PROSPECTIVE DEMAND FOR WATER IN THE WEST PILBARA OF WA

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EXECUTIVE SUMMARY

This study develops estimates of current and future water usage in the Pilbara. This information is to be used by the Department of Water in regional water planning processes for the Pilbara and to complement other work on the water resources of the region.

The study area is the Pilbara Groundwater Area, which makes up the western two-thirds of the Pilbara Region. Water use estimates for the ports and iron ore mines were revised in October 2007 and reflect water use in 2006 and 2006-07 depending on the company under discussion. Estimates for the other water use sectors and other minerals were prepared in October 2006 and generally reflect water use patterns in 2005.

The resources sector is the major component of the economy of this region. Iron ore mining and oil and gas sector activities dominate economic output measures and employment to a lesser extent. Pastoral activities, traditionally the major industry of the region, now contribute a very small part of the economy.

While the energy sector is a major component of the Pilbara economy, it is a relatively small user of water. Mining, on the other hand, is a large water user. While information on water use has been assembled for all sectors, the emphasis is on mining and the associated handling sectors because they are the major users.

Water use in industry is considered in terms of heavy and light industry including commercial activities. Heavy industry includes LNG plants, mineral processing, salt processing, and chemical plants. Information on water use for each of these was obtained directly from the operating companies.

Light industry is classified to include fabrication, building and construction, commercial and retail, transport and storage. Information provided by the Water Corporation demonstrated a close relationship between the volumes of water used for residential purposes and water used for light industrial-commercial purposes. This makes sense as these sectors are population dependent. Once allowance is made for the volume of water used by heavy industry, there is a consistent relationship between population and industrial-commercial activity, for all towns in the Pilbara.

This study brings together three sets of information on water use in the Pilbara. First there is information which is on the public record, but is difficult and time consuming to access and interpret. Secondly, there is information which can be inferred from other data – as described above for industrial water use. Thirdly, there is information obtained from companies.

All individual company data cited in this report is obtainable from public sources. However, this data is of limited value by itself, and it has been essential to the study that it be complemented by data from individual companies. The information provided by industry is a key component of this study. Detailed and commercially sensitive information has been provided by mining companies, by major industrial water users, and the Water Corporation. The authors have given firm undertakings that confidentiality will be respected, and for this reason, much of the data is presented in this report in an aggregated form.

Partly because of the sensitivity of the individual company information and partly to facilitate the presentation of the information, water use data is presented in this report in four sub-areas

of the Pilbara. These are South Coastal (centred on Dampier and Onslow), North Coastal (centred on Port Hedland), Central West (centred on Tom Price and Paraburdoo) and East Pilbara (centred on Newman).

This study estimates that close to 127,000 ML of water a year will be used in the Pilbara in 2007 including water taken from pits in dewatering operations and returned to the environment. Thirty five percent of the water used is in mining operations. Just under a third is represented by mine dewatering operations while port operations of mining companies account for a further 7%. In total, the mining sector accounts for 72% of total water use including that water discharged back into the local environment

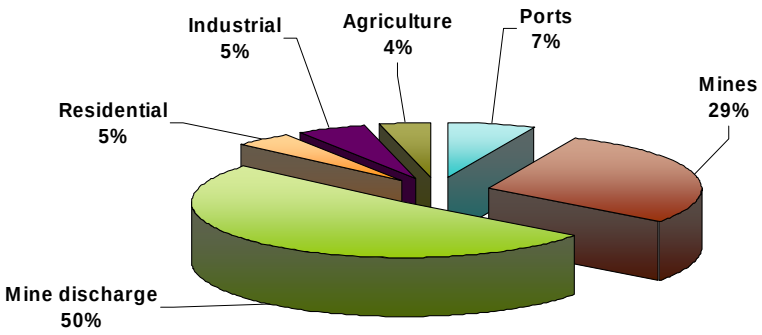
This dominant place held by the mining sector will become more pronounced in the future. The sum of the three categories of mining use – mining operations, mine dewatering returned to the environment and port operations – are forecast to increase to 87% of the total in 25 years time.

The volume of water used in the Pilbara is anticipated to grow to 282,140 ML. Mining is estimated to account for 243,850 ML of this total.

Water from mine dewatering which is returned to the environment is a particular category of water, in that its loss to the system is more transient than other uses. While there will be some losses in the process, the water is not permanently removed. Unlike the other categories of water use which demonstrate fairly consistent trends, dewatering volumes vary considerably depending on the attributes of particular mining pits and the times at which they are brought into production.

Mine dewatering volumes are anticipated to increase from the current level of 39,000 Ml to 144,000 ML over the next 25 years representing half of total "use". However, in general terms, usage rises to 150,000 ML in the first decade and stays at that level for a decade before declining.

Water use in 2031



STUDY SETTING

INTRODUCTION

This report provides estimates of current and future water use in the Pilbara. These estimates are to form one component of a Pilbara Regional Water Plan. The other major component will be an assessment of current and prospective water sources for the Region.

The work on water sources is to be undertaken by the Department of Water and will be based on reports for the two main areas - the Central Pilbara Groundwater Study and the Pilbara Coast Water Study.

This study complements the water source studies. It draws on the findings of a separate project completed for the Department of Planning and Infrastructure on projected demand for regional port services. The Pilbara Ports study addressed development plans and future growth potential at the ports with an emphasis on iron ore as the dominant product being shipped from the region.

The area covered by this study is the Pilbara Groundwater Area (Figure 1), but the report includes comment on large developments between the area and the Northern Territory border.

The planning horizon is twenty years and the study area covers parts of the four Local Government Areas included in the Pilbara Region.

The detailed terms of reference for this study are included in Appendix 1. The study was undertaken by Economics Consulting Services, and a précis of the company is included in Appendix 2.

Water use estimates for the ports and iron ore mines were revised in October 2007 and reflect water use in 2006 and 2006-07 depending on the company under discussion. Estimates for the other water use sectors and other minerals were prepared in October 2006 and generally reflect water use patterns in 2005.

CONCEPTS AND APPROACH

Water *use* is a challenging concept. Water is not always used in the sense that its consumption precludes further or future use by others. Water is used in personal consumption or production processes and then returns to the ground or water bodies before being returned as rainfall. The water cycle means that water is not completely lost to the system but may be lost to some uses for a period of time if it is contaminated in some way. It may also be lost to other consumers in a downstream location and could be moved to another catchment or aquifer.

Water *use* is defined by the Australian Bureau of Statistics to include water supplied from mains water systems; self supply (surface or groundwater) and re-use water. *Use* thus includes water that may be recycled a number of times. It may also include water from mine dewatering operations where the water is pumped from mine operations and discharged back

into local waterways. The water may thus have been moved in the landscape but could end up back in the groundwater system with negligible loss from the region. Under this definition, the largest water users will be the public water supply authorities and the mining companies involved in mine dewatering. In one sense, neither would be regarded as *consumers* of water.

The term *consumption* attempts to restrict the concept of use to that water which is not replaced or supplied to others. Hence, in-stream use and water supplied to others is subtracted from the water *use* volume. It is debateable whether water from mine dewatering activities is defined as consumption and hence mine site use can overstate the perceived water use.

The emphasis in this study is on *consumption* rather than *use* as it is end users that drive demand and not water supply organisations. Mining is a very large part of the Pilbara economy and is a major water user. Hence the issue of mine dewatering is significant for this region. The distinction is not always clear. Water taken from mines in de-watering operations and returned to the same aquifer, but at a distance, will have at least a local impact on that aquifer. In this study, every effort has been made to separately identify water that is being withdrawn from groundwater reserves for purposes of mine de-watering.

This report adopts the common nomenclature of "use" in the broad sense and hence includes mine dewatering as water "use" although it can be argued that this is not the case.

The mining sector is the major user of water in the region, as well as being the major driver of industry activity. However, this study covers all areas of economic activity, including households. The study involved consultation with all water service providers, some of whom are self supply, in the region and a survey of key water users. Statistical information was obtained from the Water Corporation and the Australian Bureau of Statistics (ABS). Local Government Authorities and the Pilbara Development Commission were contacted, along with Government agencies that play a role in the development of the Region.

THE WATER CHALLENGE IN WA

Water management is one of the most challenging issues facing Western Australians today. Changing climatic and rainfall patterns, coupled with the rapid growth of the State's population, have created an urgent need to plan effectively for the State's future water needs. This involves a need to manage and meet a growing demand for water for industry and domestic purposes. At the same time, there is increasing public awareness of the fragility of many environments, and water needs to be set aside for these purposes.

The challenge in the Pilbara is to facilitate growth of an industry with large water needs, in an area where water resources, while abundant in terms of average total volumes are limited in terms of availability at a point in space or time. The challenge will only increase as economic activity in the minerals and energy sector continues, as is anticipated.

Water use across the State doubled between 1985 and 2000, and increased by a further 10% in the period from 2000 to 2005.

Table 1: Water Consumption by Industry Group and Region

Water Consumption, by User Group			
Industry Group	Australia (GL)	West Aust (GL)	Pilbara (GL)
Agriculture	12,191	535	11
Forestry & Fishing	51	25	nsi
Mining	413	183	79
Manufacturing	589	81	13
Household	2,108	362	11
Other	3,415	309	nsi
Total	18,767	1,495	114

Water Consumption, by User Group			
Industry Group	Australia (%)	West Aust (%)	Pilbara (%)
Agriculture	65.0	35.8	9.6
Forestry & Fishing	0.3	1.7	-
Mining	2.2	12.2	69.3
Manufacturing	3.1	5.4	11.4
Household	11.2	24.2	9.6
Other	18.2	20.7	-
Total	100.0	100.0	100.0

In this study, the categories are not the same as those used by the ABS. Water use for industrial and commercial purposes is classified as manufacturing. This has elevated the measure for manufacturing and reduced "other". Water use by the forestry and fishing sector and the "other" sector have not been separately identified in this study. Forestry is non-existent and fisheries are a very minor part of the economy and are included with "manufacturing". The "other" sector includes public utilities such as power generation, wastewater, roads and communications. These industries, also, are included within the "manufacturing" sector for the Pilbara.

The agriculture sector accounts for 65% of water consumption nationally, 36% in Western Australia, but only 11% in the Pilbara (Table 1)[1]. The mining sector accounts for 2% nationally, 12% in WA, and 70% in the Pilbara. Water use by the mining sector in WA accounts for 44% of the Australian total water use by this sector. Water use by the mining sector in the Pilbara represents 19% of the Australian total for the sector.

[1] ABS. (2006) Water Account Australia 2004-05. Catalogue 4610.0. December 2006. Data for the Pilbara are a product of the current study.

CONSUMPTION AND USE

The Commonwealth Statistician makes a distinction between the "use" of water and the "consumption" of water, as discussed above.

> *The use of freshwater in situ, such as water use for hydro-electricity generation and aquaculture purposes is classified as in-stream use, and is included in the accounts as self-extracted water use. In-stream volumes are considered to be a type of non-consumptive use, for although these volumes are also considered to be a form of regulated discharge, an economic benefit is gained from the use of the water prior to discharge.*[2]

Consumption of water by the mining sector, as estimated in the Water Account for Australia, includes "in-stream" use of water in de-watering operations. While this component is not separately identified by the ABS for Western Australia, at a national level mine dewatering represents 30% of total use of water in the mining sector.[3]

WATER PLANNING

In 2003, Western Australia commenced the development of a State Water Strategy as an integrated set of initiatives designed to address the State's water issues.[4] An important component of the State Water Strategy is improved efficiency and management of water use.

Current planning processes involve development of management plans at a regional, sub-regional or local area level. The scope of these plans has been broadened since 2000 to provide entitlements for the environment.

Under its State Water Strategy: "Securing Our Water Future", Western Australia has committed to improving the management of water resources. This includes developing a State Water Plan to provide state-wide management principles through to 2030. The Plan will be implemented through regional water plans.

In Western Australia, regional management plans are developed to integrate the management of all natural resources, whilst protecting the water resource values of an area. Furthermore, six regions of the state, covering the areas of greatest water resource development, have regional bodies set up under national resource management strategies for integrated management of resources in those areas.

At a high level, Western Australia has a comprehensive policy framework for determining and providing a water regime for the environment.[5] Water for the environment is specified through ecological water requirements and environmental water provisions. Through water management plans, environmental water provisions provide a flow regime aimed at protecting in situ values and maintaining environmental systems.

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2 ABS (2006) Water Account Australia. *Op cit* Page 3.

3 ABS (2006) Water Account Australia. *Op cit* Page 88, Table 5.10.

4 Western Australian Department of Premier and Cabinet 2006. Draft Water Policy Framework Discussion Paper (a component of the State Water Plan). http://www.statewaterstrategy.wa.gov.au (accessed 4 September 2006).

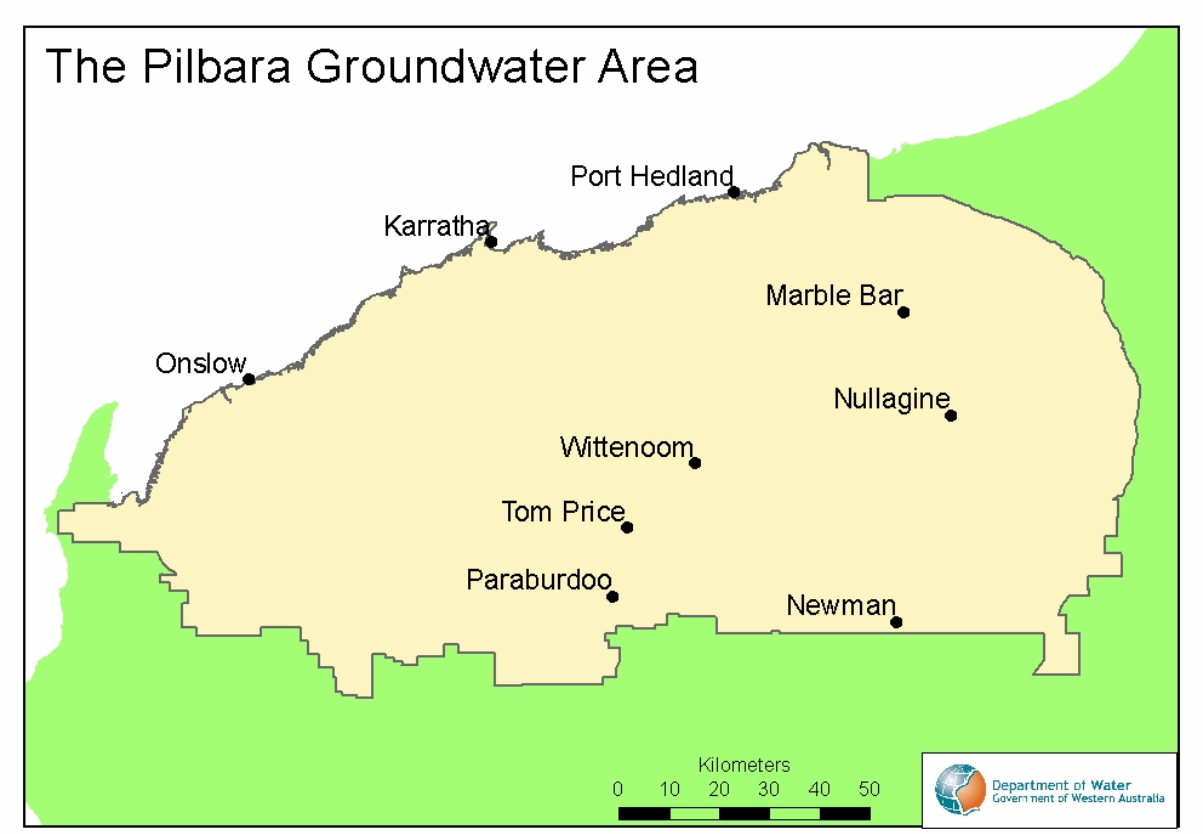
5 Department of Water. (2000) Statewide Policy No. 5. Environmental Water Provisions Policy for Western Australia. November 2000. (Department of Water website.)

INTRODUCTION

THE STUDY AREA

This study is about the current and prospective uses of water in the Pilbara Groundwater Area, which makes up most of the Pilbara Region (Figure 1). The Terms of Reference for the study also require the identification of any significant developments outside of this area which may have major implications for water demand within the West Pilbara.

Figure 1: The Study Area



The Pilbara Groundwater Area covers the western two thirds of the Pilbara Region. This is a vast region covering more than 500,000 square kilometres, or about a fifth of the State of Western Australia.

