PILBARA IRON ORE AND INFRASTRUCTURE PROJECT

Chichester Operations Groundwater and Bore Management Plan

21 August 2009

45-PL-EN-0005

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1	1 May 2008	issued for Use	Katrina Burke		Diane Dowdell
1a	13 July 2009	Incorporate management strategies from dewatering and injection proposal	Amy Barker	Paul Connolly	
2	21 August 2009	Issued for use			Diane Dowdell

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1. INTRODUCTION

1.1 PROJECT OVERVIEW

Fortescue Metals Group Limited (Fortescue) has commenced operation of the Pilbara Iron Ore and Infrastructure Project (the Project), which consists of several iron ore mines and associated rail and port infrastructure in the Pilbara region of Western Australia. The primary environmental approvals for the project have been obtained in four stages:

- Stage A consisting of an iron ore export facility at Port Hedland and a north-south railway from the central Pilbara to Port Hedland (approved under Ministerial Statement 690);
- Stage B consisting of two iron ore mines in the Eastern Pilbara (Christmas Creek and Mindy Mindy) and an east-west spur rail line connecting to the Stage A railway (approved under Ministerial Statement 707);
- Cloudbreak iron ore mine west of the Christmas Creek area (approved under Ministerial Statement 721 and Commonwealth Assessment EPBC 2005/2205); and
- Port facility upgrade of the third berth at Anderson Point, Port Hedland: Dredging and wharf construction (approved under Ministerial Statement 771).

The Cloudbreak and Christmas Creek mine sites are located on the southern slopes of the Chichester Range; collectively the two mine sites are referred to as the Chichester Operations.

During the initial stages of operation, mining is proposed for the Cloudbreak and Christmas Creek areas, with ore hauled by truck from Christmas Creek to the ore processing facility at Cloudbreak. Ore from Cloudbreak and Christmas Creek will be transported by train along the approved north-south (Stage A) and east-west (Stage B) railways to Port Hedland.

Proposed extensions of the rail line to the south and to the east will be considered in future expansions.

The existing infrastructure at Fortescue's Herb Elliott Port provides for train unloading, stacking, reclaiming and ship loading of iron ore via a conveyor system. Expansion of the port facility to include an additional fourth and fifth berth and increased reclaiming capacity is proposed to handle increased ore production from the Chichester Operations.

1.2 PURPOSE

The purpose of this plan is to address the management actions required prior to and during construction, operations and decommissioning. This plan is applicable to all areas of construction and operation for proposed and active mines. Additionally, the plan is written to address Ministerial Statement 707 (Condition 9) and Ministerial Statement 721 (Condition 9).

The plan outlines the following:

- Monitoring and bore management strategies that will be used during groundwater abstraction activities; and
- Potential impacts from mining operations on the local hydrogeology and allows mitigation measures to be implemented.

Specific objectives include:

- Establish a baseline dataset of groundwater monitoring over the project areas from a network of strategically located monitoring bores;
- Continue to investigate and review dewatering methods focussing on achieving the required advance dewatering with minimal net pumping;
- Investigate water disposal options as a method of minimising drawdown impact and maintaining water quality on the Fortescue Marshes, groundwater dependent vegetation and pastoral bores;
- Define the appropriate environmental triggers for contingency plans; and
- Manage groundwater use strategically by review of the baseline groundwater dataset, dewatering volumes and methods and actioning preventative measures where required to limit net environmental impact.

1.3 SCOPE

This plan applies to the management of groundwater and bores associated with the Chichester Operations.

1.4 BACKGROUND

The Project is located within the eastern Fortescue Valley, a trough between the Chichester and Hamersley Plateaux; the eastern portion drains into the Fortescue Marshes. The mines are located in the northern section of the valley, in the Chichester Range.

Throughout the region groundwater levels are a subdued reflection of topography. Maximum groundwater levels (approximately 430 mRL) were observed along the

topographic highs associated with rocks of the Hamersley and Fortescue Groups, whilst groundwater levels were lowest in low-lying areas associated with creeks and the Fortescue Marshes and Fortescue River system. Groundwater levels in the vicinity of the Fortescue Marshes are below 400mRL, which represents the bed of the Marshes.

The continued expansion of the Chichester Operations requires ongoing dewatering to sustain mining operations. Disposal of abstracted groundwater surplus to supply requirements is via injection into local groundwater bodies of similar water quality.

The infrastructure for the freshwater system includes:

- Bores for mine pit dewatering and injection to local groundwater bodies;
- Lined transfer ponds and associated pumps for onward delivery of water;
- Settlement ponds for sump water; and
- Pipelines to convey water throughout the mine dewatering and injection system.

In a letter dated 16 February 2009, the Chairman of the Environmental Protection Authority (EPA) advised Fortescue:

> *"…that the proposed Hillside Borefield, whilst not specifically named in the PER, is in accordance with the approved proposal.*
>
> *…the establishment of the Hillside Borefield is consistent with the existing assessment and approval of this proposal. The Hillside Borefield should be included in the Groundwater and Bore Management Plan required by Condition 9-1 of Ministerial Statement No. 721 and vegetation and groundwater levels should be closely monitored and managed according to trigger levels set out in the Plan."*

A copy of this letter is presented in Appendix A.

Fortescue envisages a similar injection system dedicated to the abstracted saline water but is currently proposing a trial before seeking formal approval.

Fortescue has prepares Groundwater Operating Strategies to support licence applications to take water submitted to the Department of Water which address the issues associated with mine dewatering and injection for the Cloudbreak minesite, a start up water supply and monitoring bores for the Chichester Operations (including Christmas Creek).

1.5 POTENTIAL ENVIRONMENTAL IMPACTS

Extensive groundwater investigations have been carried out, both in proposed mine areas and regionally to develop an understanding of the hydrogeology operating within the Chichester Operations. Dewatering at Cloudbreak began in 2008 and has been closely monitored. The hydrogeological data and operating experience has been utilised to develop, calibrate and fine tune the numerical groundwater model for the Cloudbreak area. The model effectively predicts what the effects of dewatering and injection will have on local and regional hydrogeology. Dewatering and injection systems have been designed based on this model to maximise pump efficiency and minimise environmental impacts.

The *Cloudbreak Hydrogeological Assessment* (CB-PL-HY-0001) provides a technical assessment and summary of the analyses of dewatering and groundwater disposal at Cloudbreak. The assessment has been based on the Cloudbreak Three Year Mine Plan.

