

Department of Trade, Business and Innovation

Adelaide River Off-stream Water Storage - Part A: Preliminary Assessment

August 2020

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Executive summary

Project context

The Department of Trade, Business and Innovation (DTBI), in partnership with Power and Water Corporation (PWC), has identified that there is a strategic need to address the supply and demand issues associated with water in the greater Darwin region. This Preliminary Assessment has been developed to:

- Confirm the strategic need and priority for water supply augmentation (the Project) in the region
- Investigate and assess non-infrastructure and infrastructure options
- Provide a robust rationale and justification for progression of a preferred water supply strategy to a Detailed Business Case (DBC).

The purpose of the Preliminary Assessment is outlined in Figure 1.



Figure 1: Purpose of the Preliminary Assessment

Water supply in the greater Darwin region is not sufficient to meet future demand

There are two key organisations in the Northern Territory with responsibility for the management and delivery of water in the greater Darwin region. These are:

- PWC, which is the sole licensed water provider in the region. PWC owns and manages the Darwin River Dam, the reticulation network and provides water to users across the reticulated water network.
- The Department of Environment and Natural Resources (DENR) which administers the *Northern Territory Water Act 1992* and provides water management and monitoring services on behalf of the Northern Territory Government.

Water in the greater Darwin region is sourced from surface water and groundwater resources. In the greater Darwin region urban area, water is supplied through the reticulated network owned and managed by PWC. PWC draws water for its network from the Darwin River Dam and through an allocation from the Howard groundwater resource. The majority of the water for the Darwin rural region is sourced directly by users from groundwater resources through bores. Water demand in the greater Darwin region primarily consists of urban, industrial, commercial, government and non-revenue water consumption for PWC's network and rural stock, domestic, agriculture and horticulture consumption for the groundwater resource. The location of the major surface and groundwater resources are shown in Figure 2.

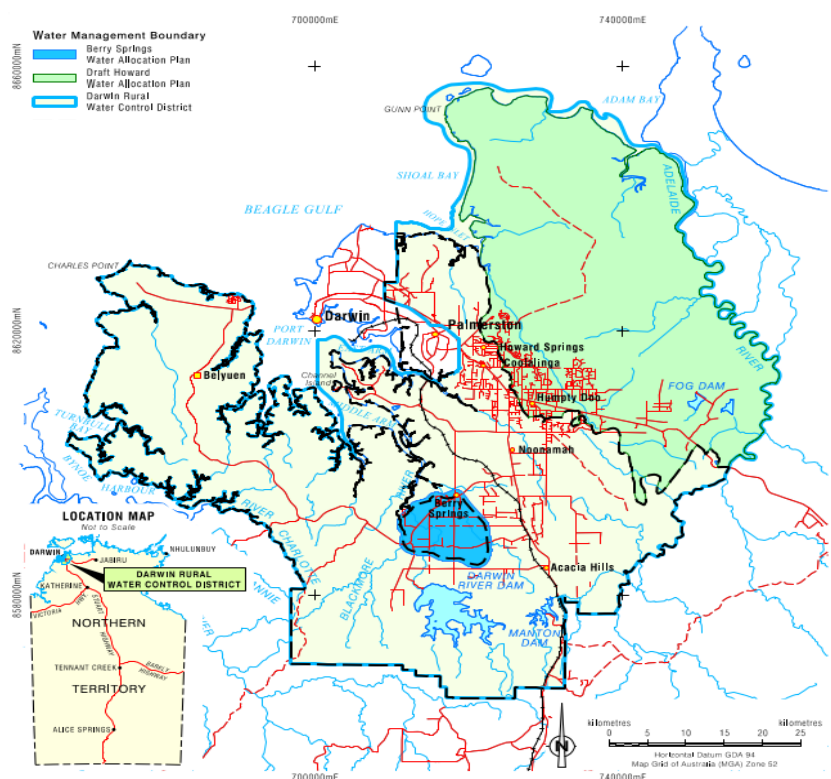


Figure 2: Darwin Rural Water Control District and Water Allocation Planning areas¹

Rural water supply

The Darwin rural area has a number of discrete groundwater resources, which are located within the Darwin Rural Water Control District (DRWCD). Over the past 30 years' reliance on groundwater within the DRWCD has increased significantly from approximately 1,000 bores in the 1980s to over 8,000 bores in 2019.

¹ Department of Environment and Natural Resources, 2020.

The major groundwater resources in the greater Darwin region are already over allocated and over used. The Howard Groundwater System (HGS) is the largest, and most used, groundwater resource in the greater Darwin region. The West and Central Zones of the HGS supply 80 per cent of current extraction. These zones are 300 per cent to 380 per cent, and 100 per cent to 150 per cent over extracted respectively². The Department of Environment and Natural Resources (DENR) has estimated that extraction from the HGS would be required to be reduced by 24,000 ML p.a. to return the groundwater network to a sustainable level of extraction. The extraction from the Berry Springs groundwater resource estimated to be approximately equal to its sustainable yield of 8,900 ML p.a. The remainder of the DRWCD may have additional resources available however it is understood that the highly productive areas are already fully utilised.

Given this, the available supply of groundwater is assumed to be at its maximum and no further allocations would be granted other than those required under current legislative provision. In the absence of the identification of new groundwater resources, any growth in domestic, stock, agriculture or horticulture demand in the rural region will need to be supported by water from an alternate resource or additional demand management measures to reduce the existing demand.

Reticulated water network

The reticulated water network, managed by PWC, is supplied by the Darwin River Dam and PWC's allocation from the HGS. Constructed in 1972 Darwin River Dam has an earth embankment 518 metres long with an unregulated 265 metre wide spillway. The Dam was upgraded in 2010 and has a storage capacity of 305 GL and an assessed yield of 33,780 ML p.a., supplying approximately 85 per cent of Darwin's reticulated water with the remainder sourced from PWC's groundwater allocation. The assessed yield of the sources on which the reticulated network relies was 42,200 ML p.a. in 2019 which assumes full extraction from PWC's groundwater allocation of 8,420 ML p.a.. PWC has not extracted their full license from their HGS in recent seasons. This has resulted in an increase in the required production from Darwin River Dam and potential extraction above its assessed yield³. Overall, the reticulated water supply system has operated at its approximate yield over the last 10 years.

Based on the current understanding of climate change, population growth and long-term economic growth Figure 3 displays the base case supply and demand for the existing reticulated network. It is currently projected that climate change will result in increased evaporation and a reduction to dam inflows, resulting in a reduction in yield over time.

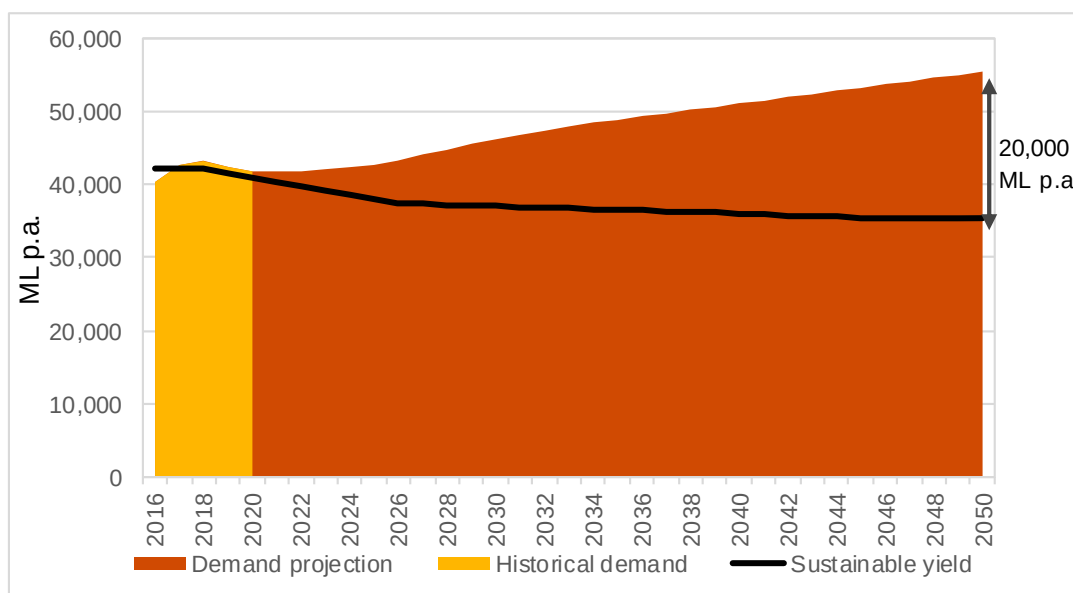


Figure 3: Supply and demand greater Darwin region water supply balance⁴

² SMEC through information provided by DENR, 2020.

³ Assessed yield is the total volume of water estimated to be able to be extracted while meeting PWC's Level of Service objectives.

⁴ SMEC and Power and Water Corporation (2020).

This base case assumes that no major industrial, agricultural/horticultural or commercial development involving a step change in water demand occurs and that growth in residential, industrial/commercial, and government use continues at the long run trend, with continued efficiency in water consumption as per PWC's *Living Water Smart* program. The base case confirms the minimum levels of water required to support current activities and the impact if no augmentation to the water supply is undertaken under PWC's current Levels of Service (LOS).

Figure 3 also demonstrates that under the base case assumptions, water demand will exceed the assessed yield of the reticulated water network from 2021 with a shortfall of 20,000 ML p.a. by 2050. This forecast shortfall between yield and demand creates a significant short to medium term water security risk. PWC LOS will be breached under this scenario and the risk of water restrictions needing to be imposed on the greater Darwin region to ensure long term continuity of water supply increases. The forecast assessed yield also assumes that PWC takes its full groundwater allocation.

PWC, through its 2013 *Darwin Region Water Supply Strategy*, identified a range of initiatives and projects to increase water security and enable growth. These include the implementation of Manton Dam's Return to Service to meet immediate water requirements and the delivery of Adelaide River Off-stream Water Supply (AROWS) in the longer term. Project planning activities for both of these projects have been approved by the PWC board and funding for the next four years is identified in PWC's *Statement of Corporate Intent*. However, while part of PWC's future planning, and endorsed by the PWC board, they do not form part of the base case for this report as they are not committed or funded projects and are still subject to consideration and approval by the NT Government.

More water is needed to enable and drive economic growth

The greater Darwin region has a number of strategic advantages to drive economic development. Firstly, the strategic location of gas reserves across the Northern Territory provides the opportunity to support downstream processing and manufacturing in the oil and gas sector through the development of Middle Arm. Secondly, the opportunity to capitalise on the Darwin rural region being the most productive area for horticultural development in the Northern Territory. These opportunities cannot be realised without access to an additional water source. The identified economic value of this opportunity, developed in the Economic Assessment, is over \$900 million in net present value terms over the life of the investment if the total industrial, agricultural and horticultural growth is realised.

Each of these sectors has substantial water requirements. Given the identified lack of available water supply, the economic future of the greater Darwin region related to these activities depends on water being made available to support new economic activities.

The industrial opportunity and water demand

Darwin is located on a world-class harbour, proximate to rapidly growing markets throughout Asia and there are a range of opportunities to expand the oil and gas sector that will further catalyse industrial activity. Key demand in growth sectors is expected at the Middle Arm Gas and Strategic Minerals Precinct (Middle Arm Precinct). The Middle Arm Precinct is a 2,300 to 2,500 ha industrial precinct, located on the Middle Arm peninsula in Darwin Harbour. The precinct can accommodate industries such as:

- Industrial - Oil and Gas, Chemical and Minerals
- Utilities - Power generation
- Logistics - Rail
- Commercial.

The identification of water requirements for Middle Arm was undertaken in close collaboration with the Department of Infrastructure, Planning and Logistics (DIPL), DTBI, and industry participants to develop an estimated profile of expected water demand over time. These estimates have then been moderated to account for:

- The risk of the projects being delayed, with most projects in the revised demand profile expected to start in 2024 or later to more closely align to the expected timeframes for both gas and water availability and project approval processes
- The chance of success of the project, with the chance of success ranging between 25 per cent and 75 per cent for each project in the mid-case.

Whilst this analysis has been undertaken on a project-by-project basis, this information is commercial-in-confidence and therefore cannot be represented by company in this Preliminary Assessment. Figure 4 illustrates the aggregated forecast demand under High, Mid and Low Cases of development at the Precinct. This forecast water demand profile is currently being tested via market engagement with the industrial sector and is expected to evolve over time.

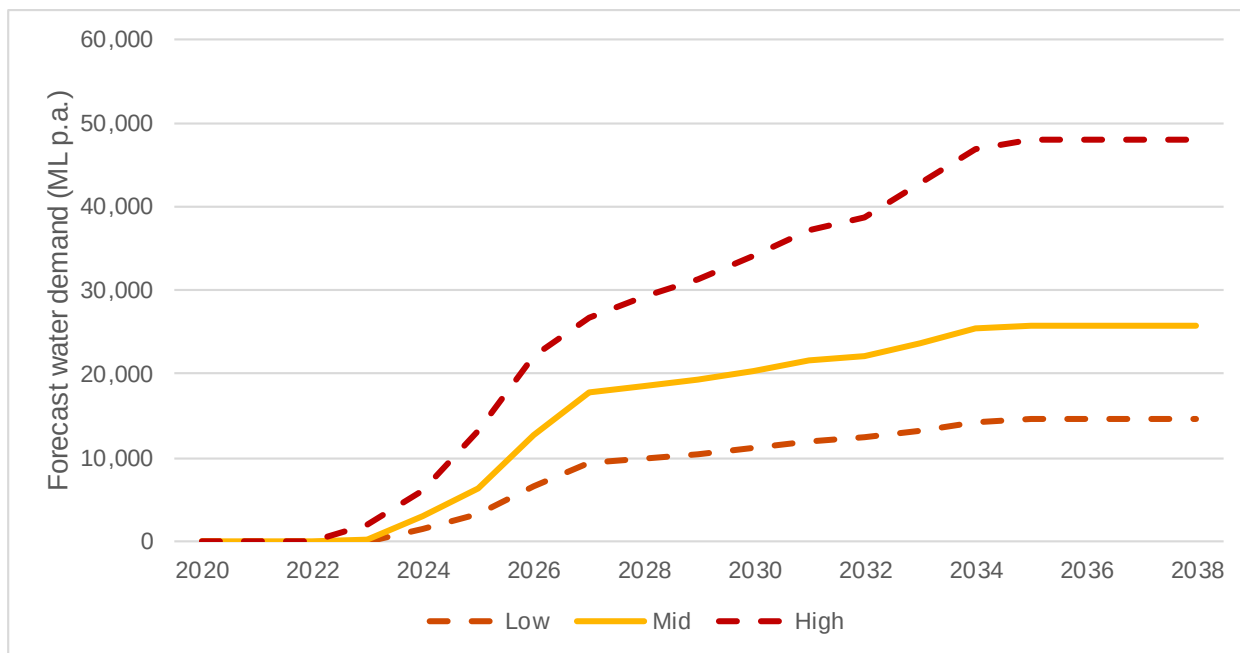


Figure 4: Forecast water demand growth at Middle Arm associated with major industry

The agricultural and horticultural opportunity and water demand

The greater Darwin region has a diverse agricultural and horticultural sector, with agricultural land occupying approximately 550 square km⁵ with potential for expansion. The NT is already a substantial producer and supplier of high-quality mangoes, melons and Asian vegetables to domestic and international markets. The horticulture industry in the Northern Territory has grown significantly, and now produces around 52 per cent of Australia's total mango crop⁶, with the greater Darwin region producing 67 per cent of the NT's total crop⁷.

Many factors determine the success of agricultural and horticultural developments, including climate, soils, pests and diseases, as well as the key agronomic, management, financial, and market and supply chain factors. Access to a reliable water supply is a key challenge constraining growth in horticulture in the greater Darwin region. Based on the results of market engagement with the agricultural and horticultural industries, it is believed that there is demand for a 2,000 ha horticultural precinct if land and water are packaged together as single marketable commodity. The most prospective regions identified for an horticultural precinct appear to be both Lambells Lagoon and Middle Point.

Lambells Lagoon is well suited to horticulture, with existing production in the area including bananas, pineapples, mangoes, passionfruit, rockmelons, honeydew melons, watermelons, pumpkins, papaya, durian, bitter melon, dragon fruit and other tropical species⁸. Approximately 1,994 ha of Crown owned land has been identified as possible for further development and suitable for agriculture and horticulture. The prospective land at Middle Point covers approximately 2,840 ha of land

⁵ Australian Government Department of Agriculture, Water and the Environment: ABARES. *About my region – Greater Darwin Northern Territory*. Accessed at <https://www.agriculture.gov.au/abares/research-topics/aboutmyregion/nt-darwin#regional-overview>

⁶ The Territory (2019). *Agribusiness*. Accessed at <https://theterritory.com.au/invest/key-sectors/agribusiness>

⁷ ABC (2020). *Northern Territory confirmed as mango king, producing 52 per cent of national crop*. Accessed at <https://www.abc.net.au/news/rural/2020-05-14/northern-territory-claims-title-of-biggest-mango-producer/12246604>

⁸ Queensland Country Life (2018). *On the market: NT delivers Sweet Life Farms*. Accessed at <https://www.queenslandcountrylife.com.au/story/5596165/nt-delivers-the-sweet-life-video/>

potentially suitable for horticulture. This land is currently owned by the NT Land Corporation and is planned for future development. Mangoes, bananas and dragon fruit are already produced at Middle Point.

Given the current horticultural activity in the Lambells Lagoon area and the findings from CSIRO's Northern Australia Water Resource Assessment (NAWRA), the expected overall crop mix is assumed to be split between three main crop types: mangos, citrus (lemons and oranges) and Asian vegetables (okra is used as a proxy for Asian vegetables). The ultimate expected crop mix is outlined in Table 1.

Table 1: Ultimate crop mix

Crop type	Ultimate land developed (ha)
Mango	1,000
Citrus oranges	250
Citrus lemons	250
Okra	500

Forecast water demand at Lambells Lagoon and Middle Point

Table 2 displays the total water demand based on the identified crop mix and the water requirement from each crop at maturity and full production. These values were selected following a comprehensive assurance process, consisting of both desktop research and market consultation.

Table 2: Annual agricultural and horticultural water demand (ML p.a.)

	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Total	1,785	3,570	5,355	7,140	8,925	10,710	12,495	14,280	16,065	17,850

Total forecast additional demand

It is evident that there is a strategic need for investment in additional water supply for the greater Darwin region. The total forecast additional water demand required to facilitate growth in the urban, industrial and agricultural/horticultural sectors, and ensure long-term water security, is outlined in Figure 5.

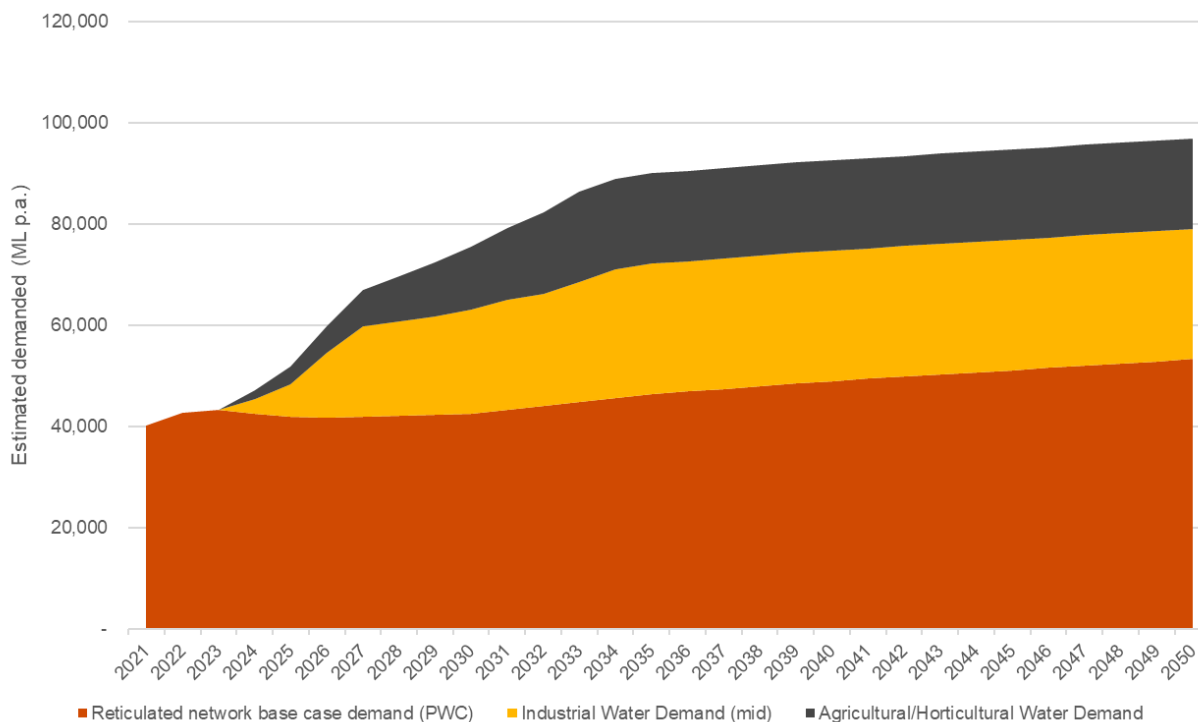


Figure 5: Total forecast additional water demand

Based on the project drivers, and the demand and supply balance, a range of problems and opportunities were identified. These were developed and confirmed through an Investment Logic Mapping process undertaken with key representatives from the NT Government, industry and the Project's advisors. The problems and opportunities are listed in Figure 6.

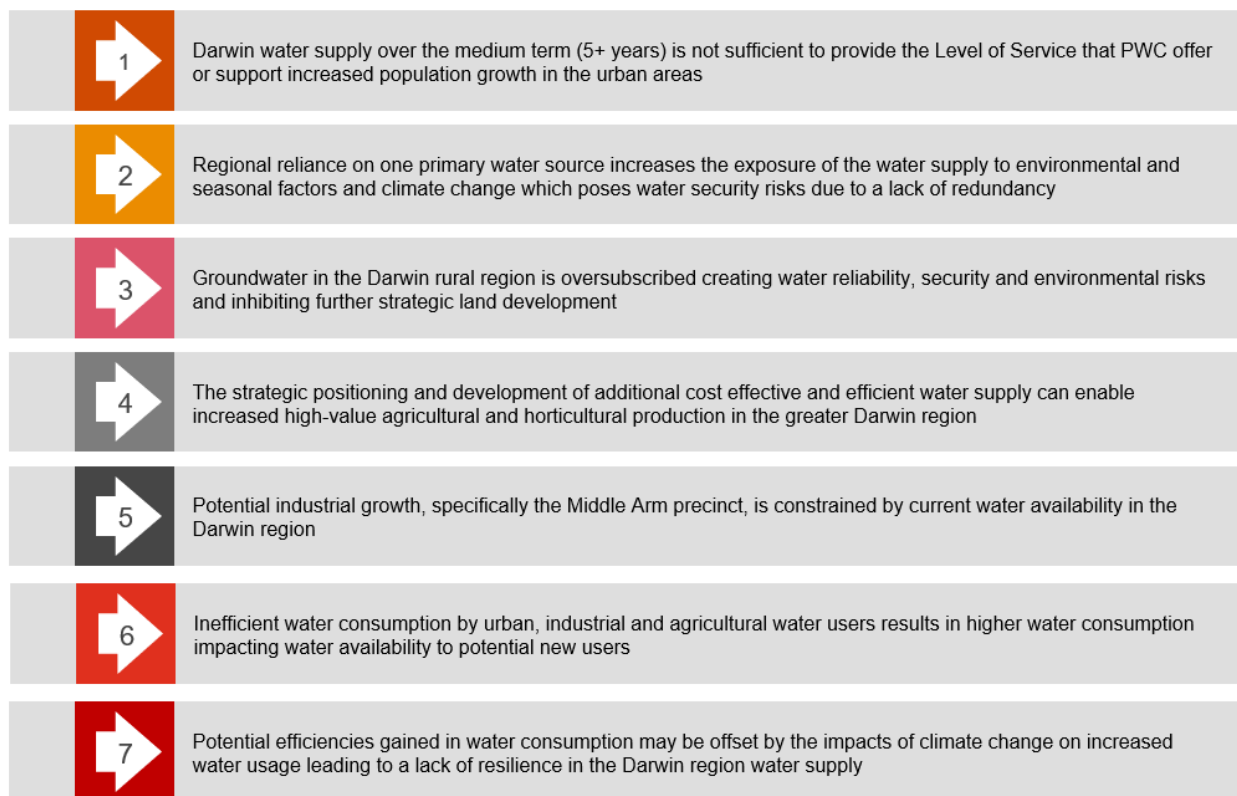


Figure 6: Problems and opportunities

Whilst the over-allocation of the groundwater resource was identified as a key problem, there are many specific policy responses which should be taken, prior to infrastructure solutions being considered, as previous investigations undertaken by the NT Government have indicated that the cost of the distribution and reticulation infrastructure to service rural suburbs is significant. Given this, it was agreed by the key stakeholders in the NT Government that reducing the over-extraction from the groundwater resource would be excluded from the scope of this Project. This project is subsequently focussed on ensuring sufficient water availability for the forecast growth in urban, industrial and agricultural/horticultural sectors to enable the continued economic growth of the greater Darwin region.

Options assessment

A key part of the Preliminary Assessment is a multi-stage options assessment process designed to undertake progressively more quantitative based assessment as the number of options and their scope becomes more defined. The options assessment utilised a filtering process, multi-criteria assessment (MCA) and Rapid Cost Benefit Analysis (CBA) to determine the preferred options for more detailed consideration. The options assessment process and the outcomes of each stage is shown in Table 3.

Table 3: Preliminary Assessment options assessment process

Options assessment stage	Process	Outcomes
ILM options longlist identification	Identify the full range of options which could respond to the problems and opportunities developed in the ILM	18 options identified
High level options longlist filtering	- Review the options longlist to develop a shortlist for assessment in an MCA - Those options which do not meet the service need considered on their potential to form part of a package of lower cost initiatives - Options which are not feasible or cannot meet the service need removed	18 options from the ILM longlist assessed 10 options progressed to the MCA, in addition to the base case
Multi Criteria Assessment	- Undertake an MCA of the shortlisted options from the ILM to determine a set of options for progression to a Rapid CBA - Assess each option against a set of criteria developed to link to the service need of the Project	10 options assessed in addition to the base case 5 options progressed to the Rapid CBA
Rapid CBA	- Assess the options progressed from the MCA in a CBA framework to determine benefit cost ratios and net present values of the options to determine a preferred option - Considers whether the additional economic benefits realised from the larger options outweigh the cost of realising the increased supply	5 options assessed

MCA outcomes

An MCA was completed using a qualitative assessment of the options against an agreed set of criteria to determine the preferred options for consideration in the Rapid CBA. The six criteria used to assess the options in the MCA were; deliverability, economic impact, strategic alignment to the Northern Australia Agenda, cost, environmental and social impact, and adaptability. A summary of the options assessed in the MCA is included in Table 4⁹.

⁹ Under all of these options it is assumed that PWC retains its current allocations to both Darwin River Dam and the groundwater resource.

Table 4: MCA options summaries

Option	Indicative yield (ML p.a.)	Direct Capital Indicative cost (\$million) ¹⁰	Delivery time frame	Stageable
Base case	N/A	N/A	N/A	N/A
Option 1 – Do minimum	6,000 – 8,000	\$10 – \$20 million	5 - 10 years ¹¹	✓
Option 2 – Recycled water	5,000	\$30 million	2 years	✓
Option 3 – Do minimum & disaggregated supply	11,000 – 13,000	\$40 - 60 million	2-10 years	✓
Option 4 – Manton RTS & AROWS 1a (PWC's existing strategy)	17,500	\$580 million	3 – 5 years	✓
Option 5 – Manton RTS & AROWS 1c	38,500	\$675 million	3 – 5 years	✓
Option 6 – Desalination	60,000	\$1,400 million	2 - 5 years	✓
Option 7 – AROWS 3	60,000	\$610 million	5 years	X
Option 8 - In-stream dams	150,000 – 800,000	\$180 - \$850 million	> 10 years	X
Option 9 – Manton RTS & AROWS 3	67,500	\$720 million	3 – 5 years	✓

The outcome from the MCA was a ranked list of the 11 options, displayed in Table 5.

Table 5: Options ranking

Rank	Option in ranked order	Score (out of 5)
1	Option 9 – Manton RTS & AROWS 3	4.10
2	Option 5 – Manton RTS & AROWS 1c	3.90
3	Option 7 – AROWS 3	3.80
4	Option 3 – Do minimum & disaggregated supply	3.40
5	Option 8 - In-stream dams (Marrakai, Mount Bennett and Upper Adelaide River Dams)	3.12
6	Option 4 – Manton RTS & AROWS 1a	3.09
7	Option 6 – Desalination	3.07
8	Option 2 – Recycled water	2.51
9	Option 1 – Do minimum	2.32
10	Base case	1.20

The process has confirmed that those options which can provide sufficient water for both economic development and water security over the short, medium and long term are the strongest performing. The options which include Manton RTS and AROWS perform most strongly as they respond to short-term water security risks with differing medium and long term

¹⁰ Note – AROWS and In-stream dam options do not include the network distribution infrastructure e.g. piping in the costs estimate. This cost is expected to be significant for the in-stream dams.

¹¹ Whilst some savings are able to be realised earlier, it is expected to take between 5 and 10 years for the full demand reduction to be realised.

performance relative to the AROWS scale. Based on the outcomes of the MCA, the top five performing options from the MCA were progressed to the rapid CBA.

- 1 Option 9 – Manton RTS & AROWS 3
- 2 Option 5 – Manton RTS & AROWS 1c
- 3 Option 7 – AROWS 3
- 4 Option 3 – Do minimum & disaggregated supply
- 5 Option 8 - In-stream dams.

Economic assessment

A rapid economic analysis examined the potential costs and benefits of the five shortlisted options. The key benefits for each option included:

- Reduction in the incidence of water restrictions for households connected to the reticulated network
- Increased industrial output at the Middle Arm Precinct which was unlocked by the additional water
- Increased horticultural production enabled by the additional water.

The rapid economic analysis is displayed in Table 6.

Table 6: Rapid economic analysis results (\$m, discounted at 7 and 4 per cent real)

	Do minimum & disaggregated supply	Manton RTS & AROWS 1c	AROWS 3	UARD	Manton RTS & AROWS 3
Option	3	5	7	8	9
Costs					
Capital costs	\$431	\$659	\$872	\$769	\$957
Operating costs	\$134	\$148	\$250	\$61	\$253
Total Costs	\$566	\$807	\$1,122	\$830	\$1,212
Benefits					
Urban user benefits	\$57	\$59	\$61	\$48	\$59
Industrial user benefits	\$284	\$444	\$440	\$224	\$539
Agricultural / Horticultural user benefits	\$0	\$0	\$256	\$157	\$284
Total Benefits	\$341	\$503	\$758	\$429	\$882
NPV @ 7% discount rate	\$ -224	\$ -303	\$ -364	\$ -401	\$ -330
BCR @ 7% discount rate	0.60	0.62	0.68	0.52	0.73
BCR @ 4% discount rate	0.84	0.86	1.03	0.97	1.05

These results indicates that:

- There is a need for Manton Dam RTS to be implemented in the short term to overcome the impending urban supply shortfall.

- This has been recognised by PWC and is a key component of their water supply strategy.
- There is an opportunity to develop AROWS 3 to provide 60 GL p.a. of additional water to provide further urban water security as well as to realise growth in industrial demand and provide opportunities for the agricultural and horticultural sector.
- In the longer term, there may be opportunities to further explore the Upper Adelaide River Dam to provide continued growth for agriculture and horticulture in the areas in close proximity to the dam.
 - The capital cost of the Upper Adelaide River Dam is relatively low if there is the ability to remove significant pipeline and water treatment infrastructure. By implementing AROWS 3 and Manton RTS in the shorter term, there will be limited need for additional treated water to be delivered to the greater Darwin region. The Upper Adelaide River Dam could, therefore, be constructed as a stand-alone asset providing a relatively low-cost source of additional supply for the agriculture and horticulture industry. Given that the Upper Adelaide River Dam is reliant on a subset of the AROWS catchment, hydrological risks will need to be carefully managed in the planning phases of both of these potential projects.
- There is also an opportunity to explore small scale disaggregated water supply options including desalination and recycled water to supplement the water supply as required. This is likely to be for dedicated industrial demand where there are short term constraints limiting industrial growth where there is a high willingness and capacity to pay for the water
- Non-infrastructure, demand management options have the potential to provide a reduction in water use over the short to medium term, and hence an increase in available supply, of 6,000 – 8,000 ML p.a. While substantial, these volumes are not adequate to offset forecast growth from industrial use. Demand management and water efficiency options are likely to be lowest cost options to increase water availability in the region. These options should be investigated and pursued by the NT Government to promote more efficient and responsible use of water and be implemented alongside any infrastructure solution to maximise the benefits of any investment.

Conclusions and recommendations

The Northern Territory has recognised that there is a strategic need to address the supply and demand issues associated with water in the greater Darwin region. Without a new water supply, the greater Darwin region is likely to be subject to water restrictions in the medium term, and new investment and growth in the agricultural, horticultural and industrial sectors will likely be constrained. A comprehensive range of options was identified and investigated in response to the key problems and opportunities. Whilst a number of these options appeared to have a number of strengths, they also have some limitation which meant they could not respond to the service need and therefore they will not be investigated in further detail. These include:

- Option 8 – UARD has been discounted due to its inability to meet the short and medium term water requirements, and significant development risks. However, as discussed above, its long term development could provide continued growth for the agricultural and horticultural industries.
- Option 7 – AROWS 3 has been discounted as it cannot meet the short term water requirement.
- Option 5 – Manton RTS and AROWS 1c has been discounted as it does not provide sufficient water to fully activate the industrial precinct and provides no water for agricultural or horticultural growth.

It is recommended that DTBI:

- Obtain endorsement to progress the Project to the DBC phase
 - The recommended options to progress to the DBC are:
 - Option 9 – Manton RTS and AROWS 3
 - Option 3 – Do minimum and disaggregated supply (including the delivery of a desalination plant at Middle Arm as part of the disaggregated supply component)
- Explore in greater detail the following components of the project in the DBC:
 - Environmental impacts

Executive summary

- Legal and regulatory considerations
- Delivery model
- Financial analysis, including detailed costs and potential funding options.
- Commence works to progress Manton Dam's return to service and AROWS to minimise timeframes post completion of the DBC, including:
 - Developing an Environmental Impact Statement (EIS)
 - Undertaking community and landowner consultation to ascertain community support for the Project
 - Investigations surrounding potential native title implications
 - Developing water allocations and licencing frameworks for the additional water supplied under the Project
 - Engaging with Infrastructure Australia to confirm ongoing support for the Project from Federal Government, including developing a Stage 2 (Options Analysis) submission.

In addition to progressing the DBC and associated activities for the preferred options, it is also recommended that the NT Government pursue further regulatory and reform initiatives. These initiatives could include:

- Implementing further demand management measures, building on the success of *Living Water Smart*, to ensure maximum value is obtained from any subsequent infrastructure investment.
- Implementing a water tariff that is based on full cost pricing principles across the PWC network to assist with the high per capita water use across residential, commercial and industrial, and government sectors.
 - This recommendation is in line with competition reform which has been undertaken across Australia since the 1990s. Full cost pricing is a central tenet of the competition policy reform agenda and has been reconfirmed as a component of the *National Water Initiative Pricing Principles* by the Australian Government's 2015 *Review of Competition Policy*.

Further investigation is required to manage the overuse of groundwater resources across the greater Darwin region. This Preliminary Assessment has noted the ongoing issues related to this overuse, however, this issue has been determined by the NT Government as beyond the remit of the AROWS project. To materially reduce this overuse, a significant and potentially Territory wide reform program is required. This is a complex task which can be undertaken alongside other water supply and demand initiatives. These will likely include initiatives such as legislative reform to limit extraction from groundwater resources, introduce more stringent licensing requirements, and mandate metering at every bore, and further studies to increase the confidence of estimates of sustainable extraction and use of ground water resources

The DBC will provide analyse the two shortlisted options and provide clear direction for the Northern Territory Government to ensure that the future population and economic growth for the greater Darwin region is enabled.

Glossary

Abbreviation	Description
AROWS	Adelaide River Off-stream Water Storage
BCDF	Business Case Development Framework
BQ	Building Queensland
CBA	Cost Benefit Analysis
CCRP	Climate Change Research Program
CIPS	Channel Island Power Station
CRCNA	Cooperative Research Centre for Developing Northern Australia
CWU	Conjunctive Water Use
DBC	Detailed Business Case
DCM	Department of Chief Minister
DENR	Department of Environment and Natural Resources
DIPL	Department of Infrastructure, Planning and Logistics
DPIR	Department of Primary Industry and Resources
DRWCD	Darwin Rural Water Control District
DTBI	Department of Trade, Business and Innovation
DTF	Department of Treasury and Finance
EPBC	Environmental Protection and Biodiversity Conversation
GL	Gigalitres
GL p.a.	Gigalitres per annum
GRP	Gross Regional Product
GSA	Gas Sales Agreement
GSP	Gross State Product
ha	Hectares
HGS	Howard Groundwater System
IA	Infrastructure Australia
ILM	Investment Logic Mapping
Km	Kilometre
LGA	Local Government Area
LNG	Liquefied Natural Gas

Abbreviation	Description
LOS	Levels of Service
MAR	Managed Aquifer Recharge
MCA	Multi-Criteria Assessment
ML	Megalitres
ML p.a.	Megalitres per annum
NAWRA	Northern Australia Resource Assessment
NT	Northern Territory
PAF	Project Assessment Framework
PwC	PricewaterhouseCoopers
PWC	Power and Water Corporation
RO	Reverse osmosis
RTS	Return to Service
SWRO	Seawater reverse osmosis
Tcf	Trillion cubic feet
TGen	Territory Generation
UARD	Upper Adelaide River dam
VHT	Vapour Heat Treatment
WWTP	Waste Water Treatment Plant

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1 Introduction

1.1 Purpose and overview

The Department of Trade, Business and Innovation (DTBI), in partnership with Power and Water Corporation (PWC), has identified that there is a strategic need to address the supply and demand issues associated with water in the greater Darwin region. PricewaterhouseCoopers (PwC) has been engaged to develop a Detailed Business Case (DBC) which investigates and evaluates a range of potential water supply augmentations and interventions that respond to the expected future population-related residential, industrial and agricultural and horticultural demand. The DBC is being delivered in two parts as illustrated in Figure 7.

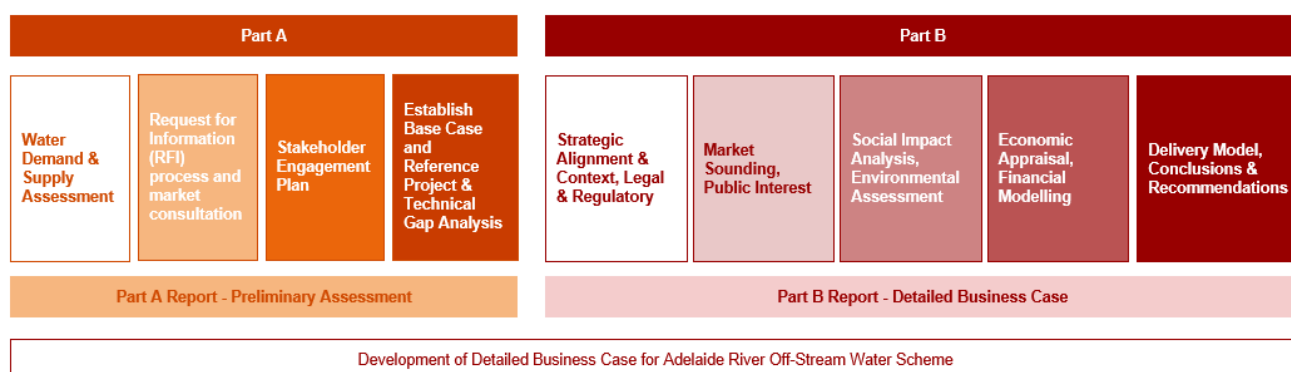


Figure 7: Development process for the AROWS DBC

This report is the Preliminary Assessment report, the key deliverable under Part A of the DBC. It confirms the need and priority for intervention and provides DTBI with a robust rationale and justification to progress the evaluation and development of the DBC.

As detailed in Figure 8, the purpose of the Part A: Preliminary Assessment is to:

- Document the strategic rationale and key drivers for the Project
- Identify the likely future demand for water from the Project, through a market consultation process
- Assess the balance between water supply and demand
- Confirm the expected benefits the Project will deliver
- Comprehensively assess a range of potential infrastructure and non-infrastructure options
- Identify the water yields for each proposed Project option
- Develop a preliminary economic rationale substantiating investment in the preferred solution
- Develop the scope and specification of a preferred technical solution
- Commence engagement with Infrastructure Australia (IA).



Figure 8: Purpose of Part A Preliminary Assessment

1.2 Preliminary Assessment framework

The Part A: Preliminary Assessment has been developed to broadly align with IA's Stage 2 (options analysis) process under the *Infrastructure Australia Assessment Framework*¹². It has also been informed by Building Queensland's (BQ) *Business Case Development Framework (BCDF)*¹³ and the Queensland Government's *Project Assessment Framework (PAF)*¹⁴. Supplementary guidance material from other jurisdictions has been referenced to assist with the development of the Part A: Preliminary Assessment, and ensure it accords with leading practice business case development principles.

1.3 Document structure

The Part A: Preliminary Assessment is structured into the following sections and chapters:

1.3.1 Part 1 – Project Background

Chapter 2 – Proposal Background: This chapter provides an overview of the Project drivers, the Project's location and its geographical context, along with a summary of key previous reports or analysis on the region.

¹² Infrastructure Australia (2018). *Assessment Framework*. Accessed at https://www.infrastructureaustralia.gov.au/sites/default/files/2019-06/infrastructure_australia_assessment_framework_2018.pdf

¹³ Building Queensland (2020). *Framework*. Accessed at <https://buildingqueensland.qld.gov.au/frameworks/>

¹⁴ Queensland Treasury (2019). *Project assessment framework*. Accessed at <https://www.treasury.qld.gov.au/programs-and-policies/project-assessment-framework/>

Chapter 3 – Base Case Supply and Demand: This chapter confirms the current water supply and demand scenario across the greater Darwin region. This chapter serves as a baseline against which potential options can be assessed.

1.3.2 Part 2 – Strategic Rationale

Chapter 4 – Potential water demand: This chapter forecasts the likely water demand from industrial and agricultural / horticultural expansion areas over the Project appraisal period.

Chapter 5 – Problem identification and service need: This chapter uses the Investment Logic Mapping (ILM) process outcomes to articulate the strategic requirements to be addressed by the Project, with specific focus on potential opportunities and the importance of capitalising upon them.

Chapter 6 – Expected Benefits: This chapter responds to the previous chapter, *Problem identification and service need*, by documenting the expected outcomes and benefits that can be realised by responding to the problems and opportunities.

Chapter 7 – Strategic context: This chapter highlights the Project's alignment with the City of Darwin's priorities, and the Northern Territory and Australian Government policies and plans.

1.3.3 Options Assessment

Chapter 8 – Options identification and development: This chapter provides an overview of the options identified and confirmed in ILM process, filters the options according to their ability to address the service requirements and describes the options progressed through the detailed options assessment.

Chapter 9 – Options assessment: This chapter comprehensively assesses each proposed Project option through a Multi-Criteria Assessment (MCA) process.

Chapter 10 – Rapid Cost Benefit Analysis: This chapter evaluates the economic viability of each Project option through the relevant quantitative measures and helps to identify a preferred solution to the confirmed service needs.

Chapter 11 – Reference Project: This chapter details the preferred option's technical scope, specification and functional outputs.

1.3.4 Part 4 – Next Steps

Chapter 12 – Conclusions and Recommendations: This chapter summarises the key findings and outcomes of the Part A: Preliminary Assessment and provides recommendations based on the analysis undertaken throughout the report.

Chapter 13 – Detailed Business Case implementation plan: This chapter provides a recommendation to DTBI on the next steps associated with the subsequent DBC phase.

2 Proposal background

2.1 Introduction

DTBI, in partnership with PWC, is seeking to define and generate solutions to increase the greater Darwin region's water supply. A range of infrastructure and non-infrastructure solutions have been investigated previously and will continue to be considered in the Preliminary Assessment and proposed DBC. This chapter will summarise a background to the project to provide context for the Preliminary Assessment, including:

- Study area
- Project drivers
- Previous analysis.

2.2 Study area

The study area of the Project is the greater Darwin region, pictured in Figure 9. Greater Darwin is comprised of three Local Government Areas (LGA), including the City of Darwin, Litchfield and Palmerston, and accounts for less than 1 per cent of the Northern Territory with a total area of 316,391 hectares (ha)¹⁵. The region has a population of 148,564 persons¹⁶ and a prominent and active indigenous community represented by the traditional owners of the land, the Larrakia people.

Despite being the smallest Australian Capital City, the region's locality is pivotal to Australian businesses and industries due to the connection it provides to South East Asia. Darwin's continued integration into Asian markets and established sister city program will enable the region to further enhance their economic link to global supply chains, which are likely to drive Australia's economy over the foreseeable future. As a result, the greater Darwin region has become a service hub for several industries in the Northern Territory, including tourism, mining, offshore oil and gas production and tropical horticulture.



Figure 9: Boundaries of the greater Darwin region

¹⁵ Department of Agriculture, Water and the Environment (2018). *About my region – Greater Darwin Northern Territory*. Accessed at <https://www.agriculture.gov.au/abares/research-topics/aboutmyregion/nt-darwin#regional-overview>

¹⁶ ABS (2018). *Greater Darwin (GCSA) (7GDAR)*. Accessed at https://itt.abs.gov.au/itt/r.jsp?RegionSummary®ion=7GDAR&dataset=ABS_REGIONAL_ASGS2016&geoconcept=ASGS_2016&measure=MEASURE&datasetASGS=ABS_REGIONAL_ASGS2016&datasetLGA=ABS_REGIONAL_LGA2018®ionLGA=LGA_2018®ionASGS=ASGS_2016

2.3 Project problems and opportunities

Options to increase the greater Darwin region's water supply have been investigated over many years. Consistent throughout each analysis, are key strategic themes which communicate why investigations continue to be undertaken and why an investment should be made. These themes are the key project problems and opportunities, and clearly describe the strategic rationale for investment in new water infrastructure. The key project problems and opportunities that have been articulated for the Preliminary Assessment and confirmed with key stakeholders within the Northern Territory (NT) Government, are displayed in Figure 10.

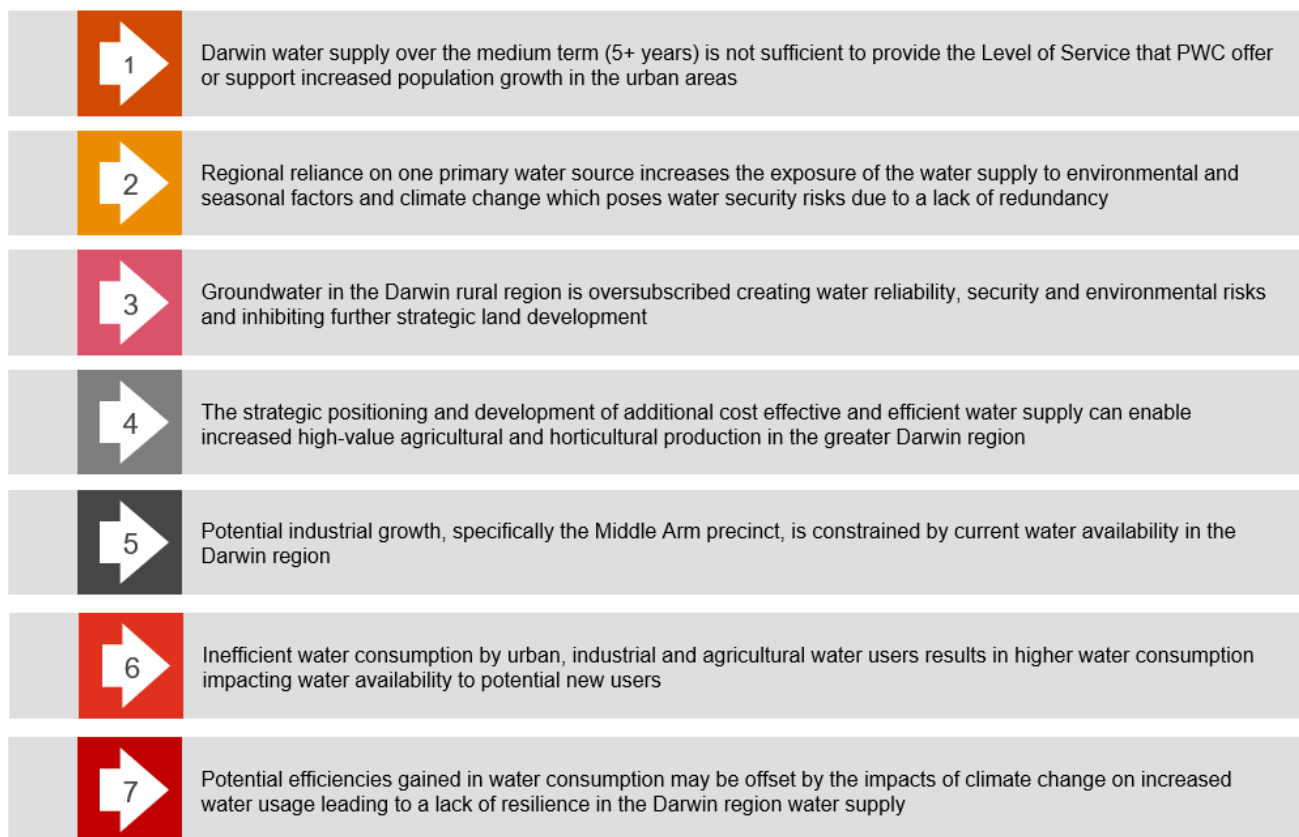


Figure 10: Project drivers

Further detail regarding the problem and opportunity statements is provided in *Chapter 5 - Problem identification and service need*.

2.4 Previous analysis

2.4.1 Approach to reviewing previous studies

As detailed in Figure 11, a significant amount of planning, investigation and analysis has been conducted on the water supply in the greater Darwin region and potential enhancement options and interventions. Prior to the development of this Preliminary Assessment, the Project team completed a comprehensive analysis of each report detailed in Figure 11, with specific focus on the purpose, methodology and outcomes and recommendations. The analysis of these reports provided a robust foundation for the Project team to further develop the Project's strategic need, and potential options and solutions associated with the region's water supply.

Consultant	Organisation	Previous analysis of AROWS	Year									
			2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
SMEC	PWC	Interbasin Transfer Options Study for the Darwin Water Supply System										
SMEC	PWC	Darwin Region Water Supply Strategy										
SMEC	PWC	Darwin Water Supply Medium Term Options Assessment										
DENR		A Preliminary Assessment of groundwater use in parts of the Darwin Rural Water Control District and Palmerston Municipality										
CSIRO		Water resource assessment for the Darwin catchments (NAWRA)										
GHD		Territory Generation: CIPS Desalination Update										
SMEC	PWC	AROWS Options Development: Supplementary Options Assessment										

Figure 11: Timeline of previous work regarding the greater Darwin region's water supply

A high-level summary of each report is detailed in the below paragraphs.

2.4.2 Interbasin Transfer Options Study for the Darwin Water Supply System 2011, SMEC

PWC engaged SMEC to assist in assessing a number of alternative options for a water supply system augmentation that may take place in the medium to long term. The investigations focussed on options including:

- Construction of Marrakai Off-stream Water Storage (now known as the AROWS project) located adjacent to and west of Adelaide River and east of Manton Dam
- Pumped water supply from the Adelaide River to one or more of Manton Dam, Darwin River Dam or the proposed Marrakai Off-stream Water Storage
- Transfer of flow from the proposed Warrai Dam (now known as the Upper Adelaide River Dam) via the Adelaide River to a pump station capable of transfer of water to the proposed Marrakai Off-stream Water Storage or directly to the Darwin region water supply system
- Pumped water supply from Hanna's Pool on the Finniss River to Darwin River Dam.

Various demand scenarios were considered, ranging from supplying an additional 30,000 Megalitres per annum (ML p.a.) up to a maximum of 80,000 ML p.a. The range investigated represents PWC's lower and upper demand projections. Outcomes of the analysis included:

- The Adelaide River offers a significant potential water supply for the Darwin region water supply system
- The Adelaide River Pumping Scheme is a feasible option for harvesting flood flows from the Adelaide River
- The Marrakai Off-stream Storage Scheme (now known as the AROWS project) is a feasible storage site for water harvested from the Adelaide River
- The Adelaide River could be used as a conduit for water released from a future Warrai Dam to be harvesting downstream without significant losses
- The construction of Warrai Dam does not significantly diminish the amount of water available for harvest from the Adelaide River, regardless of the transfer method.