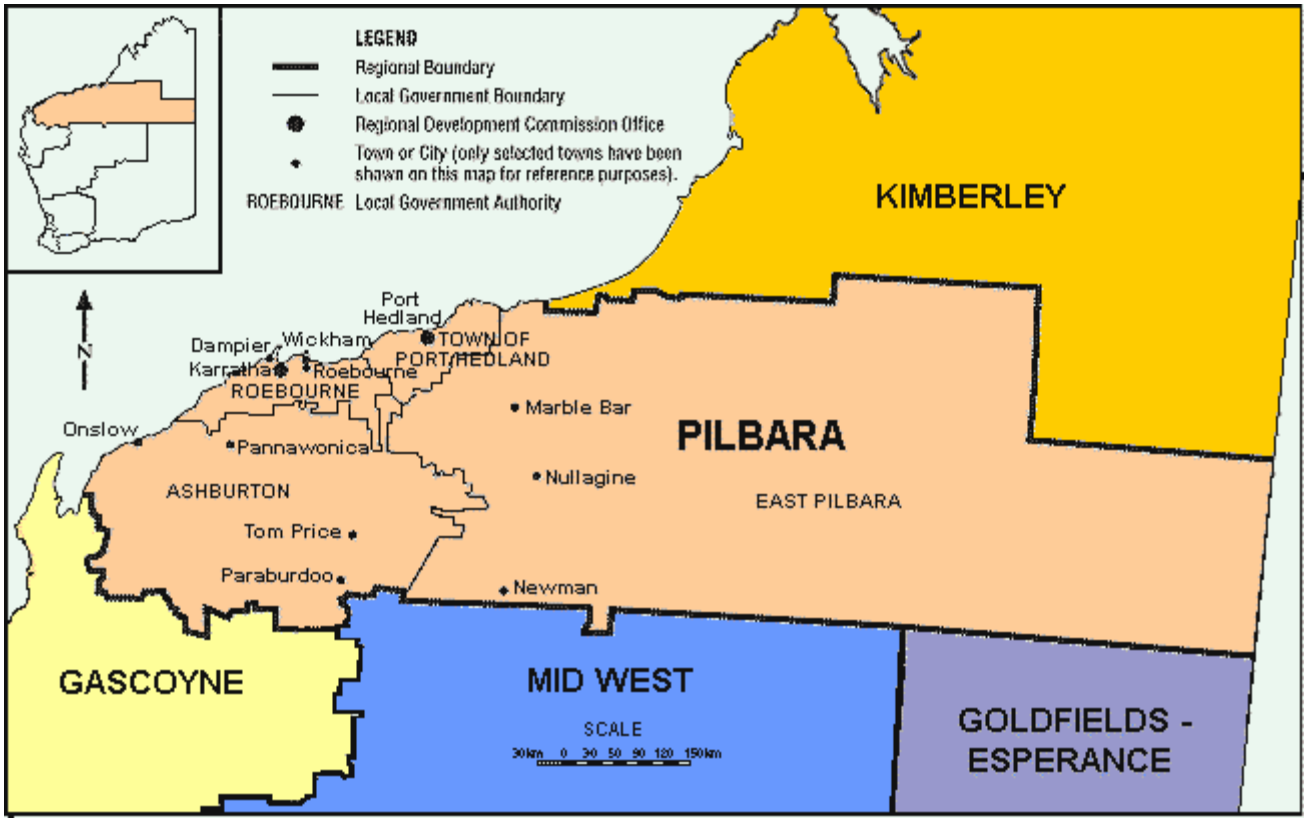
The Pilbara is an ancient and arid land. It is one of the oldest landscapes on earth with rocks dated at 2.5 million years. This is a corollary of the extreme geological stability of the area. The Pilbara is one of the world's richest minerals areas with many iron ore and other mines as well as extensive gas and petroleum resources in adjacent offshore areas. The Pilbara is also an ancient Aboriginal land of "The Dreaming" and is of great importance in Aboriginal culture and creation legends.

Stretching more than 300 kilometres through the Pilbara is the Hamersley Range. In the south the mountains slope gently up to flat-topped outcrops and in the north rise from Spinifex plains. The Great Sandy Desert to the east is a seemingly endless stretch of sand ridges and sandy desert. Only chains of salt lakes break the pattern.

While the water resources of the region are limited mainly to groundwater, significant surface water features include the Fortescue River, the Harding River, and the extensive natural wetlands of Millstream-Chichester National Park

The region's population was estimated at 39,282 people in 2005, with the majority residing in the western third of the region. The eastern third is largely deserted with only a very small Indigenous population. There are four local government areas; the Shires of Ashburton, East Pilbara, Roebourne and the Town of Port Hedland. The major town centres are Port Hedland, South Hedland and Karratha. Other important centres are Roebourne, Wickham, Point Samson, Dampier, Onslow, Pannawonica, Paraburdoo, Tom Price, Yandeyarra, Marble Bar, Newman, Jigalong and Nullagine (Figure 2).

Figure 2: Local Government Areas and major towns of study area



ECONOMIC ACTIVITY IN THE AREA

Economic activity in the Region is dominated by the resources industries. In 2003-04 iron ore overtook oil and condensates as the single largest sector, with annual production representing 37 per cent of the regional economy (Table 2 and Figure 3). Oil and condensates form the second most significant sector, with production representing 34 per cent of the regional total. Including gas production, the hydrocarbons sector makes up more than 56 per cent of the regional economy.

In total, the mining and energy resources sectors account for 95 per cent of the economic output of the Region.

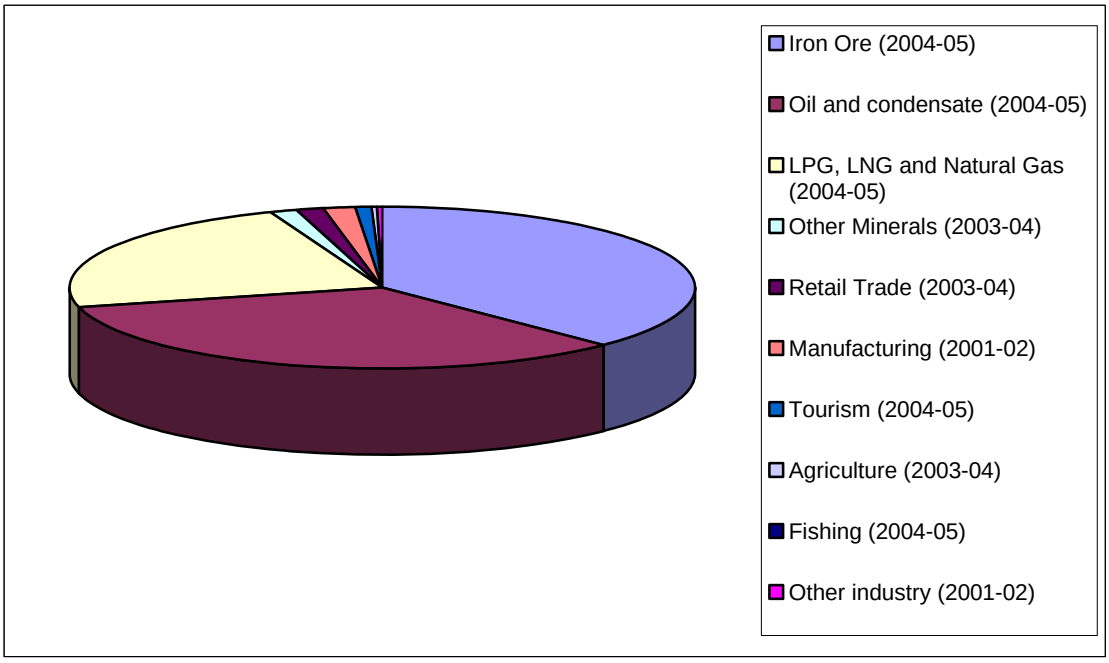
Agriculture, which was responsible for opening up the region, is now a very small of the economy. Fishing has also reduced in significance leaving an economy dominated by the mining and energy sectors.

The region remains strongly focused on overseas exports. It is characterised by relatively low unemployment rates, despite a relatively high rate for the indigenous population. While the region has strong economic prospects, the anticipated population growth is relatively low, largely because the mining sector is capital rather than labour intensive and because of the increasing trend towards fly in-fly out employment arrangements.

Table 2: Value of Production, Pilbara Industries

Pilbara Value of Production, by Industry.		
Sector	$ millions	Percentage of Total
Iron Ore (2004-05)	7,973	37.4
Oil and condensate (2004-05)	7,208	33.8
LPG, LNG and Natural Gas (2004-05)	4,876	22.9
Other Minerals (2003-04)	282	1.3
Retail Trade (2003-04)	345	1.6
Manufacturing (2001-02)	309	1.4
Tourism (2004-05)	226	1.1
Agriculture (2003-04)	46	0.2
Fishing (2004-05)	15	0.1
Other industry (2001-02)	32	0.2
TOTAL	21,312	100.0

Figure 3: Value of Production, Pilbara Industries



CLIMATE

The Pilbara has a climate of extremes, with considerable variability. Severe droughts and major floods can occur at close intervals and average rainfall records are misleading.

Daily maxima and minima temperatures average 26 degrees (Celsius) and 14 degrees in winter; and 39 degrees and 26 degrees in summer. Temperatures and variability in inland areas are higher than coastal areas.

Climatic conditions are dominated by tropical cyclones, which occur predominantly in January to March. Other rainfall comes from local thunderstorms and, in the south-west, from the northern edge of frontal systems that bring winter rains to the south-west of the State.

Cyclones form over the sea and generally track a south-west course parallel to the coast. In two cases out of three, the cyclone changes direction to the southeast crosses the coast and proceeds inland. They generally bring heavy rainfall to the arid region.

The region is arid, with the average annual rainfall ranging from 200 mm to 350 mm. There is significant variation, with a coefficient of variation ranging from 0.4 to 0.7. This compares with coefficients of 0.2 for the south-west of WA, and 0.3 for the Kimberley.

WATER RESOURCES

Allocations by the government to draw groundwater total 261 GL (Table 3). Allocations are dominated by the mining industry. The iron ore industry accounts for more than half (56%) of the licence allocations with other mining industries another quarter (28%).

Water licence allocations are only broadly indicative of the levels of actual use, because they represent the maximum allowable volume of abstraction in any one year. Licence allocations represent a form of reserve upon which operators can draw, and are more a reflection of possible water draw needs rather than indicating current levels of use. Further, the licence allocations make no distinction between water that is abstracted during dewatering operations and water that is actually consumed. The license allocations thus include an allowance for the possible volume of water that might have to be pumped from a mine open pit following a cyclonic rainfall event.

Table 3: Water Allocations by Industry Type

Industry Type	Allocation (ML)	Percent of Total
Iron Ore	145,879	55.9
Other Mining	72,286	27.7
Mining Exploration	641	0.2
Water Supply Schemes (Public and Private)	41,230	15.8
Other (pastoral and industry)	1,111	0.4
TOTAL	261,147	100.0

Source: Department of Water: Water Licence Database

WATER ABSTRACTION AND DELIVERY SYSTEMS

The East Pilbara and West Pilbara Water Supply Schemes cover most coastal towns in the region.[6] The East Pilbara Scheme draws water from the Yule and De Grey River Borefields, while the West Pilbara sources water from the Millstream Aquifer and the Harding Dam.

The East Pilbara Scheme provides water to Port Hedland, South Hedland and Wedgefield. It also services industrial estates and the ports of Port Hedland and Finucane Island – each a significant user of water.

The West Pilbara Scheme provides water to Karratha, Dampier, Roebourne, Wickham, Cossack and Point Samson. It also meets the water needs of industrial areas and the Ports of Dampier and Cape Lambert.

West Pilbara Water Supply Scheme

Pilbara Iron owns and operates the water reticulation system for Dampier. However, the Water Corporation delivers water into the system, under a bulk supply agreement with Pilbara Iron. The company is responsible for maintenance of the reticulation network and for customer billing.

The West Pilbara Water Supply Scheme draws water from either the Harding Dam or the Millstream Aquifer with the level of use governed by Management Plans.

The Harding Dam is located on the Harding River, 23 kilometres south of Roebourne. Problems with high turbidity were addressed in 2004 with the construction of an advanced micro-filtration treatment plant. This removes suspended matter and greatly improves the quality of water delivered from the dam.

More recently, the massive industrial growth of the Pilbara Region, centred on resource-processing activity on the Burrup Peninsula, has required enhancement of the West Pilbara scheme. The Water Corporation has constructed a seawater pipeline scheme and a seawater desalination plant on the Burrup Peninsula to provide the water necessary for new projects. The seawater scheme has the capacity to supply 280 megalitres of water per day (100 Gigalitres annually).

The desalination scheme serves a dual purpose. It provides a source of cooling water for industrial projects. A desalination plant has been built to meet the freshwater needs of Burrup Fertilisers, with the plant capable of producing 3.6 megalitres of desalinated water per day. (1.3 GL/year). This capacity can be readily expanded.

East Pilbara Water Supply Scheme

Port Hedland currently obtains its water from the De Grey and Yule River Borefields. Plans are underway to design a major upgrade of the water supply to increase the capacity from 11

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[6] This section draws on information from the Water Corporation and the Department of Local Government and Regional Development:

- Department of Local Government and Regional Development. (2003) Pilbara Economic Perspective. May 2003.
- Water Corporation (2006) West Pilbara Water Supply Scheme. Information for Schools. (Water Corporation website.)

GL per annum to 15.5 GL. This project will also cater for the planned BHP expansions at Nelson Point and Finucane Island material handling facilities, and will assist with future industrial expansion.

The Water Corporation is also upgrading the current supply main between Port Hedland and South Hedland. Treated wastewater is also an important source of water for reticulation of grassed and garden areas.

Other water supply schemes

Newman Township and the Newman and Mount Whaleback mines are supplied with water from the Ophthalmia Dam, located about 20 kilometres north of Newman on the upper reaches of the Fortescue River. The Dam and reticulation infrastructure are owned by BHP Billiton while the water supply service is operated by the Water Corporation.

The Water Corporation operates water services for Onslow, Nullagine and Marble Bar. Onslow water is sourced from borefields adjacent to the Cane River while Nullagine and Marble Bar use local borefields.

Pilbara Iron owns and operates schemes for Tom Price and Paraburdoo, while Robe River Iron Associates is responsible for Pannawonica's water supply.

Major Aboriginal community water supply and sewerage schemes are operating at Jigalong and Yandeyarra, while water supplies are available at Ngurrawaana, Warralong, Goodabinya, Punmu and Kiwirrkurra. Remote communities are designated as private suppliers and their water needs are provided for under the Remote Area Essential Services Program (RAESP). There are 21 communities under the RAESP in the Pilbara.

Communities are provided with maintenance, repair, and capital works for water and wastewater infrastructure. The project is funded by the (Commonwealth) Office of Indigenous Policy Coordination and the State Department of Housing and Works. Delivery of services is contracted out by competitive tender, and is currently managed in WA by Parsons Brinckerhoff Pty Ltd.

Environmental considerations

There are many environmental issues associated with ground and surface water use in the Pilbara:

- Watertable declines: Abstraction of groundwater may reduce the amount of water available to flora and fauna.
- Influx of saline water: Abstraction in coastal areas may induce an influx of salt water being introduced to the aquifer area.
- Land subsidence: Dewatering of subterranean silt or clay confining layers may cause covering land to subside into cavities in carbonate rocks. Potential for subsidence exists in the Fortescue valley, Hamersley Range and Oakover Valley.
- Stygofauna: Dewatering may adversely impact stygofauna. Little is known about these groundwater-dwelling organisms or the potential impacts on them of mining operations.
- Acid Rock Drainage: Acidic compounds may be spontaneously generated by various open-cut mining practices combined with low rainfall and high evaporation rates.

- Remnant mine pits: Abandoned mines may form lakes, and initiate geochemical and hydrological processes, such as the formation of hypersaline bodies of water as a direct result of high evaporation rates and low recharge rates.
- General: Dewatering and mining operations can have impacts on vegetation and aquifer sustainability. Groundwater may be contaminated by mining wastes and chemicals, and the disposal of dewatering discharge.
- A further environmental consideration is the final condition of the new ecosystems that are created. Discharges to the environment cause local inundation for the duration of the project. When dewatering ceases at the end of the mine life, the ecosystems must again respond to the changed conditions.
- Pressure on wetlands: There are significant wetlands in the Pilbara region that have been recognised as nationally important (Table 4).

Table 4: Nationally Important Wetlands of Pilbara Region[7]

Wetland	Reference	Area (ha)
De Grey River	WA 065	13,600
Fortescue Marshes	WA 066	100,000
Karijini (Hamersley Range) Gorge	WA 067	80
Leslie (Port Hedland) Saltfields System	WA 068	13000
Millstream Pools	WA 069	150
Kookhabinna Gorge	GAS 001	125
Yadiyugga Claypan	GAS 004	400
TOTAL	**PIL**	**127,355**

[7] Extracted from Environment Australia (2001) A Directory of Nationally Important Wetlands in Australia. (Website of Australian Government Department of the Environment and Heritage.)

OVERVIEW OF CURRENT WATER USE

This section provides an overview of current levels of usage to set the scene for the later more detailed discussions of current and prospective volumes of water use in each major category of use.

There are seven town water supply networks and a large number of private supply arrangements for individual mines, campsites, pastoral stations, remote aboriginal communities and commercial entities such as road houses and tourist centres. However, the network supplies are the most significant source for residential and industrial use (Table 5).

Heavy industry is a category of manufacturing activity that usually involves the conversion of large volumes of raw materials and partially processed materials into products of higher value; hallmarks of this form of industry are considerable capital investment in large machinery, heavy energy consumption, and final products of relatively low value per unit weight.

Another feature of heavy industries is their potential impact on neighbouring industry or residents. Impacts may be in the form of odour, vibration, light or noise hazard, or in terms of the hazardous nature of the chemicals used or produced. So the classification of an industry as "heavy" is a combination of the volumes of materials processed and the hazardous nature of the commodities used in the production process. Western Australian examples of heavy industries would include large chemical and fertiliser plants, natural gas plants, heavy engineering construction, cement production, and raw materials processing such as a cannery, abattoir or paper pulp plant.

Heavy industry does not have a single fixed meaning compared to light industry. In general, heavy industry is viewed as more capital intensive, as requiring a larger fixed facility, and as having a larger environmental impact.

Because of their size and importance as a user of water, water use by heavy industry has been calculated by direct inquiry of the firms involved or proposed to be involved. For the Pilbara, the industries included in the heavy industry category are salt production, chemicals manufacture and gas processing. The heavy industry category also includes use by the iron ore ports. The most significant of these, by far, is the iron ore operations at the ports where the major use of water is for dust suppression.

As a broad generalisation, the networked water supplies deliver a third (36%) of their water to residential, a third (27%) to heavy industry and a third (27%) to light industrial and commercial use. A further 10% is used for "other" purposes, which includes commercial (For example, retail and professional services where these have been separated in the published data from residential water use.)

The data demonstrate that the volumes of water used vary considerably over time. Consumption in years of high use has been between 20% and 40% above the average.