The main risks to groundwater associated with the dewatering and injection program comprise movement of the saline groundwater front or "interface" and changes to local groundwater levels. The potential impacts to groundwater are changes to the groundwater quality and levels. This can also impact the subterranean environment and groundwater dependent ecosystems. Potential impacts are summarised below:

- increasing salinity levels in local and regional groundwater;
- loss of stygofaunal habitat;
- effects on phreatophytic vegetation (i.e. groundwater-dependent vegetation communities);
- effects on Mulga vegetation communities;
- effects on the Fortescue Marshes and resultant impacts to the local ecology;
- contamination of groundwater from release of hydrocarbons an chemicals;
- reduction in yields and water quality from station bores;
- potential for cumulative impacts from mining operations at Cloudbreak and Christmas Creek; and
- increased turbidity of the receiving aquifer.

Measures to be undertaken by Fortescue to manage and mitigate the potential environmental impacts are outlined in Section 5.

1.6 OTHER RELEVANT DOCUMENTS

The following Fortescue documents should be read in conjunction with this plan:

- *Cloudbreak Operational Environmental Management Plan* (CB-PL-EN-0001);
- *Stygofauna Survey Plan* (45-PL-EN-0010);
- *Fortescue Marshes Management Plan* (45-PL-EN-0009);
- *Cloudbreak Hydrogeological Assessment* (CB-PL-HY-0001); and
- Groundwater Operating Strategies as approved by the Department of Water.

2. STAKEHOLDER CONSULTATION

Fortescue has undertaken an extensive stakeholder consultation program whereby landowners, regulators and other relevant parties have been consulted with regard to investigation and design of the Project.

Fortescue applies the principles of its *Stakeholder Consultation Strategy* (100-PH-EN-0003) for the development and implementation of stakeholder engagement during management plan development and implementation.

3. APPLICABLE LEGISLATION

Fortescue, its employees and contractors will comply with all Commonwealth and State legislation that applies to the development and operation of the Pilbara Iron Ore and Infrastructure Project. Legislation relevant to water management and its applicability are outlined in Table 1.

Table 1: Relevant Legislation and its Application

State Government Legislation	Application
Environmental Protection Act 1986	Environmental Impact Assessment and Ministerial approval processes; regulation of prescribed premises and prevention of pollution and environmental harm
Rights in Water and Irrigation Act 1914	Regulation of activities that (potentially) impact on the State's water resources

Linkages between requirements contained in Ministerial Statement conditions and commitments in this plan are contained in Table 2.

Table 2: Response/Evidence to Requirements of Ministerial Statements 707 and 721 in Relation to Groundwater Management

Condition	Requirement	Location in Plan
9-1 of MS 707 & 721	Provide a framework to predict and measure impacts	Section 5.1
9-1 of MS 707 & 721	Protect and maintain the quality of the water in the aquifer	Section 5.2
9-1 of MS 707	Protect phreatophytic vegetation and any other groundwater dependent ecosystems	Section 5.3
9-1 of MS 707 & 721	Define appropriate environmental triggers for contingency plans	Section 5.5
9-1 of MS 721	Ensure that station bores within the area of groundwater drawdown maintain adequate outputs for pastoral purposes	Section 5.4
9-1 of MS 721	Protect phreatophytic vegetation	Section 5.3

Note: The *Chichester Operations Groundwater and Bore Management Plan* is the same as the Borefield and Dewatering Management Plan as mentioned in Ministerial Statements 707 and 721. The title is the only differing factor.

4. ROLES AND RESPONSIBILITIES

Table 3 provides provisional roles and responsibilities of the personnel responsible for the implementation of the *Chichester Operations Groundwater and Bore Management Plan*.

Table 3: Roles and Responsibilities

Position	Responsibility
Environment Superintendent	Implement and maintain the management plan Conduct regular reviews of the management plan Ensure the management plan is being complied with by all personnel and contractors Participate in compliance audits and inspections
Managers / Superintendents (Mining/Construction)	Ensure all personnel are aware of their obligations in relation to this management plan Participate in compliance audits and inspections
Hydrogeology Manager	Conducts reviews of all aquifer monitoring data and provides monitoring information to the Environment Department Update Groundwater Operating Strategies as required
All Fortescue personnel, contractors and visitors	Comply with the requirements of this management plan Report all incidents to the site Project Manager

5. ENVIRONMENTAL MANAGEMENT

A series of management objectives has been determined. For each of these objectives, several management actions have been developed to ensure the impacts from Fortescues operations are managed, and a range of monitoring and assessment functions to which the plan is being implemented. The general approach to management of groundwater and bores has been detailed according to the following structure:

Item	Content
Objective	What is intended to be achieved?
Management Actions	Tasks that will be undertaken to ensure the Objective is met, lists of procedures required
Performance Indicators	Qualitative or quantitative measurement to gauge the performance of the actions undertaken
Monitoring	Details of measurement of performance indicators
Reporting	Nature, timing and responsibility for reporting results
Corrective Action	Action to be taken if monitoring indicates objective is not being met
Term	Active term of management plan
Responsibility	Delegation/nomination of responsibilities for overseeing management plan operation

Monitoring, triggers, response and contingency requirements are generally detailed in relevant Groundwater Operating Strategies as approved by the Department of Water. These are referenced throughout the remainder of this plan and have been provided in Appendix B.

5.1 BASELINE MONITORING

A monitoring programme of water level and water quality over selected bores will be undertaken by Fortescue to measure the potential environmental impacts. Baseline monitoring requirements are outlined below.

Objective	Provide a framework to predict and measure impacts.
Management Actions	Maintain a monitoring programme for water level and water quality over selected monitor bores and station bores for at least one year prior to mining. Modify the current monitor bore network through the Cloudbreak and Christmas Creek areas to provide a comprehensive coverage of groundwater conditions throughout the project area (current and proposed monitor bore locations are provided on Figure 2 to be part of the groundwater monitoring network). Details of the monitor bore network are provided in the Groundwater Operating Strategy. If the Fortescue Marsh Environmental Investigation proposal proceeds then any bores established will be included in the monitoring network. Collect water levels from the monitoring bore network monthly. Collect field water quality measurements of pH and EC monthly. Collect water samples for laboratory analysis of major ionic species every six months. A weather station is to be set up at the Cloudbreak mine area. Once established, data will be recorded daily from this station.
Performance Indicators	Annual audits of data to check validity and trends of groundwater data. Anomalies observed during monthly monitoring investigated at the completion of each months monitoring cycle.
Monitoring	Annual audits of groundwater data. Monthly review of monitoring data recorded each month.
Reporting	In compliance with GWL licence conditions, Fortescue will present abstraction and groundwater monitoring data to the DoW in the form of quarterly and annual groundwater monitoring reviews. A Triennial Report discussing the previous three years of data.
Corrective Action	Review processes and repeat sampling if anomalies are found in the baseline data set.
Term	Life of the project.
Responsibility	Managers, Construction, Mining and Hydrogeology. Head of Environment. Environment Superintendent.

