Water for the Future - Statutory water planning for the Pilbara

Final report to the Department of Sustainability, Environment, Water, Population and Communities

Looking after all our water needs

Department of Water
October 2010
Contents

1 Introduction ..........................................................................................................................1
   1.1 Background ..................................................................................................................1
   1.2 The Pilbara region .......................................................................................................1
   1.3 Projects in the Pilbara region .......................................................................................2

2 How was the WFTF project for Pilbara implemented? .................................................3
   2.1 Mapping WFTF milestones (Schedule A18) to WFTF project activities (A9) ..........3
   2.2 How WFTF project activities relate to the Department of Water allocation planning process .................................................................4

3 Statement against project activities (Schedule A9) .....................................................7
   Activity 1: Investigation and assessment of coastal alluvial aquifers ..............................7
   Activity 2: Drilling investigation and assessment of alluvial aquifers .............................9
   Activity 3: Numerical modelling of the West Canning Basin ......................................10
   Activity 4: Ecological water requirements study .........................................................11
   Activity 5: Cultural and social values study .................................................................13
   Activity 6: Environmental reference sites study .........................................................14
   Activity 7: East Pilbara water study .............................................................................14
   Activity 8: Processing backlog of bore and mining reports ..........................................15
   Activity 9: Significant infrastructure based supplies study .........................................16
   Activity 10: Enhanced recharge study .........................................................................17

4 Statement against project objectives (Schedule A7) ..................................................19

5 Findings and management implications .......................................................................25
   Appendix A — Products completed through the project .............................................28
   Appendix B — Products submitted as evidence for completion of May 2010 milestones ...30

Appendices

Appendix A — Products completed through the project .............................................28
Appendix B — Products submitted as evidence for completion of May 2010 milestones ...30

Figures

Figure 1 How Water for the Future project activities relate to the Department of Water water allocation planning process .................................................................5

Tables

Table 1 Mapping milestones to project activities .............................................................3
1 Introduction

1.1 Background

This report is one of four reports on projects funded under the Australian Government’s ‘Water for the Future’ program (originally ‘Water Smart Australia’) and designed to improve our knowledge in four priority areas – the Pilbara, the Gnangara mound, the Collie catchment and the South West groundwater areas.

This report, on statutory water planning in the Pilbara, represents the final commitment under the Water for the Future funding deed for the Pilbara project. It describes the work undertaken in this project and compares what was achieved to the original goals. There were ten ‘project activities’ carried out:

- investigation and assessment of coastal alluvial aquifers
- drilling investigation and assessment of alluvial aquifers
- numerical modelling of the West Canning Basin
- ecological water requirements study
- cultural and social values study
- environmental reference sites study
- East Pilbara water study
- processing backlog of bore and mining reports
- significant infrastructure based supplies study
- enhanced recharge study

1.2 The Pilbara region

The Pilbara is an arid region in the north-west of Western Australia. The average annual rainfall is between 200 mm and 350 mm. Rainfall is highly variable and is dominated by irregular tropical cyclones. The concept of ‘sustainable yield’ takes on a different relative and temporal meaning in the Pilbara. Extended droughts are followed by major floods at unpredictable intervals, highlighting the need to plan water supply for the worst case scenario, and not for the average rainfall.

The Pilbara region is experiencing major industrial and population growth. Consequently the demand for water, particularly at coastal ports and towns, has been increasing. In this arid region, groundwater resources, mostly in the alluvial aquifers of coastal rivers, are recharged by cyclonic flood flows. They have significant environmental, social and cultural values. Information generated through this project will help to provide a clear management framework to keep abstraction from these aquifers at a sustainable level while protecting environmental values and other public benefits.
The limited and episodic rainfall, with highly variable groundwater recharge, the ‘boom and bust’ nature of the population, and the high cost of alternative water sources present significant water planning and management challenges. Ironically, well inland from the major population centres, mining in the hard rock of the central Pilbara often intercepts significant quantities of fresh water in disconnected fractured rock ‘aquifers’. While this water is used at mine sites for consumption, processing and dust suppression, the supply is too erratic and the transport costs too prohibitive for it to be a major part of the solution for coastal water supplies at this stage.

1.3 Projects in the Pilbara region

To respond to the rapidly changing circumstances in the Pilbara, the Department of Water initiated three significant projects:

- The Pilbara regional water plan identified the priority issues and, working with regional stakeholders, set strategic objectives and priority actions for the region’s future water supplies.

- The Pilbara water in mining guideline consolidated advice linked to regulatory approvals. It promotes a ‘whole of water cycle’ approach to water management including efficient and beneficial use of water at mines, minimising impacts of changes to groundwater regimes, and reducing water needs at the water-poor ports.

- This project, statutory planning in the Pilbara, was initiated so that groundwater used to augment the region’s water supplies could be adequately understood and managed.
2 How was the WFTF project for Pilbara implemented?

2.1 Mapping WFTF milestones (Schedule A18) to WFTF project activities (A9)

The project was divided into 10 main components, described as ‘project activities’ in Schedule A9 of the deed. Each project activity was achieved by completing specific milestones as described in schedule 18 of the deed. The deed specified agreed timelines by which each milestone had to be completed over the three-year project. The table below gives details of the project activities and their related milestones.