Table 5: Water Use in Scheme Water Supplies

	Average Use (Recent Years) (ML)	Highest Annual Use (Past 11 Years) (ML)
West Pilbara		
Heavy industry	3,017	3,635
Light industry	1,779	2,306
Residential	3,049	3,200
Other	848	unknown
Total	8,693	9,117
East Pilbara		
Heavy industry	4,370	5,788
Light industry	2,072	3,477
Residential	2,535	2,624
Other	1,932	unknown
Total	10,909	12,234
Onslow		
Industrial	104	106
Residential	121	137
Other	2	unknown
Total	227	247
Marble Bar		
Industrial	47	63
Residential	57	83
Other	1	unknown
Total	105	146
Nullagine		
Industrial	18	22
Residential	23	31
Other	1	unknown
Total	42	49
Newman		
Industrial	3,114	3,540
Residential	3,664	4,211
Other	0	unknown
Total	6,778	7,874
Tom Price		
Industrial	423	874
Residential	529	982
Other	0	unknown
Total	952	2,103
Total Water Use for Heavy Industry	7,387	0
Total Water Use for Other Industry	7,557	
Total Water Use for Residential	9,978	
Total Water Use - Other	2,784	
Overall Total	27,706	

Totals include other incidental usage. Highest annual use figures are for various years.

Scheme water supplies are the major source of water for residential and industry use in the Pilbara. Non-scheme supplies for residential use total 963 ML and for industrial use total 894 ML annually. Non-scheme residential use represents 10% of total residential water use for the Pilbara, and non-scheme industrial use represents 6% of total industrial use.

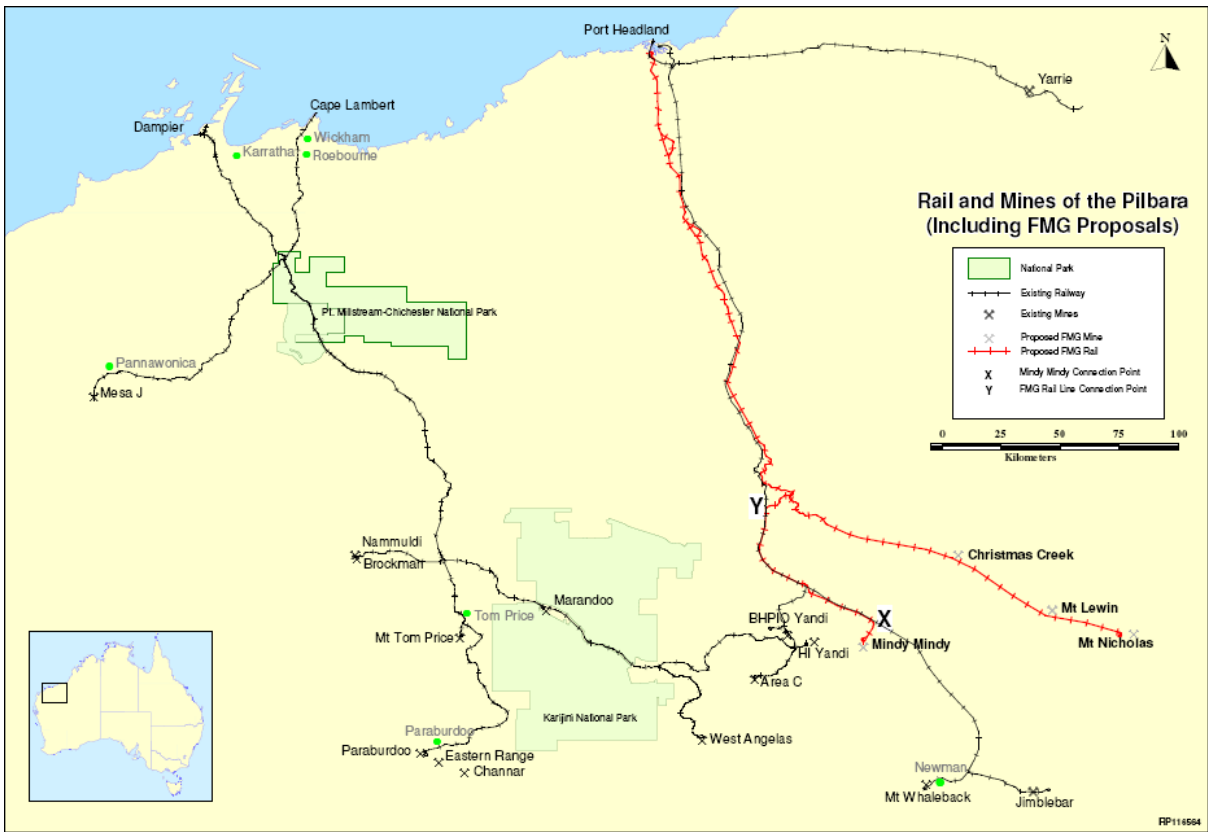
WATER FOR PILBARA PORTS

CURRENT WATER USAGE

Water supplied by the Water Corporation to the towns of Port Hedland and South Hedland, and to Dampier, Karratha Wickham, Roebourne and Cape Lambert is for industrial and residential use. Industrial use makes up the largest component with most of that used in port operations for the preparation and loading of iron ore.

Iron Ore is sourced and railed through two separate networks, with BHP Billiton shipping through Port Hedland, and Pilbara Iron and its associate companies shipping through Dampier and Cape Lambert (Figure 4). FMG and Atlas Iron plan to commence shipping in the first quarter of 2008 from Port Hedland. Aurox Resources and Atlas Iron will also commence operations in the next few years through a multi-user facility at Port Hedland.

Figure 4: Iron Ore Rail and Port Networks



Water for iron ore operations is used to:

- suppress dust on roads and iron ore stockpiles
- reduce dust during handling of the iron ore and to preserve the iron ore condition.
- equipment cooling.
- wet screening.
- washing down equipment and belts.
- gardening and landscaping.
- Personal consumption and Ablutions

Of all these uses, dust suppression is the dominant one. The major companies each have plans to continually improve the efficiency with which water is used. These plans are largely directed to dust suppression, while maintaining standards for dust emissions on the work sites and in the local towns.

The usage of water at the ports and at the mines can be roughly broken down into three main components. Average water use at the ports is estimated as follows:

- Dust suppression, including wash down of equipment and belts: 77%
- Ore conditioning, and equipment cooling: 13%
- Gardening landscape and personal use: 10%.

At the mines, these proportions are quite different largely because of the higher level of ore beneficiation. At the mine sites, the proportions are estimated as:

- Dust suppression, including wash down of equipment and belts: 61%
- Ore treatment, and equipment cooling: 33%
- Gardening landscape and personal use: 6%.

Dampier

The iron ore loading facilities at Dampier are owned by Rio Tinto and operated by Pilbara Iron. There are two ship loading terminals - Parker Point and East Intercourse Island. Each has facilities for train unloading, ore stockpiling, blending and ship loading.

Water is supplied by the Water Corporation for operations at Parker Point and Intercourse Island. In an average year, water use in the ports represents more than a third of total water use. These numbers are separate from town (residential and commercial) supplies. A small proportion of the water was recycled at Cape Lambert in 2006 (13%) but there was no recycling at Dampier. [8]

Port Hedland

BHP Billiton Iron Ore (BHPB) owns and operates the Nelson Point and Finucane Island iron ore bulk handling facilities located at Port Hedland. These facilities include train unloading, ore screening, crushing, stockpiling and ship loading activities.

The Fortescue Metals Group Limited (FMG) is developing a new iron ore project with export facilities in the Port Authority area. Shipments are expected around June 2008.

The Port Authority also operates bulk loading facilities which handle a range of minerals including salt, manganese, chromite and copper concentrate. A number of small iron ore companies are looking to export through the port and a new bulk handling facility is being

8 Hamersley Iron (2006) Social Safety and Environmental Report 2006

developed capable of handling the current minerals and new iron ore shipments. Smaller projects include Aurox Resources and Atlas Iron who may start shipments in 2008 or 2009.

The Port Hedland iron ore facilities use almost half of all water supplied by the Water Corporation through the East Pilbara Water Supply System.[9] The water used comes from borewater supplied by the Water Corporation and reclaimed process water recycled onsite. Separate pump stations provide water to the BHP Billiton Nelson Point operations and Finucane Island.

Water is reclaimed at each of the operating centres and treated in recovery plants at Nelson Point and Finucane Island. These plants have achieved an average recovery of 11 ML/day, or 4.0GL a year. Effectively, water is used an average of two times during the process.

Sea water has been considered as an alternative to the use of fresh water for various processing at the port. Sea water was used for dust suppression for a number of years but the chlorine was found to interfere with the iron smelting process. BHPB customers now consider the use of sea water in ore processing to be unacceptable. In order to maintain quality control of the ore produced, sea water is no longer considered an appropriate source of water for dust suppression.

Cape Lambert (Port Walcott)

Pilbara Iron operates the Robe River Iron export facilities at Cape Lambert with that company having been taken over by Rio Tinto. Cape Lambert operations include a power station, rail and port facilities, ore crushing and screening plant, laboratory and other vital support services.

Water is supplied by the Water Corporation with a small proportion recycled at Cape Lambert in 2006 (13%)[10]

FUTURE WATER USAGE

Future water use in iron ore operations will be a function of iron ore shipments and the efficiency of water use.

Iron Ore Shipments

Western Australian exports of iron ore totalled 249 million tonnes in 2006 with 96% shipped to the four major East Asian steel producing countries of China, Japan, South Korea and Taiwan.

The market share held by Western Australian producers has been highest in Taiwan while the South Korean and Japanese market shares have been trending upwards, although the actual tonnages are fairly stable. Market penetration of Western Australian iron ore into these

9 BHP Billiton Iron Ore (2006) Water Use Efficiency Plan Port Hedland Operations. August 2006. (BHP Billiton web site.)

10 Hamersley Iron (2006) Social Safety and Environmental Report 2006

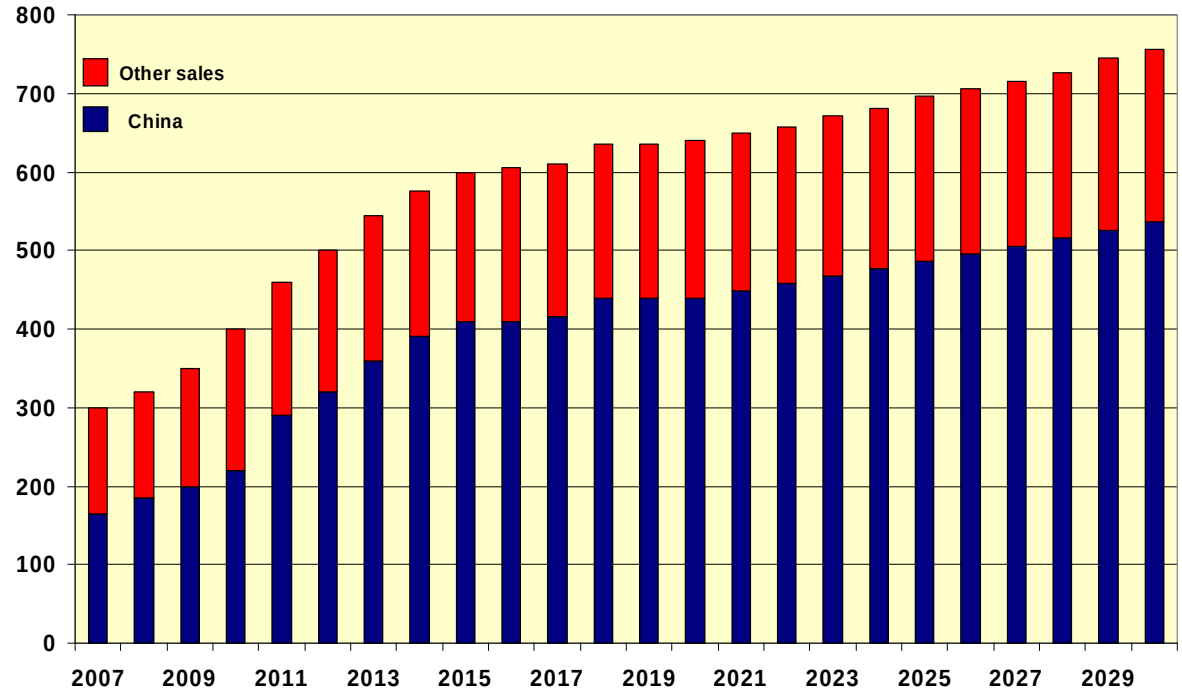
markets is now over 60% of total demand. Western Australia has been less successful in meeting Chinese import demand and holds just under 40% of that market.

All iron ore producers are expanding production and a range of other companies are starting new projects. Producer plans have generally been publicised and have been amalgamated by ports for this study. The companies included are Rio Tinto, BHP Billiton, FMG, Aurox Resources and Atlas Iron. The Citic magnetite project at Cape Preston and the hematite project at Koolan Island are included in export sales of iron ore but are not included in the water assessment as they will have their own water supplies.

Expansion in future shipments will depend primarily on the success Western Australian producers have in supplying iron ore to the Chinese market. This proportion should increase in the future as the State has a competitive advantage in shipping costs over most competitors.

This study has adopted a medium growth scenario for the East Asian countries and assumes that market penetration into China will increase to 50% in the medium term. The market share for Japan, Taiwan and South Korea remains constant at current levels of around 60%. The total potential sales including small sales in Australia increase from 305 million tonnes in 2007 to an estimated 766 Mt in 2030 (Figure 6).

Figure 6: Available export market (million tonnes per annum)



Source: Economics Consulting Services forecast

Producer proposals reflect the boom conditions and are very optimistic. Striving to capture market share, they significantly exceed the forecast demand based on the growth scenarios used (Figure 7). This graph is for all Western Australian iron ore.

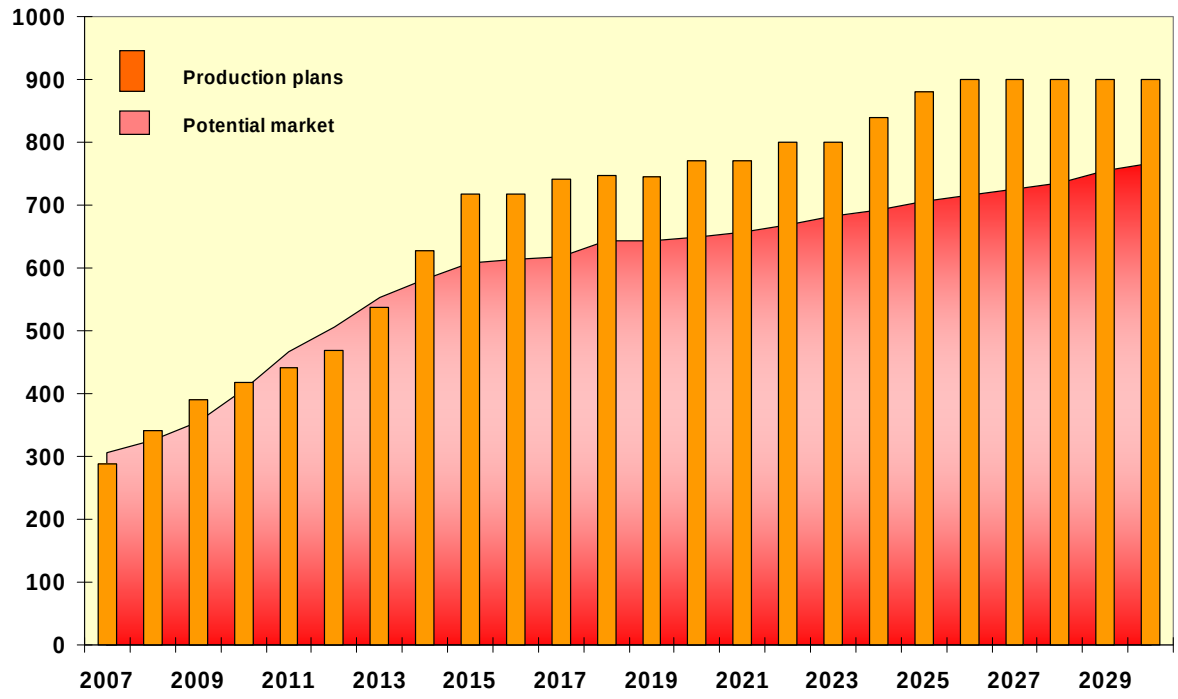
Rio Tinto has committed to an expansion from all of its mines from the current 165 Mtpa to 220 Mtpa with target plans to take the total to 320 Mtpa. Rio Tinto is expanding the Dampier port facilities to 140 Mtpa and Cape Lambert facilities to 80 Mtpa. The company has also indicated that it would like to achieve production of 320 Mtpa by around 2015.

BHPB has committed to expand its operations to 155 Mtpa by around 2012. It has indicated as part of Rapid Growth Phase 5 that it would also like to double production to over 300 Mtpa by 2015 and a possible upgrade to 350 Mtpa by 2020.

Fortescue Metals Group Limited (FMG) shipments will ramp up to an initial capacity of 45 Mtpa in 2008-09 with plans to expand this to 55-60 Mtpa. Long term targets of 90 and 200 Mtpa have been expressed.

The sum of all producer plans in Western Australia slightly exceeds the forecast market demand available to Western Australian producers in 2008 and 2009 and significantly exceeds sale potential from 2014 (Figure 7).

Figure 7: Forecast demand and producer proposals (million tonnes)



Source: Economics Consulting Services forecast

It is not surprising that production planes exceed expected demand as all producers are striving to increase market share before any "softening" in demand in eastern Asia. It is anticipated that supply will exceed demand at some point given the enormous investment in all countries going into increased ore production. What is perhaps surprising is that the market potential remains there until 2014 by which time significant new production will have come "on-line".

