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

Securing Western Australia's water future

Mid West regional water supply strategy

A long-term outlook of water demand and supply

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Regional water supply strategy series

Mid West
regional water supply strategy

A long-term outlook of water demand and supply





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Disclaimer

A message from the Minister

The Mid West region has great potential for future growth. Stretching from the shores of the Indian Ocean at Geraldton right through to the Gibson Desert, the region is renowned for its array of mineral resources, tourism opportunities and the agricultural and fishing industries.

The State Government is committed to the sustainable development of the Mid West, and the *Mid West regional water supply strategy* is an important step in preparing the region for further development. The strategy considers a range of water demand scenarios for mining, industry, agriculture and towns in the region and identifies water supply options to meet demand well into the future.

Water that is currently available in the region can present quality and access challenges, which need to be considered when planning future mining, agricultural and industrial developments.

The good news is that the strategy's water demand forecasts indicate water supplies for Geraldton and the region's other major towns are secure until at least 2030. The long-term outlook for meeting the increasing water demand in the 'SuperTowns' of Jurien Bay and Morawa is also positive.

In 2012 the State Government commenced a four year, $1.9 million Royalties for Regions-funded investigation of new and existing groundwater resources in the East Murchison to support economic growth in the region.

In addition, we recently commenced an assessment of water resources to support growth of irrigated agriculture in the West Midlands, as part of the Government's Water for Food program, which is also supported by Royalties for Regions.

The government is committed to securing a bright future for regional Western Australia. Our water planning and investment in the Mid West region is further evidence of the importance we place on our regional towns and industry.

Hon Mia Davies MLA

Minister for Water

Contents

Figures

Tables

Summary

Water use in the Mid West region could more than double over the next 30 years, from 75 gigalitres[1] per year (GL/year) to over 180 GL/year. The main drivers of growth in the region include:

- proposed and planned mining projects
- a potential future port and industrial estate at Oakajee
- development of new areas for irrigated agriculture
- growth of Geraldton and rural towns, including the 'SuperTowns' of Jurien Bay and Morawa.

The Mid West region is almost entirely dependent on groundwater for its water needs. The total volume of groundwater available in the region is greater than the projected demand. However, localised shortages and competition for high quality water sources will increase with rising demand.

More than 200 GL/year of groundwater is still available for general use in the Northern Perth Basin, which underlies much of the western part of the region. Most of the fresh to marginal quality water used in the region will continue to be drawn from these sedimentary aquifers within 100 km of the coast.

Further inland, groundwater in fractured rock aquifers is generally saline and the volumes are often small or unable to be maintained over time. Most mining activities can adapt to using the water available, but the growing magnetite mining industry requires greater volumes of higher quality water. Future water solutions for mining include the treatment and use of locally available, lower quality water as well as higher quality water supplies at a distance from mine sites. The Department of Water's $1.9 million Royalties for Regions-funded investigation of palaeochannels in the East Murchison will be completed in 2016 and provide new water supply options for future mining development.

Projected water needs for industrial uses in the Mid West region largely depend on whether and when a new port is established at Oakajee in response to growth in magnetite mining. Local groundwater is limited, so water supply options include piping water from the Carnarvon Basin (for which more detailed groundwater investigations will be needed), piping water from the Northern Perth Basin (which may include trading of water licenses) or seawater desalination on-site.

[1] 1 gigalitre equals 1 billion litres

Most of the likely growth in urban water demand is for the Geraldton-Dongara Regional Water Supply Scheme. There is sufficient water from current groundwater sources to meet this demand until after 2030. Sufficient water is also available to meet demand in the towns of Jurien Bay and Morawa, even under the high population growth forecasts for the State Government's Regional centres development plan ('SuperTowns') initiative.

The upper demand range for agriculture assumes that 2500 ha of land is developed for irrigated agriculture in addition to existing areas, requiring 30 GL/year by 2043. The most economically viable water source for growth of irrigated agriculture in the region is locally available, high quality groundwater, where it coincides with high quality agricultural land. Effectively meeting future demand for agriculture will depend on targeted groundwater investigations and planning, and early consideration of water supplies for new projects. Commencing in 2015, the Water for Food Midlands groundwater and land assessment project, funded by the Royalties for Regions initiative, will assess the potential for expansion of irrigation agriculture in an area west of Moora to Dongara.

The future water demand scenarios (Figure 1) reflect the development potential for a diverse range of industries in the Mid West region. Our strategy for managing the region's water resources therefore must be adaptable to a variety of possible futures.

The Department of Water has developed the *Mid West regional water supply strategy* to inform long-term planning and regional development. Five strategies guide how government, industry and the community can work together to ensure water is available to meet future demand in the Mid West region.

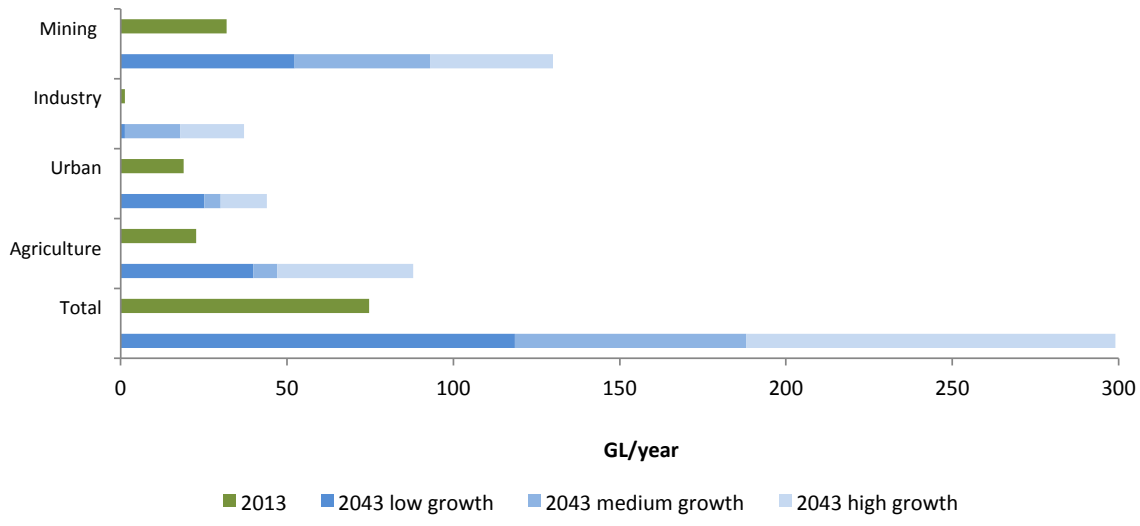

Figure 1 | Current and estimated future water demand by sector in the Mid West region

Strategy 1:

Maximise the sustainable use of local groundwater resources as a cost-effective supply for the long-term.

The *Arrowsmith groundwater allocation plan* (DoW 2010a) and *Jurien groundwater allocation plan* (DoW 2010b) provide the allocation limits and approach to managing groundwater resources in the Northern Perth Basin.

As water demand pressure in the Northern Perth Basin increases, new knowledge will inform our next phase of planning. Recent and proposed investigations into groundwater, ecosystems and climate studies, information from private sector water resource investigations and Department of Agriculture and Food WA land assessments will underpin increasingly precise allocation limits and optimised water management.

The department recognises changing stakeholder needs in the Mid West region. We will continue to engage Mid West region stakeholders on policy options for releasing and managing available water. We will also implement measures to address the difference between existing licensed entitlements and the water required in high competition areas, to maximise the water available for new water developments.

Strategy 2:

Make the best use of water through a focus on water use efficiency, recycling and integrated water and land use planning.

Water can be used more efficiently, particularly in areas of greatest scarcity, and better use can be made of fit-for-purpose water. The mining sector will increasingly make more effective use of freshwater by matching the water source quality to the various requirements of the mining process, and consider opportunities for water recycling. There is also potential for fit-for-purpose water supplies to be developed for irrigation of public open space, and new industrial demands.

Water requirements and impacts have to be considered early in land use planning. The Department of Water will advise other agencies and proponents of sustainable and cost-effective water supply options, and guide future growth to occur in areas where water is available.

In partnership with the Cooperative Research Centre (CRC) for Water Sensitive Cities we will support the City of Geraldton to implement the *Towards a water sensitive city: Greater Geraldton water planning and management strategy* (2014) to become a ‘water sensitive’ city.

Strategy 3:

Investigate and assess water resources to support regional development.

The department's program of groundwater resource investigations identifies areas where water is available to support regional development. The knowledge gained from these investigations will be used to inform future water licensing, allocation planning and water supply planning.

Our Royalties for Regions-funded investigation of palaeochannels in the East Murchison groundwater area, to be completed in 2016, will provide information on water availability and identify prospective resources close to planned or undeveloped mining areas.

The Water for Food Midlands groundwater and land assessment project, funded by the Royalties for Regions program, will investigate water and land resources to determine the potential growth of irrigated agriculture in the Mid West region. This project will be completed in 2018.

A recent groundwater investigation in the Allanooka and Casuarinas groundwater subareas of the Northern Perth Basin improved our understanding of groundwater flow and salinity. This will support strategic planning and management to best maintain these important resources for the region's major population centres.

There are several potential groundwater sources within a 70 km radius of Oakajee that would require further investigations to confirm whether they are options to support industry development.

Strategy 4:

Ensure emergency livestock water sources are available for areas with less than 600 mm annual rainfall.

The department's rural water planning program provides incentive schemes, planning and technical services, and emergency water arrangements for rural communities in dryland farming areas.

Between May and October each year the department also provides monthly updates tracking the seasonal rainfall and streamflow to assist emergency water supply planning.

Strategy 5:

Strengthen industry partnerships and collaboration in water supply planning.

The department will actively engage with mining and industry bodies to exchange information on upcoming demands and options to meet new demand. We will also work with the Water Corporation to track water demand and supply options for urban growth. This will be used to regularly review the water demand–supply balance and inform our groundwater investigation and planning priorities.

Our *Western Australian water in mining guideline* (DoW 2013a) provides a framework to address water needs of new and changing projects early in the approvals process – well before a water licence is issued. As development projects for a port and industrial estate at Oakajee are defined, further work will be needed to calculate the water quality and quantity requirements. Early planning and engagement with the department is encouraged to explore cost-effective, fit-for-purpose water supply options.

Purpose of this strategy

1.1 Background

The Department of Water manages Western Australia's water resources to support the state's economy, sustain the environment and provide amenity for the community. We continually adapt to new challenges including the rising demand and competition for freshwater resources.

The Mid West region has recently benefitted from public and private investment in major projects. These include the Mid West Energy Project, Australian Square Kilometre Array Pathfinder project and the Karara iron ore project. Regional development arms of government and the private sector are seeking to further diversify and grow the regional economy.

The availability of suitable land, energy and water is critical for regional development. Government has a core role in ensuring well planned services and land and water resources are sustainably managed to allow regional growth.

1.2 Regional scale water supply planning

This *Mid West regional water supply strategy* will help to ensure water supply investment is aligned with state development objectives and land-use planning at a regional scale. It will also provide the foundation for more detailed planning at a local area and site scale.

The strategy is based on projections of water demand for all water uses during the next 30 years. To inform future planning, investigations and decision making, it identifies:

- the timeframes for when demand will exceed existing supply
- water supply options to meet new demand
- water supply planning actions to support regional development.

Water service providers and self-supplied water users generally undertake resource investigations, water supply design and cost estimates before deciding on the best supply option. Water supply options identified in this strategy are to inform future planning and investment decisions by both government and the private sector. However, the identification of options in this strategy does not mean they will be developed and funded by the government. Appendix A has more information on the roles of water service providers and self-supply users in planning and developing water supplies.

1.3 Intended outcomes

Applying this *Mid West regional water supply strategy* will support integrated regional planning outcomes:

- Water supply planning and resource investigations support state land use and development objectives.
- Information on water resource and supply options for towns and regional development is available to government, industry and the community.
- Water users make decisions about developing water supplies based on knowledge of all available water resources and supply options.
- Innovative, efficient and integrated water supplies are developed through early detection of water shortages and timely planning.

1.4 Strategy development

This strategy has been developed with input from the Senior Officers Group for water supply planning, chaired by the Department of Water. The Senior Officers Group includes representatives from the Water Corporation and the departments of State Development, Planning, Agriculture and Food WA, Premier and Cabinet, Treasury, Finance and Regional Development. We have also consulted other relevant government agencies, industry representatives and regional stakeholders during preparation of this strategy.

Mid West regional profile

2.1 Strategy area

The Mid West region is characterised by a coastal area that includes the region's major population centres, a resource-rich hinterland dominated by dryland agriculture and a sparsely populated interior with significant mineral reserves. The region is bounded by the Wheatbelt and Gascoyne regions, known for food and fibre production, as well as the resource-rich Pilbara and Goldfields regions.

The strategy area covers approximately 475 000 km^2 and extends along the Western Australian coastline from 5 km south of Cervantes to the northern border of the Shire of Northampton and east to the Shire of Wiluna (Figure 2). The strategy area aligns with the Mid West regional planning boundary (as defined in the *Planning and Development Act 2005*), but also includes the portions of the Shires of Dandaragan and Moora (within the Wheatbelt Development Commission boundary) that fall within the Jurien groundwater area.

2.2 Water supplies

The Mid West region is almost entirely dependent on groundwater for its water needs. Land and water use in the region is therefore closely associated with the underlying hydrogeology. Groundwater in the region is clearly divided into coastal sedimentary aquifer systems to the west and irregularly fractured rock storages in the eastern part of the region (Figure 3).

Northern Perth Basin

Most freshwater is taken from sedimentary aquifers within 100 km of the coast. In particular, the Parmelia and Yarragadee formations of the Northern Perth Basin provide large volumes of good quality water (Figure 3).

The Northern Perth Basin of the Mid West region is covered by the Arrowsmith and Jurien groundwater areas. Our management of these areas is guided by the Jurien and Arrowsmith groundwater allocation plans. We review if our management of these areas is meeting the objectives stated in the allocation plans annually.

More than 200 GL/year of groundwater is still available for general use and 28.5 GL/year is reserved for public drinking water supply in the Northern Perth Basin. We are steadily increasing our management of the water resources as demand approaches the allocation limits set for the Arrowsmith and Jurien groundwater areas.

Our knowledge of the Northern Perth Basin is supported by the collection of large volumes of data from government investigation programs, private bore records and geological reports. We are continuing to compile this information in order to make it widely available to groundwater professionals, groundwater users and the general public.

