: Red-brown moderately consolidated clay

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

SHALE: Black-dark grey goethitic mineralised Fe shale predominant with minor vugh/oxidised surfaces. Moderate water flows in zone fresh water.

CLAY: Brown-red clay

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

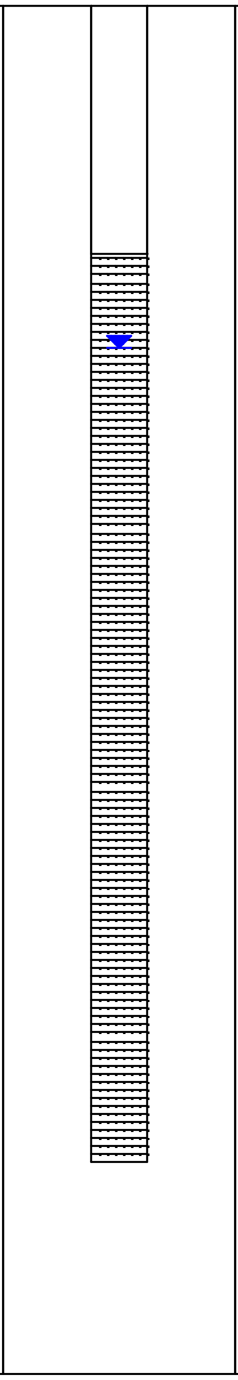
SHALE: Brown highly oxidised hard shale fragments angular conchoidal fractured < 0.5cm diameter fragments.

CLAYSTONE: Grey brittle claystone.

CHERT: Brown highly oxidised slightly broken chert.

CLAY: Grey very densely aggregated/puggy clay.

CHERT: Dark grey-black haematitic chert. Moderate oxidised slightly broken surfaces associated with moderate to good flows.



155 mm Blank Cl 9 PVC (0-15.9mbgl)

155 mm Screen Cl 9 PVC (15.9-75.9mbgl)

aquaterra

Suite 4, 125 Melville Parade
Como
WA 6152
Australia
Tel: (+61) (08) 9368 4044
Fax: (+61) (08) 9368 4055

WELL LOG

Well No: E19T

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

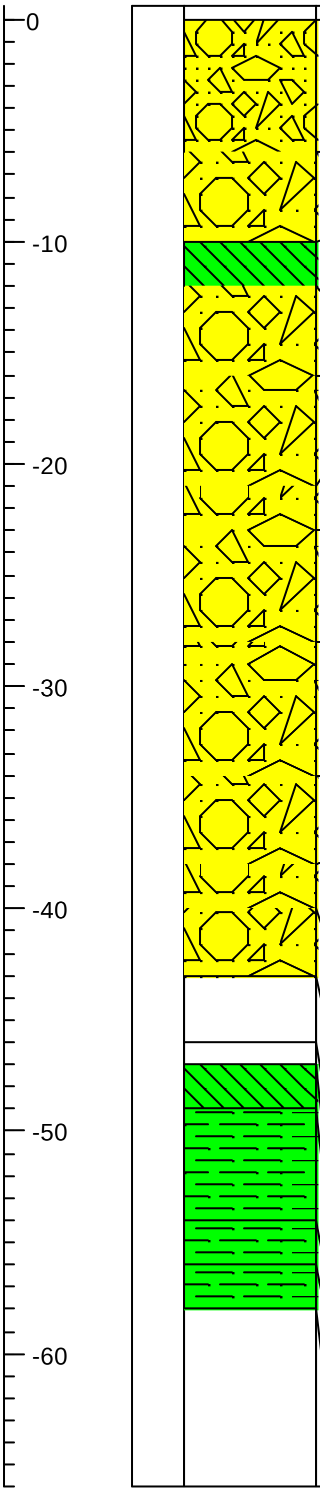
Commenced: 24/03/2005
Completed: 29/03/2005
Drilled: Connector
Logged By: RFToll

Method: Mud Rotary
Fluid: Mud
Bit Record: 10 inch

Area: Christmas Creek
East: 787418m(AMG)
North: 7518530m(AMG)
Elevation: 437(mRL)

Static Water Level: 22.3 mbgl
Date: 29/03/2005

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



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

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

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

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

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

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

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

ALLUVIUM: Brown alluvial mix of 80% chert subangular/subrounded 0.5-5 cm diameter + 20% pitted calcrete fragments

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

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

ALLUVIUM: 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

SHALE/SAPROCK: Brown oxidised shale/saprock brittle with moderate clay development on surfaces

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

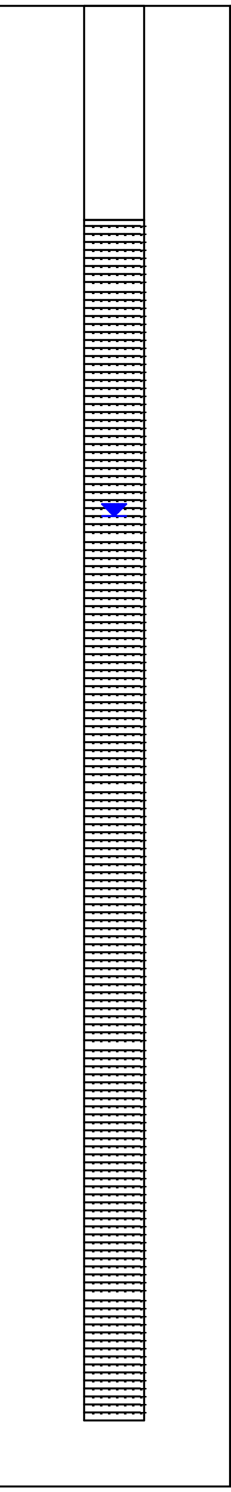
Field Notes

Upper alluvial sections falling in; unable to stabliise hole, hole discontinued. No hydraulic data gather as hole backreamed to remove gear.

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

40-50m: Likely zone of instability - fallback on hammer when backreaming from 58 metres -

49-58m: Minor aquifer - not tested as zone became bogged and drilling required backreaming - several attempts to get through zone failed- hole abandoned



Notes

155 mm Blank PVC (0-9mbgl)

155 mm Screen PVC (9-63mbgl)

aquaterra

Suite 4, 125 Melville Parade
Como
WA 6152
Australia
Tel: (+61) (08) 9368 4044
Fax: (+61) (08) 9368 4055

WELL LOG

Well No: E41T

Client: Fortescue Metals Group
Project: Christmas Creek groundwater exploration

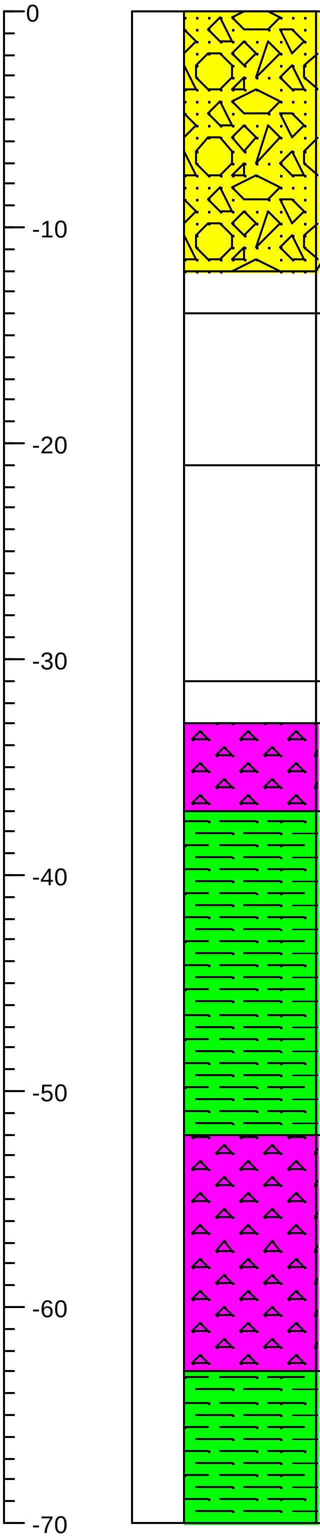
Commenced: 22/03/2005
Completed: 24/03/2005
Drilled: Connector R3
Logged By: Steve Collett

Method: Air Percussion
Fluid: Air
Bit Record: 10 inch

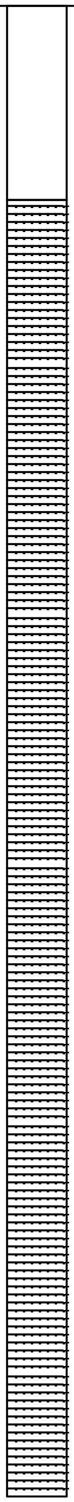
Area: Christmas Creek
East: 794037m(AMG)
North: 7519273m(AMG)
Elevation: 438mAHD

Static Water Level:
Date:

Depth (mbgl) | **Geology** | **Graphic Log** | **Well Completion Diagram** | **Notes**



Lithological Description	Field Notes
COLLUVIUM: Brown silty aggregate, goethite fragments to 60%, maghaemite pisoliths to 20%	
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	
SHALE/CHERT: Brown banded chert (20%) and goethite rich shale	
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	
SHALE: Brown iron stained kaolin shale, thin chert bedding to 20% of sequence	
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
SHALE: Black soft carbonaceous shale, with minor thin chert beds	EOH at 70mbgl



Suite 4, 125 Melville Parade
Como
WA 6152
Australia
Tel: (+61) (08) 9368 4044
Fax: (+61) (08) 9368 4055

WELL LOG

Well No: F02T

Client: Fortescue Metals Group
Project: Christmas Creek groundwater exploration

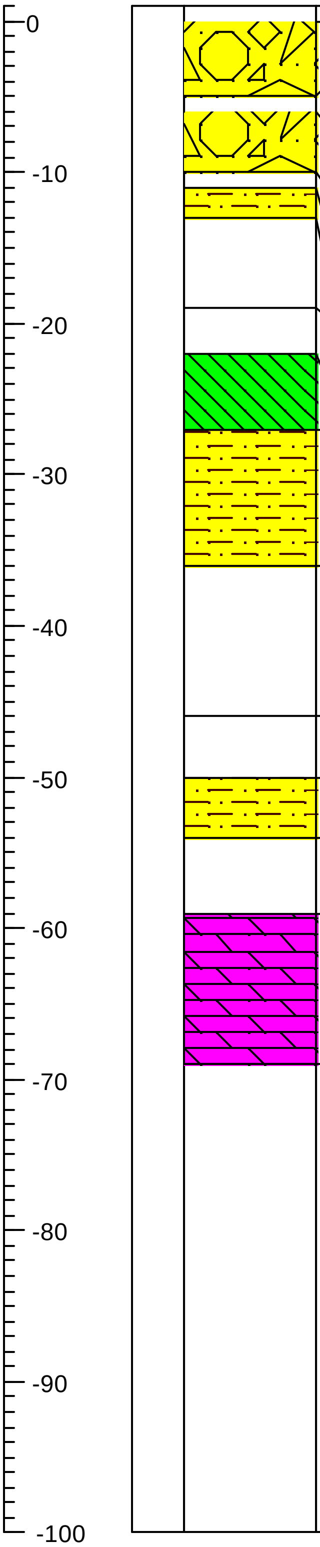
Commenced: 05/03/2005
Completed: 08/03/2005
Drilled: Connector R3
Logged By: Steve Collett

Method: Air Percussion
Fluid: Air
Bit Record: 10 inches

Area: Christmas Creek
East: 788019m(AMG)
North: 7513024m(AMG)
Elevation: 416mAHD

Static Water Level: 11.33mbgl
Date: 08/03/2005

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



ALLUVIUM: Brown fine to very coarse agregate, fragments to 60%

CALCRETE: White earthy calcrete

ALLUVIUM: Brown silty aggregate , aggregate predominatly chert

CALCRETE: White earthy calcrete

SILT: Brown silt minor pisolith content

CALCRETE: Light Brown earthy calcareous silt

CALCRETE: White calcrete and chalcedony Karstic highly water bearing

CLAY: Brown silty clay, puggy

SILT: Brown silt lucustrine

CALCRETE: White calcrete,
36-40m: pinkish and earthy,
40-46m: earthy + chalcedonic (20%) and karstic, highly water bearing

CALCRETE: Grey/white calcrete

SILT: Light brown earthy calcareous silt

SILCRETE: Grey massive silcrete (chalcedony) and brown silcrete vien infilled (secondary opaline infill)

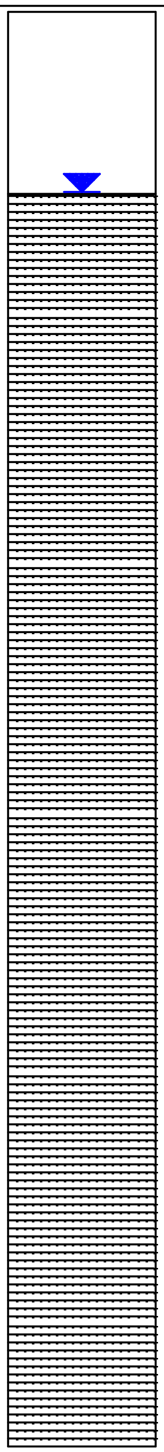
DOLOMITE: Yellow dolomite, minor fractures in chip samples where potentially interconnected would be water yielding. Moderate water yielding

19-22m: Major yield from calrete and chalcedony pH 8.78, EC 14.06 mS , ppt 7.01, yield intermittant losing air to formation.

40-46m: Major yield from calrete and chalcedony pH 8.4, EC +20000 mS , ppt +10000, yield intermittant losing air to formation.

54-59m: Moderate yield, silcrete pH 7.7 hypersaline.

59-69+m: Moderate aquifer section - hypersaline water pH 7.7 potential for greater yield if encountered faults etc.