5.2 WATER QUALITY

Monitoring of water quality throughout the project is outlined below. Further detail is available in Appendix B.

Objective	Protect and maintain the water quality in the aquifer.
Management Actions	Establish baseline groundwater data set of salinity distribution through the project area. The baseline water quality monitoring shall include full chemical analysis for the major ionic species. Conduct and monitor impacts of a trial dewatering investigation on the groundwater levels and salinity distribution. Conduct and monitor trial injection/water disposal options and the effect on the groundwater regime. On the basis of these investigations design and implement dewatering and water disposal systems tailored to minimise impact on the groundwater regime. Monitor groundwater levels, abstraction and water quality and adjust/modify dewatering regime as necessary to mitigate any adverse impact on groundwater quality (Appendix B). Water quality parameters to be monitored and the frequency of monitoring groundwater levels and quality will be provided in the Operating Strategy (Appendix B).
Performance Indicators	Existing salinity distribution does not alter significantly or to a level that is irreversible during dewatering and waste water disposal activities. Anomalies observed during monthly monitoring investigated at the completion of each months monitoring cycle.
Monitoring	All monitoring data including water quality, abstraction and water level data will be compiled on a monthly basis. Monitoring data shall be checked to confirm or otherwise that no adverse impact is occurring on the groundwater regime.
Reporting	Incident reporting system. Hydrogeological Reports as per groundwater abstraction licence conditions.
Corrective Action	If the management practices fail to preserve the groundwater quality or adverse trends in groundwater quality are observed then corrective actions will be taken, which may include but not be limited to, modification of the dewatering design, modification of disposal options, mine water control using physical barriers and reduction of pumping
Term	Life of the project.
Responsibility	Managers, Construction, Mining and Hydrogeology. Head of Environment. Environment Superintendent.

5.3 PHREATOPHYTIC VEGETATION AND GROUNDWATER DEPENDENT ECOSYSTEMS

Fortescue's strategy to manage impacts to phreatophytic vegetation and other groundwater dependent ecosystems from stress or death that may occur due to excessive groundwater drawdown is described below. Further detail is available in Appendix B.

Objective	Protect groundwater dependent vegetation from stress or death due to excessive groundwater drawdown.
Management Actions	Establish fenced photo and visual inspection monitoring points for five samphire areas prior to operations commencing (as per *Fortescue Marshes Management Plan* (45-PL-EN-0009)). In conjunction with the DEC, establish monitoring bores and carry out investigations on nature of groundwater dependence of vegetation. Use hyperspectral aerial photography to map vegetation condition, water loss and dust deposition as a baseline tool and for ongoing annual monitoring. Manage dewatering activities and water disposal to minimise drawdown impact on the groundwater dependent ecosystems such as the fringing vegetation of the Fortescue Marshes. Drawdown impact measured during quarterly vegetation condition assessment of the groundwater dependent ecosystems (Appendix B). Undertake monthly groundwater dependent vegetation condition monitoring at four sites at Cloudbreak. This involves photographing *Eucalyptus victrix* and *E. camaldulensis* at designated monitoring points and assessing the condition of the vegetation against a set of vegetation condition assessment parameters (Appendix B).
Performance Indicators	Incident reports of vegetation stress potentially attributable to Fortescue's operations.
Monitoring	Field inspections, monthly water level monitoring and photo monitoring. Landsat mapping record as general mapping tool.
Reporting	Annual report detailing photo monitoring and hyperspectral aerial photography plus field observations.
Corrective Action	Reduce dewatering activity. Move water disposal to restore groundwater levels.
Term	Life of the project.
Responsibility	Managers, Construction, Mining and Hydrogeology. Head of Environment. Environment Superintendent.

5.4 STATION BORES

Fortescue's management of station bores throughout the Project are outlined below.

Objective	Protect continuity of supply for station bores.
Management Actions	Establish water usage rates and baseline water information on existing station bores. Establish contingency plan in consultation with station manager/lease owners for alternative water supply should station bore supply be effected by dewatering drawdown. This may involve installation of another bore or conveying water to site for use. Manage dewatering activities and water disposal to minimise drawdown impact on the groundwater dependent ecosystems (Appendix B).
Performance Indicators	No measurable impact on station bores from mining operations.
Monitoring	Field inspections, annual water level monitoring of station bores in accordance with the Operating Strategy. Investigate alternative image capability and areas to be monitored as required.
Reporting	Annual report detailing field observations.
Corrective Action	Reduce dewatering activity. Adjust water disposal to restore groundwater levels.
Term	Life of the project.
Responsibility	Managers, Construction, Mining and Hydrogeology. Head of Environment. Environment Superintendent.

5.5 MONITORING AND RESPONSE

Fortescue's management strategies for monitoring and response are described below. Further detail is available in Appendix B.

Objective	Define appropriate environmental triggers for contingency plans.
Management Actions	Compile groundwater baseline data set to determine seasonal and yearly variation in groundwater levels and water quality. Set acceptable limits to allowable drawdowns based on these data and groundwater model prediction of drawdown due to dewatering and water disposal (Appendix B). Further investigate groundwater dependent ecosystems and robustness of these systems to withdrawal of groundwater and provide information on physiological character responses to groundwater extraction from dewatering of mining area in hydrogeological reports submitted to the Department of Water.
Performance Indicators	Groundwater drawdown remains in acceptable limits indicated by baseline data and model predictions.
Monitoring	Monthly monitoring of water level and abstraction.
Reporting	Monthly internal water reports shall include compilation of all monitoring data including water levels, abstraction and water quality. Hydrogeological reports shall be compiled including all data from monitoring and dewatering activities in accordance with the conditions of relevant licences. On review of data; verified trigger level exceedences will be reported to the DoW in hydrogeological reports detailing the nature of the exceedence and proposed mitigation strategies.
Corrective Action	Modify dewatering system to compensate for any adverse impact on the groundwater regime. Reduce pumping rates to limit drawdown.
Term	Life of project.
Responsibility	Managers, Construction, Mining and Hydrogeology. Head of Environment. Environment Superintendent.

5.6 DEWATERING AND INJECTION

Fortescue's management strategies to minimise potential impacts from dewatering and injection activities are described below.

