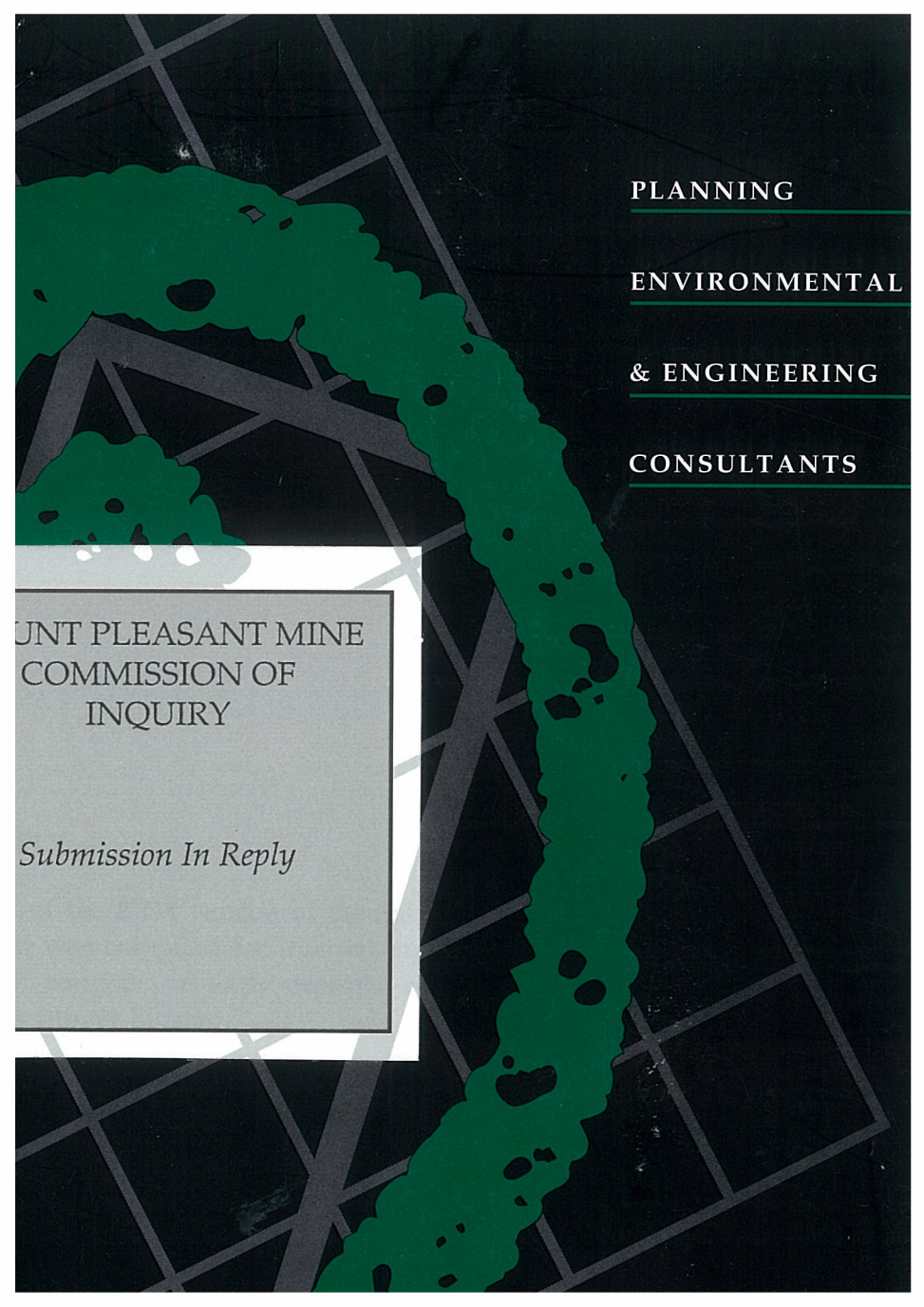
PLANNING
ENVIRONMENTAL
& ENGINEERING
CONSULTANTS
UNT PLEASANT MINE
COMMISSION OF
INQUIRY
Submission In Reply

MOUNT PLEASANT MINE COMMISSION OF INQUIRY

Submission In Reply

For:
OFFICE OF THE COMMISSIONERS OF INQUIRY FOR ENVIRONMENT AND PLANNING

February 1999
98014RP3

ERM Mitchell McCotter Pty Ltd. A.C.N. 002 773 248. A member of the Environmental Resources Management Group.

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30 March, 1999

JBD → File C. of I.

John Dwyer
Coal & Allied, Mount Pleasant Project Office
PO Box 757
MUSWELLBROOK NSW 2333

Our Reference: *98014l33*

ERM

Dear John,

RE: SUBMISSION IN REPLY

Please find enclosed one copy of the ERM version of the Submission in Reply. Please note that this document was compiled for internal purposes only. The official Submission in Reply consists of each expert's original statement submitted with a cover sheet by Minter Ellison.

Yours faithfully,
for ERM MITCHELL McCOTTER PTY LTD

Bruce Colman

Bruce Colman
Senior Associate

ERM Mitchell McCotter Pty Ltd
A.C.N. 002 773 248

A member of the
Environmental Resources Management
Group of Companies

Offices worldwide

Approved by:	*R F McCotter*
Position:	Project Director
Signed:	
Date:	*5 February, 1999*

ERM Mitchell McCotter Quality System

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Chapter 1

INTRODUCTION

1.1 SCOPE OF REPORT

This report sets out Coal and Allied's Submission in Reply to issues raised during the Primary Hearing of the Commission of Inquiry. Issues covered include:

- noise;
- air quality;
- water; and
- aboriginal issues.

The submission is the culmination of ongoing dialogue between the Applicant and agencies such as the Environment Protection Authority, Department of Land and Water Conservation, and the Department of Urban Affairs and Planning.

In addition, the community consultation process has continued with responses from the company to specific and general inquiries about the proposal from residents.

Chapter 2

NOISE

2.1 INTRODUCTION

This chapter responds to the Primary Submission by the Environment Protection Authority (EPA). Only aspects of that submission which are related to noise impacts are addressed. These are found in Section 11 and Section 14.1 of the EPA's Primary Submission.

Responses to the EPA's Primary Submission also take account of discussions with EPA officers which were held subsequent to the presentation of the Primary Submission.

Although the EPA's Submission considers all aspects of noise and vibration associated with the proposal, there are two points in the Submission which we believe require detailed consideration, namely:

- the appropriate noise criterion for daytime operations in rural areas; and
- the methodology for assessment of noise under adverse meteorological conditions.

These two points are discussed in Sections 2.2 and 2.3 of this report respectively, followed by a discussion of other aspects of the EPA's Submission.

2.2 NOISE CRITERIA

The EPA's Primary Submission indicates that the Authority suggests the following noise criteria for operational noise from the mine:

Table 2.1 EPA NOISE CRITERIA

	In Rural Areas	In Muswellbrook
For night time	35 dB(A) L_{10}	37 dB(A) L_{10}
For day time	35 dB(A) L_{10}	40 dB(A) L_{10}

(These are described in the Submission as "recommended background noise levels", but it is assumed that L_{10} levels, as stated in the table, are intended.)

The above noise levels are consistent with those recommended in ERM Mitchell McCotter's Environmental Impact Statement and Primary Submission, with the exception of the criterion for daytime noise in rural areas, which we believe is more appropriately set at 40 dB(A). The EPA's submission states that *"... the EPA guidelines are not mandatory and the adoption of a day time planning noise level of 40 dB(A) L_{10} may be acceptable if the consent authority is satisfied all feasible and cost-effective mitigation and compensation measures are applied and that the socio/economic benefits justify the development"*.

It is recognised that a daytime criterion noise level of 35 dB(A) L_{10} would follow from a strict application of the EPA's standard guidelines, based on the measured minimum repeatable background noise level in the area. However, we believe that adoption of such a criterion in this case would be undesirable for the following reasons.

i Consistency with Other Determinations

In the case of the Bengalla open-cut mine, which is immediately adjacent to Mount Pleasant, it was determined after exhaustive assessment that daytime noise levels at noise-sensitive locations should not exceed 43 dB(A) L_{10}. A significantly different determination in the case of Mount Pleasant would unfairly prejudice this development in comparison with others in the same area, having similar social and economic benefits.

The proposed Mount Pleasant development does utilise technology and operational techniques which allow a reduction from 43 to 40 dB(A) in the daytime criterion level. However, a further reduction would result in large numbers of residences being considered as "noise-affected" which would not be so considered if the noise emanated from the adjacent Bengalla mine. Such a situation is not only clearly inequitable, but would result in significant problems in compliance testing and determination of cumulative impacts.

ii Consistency with Accepted Principles of Noise Control

The level of background noise in an area is an important determinant of noise reaction. Under existing EPA policy, this is assessed as the minimum repeatable background noise level, and standard criteria state that L_{10} noise levels from any source should not exceed this by more than 5 dB. However, the time of day at which a noise occurs also influences likely noise reaction, independent of the level of background noise. This is due to the type of activities which are generally carried out at different times, as well as expectations regarding noise sources and levels.

The common-sense view would be that night-time mining noise would be more disruptive than day-time noise, even if the minimum repeatable background noise level is 30 dB(A) in both cases.

In many open-cut mines, daytime and night-time operations are equivalent, and hence only the more restrictive night-time noise criterion requires consideration. However, in the case of Mount Pleasant, care has been taken to ensure that many important noise-generating activities will occur during daytime only. In imposing the same criterion of 35 dB(A) for both daytime and night-time operations, the Commission would be ignoring the benefits of this sensible noise control practice, and would imply that noise impacts during daytime and night-time are equivalent.

The noise mitigation measures which are proposed for the project (including restriction of noisy operations to daytime) are described in the Environmental Impact Statement. These are considered to represent the maximum feasible measures in terms of equipment usage and operational controls. Hence, consistent with the EPA's submission and the above reasoning, we believe that the adoption of a 40 dB(A) criterion for daytime noise in rural areas is justified.

2.3 ADVERSE METEOROLOGICAL CONDITIONS

With respect to the assessment of noise under adverse meteorological conditions, the EPA's Submission states the following:

"The EPA recommends that noise emission levels be specified under prevailing meteorological conditions except under conditions of temperature inversions. Noise impacts that may be enhanced by temperature inversions shall be addressed by:

- *Documenting noise reports received to identify any higher level of impacts or patterns of temperature inversions,*
- *Where levels of noise reports indicate a higher level of impact then actions to quantify and ameliorate any enhanced impacts under temperature inversion conditions should be detailed in a noise management plan."*

It is assumed that "noise emission levels" in the first sentence refers to "noise imission levels" - that is, noise levels as received at a residence. The exact meaning of the phrase *"prevailing meteorological conditions"* is unclear. Further, it is unclear from the above passage whether the noise levels to be specified under "prevailing meteorological conditions" are the same as the noise level criteria as discussed in *Section 2.2* of this document, which are traditionally applied under "neutral", or still isothermal conditions. However, from discussion with EPA officers it is apparent that this is the intention.

The impact of meteorological conditions on noise levels from the mine is discussed in detail in ERM Mitchell McCotter's Primary Submission to the Commission of Inquiry. It is found that if the noise level under "prevailing meteorological conditions" is interpreted to mean the upper tenth percentile of predicted noise levels, then this is at least 5 dB above the noise level under still isothermal conditions. Subsequent analysis has concluded that the exclusion of temperature inversion conditions from the formal assessment, as described in the quotation above, makes little difference to this result - tenth percentile noise levels over the period when temperature inversions do not occur are very similar to overall tenth-percentile levels.

Hence, the application of noise level criteria under "prevailing meteorological conditions" represents an effective lowering of criteria by approximately 5 dB compared with criteria applied under still isothermal conditions. To our knowledge all previous determinations for open-cut mines in the Hunter Valley have involved noise level criteria which apply under still isothermal conditions. This therefore represents a significant tightening of noise level criteria for this project, and one that was not applied at the Bengalla mine.

It is argued in our Primary Submission that such a general tightening of criteria is not warranted, although some account does need to be taken of meteorological effects in noise assessments. We suggest an alternative, which is to apply two separate criteria - the traditional criteria, which should be met under still isothermal conditions, and criteria 5 dB higher which should be met at least 90 per cent of the time. If desired, this could be 90 per cent of the time excluding temperature inversion conditions, as described in the EPA's Primary Submission.

Following discussion with officers from the EPA, this point will need to be resolved by the Commission.

2.4 OTHER POINTS IN THE SUBMISSION

Other points in the EPA's Primary Submission are generally in agreement with the assessment and recommendations in ERM Mitchell McCotter's submission. In particular:

- we concur that an industry-wide approach is required to issues related to rail traffic noise in the Hunter Valley, and that the findings of the Hunter Valley Railway Programs Task Force will be useful in this regard;

- the EIS recommends the adoption of the EPA's criteria for noise and vibration from blasting (which are derived from ANZECC guidelines), and concludes that with appropriate blasting practice they can be complied with at all relevant locations;

- we concur that for this project, construction noise should be assessed under the same criteria as operational noise. In the EIS, construction activities were included with operational activities in modelling early stages of the mine development; and

- the EIS follows the EPA's recommendation that cumulative effects from other mines should be assessed by comparing the total noise level from all sources with the relevant criterion. It concludes that only one residence which is not affected by noise from Mount Pleasant alone may be affected due to cumulative impacts.

