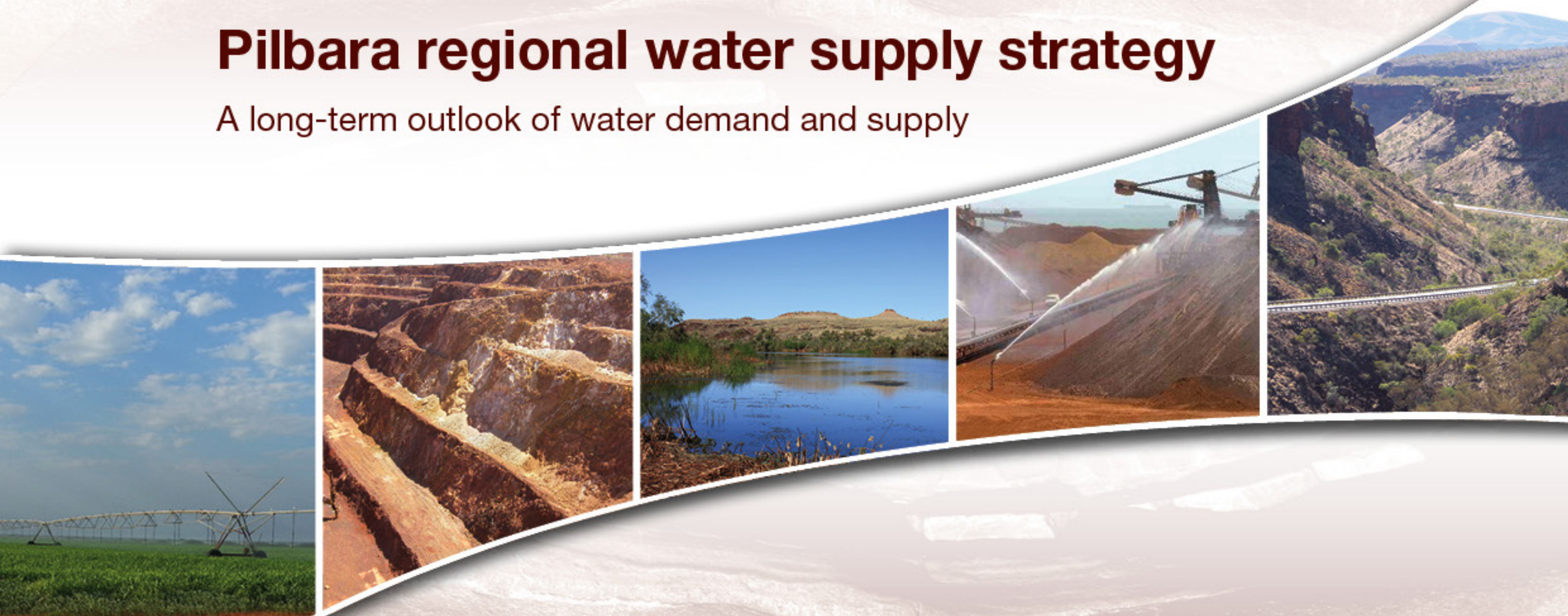
Government of **Western Australia**
Department of **Water**

Looking after all our water needs

Pilbara regional water supply strategy

A long-term outlook of water demand and supply



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Regional water supply strategy series

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A long-term outlook of water demand and supply

Department of Water
168 St Georges Terrace
Perth Western Australia 6000
Telephone +61 8 6364 7600
Facsimile +61 8 6364 7601
National Relay Service 13 36 77
www.water.wa.gov.au

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Project manager: Alana French – Senior water planner
Project board: Susan Worley – A/Director Water allocation and assessment
Liz Western – Director Regions
Hamid Mohsenzadeh – Manager Pilbara region

Project assurance: Roy Stone – A/Manager Water supply planning

For more information about this report, contact Branch Manager, Water supply planning branch.

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A message from the Minister

The strength of the Pilbara's economy and our vision for the region's future is closely linked to the availability of reliable water supplies.

Water is essential to support mining growth, to diversify the regional economy and ensure cities and towns are sustainable and liveable.

We are already investing in improved scheme water supplies to the towns of Karratha, Port Hedland and Onslow.

At the same time we are looking towards the future and putting in place long-term plans for reliable water supplies to the region as a whole.

The *Pilbara regional water supply strategy* is a crucial part of this planning. The strategy identifies ways to meet additional demands expected to emerge over the next 30 years in a timely and cost-effective way.

It shows how new water resources, new infrastructure and continued improvements in water efficiency and recycling can be combined to deliver secure and reliable water supplies for towns and industry.

New opportunities, such as using large volumes of water from mine dewatering for agricultural development, are also considered in this strategy.

Many of the options will require further investigation and investment before they can be realised. The *Pilbara regional water supply strategy* serves to guide this work and is the foundation for more detailed planning to support continued water security and investment in the region.

Hon Terry Redman MLA

Minister for Water

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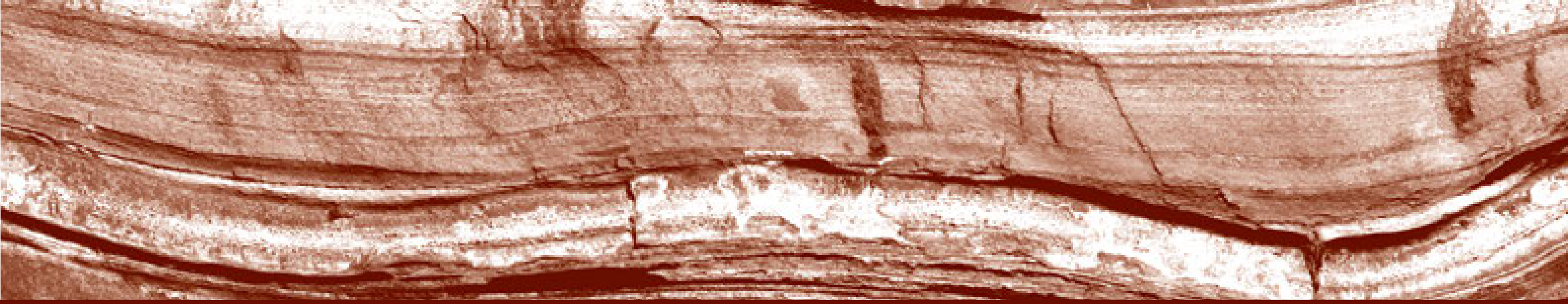


Summary

Purpose of this strategy

Strong growth in the resource sector has seen more water being abstracted at mine sites in the inland Pilbara region and hence an increased volume of dewater surplus to the mine requirements. At the same time, resource sector growth has driven an increase in water demand at the coastal towns and ports due to a growing population, service industries and dust suppression requirements.

The state government's Pilbara Cities initiative is building on mining sector growth to diversify the economy, grow the population and provide liveable towns and cities in the Pilbara. The Department of Water is working to support this vision by investigating and planning for the water supply options that will be needed during the next 30 years and beyond.

The Department of Water's modelling and assessment has clarified the reliable supply of the water resources needed for short-term water demands for the West Pilbara area (Karratha and surrounding towns and ports), Port Hedland and Onslow. As a result, new water supplies are being developed by industry and the Water Corporation. These are:

- a 10 GL/yr borefield in the Lower Bungaroo Valley being developed by Rio Tinto Iron Ore to supply their port operations in the West Pilbara area. This will enable supply from the Millstream borefield to be wholly available for town water supply
- Yule and De Grey borefield expansions by the Water Corporation[1] to supply an additional 5 GL/yr to Port Hedland
- Cane River borefield expansion by the Water Corporation to provide an additional 0.2 GL/yr, and a new desalination plant (seawater or brackish groundwater) being developed by Chevron to provide a further 0.6 GL/yr to Onslow.

This water supply strategy looks beyond these developments to provide early assessment and support further planning for new water supplies in the medium and long-term. It focuses on the three coastal schemes, but also provides an overview of regional water demand and supply.

Coastal towns and ports water demand and supply

Further new supplies for the coastal schemes could be needed in the next five to 15 years. Short-listed options to meet demand and current and future investigations into these options are described below. Water demand in the Pilbara is intrinsically linked to changes in resource development projects. The department will carefully monitor the water demand and supply balance.

[1] With some funding contribution from industry

Scheme	Short-listed options	Investigations to progress options
West Pilbara	• Improved water efficiency and recycling • Expand Bungaroo • Desalination • Other aquifers in the Hamersley Range • Lower Robe aquifer	• Department of Water[2] Hamersley Range desktop assessment (underway) • Bungaroo yield confirmation (within the next five years)
Port Hedland	• Improved water efficiency and recycling • West Canning Basin – western area (Pardoo) or eastern area (Sandfire) • Further expand the De Grey borefield • Desalination	• Water Corporation[3] Pardoo borefield investigation (underway) • Water Corporation De Grey borefield investigation (underway) • Department of Water[2] Sandfire resource investigation (underway)
Onslow	• Improved water efficiency • Expand proposed desalination plant • Recharge of the Lower Ashburton aquifer • Further expand the Cane River borefield • Lower Robe aquifer	• Chevron Birdrong borefield investigation (underway) • Proponent investigation of the Lower Ashburton aquifer (underway) • Birdrong yield confirmation (following industry investigations)

[2] With funding from the Royalties for Regions program

[3] With funding from industry

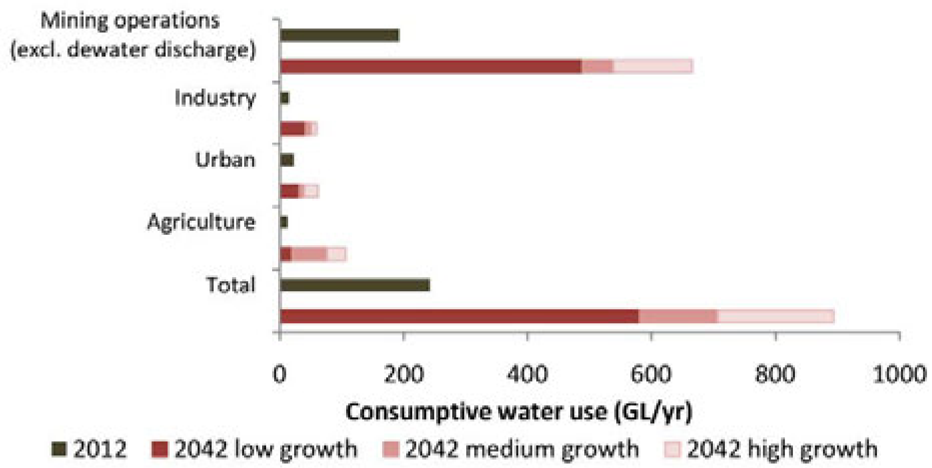
Regional water demand and supply

Approximately 400 GL/yr of water was abstracted or produced across the Pilbara region in 2012. The majority of this was for the mining sector. Consumptive use was approximately 240 GL/yr, with mine dewater discharge accounting for the remainder of the water abstracted. Consumptive water use is expected to increase to just over 700 GL/yr under a medium growth scenario and almost 900 GL/yr under a high growth (Pilbara Cities) scenario by 2042.

Water for the inland schemes is generally obtained from local fractured rock or alluvial aquifers. Many are linked to nearby mining activities, with the same source supplying both the towns and mines. Demand at these centres will be met by existing groundwater sources, other nearby groundwater sources and mine dewatering surplus.

Due to the location of mineral deposits, local aquifers will continue to be the main supply option to meet water demand at mine sites. Increased mining activity below the watertable is likely to result in greater volumes of dewater that will be surplus to mine needs.

The volume of water used for agriculture is currently low. However, irrigated agriculture is being pursued as an option for economic diversification and as a means of beneficially utilising mine dewatering surplus. The first large-scale irrigated agriculture operation using mine dewater began in late 2012 and development of the West Canning Basin for agriculture in the north-east Pilbara is underway.



Planning for future supplies

This strategy provides a short-list of feasible options for meeting demand at the coastal towns and ports, scenarios of future demand for water and triggers to inform when new investigations and additional planning will be required.

The department will also continue to work with proponents in other areas of the Pilbara to:

- identify and assess water supply options
- encourage the efficient use of water
- encourage the beneficial use of mine dewatering surplus.

To assist proponents we have developed guidelines and policy, including the *Pilbara groundwater allocation plan* (DoW 2013a), *Western Australian water in mining guideline* (DoW 2013b) and Strategic policy 2.09: *Use of mine dewatering surplus* (DoW 2013c).

New technologies and investigations may make new options available or change the feasibility of the short-listed options in this strategy. To allow for this and for other changes, we will review water supply options and the water demand–supply balance at least every two years.

The Department of Water will continue to exchange information with government agencies and regional stakeholders to ensure that water supply decision making continues to be informed and timely.

1

Purpose of this strategy

1.1 Background

The Pilbara region is important to the state's economy. It has experienced considerable growth over the past decade from the development of its large mineral, oil and gas deposits. Its strategic location close to existing and emerging markets in Asia means that there are further opportunities for growth.

Through the Pilbara Cities initiative, the state government is investing to build on mining growth to increase the regional population, promote economic diversification and improve infrastructure. The Pilbara Cities vision aims to 'build the population of Karratha and Port Hedland into cities of 50 000 people, and Newman to 15 000 people by 2035, with other Pilbara towns growing into more attractive, sustainable local communities' (PDC 2013). The initiative aims to achieve a regional population of 140 000 people by 2035. This requires planning for future water supplies. The *Pilbara regional water supply strategy* focuses on the Pilbara coastal towns and ports, where the water demand pressures will be greatest. It also provides an overview of water resources across the region to assist self-supply users.

The *Pilbara regional water supply strategy* is part of a framework of regional water planning and management.

In 2010 the Department of Water published the *Pilbara regional water plan 2010–2030* (DoW 2010a). This sets the strategic direction for managing and developing the region's water resources and includes a five-year priority action plan. Demand projections at this time showed that new water supplies and infrastructure would be needed to meet growth in the coastal towns and ports. The *Pilbara regional water supply strategy* completes action 5 of the *Pilbara regional water plan 2010–2030*; 'to identify medium and long-term water resource options across the Pilbara'.

The *Pilbara groundwater allocation plan* (DoW 2013a) completes action 12 in the *Pilbara regional water plan 2010–2030.* One of the main purposes of the allocation plan was to review and set allocation limits for aquifers that are important for water supply to the coastal towns and ports. This information provided an important foundation for developing this water supply strategy.

1.2 Regional scale water supply planning

Water supply planning takes place at different geographic and time scales and at different levels of detail, from state-wide strategic planning down to the design of a local water supply (Appendix A). The *Pilbara regional water supply strategy* helps to ensure water supply investment is aligned with state development objectives and land use planning at a regional scale. It also provides a foundation for further and more detailed planning at a local area and site scale. The *Pilbara regional water supply strategy* is based on projections of water demand for all water uses over the next 30 years, under a range of growth scenarios. To inform future planning, investigations and decision making, it identifies:

- the timeframes for when demand will exceed supply
- the water supply options to meet new demand
- actions and triggers for more detailed water supply planning.

The costs of implementing the short-listed options have been assessed at indicative levels only. Detailed costing is generally the responsibility of service providers and self-supply users and will be required before decisions are made to progress any of the short-listed options. The inclusion of options in this strategy does not imply that they will be developed and funded by the government. Appendix B of this strategy contains more information on the role that water service providers and self-supply users have in planning and developing water supplies.

1.3 Intended outcomes

The *Pilbara regional water supply strategy* supports the following outcomes:

- there is adequate planning to develop innovative, efficient and integrated water supplies
- water supply planning and resource investigations are aligned with the state land use and development objectives
- information and advice is available to government, industry and the community on water resource and supply options for the coastal towns
- water users are able to make decisions based on knowledge of all available water resources and supply options.

1.4 Strategy development

This strategy has been developed with the input and expertise of the water supply planning senior officers group, chaired by the Department of Water. The senior officers group includes representatives from the departments of State Development, Planning, Agriculture and Food WA, Premier and Cabinet, Treasury, Finance, and Regional Development and the Water Corporation.

The Department of Water has also consulted with other relevant government agencies, local government and industry representatives during the preparation of the strategy.

Pilbara regional profile

2.1 Strategy area

This strategy covers the Pilbara Development Commission region and small additional areas to encompass the West Canning Basin groundwater resource and Sandy Desert Basin catchment.

It covers the shires of Ashburton, Roebourne and East Pilbara and the Town of Port Hedland. It also includes some small portions of the shires of Broome, Derby-West Kimberley and Halls Creek (Figure 1).

2.2 Challenges

Increased water demand

The region's economy is dominated by the extraction, processing and export of minerals and gas, making resource development the major driver of water demand. The resource sector has grown rapidly in recent times, with iron ore production almost doubling over the past 10 years. This growth has seen more water being abstracted at mine sites in the inland Pilbara and an increased volume of dewater surplus to mine requirements. At the same time, it has driven an increase in water demand at the coastal towns and ports due to a growing population, service industries and dust suppression requirements.

The Pilbara's resident population has grown by approximately 25 000 people over the past 10 years, reaching almost 63 000 by June 2011 (ABS 2012a). The large fly-in-fly-out (FIFO) population in the region means that the actual population to be serviced with water is much greater. Over 80 000 people (indicative of the resident and FIFO population) were recorded in the region in the 2011 census (ABS 2012a). The Pilbara Cities initiative aims to achieve a resident population of 140 000 in the Pilbara region by 2035.

Resource development will continue to be the primary driver of future water use in the Pilbara. The Chamber of Minerals and Energy (CME) reports that there are over $20 billion of committed iron ore projects (CME 2012); new or expanded ports are being developed at Cape Lambert, Port Hedland and Cape Preston; and new Liquefied natural gas (LNG) and domestic gas projects are under construction near Onslow. These projects, and others under consideration, are expected to increase demand for water for processing and dust suppression at the ports and mine sites. They will also increase the population and hence demand for urban water, in particular in Karratha-Dampier, Port and South Hedland, Onslow and Newman. Figure 2 shows current and proposed projects in the Pilbara.

Mining growth is intrinsically linked to demand for export products. Changes in the global economy or demand for products can result in changes to mine plans; projects being deferred or brought forward; or a change in the type of industry being developed. This creates challenges in predicting future water demand.

Economic diversification developments planned under the Pilbara Cities initiative may also affect water demand and the way in which water is used in the Pilbara.

