Government of **Western Australia**
Department of **Water**

# Lower Fortescue groundwater allocation limit report

*Looking after all our water needs*

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Method used to set an allocation limit and licensing rules for the Lower Fortescue alluvial aquifer

*Looking after all our water needs*

Department of Water

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# Contents



## Appendices



## Figures

# Tables

# Summary

Demand for groundwater in the lower Fortescue River area is increasing due to mining developments. To support any development in the area and provide guidance to proponents, the Department of Water has set an allocation limit and licensing rules for the lower Fortescue alluvial aquifer, which are set out in this report.

To determine the lower Fortescue alluvial aquifer's allocation limit, the department has used a risk-based approach (DoW 2010). We use this approach in cases where knowledge about the groundwater resource is limited and competing demands for the water are limited. This allows us to develop allocation limits and licensing rules within a shorter timeframe and in a consistent manner.

This approach has four steps:

1 Identify and define the groundwater resource (including estimation of aquifer recharge).

2 Describe aquifer properties, environmental, cultural and social groundwater-dependent values and assess the risks to those properties/values from abstraction; describe the consumptive uses of water from the aquifer and assess the development risks of not abstracting water for consumptive use.

3 Assess whether any risks identified above can be managed through licensing rules.

4 Following the above assessment process, set allocation limits (the amount of water available for consumptive use) and licensing rules.

Using the process outlined above, the department has set an allocation limit for the lower Fortescue alluvial aquifer of 6.6 GL/year. As at December 2010, licence applications have fully allocated the resource and no additional water is available.

Given information about this water resource is limited, the department welcomes new investigations and data which would improve our understanding of the aquifer. If new information shows that more water is available and that impacts are manageable, then we may review the allocation limit.

The department developed a model for the lower Fortescue alluvial aquifer in 2010. In 2011, the department will complete a detailed assessment, using the model to review the allocation limit for the lower Fortescue alluvial aquifer.

# 1 Introduction

The Department of Water is responsible for deciding how much of a water resource can be taken for consumptive use and how much needs to remain in the system. Consumptive use includes water for industry, stock watering, domestic use and public water supply. Water left in the system (in situ) is for maintaining the integrity of the water resource, its water-dependent ecosystems and the cultural and social values linked to it. We decide on how much water can be taken for consumptive use through setting allocation limits and licensing rules.

## 1.1 Scope of this document

This document describes the process we used to set the allocation limit and licensing rules for the lower Fortescue alluvial aquifer. We are doing this because water demand is increasing as a result of mining activities in the area.

This document sets out:

- the resource boundary of the lower Fortescue alluvial aquifer
- existing information available on the resource
- an allocation limit for the resource
- licensing rules for the resource.

The allocation limit is set through a process of balancing the risks to the aquifer's integrity and groundwater-dependent environmental, cultural and social values in the area, with the risks of constraining development by not having water available for consumptive use.

## 1.2 What is an allocation limit?

An allocation limit is the annual volume of water set aside for use from a water resource. Allocation limits are the main tool the department uses to manage abstraction. Water is allocated up to the allocation limit through the department's licensing process and is complemented by licensing rules and other mechanisms (monitoring, investigations and compliance) to manage the impacts of water abstraction on other water users, the water resource and the environment.

## 1.3 Process used for setting the lower Fortescue alluvial aquifer's allocation limit

To set the lower Fortescue alluvial aquifer's allocation limit we used a risk-based approach, the details of which can be found in *Groundwater risk-based allocation planning process* (DoW 2010).

The risk-based approach has four steps:

1. Identify and define the groundwater resource (including estimation of aquifer recharge).
2. Describe aquifer properties, environmental, cultural and social groundwater-dependent values and assess the risks to those properties/values from abstraction; describe the consumptive uses of water from the aquifer and assess the development risks of not abstracting water for consumptive use.
3. Assess whether any risks identified above can be managed through licensing rules.
4. Following the above assessment process, set allocation limits (the amount of water available for consumptive use) and licensing rules.