2.5 MONITORING OF NOISE IMPACTS

It is proposed that the impact of noise and vibration from the mine would be monitored in two ways:

- monitoring of noise and vibration levels to ensure compliance with specified criteria and guidelines; and

- monitoring of complaints and comments from the community, and ensuring that action is taken to resolve any issues arising from these.

Monitoring of operational noise levels would be undertaken at noise-sensitive locations, using a combination of manned and unmanned monitoring techniques. The object would be to obtain a quantitative measure of the overall range of noise impacts at each location, both from Mount Pleasant mine alone and from all mines in the area. The use of real-time monitoring techniques would also be investigated.

Blast overpressure and vibration would be monitored at selected locations, using unmanned monitors with the capability to download information to a central computer. Initially, blasting locations would be at some distance from residential areas, and monitoring would be used to refine blasting practices, to ensure that as blasting moves closer, relevant criteria will continue to be met.

Details of the noise monitoring locations and protocol would be determined after approval conditions are finalised, and would be set out in the mine's Environmental Management Plan.

In addition, procedures would be set out in the Environmental Management Plan for receiving and acting on complaints and comments from the community. A 24-hour complaint hotline would be established, and procedures laid down for recording complaint details, resolving the complaint, and establishing follow-up contact with the complainant if required.

2.6 CONCLUSION

In most aspects, the EPA's Primary Submission to the Commission of Inquiry accepts and supports the noise assessment methodology set out in the Environmental Impact Statement and ERM Mitchell McCotter's Primary Submission. The EPA's general conclusion is that *"[environmental impacts associated with the proposal] will not be sufficient to withhold the development consent, subject to the implementation of appropriate strategies to reduce these impacts"*.

However, there are two major points of difference between the EPA's Submission and the assessment methodology proposed in ERM Mitchell McCotter's Primary Submission. These relate to the daytime noise criterion for rural areas, and assessment under adverse meteorological conditions. In both cases, adoption of the EPA's recommendations would result in large additional areas being assessed as noise-affected, which would have a major impact on the project's viability.

We believe that in both cases, the approach taken by the EPA is unnecessarily stringent, and that noise impacts under our alternative recommended approach will be acceptable at all residences for which the recommended criteria are met. These impacts are described in ERM Mitchell McCotter's Primary Submission.

We also believe that the adoption of appropriate monitoring practices will ensure compliance with the proposed criteria, and will ensure that any complaints or comments from the community related to noise impacts are properly addressed and resolved.

Chapter 3

AIR QUALITY

3.1 BACKGROUND

The air quality study provided details of operations and the expected emission of atmospheric particulates during five individual years in the first 20 years of operation. This information, together with several years of on-site monitoring data, was used to predict future air quality as a result of mining at the Mount Pleasant alone and cumulatively in conjunction with nearby existing and/or proposed mines.

The impact of the projected dust emissions on air quality was then assessed against EPA objectives for protection of amenity and health. Areas of possible affectation in which the objectives may not be met at some stage of the proposed operation were clearly identified.

3.2 EPA RESPONSE

The EPA advised in its primary submission that it accepted the modelling predictions as reasonable and that it was satisfied that any dust impacts from the Mount Pleasant Mine were manageable with collaborative management strategies.

The EPA also advised that the modelling projections provided a reasonable indication of the zone of cumulative impact and indicated that the proposed NEPM goal for PM_{10} concentration of 50 micrograms/m^3 (24-hr average) could be exceeded in some worst case scenarios in parts of the region at times throughout the life of the Mount Pleasant Mine.

The NEPM goal for PM_{10} is reflected in the *NSW Action for Air Plan* which was launched in March 1998. The NSW Action for Air set an interim goal for 24 - hour concentrations of PM_{10} to 50 micrograms/m^3 which, at the same time, is equal to the EPA objective for annual averages. Action for Air is a 25 year plan which focuses specifically on the Greater Metropolitan Region of Sydney, the Illawarra and the Lower Hunter.

Extensive dust monitoring in the Hunter Region of NSW together with a number of air quality studies and assessments have shown that much of the surface dust from open cut mining is contained within the respective mine sites under most

operational and weather conditions. Short-term increases in the ambient dust levels are known to occur on occasions as a result of unusual weather conditions such as dust storms, bushfires (as documented by various ambient monitoring data in the Hunter Valley in late 1997) or by activities related to intensive emissions of ambient dust (agricultural tilling, blasting in mining *etc.*)

The proponent agrees with the EPA's proposition that the NEPM and Action for Air for Air goals for PM10 are regional air quality goals which have been designed to be applied to population centres of, at least, 25,000 people over a period of the next 10 years or so and which are not intended or appropriate for use as limit conditions for any individual development proposal.

The proposed mine would operate using up-to-date dust controls and management tools to minimise, to the greatest extent possible, emissions of atmospheric particulates. Through the licensing process the EPA will be able to specify all dust controls and management procedures and to set air quality limits as well as operating, monitoring and reporting requirements. The EPA will also be able to require that the air quality management and dust control measures be improved or adjusted as needed. The Company will work with the EPA to utilise best available technology to limit emissions of PM_{10}.

The proponent supports the EPA recommendations which are aimed at obtaining a more accurate measure of the PM_{10} impacts as outlined in the EPA's primary submission. Site specific monitoring for PM_{10} concentrations is expected to be an important part of this approach especially in relation to locations in the township of Muswellbrook. The Company will assist the EPA with regional monitoring, and contribute to the preparation and implementation of any regional air quality management plan, to achieve the aims of the NSW Action for Air.

Chapter 4

WATER MANAGEMENT

4.1 BACKGROUND

This submission has been prepared following review of the Department of Land and Water Conservation (DLWC) primary submission to the Commission of Enquiry, questions arising and ongoing consultation with the DLWC. Matters addressed include issues raised by DLWC in its Primary Submission and more general issues where clarification was considered appropriate.

4.2 DLWC PRIMARY SUBMISSION ISSUES

4.2.1 Clean water diversion drains

All diversion drains and channels will be constructed to a stable form having grade and hydraulic radius designed to ensure acceptable non erosive velocities of water flow prevail. Details of drain locations and discharge points have been provided to DLWC in accordance with licensing requirements under Part 2 of the Water Act.

4.2.2 Surplus water releases

Detailed mine water balance calculations were reported in the EIS. These calculations used daily rainfall records over 21 year periods extracted from the 100 year long term record. Computer simulations indicated a deficit in mine water from the commencement of operations. The extent of this deficit will vary depending upon climatic conditions, washery coal feed and losses within the mine water system. It is therefore highly unlikely that a mine water surplus will accrue.

If surplus mine water needs to be discharged, raw water dam RW1 will be designed with a discharge facility. The design discharge rate will be no higher than estimated historical peak catchment flows at the dam location. A discharge license will be sought for compliant releases within the Hunter Salinity Trading Scheme. Significant water storage capacity developed during the first years of mining (RW1 and Piercefield Pit) will ensure that any releases can be properly managed over a succession of discharge opportunities. Surplus water discharges will migrate southward through Bengalla Mine lease area.

4.2.3 *Groundwater flows to pit voids*

It is acknowledged that development of any mine pit below the prevailing water table induces groundwater flow into the pit. Both the South and North pits will attract seepage at rates calculated through extensive computer model simulation and reported in the EIS (Supplementary Report 3). Two modelling approaches were adopted to estimate seepage rates – a vertical section and horizontal plan. The vertical section model more closely represented stratification and different bedding permeabilities while the horizontal model provided a more generalised regional simulation. Higher pit seepage rates and regional impacts from the horizontal model were conservatively adopted for planning purposes. Impacts included pressure loss and bore/well structures at risk.

Final void seepage rates will decline from the predicted maximum seepage at 21 years as the void fills and the difference in hydraulic head between void water levels and regional pressures declines. The rate of decline will depend upon prevailing climatic conditions.

To improve the assessment of potential leakage between the coal measures and the alluvial lands to the east, three additional piezometers will be installed.

4.2.4 *Long term seepage from the western fines emplacement*

The western fine rejects emplacement will have a series of impoundments progressing down slope. By constructing separate impoundments it is possible to reduce overall impact on surface water runoff. Separation also provides a means of verifying design performance through regular monitoring so the design can be refined where appropriate.

The design will allow for preferential seepage through the core of the co-disposed materials and through the impoundment wall into the environment dam located immediately down slope. In this manner all seepage will be contained within the mine water system.

To assess potential impacts of the emplacement on the groundwater system, it was conservatively assumed that leakage would occur which would be governed by the in situ permeability of the materials and the underlying weathered and unweathered strata. Calculations provided in Supplementary Report 3 of the EIS indicated a low rate of seepage and a salinity commensurate with in situ water quality; deep seepage if it occurs, will be governed by the hydraulic properties of the coal measures. Estimates given in the EIS support a rate of about 20 kilolitres per day in a westerly direction for the first few years of development with a gradual migration to easterly flow as the mine pit depressurises the surrounding coal measures. This scenario assumes occasional jointing within the coal measures act to enhance permeability

since the intergranular permeability of sandstones is very low while siltstones and shales are virtually impermeable. In the long term after (incomplete) recovery of mine void water levels, it is likely that deep seepage could revert to a westerly flow. The period for recovery however will depend on mining options at year 21 plus the very long period for recovery – potentially more than 80 years.

Mixing of leakage and coal measures waters would fall within the range of measured resident coal measures waters within the catchment, due to the low rate of leakage and relatively low mixing ratios. It is expected that continued percolation of rainfall runoff through impoundments will mobilise and reduce the overall salt mass in time however there are no substantive data to support this process at the scale proposed. pH is predicted to remain in a narrow and relatively neutral range from about 6.5 to 7.5 pH units.

Since the EIS was prepared, additional monitoring holes have been installed in the emplacement area as part of ongoing studies for the project. A summary report for six monitoring wells (to be used in the long term), in situ and core testing of materials including anisotropy checks, and parameter checks in relation to groundwater quality are summarised in the attached report. Findings confirm the presence of underlying impermeable siltstones and shales with occasional joints. Hydraulic properties are consistent with earlier predictions while water quality is highly saline, with an electrical conductivity ranging from 3,810 to 16,610 micro Siemens per centimetre.

While aggressive laboratory studies of leachate generation allow long-term salinity characteristics to be predicted, there may be inherent estimation error due to differences of scale. Accordingly the best approach is to pro-actively manage and monitor the first impoundment so the design can be refined for subsequent impoundments.

Numerous aspects of the rejects emplacement will be monitored. In particular, volumetric inflows, beaching and dewatering process, leachate quality (EC, pH and ionic speciation) and other parameters will be monitored monthly during start up, and less frequently once baseline trends are clearly developed. Hydraulic conductivity at six locations and trace elements in leachate will be measured quarterly for the first year and six monthly thereafter. Six additional multi piezometer monitoring holes will be installed near the impoundment so groundwater levels and quality (EC and pH) can be sampled monthly. Ionic concentrations and trace element profiles will be tested quarterly for the first year and six monthly thereafter. Following closure, piezometers will also be installed in the impoundment to monitor long term rainfall percolation and flushing. Impoundment pressures and water quality parameters will be monitored monthly while trace elements will be sampled twice per year.

4.2.5 *Potential groundwater impacts*

Impacts on groundwater resources in the coal measures and the alluvium were addressed in the EIS (Supplementary Report 3). There will be a regional loss of pressure in the coal measures. This loss of pressure will extend beneath the alluvial lands and may cause vertical leakage downward from the alluvium. The rate of leakage is predicted to be very low and it will be rapidly replaced by groundwater migrating through the alluvium.

No ecosystems were identified that depended on coal measure groundwaters. Any ecosystems that depend on alluvial groundwaters are unlikely to be affected due to the very low leakage rates (per unit area) and the much higher groundwater transmission of alluvium compared to coal measures.

4.2.6 *Cumulative impacts on the groundwater system*

The contribution of Mt. Pleasant to cumulative impacts on the local and regional groundwater regime, was addressed in Supplementary Report 3. Both Bengalla and Dartbrook were simulated by the regional aquifer model, and pit seepage rates re-estimated. The cumulative impact reduced the overall seepage rate to the mine pits by between 14 and 25%.

4.2.7 *Changes in surface water quality*

Changes to surface water quality caused by mining impacts on groundwater are expected to be minimal. Depressurising of coal measures during mining will reduce the upward leakage of saline groundwater currently observed at a number of regional locations. Less upward leakage to existing watercourses will reduce the accumulated (evaporative) salt load. Accordingly a slight reduction in salinity may be expected, especially in first flush events after extended dry periods.

In the long term, coal measures aquifer pressures will not recover fully. However a small increase in salinity is predicted due to re saturation of spoils and remobilisation of salts. The combined impact of lower aquifer pressures (lower hydraulic grades) and increased salinity will lend to negligible change in regional groundwater and surface water quality.

While not anticipated, if a shallow water table is caused by earth works or mine pit development, suitable control measures will be used. These may include localised drains or the planting of salt tolerant trees.

4.3 ISSUES REQUIRING CLARIFICATION

Various questions were raised about the western emplacements, including loss of catchment runoff, leakage from dams, and long term groundwater/surface water quality.