T.O.C.: +0.55magl

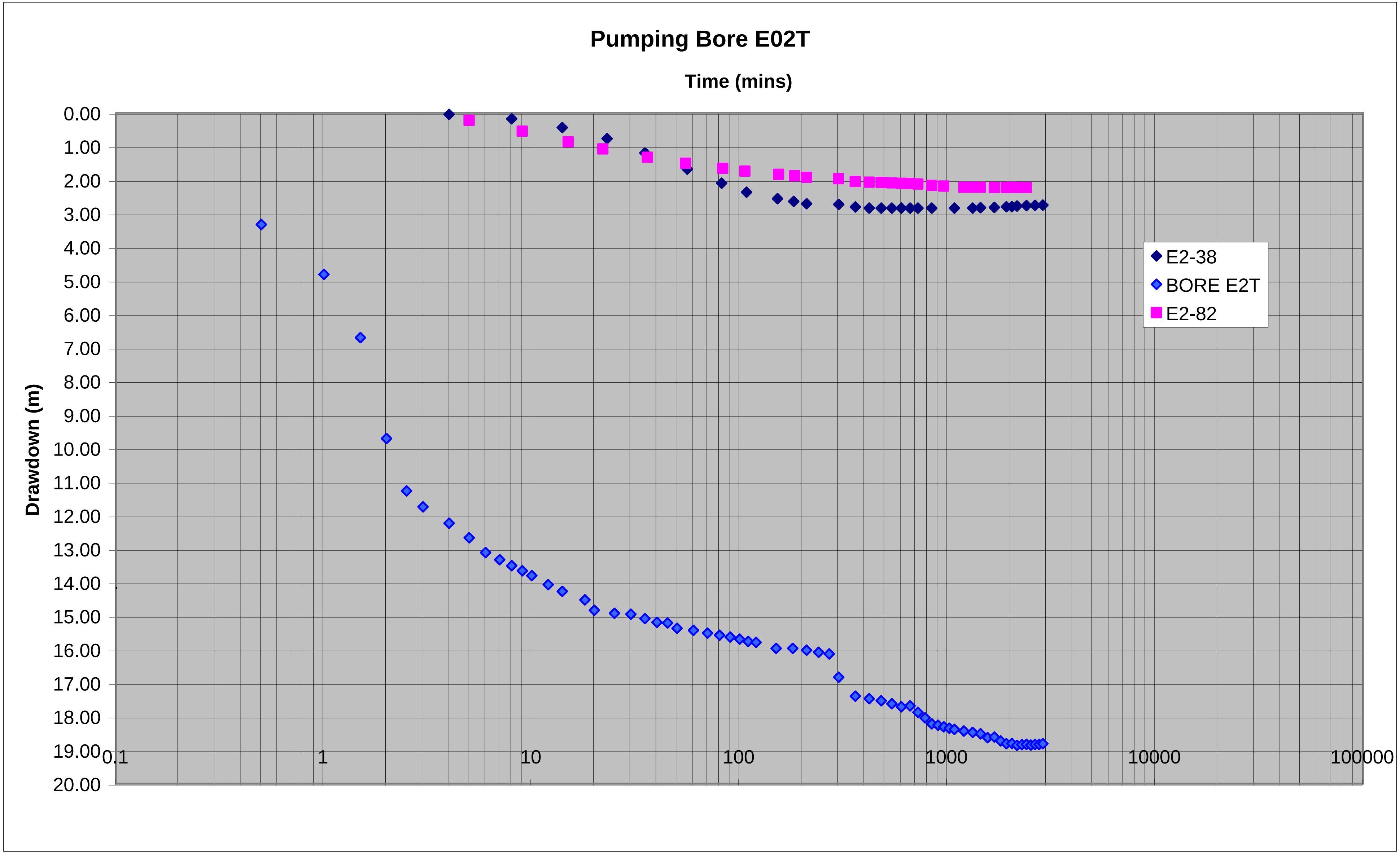
155mm Blank Cl 9 PVC (0-11.5mbgl)

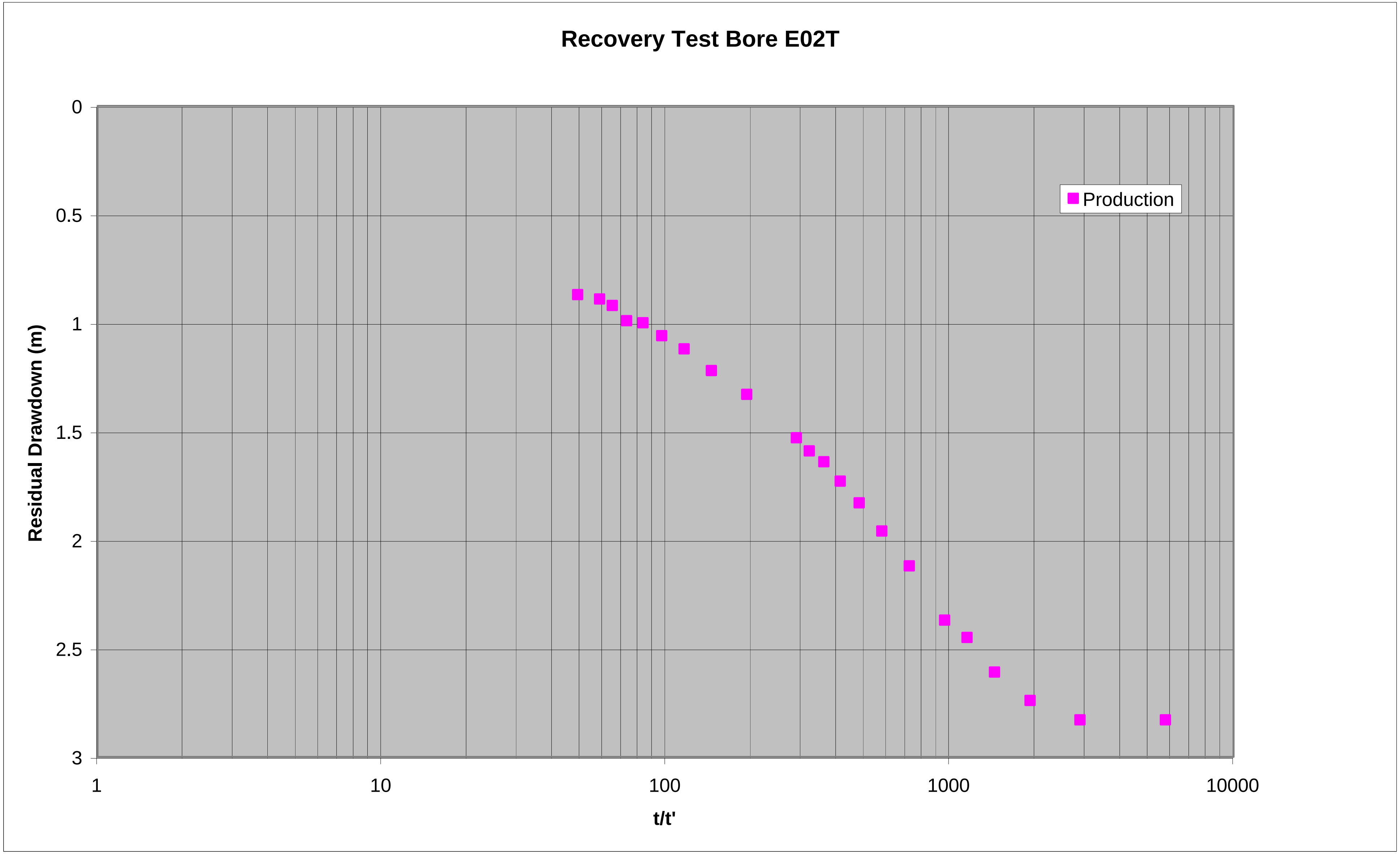
155mm Screen Cl 9 PVC (0-11.5mbgl)

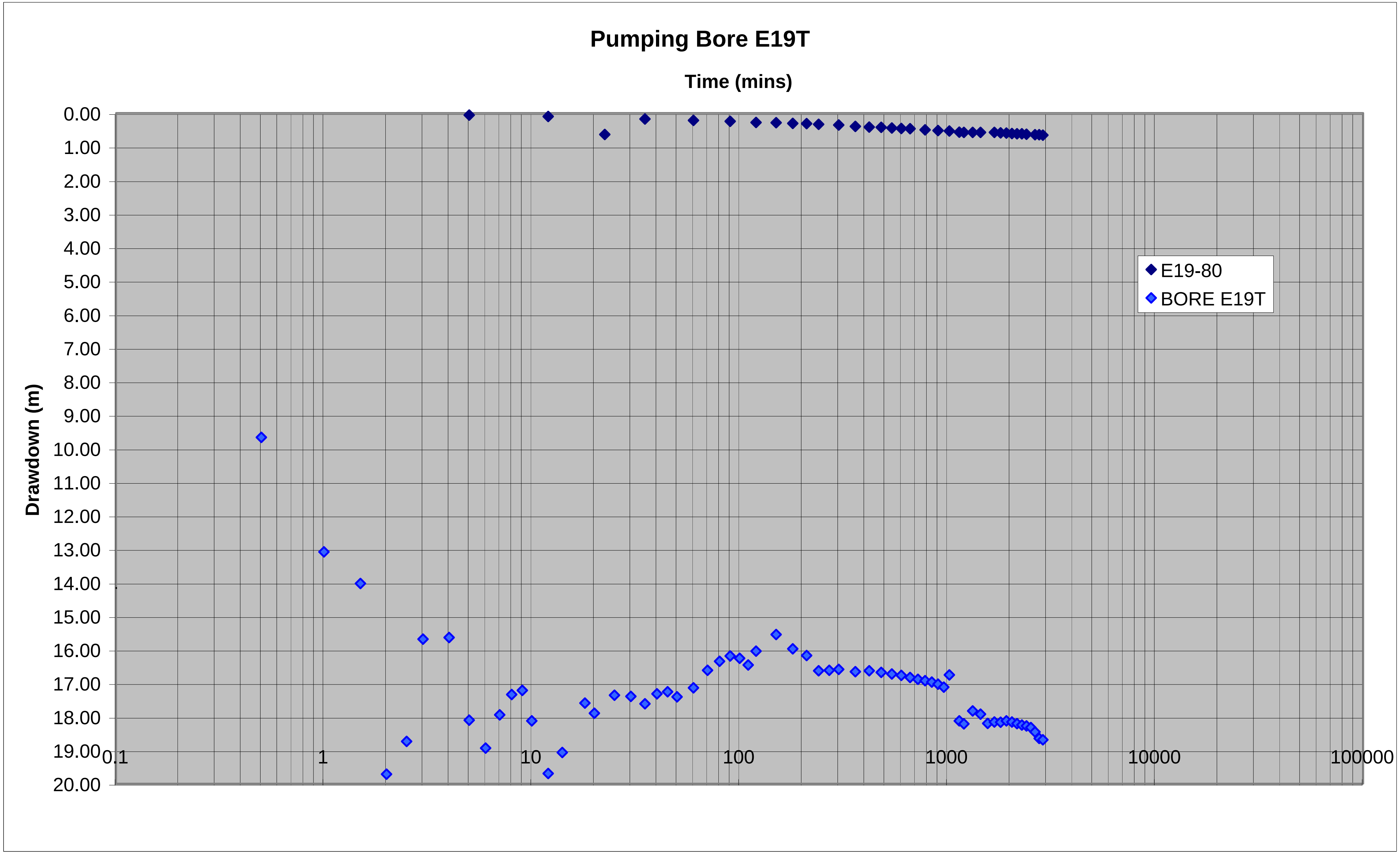
File Ref: F:\jobs\477\3000\3200 test data\Drill Logs\Log Plot Files\F02T