It was noted that while the Hanna's Pool on Finniss River Pumping Scheme offers the potential to improve reliability of the Darwin River Dam yields, it does not provide a significant additional water supply source for the Darwin region water supply system. The Study recommended that further investigations be undertaken, including environmental, water quality, planning and heritage and a confirmed target demand and timeframe be determined to enable the scheme to be optimised.

2.4.3 *Darwin Region Water Supply Strategy 2013, Power and Water Corporation*¹⁷

The Darwin Region Water Supply Strategy details PWC's plan to balance supply and demand for water to a planning horizon of 2030. The Strategy outlines the capacity of the current water supply system, forecast growth in demand, existing and proposed initiatives for demand management, future water source options and the proposed program for development of new water sources.

The strategy discusses several options to augment the Darwin region's water supply in the short and medium term (beyond 2020). It also discusses alternative supply options and evaporation reduction technology as future water source options. A high-level assessment of options was undertaken over five years to identify a shortlist of preferred options for detailed assessment and prioritising. The Strategy noted that a number of detailed hydrological, geophysical, engineering and environmental studies were yet to be undertaken for these options.

For the medium term, the Strategy presents options for:

- Future dam sites
- Augmentation of Manton Dam's Storage
- AROWS
- Desalination.

The Strategy concludes that, while returning Manton Dam to service will improve capacity of the water supply without additional supply augmentation, water restrictions may be required in the short term and demand for water will approach capacity of the system.

2.4.4 *Darwin Water Supply Medium Term Options Assessment 2016, Entura*

The Options Assessment was undertaken in partnership with PWC, to investigate short and medium term supply augmentation options that would allow PWC to continue to maintain their levels of service objectives for water source security in light of projected increases in water demand. An initial short-listing process has identified four medium term water source options for consideration, including:

- Desalination, sourcing water from the Darwin Harbour
- An in-stream dam on the upper Adelaide River (UARD)
- An off-stream storage in the Marrakai Region that would be supplied with water from a pumping station on the Adelaide River, harvesting flood flows during the wet season, known as AROWS
- The augmentation of Manton Dam's storage.

A fast-tracked high-level review of estimated yields and costs was proposed to inform further shortlisting of these options. AROWS and UARD were the only options that were able to meet the levels of service requirement for a 50-year forecast of water demand growth. AROWS was the only option that provided significant potential for staging of infrastructure.

The Options Assessment also investigated the effects of climate change on water supply. It concluded that climate change results in a major impact on system yield with a range of total system yield reductions from 13.2 per cent to 22.9 per cent for the range of water source portfolios considered. Water source portfolio options that incorporated desalination or AROWS were found to be the most resilient portfolios in relation to forecast climate change whilst water source portfolio options that included the recommissioning of the Manton Dam were found to be the least resilient.

2.4.5 *A preliminary assessment of groundwater use in parts of the Darwin Rural Water Control District and Palmerston Municipality 2017, DENR*

The purpose of this study was to present a preliminary assessment of groundwater use in the Darwin Rural Water Control District (DRWCD) in areas outside the Howard and Berry Springs groundwater systems. Further, it presents a snapshot of

¹⁷ Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013*. Supplied by PWC

the current risk of groundwater being over-used in the study area. It provides an assessment tool for both water regulation and land planning purposes.

Results from this assessment suggest that, at the time of the report:

- There is 31GL per annum of consumptive use occurring within the study area
- The majority of use is stock and domestic use (11.25 GL) and unlicensed irrigated use (13.75 GL) which accounts for 80 per cent of the consumptive use
- 80 per cent of all consumptive use occurs in groundwater resource zones that are classed as either over-used (57 per cent) or high use (23 per cent).

The findings from this assessment suggested that there is a need to monitor and regulate those groundwater resources that have been assessed as high to over-used for groundwater use. The assessment recommended several areas where further work should be undertaken in regard to water usage estimates, further resource assessments and recharge estimation.

2.4.6 Water resource assessment for the Darwin catchments, CSIRO

The Northern Australia Water Resource Assessment (NAWRA) is a comprehensive and integrated evaluation of the feasibility, economic viability and sustainability of water resource development in three priority areas in Northern Australia: the Fitzroy, Darwin and the Mitchell catchments¹⁸. The assessment sought to identify resources that could be deployed in support of potential irrigation enterprises, evaluated the feasibility of development and considered the scale of opportunities that might exist.

The NAWRA discusses AROWS as a possible future water supply site that has been shortlisted by PWC for future consideration and notes that the preferred option of PWC is AROWS. The CSIRO report found that AROWS could extract and store more than 50 GL of water per year at greater than 99 per cent reliability.

The study suggests that there is no single water storage and supply solution. Maximising the scale and cost-effectiveness of water supply in the Darwin catchment will require adopting different options in different locations at different times.

2.4.7 Territory Generation: CIPS Desalination Update 2019, GHD

Territory Generation (TGen) considered the opportunity to develop a seawater desalination facility at the Channel Island Power Station (CIPS) to provide high quality (low salinity) non-potable water for power station use and, potentially, for sale to other parties. This report documents the Concept Design and cost estimates for seawater desalination for a variety of plant sizes. TGen considered three primary capacity options for the desalination facility, at 1, 3 and 12 GL per annum (GL p.a.). The report concludes that due to constraints on available land, a 12 GL p.a. seawater reverse osmosis (SWRO) desalination plant has potential to be located on the mainland in Wickham, where land is available, closer to (potential) majority water consumption.

2.4.8 AROWS Options Development: Supplementary Options Assessment 2020, SMEC

SMEC was engaged by PWC to undertake a series of studies related to the development of the AROWS scheme, including geological, hydrogeological and geotechnical investigations, hydrologic investigations and option development for the AROWS infrastructure. The Assessment also includes cost estimates for the various infrastructure components. The recommendations from the report primarily consist of proposals for further work and investigation conducted on geotechnical, hydrological, hydraulic and structural components of the AROWS project.

2.4.9 Summary of findings

The completed studies and reports summarised above on the greater Darwin region's water supply share a number of commonalities and findings. Despite the large majority of studies highlighting the region's potential for further industrial, agricultural and horticultural development, the lack of sufficient water supply, as highlighted in Section 2.3, is an evident constraint on this potential. These previous reports demonstrate that a broad range of options has been considered over the

¹⁸ Petheram, C., Chilcot, C., Watson, I., & Bruce, C. (2018). *Water resource assessment for the Darwin Catchments*. Accessed at <https://publications.csiro.au/rpr/download?pid=csiro:EP186907&dsid=DS2>

last ten years, with AROWS subject to various investigations in different forms. Each of these previous investigations has supported and reinforced AROWS as the preferred and most prospective option to meet the greater Darwin region's water requirements. This supports the continued investigation of the AROWS project through this Preliminary Assessment and further consideration of its potential impact on the economic development of the greater Darwin region.

2.5 Summary

The need for additional water supply in the greater Darwin region has been recognised for over 10 years, and there have been numerous studies investigating options which may be viable and meet the needs of the region. There is general agreement that action should be taken as a priority to ensure a reliable water source for urban, industrial and both agricultural and horticultural consumers. PWC's *Darwin Region Water Supply Strategy* provides a plan to improve water security and enable growth in the urban water sector. Given PWC's role in the water supply network as a water supplier, not an economic development agency of the NT Government, the overall focus of the plan on ensuring security of supply for the urban sector and does not consider the supply of water required to promote further economic growth.

This Preliminary Assessment is the next step in the process and builds on the extensive body of work already undertaken by PWC and the NT Government. In addition to ensuring the water security for urban users, it also further investigates water requirements to promote and create economic growth. It recommends the preferred options to augment the greater Darwin region's water supply to provide a secure and reliable water supply for urban use and enable future economic growth in both the industrial and agricultural and horticultural sectors.

3 Base Case Supply and Demand

3.1 Introduction

Water users in the greater Darwin region currently source water through either the PWC water supply network or directly through accessing groundwater. Water supply is provided either by the Darwin River Dam or groundwater through a series of bores. Water demand in the greater Darwin region primarily consists of urban, industrial, government and commercial consumption for PWC's network and rural domestic, livestock, agriculture and horticulture consumption from groundwater through two key organisations in the Northern Territory with responsibility for the management and delivery of water in the greater Darwin region. These are:

- PWC, which is the sole licensed water provider in the region. PWC owns and manages the Darwin River Dam, the reticulation network and provides water to users across the reticulated water network.
- The Department of Environment and Natural Resources (DENR) which administers the *Northern Territory Water Act 1992* and provides water management and monitoring services on behalf of the Northern Territory Government.

Water in the greater Darwin region is sourced from either surface water or groundwater resources. Water to the Darwin urban area is supplied through the reticulated network, owned and managed by PWC. PWC draws water for their network from both Darwin River Dam and groundwater. The majority of the water for the Darwin rural region is sourced directly from groundwater resources through bores, primarily within the Howard Groundwater System (HGS). An overview of the greater Darwin region's water supply network is illustrated in Figure 12.

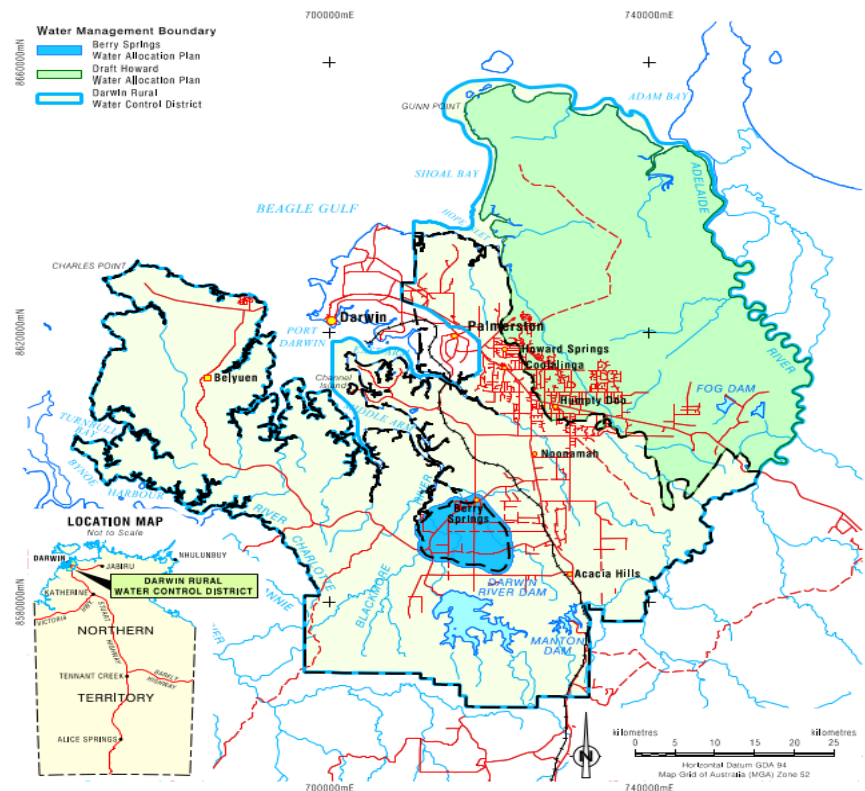


Figure 12: Greater Darwin region water supply network (Left - PWC water supply network, Right - Howard Groundwater System)¹⁹

¹⁹ PWC (2013). *Darwin Region Water Supply Strategy 2013*; Department of Environment and Natural Resources (n.d.). *Howard Groundwater System*. Accessed at https://denr.nt.gov.au/_data/assets/pdf_file/0007/386890/Howard-Goundwater-System.pdf

3.1.1 Ground water

The groundwater resources in the greater Darwin region fall with the regulatory boundary of the DRWCD. The HGS and Berry Springs groundwater resources supply water for rural domestic, stock and irrigation purposes. Extraction for the reticulated network by PWC is exclusively drawn from the HGS. PWC has a licenced extraction from the HGS to supplement public water supply on the reticulated water network.

In addition to extraction from private bores for rural domestic, stock and irrigation purposes, PWC has a licence to extract up to 8,420 ML p.a. from the Howard East and McMinns borefields for use in the reticulated network.

Over the past 30 years' groundwater development within the DRWCD has increased significantly from around 1,000 bores in the 1980s to over 8,000 bores in 2019. Much of the groundwater development has been via stock and domestic installations through basic landholder rights on small rural blocks.

Under the *NT Water Act 1992*, licences are not required for groundwater extraction for stock and domestic purpose, and road construction. There is no requirement for stock and domestic users to meter their bores, only licensed users are required to have a metered bore. Therefore, measuring the overall extraction of groundwater is a complex task, however, estimates by the Department of Environment and Natural Resources (DENR) indicate that up to 90 per cent of extraction is unlicensed.

The *Northern Territory Water Allocation Planning Framework* establishes a target limit of the level of extraction from the groundwater resources at 20 per cent of the median annual recharge. This level is set to protect the environment which also relies on groundwater flows and to ensure the sustainability of the resource. However, under current regulation and legislation there is limited capacity to enforce extraction limits to ensure that this target is maintained. Additionally, the adequacy of this 20 per cent limit is currently unknown as there have been limited detailed technical studies into the sustainable extraction levels from these groundwater resources, and the true sustainable yield may differ from this assumption.

Howard Groundwater System

The HGS has five extraction zones, North, South, East, West and Central, shown in Figure 13²⁰. The West and Central Zones are the most proximately located to the Darwin area and the majority of the Darwin rural area's existing agricultural/horticultural production in this area. Approximately 80 per cent of the current extraction occurs within the West and Central zones.

The HGS does not currently have an active water allocation plan with a defined sustainable yield. Based on analysis undertaken by SMEC and DENR the annual available extraction based on the 20 per cent rule across the HGS is up to 26,000 ML p.a.

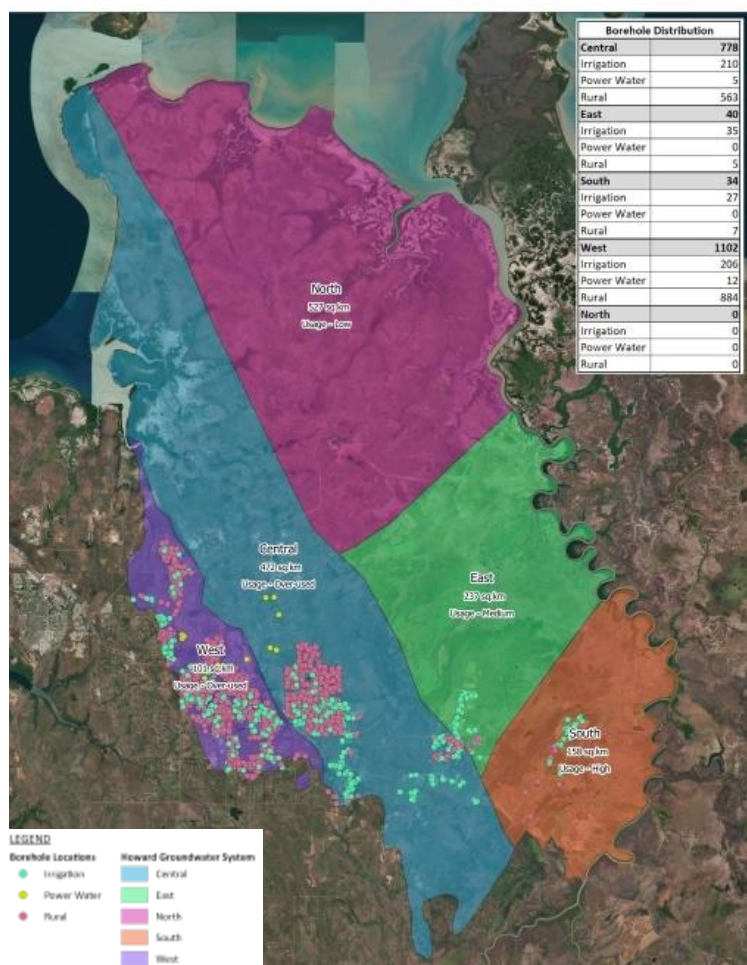


Figure 13: HGS zone system and bore locations

²⁰ SMEC (2020). Developed based on data provided by DENR.

The overall extraction of groundwater resources is discussed in Section 3.2, however, all zones other than the North are currently estimated to be over extracted. The heavily used West and Central zones are currently 380 per cent, and 150 per cent over extracted respectively, above their sustainable yields²¹. Given this, the base case assumes no development or increase in the available supply from the HGS.

Berry Springs

The Berry Springs Water Allocation Plan 2016 – 2026 has been developed in accordance with the *Water Act* and applies to an area of 105 km², encompassing the Berry Springs Dolostone Aquifer System. The surface water resources (Darwin River and Manton Dams) and, according to the Berry Springs WAP, the aquifer systems in this area are connected and extraction from either system affects water supplies for ecosystems that depend on dry season flows in the Darwin River and Berry Creek. The location of the Berry Springs groundwater resource and water allocation plan area are shown in Figure 14.

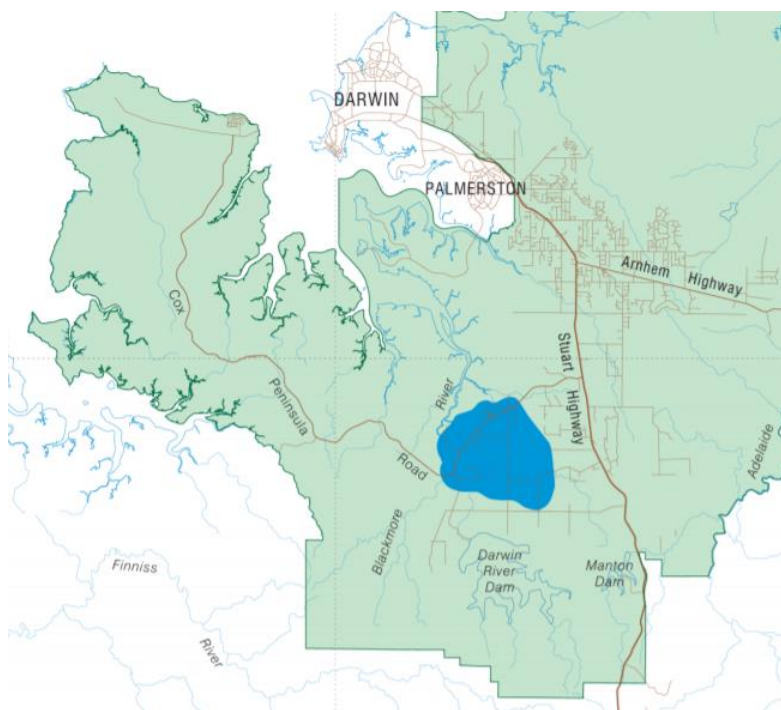


Figure 14: Berry Springs water allocation plan area

The Berry Springs water allocation plan establishes the sustainable yield for this system. Based on the plan, the overall sustainable yield for the area is 8,900 ML p.a.²². At the time of the publication, the Plan notes that extraction was 8,600 ML p.a., with therefore, limited available supply to increase extraction without compromising the sustainability of the groundwater resource. Given this, the base case assumes that there is no additional water supply available from the Berry Springs groundwater resource.

Remainder of DRWCD

Within the remainder of the DRWCD groundwater extraction matches the primary areas of rural development. The sustainable yield of the DRWCD outside of HGS and Berry Springs is estimated to be approximately 22,700 ML p.a. and its extraction is approximately 27,000 ML p.a.

²¹ SMEC (2020). Based on information provided by DENR and PWC

²² NT Government (2016). *Berry Springs Water Allocation Plan 2016 – 2026*.

Other Groundwater Resources

To date there has been limited exploration of other groundwater supply options within the DRWCD. DENR indicate that there are two groundwater aquifer systems that might have potential for to wn water supply in addition to industrial, agricultural and horticultural uses:

- Koolpinyah Dolostone East of the Adelaide River
- Marley Dolostone between Darwin River Dam and Manton Dam.

It is estimated that an additional 35 GL p.a. could potentially be extracted from a combination of the interconnected sand and dolostone aquifers in the Wildman catchment (the Koolpinyah Dolostone Aquifer east of the Adelaide River), the Kulshill Group Sandstone and the Daly River Limestone (Marley Dolostone) ²³. However, to date there has not been any detailed investigations of their likely potential as water sources and initial investigations have shown that the expected yield at each individual location is not sufficient to support any significant increase in groundwater availability. Additionally, given their location, the cost of transmission infrastructure is likely to be significant. Based on this, no further development and expansion of new groundwater resources is included in the base case water supply.

3.1.2 Surface water

There are two primary surface water storages in the greater Darwin region, the Darwin River Dam and Manton Dam both owned and operated by PWC. The Darwin River Dam was developed in 1972 as a replacement for Manton Dam and at present only the Darwin River Dam is commissioned to supply water into PWC's reticulated network.

Constructed in 1972 Darwin River Dam has an earth embankment 518 metres long with an unregulated 265 metre wide spillway. The Dam was upgraded in 2010 and has a storage capacity of 315,000 ML and an assessed yield of 33,780 ML p.a. Extraction above this level is possible (up to PWC's extraction licence of 49,100 ML p.a.) however this will compromise water security and reduce the levels of service offered, resulting in an increased likelihood of water restrictions for the community²⁴. The Darwin River Dam currently supplies approximately 85 per cent of Darwin's reticulated water with the remainder sourced from PWC's groundwater allocation.

The Darwin River Dam is significantly exposed to climatic factors, undergoing substantial changes in water storage levels over the wet and dry seasons within a calendar year. Approximately two-thirds of the reduction in storage levels each year is due to evaporation²⁵. Figure 15 shows the dam storage levels since 1980, demonstrating the variations in storage levels each year.

²³ Vanderzalm J, Barry K, Davies P, Gonzalez D, Hughes J, Page D, Petheram C, Rogers L, Taylor A, Turnadge C and Yang A (2018). *Chapter 5: Opportunities for water resource development in the Darwin catchments*. In: Petheram C, Chilcott C, Watson I and Bruce C (eds) (2018) Water resource assessment for the Darwin catchments. A report to the Australian Government from the CSIRO Northern Australia Water Resource Assessment, part of the National Water Infrastructure Development Fund: Water Resource Assessments. CSIRO, Australia.

²⁴ Power and Water Corporation (2013). *Darwin Region Water supply Strategy 2013*.

²⁵ Power and Water Corporation (2019). *Living Water Smart Darwin Region*. Accessed at <https://www.livingwatersmart.com.au/wetthatwasnt>.

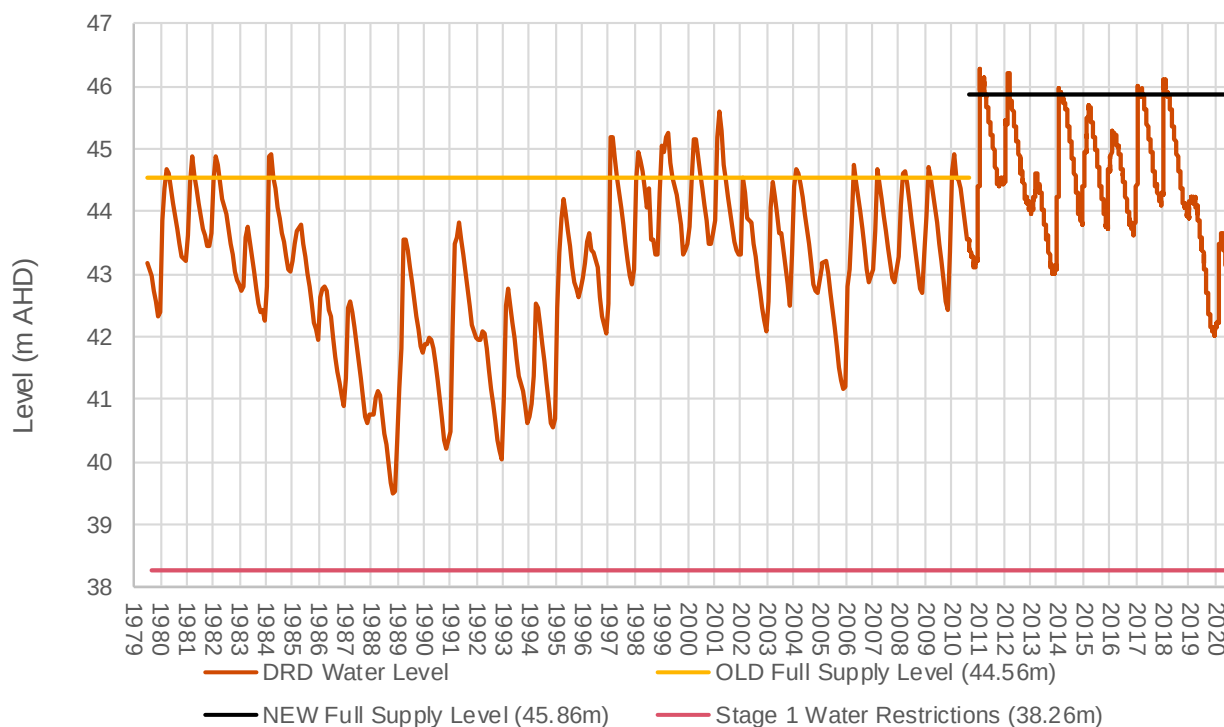


Figure 15: Darwin River Dam storage level²⁶

Given the significant fluctuations in storage levels, the Darwin River Dam is dependent on high rainfall wet seasons for recharge. As seen in Figure 15, when multiple successive poor recharges are experienced, as they have been recently, the storage levels are depleted with near-term water security risks emerging. From a full supply level in 2017 and 2018, the low rainfall in the 2019 wet season resulted in a recharge to only 78 per cent. As of May 2020, a further below-average wet season has seen storage only recharged to 70 per cent. Further successive poor wet seasons will see further reductions in the storage level of the Dam, potentially requiring the implementation of water restrictions, which have not previously been implemented in Darwin. Further impacts due to climate change are also expected to have a continued impact on the Darwin River Dam. While the precise impacts of climate change are unknown, it is expected to result in overall declining yields from the Darwin River Dam.

PWC has modelled numerous scenarios to determine yield estimates for the existing Darwin River Dam including a future climate change impacted scenario to 2090. Table 7 provides the estimated yield for the existing scenario and business-as-usual demand reduction factors scenario. Climate change has been included for the 2030 scenario to account for reduction in yield due to climate change impacts.

Table 7: 2030 Yield Estimates for the reticulated water network

Storage	Existing scenario	Climate change scenario (2030)
Assessed yield (ML p.a.)	42,200	38,000

Manton Dam

Manton Dam was built in the early 1940s and served as Darwin's principal water supply source until Darwin River Dam was commissioned in 1972. Since 1988, Manton Dam has been used for recreation. The dam has a capacity of 14,000 ML and could yield up to 7,300 ML p.a., however, due to inadequate infrastructure and water quality challenges it is not currently

²⁶ Power and Water Corporation, *Darwin River Dam*, accessed May 2020.

used as part of the water supply system²⁷. The return to service of Manton Dam is identified in the *Darwin Region Water Strategy* and whilst further investigations have been funded by PWC, the project does not currently have full funding committed by the NT Government. Given this, its return to service is not included in the base case, however it is considered in the Options Assessment (described in Chapter 8 and 9) as it is an existing infrastructure asset that could potentially be recommissioned.

3.1.3 Greater Darwin region supply summary

The water supply to the greater Darwin region is predominantly supplied by the groundwater resources and the Darwin River Dam. The reticulated networks sustainable supply is approximately 45,000 ML p.a., comprising 37,000 ML p.a. of surface water from Darwin River Dam and PWC's allocation to extract 8,400 ML p.a. from the groundwater network.

Based on the current groundwater supply, and current committed and funded water augmentation projects, there is expected to be no change to the current forecast supply level, this reflects a 'Do Nothing' base case. Outlined in Figure 16 is the current modelled forecast sustainable yield for PWC's network to 2050. The overall yield is expected to gradually decline from 42,200 ML p.a. in 2018 to 34,500 in 2050 due to the forecast impact of climate change.

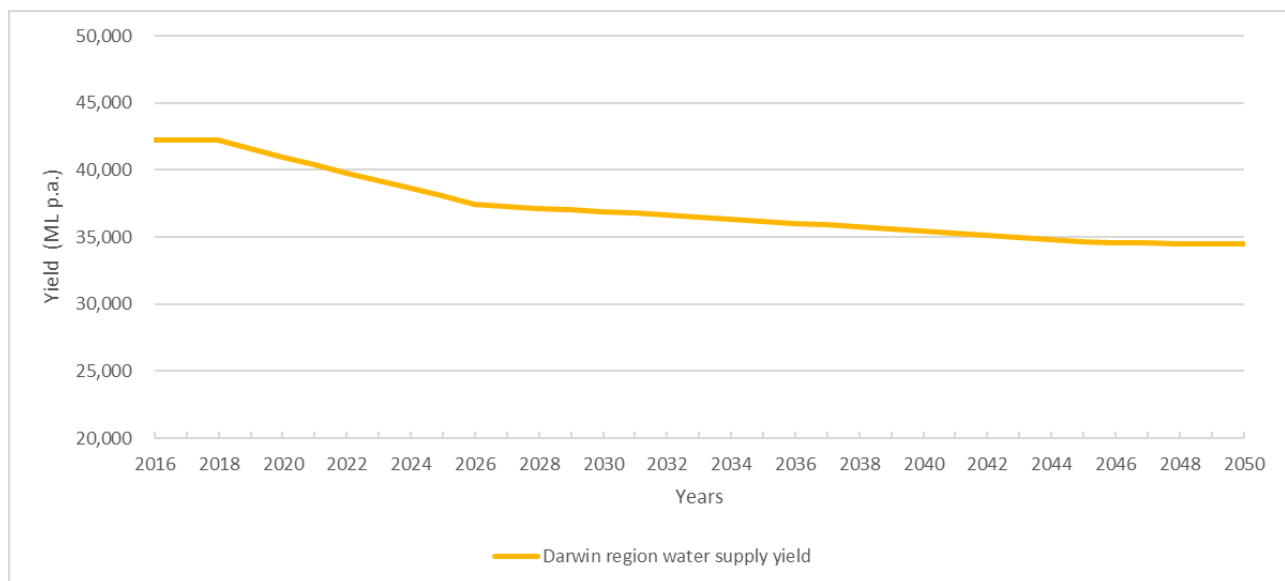


Figure 16: Forecast base case Darwin region water supply yield (ML p.a.)²⁸

3.2 Greater Darwin region water demand

3.2.1 Groundwater

Groundwater is used primarily for rural domestic, stock and irrigation purposes as discussed in Section 3.1.1. Establishing historical and current groundwater consumption profile is a complex task. Stock and domestic use are not required to have a license for extraction and under the *Water Act* are allowed to freely take water from any waterway on, or adjacent to, their land and groundwater beneath the land²⁹. Unlicensed users are also not required to meter bores used to access the groundwater area also not metered and therefore there is no detailed long term data collection to understand current and historical extraction from these users. Despite these challenges DENR has estimated the number of bores drilled per year across the DRWCD. Figure 17 illustrates the significant increase in bore development over the past thirty years.

²⁷ Power and Water Corporation (2013). *The Darwin Water Story*. Accessed at https://www.powerwater.com.au/__data/assets/pdf_file/0021/8445/2013-Power-and-Water-Corporation-The-Darwin-Water-Story.pdf

²⁸ Power and Water Corporation (2020).

²⁹ Northern Territory Government (2018). *Northern Territory Water Regulatory Reform Directions Paper*.

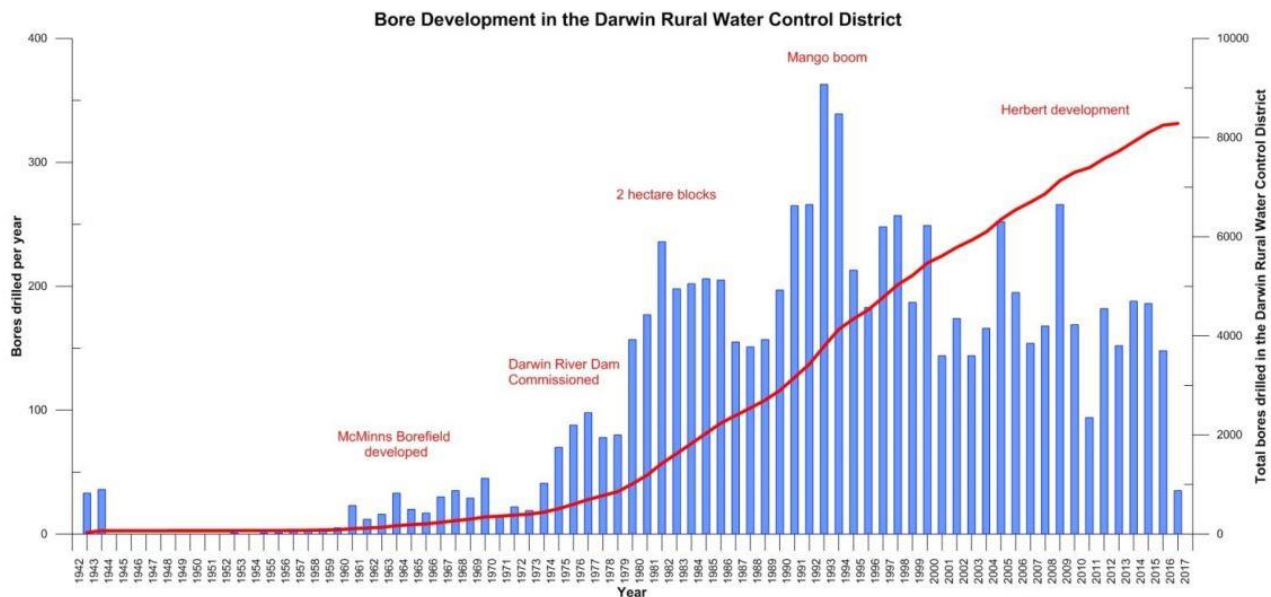


Figure 17: Bores constructed and cumulative total number of bores (red line) across the DRWCD and Palmerston municipality³⁰

DENR has also undertaken research and analysis to establish the current extraction from the groundwater resources in the Darwin rural region. Based on this analysis, the estimated extraction and user group as at 2017 is shown in Table 8.

Table 8: Darwin groundwater use summary³¹

System	Estimated sustainable yield (ML)	Estimate of current use (ML)	Estimated use (stock and domestic) (ML)	Estimated use (other) (ML)
Howard Groundwater System				
Howard North	6,600	62	56	6
Howard Central	11,000	18,804	3,647	13,271
Howard East	3,000	6,358	165	6,414
Howard West	3,600	12,640	7,924	4,834
Howard South	1,800	3,235	137	2,745
Sub-total	26,000	41,099	11,928	27,270
Berry Springs	8,900	8,150	1,005	7,595
Remainder of DRWCD	22,689	26,684	9,816	16,867
Total	57,589	75,932	22,749	51,732
Remainder of Darwin	87,229	4,705	1,434	3,270

³⁰ DENR (2017). *A preliminary assessment of groundwater use in parts of the Darwin Rural Water Control District and Palmerston municipality*. Technical report 2/2018D, August 2017

³¹ SMEC through data provided by DENR, 2020.

As previously discussed, the *Northern Territory Water Allocation Planning Framework* allows for a maximum extraction of 20 per cent of annual recharge.

All zones of the HGS, except the North, are over extracted with the West and Central zones 380 per cent, and 150 per cent over extracted respectively³². The Berry Springs resource is currently at its sustainable yield. Outside of the DRWCD, within the Darwin Region, current extraction is estimated at 4.7 GL per annum in comparison to an estimated sustainable yield of 87 GL per annum. As part of this, it is estimated in Vanderzalm et al (2018) that an additional 35 GL per annum could potentially be extracted from a combination of the interconnected sand and dolostone aquifers in the Wildman catchment (the Koolpinyah Dolostone Aquifer east of the Adelaide River), the Kulshill Group Sandstone and the Daly River Limestone (Marley Dolostone). However, to date there has not been any concerted investigations of their likely potential as town water supply sources. Broad scale groundwater investigations would be required to determine the feasibility of extracting and supply groundwater elsewhere. It is anticipated that the yield from these identified areas is low.

DENR estimates that extraction would have to reduce by 24,000 ML p.a. to achieve sustainable groundwater extraction across the DRWCD. As noted in the Northern Territory Government's *Northern Territory Water Regulatory Reform Directions Paper 2018* there are a range of regulatory and legislative constraints to the ability to monitor and regulate groundwater extraction, particularly in the Darwin rural region. Significant reform, including amendments to the *Water Act 1992* would be required, to more effectively manage the groundwater resource³³.

In summary, achieving reductions in groundwater extraction would require:

- Regulatory and legislative amendments
- Demand management initiatives to reduce extraction
- Water supply augmentation to substitute for reduced extraction (at least 24,000 ML p.a.)
- Connection of the rural region to the water network
 - Previous investigations undertaken by the NT Government have indicated that the cost of the distribution and reticulation infrastructure to service rural suburbs is significant.

Alternatively, additional water supply could be unlocked by varying the regulation related to limiting total extraction from aquifers to 20 per cent of the total annual recharge.

Given the scope of this project to ensure near-term water security and provide water for economic development, it was considered out-of-scope for this project to provide 'substitute' water for reduced groundwater extraction. Using additional water supply to reduce groundwater extraction water would divert this supply from new economic development activities and benefits. Therefore, as existing demand exceeds sustainable supply, in the absence of additional water supply augmentation, there is also no associated allowable growth in the demand forecast for groundwater resources.

3.2.2 Reticulated water network

The average consumption of reticulated water for the greater Darwin region is outlined in Table 9.

Table 9: Average water use per customer type in the greater Darwin region (ML p.a.)³⁴

Water use customer type	Average for period 2007/08 to 2016/17
Residential	19,434
Commercial and Industrial	9,306
Government	6,192

³² SMEC through information provided by DENR, 2020.

³³ Northern Territory Government (2018). *Northern Territory Water Regulatory Reform Directions Paper*.

³⁴ SMEC through information provided by Power and Water Corporation, 2020.

Water use customer type	Average for period 2007/08 to 2016/17
PWC	1,129
Non-revenue water	5,952
Total	42,013

The total consumption of water from the reticulated network in Darwin has remained relatively constant over the last decade. This has largely been achieved by matching urban growth with demand reductions per capita in the residential sector. Figure 18 shows historical water use in the Darwin area by use. It demonstrates, that despite a 23 per cent increase in Darwin's population over this period the overall proportion of residential consumption has remained fairly static.

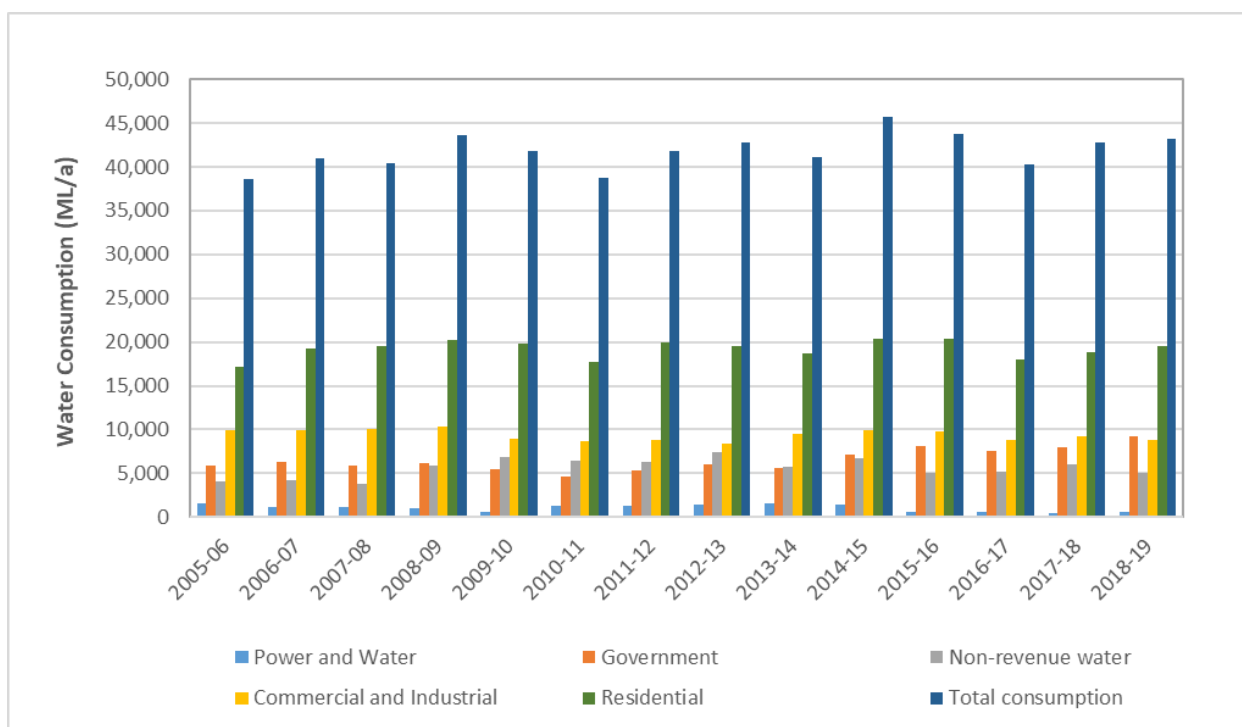


Figure 18: Darwin historical water consumption³⁵

PWC's *Living Water Smart* initiative is a program aimed at reducing water use within the greater Darwin region through a comprehensive educational and behavioural change program. The initiative has been successful to date and is on track to achieve its target of reducing water demand by 7,600 ML p.a. by 2025/26. A more detailed overview of urban water consumption, and the potential for urban water consumption efficiencies is provided in 12.6 Appendix C – Current Water Demand and Supply Assessment Report.

Figure 19 shows the non-residential water consumption, converted to per capita, from 2005/06 to 2017/18. Over this period it can be seen that the efficiency of water use by the commercial and industrial sector has increased, however there has been an overall increase in water use by the government sector and no apparent improvement in efficiency by the government sector.

³⁵ SMEC (2020). Through information provided by PWC.

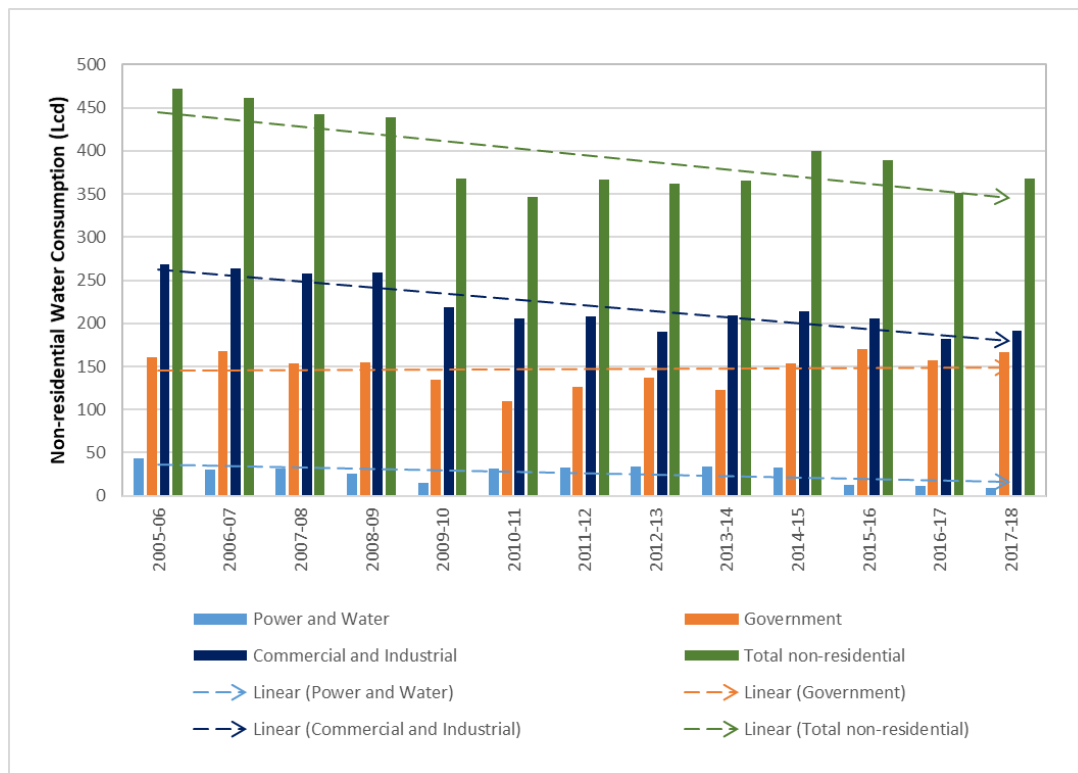


Figure 19: Darwin non-residential per capita water use 2005-06 to 2017-18

Water demand in Darwin has been managed by PWC through progressive implementation of demand management practices, as well as augmentations to the supply through expansions to the Darwin River Dam and the Howard East Borefields. During that period the overall annual demand has remained at or near the current yield (about 42,200 ML p.a).

3.2.3 Levels of service

The levels of service (LOS) water supply security concept is founded on the principal of defining an acceptable level of reliability for supplied water. Alternative water supply management options are predicated on the assumption that the reliability of the water supply source is assured. The LOS approach determines how the yield of a supply area's water resources can be optimised in conjunction with pre-set water restriction levels (i.e. levels of service). This allows for planned augmentations to water supply systems, avoiding the expenses associated with constructing additional water supply infrastructure at short notice during or immediately following a drought event.

For the greater Darwin region to ensure appropriate water security, LOS have been established which provide for two levels of reliability of water supply: 95 per cent unrestricted demand reliability (water restrictions 1 in 20 years), and 99 per cent restricted demand reliability (severe water restrictions 1 in 100 years).

Overall, it is expected that incremental increases in water efficiency are expected to occur which will cater for continued forecast growth in population and enable the current industrial and commercial activities to continue to operate with an assumed level of natural organic growth until water source augmentation is complete. This will result in a continued gradual increase in total water consumption from the reticulated network. Figure 20 is a schematic diagram of PWC LOS standards, and the Darwin River Dam storage levels that would trigger the implementation of demand management activities to ensure the LOS are achieved.

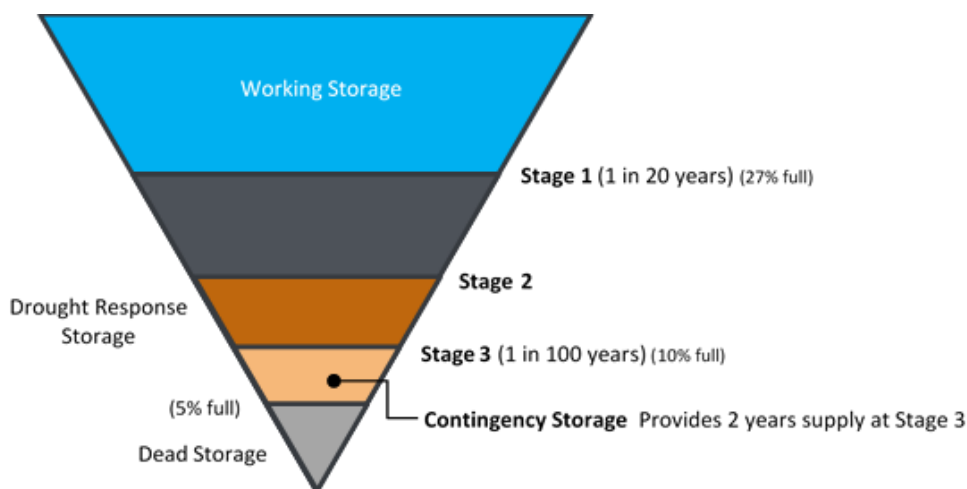


Figure 20: Application of LOS objectives to Darwin River Dam³⁶

3.2.4 Base case future water demand

The base case future water demand for the reticulated network is based on PWC's current base case modelling. The assumptions underpinning this modelling were tested through the Preliminary Assessment by SMEC and determined to be reasonable and robust based on current assumptions and understanding. This base case assumes that no major additional industrial or commercial development involving a step change in water demand occurs and that the growth in residential, industrial/commercial and government use continues to grow at the long run trend, with increased efficiency in water consumption in the short term as per the *Living Water Smart* program.

This definition of the base case allows an understanding of the water required to sustain the current levels of commercial activity in the region and support long-run forecast population growth to determine the minimum level of water required under a 'Do Nothing' demand scenario. This also reflects that, in the absence of available water, it is expected that step change growth in these sectors would not occur. The overall potential for future growth in these sectors, and the implications for water demand, are discussed in *Chapter 4- Potential water demand*. Figure 21 outlines the base case demand forecast.

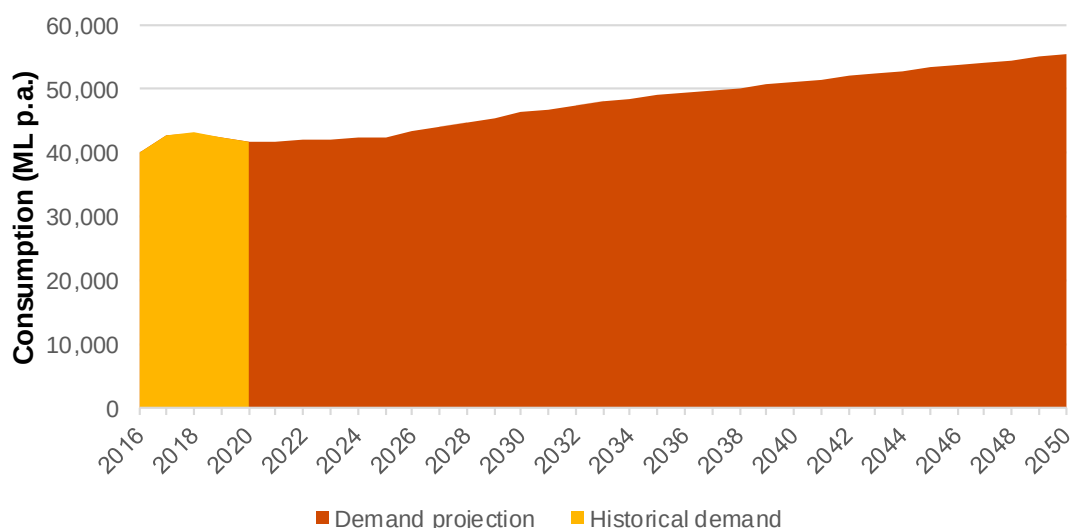


Figure 21: Base case future reticulated network demand

³⁶ Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013*. Modified by SMEC.

3.3 Water supply and demand

3.3.1 Base case

The base case for the project represents a 'Do Nothing' scenario for the water supply in the greater Darwin region. This enables an understanding of the minimum levels of water required to support current activities and the impact in the future if no augmentation to the water supply was undertaken under PWC's current LOS and current levels of commercial activity are sustained alongside long-run forecast population growth. The potential future growth in the industrial and agricultural and horticultural demand is discussed in *Chapter 4 - Potential water demand*.

The major groundwater resources in the greater Darwin region are already over allocated and over used. It is estimated that extraction would be required to be reduced by 24,000 ML p.a. to return them to a sustainable level of extraction. Given this, under the base case the available supply of groundwater is assumed to be at its maximum and no further allocations would be granted.

In the absence of the identification of new groundwater resources, any growth in the domestic, stock or agriculture and horticulture demand in the rural region will need to be supported by water from an alternate resource.

The reticulated network has operated at its assessed yield over the last 10 years. Based on the current understanding of climate change, population growth and long term economic growth. Figure 22 displays the base case supply and demands for the reticulated network based on the analysis in Section 3.1.3.