Using the risk-based approach, the allocation limit is based on a proportion of the estimated average annual recharge to (or discharge from) the aquifer. The proportion is determined by considering risks to the resource and dependent in situ and consumptive values, and the ability to manage those risks.

## 1.4 Need for a water licence

The aquifer is within the Pilbara groundwater area, which was proclaimed in 1996 under the *Rights in Water and Irrigation Act 1914* (WA). This means that water users need a licence from the department to legally take groundwater or construct a bore in this area. However, taking water for non-intensive stock watering or for domestic use is exempt from licensing.

# 2 The lower Fortescue resource

## 2.1 Resource boundary

The department has defined the extent of the aquifer (Figure 1) based on the hydrogeology described in Commander (1994). The resource boundary is based on the extent of the alluvial aquifer gravels, as estimated and defined by Commander (1994). The resource is defined in the department's systems as such: Pilbara groundwater area – Lower Fortescue – alluvial aquifer.

## 2.2 Hydrogeology

The lower Fortescue alluvial aquifer is associated with the Fortescue River on the Ashburton Plain. Please note this aquifer is also known as the 'Balmoral aquifer'.

The aquifer extends over a former delta up to 15 km north-west of the Fortescue River (Figure 1). The alluvial deposits of the delta are up to 30 m thick, with an estimated saturated thickness of up to 15 m. The aquifer grades laterally into the floodplain into clay and silt (Commander 1994).

The aquifer is recharged directly by periodic streamflow from the Fortescue River. See the characteristics of interest in Table 1.

*Table 1 Characteristics of interest of the Lower Fortescue alluvium (taken from Commander 1994 and Haig 2009)*

| Characteristic | Value or description |
|---|---|
| Water quality | 500–1000 mg/L (2000 mg/L towards the coast) |
| Maximum aquifer thickness | 30 m |
| Maximum recharge estimate | 22.7 GL (based on area 200 $km^2$) |
| Throughflow estimate | 9.2 GL/year |
| Average annual recharge | 11 GL/year |

While the maximum recharge estimate appears quite large, it is based on an above-average recharge event. Average annual recharge and throughflow provide more appropriate estimates of annual water balance for allocation planning purposes.

For the lower Fortescue alluvial aquifer, an average annual recharge of 11 GL/year has been inferred from the estimated average annual discharge (Commander 1994). The assumption is that in the absence of abstraction, the aquifer is in approximate equilibrium and therefore recharge approximately equals discharge.