4.3.1 Loss of catchment runoff

Development of the fine rejects emplacement will result in loss of runoff within the local north western and southern catchments over the mine life. Within the north western sub-catchment, approximately 43% loss of runoff (measured at the confluence with Sandy Creek) will occur during years 1 to 9 of mining, reducing to 34% during years 10 through 20. In the southern sub-catchment, 30 % of runoff will be lost during the final years of mining. In the greater Sandy Creek catchment above the confluence with the southern sub catchment, approximately 3.6% of runoff will be lost during the mine life. Runoff will be restored post mining and surface water quality will not be impaired.

There will be no impact on landholders in the north western sub-catchment since there are no dams on the main stream watercourse between the rejects area and the confluence with Sandy Creek. There are a number of dams above the rejects area but these will not be affected.

Runoff in the southern sub catchment will only be reduced during the final years of mining and then only if areas in the north western sub catchment are exhausted. There are several dams in this catchment which may be affected for a relatively short period.

4.3.2 Leakage from rejects emplacement

Possible leakage from the rejects emplacement has been addressed under item 4.2.4 above. Additional field studies have confirmed a generally low permeability hardrock beneath the emplacement with saline groundwater at shallow depths.

The first impoundment will be intensively monitored to ensure design criteria minimise leakage.

4.3.3 Environmental monitoring

Coal and Allied will prepare an overall water management plan before the mine is developed. The plan will incorporate:

- Management of impacts from surface and groundwaters, dams and diversions;

- Separation of clean water from mine water;
- Storm water management to a minimum design criteria of 1:10 year event;
- Regular maintenance of all drainage systems; and
- Management and monitoring of the western rejects emplacement.

The existing monitoring programme will be expanded to include additional surface water and groundwater piezometers. A revised monitoring plan will be prepared in consultation with DLWC and will incorporate:

- Details of all existing and proposed monitoring sites, measurement parameters and frequency of monitoring;
- Incorporation of water storages (levels, water quality etc.);
- All pre-mining baseline data;
- A programme to refine monitoring locations during mine development (some drains and piezometers will be progressively changed or removed);
- Monitoring of spoils leachate at a number of piezometer locations; and
- An annual report consolidating all data (including electronic data in a format acceptable to DLWC), supported by interpretation.

APPENDIX

Appendix A

WATER MONITORING DATA

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Environment&Infrastructure

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ACN 078 004 798
A NATA Certified Quality Company

Our reference: 58E047B.LT_1245/DT/tc

21 September 1998

Mr R. Gordon
Environmental Services
Rio Tinto Coal NSW
PO. Box 315
SINGLETON NSW 2330

ERM Mitchell McCotter Quality System

Referred to	BM	Ref. No.	98014

Date Received 4 FEB 1999

Source: PPK

	Yes	No
Data suitability check required	☐	☑
Data is:		
Current	☐	☐
Applicable to project	☐	☐

Checked by:

Attach explanation for no answers or data problems

Signature: BM Date: 4/2/99
Project Manager

Dear Mr Gordon

Field Work at the Western Rejects Area

This letter report is in response to your request on Tuesday 4 August 1998, for a brief report on the field works undertaken at the Western Rejects Area as part of the Mount Pleasant EIS study. As you may recall, at your request all data obtained from the field works was forwarded in raw format to Colin Mackie in March this year, and PPK was directed not to produce a summary report.

1. Introduction

A field work program was undertaken at the proposed Western Rejects Area, to obtain background hydrogeological data as part of the Mount Pleasant EIS study. PPK personnel commenced field activities in November 1997, supervising the drilling operations, logging all core, and supervising monitoring bore installation. Following completion of bore installations, PPK developed the monitoring bores, undertook groundwater chemistry sampling, and conducted hydraulic testing on all the bores. Additionally, selected drill core was forwarded to a laboratory for determination of hydraulic properties of representative lithology's.

2. Drilling and Monitoring Bore Installation

Diamond drilling was undertaken by McDermotts Drilling using a Pioneer 1600 drill rig. All drilling was under the direct supervision of a PPK hydrogeologist.

The six sites chosen for drilling and monitoring bore installation, were selected to provide adequate coverage to both characterise the hydrogeological setting of the rejects area, and provide groundwater monitoring sites for continuous long term monitoring to assess performance and integrity of the storage areas.

Two holes were drilled at each site with the first hole HQ diamond cored (nominal hole diameter 96.1mm) to a nominal depth of around 20m. Core from the HQ hole was carefully logged by a PPK hydrogeologist to determine lithology and identify any hydrogeologically significant structural features. At the completion of the first hole, the drilling rig was moved a couple of metres from the first hole, and a second hole was drilled to a nominal depth of around 6m using either a blade or hammer drill bit. Both bores were completed as 50mm Class 18 uPVC monitoring bores, screened with 3 to

6m of machine slotted casing at the base of the hole, and gravel packed to strategic depths. The deep monitoring bores at each site were hydraulically isolated below the depth of the shallow monitoring bores, with bentonite clay plugs. Both monitoring bores at each site were also completed with a surface bentonite plug to prevent the ingress of surface water.

Note that the deeper completions are designated as "Lower" or "L" holes, while the shallow completions are designated "Upper" or "U" holes. Thus monitoring bore WRA1L is the deeper completion located at site WRA1.

All bores intersecting groundwater were developed using surge and purge techniques.

At the completion of the monitoring bore installation program, deep hole collars at all sites were surveyed to datum by Monteath and Powys surveyors, under direction of Coal & Allied Operations. All borehole lithology and completion details are provided in Appendix A, while Table 1 provides a brief summary of completion details.

Table 1: Summary of monitoring bores completions.

Borehole Name	Easting (m ISG)	Northing (m ISG)	RL TOC m(AHD)	Drilled Depth (mBGL)	Cased Depth (mBTOC)	Screened Interval * (mBTOC)
WRA1U			217.875	6.56	6.63	0.6 - 6.6
WRA1L	280421.0	1430370.0	218.1	20.15	19.42	13.6 - 20.4
WRA2U			261.96	6.16	6.62	0.8 - 6.6
WRA2L	281250.6	1432566.8	262.1	18.5	19.1	10.6 - 18.6
WRA3U			257.72	8.0	6.93	0.9 - 6.9
WRA3L	281404.8	1431972.4	258.2	21.75	22.24	10.0 - 21.8
WRA4U			241.385	8.06	8.14	1.8 - 8.1
WRA4L	280872.7	1432060.2	242	21.7	22.4	9.4 - 22.4
WRA5U			228.125	7.52	7.64	1.6 - 7.6
WRA5L	280318.3	1431995.3	228.7	18.64	19.26	9.7 - 19.3
WRA6U			212.3	8.33	8.43	2.4 - 8.4
WRA6L	279690.3	1431963.5	211.7	18.65	18.95	9.7 - 19.0

Notes: * Screened interval includes gravel packed interval.
RL TOC – Relative Level Top Of Casing
ISG – International Survey Grid
AHD – Australian Height Datum
BGL – Below Ground Level
BTOC – Below Top Of Casing

3. Groundwater Sampling

In December 1997, groundwater samples were obtained to provide background water quality data from all monitoring bores containing sufficient groundwater for sampling. Immediately prior to groundwater sampling, all sampled bores were either purged to evacuate at least 3 bore volumes, or in the case of low yielding bores, purged dry and

allowed to recover before sampling. Field chemical parameters were monitored during the purging process and final readings are presented in Table 2, along with an additional set of recordings obtained in March 1998.

Table 2: Field measured chemical parameters.

Borehole	pH 9-10/12/97	EC 9-10/12/97 (uS/cm)	pH 2/03/98	EC 2/03/98 (uS/cm)
WRA1U	7.2	5360	6.8	5660
WRA1L	7	4920	7.2	4270
WRA2U	ns	ns	ns	ns
WRA2L	7.9	5900	7.1	5460
WRA3U	7.1	7060	7	6150
WRA3L	6.5	16610	6.6	13480
WRA4U	7.1	7140	6.9	6750
WRA4L	6.8	5380	6.6	4810
WRA5U	7	3890	7	3810
WRA5L	7.6	5730	7.1	5870
WRA6U	6.9	9870	6.5	10100
WRA6L	7.6	5640	6.6	5480

Notes: ns = not sampled

Groundwater samples were collected under standard PPK sampling and chain of custody protocols, and dispatched to the NATA registered Australian Laboratory Services P/L in Sydney for analysis. Table 3 summarises the analytical results for the groundwater sampling program, and full analysis reports are provided in Appendix B.

Table 3: Summary of groundwater chemistry results.

Analysis	WRA1 Lower	WRA2 Lower	WRA3 Upper	WRA3 Lower	WRA4 Upper	WRA4 Lower	WRA5 Upper	WRA5 Lower	WRA6 Upper	WRA6 Lower
Ca^{2+}	35	20	10	39	77	48	27	17	24	14
Mg^{2+}	190	222	203	970	406	214	213	215	567	126
Na+	741	1080	960	2200	1150	868	545	922	1440	609
K+	14	20	23	30	31	19	17	20	39	16
CO_3^{2-} *	<1	60	<1	<1	<1	<1	<1	54	<1	30
HCO_3^- *	948	995	1360	1490	1110	1200	717	933	1610	1160
Alk. *	948	1060	1360	1490	1110	1200	717	987	1610	1190
SO_4^{2-}	79	63	70	393	186	151	76	69	217	52
Cl^-	1020	1610	1080	4890	2240	1120	936	1380	2630	1320

Analysis	WRA1 Lower	WRA2 Lower	WRA3 Upper	WRA3 Lower	WRA4 Upper	WRA4 Lower	WRA5 Upper	WRA5 Lower	WRA6 Upper	WRA6 Lower
Fe	<0.1	<0.1	<0.1	<0.1	<0.1	2	<0.1	0.4	<0.1	<0.1

Notes: All concentrations are mg/L
* - reported as $CaCO_3$
Alk. - Alkalinity

4. Hydraulic Testing

Field Testing

With the exception of WRA2U which did not intersect groundwater, all monitoring bores were hydraulically tested in the field using standard slug tests and Hvorslev analysis. It should be noted here that hydraulic tests were not conducted on open holes (prior to completion) due to drilling rig scheduling requirements.

Slug tests consist of rapidly injecting or extracting a volume of water from the bore and recording the recovery of the water level within the bore. Analysis using Hvorslev analysis provides a hydraulic conductivity for the interval tested. All hydraulic conductivities obtained from the field hydraulic testing and summarised in Table 4, while graphical presentations of the data can be found in Appendix C.

Table 4: Summary of field tested hydraulic conductivities.

Borehole	Hydraulic Conductivity (m/day)
WRA1U	2.1E-03
WRA1L	6.2E-01
WRA2U	not tested
WRA2L	1.6E-04
WRA3U	6.1E-02
WRA3L	1.9E-03
WRA4U	1.9E-02
WRA4L	1.3E-02
WRA5U	7.0E-02
WRA5L	4.9E-03
WRA6U	2.9E-02
WRA6L	2.1E-02

Laboratory Testing

Fourteen drill core intervals representing the dominant lithology's were selected from the core at the completion of the drilling program. These samples were dispatched to Core Laboratories Australia Pty. Ltd. in Perth where 12 of the samples were selected for laboratory determination of vertical and horizontal hydraulic conductivity. The results of this testwork are summarised in Table 5 while Appendix D contains a copy of the laboratory report.

Table5: Summary of laboratory determined hydraulic conductivities.

Borehole	Rocktype	Depth		Orientation	Hydraulic conductivity	
		From	To		20°C.	60°F.
		(mBGL)	(mBGL)		m/day	m/day
WRA1	MS/ST	8.64	8.86	Horizontal	2.19E-03	1.96E-03
	MS/ST			Vertical	3.74E-05	3.34E-05
WRA1	Lam.	10.25	10.42	Horizontal	8.64E-04	7.71E-04
	Lam.			Vertical	3.60E-05	3.21E-05
WRA2	SS fg. w.	4.61	4.80	Horizontal	2.49E-03	2.22E-03
	SS fg w.			Vertical	9.13E-05	8.15E-05
WRA2	ST massive	10.76	10.95	Horizontal	3.14E-05	2.80E-05
	ST massive			Vertical	7.16E-06	6.39E-06
WRA2	Lam.	15.49	15.66	Horizontal	1.69E-05	1.50E-05
	Lam.			Vertical	3.73E-06	3.33E-06
WRA3	ST	8.85	9.00	Horizontal*	5.12E-04	4.57E-04
	ST			Vertical	3.97E-06	3.54E-06
WRA4	silt/clay hw.	4.49	4.62	Horizontal*	<8.30E-07	<7.41E-07
	silt/clay hw.			Vertical*	1.21E-03	1.08E-03
WRA4	Lam. SS & ST	11.23	11.38	Horizontal	1.87E-04	1.67E-04
	Lam. SS & ST			Vertical	1.75E-05	1.56E-05
WRA5	SS fg.	7.59	7.82	Horizontal	8.30E-07	1.48E-06
	SS fg.			Vertical	8.30E-07	7.41E-07
WRA5	Lam. SS & ST	10.76	11.00	Horizontal	1.37E-05	1.22E-05
	Lam. SS & ST			Vertical	5.37E-05	4.80E-05
WRA6	Lam. SS & ST	6.57	6.85	Horizontal	4.54E-05	4.05E-05
	Lam. SS & ST			Vertical	1.02E-05	9.12E-06
WRA6	SS fg.	13.82	14.00	Horizontal	7.21E-06	6.43E-06
	SS fg.			Vertical	2.85E-06	2.54E-06

Notes: * permeability measured by probe permeameter.
MS - mudstone
ST - siltstone
Lam. - laminated
SS - sandstone
fg. - fine grained
w. - weathered
hw. - highly weathered

Reference to the core permeability data shows that hydraulic conductivities are generally very low, and that horizontal hydraulic conductivity is generally greater than vertical hydraulic conductivity.