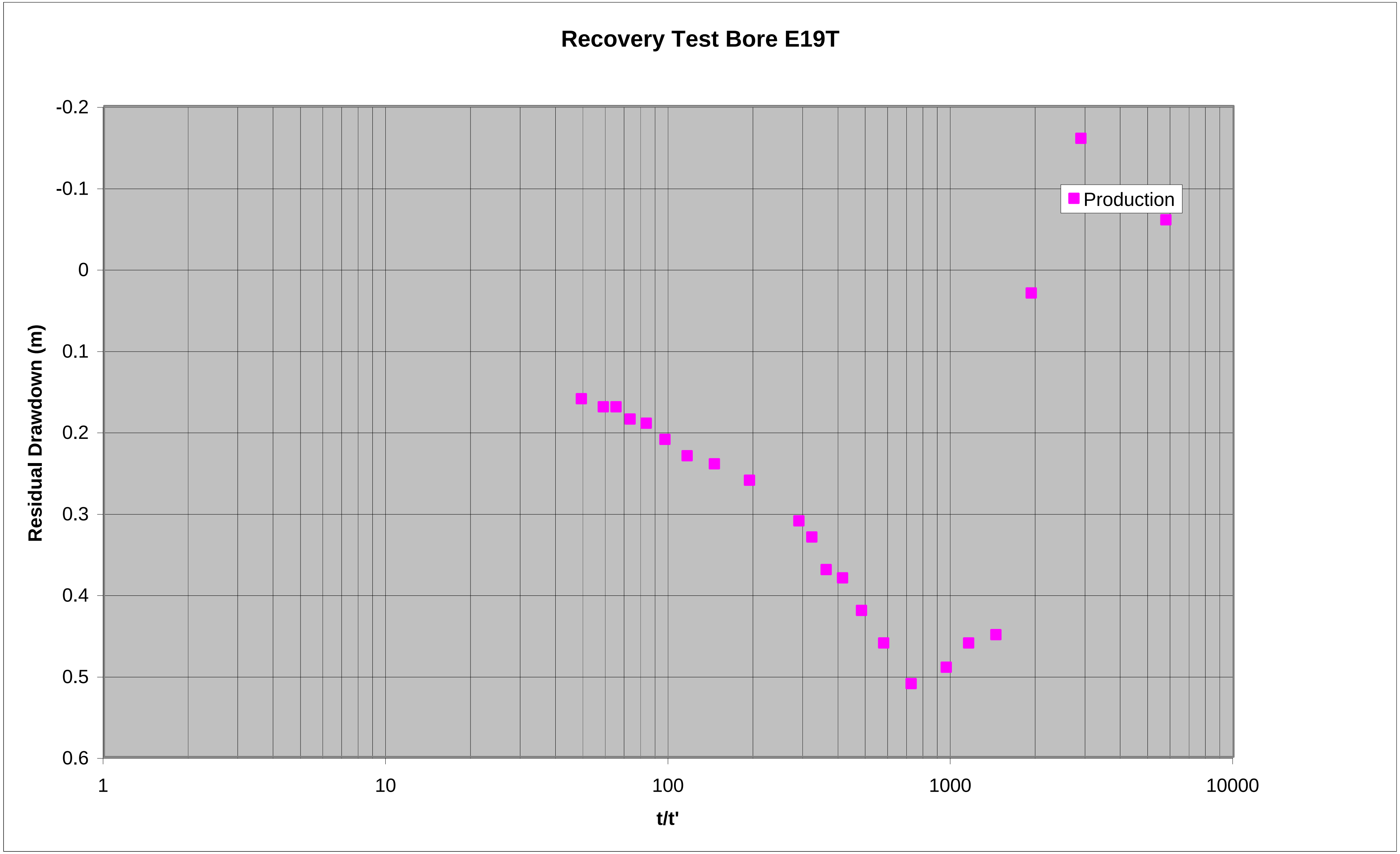
APPENDIX F

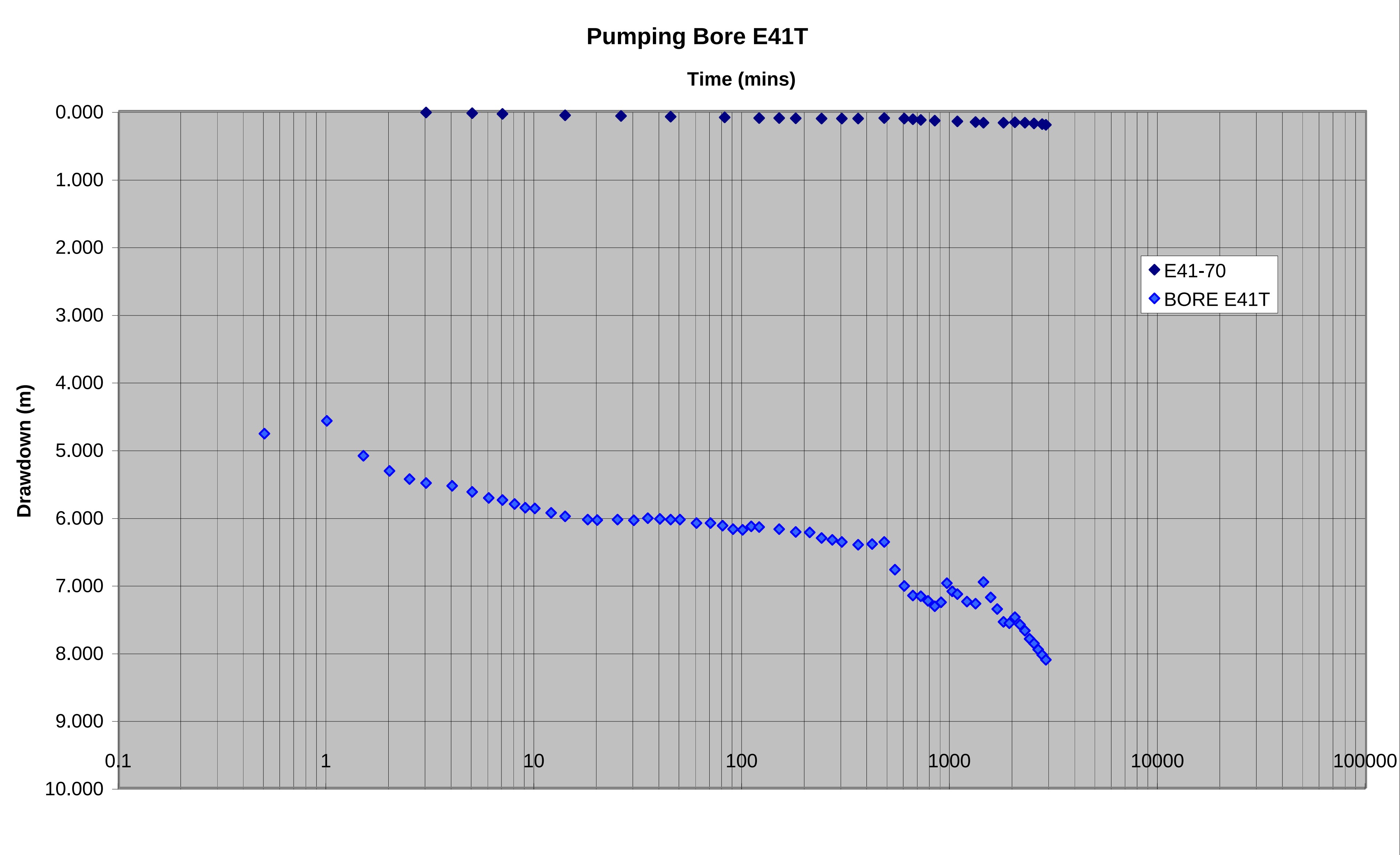
TEST PUMPING DATA FOR THE CHRISTMAS CREEK TRIAL BORES

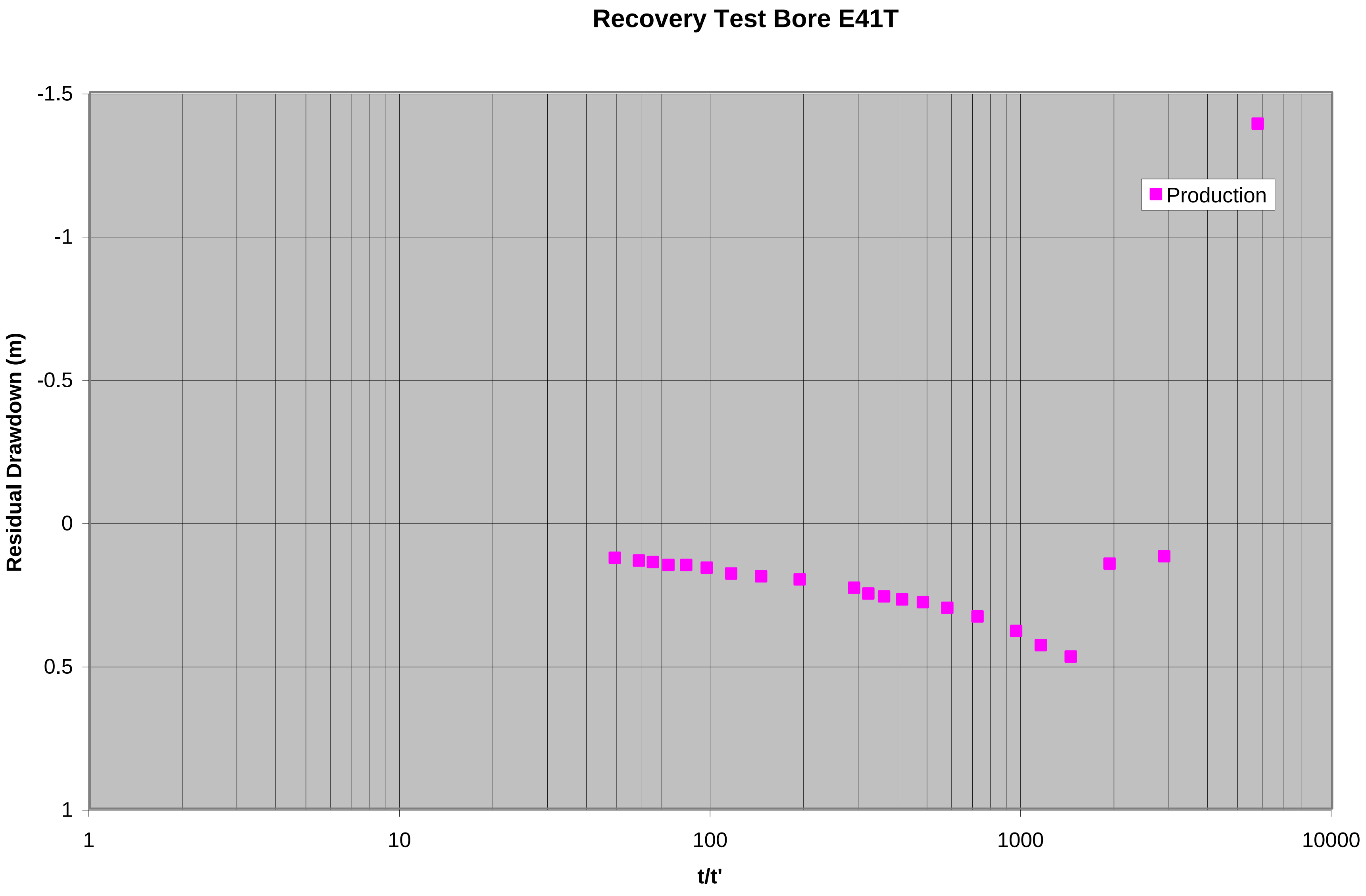

Pumping Bore E02T
Time (mins)
Drawdown (m)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
16.00
17.00
18.00
19.00
20.00
0.1
1
10
100
1000
10000
100000
◆ E2-38
◇ BORE E2T
■ E2-82


Recovery Test Bore E02T
Residual Drawdown (m)
0
0.5
1
1.5
2
2.5
3
1
10
100
1000
10000
t/t'
Production


Pumping Bore E19T
Time (mins)
Drawdown (m)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
16.00
17.00
18.00
19.00
20.00
0.1
1
10
100
1000
10000
100000
◆ E19-80
◇ BORE E19T


Recovery Test Bore E19T
Residual Drawdown (m)
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
1
10
100
1000
10000
t/t'
Production


Pumping Bore E41T
Time (mins)
Drawdown (m)
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
8.000
9.000
10.000
0.1
1
10
100
1000
10000
100000
◆ E41-70
◆ BORE E41T


Recovery Test Bore E41T
Residual Drawdown (m)
-1.5
-1
-0.5
0
0.5
1
1
10
100
1000
10000
t/t'
Production

APPENDIX G

CONDUCTIVITY AND TEMPERATURE DATA FOR THE CHRISTMAS CREEK BORES

WESTLOG WIRELINE SERVICES

HOLE NO. E02T

LOGGED 14/04/05 at 10:05

COMPANY FORTESCUE METALS
AREA LEWIN
PROSPECT
OPERATOR TONY

DRILLING DATA

PERM DAT GL
ELEV
AZIMUTH
INCLIN
HOLE POS
HOLE DIA
DEPTH

CASING DATA

CASE-TYP PVC
CASE-DTH 75 M
CASE-DIA
CASE-THK

FLUID DATA

FLD TYPE WATER
FLUIDLEV
LOGTYPE TD+5

TOOL: Tmrg--Merged Log
Serial Number: A637
Spacer (cm) : n/a

CHANNEL DATA

CHANNEL	AMPLITUDE	RANGE	CHART	AREA	SENSOR OFFSET	FILTER CNST	PLOT TYPE
1 - INDUCTION	0 -	1000	7.0 -	17.0	100	1.0	1
2 - TEMPERATURE de	25.0 -	35.0	0.0 -	5.0	48	1.0	1

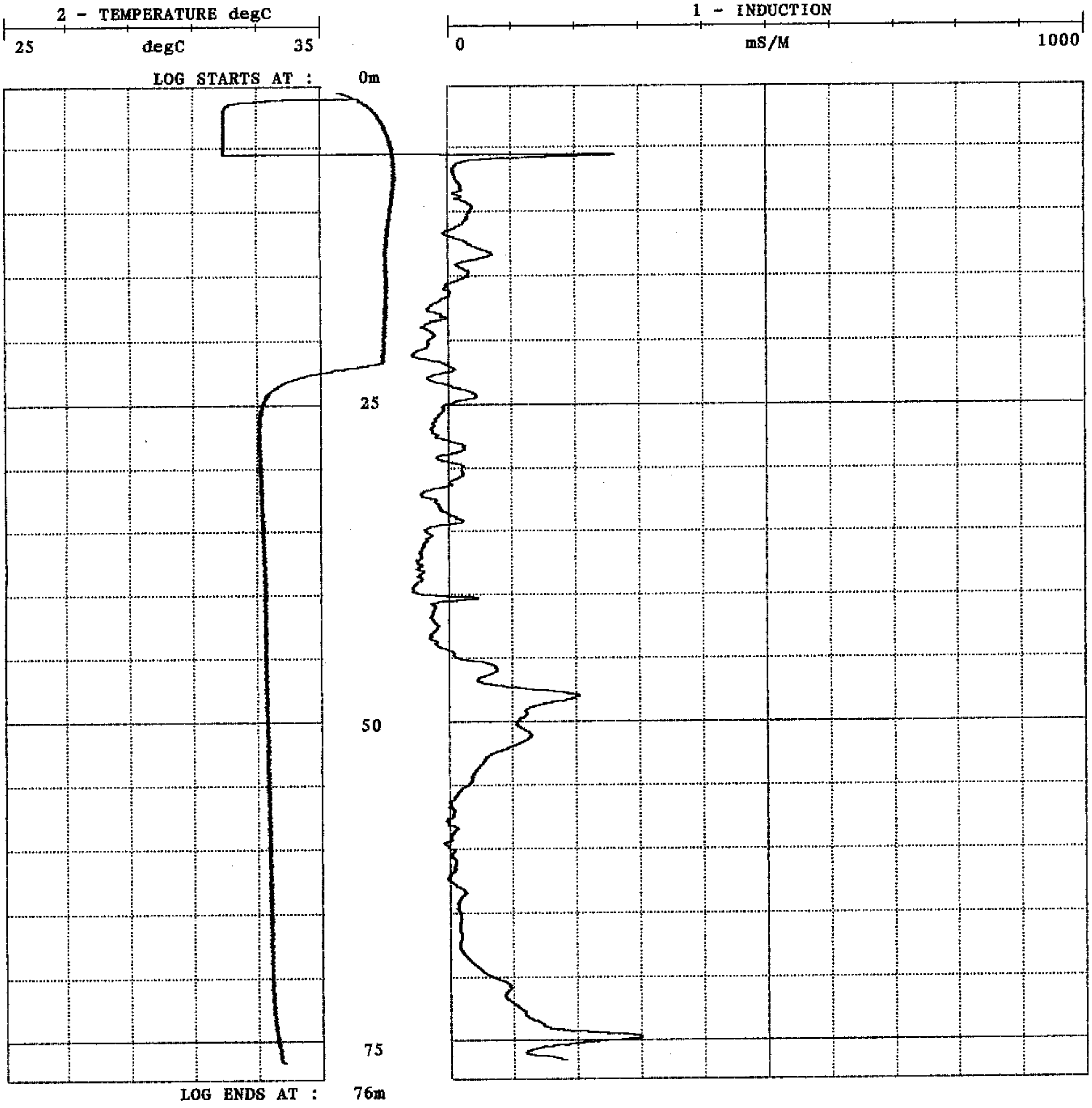
CALIBRATION DATA

CHANNEL	units	slope	offset	C1	C2	C3	C4
1 - INDUCTION	mS/M	1.000000	30	0.000	-1.00	INDN	LOK
2 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602