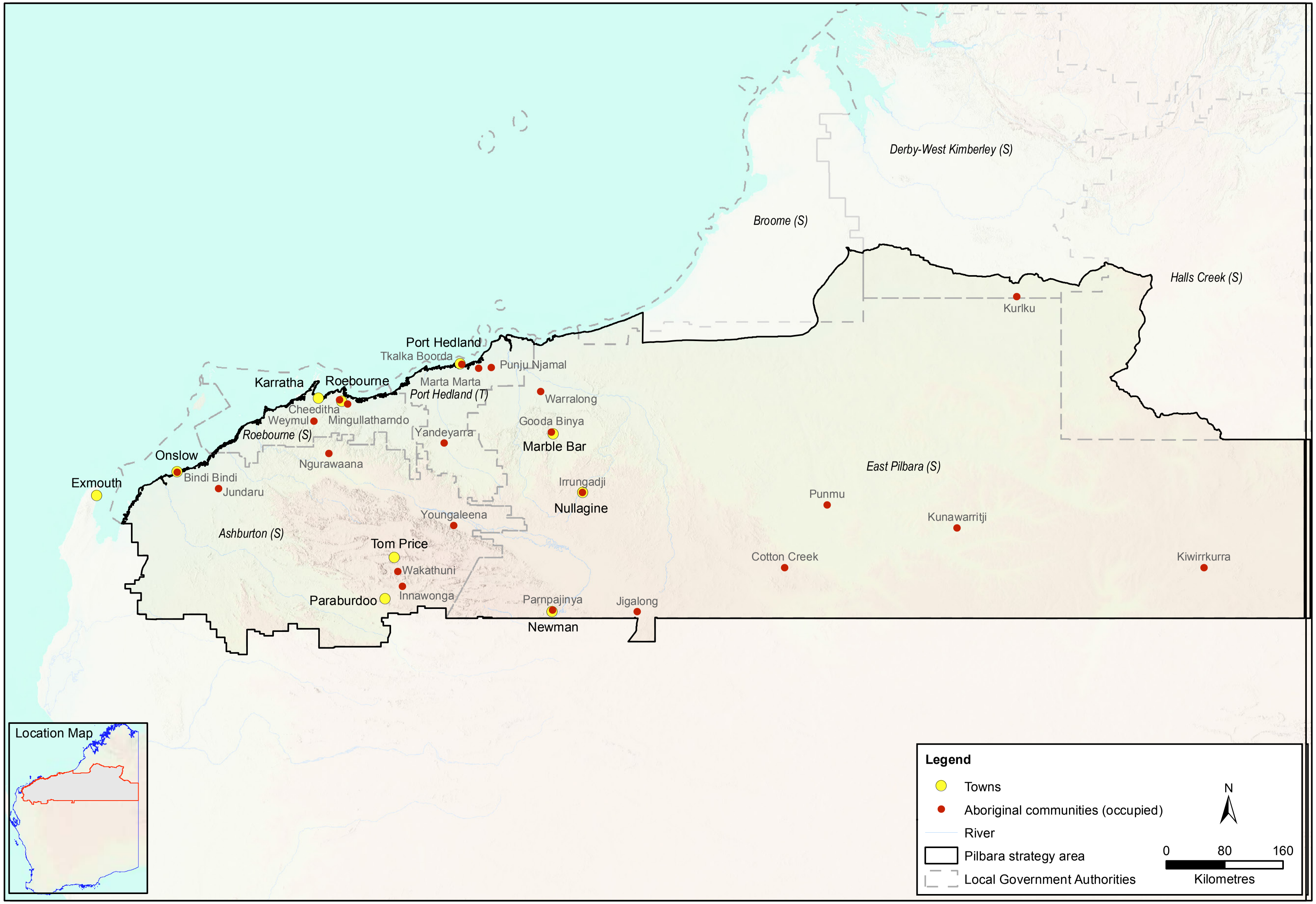


Figure 1 | Pilbara regional water supply strategy area

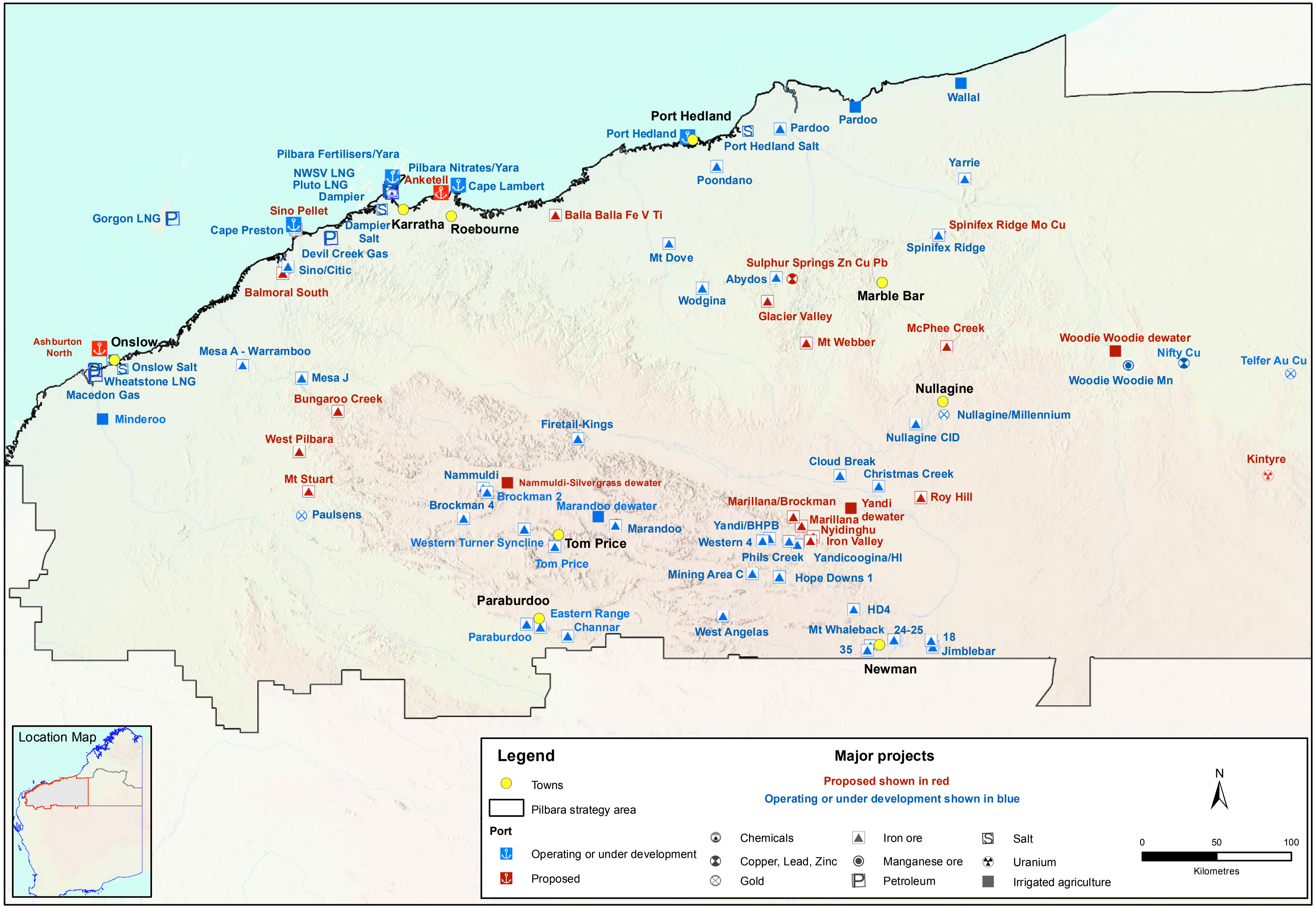


Figure 2 | Current and proposed projects in the Pilbara in 2013

Episodic climate

An important consideration in managing current water supplies and planning for future water supplies is the Pilbara's episodic climate. Recharge of groundwater and surface water sources is primarily due to cyclones. The number of cyclones and their intensity varies from year to year. This means there can be extended periods of no or low rainfall, reducing the available supply from a resource.

Predictions of future climate for the Pilbara are inconclusive. Recent analysis suggests cyclone intensities may increase, but that they may occur less frequently (IOCI 2012). This could increase the variability of an already variable water supply.

The CSIRO in partnership with the Department of Water, other agencies and industry is currently assessing predictions for the future climate of the Pilbara and the implications for water resources under the Pilbara water resource assessment project. The Department of Water will reassess this strategy if this project suggests a level of variability beyond the current assumptions.

Water resource characteristics and distance to demand centres

Historically, the most important aquifers for supply to the coastal towns and ports are the alluvial aquifers within 100 km of these centres. Surface water systems play an important role in recharging alluvial groundwater resources during floods, while groundwater resources help sustain river environments between floods. Recharge to these aquifers is episodic and they have limited storage, which affects the supply yield and reliability.

In addition, the alluvial aquifers support river pools and fringing riparian vegetation, which are often of high cultural and ecological value. The river pools, and the rivers themselves, are significant to Aboriginal people as they give life to an otherwise harsh country and enrich their traditional lifestyle (Juluwarlu Aboriginal Corporation 2007). Permanent pools of the Pilbara region are considered sub-regionally significant as they support significant vertebrate and invertebrate fauna (Kendrick & Stanley 2002). The De Grey River and Millstream wetlands are of particular significance and are listed in the *Directory of important wetlands in Australia* (Environment Australia 2001) due to their high ecological, historical and cultural values. The *Pilbara groundwater allocation plan* (DoW 2013a) and its supporting reports contain further detail on how the cultural and ecological values have informed our management of the alluvial aquifers.

The costs of developing groundwater vary depending on the distance from the source to the demand centre. In the Pilbara, groundwater is often the cheapest option when it is available within 100 km of the demand centre. However, when local groundwater is not available, the costs can be high as long-distance pipelines are expensive and considerable energy is required to pump groundwater over long distances.

There are few new groundwater supply options of 5 GL/yr or greater within 100 km of the Pilbara coastal towns and ports.

All surface watercourses dry up for at least part of the year, and stream flow is a direct response to seasonal rainfall from cyclones and thunderstorms. The high evaporation rates and turbidity problems mean that there has been only limited development of surface water resources. However, the Harding Dam on the Harding River is an important source for the West Pilbara water supply scheme. The Ophthalmia Dam near Newman is also used for recharging groundwater.

2.3 Water supplies

Water supply schemes

There are nine water supply schemes in the Pilbara region. These are summarised in Table 1. Alluvial aquifers are the predominant source of water for the larger schemes.

The West Pilbara, Port Hedland and Onslow water supply schemes provide most of the water used by the coastal towns and ports. Water for these schemes is obtained from the Harding Dam, Millstream aquifer and alluvial aquifers underlying the De Grey, Yule and Cane rivers.

The Department of Water began investigative work[4] in 2007 on nine aquifers identified as current or potential water supply options for the coastal towns. These included six alluvial aquifers, the Millstream aquifer and two aquifers in the West Canning Basin (Figure 3). We have used this information to review or set allocation limits[5] and provide more certainty on the volume of water available to reliably supply these centres. The *Pilbara groundwater allocation plan* (DoW 2013a) provides detailed information on the allocation limits and management of these resources. This information has been used in our assessment of future water supply options.

To reduce demand on the town water supply schemes the Water Corporation has recently implemented a water efficiency program across its licensed operations in the Pilbara. Measures implemented to date are estimated to save 2.1 GL/yr and projects still underway (smart metering trial and improvements to the Karratha water recycling scheme) aim to save a further 1.65 GL/yr (Marsden Jacobs Associates 2012).

All non-residential scheme water customers using more than 20 000 kL/yr are required to complete a water efficiency management plan to identify opportunities for improving water efficiency in accordance with the Water Agencies (Water Use) By-Laws 2010.

[4] Supported by funding from the Australian Government's Water for the Futures initiative.

[5] An allocation limit is the annual volume of water set aside for consumptive use from a water resource.

Table 1 Water supply schemes			
Scheme	Towns and ports supplied	Water service provider	Water source
West Pilbara	Karratha, Roebourne, Wickham, Point Samson, Dampier, Cape Lambert	Water Corporation (Hamersley Iron is the service provider for Dampier)	Millstream aquifer and Harding Dam
Port Hedland	Port Hedland, South Hedland, Finucane Island	Water Corporation	Yule River and De Grey River alluvial aquifers
Onslow	Onslow	Water Corporation	Cane River alluvial aquifer
Newman	Newman	Water Corporation[6]	Fortescue and tributary alluvial aquifers and Wittenoom Formation
Marble Bar	Marble Bar	Water Corporation	Coongan fractured rock aquifer
Nullagine	Nullagine	Water Corporation	Nullagine alluvial and fractured rock aquifers
Tom Price	Tom Price	Hamersley Iron	South Fortescue River alluvial aquifers and Marandoo mine surplus dewater
Paraburdoo	Paraburdoo	Hamersley Iron	7 Mile and Ballany Creek alluvial aquifers
Pannawonica[7]	Pannawonica	Hamersley Iron	Robe River alluvial aquifer

[6] Water obtained from BHP Billiton

[7] Note: Pannawonica is not a licensed service under the *Water Licensing Services Act 1995* as it is a closed mining town.

Self-supply groundwater

Groundwater is the primary supply source for meeting non-scheme water demands such as for stock, agriculture, mining and some industrial demands. Mining supply includes supply of potable water to mining camps and villages, which are exempt from services licensing under the *Water Licensing Services Act 1995* and the soon to commence *Water Services Act 2012*.

The *Pilbara groundwater allocation plan* (DoW 2013a) provides the allocation limits and licensing approach for groundwater resources in the Pilbara.

Groundwater resources in the Pilbara are shown in Figure 3 and current allocation limits and availability of groundwater are provided in Appendix C.

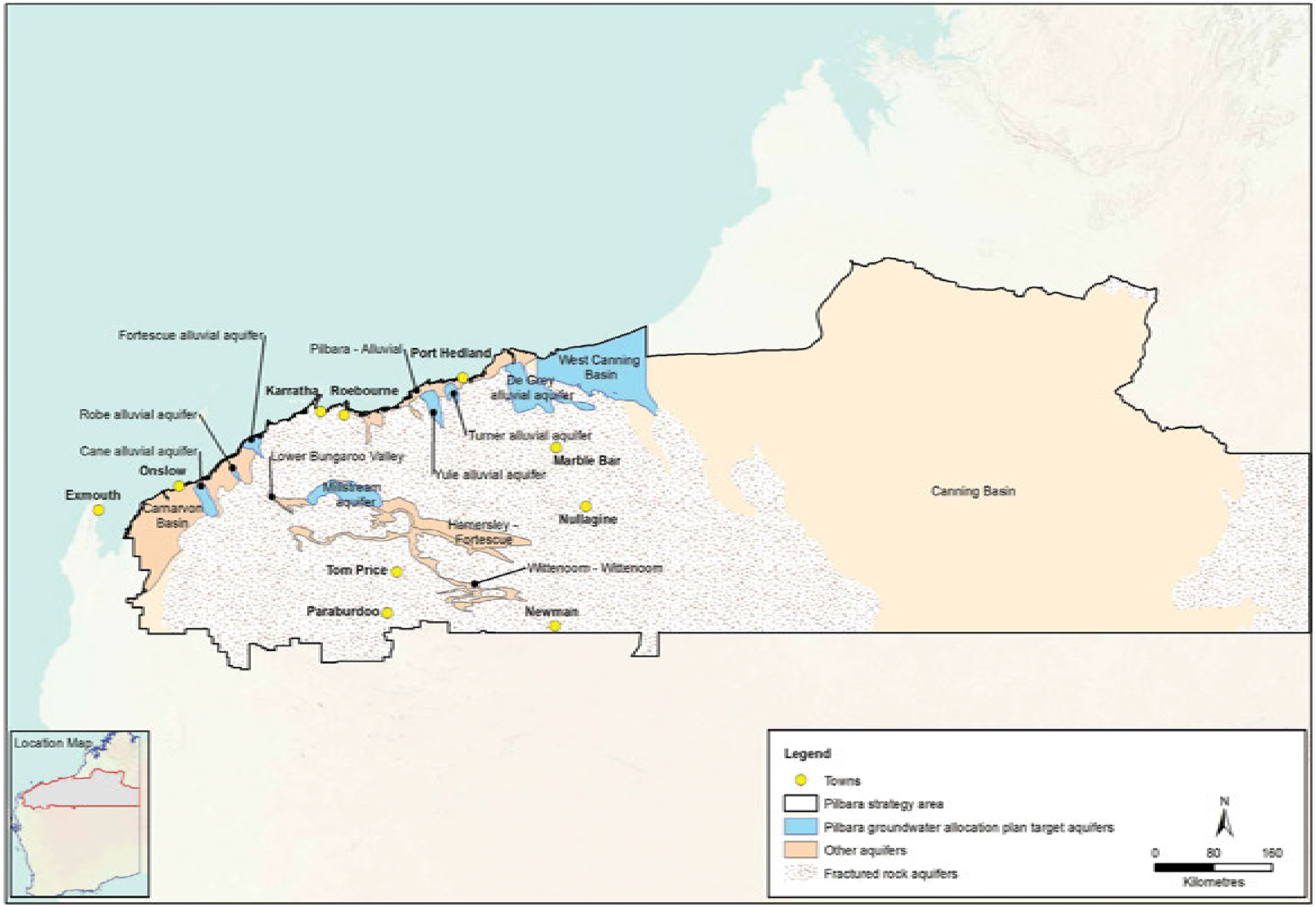


Figure 3 | Groundwater resources in the Pilbara

Desalination

Desalination does not currently form a large component of supply in the Pilbara. However, a small desalination plant currently supplies Yarra Pilbara Fertiliser's liquid ammonia plant on the Burrup Peninsula, and Citic Pacific is constructing a 51 GL/yr desalination plant at Cape Preston. Desalination of brackish groundwater is also proposed for Onslow.

New technology means that the cost of desalination is becoming cheaper and seawater desalination is one of the few options available in the Pilbara that is independent of climate.

The availability and cost of energy, and access to a suitable site, are important factors in considering desalination. Environmental impacts including the carbon footprint of the process and the effects of brine discharge also need to be considered.

Water recycling

Approximately 1.9 GL/yr of urban wastewater (66 per cent of the total available) is currently reused in the Pilbara, largely for irrigation of public open space and sporting ovals (Water Corporation 2012). The Water Corporation is investing in upgrades to existing wastewater treatment facilities to enable some increased water recycling. Further expansions are subject to negotiation with developers and local government and agreed funding.

Mine dewatering surplus

Where mineral resources are located below the watertable dewatering is required for mine safety and access. The Department of Water's *Western Australian water in mining guideline* (DoW 2013b) and *Pilbara groundwater allocation plan* (DoW 2013a) advise proponents to make use of dewater to mitigate environmental impacts and for onsite mine processing and dust suppression as a first priority.

Mine dewatering surplus is the volume of water from a mine dewatering operation that is surplus to the water requirements of that mine. The department encourages productive and beneficial use of surplus dewater. This could include its use for irrigated agriculture, other mining operations, industrial use, or town water supply. We have recently published Strategic policy 2.09: *Use of mine dewatering surplus* (DoW 2013c) to promote and encourage the appropriate use of mine dewatering surplus and provide information on the considerations for proponents and approvals required.

In the Pilbara, the volume of mine dewatering surplus is expected to increase as more operations move to below watertable mining. The first irrigated agriculture project using surplus dewater began in late 2012 and further projects are proposed. Projects proposed under the government's *Water for Food* initiative aim to support the increased use of mine dewatering surplus for agriculture. Mine dewatering surplus is now being used to supply town water schemes for some inland towns close to mine sites, such as Tom Price.

A key consideration for third party users of surplus dewater is the finite life of the mine and variable nature of surplus volumes over the mine life. Mine dewatering surplus may provide opportunities for short-term transient developments or third party uses that are linked to that mine (such as a supplier of goods or a dedicated mine town). Alternatively, it may support longer term developments where a sustainable supply is available following the mine closure. In all cases the variability in supply over the project period needs to be reconciled with the reliability required by the user.

Water quality and potential fit-for-purpose use is another consideration. Mine dewater quality from current operations varies from fresh to saline. At some sites the water contains high levels of nitrates. This may provide a benefit for use in agriculture by reducing the need for fertilisers.

A company's willingness to provide dewater to a third party, land tenure restrictions (e.g. on clearing, native title and use of economic plant species), and the distance between the supply and the demand centre are other considerations for implementing a development based on third party supply of mine dewater surplus. Further detail can be found in Strategic policy 2.09: *Use of mine dewatering surplus* (DoW 2013c).

Water demand and supplies for the coastal towns and ports

3.1 Approach

Projecting water demand

In consultation with relevant state agencies and industry representatives, the Department of Water has developed high, medium and low growth scenarios to predict future demand for the West Pilbara, Port Hedland and Onslow water supply schemes.

In the West Pilbara and Port Hedland each scenario contains two components of demand:

- total demand – includes growth of both urban (residential, light industrial, commercial and irrigation of public open space) and heavy industry (dust suppression and oil, gas, salt and ammonium nitrate production)
- urban demand – includes urban growth and existing heavy industry commitments that must be met by the existing scheme, but excludes new heavy industry growth.

The low and medium growth scenarios are based on the historical situation of iron ore growth driving growth in other sectors. Projected iron ore growth has been used as a basis for estimating likely growth in the residential, commercial and light industrial water demand based on historical trends. The medium growth scenario also incorporates the Water Corporation's short-term predictions for urban growth. Iron ore exports to 2020 are based on projections from the Department of State Development. Growth rates of between two and three per cent have been assumed post-2020. These projections are consistent with those produced by the CME in *Pilbara population and employment study* (PWC 2012), although the CME growth rate (to 2018) is slightly lower. More detail on our methodology is provided in Appendix D.

The high growth scenario represents a shift away from growth driven solely by iron ore, with higher population growth resulting from a more diversified economy. It reflects the Pilbara Cities vision of a population of 50 000 each in Karratha-Dampier and Port Hedland by 2035 and also encompasses a higher level of growth in the iron ore sector.

The high growth scenario remains dependent upon continuing buoyancy in the market for iron ore and LNG exports.

Demand projections for Onslow have been based on assumptions about the level of development at the proposed Ashburton North Strategic Industrial Area (ANSIA) and the implications of these developments on population and service industries within Onslow.

A population of 2200 is predicted by 2016 as a result of the BHP Billiton (BHPB) Macedon and Chevron gas projects (WAPC 2011). The high growth scenario includes additional population growth to 4000 people by 2022 (WAPC 2011) as a result of further new projects (currently only conceptual) at ANSIA. In the medium growth scenario, these new projects are assumed to occur by 2032.

Water demand forecasts provided in this strategy are estimated at one point in time and are subject to change. The certainty of assumptions used to project demand decreases the further ahead the projections are made.

All mineral resource development is influenced by fluctuating global demand for products derived from raw materials. Changes in market demand and subsequent deferral or fast-tracking of projects directly affects water demand for mining and port water use, and will also indirectly affect urban water demand due to flow on effects on the regional population and service industries.

Timeframes for water supply development

Typical timeframes for developing new large water supplies can range from three to 10 years from conception to implementation. Factors influencing the timeframe include:

- the scale and complexity of the supply option
- the distance from the water source to the demand centre
- the level of knowledge of a water resource (yield, quality, effects of abstraction) and therefore level of investigations required. Investigations can take three to five years where knowledge of a water resource is poor
- the potential effects of the water supply option on environmental, social and cultural values and approvals required
- the availability of existing infrastructure.

As our basis for planning we have assumed that groundwater investigations should occur at least five years prior to a demand–supply gap occurring, detailed planning and negotiations three years prior and construction commencing two years prior (that is it is important not to have expenditure too far ahead of demand).

Informing planning

Many of the water supply options identified in this strategy require further planning, investigations, negotiations or policy development before a decision can be made to implement them. To ensure that we are prepared to meet the range of growth scenarios we use the high growth scenario to inform the timing of investigations and other work needed. The decision to invest in constructing a water supply option can then be brought forward or moved back according to actual demand. The medium growth scenario informs our current estimate of when a new water supply (and investment decision) is likely to be required. This approach is illustrated in Figure 4. This approach assumes that most options can generally be investigated and implemented within five years.

We will review the water demand–supply balance every two years to determine if there are any significant changes in the supply/demand projections and/or the feasibility of the available options.