Objective	To ameliorate or minimise potential regional impacts from dewatering and injection activities.
Management Actions	Dewatering will be from closely-spaced bores around the perimeter of mining strips to maximise well interference effects, this minimising abstraction rates. Water abstracted during dewatering operations will be re-used on site wherever possible. Water surplus to site requirements will be injected to the south of the active pits to maintain hydraulic heads, and to stabilise the fresh/saline groundwater interface and injected into laterally located borefields to the east and west of mining operations (the Hillside Borefield) and abandoned pits to conserve groundwater resources. Where the amount of water requiring disposal exceeds the injection capacity available at the time, Fortescue will implement the contingencies as detailed in Appendix B. Regular monitoring of the in-pit and regional monitoring bore network will be undertaken, with critical review of monitoring data to guide appropriate adjustment of both dewatering and injection rates and locations to meet environmental objectives (Appendix B).
Performance Indicators	Not exceeding impact trigger levels Maintaining or improving vegetation health
Monitoring	Monthly monitoring of groundwater levels, water quality and abstraction/injection volumes will be undertaken. Exceedences of trigger levels are automatically identified by Fortescue's groundwater database.
Reporting	Incident reporting system. Quarterly Groundwater Monitoring Review. Annual Groundwater Monitoring Review. Annual Environmental Report.
Corrective Action	Where a Level 1, Level 2 or EC trigger level is exceeded, Fortescue will implement the response described in Appendix B.
Term	Life of the project.
Responsibility	Managers, Construction, Mining and Hydrogeology. Head of Environment. Environment Superintendent.

5.7 CLOSURE

The plan to restore the hydrogeology of the project area to the original groundwater conditions is outlined below.

Objective	To restore the hydrogeology of the project area to the original groundwater conditions.
Management Actions	Mined out pit areas are to be infilled with waste rock ensuring that no 'windows' are open to the groundwater regime. Should saline water disposal to abandoned pits be necessary then a groundwater model will be used to assess the net effect and acceptability of this practice on the groundwater regime. The groundwater model would be used to predict the fate of a groundwater saline plume emanating from the pit disposal.
Performance Indicators	Comparison of pre and post mining monitoring data.
Monitoring	Monthly water monitoring in post closure areas and shall include water levels and water quality for 12 months following closure. Following the 12 month period, the requirement for monitoring will be reviewed. A post closure hydrogeological report shall be compiled including all data from monitoring activities.
Reporting	Post closure hydrogeological report.
Corrective Action	Increase or decrease water disposal to abandoned pits and injection bores as necessary to ensure groundwater saline plume emanating from the pit is in accordance with the groundwater model.
Term	Life of project.
Responsibility	Managers, Construction, Mining and Hydrogeology. Head of Environment.

6. REVIEW

It is important that plans and procedures are frequently reviewed and revised as Fortescue's operations change and opportunities for improved management practices are identified. This Management Plan is a living document and will be modified periodically to reflect changes to the mine plan, developing knowledge of the hydrogeology, results of water monitoring and reviews of this information.

This Management Plan will be reviewed at least every five years, or when significant additional information comes to hand. The review will be based on achieving approval requirements, Fortescue commitments, and progress in implementing the management plan and will incorporate any new investigations, information, techniques and advice from experts and regulatory authorities.

Upon review, the document will be revised where appropriate and the revision status will be updated in accordance with Fortescue's document control procedures.

7. CONSOLIDATED MANAGEMENT ACTIONS

Table 4 provides a summary of the management actions identified within this plan.

Table 4: Summary of Management Actions

Environmental Aspect	Management Actions
Baseline Monitoring	Maintain a monitoring programme for water level and water quality over selected monitor bores and station bores for at least one year prior to mining. Modify the current monitor bore network through the Cloudbreak and Christmas Creek areas to provide a comprehensive coverage of groundwater conditions throughout the project area (current and proposed monitor bore locations are provided on Figure 2 to be part of the groundwater monitoring network). Details of the monitor bore network are provided in the Groundwater Operating Strategy. If the Fortescue Marsh Environmental Investigation proposal proceeds then any bores established will be included in the monitoring network. Collect water levels from the monitoring bore network monthly. Collect field water quality measurements of pH and EC monthly. Collect water samples for laboratory analysis of major ionic species every six months. A weather station is to be set up at the Cloudbreak mine area. Once established, data will be recorded daily from this station.
Water Quality	Establish baseline groundwater data set of salinity distribution through the project area. The baseline water quality monitoring shall include full chemical analysis for the major ionic species. Conduct and monitor impacts of a trial dewatering investigation on the groundwater levels and salinity distribution. Conduct and monitor trial injection/water disposal options and the effect on the groundwater regime. On the basis of these investigations design and implement dewatering and water disposal systems tailored to minimise impact on the groundwater regime. Monitor groundwater levels, abstraction and water quality and adjust/modify dewatering regime as necessary to mitigate any adverse impact on groundwater quality (Appendix B). Water quality parameters to be monitored and the frequency of monitoring groundwater levels and quality will be provided in the Operating Strategy (Appendix B).
Phreatophytic vegetation and Groundwater Dependent	Establish fenced photo and visual inspection monitoring points for five samphire areas prior to operations commencing (as per *Fortescue Marshes Management Plan* (45-PL-EN-0009)).

Environmental Aspect	Management Actions
Ecosystems	In conjunction with the DEC, establish monitoring bores and carry out investigations on nature of groundwater dependence of vegetation. Use hyperspectral aerial photography to map vegetation condition, water loss and dust deposition as a baseline tool and for ongoing annual monitoring. Manage dewatering activities and water disposal to minimise drawdown impact on the groundwater dependent ecosystems such as the fringing vegetation of the Fortescue Marshes. Drawdown impact measured during quarterly vegetation condition assessment of the groundwater dependent ecosystems. Undertake monthly groundwater dependent vegetation condition monitoring at four sites at Cloudbreak. This involves photographing *Eucalyptus victrix* and *E. camaldulensis* at designated monitoring points and assessing the condition of the vegetation against a set of vegetation condition assessment parameters (Appendix B).
Station Bores	Establish water usage rates and baseline water information on existing station bores. Establish contingency plan in consultation with station manager/lease owners for alternative water supply should station bore supply be effected by dewatering drawdown. This may involve installation of another bore or conveying water to site for use. Manage dewatering activities and water disposal to minimise drawdown impact on the groundwater dependent ecosystems (Appendix B).
Monitoring and Response	Compile groundwater baseline data set to determine seasonal and yearly variation in groundwater levels and water quality. Set acceptable limits to allowable drawdowns based on these data and groundwater model prediction of drawdown due to dewatering and water disposal (Appendix B). Further investigate groundwater dependent ecosystems and robustness of these systems to withdrawal of groundwater and provide information on physiological character responses to groundwater extraction from dewatering of mining area in hydrogeological reports submitted to the Department of Water.
Dewatering and Injection Aquifer Management	Dewatering will be from closely-spaced bores around the perimeter of mining strips to maximise well interference effects, this minimising abstraction rates. Water abstracted during dewatering operations will be re-used on site wherever possible. Water surplus to site requirements will be injected to the south of the active pits to maintain hydraulic heads, and to stabilise the fresh/saline groundwater interface and injected into laterally located borefields to the east and west of mining operations (the Hillside Borefield) and abandoned pits to conserve groundwater resources. Regular monitoring of the in-pit and regional monitoring bore

Environmental Aspect	Management Actions
	network will be undertaken, with critical review of monitoring data to guide appropriate adjustment of both dewatering and injection rates and locations to meet environmental objectives (Appendix B).
Closure	Mined out pit areas are to be infilled with waste rock ensuring that no 'windows' are open to the groundwater regime. Should saline water disposal to abandoned pits be necessary then a groundwater model will be used to assess the net effect and acceptability of this practice on the groundwater regime. The groundwater model would be used to predict the fate of a groundwater saline plume emanating from the pit disposal.