Log No. FILENAME
1 - E02TI 0
2 - E02TT 1

REPLAY of C:\LOGS\Merge Log at 12:55 on 19/04/05

SCALE: 1 TO 500
using
DEPTH CORRECTION



WESTLOG WIRELINE SERVICES

HOLE NO. E19T

LOGGED 14/04/05 at 08:43

COMPANY FORTESCUE METALS
AREA LEWIN
PROSPECT
OPERATOR TONY

DRILLING DATA

PERM DAT GL
ELEV
AZIMUTH
INCLIN
HOLE POS
HOLE DIA
DEPTH

CASING DATA

CASE-TYP PVC
CASE-DTH 63 M
CASE-DIA
CASE-THK

FLUID DATA

FLD TYPE WATER
FLUIDLEV
LOGTYPE TD+5

TOOL: Tmrg--Merged Log
Serial Number: A637
Spacer (cm) : n/a

CHANNEL DATA

CHANNEL	AMPLITUDE RANGE	CHART AREA	SENSOR OFFSET	FILTER CNST	PLOT TYPE
1 - INDUCTION	0 - 1000	7.0 - 17.0	100	1.0	1
2 - TEMPERATURE de	25.0 - 35.0	0.0 - 5.0	48	1.0	1

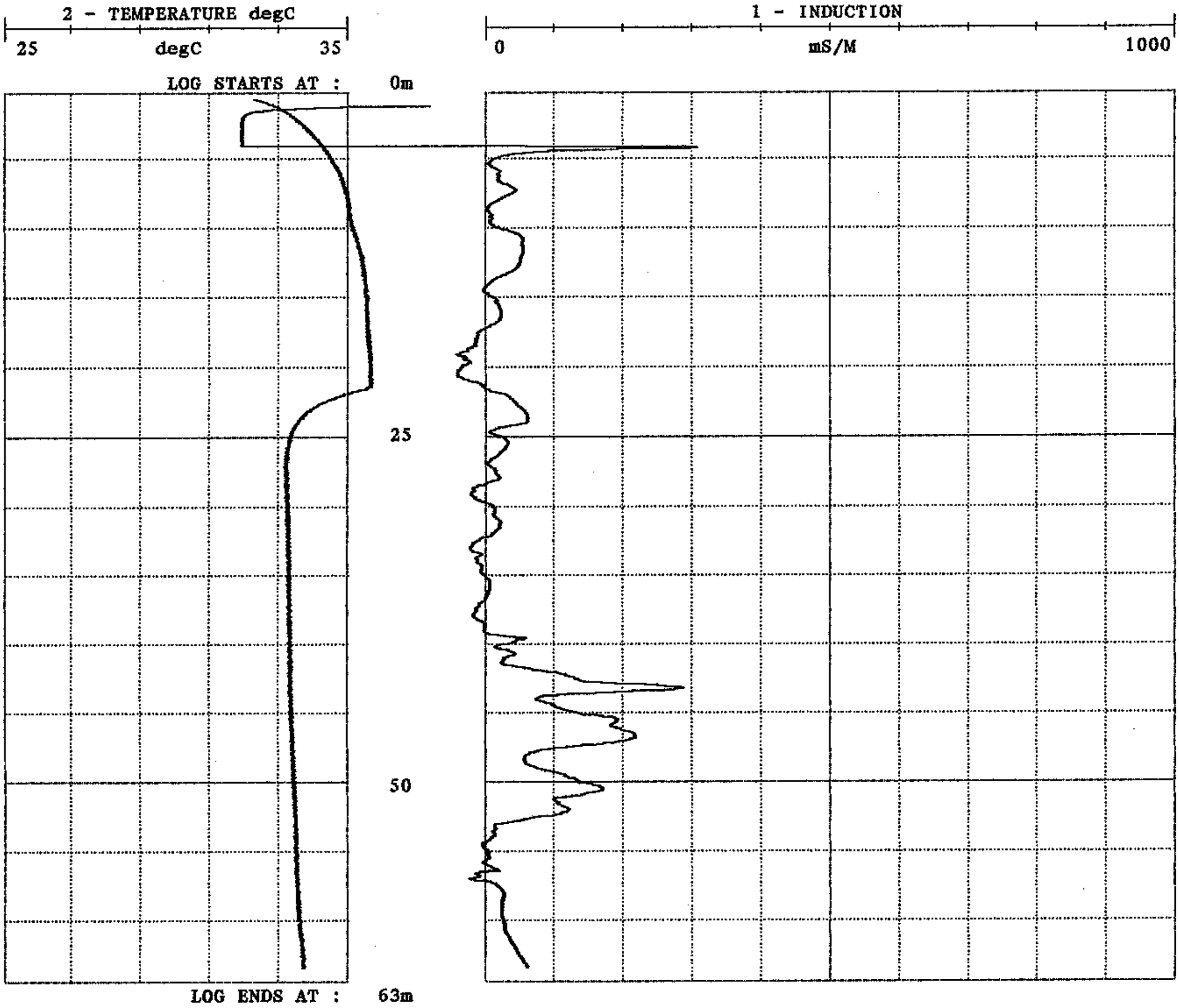
CALIBRATION DATA

CHANNEL	units	slope	offset	C1	C2	C3	C4
1 - INDUCTION	mS/M	1.000000	30	0.000	-1.00	INDN	LOK
2 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602

Log No.	FILENAME	
1 -	E19TI	0
2 -	E19TT	0

REPLAY of C:\LOGS\Merge Log at 10:37 on 19/04/05

SCALE: 1 TO 500
using
DEPTH CORRECTION



WESTLOG WIRELINE SERVICES

HOLE NO. E41T

LOGGED 14/04/05 at

COMPANY FORTESCUE METALS
AREA LEWIN
PROSPECT
OPERATOR TONY

DRILLING DATA

PERM DAT GL
ELEV
AZIMUTH
INCLIN
HOLE POS
HOLE DIA
DEPTH

CASING DATA

CASE-TYP PVC
CASE-DTH 69 M
CASE-DIA
CASE-THK

FLUID DATA

FLD TYPE WATER
FLUIDLEV
LOGTYPE TD+5

TOOL: Tmrg--Merged Log
Serial Number: A637
Spacer (cm) : n/a

CHANNEL DATA

CHANNEL	AMPLITUDE	RANGE	CHART	AREA	SENSOR OFFSET	FILTER CNST	PLOT TYPE
1 - INDUCTION	0 -	1000	7.0 -	17.0	100	1.0	1
2 - TEMPERATURE de	25.0 -	35.0	0.0 -	5.0	48	1.0	1
3 - TEMPERATURE de	25.0 -	35.0	0.0 -	5.0	48	1.0	1

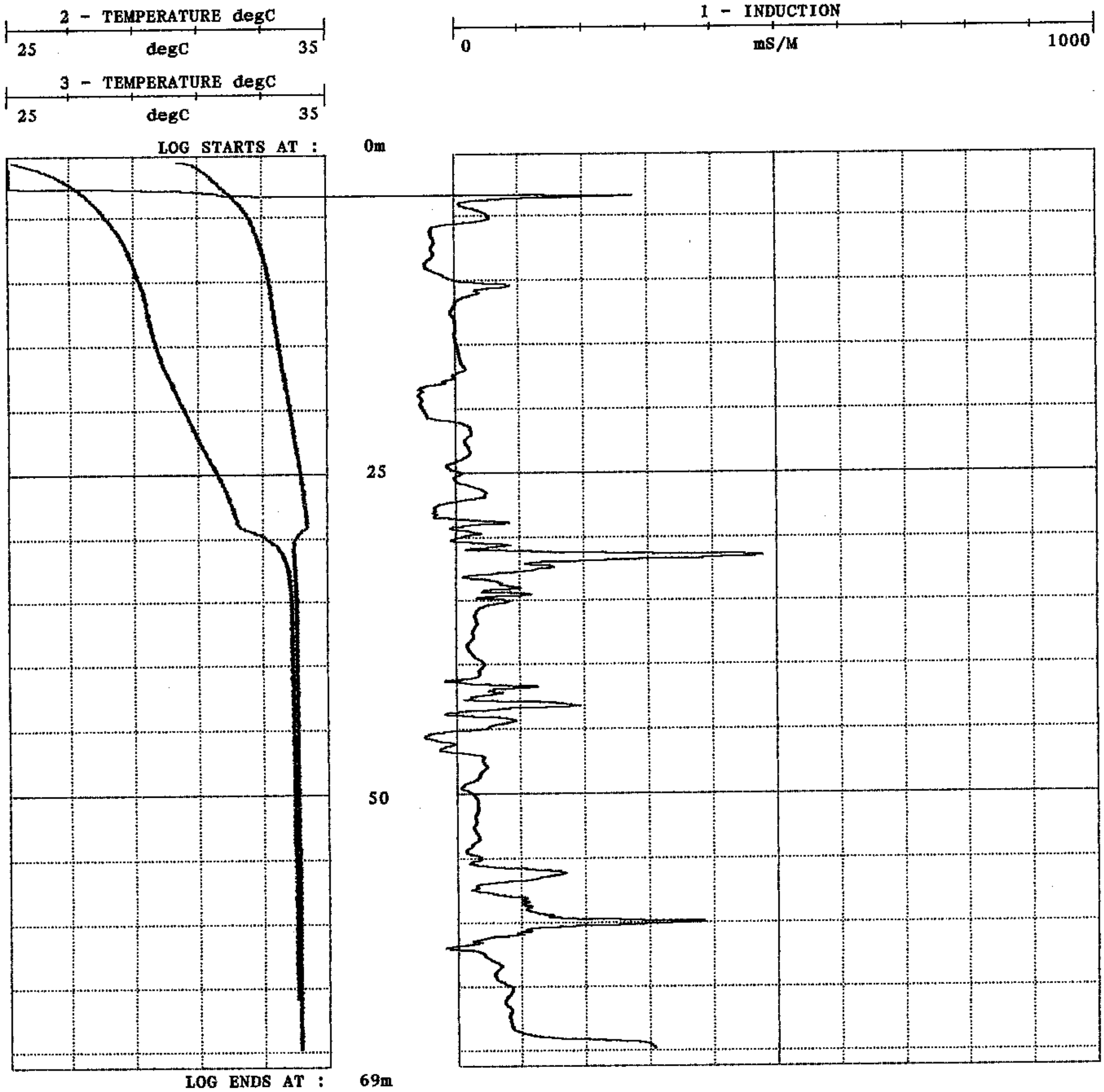
CALIBRATION DATA

CHANNEL	units	slope	offset	C1	C2	C3	C4
1 - INDUCTION	mS/M	1.000000	30	0.000	-1.00	INDN	LOK
2 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602
3 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602

Log No.	FILENAME	
1 -	E41TI	0
2 -	E41TT	0
3 -	E41TT	2

REPLAY of C:\LOGS\Merge Log at 10:27 on 19/04/05

SCALE: 1 TO 500
using
DEPTH CORRECTION



WESTLOG WIRELINE SERVICES

HOLE NO. F02T

LOGGED 14/04/05 at

COMPANY	FORTESCUE METALS
AREA	CHRISTMAS CREEK
PROSPECT	
OPERATOR	TONY

DRILLING DATA

PERM DAT	GL
ELEV	
AZIMUTH	
INCLIN	
HOLE POS	
HOLE DIA	
DEPTH	

CASING DATA

CASE-TYP	PVC
CASE-DTH	96 M
CASE-DIA	
CASE-THK	

FLUID DATA

FLD TYPE	WATER
FLUIDLEV	
LOGTYPE	TD+5

TOOL: Tmrg--Merged Log
Serial Number: A637
Spacer (cm) : n/a

CHANNEL DATA

CHANNEL	AMPLITUDE RANGE	CHART AREA	SENSOR OFFSET	FILTER CNST	PLOT TYPE
1 - INDUCTION	0 - 1000	7.0 - 17.0	100	1.0	1
2 - TEMPERATURE de	25.0 - 35.0	0.0 - 5.0	48	1.0	1
3 - INDUCTION	0 - 5000	7.0 - 17.0	100	1.0	1