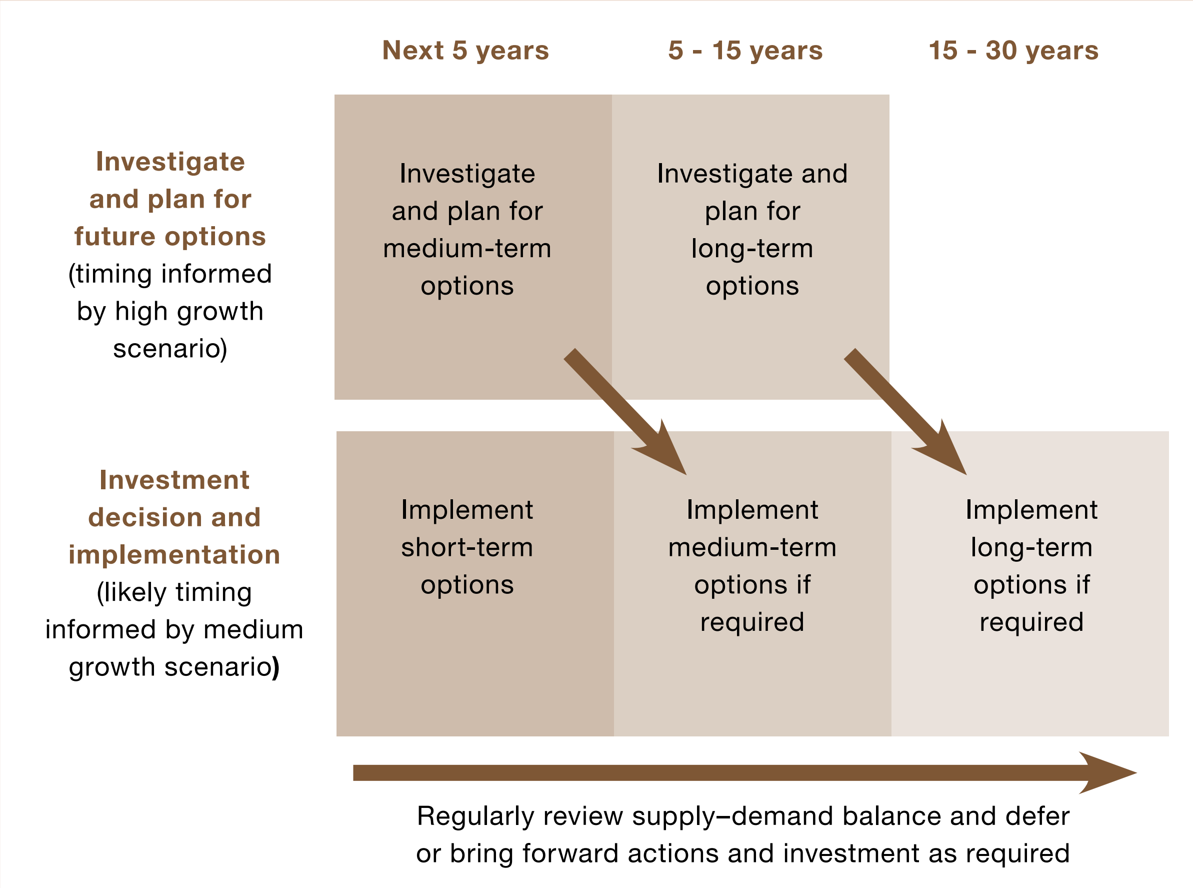


Figure 4 | Process for informing water supply planning

Assessing supplies

The Department of Water, in consultation with an across-government senior officers group, assessed around 60 technically feasible options to develop a recommended profile of short-listed options for each scheme. The process we used is described in Figure 5.

The long list of options included:

- expanding existing sources
- new groundwater or surface water sources within the Pilbara
- transfer of water from the Kimberley
- seawater desalination
- water optimisation strategies (e.g. increased water recycling, improved efficiencies and water restrictions)
- alternative sources such as mine dewatering surplus.

A range of source options within the Pilbara and their distance to the demand centres are shown in Figure 6.

Criteria used to assess options included cost, certainty, effects on dependent values, timing and water quality (see Appendix D for more detail).

Exploration, investigations and developments in new areas of the Pilbara or advances in technology are likely to result in new options being identified or an increase in the feasibility or cost-effectiveness of options that were not on our short-list of options. The Department of Water will regularly re-evaluate existing options and identify and evaluate potential new options that arise.

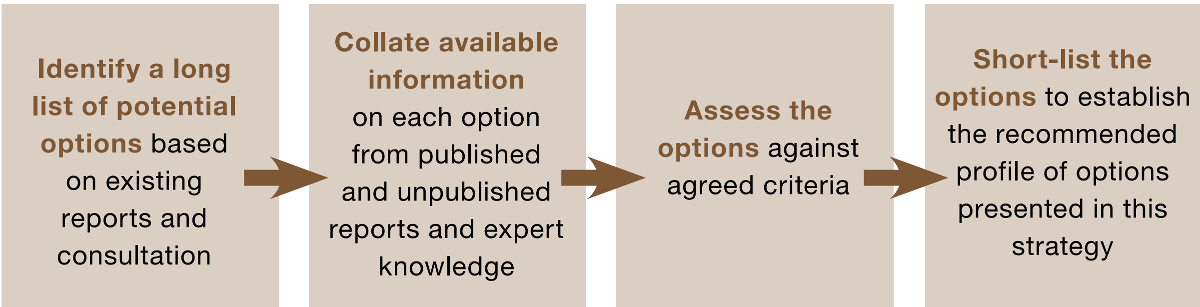


Figure 5 | Options assessment process

Adaptive management

This strategy contains scenarios of future demand for water in the Pilbara region that reflect the uncertainty associated with regional development and the starting of new large projects. Recent history has also shown that water supply solutions not thought of even a short time ago can arise from new technologies or investigations.

The department therefore closely monitors the water demand and supply balance for water users in the region. Changes in the level of water demand will trigger a response to move to the different stages of planning and supply development. We will continue to exchange information between government agencies and regional stakeholders on regional demand issues and supply options to ensure that decision making is well informed and timely.

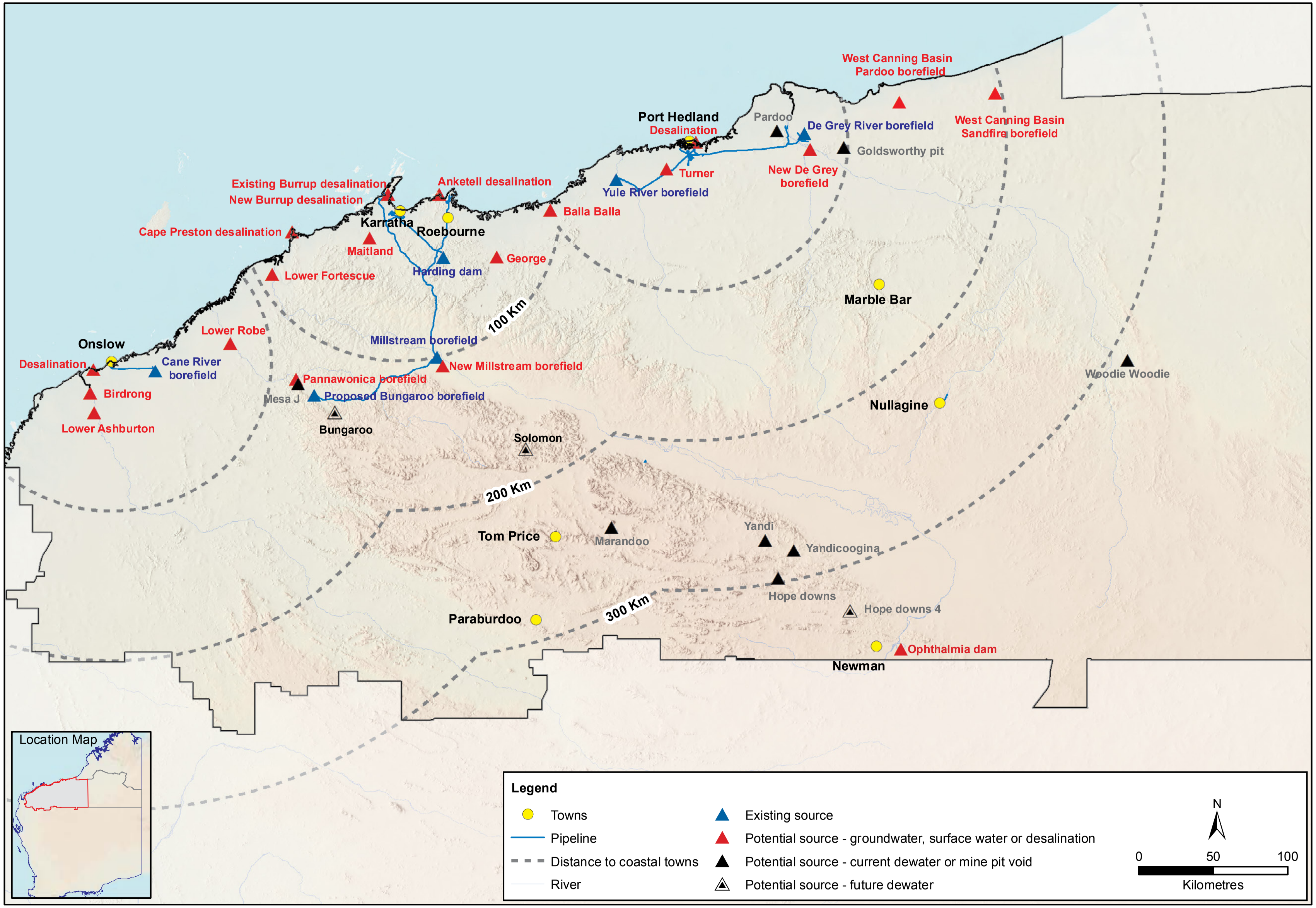


Figure 6 | Water supply options within the Pilbara and proximity to the demand centres

3.2 Other considerations

Water supply management and funding

The state's priority is that adequate water supplies are provided to meet urban water demands to the Pilbara towns. Where town water supply expansions are largely to the benefit of the private sector, government may negotiate a funding arrangement with the private sector for the provision of the expanded town water supply infrastructure.

The private sector is generally expected to fund water supplies to support agriculture, mining and heavy industrial (including ports) developments. The state will work with the private sector to identify water supplies and undertake strategic planning and investigations to understand the water resource, to ensure the security of water resources and undertake various regulatory responsibilities. The state government through the Department of Water invests significant funds to investigate groundwater and other water resources. The scale of Department of Water's investigations will vary depending on state policy objectives. Detailed investigations and feasibility planning are usually funded and may be undertaken by the private sector.

Opportunities for public–private partnerships for developing new water supplies for the towns and industry proponents will be explored by government where mutual benefits are established.

Detailed source and supply infrastructure planning and implementation is almost always undertaken by water service providers or project proponents for their own business purposes.

State agreement Acts

State agreement Acts are contracts between the state and proponents of major resource projects which are ratified by an Act of the State Parliament. They specify the rights, obligations, terms and conditions for development of the project and establish a framework for ongoing relations and cooperation between the state and the project proponent (DSD 2013a). In some instances, they include commitments in relation to water supply identification, development and/or operation. State agreement Acts relevant to water supply for the coastal towns and ports in the Pilbara are:

- *Iron Ore (Mount Newman) State Agreement Act 1964 (WA)* – relevant to Port Hedland
- *Iron Ore (Robe River) Agreement Act 1964 (WA)* – relevant to the West Pilbara.

Other agreements between the state and industry

The state negotiated an agreement with Rio Tinto Iron Ore (RTIO) in relation to water supply for the West Pilbara water supply scheme in 2011. Under this agreement RTIO will develop a new borefield in the Lower Bungaroo Valley to meet their water needs closer to the coast and surrender their existing entitlement for supply from the Millstream aquifer. In return, some of RTIO's secondary processing obligations under other agreements with the state will be amended.

The state development agreement negotiated between the state and Chevron in 2011 commits Chevron to developing a new water supply for Onslow. Under this agreement Chevron must build and hand over to the state a 2 ML/day desalination plant.

Water service agreements

Water service agreements are commercial contracts between a water service provider and a customer for the transfer and/or supply of scheme water. They include commitments in relation to water entitlements, water security and pricing. There are a number of water service agreements between industry and the Water Corporation in the Pilbara. Water entitlements under these agreements have been included in our water demand–supply analysis.

3.3 West Pilbara

The West Pilbara area includes the towns of Karratha, Roebourne, Dampier, Wickham and Point Samson; the existing ports at Dampier and Cape Lambert; and the proposed ports at Anketell and Cape Preston (Figure 9).

Towns and existing ports

Current supplies

The West Pilbara water supply scheme (WPWSS) is the primary supply for the towns and ports. Water is currently obtained from the Harding Dam and the Millstream borefield, which are both recharged by cyclones and autumn thunderstorms. Cyclones are episodic and unpredictable. Both sources are located relatively close to one another. This means they are recharged together or experience extended droughts together.

The Water Corporation is licensed to abstract 15 GL/yr from the combined sources. However, the amount of water available in a given year will depend on how recently recharge has occurred. Based on historical data and modelling in 2010 the long-term reliable supply from the Millstream borefield was set at 6 GL/yr and for the combined sources of Harding Dam and the borefield it is estimated to be 10 GL/yr. Abstraction in particular years may be up to 15 GL/yr if availability of supply is favourable (replenished from wet weather) and infrastructure capacity is available. A reliable supply of 10 GL/yr from the Millstream borefield and Harding Dam has therefore been assumed as the basis for estimating the likely need and timeframes for new supplies for the West Pilbara. However, in some cases final investment decisions may be able to be delayed by one to two years if recharge has recently occurred.

More information on how the Department of Water set the long-term reliable yield for the Millstream borefield and the current operation of the Millstream–Harding sources can be found in *Millstream aquifer – determination of a long-term sustainable yield and long-term reliable allocation* (DoW 2010b) and the *Pilbara groundwater allocation plan* (DoW 2013a).

Water efficiency measures have been implemented at the ports and within the towns since the early 2000s. These measures have resulted in significant water savings to date and have delayed the need for a new source. For example, RTIO has reduced water use at the Dampier port by almost 30 per cent through a water savings program.

A new water supply is being developed by RTIO in the Lower Bungaroo Valley. This will connect into the existing WPWSS and supply their port operations and township requirements (see the section 'Committed new water supplies' for more detail).

Supply from the existing scheme is currently supplemented by:

- the Karratha and Wickham recycled water schemes, which supply treated wastewater for the irrigation of public open space
- water recycling by industry within their port operations
- the Burrup seawater supply scheme which provides seawater to industry for cooling purposes and desalination.

Water demand

Demand on the WPWSS has been approximately 12 to 13 GL/yr over the past three years. This exceeds the long-term reliable supply from the Millstream aquifer and Harding Dam. Around 35 per cent of the current demand is for heavy industry, with most of this used for dust suppression of iron ore stockpiles at the ports primarily to meet health and safety and regulatory requirements[8].

[8] Sea water cannot be used on stockpiles for dust suppression, as it adversely affects ore quality and exceeds parameters for customer ore processing requirements.

Under a medium growth scenario total water demand is projected to increase by almost 10 GL/yr by 2022 and 15 GL/yr by 2042 (Table 2). Around 30 GL/yr of new demand is expected under a high (Pilbara Cities) growth scenario.

Growth scenarios remain dependent upon global economic growth and the subsequent level of demand for iron ore and LNG.

Table 2 Projected water demand (GL/yr) to 2042 for the West Pilbara

	2012	2022	2032	2042
Urban demand				
Low growth	8.5	10	10.5	11
Medium growth	8.5	11.5	12.5	13.5
High growth	8.5	14.5	20	26
Industrial demand				
Low growth	4.5	9	11	13
Medium growth	4.5	10.5	13	15
High growth	4.5	11.5	14	16.5
Total demand				
Low growth	13	19	21.5	24
Medium growth	13	22	25.5	28.5
High growth	13	26	34	42.5

Committed new water supplies

RTIO is constructing a new 10 GL/yr borefield in the Lower Bungaroo Valley to supply their port and township requirements (referred to as Bungaroo 1a). This will connect into the existing WPWSS and is anticipated to be completed in 2013. Under an agreement with the state administered by the Department of State Development (DSD), RTIO will relinquish their existing entitlements to water from the Millstream aquifer, freeing this up to supply urban demands.

The Water Corporation has begun work on the first stage of upgrades to increase the capacity of the pipeline from the Millstream borefield to the coast. These upgrades will provide a reliable scheme supply of 16 GL/yr. Planning and design work has been completed for further upgrades to a capacity of 20 GL/yr.

If required, the agreement between the state and RTIO enables the Water Corporation to purchase water from RTIO (surplus to RTIO's needs). The Water Corporation could also draw more than 10 GL/yr from Millstream borefield and Harding Dam, subject to recharge and sufficient pipeline capacity. Based on our demand projections around 1 to 2 GL/yr surplus capacity may be available until 2016, declining to 0 GL/yr by 2018.

Figure 7 provides the demand–supply balance for urban water needs. It also includes existing supply agreements between the Water Corporation and non-RTIO industries, as these industries will need to continue to be supplied from the Millstream borefield and Harding Dam. Under a high growth scenario a new urban water supply will be needed by 2017 and under a medium growth scenario by 2023[9].

Figure 8 provides the demand–supply balance for total water demand. It covers the combined industrial (RTIO and non-RTIO) and urban water demand. To meet total demand a new source is needed two to four years earlier than the timeframe for urban supply.

In figures 7 and 8 the upper and lower bounds of the demand range represent demand under the high and low growth scenarios respectively.

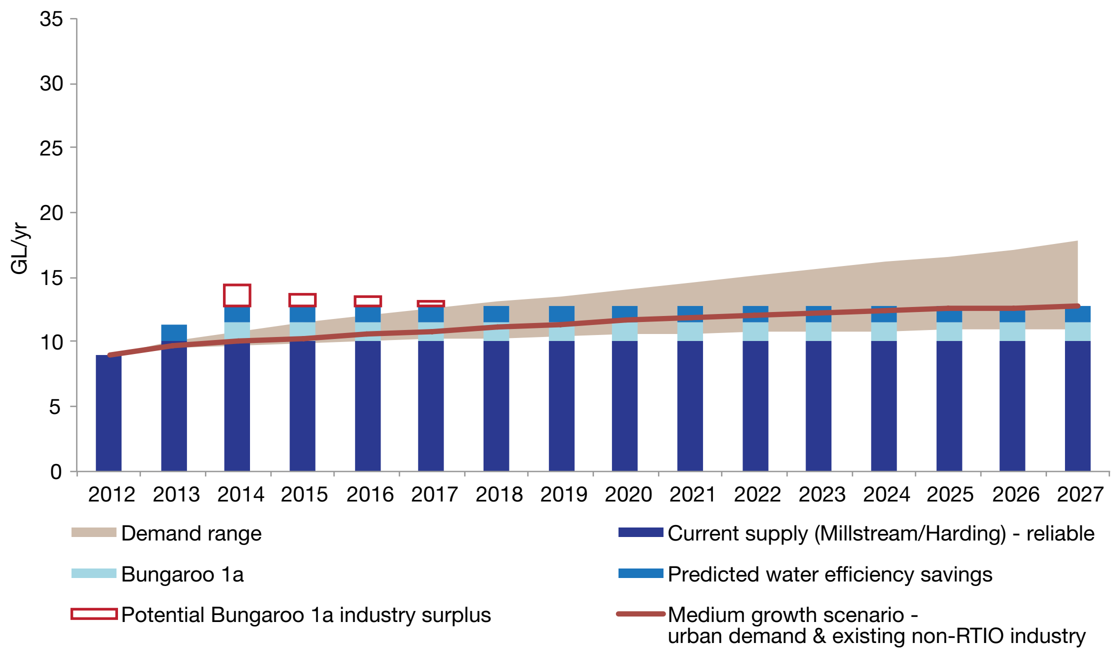


Figure 7 | Projected urban water demand to 2027 and current and committed water supplies for the West Pilbara

[9] In determining the timeframe for the next source allowance is made for annual variability

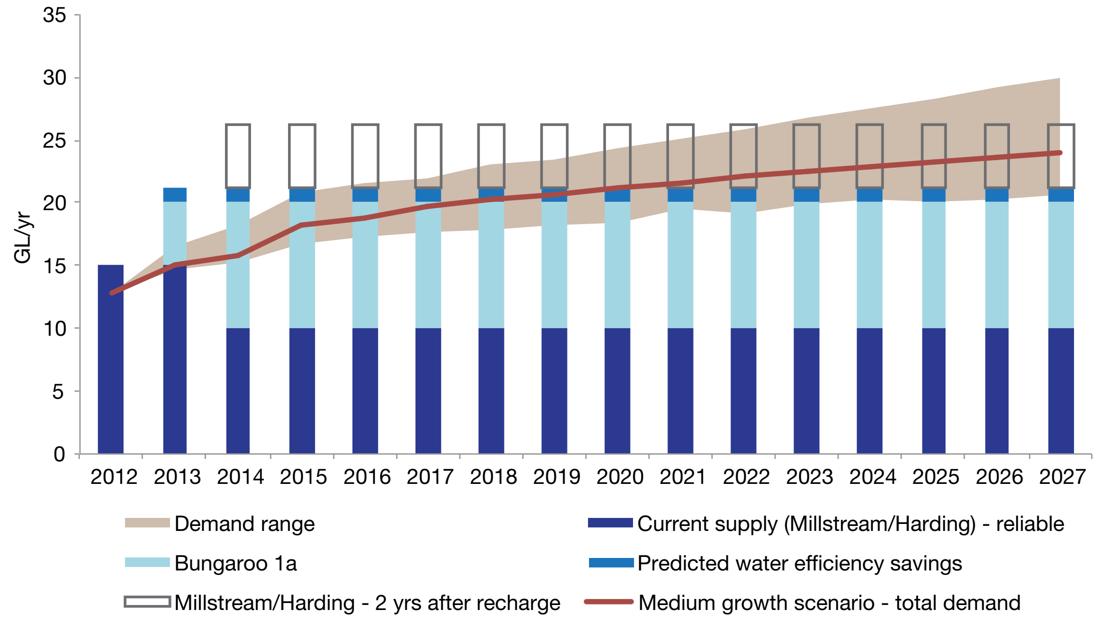


Figure 8 | Projected total water demand to 2027 and current and committed water supplies for the West Pilbara

Future water supply options

Increased water use efficiency and alternative fit-for-purpose water supplies (particularly for industry and public open space purposes) should continue to be implemented to help delay the need for further new large water sources.

Four major scheme users have received funding through the Water Corporation's recent water efficiency program to implement water efficiencies and/or alternative water supplies such as sea water, onsite desalination, onsite wastewater treatment and recycling and groundwater. These projects are expected to save 0.335 GL/yr (Marsden Jacobs Associates 2012).

The Water Corporation is also upgrading the existing wastewater recycling scheme to increase the supply of recycled water by 0.15 GL/yr. Further upgrades are likely to be required in the future to meet growing demand for irrigation of public open space. Opportunities may also exist for supply of recycled water for dust suppression or via a third pipe for outdoor residential use in the future.

Industry recycling programs are also being actively pursued, an example being the use of recycled water in the process plant of the Cape Lambert port operations, which currently represents approximately 50 per cent of the plant demand and significantly reduces the plant draw on fresh water.

Small, local aquifers such as the Maitland River aquifer (small volumes and brackish water quality) may also provide alternative supply options for smaller industry.