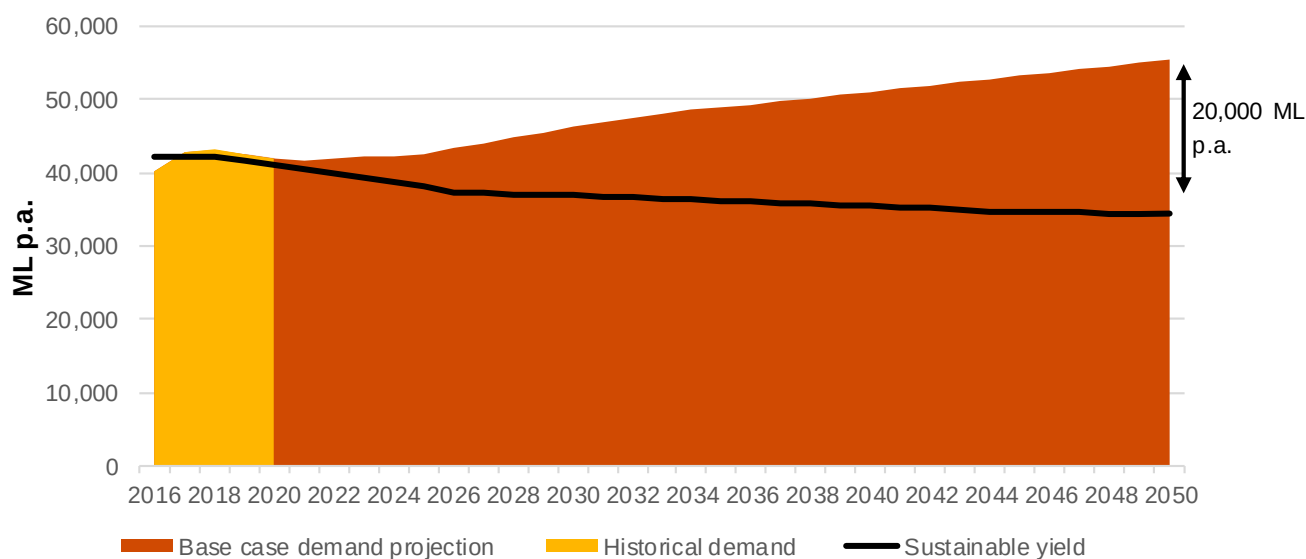


Figure 22: Supply and demand reticulated network balance

This graph demonstrates that under the base case assumptions water demand will exceed the yield of the reticulated water network with a shortfall of 20,000 ML p.a. by 2050. This base case assumes no water dependent major economic development or growth, and only long run organic growth in population and commercial/industrial demand. It also assumes no further water supply augmentation would be undertaken.

This forecast shortfall between yield and demand creates a significant near term water security risk. PWC's LOS would be breached under this scenario and water restrictions would be implemented with greater frequency to ensure long term continuity of water supply, shown in Figure 23.



Figure 23: Incidence of water restrictions under base case scenario

PWC has a water supply strategy developed to ensure that it can continue to meet its LOS obligations. Further water demand measures in addition to PWC's *Living Water Smart* program could also result in decreases to growth in per person water consumption. However, these are not included in the base case as they are not funded or committed projects or policy interventions by the NT Government.

The supply and demand base case confirms:

- There is a significant near-term water security risk for the greater Darwin region
- There is currently insufficient water available in the system to support any major water dependant industrial or agricultural/horticultural development.

4 Potential water demand

4.1 Introduction

This chapter investigates the future opportunities that could be facilitated by an increase in water supply for the greater Darwin region. This chapter builds on work in Chapter 3, Base Case Supply and Demand, which highlights growth in urban water demand across the PWC network. This chapter includes:

- Industrial water demand growth
- Agricultural and horticultural water demand growth
- Total forecast additional demand.

4.2 Industrial water demand growth

The greater Darwin region holds many strategic advantages for growing industrial activity in the region. Darwin is located on a world-class harbour, proximate to rapidly growing markets throughout Asia and there are a range of opportunities to expand the oil and gas sector that will further catalyse industrial activity.

Darwin is a key Liquefied Natural Gas (LNG) export hub, with the recent commissioning of the Ichthys LNG Project to complement the ConocoPhillips-operated Darwin LNG Plant. Darwin is now home to three LNG trains and is the service and supply centre of the world-first Prelude Floating LNG project in the Timor Sea³⁷. Darwin's LNG plants are fed by the reserves that lie offshore from Darwin in the Timor Sea. With a further 30 trillion cubic feet (Tcf) gas in proven offshore reserves yet to be developed, the immediate opportunity for life-extension and expansion of existing LNG plants is promising. The Territory Government's vision for the NT to become a world-class gas production, manufacturing and services hub by 2030, is being implemented through the NT Gas Strategy³⁸.

The provision of affordable gas in large volumes capable of supporting and expanding industry is an attractive proposition for potential investors. To encourage development, growth and diversification of Darwin's gas hub and downstream opportunities, attracting gas-based processing and manufacturing and expanding service and supply capabilities is necessary. Opportunities exist for condensate refining, production of ethane-based petrochemicals, and the manufacturing of methane-based products including methanol, ammonia and ammonium nitrate, urea, other fertilisers that use local phosphate deposits, and energy intensive industries³⁹.

However, these large industrial developments in the greater Darwin region require other critical inputs, such as significant volumes of water. Without investment in a new water supply that will not only provide water but also certainty to investors, growth in industrial activity will remain constrained.

4.2.1 Middle Arm Gas and Strategic Minerals Industrial Precinct

Key demand in growth sectors is expected at the Middle Arm Industrial Precinct. The Middle Arm Gas and Strategic Minerals Industrial Precinct is a 2,300 to 2,500 ha industrial precinct, with 600 ha allocated for downstream gas opportunities and 510 ha for strategic minerals, located on the Middle Arm peninsula in Darwin Harbour. The location of the Precinct and high-level master planned zones are displayed in Figure 24.

³⁷ The Territory (2020). *Oil and gas*. Accessed at <https://theterritory.com.au/invest/key-sectors/oil-and-gas>

³⁸ Ibid

³⁹ The Territory (2020). *Building on our foundation gas industry: The Territory's oil and gas story*. Accessed at <https://theterritory.com.au/invest/key-sectors/oil-and-gas/building-on-our-foundation-gas-industry-the-territorys-oil-and-gas-story#item-3>

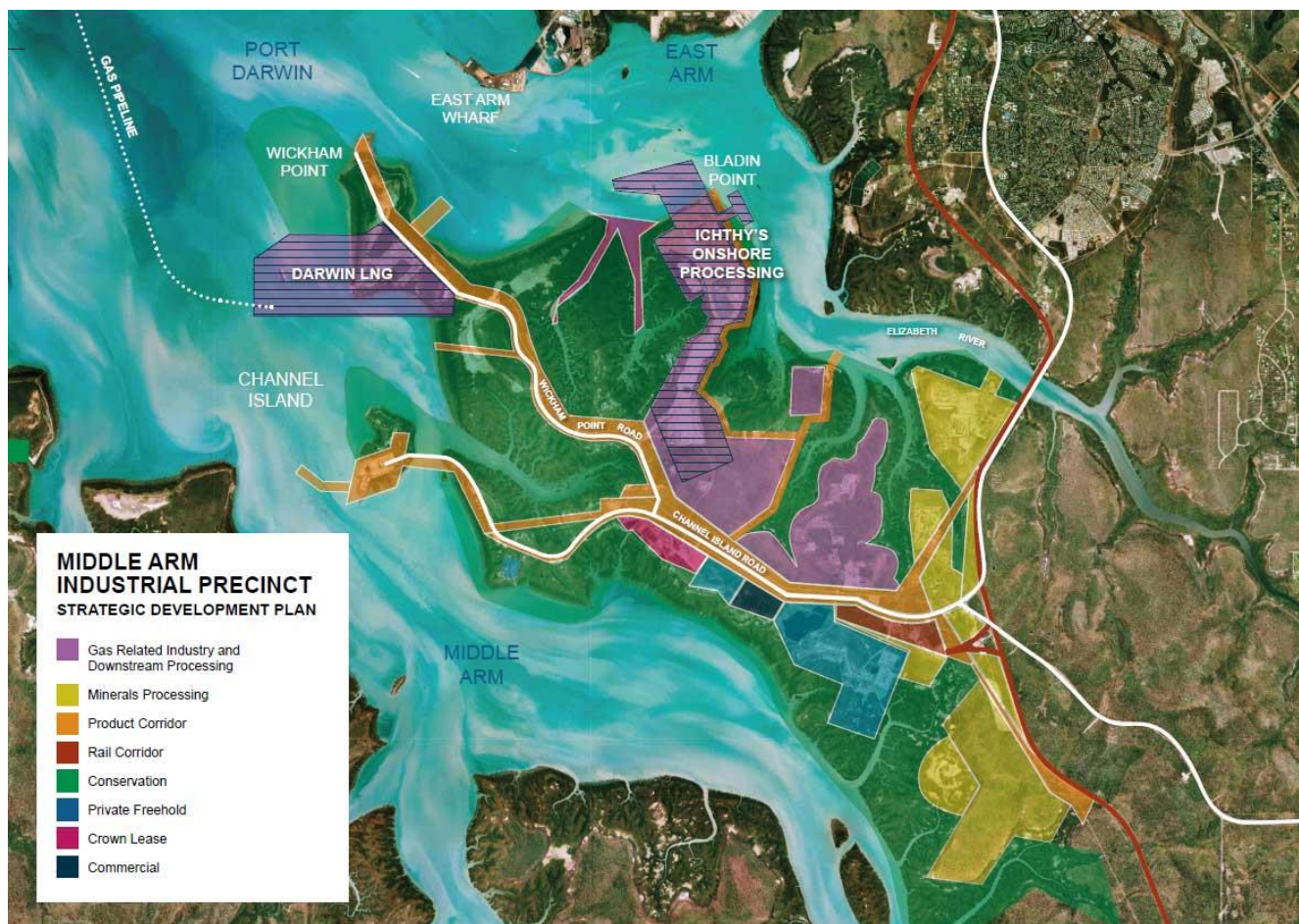


Figure 24: Middle Arm Gas and Strategic Minerals Industrial Precinct⁴⁰

The Precinct will provide a variety of lot sizes, ranging from 5-160 ha, to accommodate large strategic industries for downstream gas processing and related developments.

The potential industries that the precinct can accommodate include, but are not limited to:

- Industrial - Oil and Gas, Chemical and Minerals
- Utilities - Power generation
- Logistics - Rail
- Commercial.

The demand for this site will to some degree be dependent on the reliable and relatively cost-effective supply of gas from either onshore (principally Beetaloo) or offshore (principally Inpex or DLNG) developments, and therefore the forecast growth of the Middle Arm Precinct is linked to the success of these projects.

⁴⁰ Northern Territory Government (2020). *Middle Arm Industrial Precinct*. Accessed at <https://theterritory.com.au/invest/investment-opportunities/middle-arm-industrial-precinct>

Onshore gas development

The under-explored onshore shale resources of the Territory offer a significant development opportunity. The Beetaloo Basin spreads over more than 25,000 square kilometres (km) of prospective unconventional shales within multiple-stacked petroleum plays. Exploration to date indicates a 'P50 gas-in-place resource' of at least 500Tcf in one shale layer alone⁴¹.

Further exploration works are planned to prove-up this new gas province, which may underwrite investment in expansion of LNG exports, a new gas-based processing and manufacturing industry, and delivery of gas to industrial and retail customers in eastern Australian markets. The Beetaloo Basin is shown in Figure 25.

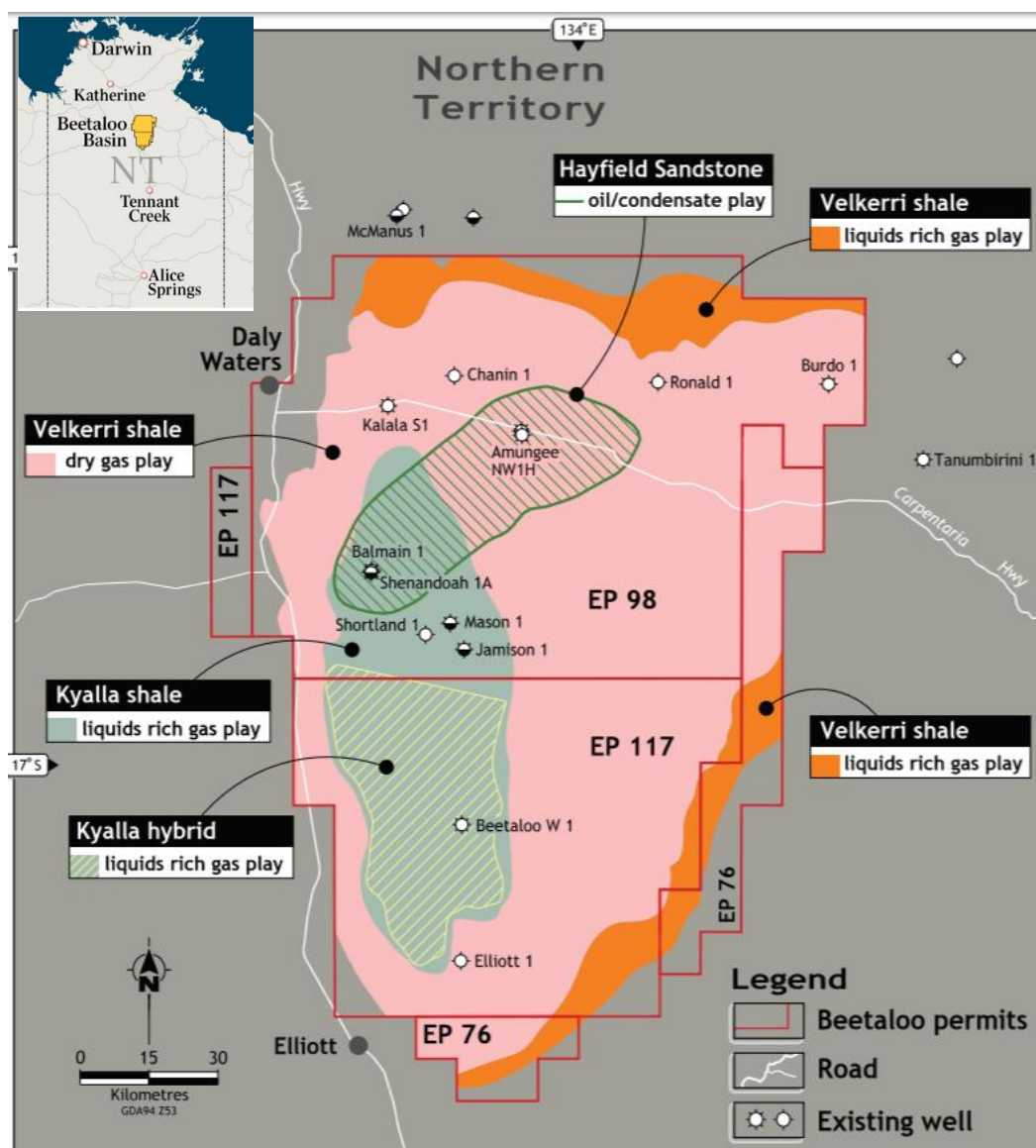


Figure 25: Beetaloo Basin⁴²

The two major potential exploration and production companies exploring the Beetaloo Basin are Origin Energy and Santos. Both companies are at a very preliminary stage of exploration with both having drilled only a handful of wells, although early

⁴¹ The Territory (2020). *Oil and gas*. Accessed at <https://theterritory.com.au/invest/key-sectors/oil-and-gas>

⁴² Origin(n.d.). *Beetaloo Basin Gas*. Accessed at https://assets-us-01.kc-usercontent.com/d2a4858c-93cb-001e-6517-8c2d5a06edc5/0d15e1f8-24bf-4166-a783-3db0eab3a30a/J010291%20Origin%20NT%20Poster%20A0%20Beetaloo%20Basin%20Gas_Print.pdf

stage production tests from both companies have been promising. An indicative timeline for the development of the Beetaloo Basin into a fully operational LNG export project is outlined in Figure 26.

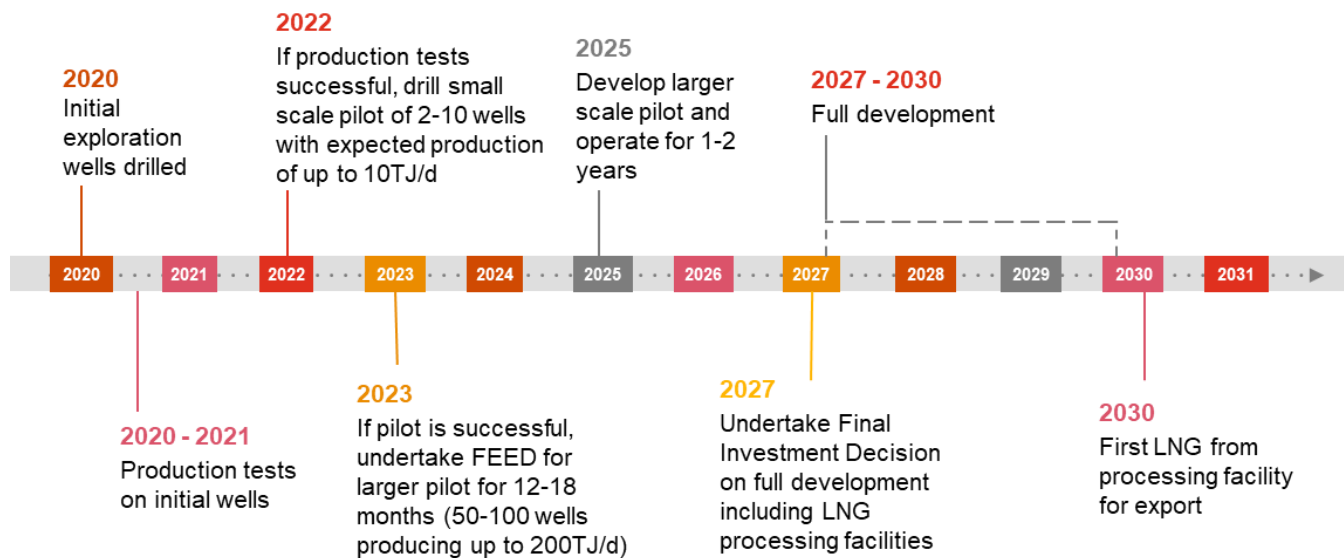


Figure 26: Indicative exploration and development profile for a major LNG project

This process shows that it is unlikely that the LNG processing facilities for the Beetaloo Basin gas resource will be fully operational until approximately 2030. However, there is likely to be some early gas available in the pilot stages of the projects by the mid-2020s. This gas is unlikely to be sufficient to justify an LNG facility and could be either transported to the east coast, via Jemena's Northern Gas Pipeline, or to Darwin, via APA's Amadeus Gas Pipeline⁴³. However, both of these pipelines are likely to be at capacity which may require new pipelines to transport the gas. If current or new pipeline facilities are able to transport this gas to Darwin and there is sufficient gas demand, Darwin is likely to be a more cost-effective solution than the east coast (even with the cost of new pipelines). However, there are several commercial agreements which would be required to enable this to occur including:

- Pipeline access agreement
- Gas Sales Agreement (GSA).

The GSA that the offtakers (the industrial demand from Middle Arm) are likely to request will be a long-term agreement to provide certainty to establish operations at the Precinct. There is a potential that the gas producers will seek only short term (under five year) agreements to allow full flexibility to re-purpose this gas for LNG export liquefaction facilities become available.

This indicates that there could be in excess of 100TJ/d of gas which is currently uncontracted which could be supplied to Middle Arm by approximately 2025.

Offshore gas development

Ichthys LNG is ranked among the most significant oil and gas projects in the world. Located about 220 kilometres offshore of Western Australia and 820 kilometres southwest of Darwin, the Ichthys Field covers an area of around 800 square kilometres in water averaging depths of around 250 metres. The Ichthys Field is estimated to contain more than 12 Tcf of gas and 500 million barrels of condensate⁴⁴. Ichthys LNG is expected to produce 8.9 million tonnes of LNG per annum and 1.6 million tonnes of LPG per annum, along with more than 100,000 barrels of condensate per day at peak.

⁴³ This report has not assessed the capacity of these pipelines to transport the required volumes of gas.

⁴⁴ INPEX (n.d.). *Ichthys LNG*. Accessed at <https://www.inpex.com.au/projects/ichthys-lng/>

Potential water demand

The Barossa Project is a gas and light condensate field located offshore approximately 300 kilometres north of Darwin. Barossa is a leading candidate to backfill the Darwin LNG facility when it will no longer be economic to produce gas from the Bayu-Undan field. The Bayu-Undan field is expected to come to the end of its field life in late 2022⁴⁵. Barossa would ensure continued operation of the DLNG facility for a further 20 plus years, providing ongoing economic and social benefits to Darwin⁴⁶. The Barossa project is a joint venture between Santos, SK E&S and JERA⁴⁷.

Forecast water demand at Middle Arm

The Department of Infrastructure, Planning and Logistics (DIPL) engaged Wood PLC to develop water demand forecasts for two scenarios based on the complete development of Middle Arm under two scenarios, a base case area and an expanded area. These two areas are shown in Figure 27 and Figure 28.

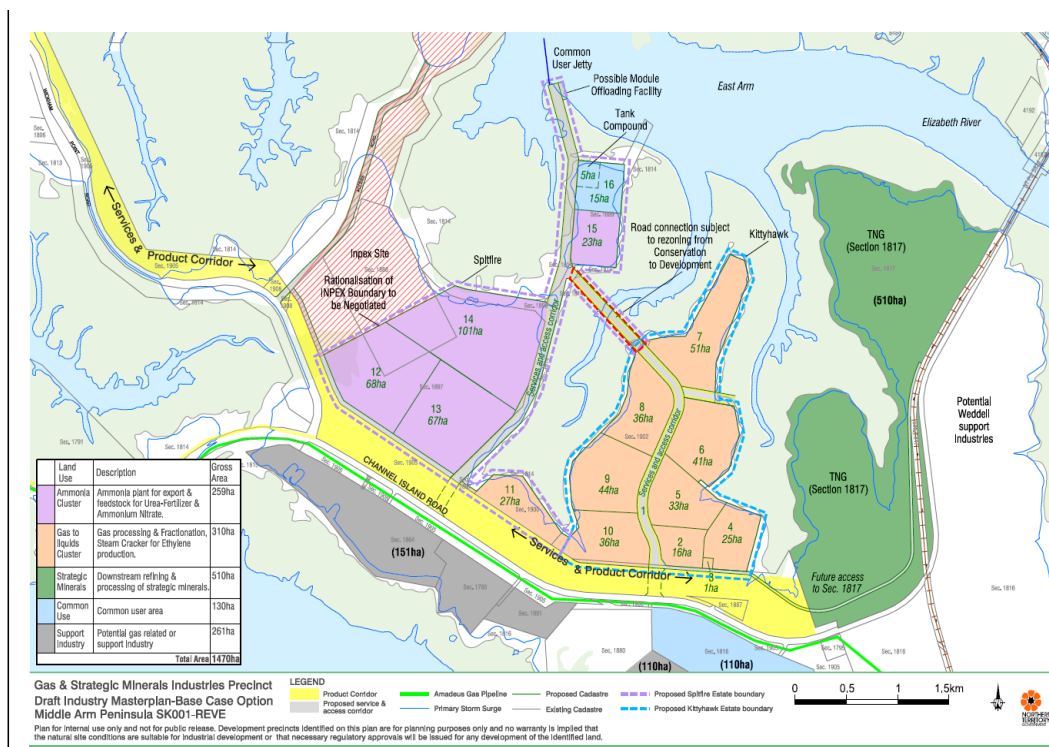


Figure 27: Middle Arm base case area

⁴⁵ Santos (2020). *Santos Shareholder Review 2019*. Accessed at <https://www.santos.com/wp-content/uploads/2020/02/2019-shareholder-review.pdf>

⁴⁶ ConocoPhillips Australia (n.d.). *Barossa Project*. Accessed at <http://www.conocophillips.com.au/what-we-do/our-projects-activities/barossa-project/>

⁴⁷ Offshore Engineer (2020). *Santos to Sell Barossa Stake to JERA*. Accessed at <https://www.oedigital.com/news/477631-santos-to-sell-barossa-stake-to-jera>

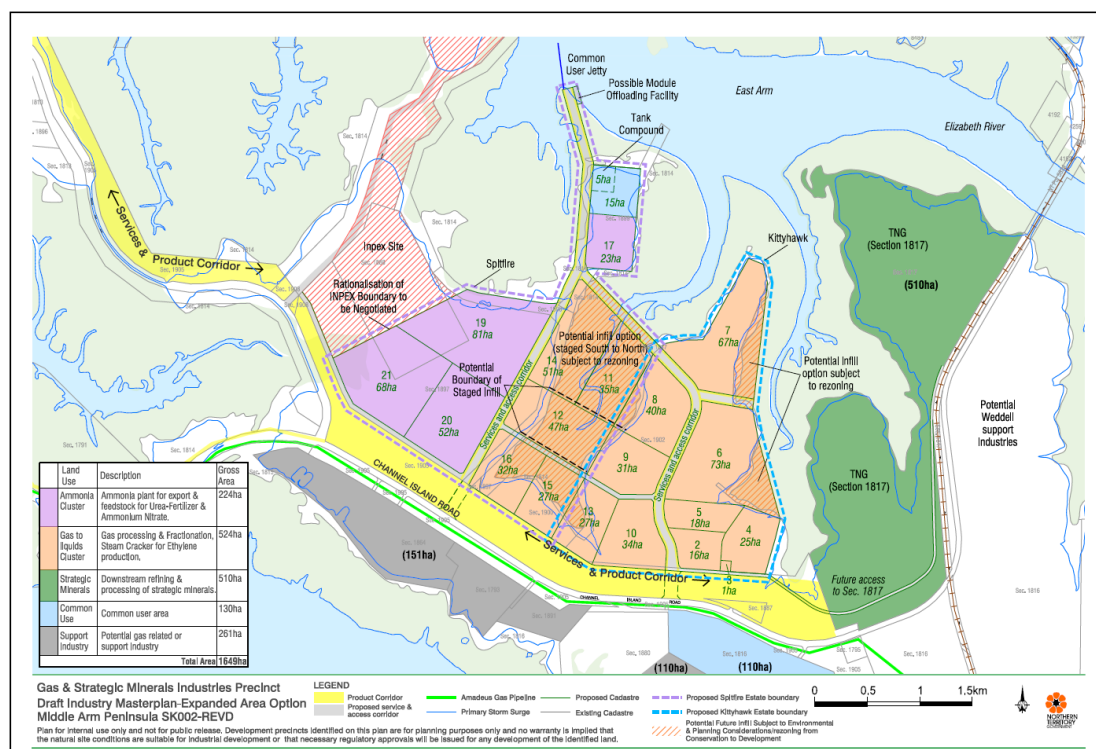


Figure 28: Middle Arm expanded area

These two scenarios provide a total of 2,340 ha and 2,519 ha of additional development area respectively. Wood PLC estimated the ultimate water demand under the base case would be approximately 46GL p.a. rising to 48GL p.a. under the expanded area.

However, the work undertaken by Wood PLC did not consider the potential timing of the demand for these industrial developments, and thus the demand for the associated water. PwC has subsequently worked closely with DIPL, DTBI and industry participants to develop an assumed estimated profile of expected water demand over time. The starting point for this analysis was identifying the projects likely to proceed at the Middle Arm Industrial Precinct based on known investment identification and attraction activities already underway, with each project start date based on information provided by the proponents. Overlaid on top of this identified demand is unspecified additional demand to account for future growth opportunities which have not yet been identified. This unspecified demand commenced in 2028 and equates to approximately 10 per cent of total demand in 2035 in the mid-case.

These estimates have then been adjusted to account for:

- the risk of the projects being delayed, with most projects in the revised demand profile expected to start in 2024 or later to more closely align to the expected timeframes for both gas and water availability
- the chance of success of the project, with the chance of success ranging between 25 per cent and 75 per cent for each project in the mid-case.

Whilst this analysis has been undertaken on a project-by-project basis, this information is largely commercial-in-confidence and therefore cannot be represented by company in this Preliminary Assessment. Figure 29 illustrates the aggregated forecast demand under High, Mid and Low Cases.

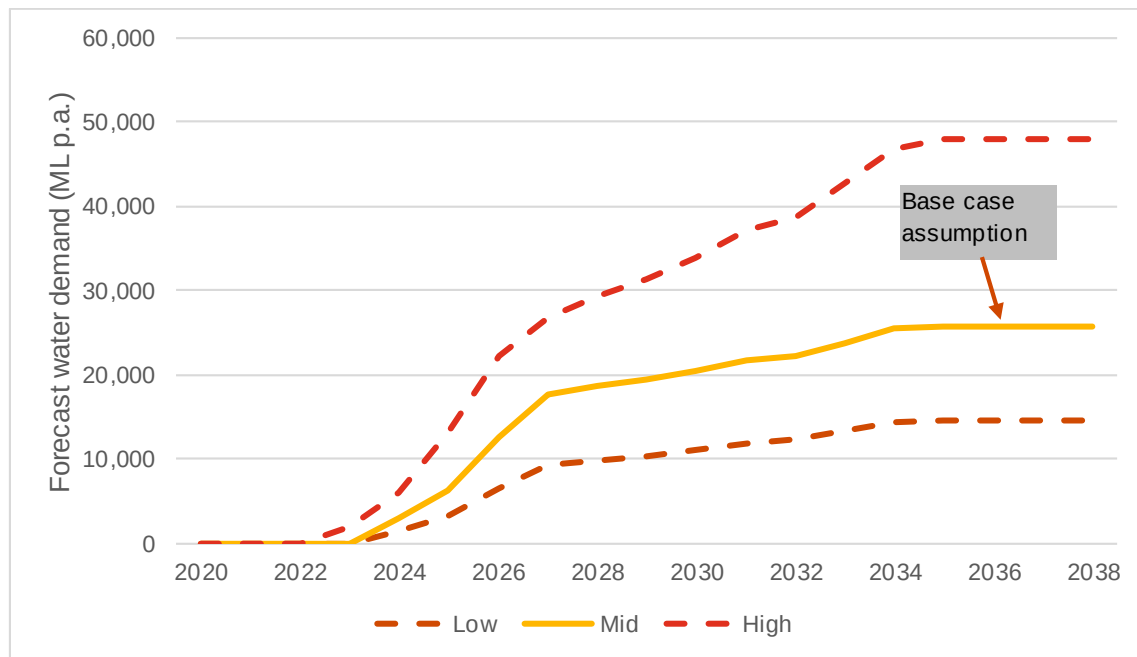


Figure 29: Forecast water demand at Middle Arm

This forecast water demand profile is currently being tested via market engagement with the industrial sector and is expected to evolve over time. Preliminary market sounding and PwC's market experiences indicates that industrial consumers will require water with close to 100% reliability.

4.2.2 Other industrial demand

The Middle Arm precinct has been the focus of the industrial demand analysis for this Preliminary Assessment, however there are numerous potential other industrial demand precincts which may develop or grow across the greater Darwin region. These include Middle Point, Glyde Point, Gunn Point and Weddell. These are to some extent included in the urban demand profiles developed by PWC and SMEC, however additional growth from these precincts represent an upside to the potential water demand and industrial development growth expected to occur across the region as a direct result of the AROWS project. This has been excluded from the analysis to help ensure it is based on a conservative and achievable water demand profile.

4.3 Agricultural and horticultural water demand growth

The greater Darwin region has a diverse agricultural and horticultural sector, occupying approximately 50,000 ha with potential for further expansion. In 2017–18, the gross value of agricultural and horticultural production in the greater Darwin region was \$83 million⁴⁸. The NT is already a substantial producer and supplier of high-quality mangoes, melons and Asian vegetables to domestic and international markets. The horticulture industry in the Northern Territory has grown significantly, and now produces around 52 per cent of Australia's total mango crop⁴⁹, with Darwin producing 67 per cent of the NT's total crop⁵⁰.

Many crops that grow in the Territory are harvested earlier than those grown in southern or eastern Australia. This gives the Territory a distinct market advantage in Australia as well as providing counter-seasonal opportunities in overseas markets. Growth in demand for Australia's horticultural produce is burgeoning in South East Asia, China and the USA, presenting opportunities for future growers to enter the market⁵¹. Tropical fruits are in high demand in Asian markets and new

⁴⁸ Australian Government & Department of Agriculture, Water and the Environment (2019). *About my region – Greater Darwin Northern Territory*. Accessed at <https://www.agriculture.gov.au/abares/research-topics/aboutmyregion/nt-darwin#agricultural-sector>

⁴⁹ The Territory (2019). *Agribusiness*. Accessed at <https://theterritory.com.au/invest/key-sectors/agribusiness>

⁵⁰ ABC (2020). *Northern Territory confirmed as mango king, producing 52 per cent of national crop*. Accessed at <https://www.abc.net.au/news/rural/2020-05-14/northern-territory-claims-title-of-biggest-mango-producer/12246604>

⁵¹ The Territory (n.d.). *Horticulture, broad acre cropping and forestry*. Accessed at <https://theterritory.com.au/invest/investment-opportunities/horticulture-broad-acre-cropping-and-forestry>

investment can support further development of the horticultural industry⁵². High quality land and water resources are required to support successful agricultural development.

The CSIRO has also investigated the role that social capital plays in the success of agricultural and horticultural developments. Proximity to other agricultural development creates a community of practitioners from which experiences can be shared. Many of the large-scale agricultural and horticultural projects are often directed from head offices a long distance from the farm operations, which add complexity and transaction costs and do not foster an environment where social capital can be built. Farming co-operatives provide support advice and direct services and inputs to farmers and are vital institutions for the farming community⁵³. Proximity to other agricultural and horticultural developments also allows new investors to capitalise on existing processing, packing, supply chain and utilities infrastructure.

Many factors determine the success of agricultural and horticultural developments, including climate, soils, pests and diseases, as well as the key agronomic, management, financial, and market and supply chain factors. Access to a reliable water supply is a key challenge constraining growth in agriculture and horticulture in the greater Darwin region however, it is not the only challenge. Other barriers to growth in agricultural/horticultural development in the region include:

- **Supply chain infrastructure** – the success of an agricultural and horticultural investment is heavily dependent on the supporting supply chain. Aside from being a significant cost to consider, there is a lack of adequate supply chain and transport infrastructure in Northern Australia to access international and domestic consumer markets.
- **Cost** – a key determinant of the competitiveness and sustainability of the agricultural and horticultural sector is the cost and time required for freight, which is driven by the effectiveness of the supply chain. Currently, logistics is the largest single cost item in the production of many agricultural industries, amounting to as much as 48.5 per cent of farm-gate costs in some instances⁵⁴.
- **Climate change** – risks for future agricultural and horticultural developments include higher temperatures, increased rainfall variability and an increase in the frequency of natural disasters. Studies show that developments in renewable energy, water infrastructure and advances in research and development for climate resilient species can improve agricultural/horticultural production in Northern Australia, amidst a period of adapting to climate change⁵⁵.
- **Regulatory barriers** – the governance strength and social responsibility of Australia is relatively high which may both attract and deter investors. Greater governance strength ensures lower risk in investments, however, it generally also attracts a longer and more rigorous process for investment approval.
- **Protocols** – protocol requirements can make exporting certain produce to certain jurisdictions difficult. For example, many importing jurisdictions require mangoes to be treated (via Vapour Heat Treatment (VHT), or irradiation) prior to accepting Australian mangoes. Lack of access to treatment facilities can hinder investment opportunities as the export potential is more limited. However, the 6,000m² Darwin Airport Freight Hub is expected to be completed by late 2020 and will include cold storage and a VHT plant that will create opportunities to export mangoes and other fresh produce to Asian markets⁵⁶.

Based on the results of market engagement with the agricultural and horticultural industries, it is believed that there is demand for water from existing agricultural producers, as well as demand for an approximately 2,000 ha agricultural and horticultural precinct if land and water are packaged together as single marketable commodity. The most prospective regions identified for an agricultural and horticultural precinct appear to be both Lambells Lagoon and Middle Point. These are discussed in further detail below.

⁵² The Territory (2019). *Agribusiness*. Accessed at <https://theterritory.com.au/invest/key-sectors/agribusiness>

⁵³ Ash, A., Watson, I. of CSIRO. *The Rangeland Journal* (2018), Vol 40, p 301-314. *Developing the north: learning from the past to guide future plans and policies*. Accessed at <https://www.publish.csiro.au/rj/pdf/RJ18034>

⁵⁴ Agrifutures (2019). *The impact of freight costs on Australian farms*.

⁵⁵ Supriya, M. et.al (2018). *Exploring agricultural development and climate adaptation in northern Australia under climatic risks*. *Rangeland Journal* (40)4. Accessed at Charles Darwin University, Research Outputs.

⁵⁶ ABC (2019). *NT Country Hour*. Accessed at <https://www.abc.net.au/radio/programs/nt-country-hour/export-freight-hub-for-darwin-airport/11650578>

4.3.1 Lambells Lagoon and Middle Point

Lambells Lagoon

The prospective properties at Lambells Lagoon include Sections 1580 1706, Hundred of Guy. These two sections combined have approximately 1,994 ha of land suitable for agriculture and horticulture and is currently vacant crown land. These sections are outlined in Figure 30.

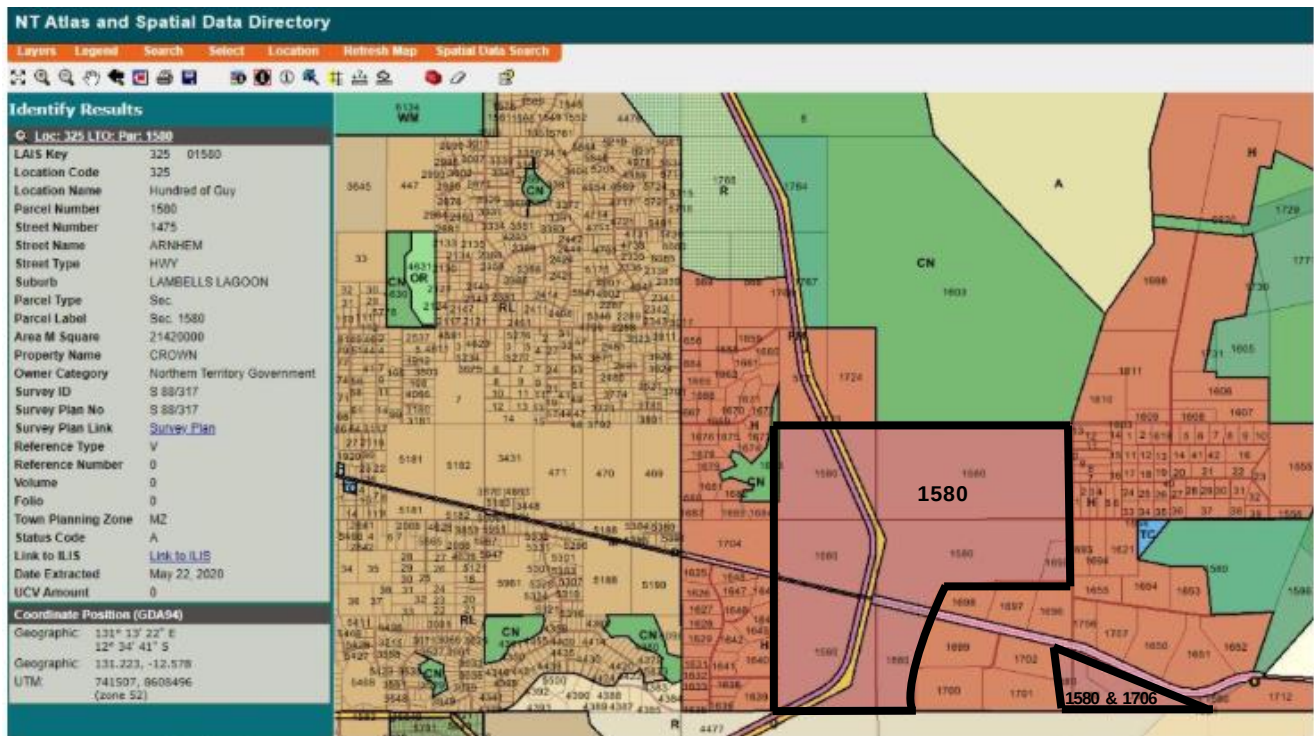


Figure 30: Lambells Lagoon location (Sections 1580 and 1706)

Lambells Lagoon has been described as being very well suited to horticulture. Previous development in the area has included bananas, pineapples, mangoes, passionfruit, rockmelons, honeydew melons, watermelons, pumpkins, papaya, durian, bitter melon, dragon fruit and other tropical species⁵⁷.

Middle Point

The prospective land at Middle Point includes sections 1585, 1539, and 1529, all also part of Hundred of Guy. These sections cover approximately 2,840 ha of land potentially suitable for horticulture. This land is currently owned by the NT Land Corporation and is planned for future development. These sections are identified in Figure 31. Middle Point has been identified as prospective for horticulture and already produces mangoes, bananas and dragon fruit⁵⁸.

⁵⁷ Queensland Country Life (2018). *On the market: NT delivers Sweet Life Farms*. Accessed at <https://www.queenslandcountrylife.com.au/story/5596165/nt-delivers-the-sweet-life-video/>

⁵⁸ Department of Primary Industry and Resources (1996). *Horticulture Division Technical Annual Report 1995-1996*. Accessed at https://dpiir.nt.gov.au/_data/assets/pdf_file/0020/233480/tb257.pdf

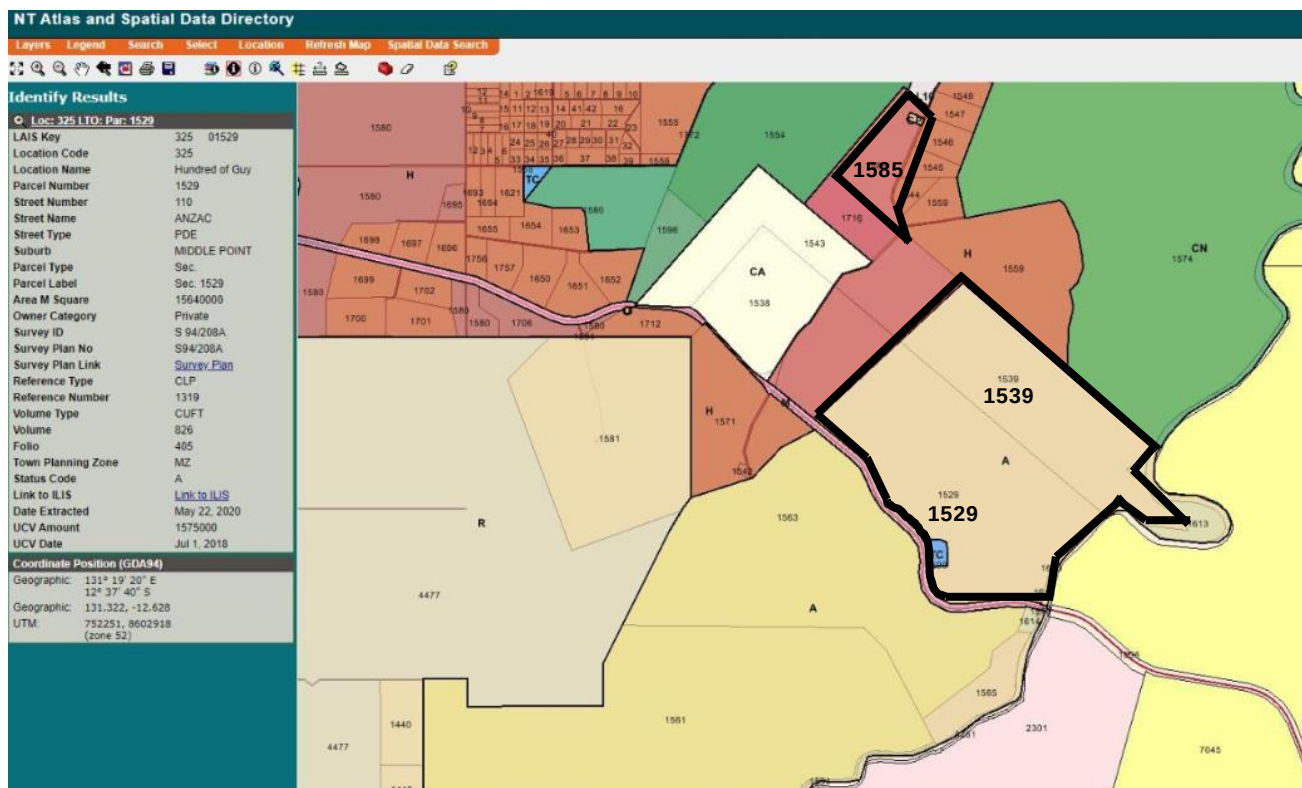


Figure 31: Middle Point location (Sections 1585, 1539, and 1529)

The North Australian Water Resource Assessment (NAWRA) database developed and maintained by CSIRO, is an interactive, data interrogation tool. It provides an indicative assessment on land suitability, soil, water, climate and Indigenous interests for the Gilbert, Fitzroy and Darwin water catchments. The NAWRA database has been used to investigate the land suitability for the prospective agricultural and horticultural regions. Land suitability is indicated through a five-point colour scale shown in Table 10.

Table 10: NAWRA land suitability colour scale

	Class 1: Highly suitable land with negligible limitations
	Class 2: Suitable land with minor limitations
	Class 3: Moderately suitable land with considerable limitations
	Class 4: Currently unsuitable land with severe limitations
	Class 5: Unsuitable land with extreme limitations

According to CSIRO's accompanying Land Suitability report⁵⁹, only 1 per cent of land in the Darwin catchment is Class 2. However, Asian vegetables, bananas and mangoes under trickle irrigation each have nearly 30 per cent of the area mapped as moderately suitable Class 3.

Figure 32 to Figure 36 provide an indication of the soil suitability at Lambells Lagoon and Middle Point for various crops.

⁵⁹ Land suitability of the Fitzroy, Darwin and Mitchell catchments. A technical report from the CSIRO Northern Australia Water Resource Assessment, part of the National Water Infrastructure Development Fund: Water Resources Assessments, CSIRO, Australia.