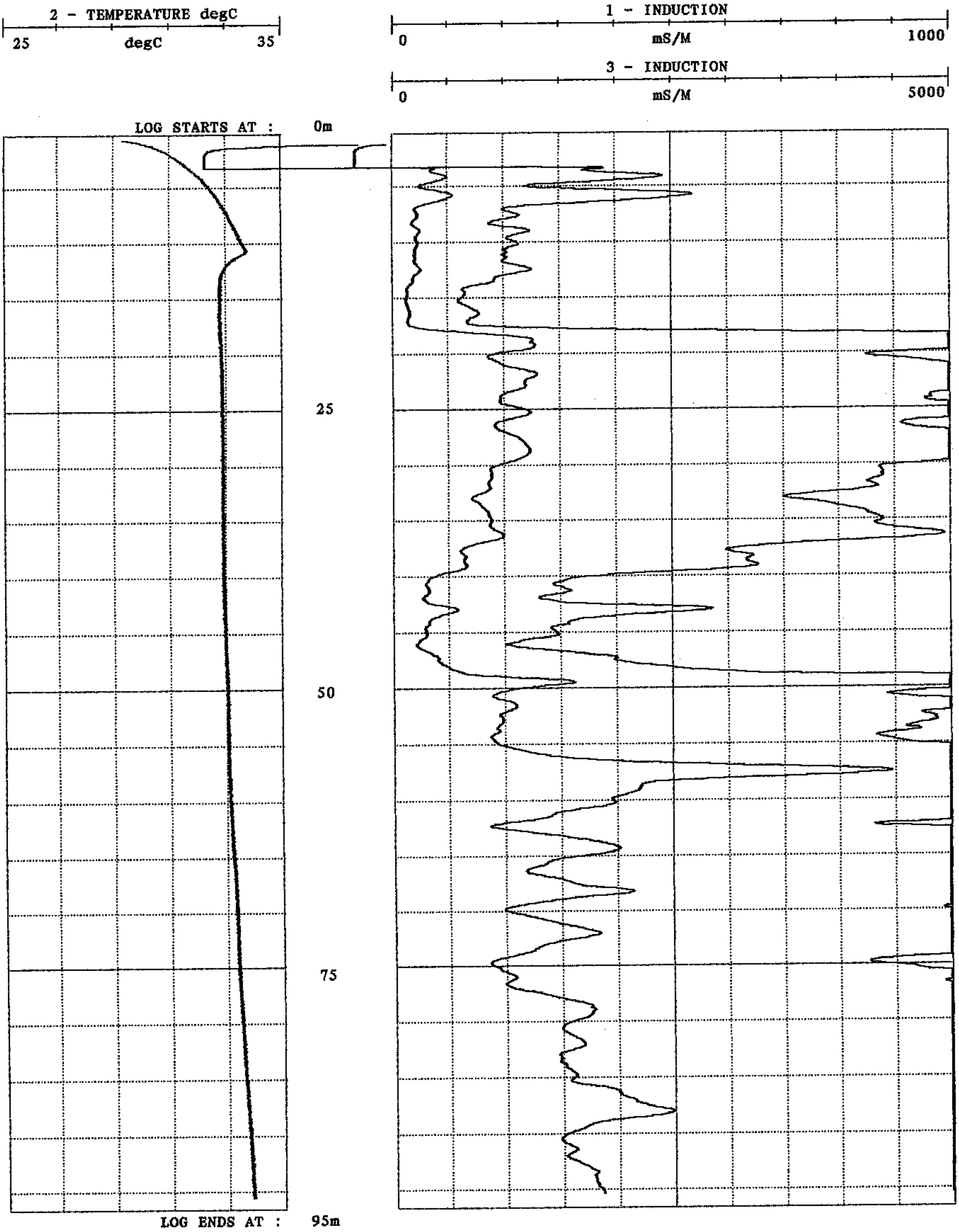
CALIBRATION DATA

CHANNEL	units	slope	offset	C1	C2	C3	C4
1 - INDUCTION	mS/M	1.000000	45	0.000	-1.00	INDN	LOK
2 - TEMPERATURE de	degC	0.056795	-326.939	20.00	6109	48.00	6602
3 - INDUCTION	mS/M	1.000000	45	0.000	-1.00	INDN	LOK

Log No.	FILENAME	
1 -	F02TI	0
2 -	F02TT	0
3 -	F02TI	0

REPLAY of C:\LOGS\Merge Log at 11:46 on 19/04/05

SCALE: 1 TO 500
using
DEPTH CORRECTION



Appendix B

Stygofauna Sampling Programme March 2005

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Appendix B: Fortescue Metals Group: Subterranean Mangement Plan - Bore Data March 2005

Site Code	Date	Site name	Bore use	Depth to water (m)	Depth to bottom (m)	Bore diameter (mm)	Collar type	Casing Type	Cover	Locked	Number of adjacent bores	Infrastructure	Bore Comment
FMG01	11/03/2005	Badgeannah Well	Extraction	7.54	12.5	1500	Concrete	Concrete	Yes	No	0	Active windmill and two storage tanks.	Well in good condition, used for pastoral extraction. Conductivity high @ 10400us/cm.
FMG02	11/03/2005	Twenty Two Bore	Observation	12.94	17	125	None	PVC	No	No	2	Unused windmill.	Dead vertebrate in bore, ORP negative value, O2 low. Requires purge and capping.
FMG03	11/03/2005	WSE061	Observation	20.88	48	50	PVC	PVC	Yes	No	0		Kink in bore, had to use bailer to extract H2O for in-situ readings, otherwise good condition.
FMG04	11/03/2005	Limestone Bore	Extraction	5.7	31	125	None	PVC	No	No	1	Solar pump down hole, not active.	Bore condition generally good BUT full of reptile eggs and frogs. Suggest bore has been anoxic but has recovered. Requires capping. (may be difficult with solar pump in bore).
FMG05	11/03/2005	Sausage Bore	Observation	7.63	32	125	PVC	PVC	No	No	0		Bore in good condition but requires capping.
FMG06	11/03/2005	Kullawarri Well	Observation	6.31	21	125	None	PVC	Yes	No	1	Abandoned mill on nearby collapsed well.	Frogs in bore, otherwise in good condition..
FMG07	11/03/2005	Mt. Lewin Drillers Bore	Extraction	21.77	27	125	None	PVC	Yes	No	1	None; Ex mine camp extraction bore.	Bore in good condition.
FMG08	12/03/2005	Seventeen Mile	Extraction	7.42	10	125	Steel	Steel	No	No	0	Abandoned mill	Bore in poor condition, casing severely corroded and collapsing. Suggest find alternative bore.
FMG09	12/03/2005	Old Bore	Extraction	9.56	17	125	Steel	Steel	No	No	0	Abandoned mill	Kink in bore @ 25m, use smaller net when sampling bore. Otherwise in good condition but requires capping.
FMG10	12/03/2005	Edenholme Bore	Observation	11.25	25	150	PVC	PVC	Yes	No	1	Mill on nearby bore	Bore in good condition.
FMG11	12/03/2005	Near Mt. McKay	MRD Extraction	1.71	43	150	Concrete	PVC	No	No	0	None	Dead vertebrate in water, Negative ORP, 0% O2, water anoxic. Requires purging and capping.
FMG12	12/03/2005	Bonney Downs	MRD extraction	9.53	59	150	concrete	PVC	No	No	0	No infrastructure	Bore in good condition but requires capping.
FMG13	12/03/2005	Dandy Well	Extraction	2.56	5	1500	concrete	none	No	No	0	Active mill, tank and trough.	Well in good condition with tin sheet for lid. Stygofauna in sample.
FMG14	12/03/2005	Knuckleduster Bore	Extraction	13.7	17.5	100	concrete	fibro cement	Yes	No	0		Bore in good condition, Stygofauna in sample.
FMG15	12/03/2005	Eaton Bore	Observation	15.71	19	150	None	P.V.C.	Yes	No	1	None but mill over adjacent well.	Bore in good condition.
FMG16	12/03/2005	Six Mile Bore	Observation	11.67	25	150	Steel	P.V.C.	No	No	1	None but solar pump on nearby bore.	Bore Anoxic with negative ORP and 0% O2. Dead vertebrate in bore. Requires purging and capping.
FMG17	13/03/2005	Twenty Two Mile	Ex extraction	13.15	27	100	P.V.C.	Steel	No	No	0	None, abandon mill	Bore full off recently killed frogs. Negative ORP, 0% O2 and smell of machine oil in bore. CONTAMINATED. Requires purging and capping.
FMG18	13/03/2005	F7A	Observation	14.17	79	50	P.V.C.	P.V.C.	Yes	No	1	None	Bore in good condition but CONTAMINATED with machine oil. Requires purging.
FMG19	13/03/2005	F1A	Observation	8.67	55	50	P.V.C.	P.V.C.	Yes	No	1	None	Bore in good condition but CONTAMINATED with machine oil. Requires purging
FMG20	13/03/2005	Shingles Bore	Observation	25.84	45	125	None	Steel	No	No	1	None. Solar pump on adjacent bore.	Bore in good condition but require capping.
FMG21	13/03/2005	Old Waterloo Bore	Ex extraction	30.38	42	125	Concrete	P.V.C.	No	No	0	None. Abandon mill, tanks and troughs.	Bore condition below average, corrosion evident but not severe. Requires capping.
FMG22	13/03/2005	Freds Bore	Oservation	29.11	33	125	Concrete	Steel	No	No	0	None. Solar mill on nearby well.	Bore has minimal corrosion but requires capping.
FMG23	13/03/2005	MM007	Observation	19.53	22	125	P.V.C.	None	No	No	0	None	Requires casing and capping. Water very turbid.
FMG24	13/03/2005	Corktree Bore	Observation	7.18	30	125	Concrete	P.V.C.	No	No	1	None but mill on nearby bore.	Dead vertebrate in bore, negative ORP and 0% O2. Bore requires purging and capping.
FMG25	14/03/2005	Mulga Bore	Observation	6.05	9.5	200	Steel	None	No	No	1	None, mill abandon.	Bore requires casing and capping.
FMG26	14/03/2005	Cook Bore	Observation	5.21	10	125	None	P.V.C.	No	No	0	Mill abandon.	Bore requires capping otherwise in good condition. Stygofauna in sample.
FMG27	14/03/2005	CDBB128	Observation	21.51	67	150	P.V.C.	None	Yes	No	1	None	Bore requires casing. Water very turbid otherwise in good condition.
FMG28	14/03/2005	Minga Well	Extraction	4.83	7	1200	Concrete	None	Yes	No	0	Mill with adjacent tank.	Well in good condition.

Appendix B: Fortescue Metals Group: Subterranean Management Plan - Field Chemistry March 2005

Site Code	Date	Field Conductivity (us/cm)	Field Salinity (ppt)	Field pH	Temperature	Oxygen (%)	Oxygen (mg/L)	Turbidity (NTU)	Redox (mV)	Comments
FMG01	11/03/2005	10400	5.84	6.67	26.54	40	3.1	70.5	579	Conductivity was over max range; 10.4 mS/cm.
FMG02	11/03/2005	6558	3.61	7.21	27.91	18.6	1.6	258.8	-343	
FMG03	11/03/2005	2118	1.07	6.65	0	55.7	4	-9999	337	Kink in bore disallowed Yeo Kal meter to reach water table in situ. Readings are from water capture by a bailer and brought to the surface. Turbidity was over max range. Temperature not recorded.
FMG04	11/03/2005	1573	0.78	6.98	30.56	7.1	0.5	222.5	366	
FMG05	11/03/2005	1636	0.82	6.72	29.55	2.9	0.2	132.2	415	
FMG06	11/03/2005	1039	0.5	7.24	28.4	67.3	5.2	77.7	381	
FMG07	11/03/2005	1280	0.62	7.11	30.33	20.9	1.6	-9999	433	Turbidity over maximum range.
FMG08	12/03/2005	7683	4.25	6.54	28.86	4.3	0.3	183.6	-6	
FMG09	12/03/2005	579	0.28	7.41	28.51	2.8	0.2	101.2	35	
FMG10	12/03/2005	615	0.31	7.33	28.61	82.5	6.4	73.8	482	
FMG11	12/03/2005	4722	2.5	7.02	30.54	1.4	0.1	84.7	-443	Dead animal in bore when sample taken.
FMG12	12/03/2005	561	0.28	7.01	29.83	5.3	0.4	135.5	32	
FMG13	12/03/2005	1785	0.89	6.99	28.8	26.5	2	91.5	2.2	
FMG14	12/03/2005	5500	2.96	6.98	30.25	60.2	4.4	111.1	238	
FMG15	12/03/2005	3029	1.57	6.86	29.4	80	6.1	-9999	297	Turbidity maxed out.
FMG16	12/03/2005	3976	2.08	6.97	30.1	1.1	0.1	194.2	-441	Dead varanus in hole.
FMG17	13/03/2005	1033	0.53	7.23	27.98	0.8	0.1	107.2	-201	2 x 250ml water taken for centrifuge (nutrients) - machine oil contamination.
FMG18	13/03/2005	1278	0.63	6.47	29.11	84.1	6.4	75.3	384	Slight machine oil smell.
FMG19	13/03/2005	3505	1.82	6.94	28.84	79.6	6.1	80	466	
FMG20	13/03/2005	358	0.16	7.56	29.48	2	0.1	330.5	344	
FMG21	13/03/2005	1363	0.68	6.37	29.47	16.3	1.2	188.8	425	
FMG22	13/03/2005	429	0.21	6.68	29.19	2.3	0.2	272.6	-71	
FMG23	13/03/2005	2571	1.33	6.02	29.17	92.7	7.2	-9999	464	Turbidity over max range due to uncased bore.
FMG24	13/03/2005	1164	0.58	6.92	29.51	3	0.2	206	-92	Bore very silty with strong organic smell.
FMG25	14/03/2005	3357	1.75	6.87	30.09	6.2	0.5	111.2	537	Bore not cased and water very silty.
FMG26	14/03/2005	9900	5.55	7.26	31.08	7.9	0.6	31.5	479	
FMG27	14/03/2005	2424	1.24	9.02	30.39	8.1	0.6	-9999	374	Bore not cased and very silty, turbidity maxed out at 600+.
FMG28	14/03/2005	1646	0.83	7.71	27.97	80.9	6.3	79	427	

Appendix B: Fortescue Metals Group: Subterranean Management Plan - Invertebrate Data March 2005