Given the large efficiency gains achieved by industry and residents over the past ten years additional savings will become more difficult to achieve. The Water Corporation will continue to identify further opportunities for improvements in water efficiency by scheme users.

It is likely that the Bungaroo aquifer could sustainably supply more than 10 GL/yr. A further 5 GL/yr may be possible from the borefield currently being developed (referred to as Bungaroo 1b) and further supply may be possible from an alternative part of the aquifer with a new borefield (referred to as Bungaroo 2). Further investigation is needed to confirm the aquifer yield.

It is also possible that there are other prospective water supply aquifers similar to Bungaroo, within the palaeochannels and valleys of the Hamersley Range. The Department of Water has received funding through Royalties for Regions to collate information on potential water sources, identify potential borefield sites and determine the additional investigation work needed. This study includes identifying possible new borefield sites and additional investigation work required for Bungaroo 2.

The government announced funding for a 6 GL/yr desalination plant (at a cost of $370 million) in October 2010. This was deferred, but may be an option for future water supply. Design work and environmental approvals for a 6 GL/yr plant have been completed. The only approvals still needed are for the construction of a pipeline to connect the plant to the scheme.

Up to 5 GL/yr is available from the Lower Robe aquifer, around 150 km south-west of Karratha. However, the distance to the source means that the cost of developing this option is currently greater than localised desalination.

Other large water supply options include surplus mine dewater from mine operations in the central Pilbara or an integrated Port Hedland and West Pilbara scheme from the West Canning Basin. These options are located 300 to 400 km from Karratha, making both the capital and ongoing operating cost of these options relatively high. These options may become more viable in the longer term.

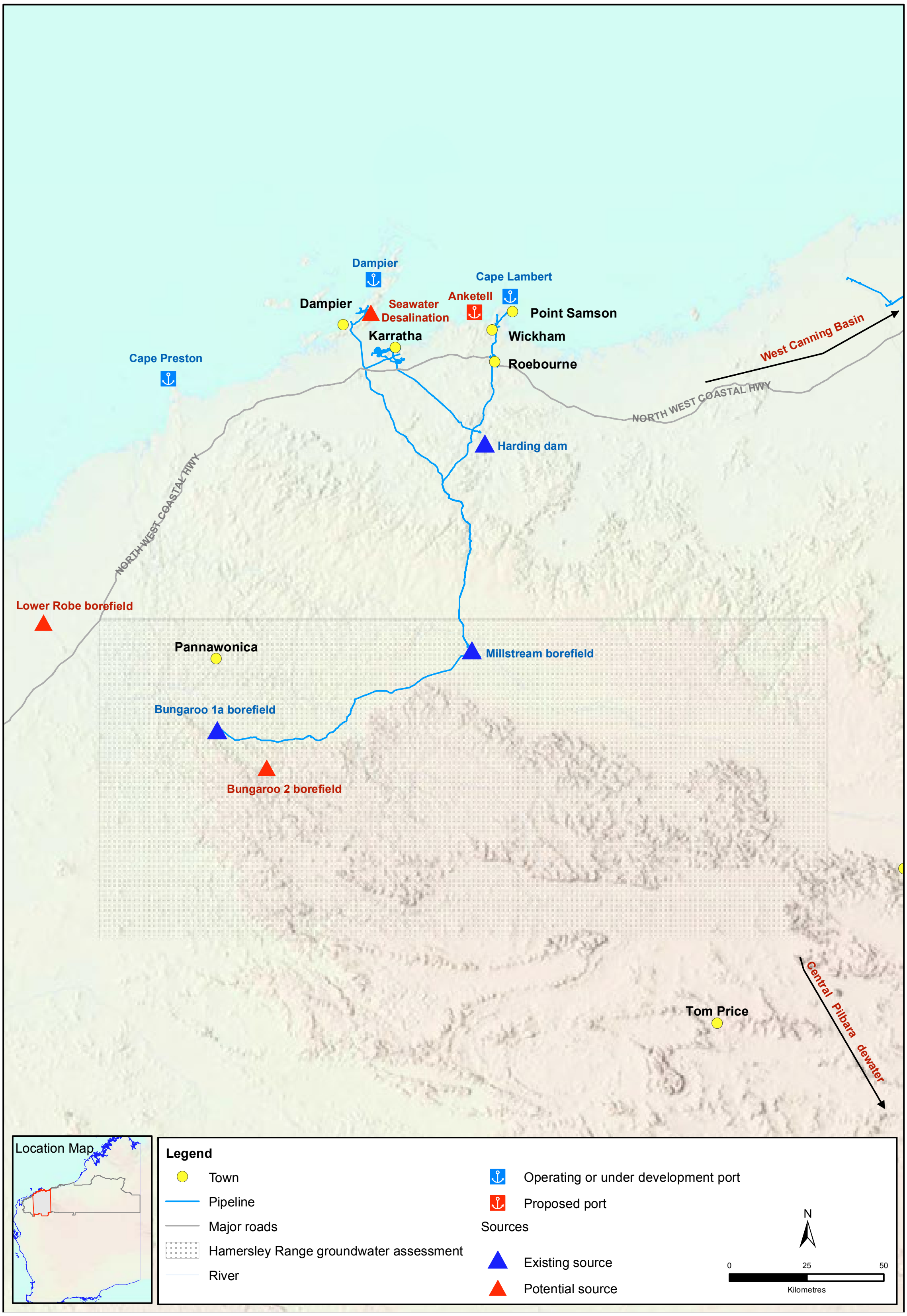


Figure 9 | West Pilbara water supply scheme and potential supply options

Cape Preston and Anketell

A new port is currently being built at Cape Preston, 100 km south-west of Karratha, to support the Sino Iron magnetite project. Magnetite concentrate will be pumped via a slurry pipeline to the port. The project also includes the production of magnetite pellets for export.

Water demands for the port operations are likely to be quite low; however, the processing and transport of the magnetite requires large volumes of water. Sino Iron is constructing a 51 GL/yr desalination plant to meet their operational water needs. Proponents have also proposed desalination for other potential magnetite projects near Cape Preston. This system is not currently connected to the WPWSS.

Anketell, 30 km east of Karratha, has been identified as the next major deepwater port for the Pilbara. The area is proposed to include a multi-user port with an ultimate capacity of up to 350 Mtpa and an 838 ha strategic industrial estate to provide opportunities for new exports and processing of iron ore and other minerals. Approvals have been sought for an initial 115 Mtpa port.

Proponents have proposed desalination as the water supply. There may be opportunities for sharing of water supply infrastructure between proponents to avoid infrastructure duplication and reduce environmental impacts and costs. These opportunities will be considered by DSD when negotiating with industry proponents.

Supplementary water supply options that could reduce water demand at the ports include wastewater recycling, reuse of water from slurry pipelines and use of sea water where practical.

Given the proximity of Anketell to the WPWSS there may be scope to examine potential connections between sources supplying Anketell and the WPWSS in the future to increase the diversity and security of supply to these areas.

The development of Anketell Port remains dependent on the securing of financial backing for the project.

3.4 Port Hedland

Towns and existing ports

Current supplies

The Port Hedland regional scheme supplies water to the towns and ports of Port Hedland, South Hedland, Finucane Island and Nelson Point (Figure 12). Water is obtained from the De Grey and Yule River borefields. Both sources rely on cyclones and autumn thunderstorms for recharge of alluvial aquifers.

Following modelling and assessment, the Department of Water increased the allocation limits to 10 GL/yr and up to 10.5 GL/yr for the De Grey and Yule respectively (total of up to 20.5 GL/yr). However, supply is currently limited by the infrastructure delivery capacity.

The Water Corporation has recently upgraded the De Grey system by 1 GL/yr to allow for the supply of 8 GL/yr and is also upgrading the Yule borefield and infrastructure (see section 'Committed new water supplies' for more detail).

Water supply to the town and ports is supplemented by:

- the Port Hedland recycled water scheme, which supplies treated wastewater for the irrigation of public open space
- water recycling by industry within their port operations
- one company using self-supplied groundwater piped to its port.

Water demand

Demand on the Port Hedland regional scheme has been between 9.5 to 11 GL/yr over the past three years. A further 0.6 GL/yr of industrial demand is met by self-supply. Approximately half of the demand in Port Hedland is for heavy industry.

Demand projections to 2042 are presented in Table 3.

Table 3 Projected water demand (GL/yr) to 2042 for Port Hedland

	2012	2022	2032	2042
Urban demand				
Low growth	5.5	6.5	8	9
Medium growth	5.5	8	10	11
High growth	5.5	10	14.5	18.5
Industrial demand[10]				
Low growth	5.5	14	17.5	21
Medium growth	5.5	15	19	23.5
High growth	5.5	20	26	31
Total demand				
Low growth	11	20.5	27.5	30
Medium growth	11	23	29	34.5
High growth	11	30	40	49.5

[10] Includes 0.6 GL/yr self-supplied

Committed new water supplies

The Water Corporation (with some funding from industry) is expanding the Yule borefield and upgrading infrastructure to provide up to an additional 4 GL/yr (total supply of 10.5 GL/yr). This will be used to supply future water needs in Port Hedland. The Water Corporation anticipates these upgrades will be completed in 2014.

Figure 10 provides the water demand–supply balance for urban water demand. It also includes some growth in industry up to current entitlements stipulated in supply agreements between industry and the Water Corporation. Supply of 10.5 GL/yr from the Yule borefield and 8 GL/yr from the De Grey borefield, combined with efficiency savings, will meet predicted new urban demand under a high growth scenario until 2023. A new source is not required until 2032 under a medium growth scenario.

Figure 11 provides the demand–supply balance for total water demand in Port Hedland. It covers all new industrial and urban growth. Meeting this demand will require additional industrial supplies to be developed in the shorter term (2015 under a high growth scenario and 2018 under a medium growth scenario).

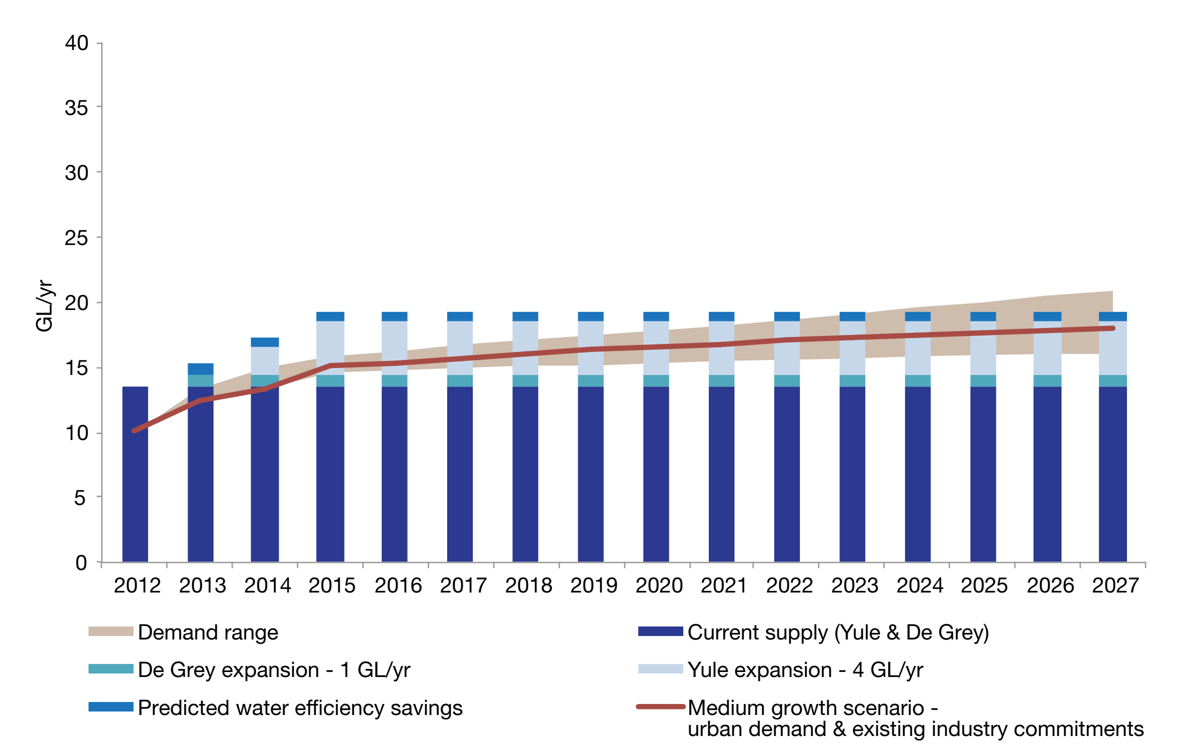


Figure 10 | Projected urban water demand to 2027 and current and committed supplies for Port Hedland

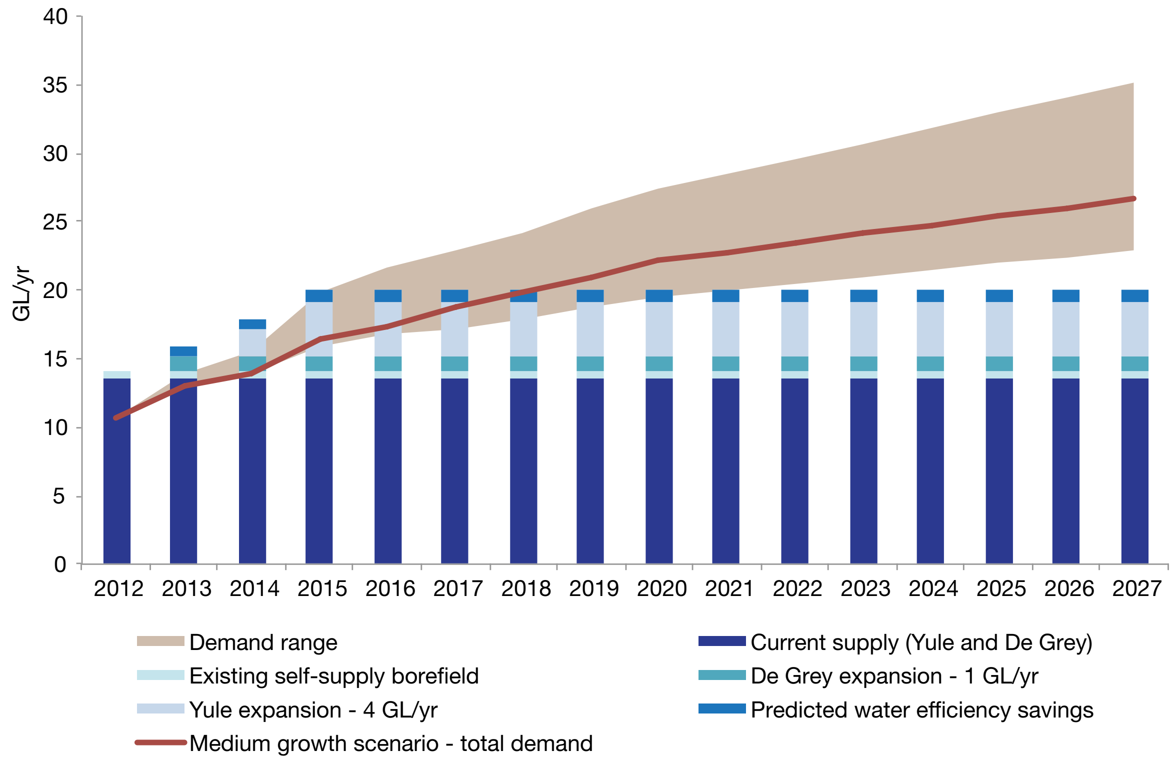


Figure 11 | Projected total water demand to 2027 and current and committed supplies for Port Hedland

Of note is that recharge of the Yule River aquifer is not as regular as that of the De Grey aquifer, with its much larger catchment. Low flow years for the Yule River are estimated to occur approximately once every four years based on the streamflow record. Sustained abstraction of 10.5 GL/yr poses a risk to groundwater dependent values and long-term quality of the resource, particularly in years of low flow. To manage this risk abstraction will either be reduced to 8.5 GL/yr during years of low flow or a higher level of management and/or additional approvals will be needed to manage the effects of abstraction at 10.5 GL/yr. The Department of Water will continue to work with the Water Corporation and stakeholders to provide a reliable supply to Port Hedland while ensuring that adverse effects are managed and the resource remains productive in the long-term. The *Pilbara groundwater allocation plan* (DoW 2013a) and *Lower De Grey and Yule groundwater allocation limits report* (DoW 2012) provide further detail on the proposed management of the Yule aquifer.

Future water supply options

There is potential for the De Grey aquifer, with its more regular flows, to provide a further 2 GL/yr for urban water supply. The Water Corporation is conducting investigations to determine an appropriate location for additional bores. The pipeline capacity will need to be increased.

As in the West Pilbara, continued improvements in water use efficiency and alternative fit-for-purpose water supplies are important to assist in delaying the need for new large water sources. One large scheme user has received funding through the Water Corporation's recent water efficiency program to establish a recycled water supply (Marsden Jacobs Associates 2012).

To meet future public open space watering requirements expansion of the existing wastewater recycling scheme is likely to be needed. Opportunities may also exist in the future for supply of recycled water for dust suppression or via a third pipe for outdoor residential use.

Given the large efficiency gains achieved by industry and residents over the past ten years additional savings will become more difficult to achieve. The Water Corporation will continue to identify further opportunities for improvements in water efficiency by scheme users.

Fortescue Metal Group (FMG) has proposed a slurry pipeline to transport magnetite from their North Star project to Port Hedland. If built, this could present an opportunity to reduce demand on high quality scheme supplies. Water from the pipeline could be treated to a fit-for-purpose standard for non-potable uses such as dust suppression.

The Water Corporation (with funding from an industry partnership) has recently completed investigations for a 10 GL/yr borefield in the West Canning Basin (Pardoo area) to supply an industry scheme. The Department of Water has reserved 10 GL/yr from the Wallal aquifer for this purpose. Development of the scheme is subject to assessment of the outcomes of this investigation, and negotiations and investment by industry. If the scheme proceeds the state may investigate the potential to secure some of this water for urban water needs.

Desalination of sea water is an alternative option for urban or industrial water supply. Due to the shallow marine environment access to a jetty or very long inlet and outlet pipelines (increasing the cost of the option) are needed. The option of desalination is being considered by industry in parallel to the West Canning Basin option. There are also proposals for third party desalination supplies.

The West Canning Basin is a large resource. The Department of Water is investigating the eastern part of this aquifer (Sandfire area) to confirm the potential yield. The distance to Port Hedland is 150 to 250 km, and the capital cost of developing it as a supply, means this is a longer term supply option.

Surplus mine dewater is a long distance, higher cost option that may become more viable in the longer term. Mine sites with large volumes of dewater surplus to their requirements, such as Woodie Woodie, Yandicoogina and Hope Downs are located around 300 km from Port Hedland.

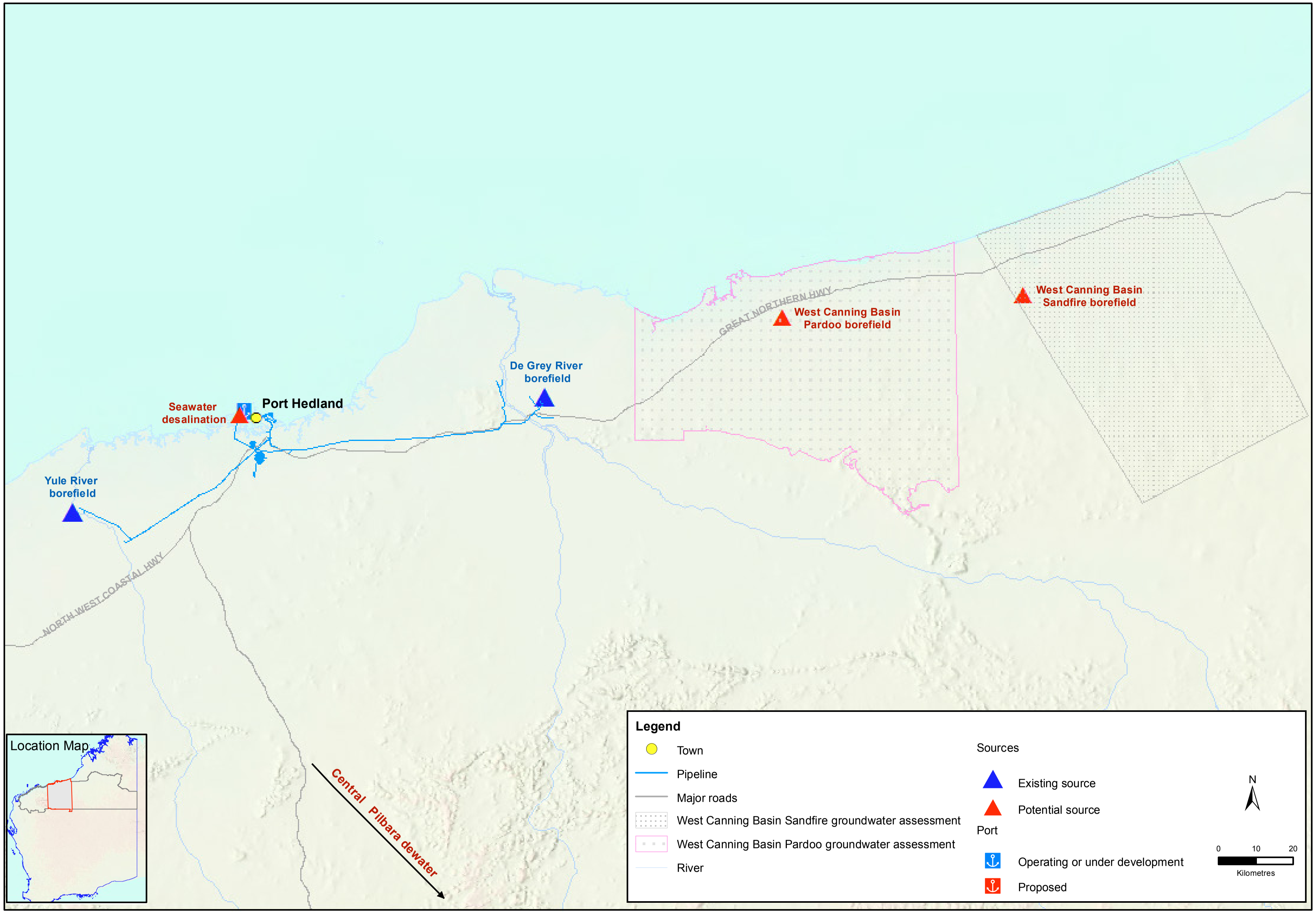


Figure 12 | Port Hedland regional water supply scheme and potential supply options (West Canning Basin borefield locations indicative only)

3.5 Onslow and the Ashburton North Strategic Industrial Area

Ashburton North Strategic Industrial Area

The Ashburton North Strategic Industrial Area (ANSIA) is located around 11 km south-west of Onslow. It consists of around 8000 ha of land that has been set aside to provide a multi-user LNG and hydrocarbon based industrial area and associated deepwater port. In 2008, land within ANSIA was allocated for three projects:

- BHPB's Macedon gas project
- Chevron's Wheatstone LNG project
- ExxonMobil and BHPB's Scarborough LNG project.