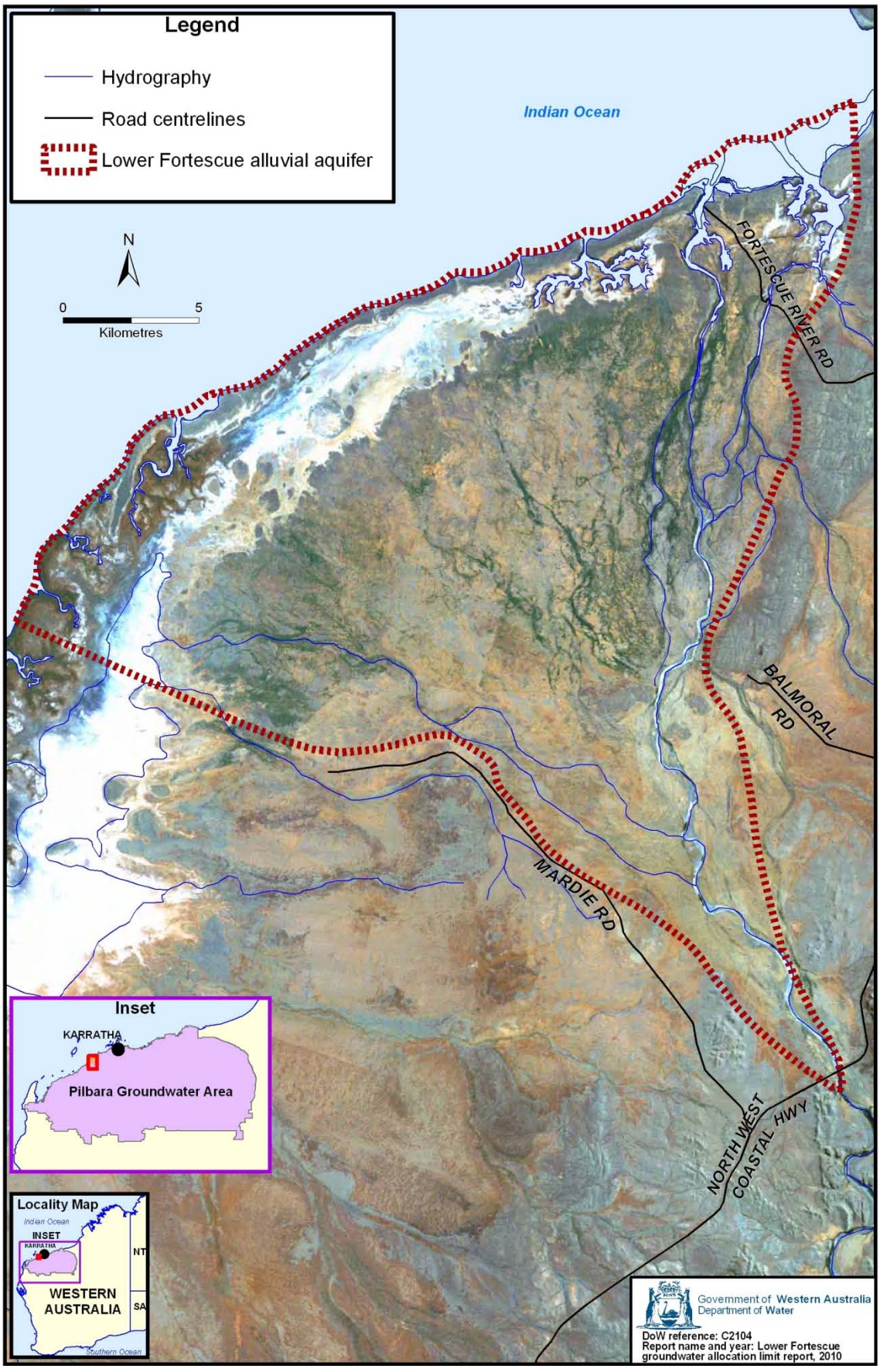


*Figure 1 Resource boundary of the lower Fortescue alluvial aquifer*

# 3 Assessment

## 3.1 Assessment panel

The assessment panel included the following Department of Water staff:

- District Manager, Pilbara region
- Regional Hydrogeologist, Pilbara region
- Project Hydrogeologist, Groundwater Assessment
- Project Environmental Scientist, Environmental Water Planning
- Project Water Planning officer, Allocation Planning.

## 3.2 Aquifer properties

To maintain the aquifer's ability to yield water for consumptive use in the long term, it is essential to maintain the quantity and quality of its water; that is, the integrity of the aquifer.

A key consideration for managing the long-term integrity of the aquifer is maintaining the position of the saltwater interface. The aquifer's salinity increases towards the coast due to seawater intrusion into the aquifer. Adequate freshwater throughflow towards the coast is needed so the position of the saltwater interface is maintained.

Salinity also increases away from the river, which is the main source of freshwater recharge (from river flows) to the aquifer. To prevent saline intrusion towards the river, the freshwater volume needs to be maintained to stop salt water moving in from the aquifer's flanks.

## 3.3 Groundwater-dependent ecosystems

The department conducted a desktop review and a short-duration field survey to investigate potential groundwater-dependent ecosystems associated with the lower Fortescue alluvial aquifer. Where possible, the review made use of regional ecological assessments to consider the significance of ecosystems in a regional context. Site-specific survey information was also included in the review where it was available.