8. REFERENCES

Ecoscape (2009). *Flora and vegetation impact assessment from dewatering at Fortescue Cloudbreak Mine* (June 2009).

Environ (2005). *Pilbara Iron Ore and Infrastructure Project, Cloudbreak Public Environmental Review* (September 2005).

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Figures

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Figure 1

Regional Project Location

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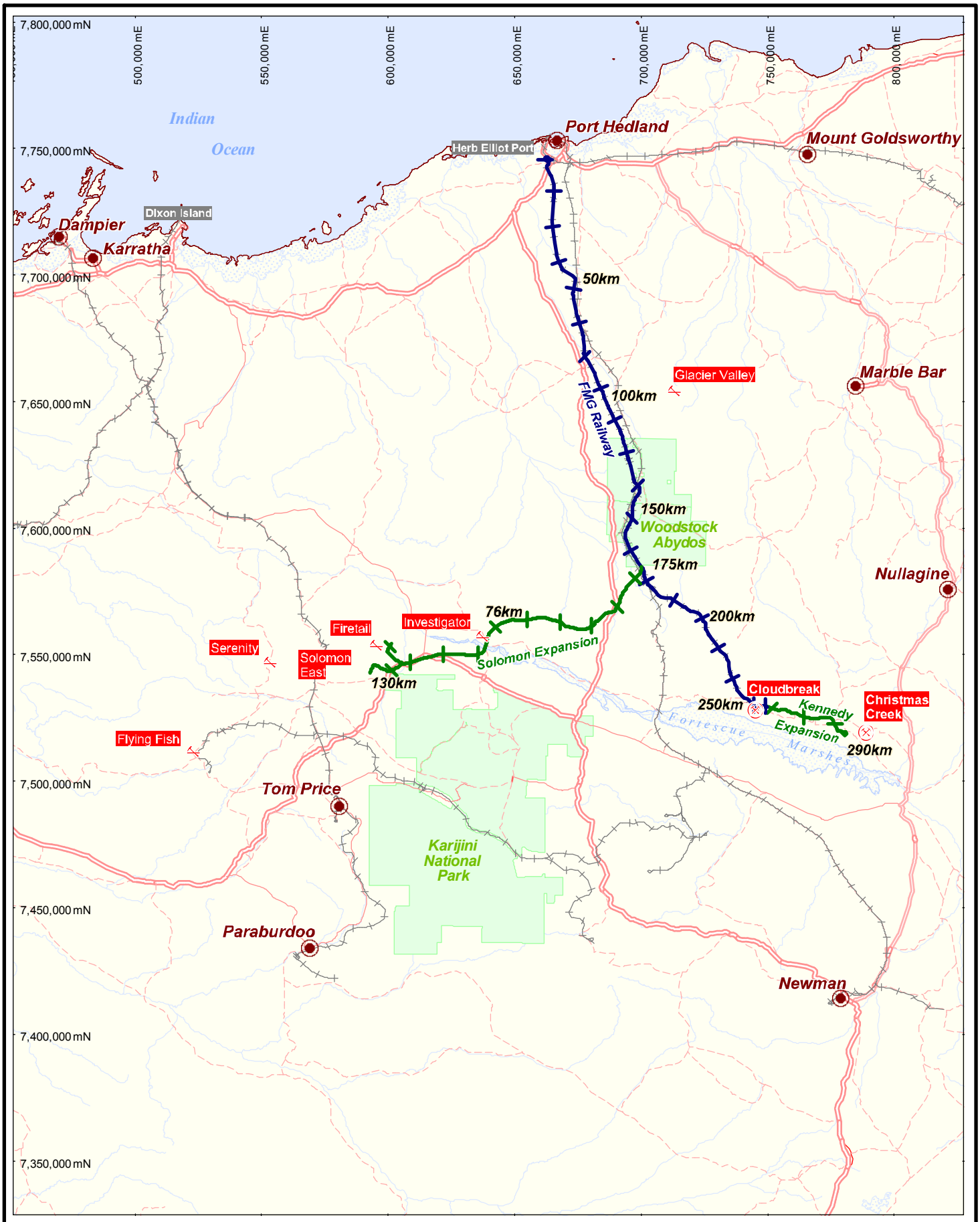

Location Map

Legend

- Towns
- Major Roads/Tracks
- Creeks
- FMG Railway
- FMG Proposed Railways
- Other Railways
- FMG Mines
- FMG Resources

N

0 20 40 80
kilometres

Fortescue Metals Group Ltd

FMG Regional Project

Author: P. Connolly	Date: 3/8/2009
Drawn By: U. Boldbayar	Revision: 0
Doc No: 100_MP_EN_0003	Confidentiality: 1
Projection: MGA Zone 50 (GDA 94)	Scale: 1:2million