Production from the Macedon project began recently and construction of the Wheatstone project is underway. The feasibility of the ExxonMobil/BHPB's Scarborough LNG project is being assessed.

In addition to the above projects, stages 1b and 1c of the development propose to include land to accommodate a mixture of hydrocarbon activities such as ammonium processing and gas to liquid processing, a corridor for utilities and services, a general industry area and transient workforce accommodation (Taylor Burrell Barnett Town Planning and Design 2011). Additional land is also available for future longer term development (Stage 2).

Proponent funded desalination of brackish groundwater from the Birdrong aquifer and seawater desalination are proposed to meet construction and operational demands for the Macedon and Wheatstone gas projects.

Water demand and supplies for ANSIA beyond these projects are currently uncertain. Water demand will depend on the exact nature, size and timing of new industries locating within the estate.

Supply options include:

- seawater desalination
- further supply from the Birdrong aquifer (The aquifer is around 500 m deep and has brackish water. The potential yield of this aquifer is currently unknown. Investigations underway by industry will provide additional information on the potential yield.)
- seawater supply where practical for construction or cooling towers
- a local wastewater recycling scheme
- the Lower Robe aquifer to the east of Onslow
- third party supply from managed recharge of the Lower Ashburton alluvial aquifer.

The development of an integrated scheme for future industries could provide economic and environmental benefits. Opportunities for the establishment of an integrated scheme will be negotiated between proponents and the DSD.

Onslow

Current supplies

Onslow's water supply is from the Cane River borefield. The Water Corporation is licensed to abstract up to 0.55 GL/yr from this source. However, infrastructure capacity constraints mean that supply is currently limited to around 0.35 GL/yr. The Water Corporation is carrying out upgrades to increase the capacity of the scheme.

Water demand

Based on abstraction in recent years, demand is currently around 0.3 GL/yr. Growth in Onslow has historically been very low. However, Onslow is experiencing significant recent population growth as a result of the developments at ANSIA. The Macedon and Wheatstone projects are expected to result in a tripling of Onslow's resident population from around 700 to 2200 by 2016.

Projected demand for Onslow is shown in Table 4. These projections do not include water demand for the ANSIA construction workforce, as these workers will be based at ANSIA and self-supplied by proponents.

Due to the unprecedented growth in Onslow historical growth patterns cannot be used to provide an indication of future growth. In addition, the small size of the existing scheme means that projections are very sensitive to assumptions. One large industry project can have major implications for the town's population and water demand. Projections will continue to be updated as greater certainty emerges around future projects at ANSIA.

Table 4 Projected water demand (GL/yr) to 2042 for Onslow

	2012	2022	2032	2042
Low growth	0.3	0.75	0.85	0.9
Medium growth	0.3	1.0	1.45	1.6
High growth	0.3	1.35	1.65	1.8

Committed water supplies

The Water Corporation anticipates that upgrades to the existing Cane River borefield will be complete in 2013–14. This will provide an additional 0.2 GL/yr to the scheme.

Under their state development agreement (administered by DSD), Chevron is required to commission and connect to the scheme a 2 ML/day (approximately 0.6 GL/yr) desalination plant. This is required to meet new urban demand arising from an increased population in Onslow as a result of the Wheatstone project. Desalination of brackish groundwater from the Birdrong aquifer is being investigated in consultation with the Department of Water and the Water Corporation. Use of this resource is subject to confirmation of yield and water quality. Seawater desalination is an alternative option.

The timeframe for a further new source will depend on the timing of further development at ANSIA. This could be as early as 2022 (Figure 13). We will regularly review and update the projections to reflect information on new projects.

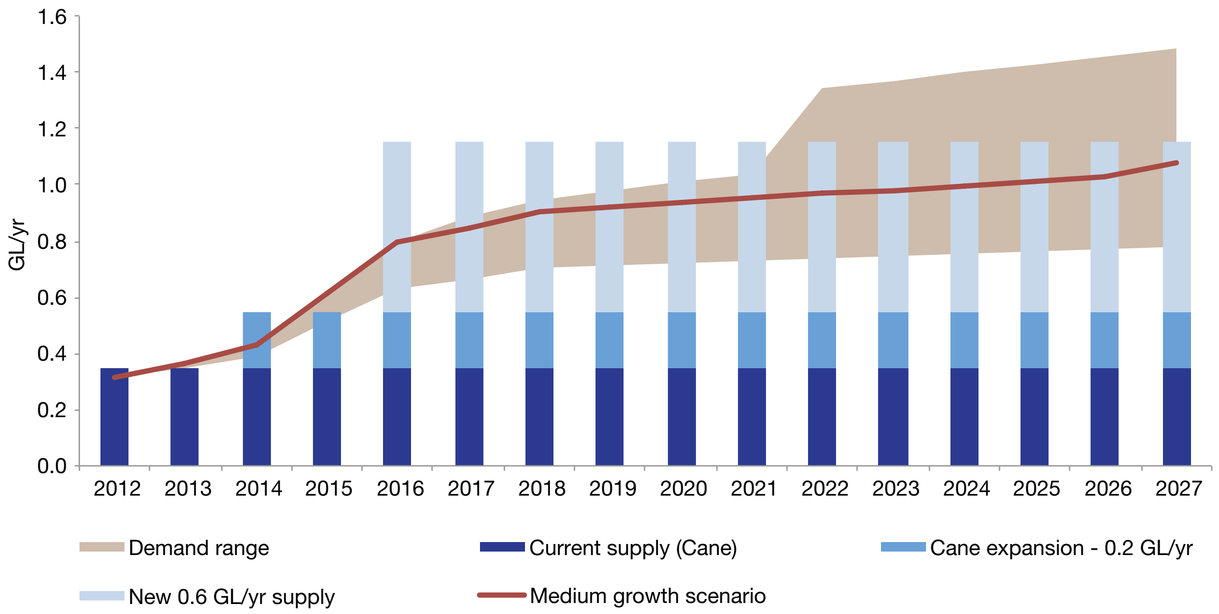


Figure 13 | Projected water demand to 2027 and current and committed supplies for Onslow

Future water supply options

Increased water use efficiency measures should continue to be implemented to help delay the need for further new large water sources. There is currently no reuse of wastewater in Onslow. Proposals for a recycled water scheme to irrigate public open space have not progressed due to the high cost.

The desalination plant being developed by Chevron could be expanded in the future to meet increases in demand, subject to confirmation of the yield from the Birdrong aquifer.

Third party supply of water from managed recharge of the Ashburton alluvial aquifer is a further alternative option. This option is also subject to confirmation of the yield, licensing and negotiation of a water supply agreement.

An additional 0.35 GL/yr has been reserved from the Cane River borefield for future public water supply. However, the aquifer is low yielding and there are salinity constraints, which mean additional yields are likely to be limited.

Up to 5 GL/yr is available from the Lower Robe aquifer. However, the distance to the source (~75 km) means this is currently a higher cost option.

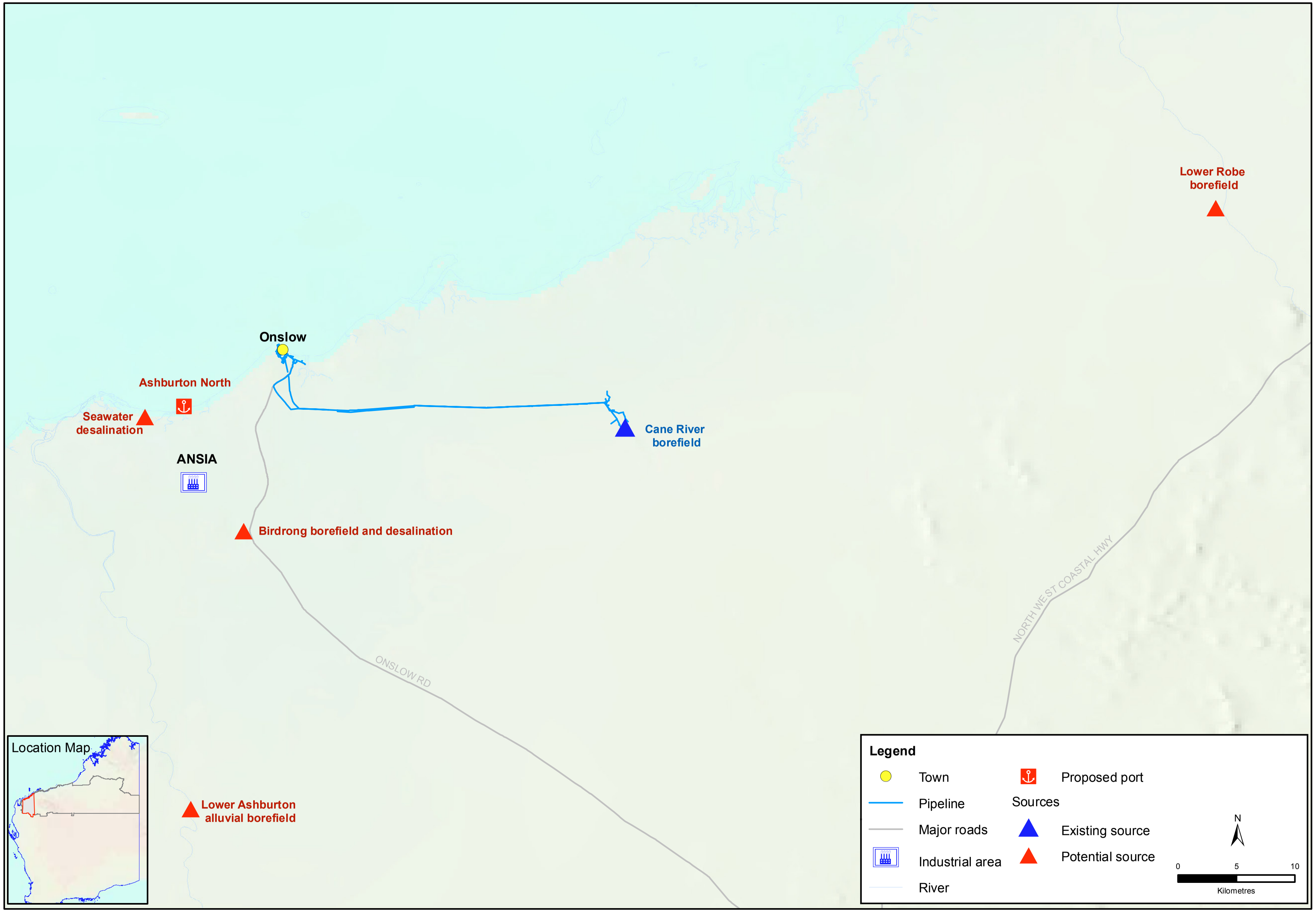


Figure 14 | Onslow water supply scheme, ANSIA and potential supply options

4

Securing future supply for the coastal towns and ports

This chapter outlines the strategy for securing future supply for the coastal towns and ANSIA. It provides:

- the short-listed options for meeting future demand
- the actions needed to implement these options
- the triggers to initiate these actions.

The Department of Water will review the demand–supply situation every two years to determine if there have been any significant changes, assess progress against actions and determine if triggers for initiating new actions have been reached.

4.1 West Pilbara

The next source option for the West Pilbara is in progress with RTIO developing a new 10 GL/yr borefield in the Bungaroo Valley to supply their port operations and township needs. Under their agreement with the state, RTIO will relinquish their existing entitlements to supply from the Millstream aquifer, securing this water for urban supply to the West Pilbara towns. The Water Corporation is upgrading existing infrastructure (with some funding from industry) to increase the transfer capacity of the WPWSS. The first stage of the upgrades will allow for the reliable delivery of 16 GL/yr to the West Pilbara ports and towns. Design work has been completed for upgrades to 20 GL/yr.

Table 5 identifies the likely next source options to meet future demand for the West Pilbara scheme. These are dependent on the outcomes of more detailed planning, negotiations and investigation. Therefore alternative options have also been identified to ensure that a range of options remain available prior to a final investment decision being made.

4.2 Port Hedland

The Water Corporation has recently completed upgrades to the De Grey infrastructure to allow delivery of an additional 1 GL/yr and is currently expanding the Yule borefield and upgrading infrastructure to supply up to a further 4 GL/yr to Port Hedland.

Table 6 identifies the likely next source options to meet future demand for the Port Hedland scheme. These are dependent on the outcomes of more detailed planning, negotiations and investment by industry. Therefore alternative options have also been identified to ensure a range of options remain available prior to a final investment decision being made.

Table 5 West Pilbara water supply scheme future water supply strategy

ID	Option	Constraints	Actions	Who	Timing/trigger
Committed options in progress					
WP1	Bungaroo borefield (10 GL/yr)	• Capacity of existing pipeline from Millstream aquifer to the coastal towns is limited to 15-16 GL/yr	Complete borefield and pipeline to Millstream	RTIO	In progress for completion in 2013
			Update WPWSS operating strategy	WC	2013
			Complete upgrades to increase capacity of existing pipeline to 20 GL/yr	WC	Staged with timing informed by quarterly WC and RTIO short-term demand projections
Recommended next source options[11]					
WP2	Water efficiency and recycling initiatives at towns and ports to help delay the need for further sources: • water sensitive urban design • increased water recycling • improved water efficiency • develop alternative fit-for-purpose supplies	• Savings progressively more difficult to achieve after savings made in previous programs • Cost of replacing infrastructure and upgrading old infrastructure • Cost of developing recycling schemes • High transient population in the Pilbara means that take-up of programs can be difficult	Complete guidelines for water efficiency at the ports	DoW	2013
			Consider opportunities for water efficiency and recycling in local government planning	Shire of Roebourne	Ongoing
			Provide advice on urban and industry development proposals to ensure consideration for water efficiency and alternative water supplies	DoW	Ongoing
			Complete planned wastewater recycling scheme upgrades to allow increased water recycling	WC	In progress for completion in 2013
			Identify and deliver (where appropriate) further opportunities for water efficiency and recycling	WC	Ongoing
			Continue annual WEMP programme for businesses using in excess of 20 000 kL/yr from the scheme	WC	Ongoing
WP3	Bungaroo existing borefield expansion (potentially 5 GL/yr)	• Yield requires confirmation • Third party ownership of borefield and pipeline	Confirm borefield yield	RTIO/DoW	5 years prior to demand–supply gap
			Amend allocation limit if appropriate	DoW	Following yield assessment
			Work with RTIO to ensure the appropriate balance of industrial and public water supply needs	DoW	Following yield assessment
			Establish water service provision arrangements	DoW/RTIO/ WC/ DSD	4 years prior to demand–supply gap
			Initiate design, approvals, detailed costing and agreement for the supply of water	RTIO/ WC	4 years prior to demand–supply gap
			Initiate construction	RTIO/WC	2 years prior to demand–supply gap
Alternative next source options/future source options					
WP4	Bungaroo new borefield in alternative part of the aquifer	• Yield uncertain • High capital costs • Located under mining tenements held by various companies	Complete desktop assessment to identify prospective borefield sites and further work required	DoW	In progress for completion in 2014
			Initiate further investigations as required to confirm the aquifer yield	DoW/RTIO	5 years prior to demand–supply gap
			Amend allocation limit if appropriate	DoW	Following investigation
			Work with RTIO to ensure the appropriate balance of industrial and public water supply needs	DoW	Following investigation
			Consult with mining tenement holders	DoW/DSD	Ongoing
			Complete pre-feasibility costings to allow comparison with desalination	DoW/WC	3 years prior to demand–supply gap
WP5	Seawater desalination (6 GL/yr +)	• High energy demands • High capital and operating costs • High carbon footprint			
WP6	Other 'Bungaroo-like' aquifers in the palaeochannels and valleys of the Hamersley Range	• Insufficient existing knowledge of potential sources • Located under mining tenements held by various companies	Complete desktop assessment to identify prospective aquifers and further work required	DoW	In progress for completion in 2014
WP7	Lower Robe aquifer	• Distance (~150 km) to demand centre means currently higher cost than alternatives			

[11] Based on current circumstances. This will be re-evaluated following the outcomes of investigations, more detailed costing and design work and/or negotiations with private industry. We will also regularly re-evaluate existing options currently not included in this shortlist and identify and evaluate potential new options that arise.

Table 6 Port Hedland regional water supply scheme future water supply strategy

ID	Option	Constraints	Actions	Who	Timing/trigger
Committed options in progress					
PH1	Yule borefield expansion (4 GL/yr)	• Uncertainty about reliability at 10.5 GL/yr means that abstraction may be reduced in low recharge years	Complete impact assessment for abstraction of 10.5 GL/yr during low recharge years	WC/ DER/ DoW	In progress for completion in 2013
			Complete borefield expansion and infrastructure upgrades	WC	2014
Recommended next source options[12]					
PH2	Water efficiency and recycling initiatives at towns and ports to delay the need for further sources: • water sensitive urban design • increased water recycling • improved water efficiency • develop alternative fit-for-purpose supplies such as reclamation of water from slurry pipelines	• Savings progressively more difficult to achieve after savings made in previous programs • Cost of replacing infrastructure • Cost of developing recycling schemes • High transient population in the Pilbara means that take-up of programs can be difficult	Complete guidelines for water efficiency at the ports	DoW	2013
			Consider opportunities for water efficiency and recycling in local government planning	Town of Port Hedland	Ongoing
			Provide advice on urban and industry development proposals to ensure consideration for water efficiency and alternative water supplies	DoW	Ongoing
			Identify and deliver (where appropriate) further opportunities for water efficiency and recycling	WC	Ongoing
			Continue annual WEMP programme for businesses using in excess of 20,000kL/yr from the scheme	WC	Ongoing
PH3	West Canning Basin (Pardoo) (10 GL/yr scheme, potential 0.5 GL/yr for urban)	• Subject to outcome of investigations, negotiation with potential industry customers and industry investment	Complete investigation and assessment to confirm yield	WC/DoW	Investigation complete, assessment in progress
			Initiate discussion with industry	DSD	4 years prior to demand–supply gap
			Establish water service provision arrangements	Industry/ DSD/ DoW	3 years prior to demand–supply gap
			Initiate design, approvals, detailed costing and agreements for the supply of water	WSP	3 years prior to demand–supply gap
			Initiate construction	WSP	2 years prior to demand–supply gap
Alternative next source options/future source options					
PH4	De Grey borefield further expansion (2 GL/yr)	• Further work required to determine an appropriate borefield location • Infrastructure upgrades required to increase pipeline capacity	Complete borefield investigation and assessment	WC/DoW	5 year prior to demand–supply gap
PH5	Seawater desalination	• High energy demands • High capital and operating costs • Shallow offshore coastline constrains location of a plant • High carbon footprint			
PH6	West Canning Basin (Sandfire)	• High capital costs due to distance to demand centre • Insufficient knowledge of resource and yield	Complete investigations to determine potential yield	DoW	In progress for completion in 2016
			Amend allocation limit if appropriate	DoW	Following investigation

[12] Based on current circumstances. This will be re-evaluated following the outcomes of investigations, more detailed costing and design work and/or negotiations with private industry. We will also regularly re-evaluate existing options currently not included in this shortlist and identify and evaluate potential new options that arise.

4.3 Onslow

The Water Corporation is expanding the Cane River borefield and upgrading infrastructure to supply an additional 0.2 GL/yr to meet short-term urban water supply needs in Onslow. Chevron is also developing a new 0.6 GL/yr supply to meet the urban water needs resulting from growth in Onslow from their Wheatstone gas project. Chevron is investigating desalination of brackish water from the Birdrong aquifer but this is subject to confirmation of yield and water quality. Seawater desalination is an alternative option.

Table 7 provides the short-listed options for meeting future demand for the Onslow scheme.

4.4 Ashburton North Strategic Industrial Area

Proponent funded desalination of brackish groundwater from the Birdrong aquifer and seawater desalination are proposed to meet construction and operational demands for the Macedon and Wheatstone gas projects.

Table 8 identifies a range of water supply options to meet future demand at ANSIA and constraints to their development. It also identifies actions for government to address these constraints where appropriate. Supply to ANSIA will primarily be self-supplied by proponents. However, it is recommended that opportunities for shared infrastructure be investigated.