Given that the demand forecast includes a higher market share for China, it is unlikely that supply can exceed demand and therefore this study assumes that the production proposals are

scaled back to match the demand forecast. The assumption used in this study is that around half of any required reduction is met by the new producers and the other half shared by the two large existing producers. Specific details on the calculations can not be provided as they may be interpreted to reflect on the capacity of individual companies to develop new projects

Port Shipment Forecast

The forecast means that Port Hedland will export around 300 Mtpa by 2015 and nearly 400 Mtpa in 2030. Dampier and Cape Lambert will exceed 160 Mtpa by 2030 (Table 5).

Shipments of iron ore through the Dampier Ports are currently around 110 Mtpa and through Cape Lambert 55 Mtpa. This study assumes that the Dampier facilities will expand to about 150 Mtpa by 2015 with all Rio Tinto expansion beyond that at Cape Lambert. It has been assumed that Cape Lambert is more accessible for expansion than the Dampier facilities. This means that Cape Lambert will handle more ore than the Dampier facilities within the next decade.

Table 5: Iron ore shipments through Pilbara ports

	Port Hedland (Mt)	Dampier (Mt)	Cape Lambert (Mt)	Total (Mt)
2007	115	110	55	280
2008	140	110	55	305
2009	160	110	55	325
2010	180	110	80	370
2011	210	130	80	420
2012	220	130	100	450
2013	260	140	100	500
2014	280	145	100	525
2015	300	150	100	550
2016	305	155	100	560
2017	310	155	100	565
2018	325	140	125	590
2019	325	145	125	595
2020	335	140	125	600
2021	335	150	125	610
2022	340	155	125	620
2023	345	150	135	630
2024	350	140	150	640
2025	360	150	150	660
2026	365	155	150	670
2027	370	150	160	680
2028	375	155	160	690
2029	385	155	170	710
2030	390	160	170	720

Anticipated water usage

Use of water in mineral processing operations at the ports was identified from public records.[11] For both the ports at Dampier and Cape Lambert, and at Port Hedland and Finucane Island, water is provided by the Water Corporation in conjunction with its supply to the towns of Dampier and Karratha and Port Hedland.[12]

Dampier iron ore facilities used 1,326 ML of water in 2006 representing 13 litres per tonne (L/t) of iron ore handled. This was well below the 20 litres used three years earlier in 2003. Changes in the mix of iron ores and the need to reduce dust levels mean that medium term water use levels will increase and 20 L/t has been used in this study for Dampier.

Water use at Cape Lambert in 2006 was 22 L/t and is forecast to remain around this level.

BHP Billiton Iron Ore has adopted a water efficiency target of a 10 % reduction in fresh water consumption for its port operations by 2012. Water use in 2006 was about 43 litres per tonne of ore shipped through the Port. This is expected to increase to 44 litres per tonne for 2008 and 2009 and then to be brought down to 30 litres a tonne by 2020. Water use at Port Hedland is substantially higher than Cape Lambert and Dampier primarily due to the location of the stockpiles near the town centre and the need for dust minimisation.

FMG water use has been assessed in this study as the same as BHP Billiton given the location in Port Hedland.

The implications of these calculations are that water demand for the ports will increase dramatically over the next 23 years. While that is a long period for projections, the calculations indicate an increase from the current 8,350 ML to an estimated 18,640 ML in 2030 – an increase of 120 % despite the anticipated efficiency savings in water (Table 6).

11 Rio Tinto Iron Ore (2006) Sustainable Development Report –Rio Tinto Iron Ore website.

12 BHP Billiton Iron Ore (2006) Water Use Efficiency Plan Port Hedland Operations. August 2006. (BHP Billiton website.)

Table 6: Projected Demand for Water for Pilbara Ports[13]

Year	Port Hedland (ML)	Dampier (ML)	Cape Lambert (ML)	Total (ML)
2007	4,945	2,208	1,202	8,354
2008	6,160	2,200	1,210	9,570
2009	6,560	2,200	1,210	9,970
2010	7,001	2,200	1,760	10,961
2011	7,980	2,600	1,760	12,340
2012	8,140	2,600	2,200	12,940
2013	9,360	2,800	2,200	14,360
2014	9,800	2,900	2,200	14,900
2015	10,200	3,000	2,200	15,400
2016	10,065	3,090	2,200	15,355
2017	9,920	3,100	2,200	15,220
2018	10,075	2,800	2,750	15,625
2019	9,750	2,900	2,750	15,400
2020	10,050	2,800	2,750	15,600
2021	10,050	3,000	2,750	15,800
2022	10,200	3,100	2,750	16,050
2023	10,350	3,000	2,970	16,320
2024	10,500	2,800	3,300	16,600
2025	10,800	3,000	3,300	17,100
2026	10,950	3,100	3,300	17,350
2027	11,100	3,000	3,520	17,620
2028	11,250	3,100	3,520	17,870
2029	11,550	3,100	3,740	18,390
2030	11,700	3,200	3,740	18,640

[13] Estimates by Economics Consulting Services

WATER FOR RESIDENTIAL USE

CURRENT WATER USAGE

Residential water to the port townships of Dampier and Port Hedland is supplied through the same network as supplies the ports and other commercial and industrial activities. While there has been some distinction between commercial and industrial usage in Water Corporation publications in the past, this separation is proving to be of limited value as the distinction has been fairly subjective (Water Corporation, personal communication).

The primary source of data for residential water use is the Water Corporation for the towns for which it provides services. To develop a comprehensive picture of water use across the region, the approach adopted has been to estimate the average levels of water consumption per head of population for different parts of the Pilbara, and then to apply this average consumption levels to town and other populations.

Information on water use in the towns of Karratha-Dampier, Newman, Port Hedland and South Hedland is available from publications of the Office of Water Regulation (now Department of Water) and the Economic Regulation Authority in WA.[14] These reports provide information on the volumes of water use in each town on a "per residence" basis.

From this information it is possible to impute the volumes of water used on a "per head of population" basis. There is some variation between the towns of the Pilbara. However, these consumption rates can be used to calculate total residential use in towns by multiplying populations by average usage for the nearest known town.

Unfortunately, one difficulty with this approach is that the precise populations of regional towns are unknown. The ABS does produce population estimates for regional areas at the Local Government Authority level.[15] Estimates of town populations can be found in many places – tourism information sites; police information sites, Education Department sites. Generally these data are not consistent and there is wide variation (plus or minus 25%) in town population estimates. Nonetheless, this information has been used, relying first on information from Government agencies, and being guided by the estimated total for the LGA.

The town populations of the Pilbara are dominated by the port towns of Karratha-Dampier, with 22% of the Pilbara's total, and Port Hedland-South Hedland with 36% (Table 7).

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14 Office of Water Regulation (2001) Statistical Profile and Performance Benchmarking of Water Supply Services in 32 Major Western Australian Towns 1999/2000. June 2001. (Economic Regulation Authority Website.)
Economic Regulation Authority (2004) Water Performance Information – 32 Towns 1999-2003. June 2004. (Economic Regulation Authority Website)

15 Australian Bureau of Statistics (2006) Regional Population Growth, Australia, 2004-2005. Catalogue 3218.0. Issued February 2006

Table 7: Population and Water Use of Pilbara Towns

Town	Population (number)	Water Use (ML)
Ashburton LGA		
Tom Price	2,597	529
Paraburdoo	1,484	302
Onslow	594	121
Pannawonica	519	106
Other residential	705	144
LGA TOTAL	5,900	1,202
Roebourne LGA		
Karratha/Dampier	10,788	2,221
Roebourne	1,319	272
Wickham	2,702	556
Other residential	691	142
LGA TOTAL	15,500	3,191
Port Hedland LGA		
Port Hedland	4,424	895
South Hedland	8,107	1,640
Other residential	969	196
LGA TOTAL	13,500	2,731
East Pilbara LGA		
Newman	5,985	3,664
Nullagine	37	23
Marble Bar	93	57
Other residential	118	72
LGA TOTAL	8,000	3,817
PILBARA TOTAL	42,900	10,941

FUTURE WATER USE

While the volumes of residential water use will vary from year to year depending upon seasonal conditions and any awareness of the need to conserve this scarce resource, the main determinant of water consumption over the years will be population numbers.

The current population of the Pilbara is estimated to be 42,900. It is projected to grow to 51,000 by the year 2031.[16] [17] This ABS estimate has been modified by the Department of Planning and Infrastructure in the light of more recent population data, to produce an estimate of 50,200 by the year 2031[18]. This later projection has been used in the current study. The ABS is projecting reductions in the numbers of young people in the region, with increases for every age group over the age of 40 years and reductions for every age group under this age.

16 Australian Bureau of Statistics. Estimated Resident Population; 2001 – 2031. (Ministry for Planning website)

17 Western Australian Planning Commission (2005) Western Australia Tomorrow. Population Report No. 6. November 2005

18 Western Australian Planning Commission. (2005) Western Australia Tomorrow. Population Report No. 6. November 2005

This projection for the Pilbara represents an overall growth in population of 17% over the next 25 years. This increase compares with the ABS population projection for the whole of Western Australia, which is for a 36% increase in population over the next 25 years.

The WA Planning Commission has produced population projections for each of the four Local Government Areas of the Pilbara, to the year 2016, with an overall projection for the Pilbara to the year 2031. Earlier, the ABS produced three population projections for Pilbara LGA's; nominating them as "low", "medium" and "high", with "medium" regarded as the most likely and the other estimates providing a low and high range of possibilities. The WA Planning Commission projection corresponds to the ABS "medium" projection. These projections have been re-worked in the present study by extending the LGA population projections for 2016, to the year 2031 (Table 8).

The projected Pilbara population increase of 17% is comprised of increases of 11% for Ashburton, 29 per cent for Port Hedland and 18 per cent for Roebourne. Population in the East Pilbara LGA is expected to decline slightly, by 3%.

Table 8: Pilbara Population Projections

	Population Projections Pilbara LGAs				
Year	**Ashburton**	**East Pilbara**	**Port Hedland**	**Roebourne**	**Total**
2006	5,900	8,000	13,500	15,500	42,900
2011	6,033	7,953	14,216	16,033	44,235
2016	6,169	7,906	14,970	16,585	45,630
2021	6,308	7,860	15,764	17,155	47,087
2026	6,451	7,814	16,600	17,746	48,610
2031	6,596	7,768	17,480	18,356	50,200

Recent history has shown a reduction in the Pilbara population, particularly in the period between 1991 and 1996, when it declined by some 6,000 persons. From 1996, the population has been stable at a little more than 40,000.

The Ashburton LGA has the lowest level of projected population growth. The mining towns are anticipated to grow at three times the rate of the non-mining towns since the impetus for growth is coming from this sector.

The projections include a step increase, over two years, in the population of Onslow with the establishment of the BHP Billiton LNG plant, which may commence construction soon. Permanent staff numbers for the LNG plant are expected to total 90 employees.[19] In their planning work, BHPB have found that most will prefer to fly in-fly out from Perth. However, BHPB and the local community are keen to maximise the numbers of employees choosing to reside locally. In this study, the number of permanent local employees is put at 30 with fly in-fly out staff numbers at 60. With provision for associated family members, this gives an effective increase in local population of 100 persons. These increased population numbers are built into the projected residential water use for towns of the Ashburton Shire (Table 9).

19 BHP Billiton (2006) Pilbara LNG Newsletter. November 2006.

Table 9: Projected Annual Residential Water Use for Towns of the Ashburton Shire

Year	Tom Price (ML)	Paraburdoo (ML)	Onslow (ML)	Pannawonica (ML)	Other (ML)	Total (ML)
2006	529	302	121	106	144	1,202
2007	532	304	131	107	144	1,218
2008	536	306	140	107	145	1,234
2009	539	308	140	108	145	1,240
2010	543	310	141	109	145	1,247
2011	546	312	141	109	146	1,254
2012	550	314	141	110	146	1,261
2013	553	316	142	111	146	1,268
2014	557	318	142	112	146	1,275
2015	561	320	142	112	147	1,282
2016	564	322	142	113	147	1,289
2017	568	324	143	114	147	1,296
2018	571	326	143	115	148	1,303
2019	575	328	143	115	148	1,310
2020	579	330	144	116	148	1,317
2021	583	333	144	117	149	1,325
2022	586	335	144	117	149	1,332
2023	590	337	145	118	149	1,339
2024	594	339	145	119	150	1,347
2025	598	341	145	120	150	1,354
2026	602	343	146	121	150	1,361
2027	606	346	146	121	151	1,369
2028	609	348	146	122	151	1,377
2029	613	350	146	123	151	1,384
2030	617	352	147	124	152	1,392
2031	621	355	147	124	152	1,400

The overall consumption of water for residential purposes for the Ashburton LGA is projected to grow from 1,202 ML in 2006 to 1,400 ML in 2031 – an increase of 16.5%.

The Roebourne LGA has a relatively high projected rate of population growth because a greater part of its population is in centres servicing the mining sector. Again, as for Ashburton, the growth is expected to be unevenly spread across the Shire. For this analysis, the mining towns are anticipated to grow at three times the rate of the non-mining towns.

The projection is for an increase in the residential consumption of water in the Roebourne Local Government Area from 3,191 ML in 2006, to 4,058 ML in 2031 – an increase of 27% over 25 years (Table 10).

Table 10: Annual Residential Water Use for Towns of the Roebourne Shire

Year	Karratha/ Dampier (ML)	Roebourne (ML)	Wickham (ML)	Other (ML)	Total (ML)
2006	2,221	272	556	142	3,191
2007	2,244	273	562	142	3,222
2008	2,268	274	568	143	3,253
2009	2,292	275	574	143	3,284
2010	2,316	276	580	144	3,315
2011	2,340	277	586	145	3,347
2012	2,365	278	592	145	3,380
2013	2,390	279	598	146	3,412
2014	2,415	280	604	146	3,445
2015	2,440	281	611	147	3,478
2016	2,466	282	617	147	3,512
2017	2,492	283	624	148	3,546
2018	2,518	284	630	148	3,580
2019	2,544	285	637	149	3,615
2020	2,571	286	644	149	3,649
2021	2,598	287	650	150	3,685
2022	2,625	288	657	150	3,720
2023	2,653	289	664	151	3,756
2024	2,681	290	671	151	3,793
2025	2,709	291	678	152	3,830
2026	2,737	292	685	152	3,867
2027	2,766	293	692	153	3,904
2028	2,795	294	700	153	3,942
2029	2,825	295	707	154	3,981
2030	2,854	296	715	154	4,019
2031	2,884	297	722	155	4,058

The Port Hedland LGA has the highest anticipated rate of population growth of the Shires of the Pilbara. Unlike the other LGA's, the growth is expected to be relatively evenly spread across the Shire.

The projection is for an increase in the residential consumption of water in the Port Hedland Local Government Area from 2,731 ML in 2006, to 3,617 ML in 2031 – an increase of 32% over 25 years (Table 11).

Table 11: Annual Residential Water Use for Towns of the Port Hedland Shire

Year	Port Hedland (ML)	South Hedland (ML)	Other (ML)	Total (ML)
2006	895	1,640	196	2,731
2007	905	1,659	198	2,762
2008	915	1,677	200	2,793
2009	926	1,696	203	2,825
2010	936	1,715	205	2,857
2011	947	1,735	207	2,889
2012	957	1,754	210	2,921
2013	968	1,774	212	2,954
2014	979	1,794	214	2,988
2015	990	1,815	217	3,022
2016	1,001	1,835	219	3,056
2017	1,013	1,856	222	3,090
2018	1,024	1,877	224	3,125
2019	1,036	1,898	227	3,161
2020	1,047	1,919	229	3,196
2021	1,059	1,941	232	3,232
2022	1,071	1,963	235	3,269
2023	1,083	1,985	237	3,306
2024	1,096	2,008	240	3,343
2025	1,108	2,030	243	3,381
2026	1,121	2,053	245	3,419
2027	1,133	2,076	248	3,458
2028	1,146	2,100	251	3,497
2029	1,159	2,124	254	3,536
2030	1,172	2,148	257	3,576
2031	1,185	2,172	260	3,617

The resident population of the East Pilbara LGA is anticipated to decline slightly over the next 25 years, and household water consumption is projected to decline in the same way. The same rate of decrease has been assumed for each of the towns of the East Pilbara.

The projection is for a slight decrease in the residential consumption of water in the East Pilbara Local Government Area, from 3,816 ML in 2006, to 3,705 ML in 2031 – a decline of 3% over 25 years (Table 12).

Overall, the growth in residential consumption of water for the whole Pilbara is projected to increase from 10,940 ML in 2006 to 12,780 ML in 2031.

Table 12: Annual Residential Water Use for Towns of the East Pilbara Shire

Year	Newman (ML)	Nullagine (ML)	Marble Bar (ML)	Other (ML)	Total (ML)
2006	3,664	23	57	72	3,816
2007	3,660	23	57	72	3,812
2008	3,655	23	57	72	3,807
2009	3,651	23	57	72	3,803
2010	3,647	23	57	72	3,798
2011	3,643	23	57	72	3,794
2012	3,638	23	57	71	3,789
2013	3,634	23	57	71	3,785
2014	3,630	23	56	71	3,780
2015	3,625	23	56	71	3,776
2016	3,621	23	56	71	3,771
2017	3,617	23	56	71	3,767
2018	3,613	23	56	71	3,762
2019	3,608	23	56	71	3,758
2020	3,604	23	56	71	3,754
2021	3,600	23	56	71	3,749
2022	3,596	23	56	71	3,745
2023	3,591	23	56	71	3,740
2024	3,587	23	56	70	3,736
2025	3,583	22	56	70	3,732
2026	3,579	22	56	70	3,727
2027	3,575	22	56	70	3,723
2028	3,570	22	56	70	3,718
2029	3,566	22	55	70	3,714
2030	3,562	22	55	70	3,710
2031	3,558	22	55	70	3,705

INDUSTRIAL AND COMMERCIAL USE

CURRENT WATER USAGE

Industrial use of water is usefully split into two categories – heavy and other. (The introduction to "Overview of Current Water Use" discusses the distinction between heavy and other industry.) In the Pilbara the heavy industries are salt processing, LNG gas processing, and ammonia fertilisers on the Burrup. Other industrial uses are a mix of light industrial and commercial activities.