The review:

- identified and described the types of potential groundwater-dependent ecosystems
- mapped the likely distribution of groundwater-dependent ecosystems
- considered the conservation significance of groundwater-dependent ecosystems
- considered the sensitivity of groundwater-dependent ecosystems to water regime change, identifying the most sensitive components.

Aquifer ecosystems in the Pilbara are associated with communities of stygofauna, troglofauna or, in some cases, the presence of both. Stygofaunal communities have been discovered within the lower Fortescue River. Previous studies indicate that 55 taxa of stygofauna have been recorded for the lower Fortescue alluvium (Halse 2007; Reeves et al. 2007).

There appears to be few permanent pools along the Fortescue River downstream of the North West Coastal Highway (see Figure 2). Based on the current available information, Tom Bull and Mungajee pools are considered permanent. Given rates of evaporation greatly exceed rainfall (approximately 300 mm compared with approximately 270 mm) and depths to groundwater near the river are often shallow, permanent pools are considered to have some connection to groundwater. That is, the river channel intersects the watertable and pools are sustained through dry periods by groundwater inflow.

The deep-rooted vegetation associated with the riparian zone of the Fortescue River, its tributaries and surrounding floodplain is possibly groundwater-dependent. Based on the known root depths of dominant species in the riparian zone and the depth to groundwater in this area, it is likely the vegetation is accessing groundwater, at least in part, to meet its water requirements. The condition of the vegetation communities has been significantly affected by cattle grazing and weed invasion (mesquite).

