



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

Lower Turner groundwater allocation limit report

Method used to set an allocation limit and licensing rules for the lower Turner alluvial aquifer

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rules for the lower Turner alluvial aquifer

Looking after all our water needs

Department of Water

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Summary

Demand for groundwater in the lower Turner River area is increasing due to extra water requirements for mining and related industry. To support any development in the area and provide guidance to proponents, the Department of Water (DoW) has set an allocation limit and the licensing rules for the lower Turner alluvial aquifer, which are set out in this report.

To determine the lower Turner alluvial aquifer allocation limit, the department has used a risk-based approach (DoW 2010). We use this approach in areas where knowledge about the groundwater resource is limited and competing demands for the water do not exist. This allows us to develop allocation limits and licensing rules quickly and consistently.

This approach has four steps:

- 1 Identify and define the groundwater resource.
- 2 Describe aquifer properties, groundwater-dependent values and consumptive uses and assess the risks.
- 3 Assess whether any risks can be managed through licensing rules.
- 4 Set allocation limits and licensing rules.

Using the process outlined above, the department has set an allocation limit for the lower Turner alluvial aquifer of 0.42 GL/yr. As at January 2011, water is still available for licensing.

As there is only limited information about this water resource, the department welcomes new investigations and data which would improve our understanding of the aquifer. If new information shows that more water is available than the estimate that has been used in this report, and that the effects of increased abstraction are manageable, then we may review the allocation limit.

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 how much water is available 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 Turner alluvial aquifer. We are doing this because water demand is increasing as a result of mining and related industry activities in the area.

This document sets out:

- the resource boundary of the lower Turner alluvial aquifer
- existing information about 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 the 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. The allocation limit, and other mechanisms such as monitoring, investigations and compliance, are used to manage the impacts of water abstraction on other water users, the water resource and the environment. As more information about a resource becomes available, the allocation limit may be revised accordingly.

1.3 Process used for setting the lower Turner alluvial aquifer allocation limit

To set the lower Turner alluvial aquifer 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 and 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 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*. 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 Turner resource

2.1 Resource boundary

The department has defined the extent of the aquifer (Figure 1) based on the lobe of low salinity groundwater coinciding with the distribution of alluvial gravels, which extends from the northern limit of the exposed basement rock to the tidal flats in the north-west.

The boundary is also based on the aquifers described by Farbridge (1966) and considers the approximate extent of saturated zones in the alluvial sediments and weathered bedrock.

The resource is defined as: Pilbara groundwater area – Lower Turner – alluvial aquifer.