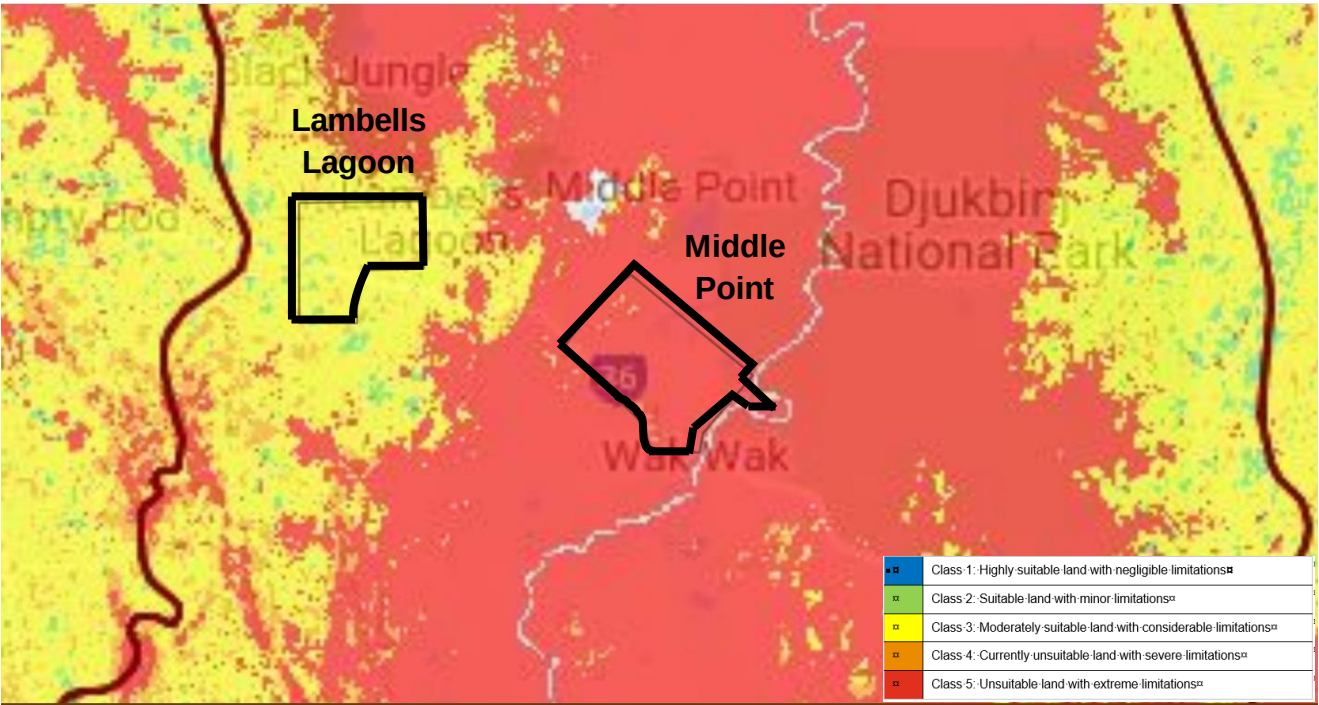


Figure 32: NAWRA data on Lambells Lagoon and Middle Point (mango, perennial, trickle)

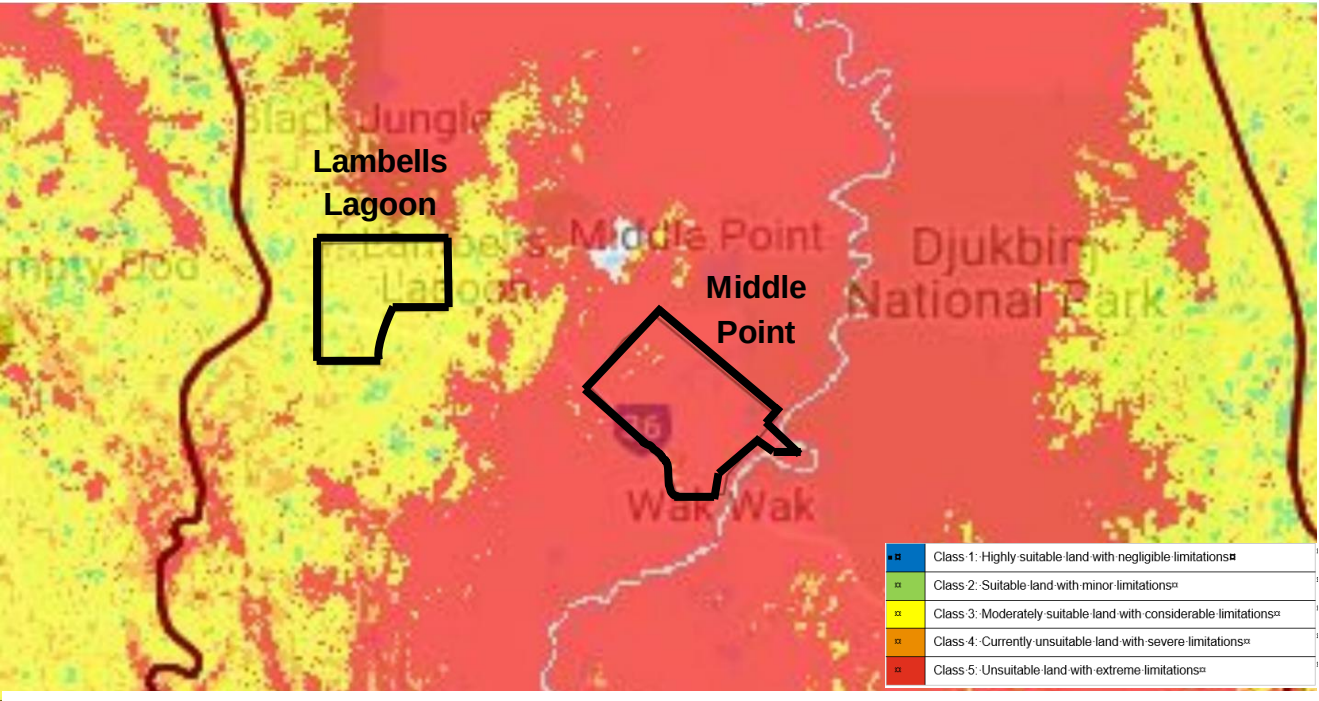


Figure 33: NAWRA data on Lambells Lagoon and Middle Point (mango, perennial, spray (overhead))

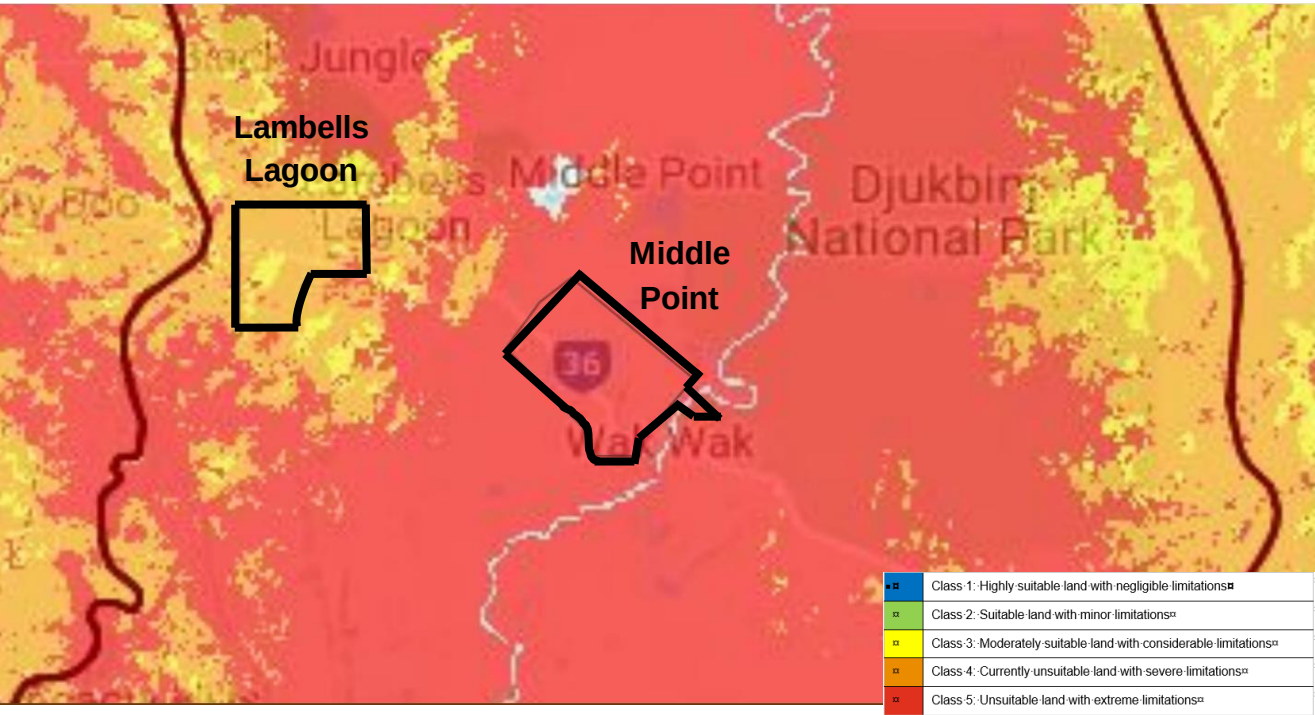


Figure 34: NAWRA data on Lambells Lagoon and Middle Point (avocado, perennial, mini sprinklers)

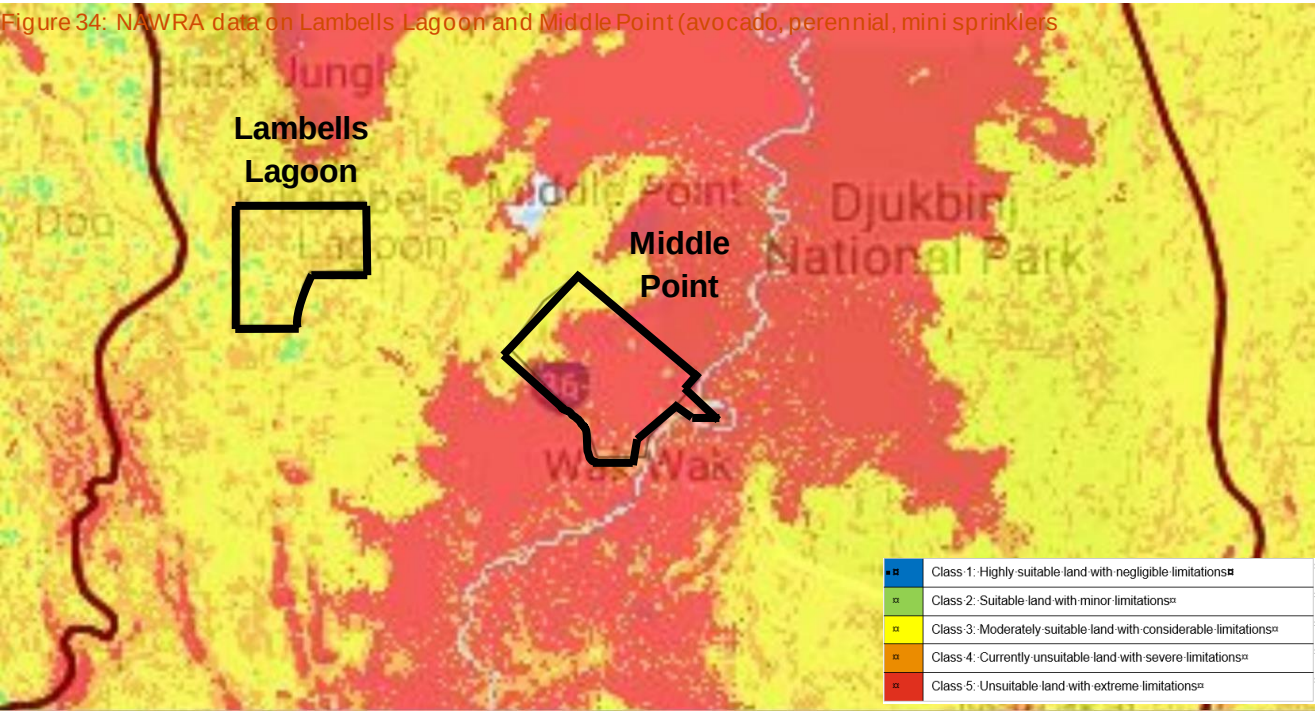


Figure 35: NAWRA data on Lambells Lagoon and Middle Point (Asian vegetables, dry season, trickle)

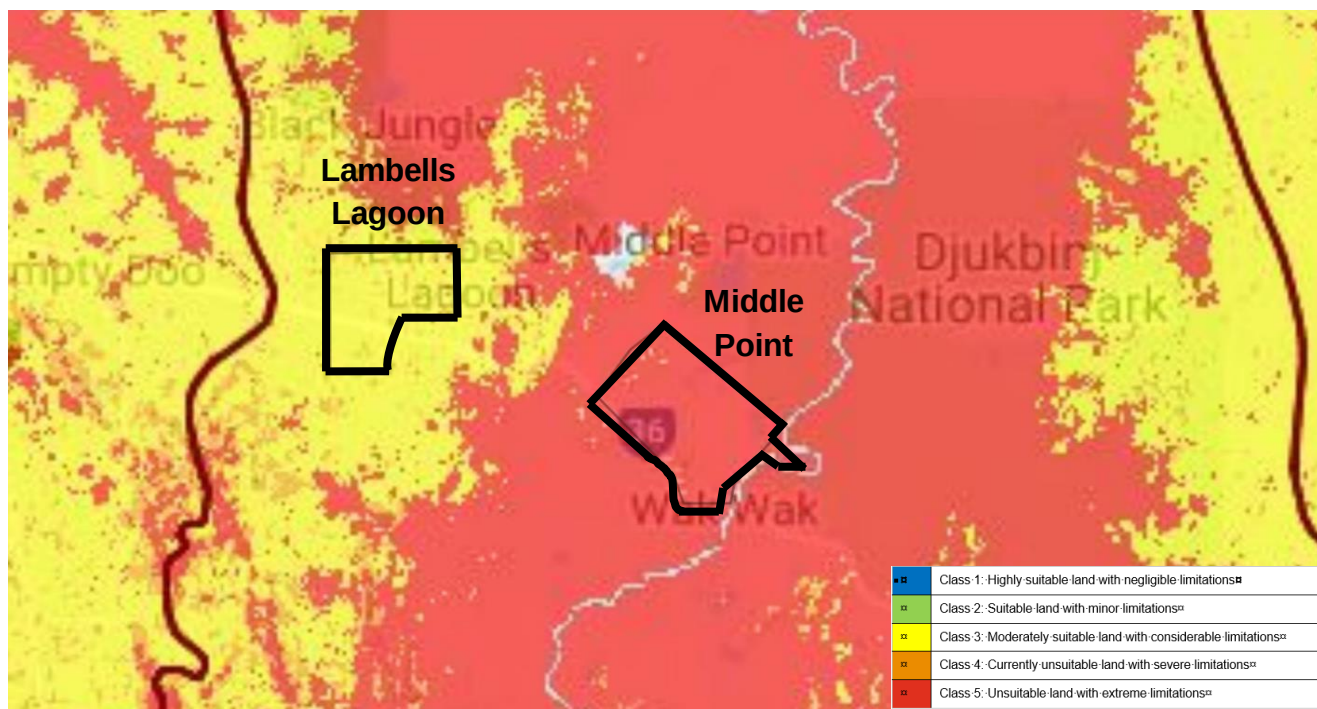


Figure 36: NAWRA data on Lambells Lagoon and Middle Point (Citrus, perennial, mini sprinklers)

The NAWRA data indicates that the vast majority of the Lambells Lagoon region is suitable for producing mangos, Asian vegetables and citrus, albeit with some limitations. The region appears to be unsuitable for growing avocados. Middle Point has some prospective land for mangos but appears to be largely unsuitable for other horticultural crop types examined.

Forecast agricultural and horticultural demand at Lambells Lagoon and Middle Point

Based on the CSIRO's NAWRA data and market sounding outcomes, there appears to be potential to activate a 2,000 ha precinct in the Lambells Lagoon and Middle Point areas, firstly utilising the 1,994 ha of vacant crown land at Lambells Lagoon and then potentially expanding to other areas in Lambells Lagoon which are currently privately held as well as the NTLC land at Middle Point. Given the current horticultural activity in the Lambells Lagoon area and the findings from NAWRA, the expected overall crop mix is estimated to be split between three main crop types: mangos, citrus (lemons and oranges) and Asian vegetables (okra is used as a proxy for Asian vegetables). The ultimate expected crop mix is outlined in Table 11.

Table 11: Ultimate crop mix

Crop type	Ultimate land developed (ha)
Mango	1,000
Citrus oranges	250
Citrus lemons	250
Okra	500

For the purposes of the Preliminary Assessment, this land is assumed to be taken up evenly over ten years, commencing two years after the completion of the supply augmentation. This assumption has been tested with various agricultural/horticultural market participants and has the broad support of the agriculture and horticulture industry. Based on these assumptions, the estimated annual land uptake is identified in Table 12. This is based on the potential large-scale augmentation being available from 2027.

Table 12: Annual agricultural and horticultural land uptake (ha)

Crop type	Total	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Mango	1,000	100	100	100	100	100	100	100	100	100	100
Citrus Oranges	250	25	25	25	25	25	25	25	25	25	25
Citrus Lemons	250	25	25	25	25	25	25	25	25	25	25
Okra	500	50	50	50	50	50	50	50	50	50	50
Total	2,000	200	200	200	200	200	200	200	200	200	200

Forecast water demand at Lambells Lagoon and Middle Point

Table 13 displays the water demand from each crop at maturity and full production. These values were selected following a comprehensive assurance process, consisting of both desktop research and market consultation. Following the retrieval of data presented across a wide variety of trusted sources, the water demand per crop was refined and selected from CSIRO's *Agricultural Viability: Darwin catchments* report, Citrus Australia's *ORC Evidence Requirements for the Citrus Industry*, *Northern Territory Irrigated Agriculture Feasibility Study*⁶⁰ and PwC's market intelligence.

These values were subsequently substantiated through market sounding and consultation with relevant stakeholders and agricultural/horticultural market participants. Where feasible, the highest water demand value was selected to mitigate the risk of under-forecasting agricultural and horticultural water demand and subsequently overstating the associated benefits.

Table 13: Water demand by crop (ML/ha p.a.)

Crop type	Water demand
Mango ⁶¹	7
Citrus Oranges ⁶²	18
Citrus Lemons ⁶³	18
Okra ⁶⁴	4

Using the annual land uptake and relevant water demands by crop, the total estimated water demand over time is represented in Table 14. This forecast is an indicative forecast and will ultimately be determined by the market once the project is operational. The demand stated assumes irrigation of mature crops. While the actual water demand will increase over time, there will need to be certainty of supply from the outset. As such, the water demand for mature crops has been used.

⁶⁰ Jacobs (2018). *Northern Territory Irrigated Agriculture Feasibility Study – Preliminary Business Case for Investment*. Provided by DTBI.

⁶¹ Substantiated through extensive market sounding

⁶² Citrus Australia (2015). *ORC Evidence Requirements for the Citrus Industry*. Accessed at <http://www.planthealthaustralia.com.au/wp-content/uploads/2012/11/Citrus-ORC-Evidence-Framework-Perennial-trees.pdf>

⁶³ Citrus Australia (2015). *ORC Evidence Requirements for the Citrus Industry*. Accessed at <http://www.planthealthaustralia.com.au/wp-content/uploads/2012/11/Citrus-ORC-Evidence-Framework-Perennial-trees.pdf>

⁶⁴ Ash A, Bristow M, Laing A, MacLeod N, Niscidi, A, Paini D, Palmer J, Poulton P, Prestwidge D, Stokes C, Watson I, Webster T and Yeates S (2018) *Agricultural viability: Darwin catchments*. A technical report from the CSIRO Northern Australia Water Resource Assessment, part of the National Water Infrastructure Development Fund: Water Resource Assessments. CSIRO, Australia.

Table 14: Annual agricultural and horticultural water demand (ML p.a.)

Crop type	Maximum demand	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Mango	7,000	700	1,400	2,100	2,800	3,500	4,200	4,900	5,600	6,300	7,000
Citrus Oranges	4,425	443	885	1,328	1,770	2,213	2,655	3,098	3,540	3,983	4,425
Citrus Lemons	4,425	443	885	1,328	1,770	2,213	2,655	3,098	3,540	3,983	4,425
Okra	2,000	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
Total	17,850	1,785	3,570	5,355	7,140	8,925	10,710	12,495	14,280	16,065	17,850

Risks and opportunities

There are a number of potential risks and opportunities related to the forecast demand which may need to be investigated in the DBC:

- **Demand for produce:** To substantially increase the supply of certain crops, it will be important to ensure that there is a market for the produce. For some products, including mangos, the domestic market is nearing saturation, and additional supply may cause downward pressure on prices. It will become increasingly important for primary producers to access international markets at premium prices. There is strong demand for Australian produce from many Asian and North America markets and this is a potential growth area for Northern Australian produce. However, to access many markets there are strict protocol requirements for export, which for mangos includes treatment for fruit flies. The NT Government is progressing development of a VHT facility to overcome this barrier which will provide further certainty for the ongoing demand for increased production.

- **Supply chain infrastructure:** It is critical to ensure that the agricultural and horticultural precinct has secure and reliable supply chains to enable transport of the product to either the domestic market or to air and sea ports for export. Given the mango harvest is generally undertaken towards the beginning of the wet season, if the transport networks are at risk due to flooding and weather events, the value of the crops may also be at risk.

Rail is the main transport mode for moving bulk minerals while also supporting road transport in moving grains, livestock and other agricultural/horticultural products. Use of rail is dominated by the mining industry and generally not suitable for agricultural products due to transporting conditions required for agricultural and horticultural produce. The agriculture and horticulture industry currently heavily utilises road transport to move produce from farm to exporting hubs due to the customisability in terms of timing, volume and storage conditions of trucks. The northern jurisdictions have key high ways connecting export hubs and major centres in Northern Australia such as the Bruce Highway, the Great Northern Highway and Stuart Highway.

- **Export supply chains:** As noted previously, the ability to export the produce will become increasingly important for the growth of the agricultural and horticultural industries across the greater Darwin region. A large proportion of the produce which is grown in the greater Darwin region is transported to Queensland, New South Wales or Victoria for either domestic consumption or export. If the region is to achieve its full potential, it would be ideal to have a direct export supply chain from Darwin. The NT Government is currently progressing the Darwin International Airport Freight Hub, which includes cold storage and a VHT facility. This investment has the potential to assist in the export of additional produce enabled by the AROWS project and help to maintain high prices across the various markets for producers.
- **Value added opportunities:** Whilst the demand for fresh produce from the region could potentially be limited by the domestic demand profile, there is an additional opportunity for introducing value added processing of the produce locally to retain more of the value of produce in the regional economy. This could include production of flours, dried fruits, canned goods, jams, juices and cosmetic products. Value added goods will also create value from produce which is not at a high enough grade for market.

4.3.2 Areas discounted from further analysis

There have been several areas identified as potential agricultural and horticultural precincts in the greater Darwin region which have not been progressed for further analysis at this time, including:

- **Gunn Point** – despite having suitable soils and an excess of available land held by the NT Land Corporation and allocated for future development, this has been excluded due to its large distance from either the proposed water source or the pipeline route, leading to excessive costs.
- **Eastern Marrakai** – Similar to Gunn Point, Eastern Marrakai is considered too far from the proposed water infrastructure to justify further analysis as the agricultural and horticultural precinct for this Preliminary Assessment.
- **Lake Bennett** – Lake Bennett is an established agricultural/horticultural area with several mango farms currently operational. It is a highly prospective region for the agricultural and horticultural precinct given its proximity to the

proposed AROWS infrastructure, however the land in the region is predominantly privately held, creating complexities in establishing a new precinct.⁶⁵

- **Wildman** – Wildman is also considered too far from the proposed water infrastructure to justify further analysis as the agricultural and horticultural precinct for this Preliminary Assessment.

While these areas have been discounted at this stage, market sounding indicated that existing producers proximate to these regions may be interested in expanding their current operations if they had access to a cost-effective and reliable water supply.

4.3.3 Agricultural and horticultural demand summary

There is significant potential in the greater Darwin region for expanded and new agricultural and horticultural production, particularly at Lambells Lagoon and Middle Point. While further investigations must be undertaken to more fully understand soil suitability, these areas are already producing a diverse range of horticulture. It is expected that the total 2,000 ha is likely to be taken up over approximately 10 years, starting with 50 ha in the first year.

Development of these areas presents new opportunities to diversify or value add, and for niche sectors to emerge from new and existing agribusinesses. A new agricultural/horticultural development area that is facilitated by an increased water supply will provide certainty for investment and stimulate growth and output of the region. If excess water becomes available and agriculture and horticulture development is successful in the chosen precinct, there is potential for a wider expansion of agriculture and horticulture in the region. Development at Lambells Lagoon or Middle Point may act as a stepping-stone for future development in the areas identified in Section 4.3.2.

Preliminary market sounding and PwC experience suggests that the level of service requirements for the agricultural and horticultural sectors will be less than 100% reliability. These industries have a number of options to reduce their use of water on an annual basis including the use of on-farm storage facilities and optimisation of the crop types and yields. In areas with water priorities, the majority of agricultural and horticultural users rely on medium priority water allocations.

4.4 Total forecast additional demand

It is evident that there is a strategic and critical need for investment in additional water supply for the greater Darwin region. The forecast demand assessment displays the total forecast additional water demand required to facilitate growth in the urban, industrial and agricultural and horticultural sectors.

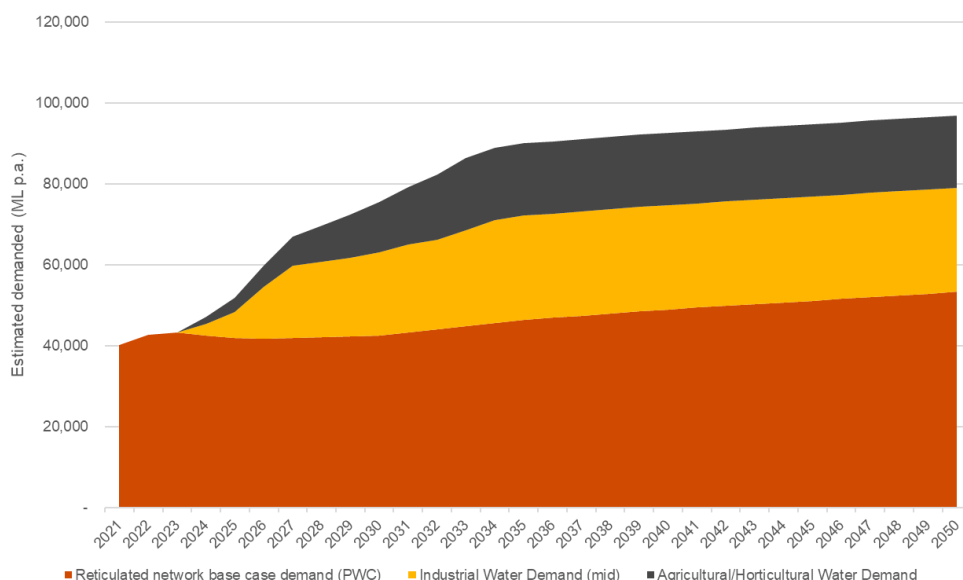


Figure 37: Total forecast additional water demand

⁶⁵ Whilst landowners may establish a demand for additional water, this is considered an upside potential for this analysis.

5 Problem identification and service need

This chapter provides strategic rationale and justification for the need to augment the greater Darwin region's water supply. This chapter includes:

- Investment Logic Mapping
- Problems and opportunities.

5.1.1 Purpose and overview

The chapter demonstrates a clear strategic rationale and need for the project by outlining the problems and opportunities that the Project is responding to which underpin the service need. Identifying and confirming the service need is critical in the lifecycle of developing an infrastructure project proposal. A clearly defined service need is essential to determine the appropriate solution/s available to address the identified needs and facilitate an investment decision. As the Project progresses, the service need will be a fundamental point of reference for project development and feasibility.

5.2 Investment Logic Mapping

The problem identification and service need for the Project were developed in consultation with key project stakeholders through an ILM process, which was facilitated in accordance with best practice principles. Originally developed by the Victorian Department of Treasury and Finance, the ILM is part of the investment Management Standard which has been adopted across several Australian jurisdictions.

ILM supports the development of the strongest case for an individual investment. It articulates the strategic rationale for a proposed investment and can be modified to reflect changes to the logic throughout its lifecycle. ILM is a technique that requires robust discussion by key project stakeholders to define the problems and opportunities, benefits, strategic responses and potential solution options. The output is a diagram, or map, that depicts the logic for a proposed investment on one page – the Investment Logic Map. The ILM for this project is displayed in Figure 38.

5.2.1 ILM workshops

PwC designed an ILM approach to appropriately and effectively respond to the unique and challenging nature of the Project, where there were a large and diverse cohort of stakeholders to be consulted. To achieve the required outcomes, PwC facilitated two ILM Workshops (the workshops) in April 2020. Both workshops were attended by NT Government stakeholders and industry representatives. The first workshop focussed on agricultural/horticultural stakeholders and the second workshop focussed on industrial stakeholders. Each workshop delivered the same information to stakeholders, with the smaller group sizes allowing participants the opportunity to provide valuable insights about their industry, speak freely among their peers and contribute to the development of the ILM.

The list of organisations represented at the ILM workshops is presented in Table 15.

Table 15: ILM attendees

Project team	NT Government	Agricultural/horticultural stakeholders	Industry stakeholders
• PwC • SMEC	• DTBI • Department of Treasury and Finance • Department of Infrastructure, Planning and Logistics	• NT Farmers	• Australian Petroleum Production and Exploration Association • PWC

Project team	NT Government	Agricultural/horticultural stakeholders	Industry stakeholders
	- Department of Environment and Natural Resources - Department of the Chief Minister		

The core objective of each workshops was to discuss and confirm the needs to be addressed (service needs) and outcomes sought (service requirements) for the Project.

The ILM for the Project confirmed the following:

- The problems and opportunities that the Project would respond to (service need)
- The expected benefits from addressing the problems or realising the opportunities
- The potential strategic responses to the problems and opportunities
- The solutions or options which could be progressed to respond to the problems and opportunities and deliver the expected benefits.

This chapter discusses the problems and opportunities. The benefits are outlined Chapter 6 Expected benefits and the strategic responses and options are detailed in Chapter 8 Options identification and development.

5.2.2 ILM

An ILM is a strategic document which outlines on one page the key logic behind a proposed project or initiative. It was developed collaboratively with key stakeholders and the project team. The ILM is displayed in Figure 38.

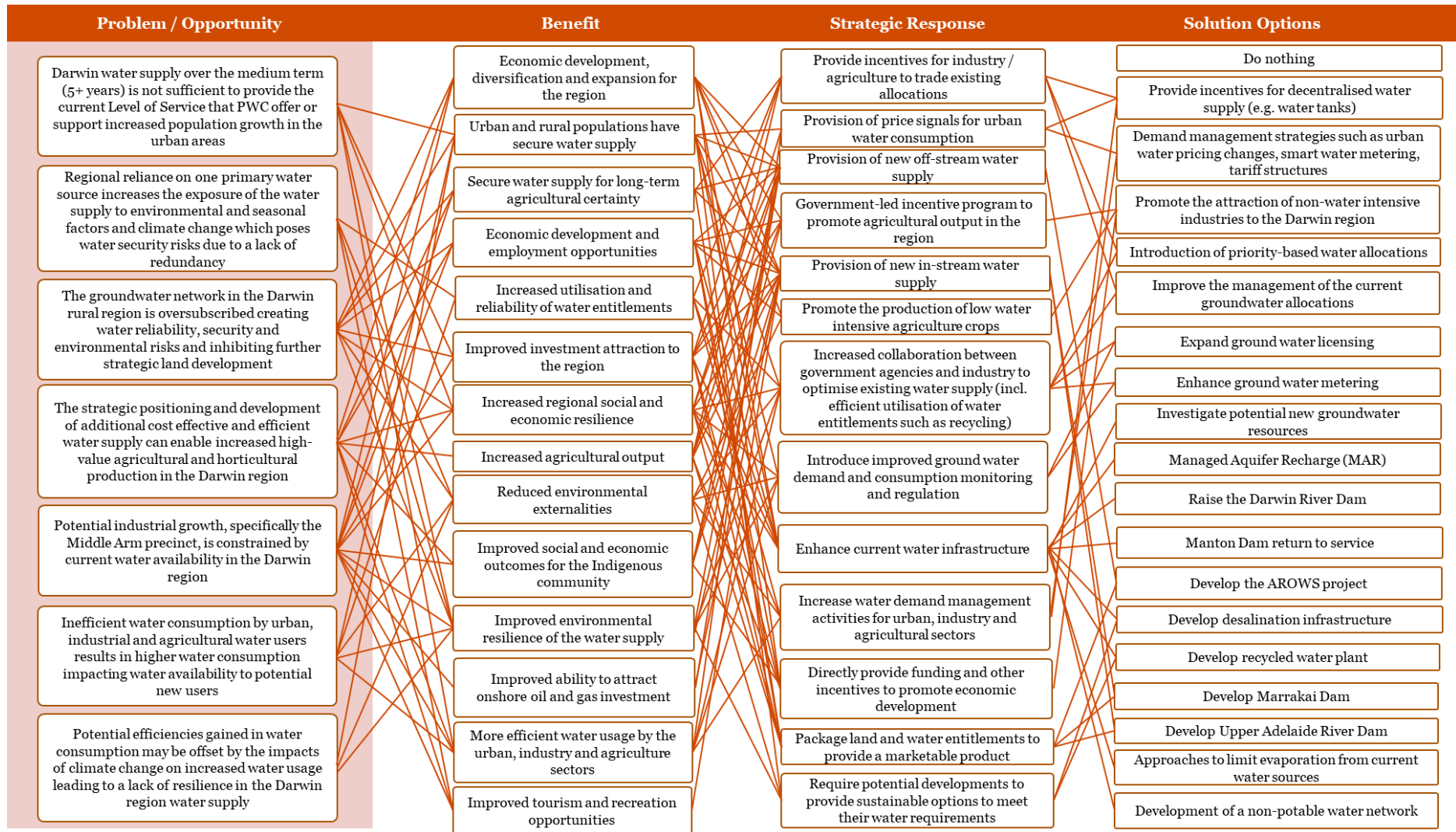


Figure 38: ILM

5.3 Problems and opportunities

Each of the problems and opportunities identified in the ILM are described in detail in this section.

5.3.1 Problem 1:

Darwin water supply over the medium term (5+ years) is not sufficient to provide the current Levels of Service that PWC offer or support increased population growth in urban areas

The current available water supply in the greater Darwin region is not sufficient to cater for growing demand from urban consumers. This section covers:

- Current water supply and Levels of Service provided by PWC
- Household water consumption patterns in the greater Darwin region
- Anticipated population growth in the greater Darwin region and the subsequent increase in water demand.

Current water supply and Levels of Service

Water in the greater Darwin region is currently sourced through either the PWC reticulated water supply network or through accessing groundwater. As discussed in the Supply and Demand chapter, Darwin River Dam supplies approximately 80 to 95 per cent of Darwin's annual reticulated water supply (approximately 37,000 ML per annum), with the remainder sourced from groundwater resources, including the Howard East and McMinns borefields (approximately 4,800 ML). Table 16 displays the current water demanded in the greater Darwin region.

Table 16: Current approximate greater Darwin water demand (ML p.a.)

Demand (ML p.a.)	Surface water	Groundwater	Total
Metered water demand (PWC)	37,000	4,800	41,800
Licensed groundwater extraction	-	21,600	21,600
Stock and domestic extraction	-	7,200	7,200
Other extraction*	-	9,700	9,700
Total demand / extraction	37,000 ML p.a.	43,300 ML p.a.	80,300 ML p.a.

**Unlicensed or unregistered groundwater extraction
Source: SMEC*

To ensure adequate water security, PWC has defined levels of service for the greater Darwin region, as outlined in their *2013 Darwin Region Water Supply Strategy*. The Levels of Service objectives relate to a number of specific measures including the desirable maximum frequency, duration and severity of water restrictions expected by the community⁶⁶. The Levels of Service objectives provide the basis for two levels of reliability of water supply:

- 95 per cent unrestricted demand reliability - Stage 1 water restrictions, 1 in 20 years (27 per cent full)
- 99 per cent restricted demand reliability - Stage 3 water restrictions, 1 in 100 years (10 per cent full).

To preserve these levels of service, PWC modelling has shown that intervention will be required by 2026. Figure 39, based on the *Darwin Region Water Supply Strategy* illustrates that a higher yield is required to meet projected consumption in the

⁶⁶ Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013*. Supplied by PWC

greater Darwin region over the medium to long term. By 2025/26 current modelling indicates that demand for reticulated water will exceed the available yield.

PWC is planning for this near-term water security risk includes the return to service of the Manton Dam by 2025/26 with further supply augmentation through the AROWS Stage 1a project by 2031/32, as articulated in the *Darwin Region Water Supply Strategy*. However, neither of these options are currently funded or committed and are therefore not part of the base case for this Project. Therefore, in the absence of water supply augmentation there will be a widening gap between the sustainable yield of the water supply and the consumption demands shown in Figure 39. In the absence of delivering increased supply:

- The incidence of water restrictions will increase
- Significant non-infrastructure demand management initiatives will be required
- There will not be sufficient water for any material expansion in industry, nor agriculture and horticulture, limiting future economic growth.

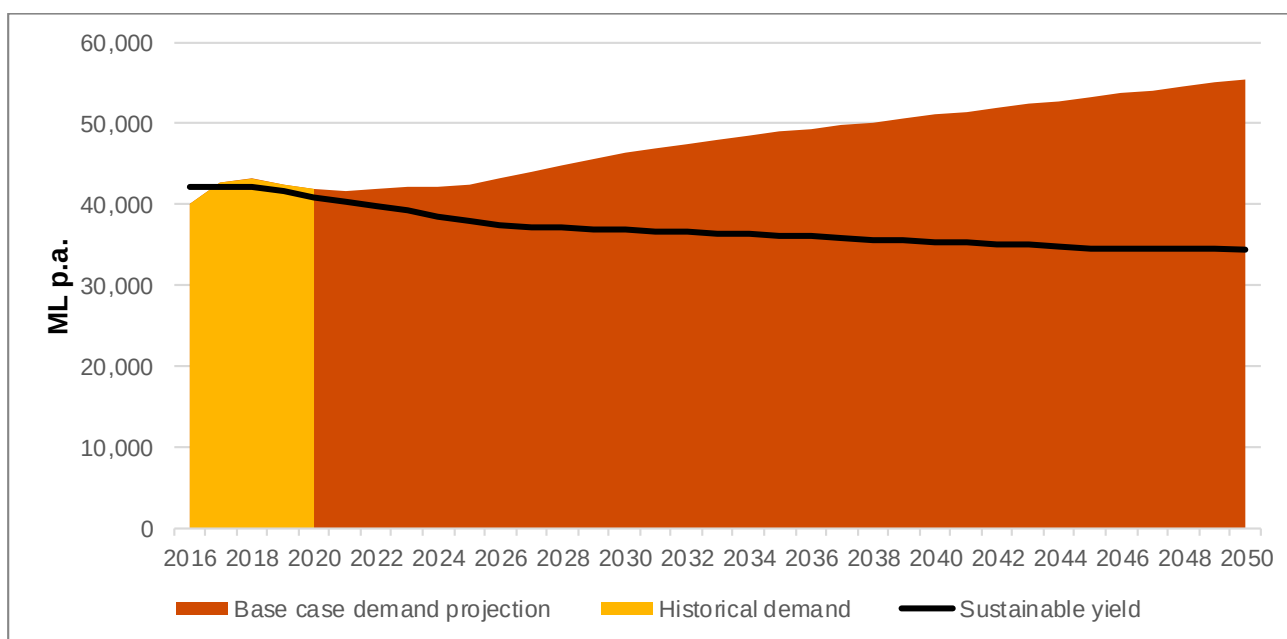


Figure 39: Darwin region reticulated network demand and supply forecasts⁶⁷

NT household current water consumption

The NT consumes more water per household than any other state or territory in Australia. Figure 40 illustrates that residential water consumers are the highest within the reticulated network.

⁶⁷ Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013: Overview and current status*. Supplied by PWC

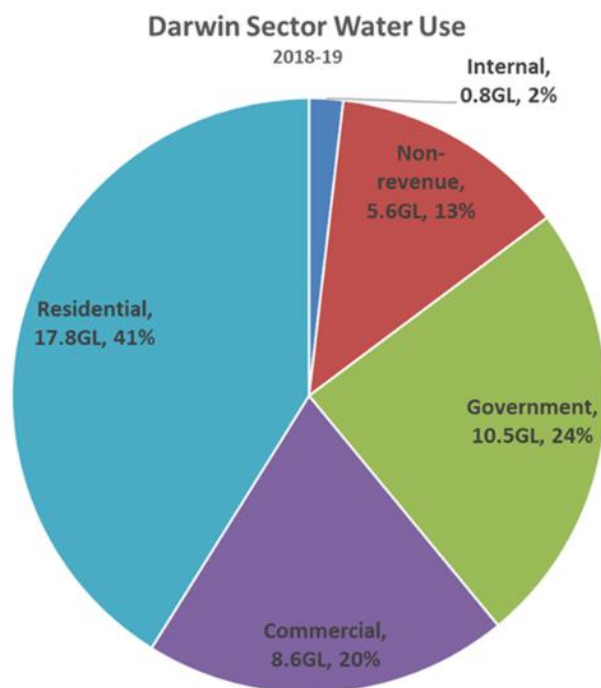


Figure 40: Greater Darwin region water consumption by sector⁶⁸

The NT consumes nearly double the water per person than any other state or territory in Australia, and the greater Darwin region has never been subject to water restrictions. The importance of this historical factor is significant. Figure 41 shows the significantly high level of residential water use in the NT, relative to other states and territories.

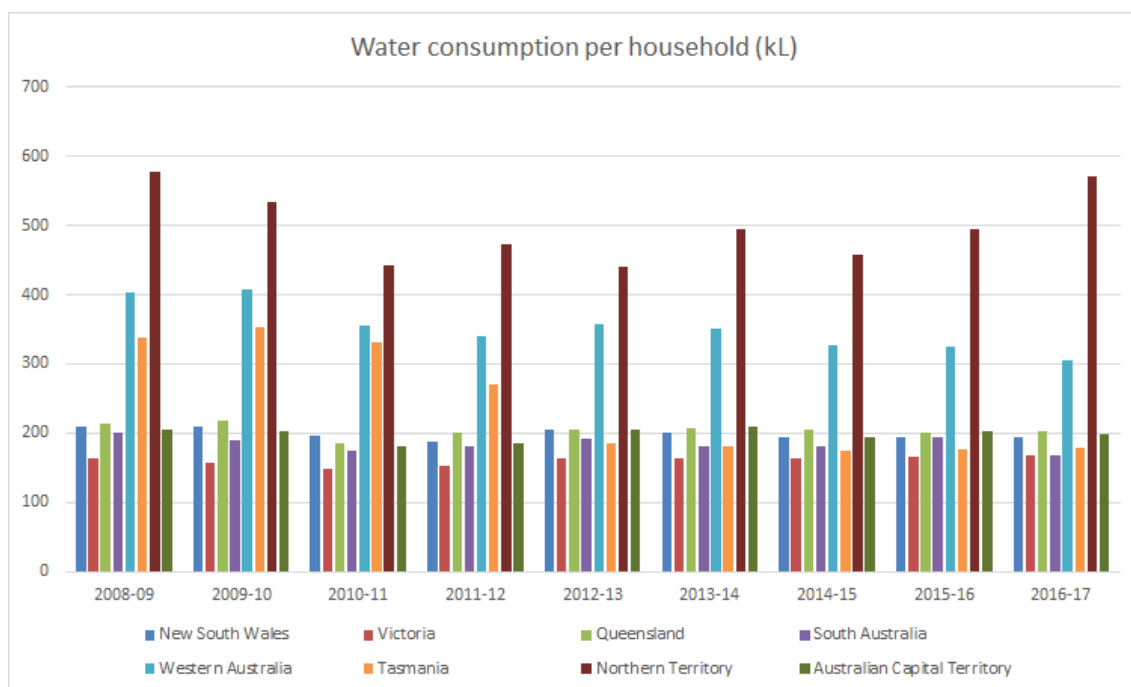


Figure 41: Water consumption per household (kL)⁶⁹

⁶⁸ Supplied by PWC

⁶⁹ Australian Bureau of Statistics (2019). 4610.0 – Water Account, Australia, 2016-17.

Based on the average household size, the NT consumes approximately 200kL per person, as compared to approximately 120kL per person in Western Australia and 85kL per person in other states and territories. Despite efforts in recent times to reduce usage through the 'Living Water Smart' demand management initiative, high water consumption is a historical issue in the Territory. A significant proportion of water is used outdoors on irrigation, pools and ponds, particularly in the dry season. This is caused by the impacts of climatic factors, such as evaporation, and lifestyle (e.g. approximately 30% of households in Darwin have a swimming pool as compared to the Australian average of about 12%⁷⁰).

High household water consumption is expected to continue in the absence of strong demand management measures. Significant water savings along with an increase in supply will need to be achieved to meet the demands of the growing population. Appendix C, Current Water Demand and Supply Assessment Report, details that even demand management measures would not provide enough additional supply to offset the growing population over the long term.

Increase in population of the NT

The NT Government has a vision to return the population growth rate to the historical long-run average of 1.4 per cent, from the recent low growth path of 0.6 per cent⁷¹. This strategy is part of a broader economic development target to double the economic growth rate of the NT to 5.0 per cent, through the realisation of a number of major projects, sustainable economic development and attracting new private sector investment⁷².

Population growth will result in increasing demand and competition for water for urban, industrial and agricultural and horticultural uses. As Darwin is reliant on climate dependant sources, climate variability impacts the availability of supply and the Levels of Service to urban, industrial and agricultural users. As annual extraction by these users increases, water levels will continue to drop at the end of the dry season each year, threatening a fall in water levels not previous experienced.

The required additional future supply is not available from the existing Darwin system and is currently insufficient to cater for growth. Whilst the NT Government has not previously imposed water restrictions on customers in the greater Darwin region, PWC modelling indicates that water supply intervention will be required by 2026 to meet future water demand and provide sufficient water security, reliability and resilience in the event of climate change impacts. Infrastructure Australia has also identified that an additional water source to meet demand is a critical urban water infrastructure requirement for the greater Darwin region⁷³.

Service requirement

In addition to demand management activities, a new water source is required to maintain the current Levels of Service offered by PWC and support economic and population growth targets.

5.3.2 Problem 2:

Regional reliance on one primary water source increases the exposure of the water supply to environmental and seasonal factors and climate change which poses water security risks due to a lack of redundancy

With a dry tropics climate, Darwin experiences high average temperatures, a monsoonal wet season lasting four to five months, and a largely rain-free dry season lasting seven to eight months on average. The region's water supply is strongly influenced by these climate factors, including the seasonal nature and variability of rainfall in the region each year.

This section covers:

- Seasonal factors affecting water supply in the NT

⁷⁰ SMEC (2020), *Appendix C – Supply Demand Report*.

⁷¹ Northern Territory Government (2018). *2018-2028 Northern Territory Population Growth Strategy*. Accessed at https://population.nt.gov.au/_data/assets/pdf_file/0007/559384/Population-Strategy.pdf

⁷² The Territory (n.d.) *Why the Territory*. Accessed at <https://theterritory.com.au/invest/why-the-territory>

⁷³ Infrastructure Australia (2019). *Northern Australia Audit*. Accessed at https://www.infrastructureaustralia.gov.au/sites/default/files/2019-06/ia_northern_australia_audit.pdf

- Other risks affecting water supply.

Seasonal factors affecting water supply

Annual rainfall in the greater Darwin region is highly variable, as illustrated in Figure 42⁷⁴.

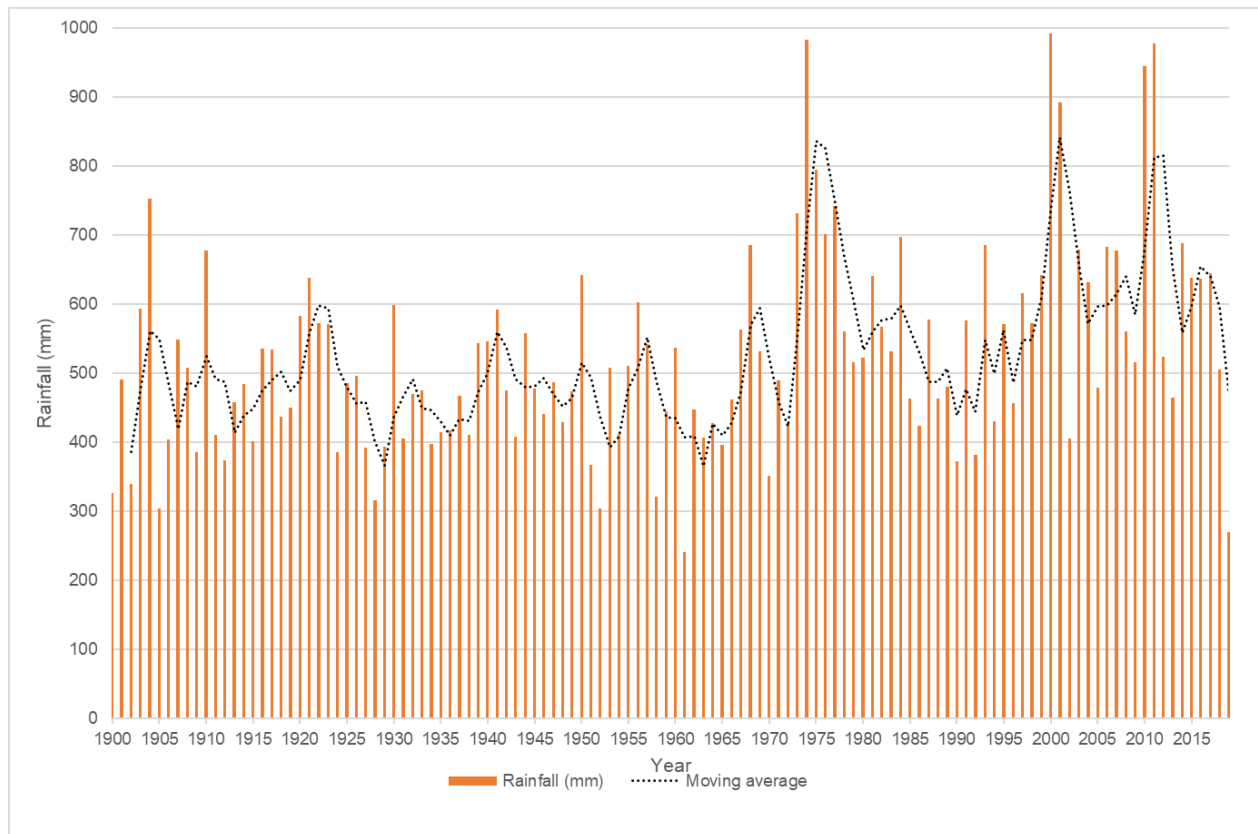


Figure 42: NT annual rainfall 1900 to 2019⁷⁵

Water levels in the Darwin River Dam are significantly impacted by the dry season and if there are sustained periods with poor wet seasons, as has been experienced in the past two years, this results in insufficient recharge to the Darwin River Dam, as well as groundwater sources. Figure 43 displays the Darwin River Dam historical storage levels.

⁷⁴ Bureau of Meteorology (2020). *Climate change – trends and extremes; Australian climate variability and change – Time series graphs*. Accessed at http://www.bom.gov.au/climate/change/index.shtml#tabs=Tracker&tracker=timeseries&tQ=graph%3Drain%26area%3Dnt%26season%3D0112%26ave_yr%3D0

⁷⁵ Bureau of Meteorology (2020). *Climate change – trends and extremes; Australian climate variability and change – Time series graphs*. Accessed at http://www.bom.gov.au/climate/change/index.shtml#tabs=Tracker&tracker=timeseries&tQ=graph%3Drain%26area%3Dnt%26season%3D0112%26ave_yr%3D0

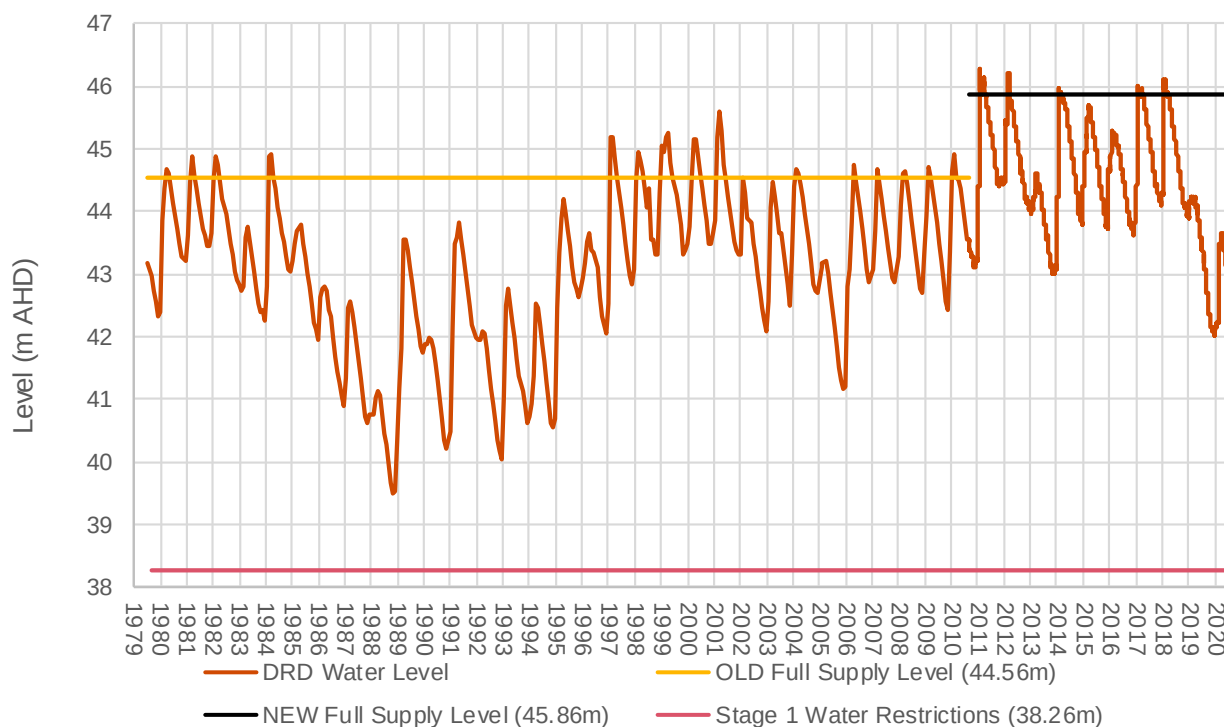


Figure 43: Historical Darwin River Dam storage levels⁷⁶

The Darwin River Dam is the region's principal water supply source and decreasing water levels place the target LoS at risk.

Other risks affecting water supply

Catchment-related risks have the potential to impact on supply from both ground and surface water sources. Rural residential and horticultural land use poses a risk of contamination to the public water supply. The Darwin River Dam catchment is a closed catchment, however, water quality in reservoirs can also be affected by flood damage, bush fires, feral animals and weeds. Loss of supply could also be caused by contamination, equipment failure or terrorism⁷⁷.

In the event that supply from Darwin River Dam becomes unavailable, an alternative supply must be provided by PWC. This supply must be from a source independent of the Darwin River Dam. Additionally, the ground water resources in the greater Darwin region are already oversubscribed and therefore have limited capacity to supply additional water without serious environmental impacts. There is also a risk that the annual allocations may be reduced if the groundwater system does not adequately recharge which would further impact the ability for PWC to access groundwater resources.

This is a significant risk and an alternative water source is therefore required to provide network redundancy and reliability of supply if the existing primary water sources are compromised.

Service requirement

Decrease exposure of the water supply to environmental and seasonal factors and improve network resilience and redundancy by investing in an alternate water source.

⁷⁶ Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013: Overview and current status*. Supplied by PWC

⁷⁷ Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013*. Supplied by PWC

5.3.3 Problem 3:

The groundwater in the Darwin rural region is oversubscribed creating water reliability, security and environmental risks and inhibiting further strategic land development

Over extraction of the groundwater in the greater Darwin region has resulted in a number of risks affecting consumers and the environment. This section covers the current groundwater issues affecting future water supply to the greater Darwin region.

Extraction from groundwater resources

Over the past 30 years' groundwater development within the Darwin Rural Area has increased significantly from around 1,000 bores in the 1980s to over 8,000 bores in 2019. Much of the groundwater development has been via stock and domestic installations through basic landholder rights on small rural blocks. Groundwater is an integral part of the diversification, security and emergency supply of water for the greater Darwin region and integral to the current and future growth and productivity of the Darwin rural region.

PWC's Howard East and McMinns Borefields are located within the Howard Groundwater System (HGS) which is divided into five management zones. Around 80 per cent of current groundwater extraction comes from just two of the management zones, West (Howard East) and Central (McMinns), with the majority of the rural population and agricultural / horticultural development occurring in this area which is most proximate to the Darwin urban area. The estimated annual extraction from the HGS is 43,500 ML of which:

- 26,600 ML is licensed extraction⁷⁸
- 7,200 ML is rural stock and domestic extraction
- 9,700 ML is unlicensed irrigation extraction.

To protect the environment and ensure the sustainability of the resource, the available groundwater for extraction under the NT Water Allocation Framework is legislated to target a maximum of 20 per cent of the annual median recharge. However, as discussed in Chapter 3 Base Case Supply and Demand, under current regulation and legislation there is limited capacity to enforce extraction limits to ensure that this target is maintained. Given this extraction from the West and Central management zones are estimated to be 380 per cent and 150 per cent of the modelled yield, respectively. In addition to existing over extraction, successive poor wet seasons in 2018 and 2019 means that groundwater systems have not completely recharged.

Oversubscription of the groundwater network results in:

- Lack of water reliability for agriculture and horticulture
- Reductions in the water table over and above the seasonal variation
- Impacts to spring flows and water available to the ecosystem.

Service requirement

Improve reliability and sustainability of the water supply by investing in new water infrastructure.

5.3.4 Problem 4:

The strategic positioning and development of additional cost effective and efficient water supply can enable increased high-value agricultural and horticultural production in the greater Darwin region

There is significant opportunity for the expansion of the horticulture industry in the greater Darwin region with continued strong growth in demand for high value produce. This section covers:

⁷⁸ Including PWC extraction allocation.

- Current product mix
- Demand for high value produce
- Availability of water.

Current product mix

There is approximately 50,000 ha of developable agricultural and horticultural land in the greater Darwin region. In 2017-18, the gross value of agricultural production in the greater Darwin region was \$83 million. The horticulture industry in the NT has grown significantly, and, by way of examples, now produces around 50 per cent of Australia's total mango crop. The Darwin rural region is the most productive horticultural region in the NT, producing large volumes of mangos, melons, watermelons and many other crops. Mangoes are the most important horticultural commodity for the greater Darwin region, based on the gross value of agricultural and horticultural production, which is \$41 million⁷⁹. Figure 44 shows the value of other agriculture and horticulture production in the greater Darwin region.