Table 1 Mapping milestones to project activities

<table>
<thead>
<tr>
<th>Project activities</th>
<th>Related milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigation and assessment of coastal</td>
<td>Milestone 1 – Pilbara coast alluvial aquifer assessment and review – lower Fortescue, lower Yule, lower De Grey and lower Robe rivers</td>
</tr>
<tr>
<td>alluvial aquifers</td>
<td>1.1 – Award contract to external contractor</td>
</tr>
<tr>
<td></td>
<td>1.2 – Completion of desktop study, field work, model calibration and calibration reporting</td>
</tr>
<tr>
<td>Drilling investigation and assessment of</td>
<td>Milestone 2 – Millstream aquifer and Turner River drilling and modelling program</td>
</tr>
<tr>
<td>alluvial aquifers</td>
<td>2.1 – Award contract to external contractor</td>
</tr>
<tr>
<td></td>
<td>2.2 – Completion of the airborne geophysical surveys, desktop studies, numerical modelling, and draft reporting</td>
</tr>
<tr>
<td></td>
<td>2.3 – Completion of hydrogeological assessment, final reporting and project completion</td>
</tr>
<tr>
<td>Numerical modelling of the West Canning</td>
<td>Milestone 3 – West Canning Basin</td>
</tr>
<tr>
<td>Basin</td>
<td>3.1 – Award to external contractor</td>
</tr>
<tr>
<td></td>
<td>3.2 – Completion of hydrogeological model by external contractor</td>
</tr>
<tr>
<td></td>
<td>3.3 – Completion of final hydrogeological report, resource assessment and modelling by external consultant</td>
</tr>
<tr>
<td>Ecological water requirements study</td>
<td>Milestone 4 – Ecological water requirements</td>
</tr>
<tr>
<td></td>
<td>4.1 – Completion of Stage 1 of EWR</td>
</tr>
<tr>
<td></td>
<td>4.2 – Completion of Stage 2 of EWR</td>
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<tr>
<td></td>
<td>4.3 – Completion of Stage 3 of EWR</td>
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<tr>
<td></td>
<td>4.4 – Completion of Stage 4 of EWR</td>
</tr>
<tr>
<td></td>
<td>4.5 – Completion of Stage 5 of EWR</td>
</tr>
<tr>
<td></td>
<td>4.6 – Completion of Stage 6 of EWR</td>
</tr>
<tr>
<td>Cultural and social values study</td>
<td>Milestone 5 – Cultural and social values study</td>
</tr>
<tr>
<td></td>
<td>5.1 – Completion of Stage 1 of assessment of cultural and social water values</td>
</tr>
<tr>
<td></td>
<td>5.2 – Completion of Stage 2 of assessment of cultural and social water values</td>
</tr>
<tr>
<td></td>
<td>5.3 – Completion of Stage 3 of assessment of cultural and social water values</td>
</tr>
</tbody>
</table>
### Project activities | Related milestones
---|---
Environmental reference sites study | Milestone 6 – Environmental reference sites
6.1 – Completion of Stage 1 of establishment and monitoring of reference sites
6.2 – Completion of Stage 2 of establishment and monitoring of reference sites
6.3 – Completion of Stage 3 of establishment and monitoring of reference sites
East Pilbara water study | Milestone 7 – East Pilbara water study
Processing backlog of bore and mining reports | Milestone 8 – Backlog of bore and mining reports
8.1 – Completion of Stage 1 of contract to update backlog
8.2 – Completion of Stage 2 of contract to update backlog
8.3 – Completion of Stage 3 of contract to update backlog
Significant infrastructure based supplies study | Milestone 9 – Significant Infrastructure based supplies study
9.1 – Detailed work on additional evaluations run
9.2 – Final run of evaluation run
9.3 – Reporting
Enhanced recharge study | Milestone 10 – Enhanced recharge study
10.1 – Completion of detailed assessment by external consultant
10.2 – Completion of contract by external consultant

## 2.2 How WFTF project activities relate to the Department of Water allocation planning process

As described above, ten project activities were completed for this project. Each of the project activity will inform different stages of the planning process as shown in Figure 1 below.
Figure 1  How Water for the Future project activities relate to the Department of Water - water allocation planning process
3 Statement against project activities (Schedule A9)

Activity 1: Investigation and assessment of coastal alluvial aquifers

Background

The aim of this project activity was to investigate and assess four alluvial aquifers:

- lower Fortescue
- lower Yule (replaced previously proposed Maitland)
- lower De Grey (replaced previously proposed George)
- lower Robe.

This investigations and assessments were intended to:

- determine the viability of the resources for development of new water supplies
- increase our understanding of groundwater and surface water interaction.
- assist in improving the management regimes of resources already in use as water supplies
- support work being conducted in parallel project activities to determine ecological water requirements and identify the level of risk to social and cultural values associated with the possible development of the resources.

Work conducted and products developed

Milestone 1 – Pilbara coast alluvial aquifer assessment and review

The Department of Water conducted a detailed review of the potential of some of the water resources on the Pilbara coast (Haig 2009). These investigations indicated that the Maitland and George alluvial aquifers have only low potential for significant water use. Hence the department sought and was granted a variation to investigate the lower Yule and lower De Grey alluvial aquifers instead.

Data collected was used to produce predictive computer models for the four alluvial aquifers.

Works completed for this project activity include:

- Collating and interpreting a broad range of data and information sources.
- Producing an inventory of existing bore monitoring networks in remote areas. We have confirmed locations and conditions of existing bores which have not been serviced for a long time.
- Measuring hydrogeological and hydrochemical parameters, including water level.
• Installing data loggers to automatically record water level in bores.