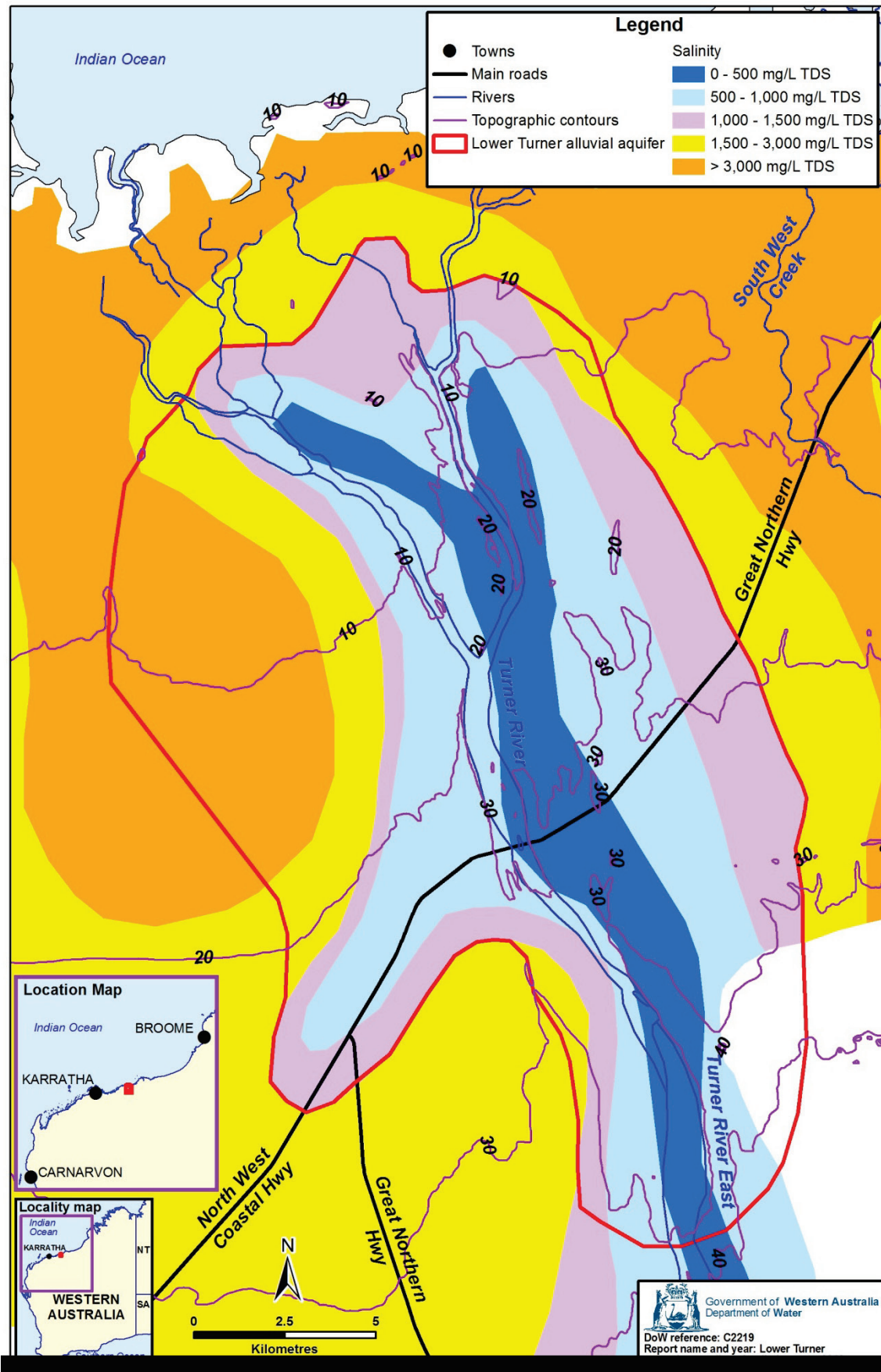


Figure 1 Resource boundary of the lower Turner alluvial aquifer

2.2 Hydrogeology

The lower Turner groundwater resource consists of two aquifers, the quaternary alluvium aquifer and the weathered bedrock aquifer of Archaean granites and greenstones of the Pilbara Craton. The quaternary alluvium fills a short, northerly trending valley that coincides with the present locations of the East Turner and West Turner rivers. The recent alluvium overlies this within the current river channel.

The alluvial deposits are up to 43 m thick with an estimated saturated thickness of 6 to 7 m at the base. The weathered bedrock aquifer has secondary calcrete development which has shown low pumping yields in previous testing. Water quality sampling has indicated that the alluvial sediments and bedrock are interconnected, so they are best managed as one aquifer with a single allocation limit.

The aquifer is recharged directly through periodic streamflow from the Turner River, and by throughflow. Water quality is reasonable inland and upstream but diminishes rapidly towards the coast due to saltwater intrusion (Haig 2009).

The characteristics of the lower Turner alluvial aquifer are shown in Table 1.

Table 1 Characteristics of interest of the lower Turner alluvium

Characteristic	Value or description
Water quality	215–2000 mg/L (3000 mg/L towards the coast)
Saturated aquifer thickness	9 m
Mean annual groundwater recharge	0.7 GL
Long-term mean annual river flow (1985–2005)	29 GL
Groundwater throughflow estimate	0.1 GL/yr at a TDS < 2000 mg/L

Farbridge (1966) calculated a mean annual aquifer recharge of 0.7 GL/yr, which was considered to be the yield that could safely be withdrawn from the aquifer system over a three-year period.

The Turner River borefield supplied water to Port Hedland from 1969 to 1980. The use of the resource was discontinued because of the limited yield and because of water quality problems. Production in 1967 was about 0.3 GL/yr and it was concluded that it could not be increased because of the risk of high salinity. It was noted that this risk might be reduced if production bores were spaced further apart.

Skidmore (1996) estimated that there is an average recharge to the Turner River alluvium of 90 000 m³/yr/km of river, based on the work of Farbridge (1966). This work was re-examined as part of this allocation report and it was considered that the thickness and permeability of the alluvium at the southern end may have been overestimated. Given this uncertainty, there was insufficient evidence to revise the Farbridge annual recharge estimate of 0.7 GL. Further investigation work is required (as recommended in Haig (2009)) and the recharge estimate will be reviewed as more information becomes available.