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Figure 2

Location of Groundwater Monitoring Bores between Cloudbreak and Christmas Creek

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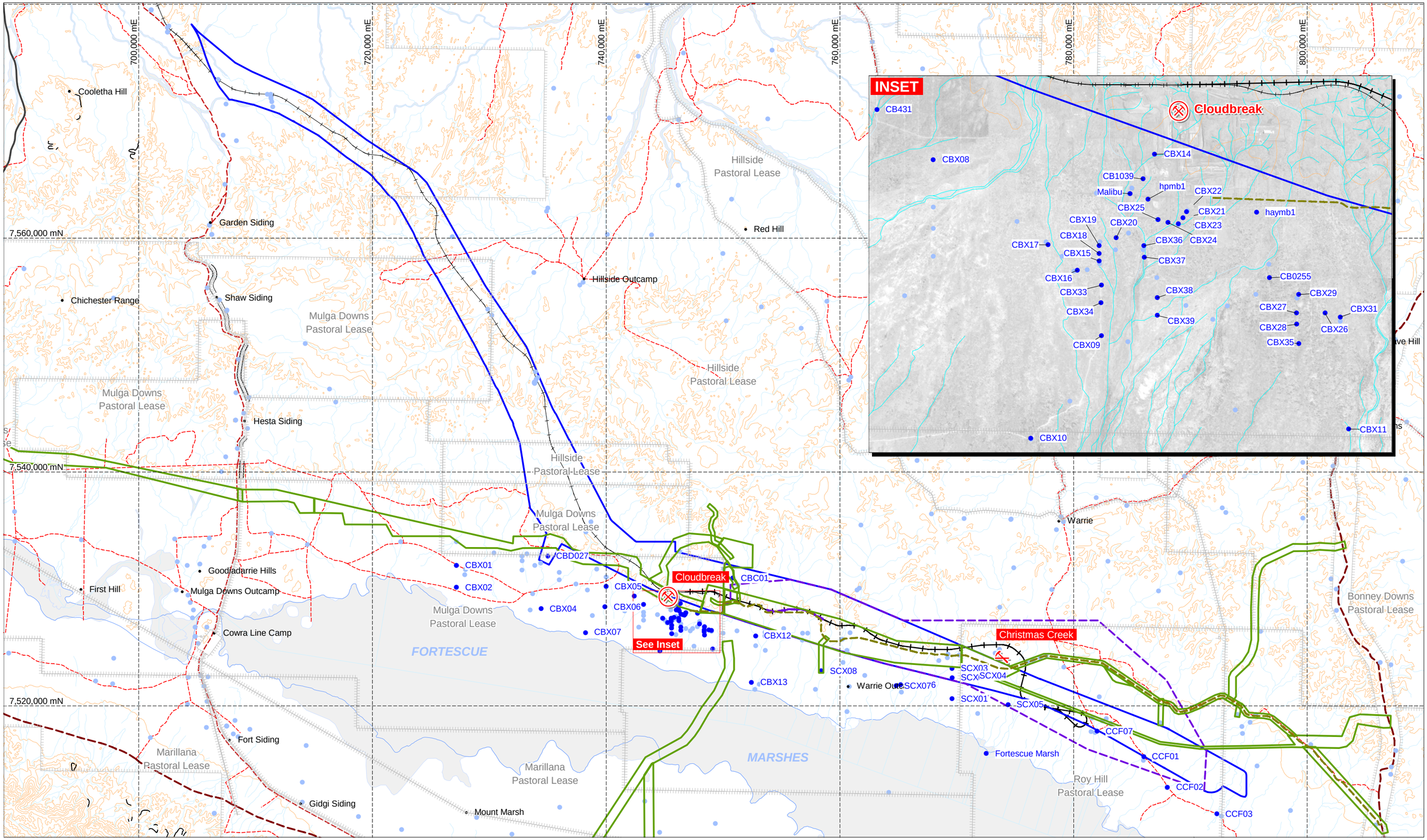
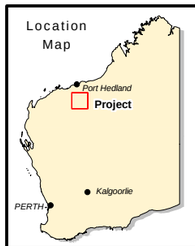


Location Map



Legend

- FMG Miscellaneous Licence
- Pastoral Lease Boundary
- Rail Corridor - FMG Stage B
- Revised Christmas Creek Investigation Corridor
- Cloudbreak Access Road
- Monitoring Bores
- Bores and Wells

N

0 2.5 5 10
kilometres

Fortescue Metals Group Ltd

FIGURE 2
Location of Groundwater Monitoring Bores Between Cloudbreak & Christmas Creek

Author: K. Burke	Date:30/3/2008
Drawn By: A. Weston	Revision:
Dwg No: 08_226	Report No:
Projection: MGA Zone 50 (GDA 94)	Scale: 1:300,000

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Appendices

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Appendix A

Letter from the EPA Confirming that the Hillside Borefield is Consistent with the Existing EPA Assessment and Approval for Cloudbreak (MS 721)

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Environmental Protection Authority

The Atrium,
Level 8, 168 St Georges Terrace,
Perth, Western Australia 6000.
Telephone: (08) 6364 6500.
Facsimile: (08) 6467 5557.

Postal Address: Locked Bag 33,
Cloisters Square, Perth, Western Australia 6850.
Website: www.epa.wa.gov.au

LR-100-E-0702

Ms Diane Dowdell
Head of Environment
Fortescue Metals Group Ltd
PO Box 6915
EAST PERTH WA 6892

Your Ref: LS-100-E-0107
Our Ref: DOC55193
Enquiries: Anthony Sheehan (6467 5439)
Email: anthony.sheehan@dec.wa.gov.au

Dear Ms Dowdell

PILBARA IRON ORE & INFRASTRUCTURE PROJECT: CLOUD BREAK (NO BENEFICIATION) - STATEMENT NO. 721

Thank you for your letter to the Department of Environment and Conservation dated 3 June 2008, requesting confirmation from the Environmental Protection Authority that the proposed Hillside Borefield, whilst not specifically named in the PER, is in accordance with the approved proposal.

I am satisfied that the establishment of the Hillside Borefield is consistent with the existing assessment and approval of this proposal. The Hillside Borefield should be included in the Groundwater and Bore Management Plan required by Condition 9-1 of Ministerial Statement No. 721 and vegetation and groundwater levels should be closely monitored and managed according to trigger levels set out in the Plan.

Yours sincerely

Vogel

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Appendix B

Monitoring, Triggers, Response, and Contingency Management

(Taken from Fortescue's Chichester Operations Groundwater Operating Strategies)

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1. MONITORING AND RESPONSE

Fortescue has been undertaking dewatering and injection activities at Cloudbreak since September 2008 and has developed a sound understanding of the local hydrogeological regime in which it operates.

The objective of the groundwater management system is to have in place sufficient injection infrastructure to exceed the disposal requirements by 5 to 10 percent of the total excess dewater disposal requirements. This will ensure that the need to dispose of excess water via other disposal methods (such as in-pit infiltration, and controlled releases to the environment) are minimised.

However, Fortescue recognises that the model used to predict hydrogeological responses are generated based on a number of assumptions which may affect the accuracy of the model. In the event that the hydrogeological response is different to model predictions, Fortescue will respond so that any impacts to the environment are minimised or avoided.

Fortescue currently has in place an extensive environmental monitoring programme associated with dewatering and injection activities at Cloudbreak. As detailed in the groundwater operating strategy required by the DoW, groundwater monitoring currently conducted includes the following:

- Volume abstracted;
- Groundwater level;
- Electrical conductivity; and
- Full chemical analysis.

Fortescue also undertakes vegetation monitoring in accordance with the *Mulga and Other Flora and Communities Management Plan* and *Fortescue Marshes Management Plan*. In particular, the following vegetation types are monitored:

- Mulga communities;
- Groundwater dependent vegetation; and
- Samphire communities.

These impacts, and the associated monitoring and triggers set, and Fortescue's proposed responses are outlined in following sections.

1.1 GROUNDWATER MONITORING

Fortescue has an extensive monitoring bore network and groundwater monitoring team. The monitoring bore network includes production bores, purpose-built monitoring bores and local station bores.