5. Water Level Monitoring

Water levels recorded up until 2 March 1998, are summarised in Table 6 below.

Table 6: Summary of water level recordings to 2 March 1998.

Borehole	SWL 18/11/97 (mBTOC)	SWL 9/12/97 (mBTOC)	SWL 10/12/97 (mBTOC)	SWL 2/03/98 (mBTOC)	Water RL 18/11/97 (mAHD)	Water RL 9/12/97 (mAHD)	Water RL 10/12/97 (mAHD)	Water RL 2/03/98 (mAHD)
WRA1U	6.020	6.320	nd	6.485	211.855	211.555	nd	211.390
WRA1L	2.130	2.260	nd	2.820	215.970	215.840	nd	215.280
WRA2U	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
WRA2L	nd	nd	9.615	10.810		nd	252.485	251.290
WRA3U	3.510	nd	3.560	3.840	254.210	nd	254.160	253.880
WRA3L	13.720	nd	14.970	15.670	244.480	nd	243.230	242.530
WRA4U	3.770	nd	3.872	4.070	237.615	nd	237.513	237.315
WRA4L	3.640	nd	3.770	4.000	238.360	nd	238.230	238.000
WRA5U	2.590	2.702	nd	3.090	225.535	225.423	nd	225.035
WRA5L	2.760	3.118	nd	3.540	225.940	225.582	nd	225.160
WRA6U	1.440	1.460	nd	1.895	210.860	210.840	nd	210.405
WRA6L		1.644	nd	2.390	211.700	210.056	nd	209.310

Notes: SWL – Static Water Level
mBTOC – metres Below Top Of Casing
RL – relative level
mAHD – metres Australian Height Datum.

I trust this letter report fulfils your requirements, however should you have any questions regarding the data, I am contactable through our Perth office on (08) 9389 8668.

Yours sincerely

David Thomson
Hydrogeologist
PPK Environment & Infrastructure Pty Ltd

Encl: Appendix A: Borehole Completion Logs
Appendix B: Groundwater Chemistry Results
Appendix C: Field Hydraulic Test Data
Appendix D: Laboratory Hydraulic Test Report

Appendix A

Borehole Completion Logs

BORE COMPLETION DETAILS - WRA1L

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION

SANDY SILT/CLAY, light brown, extremely weathered bedrock.

SANDSTONE, light brown, f.g. high weathered

Core Loss

Interbedded SANDSTONE, SILTSTONE, MUDSTONE and silt/clay. Residual with float. Rubble from 4.4m

Core Loss

INTERBEDDED MUDSTONE/SILTSTONE (LAMINITE) red brown, light grey to dark grey, highly weathered.
Rubbly to 6.6m. Fine roots at 8m.

INTERBEDDED SANDSTONE(fg)-SILTSTONE/MUDSTONE Yellow brown with light an dark grey layers Laminated, often whispey. Highly weathered and firm.
Core quite competant initially but parts along lam. and bedding after drying.
Rubble zone 13.70 - 13.80m, clayey, core has rolled in core barrel.

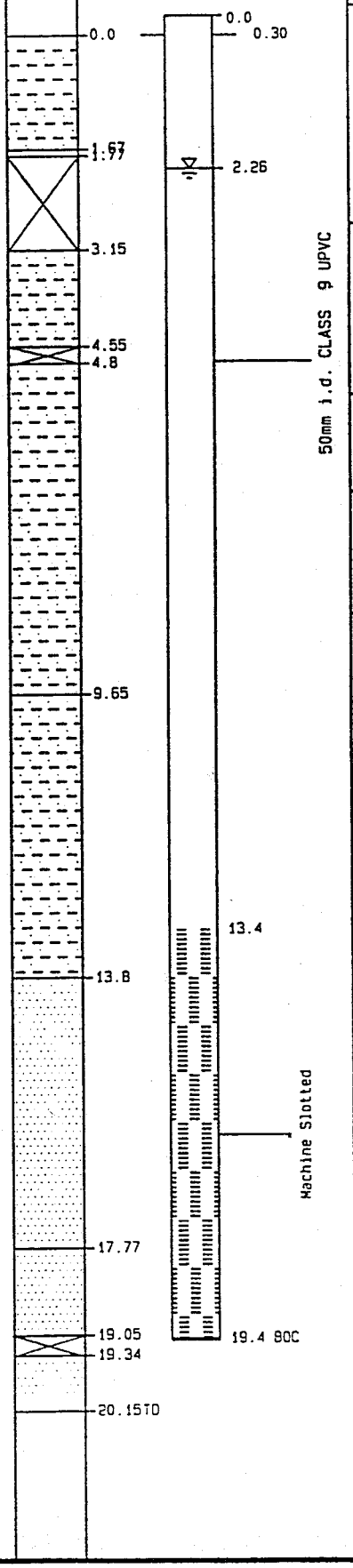
SANDSTONE, fine grained, light grey with Fe ox. stained bands around joints.
Coaly liminations: 14.10 - 14.17
14.90 - 15.00

INTERBEDDED SANDSTONE/MUDSTONE, light and dark grey, beds up to 8cm thick. Highly weathered at top 5cm, otherwise moderately weathered.

CORE LOSS in rubble zone

INTERBEDDED SANDSTONE/MUDSTONE, light and dark grey, beds up to 8cm thick, moderately weathered.

LOG



DEPTH

0
10
20

DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : PIONEER 1600
Date Drilled : 11/11/97
Coordinates : 280421 mE 1430370mN
Casing R.L. : 218.1 mAHD
Top of Casing : 0.30 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand
from 13.6m to 20.4mBTOC

CEMENT DETAILS

Surface Casing Cemented
from 0.300m to 0.4mBTOC
Bentonite Seal 10.9m to 13.6mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: 2.26mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : 7.0 Temp.:
Conductivity : 4920 µS/cm

NOTES

Hole augered for first metre.

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DRAWN DT DATE 02-Mar-98

BORE COMPLETION DETAILS - WRA1U

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION | LOG | DEPTH

0

SANDY SILT/CLAY, light brown, extremely weathered bedrock.

SANDSTONE, light brown, f.g. high weathered

Core Loss

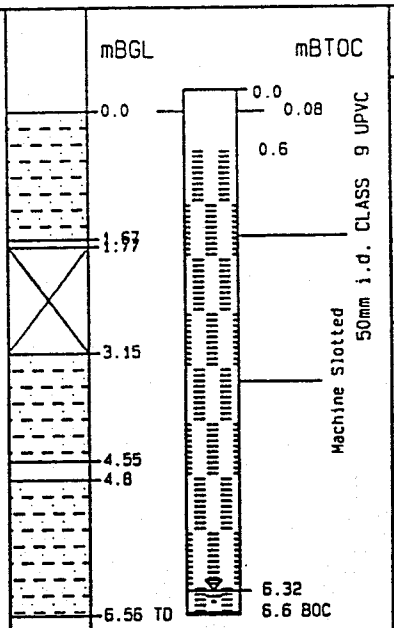
Interbedded SANDSTONE, SILTSTONE, MUDSTONE and silt/clay. Residual with float. Rubble from 4.4m

Core Loss

INTERBEDDED MUDSTONE/SILTSTONE (LAMINITE) red brown, light grey to dark grey, highly weathered.

10

20



DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : PIONEER 1600 AUGER
Date Drilled : 11/11/97
Coordinates : 280421 mE 1430370mN
Casing R.L. : 218.1 mAHD
Top of Casing : 0.08 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand
from 0.6m to 6.63mBTOC

CEMENT DETAILS

Surface Casing Cemented
from0.08m to 0.4mBTOC
Bentonite Seal 0.4m to 0.6mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: 6.32mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : Temp.:
Conductivity :

NOTES

Hole augered with water
assist to remove cuttings

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BORE COMPLETION DETAILS - WRA2L

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION	LOG	DEPTH

0

TOPSOIL, brown, clayey silt/silty clay

CORE LOSS

CLAY, silty, light brown to orange brown, weathered bedrock (siltstone), rock fragments common, fine sand and silt layers are weaker layers.

INTERBEDDED SILTSTONE/SANDSTONE/MUDSTONE, highly weathered, orange brown, light grey mottling in clayier (mudstone) layers.

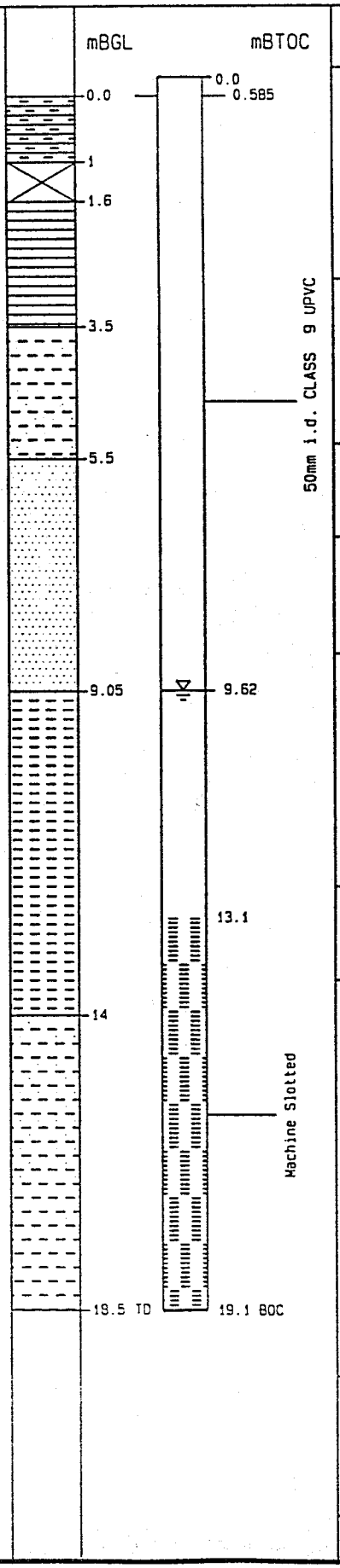
SANDSTONE light yellow brown, fine to course grained, highly weathered, occasional bedding lam. 5 -10 degrees.

10

MUDSTONE, orange brown to dark grey, highly weathered to 9.9m then fresh.

INTERBEDDED SILTSTONE & SANDSTONE, light & dark gray (laminate).

20



DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : UNIVERSAL 650
Date Drilled : 18/11/97
Coordinates : 281251 mE 1432567mN
Casing R.L. : 262.1 mAHD
Top of Casing : 0.585 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand
from 10.6m to 18.63mBTOC

CEMENT DETAILS

Surface Casing Cemented
from 0.30m to 0.4mBTOC
Bentonite Seal 9.6m to 10.6mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: 9.62mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : 7.9 Temp.:
Conductivity : 5900 µS/cm

NOTES

First metre augered

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BORE COMPLETION DETAILS - WRA2U

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION	LOG	DEPTH

0

TOPSOIL. brown, clayey silt/silty clay

CORE LOSS

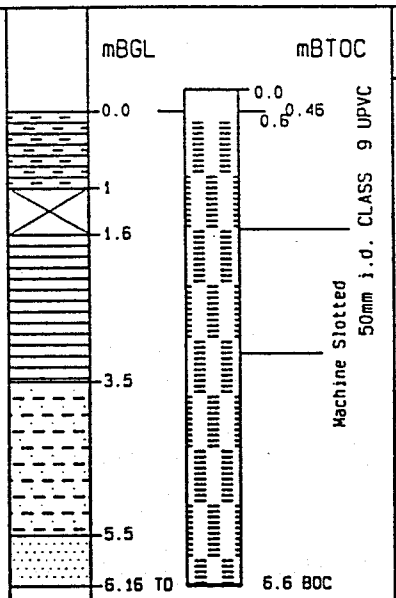
CLAY, silty, light brown to orange brown, Weathered bedrock (siltstone), rock fragments common, fine sand and silt layers are weaker layers.

INTERBEDDED SILTSTONE/SANDSTONE/MUDSTONE, highly weathered, orange brown, light grey mottling in clayier (mudstone) layers.

SANDSTONE light yellow brown, fine to course grained, highly weathered, occasional bedding lam. 5 -10 degrees.

10

20



DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : UNIVERSAL 650
Date Drilled : 18/11/97
Coordinates : 281251 mE 1432567mN
Casing R.L. : 262.1 mAHD
Top of Casing : 0.46 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand
from 0.8m to 6.62mBTOC

CEMENT DETAILS

Surface Casing Cemented
from0.46m to 0.6mBTOC
Bentonite Seal 0.6m to 0.8mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: *DRY*
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : Temp.:
Conductivity :

NOTES

Augered with water assist to remove cuttings.

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BORE COMPLETION DETAILS - WRA3L

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION

0

TOPSOIL, silty clay/clayey silt, brown.

CLAY, silty to SILT, mottled orange yellow and light grey, weathered residual.