• Topographic surveying – airborne laser technology (light detection and ranging – LiDAR) was used to accurately measure large areas to confirm surface water flow.

• Geophysical surveying – airborne transient electromagnetic and gravity geophysics was used to accurately measure aquifer distribution, and depth and composition (e.g. salinity) of groundwater.

• Constructing numerical groundwater models for the lower Fortescue, lower Yule, lower De Grey and lower Robe rivers.

The models have been used to assist in determining ecological water requirements and assess levels of risk to cultural values associated with the possible development of the resources. The models will also be used to set allocation limits and decide how much water can be taken from the resources for consumptive use. Allocation limits and rules to manage resources will be the main input into water management plans for the region.

**Milestone 1 products**

<table>
<thead>
<tr>
<th>Milestone Number</th>
<th>Milestone Detail</th>
<th>Product Status</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.1 – Award contract to consultant</td>
<td></td>
<td>• LiDAR metadata statement</td>
</tr>
<tr>
<td></td>
<td>1.2 – Completion of desktop study, fieldwork, model calibration and interim</td>
<td>Completed</td>
<td>• FALCON gravity and magnetic acquisition and processing</td>
</tr>
<tr>
<td></td>
<td>reporting</td>
<td></td>
<td>• FALCON interpretation of airborne data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Tempest geophysics acquisition and processing</td>
</tr>
<tr>
<td></td>
<td>1.3 – Completion of modelling, hydrogeological assessment and final reporting</td>
<td>Completed</td>
<td>• Numerical groundwater model for lower Fortescue</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Development of subregional scale numerical groundwater model of the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>lower Yule Catchment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Lower De Grey groundwater model</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Conceptual hydrogeology and model design</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Lower Robe river groundwater model</td>
</tr>
</tbody>
</table>
Activity 2: Drilling investigation and assessment of alluvial aquifers

Background

This project activity was to have been an investigation to assess the hydrogeology of the Turner alluvial aquifer and to improve our knowledge of the Millstream aquifer. The intention was to use results from the investigation to construct a groundwater computer model for the Turner alluvial aquifer and to improve the computer model for the Millstream aquifer.

The Turner alluvial aquifer was considered to be the next source for expanding the public water supply for Port Hedland, while the Millstream aquifer supports a national park and is an important part of the public water supply for Karratha.

Work conducted and products developed

Milestone 2 – Millstream and Turner River aquifers geophysical investigation and assessment

Two variations to the scope of this project activity were sought by the department.

- The department reviewed the potential of several water resources as part of the previous project activity (Section 3.1 above). A detailed review of available information on several potential and existing water resources was completed as part of project activities 3.1 and 3.2. The review indicated that the Turner alluvial aquifer is not viable as a significant future resource. The water available is of marginal quality and is limited in quantity. This prompted the department to request a variation to remove the Turner alluvial aquifer from the scope of this project activity.

- During 2007 Western Australia experienced a shortage of drillers and equipment, which was leading to a considerable increase in costs. This prompted the department to request a variation to use airborne geophysical surveys as an alternative method of gathering the required data for upgrading the model for the Millstream aquifer.

Both requests were accepted. The department proceeded in the following way.

- We used the available information from the Turner aquifer to determine an allocation limit and set up management rules for future water use from the resource. The surplus funding was used against Milestone 3.1 above, to complete airborne surveys on the lower De Grey, Yule, Robe and Fortescue aquifers and to construct groundwater models for these.

- We proceeded with a deeper analysis of existing data sets for Millstream aquifer. This revealed that additional water level and chemistry data as well as topographic surveys data were essential for constructing the computer model. Following this, data loggers to automatically record water levels were installed on bores, analysis of water chemistry was completed and an airborne
topographical survey was conducted. A computer model was then constructed using the newly collected data and existing data sets.

The main outcomes of this project activity include the computer model for the Millstream aquifer and the establishment of rules for managing future water use from the Millstream aquifer.

**Milestone 2 products**

<table>
<thead>
<tr>
<th>Milestone number</th>
<th>Milestone detail</th>
<th>Product status</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2.1 – Award contract to consultant</td>
<td>Completed</td>
<td>• Millstream model recalibration</td>
</tr>
<tr>
<td></td>
<td>2.2 – Completion of the airborne geophysical surveys, desktop studies, numerical modelling and draft reporting</td>
<td>Completed</td>
<td>• Final Millstream model and calibration</td>
</tr>
<tr>
<td></td>
<td>2.3 – Completion of hydrogeological assessment, final reporting and project completion</td>
<td>Completed</td>
<td></td>
</tr>
</tbody>
</table>

**Activity 3: Numerical modelling of the West Canning Basin**

**Background**

The aim of this project was to develop a numerical groundwater model for the West Canning Basin aquifer using information available from previous studies conducted by the department and others.

**Work conducted and products developed**

**Milestone 3 – West Canning Basin**

The numerical groundwater modelling tool for the West Canning Basin was produced following a hydrogeological assessment. This tool will assist with the assessment of groundwater abstraction licences and the determination of allocation limits.

Major work conducted through this project involved:

- reviewing available information on the hydrogeology of the West Canning Basin
- checking the location and assessing the condition of monitoring bores to produce a bore inventory
- installing piezometers into perennially flowing springs, to confirm their relationship to the aquifer
- developing a numerical groundwater modelling tool for the West Canning Basin based on the results of investigations undertaken as part of the project activity and previous work
• using trace metals hydrochemistry and isotopic techniques to analyse the age of groundwater in different parts of the aquifer and predict flow paths and recharge sources within the aquifer.