Fortescue's current groundwater monitoring programme aims to detect impacts caused by dewatering and injection activities on groundwater resources, the environment and other users. The monitoring schedule which includes all Chichester Operations is provided in Table 1.

Table1: Chichester Operations Groundwater Monitoring Schedule

Frequency	Monitoring
Dewatering and Injection Bores	
6 Monthly	Chemical analysis
Monthly	Field measurement of EC
	Abstraction volumes (from cumulative flow meter reading)
	A note of whether the bore is pumping
Monitoring Bores	
6 Monthly	Chemical analysis
3 Monthly	Groundwater level monitoring
	Field measurements of EC
Monthly	Groundwater level monitoring
	Field measurements of EC

Groundwater levels are measured using a field groundwater probe. Salinity is measured using a field EC measurement probe which is lowered to the screen interval. In some cases, bore loggers are also deployed.

Flow meters are located throughout the water conveyance network and are fitted on each abstraction and injection bore, and at discharge points to transfer dams, storage ponds and discharge points.

1.1.1 Impact Triggers

A system of trigger levels, based on Ecoscape's flora and vegetation impact assessment for dewatering (Ecoscape 2009) and predicted aquifer response modelling has been developed. Trigger levels are established to provide advanced warning so that management responses can be implemented.

Trigger levels are categorised as follows:

- Level 1 – groundwater levels are divergent from predicted groundwater levels;
- Level 2 – groundwater levels may potentially impact upon the environment; and
- Salinity – electrical conductivity is divergent from that predicted (this may occur independently or during a Level 1 or Level 2 trigger).

Level 1 triggers ensure that Fortescue is able to quickly detect aquifer responses that deviate from the prediction derived from the model and can implement management responses accordingly.

Level 2 triggers ensure that where there has been a significant deviation from the predicted aquifer response, Fortescue is able to respond to mitigate any potential environmental impacts. A Level 2 trigger is an escalation to a Level 1 trigger.

Salinity trigger levels are set independently to Level 1 and Level 2 triggers and are designed to ensure that Fortescue can respond to salinity levels (measured as electrical conductivity – EC) that deviate from the predicted modelling.

Trigger levels require the monitoring of the following parameters:

- aquifer drawdown (dewatering);
- aquifer mounding (injection); and
- EC.

Fortescue's groundwater database is set up such that a trigger level exceedence is automatically identified when monitoring data is entered into the system.

1.1.2 Level 1 Triggers

Level 1 triggers include both maximum and minimum groundwater level limits, depending on the predicted aquifer response. For injection areas, a minimum depth to groundwater has been defined. For abstraction areas, a maximum depth to groundwater has been defined.

Groundwater level triggers are based on a percentage change from the predicted aquifer response (from baseline conditions +/- seasonal groundwater variations).

The percentage variance from predicted aquifer responses has been assessed based on a review of model uncertainty via a sensitivity assessment for the range of measured hydraulic conductivities and storativities. Based on this assessment, a factor of 1.6 has been applied to the predicted groundwater levels that are greater than 1.1 metres below ground level. In other words, the groundwater level equals the baseline level plus 1.6 times the predicted change. For example, for a baseline depth to groundwater of 10 m and a predicted aquifer rise of one metre, the trigger level would be 10 - (1 x 1.6) = 8.4 m.

Level 1 Response

Where a Level 1 trigger level is exceeded, Fortescue will implement the following:

- Initiate a hydrogeological assessment with the objective of determining the reason(s) for the divergence;
- If necessary, implement changes to the water management system; and
- Explore improvements in the trigger levels based on new data.

1.1.3 Level 2 Triggers

Level 2 triggers are based on Ecoscape's flora and vegetation impact assessment for dewatering (Ecoscape 2009). In developing an escalated action trigger the following two assumptions are made:

- Mulga communities, though not groundwater dependent, may be susceptible to mounding of the groundwater level to less than 2m from ground surface; and
- Phreatophytic vegetation (groundwater dependent) may be susceptible to drawdown of the groundwater level of more than 20m from ground surface.

Based on Ecoscape's assessment and a 10 percent precautionary factor, Level 2 triggers include both maximum and minimum groundwater level limits, as described above. For injection regions, the minimum depth to groundwater is 2.2m. For abstraction regions in areas where phreatophytic vegetation is present the maximum depth to groundwater is 22m.

Level 2 Response

Where a Level 2 trigger is exceeded, Fortescue will modify operational activities to ensure that the actual groundwater level does not continue to exceed the trigger value. Management responses may include:

- Reducing volumes of water going to the affected area by redirecting water to other injection areas;

- Redirect disposal to transfer ponds;
- Redirect disposal to infiltration ponds;
- Redirect disposal to void mine pits (where available); and
- Implement the *Dewatering Discharge Contingency Procedure* (M-PR-EN-0001) allowing the discharge of up to 20,000 kL/day.

If the volume of water requiring disposal exceeds all of the above options, then Fortescue will further reduce or stop dewatering or injection in the affected area.

If the Level 2 trigger exceedence is not reduced within a period of five days, Fortescue will notify the DoW within ten days and report on the matter in the Annual Groundwater Review.

1.1.4 Electrical Conductivity

EC trigger levels are based on a percentage change from baseline levels, with the percentage change defined in the context of the range of EC levels that are measured at the Chichester Operations (which cover many orders of magnitude). Based on this range of values and range of groundwater types, a factor of 1.5 has been adopted for EC trigger levels (i.e. the EC trigger equals the baseline EC value multiplied by 1.5).

Groundwater levels and EC trigger levels have been established only for bores with a statistically valid number of measurements. Recently commissioned bores do not presently have trigger levels. These will be determined once sufficient monitoring data is available.

EC Response

Where an EC trigger level is exceeded, Fortescue will implement the following:

- Initiate a hydrogeological assessment with the objective of determining the reason(s) for the divergence;
- If necessary, implement changes to the water management system;
- Explore improvements in the trigger levels based on new data; and/or
- Report on any exceedences in the Annual Groundwater Review.

1.2 MULGA VEGETATION MONITORING

Mounding caused by injection activities has the potential to affect the health of Mulga vegetation. To ensure that aquifer mounding does not impact on Mulga vegetation Fortescue monitors groundwater levels and vegetation health.

Fortescue currently undertakes monthly vegetation condition monitoring of Mulga vegetation at four sites at Cloudbreak. This involves photographing Mulga at designated monitoring points and assessing the condition of the Mulga against a set of vegetation condition assessment parameters adapted from Lay and Meissner (1985) as outlined in Table 2.