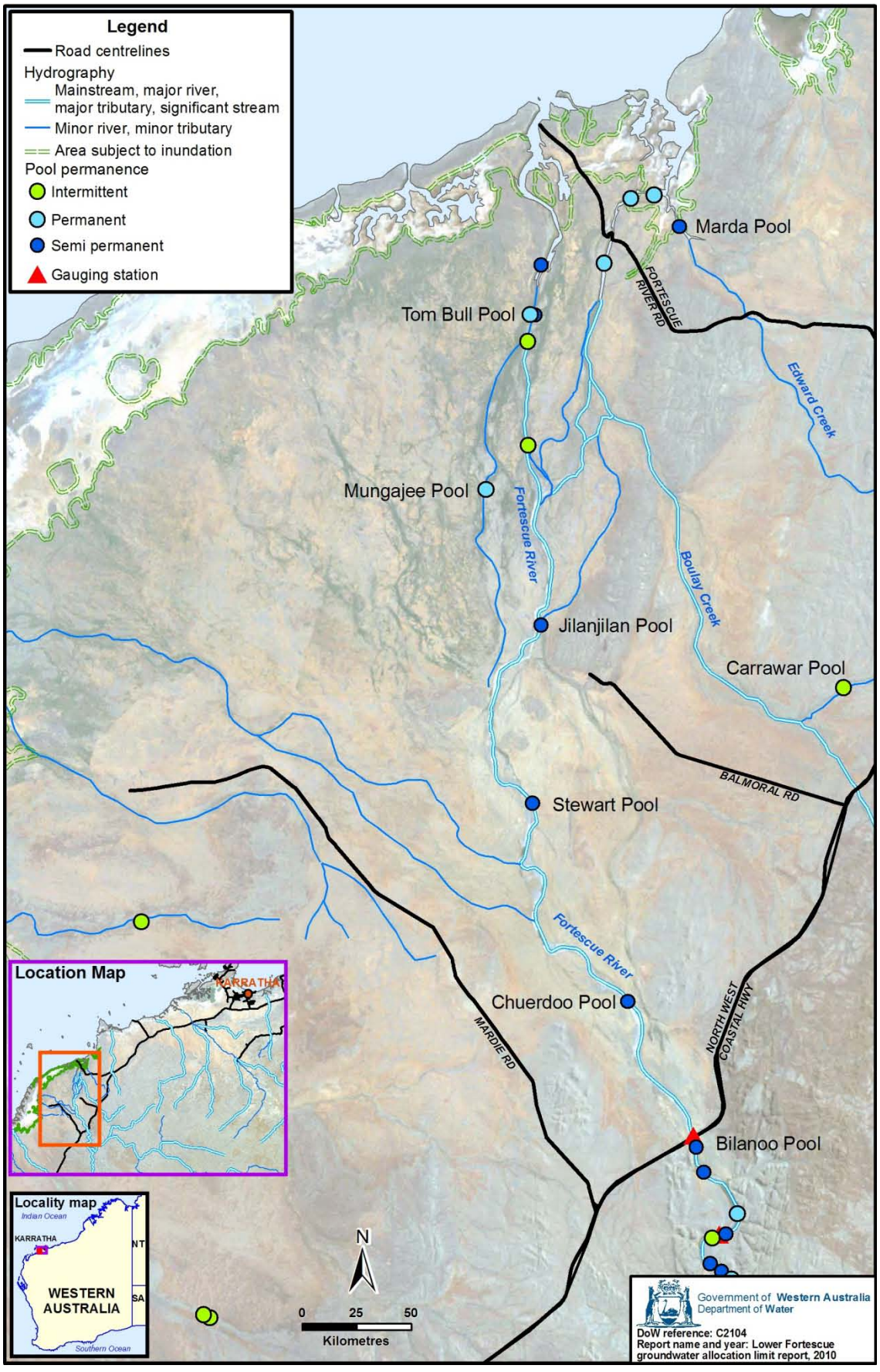


*Figure 2 Pools along the lower Fortescue River*

## 3.4 Cultural and social values

The lower Fortescue area is within the Kuruma Marthudunera (WC99/12) and Yaburra and Marthududhunera (WC96/98) Native Title claim areas, which are both undetermined. The department has consulted with the Kuruma Marthudunera Traditional Owners through the Pilbara Native Title Service.

During an on-country visit with Traditional Owners, they expressed a desire to maintain the environmental health of their country and the attractiveness of the landscape by protecting the permanent waterholes in the area (see Figure 2) and the native flora and fauna. They also expressed concern about the welfare of the aquatic fauna and the effects of taking groundwater on the trees in the area, which have a special cultural significance. They recommended that water levels, salinity and trees be closely monitored. We have considered these recommendations in developing the licensing rules in Section 4.2.

## 3.5 Current consumptive use

In 2009 at the start of the allocation planning process for the lower Fortescue area, there was:

- no licensed abstraction within the aquifer boundary
- some exempt (unlicensed) stock and domestic use.

As at December 2010, there are licences in place and applications for water for mining exploration.

## 3.6 Future consumptive use and demand

Groundwater demand has increased as a result of mining activities within the area. Nearby mining projects have a total projected demand of up to 200 GL/year, which is much higher than the lower Fortescue alluvial aquifer is able to supply. Two projects have received approval from the Environmental Protection Authority based on a commitment to supply water from seawater desalination, which is the other main option for water supply in the lower Fortescue area.

# 4 Allocation limit decision and licensing rules

## 4.1 Assessment of risks

To determine the annual volume of water to be allocated for abstraction, the Department of Water assigned ratings (high, medium or low) to in situ risk and development risk. We then used a risk matrix (Section 4.3.2) to convert the risks into a proportion of average annual recharge.

The department's risk assessment has two components:

- in situ risk: the risks to aquifer properties and to environmental, social and cultural values that may arise from groundwater abstraction
- development risk: the risks to consumptive use that may arise if water is not abstracted.

Table 2 shows what we considered in assigning risk ratings.

### 4.1.1 Initial risk assessment

For the lower Fortescue alluvial aquifer we assigned a medium risk to in situ values from abstraction, as well as a medium risk to development from restricting abstraction. For the overall in situ and development risks we took the highest risk rating (Table 2).