Table 7 Onslow water supply shceme future water supply strategy

ID	Option	Constraints	Actions	Who	Timing/trigger
Committed options in progress					
O1	Cane River borefield expansion (0.2 GL/yr)		Complete borefield expansion and infrastructure upgrades	WC	In progress for completion in 2014
O2	Desalination plant (seawater or Birdrong aquifer) to be developed by Chevron (~0.6 GL/yr)	• Birdrong option subject to confirmation of yield and water quality	Complete investigations and source development	Chevron	Proposed for completion in 2016
Potential future source options					
O3	Water efficiency and recycling initiatives to help delay the need for further sources: • water sensitive urban design • water recycling • improved water efficiency • development of alternative fit-for-purpose supplies	• Water efficiency measures become progressively more difficult to achieve after savings made in previous programs • Cost of developing recycling schemes • High transient population in the Pilbara means that take-up of demand management programs can be difficult	Consider opportunities for water efficiency and recycling in local government planning	Shire of Ashburton	Ongoing
			Provide advice on urban and industry development proposals to ensure consideration for water efficiency and alternative water supplies	DoW	Ongoing
			Identify and deliver (where appropriate) further opportunities for water efficiency and recycling	WC	Ongoing
			Continue annual WEMP programme for businesses using in excess of 20 000kL/yr from the scheme	WC	Ongoing
O4	Expansion of O2	• Birdrong option subject to confirmation of yield and water quality			
O5	Third party supply from the Lower Ashburton aquifer	• Subject to confirmation of yield, assessment of water quality risks, service provider licence and other approvals	Complete investigations and assessment	Proponent/ DoW	In progress
O6	Cane River borefield further expansion	• Low yielding aquifer with salinity constraints and so additional yield unlikely			
O7	Lower Robe borefield	• Distance (~75 km) to Onslow means currently higher cost than alternatives			

Table 8 Ashburton North Strategic Industrial Area future water supply strategy

ID	Option	Constraints	Actions	Who	Timing/trigger
A1	Adopt technologies and practices that maximise water use efficiency including: • water recycling • use of seawater (e.g. for construction or cooling purposes) where practical	• Industrial water recycling requires: • development of an initial source option (i.e. A2-A6) • a large, consistent base water use to produce a viable volume with the required certainty of supply • management of health risks	Provide advice on development proposals to ensure consideration for water efficiency and alternative water supplies	DoW	Ongoing
A2	Seawater desalination (central plant or reticulated to individual plants)	• High energy and operational costs • High carbon footprint	Facilitate shared infrastructure where feasible	DSD	Through industry negotiations
A3	Birdrong groundwater and desalination	• Aquifer yield uncertain	Add assessment of Birdrong yield to state groundwater investigation program priority list	DoW	2013
A4	Lower Robe alluvial aquifer	• Relatively high cost due to distance to the source			
A5	Lower Ashburton alluvial aquifer	• Subject to confirmation of yield, service provider licence and other approvals	Complete investigations and assessment	Proponent/ DoW	In progress
A6	Integration with expansion of the Onslow town water supply scheme	• Lack of capacity within the scheme means a new source would need to be developed	Next action subject to resource investigations (A2 to A5)		

5

Water demand and supplies for the Pilbara region

Previous chapters have focused on water demand and supply options for the coastal towns and ports. This chapter provides an overview of water demand and supply at a regional scale. It includes both the coastal and inland areas of the Pilbara.

5.1 Approach

Projecting water demand

To project regional water demand we used a combination of:

- published and unpublished information from agencies and industry on growth forecasts for iron ore mining and large industry or agriculture projects
- water demand projections for the coastal towns and ports as described in Chapter 3
- projections from the department's water demand scenario modelling tool where more detailed information was not available. This tool uses regional economic growth data from the Monash TERM model to estimate future growth.

The high growth scenario is based on achieving the Pilbara Cities vision of 140 000 people in the Pilbara by 2035 and a more diversified economy. The medium and low growth scenarios represent the historical situation of the resource sector continuing to be the only significant driver of growth in the region.

Further information can be found in Appendix E.

Assessing supplies

A large component of the water demand in the inland Pilbara is met from local fractured rock aquifers. Allocation limits are not set for fractured rock aquifers due to aquifer characteristics (such as storage often being difficult to predict) and how water is abstracted for mining purposes. Abstraction from these aquifers is based on a case-by-case assessment following local investigations by proponents.

Therefore, we have not developed water demand and supply balances or provided a detailed description of water supply options in this chapter. An overview of water supplies and potential new opportunities (such as beneficial uses of mine dewatering surplus) is included for each of the sectors.

5.2 Current water demand

Current water demand is the base for projecting water demand into the future and provides the volume of water used per person, or industry output.

We have used information from our water licensing database, water metering reports from proponents, information on water produced by alternative sources such as desalination or wastewater recycling and estimates of unlicensed water use to determine current water demand.

Two components of water demand are described:

- water abstraction or production: all water abstracted from surface water or groundwater, or produced from alternative sources, including for mine dewatering
- consumptive water use: only water that is used for processing, dust suppression, irrigation, consumption and other related purposes. Excludes mine dewater that is discharged to the environment.

Total for region

The majority of water in the Pilbara is used in the mining sector. Water use in mining operations and mine dewater discharge accounts for almost 90 per cent of all water abstracted or produced (Figure 15). In 2012, approximately 400 GL/yr of water was abstracted or produced. Consumptive water use is estimated to be around 240 GL/yr (Table 9). Large volumes of mine dewatering surplus are located in the inland Pilbara, 300 to 400 km from the coastal demand centres.

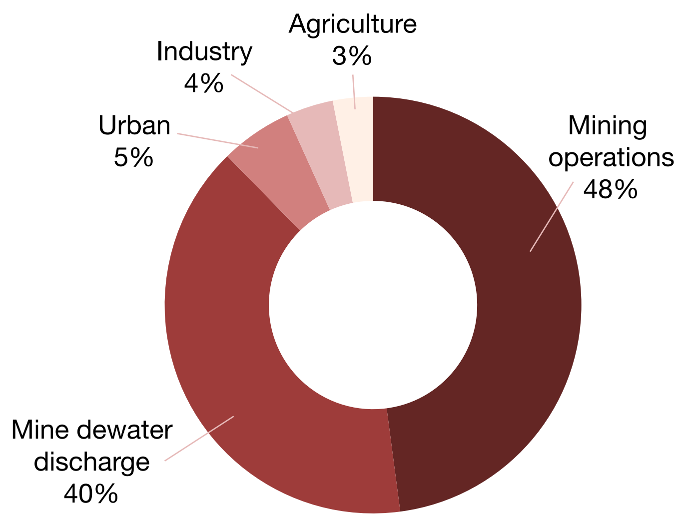


Figure 15 | Breakdown of regional water abstraction or production in 2012

Table 9 Current regional water demand in the Pilbara

Component	Volume GL/yr
Licensed water entitlements	614
Water abstraction	394
Consumptive use	235
Unlicensed water use	6
Wastewater recycling	2
Seawater desalination	<1
Total water abstraction or production	**402**
Total consumptive water use[13]	**243**

[13] Excludes mine dewater discharge

Urban

Urban water uses include residential, light industrial, commercial and irrigation of public open space within the towns and aboriginal communities. Just over 22 GL/yr is currently used for urban purposes across the Pilbara. Most of this is supplied from town water supply schemes (Table 11). Current water use for each scheme is summarised in Table 10.

Table 10 Town water supply schemes

Scheme	Current water use GL/yr	Licensed water entitlement GL/yr
West Pilbara	12.8[14]	15.0[15]
Port Hedland	10.0[14]	20.5[16]
Onslow	0.3[14]	0.55[16]
Newman	2.4[17]	10.0[18]
Marble Bar	0.15[14]	0.2
Nullagine	0.06[14]	0.08
Tom Price	1.1[19]	11.0[18]
Paraburdoo	0.6[19]	9.0[18]
Pannawonica	0.5[14]	0.7

[14] Based on average water abstraction from the past three years

[15] Abstraction of full 15 GL/yr relies on regular recharge from cyclones. The long-term reliable supply of current sources is 10 GL/yr

[16] Full entitlement is currently unable to be supplied due to infrastructure capacity constraints. The Water Corporation is currently upgrading infrastructure

[17] From ERA 2010

[18] Allocation is for both public water supply and mine water use

[19] Estimate based on estimated population

Heavy industry

Heavy industrial use includes water used for dust suppression associated with bulk handling of ore and other uses at the coastal ports, and oil and gas, salt and ammonium nitrate production. Current water use by heavy industry across the Pilbara region is estimated to be approximately 15 GL/yr.

Most of this is supplied from town water supply schemes (Table 11). Current water use for each of these schemes is summarised in Table 10.

Table 11 Current water supplies for urban and heavy industry

	Heavy industry GL/yr	Urban GL/yr
Town water supply scheme	9.2	18.7
Self-supply groundwater	6	1.8
Wastewater recycling	0	1.9
Desalination	<1	0
Total	**15.2**	**22.4**

Mining

Approximately 520 GL/yr is currently licensed for use on mine sites and associated activities[20] across the Pilbara. The majority of this is for iron ore mining, with smaller volumes for gold, copper, nickel, manganese and tantalite mining.

To determine current water demand for mining we have analysed data from licensee water metering reports between 2009 and 2011 for mines with an allocation of 1 GL/yr or greater. We found that average abstraction is approximately 65 per cent of the licensed water entitlements[21] and average consumptive use for mining operations is approximately 30 per cent of the licensed water entitlements. In 2012, a small volume of water abstracted was also used for agriculture. The remainder of water abstracted is mine dewater discharge. In some cases all or a part of the water entitlement is required to mitigate adverse effects on, and to support, environmental values.

Based on this analysis, current water abstraction for the mining sector is estimated to be approximately 360 GL/yr and consumptive water use 190 GL/yr (Figure 16).

[20] Mining purposes includes dust suppression, mine processing, camps, dewatering, exploration and mine and rail construction. It excludes port operations and construction and oil and gas processing, which are included under industry

[21] The full entitlement is the volume required by a company when reaching full production, and if dewater is required, will meet predicted peak dewatering rates (including high rainfall events). Actual abstraction varies throughout the life of the mine.

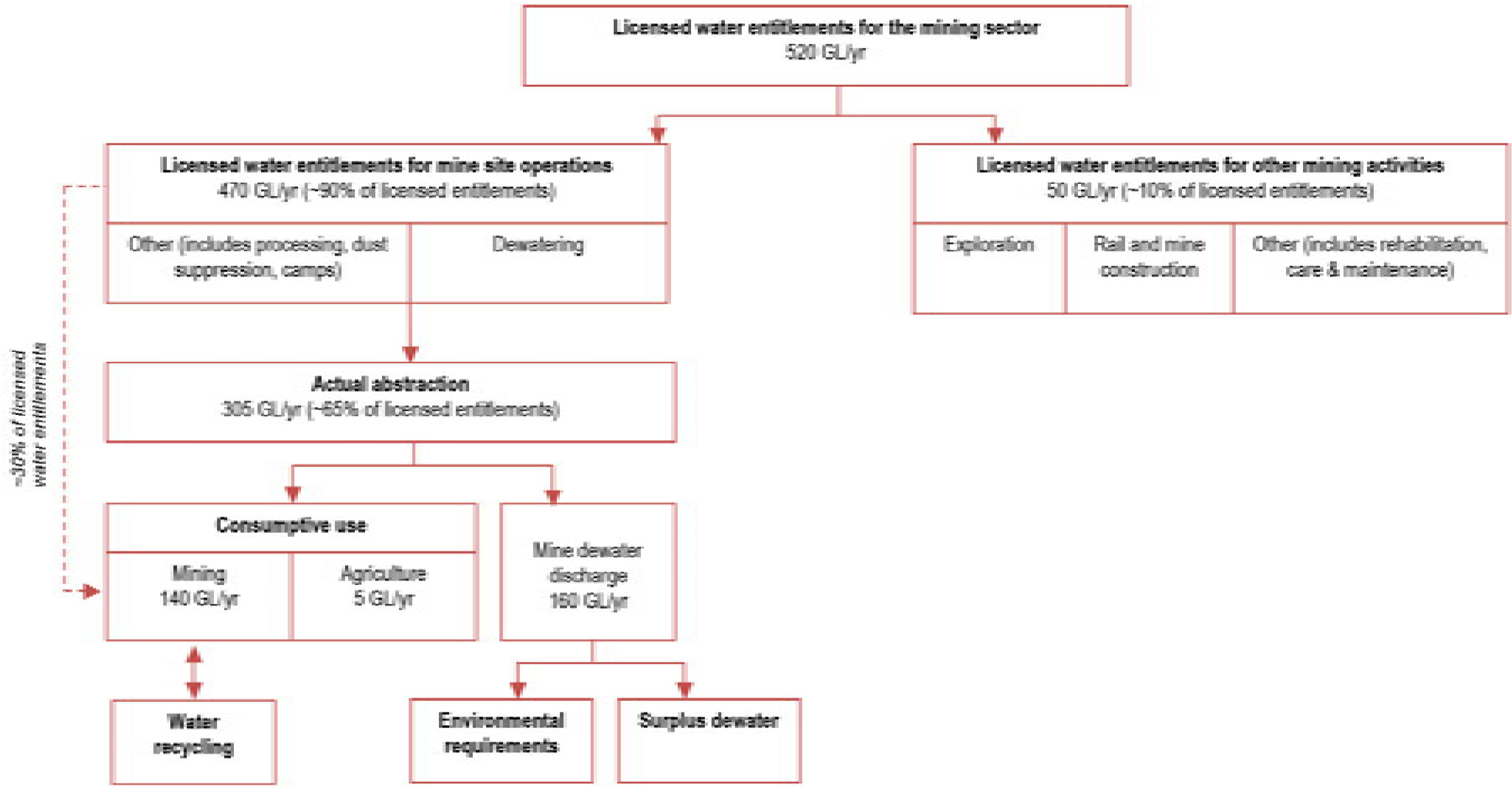


Figure 16 | Snapshot of mining licensed water entitlements and estimated abstraction and use for 2012

Agriculture

The majority of water currently used for agriculture is for stock watering (non-intensive stock grazing) and is not required to be licensed by the Department of Water. It is estimated that unlicensed stock water use across the Pilbara is 6.2 GL/yr[22].

Current water entitlements for intensive or irrigated agriculture in the Pilbara region total approximately 18 GL/yr. However, current use is less than 1 GL/yr as irrigated agriculture projects are in the early phases of development. The remainder is expected to be taken up as the irrigated areas are incrementally established over the next five years. In addition, it is estimated that around 5 GL of mine dewatering surplus was used for agricultural activities in 2012. This usage will increase over 2013, given the Hamersley Agricultural Project only became operational in late 2012 and other similar projects are planned for other areas in the Pilbara.

5.3 Future water demand and supply

Total for region

Under a medium growth scenario total water demand for the Pilbara region is expected to almost triple by 2042 (Table 12). Figure 17 provides a breakdown of future use by sector.

Table 12 Projected regional water demand in 2042

	2012	2042		
		Low growth	Medium growth	High growth
Water abstraction/production (GL/yr)	400	950	1080	1330
Consumptive water use (GL/yr)	240	580	710	890

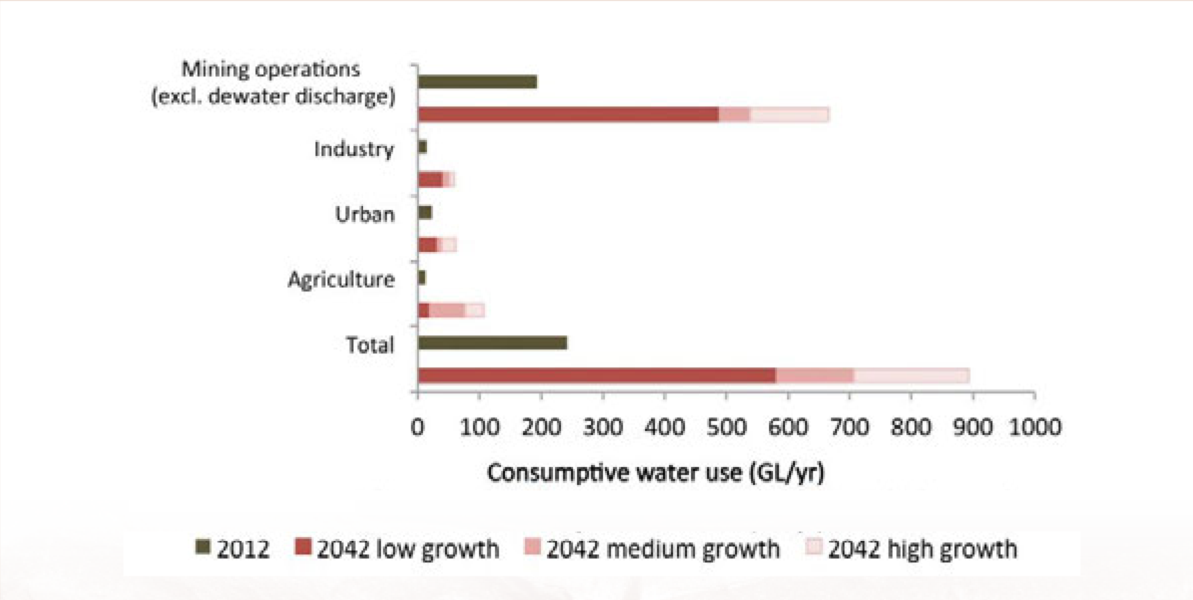


Figure 17 | Projected consumptive water use in 2042 for the Pilbara region

22 Based on stock estimates from ABS 2011 data

Urban

The strongest population and service industry growth is expected to occur in the coastal towns and Newman. Under a medium growth scenario urban water use for the Pilbara region is projected to increase to around 40 GL/yr by 2042.

The upper bound of the projections in Figure 18 reflects population growth in line with projections under the Pilbara Cities initiative. This is expected to result in a water demand of around 60 GL/yr by 2042.

A detailed discussion of the coastal towns situation has already been presented in Chapters 3 and 4. An overview of the inland towns and aboriginal communities is provided below.

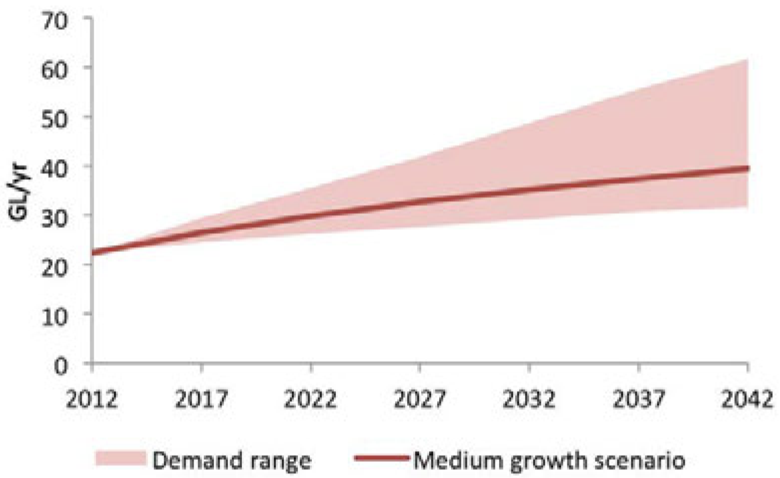


Figure 18 | Projected consumptive water use for the urban sector to 2042

Inland towns water supplies

Water for the inland town water supply schemes is generally obtained from local fractured rock or alluvial aquifers. They are often linked to nearby mining activities, with the same source supplying both the towns and mining operations. There is likely to be sufficient supplies available to meet predicted demand for these towns. The department will continue to monitor demand and supply for these areas and work with water service providers and resource companies to ensure ongoing adequate water supplies. Table 13 summarises the current demand–supply situation for each scheme.

Of the inland towns, Newman is expected to experience the greatest growth. Under a medium growth scenario Newman's water demand is predicted to increase from around 2.4 GL/yr currently to approximately 4 GL/yr in 2042. However, demand could be over 5 GL/yr if Pilbara Cities population projections are met.

To meet the growing water demand in Newman, BHPB is upgrading the water treatment plant and developing a new borefield at the Homestead Creek area to the north-west of the town. This is expected to meet demand for at least the next 20 years.

Table 13 Inland towns water demand and supply

Scheme	Water demand and supply
Newman	Increasing demand to be met by new borefield at Homestead Creek. May also be potential for piped mine dewater from the Jimblebar mine (if feasible and cost-effective).
Marble Bar	Limited scope for expansion of the existing source but water demand is not expected to increase significantly.
Nullagine	Limited scope for expansion of the existing source but water demand is not expected to increase significantly.
Tom Price	Excess dewater from Marandoo is expected to meet demand while the mine is operating. Dewater will also be reinjected into the Southern Fortescue borefield to replenish the existing supply aquifer. Options following mine closure include reverting to the Southern Fortescue borefield or taking dewater from the more distant Nammuldi-Silvergrass mining projects.
Paraburdoo	Current source is expected to meet demand. Potential for nearby borefields supplying Tom Price to be diverted to Paraburdoo if required.
Pannawonica	Current source is expected to meet demand, with mine at Pannawonica close to completion. Other nearby sources include Bungaroo, Robe River or the Warramboo borefield for the Mesa A mine.

Aboriginal community water supplies

The Department of Housing is the primary agency responsible for managing water supplies to Aboriginal communities. However, management depends on the community's location (town-based or remote) and size.

Water supplies for town-based communities are generally provided from town water supply schemes managed by the Water Corporation. The Water Corporation supplies water to a central point within the community, but does not manage the distribution of water to individual lots. The ongoing maintenance of distribution infrastructure within the community is managed by the Department of Housing.

Remote communities with five or more houses or a population of over 50 people are managed under the Department of Housing's Remote Aboriginal Essential Services Program. This program includes:

- the ongoing maintenance of the water supply infrastructure and water quality sampling. In the Pilbara this is undertaken by the Pilbara Meta Maya Regional Aboriginal Corporation
- planning and construction of new water supplies and infrastructure, for example new groundwater bores, storage tanks or water treatment systems.

Water supplies for smaller communities are self-managed. The Department of Housing provides support in the case of emergencies.

Appendix F provides a summary of the management arrangements for Aboriginal communities in the Pilbara region.

The Department of Housing is currently developing guidelines to set out equitable, minimum service requirements for small, remote Indigenous and non-indigenous towns and communities.

Supplies for remote communities are generally obtained from local fractured rock aquifers. The reliability of supply and water quality varies from community to community.

Heavy industry

Industrial water use across the Pilbara region is projected to increase to between 40 and 60 GL/yr by 2042 (Figure 19 [23]). This demand is focussed around the coastal towns and ports. There is uncertainty about the potential water demand for new strategic industrial estates as it will be influenced by the resultant timing and nature of projects locating in these areas It should also be noted that construction water requirements can often be higher than operational water needs and can cause additional short-term spikes in water demand. A detailed discussion of water supplies for heavy industry is provided in chapters 3 and 4.