Information on water use for heavy industry has been obtained from the companies. Larger light industries, such as Mermaid Marine, are not large users of water and their consumption is included in the Water Corporation total scheme use.

Light industrial and commercial use of water is measured by the Water Corporation for the schemes that it manages. These data demonstrate a strong relationship between industrial and commercial use of water and the population numbers in a town or area. This relationship has been used to estimate the volumes of water used for industrial purposes in those areas not serviced by the Water Corporation.

FUTURE WATER USE

LNG gas processing

Woodside is currently completing a fifth LNG train at its Burrup site. LNG plants are not large users of water, and obtain some of their water from internal condensation of cooling water. The fifth train will lead to an increase of some 11% in the volume of water used.

Woodside is evaluating the development of a second LNG plant on the Burrup Peninsula to process gas from its Pluto project. This plant will be a short distance from, but quite separate from, the existing plant and is expected to come into full production in 2010.

BHP Billiton has been evaluating the development of its Scarborough gas resource, some 280 kilometres north west of Onslow. A detailed site selection process has concluded with a decision that the LNG plant for this field should be located on the Onslow Industrial Area. The capacity of the plant will be about half the size of the first four trains for the Burrup LNG plant. Water for the BHP Billiton plant will be obtained from a reverse osmosis plant, supplemented by water produced from cooling operations

Water use in LNG processing is estimated to grow to 500 ML a year by 2010, and then to remain at this level. Of this total, about a third will be provided from seawater desalination. The contribution of desalination could be higher than this level depending on the source mix adopted by the Water Corporation for the Burrup industries.

Salt production

There are three existing salt production operations in the Pilbara and a fourth being established. Salt operations are not large users of water; with the largest existing plants each using less than 100 ML a year.

Dampier Salt operates salt processing plants at Dampier (Mistaken Island), Port Hedland and Lake McLeod (Cape Cuvier), near Onslow. The Dampier and Port Hedland operations each produce 3 million tonnes of salt a year and the Onslow operation about half that amount. The Onslow plant, however, uses more water because it also produces equal quantities of salt and gypsum, and the gypsum process is a higher user of fresh water.

Straits Yannarie Salt hopes to construct a 3 million tonne per annum solar salt field on the eastern margin of Exmouth Gulf. Production is planned to build to 10 million tonnes per annum.

Total water use by the salt production industry is currently about 220 ML a year. This is expected to grow to 270 ML within 4 years and then to 430 ML within 10 years. While most of the existing supply is from public water supply, the growth in use is expected to be provided from desalination of seawater.

Fertilisers

The world's largest Greenfield ammonia plant was opened on the Burrup in April 2006. The plant uses natural gas as feedstock to produce fertiliser and industrial products.

Burrup Fertilisers uses a dual supply of seawater and desalinated seawater for its processing plant. Water is supplied by the Water Corporation. Total seawater supplied is 22,600 ML and the volume of desalinated water is 1,300 ML a year. Water use by Burrup Fertilisers has not been accounted for in the consumption figures for industrial water use for the Pilbara because it is regarded, in this study at least, as a separate scheme. At the same time, it is recognised that the Burrup desalination plant is a potential supplier of water into the West Pilbara water supply network (Table 13).

Table 13: Water use by industrial and commercial sectors

Year	South Coastal		North Coastal		Central	East	
	Heavy Ind (ML)	Light Ind (ML)	Heavy Ind (ML)	Light Ind (ML)	West (ML)	Pilbara (ML)	Total (ML)
2006	1,665	2,040	65	2,312	865	3,236	8,517
2007	1,763	2,066	65	2,338	870	3,232	8,571
2008	1,789	2,092	65	2,364	875	3,228	8,625
2009	1,921	2,111	65	2,391	880	3,225	8,672
2010	1,963	2,131	65	2,418	885	3,221	8,719
2011	1,964	2,150	65	2,445	891	3,217	8,768
2012	1,964	2,170	65	2,473	896	3,213	8,816
2013	1,964	2,190	65	2,501	901	3,209	8,866
2014	1,964	2,210	65	2,529	906	3,206	8,916
2015	1,964	2,230	65	2,558	912	3,202	8,966
2016	1,964	2,250	65	2,586	917	3,198	9,017
2017	1,964	2,271	65	2,616	923	3,194	9,069
2018	1,964	2,292	65	2,645	928	3,191	9,121
2019	1,964	2,313	65	2,675	933	3,187	9,174
2020	1,964	2,334	65	2,705	939	3,183	9,227
2021	1,964	2,356	65	2,736	945	3,179	9,281
2022	1,964	2,378	65	2,767	950	3,176	9,335
2023	1,964	2,400	65	2,798	956	3,172	9,390
2024	1,964	2,422	65	2,830	961	3,168	9,446
2025	1,964	2,444	65	2,862	967	3,164	9,502
2026	1,964	2,467	65	2,894	973	3,161	9,559
2027	1,964	2,490	65	2,927	979	3,157	9,617
2028	1,964	2,513	65	2,960	984	3,153	9,675
2029	1,964	2,536	65	2,993	990	3,150	9,734
2030	1,964	2,560	65	3,027	996	3,146	9,794
2031	1,964	2,584	65	3,061	1,002	3,142	9,854

WATER FOR LIVESTOCK

CURRENT WATER USAGE

Agricultural use of water in the Pilbara is limited to the use of water for livestock. There is virtually no irrigated agriculture in the region. Similarly, there is virtually no intensive raising of animals or feed-lot production of animals – although a number of the pastoral stations are managed in conjunction with more intensive farms in the South West of the State and animals are grown on the pastoral property and then "finished" on agricultural land or in feed lots.

Pastoral Stations occur throughout the western third of the Pilbara Region covering some 14.6 million hectares and representing about 28% of the total Pilbara land area. There are 55 pastoral enterprises in the Pilbara, and this number has been reducing over the years. However, this has occurred by amalgamations, so that the total area of land managed under pastoral leases has remained relatively constant.

It is estimated that in 2001 there were 250,000 cattle and 49,000 sheep in the Pilbara region[20], and the bulk of these are in the West Pilbara, although there are some cattle in the southern parts of the East Pilbara Shire.

The volumes of water used by livestock can be calculated on the basis of the average volumes used per animal. This is assessed to be 100 litres a day for cattle and 9 litres a day for sheep.[21]

The water use by livestock is then calculated by multiplication. This calculation provides an estimate of water use by cattle of 9,125 ML per year. For sheep, the estimate derived is 161 ML a year, giving a total of 9,286 ML.

This estimated use of water for livestock purposes would not all come from bores and wells. While these are the predominate source, some livestock will have access to occasional springs and some will access river frontages and residual pools in rivers after they have ceased to flow. While the actual numbers of animals with access to natural streams are not

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20 Scadding, Garry (2004) N212 – Pilbara Project. Agriculture – Economic Perspective. Murdoch University Publication. (Murdoch University website.)

Subotic, Milica. (2004) Environment: Rangelands of the Pilbara. Murdoch University Publication. (Murdoch University website.)

21 Croker, Keith and Roy Butler (2004) Getting into Sheep, and Introductory Guide. Department of Agriculture Bulletin 4577. April 2004. (Department of Agriculture and Food website.)

Department of Agriculture (WA) (2003) Information on Pastoral Businesses in the Rangelands of Western Australia. Miscellaneous Publication 24/2003. August 2003. (Department of Agriculture and Food website.)

Department of Agriculture (WA) Pastoral Resources and their Management in the Pilbara Region of WA. Miscellaneous Publication 21/2004. (Not available electronically.)

known, it is considered that they would represent a small proportion of the total. Recognition of them would suggest that the estimate for total water use be interpreted as a maximum.

On the basis of information on the location of cattle and sheep in the Pilbara, it is possible to allocate the total water use into an estimate of volumes of use for each LGA.[22] These are:

- Ashburton LGA 4,200 ML
- Roebourne LGA 1,400 ML
- Port Hedland LGA 2,800 ML
- East Pilbara LGA 900 ML

FUTURE WATER USE

Improved rangeland management in recent decades has focused on the achievement of a more sustainable industry. This objective has required that stock numbers on pastoral properties be reduced. This process occurred in the 1970's and 1980's, and is now relatively complete with stock numbers being stable over recent years.

While numbers of animals will vary from year to year, depending on seasonal conditions, over the longer term stock numbers are anticipated to remain fairly constant.[23]

The Department of Agriculture does not anticipate any significant changes in the nature of the agricultural industries of the Pilbara for the foreseeable future.

The expectation, then, is for livestock use of water in the Pilbara to remain at an average of 9,300 ML for the medium to long term future.

[22] WA Department of Agriculture and Food. (2006) Meat and Live Animals. (From the agrifoodinfonet website.)

[23] WA Department of Agriculture and Food, Karratha Office. Personal communication September 2006..

WATER FOR IRON ORE MINING

CURRENT LEVELS OF USE

Forms of use

Information from the operating companies illustrates the significance of dewatering as a form of water "use" for the mining sector. On the basis of current use, dewatering is as large a use of water as is water used for operations. This is the case for the iron ore industry. It is also the case for other mining, although in the latter case, the numbers are severely skewed by a few mining operations that have large dewatering requirements.

The water that is used for mine processes can be separated into water for domestic use (camps and towns); water for processing of ore; and water for dust suppression. Water for domestic use is highly variable depending on the situation and whether the mining company provides the water supply. If this volume is removed from the equation, the water for ore processing is about 60% of the total and water for dust suppression is about 40%.

Mining companies were asked why they used good quality water for their dust suppression and ore processing. In both cases there is a concern from the customer about the level of chlorides in the final product. Pilbara material is high in chlorides to start with. Chlorides in the ore attack the linings of blast furnaces, which decreases their economic life and carries a severe cost penalty. To stay below the penalty limits set for chlorides, water used for dust suppression and ore beneficiation needs to be close to potable.

Pilbara Iron (Rio Tinto)

Pilbara Iron operates iron ore mines at Brockman, Paraburdoo, Channar and Eastern Range, Marandoo, Pannawonica – Mesa J, Tom Price, West Angelas and Yandicoogina.

In 2006, Rio Tinto withdrew 41,318 ML of fresh water across all of its Pilbara mine, rail and port operations[24] This water included water taken from pits to allow mining to proceed either following rainfall events or because mining is taking place below the groundwater table. The volume of water extracted in a year is thus a function of the mining activity and the rainfall.

Large volumes of water from dewatering activity were returned to the environment at Pannawonica and Yandicoogina mine sites in 2006 with significant but lower volumes at Paraburdoo, Brockman and Nammuldi. ,

Allowing for the water that was discharged back to the environment, Pilbara Iron reported "water use" as 20,683 ML in 2006.

[24] Rio Tinto Iron Ore Sustainability Report (2006). Pilbara Iron website.

This water use does not include towns or mining camps. That water is included in the section on residential and other industrial use. More detail on Pilbara Iron mine operations is included in the following sections.

South Coastal area

Pannawonica – Mesa J

Mesa J is owned and operated by Robe River, with support services provided by Pilbara Iron. Mining commenced in 1994, and the operation produces pisolite fines and lump ore. Ore is recovered from mixed waste material in the two process plants, with waste sent to an in-pit tailings dam. Ore is railed to Cape Lambert for further crushing and screening into discrete products. [25] The main pits are under the watertable and substantial volumes of water are abstracted from the pits. Large volumetric licenses are held by the company to allow dewatering after cyclonic rain events.

The total volume of water abstracted in 2004 was 15,941 ML, of which 4,307 ML was used. Recycled water totalled 4,235 ML. Production at Mesa J will be slowly phased out and replaced by Mesa A and then Beasley River. Mesa A is above the water table and will thus not require dewatering allowances but will require water for dust suppression.

Central West Pilbara area

Marandoo

The Marandoo mine is located 45 km from Tom Price and was commissioned in 1994. Marandoo mines, crushes and screens Marra Mamba fines and lump products, which are blended with other ore types at the port. There is no wet processing at Marandoo and therefore no tailings dam on site. The mine railed out 12 Mt in 2006 and used 531 ML of water or 45 L/t. [26] A small proportion of water was recycled (18%) with no water discharged to the environment.

Brockman and Nammuldi

Brockman, a fly-in fly-out operation located about 60 kilometres north-west of Tom Price, started production in 1992.27 The Brockman mine produces fines and lump products, which are blended at the port.

The Nammuldi mine, north of Brockman, forms part of a larger iron ore province that includes the Silvergrass and Homestead deposits. With a strike length of 14 kilometres it is a focal point for future expansion in the area.

Brockman and Nammuldi share infrastructure but do not operate simultaneously. There are around 140 employees at these mine operations. They work to a fly-in, fly-out roster and typically reside in Perth.

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25 Pilbara Iron (200$_6$) Site Reports Mines – Pannawonica Mesa J. (Pilbara Iron Website.)

26 Pilbara Iron (2006) Site Reports Mines – Marandoo. (Pilbara Iron Website.)

27 Pilbara Iron (2006) Site Reports Mines – Brockman and Nammuldi. (Pilbara Iron Website.)

Ore railed in 2006 was close to 19 million tonnes and the mines used 1,400 ML of water. Around 60% was returned to the environment with 73 L/t used in mining, processing and rail operations.

Mount Tom Price

Mount Tom Price is Pilbara Iron's oldest and largest operation and commenced production in 1966, four years after the discovery of the deposit.[28]

This mine is a massive orebody eight kilometres long and more than one kilometre wide. The operation involves mining, crushing and dry processing high-grade rich hematite iron ore to produce lump and fines, which are blended into products at the port. Mining at Mount Tom Price provided 15 Mt of ore in 2006.

More than 700 employees work at the operations and reside in the nearby town of Tom Price.

The Mount Tom Price withdrew 5,580 ML of water in 2006 and discharged 619 ML (10%) back to the environment. The water used, 4,309 ML represented 295 L/t of ore railed.

Paraburdoo, Channar and Eastern Range

The Paraburdoo, Channar and Eastern Range mines are located in close proximity to one another and are operated by Pilbara Iron as the Greater Paraburdoo operation.[29]

The Paraburdoo mine is fully owned by Hamersley Iron with the Channar mine owned by Hamersley Iron in joint venture with an Australian subsidiary of the China Iron and Steel Industry and Trade Group Corporation and the Eastern Range mine owned in joint venture with Baosteel, of China.

The mines produce hematite ore in lump and fines. Paraburdoo receives ore from Channar and Eastern Range by overland conveyor for processing and transport. Fine ore is upgraded in the Paraburdoo Fines Processing Plant and the ores are blended with other ores at the port. In 2004, approximately 31 million tonnes was produced from the three mines.

There are close to 400 employees at the Greater Paraburdoo operations, and they typically reside in the nearby town of Paraburdoo.

The mines extracted 7,092 ML of freshwater in 2006, and used 5,339 ML in operations discharging 1,753 ML to the environment.

East Pilbara area

West Angelas

The West Angelas mine, which opened in 2002, is owned and operated by Robe River, with support services provided by Pilbara Iron. The operations produce Marra Mamba fines and lump ore, which are crushed and screened into discrete products on site. Production in 2006

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[28] Pilbara Iron (2005, 2006) Site Reports Mines – Mount Tom Price. (Hamersley Iron Website.)

[29] Pilbara Iron (2005, 2006) Site Reports Mines – Paraburdoo, Channar and Eastern Range. (Hamersley Iron Website.)

was 23 million tonnes. An expansion program is nearly completed to increase annual production capacity to 25Mt.[30]

The volume of water used at the mine in 2006 was 1,613 ML. This is net of the water used at the township, and there was no excess from de-watering operation to be returned to the environment. Water use per tonne of ore shipped averages 70 litres.

Mount Whaleback and satellite ore bodies

BHP Billiton Iron Ore has six mining operations in the Pilbara - Mt Whaleback and nearby Satellite Orebodies 23, 25, 29 and 30, Jimblebar, Yandi, and Area C. These mines produced 105 million tonnes of iron ore in 2006. Processing and shipping facilities are located at Nelson Point and Finucane Island, Port Hedland.[31]

A small mine is located in the northern Pilbara area at Yarrie near the old Goldsworthy project.

Total water "used" in the iron ore operations in 2006-07 was 14,980 ML with 4,440 recycled (30%). Water used was dominated by the Mt Whaleback and port and rail operations (Table 14).

Table 14: BHP Billiton water use (Megalitres in 2006-07)

Site	Water used (ML)
Mt Whaleback	5,290
Port & Rail	3,310
Mining Area C	2,140
Yandi/Marillana Creek	1,350
Orebody 18	1,030
Orebody 23/25	980
Yarrie/Nimingara	880
Total	14,980

Source: BHP Billiton Sustainability Report website

Mount Whaleback is BHP Billiton's largest mine. At 5.5km long and 1.5km wide Mt Whaleback is one of the largest single pit open cut iron ore mines in the world. The ore is processed to a maximum size of 100mm for rail transport and further processing at the Company's shipping terminal at Port Hedland. Ore from the Yarrie mines is similarly processed into lump and fines products for shipment.

BHP Billiton acquired the Jimblebar operation (formerly McCamey's Monster) in 1992. It is located 42 km east of Newman. Production from the Jimblebar deposit has been increased in recent years so that blending with the high grade deposit at Mount Whaleback, the productive life of that mine can be extended.

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30 Pilbara Iron (2006) Site Reports Mines – West Angelas. (Hamersley Iron Website.)
31 From BHP Billiton Iron Ore website

Orebody 23 and Orebody 25 are associated with Mount Whaleback and are operated in conjunction with it. This mine used a total volume of 820 ML of extracted water in 2006-07.