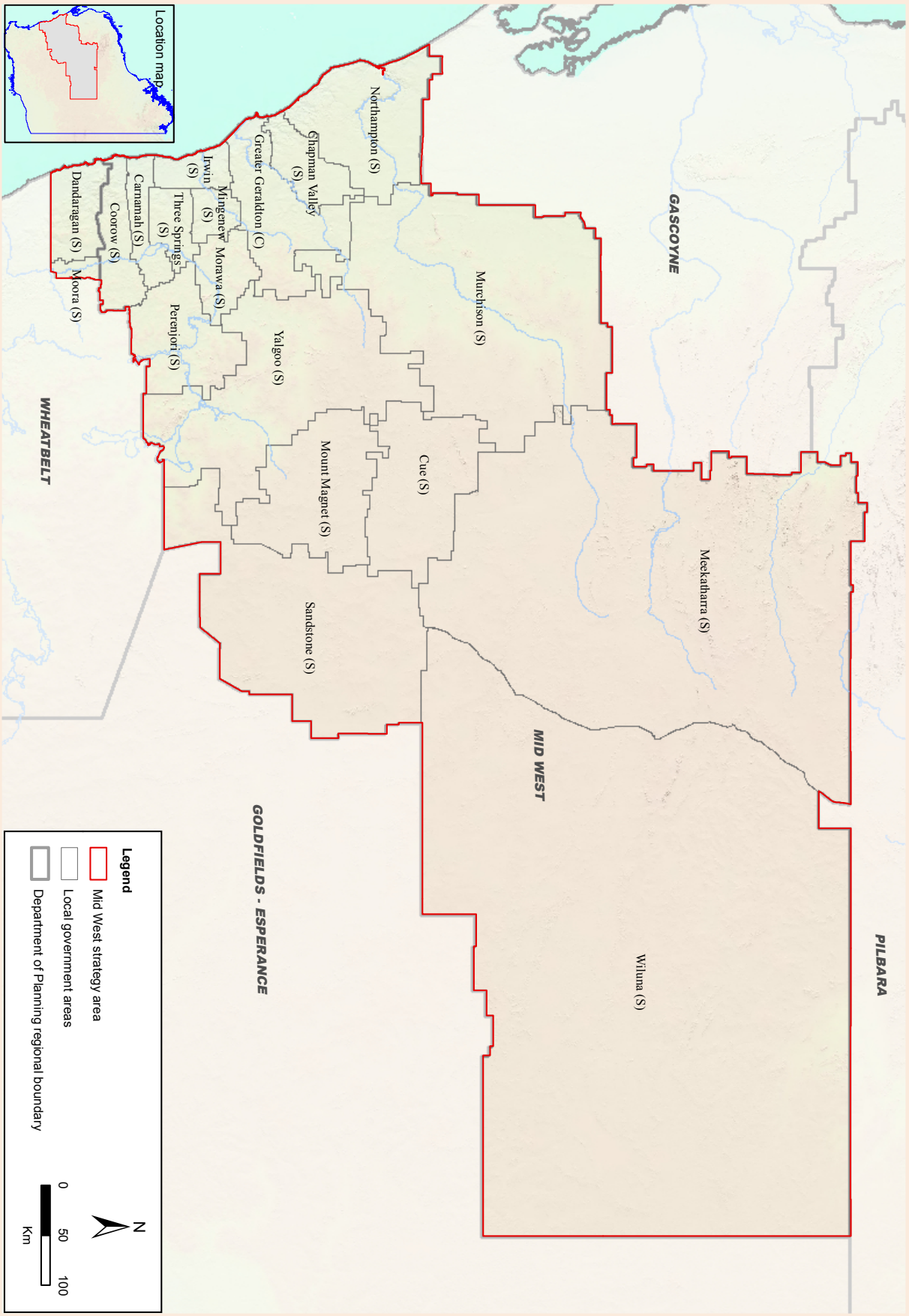

Figure 2 | Local Government Authority boundaries within the Mid West region

We recently completed a comprehensive groundwater investigation of the Allanooka and Casuarinas groundwater subareas in the Northern Perth Basin. The study improved our understanding of groundwater flow and salinity and will allow the development of strategies on how to best manage and preserve these important resources.

In our next revision of the Arrowsmith and Jurien allocation plans, scheduled for after 2017, we will use this new information from investigations into the hydrogeology of aquifers and groundwater-dependent ecosystems of the Northern Perth basin. The impacts of climate change on recharge will also be reviewed during this process.

Inland fractured rock

The eastern, inland part of the region is dominated by fractured-rock, alluvium, calcrete and palaeochannel deposits, which have poor yields of mainly saline groundwater (Figure 3). These resources are mostly within the Gascoyne and East Murchison groundwater areas.

Our knowledge of groundwater in the inland parts of the Mid West region has largely been gained from investigations by mining companies and pastoralists to develop water supplies. We have also compiled information from regional groundwater assessments and various hydrogeological reports to locate water resources to support development in the region.

The Department of Water is now starting an investigation into the palaeochannel aquifer systems of the East Murchison groundwater area, where hydrogeological information is currently very limited. The $1.9 million Royalties for Regions-funded project will be completed in 2016. It will significantly improve our knowledge of aquifer extent, storage, recharge zones, water quality and acceptable yield of palaeochannels in the region.

Surface water

The Mid West region has an extensive network of rivers and streams, many of which support important ecological and social values. Most of these waterways are seasonal, flowing only when there is high summer rainfall or a wet winter. They tend to be brackish (1501–5000 mg/L) and often interact with groundwater.

Six surface water areas within the Mid West region are proclaimed for licensing purposes under the *Rights in Water and Irrigation Act 1914:*

- Gascoyne River (majority in Gascoyne region)
- Greenough River
- Eneabba coastal tributaries
- Hill River and tributaries
- Irwin River and tributaries
- Nambung/Cataby coastal tributaries.

Variable rainfall and surface water yields in the region mean taking water from rivers is limited to opportunistic small-scale use. High evaporation rates and sandy soils also hinder the capture and storage of surface water runoff.

There are currently no allocation limits set for proclaimed surface water resources in the region and proposals to take surface water are assessed on a case-by-case basis.

In unproclaimed surface water areas, landowners can take water without a licence provided they do not significantly diminish the flow of water in the watercourse.

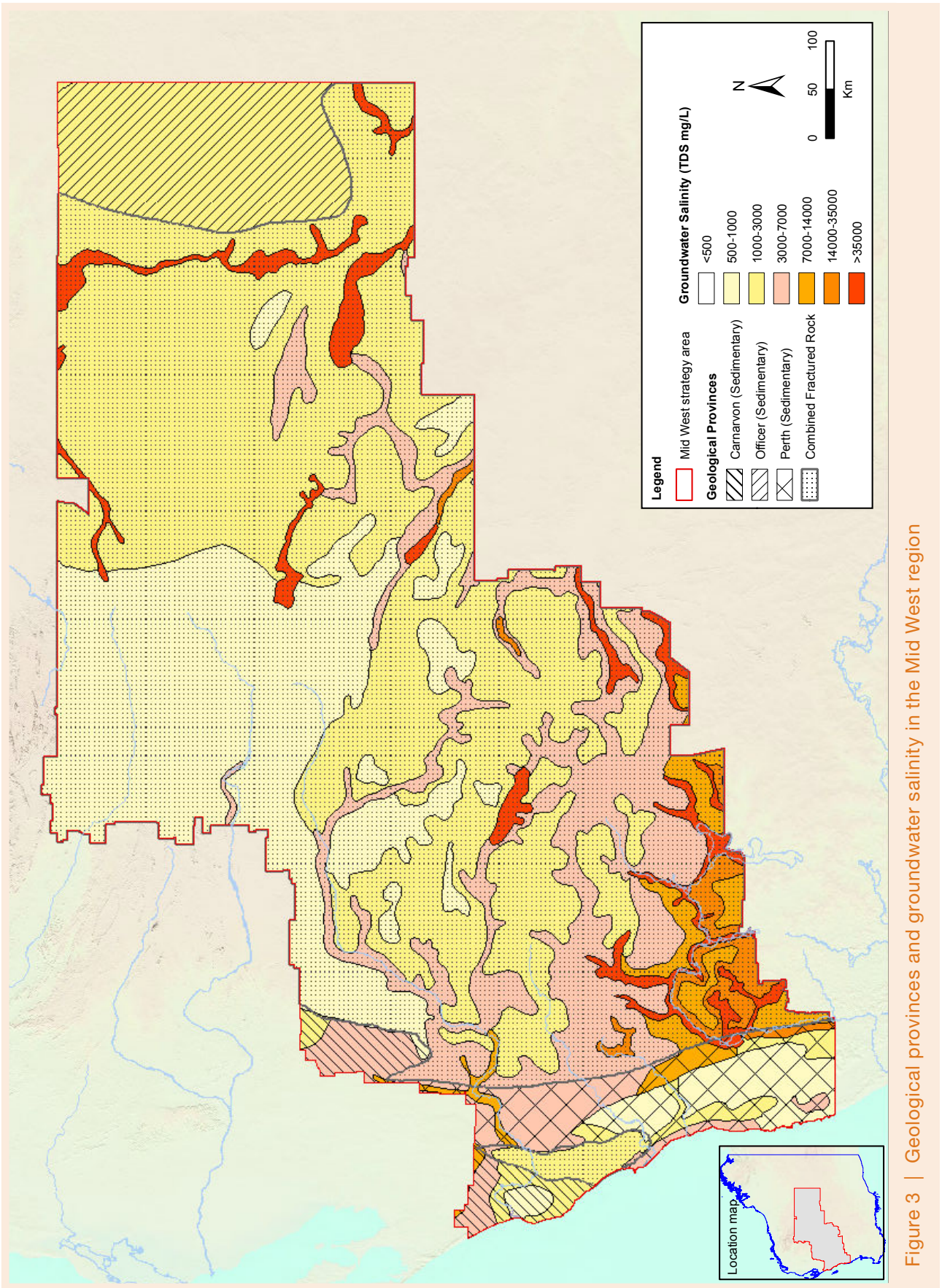

Figure 3 | Geological provinces and groundwater salinity in the Mid West region

Seawater desalination

Seawater desalination is not currently used as a water source in the Mid West region, although it has been identified as a potential option for supplying a port and industrial estate at Oakajee. New technology means that the cost of desalination is decreasing and it is one of the few water supply options that is independent of climate.

The availability and cost of energy, the carbon footprint and the effects of brine discharge are important factors in considering desalination.

Alternative water supplies

Alternative water supplies such as recycled wastewater, grey water, stormwater and rainwater tanks are important fit-for-purpose options that can help reduce the pressure on the region's potable water supply schemes or high quality groundwater resources. These technologies can be applied at the scale of lot, estate or suburb.

Use of recycled water by industry and for public open space in 2013 was estimated to be 0.3 GL. Around 23 per cent of wastewater in the region is currently reused, primarily for irrigation of sporting grounds and public open space (Water Corporation 2012). This includes recycling schemes in Geraldton, Kalbarri, Dongara and Morawa. The Narngulu wastewater treatment plant was built as a high performance 3.5 ML/day, aerated lagoon system to service the Narngulu Industrial area (DEC 2008). There is potential for future reuse by industry or for irrigation purposes.

The City of Geraldton is also implementing pilot projects examining the potential to harvest and redirect stormwater from urban catchments. Stormwater is currently harvested from grain storage sheds at the Geraldton port, infiltrated into the superficial aquifer and used for irrigating public open space (City of Greater Geraldton 2014).

The Department of Water's *Guideline for the approval of non-drinking water systems in Western Australia* (2013b) provides advice to land developers and local governments on creating a development-scale supply of non-drinking water.

2.3 Challenges to regional water supplies

Increasing demand for water

An estimated 75 GL/year of water is currently abstracted (almost entirely from groundwater) for consumptive use in the Mid West region. Our forecasts indicate demand could grow to more than 180 GL/year by 2043 under a medium growth scenario (Figure 4). Much of this projected water demand relates to industries that are not yet established in the region, so there is a wide range of possible growth scenarios.

In addition to the volume of water required, the location, quality and depth to water have to be considered in forecasting if water is available to support future regional development. In total, there is enough water throughout the Mid West region to meet a high growth scenario for water demand to 2043. However, in reality demand will increase faster for the best quality and most accessible groundwater resources.

Competition is most likely to occur in the Northern Perth Basin in areas that are identified for intensive development of high water use industries. The high quality groundwater from the Northern Perth Basin could also be sought to meet more distant demands such as for magnetite mining in the East Murchison groundwater area or to supply Perth's Integrated Water Supply Scheme.

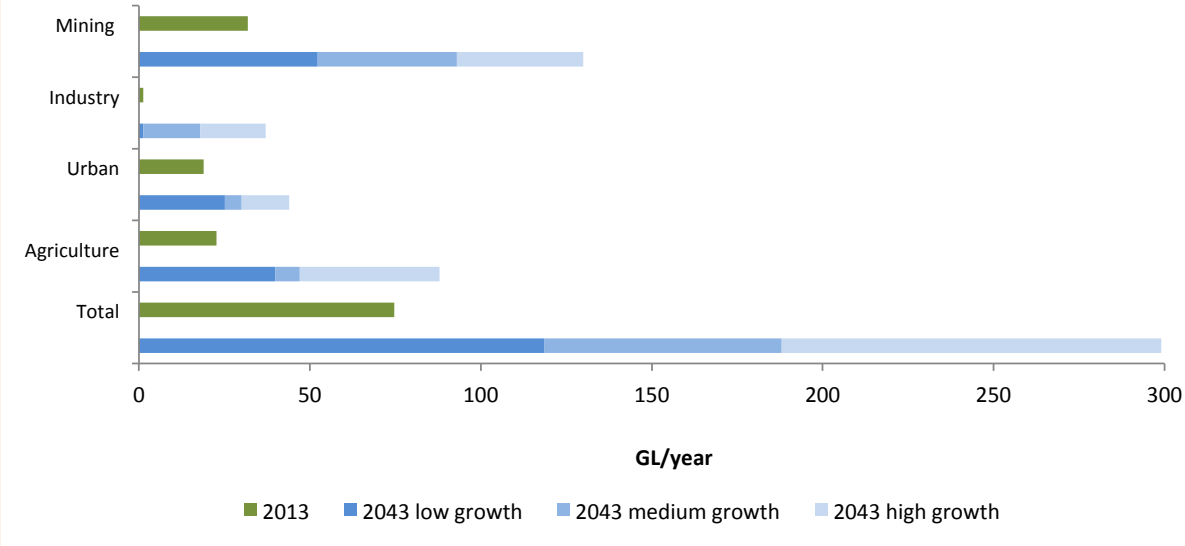

Figure 4 | Current and estimated future water demand by sector in the Mid West region

Climate

Coastal areas of the Mid West region generally receive an average of 400 to 500 mm of rainfall per year, with most rain falling during May to September. Since the year 2000, Geraldton has exceeded the long-term average rainfall only once (Figure 5).

Inland areas of the region receive less than 250 mm/year, with more erratic rainfall as a result of summer thunderstorms or depressions from cyclonic events occurring in the north. Wiluna, one of the furthest inland towns of the region, has experienced an increased average annual rainfall over the last ten years compared to the long-term recorded average (Figure 6).

Department of Water modelling indicates that there will be increased temperatures and decreased rainfall across the Northern Perth Basin for each of three future climate scenarios (wet, median and dry), which are based on twelve global climate models and four emissions scenarios (Marillier et al, in press). Recharge to aquifers will reduce under these scenarios so the total volume of water available today in the Mid West region may change in the future.