• conducting airborne geophysical surveys for the lower De Grey aquifer, (see Activity 2 above) which provided additional data that contributed to the development of the modelling tool.

### Milestone 3 products

<table>
<thead>
<tr>
<th>Milestone number</th>
<th>Milestone detail</th>
<th>Product status</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Award contract to external consultant</td>
<td>Completed</td>
<td>• Radiocarbon age dating of groundwater</td>
</tr>
<tr>
<td>3.2</td>
<td>Completion of hydrogeological model</td>
<td>Completed</td>
<td>• West Canning Basin model design</td>
</tr>
<tr>
<td>3.3</td>
<td>Completion of final hydrogeological report, resource assessment and modelling by external consultant</td>
<td>Completed</td>
<td>• West Canning Basin modelling project</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Determining the age of groundwater in the recharge zone and north-eastern section of West Canning Basin</td>
</tr>
</tbody>
</table>

### Activity 4: Ecological water requirements study

#### Background

This project activity was an investigation to confirm the distribution of ecosystems dependent on groundwater and to determine the water requirements of these systems.

#### Work conducted and products developed

### Milestone 4 – Ecological water requirements

The investigation of groundwater-dependent ecosystems occurred in parallel with the hydrogeological investigations (project activities 3.1 and 3.2).

The major outcomes of this project activity were the confirmed locations of groundwater-dependent systems and the understanding of their significance. Information gathered was used to develop conceptual models of links between ecosystems and hydrology.

Individual products developed through this project activity were:

• a complete study of aquatic ecosystems of the Robe River using a long-term ecological data set

• a report on the distribution of fish in relation to groundwater fed pools in the Fortescue and Yule rivers

• reports on macroinvertebrates within Pilbara aquatic ecosystems
• a review of the monitoring and management of the Millstream aquifer and its water-dependent ecosystems
• a map of the distribution and permanency of river pools throughout Pilbara completed using satellite imagery
• reports on the groundwater-dependent ecosystems based on distribution, conservation, significance and links between hydrogeology and groundwater-dependent ecosystems for the Millstream, De Grey, lower Fortescue and lower Robe aquifers.
• methodologies to determine ecological water requirements.

The methodologies were developed specifically to be applied to the variable nature of the Pilbara climate. The main work in developing these methodologies was:

• the development of a database for the distribution of vegetation in relation to depth to groundwater
• the development of techniques to quantify water use by groundwater-dependent vegetation
• analysis of available hydrological datasets to set ecological water requirements as thresholds at representative sites.

**Milestone 4 products**

<table>
<thead>
<tr>
<th>Milestone number</th>
<th>Milestone detail</th>
<th>Product status</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 – Completion of Stage 1 EWR</td>
<td>4.2 – Completion of Stage 2 EWR 4.3 – Completion of Stage 3 EWR 4.4 – Completion of Stage 4 EWR</td>
<td>Completed</td>
<td>• Pilbara River Pool project – progress report – November 2008 • Long-term ecological river system</td>
</tr>
<tr>
<td>4.5 – Completion of Stage 5 EWR</td>
<td>Completed</td>
<td>• De Grey river values and issues • Fishes in groundwater-dependent pools • Habitat associated with aquatic invertebrates in river pools • Long-term ecological river systems • Millstream status report • Pool mapping metadata</td>
<td></td>
</tr>
<tr>
<td>4.6 – Completion of Stage 6 EWR</td>
<td>Completed</td>
<td>• Millstream: Ecological values and issues • Lower Robe: Ecological values and issues • Lower Fortescue: Ecological values and issues • Determining water level ranges of Pilbara riparian species</td>
<td></td>
</tr>
</tbody>
</table>
**Activity 5: Cultural and social values study**

**Background**

The aim of this project activity was to assess the values placed on water-dependent features by Aboriginal people through consultation with traditional owners. This knowledge would then enable us to use hydrogeological information from other project activities to determine water regimes necessary to sustain these features and set up management rules to ensure a low level of risk if water is to be allocated to other purposes.

**Work conducted and products developed**

**Milestone 5 – Cultural and social values studies**

The department consulted traditional owners to identify culturally significant water features. Further information collected about the broader significance of water resource areas to Indigenous communities was also collected.

The department is using this information to set allocation limits (or regimes) that will sustain identified water features. Parallel to this, we will use results of hydrogeological investigations and models developed to set up water regimes to maintain water resources with identified Indigenous values to a low level of risk.

**Milestone 5 products**

<table>
<thead>
<tr>
<th>Milestone number</th>
<th>Milestone detail</th>
<th>Product status</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5.1 – Completion of Stage 1 of assessment of cultural and social water values</td>
<td>Completed</td>
<td>• Pilbara – cultural and social water values –Stage 1</td>
</tr>
</tbody>
</table>
|                  | 5.2 – Completion of Stage 2 of assessment of cultural and social water values | Completed      | • Pilbara – cultural and social water values –Stage 2  
|                  |                                                       |                | • Ethnographic heritage survey                      |
|                  | 5.3 – Completion of Stage 3 of assessment of cultural and social water values | Completed      | • Pilbara – cultural and social water values –Stage 3  |
Activity 6: Environmental reference sites study

Background

The aim of this project activity was to develop a network of well monitored reference sites across the Pilbara to differentiate between the effects of groundwater or surface water abstraction and those caused by climate change or climate variability.