The mines associated with Mount Whaleback produced over 30 Mtpa of blended product in 2006-07. Total water use at the Mount Whaleback operations was 7,300 ML in 2006-07, [32]

Yandi

At the Yandi and Area C mines, ore is crushed and screened to final product (shipping) size specifications (lump and fines) before railing to Port Hedland.

BHP Billiton Iron Ore has two Beneficiation facilities, one at Mt Whaleback and the other at Finucane Island. The Mt Whaleback beneficiation plant treats contact ores using a heavy medium (ferrosilicon), drums, cyclones and spiral circuit techniques to separate the heavier iron ore from the lighter overburden materials. The Finucane Island beneficiation plant uses a similar process to upgrade ore from Yarrie through a wet high intensity magnetic separation circuit and spirals and jigs. The Finucane Island plant is to be removed to allow increased stockpile yards at the port.

The Yandi (Marillana Creek) operation is located some 90 km northwest of Newman. It commenced in 1992 at a production rate of 5 Mtpa. It currently produces about 42 Mtpa of pisolitic fine ore and used 1,350 ML of water in 2006.

Mining Area C

Production from the Mining Area C commenced in 2003 and was about 22 Mt in 2006... Water use was 2,140 ML or about 100 L/t of ore railed. A small volume of excess water from dewatering was returned to the environment.

North Pilbara area

Yarrie

Mining at Yarrie, the easternmost of the "Goldsworthy mines", in the north Pilbara commenced in 1993. The operation was designed to progressively replace the depleting resources of Shay Gap and Nimingarra. Egg Creek and Cundaline are also part of the general Yarrie - Nimingarra mining operations.

Production from the areas is currently about 6 Mtpa.

FUTURE WATER USE

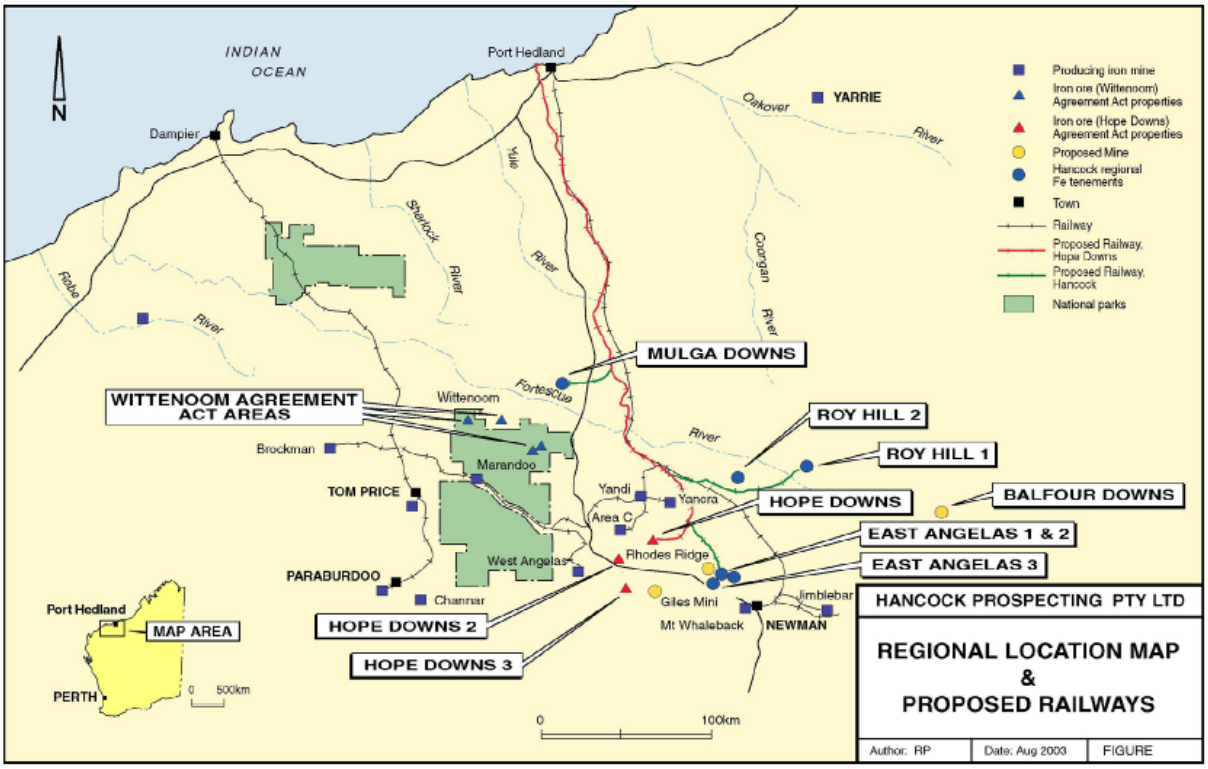
Hope Downs

Pilbara Iron is currently developing the Hope Downs project midway between Newman and Tom Price. The project involves the development of the three mines, rail lines to Port

[32] BHP Billiton (2007) Sustainability Report (BHP Billiton website.)

Hedland and the development of port facilities at Finucane Island.[33] Stage 1, expected to commence shipments in 2008, will have an annual capacity of 22 Mtpa. Completion of Stage 2 will bring capacity to 30 Mtpa.

Figure 8: Locations of the Hope Downs mines



Fortescue Metals

The development of the Pilbara Iron Ore and Infrastructure Project Stage A and B, and specifically the rail and port components provide the infrastructure required to facilitate the development of other projects in the region (Figure 4). FMG has outlined its projects in the following way for environmental approval:

• Stage A Project: Proposed port and a 190km long north-south railway from north of the Chichester Ranges in the Central Pilbara to Port Hedland;

• Stage B Project: (Christmas Creek and Mindy Mindy) mines and a 120km long east-west rail spur; and

• Cloud Break Project: The Cloud Break mining operations.

The Stage B Proposal includes three mine sites on the edge of the Chichester Ranges and one further south on the edge of the Hamersley Ranges, and a 160 km east-west rail spur to

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[33] Hancock Prospecting Pty Ltd and the Hope Downs Project. (2005) Presentation to the China Metal Ore 2005 Metal Bulletin Conference. April 2005. (Hancock Prospecting website.)

connect the mine sites near the Chichester Ranges to the north-south railway. The proposed Mt Nicholas mining area is located approximately 110 km north-east of Newman., whilst the proposed Mt Lewin and Christmas Creek mines are located approximately 95 km northeast and 100 km north of Newman respectively. Cloud Break will be developed first with Mt Levin and Mt Nicholas possibly in twenty years time (Figure 6).

Ore production is anticipated to total 45 Mtpa, commencing 2008 with expansion already being planned for 55-60 Mtpa. Water used in mining operations and the beneficiation plant will total 8 GL of water a year, some of which will come from a borefield and some from mine dewatering.

Water from dewatering operations at Christmas Creek are estimated at 1.15 GL a year and will be used in the beneficiation plant and this will be supplemented with water from the Cloud Break dewatering operations, which are expected to yield 5,329 ML a year.

The ore mined at Christmas Creek will need to be beneficiated and this process requires considerable volumes of water. Mining at Christmas Creek is planned to commence in Year 7 and the beneficiation plant will commence operations at the same time. The stored water from dewatering at Cloud Break will then be used in the beneficiation plant. From Year 7, water required for beneficiation will be provided by a combination of ongoing pit dewatering at Christmas Creek and Cloud Break and the Mt Lewin bore field.

At least two magnetite projects are under consideration in the Pilbara coast area at Cape Preston and two smaller iron ore companies are looking at road transport to Port Hedland. All projects are at the feasibility stage and detailed consideration is still to be given to water needs. The CP Mining project at Cape Preston has indicated that they are prepared to construct a desalination plant if groundwater supplies are not adequate. Given the early stage of these studies, water use estimates have not been included. It is conceivable that any production will displace a part of production from the established Pilbara producers making the net change in iron ore output small.

WATER USE SUMMARY

This section of the report was prepared in September 2006. Sections in this report on port operations (Chapter on Pilbara Ports) and the above sections in this Chapter on individual iron ore mines were revised in October 2007. The following sections on broader mining operations and the Chapter on other minerals have not been revised.

The anticipated volumes of water use by mines are expected to alter considerably over the coming 20 years. Water use by the mining sector is divided into water that is actually used up in the process and water that is returned to the environment. In 2005, total water use in operations represented about 57% and water returned to the environment about 43% of all use (Table 15). These relative proportions are anticipated to reverse over the next five years, by which time water use will have fallen to 41% and water returned to the environment will have increased to 59%. By the year 2031, the proportions are anticipated to settle back so that water use is about equal to water returned to the environment.

More dramatic is the anticipated total use of water. Over the next 25 years, the total volume of water used in iron ore mining operations is anticipated to grow by 130%, and the volume of water from dewatering which is returned to the environment to increase by 230%.

Of the four regions identified in this study, the greatest concentration of production and the highest level of water use was in the Central West. This region uses about 60% of all water used in iron ore operations and is responsible for about 40% of all water returned to the environment across the Pilbara. These percentages remain largely unchanged over the 25 years to 2031.

Water use by the iron ore industry in the South Coastal area of the Pilbara represents an interesting contrast. In that region, water use for mining operation is anticipated to reduce by a third. At the same time, water returned to the environment is anticipated to more than double.

Table 15: Water use in iron ore mining (2005-06 estimates)

Year	East Pilbara		Central West		North Coastal	
	Mine Operations (ML)	Return to Environment (ML)	Mine Operations (ML)	Return to Environment (ML)	Mine Operations (ML)	Return to Environment (ML)
2006	6,086	6,123	19,877	10,507	1,372	1,765
2007	9,400	6,750	21,620	10,600	1,400	1,780
2008	16,400	19,750	24,492	15,500	1,440	1,800
2009	19,600	31,800	29,882	28,000	1,490	1,850
2010	24,400	41,700	26,202	32,700	1,550	1,924
2011	24,400	41,700	32,918	32,700	1,600	2,000
2012	24,550	41,700	32,913	34,200	1,660	2,100
2013	24,600	31,800	31,244	36,500	1,730	2,150
2014	24,600	31,850	38,990	38,500	1,800	2,240
2015	24,700	31,850	34,851	41,200	1,870	2,330
2016	24,750	31,800	30,889	41,200	1,950	2,300
2017	24,800	31,800	36,400	42,200	2,000	2,300
2018	24,800	31,700	36,100	39,800	2,080	2,250
2019	24,900	31,700	36,100	41,600	2,200	2,200
2020	24,900	31,600	36,200	39,700	2,250	2,150
2021	24,900	31,600	38,100	39,200	2,350	2,100
2022	24,900	31,600	36,100	39,200	2,450	2,050
2023	24,900	31,600	37,600	39,200	2,550	2,000
2024	24,900	31,600	38,500	39,200	2,650	2,000
2025	24,900	31,600	40,000	39,200	2,740	2,000
2026	24,900	31,600	40,200	36,700	2,840	2,080
2027	24,900	31,600	41,400	36,700	2,950	2,163
2028	24,900	31,600	41,900	34,700	3,050	2,250
2029	24,900	31,600	43,100	34,700	3,160	2,340
2030	24,900	31,600	43,100	33,700	3,280	2,433
2031	24,900	31,600	43,100	33,700	3,400	2,531

Table 15 (Continued): Water use in iron ore mining

Year	South Coastal		Total Pilbara	
	Mine Operations (ML)	Mine Return to Environment (ML)	Mine Operations (ML)	Mine Return to Environment (ML)
2006	5,382	6,679	32,717	25,074
2007	5,400	6,700	37,820	25,830
2008	5,400	8,500	47,732	45,550
2009	5,400	8,500	56,372	70,150
2010	5,400	10,000	57,552	86,324
2011	5,400	12,200	64,318	88,600
2012	5,000	14,000	64,123	92,000
2013	4,500	14,000	62,074	84,450
2014	4,000	15,000	69,390	87,590
2015	3,500	15,000	64,921	90,380
2016	3,500	15,000	61,089	90,300
2017	3,500	15,000	66,700	91,300
2018	3,500	15,000	66,480	88,750
2019	3,500	15,000	66,700	90,500
2020	3,500	15,000	66,850	88,450
2021	3,500	15,000	68,850	87,900
2022	3,500	15,000	66,950	87,850
2023	3,500	15,000	68,550	87,800
2024	3,500	15,000	69,550	87,800
2025	3,500	15,000	71,140	87,800
2026	3,500	15,000	71,440	85,380
2027	3,500	15,000	72,750	85,463
2028	3,500	15,000	73,350	83,550
2029	3,500	15,000	74,660	83,640
2030	3,500	15,000	74,780	82,733
2031	3,500	15,000	74,900	82,831

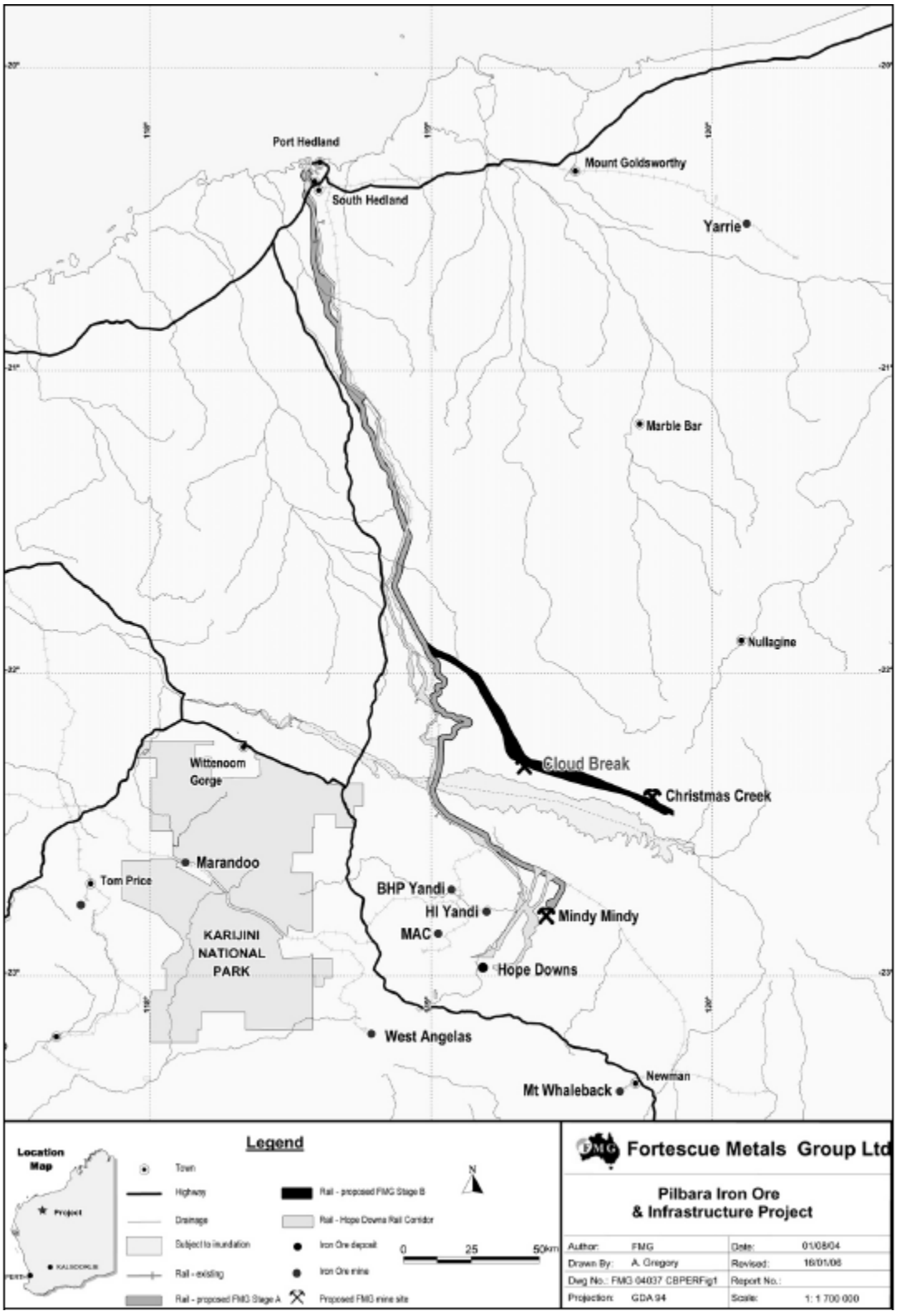
Environmental consideration:

The Fortescue Metals proposal raises a potentially significant environmental issue for water management in the area. The proposed Stage B and Cloud Break mining areas are located within the upper Fortescue River catchment. Total clearing within the Fortescue River catchment will reduce as a result of the project changes. Runoff from this catchment drains to the Fortescue Marshes which form an extensive intermittent wetland parallel to and just south of the project mines areas. The main potential impacts from the proposed mine developments on this catchment would be a potential reduction of surface water runoff volume and water quality in the downstream environment.

The cumulative impacts of the amended project were assessed by the Environmental Protection Authority, which concluded that there was adequate provision to protect the Fortescue Marshes.[34]

[34] Environmental Protection Authority, WA. (2006) Pilbara Iron Ore and Infrastructure Project: Cloud Break (no beneficiation) Fortescue Metals Group Limited. Bulletin 1216. January 2006.

Figure 9: Location of Proposed Fortescue Metals Developments



WATER FOR OTHER MINING

As already discussed, the mining sector other than iron ore has significant water allocations (Table 3) and is a potentially important user of water in the region. These other miners and mineral explorers hold a quarter of the total water allocations in the Region.

Other minerals are comprised of manganese, gold, copper, tantalite and silver lead zinc. The holders of groundwater allocation licences were identified from the Department of Water database. Details of the types of mining operations, some of the plans for development and contact information were obtained from the Australian Mining Register.[35] Each of the minerals being developed and mined in the Pilbara holds substantial water allocations, with the exception of silver lead zinc which is not yet in production (Table 16).