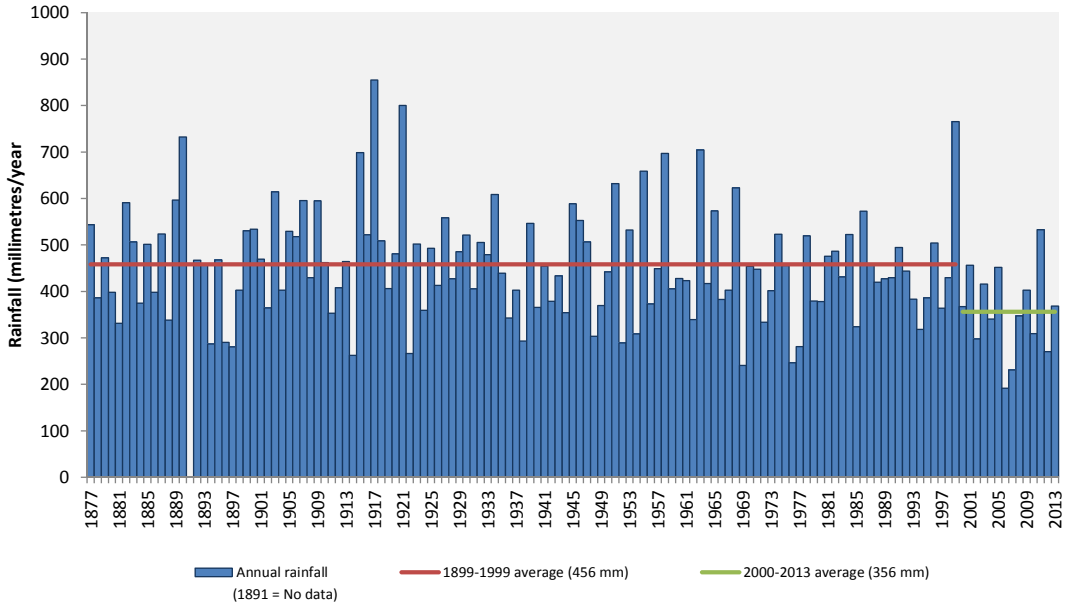

Figure 5 | Historical annual rainfall for Geraldton[2]

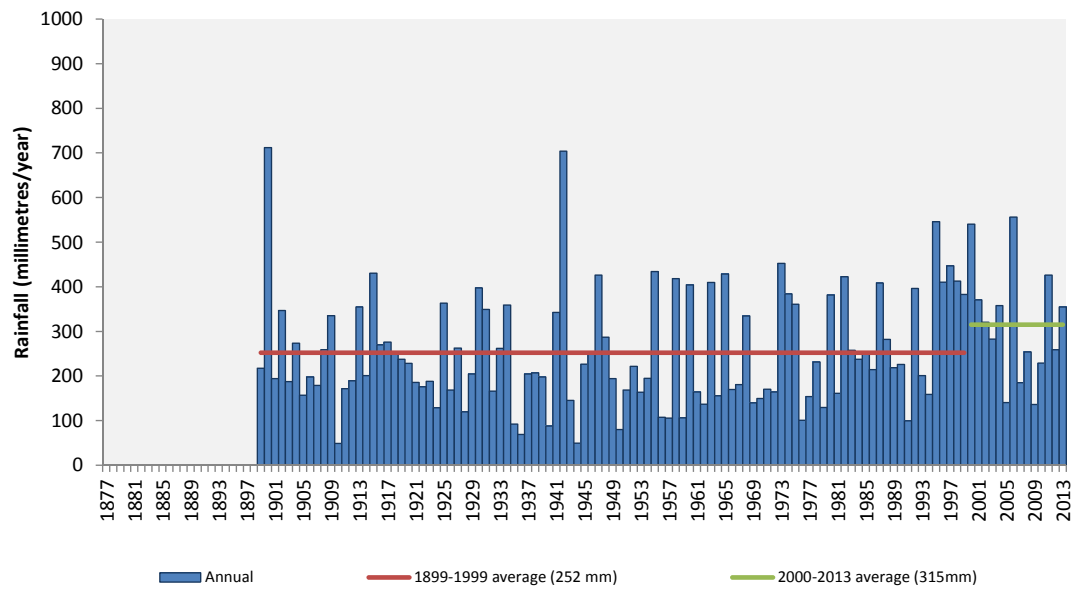

Figure 6 | Historical annual rainfall for Wiluna[2]

[2] Data from Bureau of Meteorology 2014 a, b

Mid West regional water demand and supply

In 2013, water demand for the Mid West region was approximately 75 GL/year. This was almost entirely sourced from groundwater. Less than one per cent was from other sources such as surface water and recycled water.

The total volume of groundwater licensed for use in the region is 186 GL/year. However, according to monitoring data submitted by water users only 65 GL of the total licensed entitlements was actually used in 2013. A further 10 GL is estimated to be used for purposes that do not require a licence (e.g. stock and domestic purposes). The difference between the volume of water licensed and the volume actually abstracted is due to large fluctuations in water use throughout mine lifecycles and variations in crop water demands from year to year.

A water demand scenario-modelling tool was used to estimate future water demand in the Mid West region (see Appendix B – Methodology). The tool combines regional economic growth data and population forecasts to estimate a range of water demand scenarios to 2043. We have also taken account of advice received from across government and industry on the potential for the following trend-breaking growth:

- proposed and planned mining projects
- a potential new port and industrial estate at Oakajee
- developing new areas for irrigated agriculture
- urban expansion, particularly in Geraldton and the towns of Jurien Bay and Morawa, which are involved in the Regional centres development plan ('SuperTowns') initiative.

Our forecasts indicate that under a medium growth scenario regional economic growth could result in a doubling of the demand for water in the Mid West region over the next thirty years (Table 1). The iron ore sector is expected to be the major driver of this increased water demand. This will increase water use directly for mining operations and industrial port water use, and indirectly for the regional population and service industries. Current and proposed mining and industry projects are shown in Figure 7.

In 2012–13, 10.7 million tonnes of iron ore were exported (Geraldton Port Authority 2013). With recent upgrades, the Geraldton port now has the capacity to handle 20 million tonnes per annum (Mtpa) of iron ore.

A site at Oakajee, approximately 30 km north of Geraldton, has been identified as a potential location for a new port that could support the forecast long-term growth of iron ore exports from the region. Planning for the port indicates a start-up capacity of 45 Mtpa of iron ore, with the capacity to increase to 70 Mtpa. A third berth could increase capacity to 105 Mtpa.

Table 1 Projected water demand by sector in the Mid West region

Sector		Water licensed (GL/year)	Water taken (GL/year)	Water quality required*	Projected water demand range† by 2043 (GL/year)	Groundwater subareas with high water demand
Mining		111	32	Fresh to hyper-saline	52–130 (93)	Egerton, Meekatharra, Mullewa/Byro
Industry		1	1	Fresh to brackish	1–37 (18)	Casuarinas, Dongara, Kalbarri/ Eurardy
Agriculture		48	15	Fresh to marginal	28–74 (35)	Dongara, Eneabba Plains, Twin Hills
Unlicensed stock and domestic		0	8	Fresh to brackish	11–14 (12)	
Town water supply schemes		22	13	Fresh to marginal	20–35 (23)	Allanooka, Cervantes, Dongara
Urban – self supplied	Licensed	4	3	Fresh to brackish	6–9 (7)	Casuarinas, Dongara
	Non-licensed	0	3			
Total		186	75		118-299 (188)	

* See Appendix C

† Medium demand in brackets

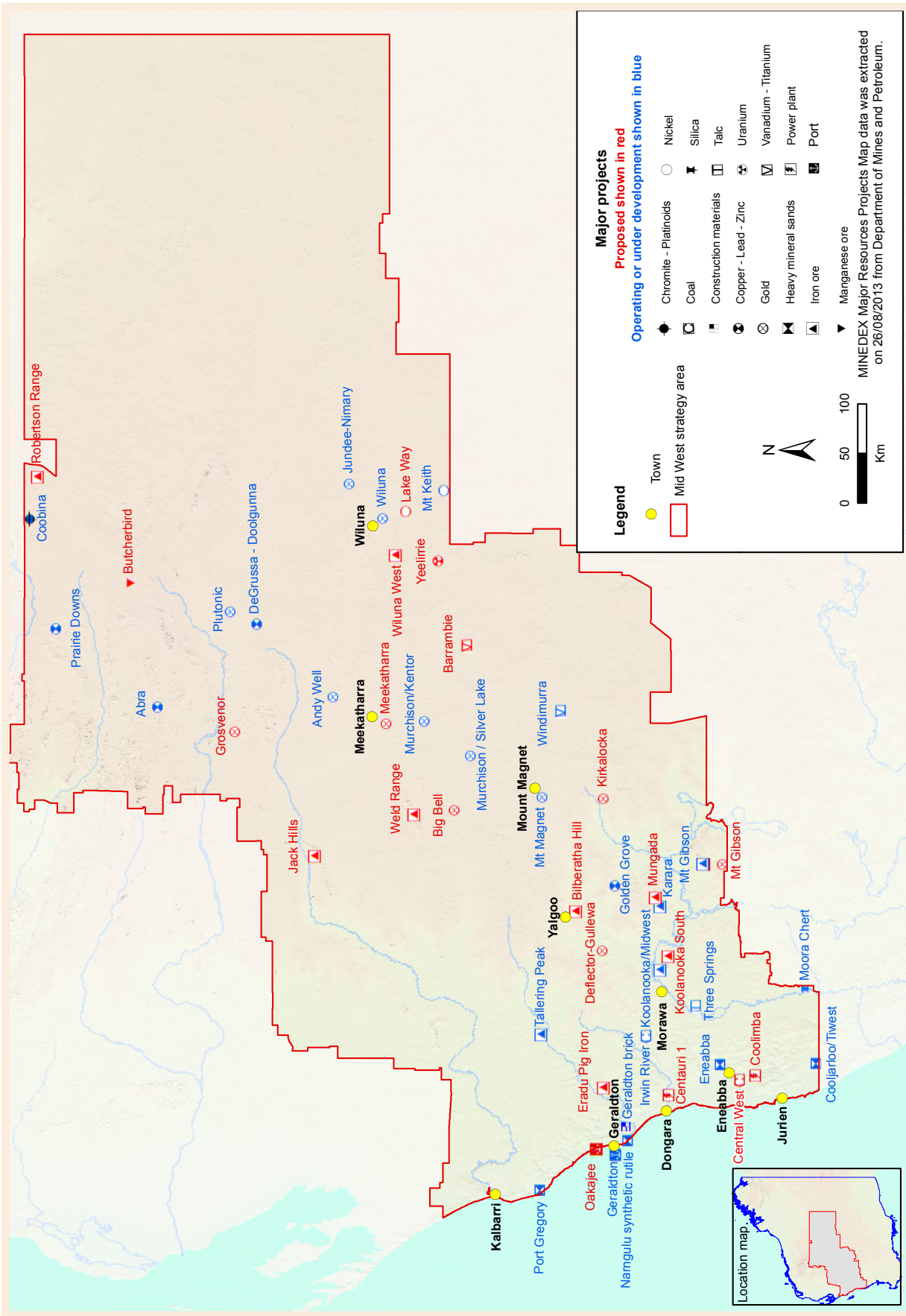

Figure 7 | Current and proposed mining and industry activities in the Mid West region

3.1 Mining

Approximately 111 GL/year of water is currently licensed for mining activities in the region. This includes water for mine dewatering, mineral processing, dust suppression, exploration and mine camps.

In 2013, only 32 GL/year was abstracted[3]. Most of this water was used on-site; however, an estimated 1.4 GL/year of excess dewater was discharged to the environment. Controlled releases of dewatering surplus are subject to regulation by the Department of Water and the Department of Environment Regulation to minimise impacts on the environment and optimise use of fit-for-purpose water.

The emerging iron ore, uranium and on-shore gas industries will create further demand for water in addition to established mining activities targeting gold, mineral sands and base metals. Water abstraction for the mining sector in the Mid West region is expected to increase to around 90 GL/year under a medium growth scenario and 130 GL/year under a high growth scenario by 2043 (Figure 8).

Further information on water demand and supply for the different mining sectors is provided below.

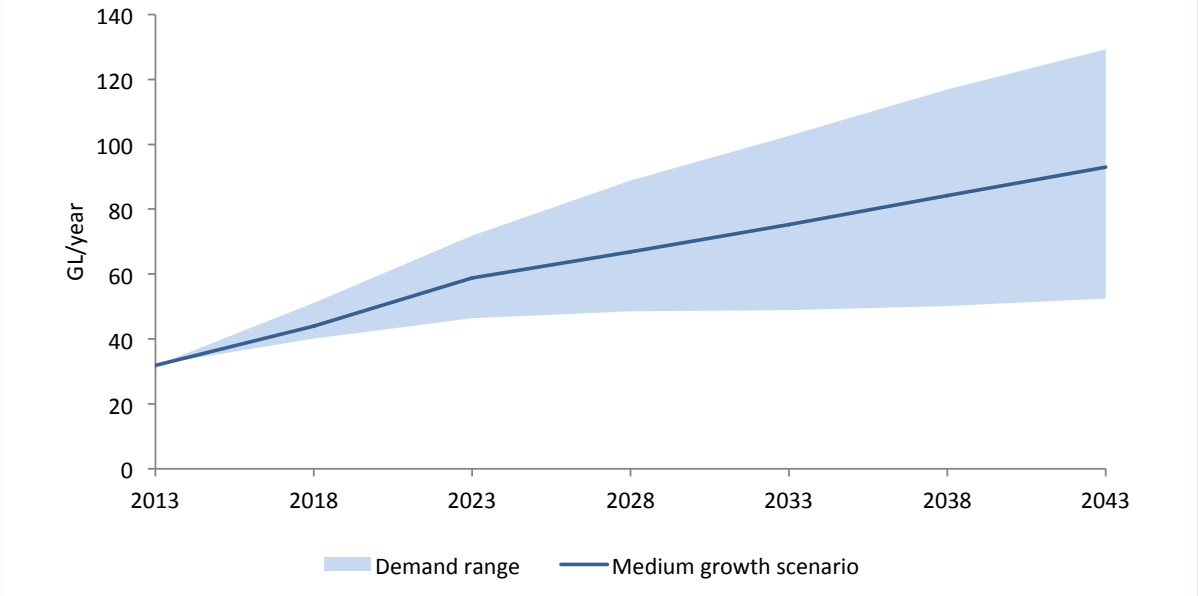

Figure 8 | Projected water demand for mining in the Mid West region

[3] Abstraction estimate is based on monitoring data from licensed water metering reports. Abstraction is lower than licensed entitlements as the full entitlement is the volume required by a company when reaching full production, and if dewatering is required, will meet peak dewatering rates (including during high rainfall events). Abstraction will vary throughout the life of a mine.

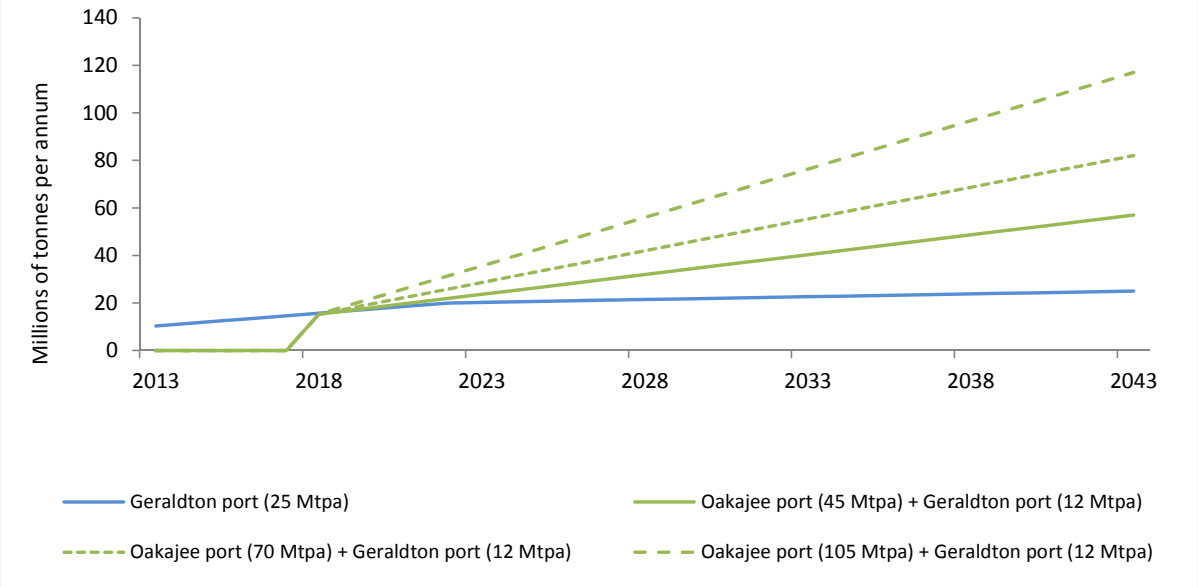

Figure 9 | Iron ore export capacity scenarios in the Mid West region

Iron ore

Proposed development of magnetite ore bodies within the Gascoyne and East Murchison groundwater areas is the main driver for an increase in mining water demand. The first shipment of magnetite from the Mid West region was made in early 2013. Until then hematite was the only iron ore exported from the region. The emergent magnetite industry requires higher quality groundwater for some phases of mineral processing.