SILTSTONE, orange to light yellow, highly weathered. From 5m, lamination becomes appar apparent and bedding becomes definite with mudstone layers discernable.

10

SILTSTONE, laminated, dark grey with light and dark layers, not weathered. Bedding 0 to 5 degrees from horizontal.

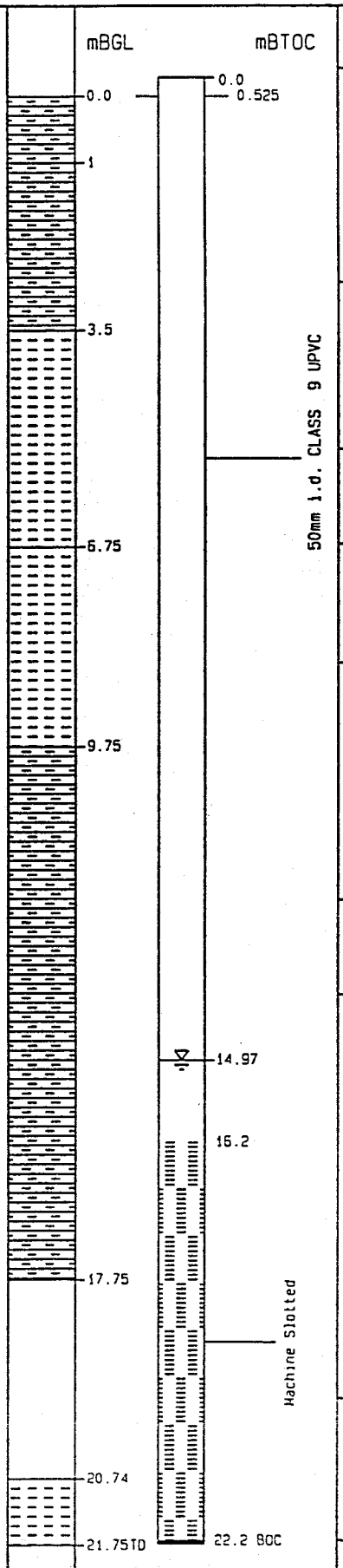
INTERBEDDED SILTSTONE AND MUDSTONE, light and dark grey, bedding planes at 0-5 degrees no breaks in core for interval.

COAL

20

SILTSTONE, light grey, fresh, no breaks.

LOG



DEPTH

DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : PIONEER 1600
Date Drilled : 14/11/97
Coordinates : 281405 mE 1431972mN
Casing R.L. : 258.2 mAHD
Top of Casing : 0.525 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand
from 10.0m to 21.8mBTOC

CEMENT DETAILS

Surface Casing Cemented
from0.52m to 0.7mBTOC
Bentonite Seal 9.0m to10.0mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: 14.97mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : 6.5 Temp.:
Conductivity : 16610 µS/cm

NOTES

Augered first metre.

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DRAWN DT DATE 02-Mar-98

BORE COMPLETION DETAILS - WRA3U

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION

0

TOPSOIL, silty clay/clayey silt, brown.

CLAY, silty to SILT, mottled orange yellow and light grey, weathered residual.

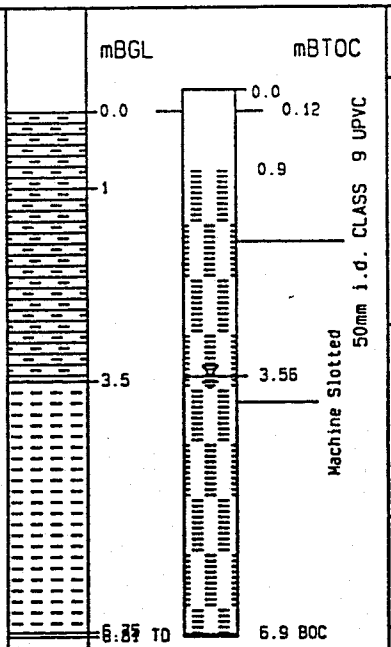
SILTSTONE, orange to light yellow, highly weathered. From 5m, lamination becomes apparent and bedding becomes definite with mudstone layers discernable.

SILTSTONE, laminated, dark grey with light and dark layers, not weathered. Bedding 0 to 5 degrees from horizontal.

10

20

LOG DEPTH



DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : PIONEER 1600
Date Drilled : 14/11/97
Coordinates : 281405 mE 1431972mN
Casing R.L. : 258.2 mAHD
Top of Casing : 0.12 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand
from 0.9m to 6.93mBTOC

CEMENT DETAILS

Surface Casing Cemented
from0.12m to0.22mBTOC
Bentonite Seal0.22m to 0.9mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: 3.56mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : 7.1 Temp.:
Conductivity : 7060 µS/cm

NOTES

Augered with water assist to remove cuttings.

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DRAWN DT DATE 02-Mar-98

BORE COMPLETION DETAILS - WRA4L

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION	LOG	DEPTH

0

TOPSOIL, silty CLAY/clayey SILT, brown

CLAY silty/SILT clayey, light orange brown, sandy with gravelly lenses, weathered rock fragments at base.

CORE LOSS

CLAY silty + clayey SILT, mottled orange yellow & brown, minor rounded qtz. pebbles @ 4m. @ 4.6m extremely weathered siltstone bleached cream/buff Most likely an extremely weathered claystone with siltstone layers.

CORE LOSS

WEATHERED CLAYSTONE/SILTSTONE, mottled orange brown & light grey. Some lamination.

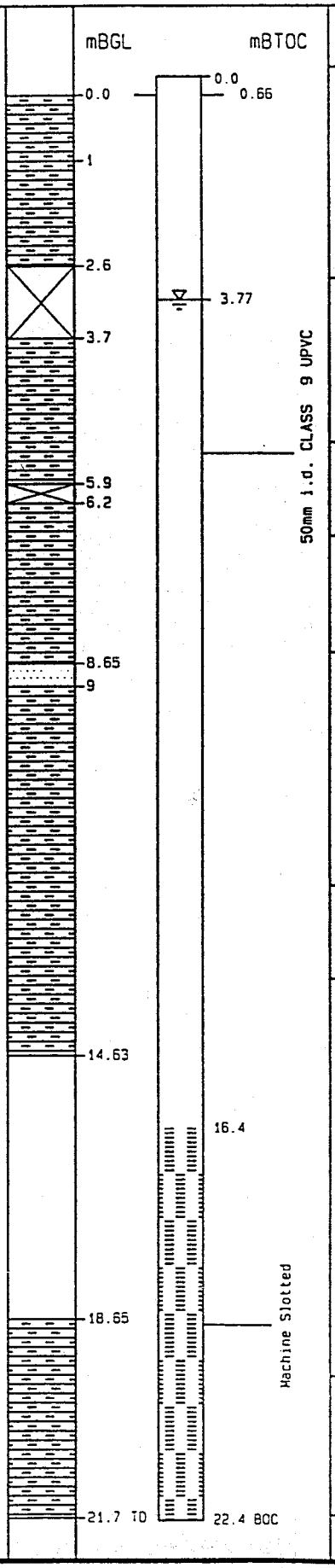
SANDSTONE, fine grained.

10

INTERBEDDED MUDSTONE/SILTSTONE, light to dar strongley weathered. Occasional sandstone lenses approx. 5 cm thick.

COAL

20 INTERBEDDED SILTSTONE/MUDSTONE (laminate) mostley siltstone, light grey. Core breaks readily along bedding planes.



DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : PIONEER 1600
Date Drilled : 13/11/97
Coordinates : 280873 mE 1432060mN
Casing R.L. : 242.0 mAHD
Top of Casing : 0.66 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand
from 9.40m to 22.40mBTOC

CEMENT DETAILS

Surface Casing Cemented
from 0.66m to 1.06mBTOC
Bentonite Seal 8.40m to 9.40mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: 3.77mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : 6.8 Temp.:
Conductivity : 5380 µS/cm

NOTES

Augered first metre.

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DRAWN DT DATE 02-Mar-98

BORE COMPLETION DETAILS - WRA4U

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION	LOG	DEPTH

0

TOPSOIL, silty CLAY/clayey SILT, brown

CLAY silty/SILT clayey, light orange brown, sandy with gravelly lenses, weathered rock fragments at base.

CORE LOSS

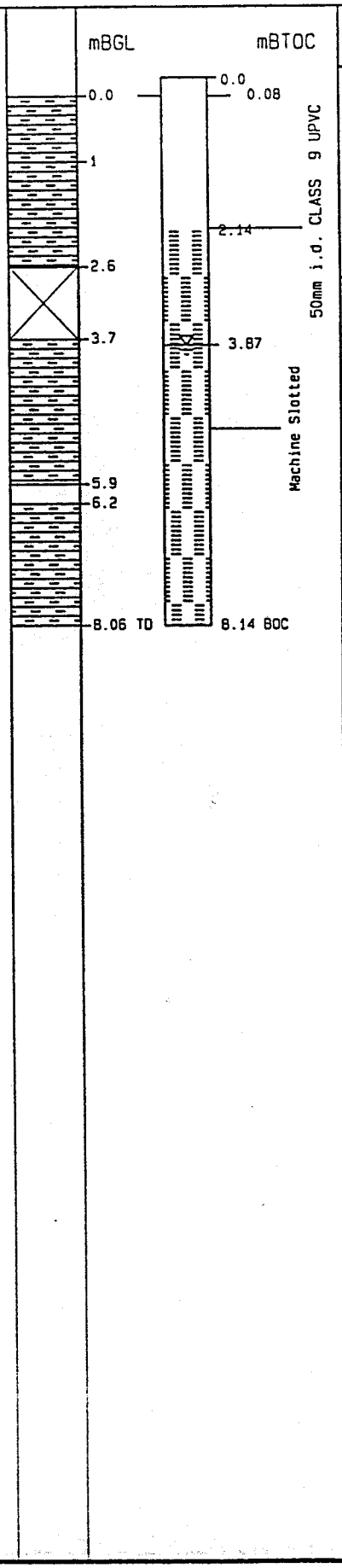
CLAY silty + clayey SILT, mottled orange yellow & brown, minor rounded qtz. pebbles @ 4m. @ 4.6m extremely weathered siltstone bleached cream/buff Most likely an extremely weathered claystone with siltstone layers.

CORE LOSS

WEATHERED CLAYSTONE/SILTSTONE, mottled orange brown & light grey. Some lamination.

10

20



DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : PIONEER 1600
Date Drilled : 13/11/97
Coordinates : 280873 mE 1432060mN
Casing R.L. : 242.0 mAHD
Top of Casing : 0.08 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand
from 1.8m to 8.14mBTOC

CEMENT DETAILS

Surface Casing Cemented
from0.08m to0.48mBTOC
Bentonite Seal0.48m to 1.8mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: 3.87mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : 7.1 Temp.:
Conductivity : 7140 µS/cm

NOTES

Augered with water assist
to remove cuttings.

PPK
Environment&Infrastructure

DRAWN DT DATE 02-Mar-98

BORE COMPLETION DETAILS - WRA5L

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION	LOG	DEPTH

0

Silty CLAY/clayey SILT, light orange brown with light grey mottling, minor sand layers stiff but crumbly. 2.5-2.7m rounded pebbly layer.

CORE LOSS, drill bit broke, likely sandstone float, sandstone in last 10cm.

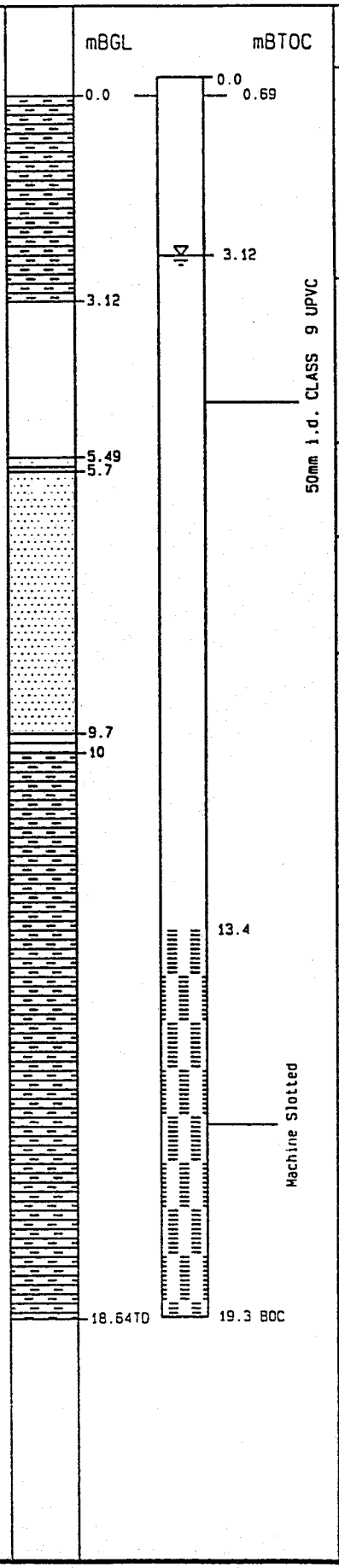
CLAY, mottled light grey & orange, rock fragments common near base (bedrock)

SANDSTONE, fine to medium grained, yellow to orange brown, highly weathered, rubble zones: 5.7-7.0m, 7.1-7.2m.