Table 16: Operations for Mining Other Than Iron Ore

Company	Mine Site
Manganese	
Pilbara Manganese Pty Ltd	Woodie Woodie Mine Site
Pilbara Manganese Pty Ltd	Woodie Woodie Mine Site
Pilbara Manganese Pty Ltd	Woodie Woodie Mine Site
Gold	
Kitchener Mining NL	Bamboo Creek Borefield
Nustar Mining Corporation Limited	Paulsens Gold Project
Opus Exploration Pty Ltd	Indee Gold Project (expired in June)
Opus Exploration Pty Ltd	Indee Gold Project
Sipa Exploration NL	Paraburdoo Gold Project
Copper	
Fox Radio Hill Pty Ltd	Southern Borefield
Fox Radio Hill Pty Ltd	Wesy Whundoo Copper Project
Straits (Whim Creek) Pty Ltd	Whim Creek Copper Project
Silver lead zinc	
East Coast Minerals NL / Legend Mining Ltd	Elizabeth Hill Mine
Tantalite	
Sons of Gwalia Ltd	Wodgina Operations, Northern Borefield
Sons of Gwalia Ltd	Wodgina Operations, Old Borefield
Sons of Gwalia Ltd	Wodgina Operations, Breccia Borefield

Note: There are three Woodie Woodie mine sites and three mine sites for Wodgina Operations, each with its own water allocation.

[35] Resource Information Unit (2006) Register of Australian Mining 2005/06. (Economics Consulting Services copy.)

CURRENT AND PROSPECTIVE WATER USERS

Each of these licence holders was contacted and asked for information on their current and future volumes of water use.

Manganese

Manganese is mined at four pits in the Woodie Woodie site by Consolidated Minerals. Three water abstraction licences are held by that company and this is a significant part of the total water licence allocation for the area.

The Woodie Woodie mines are 400 km south east of Port Hedland. Consolidated Minerals advises that they current level of usage for mining operations is small and will remain so. Water from dewatering operations, however, is expected to grow sharply in the future as mining operations move to new pits. Dewatering is expected to double in 2007 and then more than double again in the next five years. It is then expected to remain at this level for a considerable number of years.

Gold

There are five major gold explorers or producers in the Pilbara. In the Port Hedland area there is the Indee Gold project which has only recently commenced production. Indee has a relatively small water licence and expects to use up to 80 per cent of its licence allocation for many years as it has a large resource.

There are two gold explorers in the East Pilbara – Bamboo Creek and Wedgetail Exploration, in the vicinity of Nullagine. Bamboo Creek is currently being assessed with some trial mining. Wedgetail is about to commence production. Both have small licence allocations.

In the Central West area of the Pilbara there are two significant gold miners – Paraburdoo and Paulsens. Paulsens recovers considerable water from dewatering operations and uses about half of it for mine operations and dust suppression. It obtains potable water by reverse osmosis treatment of a small part of the volume taken from dewatering.

Copper

There are three copper producing mines in the Pilbara. Two, the Fox Radio Hill mines at Southern Borefield and Whundoo have nickel associated with them and are located near Karratha. The third producer is Whim Creek, which is south of Port Hedland. A fourth miner could develop soon at Panorama which is also south of Port Hedland, where promising associations of copper and zinc have been identified.

Each of these producers has a relatively small licence allocation. Apart from Whim Creek, they do not have dewatering operations and expect to use some 60 to 80 per cent of their licence allocation for many years into the future.

Silver lead zinc

The Elizabeth Hill mining tenement is located 40 km south of Karratha. An exploratory drilling program is underway which has identified reserves of platinum as well as silver lead zinc.

The current volumes of water being used are about 60 ML a year. This level of usage is anticipated to be maintained while the exploratory phase of operations continues. If and when a viable mining operation is identified, the whole question of water use will need to be addressed.

Tantalite

Tantalite is mined at the three Wodgina sites. These are operated by Sons of Gwalia, and are located 100 km south of Port Hedland.

The Wodgina operations have three water abstraction licences, with a significant total allocation. Process water is taken from three borefields and from surface water taken from an abandoned pit. Total water used is equivalent to approximately 60% of the Wodgina licence allocation.

Dewatering is not routinely undertaken at Wodgina. Water entering pits from seepage and rainfall events is sporadically pumped and used (recycled) for dust suppression purposes on roads. The volume of water pumped [when available] from the two pits forms a very small component of Wodgina's overall water balance and is not routinely metered.

Given the company's current plans, water abstraction at Wodgina is not anticipated to change markedly in the foreseeable future, compared with that recorded over the recent 12 months. In the longer term, however, emergence of new market opportunities could bring forth an expansion of operations and hence an increase in the level of water usage. Any increases in production can be expected to require equivalent increases in the volume of processing water needed.

Other Prospects:

Molybdenum

Moly Metals has announced its intention to proceed with a full study of its Spinifex Ridge resource. A mine with an output of 15 million tonnes per annum for 20 years could be developed. Spinifex Ridge is 150 kilometres south east of Port Hedland.

Copper zinc

Sipa is progressing to feasibility studies for its Panorama project with a strong drilling program announced for 2007. The potential mine site is 120 kilometres south east of Port Hedland, and is a sound prospect for a large copper zinc producer.

Sulfur Springs

Sulfur Springs is another copper zinc prospect in the same area as the Panorama project.

SUMMARY OF WATER USE

Current water use by mining other than iron ore totals 5,438 ML, and water returned to the environment a further 7,747 ML (Table 17).

Table 17: Water use by mines other than iron ore

Year	East Pilbara		Central West		North Coastal	
	Mine Operations (ML)	Return to Environment (ML)	Mine Operations (ML)	Return to Environment (ML)	Mine Operations (ML)	Return to Environment (ML)
2006	640	0	980	720	3,038	6,607
2007	740	0	980	720	3,035	12,300
2008	740	0	980	720	3,040	60,300
2009	740	0	980	720	3,035	60,300
2010	740	0	980	720	3,035	60,300
2011	740	0	980	720	3,035	60,300
2012	740	0	980	720	3,035	60,300
2013	740	0	980	720	3,035	60,300
2014	740	0	980	720	3,035	60,300
2015	740	0	980	720	3,035	60,300
2016	740	0	980	720	3,035	60,300
2017	740	0	980	720	3,035	60,300
2018	740	0	980	720	3,035	60,300
2019	740	0	980	720	3,035	60,300
2020	740	0	980	720	3,035	60,300
2021	740	0	980	720	3,035	60,300
2022	740	0	980	720	3,035	60,300
2023	740	0	980	720	3,035	60,300
2024	740	0	980	720	3,035	60,300
2025	740	0	980	720	3,035	60,300
2026	740	0	980	720	3,035	60,300
2027	740	0	980	720	3,035	60,300
2028	740	0	980	720	3,035	60,300
2029	740	0	980	720	3,035	60,300
2030	740	0	980	720	3,035	60,300
2031	740	0	980	720	3,035	60,300

The data show that water use by mines other than iron ore represent about 14% of the total, and iron ore mining 86% of all water used in mining. Water returned to the environment from other mining is some 24% of the total for all mining.

These proportions are anticipated to change significantly over the next 25 years. Other mining will become a relatively small user of water in its operations, compared with the iron ore sector, and a relatively more significant contributor to water returned to the environment. Water used in other mining is anticipated to fall from 14% of the total for all mining in the Pilbara, to 7% by 2031. Water returned to the environment for other mining is anticipated to rise from 24% of the total, to 43%.

Whereas iron ore mining and water use by that sector is centred on the Central West area, the other mining sector is centred on the north coastal area of the Pilbara. The north coastal area represents slightly more than half of water used in mining operations for mines other than iron ore. In terms of water returned to the environment, the north coastal area is the dominant part of the total for the sector, accounting for almost all water returned to the environment.

Table 17 (continued): Water use by mines other than iron ore

Year	South Coastal		Total Pilbara	
	Mine Operations (ML)	Return to Environment (ML)	Mine Operations (ML)	Return to Environment (ML)
2006	780	420	5,438	7,747
2007	1,180	520	5,935	13,540
2008	1,180	520	5,940	61,540
2009	1,180	520	5,935	61,540
2010	1,180	520	5,935	61,540
2011	1,180	520	5,935	61,540
2012	1,180	520	5,935	61,540
2013	1,180	520	5,935	61,540
2014	1,180	520	5,935	61,540
2015	1,180	520	5,935	61,540
2016	1,180	520	5,935	61,540
2017	1,180	520	5,935	61,540
2018	1,180	520	5,935	61,540
2019	1,180	520	5,935	61,540
2020	1,180	520	5,935	61,540
2021	1,180	520	5,935	61,540
2022	1,180	520	5,935	61,540
2023	1,180	520	5,935	61,540
2024	1,180	520	5,935	61,540
2025	1,180	520	5,935	61,540
2026	1,180	520	5,935	61,540
2027	1,180	520	5,935	61,540
2028	1,180	520	5,935	61,540
2029	1,180	520	5,935	61,540
2030	1,180	520	5,935	61,540
2031	1,180	520	5,935	61,540

FINDINGS AND CONCLUSION

The purpose of this study is to provide a comprehensive report on current and future water use in the Pilbara. The water using activities of the Pilbara have been divided into port use, mine operations, mine dewatering which is returned to the environment, household or residential, industrial-commercial and agriculture.

The industry of the Pilbara region has changed dramatically over the past 25 years and can be anticipated to change, again dramatically, over the next 25 years. As in the past few decades, mining is anticipated to expand significantly and with the increased throughput of bulk ores through the ports, there will be a significant expansion of port activities and water use in the ports. The study suggests that there will be only a relatively modest expansion of populations and of industrial activity, with some expansion of volumes of water used but significant decline in the relative importance of these sectors. The agriculture sector is expected to remain static for the duration of the period under study.

The value of this study is twofold. It brings together information which is on the public record, but is difficult and time consuming to access and interpret. Secondly, it presents, in summary form, information provided by major industry participants in the Pilbara Region.

Some information on water use is available on the public record, and all individual company data cited in this report is sourced from public sources. However, this data is of limited value by itself, and it has been essential to the study that it be complemented by data from individual companies.

The information provided by industry is a key component of this study. Companies have been prepared to provide detailed water use data, and the authors are most grateful for that. Data and forward estimates have been provided by the mining companies of the region, by major industrial water users, and the Water Corporation. This information is considered by the companies involved to be commercially sensitive, and the authors have given firm undertakings that its confidentiality will be respected. For this reason, much of the data is presented in this report in an aggregate form.

Partly because of the sensitivity of the individual company information and partly to facilitate the presentation of the information, water use data is presented in four sub-areas. These are South Coastal (centred on Dampier and Onslow), North Coastal (centred on Port Hedland), Central West (centred on Tom Price and Paraburdoo) and East Pilbara (centred on Newman).

Iron ore mining operations hold more than half of the water licence allocations for the Pilbara. Although mining is not as large as the energy sector in terms of value of production, hydrocarbon recovery and processing is a relatively small water user. Water use by miners in their port operations is a major area of consumption. These activities thus received considerable attention in the detailed work of the study.

In the south coastal area, water extracted and returned to the environment accounts for over 30% of water “use” and is the largest component of use (Table 18). Water use in all aspects of mining including the port operations represents over 50% of water use in the region in

most years. The next largest sector is the industrial and commercial category followed closely by residential and agriculture.

Over the next 25 years total water use in the area is estimated to increase by over 40%. The relative size of water use by some categories of user is expected to change dramatically. Use for mining operations will decline in relative terms while water for port operations will more than double Water use by other water users will show only modest growth, or no growth in the case of agriculture. As a result, their percentage share of the total water use for the south coast is anticipated to decline significantly.

The doubling in port use is especially significant in water planning as water for this use has been supplied from the public scheme supply. The volume of water used for port operations is anticipated to grow from 3,040 ML to 6,940 ML over the next 25 years. During the same period there will be a modest increase in residential (up by 893 ML) and industrial-commercial (up by 843 ML), both of which are largely supplied from scheme supplies.

Table 18: Summary of water use in the South Coastal area of the Pilbara

Year	Port Use (ML)	Mine Operations (ML)	Mine Return to Environment (ML)	Residential (ML)	Industrial (ML)	Agriculture (ML)	TOTAL (ML)
2006	3,041	6,162	7,099	3,312	6,705	3,000	29,318
2007	3,409	6,580	7,220	3,353	6,829	3,000	30,391
2008	3,410	6,580	9,020	3,393	6,881	3,000	32,284
2009	3,410	6,580	9,020	3,424	7,032	3,000	32,466
2010	3,960	6,580	10,520	3,456	7,094	3,000	34,610
2011	4,360	6,580	12,720	3,488	7,114	3,000	37,262
2012	4,800	6,180	14,520	3,521	7,134	3,000	39,154
2013	5,000	5,680	14,520	3,554	7,154	3,000	38,907
2014	5,100	5,180	15,520	3,587	7,174	3,000	39,560
2015	5,200	4,680	15,520	3,620	7,194	3,000	39,214
2016	5,290	4,680	15,520	3,654	7,214	3,000	39,359
2017	5,300	4,680	15,520	3,688	7,235	3,000	39,423
2018	5,550	4,680	15,520	3,723	7,256	3,000	39,729
2019	5,650	4,680	15,520	3,758	7,277	3,000	39,885
2020	5,550	4,680	15,520	3,793	7,298	3,000	39,842
2021	5,750	4,680	15,520	3,829	7,320	3,000	40,099
2022	5,850	4,680	15,520	3,865	7,342	3,000	40,256
2023	5,970	4,680	15,520	3,901	7,364	3,000	40,435
2024	6,100	4,680	15,520	3,938	7,386	3,000	40,624
2025	6,300	4,680	15,520	3,975	7,408	3,000	40,883
2026	6,400	4,680	15,520	4,012	7,431	3,000	41,043
2027	6,520	4,680	15,520	4,050	7,454	3,000	41,224
2028	6,620	4,680	15,520	4,088	7,477	3,000	41,385
2029	6,840	4,680	15,520	4,127	7,500	3,000	41,667
2030	6,940	4,680	15,520	4,166	7,524	3,000	41,830
2031	6,940	4,680	15,520	4,205	7,548	3,000	41,893

Total water use in the north coast area is a little lower than the south coast area, at 25,500 ML a year. Water use in the north coast is also dominated by mining and related activities (Table 19). Residential, industrial-commercial, and agriculture use approximately the same amount at about 10% of the total.

Over the next 25 years, the north coast area demonstrates similar trends to the south coast. The dramatic difference is in the volumes of water from dewatering operations being returned to the environment. This component is anticipated to grow from 14,080 ML (40% of the total) to 62,830 ML (70% of the total).

There will be significant pressures on public water supplies, with port use expected to grow by nearly 7,000 ML, residential by 886 ML, and industrial-commercial by 749 ML. Residential, industrial-commercial and agriculture each decline significantly as a share of the total, from about 10% to about 3%.

Table 19: Summary of water use in the North Coastal area of the Pilbara

Year	Port Use (ML)	Mine Operations (ML)	Mine Return to Environment (ML)	Residential (ML)	Industrial (ML)	Agriculture (ML)	TOTAL (ML)
2006	4,797	4,410	8,372	2,731	2,377	2,800	25,487
2007	4,945	4,435	14,080	2,762	2,403	2,800	31,425
2008	6,160	4,480	62,100	2,793	2,429	2,800	80,762
2009	6,560	4,525	62,150	2,825	2,456	2,800	81,315
2010	7,001	4,585	62,224	2,857	2,483	2,800	81,948
2011	7,980	4,635	62,300	2,889	2,510	2,800	83,114
2012	8,140	4,695	62,400	2,921	2,538	2,800	83,494
2013	9,360	4,765	62,450	2,954	2,566	2,800	84,895
2014	9,800	4,835	62,540	2,988	2,594	2,800	85,557
2015	10,200	4,905	62,630	3,022	2,623	2,800	86,179
2016	10,065	4,985	62,600	3,056	2,651	2,800	86,157
2017	9,920	5,035	62,600	3,090	2,681	2,800	86,126
2018	10,075	5,115	62,550	3,125	2,710	2,800	86,375
2019	9,750	5,235	62,500	3,161	2,740	2,800	86,186
2020	10,050	5,285	62,450	3,196	2,770	2,800	86,552
2021	10,050	5,385	62,400	3,232	2,801	2,800	86,668
2022	10,200	5,485	62,350	3,269	2,832	2,800	86,936
2023	10,350	5,585	62,300	3,306	2,863	2,800	87,204
2024	10,500	5,685	62,300	3,343	2,895	2,800	87,523
2025	10,800	5,775	62,300	3,381	2,927	2,800	87,983
2026	10,950	5,875	62,380	3,419	2,959	2,800	88,383
2027	11,100	5,985	62,463	3,458	2,992	2,800	88,798
2028	11,250	6,085	62,550	3,497	3,025	2,800	89,206
2029	11,550	6,195	62,640	3,536	3,058	2,800	89,779
2030	11,700	6,315	62,733	3,576	3,092	2,800	90,217
2031	11,700	6,435	62,831	3,617	3,126	2,800	90,509

The central west area of the Pilbara is the largest water user, with total use of 40,507 ML, of the four areas identified for separate discussion in this study. In this area, mining operations use 55% of water use and exceed mine dewatering which accounts for 28% of use (Table 20). This area is also the largest in terms of water used for agriculture, which in this area represents 11% of the total. Residential and industrial-commercial users are relatively small consumers of water.

For the future, the relative importance of mining and dewatering to the environment and users of water are expected to be maintained

There is expected to be very little pressure on scheme supplies of water, as residential use (up 171 Ml) and industrial-commercial use (up137 ML) will show only modest growth.

Total use of water, however, is estimated to grow rapidly by 110% over the 20 years. However, this will not keep pace with the north coast area where growth will be rapid as some mines with high volume dewatering operations will come on stream during the period of projections.