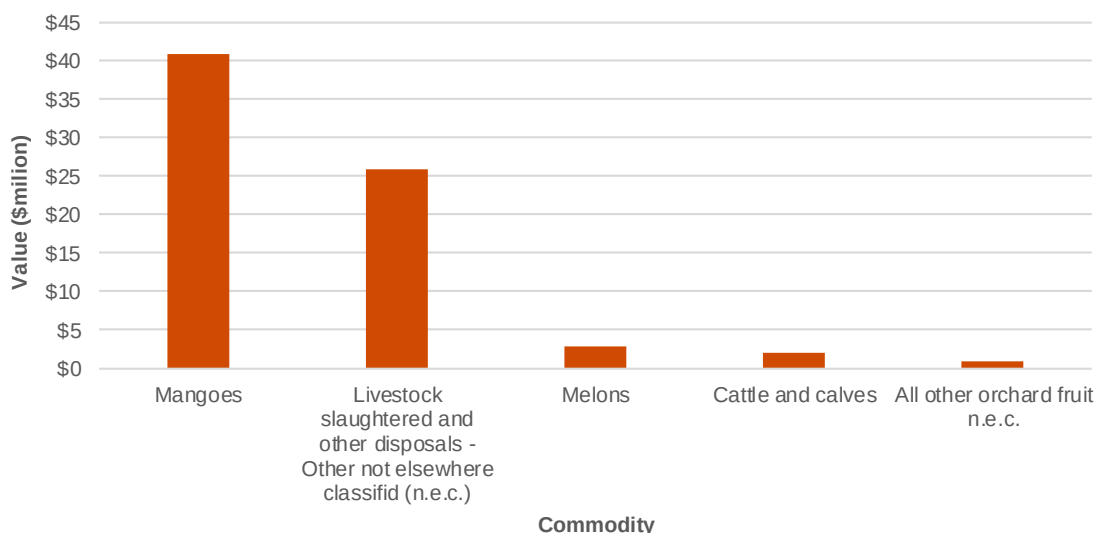


Figure 44: Value of agricultural and horticultural production in greater Darwin region⁸⁰

Demand for high value produce

Based on the greater Darwin region's capabilities in agriculture and horticulture, and the availability of land, value adding activities can be investigated to expand the industry's production capabilities and productivity. Even with the impacts of climate change, investigations have been undertaken for certain crop types to be grown in the NT, and Northern Australia more broadly, as the weather conditions are more favourable for certain crops than southern jurisdictions. The Climate Change Research Program (CCRP) has funded a climate adaption project to determine the costs and opportunities of relocating tomato, cotton, peanut and rice production to various regions across Northern Australia. Success of the expansion is dependent on a variety of factors, including securing water and associated infrastructure⁸¹.

While some developing countries in Asia are currently self-sufficient in meeting their food demand, due to urbanisation, future land constraints and changing diets, countries such as India, Vietnam and Malaysia are forecast to become net importers of agricultural and horticultural produce. The reputation of the Australian agriculture and horticulture industry to provide high quality and safe produce, grown in a clean environment means the greater Darwin region is well placed to meet this future demand. There is significant opportunity for the expansion of the horticulture industry in this region with continued strong growth in demand for high value produce. Darwin International Airport has planned to facilitate the

⁷⁹ ABS (2018). 7503.0 – Value of Agricultural Commodities Produced, Australia, 2017-18.

⁸⁰ ABS (2018). 7503.0 – Value of Agricultural Commodities Produced, Australia, 2017-18.

⁸¹ Department of Agriculture, Water and the Environment (2019). *Adapting to a changing climate*. Accessed at <https://www.agriculture.gov.au/ag-farm-food/climatechange/australias-farming-future/adapting-to-a-changing-climate>

expansion of international airfreight through the development of an export hub, which will further increase opportunities for agricultural and horticultural growth in exports.

A wealthier Asian population is also likely to have increased capital and appetite for investing. As a result, a significant proportion of investment from Asia into Australia is now moving into agriculture, horticulture and food products, which is well aligned with the greater Darwin region's production capabilities. Australia represents a safe, reliable and open investment destination with a high-performing and well-managed economy. A key recommendation from the Cooperative Research Centre for Developing Northern Australia's (CRCNA) Agricultural Investor Identification Report⁸² was the potential to investigate Priority Agricultural Development Areas and associated programs of de-risking for investment to ensure private and public investment is focused and significant. To meet the NT Government's target economic growth rate of 5 per cent, significant growth in industry, agriculture and horticulture will be required, with all sectors requiring increased water availability and security to enable growth.

Water availability

High value horticulture requires high volumes of water, with estimates ranging from 7 to 12 ML/ha per annum. Extraction from key groundwater resources that service the horticultural industry in the region are at, or above, sustainable levels. This is inhibiting potential agricultural and horticultural development in the region and creating a barrier for domestic and international investment in the NT. A new water supply could enable development of new high value agricultural and horticultural precincts, allow for the expansion of existing operations and the transition to higher value, more water intensive, crops. A new water source would provide increased reliability which is particularly valuable for horticultural producers with perennial crops who rely on income from a single or short season each year (e.g. mangoes). A detailed assessment on the potential agricultural demand, including potential crop types and development areas, associated with increased water supply is included in *Chapter 4 - Potential water demand*.

To enable new high value agricultural and horticultural development in the future, an increased supply of affordable and reliable water is needed.

Service requirement

Capitalise on the demand for high-value agriculture/horticulture by providing a cost-effective and reliable water supply which can enable increased agricultural and horticultural production in the greater Darwin region.

5.3.5 Problem 5:

Potential industrial growth, specifically the Middle Arm precinct, is constrained by current water availability in the greater Darwin region

Industrial growth in the greater Darwin region is currently constrained due to a lack of affordable, reliable water for industrial use. This section covers:

- Overview of Middle Arm Precinct
- Water requirements for tenants.

Middle Arm Precinct

Located on the Middle Arm Peninsula in Darwin Harbour, the Middle Arm Industrial Precinct will provide a variety of lot sizes to accommodate large strategic industries for downstream gas processing and gas related developments. Middle Arm is already home to the ConocoPhillips Darwin LNG Plant and the INPEX Ichthys Onshore LNG Processing Facility. Overall, the precinct can accommodate a range of incoming industries including:

- industrial - oil and gas, chemical and minerals
- utilities - power generation

⁸² CRCNA and PwC (2019). *Agricultural Investor Identification Report*.

Problem identification and service need

- logistics - rail
- commercial⁸³.

The Department of Infrastructure, Planning and Logistics (DIPL) engaged Wood PLC to develop water demand forecasts for the complete development of Middle Arm under two scenarios, a base case area and an expanded area. These two scenarios provide a total of 2,337 ha and 2,516 ha of additional development area respectively. The expanded area is shown in Figure 45.

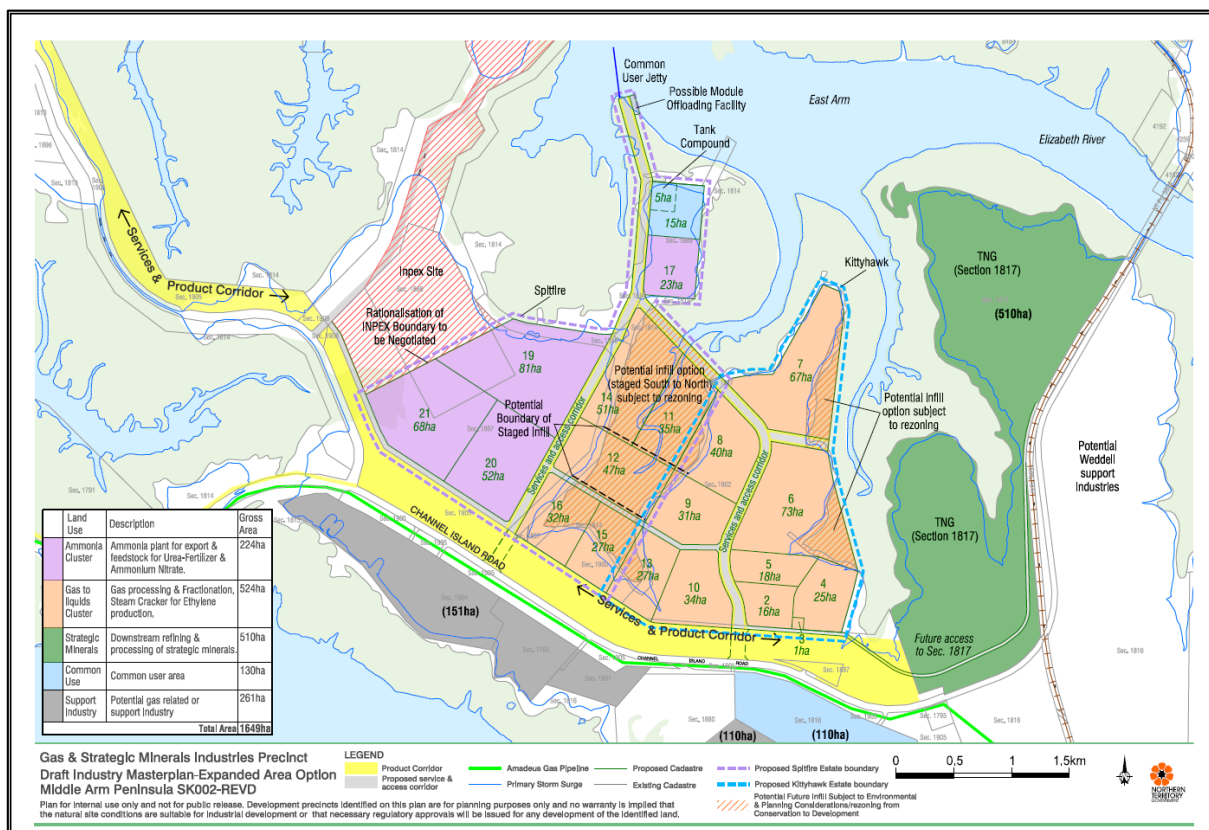


Figure 45: Middle Arm expanded development area

The emerging Middle Arm Industrial Precinct presents new opportunities for expanding the oil and gas industry in the NT, due to Middle Arm's ease of access and proximity to existing services. Development of Middle Arm is a primary strategic goal of the NT Government and is key for the continued economic growth of the Northern Territory and the greater Darwin region.

Industrial water demand

The new industrial tenants at the Middle Arm industrial precinct are anticipated to require a significant volume per annum of additional water supply. The Middle Arm Industrial Precinct has substantial potential water requirements, with the estimated ultimate water demand between approximately 46,000 ML p.a. and 48,000 ML p.a. Forecast demand for the Middle Arm Industrial Precinct is discussed in *Chapter 4 - Potential water demand*.

Based on the current supply and demand balance, and the information provided in Chapter 3 - Base Case Supply and Demand there is insufficient water available to support any meaningful industrial development without compromising urban water security. Development of the Middle Arm Industrial Precinct is a key component of the NT's Economic Development

⁸³ The Territory (n.d.). *Middle Arm Industrial Precinct*. Accessed at <https://theterritory.com.au/invest/investment-opportunities/middle-arm-industrial-precinct>

Strategy. The ability to provide water and other facilitating infrastructure is essential to attract tenants, contributing to employment, population and economic growth targets of the greater Darwin region.

Service requirement

A new water supply is required to attract and secure new investment and meet the needs of tenants at the Middle Arm Industrial Precinct.

5.3.6 Problem 6:

Inefficient water consumption by urban, industrial and both agricultural and horticultural water users results in higher water consumption impacting water availability to potential new users

A history of limited water demand management in the NT has contributed to inefficient water consumption by urban, industrial and both agricultural and horticultural water consumers. This section covers:

- Limited attempts at water demand management in the NT
- Low cost of water relative to other jurisdictions.

A history of limited approaches to water demand management

Historically, up to 60 per cent of the greater Darwin region's water is consumed by the residential sector, followed by the non-residential commercial and Government sectors⁸⁴. On average, about three quarters of the greater Darwin region's annual water consumption is for outdoor water use. Water consumption also varies greatly with the wet/dry tropical seasons, with outdoor use in households increasing up to ten-fold in the dry season. Therefore, the greater Darwin region's water consumption and usage patterns are very highly correlated to Darwin's climate⁸⁵.

As discussed in Problem 1, when compared to the rest of Australia, Darwin's residential water consumption is over twice as high as other jurisdictions. The 2013 *Living Water Smart* initiative, aimed at reducing water use within the greater Darwin region through a comprehensive educational and behavioural change program, is on track to achieve its target of reducing water demand by 7,600 ML p.a. by 2025/26. The program included measures to improve asset management (reducing water losses and managing system pressure) and through a comprehensive program of water conservation. Among residential and industrial users, consumption has gradually decreased on a per capita basis for these sectors with targeted savings being currently met.

However, as seen in Figure 46, the Government sector, which accounts for approximately 20 per cent of the reticulated water consumption, has progressively increased its consumption of water.

⁸⁴ Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013*. Supplied by PWC

⁸⁵ Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013*. Supplied by PWC

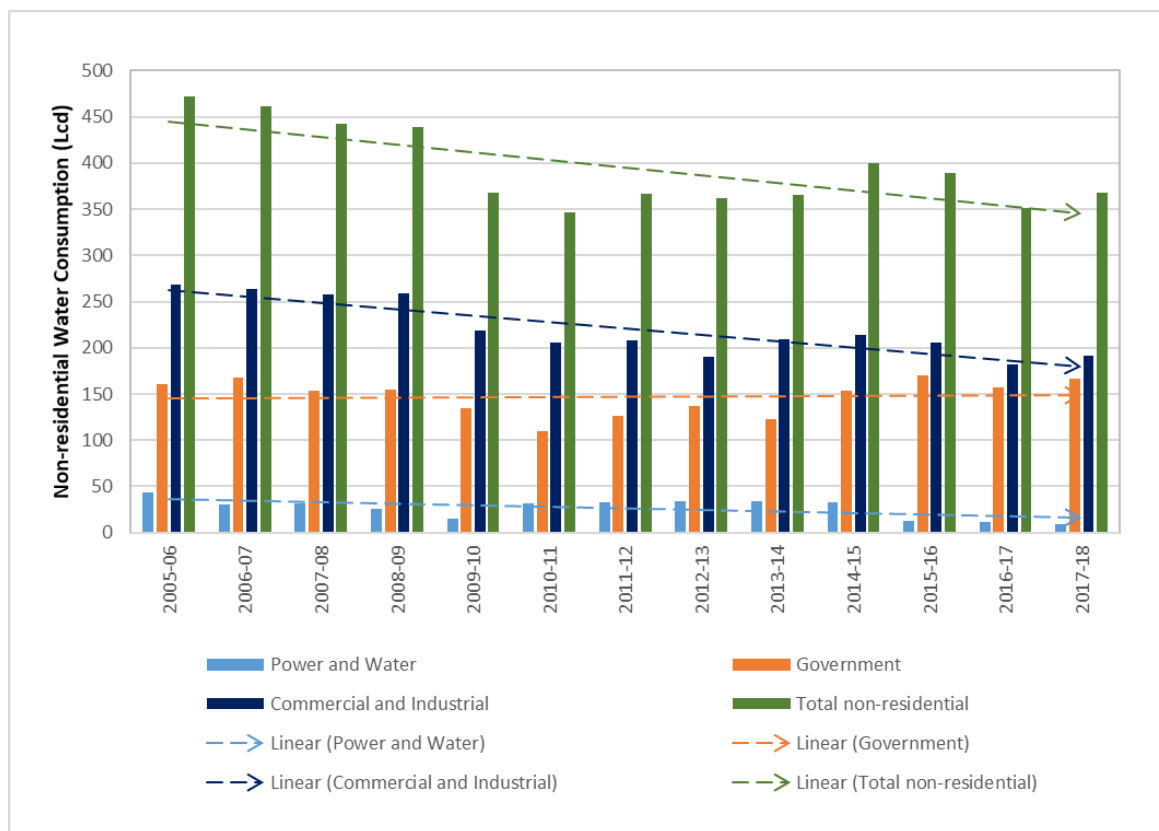


Figure 46: Water consumption by non-residential sector⁸⁶

Low cost of water

Contributing to the inefficient use of water is the fact that it is provided at low cost. As illustrated in Figure 47, the residential volumetric water tariff in the NT of \$1.96 per kiloliter is the second lowest of all states and territories, only behind Hobart. Whilst the overall water charges for the NT may be substantial, it is the volumetric component which will have the greatest impact on overall consumption. A high fixed charge for water may actually encourage greater inefficiency as customers feel they have already paid for the water and thus have a right to unfettered consumption.

⁸⁶ Power and Water Corporation (2020).

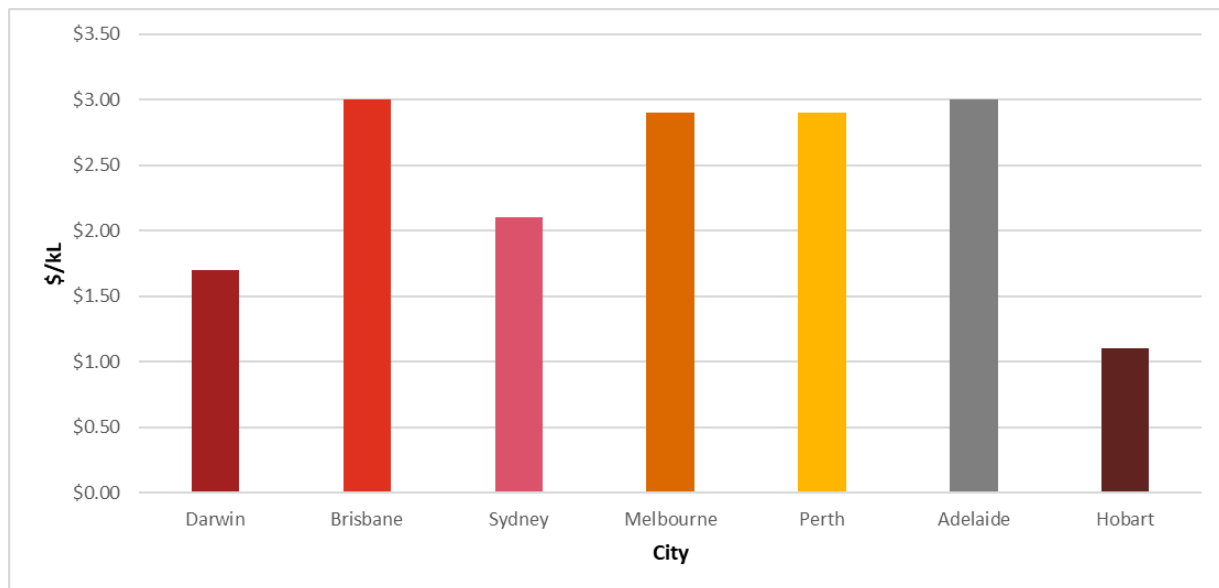


Figure 47: Variable water usage charges for Australian capital cities

Additionally, agricultural and horticultural landholders have the right, without need of a license, to take groundwater and surface water on their land for domestic use, stock watering and irrigating a garden no larger than 0.5 ha. This could create a potential lack of willingness to pay by agricultural/horticultural producers for a new water source, given historical access to 'free' water on their property. However, reliability of water may encourage producers to switch to reticulated water supply and incentivise expansion. Cost savings on bore maintenance and electricity costs may also be a benefit for users.

Service requirement

Encourage more efficient water usage whilst also providing a reliable and affordable increase to the water supply for the region by investing in new water infrastructure.

5.3.7 Problem 7:

Potential efficiencies gained in water consumption may be offset by the impacts of climate change on increased water usage leading to a lack of resilience in the greater Darwin region water supply

While demand management measures have the potential to reduce water consumption to some degree, the effects of climate change may offset the water savings. This section covers climate change impacts affecting the supply and demand of water in the greater Darwin region.

Climate change impacts

Climate change is evident through meteorological changes in the NT, elsewhere around Australia and the world. The impacts of climate change on yields available from Darwin River Dam and the recommissioned Manton Dam are expected to be significant. Increases in evapotranspiration will affect runoff storages, as well as an increase in evaporation from the dams themselves⁸⁷.

Currently each year, two thirds of the reduction in volumes in the Darwin River Dam is due to evaporation and one third consumption. Table 17 demonstrates the effect the climate change will have on total system yield by 2065⁸⁸.

⁸⁷ Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013*. Supplied by PWC

⁸⁸ Entura (2016). *Darwin Water Supply Medium Term Water Source Options Assessment*, Table 14.2. Provided by PWC.

Alternate modelling by PWC has also identified the potential for a 13 per cent reduction in yield from Darwin River Dam and a 3 per cent reduction in yield from Manton Dam by 2030⁸⁹. The impact of both these scenarios compared to the current system yield is shown in Table 17.

Table 17: Total system yield comparison with climate change

Scenario	Current system yield (ML p.a.)	2030 System yield with climate change (ML p.a.)	Percentage reduction (%)	2065 System yield with climate change (ML p.a.)	Percentage reduction (%)
Existing system	42,800	37,876	13.0	35,100	18.0
Manton Dam RTS	49,000	47,573	3.0	40,200	21.9
AROWS only (leapfrog Manton Dam RTS)	83,000	N/A ⁹⁰	N/A	73,300	13.2

The greater Darwin region has already been affected by climate change, faces significant future challenges to the built and natural environments. Predicted climate change effects for the region include:

- Increased extreme rainfall events
- A greater number of cyclones
- Increased daily temperature maximums, and increased evaporation from surface water storages and surface and groundwater resources
- Risks of saltwater intrusion into freshwater aquifers.

If rainfall events become more intense but with an increased average recurrence interval (i.e. less frequent or longer dry periods), this can have the impact of increasing yield from storage recharge but at the same time increasing demand.

Other climate change effects on water supply and demand in the region include:

- Higher temperatures are likely to lead to an increase in outdoor watering to keep gardens, parks and sporting facilities from looking heat stressed, particularly if plants are tropical in nature and not used to hot dry conditions that could prevail for longer periods of time
- Increased pool evaporation with no rainfall diverters or water tanks in significant use within a region, will lead to higher potable demand for water to fill pools
- Behavioural change in people using water to hose down driveways and houses to help them 'cool down'. Extreme weather conditions can increase shower water use as cooler weather increases shower duration while hot weather increases shower frequency
- Water quality risks in reservoirs (fire, algal blooms)
- Potential offset to demand if temperatures become too uncomfortable for some residents, causing either a slow-down in net migration into Darwin from Interstate or an increased net migration out of Darwin to cooler areas within Australia.

The future distribution of rainfall events will also impact on demand for water, where the longer the duration between rainfall events the potential for higher residential demand for external water use. To provide security against the effects of climate change, an additional water source independent of the Darwin River Dam is required.

⁸⁹ Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013*. Supplied by PWC

⁹⁰ Given the current phase of the project climate change scenarios are not currently available for the AROWS options. These will be developed during the Detailed Business Case phase

Service requirement

A new water source is required to offset the impacts of climate change on current water sources that will not be able to meet future demand.

5.4 Summary

This chapter has confirmed there is a service need to develop a new water storage solution in the greater Darwin region and demonstrated the significant impact to the region if no action is taken. Without investment in new water infrastructure, the greater Darwin region will be subject to increased risk water restrictions in the medium term and will not be able to provide a consistent Levels of Service for the growing population. Climate change is likely to exacerbate this by increasing demand for water by households, and also increasing evapotranspiration and rainfall variability.

There is a significant opportunity to leverage the growing gas industry in the NT by establishing a gas-based manufacturing and industrial hub at the Middle Arm Industrial Precinct. The Middle Arm Industrial Precinct has the potential to create a step-change economic boost for the greater Darwin region, however, the development and growth of the Precinct is currently constrained by access to a water supply that can meet the volumes required by new industrial users. The agricultural and horticultural sector also has significant potential to expand in the region, however, access to reliable water for new and existing farmers is constrained and this potential is not being realised.

6 Expected benefits

6.1 Introduction

The purpose of this chapter is to respond to *Chapter 5 - Problem identification and service need*, by elaborating on the intended benefits sought by NT Government through the development of the Project. This chapter documents the intended benefits expected to be realised in responding to the service need and provides an initial baseline of the expected benefits that may be realised if the problems and opportunities outlined in the previous chapter are addressed. These benefits will be further developed and explored in detail through the DBC stage. This chapter includes:

- Approach
- Benefits sought.

6.2 Approach

This chapter has been developed in accordance with IA's *Assessment Framework*⁹¹, and informed by BQ's BCDF⁹² and NSW Treasury *Business Case Guidelines*⁹³.

As discussed in *Chapter 5 - Problem identification and service need*, the ILM process was developed in consultation with the Project's key stakeholders. Following two workshops, the PwC team conducted a comprehensive desktop review to ensure the intended benefits identified during the workshops are sufficient to confirm the priority and need for the Project. For this Preliminary Assessment, only those benefits identified through the ILM have been included. A comprehensive benefits realisation process will be undertaken if the project progresses to the DBC stage.

6.3 Benefits sought

The intended benefits of the Project have been categorised into five key categories, including:

- Economic benefits
- Environmental benefits
- Social and community benefits
- Industrial sector benefits
- Agricultural and horticultural sector benefits.

6.3.1 Economic benefits

Increasing the water supply in the greater Darwin region will result in economic benefits for a range of stakeholders. A strong economy increases job opportunities, population, standards of living, consumer choices and liveability. It supports more social and cultural activities, and enhances services valued by the community⁹⁴.

The NT has abundant natural resources that create investment potential, with a new water resource supporting and enabling investment attraction in key growth areas. The NT's position as a gateway to Asia, a key defence hub and home to a rich diversity of mineral, gas, petroleum, agricultural and horticulture resources, all provide strategic opportunities required to underpin future economic growth. Private sector investment can grow business and industry in the greater Darwin region

⁹¹ Infrastructure Australia (2018). *Assessment Framework*. Accessed at https://www.infrastructureaustralia.gov.au/sites/default/files/2019-06/infrastructure_australia_assessment_framework_2018.pdf

⁹² Building Queensland (2020). *Strategic Assessment BCDF*. Accessed at <https://buildingqueensland.qld.gov.au/wp-content/uploads/2020/04/Stage-1-Strategic-Assessment.pdf>

⁹³ NSW Treasury (2018). *NSW Government Business Case Guidelines*. Accessed at <https://www.treasury.nsw.gov.au/sites/default/files/2018-08/TPP18-06%20%20NSW%20Government%20Business%20Case%20Guidelines.pdf>

⁹⁴ Northern Territory Government (2017). *Our Economic Future: Northern Territory Economic Development Framework*. Accessed at https://cmsexternal.nt.gov.au/_data/assets/pdf_file/0008/434546/economic-development-framework.pdf

to provide jobs and generate wealth. Investment by the NT Government in new water infrastructure will help catalyse private sector investment and accelerate economic development⁹⁵.

The Territory Government's vision for the NT to become a world-class gas production, manufacturing and services hub by 2030, is being implemented through the NT Gas Strategy⁹⁶. To encourage development, growth and diversification of Darwin's gas hub and downstream opportunities, attracting gas-based processing and manufacturing and expanding service and supply capabilities is necessary. These industries require substantial volumes of water and realising the economic growth potential from these industries relies on the availability of water. An increase in large scale industrial activity will deliver local economic growth opportunities to businesses and the community through employment opportunities and increased output.

The Darwin rural region is the most productive agricultural and horticultural region in the Northern Territory. Significant demand domestically and internationally means that there is the opportunity for expansion of this sector. Expansion to higher value crops, and expansion of the sector, would provide employment opportunities and increase the overall gross regional product of the greater Darwin region. Additional benefits for the agricultural, horticultural and industrial sectors are discussed in Section 6.3.4 and Section 6.3.5.

Tourism is a major employer and contributor to the NT economy. Increasing Darwin's water supply will indirectly support the tourism industry, as it will create jobs through economic development in other industries which improves liveability of the region. As the population of the greater Darwin region grows and employment opportunities increase, residents and their families will seek nature, holiday and cultural experiences in Darwin and the surrounding area and attract visiting friends and relatives to the region.

Table 18: Economic benefits

Benefit description	Related stakeholders	Potential beneficiaries	Possible measures
Economic development, diversification and expansion for the region	- NT Government - Investors - Community	- Greater Darwin region residents - Businesses	- Economic output e.g. GRP or GSP - Population growth - Diversification/expansion of agriculture and horticulture in the greater Darwin region
Economic development and employment opportunities	- NT Government - Businesses - Community	- Greater Darwin region labour force - Businesses in the region	Employment
Improved investment attraction to the region	- NT Government - Potential investors - Businesses	- Businesses in the Greater Darwin region and the NT - Industry	- Economic output e.g. GRP or GSP - Inbound (foreign and domestic) investment in the Territory - Employment
Improved tourism and recreation opportunities	- NT Government - Potential international and domestic tourists - Community	- Community - Tourism and hospitality industry - Potential tourists - Community	Tourism metrics such as visitor arrivals, length of stay, hotel occupancy rates

⁹⁵ Northern Territory Government (2017). *Our Economic Future: Northern Territory Economic Development Framework*. Accessed at https://cmsexternal.nt.gov.au/__data/assets/pdf_file/0008/434546/economic-development-framework.pdf

⁹⁶ Ibid

Benefit description	Related stakeholders	Potential beneficiaries	Possible measures
	Tourism and hospitality operators		- Employment in tourism industry - Expenditure in the greater Darwin region and NT

6.3.2 Environmental benefits

As the effects of climate change become more pronounced, the climate in the greater Darwin region will become more variable. As discussed in *Chapter 5 - Problem identification and service need*, increased water usage as a result of an increase in average temperatures will decrease the resilience of the Darwin water supply. A resilient water supply is the ability of the ecological system to absorb disturbances such as environmental pressures, population growth and changes in consumer behavior⁹⁷, while retaining the same ways of functioning. Provision of a new water supply could support reduced over-extraction of bores and slow depletion of the Darwin River Dam, returning both resources to a more sustainable level.⁹⁸ Reducing extraction from groundwater resources however requires substantial regulatory and legislative action in addition to any infrastructure option. A new water supply will provide security and reliability when the effects of climate change are realised, benefiting urban, agricultural/horticultural and industrial users.

A new water supply, combined with regulatory and tariff reform, could encourage urban, agricultural, horticultural and industrial consumers to become more water efficient. The cost of accessing the new reticulated water supply may encourage consumers to improve efficiency of their water use and decrease consumption, so that they can decrease their costs. This not only benefits consumers but also the environment, as decreasing consumption will improve sustainability of the water supply in the long term.

Table 19: Environmental benefits

Benefit description	Related stakeholders	Potential beneficiaries	Possible measures
Reduced environmental externalities	- NT Government - Industry - Agricultural and horticultural producers - Community	- Greater Darwin region and NT residents - Agricultural and horticultural producers	- Adherence to environmental flow objectives (i.e. annual/daily/wet season flows) - Adherence to sustainable bore extraction levels - Monitoring of water quality in bores
Improved environmental resilience of the water supply	- NT Government - PWC - Agricultural and horticultural producers	- Darwin residents - Agricultural and horticultural producers - Potential industrial investors	- Water consumption levels - Dam and bore levels
More efficient water usage by the urban, industrial and agriculture and horticulture sectors	- NT Government - PWC - Darwin residents	- Darwin residents - Agricultural and horticultural producers - Industry	- Water consumption and/or saving levels - Dam and bore levels

⁹⁷ 100 Resilient Cities (2019). *Water and Sanitation*. Accessed at <http://100resilientcities.org/wp-content/uploads/2019/07/Resilience-POV-water-FINAL-WEB.pdf>

⁹⁸ Note that due to the costs of supplementing groundwater, and the key objectives for the project to enable economic growth, this has not been investigated in this Preliminary Assessment.

Benefit description	Related stakeholders	Potential beneficiaries	Possible measures
	- Agricultural and horticultural producers - Industry		

6.3.3 Social and community benefits

Economic development creates social and community benefits through increased business activity, greater access to employment and improved liveability of the greater Darwin region.

A new water supply and subsequent expansion of the agricultural/horticultural and industrial sectors, including associated demand in ancillary industries, will offer increased choice in employment. A more diverse employment mix creates diversification in the economy, resulting in a more resilient and stable community and improving overall livability of the region as it is less exposed to 'boom-bust' cycles. Expansion of the agricultural and horticultural industry also provides significant opportunity for producers to partner with regional Indigenous communities in prospective agricultural/horticultural areas, providing employment and training.

Improving liveability of the greater Darwin region will help to achieve the NT Government's goal of increasing population growth. The community will also benefit from reduced frequency in water restrictions, which may have caused stress to businesses and households, resulting in adverse health impacts. The expected social and community benefits of the Project may ultimately lead to significant downstream benefits for the greater Darwin region and the NT.

Table 20: Social and community benefits

Benefit description	Related stakeholders	Potential beneficiaries	Possible measures
Increased regional social and economic resilience	NT Government	- Darwin and NT residents - Darwin and NT businesses	- Employment - Business confidence
Improved social and economic outcomes for the Indigenous community	- NT Government - Indigenous communities in the greater Darwin region - Social services	Indigenous communities in the greater Darwin region	Number of social service users from Indigenous communities
Urban and rural populations have secure water supply	- NT Government - PWC - Urban and rural populations	Darwin urban and rural population	- Water consumption levels - Dam and yield to demand ratio levels

6.3.4 Agricultural and horticultural industry benefits

Increased water supply will encourage development and expansion of the agriculture and horticulture industry in the greater Darwin region. As discussed in *Chapter 5 - Problem identification and service need*, water levels in the Darwin River Dam are at risk with several consecutive poor wet seasons, and borefields in the region are currently over extracted. This is unsustainable and unreliable for producers in the long term. A secure and reliable water supply provides long-term certainty for producers, allowing them to reinvest in their business, employ workers and improve their profitability. Agribusiness also supports a range of industries, such as agrichemicals, farm machinery, fencing, irrigation equipment, manufacturing, packaging and product distribution. Growth in agriculture and horticulture will support these ancillary industries in the supply chain, providing employment and growth of these businesses.

Growing Asian economies will create strong demand for products that the NT can produce competitively. A new water supply will encourage growth and expansion of agribusinesses, allowing them to increase their yield and access new markets, further improving profitability for producers.

Table 21: Agricultural and horticultural benefits

Benefit description	Related stakeholders	Potential beneficiaries	Possible measures
Secure water supply for long-term agricultural certainty	- Agricultural and horticultural producers - Potential investors	Ancillary businesses in the supply chain	Growth in agricultural and horticultural output
Increased reliability of water entitlements	- PWC - Agricultural and horticultural producers	- Existing agricultural and horticultural producers - Potential new agricultural and horticultural producers	- Agricultural and horticultural output - Crop yields
Increased agricultural output	- NT Government - Agricultural and horticultural producers	- Consumers - Labour force - Ancillary businesses in supply chain.	- Value of agricultural and horticultural output - Agricultural and horticultural yield - Number of farms in the greater Darwin region - Profitability of agricultural and horticultural producers

6.3.5 Industrial industry benefits

The NT has globally significant onshore and offshore energy reserves, and a long history as a supplier of oil and gas to global markets⁹⁹. The ready supply of reliable gas creates opportunities for businesses which are heavily reliant on gas supplies, including fertiliser production and minerals processing. As discussed in Section 6.3.1, water is a critical resource for ensuring investment in these industries can occur. A reliable water supply will attract increased industrial investment and will benefit Territorians through access to employment and also benefit businesses in the supply chain.

Table 22: Industrial industry benefits

Benefit description	Related stakeholders	Potential beneficiaries	Possible measures
Improved ability to attract onshore oil and gas investment	- NT Government - Industry - Potential investors - NT Land Development Corporation	- Businesses - Industry - Ancillary businesses in the supply chain	Economic output e.g. GRP or GSP

6.4 Summary

This chapter has responded to *Chapter 5 - Problem identification and service need*, by detailing the benefits that can be realised if the identified problems and opportunities can be addressed. The benefits presented in this chapter, and the ability for the options to respond to them, is further considered in the options assessment, presented in Chapter 9. A full benefits realisation process is expected to be undertaken in the DBC stage.

⁹⁹ Northern Territory Government (2017). *Our Economic Future: Northern Territory Economic Development Framework*. Accessed at https://cmsexternal.nt.gov.au/_data/assets/pdf_file/0008/434546/economic-development-framework.pdf

7 Strategic context

7.1 Introduction

This chapter outlines the key federal, territory and local government priorities and policies that support development of the AROWS Project. An overview of the priorities and policies is illustrated in Figure 48.

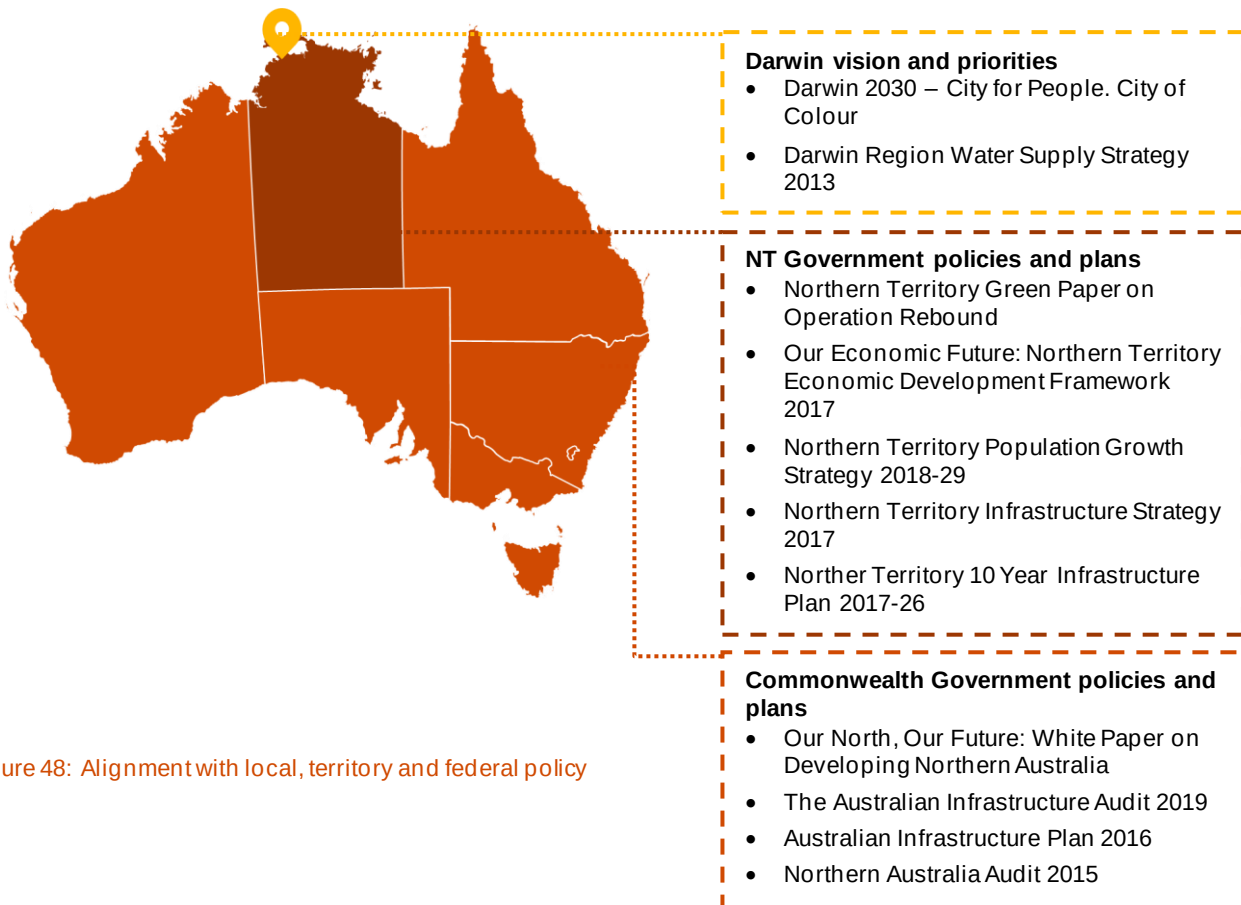


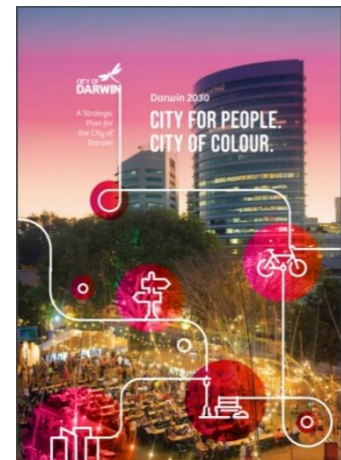
Figure 48: Alignment with local, territory and federal policy

7.2 Alignment with Darwin vision and priorities

7.2.1 *Darwin 2030 – City for People. City of Colour 2019, City of Darwin*¹⁰⁰

The Strategic Plan provides a vision for the City of Darwin over the next ten years. It draws on the community, existing Council strategies and plans, commitments to key stakeholders and states the strategic direction for Darwin by 2030.

One of the five key strategic directions for Darwin is to be 'a smart and prosperous city'. By 2030, Darwin will attract and retain more residents and offer sustainable investment opportunities. This will be achieved through support initiatives that aim to grow the economy and retain people and jobs in Darwin. Investment in a new water supply is an example of an infrastructure support initiative and will be vital to support the growing population in the greater Darwin region. The AROWS project will be a catalyst in growing the economy and providing employment in Darwin, particularly in the agricultural/horticultural and industrial sectors.



7.2.2 *City of Darwin Economic Outlook 2019/2020, .id*¹⁰¹

The Economic Outlook explores recent economic trends to draw conclusions about the likely outlook for the City of Darwin economy to 2020. It analyses leading indicators such as project pipeline, unemployment, population growth and business confidence. Owing to the global impacts of COVID-19, the conclusions of this report are likely to be outdated and no longer accurate.

7.2.3 *Greater Darwin Region Water Supply Strategy 2013, Power and Water Corporation*¹⁰²

The greater Darwin Region Water Supply Strategy details PWC's plan to balance supply and demand for water to a planning horizon of 2030. The Strategy outlines the capacity of the current water supply system, forecast growth in demand, existing and proposed initiatives for demand management, future water source options and the proposed program for development of new water sources¹⁰³.

The strategy discusses several options to augment the greater Darwin region's water supply in the short and medium term (beyond 2020), where a high-level assessment of options was undertaken over five years to identify a shortlist of preferred options for detailed assessment and prioritising. The AROWS project is discussed in reference to PWC's source augmentation options for the medium term.

¹⁰⁰ City of Darwin (2019). *Darwin 2030 – City for People. City of Colour*. Accessed at https://www.darwin.nt.gov.au/sites/default/files/publications/attachments/strategic_plan_2019_web_new.pdf

¹⁰¹ .id (2019). *City of Darwin economic outlook 2019/2020*. Accessed at https://www.darwin.nt.gov.au/sites/default/files/publications/attachments/darwin_economic_outlook_2019_final.pdf

¹⁰² Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013*. Supplied by PWC

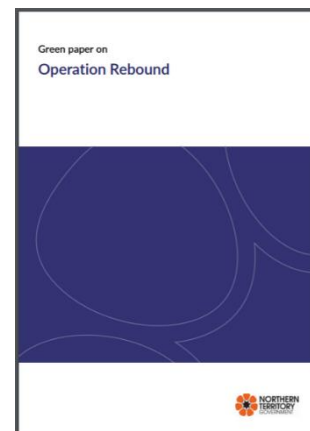
¹⁰³ Ibid.

7.3 Alignment with Northern Territory Government policies and plans

7.3.1 Northern Territory Green Paper of Operation Rebound 2020, DTBI¹⁰⁴

The Operation Rebound paper is a plan to recover and rebuild the NT economy after the impacts of the COVID-19 pandemic. The paper outlines the economic response as three phases: survive, adapt and rebound. The paper outlines 27 immediate 'Rebound Initiatives' to progress the NT economy to recovery. The initiatives focus on marketing, fast tracking approvals, strategic investment in new infrastructure and enabling infrastructure, supporting existing and emerging industries and skills development.

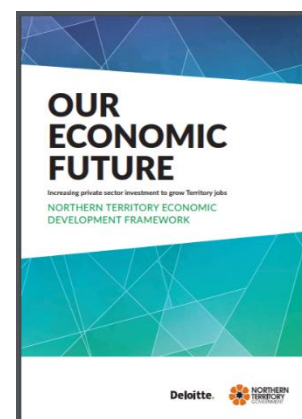
One initiative is to provide 'water security for our environment, for drinking, growing and making'. The Plan explains that the Territory's future will be secured by adequate and efficient supply of water. The Government will accelerate the development of a Strategic Water Plan for each region of the Territory. The Project aligns with this initiative through the delivery new water infrastructure that can provide a reliable water supply for urban consumers, as well as enabling investment in agriculture, horticulture and industry.



7.3.2 Our Economic Future: Northern Territory Economic Development Framework 2017, DTBI¹⁰⁵

The Economic Development Framework is intended to inform the NT's long-term decision making and deliver policy and regulatory certainty for investors. The framework identifies several competitive advantages of the NT that provide potential for economic growth, and outlines actions to grow priority and developing sectors.

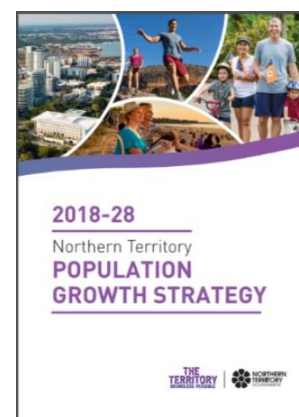
Agribusiness is identified as an industry with significant global growth and demand in which the NT has a comparative advantage. Improving access to productive land and strategically managing critical inputs, such as water, are critical to the agribusiness sector. The framework includes an action to undertake a comprehensive review of water policies to provide certainty and secure sustainable water allocations to drive economic growth. The Project will provide a reliable water supply to agricultural and horticultural regions, encouraging domestic and foreign investment in the region and providing certainty to current producers.



7.3.3 Northern Territory Population Growth Strategy 2018-29, DTF¹⁰⁶

The NT Government has a vision to sustainably grow the population to support the economy, encourage growth and provide better services for Territorians. The goal is to return the population growth rate to the historical long-run average of 1.4 per cent, from the recent low growth path of 0.6 per cent. Stimulating the population growth rate will support business and investor confidence in future economic conditions, which will subsequently support stronger population growth. All efforts in increase population growth will result in pressure on the water supply in the greater Darwin region, requiring a new water source to ensure reliability for the growing population and economy.

Several actions are proposed to achieve the growth targets, including attracting investment and creating jobs. A key driver for the Project is its ability to provide a reliable water source that will encourage growth in the agricultural, horticultural and industrial sectors. Investment in the Project will support the implementation of this action.



¹⁰⁴ Northern Territory Government (2020). *Green paper on Operation Rebound*. Accessed at https://business.nt.gov.au/__data/assets/pdf_file/0010/885358/operation-rebound-green-paper.pdf

¹⁰⁵ Northern Territory Government (2017). *Our Economic Future: Northern Territory Economic Development Framework*. Accessed at https://cmsexternal.nt.gov.au/__data/assets/pdf_file/0008/434546/economic-development-framework.pdf

¹⁰⁶ Northern Territory Government (2018). *Northern Territory Population Growth Strategy 2018-28*. Accessed at https://population.nt.gov.au/__data/assets/pdf_file/0007/559384/Population-Strategy.pdf

7.3.4 Northern Territory Infrastructure Strategy 2017, DTBI¹⁰⁷

Drawing from the Northern Territory Government's vision outlined in the Economic Development Framework, the Infrastructure Strategy sets the NT's long-term infrastructure agenda, providing a clear framework for government to plan, assess, select prioritise and invest in infrastructure. Government investment in infrastructure will create jobs, provide critical enablers for new business investment and long-term economic growth.

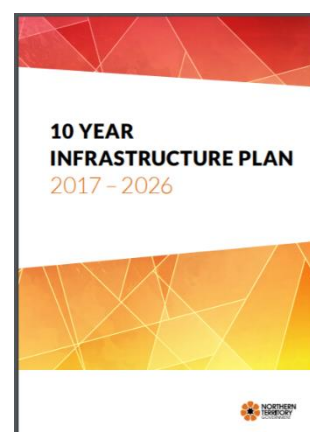
The Strategy notes that water and other essential services infrastructure is necessary to support business activity. It comments on the existence of land use studies and actions to develop sustainable water resources and recognises that these are enablers for future growth and private investment. The Strategy notes that there is an opportunity to expand the NT's productive capacity, however, infrastructure must align and enable private investment. The Project will capitalise on this opportunity, enabling growth in the productive capacity of the agricultural and industrial sectors, through the provision of a reliable water supply for the greater Darwin region.



7.3.5 Northern Territory 10 Year Infrastructure Plan 2017-2026, DIPL¹⁰⁸

The 10 Year Infrastructure Plan is informed by the Economic Development Framework and the Infrastructure Strategy, and provides an assessment of where sectors have prioritised infrastructure investment and planned infrastructure projects over a 10 year horizon. The document identifies objectives for infrastructure delivery, the impact of infrastructure spend on the economy and provides assessments of proposed infrastructure projects for growth.

The plan recognises that unless water consumption can be reduced, augmentation of the greater Darwin region's water source (e.g. the AROWS project) and treatment infrastructure will be required within the next 10 years to meet projected demand growth. It notes that investment is needed to expand and increase infrastructure to ensure safe and reliable water and that access to water can be a constraint for many agricultural and horticultural projects.



7.4 Alignment with Australian Government policies and plans

7.4.1 Infrastructure Australia's Infrastructure Priority List¹⁰⁹

The Infrastructure Priority List is a prioritised list of nationally significant investments. It provides decision makers with advice and guidance on specific infrastructure investments that will underpin Australia's continued prosperity. The Priority List is a live document and updated regularly by Infrastructure Australia.

The greater Darwin region water supply infrastructure upgrades are listed as a priority initiative in the list for the medium term (5 – 10 years). The Priority List notes that failure to expand Darwin's water supply will increasingly constrain population and economic growth and is also likely to impact on business and investor confidence¹¹⁰.

¹⁰⁷ Northern Territory Government (2017). *Infrastructure Strategy*. Accessed at https://cmsexternal.nt.gov.au/_data/assets/pdf_file/0006/430917/infrastructure-strategy.pdf

¹⁰⁸ Northern Territory Government (2017). *10 Year Infrastructure Plan 2017-2026*. Accessed at https://dipl.nt.gov.au/_data/assets/pdf_file/0004/428854/ntg-10-year-infrastructure-plan-web.pdf

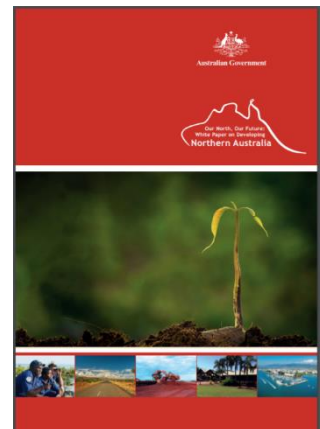
¹⁰⁹ Infrastructure Australia (2020). *Infrastructure Priority List*. Accessed at https://www.infrastructureaustralia.gov.au/sites/default/files/2020-05/current_priority_list.pdf

¹¹⁰ Infrastructure Australia (2020). *Infrastructure Priority List: Project and Initiative Summaries*. Accessed at https://www.infrastructureaustralia.gov.au/sites/default/files/2020-03/2020_infrastructure_priority_list_low_resolution_-_updated.pdf

7.4.2 *Our North, Our Future: White Paper on Developing Northern Australia*¹¹¹

The purpose of the White Paper is to provide a policy framework that can assist in overcoming the barriers that hinder economic growth and development in Northern Australia. To unlock the north's full potential, the Commonwealth Government will address challenges to development by:

- Making it easier to use natural assets, in close consultation with, and the support of, Indigenous communities
- Providing a more welcoming investment environment
- Investing in infrastructure to lower business and household costs
- Reducing barriers to employing people
- Improving governance.



Of relevance to the Project is the White Paper's support of investment in key enabling infrastructure to create greenfield supply chains across agriculture, horticulture, aquaculture and previously stranded energy and minerals resources. Investment in this essential infrastructure will serve as the catalyst for new large-scale projects in the key investment priority areas.

The White Paper explains that the greater Darwin region comprises the Northern Territory's largest and most valuable irrigation area, watered mainly using groundwater. The development of several small to moderate sized dams would enable this area to be increased tenfold, up to 30,000 ha. The region's proximity to Darwin would provide opportunities for dams with multiple uses.

The White Paper also discusses the requirement for long term investments to have long term certainty over water supply. The White Paper suggests that, given there is less existing water storage infrastructure in the north compared with the rest of Australia, new water infrastructure in Northern Australia could present greater opportunities for investment than the more developed south.

7.4.3 *The Australian Infrastructure Audit 2019, Infrastructure Australia*¹¹²

Infrastructure Australia has responsibility to strategically audit Australia's nationally significant infrastructure, and develop 15 year rolling infrastructure plans that specify national and state level priorities. The 2019 Audit covers transport, energy, water, telecommunications and social infrastructure, and determines the major challenges and opportunities facing Australia's infrastructure over the next 15 years and beyond.

The Audit recognises that the water sector across Australia faces unprecedented risks and challenges, including climate change, population growth, ageing assets, and competing interests. Failure to adequately address these challenges could lead to rising water bills, as well as exposing users to risks of declining service quality and reliability. The Audit explores key trends impacting the water sector across Australia, specifically noting the challenges faced in Northern Australia, including seasonal variability and high costs of infrastructure.



Many of the key drivers for the Project are discussed in the Audit, demonstrating the criticality of government investment in new water supply infrastructure in the short term.