The process used to determine an allocation limit for the Turner River resource has used the 0.7GL/yr estimate of average annual recharge as a starting point for determining how much water can be sustainably used from the resource. In determining the allocation limit the department has considered the possible impacts of water abstraction on the resource, including the water quality of the resource and possible impacts on in situ values. These considerations and the allocation limit are discussed below.

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.

An important 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. 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, 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 any groundwater-dependent ecosystems (GDEs) that may be associated with the lower Turner 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 possible types of 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.

No stygofauna surveys have been conducted within the lower Turner alluvial aquifer. Sampling of the nearby De Grey River alluvial aquifer, which has a similar hydrogeological setting and water quality has yielded stygofauna from three higher taxonomic groups. These results suggest that the lower Turner alluvial aquifer may support stygofauna populations.

Analysis of satellite imagery indicates that there are two near-permanent pools within the study area (DoW 2009) (Figure 2). Two unnamed pools have been present in five out of the six years examined between 1999 and 2007. A further four intermittent pools have also been identified.

Permanent pools of the lower Turner River are considered to provide refuges for aquatic and terrestrial flora and fauna. Consistent with the conclusions of May and McKenzie (2002), permanent pools in the lower Turner River are considered subregionally significant and impacts on them as a result of water abstraction should be avoided.

Vreeswyk et al (2004) has identified the vegetation system occurring along the banks and channels of the lower Turner River as a 'gallery melaleuca eucalypt woodland' site type. This occurs as a *Melaleuca argentea* or *Eucalyptus camaldulensis* woodland with trees of variable density and 6 to 12 m tall. The site type has been identified as being important as refuge for native fauna (Vreeswyk et. al. 2004).

Limited vegetation surveys around Moorambine Pool have found *M. argentea*, *M. glomerata*, *E. camaldulensis* and *E. victrix* lining the river around this pool.

Previous desktop investigations by the department have identified the vegetation communities dominated by *E. camaldulensis*, *E. victrix* and *M. argentea* as likely to be groundwater-dependent or have potential to be affected by groundwater abstraction. In particular *M. argentea* has been found to be adapted to areas where the depth to groundwater is 2 to 3 m, and the species has difficulty adjusting to short periods of dry conditions (Graham 2001).