Site Code	Class	Order	Family	Genus	Lowest	Number identified	LogAbund	ID by	Comments
FMG01	Crustacea	Amphipoda	Paramelitidae	-	Paramelitidae	1	1	MDS	Immature, too small to ID
FMG01	Crustacea	Copepoda	Cyclopidae	Diacyclops	Diacyclops humphreysi humphreysi	4	1	JSC	Slide STY174
FMG01	Oligochaeta	Tubificida	Enchytraeidae	-	Enchytraeidae PST1	11	2	AMP	Slide CLM122
FMG01	Crustacea	Spelaeogriphacea	-	-	Spelaeogriphacea	1	1	MDS	Lost 1 in mint condition, other one in poor condition
FMG01	Crustacea	Copepoda	Canthocamptidae	Elaphoidella	Elaphoidella sp.	6	1	JSC	Slide STY172
FMG02	Nematoda	-	-	-	Nematoda sp. 1	1	1	MDS	Rat Tailed Species, drawn previously, Slide CLM123
FMG03	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	JSC	-
FMG04	Oligocheata	Tubificida	Phreodrilidae	Phreodrilus	Phreodrilus peniculus	1	1	AMP	-
FMG04	Nematoda	-	-	-	Nematoda	1	1	MDS	-
FMG05	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	JSC	-
FMG06	Crustacea	Amphipoda	Paramelitidae	Pilbarus	Pilbarus millsi	1	1	JSC	-
FMG06	Oligochaeta	Tubificida	Enchytraeidae	-	Enchytraeidae PST1	3	1	AMP	-
FMG06	Crustacea	Amphipoda	Bogidellidae	-	Bogidellidae	2	1	JSC	-
FMG06	Crustacea	Copepoda	-	-	Cyclopoida	1	1	JSC	Juvenile
FMG07	Oligochaeta	Tubificida	Enchytraeidae	-	Enchytraeidae PST1	7	1	AMP	-
FMG08	Arachnida	Acariformes	-	-	Oribatida group 4	1	1	JSC	Group 4. Slide STY154
FMG09	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	JSC	-
FMG10	Crustacea	Ostracoda	-	-	Ostracoda (Unident.)	1	1	MDS	Half shell only
FMG11	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	MDS	-
FMG12	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	JSC	-
FMG13	Polychaeta	-	Nereidae	-	Nereidae	1	1	MDS	Excellent condition.
FMG13	Crustacea	Ostracoda	-	-	Ostracoda (Unident.)	69	3	MDS	Not all picked, whole animals
FMG13	Crustacea	Copepoda	Cyclopidae	Microcyclops	Microcyclops varicans	14	2	JSC	Slides STY175 & STY176
FMG13	Oligocheata	Tubificida	Phreodrilidae	Phreodrilus	Phreodrilus peniculus	5	1	AMP	-
FMG13	Oligochaeta	Tubificida	Phreodrilidae	-	Phreodrilid with bifid ventral chaetae	1	1	AMP	-
FMG13	Crustacea	Amphipoda	Paramelitidae	Pilbarus	Pilbarus millsi	14	2	MDS	No sternal gills
FMG14	Crustacea	Copepoda	Ameiridae	Abnitocrella	Abnitocrella sp.	3	1	JSC	Possibly Newmani but need to check. Slide STY173.
FMG14	Crustacea	Isopoda	Tainisopidae	Pygolabis	Pygolabis sp. 3	3	1	MDS	-
FMG14	Crustacea	Amphipoda	Paramelitidae	Pilbarus	Pilbarus millsi	26	2	MDS	All small but no sternal gills

Appendix B: Fortescue Metals Group: Subterranean Management Plan - Invertebrate Data March 2005

Site Code	Class	Order	Family	Genus	Lowest	Number identified	LogAbund	ID by	Comments
FMG14	Crustacea	Ostracoda	-	-	Ostracoda (Unident.)	48	3	MDS	Mostly shells, some whole but not all picked
FMG14	Oligocheata	Tubificida	Phreodrilidae	Phreodrilus	Phreodrilus peniculus	62	3	AMP	Not all picked. Slide # CLM121
FMG14	Rotifera	Bdelloidea	-	-	Bdelloidea	1	1	MDS	Lost in melt.
FMG15	Oligochaeta	Tubificida	Enchytraeidae	-	Enchytraeidae PST1	2	1	AMP	Immature and fragments only
FMG15	Crustacea	Ostracoda	-	-	Ostracoda (Unident.)	8	1	MDS	1 whole animal and shells.
FMG15	Crustacea	Amphipoda	Paramelitidae	Pilbarus	Pilbarus millsi	8	1	MDS	No sternal gills.
FMG15	Crustacea	Syncarida	Parabathynellidae	-	Parabathynellidae	3	1	MDS	in excellent condition.
FMG16	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	MDS	-
FMG17	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	JSC	-
FMG18	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	JSC	-
FMG19	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	JSC	-
FMG20	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	JSC	-
FMG21	Oligochaeta	Tubificida	Phreodrilidae	-	Phreodrilid with bifid ventral chaetae	13	2	AMP	Same as species at FMG 13 but not peniculus.
FMG21	Crustacea	Ostracoda	-	-	Ostracoda (Unident.)	8	1	MDS	Whole animals and half shells.
FMG22	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES		0	JSC	-
FMG23	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	JSC	-
FMG24	Crustacea	Ostracoda	-	-	Ostracoda (Unident.)	2	1	JSC	2 whole animals plus 19 half shells.
FMG25	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	JSC	-
FMG26	Crustacea	Copepoda	Cyclopidae	Diacyclops	Diacyclops humphreysi humphreysi	29	2	JSC	Slide STY140
FMG26	Crustacea	Amphipoda	Paramelitidae	Pilbarus	Pilbarus millsi	43	2	JSC	No sternal gills, 3 accessory flagella, very small
FMG26	Crustacea	Copepoda	Ameiridae	Parapseudoleptomesochra	Parapseudoleptomesochra 'tureei'	39	2	JSC	Slide STY139
FMG27	NO CLASS	NO ORDER	NO FAMILY	NO GENUS	NO INVERTEBRATES	0	0	JSC	-
FMG28	Crustacea	Copepoda	Cyclopidae	Microcyclops	Microcyclops varicans	18	2	JSC	-
FMG28	Crustacea	Ostracoda	-	-	Ostracoda (Unident.)	35	2	MDS	2 morphotypes, one possibly surface water.
FMG28	Oligocheata	Tubificida	Phreodrilidae	Phreodrilus	Phreodrilus peniculus	3	1	AMP	-

Appendix C

Railway Alternatives

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APPENDIX C: RESOURCE, ACCESS, ECONOMIC, ENGINEERING AND ENVIRONMENTAL ASSESSMENT OF RAIL ALTERNATIVES

ROUTE	1	2	3	4	5	6	7
RESOURCE							
Access to FMG resources (Christmas Creek, Cloud Break)	5 km spur required to access Christmas Creek	Direct access to all resources	Direct access to all resources	3.4 km conveyor or haul road required to access Cloud Break (see Figure 1)	longer conveyor or haul road required to access Cloud Break (see Figure 1)	longer conveyor or haul road required to access Cloud Break (see Figure 1)	longer conveyor or haul road required to access Cloud Break (see Figure 1)
Efficient transport of resources	Extra step in materials handling may cause lump product degradation	Minimum use of conveyors	Loading and unloading of dump trucks may cause further lump product degradation	Even longer conveyors or loading and unloading of dump trucks may cause further lump product degradation	Even longer conveyors or loading and unloading of dump trucks may cause further lump product degradation	Even longer conveyors or loading and unloading of dump trucks may cause further lump product degradation	Extremely inefficient due to transporting all ore from eastern end of Chichester Range south to Mindy Mindy
ACCESS							
Underlying tenure	Crosses Mulga Downs, Marillana, Roy Hill stations	Crosses Mulga Downs, Marillana, Roy Hill stations. *Railway and Port (The Pilbara Infrastructure Pty Ltd) Agreement Act 2004* includes this route.	Crosses Mulga Downs, Marillana, Roy Hill stations	Crosses Mulga Downs, Marillana, Roy Hill stations	Crosses Mulga Downs, Marillana, Roy Hill Stations but dissects Hillside Station; adverse impact on stock route from Hillside towards Warrie Camp area	Crosses Mulga Downs, Marillana, Roy Hill Stations but dissects Hillside Station	Crosses Marillana, Roy Hill stations
Traditional owners (Native Title Claimants)	Crosses Native Title Claims by Palyku and Nyiyaparli People	Crosses Native Title Claims by Palyku and Nyiyaparli People. Assessed in detail.	Crosses Native Title Claims by Palyku and Nyiyaparli People	Crosses Native Title Claims by Palyku and Nyiyaparli People	Crosses Native Title Claims by Palyku and Nyiyaparli People	Crosses Native Title Claims by Palyku and Nyiyaparli People	Crosses Native Title Claims by Palyku and Nyiyaparli People
Cultural heritage	FMG has agreed with the traditional owners to avoid and protect *Millimpirinyha* (the Fortescue Marsh)	Agreement in principle with the traditional owners	Agreement in principle with the traditional owners	Agreement in principle with the traditional owners	Agreement in principle with the traditional owners	Agreement in principle with the traditional owners	Natural features of the Fortescue Plain are potentially ethnographic sites.
ECONOMIC							
Capital Costs (CAPEX) to Christmas Creek							
Length of new rail line (from Stage A line to Christmas Creek) (km) **Start point = Stage A tie-in**	141 (from "start point"[1])	135 (from "start point"[1])	111 (from "start point"[1])	109 (from "start point")	131 (from "start point")	118 (from "start point")	113 (from bend near Mindy Mindy)
Elevation (mAHD)[2]	516	516	469	482	472	487	516
Capital cost[3] (from Stage A line to Christmas Creek) ($M)	238	250	181	190	321	226	242-315
Operating Costs (OPEX) to Christmas Creek							
Travel distance from "start point" to Christmas Creek (km)	125	120	111	109	131	118	232
Additional cycle time to Christmas Creek relative to fastest cycle time (h)	0.4	0.3	0	0	0.5	0	4
Additional fuel usage per annum relative to lowest fuel use (ML)	~ 2	0	0	~ 2	~ 2	~ 2	~ 14
Additional rail equipment required	Additional locomotive needed			Additional locomotive needed			
ENGINEERING							
Additional complete crossings of Chichester Range	0	0	0	0	0	0	0
Cut and fill	Cut and fill required for ~45 km between junction with north-south line and footslopes, then fill the full length of Fortescue Marsh	Cut and fill required for ~55 km between junction with north-south line and footslopes	Cut and fill required for ~30 km between junction with north-south line and footslopes	Cut and fill required for ~40 km between junction with north-south line and footslopes	Cut and fill required for ~30 km between junction with north-south line and footslopes	Cut and fill required for ~40 km between junction with north-south line and footslopes	Fill required across Fortescue River flood plain
Borrow areas	Very large borrow areas would be needed, potentially impacting the Fortescue Marsh	Any excess fill could potentially come from borrow areas that may later be mined in the Cloud Break area	Excess fill most likely to come from borrow areas that would otherwise not be impacted	Excess fill most likely to come from borrow areas that would otherwise not be impacted	Excess fill most likely to come from borrow areas that would otherwise not be impacted	Excess fill most likely to come from borrow areas that would otherwise not be impacted	Large borrow areas would be needed, potentially impacting the Fortescue Marsh

ROUTE	1	2	3	4	5	6	7
Access to Cloud Break by Conveyor							
Additional infrastructure to access Cloud Break	None	None	None	Conveyor 3.4 km long	None	None	None
Additional capital cost [4] to access Cloud Break ($M)	10	0	0	91-118	0	0	0
Total capital cost[1] (Stage A to Christmas Creek, and Cloud Break) ($M)	0	0	0	244-317	0	0	0
Additional distance, fuel to Cloud Break	0	0	0	More due to conveyor (3.4km)	None	None	None
Access to Cloud Break by Haul Roads							
Additional infrastructure to access Cloud Break	None	None	None	None	60 km haul road	60 km haul road	60 km haul road
Additional capital cost[4] to access Cloud Break ($M)	0	0	0	0	18-23	18-23	18-23
Operating cost per annum to access Cloud Break[5] ($M)	0	0	0	0	111	111	111
Number of road trains required	0	0	0	0	95	95	95
Number of drivers required	0	0	0	0	272	272	272
ENVIRONMENTAL ISSUES							
Impact on Mulga Communities (ha) (Based on rangeland mapping							
Plains fringing the Marsh land system and supporting snakewood and mulga shrublands with some halophytic undershrubs (RGECWA)	198	-	-	-	-	-	-
Hardpan plains and gilgai plains supporting groved mulga shrublands and minor tussock grasslands (RGEFAN)	-	-	-	-	-	-	29
Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey (RGEJAM)	43	174	125	66	67	104	163
Gravelly plains with large drainage foci and unchannelled drainage tracts supporting snakewood shrublands and grassy mulga shrublands (RGEMRA)	-	-	-	-	-	-	62
Alluvial wash plains with prominent internal drainage foci supporting snakewood and mulga shrublands with halophytic low shrubs (RGENAB)	-	-	-	-	-	-	62
Hardpan plains supporting groved mulga shrublands (RGEWSP)		-	-	-	-	-	
TOTAL DISTURBANCE - LAND SYSTEMS CONTAINING MULGA (ha)	**241**	**174**	**125**	**66**	**67**	**104**	**316**
Disturbance of Vegetation other than Mulga, for alternative rail routes (ha) (based on rangeland mapping)							
Stony plains and low silcrete hills supporting hard spinifex grasslands (RGEADR)	-	-	-	-	-	-	18
Linear ridges of dolerite or basalt supporting hard spinifex grasslands, with unvegetated rock piles along summits (RGEBLK)	-	-	-	-	2	2	-
Low rounded hills and undulating stony plains supporting soft spinifex grasslands (RGEBNY)	-	-	-	-	-	16	-
Flood plains with weakly gilgaied clay soils supporting coolibah woodlands with tussock grass understorey (RGECOB)	-	-	-	-	-	-	17
Hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grasslands (RGECPN)	33	33	-	-	-	-	