10 CLAYSTONE, highly weathered, gravel rock fragments - quartz, chert.

INTERBEDDED MUDSTONE/SILTSTONE, light to dark grey, laminated, highly weathered grading to fresh at approx 13.5m.

20



DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : PIONEER 1600
Date Drilled : 12/11/97
Coordinates : 280318 mE 1431995mN
Casing R.L. : 228.7 mAHD
Top of Casing : 0.69 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand
from 9.7m to 19.3mBTOC

CEMENT DETAILS

Surface Casing Cemented
from0.69m to 1.1mBTOC
Bentonite Seal 8.2m to 9.7mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: 3.12mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : 7.6 Temp.:
Conductivity : 5730 µS/cm

NOTES

Augered first metre.

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DRAWN DT DATE 02-Mar-98

BORE COMPLETION DETAILS - WRA5U

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION

0

Silty CLAY/clayey SILT, light orange brown with light grey mottling, minor sand layers stiff but crumbly. 2.5-2.7m rounded pebbly layer.

CORE LOSS, drill bit broke, likely sandstone float, sandstone in last 10cm.

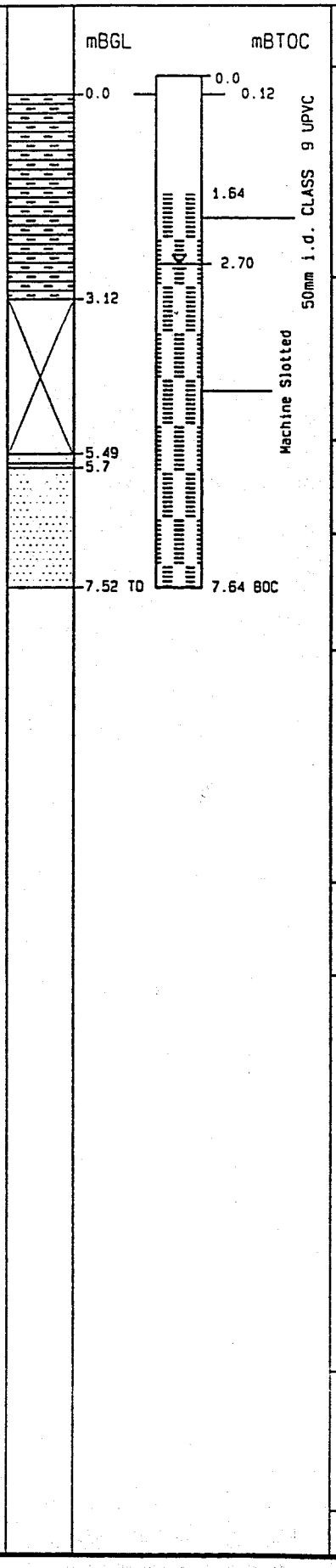
CLAY, mottled light grey & orange, rock fragments common near base (bedrock)

SANDSTONE, fine to medium grained, yellow to orange brown, highly weathered, rubble zones: 5.7-7.0m, 7.1-7.2m.

10

20

LOG



DEPTH

DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : PIONEER 1600
Date Drilled : 12/11/97
Coordinates : 280318 mE 1431995mN
Casing R.L. : 228.7 mAHD
Top of Casing : 0.12 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand
from 1.6m to 7.6mBTOC

CEMENT DETAILS

Surface Casing Cemented
from0.12m to 0.4mBTOC
Bentonite Seal 0.4m to 1.6mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: 2.70mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : 7.0 Temp.:
Conductivity : 3890 µS/cm

NOTES

Augered with water assist to remove cuttings.

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DRAWN DT DATE 02-Mar-98

BORE COMPLETION DETAILS - WRA6L

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION

0

TOPSOIL, clayey SILT red brown.

CORE LOSS due float in alluvium

SILT, CLAY, SILTSTONE, & SANDSTONE, highly disturbed sample

INTERBEDDED SILTSTONE/MUDSTONE, orange brown highly weathered, becomes less leached from 5m (light and dark grey). Moderately weathered from approximately 7m.

CORE LOSS

SILTSTONE/SANDSTONE, v.f.grain. light grey

10 INTERBEDDED SILTSTONE/MUDSTONE, highly weathered light and dark brown.

SILTSTONE/SANDSTONE, very fine grained, light grey with carbonaceous stringers (fossiliferous).

CORE LOSS

MUDSTONE, highly weathered and disturbed possible fracture zone at top.

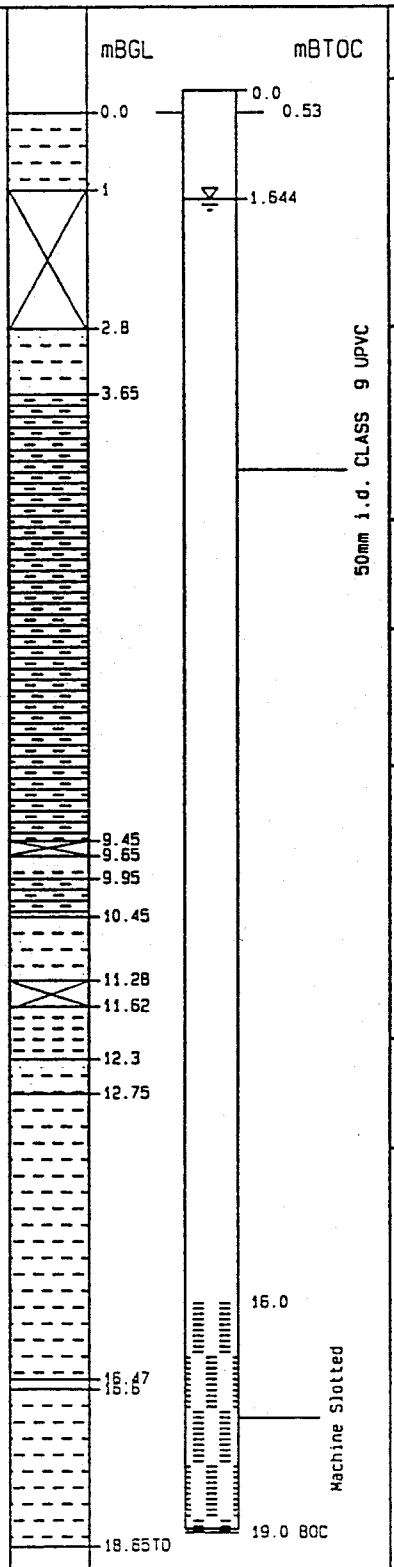
SILTSTONE/SANDSTONE, very fine grained, light grey.

INTERBEDDED SILTSTONE/MUDSTONE (LAMINITE) light and dark greys, siltstone beds upto 0.3m thick. Slightly weathered (Fe stained) from 14.05 to 14.13.
CORE LOSS from 15.45 to 15.64m.? fracture?

COAL and carbonaceous lense

INTERBEDDED SILTSTONE/MUDSTONE (LAMINITE) light and dark greys.

20



DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : UNIVERSAL 650
Date Drilled : 18/11/97
Coordinates : 279690 mE 1431963mN
Casing R.L. : 212.2 mAHD
Top of Casing : 0.53 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand from 9.7m to 18.95mBTOC

CEMENT DETAILS

Surface Casing Cemented from0.53m to 0.8mBTOC
Bentonite Seal 7.3m to 9.7mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: 1.644mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : 7.6 Temp.:
Conductivity : 5640 µS/cm

NOTES

Augered top metre

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DRAWN DT DATE 02-Mar-98

BORE COMPLETION DETAILS - WRA6U

MOUNT PLEASANT - WESTERN REJECTS AREA

STRATIGRAPHIC DESCRIPTION

0

TOPSOIL, clayey SILT red brown.

CORE LOSS due float in alluvium

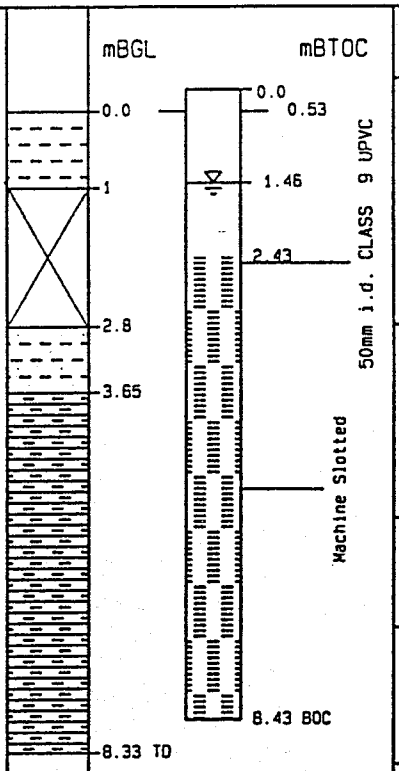
SILT, CLAY, SILTSTONE, & SANDSTONE, highly disturbed sample

INTERBEDDED SILTSTONE/MUDSTONE, orange brown highly weathered, becomes less leached from 5m (light and dark grey). Moderately weathered from approximately 7m.

10

20

LOG DEPTH



DETAILS

GENERAL INFORMATION

Location : MT PLEASANT
Driller : McDERMOTTS DRILLING
Rig Type : UNIVERSAL 650
Date Drilled : 18/11/97
Coordinates : 279690 mE 1431963mN
Casing R.L. : 212.2 mAHD
Top of Casing : 0.53 mAGL

COMPLETION NOTES

Screen Type : MACHINE SLOTTED
Material : CLASS 9 UPVC
Diameter : 50 mm
Slots : 400 micron apertures
Open Area : 2.5 %

FILTER PACK MATERIAL

2-3mm graded washed qtz. sand
from 2.4m to 8.43mBTOC

CEMENT DETAILS

Surface Casing Cemented
from0.53m to 0.9mBTOC
Bentonite Seal 0.9m to 2.4mBTOC

HYDRAULIC DATA

Top of Aquifer :
Static W.L.: 1.46mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : 6.9 Temp.:
Conductivity : 9870 µS/cm

NOTES

Augered with water assist to remove cuttings.

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DRAWN DT DATE 02-Mar-98

Appendix B

Groundwater Chemistry Results

AUSTRALIAN LABORATORY SERVICES P/L
A.C.N. 009 936 029

ANALYTICAL REPORT

CONTACT: MR PETER KUBE
CLIENT: PPK ENVIR & INFRASTRUCTURE P/L
ADDRESS: P O BOX 115
SINGLETON NSW 2330

LABORATORY: ENV SYDNEY
BATCH NUMBER: ES8549
SUB BATCH: 0
No. OF SAMPLES: 12
DATE RECEIVED: 12/12/97
DATE COMPLETED: 29/12/97

ORDER No.: 58E047B
SAMPLE TYPE: WATER
PROJECT:

Method	Analysis description	Units	LOR	WRA1 LOWER	WRA2 LOWER	WRA3 UPPER	WRA3 LOWER
ED-005F	Calcium - Filtered	mg/L	1	35	20	10	39
ED-010F	Magnesium - Filtered	mg/L	1	190	222	203	970
ED-015F	Sodium - Filtered	mg/L	1	741	1080	960	2200
ED-020F	Potassium - Filtered	mg/L	1	14	20	23	30
ED-030	Carbonate as CaCO3	mg/L	1	<1	60	<1	<1
ED-035	Bicarbonate as CaCO3	mg/L	1	948	995	1360	1490
ED-037	Alkalinity as CaCO3	mg/L	1	948	1060	1360	1490
ED-040F	Sulphate - Filtered	mg/L	1	79	63	70	393
ED-045	Chloride	mg/L	1	1020	1610	1080	4890
EG-005F	Iron - Filtered	mg/L	0.1	<0.1	<0.1	<0.1	<1.0
EZ-005	Total Cations	me/L	0.01	49.97	66.76	59.55	178
EZ-010	Total Anions	me/L	0.01	49.38	67.93	59.12	176
EZ-015	Actual (Anion / Cation) Difference	me/L	0.01	0.59	1.17	0.43	2.31
EZ-020	Allowed (Anion / Cation) Difference	me/L	0.01	0.87	1.16	1.02	2.83

COMMENTS:

Ionic balance for WRA6 LOWER out of acceptable limits due to analytes not quantified in this report. Iron LOR's raised (x10) for WRA3 LOWER & WRA8 LOWER due to the high concentration of dissolved salts.

• This is the Final Report which supersedes any preliminary reports with this batch number.