Work conducted and products developed

Milestone 6 – Environmental reference sites

This project activity involved collaboration with academic and industry representatives to determine optimal sites for the monitoring network.

The network of reference sites was developed covering areas across Millstream and the Yule alluvial aquifer. Measurements were taken to identify the impact of climate variability on these surface and ground water systems and changes to the ecosystems sustained by these resources.

Milestone 6 products

<table>
<thead>
<tr>
<th>Milestone number</th>
<th>Milestone detail</th>
<th>Product status</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6.1 – Completion of Stage 1 of establishment and monitoring of reference site</td>
<td>Completed</td>
<td>• First interim report – climate and tree water use</td>
</tr>
<tr>
<td></td>
<td>6.2 – Completion of Stage 2 of establishment and monitoring of reference site</td>
<td>Completed</td>
<td>• Climate management and ecosystem interactions</td>
</tr>
<tr>
<td></td>
<td>6.3 – Completion of Stage 3 of establishment and monitoring of reference site</td>
<td>Completed</td>
<td>• Environmental reference sites for the Yule River groundwater system</td>
</tr>
</tbody>
</table>

Activity 7: East Pilbara water study

Background

The aim of this project activity was to review and report on available information on the water resources of the East Pilbara region.

Work conducted and products developed

Milestone 7 – East Pilbara water study

This project activity was expanded to include both the East Pilbara and Pilbara coastal aquifers. Two main products were produced from this project activity:

• Pilbara coastal water study, February 2009
• East Pilbara water study, June 2010.

The Pilbara coastal water study includes the coastal areas of the East Pilbara and the coastal aquifers investigated in project activities 3.1, 3.2 and 3.3 (above). It included interpretation of large amounts of data collected from a range of previously available reports from the mining industry and monitoring exercises. The release of this report was a major achievement. The department registered a large demand for distribution of this report to the wider Pilbara community and interested general public.

The East Pilbara water study contains information about the remaining (non-coastal) aquifers. The information has been compiled mainly from mining industry information and data available from previous investigations.

Milestone 7 products

<table>
<thead>
<tr>
<th>Milestone number</th>
<th>Milestone detail</th>
<th>Product status</th>
<th>Products</th>
</tr>
</thead>
</table>
| 7                | 7.1 – Completion of contract by external contractor | Completed | • Pilbara coast water study  
• Review of borefields and groundwater exploration reports in the East Pilbara |

Activity 8: Processing backlog of bore and mining reports

Background

The aim of this project activity was to process large amounts of data provided to the department over a 10-year period from large mining water licensees. The resulting database provides information on location of monitoring bore networks, results of monitoring and aquifer properties and characteristics.

Work conducted and products developed

Milestone 8 – Backlog of bore and mining report

This project activity was completed as intended. The outcome is an up-to-date database of bore data available for decision makers within the department and importantly also for organisations who are planning to use water. The information has also been spatially referenced, allowing data to be displayed in a geographical information system and maps to be produced.
## Milestone 8 products

<table>
<thead>
<tr>
<th>Milestone number</th>
<th>Milestone detail</th>
<th>Product status</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>8.1 – Completion of Stage 1 of contract to update backlog</td>
<td>Completed</td>
<td>• Pilbara groundwater data</td>
</tr>
<tr>
<td></td>
<td>8.2 – Completion of Stage 2 of contract to update backlog</td>
<td></td>
<td>progress report</td>
</tr>
<tr>
<td></td>
<td>8.3 – Completion of Stage 3 of contract to update backlog</td>
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</tr>
</tbody>
</table>

## Activity 9: Significant infrastructure based supplies study

### Background

The aim of this project activity was to develop a modelling tool to examine the feasibility of alternative options to supply additional water to demand centres in the Pilbara. The tool allows the cost and reliability of alternative options including desalination and additional groundwater sources to be assessed.

### Work conducted and products developed

## Milestone 9 – Significant infrastructure based supplies study

This project was completed as intended. The Department of Water produced a series of reports and a computer model to examine the costs and benefits of existing and potential water supply.

This model tool is currently contributing to the decision making process for the management of the West Pilbara Water Supply Scheme which supplies the Karratha–Dampier area.

## Milestone 9 products

<table>
<thead>
<tr>
<th>Milestone number</th>
<th>Milestone detail</th>
<th>Product status</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>9.1 – Detailed work on additional evaluations run</td>
<td>Completed</td>
<td>• Integrated water planning tool</td>
</tr>
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<td></td>
<td>9.2 – Final evaluation run</td>
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<td>9.3 – Reporting</td>
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Activity 10: Enhanced recharge study

Background

The aim of this project activity was to investigate the feasibility of constructing a barrage across selected rivers upstream of alluvial aquifer systems to increase aquifer recharge by retaining flood water that was releasing into the ocean after irregular rain events.

Work conducted and products developed

In January 2008, the department reviewed this project activity and determined that construction of a barrage would have significant detrimental ecological and cultural impacts. This meant that the potential water supply was unlikely to be ecologically sustainable or cost effective. This prompted the department to cancel this project activity and request a variation to re-allocate the funds to project activity 3 (see above) where detailed scoping had identified potential funding shortfalls. Both requests were accepted.
4 Statement against project objectives (Schedule A7)

**OBJECTIVE A**
The ability to develop water sharing plans for the Pilbara with identified water shares for the mining and resources processing industry

(See Milestones 1 - 9)

The main purpose of the studies that were completed through the Water for the Future program was to provide technical information to support the development of future water allocation (or water sharing) plans.