¹¹¹ Licensed from the Commonwealth of Australia under a Creative Commons Attribution 3.0 Australia Licence. The Commonwealth of Australia does not necessarily endorse the content of this publication. Accessed at https://www.industry.gov.au/sites/default/files/June%202018/document/pdf/nawp-fullreport.pdf?acsf_files_redirect

¹¹² Infrastructure Australia (2019). *The Australian Infrastructure Audit 2019*. Accessed at <https://www.infrastructureaustralia.gov.au/sites/default/files/2019-08/Australian%20Infrastructure%20Audit%202019.pdf>

7.4.4 *Australian Infrastructure Plan 2016, Infrastructure Australia*¹¹³

The Australian Infrastructure Plan presents a comprehensive package of reforms focused on improving the way Australia invests in, delivers and uses the nation's infrastructure. It notes that in Northern Australia, seasonal weather contributes to a high cost of delivering infrastructure in the regions, meaning that the regions face unique challenges that need careful planning to build productive capacity.

The Plan recommends that more information be provided to support water infrastructure for irrigated agriculture and horticulture. Successful irrigated agriculture and horticulture is dependent on farmers having access to reliable and secure water resources. Regional water infrastructure that supports irrigated agriculture and horticulture faces particular challenges because of Australia's increasingly variable climate, growing water demand, and differences in the ability or willingness to pay. The Plan discusses the CSIRO's NAWRA and its value to the industry that was not previously available.

While the Plan recommends investment in new water infrastructure, it suggests that the water supply may be readily expanded without constructing new dams. Depending on the local environment, recharging suitable aquifers, making better use of surplus water produced by industry or smarter use of stormwater flows can supplement supply or change patterns of demand. Alternative options have been investigated throughout development of this Preliminary Assessment which have included disaggregated water supply options and managed aquifer recharge.

7.4.5 *Northern Australia Audit 2015, Infrastructure Australia*¹¹⁴

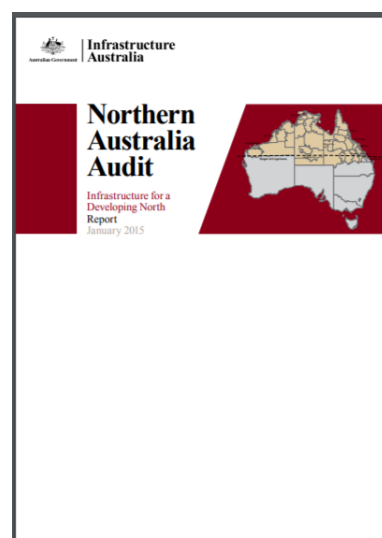
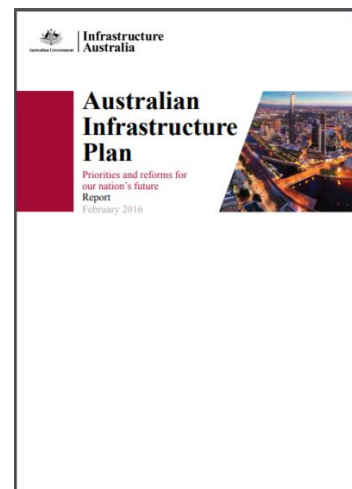
The Northern Australia Audit has assessed critical economic infrastructure gaps and requirements to meet projected Northern Australia population and economic growth through to 2031. It highlights that there are significant challenges to further development of Northern Australia, and concludes that there are infrastructure inadequacies but notes, without being prescriptive, that there are positive responses that will provide economic and social benefit. The report also emphasises that infrastructure development and maintenance requirements are best achieved by collaboration between government and the private sector.

The Audit identifies a new water source for the greater Darwin region as a critical urban water infrastructure requirement. It describes a primary infrastructure gap in urban water storage and supply, where an increase is required in the surface water storage capacity to meet demand. The Audit also identified a gap in the bulk water storage and supply of the Darwin rural area, for off-stream storage to meet demand and create future opportunities.

The Audit references the AROWS project as having potential to provide in excess of 30GL/a of additional water to support the economic and urban development within the greater Darwin region.

7.5 Summary

This chapter has presented the key government strategies, priorities and policies that the Project aligns with. It confirms the alignment of the Project with economic policies linked to employment, investment attraction and population growth.



¹¹³ Infrastructure Australia (2016). *Australian Infrastructure Plan*. Accessed at https://www.infrastructureaustralia.gov.au/sites/default/files/2019-06/Australian_Infrastructure_Plan.pdf

¹¹⁴ Infrastructure Australia (2015). *Northern Australia Audit*. Accessed at https://www.infrastructureaustralia.gov.au/sites/default/files/2019-06/ia_northern_australia_audit.pdf

8 Options identification and development

8.1 Introduction

The next stage of the Preliminary Assessment involved the identification and development of potential options. The ILM process identified a longlist of potential options that could address the problems and opportunities the Project is responding to. A high level filtering process was initially undertaken to identify those options that could potentially meet the confirmed service needs. These filtered options were subsequently analysed further through and shortlisting through an MCA process. This chapter provides:

- An overview of the approach to the options assessment process in the Preliminary Assessment
- A summary of the strategic responses and options identified in the ILM and the options filtering process
- Details the scope of the options assessed in the MCA.

8.2 Options assessment process

A key part of the Preliminary Assessment is a multi-stage options assessment process designed to iterate progressively more quantitative assessment as the number of options and their scope becomes more defined. The options assessment utilises both an MCA and Rapid CBA to determine the preferred option for more detailed consideration. This chapter presents the methodology for the options assessment process, the longlist development and filtering outcomes and the scope of the options progressed to the MCA.

The outcomes of the MCA are presented in *Chapter 9 – Options assessment* and in *Chapter 10 – Rapid cost benefit analysis*. Table 23 outlines the stages of the options assessment process and the objective and approach undertaken at each.

Table 23: Preliminary Assessment options assessment process

Options assessment stage	Process and expected outcomes
ILM options longlist identification	• Identify the full range of options which could respond to the problems and opportunities developed in the ILM
High level options longlist filtering	• Review the options longlist to develop a shortlist for assessment in an MCA • Those options which do not meet the service need considered on their potential to form part of a package of lower cost initiatives • Options which are not feasible or cannot meet the service need removed
Multi Criteria Assessment	• Undertake an MCA of the shortlisted options from the ILM to determine a set of options for progression to a Rapid CBA • Assess each option against a set of criteria developed to link to the service need of the Project
Rapid CBA	• Assess the options progressed from the MCA in a CBA framework to determine benefit cost ratios and net present values of the options to determine a preferred option • Considers whether the additional economic benefits realised from the larger options outweighs the cost of realising the increased supply

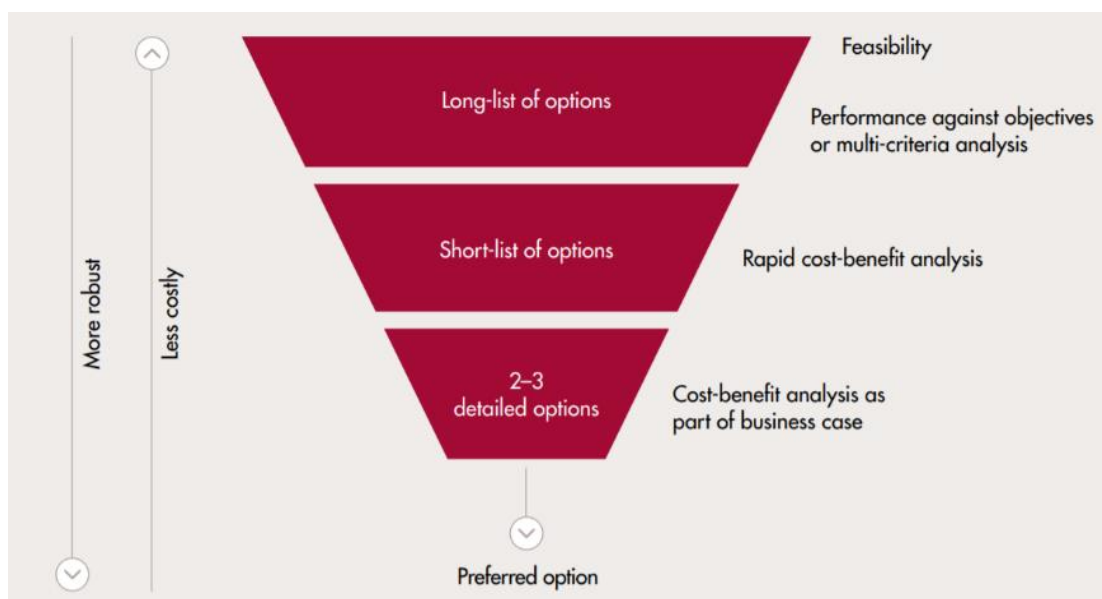


Figure 49: Infrastructure Australia options assessment evaluation techniques for options assessment¹¹⁵

This options assessment process was designed to align with guidance on best practice options assessment from the IA Assessment Framework, shown in Figure 49, as well as guidance issued by other Australian jurisdictions. In accordance with best practice it involved a broad and expansive assessment of the full suite of potential interventions available (the longlist). Following the identification of the longlist of potential options a filtering process was applied based on a number of agreed 'threshold' criteria.

8.3 Options longlist identification and filtering

The ILM process involved the identification of strategic responses that could be implemented or actioned by the Northern Territory Government to respond to the identified problems and opportunities. Identifying a comprehensive and expansive range of potential options enables a robust 'first-principles' assessment of the options ability to address the service needs. It also enables the consideration and assessment of 'bundling' opportunities where as a single initiative an option may not address the service need, but in combination with other options could deliver the required outcomes as a package.

This section outlines the strategic responses and solution options identified and confirmed through the ILM and the outcomes of the longlist filtering process.

8.3.1 ILM strategic responses and solution options

Strategic responses

Table 24 outlines the strategic responses identified and confirmed by stakeholders in the ILM workshop.

Table 24: Potential strategic responses

Strategic response	Description
Provide incentives for industry, agriculture and horticulture to trade existing allocations	Water allocations provide a right to the holder to consume certain volumes of water. There may be the opportunity to promote a market whereby holders of water allocations that do not consume their full allocation are able to sell or trade this to users who are seeking additional water.

¹¹⁵ Infrastructure Australia (2018), *Assessment Framework March 2018*, pg. 82. Accessed at https://www.infrastructureaustralia.gov.au/sites/default/files/2019-06/infrastructure_australia_assessment_framework_2018.pdf

Strategic response	Description
Provision of price signals for urban water consumption	Water in the greater Darwin region is currently one of the lowest priced in Australia, as discussed in <i>Chapter 5 - Problem identification and service need</i> . This low price is therefore not perceived as an impediment to the consumption of water and it may not truly reflect either the cost of capital to deliver the water to the user or the value of the water as a resource. Alternate water tariff structures that more truly reflect the value of water may prompt behavioural change in the consumption of water and reduce the per household consumption. This could result in a reduced need to augment water supply for urban and domestic consumption.
Provision of new off-stream water supply	Development of a new off-stream water supply would provide an increase in the available supply. Depending on the demand and sizing of the supply option it could improve both urban water security as well as make additional water available for agricultural / horticultural and industrial growth.
Government-led incentive program to promote agricultural and horticultural output in the region	The Government could use other incentives and subsidies to promote and increase agricultural and horticultural output in the region. This may help increase economic development and output without requiring augmentation to the water supply network. However the availability of water would ultimately place a constraint on the overall level of increased output able to be achieved.
Provision of new in-stream water supply	Development of a new in-stream water supply would provide an increase in the available supply. Depending on the demand and sizing of the supply option it could improve both urban water security as well as make additional water available for agricultural / horticultural and industrial growth.
Promote the production of less water intensive agriculture and horticulture crops	High value horticultural and agricultural crops generally require high volumes of water per hectare. The government could promote the development of lower water intensive crops as an alternative to still promote growth in the agricultural and horticultural sector while minimising the water required to realise this growth.
Increased collaboration between government agencies and industry to optimise existing water supply (incl. efficient utilisation of water entitlements such as recycling)	The supply and consumption of water occurs across multiple agencies and users in the greater Darwin region. Through a collaborative and comprehensive assessment of the supply and industrial consumption of water by existing and future users there could be the potential to more efficiently use the water that is currently available. This could include an increased focus on the potential re-use of water through recycling for targeted industrial locations or users before additional new water is provided or considered.
Introduce improved ground water demand and consumption monitoring and regulation	The groundwater in the greater Darwin region includes a combination of both licensed and un-licensed users depending on their user group and consumption purpose. Limited metering of bores occurs in the region. By changing regulation and increasing the requirements for bore licencing and metering a more detailed understanding of groundwater consumption may occur which could lead to more efficient management and water use.
Enhance current water infrastructure	The current infrastructure used to supply water to the Darwin rural region could be improved and enhanced, potentially at a lower cost to new infrastructure options, to augment the water supply. This could include improvements to pipelines or upgrades to the Darwin River Dam.
Increase water demand management activities for urban, industry and agricultural and horticultural sectors	Water demand management could decrease the amount of water consumed by urban, industry and agricultural and horticultural sectors without significant changes to their activities or operations. This could result in a reduced need to augment the water supply to improve water security for existing users.
Directly provide funding and other incentives to promote economic development	Economic development could be promoted, and growth could occur without augmentation to the water supply network. Funding initiatives and other incentives could be pursued to improve economic growth and also focus on industries that may require less water. The overall growth would still be constrained by the available water supply, particularly for the extractive industry and agriculture / horticulture sectors.

Strategic response	Description
Package land and water entitlements to provide a marketable product	The availability of water is not the only impediment to realising growth in agriculture / horticulture. The availability of land in proximate locations to services, and water supply, is also a limiting factor. The strategic packaging of water entitlements and land could result in an increased interest and demand from the market.
Require potential developments to provide sustainable options to meet their water requirements	New industrial developments could be required to identify how they would maximise the efficiency of their water consumption, including investigations of disaggregated water supply options for their operations such as recycled water or desalination. This could mean that any additional bulk water supply could be targeted to those users that do not have the capacity, or ability, to provide their own water supply.

ILM solution options longlist

Following the identification of the strategic responses, the ILM considered specific options or initiatives that could potentially be implemented to respond to the confirmed problems and opportunities (the service needs) (*See Chapter 5- Problem identification and service need*). The solution options developed in the ILM considered both infrastructure and non-infrastructure options, and were classified into the following categories:

- Reform – Improve service performance through amending existing governance or regulation
- Better use – Improve service performance through influencing demand e.g. demand management
- Improve existing – Improve service performance through augmentation to existing infrastructure and assets
- New – Improve service performance through construction of new infrastructure.

Table 25 outlines the options longlist developed and confirmed through the ILM process.

Table 25: ILM options longlist

Solution category	Description	Options
Do nothing	No change to current operations	Do nothing
Reform	Typically, non-asset initiatives	• Introduction of priority-based water allocations • Improve ground water licensing • Enhance ground water metering • Water conservation policy • Improve the management of the current groundwater allocations.
Better use	Typically improving service performance	• Provide incentives for decentralised water supply (e.g. water tanks) • Demand management strategies such as urban water pricing changes, smart water metering, tariff structures • Promote the attraction of non-water intensive industries to the greater Darwin region
Improve existing	Typically improving service performance via minor capital expenditure	• MAR • Expand the existing ground water • Raise the Darwin River Dam's full supply level • Manton Dam return to service (Manton RTS) • Limit evaporation from current water sources
New	Typically, new assets	• Develop the AROWS project • Develop desalination infrastructure • Develop recycled water plant • Develop Mt Bennet Dam • Develop Upper Adelaide River Dam • Development of a non-potable water network

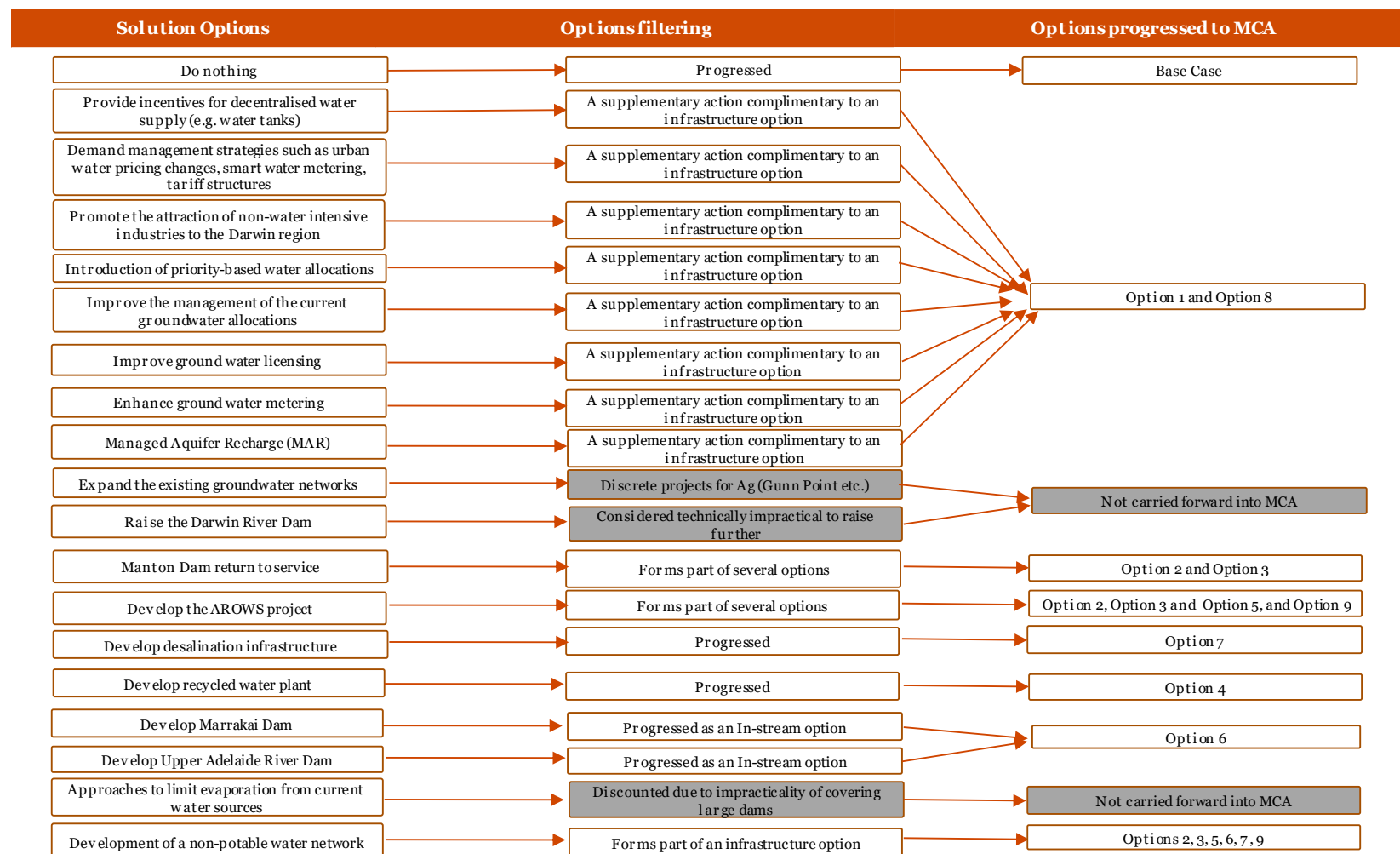
Subsequent to the ILM, the longlist of options was also tested through market sounding and engagement with government departments to ensure it was comprehensive and no key initiatives were omitted.

8.3.2 Options filtering

Identifying a comprehensive and expansive range of potential options enables a robust 'first-principles' assessment of the options ability to address the service needs. It also enables the consideration and assessment of 'bundling' opportunities where as a single initiative an option may not address the service need, but in combination with other options could deliver the required outcomes as a package. Following the ILM, the Project Team undertook an options filtering process to determine the options for progression to the MCA. The filtering considered:

- Those options that could fulfil the service need as a standalone initiative
- Those options that could not fulfil the service need as standalone initiatives but could be bundled together to form a packaged option
- Those options that could not address the service need or were known to be infeasible.

Through this assessment, the 19 options from the ILM were reduced to nine for the MCA. The outcomes of this filtering is shown in Figure 50.

Figure 50: Options filtering outcomes¹¹⁶¹¹⁶ The option progressed to the MCA are defined in detail in section 18.4.

8.3.3 Options not progressed

Three options were not progressed from the ILM into the options assessment:

- Expanding the existing groundwater
- Raising the Darwin River Dam's full supply level
- Limiting evaporation from current water sources.

The rationale for why these options were not progressed is outlined below.

Expanding the existing groundwater networks

As discussed in *Chapter 3 – Base Case Supply and Demand* existing groundwater in the greater Darwin region are contained primarily within the Koolpinyah Dolostone aquifer, which is an important water source for agricultural and horticultural development and rural water supply. Over the past 30 years' groundwater development within the Darwin Rural Area has increased significantly from around 200 bores in the 1980s to over 8,000 bores in 2019. The major extraction zones, that supply ground water to the majority of the Darwin rural region, are currently over allocated and over used, by up to 380 per cent in some areas. DENR has identified other potential groundwater aquifer systems that might have potential for town water supply:

- Koolpinyah Dolostone East of the Adelaide River
- Marley Dolostone between Darwin River Dam and Manton Dam.

Limited investigations have been undertaken to date on these potential groundwater resources. The CSIRO have undertaken high level investigations on potential new groundwater resources which could be developed in the greater Darwin region. These are shown in Figure 51.

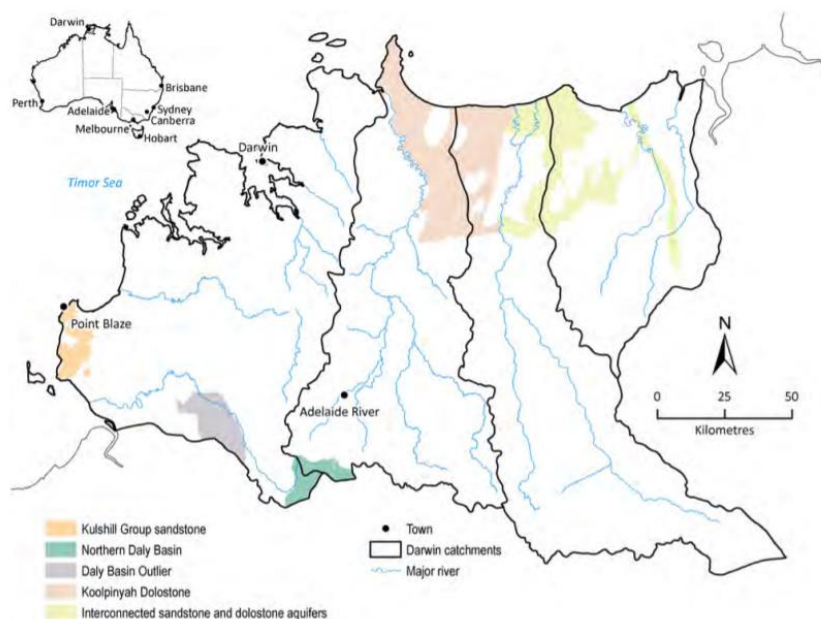


Figure 51: Hydrogeological units with potential for future groundwater resource development¹¹⁷

Initial investigations of these identified sites revealed that approximately 25,000 ML p.a. of water could potentially be made available from these groundwater resources collectively. However, no single site would be able to provide more than 10,000

¹¹⁷ CSIRO (2018). *Water resource assessment for the Darwin Catchment*.

ML p.a., with the largest (in the Wildman area) only yielding between 5,000 and 10,000 ML p.a.¹¹⁸. Based on these preliminary findings, development of new groundwater resources was not considered suitable for progression to the MCA as they do not meet the service needs of the Project, given:

- The geographical spread of the groundwater sites
- Their lack of connectivity to existing agricultural / horticultural areas and inability to reduce the consumption on currently overallocated areas
- The potential yields not enabling sufficient water for the development of a commercially viable agricultural / horticultural area in the remote areas they are located.

Raising the Darwin River Dam's full supply level

Raising the Darwin River Dam has not been subject to extensive technical investigation. However, based on initial reviews of the technical requirements and impacts associated with raising the Dam wall it was not considered to be feasible from a technical perspective as the limits of available water to the Dam catchment restricts any further supply benefits that could be achieved through further raising.

Based on this rationale it was not progressed to the MCA as it not deemed a technically feasible option.

Limiting evaporation from current water sources.

As discussed in Chapter 3 – Base Case Supply and Demand, the Darwin River Dam loses approximately two-thirds of its water storage each year due to evaporation. A review of potential technologies available to reduce evaporation from water sources was undertaken by SMEC. This review identified that commercially available solutions to reduce evaporation are targeted at small scale implementation. Given the large size and surface area of the Darwin River Dam implementing any evaporation-related technology was considered to be technically uncertain and unaffordable.

Based on this it was not progressed to the MCA as it not an option which could feasibly be delivered.

8.3.4 Over extraction of the groundwater

DENR estimates that extraction would have to reduce by 24,000 ML p.a. to achieve sustainable groundwater extraction in the HGS. As noted in the Northern Territory Government's *Northern Territory Water Regulatory Reform Directions Paper 2018* there are a range of regulatory and legislative constraints to the ability to monitor and regulate groundwater extraction, particularly in the Darwin rural region. Significant reform, including amendments to the *Water Act 1992* would be required to more effectively manage the groundwater resource and achieve the required levels of extraction reduction to return it to a sustainable yield¹¹⁹. Potential reform options to reduce extraction could include:

- Requiring water licenses for all bores, including stock and rural domestic users
- Requiring all bores to be metered and implement a charging framework
- Implementing extraction limits with the potential to purchase higher allocations
- Removing the rights under *The Water Act 1992* to extract water from a groundwater resource connected to a property for stock and domestic use
- Amending the current 'first-in-first-served' approach to water allocation.

Each of these approaches represents a significant shift from the current approach to water management in the greater Darwin region and require significant stakeholder engagement, regulatory and legislation amendments and a long term strategy to manage its implementation. A transformational shift of this scale would be required if a 24,000 ML p.a. reduction is to be achieved.

While some small-scale reductions may be achieved through demand management, reducing extraction to sustainable levels will require a large number of users to stop consuming groundwater. Therefore, if reductions in extraction are to be

¹¹⁸ CSIRO, 2018. *Water resource assessment for the Darwin Catchment*.

¹¹⁹ NT Government, 2018. *Northern Territory Water Regulatory Reform Directions Paper*.

achieved an alternate reticulated water supply network would need to be developed in the Darwin rural region to replace the reduced extraction and ensure continuity in supply. Previous investigations undertaken by the NT Government have indicated that the cost of the distribution and reticulation infrastructure to service rural suburbs is significant and likely cost prohibitive.

The cost of extending the reticulated network to connect customers would have significant potential implications for the cost of the water provided. Given the current low cost of water extraction a large-scale shift to a reticulated network, with higher water costs, is likely to receive opposition from existing users in the rural region. Any strategy that seeks to reduce groundwater extraction would need to carefully consider the equity impacts of any regulatory and legislative change and how these are required to be mitigate or compensated.

The current groundwater is over allocated and overused. In the absence of an alternative supply source this restricts the ability for further water allocation therefore preventing agricultural and horticultural development, reducing economic growth. Seeking a solution to reducing extraction and preserving the long term sustainability of these resources should be a focus of the Northern Territory government. However, given the scope of this Project, and its objectives and service needs outlined in *Chapter 5 - Problem identification and service need*, it was considered that achieving reductions in the extraction of current groundwater resources was not able to be achieved through this Project and is not appropriate for detailed consideration as an option. The intent of this Project is to ensure long term urban water security and provide water for economic development purposes, including industrial and agricultural/horticultural expansion.

A comprehensive review and response to water management and supply is recommended for the greater Darwin region, including developing a comprehensive strategy for the long term sustainable use of groundwater resources. This Strategy would need to consider in detail the respective regulatory and legislative policy options available and the appropriate responses to achieve extraction reductions. This however should be considered separate to this Report and Project. Given this, the required demand to achieve replacement reductions in extraction, and the ability of options to respond to this issue, are not considered in the options assessment.

8.4 Options scoping and development

Following the options filtering process, the revised list of sixteen options was assessed further to determine which options should be 'bundled or packaged to most positively respond to the confirmed service needs. The rationale for bundling options or progressing them as 'standalone' initiatives included:

- Can the option provide sufficient water supply to provide for either near-term urban water security, industrial or agricultural/horticultural demand?
- Can the option be delivered with the required timeframes to meet these demands, or can it be packaged with another option to reduce near-term water security risks?
- If an option does not provide sufficient water supply as a standalone initiative, can it be bundled with other low-cost options which as a combined package meets the demand requirements?

Following this process, more detailed definition, scope and assumptions were developed for each option.

8.4.1 Base case

The base case reflects the 'Do Nothing' options with no action taken to address water supply demands in the region. This includes both neither non-infrastructure initiatives to reduce demand or infrastructure options to augment the water supply. This definition of the base case accords with IA's definition.

The outcome of the 'Do Nothing' base case scenario is a significant increase in the likelihood of annual occurrence of water restrictions for the Darwin population. The implementation of these water restrictions would impact the community who are historically high users of water when compared with other Australia cities. It would also likely result in reductions to economic activity and production as industry and business would also be impacted by the lack of available water.

Figure 52 displays the forecast water security assessment undertaken by PWC as part of the *Darwin Region Water Strategy 2013*, updated to reflect 2020 context. The strategy assumes that Manton would be implemented in 2026 and AROWS Stage 1a in 2032 to ensure urban water security. Neither of these projects are funded or committed and therefore under the base case scenario the steep growth in the occurrence of water restrictions would continue to climb, as shown in Figure 52.



Figure 52: Projected water restrictions with no additional infrastructure¹²⁰

8.4.2 Option 1 – Do minimum

The 'do minimum' includes a range of non-infrastructure and low-cost initiatives which could be implemented to reduce water consumption across both the reticulated supply and groundwater.

A summary of the key factors associated with this option are outlined in Table 26.

Table 26: Option 1 key facts¹²¹

Factor	Description / Assumptions
Change in water availability (yield)	6,000 – 8,000 ML p.a.
Staging potential	Progressive rollout of a long-term strategy
Cost	\$10 – \$20 million
Implementation timeframe	5 - 10 years to realise full water consumption reductions

The successful delivery and implementation of this option requires both regulatory changes as well as demand management and behavioural change initiatives. Given this, it would require a medium and long-term strategy for implementation and to fully realise benefits.

¹²⁰ Power and Water Corporation, modified by SMEC

¹²¹ SMEC and Power and Water Corporation

The potential initiatives under this option include:

- Disaggregated water supply incentives e.g. water tanks
- Demand management strategies:
 - Urban water pricing charges
 - Smart water metering
 - Modification of tariff structures to drive reformed behaviours.
- Marketing to attract non-water intensive industries to Darwin
- Introduction of priority-based water allocations
- Improved management of current groundwater applications
- Enhanced groundwater metering
- Managed aquifer recharge.

The implementation of a number of these initiatives would require regulation and legislative change such as new tariffs, penalising high water use through charging regimes and implementation of water restrictions. Demand management strategies target behavioural change and often involve complementary educational campaigns and communication strategies. Water restrictions, such as those experienced in other parts of Australia during the Millennium Drought, can be fully implemented if necessary.

Fundamentally, this option's aim is to impact the demand patterns of industry, and domestic water users and to reduce their consumption in line with trends seen in other jurisdictions.

Appendix C - Current Water Demand and Supply Assessment Report contains a detailed analysis of the potential for reductions in consumption through demand management and non-infrastructure initiatives. Through a comparative assessment of water use patterns across Australian jurisdictions, modelling undertaken by both PWC and SMEC indicates that through an effective and successful program a reduction in per capita water use from 850 litres per day to 640 litres per capita may be achievable and realistic for the greater Darwin region and could be achieved over a 5-10 year period. This would result in a reduction of water consumption by 6,000 – 8,000 ML p.a.

Option advantages

This option has a low implementation cost relative to infrastructure options. It does not require significant capital investment by the Government to improve the water supply and demand balance in the region. The option could be bundled with an infrastructure option to provide an integrated response positively influencing both water demand and water supply to ensure the greatest impact from any capital investment.

Option disadvantages

This option requires regulatory and legislative change to be effective and will also require a significant behavioural change from the community and industry. To be effective, significant and rapid changes to the current regulatory framework for water would be required, which may result in a negative reaction by parts of industry and domestic consumers. Overall the option will only result in a relatively small increase in water availability over the long-term and does not provide sufficient water to ensure long-term urban water security or enable either industrial or agricultural / horticultural development.

8.4.3 Option 2 – Recycled water

Water recycling provides a sustainable water supply option that can be implemented at individual locations to supplement current water supply.

A summary of the key factors associated with this option is outlined in Table 27.

Table 27: Option 2 key facts

Factor	Description / Assumptions
Change in water availability (yield)	Approximately 5,000 ML p.a.
Staging potential	Wastewater plant would have to be linked to offtake agreements to align a revenue stream to construction
Cost	Approximately \$30 million for a 5,000 ML p.a. facility
Implementation timeframe	2 year delivery

There is the potential for the expansion of waste water recycling in the greater Darwin region, noted in the *Darwin Region Water Supply Strategy*. A 200ML p.a. scheme is already in operation at the Northlakes Recycled Water Treatment Plant, servicing Darwin Golf Club and Marrara sports complex. The primary opportunity for expansion is at the Palmerston Waste Water Treatment Plant (WWTP). There may also be opportunity for a recycled water plant to be attached to any proposed industrial developments at Middle Arm.

As noted by PWC in the *Darwin Region Water Supply Strategy*, and based on observed experiences across Australia, the cost of producing water from a wastewater recycling program is significant relative to traditional methods, resulting in a high cost of water. The cost of producing potable water from a bulk supply source is significantly cheaper than recycled water with facilities across Australia producing recycled water between double and quadruple the cost of traditional potable water.

There is however a significant and prospective opportunity to produce approximately 5,000 ML p.a. from the Palmerston WWTP. A 5 GL p.a. non-potable treatment plant is proposed at Palmerston to treat the water at the source to raw water quality. A raw water pipeline system is proposed for approximately 30 km from Palmerston to Strauss WTP for treatment to potable level, for use across the Darwin Urban Area.

Option advantages

The re-use of wastewater is a sustainable approach to water management and can provide specific solutions for disaggregated water supply at discrete locations. The location of the Palmerston WWTP means that the option could supply raw water to the Strauss WTP. Recycled water facilities can be developed in a relatively short time frame providing a more immediate supply option to satisfy short-term supply constraints while more comprehensive supply options are developed.

Option disadvantages

Given its location, the Palmerston WWTP has the potential to provide raw water to industrial users at Middle Arm but would be limited in its ability to provide raw water to other potential users. Other potential localities would therefore need to be considered and assessed to align with potential user requirements and willingness to pay. Recycled water is lower quality than potable water and therefore there may be concerns for some industrial users that require high quality water for use in their operations. Recycled water is typically also substantially more expensive than potable water.

While not providing a comprehensive solution, it could form part of an integrated project solution.

8.4.4 Option 3 – Do minimum and disaggregated water supply

This option combines the low cost 'Do Minimum' Option 1 with a combination of disaggregated water supply options including the recycled water infrastructure from Option 2 and a small-scale desalination plant to provide water for industrial use.

A summary of the key factors associated with this option is outlined in Table 28.

Table 28: Option 3 key facts

Factor	Description / Assumptions
Change in water availability (yield)	Approximately 21,000 – 25,000 ML p.a. - Option 1 – 6,000 – 8,000 ML p.a. - Option 2 – 5,000 ML p.a. - Desalination plant – 10,000 – 12,000 ML p.a.
Staging potential	Wastewater plant would have to be linked to offtake agreements to align a revenue stream to construction. Desalination plants can be constructed at various sizes to match the required demands.
Cost ¹²²	\$310 – \$550 million - Option 1 – \$10 - \$20 Million - Option 2 – \$30 million - Desalination plant – \$270 – \$500 million
Implementation timeframe	2 year delivery for recycled water & desalination. Approximately 10 years to realise the full water consumption reductions

The intention of this option is to assess the potential impact of a bundled package of lower-level interventions, involving a combination of targeted infrastructure treatments with regulatory change and demand management to decrease overall water consumption and produce additional water for specific discrete uses, such as industrial use at Middle Arm.

Desalination plants exist in most capital cities in Australia and provide a climate resilient and sustainable disaggregated water supply option which can be designed and delivered for a variety of purposes and scales. PWC has undertaken investigations into the potential development of desalination plants in the greater Darwin region, including technical designs undertaken by GHD in 2019 for Territory Generation. This previous work has been used to form the basis of this option regarding operations and potential cost. More detail on desalination options is included in Section 8.4.7.

This option could be included as part of a 10 – 20 year strategy to decrease overall water consumption and demand water users and could provide targeted additional water for industrial use.

Option advantages

This option represents a long-term, sustainable program to improve water use within the region, and supply targeted water for industrial use. It represents a lower cost initiative relative to larger-scale infrastructure options. Recycled water and desalination facilities can be developed in a relatively short time frame, providing a more immediate supply option to satisfy short-term supply constraints while more comprehensive long-term supply options are developed. Disaggregated water supply options can also be staged to meet demand growth. Development of a 10,000 – 12,000 ML p.a. desalination plant at Middle Arm could support some industrial growth in this precinct.

Option disadvantages

Achieving the reductions in water consumption associated with Option 1 would require a significant period of time for the regulatory and behavioural changes to come into full effect. Water supplied from either recycling of desalination has a high cost which may limit the user groups that are willing to pay to use the water. While this option could support for some industrial development, it does not provide sufficient supply to meet the identified long-term requirements for industrial and agricultural/horticultural growth more broadly.

¹²² The capital cost of the desalination plant is highly dependent on the hours of operation per day; Costs are based on GHD (2013). *Confidential PowerWater Corporation report*.

8.4.5 Option 4 – Manton RTS and AROWS 1a

This option aligns with the approach outlined in PWC's 2013 *Darwin Region Water Supply Strategy*. The intention of this option is to respond to both immediate domestic water security risks and provide water for long-term urban water security.

A summary of the key factors associated with this option is outlined in Table 29.

Table 29: Option 4 key facts

Factor	Description / Assumptions
Change in water availability (yield)	17,500 ML p.a. - Manton RTS – 7,300 ML p.a. - AROWS 1a – 10,200 ML p.a.
Staging potential	Manton RTS could be implemented in a shorter timeframe to provide a short-term augmentation to supply. AROWS could be delivered across multiple stages to meet supply needs.
Cost ¹²³	\$630 million - Manton RTS - \$110 million - AROWS 1a - \$520 million
Implementation timeframe	3 years delivery for Manton RTS, expected by 2024/25 Approximately 5 year delivery for AROWS 1a, expected by 2026/27

Manton Dam RTS

Manton Dam, located 50km southeast of Darwin, was constructed in the early 1940s and has an overall storage capacity of 14,000 ML, with the potential to yield approximately 7,300 ML p.a., Manton Dam was Darwin's primary water source until the commissioning of Darwin River Dam in 1972. Since this time Manton Dam has been placed into core and maintenance, and used for recreational purposes. Due to current infrastructure constraints and water quality, Manton Dam is not currently able to be used as a source of water. PWC's 2013 *Darwin Region Water Supply Strategy* identified the return to service of Manton as a short-term option to supply additional water to the greater Darwin region and PWC has been undertaking the required planning and investigation works to progress this project. Manton RTS would involve:

- Development of a new intake arrangement
- A new suction main pipework
- New pumping station
- Development of Strauss Water Storage and Treatment Facility.

Adelaide River Off-stream Water Storage

AROWS is a proposed new reservoir located to the West of the Adelaide River. The area would store water harvested from the Adelaide River during the flows in the wet season. This water would then be transferred to the Strauss Water Treatment Plant for treatment and distribution. Water harvested from the Adelaide River would be pumped into AROWS. A gravity fed approach not considered feasible as initial investigations have considered that the topographical area surrounding AROWS mean that development of an appropriate gravity pipeline and channel to achieve required fall to AROWS is not practical from a cost or feasibility perspective.

The AROWS project has been investigated by the Northern Territory Government and PWC since at least 2006 as a potential future option to augment Darwin's water supply. AROWS is identified in the *Darwin Region Water Supply Strategy*

¹²³ Note – this does not include the cost of additional water treatment and pipes, this is consistent for all new infrastructure options.

for delivery following Manton RTS. The AROWS project, as depicted in the *Darwin Region Water Supply Strategy*, is shown in Figure 53.

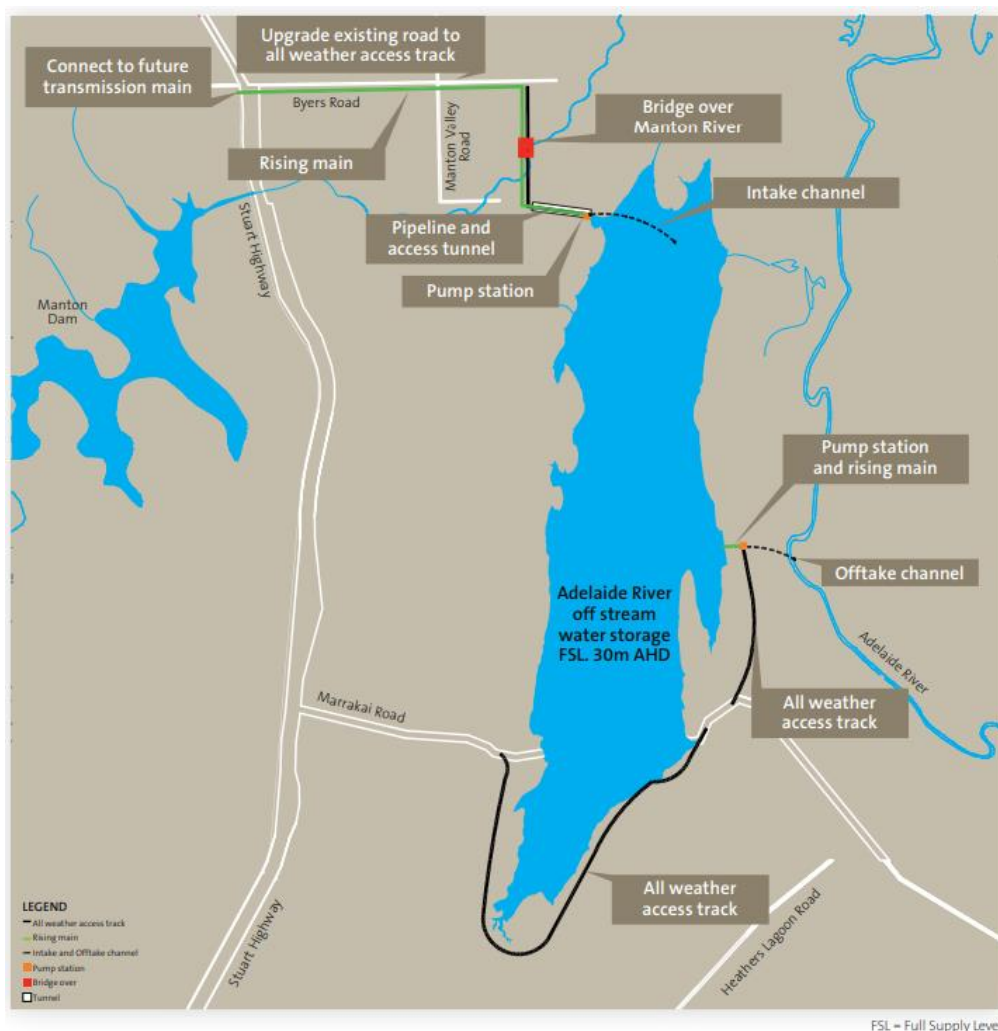


Figure 53: Adelaide River Off-stream Water Storage Scheme

The AROWS project has the potential to be staged, with upgrades to increase yield and capacity undertaken to meet incremental demand. Table 30 shows the shortlisted options from previous PWC options assessment of the AROWS project. These stages represent the optimum staging sequence from a design and technical perspective.

Table 30: AROWS development phase options

Development Phase	Construction Stage	FSL (mAHD)	Annual Yield Capacity (ML p.a.)
1	1A	RL 16.0	10,200
2	1B	RL 16.0	20,300
3	1C	RL 23.5	30,700
4	3	RL 32.0	60,200

As discussed previously, the intent of this option is to provide a sufficient increase in water supply to ensure long -term water security for the greater Darwin region population. Given this, it considers the combination of AROWS 1a and Manton RTS, which represents PWC's current planning to secure Darwin's water supply.

AROWS 1a would require:

- RL16m dam height and pumping capacity to supply 28 ML/day or 10.2GL p.a.
- Strauss Water Storage and Treatment Facility
- Harvesting pipes and pumps for water from the Adelaide River
- Pumps and piping to transfer the water to the Strauss Water Storage and Treatment Facility and then to integrate into the Darwin water grid.

Given the preliminary nature of the designs at the options assessment phase, the cost of the required pumping and pipe infrastructure has not been included as this is dependent on the final determined location that the water is required to be delivered to.

Option advantages – current endorsed PWC strategy

As an off-stream development, AROWS has a lower environmental impact when compared to an in-stream option, and therefore likely has a shorter development timeframe. The AROWS project is also strategically located near the greater Darwin region and other major existing water supply sources. This option enables sufficient yield to provide long-term urban water security for the greater Darwin region. The inclusion of Manton RTS, and its shorter delivery timeframe, means that short-term water security can also be provided for. This option still provides the ability for AROWS to be further expanded if additional increased demand necessitates further water supply augmentation.

Option disadvantages

The AROWS project requires the double handing of water, pumping in and out of AROWS, which has a high energy requirement with associated financial and environmental implications. While not as significant as an in-stream option, the AROWS project will still have environmental impacts. AROWS 1a does not provide yield for either industrial or agricultural / horticultural development.

8.4.6 Option 5 – Manton RTS and AROWS 1c

Similar to Option 4, this option includes the delivery of both Manton RTS and the AROWS project. Under this option however, the AROWS stage 1c is delivered initially, rather than as a staged solution. This would provide for an additional 20,500 ML p.a. as compared to Option 4, and would supply sufficient water for both urban and industrial use.

A summary of the key factors associated with this option is outlined in Table 31.

Table 31: Option 5 key facts

Factor	Description / Assumptions
Change in water availability (yield)	38,000 ML p.a. • Manton RTS – 7,300 ML p.a. • AROWS 1c – 30,700 ML p.a.
Staging potential	Manton RTS could be implemented in a shorter timeframe to provide a short-term augmentation to supply. AROWS 1c would be delivered in a single stage with the ability to increase capacity if required.
Cost ¹²⁴	\$675 million • Manton RTS - \$110 million • AROWS 1c - \$580 million
Implementation timeframe	3 year delivery for Manton RTS, expected by 2024/25

¹²⁴ Note – this does not include the cost of additional water treatment and pipes, this is consistent for all new infrastructure options.

Factor	Description / Assumptions
	Approximately 5 year delivery for AROWS 1c, expected by 2026/27

Manton RTS

The scope of the Manton RTS component of this option is as outlined in Section 8.4.5 and is planned for delivery by 2024/25.

AROWS 1c

As described in Section 8.4.5 the AROWS project can be built in stages, with the capacity to expand and provide increasing yields. This option represents a mid-sized AROWS and would provide sufficient water for both urban and industrial users.

Developing AROWS 1c would require:

- RL23.5m dam height and pumping capacity to supply 84 ML/day or 30,700 ML p.a.
- Strauss Water Storage and Treatment Facility
- Harvesting pipes and pumps for water in the Adelaide River
- Pumps and piping to transfer the water to the Strauss Water Storage and Treatment Facility and then to integrate into the Darwin water grid
- Pumping and pipe infrastructure to deliver water to Middle Arm precinct.

Option advantages

As an off-stream development, AROWS has a lower environmental impact when compared to an in-stream option, and therefore likely has a shorter development timeframe. The AROWS project is also strategically located near to the greater Darwin region and other major existing water supply sources. This option enables sufficient yield to provide water for both urban water security as well as for industrial users. The inclusion of Manton RTS, and its shorter delivery timeframe, means that immediate water security and expected water requirements at Middle Arm, can be provided for. This option still provides the ability for AROWS to be further developed if additional increased demand necessitates further water supply augmentation.

Option disadvantages

The AROWS project requires the double handing of water, pumping in and out of AROWS, which has a high energy requirement with associated financial and environmental implications. While not as significant as an in-stream option, the AROWS project will still have environmental impacts.

8.4.7 Option 6 – Desalination plant

This option investigates the potential for a desalination plant to provide sufficient water to meet the forecast demands outlined in *Chapter 4 - Potential water demand*.

A summary of the key factors associated with this option is outlined in Table 32.

Table 32: Option 6 key facts

Factor	Description / Assumptions
Change in water availability (yield)	Assumed 60,000 ML p.a. for the options assessment
Staging potential	Desalination plants are able to be built to various sizes and scales and could be constructed as additional supply is required.

Factor	Description / Assumptions
Cost	Approximately \$1.4 billion for 60,000 ML p.a. desalination plant ¹²⁵
Implementation timeframe	Approximately 2-5 year construction period

Desalination plants exist in most capital cities in Australia as part of their water supply infrastructure and strategies. Desalination plants provide a climate-resilient and sustainable disaggregated water supply option and can be constructed for a variety of purposes and scales. PWC has undertaken investigations into the potential development of desalination plants in the greater Darwin region, including technical designs undertaken by GHD in 2019 for Territory Generation. This previous work has been used to form the basis of this option regarding operations and potential cost.

Desalination plants have historically used either two technologies to treat seawater:

- Thermal (evaporative) processes
- Reverse osmosis (RO).

The majority of desalination plants in Australia are RO desalination plants, and for the purposes of this assessment, an RO-style plant has been assumed. While all desalination technologies are energy intensive, RO has the lowest energy consumption of commercial scale desalination¹²⁶. RO also has a relatively low upfront capital cost as compared to other technologies.

For the purposes of the options assessment, and to enable comparison across options, it was assumed that a 60,000 ML p.a. plant would be developed. A plant this size is consistent with the fully developed AROWS options, and aligns with the demand assessment. At this scale the desalination plant would be able to provide sufficient water to meet future urban water security, industrial and agricultural / horticultural water requirements. Plants of a similar size have been constructed across Australian capital cities, as shown in Table 33. The approximate cost of these facilities is also shown (based on the cost at the time of completion)

Table 33: Significant seawater desalination plants in Australia¹²⁷

Plant	Location	Approx. yield (ML p.a.)	Approx. construction cost
Wonthaggi	Melbourne	160,000	\$3.5 billion (2009)
Port Stanvac	Adelaide	100,000	\$1.8 billion (2013)
Kurnell	Sydney	91,000	\$1.8 billion (2010)
Binningup	Perth	102,000	\$1.4 billion (2013)
Kwinana	Perth	52,000	\$389 million (2006)
Tugun	Gold Coast	48,000	\$1.2 billion (2009)

The water supply of desalination plants is not as exposed to environmental and climatic factors as surface and groundwater resources. However, they are expensive to operate requiring large amounts of power. The overall cost of water produced through desalination is subject to a range of factors, particularly the size, the number of hours it is able to operate a day (a 24 hour operation is cheaper per ML than lower operational levels) and the level of water treatment required. A detailed estimate for the options assessment has not been developed, however based on work undertaken by PWC, the annualised cost could range between \$2,500 and \$5,500 per ML of water produced. These costs include operating and capital cost

¹²⁵ Extrapolated from GHD (2013). *Confidential PowerWater Corporation report* by SMEC. Compared against construction costs of other large Australian desalination plants.

¹²⁶ GHD (2013). *Confidential PowerWater Corporation report*.

¹²⁷ GHD (2013). *Confidential PowerWater Corporation report*; Capital costs are indicative only, sought from publicly available information and reports.

recovery for the desalination plant, however they do not include the costs of pumping the water. Based on this, the price charged to the user would be greater than this estimate range, if charged at full cost recovery.

Option advantages

Desalination offers a climate-resilient and sustainable water supply source that has a relatively short-term delivery timeframe relative to other large infrastructure options. Additionally, as compared to other supply options, there is more flexibility in the location of a desalination plant and it could be located close to major water demands, lowering pipeline and pumping costs. A desalination plant would also have a lower environmental impact compared to other large-scale dam options, and, promotes a more sustainable and climate resilient supply and consumption of water.

Desalination can be sized and staged depending on demand requirements, and there is the opportunity to develop smaller sized plants located at specific sites of high demand that may have the capacity to pay, such as Middle Arm, as part of an integrated project. This could reduce the scale required for other options, or enable water to be used in other locations for alternative purposes e.g. agriculture / horticulture.