*Table 2 Determining the risk of abstraction on in situ values and the risk of limiting water available for consumptive use*

| Values | | Likelihood/sensitivity | Consequences | Risk rating | Overall risk |
|---|---|---|---|---|---|
| **In situ risk** | Aquifer properties | Saline intrusion can occur with very high abstraction. There is some natural movement of the saltwater interface. | If the saltwater interface moves inland, it would take significant reductions in abstraction for it to retreat back to its natural position. | Medium | **Medium** (highest risk rating) |
| | Ecological | Groundwater-dependent ecosystems (permanent pools and vegetation) are sensitive to drops in water level. | Permanent pools are sub-regionally significant. | Medium | |
| | Cultural and social | Permanent pools and riparian vegetation are groundwater-dependent and are sensitive to water level changes. | Pools and vegetation hold cultural significance but have been degraded due to weeds and grazing. | Medium | |

| Values | | Likelihood/sensitivity | Consequences | Risk rating | Overall risk |
|---|---|---|---|---|---|
| **Development risk** | Demand for water | Considerable demand for water by mining interests. | Mining developments will require large quantities of water – more than the aquifer can provide so another source will ultimately be required. | Medium | **Medium** (highest risk rating) |
| | Water source options | The other main water source option is desalination. | Desalination can provide much more water than the lower Fortescue alluvial aquifer but is an expensive water supply option. | Medium | |

## 4.2 Licensing rules and resource management

The department assessed the capacity to manage the in situ risks identified in the initial risk assessment stage (Section 4.1.1).

Implementing suitable licensing rules to manage abstraction reduces the risks to in situ values from abstraction. To manage the risks to in situ values, the department has developed the licensing rules in Table 3.

The rules have been developed to achieve the following objectives:

- maintain the aquifer's integrity
- maintain the aquifer's water quality
- maintain in situ values
- minimise impacts to existing users
- manage the aquifer as a sustainable productive resource.

*Table 3 Licensing and management rules for the lower Fortescue River alluvium*

| Topic | Rule |
|---|---|
| Permanent, groundwater-dependent pools | 1. No impacts from abstraction on permanent river bodies and groundwater-dependent pools including those defined in Figure 2 and listed in Appendix 1. |
| Cultural values | 2. No impacts from abstraction on culturally sensitive permanent pools as listed in Appendix 1. |
| Other water users | 3. Additional abstraction must not impact on existing water users, including the existing public water supply borefield. |

| Topic | Rule |
|---|---|
| Water quality | 4. Proponents holding licence entitlements of 100 000 kL or more must monitor salinity as per the monitoring program outlined in their licence conditions and/or operating strategy.<br>5. Abstraction must not negatively impact on the current range of the saltwater interface. |

In defining an allocation limit and licensing rules for the lower Fortescue alluvial aquifer, the department recognises that this resource and the presence of mesquite weed presents a unique situation. The mesquite weed is possibly having a considerable impact on the area's water balance. We encourage any efforts to eradicate the weed and will consider re-assessing the allocation limit if eradication efforts are successful.

## 4.3 Allocation limit and water availability

### 4.3.1 Final risk assessment

The department assessed whether the level of risk determined in the initial risk assessment step (Section 4.1.1) could be reduced if we applied the licensing rules developed in Section 4.2.

We reduced the final in situ risk from medium to **low** based on the implementation of the rules in Table 3.

### 4.3.2 Using a risk matrix to determine yield

Using a risk matrix (Table 4), the final overall ratings of the in situ and development risks were used to select the appropriate yield as a proportion of average annual recharge. As Table 4 shows, a low in situ risk and a medium development risk (from Table 3) resulted in a 60 per cent proportion of recharge being selected.

*Table 4 Risk matrix for determining the proportion of yield for allocation*

| | Proportion of yield | | |
|---|---|---|---|
| High in situ risk | 5% | 25% | 50% |
| Medium in situ risk | 25% | 50% | 60% |
| Low in situ risk | 50% | **60%** | 70% |
| | Low development risk | Medium development risk | High development risk |

### 4.3.3 Allocation limit and water availability

Using the average annual recharge estimate of 11 GL/year (Table 1) and the selected yield proportion of 60 per cent, the department has set the Lower Fortescue alluvium's allocation limit at 6.6 GL/year. As at December 2010, there is no further water available for licences due to pending requested allocations.