The department will use the information from the project activities to build on the current ‘macro’ allocation plans, for the smaller coastal groundwater resources.

All work completed under the Pilbara Water for the future project will support the development of water allocation plans (water sharing plans) for the larger coastal alluvial aquifers that will:

- improve options for water supply to coastal ports and towns
- improve the uptake of fit-for-purpose water for ore handling at ports.

The plans will identify the share of water available for different water use sectors and provide security for the environment (cultural, social and ecological values).

The project team for this investigation phase will be restructured and a formal planning process for the water allocation plans will be initiated in 2010/2011.

**OBJECTIVE B**
The completion of investigation and assessment programs to support regional water accounting objectives and thus ensure the sustainable use for the water resources

(See Milestones 1 - 6)

The investigation and assessment projects provide the technical information for better water resource accounting to assist with allocation planning and management. Through the three year project, the department has improved the measurement and monitoring of the aquifers and groundwater-dependent ecosystems (project activities 1 to 6) and developed groundwater models (project activities 1 to 3) in order to:

- quantify sustainable levels of extraction from aquifers
- quantify water regimes to protect groundwater-dependent ecosystems and meet cultural and social water needs (project activities 4 to 6).

The database of bore data (project activity 8) contains up-to-date information that the department will use to monitor and account for groundwater use, and to evaluate
management approaches set out in the future allocation plans. People and organisations who are planning to use water can also get access to this information.

The information from the investigation and assessment programs will help us to meet the water accounting objective that measurement, monitoring and reporting systems are in place to ensure that water resources are managed sustainably.

**OBJECTIVES C & I**

Technical support towards the establishment of a statutory plan in which the rules and processes for recouping over-allocated systems will be clearly defined

The development of allocation limits of major new sources to foster the sustainable extraction of water in support of regional development and the evaluation of currently over-allocated systems that may be at risk by 2010

(See Milestones 1 - 7)

The Water for the Future Pilbara technical work focused on defining environmentally sustainable levels of extraction from water resources. The department will use the technical information to set clearly defined allocation limits (or consumptive pools). The allocation plans will define these limits and rules to prevent over-allocation.

The investigations carried out as part of the Pilbara program have indicated that none of the alluvial aquifers are over-allocated, and have shown that the concept of over-allocation may not be able to be applied directly to the unique Pilbara systems, which exhibit great variability both spatially and temporally. To prevent over-allocation in high use resources, such as for the lower Fortescue and Millstream aquifers, the department has set sustainable extraction limits and/or developed rules to manage abstraction.

The department will review these limits and rules when preparing statutory allocation plans, and will revise them where necessary, using further information from the investigation and assessment programs.

The department has also developed the *Pilbara water in mining guidelines*, a specific policy for managing mining abstraction and water use. Increasingly, mines in the Pilbara require dewatering below the watertable to allow for safe mining, which may not be sustainable in the long term. This policy addresses dewatering at the spatial and temporal scale appropriate to the life of the mine, to allow the recovery of the watertable when the mine closes. The department will refine this policy in the forthcoming water allocation (or water sharing) plans.
OBJECTIVE D
An improved understanding of water abstraction from regional groundwater sources to support future cost recovery programs which will be promoted through water management and planning objectives

(See Milestones 1 - 9)

Completion of the project activities has improved our understanding of groundwater abstraction and its effects on the regional groundwater resources. An important part of some of these activities was identifying which effects were due to abstraction and which were due to the highly variable climate in the Pilbara region (project activities 1 to 6).

The department is providing information on water planning and management costs across the state to the Economic Regulatory Authority, which is conducting an enquiry into recovering the costs of water resource management and planning.

The project activities have improved our understanding of the following elements that are being considered as part of cost recovery:

- the level of planning (and cost) required in a particular area, based on the risk to the resource and the environment
- public (cultural, social and ecological) and private (economic) benefit of the water resources
- potential effects (and associated costs) of individual large water users
- ongoing management of licences (and associated costs) – measurement, monitoring, resource assessment, compliance.

OBJECTIVE E
Significant progress against Clause 34 of the National Water Initiative referring to the special management requirements to support the mining sector

(See Milestones 1 - 9)

The department recognises that special management arrangements may be appropriate for mining as stated in Clause 34 of the National Water Initiative. We will use the work completed through this program to make progress on mining water reform, including developing water allocation plans and specific policies where appropriate, consistent with the National Water Commission’s recent position.

Through the Pilbara water allocation planning process the department has completed and published the Pilbara water in mining guideline. This was developed to integrate water planning and mine planning processes to ensure efficient and effective management of water resources and to help align cross-government approvals associated with water and project development.
As stated under objective A, the department is currently developing macro allocation plans for the smaller coastal groundwater resources. The Water for the Future projects will assist in the development of water allocation plans (water sharing plans) for the larger coastal alluvial aquifers.

Separately to the Water for the Future program, the Department of Water has carried out work on the cumulative impacts of mining on groundwater resources. The mining guideline outlines the department’s policy which will be refined through the development of future allocation plans. The department, in partnership with other regulatory agencies and mining companies, is developing a strategy to address potential cumulative impacts in an important area, the Fortescue Marsh. The aim of the strategy is to develop a collective water management approach to provide continuing protection to the environment.

Where practical and appropriate, that is, where there is a defined water resource and competition for water, the department will use allocation plans to manage the take and effective use of water for mining. Allocation plans may not be appropriate in some areas, including fractured rock resources where sustainable levels of extraction cannot be determined, or areas with isolated large users. In these areas, the department will manage water for mining activities through licences, using the mining guideline and an impact management approach.