At present, the Geraldton port can handle 20 Mtpa of iron ore; however, we have assumed that 25 Mtpa could be exported from the region without developing a new port. Water entitlements have already been obtained to meet most of the water demand for iron ore mining under this scenario.

The potential development of a port at Oakajee would allow significant additional volumes of iron ore to be exported. Indicative scenarios for the growth of iron ore mining in the region are therefore based on three development scenarios for a port at Oakajee with an export capacity of 45 Mtpa, 70 Mtpa and 105 Mtpa (Figure 9). For these scenarios exports from Geraldton port are assumed to decrease to 12 Mtpa following construction of Oakajee.

Approximately 50 GL/year of water would ultimately be needed for magnetite mining if Oakajee is developed and gradually increases to a capacity of 45 Mtpa. More than 90 GL/year will be needed for iron ore mining if production attains a level that would see a port at Oakajee progressively expand to three berths (capacity of 105 Mtpa).

Proposed magnetite mines are located in fractured rock groundwater areas. Piping better quality and reliable volumes of groundwater from the sedimentary aquifers within the Arrowsmith and Gascoyne groundwater areas has therefore become an option to supply magnetite mines. However, as the subareas in the eastern parts of the Arrowsmith groundwater area near full allocation, increasingly long distance transport of water is needed. This constraint may drive the development of lower cost methods to use water that is more readily available, but of poorer quality. This includes treating or adapting production processes to use lower quality local groundwater.

To support the anticipated growth of magnetite mining, a major initiative is the Department of Water's investigation of palaeochannel aquifers within the vicinity of magnetite projects. The $1.9 million Royalties for Regions-funded project to be completed by June 2016 aims to define the Murchison palaeochannels in terms of their extent, water storage, yield, water quality and viability for abstraction. The study will be conducted using a fixed-wing airborne electromagnetic survey of palaeochannels within the investigation area (Figure 10). The department will work with industry to identify potential data sharing opportunities that could complement the investigation work.

Gold mining

Most gold mining occurs between Morawa and Meekatharra in the East Murchison groundwater area. In 2013, 51 GL/year was licensed for gold mining and we estimate that 15 GL of this entitlement was used. Only a small number of gold mining projects are currently operating, with the remainder under care and maintenance. Most projects do not require significant volumes of freshwater and therefore use groundwater from fractured rock, palaeochannels, alluvium and local calcrete aquifers.

Several proposals to expand or re-develop existing gold projects are in their early stages and have limited information on additional water needs. We have assumed that growth in gold mining will follow historical trends during the forecast period.

Mineral sands

Licensed water entitlements for mineral sands mining near Eneabba, Jurien Bay and Port Gregory total 22 GL/year and the estimated water use for 2013 is 5 GL.

Mineral sands mining was scaled back in the region after the global financial crisis. However, the processing of heavy minerals concentrate from other regions has increased at the expanded Narngulu processing plant near Geraldton. The department has worked closely with various mineral sand mining companies to facilitate access to groundwater for new and expanded mineral sands projects.

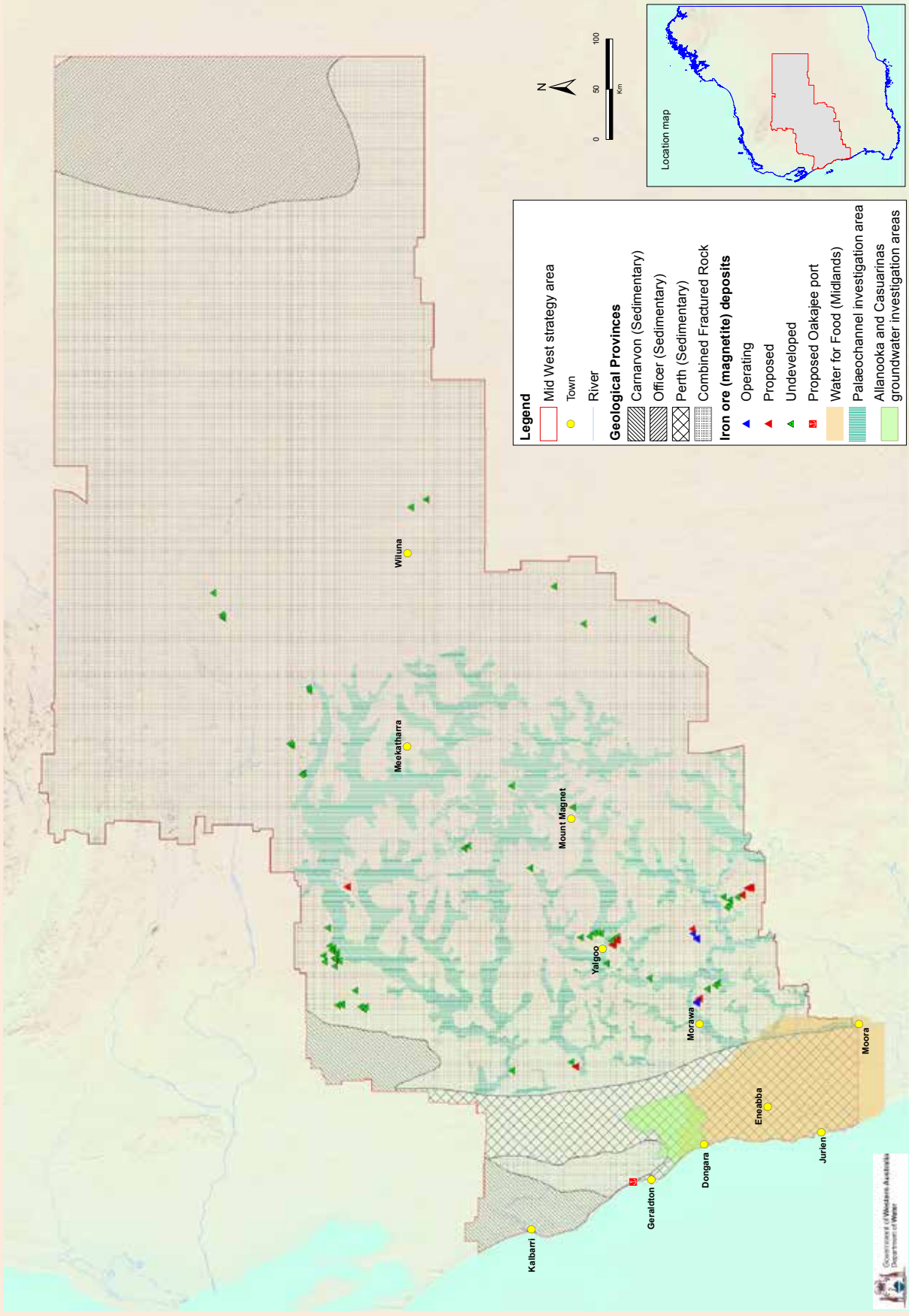

Figure 10 | Groundwater investigations in the Mid West region

Other mining

Most of the remaining water licensed for mining (24 GL/year) in the Mid West region is used in the extraction of nickel and base metals. We estimate that 7 GL was used for these mining activities in 2013.

The first vanadium mining project began production in early 2012. The forecast future water demand for current and proposed vanadium mining projects is 7 GL/year. There are currently no water licenses for uranium mining though water demand could reach 10 GL/year if proposed projects proceed to full production.

Oil and gas

Oil and gas production in the coastal areas of the Northern Perth Basin used less than 0.2 GL of the 0.7 GL of water licensed in 2013.

The growing interest in developing oil and gas resources means the demand for water by this sector is likely to increase. Shale and tight gas resources in the region are currently being explored to determine project viability. There are also numerous geothermal exploration sites indicating future growth of this industry.

On-shore gas resources in shale and tight gas formations are usually located at depths below 2000 metres, so generally well below aquifers currently used for water production or likely to be used in the future.

The Dandaragan trough is identified as the main potential shale gas area in the Mid West region. The trough is approximately 50 km wide and extends from Dongara to Dandaragan. It covers an area of the Northern Perth Basin that includes aquifers with significant volumes of unallocated, high-quality groundwater.

The volume of water needed for each well in the hydraulic fracturing process varies from project to project. It depends on the number of wells, size and length of the well and the properties of the rocks to be fractured. To extract tight and shale gas, horizontal wells are generally drilled to lengths of around 1.5 km or more and, depending on the number of fractures, could use around 20 000 kL of water per well during production. The relatively small volume of water needed for hydraulic fracturing indicates that competition for groundwater resources between shale and tight gas developments and other water demands will not be a significant issue.

Mining water supply options

Most new mining activities are located within the inland fractured rock areas, where groundwater quality is generally poor and yields are unreliable. Early consideration of water supply options in the planning process and the efficient use of water are therefore very important (Table 2).

The Department of Water's *Western Australian water in mining guideline* (DoW 2013a) assists mining proponents. We will support the mining sector in limiting its use of freshwater by matching the water source quality to the various requirements of the mining process, and consider opportunities for water recycling. High quality water should only be used for mining where it is essential or where no other suitable water source is available.

The department also encourages the productive and beneficial use of mine dewatering surplus[4]. This could include its use for irrigated agriculture, other mining operations, industrial use or urban water supply. Our Strategic policy no. 2.09: *Use of mine dewatering surplus* (DoW 2013c) promotes and encourages the appropriate use of mine dewatering surplus and provides information on the considerations for proponents and approvals required.

Table 2 Water supply options for mining in the Mid West region

Location	Option	Considerations
Northern Perth Basin	• Local groundwater • Water efficiency and local recycling • Fit-for-purpose use of poorer quality water • Water trading • Piping groundwater from other groundwater subareas	• Local water quantity and quality • Groundwater investigations and assessment • Competition with other water users • Distance to alternative sources
Fractured rock areas	• Local groundwater • Water efficiency and local recycling • Fit-for-purpose use of poorer quality water • Piping groundwater from the Northern Perth Basin or Carnarvon Basin • Piping water from palaeochannel resources in the East Murchison groundwater area • Water recycled and returned from slurry pipelines to port	• Local water quantity, quality and reliability • Groundwater investigations and assessment • Distance to source • Competition with other water users

[4] Mine dewatering surplus is the volume of water from a mine dewatering operation that is surplus to the water requirements of that mine.

3.2 Industry

Water use for industry in the Mid West region in 2013 was approximately 1.5 GL. Industries in the region include food processing, metal fabrication, chemical production and port water use. Around 1 GL was supplied through groundwater bores managed by individual water users. The Water Corporation also supplies scheme water to the Geraldton port and most industrial water users in the region.

There is a wide range of possible growth scenarios for industry in the Mid West region (Figure 11). Industry growth is linked to growth in iron ore exports and the potential development of a new port at Oakajee.

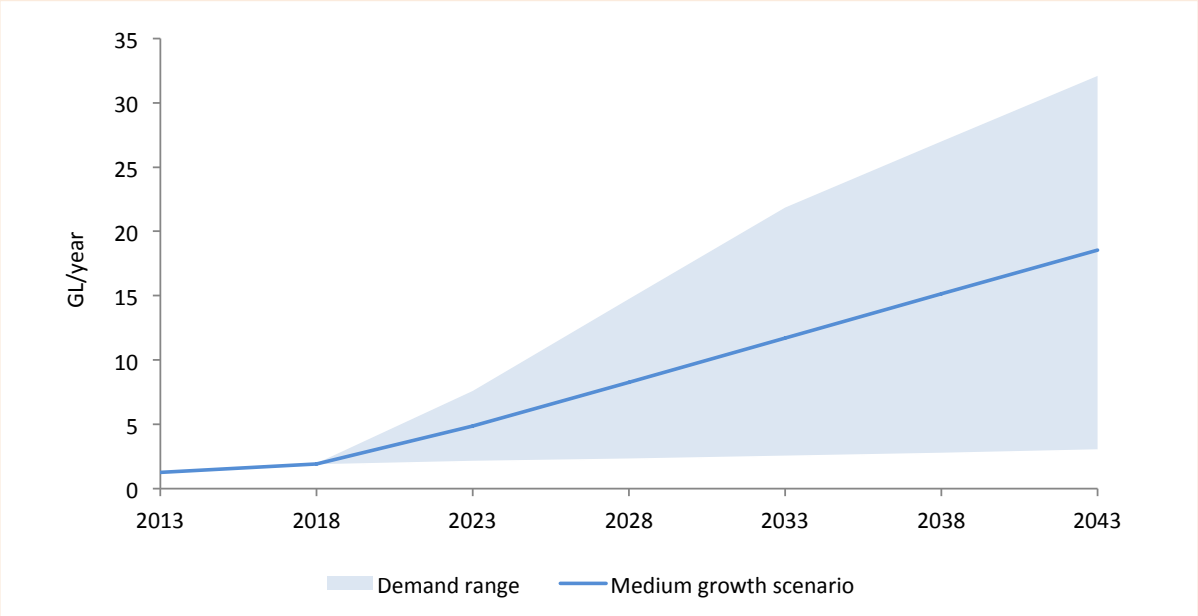

Figure 11 | Projected water demand for heavy industry in the Mid West region

Construction of a port at Oakajee and associated rail infrastructure would take approximately 36 months and require 3.5 GL of water (Oakajee Port and Rail 2010). About 5 GL/year of water would be required at the port to support the export of 45 Mtpa of iron ore. Local groundwater resources are available along the proposed rail line between the port and mine sites for construction and maintenance of the rail. However, there are insufficient volumes of local groundwater to meet operational water demands at the port.

Conceptual stage planning for Oakajee includes an industrial estate adjacent to the port facilities. Water demand for feedwater is estimated to be 29 GL/year by 2043 based on assumptions about the mix of industries that could potentially locate in the estate (GHD 2012a). This is made up of 19 GL/year of low quality (800–1000 mg/L total dissolved solids [TDS]) and 10 GL/year of high quality (100–200 mg/L TDS) feedwater for processing, cooling and dust suppression. Around 0.08 GL/year of potable water supply would also be required and is likely to be sourced from the Geraldton regional water supply scheme.

A district water management strategy (DWMS) was developed in 2012 to support the *Oakajee industrial estate structure plan* (GHD 2012a). A DWMS is a high level water management report required under the *Better urban water management* (WAPC 2008) process when developers propose a major change to land use. The Oakajee DWMS identified that forecast feedwater demand exceeds the local availability of freshwater (GHD 2012b).

In areas of limited fresh groundwater availability, heavy industry is encouraged to use lower quality water such as brackish to saline groundwater, recycled water or surplus mine dewater. Potential options to meet water demand for a port and industrial estate at Oakajee are summarised in Table 3.

Table 3 Water supply options for a port and industrial estate at Oakajee

Option	Considerations
Piping groundwater from more than 50 km away in the Carnarvon Basin	• Further investigation required to identify and confirm the size and quality of potential sources in the Gascoyne groundwater area • Distance to source
Piping groundwater from resources more than 50 km away in the Northern Perth Basin	• Competition with other water users (town and agriculture) • Distance to source
Wastewater recycling	• Low volume available from a new wastewater treatment plant north of Geraldton • Recycling within the industrial estate is a longer-term option once there is a base supply of wastewater
Reuse of water from slurry pipelines used to transport ore to the port	• Subject to development of privately owned slurry pipelines to transport ore from mine to port • Water recycled from the slurry could be returned to water deficit mine sites
Seawater desalination	• Cost effectiveness compared to long distance transport of groundwater • High energy demands, carbon footprint and brine disposal

As development projects at the port and industrial estate are further defined, additional work will be needed to more accurately gauge the water quality and quantity requirements. To ensure the efficient use of high quality water, water source quality needs to be matched to the different process water quality requirements. While the port and industrial estate are two separate developments, there are opportunities for sharing water supply infrastructure to avoid infrastructure duplication.