ROUTE	1	2	3	4	5	6	7
Sandplains and occasional dunes supporting shrubby hard spinifex grasslands (RGEDIV)			-	-	-	-	52
Rugged granitic hills supporting shrubby hard and soft spinifex grasslands (RGEGRC)	28	28	38	38	140	60	-
Stony plains and occasional tor fields based on granite supporting hard and soft spinifex grasslands (RGEMAC)	38	38	84	88	198	198	-
Hills, ridges, plateaux remnants and breakaways of metasedimentary and sedimentary rocks supporting hard spinifex grasslands (RGEMCK)	49	48	16	109	14	39	
Lake beds and flood plains subject to regular inundation supporting samphire shrublands, salt water couch grasslands and halophytic shrublands (RGEMSH)	27	-	-	-	-	-	-
Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands (RGENEW)	21	51	65	44	59	62	50
Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands (RGERIV)	-	-	-	-	4	3	-
Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands (RGEROB)	-	-	2	4	2	2	-
Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands (RGEROC)	10	10	38	38	56	43	-
Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands (RGETLG)	-	-	8	8	24	25	-
Stony alluvial plains with gilgaied and non-gilgaied surfaces supporting tussock grasslands and grassy shrublands (RGETUR)	69	111	107	87	129	114	149
Stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands (RGEURY)	-	-	-	-	-	-	7
Stony gilgai plains supporting tussock grasslands and hard spinifex grasslands (RGEWHS)	-	-	-	-	6	6	-
Basalt upland gilgai plains supporting tussock grasslands and minor hard spinifex grasslands (RGEWON)	46	46	-	-	13	5	-
TOTAL DISTURBANCE - LAND SYSTEMS NOT CONTAINING MULGA (ha)	**321**	**365**	**358**	**416**	**647**	**575**	**258**
Total Disturbance							
Overall Land disturbance[6]	564	540	483	482	714	679	574
Additional land disturbance[7]due to conveyors, access roads, laydown areas etc. to access Cloud Break (ha)	0	0	0	0	0	0	0
Total land disturbance (Stage A to Mt Nicholas and Cloud Break, including conveyors etc.) (ha)	0	0	0	0	0	0	0
Hydrological							
Hydrological impacts in Chichester Range	Least additional impact	Least additional impact	Impacts on drainage patterns along a complete crossing of Chichester Range	Impacts on drainage patterns along a complete crossing of Chichester Range	Impacts on drainage patterns along a complete crossing of Chichester Range	Impacts on drainage patterns along a complete crossing of Chichester Range	Not applicable

ROUTE	1	2	3	4	5	6	7
Hydrological impacts on mulga groves	Higher risk from point of view that flows needing to pass through culverts would be greater; risk of flooding	Culverts required to pass flow and re-establish sheet flow along 44.4 km of linear infrastructure	Culverts required to pass flow and re-establish sheet flow along 30.3 km of linear infrastructure	Culverts required to pass flow and re-establish sheet flow along 9.5 km of linear infrastructure	Culverts required to pass flow and re-establish sheet flow along 5.2 km of linear infrastructure	Culverts required to pass flow and re-establish sheet flow along 5.3 km of linear infrastructure	Culverts required to pass flow and re-establish sheet flow in areas where mulga groves could be affected
Hydrological impacts on Fortescue Marsh and Fortescue River	Closest to Marsh, with consequent risks	Negligible impacts	Negligible impacts	Negligible impacts	Negligible impacts	Negligible impacts	Effectively dams Fortescue River over 3 km wide floodplain
Impact on Vegetation Types							
Summary of Vegetation types	Samphire zone and fringing mulga above Fortescue Marsh	Mulga groves and grasslands, plus other communities in Chichester Range	Mulga groves and grasslands, plus other communities in Chichester Range	Mulga groves and grasslands, plus other communities in Chichester Range	Mulga groves and grasslands, plus other communities in Chichester Range	Mulga groves and grasslands, plus other communities in Chichester Range	Mulga groves between Roy Hill and Christmas Creek
Direct impact on mulga (including conveyors etc.) (ha)	198	0	0	0	0	0	124
Direct impact on mulga groves (including conveyors etc.) (ha)	43	174	125	66	67	104	192
Impacts on small land systems (LS) (with potentially restricted vegetation)	Impacts Cowra (small mulga-containing LS) and Marsh (samphire-containing LS surrounding the Fortescue Marsh)	None	None	None	Impacts Black (isolated and sporadic LS) and White Springs (LS which contains cracking clay) - both small non-mulga LS likely to contain restricted vegetation	Impacts Black (isolated and sporadic LS) and White Springs (LS which contains cracking clay) - both small non-mulga LS likely to contain restricted vegetation	Impacts two small non-mulga LS: Adrian (associated with Fortescue Marsh and River) and Narbung (only 2 occurrences in Pilbara) - likely to contain restricted vegetation.
Impacts on land systems (LS) (restricted to the region)	Impacts Turee LS (cracking clay and some mulga) and Washplain LS (restricted to Fortescue Valley -contains mulga). In addition impacts the Marsh LS containing restricted samphire spp.	Impacts Turee LS (cracking clay and some mulga) and Washplain LS (restricted to Fortescue Valley -contains mulga)	Impacts Turee LS (cracking clay and some mulga) and Washplain LS (restricted to Fortescue Valley -contains mulga)	Impacts Turee LS (cracking clay and some mulga) and Washplain LS (restricted to Fortescue Valley -contains mulga)	Impacts Turee LS (cracking clay and some mulga) and Washplain LS (restricted to Fortescue Valley -contains mulga). In addition impacts the River LS restricted to major river systems.	Impacts Turee LS (cracking clay and some mulga) and Washplain LS (restricted to Fortescue Valley -contains mulga). In addition impacts the River LS restricted to major river systems and the Bonney LS with isolated occurrences in the Pilbara.	Impacts Turee LS (cracking clay and some mulga) and Washplain LS (restricted to Fortescue Valley -contains mulga). In addition impacts several other LS restricted to the region: Coolibah, Fan, Marillana and Urandy.
Vegetation Condition							
Fire history	Fires in 1999 and 2000 burnt the same area near Cloud Break. Areas burnt to the west of Christmas Creek, near Roy Hill, and near Mt Nicholas. 10 year history intersects scattered areas of this route.	Fires in 1999 and 2000 burnt the same area near Cloud Break. Areas burnt to the west of Christmas Creek, near Roy Hill, and near Mt Nicholas. 10 year history intersects scattered areas of this route.	Areas burnt to the west of Christmas Creek, near Roy Hill, and near Mt Nicholas. 10 year history intersects scattered areas of this route.	Areas burnt to the west of Christmas Creek, near Roy Hill, and near Mt Nicholas. 10 year history intersects scattered areas of this route.	Areas burnt to the west of Christmas Creek, near Roy Hill, and near Mt Nicholas. 10 year history intersects large area of the northern portion of this route.	Areas burnt to the west of Christmas Creek, near Roy Hill, and near Mt Nicholas. Large area burnt in Chichester Range in 1997. 10 year history intersects a large area of this route.	Areas burnt near Roy Hill, and near Mt Nicholas. 10 year history intersects only a small area of this route.
Weed invasion	Weed invasion likely due to long term grazing	Weed invasion. FMG survey found 13 species, with heavy infestation in creeklines	Less weed invasion likely in Chichester Range due to inaccessibility, but weed invasion in footslopes.	Less weed invasion likely in Chichester Range due to inaccessibility, but weed invasion in footslopes.	Less weed invasion likely in Chichester Range due to inaccessibility, but weed invasion in footslopes. Stock route to Warrie Camp likely to more infested.	Less weed invasion likely in Chichester Range due to inaccessibility, but weed invasion in footslopes.	Weed invasion likely due to long term grazing
Grazing history	Area grazed for approximately 100 years.	Area grazed for approximately 100 years.	Foothills grazed for approximately 100 years, but higher elevation areas likely to be less affected due to inaccessibility.	Foothills grazed for approximately 100 years, but higher elevation areas likely to be less affected due to inaccessibility.	Foothills grazed for approximately 100 years, but higher elevation areas likely to be less affected due to inaccessibility.	Foothills grazed for approximately 100 years, but higher elevation areas likely to be less affected due to inaccessibility.	Area grazed for approximately 100 years.

ROUTE	1	2	3	4	5	6	7
Greenhouse gas Emissions							
Additional fuel use[8] relative to Route 4 and greenhouse gas emissions (to/from Christmas Creek)	All comparable due to comparable distance and cycle time						Additional 14 ML/y diesel fuel, hence 35% increase in tCO_{2e}/y greenhouse gas emissions for life of project
Greenhouse gas emissions due to land clearing	Negligible relative to fuel use						
Greenhouse gas emissions (Cloud Break, via haul roads)	**0**	**0**	Very large increase due to fleet of 31 road trains				

[1] Start Point is (704640mE, 7575352mN)

[2] In the case of routes 1,2 and 7, the highest elevation of the crossing is on the Stage A North-South Line

[3] Based on best estimate cost, increasing by up to 15% for Route 2 and 30% for all other routes.

[4] Estimated costs with + 30% Contingency

[5] Based on 45Mtpa ore from Cloud Break, by extrapolating costs estimated by GHD in Mindy Mindy concept study

[6] This area is based on a 40m corridor along the full length of the route, including rail loops and spur lines as shown in Figure 1

[7] This area is based on a 10 m corridor along each conveyor route, including an access road. It does not include the area of rail sidings or loops required in every case at Christmas Creek, and either at Cloud Break or the rail route to which a conveyor would carry ore from Cloud Break. Note that haul roads would result in additional disturbance 5-10 times larger, due to the much greater width of a haul road.

[8] Fuel use is approximate and based on average use for the whole project. During final design, simulators would be used to simulate the way a train would be powered over the Chichester Range, thus allowing more realistic estimates of fuel use. To be compared with 40 ML/y diesel fuel use for rail transport for the whole project.

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Appendix D

Peer Review of Stage B Flora and Vegetation Report

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PUBLIC ENVIRONMENTAL REVIEW OF PILBARA IRON ORE AND INFRASTRUCTURE PROJECT: STAGE B EAST-WEST RAILWAY AND MINE SITES, JAN 2005

REVIEW OF APPENDIX J: VEGETATION AND FLORA SURVEY

Completed by Dr E. van Etten, April 2005.

Vegetation Theory & Impact Assessment

This reviews starts with a brief coverage of some basic principles of vegetation science to provide a conceptual basis for my comments. This was felt to be important as some fundamental assumptions are made when delineating vegetation types and assessing their significance, often uncritically.

It is now standard practice in impact assessment to identify plant communities and assess their conservation significance based on rarity, threats and other attributes in a similar way of thinking to that done for species. Such information is also required under some environmental legislation such as the new clearing legislation and laws governing protection of significant ecological communities.

The main problem however is that, unlike most species (accepting that species boundaries are also sometimes not clear cut), plant communities and vegetation types are rarely discrete entities and usually have continuous variation in terms of plant species composition (also called floristics) as well as spatially (that is gradual transitions are common). This reflects the widely accepted view that plant species primarily respond individually to key environmental factors (moisture, nutrients, temperature etc) rather than being controlled by interactions with other species. Classification procedures attempt to divide this continuous variation into discrete types but these should really be viewed as abstract entities used to help us describe and understand vegetation patterns.

Where the physical environment is highly sorted and strongly patterned, distinct vegetation units with reasonably clear boundaries can often be observed in the field. This is so for the Pilbara where distinct landform patterning is the norm. However even where discrete patches of a particular vegetation type can be identified (such as similar vegetation of a certain landform), each patch will be different, to some degree, to the others. With increasing geographic distance apart, it is more likely that patches will vary due to stochastic nature of plant species distribution, chance events and environmental differences due to climatic gradients and other factors. In this respect, assessment of significance at a regional scale is somewhat flawed as regional differences within broad types of vegetation are to be expected.

Therefore it is not unexpected for the mulga woodland of the footslopes of the eastern Chichester Ranges to be floristically different, at least to some degree, from those occupying similar landscape positions elsewhere in the Pilbara.

Another critical issue in vegetation assessment relates to choosing appropriate scale and level of abstraction. Typically vegetation can be classified as a hierarchy with broad vegetation types dividable into several subtypes, which further divide into many smaller vegetation units and so on. With each level in the hierarchy the differences in terms of species become more subtle until differences between each site or patch of vegetation are revealed.

The most appropriate point to cut this hierarchy is always a contentious issue and difficult decision. The more vegetation units that are defined by the classification (or in other words a lower cut-off of the hierarchy) the less distinct they will be in terms of floristics (i.e. plant species composition). Also, as will be discussed later, the more units and the greater likelihood that some of them will be restricted in distribution within the region.

Identification of Vegetation Types

81 vegetation types were identified and described for the FMG-B study area (Appendix J of the PER). Discussions with the consultants revealed that the classification was largely performed in the field through manual grouping of the 206+ study sites based on observed similarities in dominant species, structural attributes of vegetation and vegetation condition. Where a patch of vegetation was deemed to be different in one or more of these characteristics from other patches visited, it was described as a new type.

The consultants have considerable experience in this approach, and have done it many times before in the Pilbara and elsewhere, but the main issue is lack of consistency due to the highly subjective nature of this approach – that is another botanist is quite likely to interpret patterns and group sites differently resulting in a fundamentally different classification. Vegetation classifications derived by the main botanical consultants who work regularly in the Pilbara can be dramatically different, especially in terms of level of abstraction or, in other words, the number of vegetation types they determine for a given area. Such lack of consistency is an important issue as the 81 types have been mapped and used as the basis for assessment of conservation significance.

There are more robust and objective classification techniques available and indeed the consultants used them on the larger regional data set to determine “floristic community types” (i.e. “PATN analysis”). Also I prefer the primary vegetation classification to be based on full floristics (data which is available for most of the sites) rather than dominants, as well as on quantitative data on species (e.g. % cover) as this takes into account relative dominance at sites.

Computer-based, multivariate statistical packages (such as PATN, but there are many others) provides a high degree of objectivity in establishing vegetation classifications. Many of these packages also can demonstrate the degree of distinctiveness of vegetation types (via ordinations) and tests for significant differences between types (via ANOSIM etc). Such a numerical, multivariate approach would also lessen the confusion and conflict between the two classifications provided – the "vegetation types" of the subjective classification and "floristic community types" of the PATN classification.

I also have some concern that at the 81 group level of classification there appears to be considerable overlap in composition of dominants and at this fine level of abstraction we are seeing subtle, local variation and not always consistent differences between the defined vegetation types. Indeed many types were mapped as a mosaic of 2 or more types which appears to reflect a difficulty in separating them in the field and/or on aerial photographs, at least at scale of mapping used. Also no justification appears to be presented of why 81 types were defined – more or less types can be defined simply by altering the cut off point in the classification. I would prefer that clear statements are provided as to how (e.g. what species, soil/landform preference etc) vegetation types identified are actually different to one another. Generally the more vegetation types defined in an area, the greater likelihood that some of them will be found to be restricted in distribution and therefore of conservation significance. The number of vegetation types determined therefore is a critical decision in such analysis. Generally speaking, 81 vegetation types is a relatively large number of types given the size of the study area and the number of sampling sites (~206), with several types being defined on the basis of a single site. It is fair to state that the large number of types defined may have contributed to the high proportion of vegetation types deemed to be of conservation significance in the study area.