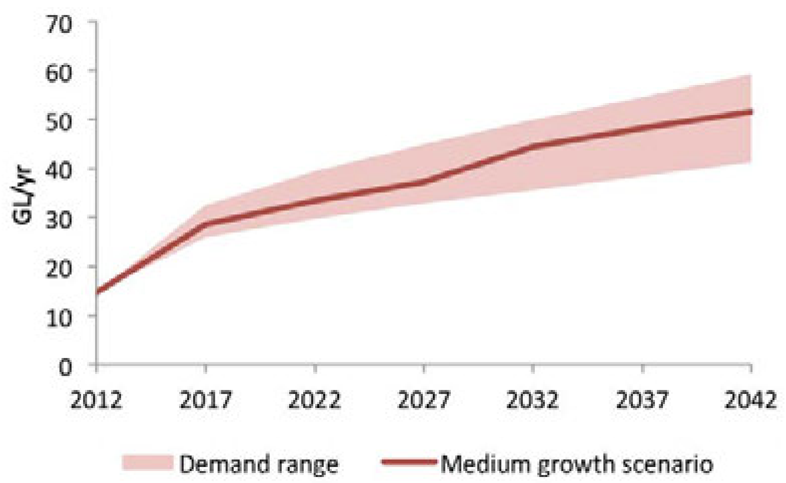


Figure 19 | Projected consumptive water use for industry to 2042

[23] This does not include water demand for magnetite pellet production at Cape Preston, which has been included under mining.

Mining

Growth of iron ore mining is expected to continue into the future with a number of existing companies in the process of expanding, and new companies looking to enter the market. As well as growth in the existing haematite exports, magnetite export is also proposed. Construction of Citic Pacific's Sino iron magnetite project is underway and there are a number of other magnetite projects under consideration.

Other existing mining operations in the Pilbara include nickel, gold, copper and manganese. Some growth in these sectors is also predicted.

There is potential for new types of mining in the Pilbara, including uranium (for example the Kintyre deposit north-east of Newman) and unconventional shale gas extraction (currently being investigated within the Canning Basin in the north-east Pilbara). Water demand and possible timeframes for these developments are currently uncertain and are not included in the demand projections.

Projected water abstraction and consumptive use for the mining sector is shown in Figure 20 and Figure 21 respectively. In developing these projections the volume of water abstracted or used per tonne of ore produced is assumed to remain constant over time. It is recognised that with increased mining below the watertable the volume of water abstracted per tonne of ore could increase and therefore future water abstraction may be underestimated.

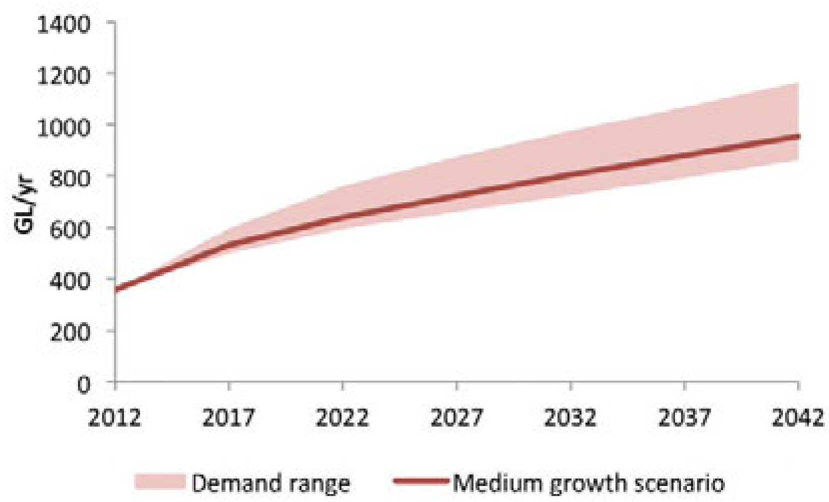


Figure 20 | Projected water abstraction for mining to 2042

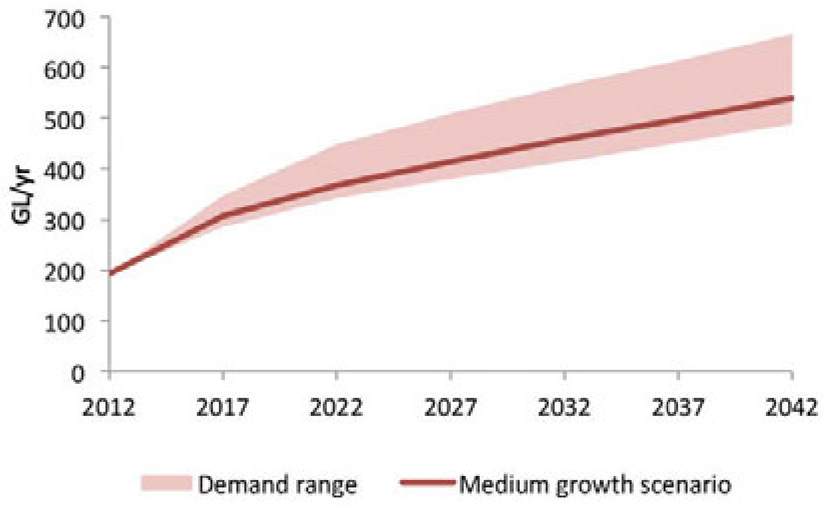


Figure 21 | Projected consumptive water use for mining to 2042

Groundwater from local fractured rock or alluvial aquifers is the primary water source for mining operations. Due to the location of mineral deposits, local fractured rock aquifers will continue to be the main supply option to meet predicted on-site demand. Abstraction of water from these aquifers is subject to investigations by proponents followed by case-by-case assessment by the Department of Water. Further information on this approach can be found in the *Pilbara groundwater allocation plan* (DoW 2013a) and *Western Australian water in mining guideline* (DoW 2013b). Descriptions of Pilbara fractured rock aquifers are detailed in the *Central Pilbara groundwater study* (Johnson & Wright 2001) and *The Pilbara coast water study* (Haig 2009).

The Department of Water encourages the efficient use of water on mining sites and, where applicable, use of mine dewater on-site to reduce the need for additional abstraction and reduce the effects of releases on the environment.

Dewater is used on many existing mine sites in the Pilbara to meet some or all of the water demand. In some cases dewater also supplies other nearby mines owned by the same company. Reinjection or recharge of water is used in some instances as a means of storing the water for later use. There are also opportunities for the supply of excess dewater to third parties to meet their mine site water demands. Strategic policy 2.09: *Use of mine dewatering surplus* (DoW 2013c) provides further information on third party use of dewater.

The water requirements for magnetite mining and processing mean that local resources may not always provide a sufficient, reliable supply. Currently proposed projects are developing desalination plants or seeking to pipe groundwater from larger resources, such as the West Canning Basin.

The West Canning Basin is a potentially large groundwater resource and there is interest in developments from all sectors. The Department of Water set an allocation limit for the resource in the *Pilbara groundwater allocation plan* (DoW 2013a). We are currently investigating this resource and the outcomes of this investigation (and proponents' investigations) will be used to review the allocation limit for the West Canning Basin. Investigations will be completed in 2016.

Agriculture

Water use for agriculture is currently low in the Pilbara and primarily only used for stock watering. However, as pastoralists seek to diversify their economic base and some below watertable mining operations seek agricultural solutions for beneficial use of mine dewatering surplus, agricultural water use may increase significantly over the next five to 10 years. There are a number of proposed developments for irrigation of cattle fodder to improve the security of feed for cattle, allow increased stocking rates in conjunction with improved management of pastoral rangelands and for sale to neighbouring stations or other markets.

Local groundwater is the most cost-effective source of water for agriculture. The availability and quality of groundwater to support more intensive agriculture varies across the Pilbara. Development of the confined Wallal aquifer of the West Canning Basin to support pastoral diversification is underway. In the future, further development of the West Canning Basin for agriculture may also be possible, subject to the outcomes of Department of Water investigations to confirm the yield of this resource and competition from other sectors. An aquifer storage and recovery scheme is also proposed on the Ashburton River to increase the availability of water for pasture irrigation.

The Department of Water has received funding through Royalties for Regions to collate information on potential water sources within the palaeochannels and valleys of the Hamersley Range. This work may also identify prospective aquifers for supplying agriculture.

Use of mine dewatering surplus from nearby mining operations is also being considered as an option to allow for diversification on nearby pastoral stations, and by mining companies as a means of managing the excess dewater in a way that realises the higher value of surplus water than discharge to the environment. In October 2012, the first large-scale agriculture project in the Pilbara using mine dewatering surplus came online. RTIO is piping surplus dewater from their Marandoo mine expansion to their Hamersley Station pastoral lease for irrigation of around 850 ha of land. The majority of irrigated land is for hay production, with a portion also being used for native seed production for mine site rehabilitation. The crops are to be grown all year round and will provide security of stock feed to Hamersley and surrounding pastoral stations. RTIO is proposing a similar scheme for managing dewater from their proposed expansion of the Nammuldi and Silvergrass mines (Strategen 2012).

Where sufficient land and water of appropriate quality is available there may also be opportunities for larger agriculture nodes, piping surplus dewater from multiple nearby mine sites.

The Pilbara Hinterland Agricultural Development Initiative (PHADI) has been developed by the Department of Agriculture and Food, the Pilbara Development Commission and the Department of Regional Development to explore irrigated agriculture using mine dewatering surplus. This initiative will further develop and implement recommendations from the *Pilbara integrated water supply pre-feasibility study* (MWH 2009, prepared for the Department of Water) and recently completed Yandicoogina and Woodie Woodie case studies funded by the Pilbara Water Opportunities program. PHADI includes a pre-feasibility study to develop a practical and achievable vision for large scale irrigated agriculture production, and pilot trials.

Development of irrigated agriculture based on mine dewatering surplus will be opportunistic and will be limited by the availability and quality of surplus dewater, i.e. it is primarily supply driven. The volumes of water to be managed (and the resulting hay production) are likely to vary in response to the dewatering activities required to meet the mine plan. Irrigated agriculture may include a combination of short-term developments limited to the life of the mine and longer term developments (where a sustainable supply can be developed post-mining). Water use projections in Figure 22 are therefore highly uncertain, but provide an indication of the potential magnitude of water use for agriculture into the future. Projected water use in 2017 is based on the development of proposed agricultural projects (using both groundwater and mine dewatering surplus as described above) to varying intensities. The medium and high growth scenarios assume that once dewatering ceases for current proposed projects other projects or alternative supplies will be developed thereby maintaining use at a similar level. The low growth scenario only includes mine dewatering surplus for current proposed projects.

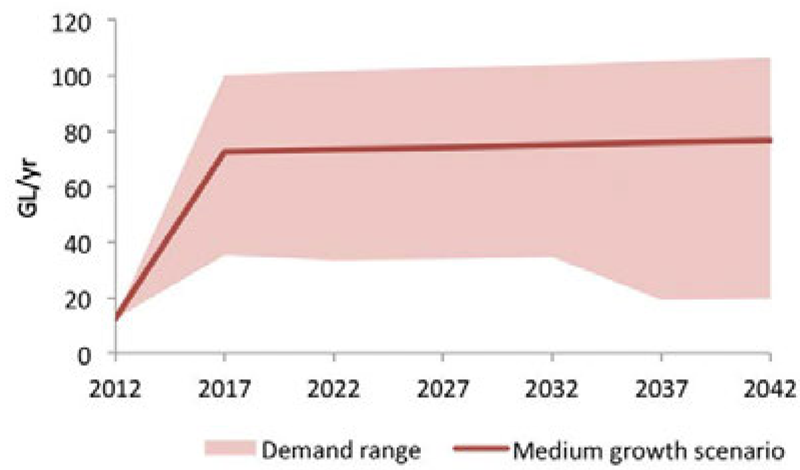


Figure 22 | Projected consumptive water use for agriculture to 2042 (includes use of mine dewatering surplus)

5.4 Planning for future supplies

Regional projections show that water use for all sectors is predicted to grow as a result of resource development within the region and economic diversification projects.

It can take three to 10 years to develop new water supplies from conception to water coming online. This means that there is a need to plan and investigate sources well in advance of when they are required.

Chapter 4 of this strategy provides the short-listed options for meeting demand at the coastal towns and ports, where the main demand pressures exist. The department will also continue to work with proponents in other areas of the Pilbara to:

- identify and assess water supply options
- encourage the efficient use of water
- encourage the beneficial use of mine dewatering surplus and work with other agencies to identify new opportunities for using this water.

To assist proponents, we have developed guidelines and policy, including the:

- *Western Australian water in mining guideline* (DoW 2013b)
- *Pilbara groundwater allocation plan* (DoW 2013a)
- Strategic policy 2.09: *Use of mine dewatering surplus* (DoW 2013c)
- Water efficiency guidelines for port water use (DoW in prep).

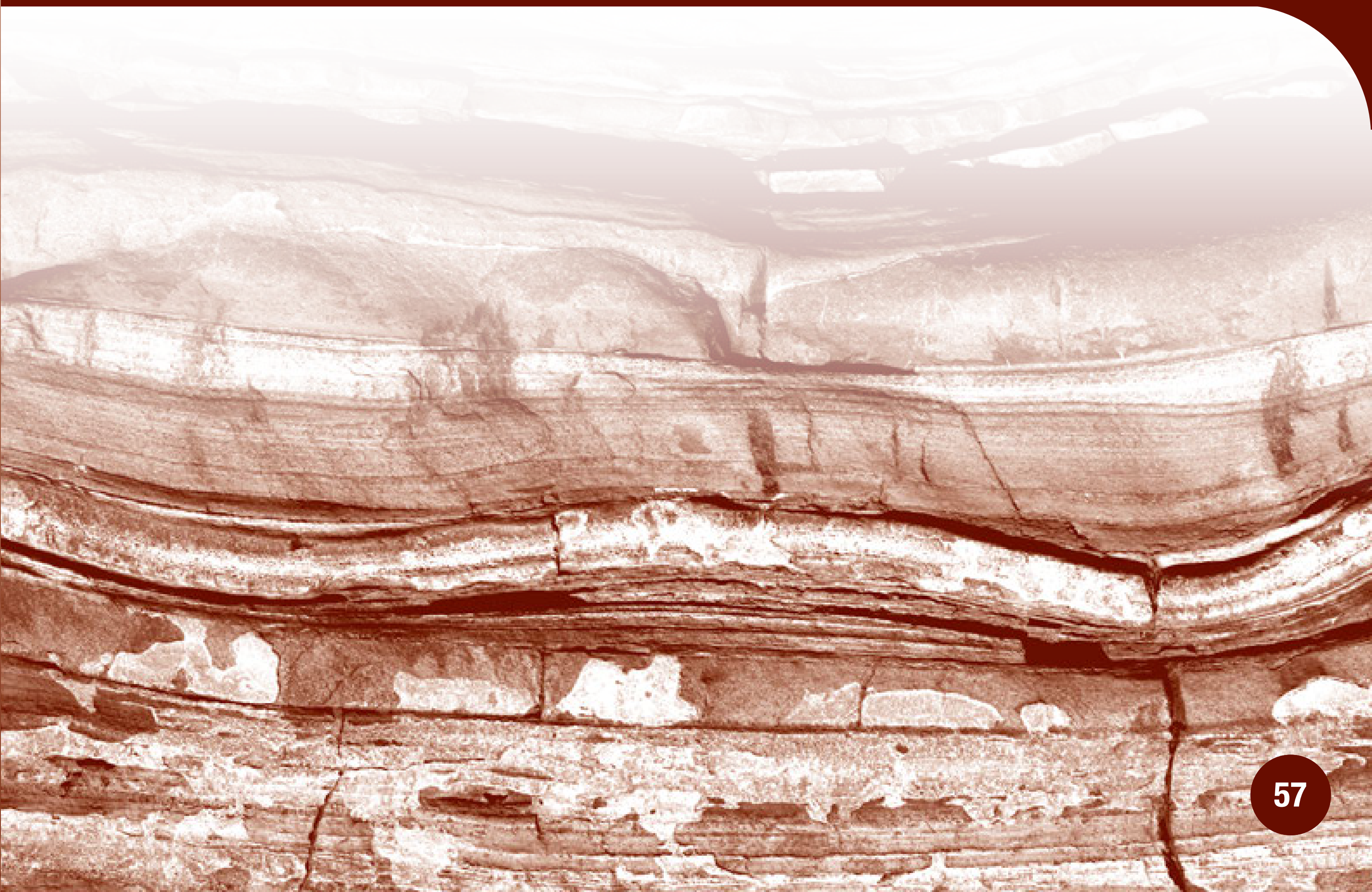
Further detail can be found in Appendix G.

Proponent or Department of Water investigations, such as the Hamersley Range assessment, may result in new supply options being identified. Changes in the technology may mean that options that are currently not feasible could become so in the future.

The department will closely monitor the water demand and supply balance for water users in the region and share information with stakeholders to ensure decision making is informed and timely. Importantly, we will review the water demand–supply balance at least every two years to determine if any significant changes have occurred.

Appendices

Pilbara regional water supply strategy



Appendix A

Water supply planning hierarchy

Water supply planning can be carried out at different geographic and time scales and at different levels of detail (Figure A1). At the strategic scale (large geographic areas and further into the future) there may be a wider range of options that can be considered. At smaller scales and a closer time frame, fewer options may be available or appropriate as the cost benefits can be assessed with greater detail and certainty.

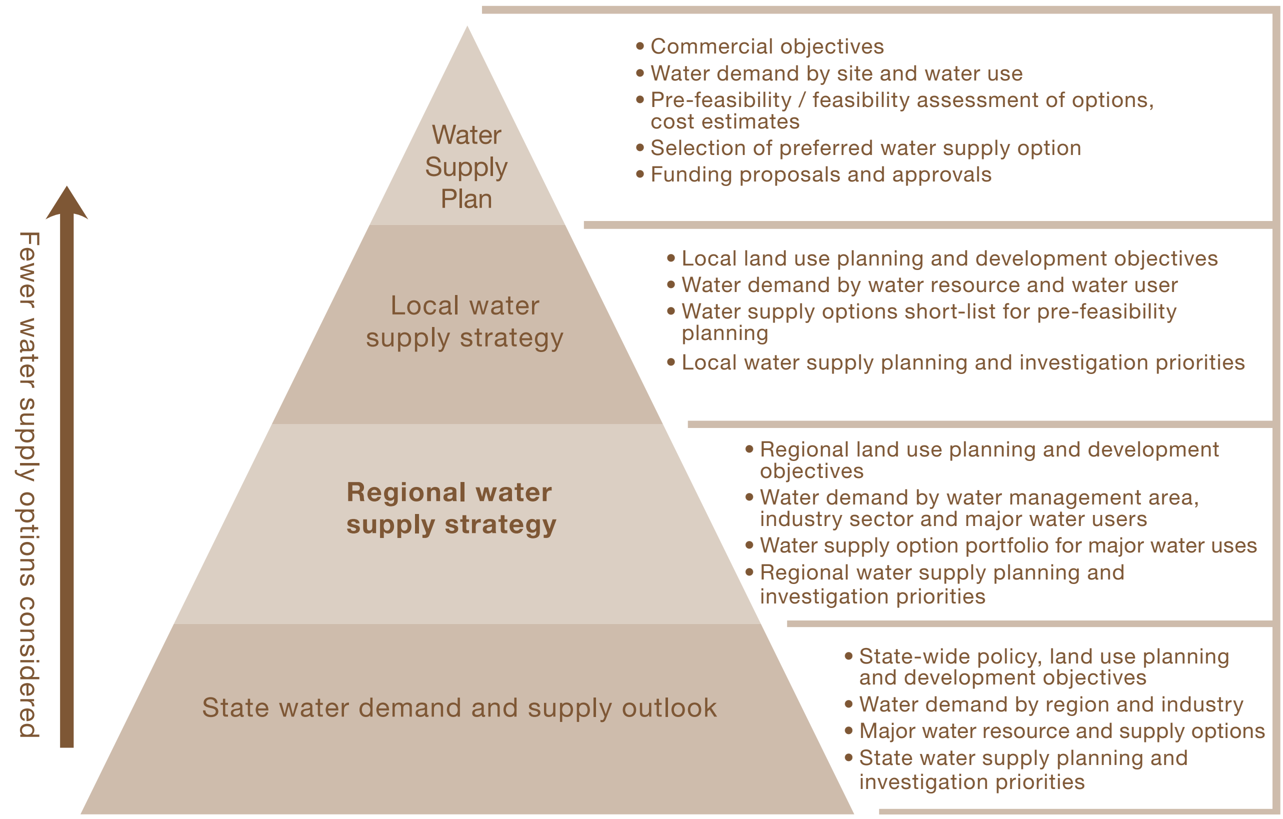


Figure A1 | Conceptual model showing the different scales of water supply planning and type of information considered at each level

Appendix B

Water supply planning roles and responsibilities

The Department of Water has established policies and guidelines to manage and regulate the state's water resources according to the objects of the *Rights in Water and Irrigation Act 1914* and Rights in Water and Irrigation Regulations 2000. We are also responsible for implementing other water management legislation, including the *Country Areas Water Supply Act 1947* and the *Water Agencies Powers Act 1984*.

In addition to our legislative functions, the Department of Water coordinates cross-agency advice on future water demand and water supply options. This includes providing policy direction for the best use of the state's water resources, and assessing and advising on how much water is available and the options to meet current and future demand. Water service providers and self-supply water users also have roles and responsibilities (Table A1) in water supply planning and development.

Table A1 Water supply planning roles

	Department of Water	Water service providers	Self-supplied water users
Geographic scale of planning	State, regional and local	Regional, scheme or development	Site and property
Water uses covered	All water uses	Scheme water (potable, non-potable, domestic, commercial, irrigation, industrial)	Mining, agriculture, industry, domestic, commercial, parks / gardens
Scale and range of water supply options assessed	All realistic major options meeting legislative requirements and policy objectives	Range of feasible options leading to a preferred option to meet policy and commercial objectives	Small range or preferred option to meet commercial objectives or private needs
Type of water resource investigations	Water yield, quality and sustainability of water resources	Water yield and quality at a range of locations to meet licensing requirements and scheme needs	Water yield and quality at specific location to meet licensing requirements and commercial or private needs
Role in supplying water	Licensing abstraction from water resources	Constructing scheme infrastructure and supplying customers	Constructing infrastructure for private use

Appendix C

Water allocation limits and availability

Groundwater resources

Allocation limits have not been set for fractured rock aquifers in the Pilbara. Licensing from fractured rock aquifers is managed by a case-by-case assessment of proposals. Table A2 provides the allocation limits, water availability and basic characteristics of other groundwater resources in the Pilbara.