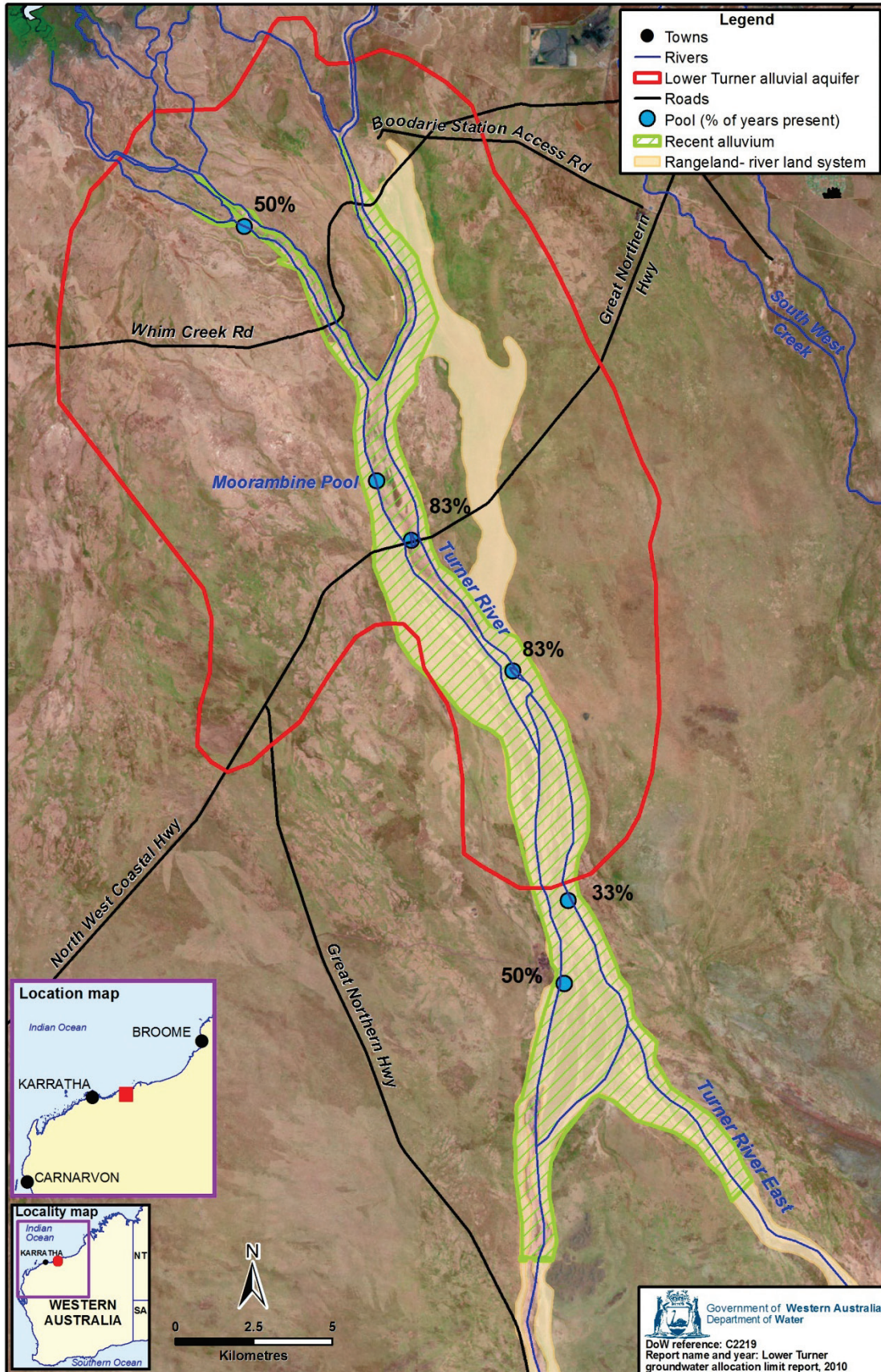


Figure 2 Pools along the lower Turner River that are possibly groundwater-dependent ecosystems and their permanency

3.4 Cultural and social values

The lower Turner area is within the Kariyarra people (WC99/3) native title claim area. The department has consulted with the Kariyarra people traditional owners through the Pilbara Native Title Service.

During an 'on-country' visit, the traditional owners identified that:

- the Turner River is a place of importance to the Kariyarra people and has associated cultural values
- riparian vegetation and water quality should be protected
- regular reporting should be provided to the Kariyarra people on the outcomes of the monitoring program.

The traditional owners were generally satisfied that the department's approach to allocation and abstraction management would protect their cultural values. This aside, it was recognised that effective monitoring and reporting is needed to assure them that this is occurring.

We have considered these recommendations in developing the licensing rules (see Section 4.2).

3.5 Consumptive use

Currently, there is limited water take from the aquifer. Water use is mainly for the Turner River estate, a rural lifestyle development to the south of the North West Coastal Highway, and for stock and domestic use, which is exempt from licensing. There is also some minor take as part of sand mining activities.

The Turner River borefield supplied town water supply to Port Hedland from 1969 to 1980. However, there is currently no water taken for public supply from the resource.

The department has estimated stock and domestic water use to be 41 500 kL/yr, as shown in Table 2.

Table 2 Estimated stock and domestic water use, which is exempt from licensing

Usage	Estimated water use kL/yr	Estimated number of water users	Total water use kL/yr
Stock bores	500	29	14 500
Semi-rural blocks	1500	18	27 000

Water use and demand is expected to increase in the future with the expansion of Port Hedland's port facility. Given its proximity to Port Hedland the lower Turner alluvial aquifer is seen as an opportunity to develop as a 'fit-for-purpose supply' to supplement port water supply.

The BHP Billiton Ore and Fortescue Metals Group rail corridors are located near the south-eastern boundary of the aquifer. There is some abstraction for construction

activities and an interim port water supply. Abstraction from this area is not considered to be having an impact on the lower Turner alluvium aquifer.

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 productive use that may arise if water is not abstracted.

For the lower Turner 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 3).

Table 3 shows what we considered in assigning risk ratings.

4.1.1 Initial risk assessment

For the lower Turner 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 3).

Table 3 Determining the risk of abstraction on in situ values and the risk of limiting water available for consumptive use

Values		Likelihood and/or sensitivity	Consequences	Risk rating	Overall Risk
In situ risk	Aquifer properties	What are the risks to the aquifer from abstraction?	Concern of saline intrusion to the aquifer from increasing pump rates of bore fields.	Medium	Medium (highest risk rating)
		What is the overall level of risks to the aquifer of abstraction?	The overall risk to the aquifer and in situ values are considered as being moderate.	Low	
	Groundwater-dependent ecosystems	Are some GDEs or components of GDEs more sensitive to changes in hydrogeological regime than others?	GDEs are sensitive to drops in water level from groundwater abstraction.	Medium	