Assessment of Conservation Significance of Vegetation Types

The conservation significance of the 81 vegetation types was assessed by the consultants using 3 sets of criteria:

1. association with mapped land systems and whether or not such systems were regionally restricted and/or outliers;
2. representation within 100 group floristic classification of region (using PATN); and
3. other key attributes such as unusual physical environment, potential restricted flora habitat and occurrence of mulga vegetation.

The first two criteria attempt to assess how well represented each of the 81 vegetation types are throughout the region; without such information one cannot truly assess conservation status. In the absence of detailed regional vegetation maps (ideally achieved using consistent scale and techniques as used to identify and map the 81 types) this is difficult as the true spatial extent of each type is unknown.

One common solution is to use surrogates of vegetation patterns as the consultants have done with land system maps. However these are defined and mapped at a far broader scale than the vegetation maps and have, in a general sense, been rarely tested as to the degree to which they reflect vegetation patterns. Also land systems are recognised as comprising a number of different land units and it is at this finer scale where links with vegetation types are likely to be clearer.

The eastern end of the Fortescue Valley and Chichester Ranges have a number of land systems not found or rarely found elsewhere in the Pilbara (eg Washplain, Turee, Jamindie). Although this does not necessarily mean that such systems have regionally restricted vegetation types, it suggests at least some distinctiveness of physical environment which in turns increases the likelihood of unusual and restricted vegetation types. In a general sense the Fortescue Valley and adjacent Chichester and Hamersley Range foothills on either side of the valley are unique in the region and are physically different to other valley systems within the ranges themselves. Therefore it is not unexpected to find regionally different and therefore restricted vegetation types.

The second process involves assessing representation by placing study sites within a vegetation classification of some 2000+ sites located throughout the region. The underlying assumption here is that the more sites a vegetation type is associated (grouped) with, the greater spatial extent it occupies in the region. This is a massive data set, but unfortunately the sites are not evenly spread, but rather concentrated spatially around planned mine developments and along rail corridors.

This process is referred to in the documentation as “PATN analysis” but in reality is pattern analysis using a numeric classification procedure within the PATN® software package. Almost no details are provided regarding how this classification was performed so it is difficult to assess the validity and appropriateness of the techniques used (NB a sub-consultant was used to run the analysis). For instance, PATN’s hierarchical classification module contains numerous options (such as Nearest Neighbour, Furthest Neighbour, Flexible UPGMA and Flexible WPGMA) as well as several key decisions regarding clustering (grouping) strategies such as beta level. It is not clear what measure of site similarity was used. Qualitative (i.e. presence/absence) data was used whereas quantitative data is usually preferred. These may appear to be technical issues, but different decisions can result in spurious and possibly dramatically different classification especially where many groups are defined (such as 100 group level). This demonstrates the abstract nature of vegetation classifications and the fact that the types of vegetation that they reveal are not necessarily real entities.

Nonetheless the PATN classification does reveal several important features of the vegetation of the study area. Firstly mulga woodland types of the study area are almost all in the same floristic group (no. 14) defined at broad 14 group level. Generally these are predominately found in FMG-B study area, although also in FMG-A rail corridor and Hope Downs rail corridor. The other studies did not record mulga woodland vegetation of this type. At 100 group level of classification, two mulga woodland floristic groups (no's 98 and 99) are only found in FMG-B area.

The consultants argue that even at the 100 group level, vegetation units are still broadly defined with vegetation types determined subjectively usually recognisable within further subdivisions. However there are some clear overlaps (eg several "vegetation types" are found across a number of 100 level floristic groups - see Table 5.3; Appendix J). Although there are some inconsistencies, it is fair to state that no matter how many and what types of mulga woodland are delineated, some of them may well be of regional significance due to their floristic distinction and lack of representation at least when compared to the other areas surveyed. However it is important to re-iterate that floristic distinction at a regional scale is to be expected and indeed comparison with vegetation closer to the study area, for instance in the vicinity of the Fortescue Valley and footslopes of the Chichester Ranges and Hamersley Ranges, may well yield a different result.

Many of the areas from which the 2000+ sites have been sampled appear to be uplands and few other mulga woodland areas appear to have been sampled apart from those further west along the Fortescue Valley (FMB-A and Hope Down Rail) and at West Angelas. The mulga woodlands of the West Angelas area (some 140 km to the south-west) is floristically distinct to at least some degree with most of it placed in group 13 of the 14 group level regional classification (FMG-B mulga is placed in Group 14). Although mulga woodland is not as common as hummock grassland in the Pilbara, there are significant stands of it between West Angelas and the study area, as well as elsewhere in the general vicinity of the study area. Unfortunately little data was available to compare floristics of these mulga stands. Therefore, although the regional comparison attempted involved a huge data set of many sites, the degree to which mulga woodlands of the FMG-B area are floristically distinct from other mulga woodlands, especially those in the general vicinity, remains unknown. In other words limited comparison of Area-B mulga woodlands to others of the region appears to have been achieved.

Unfortunately it is difficult to achieve such comparisons given the limited information on other mulga woodlands (and indeed other vegetation types) of the Pilbara. Given the likelihood of regional floristic differences, as outlined above and as demonstrated in the 2000+ site classification, perhaps not much would be achieved through such an onerous task. Rather it would make sense to estimate the geographic extent and distribution of the different vegetation types in the vicinity of the proposed project to help evaluate the impact of clearing vegetation. Given that detailed vegetation mapping has only been achieved for the immediate mine areas and railway corridor, the use of land systems (mapped over larger area) to predict distribution of vegetation types outside the project area is perhaps the best option to make such estimates of extent. This approach has been taken in the PER for mulga woodland by comparing disturbance within land systems dominated by mulga with the entirety of such Mulga land systems over the Chichester Range footslopes.

Appendix E

Letter from Freehills

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Freehills

6 April 2005

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Graeme Rowley
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Dear Graeme

Public Environmental Review
Pilbara Iron Ore and Infrastructure Project: E-W Railway and Mines Sites (Stage B)

You have instructed us to consider and respond to the issues raised by Hunt & Humphry in their letter to the Western Australian Environmental Protection Authority (**EPA**) of 14 March 2005. Hunt & Humphry has raised two primary criticisms of the Public Environmental Review (**PER**) prepared by Fortescue Metals Group Ltd (**FMG**) for the Pilbara Iron Ore and Infrastructure Project (**Project**):

- because mineral resources constitute part of the physical surroundings of living things, they also constitute part of the "environment" as defined in sections 3(1) and (2) of the *Environmental Protection Act* 1986 (WA) (**EP Act**). Consequently, Hunt and Humphry argue that the potential for the Project to sterilise *"known mineral (iron ore) resources"*, and the environmental effects of that alleged sterilisation, should have been assessed in the PER. Hunt & Humphry rely heavily upon their attempt to distinguish the Supreme Court decision of *Coastal Waters Alliance of Western Australia Incorporated v Environmental Protection Authority & Ors* (1996) 90 LGERA 136 (**Coastal Waters case**); and
- by not taking account of the Project's alleged impacts on the ability to exploit known mineral resources, the PER has not properly considered whether the Project is consistent with principles of sustainable development that have been promulgated by the EPA and enshrined in section 4A of the EP Act.

With respect, in our opinion the views expressed by Hunt & Humphry are either overstated, or are wrong. For reasons explained in this letter, in our view the matters raised by Hunt and Humphry fall outside the scope of what is required to be assessed in a PER prepared under the EP Act, and should properly be addressed under the *Mining Act* 1978 if and when a mineral resource beneath or adjacent to the Project is ever found and exploited.

1 Legal issues – scope of environmental assessment under the EP Act

Neither Hunt and Humphry nor Hancock Prospecting Pty Ltd (**Hancock**), in its submission on the PER, allege that the PER does not comply with the Scoping Document that had previously been agreed with the EPA. Consequently, the primary legal argument put by Hunt and Humphry is that mineral resources affected by the Project are part of the "physical surroundings" of living things (including man), and as a consequence fall within the definition of "environment" in the EP Act. Accordingly, the Project's effects on those resources, and the potential to exploit those mineral resources for economic gain, should have been assessed in the PER.

In our view, Hunt and Humphry's argument depends upon their vague and unsubstantiated allegation that the Project *"traverses areas of known mineral (iron ore) resources"*.

Despite Hunt and Humphry's assertion that known mineral resources will be affected by the Project, this is not borne out by the Hancock submission. On the contrary, it is quite clear from Part 4 of the Hancock submission ("Known and Potential Iron Ore Mineralisation") that the only iron ore deposits which have been identified and characterised are located to the north of the Project area, in the Nummuldi Member of the Chichester Ranges. Consequently, the fundamental premise behind Hunt and Humphry's letter, namely that the Project will affect known iron ore resources, is wrong. While Hancock also expressed concern about the Project's effects on known mineral resources, based upon the factual information at Part 4 of their submission they primarily appear to be concerned about:

- the Project's effects on the exploitation of potential iron ore reserves that may exist beneath land that will be affected by the Project; and
- potential constraints presented by the Project if existing mine pits are expanded, or if the Project affects the Roy Hill area.

No effort is made to explain whether there are any current or planned proposals to expand these mine pits. Moreover, Hancock's pre-feasibility for the Roy Hill area is not even complete.

Because there is no known mineral resource that will be traversed by the Project, those mineral resources cannot constitute part of the "environment" that is required to be assessed by FMG in the PER. Any such assessment, if undertaken, would be unhelpful and meaningless – it would require FMG to locate and characterise a mineral resource along the Project alignment and, having done so, assess the Project's impacts on the exploitation of that resource. Such an interpretation of the meaning of "environment", if applied to all proposed non-mining Projects within mining tenements, would have a disastrous effect on the timing and implementation of these Projects. In our view, this clearly was not contemplated by the Parliament when it drafted the EP Act. As a consequences, the reference to *"physical surroundings....of living things"* in the definition of "environment" should be understood to mean surroundings which are known to exist.

Accordingly, in our opinion a hypothetical or potential mineral resource does not constitute a part of the "environment" for the purposes of the *Environmental Protection Act* 1986 that is required to be considered in the PER for the Project.

Even if we were wrong on this issue, we still do not believe FMG would be required, at law, to assess the theoretical impacts of the Project on an unknown, and unknowable, mineral resource.

When assessing the adequacy of an environmental assessment, *"a standard of absolute perfection or compliance measured by no consideration other than whether it is possible in fact to carry out the investigation"* is not required. A concept of reasonableness must be imported into any statutory obligation to undertake an environmental assessment of a project: *Prineas v Forestry Commission of NSW* (1983) 49 LGRA 402 at 417-418; *Leatch v Director General of National Parks and Wildlife* (1993) 81 LGERA 270 at 280.

Consequently, based upon this persuasive court authority which is now accepted in most Australian jurisdictions, it would in our view be unreasonable to expect FMG to assess the impacts of the Project on a supposed mineral resource that is yet to be located and characterised.

2 Position Statement No. 6

We have been asked to comment on the sustainability issues raised by Hunt & Humphry, particularly in respect of the EPA's Position Statement No. 6 *Towards Sustainability*. In our opinion, Hunt & Humphry has selectively quoted from the Position Statement, which must be read and considered as a whole. The thrust of the Position Statement is to provide a general overview of the concept of sustainability. It is clearly stated in the foreword to the Position Statement that the EPA considers economics only *"to a limited extent"*. This position is reflected throughout the Position Statement.

There are two references to the Position Statement in paragraph 6 at page 7 of the Hunt & Humphry letter. In the first reference, Hunt & Humphry assert that the Position Statement specifies *"that the resources should not be eroded in ways that would foreclose options for future generations"*. As previously discussed, there is no basis for Hunt & Humphry to assert that the Project will *"foreclose options for future generations"* to exploit known mineral resources in the Chichester Ranges. If it comes to pass that a mineral resource is found after the Project is constructed and is operational, then the procedures to resolve those potential land use conflicts (if and when they arise) are prescribed in the *Mining Act* 1978.

On the same page, Hunt & Humphry observe that the Position Statement *"notes that whether or not a proposal interacts positively with other likely developments should be considered when proposals are being considered"*. Whilst this statement accurately reflects the Position Statement, neither Hunt & Humphry or Hancock have established that the Project will affect any other likely development. Both organisations, but in particular Hancock, are quite explicit in stating their concern about the Project's impact on the potential exploitation of mineral resources. Whether those mineral resources accurately exist and, if so, whether they will ever be exploited cannot be determined, and hence is incapable of meaningful assessment.

For similar reasons, we do not consider the references to Position Statement Nos. 6 and 7 in Schedule 1 to Hunt & Humphry's letter support their arguments, and do not warrant a line-by-line response.

For the same reasons explained at Part 1, not only is it unreasonable to require FMG to assess the economic consequences of the Project on the exploitation of unknown mineral resources, but such an assessment falls out the scope of, and is not anticipated by, the Position Statements. If the Project is approved and constructed and mineral resources are in the future discovered at or in the vicinity of the Project, any potential land use conflict would be addressed through the procedures under the *Mining Act* 1978. For example:

- An occupier of land (such as FMG) and the applicant for a mining lease must enter into a compensation agreement that would, among other things, address issues concerning the relocation or management of the mine's impacts on the Project;
- notice of a mining lease application must be given to the occupier of land affected by the proposed mining operations, at which time potential land use conflict issues could be raised with the mining lease applicant; and
- the Minister can impose conditions on a mining lease to address land use conflict issues.

It is far more practical to address actual, known land use conflicts by using the procedures under the *Mining Act* 1978 than to require the PER to assess the Project's effects on the commercial exploitation of unknown and theoretical mineral resources that may or may not ever be exploited. This is not only common sense, but is reflected by the law outlined in Part 1 of this letter.

Please do not hesitate to contact us if you have any queries or questions.-

Yours faithfully
Freehills

Tim Power
Partner

Kevin O'Sullivan
Partner