• Results apply to sample(s) as submitted by cli

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AUSTRALIAN LABORATORY
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A.C.N. 009 936 029

ANALYTICAL REPORT

CONTACT: MR PETER KUBE
CLIENT: PPK ENVIR & INFRASTRUCTURE P/L
ADDRESS: P O BOX 115
SINGLETON NSW 2330

LABORATORY: ENV SYDNEY
BATCH NUMBER: ES8549
SUB BATCH: 0
No. OF SAMPLES: 12
DATE RECEIVED: 12/12/97
DATE COMPLETED: 29/12/97

ORDER No.: 58E047B SAMPLE TYPE: WATER PROJECT:

Method	Analysis description	Units	LOR	WRA4 UPPER	WRA4 LOWER	WRA5 UPPER	WRA5 LOWER
ED-005F	Calcium - Filtered	mg/L	1	77	48	27	17
ED-010F	Magnesium - Filtered	mg/L	1	406	214	213	215
ED-015F	Sodium - Filtered	mg/L	1	1150	868	545	922
ED-020F	Potassium - Filtered	mg/L	1	31	19	17	20
ED-030	Carbonate as CaCO3	mg/L	1	<1	<1	<1	54
ED-035	Bicarbonate as CaCO3	mg/L	1	1110	1200	717	933
ED-037	Alkalinity as CaCO3	mg/L	1	1110	1200	717	987
ED-040F	Sulphate - Filtered	mg/L	1	186	151	76	69
ED-045	Chloride	mg/L	1	2240	1120	936	1380
EG-005F	Iron - Filtered	mg/L	0.1	<0.1	2.0	<0.1	0.4
EZ-005	Total Cations	me/L	0.01	88.07	58.25	43.02	59.16
EZ-010	Total Anions	me/L	0.01	89.26	58.74	42.33	60.11
EZ-015	Actual (Anion / Cation) Difference	me/L	0.01	1.19	0.49	0.69	0.95
EZ-020	Allowed (Anion / Cation) Difference	me/L	0.01	1.49	1.02	0.76	1.04

COMMENTS:

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• Results apply to sample(s) as submitted by clie

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ANALYTICAL REPORT

CONTACT: MR PETER KUBE
CLIENT: PPK ENVIR & INFRASTRUCTURE P/L
ADDRESS: P O BOX 115
SINGLETON NSW 2330

LABORATORY: ENV SYDNEY
BATCH NUMBER: ES8549
SUB BATCH: 0
No. OF SAMPLES: 12
DATE RECEIVED: 12/12/97
DATE COMPLETED: 29/12/97

ORDER No.: 58E047B SAMPLE TYPE: WATER PROJECT:

Method	Analysis description	Units	LOR	WRA6 UPPER	WRA6 LOWER	WRA7 LOWER	WRA8 LOWER
ED-005F	Calcium - Filtered	mg/L	1	24	14	29	39
ED-010F	Magnesium - Filtered	mg/L	1	567	126	190	930
ED-015F	Sodium - Filtered	mg/L	1	1440	609	733	2110
ED-020F	Potassium - Filtered	mg/L	1	36	16	14	32
ED-030	Carbonate as CaCO3	mg/L	1	<1	30	50	<1
ED-035	Bicarbonate as CaCO3	mg/L	1	1610	1160	870	1490
ED-037	Alkalinity as CaCO3	mg/L	1	1610	1190	920	1490
ED-040F	Sulphate - Filtered	mg/L	1	217	52	77	390
ED-045	Chloride	mg/L	1	2630	1320	1010	4650
EG-005F	Iron - Filtered	mg/L	0.1	<0.1	<0.1	<0.1	<1.0
EZ-005	Total Cations	me/L	0.01	111	37.97	49.33	171
EZ-010	Total Anions	me/L	0.01	111	62.12	48.50	169
EZ-015	Actual (Anion / Cation) Difference	me/L	0.01	0.51	24.15	0.83	1.98
EZ-020	Allowed (Anion / Cation) Difference	me/L	0.01	1.83	1.07	0.86	2.73

COMMENTS:

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• Results apply to sample(s) as submitted by clie

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ANALYTICAL REPORT

CONTACT:	MR PETER KUBE	LABORATORY:	ENV SYDNEY
CLIENT:	PPK ENVIR & INFRASTRUCTURE P/L	BATCH NUMBER:	ES8549
ADDRESS:	P O BOX 115	SUB BATCH:	0
	SINGLETON NSW 2330	No. OF SAMPLES:	12
		DATE RECEIVED:	12/12/97
		DATE COMPLETED:	29/12/97

ORDER No.: 58E047B SAMPLE TYPE: QUALITY CONTROL PROJECT:

Method	Analysis description	Units	LOR	WRA1 LOWER %SPK REC	WRA6 LOWER CHK	WRA7 LOWER %SPK REC	WRA8 LOWER CHK
ED-005F	Calcium - Filtered	mg/L	1	----	14	----	----
ED-010F	Magnesium - Filtered	mg/L	1	----	126	----	----
ED-015F	Sodium - Filtered	mg/L	1	----	613	----	----
ED-020F	Potassium - Filtered	mg/L	1	----	16	----	----
ED-030	Carbonate as CaCO3	mg/L	1	----	40	----	<1
ED-035	Bicarbonate as CaCO3	mg/L	1	----	1130	----	1480
ED-037	Alkalinity as CaCO3	mg/L	1	----	1170	----	1480
ED-040F	Sulphate - Filtered	mg/L	1	----	52	----	----
ED-045	Chloride	mg/L	1	101 %	1320	98.0 %	4840
EG-005F	Iron - Filtered	mg/L	0.1	103 %	<0.1	106 %	----
EK-005	Total Cations	me/L	0.01	----	38.14	----	----
EK-010	Total Anions	me/L	0.01	----	61.72	----	----
EK-015	Actual (Anion / Cation) Difference	me/L	0.01	----	23.58	----	----
EK-020	Allowed (Anion / Cation) Difference	me/L	0.01	----	1.06	----	----

COMMENTS:

Results which appear on this report are for laboratory QUALITY CONTROL purposes.

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• Results apply to sample(s) as submitted by cl

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ANALYTICAL REPORT

CONTACT:	MR PETER KUBE	LABORATORY:	ENV SYDNEY
CLIENT:	PPK ENVIR & INFRASTRUCTURE P/L	BATCH NUMBER:	ES8549
ADDRESS:	P O BOX 115	SUB BATCH:	0
	SINGLETON NSW 2330	No. OF SAMPLES:	12
		DATE RECEIVED:	12/12/97
		DATE COMPLETED:	29/12/97

ORDER No.: 58E047B SAMPLE TYPE: QUALITY CONTROL PROJECT:

Method	Analysis description	Units	LOR	METHOD BLANK 12/12/97
ED-005F	Calcium - Filtered	mg/L	1	<1
ED-010F	Magnesium - Filtered	mg/L	1	<1
ED-015F	Sodium - Filtered	mg/L	1	<1
ED-020F	Potassium - Filtered	mg/L	1	<1
ED-030	Carbonate as CaCO3	mg/L	1	----
ED-035	Bicarbonate as CaCO3	mg/L	1	----
ED-037	Alkalinity as CaCO3	mg/L	1	----
ED-040F	Sulphate - Filtered	mg/L	1	<1
ED-045	Chloride	mg/L	1	<1
EG-005F	Iron - Filtered	mg/L	0.1	<0.1
EZ-005	Total Cations	me/L	0.01	----
EZ-010	Total Anions	me/L	0.01	----
EZ-015	Actual (Anion / Cation) Difference	me/L	0.01	----
EZ-020	Allowed (Anion / Cation) Difference	me/L	0.01	----

COMMENTS:

• This is the Final Report which supersedes any preliminary reports with this batch number.

• Results apply to sample(s) as submitted by cli

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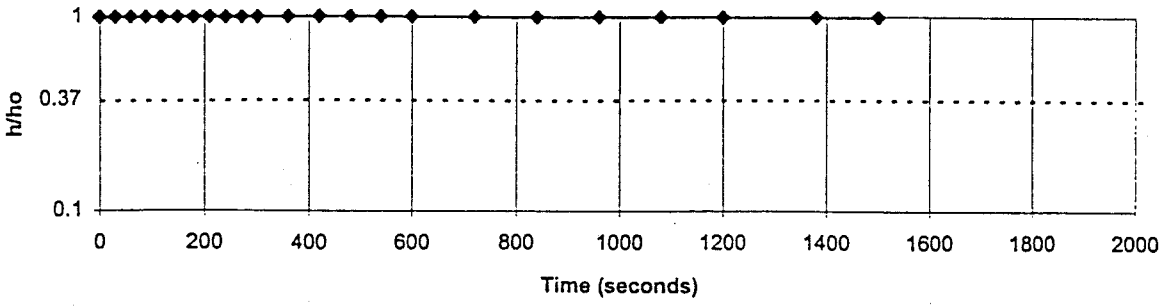
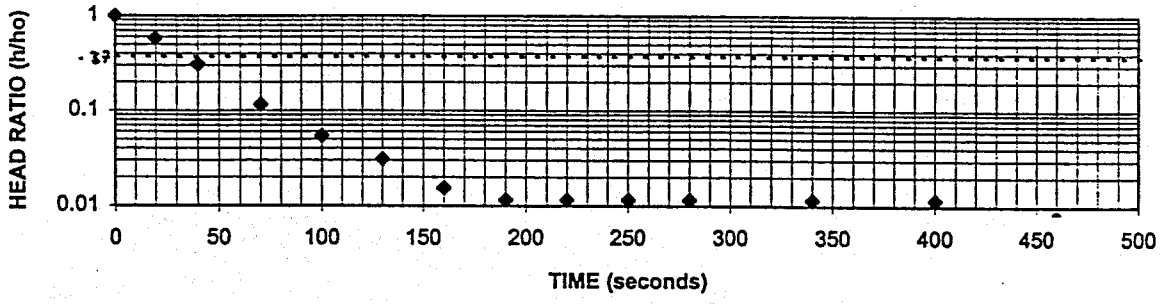
Appendix C

Field Hydraulic Test Data

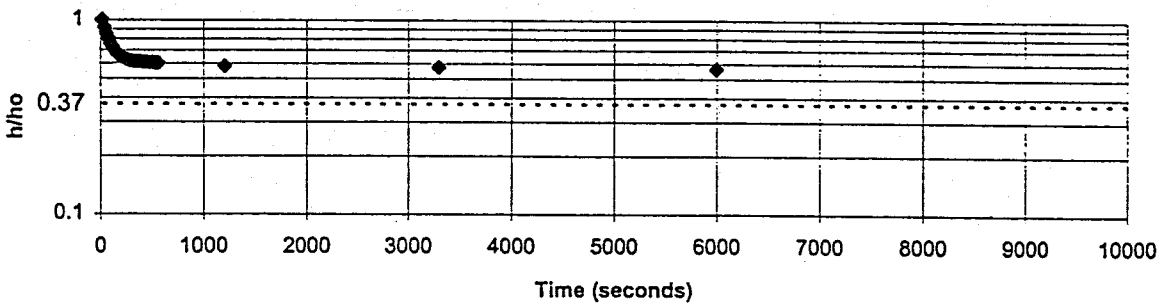
WRA1U - HVORSLEV ANALYSIS



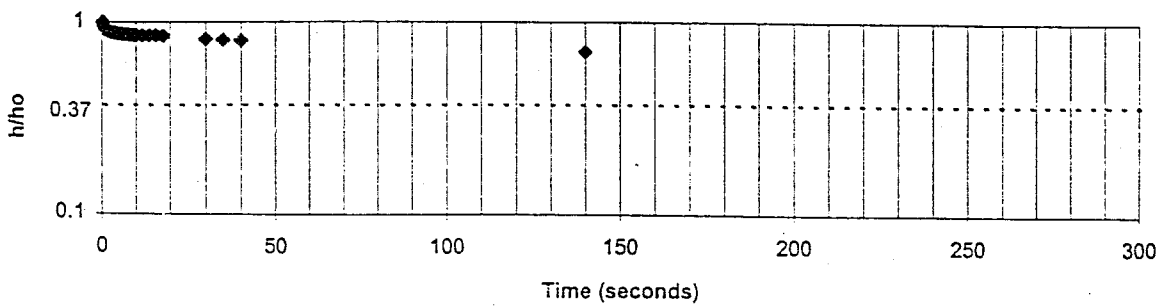
WRA1L- HVORSLEV ANALYSIS



WRA2L - HVORSLEV ANALYSIS



WRA3U - HVORSLEV ANALYSIS



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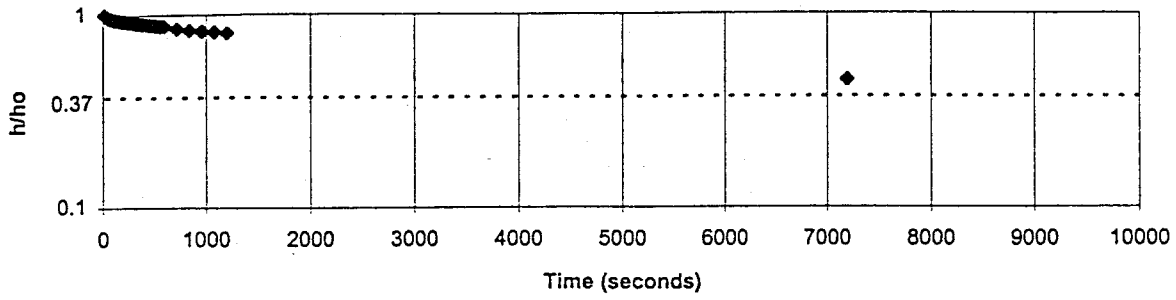
WRA3L - HVORSLEV ANALYSIS



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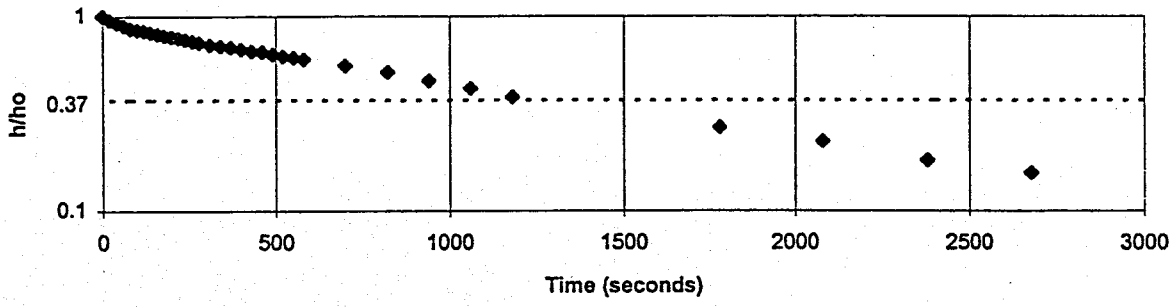