**OBJECTIVE F**

To define the surface water/groundwater interactions of aquifer systems which support local features with environmental, cultural and social values. The understanding will lead to better management strategies to protect the valued ecosystems and surface water features which may be impacted by water abstraction

*(See Milestones 1, 2, 4 & 5)*

Information from the hydrogeological investigations of the alluvial aquifers (project activities 1 and 2) has increased our understanding of the interaction between surface and groundwater by characterising the hydrological regimes, mechanisms of recharge and discharge of aquifers, and quantifying water fluxes.

In parallel with the hydrogeological investigations, activities were undertaken to understand the ecological, cultural and social values of groundwater-dependent features and the water requirements of these systems (project activities 4 and 5).

From this information, models have been developed to identify the links between these groundwater and surface water regimes and how they support ecological, cultural and social values. To manage the potential impacts of abstraction at a local scale, the Department of Water develops rules to maintain the water regimes needed to protect these dependent values.

Through these activities, the computer model for the Millstream aquifer has been improved and models for the De Grey, Yule, lower Fortescue and lower Robe alluvial
aquifers have been developed. The department has used these models to refine the
management rules for the existing use from the Millstream resource. For the
remaining resources, current rules for existing use will be reviewed and for potential
resources, rules to manage abstraction sustainably will be developed.

**OBJECTIVE G**
The improved understanding of dynamic flow systems and the environmental
flow requirements which are subject to climatic variations ranging from
monsoon flooding to prolonged periods of drought

*(See Milestones 4 & 6)*

This objective was met through project activity 4 – ‘ecological water requirements’. It
focused on the links between hydrology and ecosystems such as river pools. The
dynamic nature of the hydrological regimes, resulting from the highly variable climate
of the Pilbara, was characterised through a review of available groundwater and
surface water monitoring data.

This data was used for the numerical groundwater modelling outlined in project
activities 1 and 2 and was used to characterise the hydrological regimes required by
dependent ecosystems. The effects of this variability on ecosystems was identified
through long-term monitoring data sets such as those on the Robe River aquatic
ecosystems and the mapping of river pools completed by the department.

We also examined long-term vegetation and hydrological data sets for the Millstream
aquifer and other resources where available. The reference network project (project
activity 6) was also established to monitor the effects of climate variability on riparian
ecosystems. The Department of Water is using all of this information to determine
ecological water requirements that recognise the region’s variable and dynamic
climate.

**Objective H**
The assessment of cost/supply relationships for potential new supplies that
may be developed in support of coastal centres which directly support the
mining industry

*(See Milestone 9)*

Through project activity 9, an infrastructure supply tool was developed to provide the
department with the ability to assess the feasibility of alternative supply options,
including desalination and groundwater sources.

The Department of Water is currently using the tool to contribute to the decision
making process for the management of the West Pilbara Water Supply Scheme
which supplies the Karratha–Dampier area.
OBJECTIVES J & K

Support of a water trading environment through the increased understanding of regional water supply options utilised by water providers or other significant industries

To provide a better understanding of water resources to assess if limitations to trading may exist in the Pilbara region

(See Milestones 1 - 9)

Completion of the activities has contributed to our understanding of current and potential water sources, and current and future water demand. The allocation (or water sharing) plans being developed will facilitate trading for resources where there is a defined sustainable extraction limit (allocation limit or consumptive pool) and there is or is likely to be competition for the available water.

Water trading and water sharing in the Pilbara region between different industry sectors is being examined and options promoted where feasible. Through the Pilbara water in mining guideline, the department supports the transfer of water from mining activities to meet other demand, if it cannot be used efficiently on site.

Information gathered from the project has indicated that opportunities for trading are limited, especially in the short term. For water resources with low levels of use, water will be available within the allocation limit (or consumptive pool).

Some of the high use water resources, such as the Millstream aquifer, only have one user, so the opportunity to trade amongst water users does not exist or is limited.

There is also currently only limited opportunity to transfer water from water surplus mines (as a result of dewatering) to water deficit mines, due to the long distances involved, and the security of supply is erratic due to the relatively short duration of some mining projects. The department will use the infrastructure supply tool (project activity 9) to help assess the potential for mine dewater as a potential water source.
5 Findings and management implications

The detailed investigation and assessment of the Pilbara groundwater systems has led to a better understanding of how these systems work, including how they respond to the significant natural variations they encounter.

The three main findings and management implications from this project are:

- potential water sources to augment Pilbara towns have been assessed, and will extend the range of options for developing sustainable water supplies for towns and cities in the Pilbara region

- the needs of the groundwater-dependent and nationally significant wetlands of the Millstream Chichester National Park are protected, with a sustainable level of extraction set for the Millstream aquifer.

- Pilbara means fish, and the study highlights the unique nature of the fishes of the Pilbara: of the ten described freshwater fish, three are endemic to the region and a further two previously undescribed species were discovered. These unique fish depend on groundwater fed pools to survive extensive dry periods.

The next step is to use this and other work by the department to develop groundwater allocation plans (or water sharing plans) for all of the Pilbara coastal aquifers, the Millstream aquifer, and part of the West Canning Basin. The results of the Water for the Future project will give to the allocation planning process much greater confidence in system values, productivity and management needs. This will ultimately lead to more sustainable water use and better environmental outcomes.