Early planning and engagement with the department is encouraged to explore cost-effective, fit-for-purpose water supply options.

3.3 Agriculture

Irrigated agriculture

Irrigated agriculture in the region comprises pasture for beef production, horticulture and tree farming (fruit and nuts). In 2013, 48 GL of groundwater was licensed to irrigated agriculture and 15 GL was used. The variability of annual inputs and outputs in agricultural production means that the portion of licensed water entitlements used changes from year to year.

Most water used for irrigated agriculture occurs in the Dinner Hill, Dongara, Eneabba Plains, Twin Hills and Northampton groundwater subareas of the Northern Perth Basin. This water is mainly drawn from groundwater bores, although some properties around Northampton and the Chapman Valley also use surface water for irrigation of fruit trees and vines. Climate and soil constraints preclude the opportunity to use surface water for irrigated agriculture in most other parts of the region.

A Department of Agriculture and Food WA (DAFWA) technical report (Tille et al. 2012) identifies high quality land suitable for irrigated agriculture in the Geraldton planning region. Growth of irrigated agriculture could also occur in the southern parts of the region to offset the displacement of agricultural land due to urban expansion around Perth.

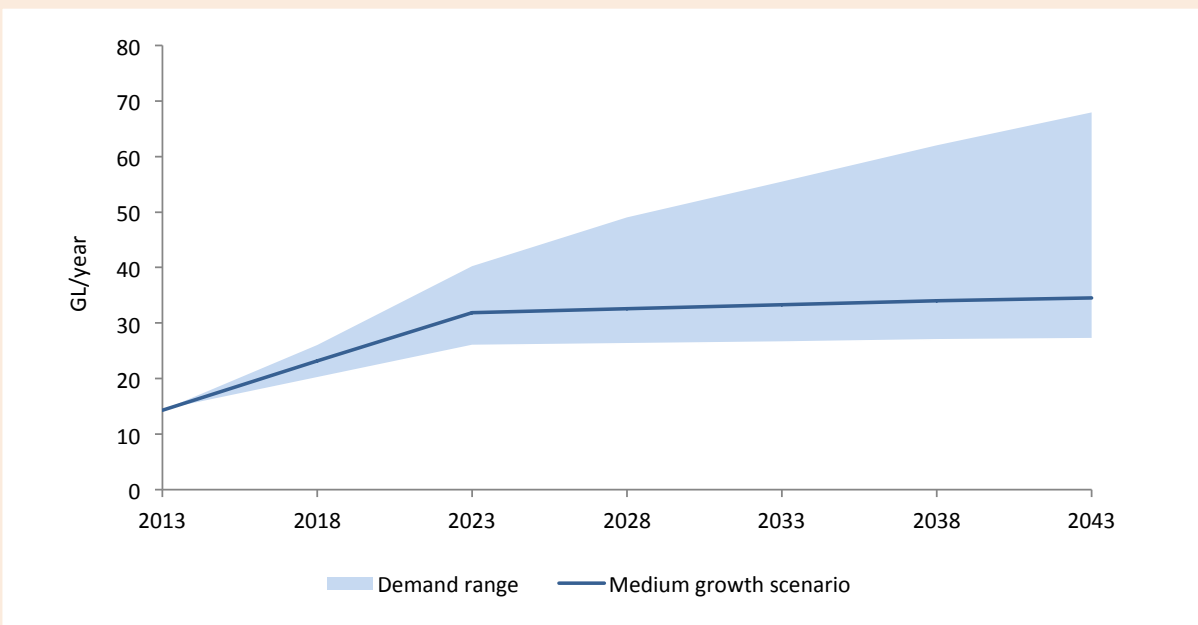

Figure 12 | Projected water demand for irrigated agriculture in the Mid West region

A medium growth water demand scenario for agriculture assumes that long-term growth trends continue in the region for agricultural exports and demand from domestic markets. The scenario also assumes that the existing staged development plans for irrigated agriculture are implemented by 2023. The upper demand range assumes that a further 2500 ha of land is developed for irrigated agriculture requiring an additional 30 GL a year by 2043 (Figure 12). Without any firm proposals to develop a large-scale irrigated agriculture precinct in the region, this high growth scenario is conceptual to inform future planning.

The most economically viable water source for irrigated agriculture in the region is locally available, high quality groundwater. There is 200 GL/year of water still available for general use from the Jurien and Arrowsmith groundwater areas. Local volumes available for self-supply users depend on the local hydrogeology and water quality.

The Badgingarra groundwater subarea has significant water resources and appropriate land for expansion of irrigated agriculture. To the north, the Twin Hills and Dongara groundwater subareas, including the Greenough Flats, also have suitable soils and available water.

The Department of Water will continue to support government objectives for determining state and regional areas of priority agriculture land. The department can assess options for allocating water in any identified irrigated agricultural areas (Table 4) with stakeholders, to establish the most effective and efficient way of accessing and licensing groundwater use to protect the security of supply.

Water for Food is a Royalties for Regions–funded program aiming to increase agricultural productivity and encourage capital investment in the sector. The Department of Water has been funded through Water for Food to lead an investigation of groundwater and supply options in the Midlands area. The project will identify opportunities for investment by identifying high quality land near available water resources.

The Water for Food Midlands groundwater and land assessment project will assess water and land resources in the area west of Moora and north to Dongara. The scope of the project has been defined based on known groundwater resources and salinity levels. The project area is covered by the Arrowsmith, Jurien and Gingin groundwater allocation plans. New information obtained through Water for Food investigations will be used to refine our management arrangements in these areas.

This year DAFWA completed an investigation that has found a supply of water for Gillingarra farmers. The investigation included an airborne geophysical survey, a drilling program and test pumping and has identified a deep palaeochannel running south-east between Gillingarra and New Norcia. Testing has indicated a potential yield of 691 kL/day of a fit-for-purpose water supply option to meet livestock water needs in the area or for irrigating pasture (DAFWA 2014).

The DAFWA will continue to progress its ‘Water use efficiency on farms’ program. This program includes demand management, efficient irrigation infrastructure, system water loss management, irrigation scheduling, crop types and metering.

Table 4 Water supply options for irrigated agriculture in the Mid West region	
Option	Considerations
Water demand management including efficient irrigation infrastructure, system water loss management, irrigation scheduling and metering	• Adoption of water efficient irrigation practices or technologies is easier to achieve in new developments compared to existing enterprises
Individual or networked groundwater abstraction in a defined area within the Northern Perth Basin	• Cost of water source investigation and development • Operational costs including energy costs associated with pumping • Competition for water from other users with higher water value per unit of use • Opportunities for cooperation to achieve cost-effective water supply development
Water trading/transfers (within or between groundwater management areas)	• Spatial variability in groundwater quality and yields • Option can either be to access existing infrastructure located close to established production bores or to develop new water infrastructure
Third party pipe (e.g. excess dewater from mining) or water from open pit mine voids	• Currently only small volumes of suitable quality excess dewater in the Mid West region • Finite life of mines and the variable nature of surplus volumes over the life of the mine • Relatively untested although trials are underway in the Pilbara region • Cost of infrastructure and treatment • Agreement of mine companies required • Quality and volumes available from mine pit voids at suitable locations requires investigation

Dryland agriculture

A groundwater licence is not required for stock and domestic water use if stocking rates are not intensive. Current unlicensed water demand for stock use is estimated to be 8 GL/year.

The Department of Water works with local government authorities and DAFWA to supply reliable and 'fit for purpose' water to dryland parts of rural and pastoral areas of WA with less than 600 mm annual rainfall. We are involved in the management of agricultural area dams and emergency water supplies in dryland farming areas that play an important role in maintaining farm water security during dry seasons. Emergency water supplies are available in the mid-west shires of Chapman Valley, Morawa, Moora, Carnamah and the City of Greater Geraldton.

Between May and October each year the department provides monthly updates on rainfall and streamflow conditions to assist in planning for emergency supplies.

Grants are available through the department's rural water planning program to develop on-farm water and community sources to improve water security for farms that are not connected to a scheme system. The following incentives are available to secure water supplies for local government and farming communities:

- Farm water supply planning scheme
- Farm water rebate scheme
- Community water supply program
- Pastoral water grant scheme.

Further information on eligibility and rebates can be found on our website; www.water.wa.gov.au

3.4 Urban

Urban water needs in the Mid West region are primarily met through town water supply schemes managed by the Water Corporation. The Water Corporation operates 22 potable town water supply schemes in the region, supplying approximately 13 GL in 2013 (Table 5). The Geraldton–Dongara regional water supply scheme (Geraldton scheme) is the largest scheme in the region, supplying potable water to Geraldton and surrounding towns.

Water for the Geraldton scheme and schemes supplying other towns near the coast is drawn from coastal sedimentary aquifers. Inland towns are generally supplied from local fractured rock aquifers.

The average annual growth rate for scheme water demand in the Mid West region for the next 30 years is projected to be between one and three per cent. Towns supplied by the Geraldton scheme are expected to grow faster than most other towns in the region (Figures 13, 14 and 15).

The Department of Water assigns drinking water for human consumption as the highest-value use of water for consumptive purposes. Reserves are therefore set aside to secure future town water supplies. Currently a further 28.5 GL/year is reserved for future public water supply in the Mid West region (Figure 16).

Table 5 Town water supply schemes in the Mid West region

Town/scheme	2013 water demand (ML)	Current water source/s
Geraldton regional water supply scheme – supplies Geraldton, Dongara, Port Denison, Mullewa, Northampton, Eradu, Narngulu industrial area	9882	Sedimentary aquifer – Yarragadee North
Jurien Bay	368	Sedimentary aquifer – Superficial Swan
Cervantes	128	Sedimentary aquifer – Superficial Swan
Leeman and Greenhead	194	Sedimentary aquifer – Lesueur Sandstone North
Kalbarri and Port Kalbarri	414	Sedimentary aquifer – Tumblagooda Sandstone
Horrocks Beach	40	Sedimentary aquifer – Tumblagooda Sandstone
Arrowsmith water supply scheme – supplies Arrowsmith, Morawa, Arrino, Perenjori, Caron, Bunjil and Latham	413	Sedimentary aquifer – Parmelia
Three Springs	135	Sedimentary aquifer – Parmelia
Mingenew	68	Sedimentary aquifer – Parmelia
Carnamah and Coorow	235	Sedimentary aquifer – Parmelia
Eneabba	49	Sedimentary aquifer – Yarragadee North
Badgingarra	13	Sedimentary aquifer – Yarragadee North
Moora	483	Sedimentary aquifer – Leederville
Wicherina	103	Sedimentary aquifer – Permian sandstone
Watheroo	27	Fractured rock aquifer
Nabawa	15	Water carting from the Geraldton scheme and local fractured rock aquifer
Yalgoo	33	Fractured rock aquifer and carting from the Geraldton scheme
Cue	109	Fractured rock aquifer
Mount Magnet	209	Fractured rock aquifer
Meekatharra	296	Fractured rock aquifer
Sandstone	27	Fractured rock aquifer
Wiluna	92	Fractured rock aquifer

In addition to scheme supply, approximately 6 GL/year of groundwater is abstracted by self-supply users for urban purposes. This includes domestic bores, irrigation of public open space and supply to Aboriginal communities. The majority of this demand occurs in the Arrowsmith groundwater area.

Geraldton and surrounding towns

The Geraldton scheme supplies Geraldton, Dongara, Port Denison, Mullewa, Northampton, Eradu, the Narngulu industrial area and farms adjacent to the scheme main pipeline. Scheme supply to Geraldton includes water distributed to commercial and industry enterprises such as the Geraldton port and Geraldton airport.

Water for the Geraldton scheme is obtained from the Allanooka, Mount Hill and Wye Farm borefields. The Water Corporation has a licence to draw up to 14 GL/year from the Allanooka and Mount Hill borefields and 0.65 GL/year from the Wye Farm borefield. In 2012–13 the scheme supplied 9.8 GL/year.

The Geraldton community has been effective in reducing their water use, with household water use decreasing by almost 30 per cent since 2006–07 (Table 6).

Table 6 Average annual household water use (kL/household/year) for Geraldton

2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
413	457	400	397	369	357	343	327

Source: National Water Commission, 2013

The Water Corporation implemented a targeted water efficiency program in 2012, which focussed on assisting households to reduce demand on the Geraldton scheme. The Water Corporation also implements an ongoing water efficiency management program with all businesses using more than 20 000 kL/year. Businesses are required to develop a water efficiency management plan, detailing opportunities and actions for water savings.

The low and medium growth scenarios for the Geraldton scheme (Figure 13) are based on WAPC (2012) band A and band C population projections respectively. The high growth scenario is based on population growth rates used by the Mid West Development Commission (2014) for the Batavia Coast sub-region, where the population grows from its current level of around 49 000 to 167 000 by 2050.

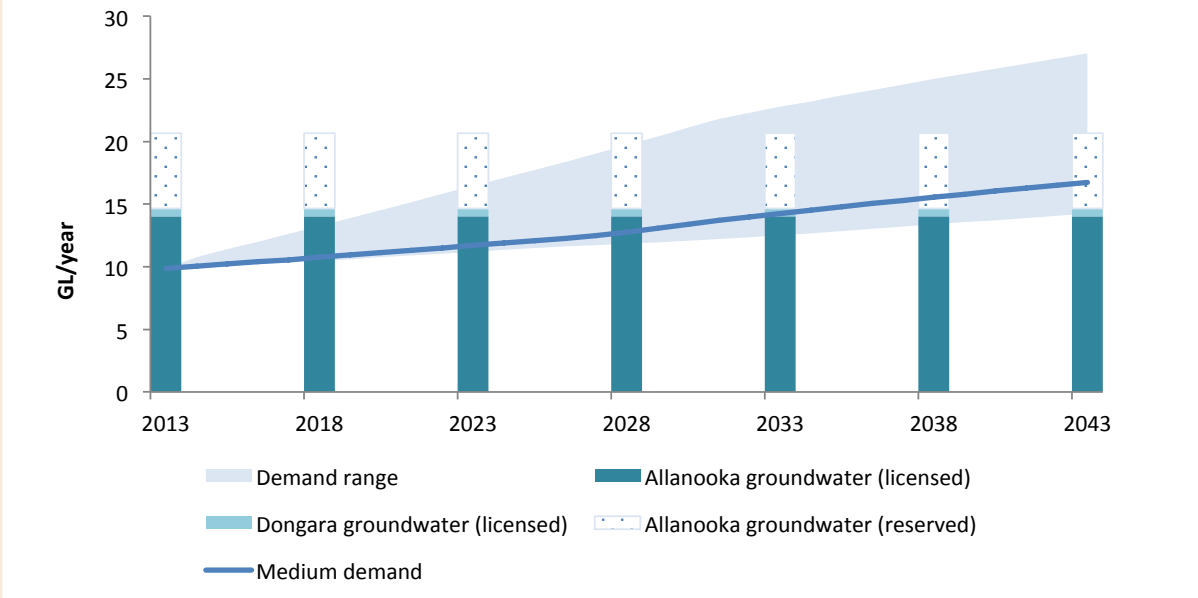

Figure 13 | Water demand and availability for Geraldton regional water supply scheme

Currently 6 GL/year is reserved for public drinking water supply in the Allanooka groundwater subarea. Recent investigations indicate that water quality and quantity may constrain further development of the existing borefield. Investigations are needed to examine if the water reserved for public drinking water supply can be sourced from the existing borefield or from a new borefield located elsewhere in the Allanooka groundwater subarea.