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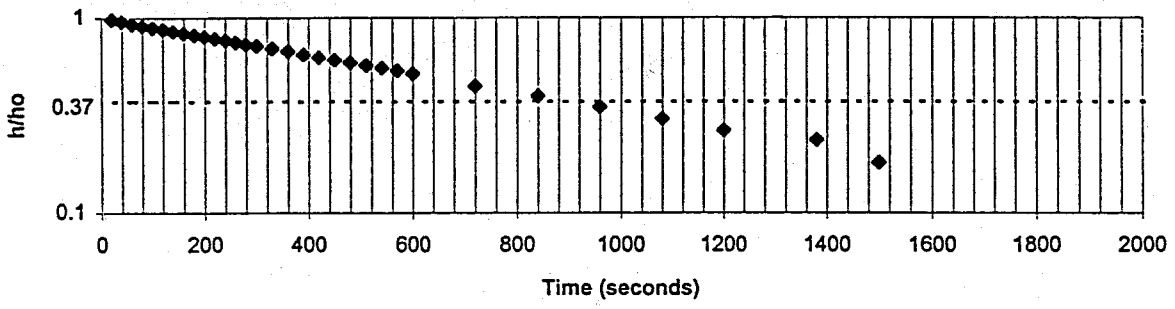

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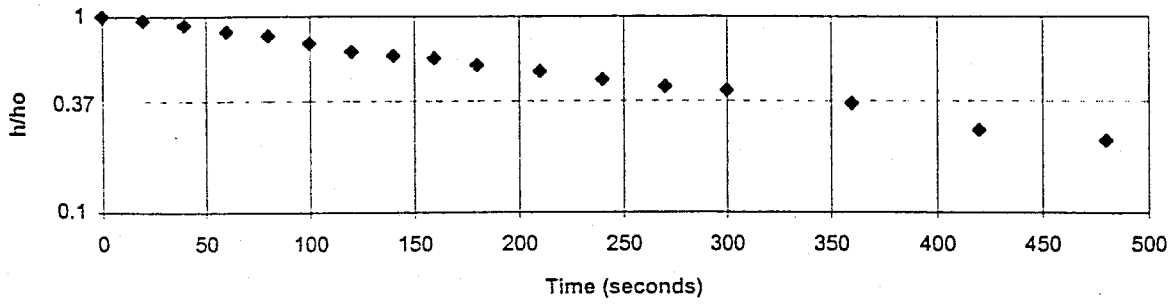

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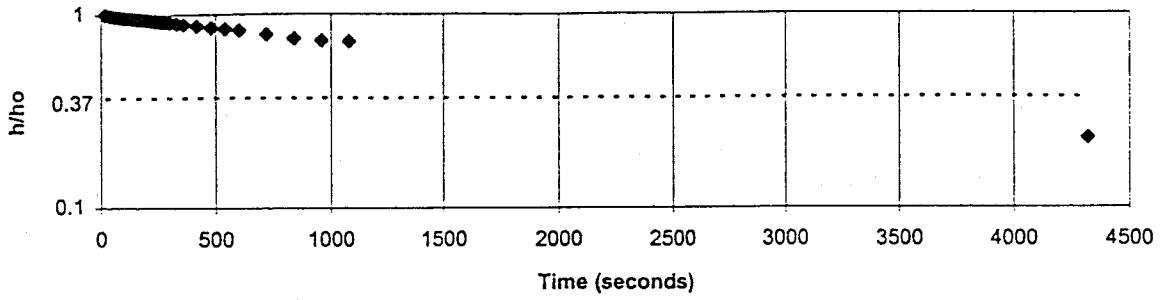
WRA5L - HVORSLEV ANALYSIS



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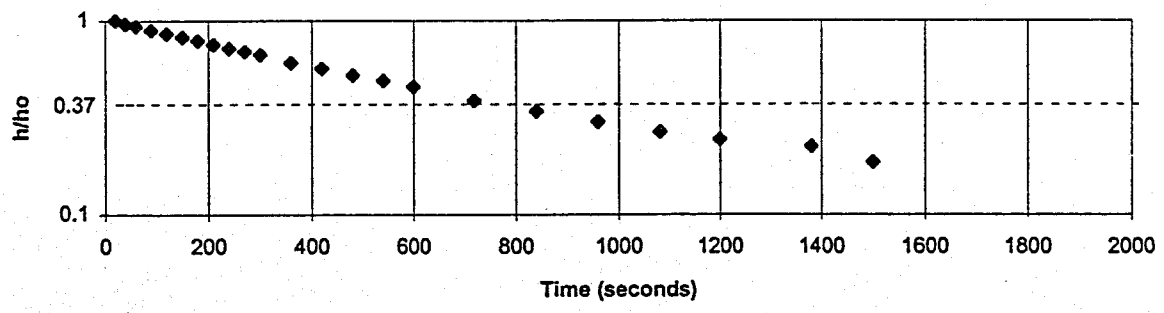

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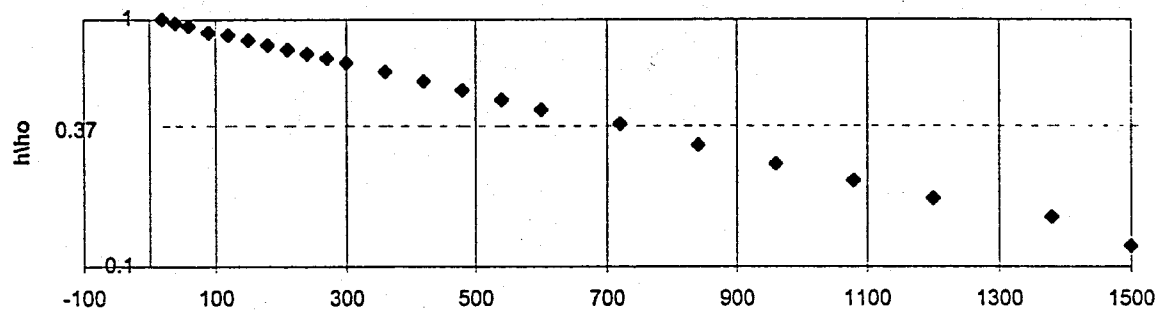

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Appendix D

Laboratory Hydraulic Test Report

CORE LABORATORIES
AUSTRALIA PTY LTD

447-9 Belmont Ave, Kewdale, Perth WA 6105
Tel (61-8) 9353 3944 Fax (61-8) 9353 1369
E-Mail corelab@corelab.com.au

Permeability Study Conducted on Mt Pleasant Borehole Samples

Prepared for
PPK Environment & Infrastructure Pty Ltd

January 1998

File: PRP-97066

Rock Properties
Core Laboratories
Perth
Australia

CORE LABORATORIES
AUSTRALIA PTY LTD

12 January, 1998

PPK Environment & Infrastructure Pty Ltd
PPK House
9 Blaxland Rd
Rhodes NSW 2138

Attention : Mr. D. Thomson

Subject : Permeabiiity Study
Well : Mt Pleasant
File : PRP-97066

Dear Sir,

Presented herein is the final report of a permeability study conducted on the twelve samples from the above well that were forwarded to our laboratory in early December, 1997.

We appreciate the opportunity to present this service to you. Please contact us should you require any further information or assistance.

Yours sincerely,
CORE LABORATORIES

Darryl Beer
Senior Core Analyst

A.C.N. 065 540 838
P.O. Box 785, Cloverdale 6985 Western Australia. Tel (61-8) 9353 3944, Fax (61-8) 9353 1369, E-Mail corelab@corelab.com.au

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INTRODUCTION

Fourteen slim-hole full-diameter cores arrived at our Perth laboratory on 10th December, 1997. We were requested by faxes dated 9th and 12th December to determine permeability on twelve of these samples and to report the data as hydraulic conductivity in metres/day.

INVENTORY

Borehole	Sample #	Depth Range (mBGL)
WRA1	1	8.64 - 8.86
WRA1	2	10.25 - 10.42
WRA2	5	4.61 - 4.80
WRA2	6	10.76 - 10.95
WRA2	7	15.49 - 15.66
WRA3	8	8.85 - 9.00
WRA4	9	4.49 - 4.62
WRA4	10	11.23 - 11.38
WRA5	11	7.59 - 7.82
WRA5	12	10.76 - 11.00
WRA6	13	6.57 - 6.85
WRA6	14	13.82 - 14.00

COMPANY : PPK ENVIRONMENT & INFRASTRUCTURE PTY LTD
WELL : MT PLEASANT

Laboratory Procedures

LABORATORY PROCEDURES

Initial Inventory

The core pieces were laid out and checked against the sample list on the two faxes received. The plug depths were taken as the depth interval as supplied on the sample list for the core pieces as requested.

Plug Sampling and Preparation

Two 1 inch diameter core plugs (one horizontal and one vertical) were drilled in each core sample using tap water as the bit lubricant. The ends of the core plugs were trimmed, and the trim ends bagged and labelled. The samples were cleaned of fines, surface dried and numbered. A total of twenty one plugs were obtained. Three plugs (8H, 9H, and 9V) were unsuccessful after several attempts, so it was decided to measure their permeabilities using a probe permeameter.

The samples were dried in a convection oven at 90°C for 24 hours, and allowed to cool to room temperature in desiccators.

Permeability Determinations

The length and diameter of each plug was recorded prior to measuring its permeability at ambient pressure (1000psi). Two standard check plugs were run in conjunction with every run of samples. Klinkenberg permeability (Kinf) values (in millidarcies, mD) are obtained directly from the CMS™300, since it operates by unsteady-state principles.

Permeability Conversions

Permeability expressed as hydraulic conductivity is temperature dependent, therefore it should be stated with the temperature for which it applies. The two standard temperatures used are 20°C and 60°F, and their respective conversion factors are:

For 20°C : $K_{inf} \times 8.303 \times 10^{-4} = K_{hc}$
For 60°F : $K_{inf} \times 7.413 \times 10^{-4} = K_{hc}$

Where : K_{inf} = Klinkenberg permeability (mD)
K_{hc} = hydraulic conductivity (m/day)

The permeability data and hydraulic conductivity data, at both standard temperatures, is tabulated on page 3.

Tabular Data

COMPANY : PPK ENVIRONMENT & INFRASTRUCTURE
WELL : MT PLEASANT

PERMEABILITY RESULTS

SAMPLE NUMBER	BORE HOLE	DEPTH FROM (mBGL)	DEPTH TO (mBGL)	ORIENT.	PERMEABILITY 1000psi NOBP Kinf (md)	PERMEABILITY 1000psi NOBP Kair (md)	HYDRAULIC CONDUCTIVITY 20°C. m/day	HYDRAULIC CONDUCTIVITY 60°F. m/day
1	WRA1	8.64	8.86	Horizontal	2.64	3.22	2.19E-03	1.96E-03
				Vertical	0.045	0.057	3.74E-05	3.34E-05
2	WRA1	10.25	10.42	Horizontal	1.04	1.37	8.64E-04	7.71E-04
				Vertical	0.043	0.084	3.60E-05	3.21E-05
5	WRA2	4.61	4.80	Horizontal	3.00	3.62	2.49E-03	2.22E-03
				Vertical	0.110	0.155	9.13E-05	8.15E-05
6	WRA2	10.76	10.95	Horizontal	0.038	0.082	3.14E-05	2.80E-05
				Vertical	0.009	0.018	7.16E-06	6.39E-06
7	WRA2	15.49	15.66	Horizontal	0.020	0.041	1.69E-05	1.50E-05
				Vertical	0.004	0.010	3.73E-06	3.33E-06
8	WRA3	8.85	9.00	Horizontal*	0.617	0.921	5.12E-04	4.57E-04
				Vertical	0.005	0.011	3.97E-06	3.54E-06
9	WRA4	4.49	4.62	Horizontal*	<0.001	0.001	<8.30E-07	<7.41E-07
				Vertical*	1.46	2.00	1.21E-03	1.08E-03
10	WRA4	11.23	11.38	Horizontal	0.225	0.368	1.87E-04	1.67E-04
				Vertical	0.021	0.044	1.75E-05	1.56E-05
11	WRA5	7.59	7.82	Horizontal	0.001	0.002	8.30E-07	1.48E-06
				Vertical	0.001	0.001	8.30E-07	7.41E-07
12	WRA5	10.76	11.00	Horizontal	0.017	0.033	1.37E-05	1.22E-05
				Vertical	0.065	0.126	5.37E-05	4.80E-05
13	WRA6	6.57	6.85	Horizontal	0.055	0.091	4.54E-05	4.05E-05
				Vertical	0.012	0.019	1.02E-05	9.12E-06
14	WRA6	13.82	14.00	Horizontal	0.009	0.017	7.21E-06	6.43E-06
				Vertical	0.003	0.008	2.85E-06	2.54E-06

NOTE : * permeability measured by probe permeameter.