The outcomes of the Water for the Future funded projects will provide the information needed to develop an allocation plan for the Pilbara groundwater management areas in 2012.

The Pilbara regional water plan (2010) provides the long-term vision for management of water resources in the Pilbara. It sets strategic directions for government investment and action, and considers ‘whole of water cycle’ management.

The Pilbara water allocation plans will comprise a number of aquifer specific operational plans. They will set objectives and management arrangements consistent with the broader objectives and approaches set out in the regional plan. The allocation plans will take account of related aspects of water management (drinking water source protection, drainage, waterways, and floodplains) so as to ensure consistency and alignment of purpose.

The Pilbara allocation plans will be among the first of the allocation plans produced under the proposed changes to the Western Australian water legislation. Current water management is largely through individual licences, and while these have served well to manage the relatively isolated water use in this region, the increase in industry and population has led to a higher total use and an increase in cumulative effects of water use. The allocation plans will improve water management at the collective scale.
The water allocation plans will ensure that the natural systems retain an adequate share of water, and that water is allocated sustainably for consumptive use. They will provide for a flexible and adaptive management of groundwater resources that is appropriate for the highly variable Pilbara environment. The plans will provide guidance on mine water management through an update to the Pilbara mining guideline. Most importantly the water allocation plans will use information gained through this project to clarify options and management needs to support better long-term planning for public water supplies.
Appendices
## Appendix A – Products completed through the project

<table>
<thead>
<tr>
<th>Milestone number</th>
<th>Milestone details</th>
<th>Products</th>
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</table>
| 1                | Pilbara coast alluvial aquifer assessment | - LiDAR metadata statement  
- FALCON gravity and magnetic acquisition and processing  
- FALCON interpretation of airborne data  
- Tempest geophysics acquisition and processing |
| 2                | Millstream geophysical investigation | - Millstream model and calibration |
| 3                | West Canning Basin | - Radiocarbon age dating of groundwaters  
- West Canning Basin model design  
- West Canning Basin modelling project  
- Determining the age of groundwaters in the recharge zone and north-eastern section of the West Canning Basin |
| 4                | Ecological water requirements study | - Long-term ecological river system  
- River pool progress report  
- De Grey river values and issues  
- Fishes in groundwater-dependent pools  
- Habitat associated aquatic invertebrates in river pools  
- Long-term ecological river systems  
- Millstream status report  
- Pool mapping metadata  
- Millstream: Ecological values and issues  
- Lower Robe River: Ecological values and issues  
- Lower Fortescue River: Ecological values and issues  
- Determining water level ranges of Pilbara riparian species: Ecological values and issues |
| 5                | Cultural and social water values study | - Pilbara – cultural and social water values – Stage 1  
- Pilbara – cultural and social water values – Stage 2  
- Ethnographic heritage survey  
- Pilbara – cultural and social water values study – Stage 3 |
| 6                | Environmental reference sites study | - First interim report – climate and tree water use  
- Climate management and ecosystem interactions  
- Environmental reference sites for the Yule River groundwater system |
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<tr>
<th>Milestone number</th>
<th>Milestone details</th>
<th>Products</th>
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<tbody>
<tr>
<td>7</td>
<td>East Pilbara water study</td>
<td>• <em>Pilbara coast water study</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Review of borefield and groundwater exploration reports in the East Pilbara</td>
</tr>
<tr>
<td>8</td>
<td>Backlog of bore and mining reports</td>
<td>• Pilbara groundwater data progress report</td>
</tr>
<tr>
<td>9</td>
<td>Significant Infrastructure-based supplies study</td>
<td>• Development of an integrated water planning tool</td>
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Appendix B — Products submitted as evidence for completion of May 2010 milestones

<table>
<thead>
<tr>
<th>Milestone number</th>
<th>Milestone details</th>
<th>Product delivered</th>
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| 1.3              | Completion of modelling, hydrogeological assessment and final reporting | • Numerical groundwater model for lower Fortescue Catchment, June 2010  
• Development of subregional scale numerical groundwater model of the lower Yule catchment, June 2010  
• Lower De Grey groundwater model conceptual hydrogeology and model design, June 2010  
• Lower Robe river groundwater model, June 2010 |
| 3.3              | West Canning Basin – completion of final hydrogeological report, resource assessment and modelling by external consultant | • West Canning Basin modelling project  
• Determining the age of groundwater in the recharging zone and north-eastern, April 2010 |
| 4.6              | Ecological water requirement – completion of Stage 6 EWR | • Millstream ecological values and issues  
• Lower Robe River – ecological values and issues  
• Lower Fortescue River – ecological values and issues  
• Determining water level ranges of Pilbara riparian species  
• Lower Fortescue River – ecological values and issues |
| 5.3              | Completion of Stage 3 of assessment of cultural and social water values | • Pilbara cultural and social water values – Stage 3 report |
| 6.3              | Environmental reference site – completion of Stage 3 of establishment and monitoring of reference sites | • Environmental reference site for the Yule River groundwater system |
| 7                | East Pilbara study – completion of contract by external consultant | • Review of borefield and groundwater exploration reports in the Pilbara |
| 8.3              | Completion of Stage 3 of contract to update backlog | • Pilbara groundwater data progress report, June 2010 |
### Shortened forms

<table>
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<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>EWR</td>
<td>Ecological water requirement</td>
</tr>
<tr>
<td>LiDAR</td>
<td>light detection and ranging</td>
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<tr>
<td>WFTF</td>
<td>Water for the Future</td>
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