Expansion of the Allanooka and Mount Hill borefields, combined with continued demand management, will secure water supplies for the next 30 years, unless there is a substantial increase in the rate of population growth as indicated in the highest growth scenario (Figure 13). The wide variability in projected growth for the Geraldton scheme is further cause to ensure ongoing review of the water demand–supply situation by the Department of Water and the Water Corporation.

Table 7 Water supply options for Geraldton regional water supply scheme

Option	Considerations
Promote water conservation, recycling and efficient use of existing scheme water supplies	• Water efficiency is progressively more difficult to achieve after savings made in previous programs
Expansion of existing Allanooka borefield or development of a new borefield in the Allanooka groundwater subarea	• Further investigation required to identify optimal location, water yield and quality in the Allanooka groundwater subarea • Treatment costs of marginal/brackish groundwater sources
Piping groundwater from the Yarragadee aquifer at other locations in the Northern Perth Basin	• Investigations needed to identify optimal location, water yield and quality • Distance to source and treatment costs of marginal–brackish groundwater sources • Competition with other water users • Opportunity for collaboration and infrastructure sharing costs
Wastewater recycling for potable use	• Capital and operating costs • Local community consultation needed • Health and regulatory considerations
Seawater desalination	• Capital and operating costs • Cost effectiveness compared to long-distance transport of groundwater • High energy demands and brine disposal • Suitable sites close to town need to be identified • Opportunities to partner with industry

The City of Greater Geraldton, Water Corporation and Department of Water are also working together to identify opportunities for improved water efficiency and alternative water supplies (Table 7) to reduce demand on the scheme and local groundwater supplies. The *Towards a water sensitive city: Greater Geraldton water planning and management strategy* (City of Greater Geraldton 2014) identifies strategies and actions addressing all aspects of the water cycle. The strategy will be implemented via the local planning strategy and scheme, as well as through local operations and works schedules. Key opportunities identified to make early gains include:

- education programs and efficiency measures to reduce annual water use to 100 kL/person
- greater implementation of water sensitive urban design through the planning and development process
- improved efficiency of irrigation of public open space, including ‘waterwise’ plantings
- reuse of wastewater from the Narngulu wastewater treatment plant.

A range of potential long-term opportunities is also identified, including sewer mining, managed aquifer recharge, third pipe schemes and wave powered desalination.

A Geraldton specialist water advisory group has been formed between relevant agencies, the Durack Institute of Technology and the CRC for Water Sensitive Cities. The group will collaborate and provide guidance to assist the City of Greater Geraldton implement the *Towards a water sensitive city: Greater Geraldton water planning and management strategy* and develop adoption pathways to transition Geraldton to a water–sensitive city.

There are also challenges for timely and cost-effective provision of services for fragmented rural residential lots around the fringe of regional centres, particularly Geraldton. This can result in increased abstraction of groundwater from individual bores that are exempt from licensing. In these circumstances the department may review allocations to prevent concentrated pressure on local groundwater resources.

Jurien Bay and Morawa

The Shires of Dandaragan and Morawa recently completed growth and implementation plans for Jurien Bay and Morawa as part of the 'Regional centres development plan' or 'SuperTowns' program. The plans propose activities and projects to stimulate economic growth and support higher populations for nine regional towns in the south-west of the state. The plans indicate a possible increase in population to 20 000 for Jurien Bay and to 2500 for Morawa by 2050.

The upper boundary of water demand projections in Figures 14 and 15 is based on the above increases in population. It represents increased water demands of 2.8 GL/year and 0.5 GL/year for Jurien Bay and Morawa respectively.

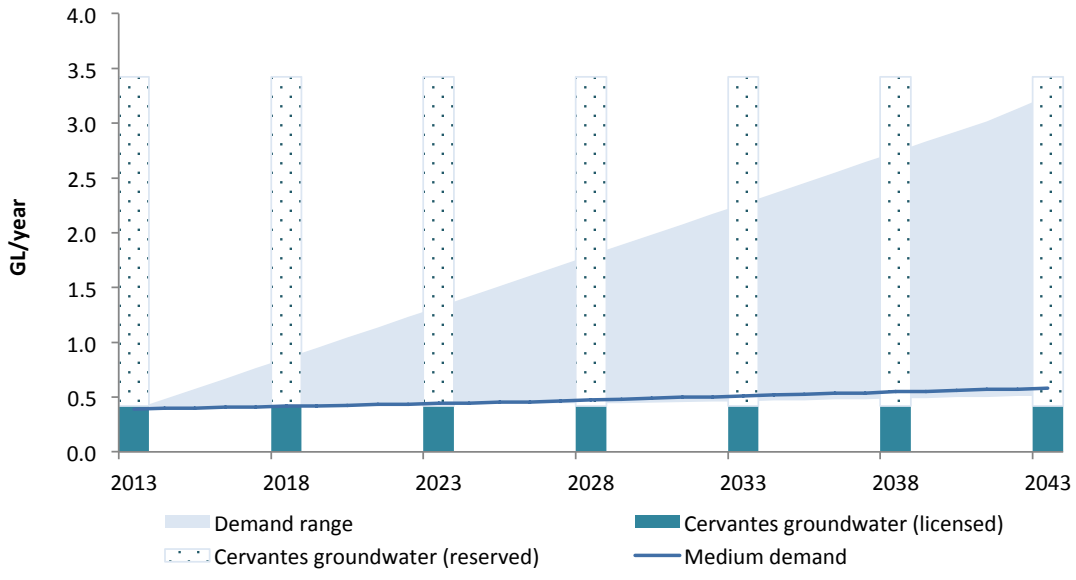

Figure 14 | Water demand and availability for Jurien Bay town water supply scheme

The Jurien Bay town water supply scheme is sourced from the Perth-Superficial Swan aquifer in the Cervantes subarea of the Jurien groundwater area. Currently a further 3 GL/year is reserved for future public water supply from the aquifer, which would be sufficient to meet demand for a population of 20 000 people (Figure 14). Increased storage capacity and additional production bores would be needed should the population exceed 10 000. A population of 15 000 would result in the need for a new wastewater treatment plant and additional pumping stations (Shire of Dandaragan 2012).

Morawa is supplied by the Arrowsmith water supply scheme. The scheme also provides water to Arrowsmith, Arrino, Perenjori, Caron and Bunjil.

Water for the scheme is sourced from the Perth-Parmelia aquifer in the Mingenew subarea, which is also used for the Mingenew town water supply scheme. The 2 GL/year reserved from this source for public drinking water supply is sufficient to meet a population of 2500 in Morawa (Figure 15). The reserve can be used for the Arrowsmith water supply scheme or to meet demand for other town water supplies.

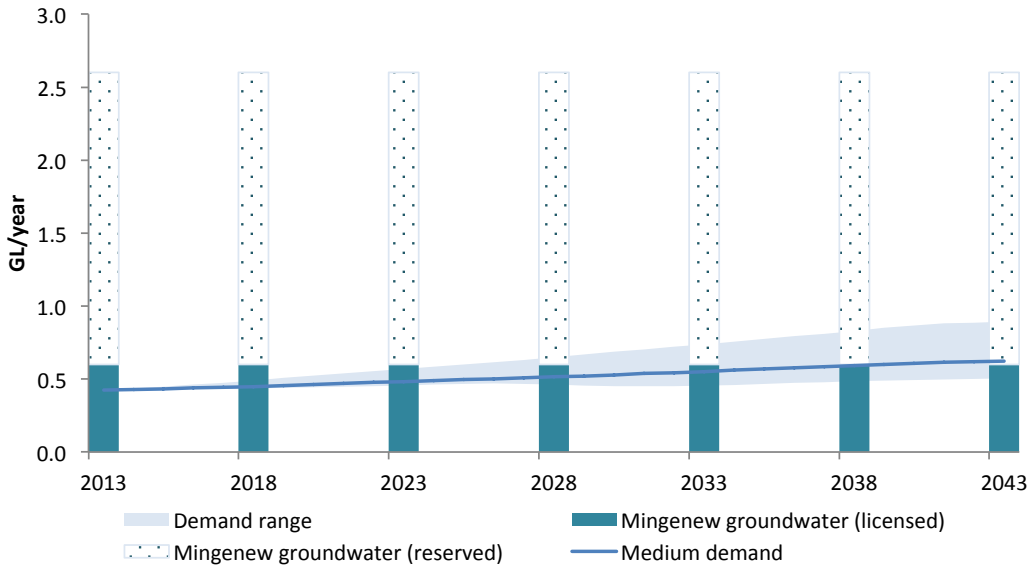

Figure 15 | Water demand and availability for Arrowsmith water supply scheme

Independent towns

Most other towns within 100 km of the coast are supplied through Water Corporation schemes that draw water from sedimentary aquifers. Future demand for these towns will be met by the existing water sources.

New developments along the Mid West region's coast that are not serviced by the Water Corporation also require water for domestic supply and public open space. Investment in water supply infrastructure is needed for these developments and small coastal towns, if they are to grow to a level anticipated by some stakeholders.

Towns further inland are generally supplied from local fractured rock aquifers. Water demand is not expected to increase significantly, but water quality issues and reliability of supply present challenges for some of these towns. The Water Corporation is managing these issues through upgrading infrastructure, water carting and improved treatment processes. Development of electro-dialysis reversal plants will improve the treatment of local groundwater for the towns of Yalgoo and Wiluna.

Most Aboriginal communities have a local bore for domestic and commercial purposes. Bondini is the only Aboriginal community currently connected to a town water supply scheme.

Community bores source water from local fractured rock aquifers of variable quality and reliability. The Department of Housing is the primary agency for managing water supplies to Aboriginal communities. Communities with five or more houses or a population of over 50 people are managed under the Department of Housing's Remote Areas Essential Services Program. This program includes:

- the ongoing maintenance of the water supply infrastructure and water quality sampling
- the planning and construction of new water supplies and infrastructure.

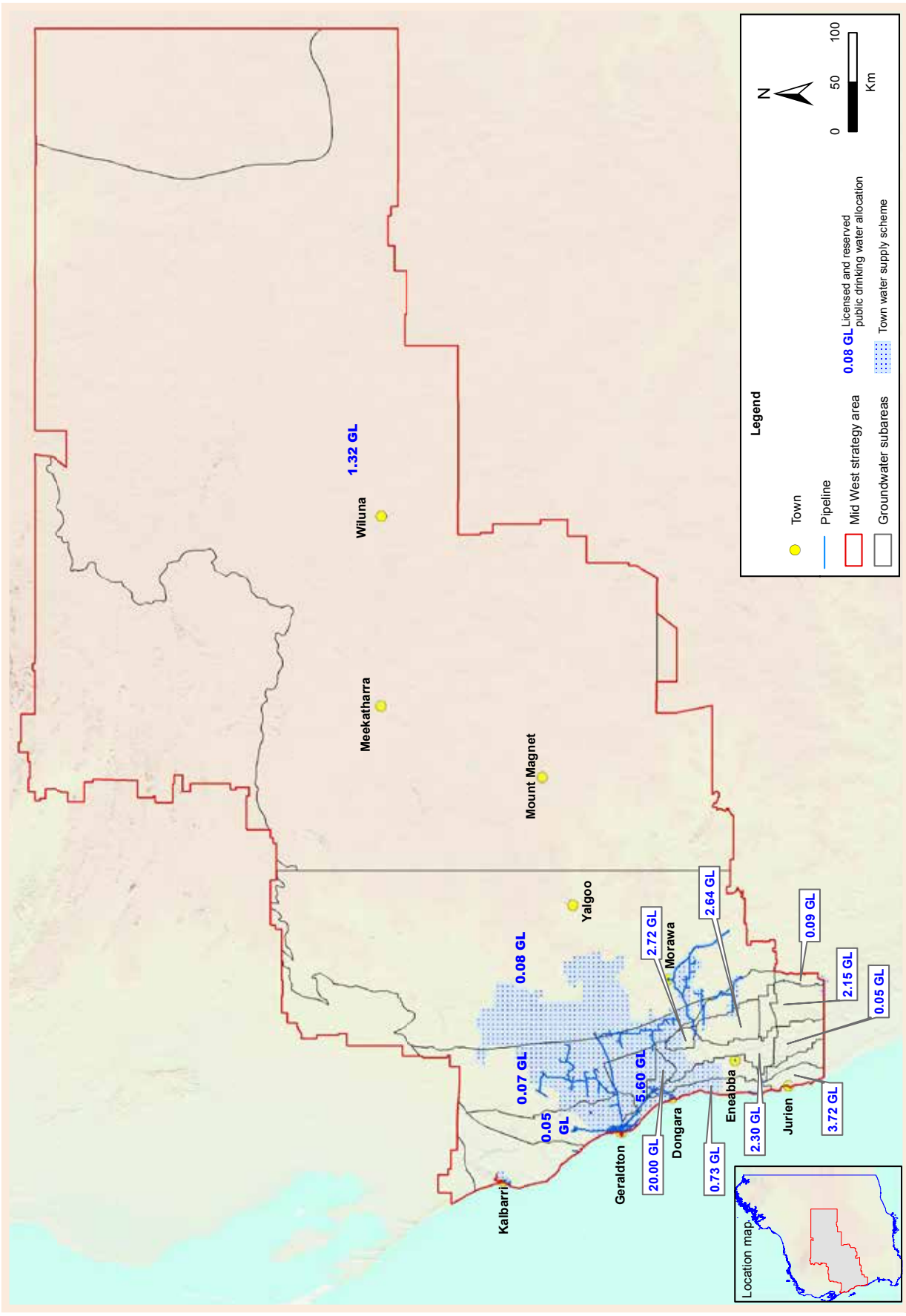

Figure 16 | Public drinking water supply schemes in the Mid West region

Mid West water supply strategy

Managing the groundwater resources of the Mid West region for productive and sustainable use is fundamental to ensuring water supplies can support regional land use planning and development objectives.

This strategy identifies that there will be competition between prospective water users for the better quality groundwater resources of the Northern Perth Basin. The allocation limits for these groundwater resources will continue to be refined by applying new knowledge of hydrogeology, soils, climate, the seawater interface and their environmental, economic and social values.

Our approach to managing groundwater use will be focussed in these areas and on resources that are currently highly allocated. In the Arrowsmith and Jurien groundwater allocation plans the Department of Water outlines various existing management approaches and policies that include:

- Statewide policy no.11: *Management of unused licensed water entitlements* (Water and Rivers Commission 2003)
- Operational policy no. 5.13: *Water entitlement transactions for Western Australia* (DoW 2010c)
- Operational policy no. 1.2: *Policy on water conservation and efficiency plans: achieving water use efficiency gains through water licensing* (DoW 2009a).

Ensuring that water supply planning and land use planning decisions are aligned is also an essential strategy to achieve integrated water and land use planning across all sectors. To achieve this, we apply the *Better urban water management framework* (WAPC 2008) to all land use planning decisions through consultation with local government authorities. This is particularly relevant where a strategic water focus is required in relation to self-supplied water users, including Water for Food projects, Oakajee port and industrial area and rural residential development.

This strategy also recognises the importance of developing fit-for-purpose water supplies, increasing water recycling, improving water efficiency and implementing water sensitive urban design. By considering water resources through all stages of the land planning process, we are able to promote wastewater, grey water and storm water recycling, the use of rainwater tanks and water efficiency for new developments.

Similarly, for major projects such as mining, the department encourages early consideration of water supply options in the project planning and approvals process. We work with water licence applicants to ensure that all possible water sources (of varying quality) are considered when assessing water licence applications.

The Department of Water has published a range of guidelines, policies, plans and reports to assist water users, government and developers, including:

- *Western Australian water in mining guideline* (DoW 2013a)
- *Guideline for the approval of non-drinking water systems in Western Australia: Urban developments* (DoW 2013b)
- Strategic policy no. 2.09: *Use of mine dewatering surplus* (DoW 2013c).