## 4.4 Monitoring and reporting

Licensees are required to complete monitoring to demonstrate their compliance with licensing rules in relation to groundwater levels, salinity and river pools. Monitoring procedures must be developed as part of the operating strategy attached to the licence conditions. Licensees' monitoring requirements are related to the volume of their licensed allocation. Licensees must report their monitoring data to the department annually. The department will review and evaluate the monitoring reports and data to see whether licence conditions are being met and risks are being managed effectively.

We will continue our existing groundwater monitoring program for the lower Fortescue. This involves biannual monitoring of groundwater levels in 11 groundwater bores across the aquifer. These provide an important regional/resource-scale reference for water resource management. We will review our groundwater monitoring program for the resource as part of the allocation planning activities in the Pilbara region scheduled for completion in 2012.

We will also continue maintenance and monitoring of the river gauging station at Bilanoo Pool. This station provides continuous stage-height (water level) data for the lower Fortescue River and is vital to detection of potential changes in aquifer recharge.

Monitoring data improves our knowledge of the resource, so that we can revise licensing rules and improve our estimate of the resource's sustainable yield.

## 4.5 Review of allocation limits

More detailed information could improve estimates of throughflow or recharge and other aspects of the resource. The department welcomes new hydrogeological investigations and data to improve our understanding of the aquifer. Monitoring data collected by licensed water users is also valuable to improve our knowledge of the resource.

The department developed a model for the lower Fortescue alluvial aquifer in 2010. In 2011, the department will complete a detailed assessment, using the model to review the allocation limit for the lower Fortescue alluvial aquifer.

If new information shows that more water can be taken without compromising the resource, then we may review the allocation limit and/or consider new proposals for water abstraction from the resource.

# Appendices

# Appendix A — River pools in the Fortescue groundwater resource area

The following list is based on pool mapping conducted by the Department of Water across the Pilbara (DoW 2009). This list may not be definitive and the licensing rules specified in Section 4.2 of this report should also be applied to any pools in the allocation area not on this list.

*Table A 1 Details of location and permanency of pools in the lower Fortescue alluvial aquifer*

| Known name | Permanency[i] | Latitude | Longitude |
|---|---|---|---|
| Tom Bull Pool | Permanent | 116.10 | -21.06 |
| Bilanoo Pool | Semi permanent | 116.15 | -21.30 |
| Unknown | Permanent | 116.12 | -21.05 |
| Jilanjilan Pool | Semi permanent | 116.10 | -21.15 |
| Mungajee Pool | Permanent | 116.08 | -21.11 |
| Chuerdoo Pool | Semi permanent | 116.12 | -21.25 |
| Stewart Pool | Semi permanent | 116.10 | -21.20 |
| Unknown | Semi permanent | 116.10 | -21.05 |

[i] Details of permanency assessment and mapping methodology are provided in Department of Water (2009).