Table 20: Summary of water use in the Central West area of the Pilbara

Year	Port Use (ML)	Mine Operations (ML)	Mine Return to Environment (ML)	Residential (ML)	Industrial (ML)	Agriculture (ML)	TOTAL (ML)
2006	0	20,857	11,227	1,081	865	4,000	38,030
2007	0	22,600	11,320	1,087	870	4,000	40,507
2008	0	25,472	16,220	1,094	875	4,000	53,069
2009	0	30,862	28,720	1,100	880	4,000	67,430
2010	0	27,182	33,420	1,107	885	4,000	72,842
2011	0	33,898	33,420	1,113	891	4,000	72,854
2012	0	33,893	34,920	1,120	896	4,000	74,616
2013	0	32,224	37,220	1,126	901	4,000	79,127
2014	0	39,970	39,220	1,133	906	4,000	81,439
2015	0	35,831	41,920	1,140	912	4,000	86,451
2016	0	31,869	41,920	1,146	917	4,000	87,563
2017	0	37,380	42,920	1,153	923	4,000	89,076
2018	0	37,080	40,520	1,160	928	4,000	85,688
2019	0	37,080	42,320	1,167	933	4,000	88,000
2020	0	37,180	40,420	1,174	939	4,000	84,713
2021	0	39,080	39,920	1,181	945	4,000	85,125
2022	0	37,080	39,920	1,188	950	4,000	85,638
2023	0	38,580	39,920	1,195	956	4,000	85,650
2024	0	39,480	39,920	1,202	961	4,000	87,063
2025	0	40,980	39,920	1,209	967	4,000	87,076
2026	0	41,180	37,420	1,216	973	4,000	85,089
2027	0	42,380	37,420	1,223	979	4,000	86,002
2028	0	42,880	35,420	1,230	984	4,000	84,515
2029	0	44,080	35,420	1,238	990	4,000	85,728
2030	0	44,080	34,420	1,245	996	4,000	84,741
2031	0	44,080	34,420	1,252	1,002	4,000	84,754

While it is the smallest area in terms of water use, the East Pilbara area is anticipated to see rapid growth in its total water use (Table 21). However, this does not pose a problem for water supply systems as most of the growth is in dewatering operations returning water to the environment and in mining operations that have their own water source.

Mining operations are anticipated to remain at 40% of all water used in the East area, while dewatering operations will expand from 27% to 48% of the total.

The East area is the only for which there is expected to be a decline, albeit slight, in the use of water for residential and industrial-commercial purposes. Agriculture is a relatively small user of water.

Table 21: Summary of water use in the East area of the Pilbara

Year	Port Use (ML)	Mine Operations (ML)	Mine Return to Environment (ML)	Residential (ML)	Industrial (ML)	Agriculture (ML)	TOTAL (ML)
2006	0	6,726	6,123	3,816	3,236	900	20,801
2007	0	10,140	6,750	3,812	3,232	900	24,834
2008	0	17,140	19,750	3,807	3,228	900	44,825
2009	0	20,340	31,800	3,803	3,225	900	60,067
2010	0	25,140	41,700	3,798	3,221	900	74,759
2011	0	25,140	41,700	3,794	3,217	900	74,751
2012	0	25,290	41,700	3,789	3,213	900	74,892
2013	0	25,340	31,800	3,785	3,209	900	65,034
2014	0	25,340	31,850	3,780	3,206	900	65,076
2015	0	25,440	31,850	3,776	3,202	900	65,168
2016	0	25,490	31,800	3,771	3,198	900	65,160
2017	0	25,540	31,800	3,767	3,194	900	65,201
2018	0	25,540	31,700	3,762	3,191	900	65,093
2019	0	25,640	31,700	3,758	3,187	900	65,185
2020	0	25,640	31,600	3,754	3,183	900	65,077
2021	0	25,640	31,600	3,749	3,179	900	65,069
2022	0	25,640	31,600	3,745	3,176	900	65,060
2023	0	25,640	31,600	3,740	3,172	900	65,052
2024	0	25,640	31,600	3,736	3,168	900	65,044
2025	0	25,640	31,600	3,732	3,164	900	65,036
2026	0	25,640	31,600	3,727	3,161	900	65,028
2027	0	25,640	31,600	3,723	3,157	900	65,020
2028	0	25,640	31,600	3,718	3,153	900	65,012
2029	0	25,640	31,600	3,714	3,150	900	65,004
2030	0	25,640	31,600	3,710	3,146	900	64,996
2031	0	25,640	31,600	3,705	3,142	900	64,988

Total water use for the Pilbara shows the dominant part played by the mining sector (Table 22). A third of all water used (34%) is employed in mining operations per se. Almost another third (29%) is represented by mining water from dewatering operations which is returned to the environment. Port operations of mining companies account for a further 7%.

The dominant place of the mining sector in water use in the Pilbara is anticipated to become even more pronounced over the next 25 years. The sum of the three categories of mining use – mining operations, mine dewatering returned to the environment and port operations – currently represent 72% of all water used. In 25 years time this proportion is estimated to grow to 87%.

Table 22: Summary of all water use in the Pilbara

Year	Port Use (ML)	Mine Operations (ML)	Mine Return to Environment (ML)	Residential (ML)	Industrial (ML)	Agriculture (ML)	TOTAL (ML)
2006	7,838	38,155	32,821	10,940	13,182	10,700	113,636
2007	8,354	43,755	39,370	11,013	13,334	10,700	127,157
2008	9,570	53,672	107,090	11,086	13,414	10,700	210,940
2009	9,970	62,307	131,690	11,152	13,593	10,700	241,279
2010	10,961	63,487	147,864	11,217	13,682	10,700	264,159
2011	12,340	70,253	150,140	11,284	13,732	10,700	267,981
2012	12,940	70,058	153,540	11,351	13,780	10,700	272,157
2013	14,360	68,009	145,990	11,419	13,830	10,700	267,964
2014	14,900	75,325	149,130	11,488	13,880	10,700	271,633
2015	15,400	70,856	151,920	11,557	13,930	10,700	277,012
2016	15,355	67,024	151,840	11,628	13,981	10,700	278,239
2017	15,220	72,635	152,840	11,699	14,033	10,700	279,826
2018	15,625	72,415	150,290	11,771	14,085	10,700	276,885
2019	15,400	72,635	152,040	11,843	14,138	10,700	279,256
2020	15,600	72,785	149,990	11,917	14,191	10,700	276,183
2021	15,800	74,785	149,440	11,991	14,245	10,700	276,961
2022	16,050	72,885	149,390	12,066	14,299	10,700	277,890
2023	16,320	74,485	149,340	12,142	14,354	10,700	278,341
2024	16,600	75,485	149,340	12,219	14,410	10,700	280,254
2025	17,100	77,075	149,340	12,296	14,466	10,700	280,978
2026	17,350	77,375	146,920	12,375	14,523	10,700	279,543
2027	17,620	78,685	147,003	12,454	14,581	10,700	281,043
2028	17,870	79,285	145,090	12,534	14,639	10,700	280,118
2029	18,390	80,595	145,180	12,615	14,698	10,700	282,178
2030	18,640	80,715	144,273	12,697	14,758	10,700	281,783
2031	18,640	80,835	144,371	12,780	14,818	10,700	282,144

PROSPECTIVE DEVELOPMENTS IN THE EAST PILBARA

The Terms of Reference call for a comment on prospective developments to the east of the Study area:

> "There will also be brief notation of any major developments that are expected in the Eastern Pilbara, lying between the GWA and the WA/NT border."

Companies and government agencies have been asked to identify any major developments that are in prospect for the area to the east of the Ground Water Area. Two areas of possible development have been identified.

Copper mining

The Nifty copper operation, operated by Birla (Nifty) Pty Ltd is expanding its existing open pit operation to include underground mining at the base of the existing open cut. The mine will have an annual throughput of 2.5 million tonnes, and will extend the life of the mine by 10 years.

The Telfer gold and copper project is already established in this region. There are no known plans to make any significant changes to the operation. Commercial production from Telfer began in 2005. It is a large mine with annual production planned at 800,000 ounces of gold and 30,000 tonnes of copper concentrate. Mine life is currently anticipated to be 23 years.

Maroochydore is a large low grade resource about 100 kilometres south east of the Nifty operation. There is currently legal action to progress a possible sale of the resource, which when settled would enable an exploration program to be undertaken.

Uranium

There are uranium reserves at Kintyre, 80 kilometres south of Telfer. The deposit has been known for some time with the State excising an area from the Rudall River National Park in 1994. The project was placed on a care and maintenance basis in 1998, and then in 2002 the project was decommissioned and rehabilitated. Any future development will only become viable with a change in State government policy.

INFORMATION SOURCES AND CONSULTATION

Data sources included:

- The ABS;
- The Department of Water database of licensed groundwater users;
- Other State Government Agencies
- Local Government authorities
- The National Land and Water Audit;
- The Water Corporation; and
- Mining companies.

The groundwater use database is useful in controlled areas but only a small part of the study area is currently subject to abstraction licensing. Some large users abstract groundwater in areas not subject to licensing and hence water use is not reported.

Consultation with groups directly involved in the provision and usage of water in the region was a significant part of the study (Table 1).

Table 1: Stakeholder Consultation

Pilbara Iron	Department of Water
BHP Billiton	Department of Planning and Infrastructure
FMG Group	Department of Agriculture and Food
Hancock Prospecting	Department of Industry and Resources
Sons of Gwalia	WA Local Government Association
Consolidated Minerals (manganese)	Shire of Ashburton
Fox Radio Hill	Shire of Roebourne
Straits (Whim Creek)	Shire of Exmouth
East Coast Minerals	Shire of East Pilbara
Sipa Exploration	Pilbara Development Commission
Nustar Mining	Port of Dampier
Opus Exploration	Port of Port Hedland
Pilbara Manganese	Water Corporation
Kitchener Mining	Department of Local Government and Regional Development

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APPENDIX 1: STUDY TERMS OF REFERENCE

BACKGROUND

There is increasing demand for water along the Pilbara Coast as a result of regional development, specifically the mining and petroleum industries. The Pilbara region will undergo continued development and expansion as levels of mining activity increases. The rate of growth has increased dramatically in the past five years with projections for further accelerated development in the upcoming decades. As a result of rapid industry growth, there have been increasing pressures on existing supply schemes that support the port facilities.

The main centres of expansion are Port Hedland, Dampier, Burrup Peninsula and Cape Lambert (Figure 1). There are concerns over the future security of water supply to these port facilities. The long-term water requirements of the sites are poorly understood.

In 2000, the Water and Rivers Commission undertook a large project funded in part by the former Department of Resources Development (DRD), the Commonwealth Government, and the Water and Rivers Commission, which looked at the issue of water resource management and demand at the mine sites in the Central Pilbara. The resulting report titled 'Central Pilbara Groundwater Study' was a great success that proved a valuable database for industry, regional developers and government in addressing water-related issues in the region.

In 2004 the Department of Industry and Resources (DoIR) completed the Pilbara Coast Petroleum and Minerals Study, which addressed potential infrastructure limitations that may hinder future development. The study provided some long-term projections of water demand; however, these projections need to be thoroughly reviewed in light current development and proposed port expansions. A key recommendation of the report, from a water resources perspective, is the development of a Regional Water Master or Strategic Plan. To progress towards any Strategic Plan, it was recognised that additional water resource assessment should be undertaken to improve the understanding of the water resources and all related issues within the Pilbara Region.

In 2006, the Department of Water (DOW) began the Pilbara Coast Water Study, which will outline current and future water resource potential along the Pilbara Coast. The scope of the study is essentially an information collecting and compilation project and is being managed through the Water Investigation and Assessment Branch. The study will review groundwater and surface water resources along the Pilbara Coast. The study will focus is on the performance of the existing production borefields, as well as evaluating other potential source options. It is proposed that the study will be completed by September of 2006. The Central Pilbara Groundwater Study and the Pilbara Coast Water Study will provide the technical basis for the development of the Pilbara Regional Water Plan. The plan is being developed by the Water Allocation Branch and has a proposed completion date of December 2007.

The Coastal water study and regional management plan both require estimates of current water use and future water demands throughout the Pilbara region. The DoIR are currently developing the Pilbara Port Planning Study that will address development plans and future growth potential at the port facilities along the Pilbara Coast. The study will focus on the iron ore mining industry and will provide current and future iron ore tonnage associated with each port. The requirement of water for dust suppression at the downstream processing sites can be linearly converted to volumes of water. Future increases in the volume of iron ore

processed at the port facilities will imply similar increases in water use, minus a small percentage to account for efficiency increases. As a result, iron ore could be used to project future water needs.

The water use and water demand scenarios that can be developed from the DPI port planning study will represent water use estimates for down stream processing of iron ore at the port facilities. There is a need to define the current and future water requirements of the users of water in the Pilbara. It is proposed that a consultant be engaged to define the current and future water demands of the Pilbara region which are above and beyond those requirements for the downstream processing of iron or at the port facilities

SCOPE OF WORKS

This request document details the Department of Water's requirement for the completion of a desktop study that identifies and quantifies the current and future water use requirements in the Pilbara region (5, 10, 15 and 20 years). The extent of the study area will be within the boundaries of the Pilbara Groundwater Area (PGA) as shown in Figure 1. There will also be brief notation of any major developments that are expected in the Eastern Pilbara lying between the GWA and the WA/NT border.

The information provided from the study will be incorporated into the Pilbara Coast Water Study and form the base line date for the regional water planning as outlined in the proposed Pilbara Regional Water Plan

It will be necessary to approach private mining and industrial organizations to inquire about current and proposed levels of water use. When possible and with the permission of the private companies, any privately held data shall be incorporated into the report.

To bring the project to completion to the satisfaction of the DoW, it is expected that the contractor will provide the following services and or products.

- **EFFECTIVELY UTILISE CONTACTS WITHIN THE PRIVATE MINING AND INDUSTRIAL SECTORS TO FACILITATE THE EXCHANGE OF INFORMATION THAT MAY BE MADE AVAILABLE TO THE PUBLIC DOMAIN. THE CONTRACTOR WILL ARRANGE MEETINGS BETWEEN PRIVATE INDUSTRY AND THE DOW FOR ANY DISCUSSIONS REGARDING THE USE OF INFORMATION THAT IS COMMERCIAL IN CONFIDENCE;**

- **EFFECTIVELY UTILISE CONTACTS WITHIN THE GOVERNMENT SECTOR TO OBTAIN DATA, REPORTS AND INFORMATION THAT MAY BE MADE AVAILABLE TO THE PUBLIC DOMAIN; AND**

- **CREATE A COMPREHENSIVE LIST OF CURRENT GROUNDWATER AND SURFACE WATER USERS AND THE ASSOCIATED VOLUME OF CURRENT WATER USE.**

DELIVERABLES

THE MAIN DELIVERABLE OF THIS ENAGAGEMENT WILL BE THE PRODUCTION OF A REPORT THAT DETAILS:

- All users of groundwater and surface water, specifically: commercial, industrial, mining, municipal (town), domestic and stock.

- Predictive demand scenarios for groundwater and surface water users to 2025, or to a suitable future date that will be negotiated between the contractor and the DoW;

- Predictive demand scenarios for the main ports along the Pilbara Coast, to include: Port Hedland, Dampier, Burrup Peninsula and Cape Lambert. The demand scenarios for the ports are intended to define the current and future water requirements that will be sourced from the West Pilbara Water Supply Scheme and the East Pilbara Water Supply Scheme. iron ore throughput at ports will be identified though the DPI Ports study however other post water requirements for processing are not readily available from this report;

- All current dewatering sites and provide dewatering volumes per site. where this dewatering is subject to reinjection/other use, and where it is left to discharge to the environment;

- Any proposed future dewatering sites and estimate future dewatering volumes for each site;

- Estimates of probability for each new source coming on line and estimation of variance in time before it comes online;

- Any known and readily available issues with future abstraction points (ie cultural values, environmental values, competing uses).

- Water use volumes per user and the associated projected volumes, preferably tables in an MS EXCEL spreadsheet. This is to include an approximated or estimated location of each user with a UTM coordinate (GDA 94) that represents the centroid of the specific use locality. It is intended that this information will form the base data for the development of a GIS database of regional water use.

- A comprehensive bibliography of all reports that pertain to water use irrespective of whether the report is within the public domain or specifically quoted in the body of the final report.

- The contracted service provider is to furnish 5 hard copies of the final report, plus an electronic version in both MS Word and Adobe Acrobat (locked) format.

- individual digital copies of each of the figures in the report;

- It is anticipated that the project will require a maximum of 2 months to complete. A draft report will be expected 2 weeks before finalization. Comments will be provided within one week of the draft being received, and any changes requested must be made prior to the presentation of the final report.

APPENDIX 2: ECONOMICS CONSULTING SERVICES

Economics Consulting Services provides strategic and financial advice to Western Australian organisations. The company has three senior consultants who undertake all of the work. The company approach is through carefully researched and considered advice and knowledge of the role of industry and government.

The company has completed 285 assignments over the last eight years for a broad range of government and corporate clients. Studies have encompassed all States of Australia and regions of Western Australia with work conducted for all levels of Government, Government businesses and Infrastructure Authorities.

Government clients have included agencies working in agriculture, water, electricity, natural gas, education, transport, regional development, industry, trade, commerce and tourism. Work has included utility businesses and government regulators.

Corporate clients have included Telstra, Western Power, the Water Corporation, BHP Billiton, Rio Tinto, Woodside, Alcoa, Hamersley Iron, WMC Resources, Chevron, Wesfarmers, APPEA and the Chamber of Minerals and Energy.

Projects have included:

Demographic, social and economic trends;
Socio-economic impact studies;
Financial evaluations and feasibility studies;
Expert witness and compensation claims;
Government submissions and reviews.

Murray Meaton, Dr Brian Martin and Allan Teede, have 80 years of government economics and policy experience and 15 years of private consulting work.

More information:
www.econs.com.au