We are monitoring shale and tight gas development in the Mid West region to determine any future impacts on the security of regional water supplies. The Department of Water provides advice through a statutory referral process to the Department of Mines and Petroleum (DMP) and the Environmental Protection Authority (EPA) on activities that have a potential impact on water resources. We will continue to inform these regulators and stakeholders on the management of potential risks from hydraulic fracturing to ensure water resources are protected.

To develop a new water supply from conception to implementation typically takes three to 10 years. Early planning and ongoing exchange of information across government and industry is therefore important to ensure cost-effective, fit-for-purpose and timely provision of water supplies.

This strategy (Table 8) contains scenarios of future demand for water in the Mid West region that reflect the uncertainty associated with future development and the starting of large new projects. The department 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.

Table 8 Strategies and actions to support regional development			
No.	Action	Lead agency	Timing/trigger
Strategy 1: Maximise the sustainable use of local groundwater resources as a cost-effective supply for the long term.			
1.1	Apply more intensive licensing management and compliance in areas of high competition for water, including addressing the differences between licensed entitlements and water use.	Department of Water	Each water licence assessment and renewal
1.2	Refine groundwater allocation limits, public water supply reserves and management arrangements in the Northern Perth Basin, as demand on the water resource increases.	Department of Water	As decided through the annual evaluation of allocation plan implementation
1.3	Continue to engage Mid West region stakeholders on the suitability of alternative policy options for releasing water in areas of high competition for water.	Department of Water	Subject to progress of changes to water legislation
Strategy 2: Make the best use of water through a focus on water use efficiency, recycling and integrated water and land use planning.			
2.1	Work with mining companies to reduce freshwater use by encouraging fit-for-purpose water options, use of mine dewater, recycling of process water and recovery of water from slurry pipelines.	Department of Water	Before a water licence application for a major project (preliminary consultation stage)
2.2	Promote the adoption of water sensitive urban design and better urban water management principles in urban and industrial planning.	Department of Water	WAPC and local government strategic planning processes; water service provider licensing
2.3	Provide technical and/or financial assistance though the rural water planning program to assist local governments and communities to identify and develop fit-for-purpose water supplies for irrigation of public open space and agriculture.	Department of Water	Annual application process
2.4	Identify areas in the Mid West region with suitable water and soil for irrigated agriculture.	Department of Water	In progress for completion in 2018
2.5	Continue to identify and implement water efficiency measures, including the water efficiency management program for businesses using more than 20 000 kL/yr from scheme water supplies.	Water Corporation	Ongoing

Table 8 Strategies and actions to support regional development (cont.)			
No.	Action	Lead agency	Timing/trigger
Strategy 3: Investigate and assess water resources to support regional development.			
3.1	Apply knowledge gained from the Water for Food projects and Northern Perth Basin groundwater investigations, groundwater-dependent ecosystem studies, climate studies and private sector investigations to improve allocation planning, water supply planning and licensing.	Department of Water	Water licence assessments and allocation plan evaluations
3.2	Investigate and assess the Murchison palaeochannels to understand the potential availability of water to support mining or other rangeland industry development.	Department of Water	In progress for completion in 2016
3.3	Identify data sharing opportunities with industry that could complement Department of Water investigation work.	Department of Water	In progress
3.4	Identify areas of the Gascoyne groundwater area that could be investigated as a potential supply for Oakajee port and industrial estate.	Department of Water	2015
3.5	Assess the potential for mine pit voids to provide a water source for other users.	Department of Water	When demand arises
3.6	Improve the availability of online water resource data to assist water user's decision making.	Department of Water	Water Information Reporting portal recently released, further updates planned
Strategy 4: Ensure emergency livestock water sources are available for areas with less than 600 mm annual rainfall.			
4.1	Prioritise local government authorities in the 600 mm and below rainfall isohyet zone to complete emergency farmland water response plans.	Department of Water	2015
4.2	Develop emergency farmland water response plans for all high-priority local authorities in the 600 mm and below rainfall isohyet zone.	Department of Water	2018
4.3	Provide seasonal response updates to assist in planning for emergency supplies.	Department of Water	Monthly from May to October

Table 8 Strategies and actions to support regional development (cont.)			
No.	Action	Lead agency	Timing/trigger
Strategy 5: Strengthen industry partnerships and collaboration in water supply planning.			
5.1	Support early planning of water supplies for an industrial estate and port at Oakajee to establish water quality and quantity requirements, identify fit-for-purpose water supplies and facilitate integrated water planning for different users.	Department of Water	Oakajee investment decision
5.2	Work with the Water Corporation to track water demand and supply options for urban growth.	Department of Water	2014 and beyond
5.3	Ensure water supply planning and land use planning decisions are aligned and integrated through implementation of the better urban water management framework.	Department of Planning	Ongoing
5.4	Establish an ongoing dialogue with mining and industry bodies to exchange information on upcoming demands and water supply options.	Department of Water	2014 and beyond
5.5	Regularly review the water demand–supply balance for the Arrowsmith and Jurien groundwater areas to incorporate the latest industry information and inform groundwater investigation and planning priorities.	Department of Water	Every two years

Appendices

Mid West regional water supply strategy

Appendix A

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, 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 9) in water supply planning and development.

The private sector is generally expected to fund water supplies to support agriculture, mining and heavy industrial (including ports) developments. The State Government through the Department of Water invests significant funds to investigate groundwater and other water resources. The scale of the Department of Water's investigations will vary depending on state policy objectives. Detailed investigations and feasibility planning are usually undertaken by the private sector.

Public-private partnerships may also be used to develop new water supplies where mutual benefits are established.

Table 9 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 a 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 B

Methodology

Estimating current water demand

In June 2014 water entitlement data for the Mid West region was uploaded from the department's Water Resource Licensing database. The 430 licences were apportioned to one or multiple usage categories to calculate the base year water demand from which growth is projected.

Data from water meters received from licensees was compiled to estimate the actual volume of water used during 2013. For licences without metered water abstraction data (i.e. generally licence entitlements less than 100 000 kL) it is assumed that the full licensed entitlement is used.

Estimates of total unlicensed stock water use applied the number of livestock from the 2011 Agricultural Census (ABS 2012) and water requirements per head – from Department of Agriculture (NSW) and Department of Agriculture and Food WA information.

Projecting future water demand

A *Water demand scenario modelling tool* was used to project future water demand for 60 water use types to 2043. The tool uses economic growth rates from the Monash TERM model that are based on historical economic trends for different industries in Western Australia.

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 economic assumptions including the intensity and duration of the resources boom.

The Monash TERM model projects growth in three phases. A high rate of investment in the resources sector occurs in the first phase. In the second phase the growth rate of the Western Australian economy slows as a new capacity plateau is established in the resources sector. In the third phase the long-term growth rate converges with historical experience for Australia as a whole with growth in Gross State Product (GSP) of 2.4 per cent per year. The duration and intensity of the phases vary in the low, medium and high growth scenarios used for modelling water demand.

Water demand projections after 2032 were extrapolated to follow the same trajectory as for the period 2021–31 as economic modelling trends from the Monash TERM model were only available to 2031.

An inter-agency working group advised on changes to modelled scenarios based on expected 'trend-breaking' industry developments and population growth (e.g. Oakajee port and industrial estate, magnetite iron ore production, 'SuperTowns'). Growth projections in published reports were converted to estimates of water use and added to the growth forecasts from the Monash TERM model.

The forecast timing and extent of growth in water demand used in this strategy is estimated at one point in time and is subject to substantial and rapid change. Deferment or abandonment of resource development and infrastructure projects would have flow on effects for growth in other sectors.

After growth rates were applied to the base year water demand for 60 usage codes (Australian New Zealand Standard Industrial Classification [ANZSIC] codes), water demand was consolidated into mining, industry, agriculture and urban sectors.

Population

We used population forecasts for 2006–26 (WAPC 2012) to project growth for residential domestic water use. High population scenarios that consider State Government policy (e.g. 'SuperTowns' or growth related to large development projects) were used where available to project high water demand for urban needs (Table 10).

Table 10 Average annual population growth rates

Scenarios	Greenough subregion (%/year)	Murchison subregion (%/year)	Jurien subregion (%/year)
Low demand			
WAPC (2012) – Band A (lowest population growth simulations)	0.8	-3.2	1.3
Medium demand			
WAPC (2012) – Band C (median value of all population simulations)	1.6	-1	1.7
High demand			
WAPC (2012) – Band E (high population growth)	2.3	0	2
Mid West Development Commission Investment Blueprint	3.4		
Shire of Morawa – Morawa Growth Plan		3.5	
Shire of Dandaragan – Jurien Bay Growth Plan			9.1

Assumptions

Assumptions need to be made as part of the process of projecting future water demand (Table 11). The water demand scenario-modelling tool relies on forecast data for population growth and industry development. Such estimates are fairly likely to reflect reality in the short-term; however, the longer the forecast timeframe, the more likely that forecasts will not reflect what actually occurs.

Generally, water supply planning was carried out based on moderate rates of growth (medium growth scenario) while acknowledging the aspirational outlook (high growth scenario) that exists in some sectors. Where large developments were identified additional water use proposed in published reports was added to the Monash TERM model growth rates.

Table 11 Assumptions about trend-breaking growth

Sector	Low	Medium	High
Iron ore	Magnetite mining uses 10 GL/year by 2020 and 15 GL/year by 2043.	Magnetite mining uses 19 GL/year by 2023 and 50 GL/year by 2043.	Magnetite mining uses 33 GL/year by 2023 and 70 GL/year by 2043.
Other mining	Uranium and vanadium mining uses 5 GL/year by 2023.	Uranium and vanadium mining uses 7 GL/year by 2023.	Uranium and vanadium mining uses 10 GL/year by 2023. New mineral sand mining uses 3.5 GL/year by 2023
Agriculture	Irrigated tree crops use an additional 10 GL/year by 2023.	Irrigated tree crops use an additional 15 GL/year by 2023.	Irrigated tree crops use an additional 20 GL/year by 2023. An additional 30 GL used for intensive agriculture by 2043.
Industry	A new port is not established and the Geraldton port expands to export 25 Mtpa of iron ore and is serviced by additional scheme water.	Construction of a port at Oakajee begins in 2019 and reaches full production (5 GL/year) by 2043. A new industrial estate begins in 2019 and requires 12 GL/year by 2043.	Construction of a port at Oakajee begins in 2019, reaches full production (5 GL/year) by 2033 and expands to 2 berths to export up to 70 Mtpa of iron ore by 2043.
Town water schemes	WAPC[1] Band A (low) population growth forecasts by local government area for 2006–26 extrapolated to 2043. For industry, commercial and municipal water users, growth rates from Monash model are applied to estimate growth in scheme water use except for port water use which is projected to double by 2033.	WAPC Band C (median) population growth forecasts by local government area for 2006–2026 extrapolated to 2043. For industry, commercial and municipal water users, growth rates from Monash model are applied to estimate growth in scheme water use except for port water use which is projected to double by 2023.	WAPC Band E (high) population growth forecasts for 2006–26 forecasts by local government area extrapolated to 2043. Mid West Development Commission[2] population forecasts for Batavia Coast sub-region to 2050 interpolated to 2043. Shire of Dandaragan[3] and Shire of Morawa[4] population forecasts for Jurien Bay and Morawa to 2041 extrapolated to 2043. For industry, commercial and municipal water users' growth rates from Monash model are applied to estimate growth in scheme water use except for port water use which is projected to double by 2023.

1 WA Tomorrow (WAPC 2012)

2 Mid West Regional Blueprint (Mid West Development Commission 2014)

3 Jurien Bay growth plan (Shire of Dandaragan 2012)

4 Morawa growth plan (Shire of Morawa 2012)

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 needed 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.

Assessing water supply options

Water supply options (Table 12) are identified and assessed for strategic projects in the Mid West region where there is a high demand for water that exceeds the current available supply. Where no groundwater or surface water is available to meet forecast demand a range of supply options and demand management was considered, depending on the intended purpose and location of water use.

The *Water resources inventory: water availability, quality and trends* (DoW 2014) is used to obtain data on groundwater and surface water availability and quality across the state. The difference between projected water demand and current availability is used to establish the potential scale of new water supplies needed for key growth areas.

Consideration of technical feasibility, approvals processes, lead times for planning and establishing new water supplies, environmental and social constraints and cost is also required when deciding on a preferred water supply. New water supply options should be sized to accommodate future growth, but not exceed capacity.

Environmental, cultural heritage and social values also require consideration as water resources in the Mid West region are often associated with significant Aboriginal sites, declared rare flora, threatened ecological communities and groundwater dependent ecosystems.

Assessment of water supply options was conducted at a conceptual level and does not indicate government endorsement of any particular project. It is expected that options would be subject to a comprehensive assessment and be progressed at the appropriate time, on a commercial basis.

Table 12 First use water supply options summary

Water supply options	
Local groundwater and surface water resources	Existing and new groundwater/surface water supplies Increased water use efficiency of existing resources (managing demand) Suitable for all water users subject to yields, water quality, access, geology (cost increases with depth and number of bores required)
Water trading, reuse, recycling, managed aquifer recharge (recharge and recovery)	Trading – allows new water users in an area which is fully allocated Reuse for mining and industry required to dewater for operation costs depends on water quality and distance (length of pipe required). Recycling – suitable option for water users such as irrigation of public open space Managed aquifer recharge – possibly stormwater, treated waste water or excess dewater injected into groundwater resources for use at a later date
Desalination, long distance transport	Costly options; at present only mining, industry and drinking water service providers tend to access these options Tend to have longer approval processes, new/latest technology required, large resource potential

Appendix C

Groundwater and surface water allocation and availability

Table 13 Groundwater availability in the Mid West region

Groundwater area	Groundwater subarea	Aquifer	Allocation limit (ML year)[1]	Water available for general use (ML/year)	Water reserved for scheme (ML/year)	Salinity range	Water level trends	Level of technical information
Shallow groundwater resources								
Arrowsmith	Dongara	Perth – Superficial Swan	8000	3938	–	Fresh–saline	No data	Medium
	Eneabba Plains	Perth – Superficial Swan	14 600	14 136	–	Fresh–saline	Declining	Medium
	Twin Hills	Perth – Surficial	600	489	–	Fresh–marginal	No data	Initial
	Darling	Perth – Surficial	2500	2150	–	Marginal–saline	No data	Initial
Gascoyne	Kalbarri/Eurardy	Carnarvon – Surficial	100	16	–	Marginal–saline	Stable	Initial
	Yuna/Eradu	Perth – Surficial (North)	500	411	–	Marginal–brackish	Seasonal	Initial
		Perth – Permian Sandstone	5000	4910	–	Marginal–brackish	Seasonal	Initial
	Northampton / Gelena	Northampton – Sedimentary	2000	1342	–	Marginal–brackish	Seasonal	Initial
		Northampton – Surficial	5000	4494	–	Marginal–brackish	Declining	Initial
		Perth – Superficial Swan	200	200	–	Marginal–saline	Stable	Initial
	Casuarinas	Perth – Surficial (North)	100	100	–	Marginal–brackish	Increasing	Initial
		Perth – Superficial Swan	100	64	–	Marginal–brackish	Stable	Medium
		Perth – Permian Sandstone	500	290	–	Marginal–brackish	Seasonal	Initial
East Murchison	Officer	Officer – Surficial	10 000	10 000	–	Fresh–saline	No data	Initial
		Canning – Grant	10 000	10 000	–	Marginal–brackish	No data	Initial
Jurien	Cervantes	Perth – Superficial Swan	30 000	23 399	3000	Fresh–brackish	Stable	Initial
	Nambung	Perth – Superficial Swan	4000	930	–	Fresh–saline	Stable	Initial
	Badgingarra	Perth – Surficial	Not set	–	–	Fresh–marginal	No data	Initial
	Dinner Hill	Perth – Surficial	1000	394	–	Fresh–saline	No data	Initial
	Watheroo	Perth – Surficial	300	210	35	Marginal–saline	No data	Initial
Middle groundwater resources								
Arrowsmith	Twin Hills	Perth – Parmelia	3400	3 354	–	Fresh–marginal	No data	Initial
	Mingenew	Perth – Parmelia	8200	440	2000	Marginal–brackish	Increasing	Medium
	Darling	Perth – Parmelia	100	100	500	No data	No data	Initial
	Tathra	Perth – Parmelia	33 400	11 370	2000	Fresh–brackish	No data	Initial
	Morrison	Perth – Parmelia	4000	3440	–	Marginal–brackish	No data	Initial
Gascoyne	Mullewa/Byro	Keogh-Ballythanna	Not set	–	–	Marginal–saline	No data	Initial
	Kalbarri/Eurardy	Carnarvon – Sandstone	1000	939	–	Marginal–saline	Stable	Initial
	Talisker/Mia Mia	Keogh-Ballythanna	37 120	0	–	No data	No data	Initial
	Yuna/Eradu	Perth – Parmelia	200	200	–	Fresh–marginal	Seasonal	Initial
		Perth – Sedimentary	1000	965	–	Marginal–saline	Seasonal	Initial
East Murchison	Officer	Officer – Sedimentary	10 000	10 000	–	Marginal–brackish	No data	Initial
Jurien	Badgingarra	Perth – Leederville – Parmelia	300	300	–	Fresh–marginal	No data	Initial
	Dinner Hill	Perth – Mirrabooka	500	500	–	Fresh–saline	No data	Initial
		Perth – Leederville – Parmelia	12 600	1162	1500	Fresh–saline	Increasing	Medium
	Watheroo	Perth – Leederville – Parmelia	100	10	–	Marginal–saline	No data	Initial

*Fractured rock and palaeochannel aquifers only have notional allocation limits, as such allocation limit refers to volume of water currently allocated.