Option disadvantages

Desalination plants have both high operating and capital cost and require large amounts of energy to operate. This results in a very high cost of water that would likely be cost prohibitive for many users if charged at a cost recovery rate. Due to their high operating costs, many examples around Australia are not used regularly are kept in 'hot' standby to provide additional water when water security is threatened. Desalination plants also have the potential to result in large discharges of brine, which given the environment of Darwin Harbour could result in negative environmental externalities.

8.4.8 Option 7 – AROWS 3

As described in Section 8.4.5 the AROWS project can be built in stages, with the capacity to expand and provide increasing yields. Each of these stages can be either delivered through a staged approach, or as a single stage of delivery. This option represents the AROWS project sized to provide sufficient water for urban, industrial and agricultural / horticultural users.

A summary of the key factors associated with this option is outlined in Table 34.

Table 34: Option 7 key facts

Factor	Description / Assumptions
Change in water availability (yield)	60,200 ML p.a.
Staging potential	The AROWS option can be staged. AROWS 3 delivers a large scale AROWS project in a single stage delivery.
Cost	\$610 million
Implementation timeframe	Approximately 5 year construction period, operational by 2025/26.

Unlike the other AROWS options, this option does not include the Manton RTS and instead seeks to accelerate the AROWS project to avoid the need for the Manton project. Given the scale of the AROWS 3 project, and the likely approvals and development timeframe, there is a risk that it could not be delivered within the five year timeframe, to be operational by 2025/26, when additional water supply for urban water security is forecast to be required.

Developing AROWS 3 would require:

- RL32m dam height and pumping capacity to supply 165 ML/day or 60,200 ML p.a.
- Strauss Water Storage and Treatment Facility
- Harvesting pipes and pumps for water in the Adelaide River
- Pumps and piping to transfer the water to the Strauss Water Storage and Treatment Facility and then to integrate into the Darwin water grid

- Pumping and pipe infrastructure to deliver water to Middle Arm precinct
- Pumping and pipe infrastructure to deliver water to agriculture and horticulture precinct.

Option advantages

As an off-stream development, AROWS has a lower environmental impact when compared to an in-stream option, and therefore likely has a shorter development timeframe. The AROWS project is also strategically located near the greater Darwin region and other major existing water supply sources. This option enables sufficient yield to provide long-term urban water security for the greater Darwin region and provide water for both industrial and agricultural / horticultural development.

Option disadvantages

The AROWS project requires the double handing of water, pumping in and out of AROWS, which has a high energy requirement with associated financial and environmental implications. While not as significant as an in-stream option, the AROWS project will still have environmental impacts. The likely approvals and development timeframes may not align with near-term water security concerns.

8.4.9 Option 8 – In-stream Dams

A summary of the key factors associated with this option is outlined in Table 35.

Table 35: Option 8 key facts

Factor	Description / Assumptions
Change in water availability (yield) ¹²⁸	• Marrakai Dam – 861,000 ML p.a. • Mount Bennett Dam – 283,000 ML p.a. • Upper Adelaide River Dam – 153,000 ML p.a.
Staging potential	Limited potential to be staged
Cost ^{129 130}	• Marrakai Dam - \$850 million • Mount Bennett Dam - \$190 million • Upper Adelaide River Dam - \$182 million
Implementation timeframe	Over 10 years

A number of in-stream dams have been suggested and investigated to differing extents over the last 20 years and most recently reviewed in the CSIRO 2018 report *Water Resource Assessment for the Darwin Catchments*. These potential in-stream dams are shown in Figure 54, and include:

- Marrakai Dam
- Mount Bennett Dam
- Upper Adelaide River Dam.

¹²⁸ Note that the yields from the in-stream dam options are not directly comparable to the AROWS options as the in-stream dams assume a lower level of reliability, and have greater impacts to the environment

¹²⁹ CSIRO (2017). *Assessment of surface water storage options in the Fitzroy, Darwin and Mitchell catchments*.

¹³⁰ Note – this does not include the cost of additional water treatment and pipes, this is consistent for all new infrastructure options.

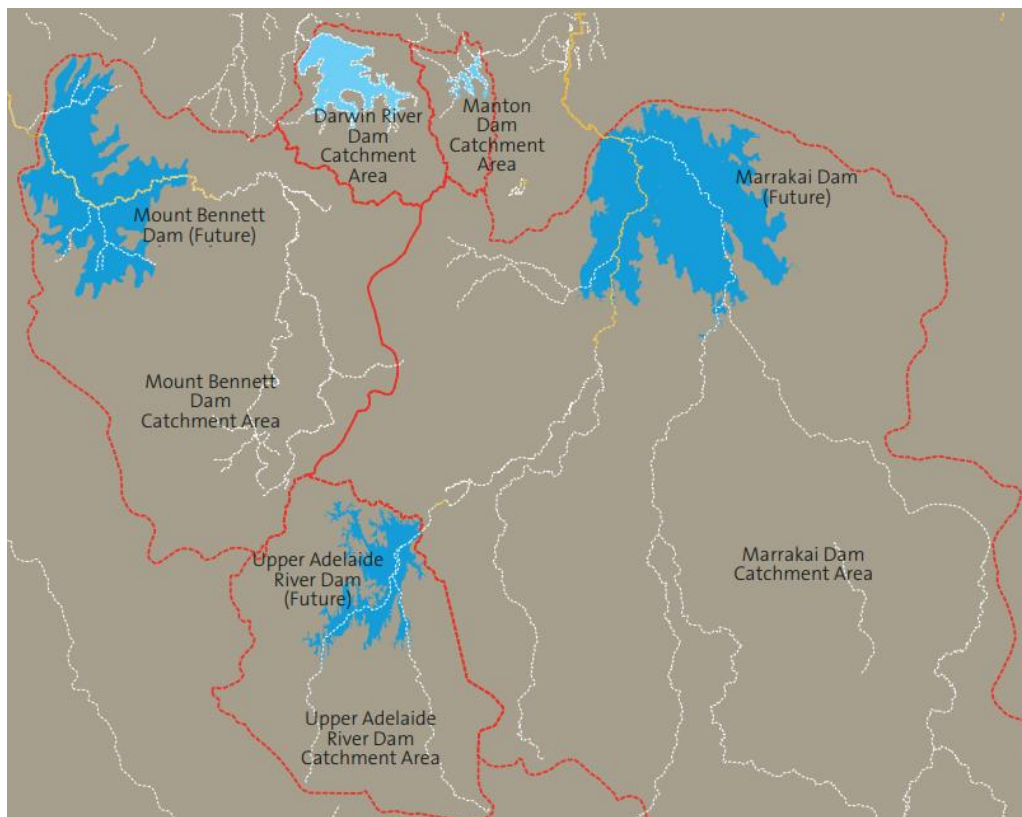


Figure 54: Future in-stream dam site options for the greater Darwin region

Outlined below are some preliminary considerations regarding each dam site. These are preliminary only, and based on existing investigations and reports. Further detailed design, environmental and technical investigations would be required if these options are progressed to the DBC.

Marrakai Dam:

The key features of the Marrakai Dam option are:

- Large in-stream dam that has a significant catchment and very high yield
- Would have significant evaporation losses as design requirements mean it would be a large dam
- Large inundation area which includes likely culturally sensitive locations
- As an in-stream dam it will have significant environmental impact that would trigger an EPBC referral and an extensive EIS
- CSIRO notes that the location of the dam wall may be subject to poor foundations which could have implications on construction costs and operational risks in meeting requirements for dam safety.

Mount Bennett Dam:

The key features of the Mount Bennett Dam option are:

- CSIRO notes that this is a low-cost water supply option, with a high yield to make irrigation water available from the Finnis River
- The catchment includes the Rum Jungle uranium mine, along with a range of other mines, which might cause water quality issues
- As an in-stream dam with significant inundation, it is likely an EPBC referral would be triggered with a significant EIS
- Requires acquisition of Aboriginal threshold land

- The inundation area includes a number of known and identified significantly important cultural features and sensitive sites.

Upper Adelaide River Dam (Warrai):

The key features of the Upper Adelaide River Dam option are:

- CSIRO notes the topography of the site is highly suitable, and yield cost is relatively low
- Both CSIRO and PWC note that there are several sacred and/or culturally significant sites within the catchment area and approximately half the catchment area overlays the Litchfield National Park as well as areas with native title claims
- As an in-stream dam it will have significant environmental impact that would trigger an EPBC referral and an extensive EIS.

Option advantages

Each of the potential in-stream dam options has the ability to provide significant volumes of water that would provide sufficient water for long-term urban water security, industry and agricultural / horticultural growth.

Option disadvantages

The dam options are all located large distances from the greater Darwin region. Therefore, despite the cost of the dam infrastructure being lower than other options, they will require significant investment in pipe networks and high ongoing water transport costs.

All three dam sites will also have long development times given the likely approvals requirements and high environmental and cultural impact risks. Each dam inundates a large land area which will likely require an EIS under an EPBC referral. An EIS can take three to four years to develop, with other major dams in Northern Australia such as Hells Gates expecting a 10+ year development and approvals period. All the dam options also impact on areas of cultural importance and significance and land tenure concerns, which will require extensive investigation and potential negotiation and engagement with traditional owners and potential native title claims that could take a long period to resolve. Overall, it is unlikely that any in-stream dam could be developed until the mid-2030s.

Of the three potential in-stream dams, the Upper Adelaide River Dam has been progressed as it has been assessed to have highly suitable topography and relatively low cost.

8.4.10 Option 9 – Manton RTS and AROWS 3

As described in Section 8.4.5, the AROWS project can be built in stages, with the capacity to expand and provide increasing yields. Each of these stages can be either delivered through a staged approach, or as a single stage of delivery. This option represents the maximum sized AROWS project which could provide sufficient water for urban, industrial and agricultural / horticultural users and alleviate near-term water security risks.

A summary of the key factors associated with this option is provided in Table 36.

Table 36: Option 9 key facts

Factor	Description / Assumptions
Change in water availability (yield)	67,500 ML p.a. • Manton RTS – 7,300 ML p.a. • AROWS 3 – 60,200 ML p.a.
Staging potential	Manton RTS could be implemented in a shorter timeframe to provide a short-term augmentation to supply. AROWS 3 delivers the largest scale AROWS project in a single stage delivery.

Factor	Description / Assumptions
Cost ¹³¹	\$720 million • Manton RTS - \$110 million • AROWS 3 - \$610 million
Implementation timeframe	3 year delivery for Manton RTS, expected by 2024/25 Approximately 7 year delivery for AROWS 3, expected by 2026/27

Manton RTS

The scope of the Manton RTS component of this option is as outlined in Section 8.4.5 and is planned for delivery by 2024/25.

AROWS 3

Developing AROWS 3 would require:

- RL32m dam height and pumping capacity to supply 165 ML/day or 60,200 ML p.a.
- Strauss Water Storage and Treatment Facility
- Harvesting pipes and pumps for water in the Adelaide River
- Pumps and piping to transfer the water to the Strauss Water Storage and Treatment Facility and then to integrate into the Darwin water grid
- Pumping and pipe infrastructure to deliver water to Middle Arm precinct
- Pumping and pipe infrastructure to deliver water to agriculture and horticulture precinct.

Option advantages

As an off-stream development, AROWS has a lower environmental impact when compared to an in-stream option, and therefore likely has a shorter development timeframe. The AROWS project is also strategically located near the greater Darwin region and other major existing water supply sources. The inclusion of Manton RTS, and its shorter delivery timeframe, means that immediate water security and expected water requirements at Middle Arm, can be provided for. The major cost drivers for the AROWS project, such as the spillway and other core infrastructure, are consistent across the various sizes of the AROWS projects. Incremental cost increases occur largely through increased pumping and piping required. Therefore, achieving significant increases in yields can be achieved at relatively low cost for the larger AROWS options and represent significant economies of scale.

This option enables sufficient yield to provide long-term urban water security for the greater Darwin region and provide water for both industrial and agricultural / horticultural development.

Option disadvantages

The AROWS project requires the double handing of water, pumping in and out of AROWS, which has a high energy requirement with associated financial and environmental implications. While not as significant as an in-stream option, the AROWS project will still have environmental impacts.

¹³¹ Note – this does not include the cost of additional water treatment and pipes, this is consistent for all new infrastructure options.

8.4.11 Options summary table

Table 37: Options summary table

Option	Yield (ML p.a.)	Cost (\$million) ¹³²	Delivery time frame	Stageable	Domestic water requirements	Industrial water requirements	Agricultural and horticultural water requirements	Meets immediate water requirements by 2025/26
Base case	N/A	N/A	N/A	N/A	X	X	X	X
Option 1 – Do minimum	6,000 – 8,000	\$10 – \$20 million	5 -- 10 years ¹³³	✓	✓	X	X	X
Option 2 – Recycled water	5,000	\$30 million	2 years	✓	✓	X	X	X
Option 3 – Do minimum & recycled water	11,000 – 13,000	\$40 - 60 million	> 10 years	✓	✓	X	X	X
Option 4 – Manton RTS & AROWS 1a	17,500	\$580 million	3 – 5 years	✓	✓	X	X	✓
Option 5 – Manton RTS & AROWS 1c	38,500	\$675 million	3 – 5 years	✓	✓	✓	X	✓
Option 6 – Desalination	60,000	\$1,400 million	2 – 5 years	✓	✓	✓	✓	✓
Option 7 – AROWS 3	60,000	\$610 million	5 years	X	✓	✓	✓	X
Option 8 – In-stream dams ¹³⁴	150,000 – 800,000	\$180 - \$850 million	> 10 years	X	✓	✓	✓	X
Option 9 – Manton RTS & AROWS 3	67,500	\$720 million	3 – 5 years	✓	✓	✓	✓	✓

¹³² These indicative costs only include the capital costs for the core infrastructure. They do not include any significant pipeline costs to connect to the existing reticulation network or connect new areas to the network. They also exclude any operating costs.

¹³³ Whilst some savings are able to be realised earlier, it is expected to take between 5 and 10 years for the full demand reduction to be realised.

¹³⁴ Note that the yields from the in-stream dam options are not directly comparable to the AROWS options as the in-stream dams assume a lower level of reliability

9 Options assessment

9.1 Introduction

The purpose of the MCA is to assess the options shortlist and identify those options for progression to the Rapid CBA stage of the Preliminary Assessment. This chapter presents the outcomes of the assessment of ten options undertaken for progression. It includes:

- Approach
- Criteria
- MCA evaluation
- MCA summary
- Summary.

9.2 Approach

9.2.1 MCA process

An MCA is a structured assessment tool used to establish a shortlist of preferred options. For the purpose of this assessment, the MCA was completed using a qualitative assessment of the options against a set of agreed criteria to determine the preferred option/s. A qualitative assessment was deemed appropriate given the level of information available on each option at this stage of the assessment. Where possible, quantitative information was used to inform the MCA including indicative capital costs and information relating to water yield. The scoring of options was based on the professional opinion of workshop attendees and project advisors and used examples and benchmarks from similar projects implemented across Australia.

The MCA process involved five steps:

- **Confirm potential options** – the longlist of solution options identified in the ILM Workshop was refined to a shortlist (with defined scope and assumptions) to be assessed in the MCA.
- **Determine criteria** – the Project Team developed criteria to assess the options against, which were tested and confirmed with the workshop attendees.
- **Determine criteria weightings** – the Project Team determined weightings for each criterion, which were moderated and confirmed by the Workshop attendees.
- **Assessment** – each potential option was assessed against the criteria by the Workshop attendees.
- **Reporting and next steps** - The findings of the MCA were reported to inform progression of the rapid economics and Preliminary Assessment.

9.2.2 MCA Workshop

An MCA Workshop was held on 1 May 2020 with the Project Team and key representatives from the Northern Territory Government, with representatives from:

- DTBI
- DCM
- DTF
- DENR
- DIPL
- PWC.

The first four steps were completed prior to the Workshop, including a preliminary evaluation by the Project Team of each option. The Workshop was then used to test the initial outcomes of the assessment and scores were moderated based on the professional opinion of the workshop attendees and the evidence and rationale for the indicative ratings.

9.3 Criteria

Six criteria were used to assess the options in the MCA shown in Figure 55.

A	Deliverability	Is it technically feasible and can it service the intended demand in the timeframe required?
B	Economic impact	To what extent will the options enable future economic growth of the greater Darwin Region?
C	Strategic Alignment to Northern Australia Agenda	Does the option allow economic development in industrial and/or agricultural markets?
D	Cost	Is the option affordable for the Territory and a cost effective solution?
E	Environmental and Social Impact	To what extent will the option be environmentally and socially acceptable?
F	Adaptability	To what extent is the option stagable, integratable and complementary to other options and actions?

Figure 55: MCA criteria

Each criterion was weighted based on their relative importance to the Project (at this stage) using a Paired Comparison Analysis. This approach compares criteria in pairs to judge which of each criterion in the pair is more important, as shown in Table 38. The analysis weightings were tested and confirmed through the MCA workshop.

Table 38: Paired Comparison Analysis

	Deliverability	Economic Impact	Strategic Alignment to the NA Agenda	Cost	Environmental & Social Impact	Adaptability	Percentage
Deliverability		1	1	1	2	3	26%
Economic Impact	-1		1	1	1	2	21%
Strategic Alignment to the NA Agenda	-1	-1		1	1	2	19%
Cost	-1	-1	-1		1	2	17%
Environmental & Social Impact	-2	-1	-1	-1		1	12%
Adaptability	-3	-2	-2	-2	-1		6%

The agreed criteria and the considerations for each criterion (sub-criteria) are displayed in Table 39.

Table 39: Sub-criteria and weightings

Criterion	Sub-criteria
A Deliverability	- Is it technically feasible and can it service the intended demand in the timeframe required? - What would be the development timeline for this option? - Does that meet demand needs for urban, industrial and agricultural/horticultural needs?

Criterion	Sub-criteria
	- Is there a likelihood of a technically viable solution that is constructible? - To what extent does the option meet the desired demand levels of the objectives?
B Economic Impact	- To what extent will the options enable future economic growth of the greater Darwin Region? - Can the option enable generation of significant new economic activity? - How significant are the costs of delivery in comparison to other options?
C Strategic Alignment to Northern Australia Agenda	- Does the option allow economic development in industrial and agricultural and horticultural markets? - Does the option support the NA Agenda - unlocking the region's full economic potential as a gateway to global markets, a source of rich resources and a home to pristine environments? - Does it support national security and resilience objectives for Northern Australia?
D Cost	- Is the option affordable for the Territory and a cost effective solution? - Are the operational costs of the option likely to be recoverable through revenue? - Will the option generate enough revenue to also repay capital costs supplied through the Territory Treasury?
E Environmental and Social Impact	- To what extent will the option be environmentally and socially acceptable? - Are there likely to be significant cultural heritage concerns from the development of this option? - Are there likely to be significant environmental concerns from the development of this option? - Are there likely to be significant negative social impacts from the development of this option? - Is it likely that land tenure could be secured?
F Adaptability	- To what extent is the option stageable, integratable and complementary to other options and actions? - Can the option be staged practically and cost-effectively to progressively meet demand? - Can the option, or part of it, be integrated with other options? - Is the option complementary in total or part to other options or actions?

The project team noted the potential overlap between the economic development and strategic alignment criteria. The inclusion of both criteria was considered important to capture the perspectives of both the NT and national stakeholders in the Project. The combined weighting of the two criteria was discussed and agreed by the project team and the MCA workshop attendees as being appropriate given the importance of water supply to enabling growth and removing existing constraints on key industries.

9.4 MCA evaluation

Each of the options was assessed on their respective ability to meet the above criteria and sub-criteria and scored on a five point scale, shown in Table 40. This section outlines scores for each option against the criteria and the rationale for the respective scores of each option.

Table 40: MCA scoring approach

Score	Justification
0	The option represents no alignment with the criteria and sub criteria.
1	The option has minimal alignment with the criteria and sub-criteria, however, has a number of significant disadvantages, limitations compared to other options.
2	The option has moderate alignment with the criteria and sub-criteria, however, has a number of major disadvantages or limitations compared to other options.
3	The option has good alignment with the criteria and sub-criteria, however, has some disadvantages or limitations compared to other options.
4	The option has strong alignment with the criteria and sub-criteria with minimal disadvantages or limitations compared to other options.
5	The option has very strong alignment with the criteria and sub-criteria with no identified disadvantages or limitations compared to other options.

9.4.1 Criterion A – Deliverability

Table 41 outlines the scores and rationale for each option for the 'Deliverability' criterion.

Table 41: Deliverability criterion assessment

Option	Score	Rationale
Base case	0	Does not meet any objectives of the Project, and results in no increase to the water supply available.
Option 1 – Do minimum	1	This option relies on both regulatory and behavioural change to realise efficiencies in water consumption. Both of these elements will require long lead times to affect the level of water demand in the greater Darwin region. Given this, it is not expected to meet the required timeframes to support urban water security, nor does provide sufficient water volumes even at full implementation.
Option 2 – Recycled water	1	While recycled water has a short timeframe for delivery it is only estimated that approximately 5,000 ML p.a. of water could be provided which is not sufficient to meet the requirements of the Project in the short or long-term.
Option 3 – Do minimum & disaggregated supply	3	This option can provide sufficient water to meet short-term demands for industrial use through either recycled water or desalination, which will reduce the requirement for an additional bulk water supply source. In the long-term it will contribute to efficiency gains across the network over the useful life of the assets.
Option 4 – Manton RTS & AROWS 1a	3	Manton RTS can be delivered within a short timeframe and provide sufficient water to reduce short-term water security risks. Overall this option is viable and deliverable however the overall demand objectives are not met, with insufficient water to meet industrial demand.
Option 5 – Manton RTS & AROWS 1c	4	Manton RTS can be delivered within a short timeframe and provide sufficient water to reduce short-term water security risks. Overall this option is viable and deliverable and also provides water to meet the project demand profile at the Middle Arm precinct. It does not however provide water to meet any agricultural/horticultural demand.
Option 6 – Desalination	3	The desalination plant has a relatively certain delivery timeframe and may be able to provide sufficient water to reduce any short-term water security risks. Overall this option is viable and deliverable and also provides water to meet the project demand profile at the Middle Arm precinct as well as agricultural/horticultural demand. Given the likely cost of water produced under this option there is the potential that there will be insufficient demand for water from a desalination plant of this size, and therefore reduce the viability and feasibility of the project being delivered.
Option 7 – AROWS 3	3	If the delivery timeframe can be achieved this option would provide sufficient water to reduce any short-term water security risks and provide water to meet the project demand profile for both industrial and agricultural/horticultural demand. However, for a project of this size, a five year delivery timeframe is considered optimistic and there is a risk that it could not be achieved. This would create a water

Option	Score	Rationale
		security risk and therefore the timely delivery of this option is considered lower than smaller infrastructure initiatives or those options including Manton RTS.
Option 8 - In-stream dams	2.5	This option cannot meet the short-term water requirements required of the Project. While all of the in-stream dam options provide sufficient water supply to meet the long-term water requirements it has a significant, and unknown, development timeframe. In addition, environmental and cultural heritage concerns may mean that some dam site options are not viable for development.
Option 9 – Manton RTS & AROWS 3	4.5	Manton RTS can be delivered within a short timeframe and provide sufficient water to reduce any short-term water security risks. Overall this option is viable and deliverable and provides water to meet the project demand profile for both industrial and agricultural/horticultural growth.

9.4.2 Criterion B - Economic Impact

Table 42 outlines the scores and rationale for each option for the 'Economic Impact' criterion.

Table 42: Economic Impact criterion assessment

Option	Score	Rationale
Base case	0	Likely to result in a negative economic impact to the Northern Territory as it will result in the imposition of water restrictions impacting on economic wellbeing. The lack of available water will restrict population, industrial and agricultural / horticultural development and may require restrictions on industry.
Option 1 – Do minimum	1	This option could realise between 6,000 – 8,000 ML p.a. in decreased water consumption. This level of additional water is not sufficient to provide for any material growth in industry or agriculture/horticulture and therefore is expected to have minimal economic impact.
Option 2 – Recycled water	1	Relatively low volumes of water are made available under this option and therefore it does not enable economic growth.
Option 3 – Do minimum & disaggregated supply	3	This option results in efficiency gains across the network through the combination of demand reductions through regulatory and behavioural responses combined with water recycling or desalination at targeted industrial locations. The combined impact of these initiatives would allow for some additional water for economic development however not of the scale required to deliver the identified service need and future demands.
Option 4 – Manton RTS & AROWS 1a	3	This option provides sufficient water to ensure the security of water for existing uses and domestic consumption, this means that there is not expected to be any requirement to reduce water use due to the implementation of restrictions. This option does not however provide sufficient water for any major economic development either by industry or agriculture/horticulture.
Option 5 – Manton RTS & AROWS 1c	4	This option provides sufficient water to meet existing uses and provide water security for domestic consumption and, also provides water to enable industrial growth and therefore promote economic development. If water is provided for industrial use this option cannot facilitate agriculture/horticulture growth.
Option 6 – Desalination	4	This option provides sufficient water to meet existing uses and provide water security for domestic consumption and also provides water to enable industrial growth and therefore promote economic development. This option can also provide water for agriculture/horticulture purposes. However, its ability to generate significant economic activity is more limited compared to other options due to the expected reduced take up associated with the high cost of water.
Option 7 – AROWS 3	5	This option provides sufficient water to meet existing uses and provide water security for domestic consumption and, also provides water to enable industrial growth and therefore promote economic development. This option also provides water for agriculture/horticulture purposes.
Option 8 - In-stream dams	5	This option provides sufficient water to meet existing uses and provide water security for domestic consumption and, also provides water to enable industrial growth and therefore promote economic development. This option also provides water for agriculture/horticulture purposes.

Option	Score	Rationale
Option 9 – Manton RTS & AROWS 3	5	This option provides sufficient water to meet existing uses and provide water security for domestic consumption and, also provides water to enable industrial growth and therefore promote economic development. This option also provides water for agriculture/horticulture purposes.

9.4.3 Criterion C - Strategic Alignment to Northern Australia Agenda

Table 43 outlines the scores and rationale for each option for the 'Strategic Alignment to Northern Australia Agenda' criterion.

Table 43: Strategic Alignment to Northern Australia Agenda criterion assessment

Option	Score	Rationale
Base case	0	The base case does not allow for the development of industries that align with the Northern Australian Agenda nor does it allow for population growth.
Option 1 – Do minimum	2	This option was considered to have low alignment as there is a low likelihood of any gains in water supply to support the agenda within its outlined timeframes. In the longer term a lower overall level of water demand by users may support urban water security and enable modest population growth.
Option 2 – Recycled water	2	This option was considered to have low alignment as there is a low likelihood of any gains in water supply to support the Agenda either through economic growth, population growth or resilience.
Option 3 – Do minimum & disaggregated supply	3	This option has medium alignment as it allows for some increased water available for economic development. However, the long implementation timeframe required for Option 1 means that the timeframe for the realisation of the full supply made available under this option is unlikely to occur within the timeframes of the Agenda.
Option 4 – Manton RTS & AROWS 1a	2	This option was considered to have low alignment as, whilst it will support population growth, there is a low likelihood of sufficient gains in water supply to support the economic growth agenda.
Option 5 – Manton RTS & AROWS 1c	5	This option provides sufficient water within the timeline of the Agenda to promote economic development and growth in key strategic industries as well as promote the resilience of the region.
Option 6 – Desalination	4	This option provides sufficient water within the timeline of the Agenda to promote economic development and growth in industrial demand as well as promote the resilience of the region. This option can also provide water for agriculture/horticulture purposes however the high cost of water from this option may limit the economic impact, and therefore alignment with the Northern Australia agenda, from this use.
Option 7 – AROWS 3	5	This option provides sufficient water within the timeline of the Agenda to promote economic development and growth in key strategic industries as well as promote the resilience of the region.
Option 8 - In-stream dams	3	This option provides sufficient water to promote economic development and growth in key strategic industries as well as promote the resilience of the region, however, water will not be available within the short or medium term.
Option 9 – Manton RTS & AROWS 3	5	This option provides sufficient water within the timeline of the Agenda to promote economic development and growth in key strategic industries as well as promote the resilience of the region.

9.4.4 Criterion D - Cost

Table 44 outlines the scores and rationale for each option for the 'Cost' criterion.

Table 44: Cost criterion assessment

Option	Score	Rationale
Base case	5	Zero capital or operating cost, noting that the negative economic impacts (or costs) associated with this option are captured in other criteria.
Option 1 – Do minimum	5	This option uses regulatory and behavioural change initiatives to decrease water consumption and therefore has a low fiscal cost of implementation.
Option 2 – Recycled water	5	Recycled water has a low cost of implementation at this scale.
Option 3 – Do minimum & disaggregated supply	4	Recycled water has a relatively low cost of implementation. Any cost associated with the recycling of water is considered against the high value of the re-use of 'unused' wastewater. Option 1 also has a low cost of implementation. Desalination infrastructure is expensive to both develop and operate and should be matched to demand sources that have the capacity and willingness to pay for the water, i.e. industrial users.
Option 4 – Manton RTS & AROWS 1a	4	The project has a lower capital cost compared to the other significant infrastructure options however is still substantially more expensive than Options 1 and 2. Increase in supply is timed to aligned with increases in urban water requirements and therefore matched to growth in urban revenue streams.
Option 5 – Manton RTS & AROWS 1c	3	The project has a high capital cost associated with the development of both Manton and the AROWS projects. While the upfront capital costs are greater than equivalent sized in-stream dam options, AROWS is more strategically located close to Darwin and therefore the pipeline and pumping costs are expected to be lower. This option has a lower capital cost than the larger AROWS options, the larger in-stream dam options and a large desalination plant.
Option 6 – Desalination	1	Desalination is the highest cost option from both a delivery and operating cost perspective. Desalination plants require significant amounts of energy to produce water as well as high capital delivery costs.
Option 7 – AROWS 3	3	The project has a high capital cost associated with the development of the full AROWS project in a single stage. This option though seeks to deliver AROWS earlier and therefore avoid the cost of the Manton RTS. While the upfront capital costs are greater than equivalent sized in-stream dam options, AROWS is more strategically located close to Darwin and therefore the pipeline and pumping costs are expected to be lower.
Option 8 - In-stream dams	2	The Mount Bennett and Upper Adelaide River site options have proportionally lower capital costs compared to the AROWS options. However, all the in-stream dam sites are a significant distance from the greater Darwin region which would result in significant capital costs for pipes and ongoing operational costs associated with transporting the water.
Option 9 – Manton RTS & AROWS 3	2.5	The project has a high capital cost associated with the development of both Manton RTS and the AROWS projects. While the upfront capital costs are greater than equivalent sized in-stream dam options, AROWS is more strategically located close to Darwin and therefore the pipeline and pumping costs are expected to be lower. AROWS 3 reflects the largest and therefore highest cost version of the AROWS project.

9.4.5 Criterion E - Environmental and Social Impact

Table 45 outlines the scores and rationale for each option for the 'Environmental and Social Impact' criterion.

Table 45: Environmental and Social Impact criterion assessment

Option	Score	Rationale
Base case	3	The base case does not include the development of any new infrastructure and therefore has zero environmental impact relating to its implementation. There will be a significant social impact however associated with the likely implementation of significant water restrictions and potential environmental impacts from increased overuse of groundwater resources.
Option 1 – Do minimum	3	This option would result in minimal impact to the environment and may support a small improvement to environmental outcomes if the use of groundwater decreases. There is however a social impact associated with changes to regulation that may alter longstanding rights to water in the rural regions.
Option 2 – Recycled water	5	The recycling of water promotes the sustainable and environmentally responsible use of water, which is a finite natural resource. This option has a high energy requirement however this may be able to be provided through renewable sources with minimal impact to the environment. There may also be a social impacts if residents feel they are being 'forced' to use recycled water, however this can be overcome if recycled water is used for predominantly industrial or agricultural/horticultural uses.
Option 3 – Do minimum & disaggregated supply	4	The recycling of water promotes the sustainable and environmentally responsible use of water, which is a finite natural resource. There is however a social impact associated with changes to regulation under Option 1 that may alter longstanding rights to water in the rural regions.
Option 4 – Manton RTS & AROWS 1a	3	Manton Dam is an existing disturbed site and therefore no significant environmental impacts are expected from its return to service. AROWS is an off-stream project and therefore has a lower environmental impact compared to in-stream options. It will still however have some level of impact on the environment and there is uncertainty around cultural heritage and land tenure issues.
Option 5 – Manton RTS & AROWS 1c	3	Manton Dam is an existing disturbed site and therefore no significant environmental impacts are expected from its return to service. AROWS is an off-stream project and therefore has a lower environmental impact compared to instream options. It will still however have some level of impact on the environment and there is uncertainty around cultural heritage and land tenure issues.
Option 6 – Desalination	3	This option would have limited environmental impacts associated with its construction and has no identified social impacts. Desalination plants have a high energy consumption which would have an environmental impact if it is powered from fossil fuel sources. Additionally, a large-scale desalination plant would produce large quantities of brine which would require disposal, most likely through discharge to the harbour, which could create environmental risks.
Option 7 – AROWS 3	3	AROWS is an off-stream project and therefore has a lower environmental impact compared to instream options. It will still however have some level of impact on the environment and there is uncertainty around cultural heritage and land tenure issues.
Option 8 - In-stream dams	2	Each dam inundates a large land area which will likely require an EIS under an EPBC referral. All the dam options also impact on areas of cultural importance and significance and land tenure concerns, these will require extensive investigations and potential negotiation and engagement with traditional owners and potential native title claims.
Option 9 – Manton RTS & AROWS 3	3	Manton Dam is an existing disturbed site and therefore no significant environmental impacts are expected from its return to service. AROWS is an off-stream project and therefore has a lower environmental impact compared to instream options. It will still however have some level of impact on the environment and there is uncertainty around cultural heritage and land tenure issues.

9.4.6 Criterion F - Adaptability

Table 46 outlines the scores and rationale for each option for the 'Adaptability' criterion.

Table 46: Adaptability criterion assessment

Option	Score	Rationale
Base case	0	The base case represents the 'Do Nothing' scenario and therefore was considered to have no complementary or stageable element.
Option 1 – Do minimum	5	This option is highly complementary to any option that seeks to augment the water supply in the greater Darwin region as its intention is to overall reduce demand and consumption patterns. It should be considered for implementation alongside any infrastructure option as a package of initiatives to ensure a sustainable approach to water consumption in the greater Darwin region.
Option 2 – Recycled water	4	Recycled water or desalination could be investigated as a supplementary water supply for specific industrial uses or sites to lower their water requirements by recycling any wastewater their operations may produce. Therefore, it should be considered on a site and user specific basis as part of a package of options in a broader water supply strategy.
Option 3 – Do minimum & disaggregated supply	5	All of the initiatives included in this option are complementary to other options and would support the delivery of a more comprehensive infrastructure option as a package of responses.
Option 4 – Manton RTS & AROWS 1a	5	AROWS 1a can be staged and its size increased as required to meet increases in demand. Can be combined with non-infrastructure options as part of a package of options in a broader water supply strategy.
Option 5 – Manton RTS & AROWS 1c	4	AROWS 1c can be further developed to a larger size if required to meet increases in demand. Any of the AROWS projects can be combined with non-infrastructure options as part of a package of options in a broader water supply strategy.
Option 6 – Desalination	3	The desalination plant could be expanded, or further plants developed, if there was a need for increased water supply. However the delivery of 60,000 ML pa. desalination plant, as scoped, represents a significant single stage development. A smaller scale desalination plant could also be located at specific sites to supply water for specific demands e.g. at Middle Arm and form part of a package of options. This is assessed under Option 3.
Option 7 – AROWS 3	3	The AROWS project can be delivered alongside other non-infrastructure options as part of a package of options in a broader water supply strategy. The Stage 3 AROWS project represents the largest format of AROWS and therefore does not reflect a staged delivery.
Option 8 - In-stream dams	2	The in-stream dam options can be delivered alongside other non-infrastructure options as part of a package of options in a broader water supply strategy. The delivery of the dams require a significant first stage to be constructed which would represent a substantial volume of water, likely beyond the required supply.
Option 9 – Manton RTS & AROWS 3	3	The AROWS project can be delivered alongside other non-infrastructure options as part of a package of options in a broader water supply strategy. The Stage 3 AROWS project represents the largest format of AROWS and therefore does not reflect a staged delivery.

9.5 MCA summary

The outcome of the assessment is summarised in Table 47, with the ranked list of options displayed in Table 48.

Table 47: MCA results

Criteria	Criteria Weighting	Base case	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9
<i>Option</i>		<i>Do Nothing</i>	<i>Do minimum</i>	<i>Recycled water</i>	<i>Do minimum & disaggregated supply</i>	<i>Manton RTS & AROWS 1a</i>	<i>Manton RTS & AROWS 1c</i>	<i>Desalination</i>	<i>AROWS 3</i>	<i>In-stream dams</i>	<i>Manton RTS & AROWS 3</i>
Deliverability	26%	0	1	1	3	3	4	3	3	2.5	4.5
Economic Impact	21%	0	1	1	3	3	4	4	5	5	5
Strategic Alignment to the NA Agenda	19%	0	2	2	3	2	5	4	5	3	5
Cost	17%	5	5	5	4	4	3	1	3	3	2.5
Environmental & Social Impact	12%	3	3	5	4	3	3	3	3	2	3
Adaptability	6%	0	5	4	5	5	4	3	3	2	3
Total Score		8.00	17.00	18.00	22.00	20.00	23.00	18.00	22.00	17.50	23.00
Weighted score		1.20	2.32	2.51	3.40	3.09	3.90	3.07	3.80	3.12	4.10
Ranking		10	9	8	4	6	2	7	3	5	1

Table 48: Options ranking

Rank	Option in ranked order	Weighted score
1	Option 9 – Manton RTS & AROWS 3	4.10
2	Option 5 – Manton RTS & AROWS 1c	3.90
3	Option 7 – AROWS 3	3.80
4	Option 3 – Do minimum & disaggregated supply	3.40
5	Option 8 - In-stream dams	3.12
6	Option 4 – Manton RTS & AROWS 1a	3.09
7	Option 6 – Desalination	3.07
8	Option 2 – Recycled water	2.51
9	Option 1 – Do minimum	2.32
10	Base case	1.20

The outcomes of the MCA process and option rankings further confirm the need for significant water supply augmentation in the greater Darwin region. The process has confirmed that those options which can provide sufficient water for both economic development and water security over the short, medium and long term are the strongest performing. Based on the MCA outcomes and criteria scoring, these options best balance cost and potential environmental impacts with economic development outcomes. The options which include Manton RTS and AROWS perform most strongly as they respond to short-term water security risks with differing medium and long term performance relative to the AROWS scale. Option 7 does not include Manton RTS, which has a cost saving but, also an associated increase in risk of not being able to be delivered in the required timeframe to alleviate the near-term water security concerns.

Option 3 performs strongly as it has the ability to provide effective disaggregated water supply at key locations of industrial demand, therefore enabling some level of economic development at a lower capital cost than other options. As individual initiatives Option 1 and Option 2 do not provide sufficient water to meet short-term water requirements or provide water for economic development purpose. However, they should both be considered for implementation alongside other larger infrastructure options as part of a holistic water supply strategy for the greater Darwin region.

9.5.1 Sensitivity testing

Two alternate sensitivity tests were undertaken against the core results to test the robustness of the outcomes, these were:

- Making cost the second most important criterion
- Making all criteria equal.

The outcomes of the sensitivity tests are shown in Table 49.

Table 49: MCA sensitivity test

Rank	Core result	Higher ranking of Cost criterion	Equal weighting
1	Option 9 – Manton RTS & AROWS 3	Option 9 – Manton RTS & AROWS 3	Option 9 – Manton RTS & AROWS 3
2	Option 5 – Manton RTS & AROWS 1c	Option 5 – Manton RTS & AROWS 1c	Option 5 – Manton RTS & AROWS 1c
3	Option 7 – AROWS 3	Option 7 – AROWS 3	Option 3 – Do minimum & disaggregated supply
4	Option 3 – Do minimum & disaggregated supply	Option 3 – Do minimum & disaggregated supply	Option 7 – AROWS 3
5	Option 8 - In-stream dams	Option 4 – Manton RTS & AROWS 1a	Option 4 – Manton RTS & AROWS 1a
6	Option 4 – Manton RTS & AROWS 1a	Option 8 - In-stream dams	Option 2 – Recycled water
7	Option 6 – Desalination	Option 6 – Desalination	Option 6 – Desalination
8	Option 2 – Recycled water	Option 2 – Recycled water	Option 8 - In-stream dams
9	Option 1 – Do minimum	Option 1 – Do minimum	Option 1 – Do minimum
10	Base case	Base Case	Base Case

The sensitivity test demonstrates that Options 3,5,7 and 9 are all within the top 5 under each test, with options 9 and 5 are first and second under both sensitivities.

9.5.2 MCA conclusions

Based on the outcomes of the MCA it was recommended that the top five ranked options be progressed for assessment through a Rapid CBA. All these options provide sufficient water to provide for some degree of water security and industrial development. Options 5, 7, 8 and 9 all provide large volumes of water to support economic development. Option 3 still includes the delivery of new infrastructure, however, represents a packaged option combining non -infrastructure and lower capital cost infrastructure options while still providing sufficient water to support industrial development.

9.6 Summary

The options shortlist was assessed through an MCA framework to determine the highest performing options for progression to a Rapid CBA. The MCA assessed each of the options against a set of criteria which were directly linked to the service needs of the Project. The MCA was undertaken and confirmed through a workshop with key representatives from across the Northern Territory Government. Based on the outcomes of the MCA, the top five performing options from the MCA were progressed to the Rapid CBA:

- 1 Option 9 – Manton RTS & AROWS 3
- 2 Option 5 – Manton RTS & AROWS 1c
- 3 Option 7 – AROWS 3
- 4 Option 3 – Do minimum & disaggregated supply
- 5 Option 8 - In-stream dams.

Assessment through a CBA framework of these options will enable analysis of whether the additional water made available for economic development under the larger options justifies the additional cost associated with these options.

10 Rapid cost benefit analysis

10.1 Introduction

The Rapid Economic Cost Benefit Analysis (CBA) is a critical component of the Preliminary Assessment and the overall DBC, as it ensures the Project option(s) progressed for more detailed analysis are the most economically viable options. This economic analysis builds upon the comprehensive analysis undertaken in Chapter 6, *Expected benefits*, by estimating and forecasting the monetisable benefits, and costs, associated with the development of each Project option. This chapter:

- Details the economic approach
- Outlines the base case and Project options
- Details the forecast water demand in the region
- Evaluates the economic viability of the different Project options, with reference to the base case
- Confirms the preferred Project option.

10.2 Approach

10.2.1 Methodology

Investment in large-scale infrastructure, such as the AROWS Project, often leads to changes in the economic environment and thus, this analysis attempts to capture all economic costs and benefits that may impact the greater Darwin region and, more broadly, the Northern Territory. The economic analysis included in this report is an economy-wide analysis that considers the overall benefits and avoided costs associated with not progressing the project options.

A rapid CBA methodology was undertaken to enable a comparison and subsequent assessment of the economic benefits associated with a number of Project options. Section 10.3.4 - Reference Projects provides a brief overview of each Project option and the associated components.

Rapid Cost-Benefit Analysis

A rapid CBA framework was used in this economic analysis, incorporating the application of discounted cash flow (DCF) techniques. CBA is an economic valuation of the costs and benefits of a project with reference to the broader community, defined as the Northern Territory for this Project. Where feasible, the rapid CBA quantifies and monetises all costs and benefits that will occur in the region as a result of the Project. The rapid CBA will monetise fewer benefits and costs, relative to that of a full CBA, due to the stage of the development and information currently available.

The steps associated with the development of the economic analysis include:

- 1 **Outline the economic appraisal framework:** develop the overarching methodology and determine key modelling assumptions.
- 2 **Scoping of the Base Case and Project options:** develop the base case scenario and options.
- 3 **Design benefit estimation framework:** determine robust methodologies to monetise the Project's benefits.
- 4 **Estimate cost estimates:** estimate the costs associated with the delivery (Capital Expenditure – CAPEX) and operating phases (Operating Expenditure – OPEX) of the Project options.
- 5 **Quantify Project benefits:** develop monetised estimates of the benefits which are likely to be realised from the AROWS Project. This includes benefits to urban, agricultural and industrial users.
- 6 **Conduct economic modelling:** determine the Benefit Cost Ratio (BCR) and Net Present Value (NPV) for the Project through incremental DCF techniques.

10.2.2 Rapid CBA measures

The Project's future costs and benefits are converted to the common time dimension, the Present Value (PV). These present values are calculated by discounting these future values through IA's recommended discount rate of 7 per cent per

annum (p.a.), which reflects the social time value of money.¹³⁵ Following these discounting calculations, the costs and benefits are used to provide conventional measures of economic performance including:

- **NPV:** defined as the difference between the PV of both total incremental benefits and costs. This allows the Project options to be compared on the same basis to determine the most efficient use of resources or greatest net benefit to the community
- **BCR:** defined as the ratio of the PV of total incremental benefits to the PV of total incremental costs.

Table 50 details the decision criteria used in the assessment of the rapid CBA results.

Table 50: Decision criteria

NPV Outcome	BCR Outcome	Appraisal
NPV > 0	BCR > 1	The Project is deemed economically viable based on monetisable.
NPV = 0	BCR = 1	The Project is deemed neutral based on monetisable impacts.
NPV < 0	BCR < 1	The Project is deemed not economically viable on monetisable benefits alone. There may be broader justification to continue to progress projects which have a BCR of less than 1 and a negative NPV.

10.2.3 Key assumptions and parameters

The key assumptions that underpin this analysis are consistent with those specified in the IA Assessment Framework. Table 51 displays the key assumptions used when undertaking the CBA.

Table 51: Economic analysis key assumptions

Assumption Criteria	Description	Source
Discount rate	7% (real) with sensitivities conducted at 4% and 10%	IA
Appraisal period	30 years from commencement of operations ¹³⁶	PwC
Base year	2021	PwC
Construction start	Subject to Project Option	SMEC
Construction end	Subject to Project Option	SMEC
Operations start	Subject to Project Option	SMEC
Residual value	Excluded from analysis	PwC

10.3 Base Case and Project Scenarios

10.3.1 Demand analysis

Figure 56 displays the non-augmented water supply and forecast total water demand in the greater Darwin region over the appraisal period. As illustrated below, there will be a significant water shortage across the appraisal period, as the non-

¹³⁵ Sensitivity analysis has been undertaken at various discount rates to show the importance of this assumption to the overall economic viability. Whilst IA has continued to recommend and require a 7% real discount rate be applied to projects it is assessing, there is ongoing debate regarding the appropriateness of this discount rate for social infrastructure projects, particularly in a low interest rate environment.

¹³⁶ As a dam is a long-life asset, it could be argued that a 50 year appraisal period is justified. To remain conservative, the core analysis has assumed 30 years with sensitivity analysis showing the impact of extending to 50 years

augmented water supply is forecast to provide approximately 35,000 ML compared to the forecast total demand of just over 96,000 ML in 2050. This will represent a shortage of over 62,000 ML by 2050.

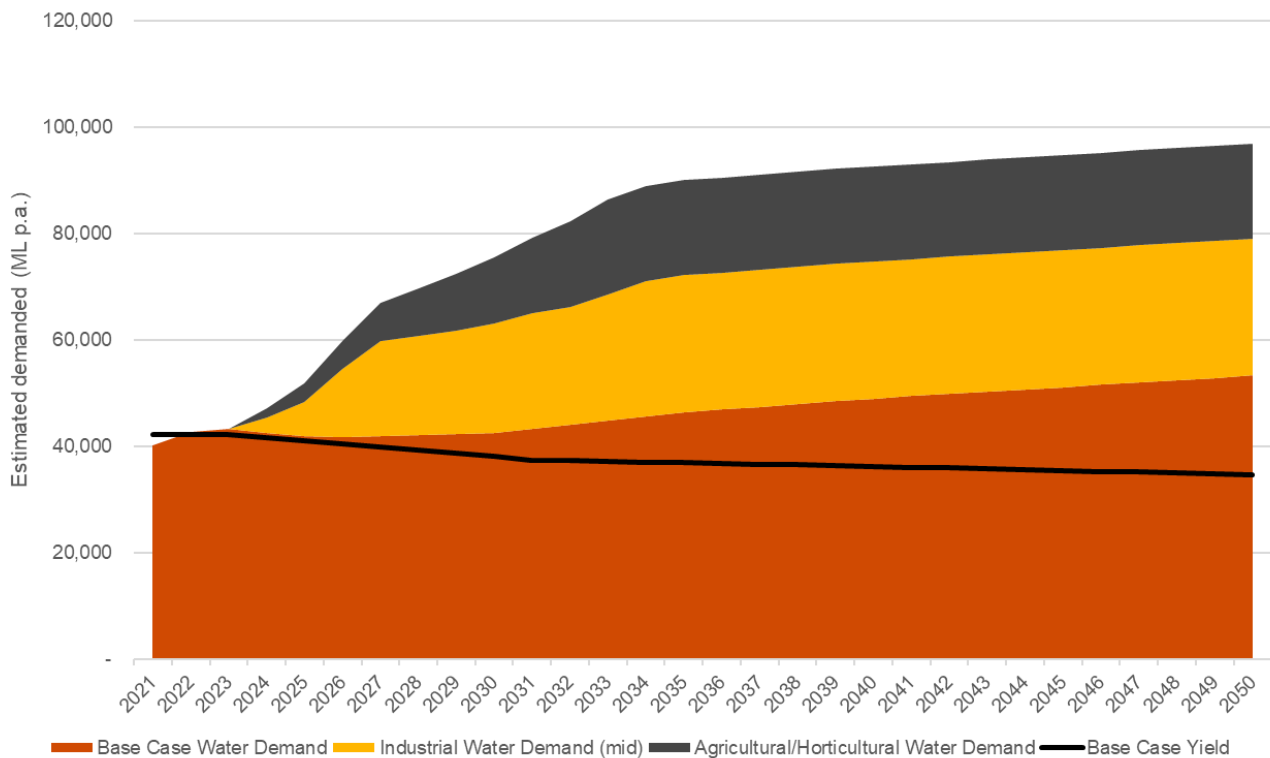


Figure 56: Total water demand profile of greater Darwin

Due to the Project's hierarchy of water supply, whereby urban, industrial and agricultural/horticultural water demand is serviced in that order, urban demand will be fulfilled prior to that of industrial and agricultural and horticultural users. Subsequently, industrial and agricultural/horticultural growth will be significantly constrained from the lack of water availability provided by the non-augmented water supply. Chapter 3, *Base Case supply and demand*, provides further details regarding greater Darwin's water supply and demand.

10.3.2 Reference Location

As highlighted in Chapter 5, *Problem Identification and service need*, there are several issues associated with the water demand and supply in greater Darwin. A significant problem in the region is the heavily constrained water availability, with current water demand across the greater Darwin region equal to, if not greater, than the current water system yield. Subsequently, several potential Project options are being proposed to address this issue. Figure 57 displays the components of each key option assessed in this chapter.

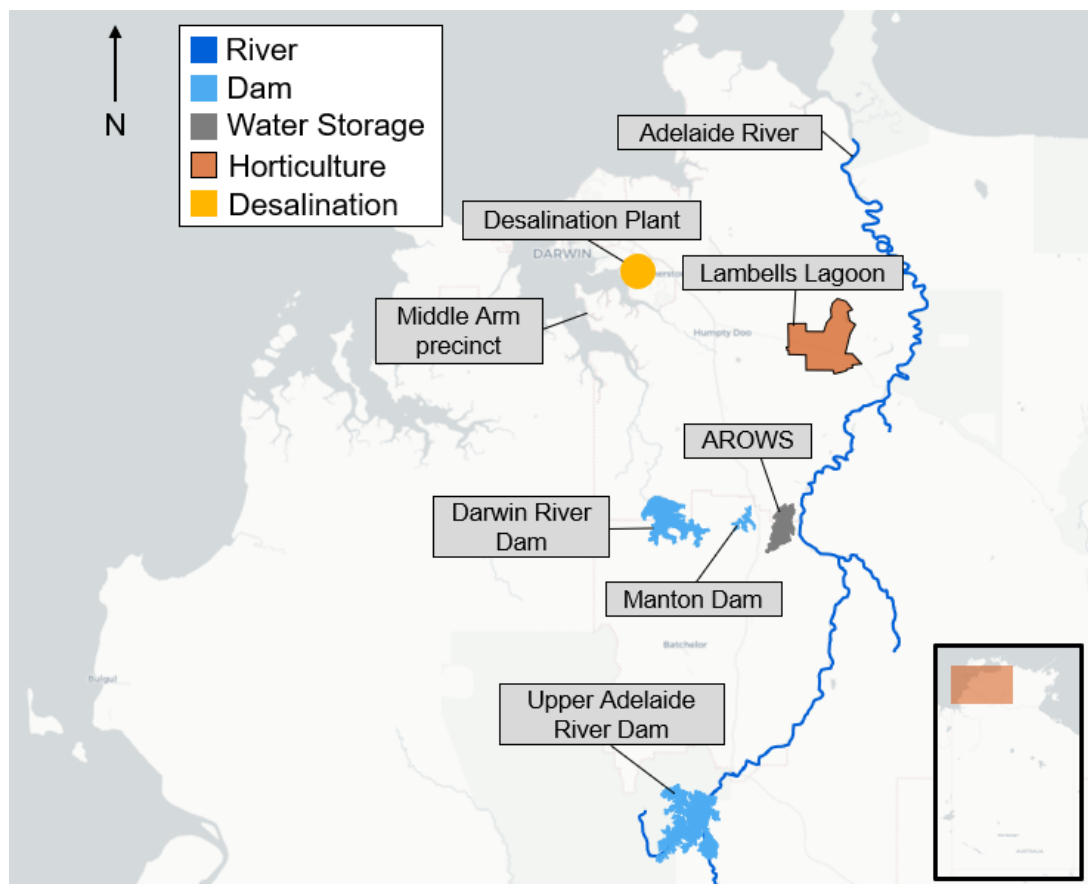


Figure 57: Potential Project components

10.3.3 Base Case

As previously highlighted in *Chapter 8 and 9, Options identification and development* and *Options assessment* respectively, the base case reflects the 'do nothing' scenario. This does not reflect PWC's current proposed water supply strategy however, it aligns with IA's requirement that the base case considers only committed and funded projects. All Project options assessed are compared against the Base Case to estimate the incremental impacts of each option.