Table A2 Groundwater resources in the Pilbara

Subarea	Aquifer[24]	Allocation limit ML/yr	Water available for licensing ML/yr[25]	Water reserved for public water supply	Water quality[26]
East Pilbara	Canning–Wallal	1 000	955	0	Marginal-brackish
East Pilbara	Hamersley–Fortescue	1 000	1 000	0	Fresh-marginal
East Pilbara	Wittenoom–Wittenoom	50 000	8 228	0	Fresh
Ashburton	Carnarvon–Lower Robe alluvial	5 090	3 000	2 000	Fresh-marginal
Ashburton	Hamersley–Millstream	15 682	0	0	Fresh
Ashburton	Lower Cane alluvial	1 000	93	350	Fresh
Ashburton	Lower Fortescue alluvial	6 600	5 578 [27]	0	Fresh
Ashburton	Lower Turner alluvial	420	0	0	Marginal-brackish
Ashburton	Pilbara–Lower De Grey alluvial	10 150	0	0	Fresh
Ashburton	Pilbara–Lower Yule alluvial	10 560	1	0	Fresh
Ashburton	Canning–Wallal	Not set	-	-	Fresh
Ashburton	Hamersley–Fortescue	Not set	-	-	Fresh
Ashburton	Lower Bungaroo Valley	10 000	0	0	Fresh
Ashburton	Pilbara–Coastal saline	2 000	0	0	Brackish–saline
Ashburton	Wittenoom–Wittenoom	20 000	15 828	0	Fresh–marginal
Ashburton	Pilbara–Alluvial	7 000	6 699	0	No data
Ashburton	Carnarvon superficial	2 000	496	0	No data
Ashburton	Carnarvon–Cape Range Limestone	0	0	0	Brackish–saline
Ashburton	Carnarvon–Birdrong	100	100	0	No data
Ashburton	Carnarvon–Birdrong.	300	0	0	Brackish–saline
West Canning–Pardoo	Canning–Broome	10 000	9 998	0	Marginal–brackish
West Canning	Canning–Wallal.	30 000	1 275 [28]	10 000	Fresh
Canning–Kimberley	Canning–Grant	100 000	85 075	0	Marginal–brackish
Canning–Kimberley	Canning–Wallal	10 000	9 780	0	No data
Canning–Kimberley	Canning–Liveringa	10 000	9 322	0	Marginal–brackish
Canning–Kimberley	Canning–Erskine	5 000	5 000	0	Fresh

24 A full stop (.) at the end of the aquifer name identifies it as a confined resource.

25 Available water for general licensing as at August 2013. Please contact our Karratha office on 08 9144 0200 for up-to-date information on water available.

26 See Table A4.

27 The staged development in the lower Fortescue is likely to take up the allocation limit. We will use new information from the development to review the allocation limit.

28 The Wallal aquifer is likely to become fully allocated soon, as the full amount has been applied for by various proponents. We will review the allocation limit for the Wallal aquifer once investigative work is completed.

Surface water resources

Allocation limits have not been set for any surface water areas in the Pilbara. Table A3 contains the proclaimed surface water areas and their characteristics.

Table A3 Surface water resources in the Pilbara

Surface water management area	Resource description	Water quality[29]
De Grey	Rivers and tributaries	Marginal
Yule	Rivers and tributaries	Fresh
Sherlock	Rivers and tributaries	Fresh
Harding	Harding reservoir	Fresh
	Other tributaries	Fresh
Karratha Coast	Rivers and tributaries	Fresh
Lower Fortescue	Rivers and tributaries	Marginal–brackish
Robe River	Rivers and tributaries	Marginal
Cane River	Rivers and tributaries	Marginal
Ashburton River	Rivers and tributaries	Marginal–brackish
Yannarie	Rivers and tributaries	Fresh
Upper Fortescue	Rivers and tributaries	Marginal
Sandy Desert Basin	Inland desert	No data

29 See Table A4.

Table A4 Water quality descriptors

Description	Salinity mg/L
Fresh	< 500
Marginal	501–1 500
Brackish	1 501–5 000
Saline	5 001–50 000
Hypersaline	> 50 000

Appendix D

Criteria used to assess and short-list water supply options

Table A5 Options assessment criteria

Criteria	Sub-criteria	Detail and explanation
Cost	Capital ($) and net economic cost ($ per kL) where available. L, M, H, VH if detail not available	Capital and $/kL costs used where available. Where information is not available assessment of whether L, M, H, VH cost based on type of option, distance to demand centre, topography, information on similar options in the region or other areas.
Timing	Lead time to commissioning (years)	Estimated lead times for development of the option, including investigations, design, approvals and construction.
Social	Community acceptability (L, M, H)	Likelihood of community support for the option, extent of impacts on regions, communities or water users which may present risks to the viability of the option.
	Human health risk (L, M, H)	Level of risk to human health from the option.
	In situ social effects (+ve, neutral, -ve, irreversible)	Potential effects on recreation, amenity, tourism sites and level of risk.
Cultural	Native title considerations (Yes, No)	Claims, agreements to be negotiated.
	In situ cultural effects (+ve, neutral, -ve, irreversible)	Potential effects on cultural sites (for example river pools) and level of risk.
Environmental	In situ environmental effects (+ve, neutral, -ve, irreversible)	Potential effects on ecosystem function, biodiversity, etc. and level of risk.
	Energy intensity (L, M, H)	As a measure of greenhouse gas emissions. Also provides an indication of operating costs.
Resource characteristics	Climate dependence (none, L, M, H)	How dependent the yield volume and reliability is on climate.
	Yield (GL/yr)	Volume of water per year that can be extracted from the source.
	Yield reliability (L, M, H)	Likelihood of obtaining the yield in a given year.
	Water quality effects (+ve, neutral, -ve, irreversible)	Potential effects of option on in-situ water quality including salinity, and acid sulfate soils.
	Water resource impacts (+ve, neutral, -ve, irreversible)	Change in flows, groundwater levels, aquifer integrity, subsidence etc.
	Fit-for-purpose (Yes, No)	Whether the quality of water appropriate for potable or non-potable use with general treatment, or is higher level or additional treatment required.

Note: L – low M – medium H – high VH – very high

Table A5 Options assessment criteria (continued)		
Criteria	Sub-criteria	Detail and explanation
Scheme characteristics	Complexity (L, M, H)	Complexity of the infrastructure required and whether it can be easily integrated into existing infrastructure. Extent to which changes or additions to existing infrastructure required.
	Flexibility (L, M, H)	Scope to defer or stop or start the option to adjust to more or less rainfall, or increased or reduced demand.
Source or scheme optimisation	Efficiency (L, M, H)	How water efficient is the option?
	Complementary sources or schemes (Yes, No)	Whether the source can be combined with another source or scheme to produce a benefit.

Note: L – low M – medium H – high VH – very high

Appendix E

Methodology for predicting demand

Determining current water demand

In September 2012 licensing data for the Pilbara strategy area was exported from the department's water resource licensing database. Information captured included licence numbers, allocation volumes and usage codes. Only current 'in-force', 'conditional approval' and 'renewal-stage' licences were included to form the base year water demand from which growth is projected. Many licences cover several water usage codes. Water usage codes were used to categorise water use into the four sectors of mining, agriculture, urban and heavy industry.

Many licensees, particularly for resource development projects, apply for a large licence entitlement, but only use a portion of this entitlement with an expectation that their water use will fluctuate in accordance with anticipated changes in production and/or dewatering rates required. In addition, where mine dewatering is occurring a significant portion of the water abstracted is not used for consumptive purposes and is discharged back into the environment.

Assumptions used in calculating current water demand are summarised in Table A6.

Table A6 Assumptions used in calculating current water demand

Issue	Action
Groundwater and surface water licence status	Licences which have the following status were included: draft-renewals and amendments (the latest in force volume), in force and conditional approvals
Scheme water supply licences	Used average water abstraction from 2010–2012, based on information submitted by water service providers to the Department of Water
Mining sector	Consumptive water use assumed to be 30 per cent of licensed water entitlements and abstraction 65 per cent of licensed water entitlements, based on analysis of data submitted to the Department of Water from 2009–2011 for mining licences greater than 1 GL/yr
Staged developments	Only accounted for current water entitlement and not reserved water
Unlicensed stock and domestic	Estimates of total stock water use applied the number of livestock from the 2011 Agricultural Census (ABS 2012) and typical water requirements per head (from Department of Agriculture and Food)
Other water sources	Information obtained from the Water Corporation for wastewater recycling schemes and desalination production
Usage codes relevant to multiple sectors	Code assigned to the sector that the majority of licences fall under

Projecting future water demand

Water demand scenarios for the Pilbara are based on a combination of information from published and unpublished sources and the Monash TERM model.

The Monash TERM model provides growth rates for 'water use indicators' which include; 'industry value added' (as $million), 'employment' or 'population' for sub-regions. The model provides low, medium and high growth scenarios that contain different macro-economic assumptions including the intensity and duration of the resources boom. Growth rates are based on historical trends.

Due to the volatile nature of demand in the Pilbara, and current government initiatives to increase population growth and economic diversity, historical trends may not provide a reliable indication of future demand. Therefore, where available, we have used more detailed information specific to the Pilbara rather than the Monash TERM model. Information sources and assumptions for each sector are summarised in Table A7.

Table A7 Water demand scenario assumptions

Sector	Category	Information source
Mining	Iron ore mining	• DSD iron ore export projections to 2020, (DSD 2013b) assumed growth rates of between 2 and 3 per cent beyond 2020 for medium and low growth scenarios and between 2 and 4 per cent for the high growth scenario
	Other mining	• Monash TERM model projections
Industry	Coastal towns and ports	• Dust suppression water use based on iron ore export projections (as detailed above) • Water use for other new industries or existing industry expansions based on project-specific information
	Inland towns	• Monash TERM model projections
Urban	West Pilbara and Port Hedland	• Medium and low growth scenarios based on assumption of mining driving growth in the residential and commercial sectors and Water Corporation short-term demand projections (see below for more information) • High growth scenario based on Pilbara Cities target of 50 000 each in Karratha–Dampier and Port Hedland by 2035
	Onslow	• Based on population projections from WAPC (2011)
	Newman	• Low growth scenario based on WA Tomorrow forecasts • Medium growth scenario based on population of 10 000 people by 2035 • High growth scenario based on Pilbara Cities target of 15 000 people by 2035
	Other towns	• WA tomorrow forecasts
Agriculture	Non-intensive agriculture	• Monash TERM model projections
	Irrigated agriculture	• Project specific information

Water use per 'unit output', 'person' or 'employment' was assumed to remain constant under all growth scenarios. Potential reductions in demand as a result of improved water use efficiency measures are therefore not included within the demand scenarios.

Assumptions need to be made as part of the process of projecting future water demand. The reliability and certainty of assumptions decreases the further ahead they are applied. Therefore, while demand projections are reasonably likely to reflect reality in the short-term, the longer the forecast timeframe, the more likely it is that forecasts will not reflect what actually occurs.

It is difficult – if not impossible – to predict the occurrence of a global financial crisis or the impact of natural disasters or climate change, all of which may significantly alter the water demand projections. Long-term forecasts of water demand should be considered as 'high level estimates' only and should not be used as a basis for investment decisions.

While water demand scenario modelling is used for this strategic assessment of water supply options it is recognised that a more detailed analysis would be required to support future water supply planning and investment decisions. Water demand is often constrained by non-water issues such as the economic feasibility of projects, planning approval, native title or environmental clearances.

Urban water demand projections for the West Pilbara and Port Hedland

To project urban water demand for water supply planning we typically use population projections. Population growth in the Pilbara is primarily driven by the workforce requirements for resource development projects. This creates challenges in predicting long-term population growth and means there are a range of views on future population. Projections can also quickly become out of date as resource companies' plans change in response to market demand for their product.

However, the Department of State Development prepares and regularly updates iron ore export projections (for low, medium and high growth scenarios). We found that historically there has been a broad relationship between urban water demand and iron ore exports (see Figure A2). For the medium and low growth scenario we have assumed this trend will continue into the future and so have used this relationship to project future urban water demand (Figure A2).

It is recognised that these projections are high level and will not capture short-term peaks or falls in urban water demand, for example as a result of major construction activity beginning or reaching completion. Prior to any investment decision, more detailed short-term urban demand projections should be produced based on the best available information on planned residential, commercial and light industrial developments. For the medium growth scenario we have incorporated the Water Corporation's current estimate of 500 new urban water services per year (approximately 0.25 GL/yr) for the next five years.

The high growth scenario is based on the Pilbara Cities population projections of 50 000 people in Karratha–Dampier and Port Hedland by 2035. It is dependent upon continuing high growth in the iron ore and LNG sector as well as a shift away from iron ore being the only driver of growth, with higher population growth resulting from a more diversified economy.

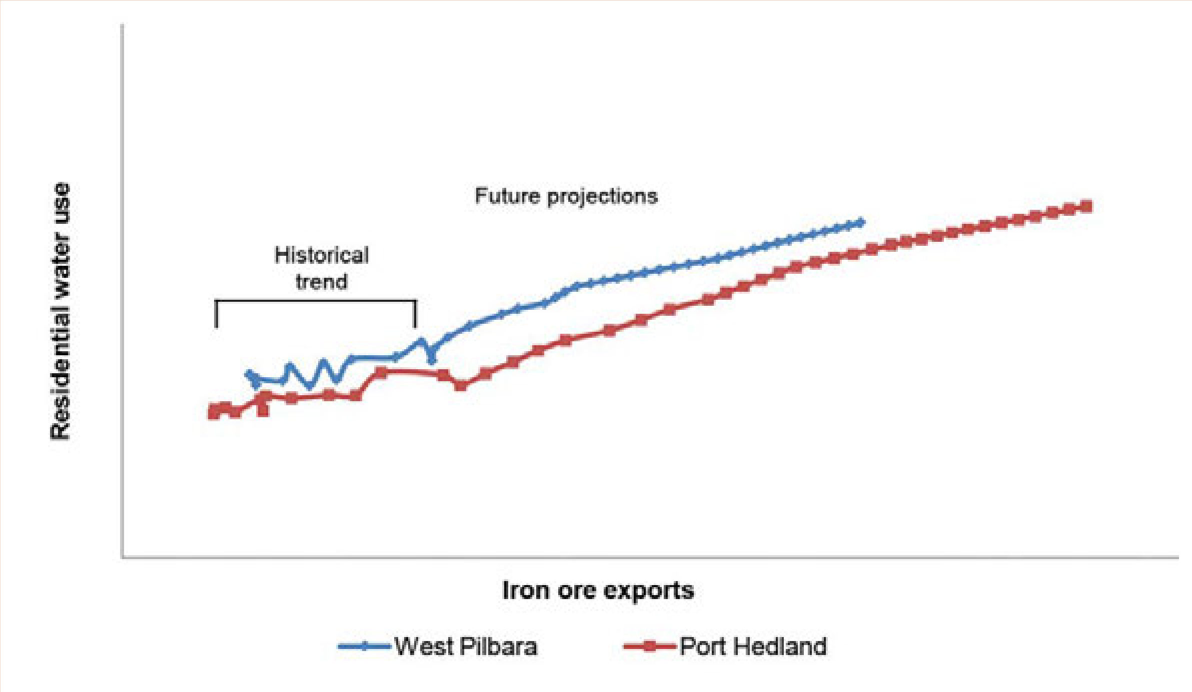


Figure A2 | Historical relationship between residential water demand and iron ore exports and future projections

Appendix F

Aboriginal community water supplies

Table A8 Management arrangements for Aboriginal community water supplies

Community	Water supply management	Water distribution management
Bindi Bindi	Water Corporation	Department of Housing
Cheeditha	Water Corporation	Department of Housing
Gooda Binya	Water Corporation	Department of Housing
Innawonga	Department of Housing	Department of Housing
Irrungadji	Water Corporation	Department of Housing
Jigalong	Department of Housing	Department of Housing
Jundaru	Self-supply	Self-supply
Kiwirrkurra	Department of Housing	Department of Housing
Kunawarritji	Department of Housing	Department of Housing
Kurlku	Self-supply	Self-supply
Marta Marta	Self-supply	Self-supply
Mingullatharndo	Self-supply	Self-supply
Ngurawaana	Department of Housing	Department of Housing
Parngurr	Department of Housing	Department of Housing
Parnparjinya	Water Corporation	Department of Housing
Punju Ngamal	Water Corporation	Department of Housing
Punmu	Department of Housing	Department of Housing
Tkalka Boorda	Water Corporation	Department of Housing
Wakathuni	Department of Housing	Department of Housing
Warralong	Department of Housing	Department of Housing
Weymul	Self-supply	Self-supply
Yandeyarra	Department of Housing	Department of Housing
Youngaleena	Department of Housing	Department of Housing

Appendix G

Policies, plans and guidelines relevant to water supply development

Table A9 Relevant policies, plans and guidelines

Water supply option	Policies, plans and guidelines
Water demand management	Operational policy 1.02: *Policy on water conservation / efficiency plans* (DoW 2009a)
	Better urban water management (WAPC 2008)
Water reuse	*Draft approval framework for the use of non-drinking water in Western Australia* (DoW 2010c)
	Guidelines for the non-potable uses of recycled water in Western Australia (Department of Health 2011)
	Operational policy 1.01: *Managed aquifer recharge in Western Australia: allocation and water quality management (DoW 2009b)*
Groundwater abstraction	*Pilbara groundwater allocation plan* (DoW 2013a)
	Operational policy 5.08: *Use of operating strategies in the water licensing process* (DoW 2011)
	Operational policy 5.12: *Hydrogeological reporting associated with a groundwater well licence* (DoW 2009c)
	Strategic policy 5.03: *Metering the taking of water* (DoW 2009d)
Mine dewatering	*Western Australian water in mining guideline* (DoW 2013b)
	Strategic policy 2.09: *Use of mine dewatering surplus* (DoW 2013c)
Water trading	Operational policy 5.13: *Water entitlement transactions for Western Australia* (DoW 2010d)
Water resource land use planning	State planning policy 2.9: *Water Resources* (WAPC 2006)

Glossary

Abstraction	Withdrawal of water from a surface water or groundwater source of supply.
Allocation limit	Annual volume of water set aside for use from a water resource.
Aquifer	A geological formation or group of formations capable of receiving, storing and transmitting water.
Consumptive water use	The total amount of water that is used for processing, dust suppression, irrigation, consumption and other purposes for mining, agriculture, urban and industry. This volume excludes mine dewater that is discharged to the environment.
Dewatering	Removal of underground water to facilitate construction or other activities. Dewatering is often used as a safety measure to allow mining below the watertable or during construction of urban and industrial areas.
Fit-for-purpose water	Water that is of suitable quality for the intended end purpose. It implies that the quality is not higher than needed.
Groundwater	The water that occurs in pore spaces and fractures in rocks beneath the ground surface. Also see aquifer.
Groundwater area	The boundaries proclaimed under the *Rights in Water and Irrigation Act 1914* and used for water allocation planning and management.
Licence	A formal permit which entitles the licence holder to 'take' water from a watercourse, wetland or underground source under the *Rights in Water and Irrigation Act 1914*.
Licensed water entitlement	The specific volume of water allocated to a licence, in a given period, bound by the rules established in the relevant plan or state-wide policy.
Mine dewatering surplus	The volume of water remaining, if any, after environmental needs and mine-site water requirements have been met.
Monash TERM	A computer model that predicts growth of different sectors within various regions of Australia.
Potable	Fresh and marginal water generally considered suitable for human consumption.
Public water supply reserve	Reservation of a volume of water, from the allocation limit, to supply drinking water for human consumption.
Recharge	All water that enters a groundwater resource, such as rainfall recharge, induced recharge from other aquifers or throughflow.
Salinity	The measure of total soluble salt or mineral constituents in water. Water resources are classified based on salinity in terms of total dissolved solids (TDS).
Subarea	A smaller area determined by the Department of Water in a proclaimed area used for water allocation planning and management purposes, the boundaries of which are primarily defined by the location of the water resource.
Surface water	Water flowing over or held in streams, rivers and wetlands on the surface of the land.
Water abstraction/ production	The total amount of water that is abstracted from surface water or groundwater, or produced by alternative sources such as desalination or wastewater recycling.
Water use efficiency	Increasing water supply efficiency and water demand efficiency to minimise the taking and use of water.
Yield	The amount of water that can be abstracted out of the system, after environmental water is met.

Shortened forms

ANSIA	Ashburton North Strategic Industrial Area
BHPB	BHP Billiton
CME	Chamber of Minerals and Energy
DAFWA	Department of Agriculture and Food
DER	Department of Environment Regulation
DoW	Department of Water
DSD	Department of State Development
FIFO	Fly-in-fly-out
IOCI	Indian Ocean Climate Initiative
LNG	Liquefied natural gas
Mtpa	Million tonnes per annum
PDC	Pilbara Development Commission
PHADI	Pilbara Hinterland Agricultural Development Initiative
RTIO	Rio Tinto Iron Ore
WAPC	Western Australian Planning Commission
WC	Water Corporation
WEMP	Water efficiency management program
WPWSS	West Pilbara water supply scheme
WSP	Water service provider

Volumes of water

One litre	1 litre	1 litre	(L)
One thousand litres	1 000 litres	1 kilolitre	(kL)
One million litres	1 000 000 litres	1 megalitre	(ML)
One billion litres	1 000 000 000 litres	1 gigalitre	(GL)

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Notes

RECYCLED CONTENT

Department of **Water**
168 St Georges Terrace, Perth, Western Australia
PO Box K822 Perth Western Australia 6842
Phone: 08 6364 7600
Fax: 08 6364 7601
www.water.wa.gov.au

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