Values		Likelihood and/or sensitivity	Consequences	Risk rating	Overall Risk
		How significant are the GDEs?	Subregional significance of permanent pools.	Medium	
	Cultural and social	Are some values or components of values more sensitive to changes in the hydrogeological regime than others?	These cultural sites are associated with GDEs and mitigation strategies used to protect these sites will also protect the cultural values.	Low	
		How significant are the identified values?	There are no regionally significant sites known that are water dependent. Important for fauna refuge	Low	
		Is there a risk of impacts on existing water users (consumptive) from increased abstraction?	Consideration should be given to unlicensed stock and domestic use within the area when considering mitigation strategies to protect other users	Low	
Development risk	Future use	How reliant is the community on abstraction from the resource?	No significant extraction occurring	Low	Medium (highest risk rating)
		How easily can future water needs be met by access to alternative supplies?	Supply would be opportunistic but add significant value to the Port Hedland water supply scheme or direct industrial supplies. Other options are being investigated.	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).

To manage the risks to in situ values, the department has developed the licensing and management rules in Table 4.

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 on existing users
- manage the aquifer as a sustainable productive resource.

Table 4 Licensing and management rules for the lower Turner alluvial aquifer

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 the appendix. 2. New bores must be placed at least 100 m away from permanent river pools.
Other water users	3. Additional abstraction must not have an impact on existing water users.
Aquifer integrity	4. Extraction of brackish water up to 2000 mg/L will be permitted from the quaternary alluvials and weathered bedrock. 5. Only extraction of water below 1000 mg/L will be permitted from the recent alluvium.
Water quality	6. Licensees with water entitlements of 100 000 kL or more must monitor salinity as per the monitoring program outlined in their licence conditions and/or operating strategy. 7. Abstraction must not adversely affect the current range of position of the saltwater interface. 8. Allocation requests above 200 000 kL/yr will not be permitted without adequate hydrogeological investigation.

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 4.

4.3.2 Using a risk matrix to determine yield

Using a risk matrix (Table 5), 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 5 shows, a low in situ risk and a medium development risk (from Table 3) resulted in a 60% proportion of recharge being selected.

Table 5 Risk matrix for determining the proportion of yield for allocation

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

4.3.3 Allocation limit and water availability

Using the average annual recharge estimate of 0.7 GL/yr (Table 1) and the selected yield proportion of 60%, the department has set the lower Turner alluvium's allocation limit at 0.42 GL/yr. The components of this figure are shown in Table 6.

Table 6 Allocation limit and components for the lower Turner alluvial aquifer

Allocation limit kL/yr	Licensable component kL/yr		Unlicensable component kL/yr
	General licensing	Public water supply	Unlicensed use
420 000	378 500	0	41 500

4.4 Monitoring and reporting

Licensees are required to carry out 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.

The department does not currently monitor any bores in the Turner River alluvial resource and there is no surface water gauging station on the river in the vicinity of the groundwater resource. 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.

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 valuable to improving our knowledge of the resource.

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.

Appendix

River pools in the lower Turner 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 7 Details of location and permanency of pools in the lower Turner Alluvial aquifer.

Name	Permanency*	Latitude	Longitude
Meerandaganna Pool	Intermittent	-20.4327	118.4296
Moorambine Pool	Unknown	-20.5056	118.4705
Unknown	Semi-permanent	-20.5227	118.4814
Unknown	Semi-permanent	-20.5600	118.5127
Unknown	Intermittent	-20.6260	118.5302
Unknown	Intermittent	-20.6498	118.5292

**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.
Bore field	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. 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 <i>Rights in Water and Irrigation Act 1914 (WA)</i> 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): <ul style="list-style-type: none">a) any river, creek, stream or brook in which water flowsb) any collection of water (including a reservoir) into, through or out of which anything coming within paragraph (a) flowsc) 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 <i>Rights in Water and Irrigation Act 1914</i> (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.
Yield	The volume of water that may be drawn from a well or water supply system.

Volumes of water

One litre	1 litre	1 litre	(L)
One thousand litres	1 000 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 information and disclaimer - Figures 1 and 2

Datum and projection information

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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 this map:

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

Road Centrelines – DoW – Current

Towns –DLI – Current

Topography – Landgate – 23/03/2009

Bores – Water Corporation – Unknown

DWAID Aquifer – DoW – Current

Rangeland Land System Mapping – Agriculture WA - Current

Aerial Imagery Satellite – Landsat - 2005

WA Coastline, WRC (Poly) – DoW – 20/07/2006

Australian Coastline - DoW – 08 September, 2002

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