[1] DoW 2014

Table 13 Groundwater availability in the Mid West region (cont.)

Groundwater area	Groundwater subarea	Aquifer	Allocation limit (ML year)[1]	Water available for general use (ML/year)	Water reserved for scheme (ML/year)	Salinity range	Water level trends	Level of technical information
Deep groundwater resources								
Arrowsmith	Dongara	Perth – Cattamarra Coal Measures North	200	195	–	Marginal–saline	No data	Initial
		Perth – Yarragadee North	4500	3253	–	Marginal–saline	No data	Initial
	Allanooka	Perth – Yarragadee North	28 800	8434	6000	Fresh–marginal	Increasing	Medium
	Twin Hills	Perth – Eneabba	400	400	–	Marginal–saline	No data	Initial
		Perth – Yarragadee North	48 800	24 579	5000	Fresh–marginal	No data	Initial
		Perth – Cattamarra Coal Measures North	500	500	–	Marginal–saline	Increasing	Initial
		Perth – Lesueur Sandstone North	200	200	–	Marginal–saline	No data	Initial
	Eneabba Plains	Perth – Eneabba	2000	600	–	Fresh–brackish	Declining	Medium
		Perth – Yarragadee North	22 500	5007	1000	Fresh–brackish	Declining	Medium
		Perth – Cattamarra Coal Measures North	100	100	–	Fresh–brackish	Stable	Medium
		Perth – Lesueur Sandstone North	1800	1330	–	Fresh–brackish	No data	Initial
	Tathra	Perth – Eneabba	100	100	–	Marginal–brackish	No data	Initial
		Perth – Lesueur Sandstone North	100	100	–	Marginal–brackish	No data	Initial
		Perth – Yarragadee North	700	700	–	Fresh–brackish	No data	Initial
		Perth – Cattamarra Coal Measures North	50	50	–	Marginal–brackish	No data	Initial
	Darling	Perth – Cattamarra Coal Measures North	400	400	–	Marginal–brackish	No data	Initial
		Perth – Lesueur Sandstone North	1400	1400	–	Marginal–saline	No data	Initial
		Perth – Yarragadee North	200	200	–	Fresh–brackish	No data	Initial
		Perth – Eneabba	400	400	–	Marginal–saline	No data	Initial
	Morrison	Perth – Yarragadee North	1000	1000	–	Marginal–brackish	No data	Initial
Gascoyne	Kalbarri /Eurardy	Carnarvon – Tumblagooda	5000	2026	–	Marginal–saline	Stable	Initial
	Yuna/Eradu	Perth – Tumblagooda	Not set	0	–	Marginal–brackish	Stable	Initial
	Northampton / Gelena	Carnarvon – Tumblagooda	100	100	–	Marginal–saline	Stable	Initial
	Casuarinas	Perth – Yarragadee North	10 000	4332	5000	Fresh–marginal	Increasing	Medium
		Perth – Cockleshell Gully	5000	3973	–	Marginal–saline	Stable	Initial
Jurien	Cervantes	Perth – Eneabba	600	600	–	Fresh–saline	Declining	Initial
		Perth – Lesueur Sandstone North	3000	0	2450	Fresh–saline	Declining	Initial
		Perth – Cattamarra Coal Measures North	100	100	–	Fresh–saline	No data	Initial
	Nambung	Perth – Cattamarra Coal Measures North	1600	1600	–	Fresh–brackish	No data	Initial
		Perth – Lesueur Sandstone North	2700	2700	–	Fresh–brackish	No data	Initial
		Perth – Eneabba	300	300	–	Fresh–brackish	No data	Initial
		Perth – Yarragadee North	8800	6300	–	Fresh–brackish	Increasing	Initial
	Badgingarra	Perth – Cattamarra Coal Measures North	400	245	–	Fresh–brackish	No data	Initial
		Perth – Yarragadee North	27 500	25 176	–	Fresh–brackish	No data	Initial

*Fractured rock and palaeochannel aquifers only have notional allocation limits, as such allocation limit refers to volume of water currently allocated.

[1] DoW 2014

Table 13 Groundwater availability in the Mid West region (cont.)

Groundwater area	Groundwater subarea	Aquifer	Allocation limit (ML year)[1]	Water available for general use (ML/year)	Water reserved for scheme (ML/year)	Salinity range	Water level trends	Level of technical information
Fractured rock and palaeochannel groundwater resources								
Arrowsmith	Darling	Perth – Fractured Rock	0	N/A	–	Marginal–brackish	No data	Initial
		Combined – Fractured Rock West – Fractured Rock	240	N/A	–	Marginal–brackish	No data	Initial
	Dongara	Northampton – Fractured Rock	0	N/A	–	Marginal–brackish	No data	Initial
	Mingenew	Perth – Fractured Rock	0	N/A	–	Marginal–brackish	No data	Initial
	Morrison	Combined – Fractured Rock West – Fractured Rock	0	N/A	–	Marginal–brackish	No data	Initial
	Tathra	Perth – Fractured Rock	0	N/A	–	Marginal–brackish	No data	Initial
Gascoyne	Mullewa/Byro	Combined – Fractured Rock West – Calcrete	0	N/A	–	Marginal–saline	No data	Initial
		Combined – Fractured Rock West – Fractured Rock	9359	N/A	–	Marginal–saline	No data	Initial
		Combined – Fractured Rock West – palaeochannel	0	N/A	–	Marginal–saline	No data	Initial
		Combined – Fractured Rock West – Alluvium	166	N/A	–	Marginal–saline	No data	Initial
	Northampton / Gelena	Northampton – Fractured Rock	1251	N/A	–	Marginal–saline	No data	Initial
	Yuna/Eradu	Northampton – Fractured Rock	0	N/A	–	Brackish–saline	No data	Initial
		Combined – Fractured Rock West – Fractured Rock	0.5	N/A	–	Brackish–saline	No data	Initial
East Murchison	Egerton	Combined – Fractured Rock West – Calcrete	0	N/A	–	Marginal–saline	No data	Initial
		Combined – Fractured Rock West – Palaeochannel	1320	N/A	–	Marginal–saline	No data	Initial
		Combined – Fractured Rock West – Alluvium	100	N/A	–	Marginal–saline	No data	Initial
		Combined – Fractured Rock West – Fractured Rock	10 307	N/A	–	Marginal–saline	No data	Initial
		Hamersley – Fractured Rock	0	N/A	–	Marginal–saline	No data	Initial
	Meekatharra	Palaeochannel – Fractured Rock	1780	N/A	–	Fresh–saline	No data	Initial
		Combined – Fractured Rock West – Fractured Rock	45 183	N/A	–	Fresh–saline	No data	Initial
		Palaeochannel – Palaeochannel	0	N/A	–	Fresh–saline	No data	Initial
		Palaeochannel – Calcrete	538	N/A	–	Fresh–saline	No data	Initial
		Combined – Fractured Rock West – Calcrete	1981	N/A	–	Fresh–saline	No data	Initial
		Combined – Fractured Rock West – Alluvium	0	N/A	–	Fresh–saline	No data	Initial
		Palaeochannel – Alluvium	0	N/A	–	Fresh–saline	No data	Initial
		Combined – Fractured Rock West – Palaeochannel	5	N/A	–	Fresh–saline	No data	Initial
Jurien	Dinner Hill	Combined – Fractured Rock West – Fractured Rock	0	N/A	–	Marginal to saline	No data	Initial
	Watheroo	Combined – Fractured Rock West - Fractured Rock	0	N/A	–	Marginal to saline	No data	Initial

*Fractured rock and palaeochannel aquifers only have notional allocation limits, as such allocation limit refers to volume of water currently allocated.

[1] DoW 2014

Table 14 Surface water availability in the Mid West region

Surface water resource	Proclamation status	Allocation limit (GL/year)[1]	Salinity range	Average annual streamflow trend	Level of resource under-standing
Murchison River	Unproclaimed	Not set	Brackish–saline	Not assessed	Initial
Northampton Coast	Unproclaimed	Not set	Marginal–saline	Not assessed	Initial
Greenough River & tributaries	Mostly proclaimed	Not set	Brackish–saline	Not assessed	Initial
Yarra Yarra	Unproclaimed	Not set	Saline	Not assessed	Initial
Irwin River	Partially proclaimed	Not set	Brackish–saline	Not assessed	Initial
Arrowsmith River	Unproclaimed	Not set	Brackish–saline	Not assessed	Initial
Eneabba Coastal tributaries	Partially proclaimed	Not set	Marginal–brackish	Not assessed	Initial
Hill River & tributaries	Mostly proclaimed	Not set	Marginal–brackish	Not assessed	Initial
Coonderoo/ Marchagee	Unproclaimed	Not set	Brackish–saline	Not assessed	Initial
Nambung/ Cataby Coastal tributaries	Partially proclaimed	Not set	Marginal–brackish	Not assessed	Initial

[1] DoW 2014

Table 15 Water quality descriptors

Salinity classification	Salinity (mg/L)
Fresh	< 500 mg/L
Marginal	501–1500 mg/L
Brackish	1501–5000 mg/L
Saline	5001–50 000 mg/L
Hypersaline	> 50 000 mg/L

Appendix D

Policies, plans and guidelines relevant to water supply development

Table 16 Policies and guidelines relevant to assessment of water supply options

Water supply option	Key policies, plans and guidelines
Water efficiency	Operational policy no. 1.02: *Policy on water conservation/efficiency plans* (DoW 2009a)
Alternative water supplies	*Guideline for the approval of non-drinking water systems in WA: urban developments* (DoW 2013b)
	Guidelines for the non-potable uses of recycled water in Western Australia (DoH 2011)
	Water sensitive urban design: Rainwater storage and reuse systems (DoW 2011a)
Groundwater or surface water resources	*Arrowsmith groundwater allocation plan* (DoW 2010a)
	Jurien groundwater allocation plan (DoW 2010b)
	WAter resources inventory 2014: Water availability, quality and trends (DoW 2014)
	Operational policy no. 5.08: *Use of operating strategies in the water licensing process* (DoW 2011b)
	Operational policy no. 5.12: *Hydrogeological reporting associated with a groundwater well licence* (DoW 2009b)
	Operational policy no. 1.01: *Managed aquifer recharge in Western Australia: allocation and water quality management* (DoW 2009c)
	Strategic policy no. 5.03: *Metering the taking of water* (DoW 2009d)
	Strategic policy no. 2.03: *Managing unlicensed groundwater use* (DoW 2009e)
	Strategic policy no. 2.09: *Use of mine dewatering surplus* (DoW 2013c)
	Safe use of bore water in rural areas (DoW 2010d)
Water trading	Operational policy no. 5.13: *Water entitlement transactions for Western Australia* (DoW 2010c)
Emergency agricultural supplies	Rural water note no. 7: *Emergency farmland water supplies* (DoW 2007)
	Farm water supply planning scheme and farm water rebate scheme: information for applicants (DoW 2013d)
All options	*Western Australian water in mining guideline* (DoW 2013a)
	Better urban water management (WAPC 2008)

Glossary

Abstraction	Withdrawal of water from a surface water or groundwater source of supply.
Allocation limit	Annual volume of water set aside for a water resource.
Aquifer	A geological formation or group of formations capable of receiving, storing and transmitting water.
Dewatering	Removing underground water to facilitate construction or other activity. It is often used as a safety measure in mining below the watertable or as a preliminary step to development in an area.
Fit-for-purpose	Water that is of suitable quality for the intended end purpose. This implies that the quality is not higher than needed.
Garden bore	A bore used for providing the household and household garden watering requirements.
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 (or licenced entitlement)	A formal permit that entitles the licence holder to take water from a watercourse, wetland or underground source under the *Rights in Water and Irrigation Act 1914*.
Management area	A defined surface water area or groundwater area proclaimed under the *Rights in Water and Irrigation Act 1914.*
Managed aquifer recharge	The purposeful recharge of an aquifer under controlled conditions in order to store water for later abstraction, to achieve environmental benefits or to mitigate the impacts of abstraction. It may involve the passive treatment of water through natural processes within the aquifer to achieve a desired water quality.
Mtpa	Million tonnes per annum.
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 for the supply of drinking water for human consumption.
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) or total soluble salts (TSS). Measurements are usually in milligrams per litre (mg/L) or parts per thousand (ppt).
Subarea	A subdivision within a surface water or groundwater area defined to better manage water allocation. Subarea boundaries are not proclaimed and can therefore be amended without being gazetted.
SuperTowns	Nine towns in the southern half of Western Australia chosen to receive Royalties for Region (Regional Centres Development Plan) funding to support population and economic growth
Surface water	Water flowing over or held in streams, rivers and wetlands on the surface of the land.
Water entitlement	The quantity of water that a person is entitled to take on an annual basis in accordance with the *Rights in Water and Irrigation Act 1914* and a licence.
Water use efficiency	Increasing water supply efficiency (e.g. reduction of leaks) and water demand efficiency (e.g. doing more with less water) to minimise the taking and use of water.
Yield	The volume of water that can be abstracted from a water resource system, after environmental water requirements are met.

Shortened forms

ABS	Australian Bureau of Statistics
ANZSIC	Australian New Zealand Standard Industrial Classification
CRC	Cooperative Research Centre
DAFWA	Department of Agriculture and Food WA
DEC	Department of Environment and Conservation (superseded)
DoH	Department of Health
DoP	Department of Planning
DoW	Department of Water
DMP	Department of Mines and Petroleum
DWMS	District water management strategy
EPA	Environmental Protection Authority
NWC	National Water Commission
WAPC	Western Australian Planning Commission
WC	Water Corporation

Volumes of water

One litre	1 litre	1 litre	L
One thousand litres	1000 litres	1 kilolitre	kL
One million litres	1 000 000 litres	1 megalitre	ML
One thousand million litres	1 000 000 000 litres	1 gigalitre	GL

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Notes

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