Table 2: Visual Assessment of Vegetation Health Adapted from Lay & Meissner (1985)

Health Scale	
0	Plant dead.
1	No foliage, stems still green. 100 percent dieback of foliage, and new growth or re-sprouts unhealthy, or absent.
2	100 percent dieback of foliage at tips of branches, new growth or re-sprouts healthy 75 – 100 percent of foliage dead, lost or damaged. Two or more factors under '3' below.
3	Discolouration (i.e. yellowing, bleaching) of whole plant, including new growth. Most leaves lost on lower growth, healthy tip growth remaining. 50-75 percent of foliage affected by disease or desiccation. Death or dieback of major stem or portion of canopy – remainder healthy.
4	Healthy plant but significant (25 – 50 percent) leaves lost or damaged. Healthy but minor stem or canopy damage (affecting less than 25 percent of plant). Discolouration (yellowing, bleaching) of foliage close to the stem (i.e. not at the tips).
5	Healthy but includes plants with up to 25 percent of leaves damaged in some way.

Where a decline in Mulga vegetation condition is detected, Fortescue will investigate to determine what the likely cause of the decline is. Where the decline can be attributed to dewatering or injection activities, Fortescue will initiate changes to the dewatering and injection program to prevent any further impacts, and where possible reverse any impacts.

1.3 GROUNDWATER DEPENDENT VEGETATION MONITORING – *EUCALYPTUS VICTRIX* AND *E. CAMALDULENSIS*

Drawdown caused by dewatering activities has the potential to affect the health of groundwater dependent vegetation. To ensure that aquifer drawdown does not impact on groundwater dependent vegetation Fortescue monitors groundwater levels and vegetation health.

Fortescue currently undertakes monthly groundwater dependent vegetation condition monitoring at four sites at Cloudbreak. This involves photographing *Eucalyptus victrix* and *E. camaldulensis* at designated monitoring points and assessing the condition of the vegetation against a set of vegetation condition assessment parameters adapted from Lay and Meissner (1985) as outlined in Table 2.

Where a decline in groundwater dependent vegetation condition is detected, Fortescue will investigate to determine the likely cause of the decline. Where the decline can be

attributed to dewatering or injection activities, Fortescue will initiate changes to the dewatering and injection program to prevent any further impacts, and where possible reverse any impacts.

1.4 SAMPHIRE VEGETATION MONITORING

Fortescue currently undertakes quarterly samphire vegetation condition monitoring at ten sites at Cloudbreak. This involves photographing samphire communities at designated monitoring points and assessing the condition of the vegetation against a set of vegetation condition assessment parameters as outlined in Table 3.

Table 3: Description of Samphire Vegetation Condition Assessment Parameters

Mature Plants – Reproductive Status		Canopy Condition	
Not in flower or fruit	A	Poor condition with numbers of dead plants and others with multiple dead or dying branches	0
In fruit	B	Fair appearance with dead branches commonly occurring	1
In flower	C	Healthy appearance, some dead material on some plants	2
In flower and fruit	D	Generally healthy appearance with new growth evident	3

Where a decline in samphire vegetation condition is detected, Fortescue will investigate to determine the likely cause of the decline. Where the decline can be attributed to dewatering or injection activities, Fortescue will initiate changes to the dewatering and injection program to prevent any further impacts, and wherever possible, reverse any impacts.

2. CONTINGENCY MANAGEMENT

The objective of groundwater management system is to have in place sufficient injection infrastructure to exceed the disposal requirements by 5 to 10 percent of the total excess dewater disposal requirements. This will ensure that the need to dispose of excess water via other disposal methods (such as in-pit infiltration, and controlled releases to the environment) are minimised.

However, Fortescue recognises that the groundwater model was generated using a number of assumptions which may affect the accuracy of the model. In the event that the groundwater management system operates differently to model predictions Fortescue may not be able to inject all excess water back into local aquifers. In the event that this occurs, Fortescue will manage the situation as set out in the following sections.

2.1 INSUFFICIENT INJECTION CAPACITY

The groundwater management system is designed to exceed total excess water disposal requirements by approximately 5 to 10 percent.

However, in the event that the injection borefield's operating capacity is exceeded, Fortescue will implement an alternative disposal option. These alternatives in relative order of priority include:

1) disposal to transfer ponds;

2) disposal to infiltration ponds;

3) disposal to void mine pits (where available); and

4) reduction (or cessation) of dewatering rates to equal injection capacity.

5) in the event that any reduction in the dewatering rate will adversely impact on production rates, then Fortescue will implement the *Dewatering Discharge Contingency Procedure* (M-PR-EN-0001) as a last resort.

Fortescue will concurrently investigate other alternatives such as the commissioning of additional injection bores to meet the excess disposal requirements.

2.2 DEWATERING DISCHARGE CONTINGENCY PROCEDURE

Fortescue's *Dewatering Discharge Contingency Procedure* (M-PR-EN-0001) outlines the circumstances in which controlled releases of excess dewater can be made into the environment. Where the requirements to discharge are met, discharge can then occur under strictly monitored conditions. The procedure identifies ten discharge points are used when undertaking this activity.

2.2.1 Contingency Situations

Controlled release to the environment may only be undertaken:

- as a contingency measure;
- where levels of EC in the water to be discharged is less than 15,000 microsiemens per centimetre (µS/cm);
- where the turbidity level in the water to be discharged is less than 100 Nephelometric Turbidity Units (NTU); and
- subject to meeting one or more of the situations described in Table 4.

Table 4: Contingency Situations

No.	Situation	Maximum Down Time (days)	Maximum Discharge Rate (kL/day)
1	Injection pipeline(s) requires maintenance/repairs	3	20,000
2	Injection bore(s) requires maintenance/repairs	21	20,000
3	Injection infrastructure taken offline for addition of injection bores	2	20,000
4	Pump failure at transfer ponds	1	35,000
5	Planning and construction delays	21	20,000

2.2.2 Discharge Monitoring

Monitoring requirements contained in the *Dewatering Discharge Contingency Procedure* (M-PR-EN-0001) are outlined in Table 5.

Table 5 Discharge Monitoring Program Details

Type	Upper Limit	Frequency	Location
Photographic	Decline in vegetation condition Erosion and scouring-	On commencement Every 7 days On cessation	At discharge point 1000 m intervals downstream At termination point
Electrical conductivity	15,000 µS/cm	Within 30 minutes of commencement Every 24 hours during Within 30 minutes of cessation	At discharge point
Turbidity	100 NTU	Within 30 minutes of commencement Every 24 hours during Within 30 minutes of cessation	At discharge point At 1000 m downstream from discharge point
Volume	20 ML/day	Prior to commencement Every 24 hours during Immediately following cessation	At discharge point

Where any trigger level is exceeded, Fortescue will immediately cease discharge to prevent any further impacts, and wherever possible, reverse any impacts. Discharge can only recommence where all minimum water quality requirements are met.