# Glossary

| | |
|---|---|
| **Abstraction** | The permanent or temporary withdrawal of water from any source of supply, so that it is no longer part of the resources of the locality. |
| **Allocation limit** | Annual volume of water set aside for use from a water resource. |
| **Aquifer** | A geological formation or group of formations capable of receiving, storing and transmitting significant quantities of water. |
| **Bore** | A narrow, normally vertical hole drilled in soil or rock to monitor or withdraw groundwater from an aquifer. |
| **Borefield** | A group of bores to monitor or withdraw groundwater. |
| **Consumptive use** | The use of water for private-benefit consumptive purposes including irrigation, industry, urban and stock and domestic use. |
| **Ecological values** | The natural ecological processes occurring within water-dependent ecosystems and the biodiversity of these systems. |
| **Ecosystem** | A community or assemblage of communities of organisms, interacting with one another, and the specific environment in which they live and with which they also interact, e.g. a lake, to include all the biological, chemical and physical resources and the interrelationships and dependencies that occur between those resources. |
| **Environment** | Living things, their physical, biological and social surroundings, and interactions between all of these. |
| **Groundwater** | Water which occupies the pores and crevices of rock or soil beneath the land surface. |
| **Groundwater area** | Boundaries proclaimed under the *Rights in Water and Irrigation Act 1914* (WA) and used for water allocation planning and management. |
| **Groundwater-dependent ecosystem** | An ecosystem that is dependent on groundwater for its existence and health. |
| **Groundwater pumping** | Extraction of water from saturated soil (groundwater) using an electric, wind powered or compressed air pump and bore hole. |
| **Groundwater recharge** | The rate at which infiltration water reaches the watertable. |
| **Hydrogeology** | The hydrological and geological science concerned with the occurrence, distribution, quality and movement of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality. |
| **Licence** | A formal permit which entitles the licence holder to ‘take’ water from a watercourse, wetland or underground source. |
| **Recharge** | Water that infiltrates into the soil to replenish an aquifer. |
| **Salinity** | The measure of total soluble salt or mineral constituents in water. Water resources are classified based on salinity in terms of total dissolved salts (TDS) or total soluble salts (TSS). Measurements are usually in milligrams per litre (mg/L) or parts per thousand (ppt). |
| **Social value** | A particular in situ quality, attribute or use that is important for public benefit, welfare, state or health (physical and spiritual). |

| | |
|---|---|
| **Stock and domestic water use** | Water that is used for ordinary domestic purposes associated with a dwelling, such as water for cattle or stock other than those being raised under intensive conditions, or water for up to 0.2 ha (if groundwater) or 2 ha (if surface water) of garden from which no produce is sold. This take is generally considered a basic right. |
| **Surface water** | Water flowing or held in streams, rivers and other wetlands on the surface of the landscape. |
| **Watercourse** | A watercourse includes the bed and banks of anything referred to in paragraph (a), (b) or (c):<br>a) any river, creek, stream or brook in which water flows<br>b) any collection of water (including a reservoir) into, through or out of which anything coming within paragraph (a) flows<br>c) any place where water flows that is prescribed by local by-laws to be a watercourse. |
| **Water-dependent ecosystems** | Those parts of the environment, the species composition and natural ecological processes of which are determined by the permanent or temporary presence of water resources, including flowing or standing water and water within groundwater aquifers. |
| **Water entitlement** | The quantity of water that a person is entitled to take annually in accordance with the *Rights in Water and Irrigation Act 1914* (WA) or a licence. |
| **Wetland** | Wetlands are areas that are permanently, seasonally or intermittently waterlogged or inundated with water that may be fresh, saline, flowing or static, including areas of marine water of which the depth at low tide does not exceed 6 m. |
| **Yield** | The volume of water that may be drawn from a well or water supply system measured in cubic metres per day, gigalitres per year, or equivalent. |

## Volumes of water

| | | | |
|---|---|---|---|
| One litre | 1 litre | 1 litre | (L) |
| One thousand litres | 1000 litres | 1 kilolitre | (kL) |
| One million litres | 1 000 000 litres | 1 Megalitre | (ML) |
| One thousand million litres | 1 000 000 000 litres | 1 Gigalitre | (GL) |

## Map disclaimer – Figures 1 and 2

*Datum and projection information*

Vertical datum: Australian Height Datum (AHD)

Horizontal datum: Geocentric Datum of Australia 94

Projection: MGA 94 Zone 50

Spheroid: Australian National Spheroid

### *Project information*

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### *Sources*

The Department of Water acknowledges the following datasets and their custodians in the production of these maps:

Hydrography, Linear (Hierarchy) – DoW – 05/11/2007

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Towns –DLI – Current

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