10.3.4 Reference Projects

Using the outcomes derived from the comprehensive MCA process detailed in *Chapter 9*, five options were selected for economic evaluation. Table 52 specifies the options to be assessed in this chapter.

Table 52: Options for economic assessment

Option Number	Description
Option 3	Do minimum, and disaggregated supply
Option 5	Manton RTS and AROWS 1c
Option 7	AROWS 3
Option 8	Upper Adelaide River Dam
Option 9	Manton RTS and AROWS 3

Chapter 8, *Options identification and development* provides further details regarding each option and the associated advantages and disadvantages.

Option 3 – Do minimum and disaggregated supply

This option includes 'do minimum', 'recycled water infrastructure' and a 'small-scale desalination plant'. Table 53 details the key factors of Option 3.

Table 53: Option 3 key components

Factor	Description / Assumptions
Change in water availability (yield)	Approximately 21,000 to 25,000 ML p.a. - Option 1 – 6,000 to 8,000 ML p.a. - Option 2 – 5,000 ML p.a. - Desalination plant – 10,000 to 12,000 ML p.a.
Staging potential	The desalination plant would have to be linked to offtake agreements to align a revenue stream to construction. Desalination plants can be constructed at various sizes to match the required demands.
Implementation timeframe	2 year delivery for recycled water & desalination plant - Approximately 10 years to realise water consumption reductions.

Figure 58 displays the total water demand that can be serviced by Option 3. As illustrated below, this option will provide a limited water supply to industrial users, servicing less than 50 per cent of industrial water demand from 2027 onwards. Due to the unsustainable water supply available to agricultural and horticultural users, Option 3 will not support the development of any agricultural/horticultural land.

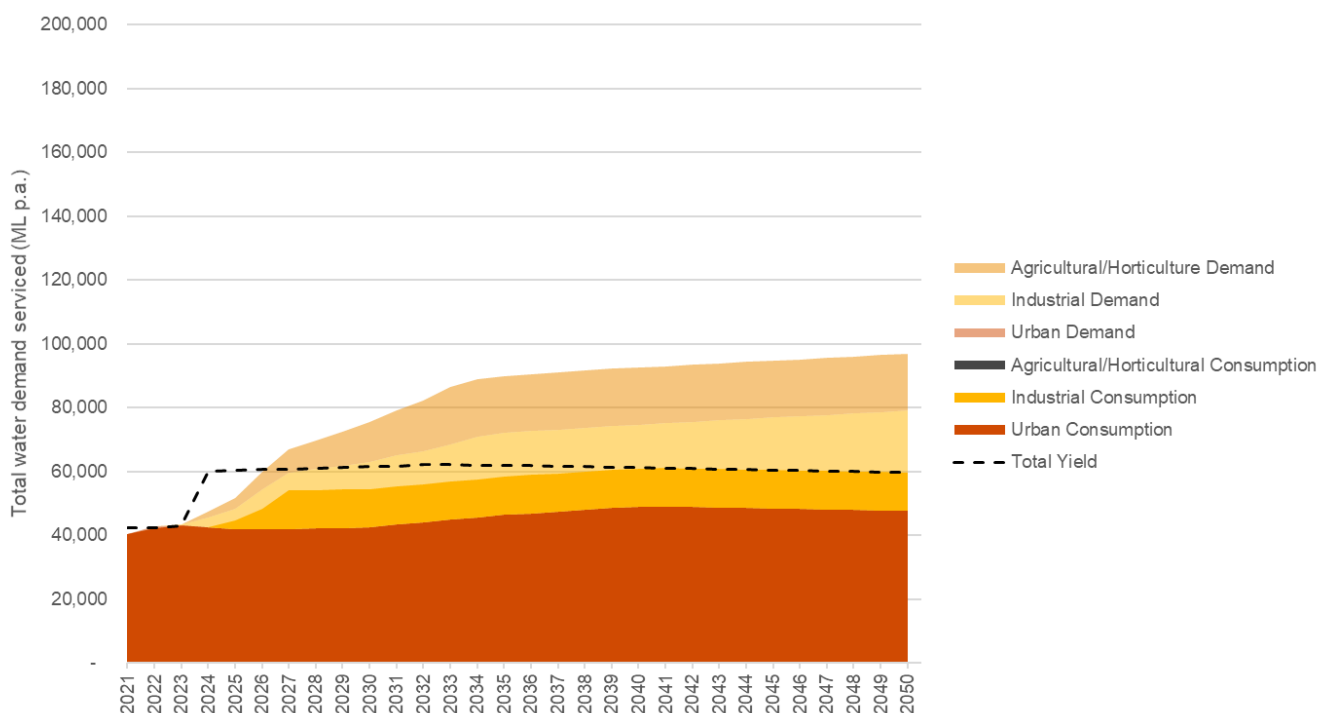


Figure 58: Water demand serviced by Option 3

Option 5 – Manton RTS and AROWS 1c

Option 5 consists of two key components, including Manton RTS and AROWS 1c. The Manton Dam, located 50km southeast of Darwin, has storage capacity of 14,000 ML p.a. and a potential yield of approximately 7,300 ML p.a. The Dam, despite being largely used as a recreational facility by the greater Darwin population, has been maintained as an emergency water supply source following the commissioning of the Darwin River Dam in 1972. The Manton RTS, informed through PWC's undertaking on the required planning and investigation works, will include:

- Development of a new intake arrangement
- A new suction main pipework
- New pumping station
- Development of Strauss Water Storage and Treatment Facility.

The second component of Option 5, AROWS, is a proposed new reservoir located to the west of the Adelaide River (see Figure 57). PWC and the NT Government have comprehensively investigated AROWS since 2006, concluding that the Project has the potential to be staged across numerous years to include upgrades to increase the yield and capacity to meet the region's growing demand. Table 54 provides a brief description of Option 5 and the key components.

Table 54: Option 5 key components

Factor	Description / Assumptions
Change in water availability (yield)	38,000 ML p.a. • Manton RTS – 7,300 ML p.a. • AROWS 1c – 30,700 ML p.a.
Staging potential	Manton RTS could be implemented in a shorter timeframe to provide a short-term augmentation to supply. AROWS 1c would be delivered in a single stage with the ability to increase capacity if required.
Implementation timeframe	• 3 year delivery for Manton RTS, expected by 2024 • Approximately 5 year delivery for AROWS 1c with construction starting in 2022. Therefore, AROWS 1c is expected by 2027.

Figure 59 displays the total water demand that can be serviced by Option 5. As illustrated below, Option 5 will provide a limited water supply to industrial users, supplying just 75 per cent of industrial water demand from 2030 onwards. Due to the unsustainable water supply available to agricultural and horticultural users, Option 5 will not support the development of any agricultural/horticultural land.

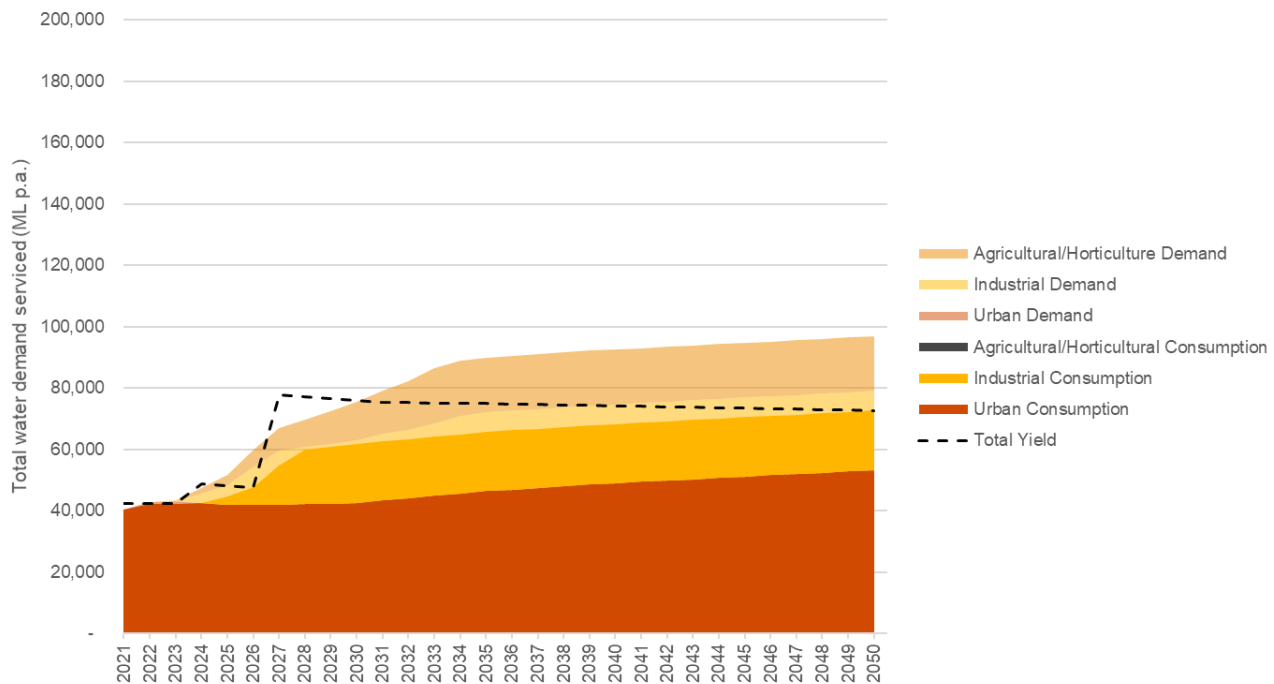


Figure 59: Water demand serviced by Option 5

Option 7 – AROWS 3

The key component of Option 7 is AROWS 3, the largest AROWS development able to provide sufficient water for urban, industrial and agricultural and horticultural users across the greater Darwin region. This option entails accelerating the development of AROWS to deliver the Project within a five year timeframe, thus avoiding the need for Manton RTS. The requirements of AROWS 3 include:

- RL32m dam height and pumping capacity to supply 165 ML/day or 60,200 ML p.a.
- Strauss Water Storage and Treatment Facility
- Harvesting pipes and pumps for water in the Adelaide River
- Pumps and piping to transfer the water to the Strauss Water Storage and Treatment Facility and then to integrate into the Darwin water grid
- Pumping and pipe infrastructure to deliver water to Middle Arm precinct
- Pumping and pipe infrastructure to deliver water to agriculture and horticulture precinct.

Table 55 provides a brief description of Option 7 and the key components.

Table 55: Option 7 key components

Factor	Description / Assumptions
Change in water availability (yield)	60,200 ML p.a.
Staging potential	The AROWS option can be staged. AROWS 3 delivers the largest scale AROWS project in a single stage delivery.
Implementation timeframe	Approximately 5 year delivery for AROWS 3, with construction starting in 2022. Therefore, AROWS 3 is expected by 2027.

Figure 60 displays the total water demand that can be serviced by Option 7. As illustrated below, this option will largely service 100 per cent of urban, excluding 98 per cent in 2025 and 97 per cent in 2026 prior to the start of operations. From

2039, 100 per cent of industrial and 88 per cent of agricultural and horticultural water demand will be serviced, resulting in an aggregate consumption of 98 per cent across the remaining years of the Project appraisal period.

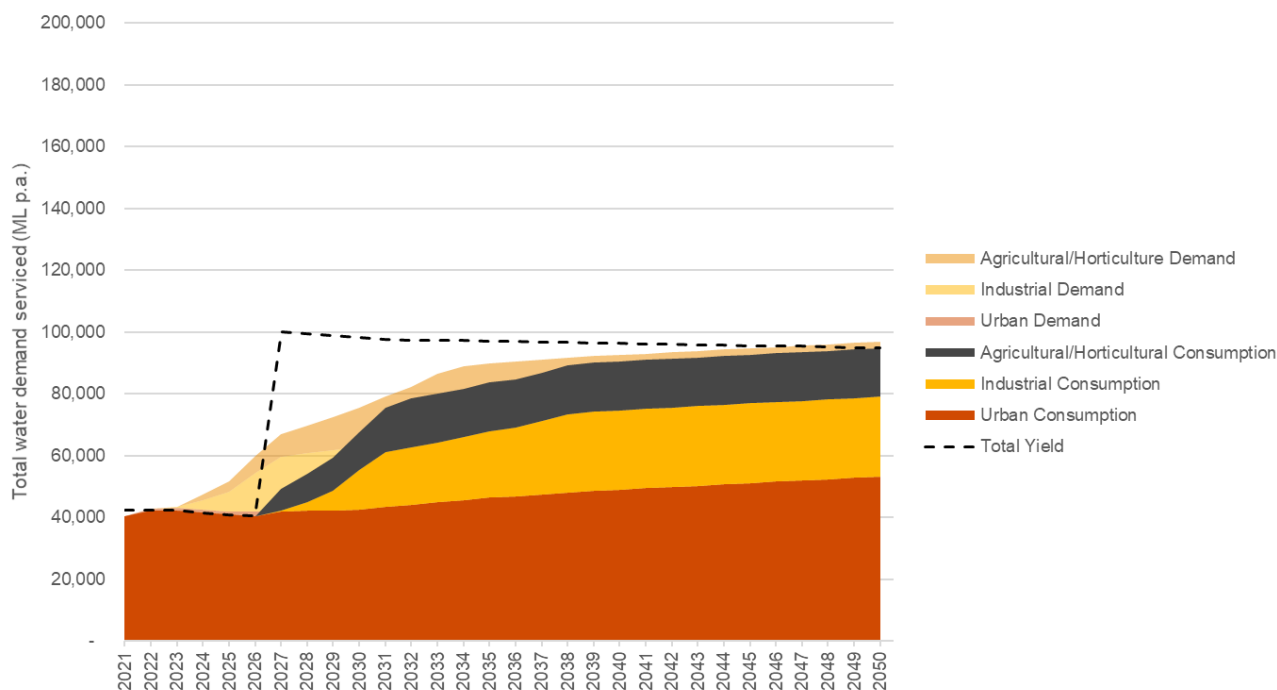


Figure 60: Water demand serviced by Option 7

Option 8 – Upper Adelaide River Dam

Option 8 consists of developing an in-stream dam at the connection point of Adelaide River and the Adelaide River west branch. The key features associated with the development of Upper Adelaide River Dam, informed by numerous studies and investigations, include:

- CSIRO notes the topography of the site is highly suitable, and yield cost is relatively low.
- Both CSIRO and PWC note that there are several sacred and/or culturally significant sites within the catchment area and approximately half the catchment area overlays the Litchfield National Park as well as areas with native title claims
- As an in-stream dam it will have significant environmental impact that would trigger an EPBC referral and an extensive EIS.

Table 56 provides a brief description of the key components included in Option 8.

Table 56: Option 8 key components

Factor	Description / Assumptions
Change in water availability (yield)	153,000 ML p.a.
Staging potential	Limited potential to be staged
Implementation timeframe	Approximately 15 year delivery for Upper Adelaide River Dam, forecast to be operational by 2037.

Figure 61 displays the total water demand that can be serviced by Option 8. Due to the Upper Adelaide River Dam's extended delivery period, a significant proportion of water demand in the region will not be serviced prior to the start of operations in 2037. For the decade prior to the start of operations, less than 60 per cent of total aggregate demand is serviced. Furthermore, it will take an additional 11 years following the start of operations in 2037 to service 100 per cent of

the total aggregate demand from urban, industrial and agricultural and horticultural users. Despite this significant lag in water supply, Option 8 will support the increasing water consumption of greater Darwin's urban population, in addition to supporting the development of several industrial precincts and 2,000 ha of agricultural/horticultural land.

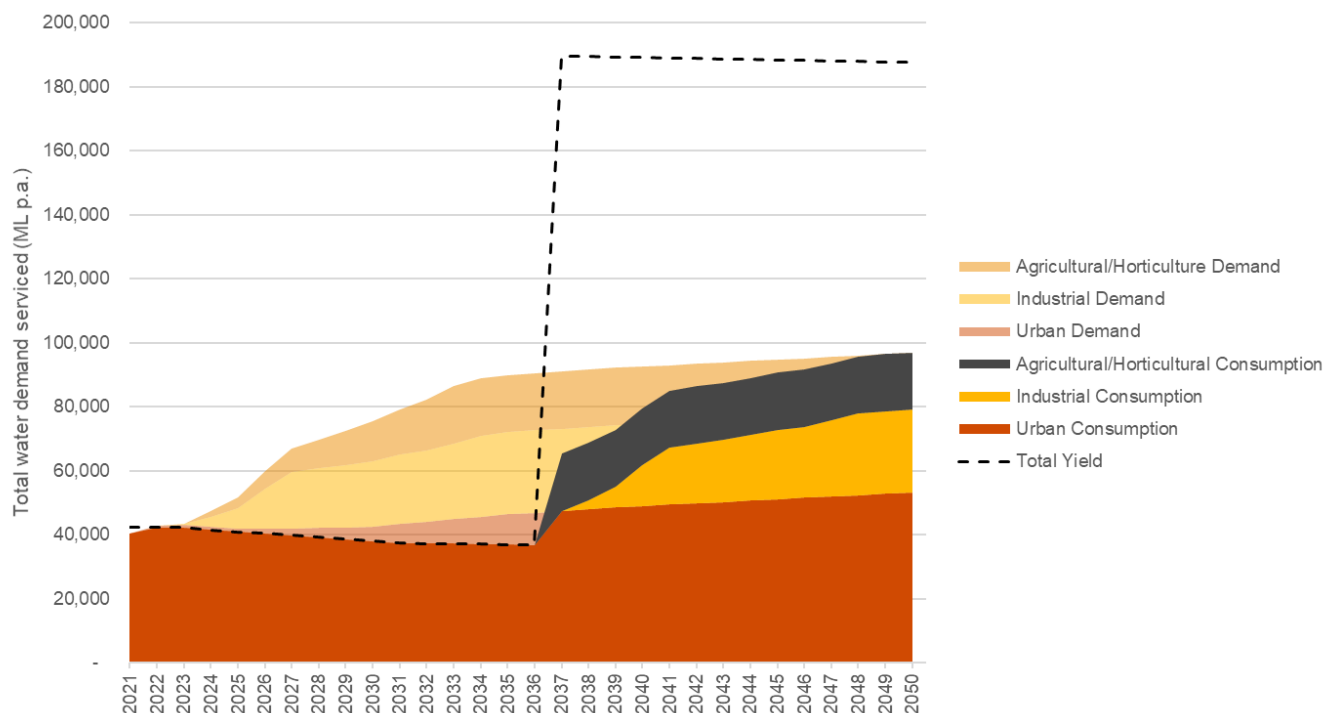


Figure 61: Water demand serviced by Option 8

Option 9 - Manton RTS and AROWS 3

Option 9 consists of two significant developments, including Manton RTS and AROWS 3. As described in above sections, AROWS 3 is the largest AROWS development able to provide sufficient water for urban, industrial and agricultural and horticultural users across the greater Darwin region. Manton RTS and AROWS 3 are planned for delivery by 2024 and 2027 respectively, with further details specified in above sections. Table 57 provides a brief description of the key components included in Option 9.

Table 57: Option 9 key components

Factor	Description / Assumptions
Change in water availability (yield)	67,500 ML p.a. - Manton RTS – 7,300 ML p.a. - AROWS 3 – 60,200 ML p.a.
Staging potential	Manton RTS could be implemented in a shorter timeframe to provide a short-term augmentation to supply. AROWS 3 delivers the largest scale AROWS project in a single stage delivery.
Implementation timeframe	3 year delivery for Manton RTS, expected by 2024 Approximately 5 year delivery for AROWS 3, expected by 2027

Figure 62 displays the total water demand that can be serviced by Option 9. As illustrated below, this option will service 100 per cent of urban, industrial and agricultural and horticultural water demand following the start of operations for both option components by 2027. Therefore, Option 9 will support the water consumption of greater Darwin's urban population, in

addition to supporting the development of several industrial precincts and 2,000 ha of agricultural/horticultural land in total, ensuring that all potential Project benefits are realised.

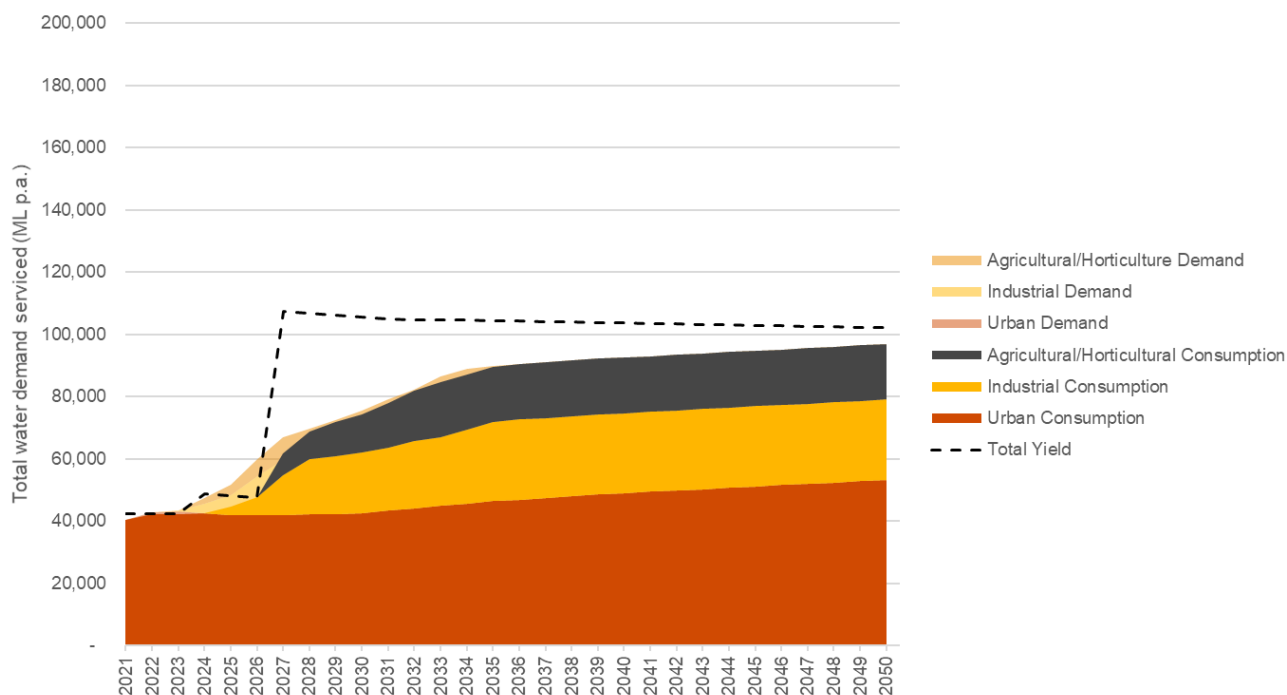


Figure 62: Water demand serviced by Option 9

Option Yield summary

Figure 63 summarises the total yield of each assessed Project option. As displayed, Option 8 will provide the largest yield, yet with a delivery period of approximately 15 years. Option 9, however, will provide a sustainable total yield for the greater Darwin region after the delivery period of just five years. The reduced delivery period of AROWS and associated Project options will mitigate the adverse impacts of a constrained water supply. Chapter 8, *Options identification and development*, provides a detailed analysis on the water yield provided by each Project option.

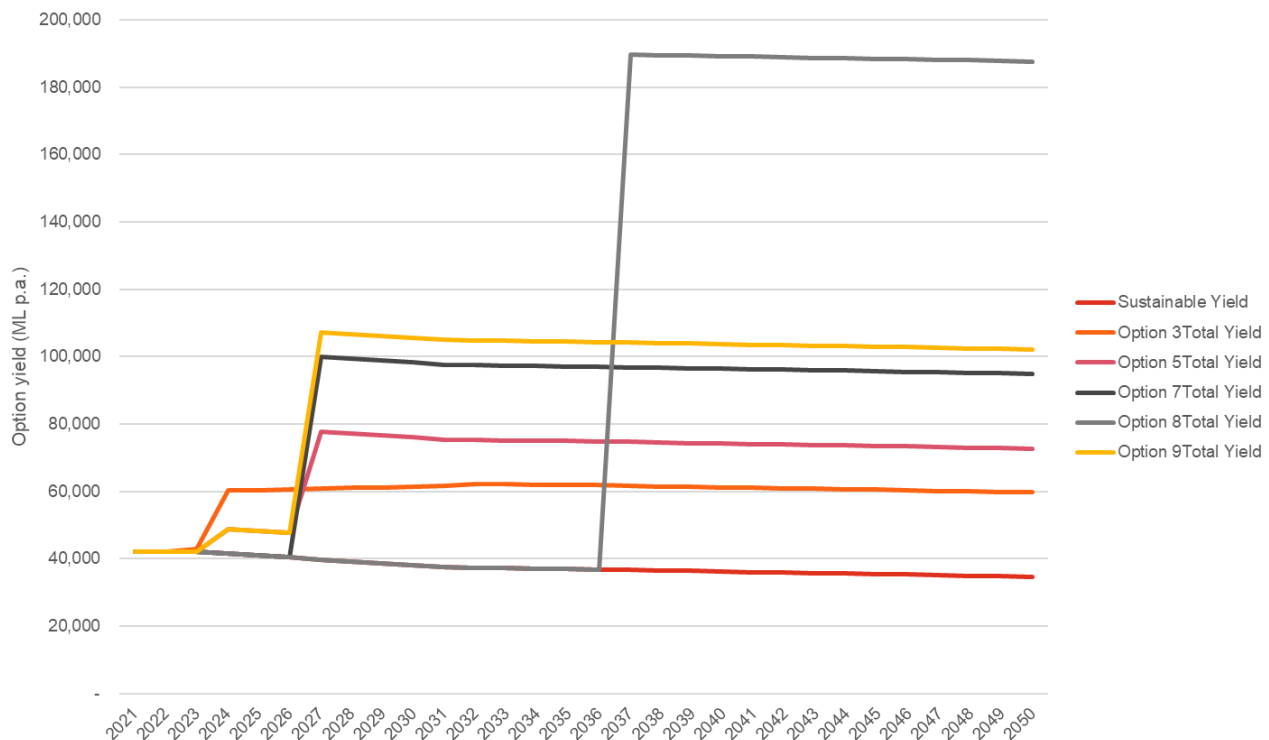


Figure 63: Summary of assessed option water yields¹³⁷

10.4 Costs

10.4.1 Introduction

There are three primary costs included in this rapid economic analysis, including:

- **Capital cost** – the estimated cost to deliver the Project
- **Operating cost** – the estimated cost to operate and maintain the AROWS Project
- **Lifecycle cost** – the total costs (CAPEX and OPEX) associated with the Project across the appraisal period.

The on-farm development cost, variable cost and opportunity cost are excluded from this section and captured in *Section 10.5.3* and *10.6* respectively instead. On-farm development and variable costs are directly correlated to agricultural and horticultural production and thus are deemed as disbenefits.

10.4.2 Capital cost

The Project's capital costs are expenses that are incurred to develop the option. All capital cost estimates were provided by SMEC, with the detailed cost estimate summary attached in Appendix D *SMEC Cost Report*. Table 58 represents the total capital costs associated with each assessed option.

¹³⁷ Note that the gradual increase in yield shown for Option 3 relates to a decrease in demand through the demand management measures. This is converted to an equivalent increase in yield for comparison purposes

Table 58: Capital cost of each project option

Project option	Option components	Construction timeframe	Real CAPEX (\$m)	PV CAPEX (\$m, discounted at 7 per cent real)
Option 3	Do minimum and disaggregated supply	2022 to 2024	\$510.7 ¹³⁸	\$431
Option 5	Manton RTS & AROWS 1c	2022 to 2027	\$859.7	\$659
Option 7	AROWS 3	2022 to 2027	\$1,099	\$872
Option 8	Upper Adelaide River Dam	2022 to 2037	\$1,329	\$769
Option 9	Manton RTS and AROWS 3	2022 to 2027	\$1,203.1	\$959

Additional costs are required to upgrade pipeline infrastructure to Middle Arm when total supply to the precinct exceeds 20 GL p.a. The total real capital cost for this infrastructure is \$77.8 million and is incurred in the year prior to demand exceeding 20 GL p.a..

10.4.3 Operating cost

The Project's operating cost estimates are the expenses incurred every year of operations. The operating costs were provided by SMEC, with the detailed cost estimate summary attached in Appendix D, *SMEC Cost Report*. Table 59 displays the real annual and total, discounted operating costs associated with each assessed option.

Table 59: Operating cost of each project option

Project option	Option components	Construction timeframe	Real OPEX (\$m p.a.)	PV of total OPEX (\$m, discounted at 7 per cent real)
Option 3	Do minimum and disaggregated supply	2022 to 2024	\$13.4	\$134
Option 5	Manton RTS & AROWS 1c	2022 to 2027	\$18.5	\$148
Option 7	AROWS 3	2022 to 2027	\$30.2	\$250
Option 8	Upper Adelaide River Dam	2022 to 2037	\$14.5	\$61
Option 9	Manton RTS and AROWS 3	2022 to 2027	\$31.7	\$253

For the purposes of the Preliminary Assessment, the costs have been estimated as an annual cost based on the cost of providing the total water requirement. This is a conservative assumption as a proportion of the costs will not be incurred as the options ramp up to providing the full water availability. Further analysis will be conducted at the DBC phase to more accurately reflect the total operation cost of each option over time.

10.4.4 Lifecycle cost

The lifecycle cost represents the total OPEX and CAPEX associated with the Project over the asset's useful life, assumed to be 30 years in accordance with Project appraisal period. The lifecycle cost presented in Table 60 incorporates the CAPEX and OPEX costs associated with the development of the AROWS Project and each assessed option.

¹³⁸ Including a \$20 million allowance for do minimum upgrades associated with non-infrastructure demand management activities.

Table 60: Project lifecycle cost for each project option (\$m, discounted at 7 per cent real)

Project option	PV OPEX (total)	PV CAPEX	Total lifecycle cost
Option 3	\$134	\$431	\$566
Option 5	\$148	\$659	\$807
Option 7	\$250	\$872	\$1,122
Option 8	\$61	\$769	\$830
Option 9	\$253	\$959	\$1,212

10.5 Benefits

The development of the AROWS Project will provide significant benefits across the region. The project benefits have been evaluated in terms of the benefits delivered to urban, industrial and agricultural and horticultural users in the Northern Territory. Due to the current development stage of the Project and available information, this rapid CBA may exclude a range of other benefits. Of these excluded benefits, the non-monetisable benefits are captured in Chapter [X], *Expected benefits*. This section will include both a quantitative and qualitative discussion of the Project's generated benefits, classified in terms of:

- **Benefits to urban users:** increased water security, monetised through reductions in the frequency and severity of water restrictions
- **Benefits to industrial users:** greater water supply supporting new industrial developments, monetised through Industry Value Added (IVA), and wages paid to the subsequent employees, monetised through salaries per employee.
- **Benefits to agricultural and horticultural users:** increased agricultural/horticultural crop output and production of higher value crops and horticulture, monetised through total net profit.

10.5.1 Benefit to urban users

As discussed in *Chapter 3 – Base case supply and demand* and *Chapter 5 – Problem identification and service need* the sustainable yield of the greater Darwin region's water supply is only just sufficient to meet current demand. As shown in Figure 64 there is expected to be a shortfall in water supply to meet water demand, in the absence of intervention, creating a near-term water security risk. This is expected to result in an increase in the incidence water restrictions being imposed on Darwin residents to mitigate this risk. Figure 65 identifies the forecast incidences of water restrictions. For this assessment, the Stage Two water restriction profile has been used. Figure 52 shows the forecast incidence of water restrictions under the base case supply and demand forecast. The greater Darwin region has not previously been subject to water restrictions.

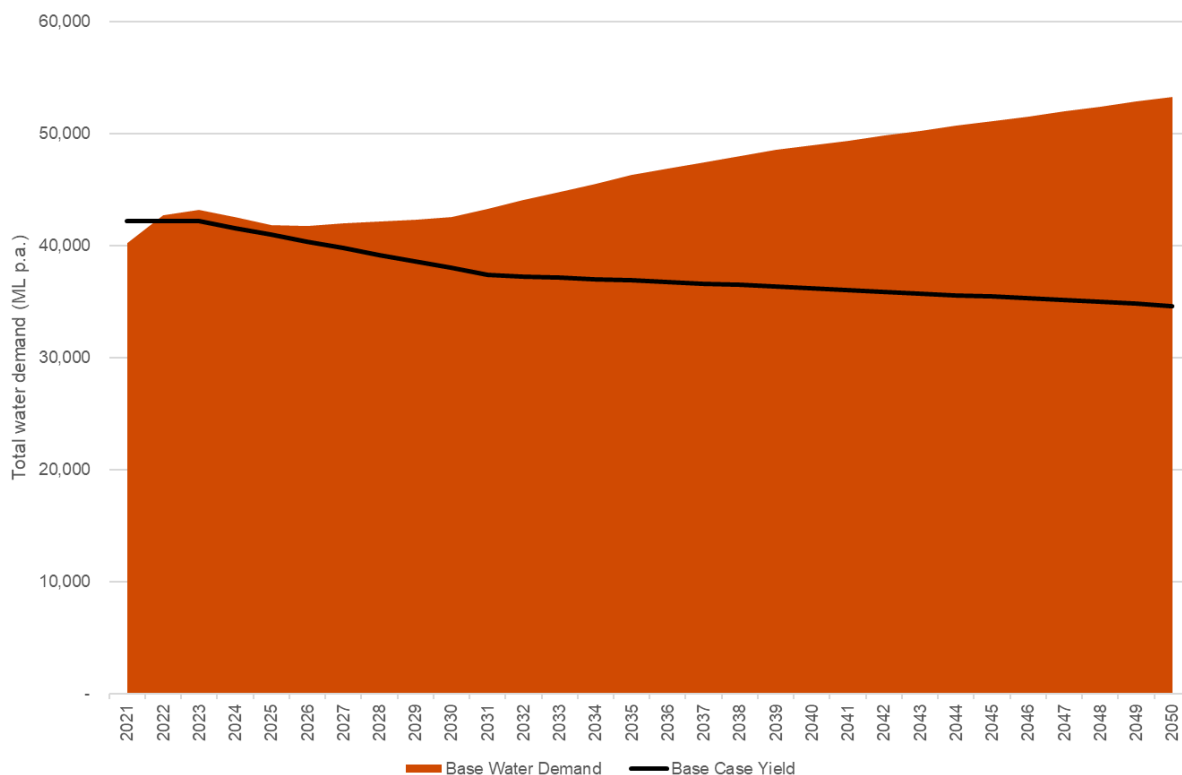


Figure 64: Urban water supply and demand

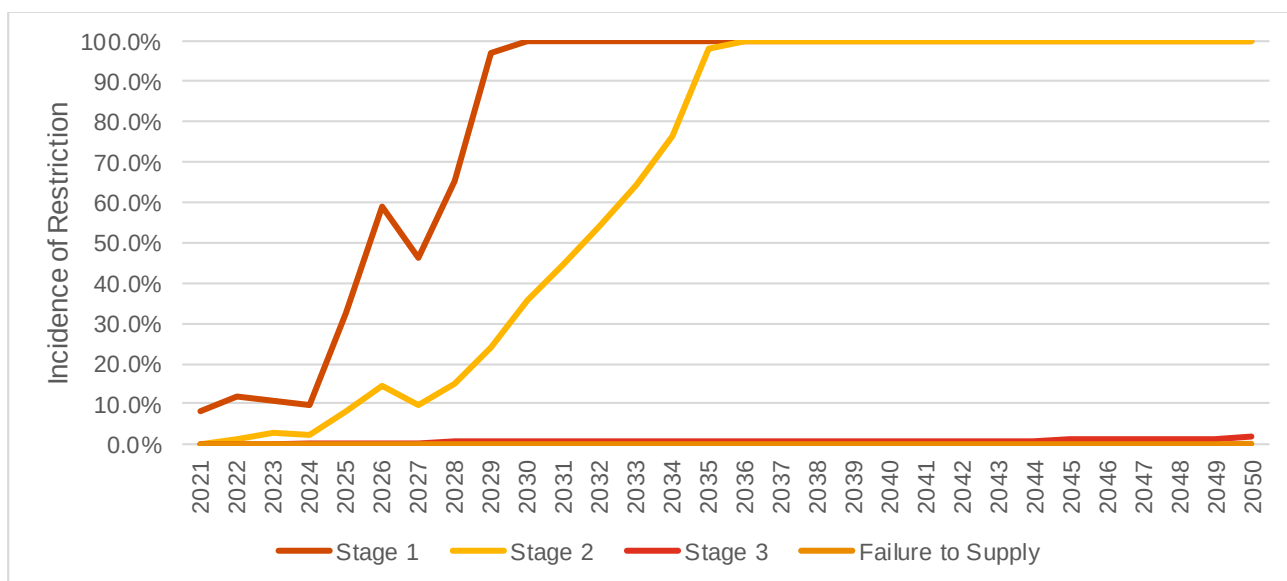


Figure 65: Projected water restrictions with no additional infrastructure¹³⁹

Water restrictions create several economic impacts and costs to urban water users, including the cost of compliance with demand management measures and the loss of both consumer and societal welfare. The direct and indirect costs of water restrictions on urban users include:

- Time and inconvenience costs of using water at prescribed times

¹³⁹ Power and Water Corporation

- Confusion regarding the composition of water restrictions and restricted timing
- Reduced recreational amenity for residents, such as gardening
- Constrained leisure activities for residents, such as private pools
- Reduced social cohesion due to likely disparities in additional water allocations
- Damage to private property from dry soil cracking
- Financial and time cost associated with purchasing and installing smart water meters, watering systems and other water saving devices
- Reduced use of green space and access to sport and recreational facilities¹⁴⁰.

Approach to monetise

Each of the options assessed results in differing impacts to the supply of water available for urban consumption, and therefore the expected future incidence of water restrictions. The monetisation of the economic impact of water restrictions was undertaken based on estimates of the Willingness to Pay to avoid water restrictions by households. The following equation was used to monetise the expected benefit to urban users from the development of each option:

$$\text{Benefit to urban users} = \text{impacted households} \times \text{Willingness to Pay} \times \text{reduced incidence of water restrictions}$$

To estimate the economic cost of water restrictions, the following inputs and components were estimated:

- Number of impacted households
- Willingness to Pay to avoid severe water restrictions
- Expected incidence of water restrictions.

Impacted households

This component represents the number of households impacted in the greater Darwin region, should restrictions be imposed on urban water users. This is estimated to include the number of households supplied via the PWC water network over the appraisal period. This has been calculated using the base case population information provided by PWC,¹⁴¹ in conjunction with greater Darwin 2016 Census data published by Australia Bureau of Statistics (ABS).¹⁴² Table 61 summarises the key household inputs and subsequent calculations.

Table 61: Inputs of greater Darwin impacted households

Measure / Input	Value
Base year population (2021)	139,045
Base year households (2021)	51,498
Calculated compound annual growth rate (CAGR) (% p.a.)	1.59%
2050 household forecast	82,598

¹⁴⁰ Productivity Commission (2011). *Australia's Urban Water Sector, Volume 1 No. 55, 31 August 2011*.

¹⁴¹ PWC (2019). *PWC model – v15.1 September 2019*.

¹⁴² ABS (2016). *2016 Census QuickStats: Darwin (SA4)*. Accessed at https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/701?opendocument

Willingness to Pay

The Willingness to Pay component of the calculation represents the price greater Darwin households are prepared to pay to avoid the implementation of water restrictions. To support the estimation, a number of studies and reports focusing on the cost of water restrictions in Australia have been referred to, including:

- Economic valuation of water reliability in South-East Queensland using choice modelling, 2007
- Willingness to Pay for increased reliability of water supply in South-East Queensland, a contingent valuation study, 2007
- Australian National University Willing to Pay research project, 2012
- Assessing the options for the Canberra water supply: an application of choice modelling, 2006
- Urban Water Restrictions: Attitudes and Avoidance Submission to Productivity Commission, 2011
- Price versus Rationing: Marshallian Surplus and Mandatory Water Restrictions, 2007
- The welfare costs of urban water restrictions, 2007
- Australia's Urban Water Sector Volume 1 Number 55, 2011.

The commonalities across this extensive list of research studies include:

- Households place a material value on being able to avoid severe water restrictions
- Generally households are only willing to pay to avoid severe water restrictions
- The Willingness to Pay of Households is not limited to just eliminating the possibility of severe water restrictions, as they are also willing to pay to reduce the likelihood of implementation.

These studies present the Willingness to Pay of households to reduce the implementation of severe water restrictions, largely valued between \$100 and \$300 p.a. Using this information, the Willingness to Pay of households in the greater Darwin region has been estimated to be \$150 p.a.¹⁴³ This value was used to represent the greater Darwin region's households Willingness to Pay due to their significant water use, relative to other States and Territories, in conjunction with their history of no water restrictions along with an assessment of the studies that most closely aligned with the greater Darwin region's demographic context.¹⁴⁴

Incidence of Water Restrictions

This component represents the likelihood of the implementation of water restrictions on urban users in the greater Darwin region. The current levels of service objectives adopted by the PWC are displayed in Figure 66.

¹⁴³ Australian Government Productivity Commission (2011). *Australia's Urban Water Sector*. Accessed at <https://www.pc.gov.au/inquiries/completed/urban-water/report/urban-water-volume1.pdf>

¹⁴⁴ Ideally primary research would be undertaken, including a bespoke Willingness to Pay survey, to determine the WTP for the directly impacted region. WTP studies require significant time and financial investment which may not necessarily justify the required investment. For the purpose of the Preliminary Evaluation, and aligned with the principles and purpose of a Rapid CBA, the inputs have been estimated based on existing data which are considered analogous. This may over or understate the results for the Darwin region.

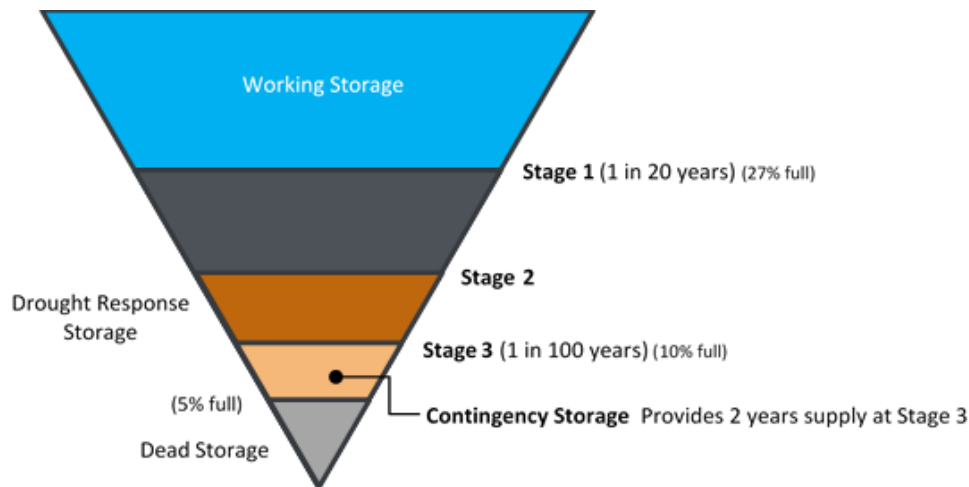


Figure 66: Levels of Service Objectives by the Power and Water Corporation ¹⁴⁵

As detailed in Figure 66, this includes:

- 95 per cent unrestricted demand reliability – Stage 1 water restrictions occurring once every 20 years
- 99 per cent restricted demand reliability – Stage 3 severe water restrictions occurring once every 100 years.

The greater Darwin region has never been subject to water restrictions and has the highest per capita household water consumption in Australia. It would be expected that any imposition of water restrictions on the greater Darwin region would be considered a significant impact to households given their current and historical water consumption trends and perceptions on the availability and cost of water. Using the Willingness to Pay studies and reports previously specified, in conjunction with comprehensive desktop research and analysis, it was concluded that water restrictions at any stage will negatively impact urban users in the region and be considered an economic cost.

A summary of the key inputs used to calculate the benefit to urban water users is provided in Table 62.

Table 62: Urban water user benefit inputs

Input / Component	Value (at 2021)	Description
Population	139,045	The population size of greater Darwin, provided by PWC
Individuals per household	2.7	The average number of individuals per household in the greater Darwin region
Impacted Households	51,498	The estimated households supplied by PWC in greater Darwin, with reference to the above two figures.
Willingness to Pay (\$ p.a.)	\$150	The Willingness to Pay of households in the greater Darwin region
Base case incidence of water restrictions (per cent p.a.)	5%	The likelihood of water restrictions at 2021 under the base case. This incidence of water restrictions increases over time, as discussed in

¹⁴⁵ Power and Water Corporation (2013). *Darwin Region Water Supply Strategy 2013*. Modified by SMEC.

Input / Component	Value (at 2021)	Description
		previous chapters and shown in Figure 52.

Total benefit to urban users

Using these key inputs, the real benefit to urban users p.a. for each Project option was calculated (see Figure 67). Each Project option, excluding Option 3, will provide largely the same real annual benefit to urban water users in greater Darwin.

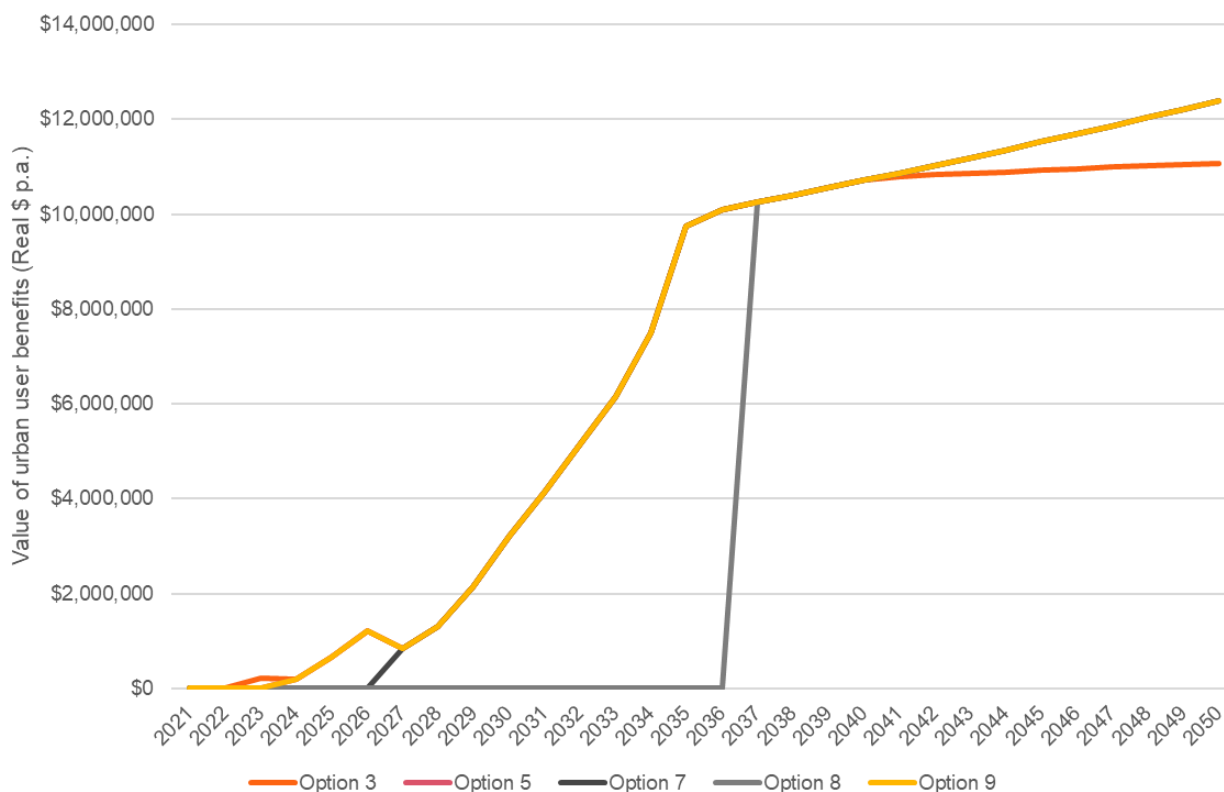


Figure 67: Real value of urban benefits from each option over the Project appraisal period

Table 63 summaries the total discounted benefits provided to greater Darwin's urban users. As detailed above, all options will deliver sufficient water yield to service future urban demand. Each option, excluding Option 8, will benefit greater Darwin urban water users by over \$70m.

Table 63: Total urban user benefits (\$m, discounted at 7 per cent real)

Project Option	Option Components	Urban user benefits
Option 3	Do minimum and disaggregated supply	\$57
Option 5	Manton RTS & AROWS 1c	\$59
Option 7	AROWS 3	\$61
Option 8	Upper Adelaide River Dam	\$48
Option 9	Manton RTS and AROWS 3	\$59

10.5.2 Benefit to industrial users

The development of the Project will enable the development of a number of industrial projects due to greater availability of water for industry purposes in the greater Darwin region. The increased water supply will support the development of several industrial precincts and plants, leading to increased industrial production levels and employment in the region. The potential industrial developments, of which provided by DIPL and commercial in confidence, are spread across a number of key industries. Table 64 details the key ANZSIC classifications of potential industrial developments in greater Darwin that are likely to be supported through an increased water supply.

Table 64: ANZSIC Classification of potential industrial developments in greater Darwin

ANZSIC Classifications ¹⁴⁶	IBISWorld Industry Description ¹⁴⁷
1701	Petroleum Refining and Petrol Fuel Manufacturing in Australia
1831	Fertiliser Manufacturing in Australia
1811	Industrial Gas Manufacturing in Australia
2139	Gold and Other Non-Ferrous Metal Processing in Australia
1090	Other Mining Support Services in Australia
2700	Gas Supply in Australia
6923	Engineering Consulting in Australia

Industry and growth assumptions

The estimated benefit to industrial users relies on a number of industry level benchmarks due to the limited availability of final output and operational information, as well as the private nature and unknown future plans of organisations. To ensure the industrial benefits accurately represent the potential industrial developments, a probability of success and scaling factor was used for each potential development. Chapter 4, *Potential water demand*, details the application of the scaling factor and probability of success.

A number of key assumptions were made throughout the industrial benefit estimation process, including:

- Increased water supply and security will support an expansion of industrial developments and subsequent production and industrial employment in greater Darwin
- The value of the benefit can be represented through the IVA and employee wages, resulting from an increased water supply available
- Wages and IVA benefit streams are proportional to the industry water demand that is met and supplied
- Wages will grow at the conservative rate of 2 per cent p.a., in alignment with the lower bound of the Reserve Bank of Australia's target inflation rate
- The ANZSIC reports and key industry ratios calculated by IBISWorld are representative of the organisation profiles provided by DIPL.

¹⁴⁶ ABS (2008). 1292.0 – Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006. Accessed at <https://www.abs.gov.au/ausstats/abs@.nsf/0/20C5B5A4F46DF95BCA25711F00146D75?opendocument>

¹⁴⁷ IBISWorld (2020). *Australia Industry Reports (ANZSIC)*. Accessed at <https://my.ibisworld.com/au/en/industry/home>

Approach to monetise

Using these assumptions, the benefit to industrial users has been calculated through the following equations:

$$\text{Gross Wages} = \text{Revenue Forecast} * \left(\frac{\text{Employees}}{\text{Revenue (\$)}} \right) * \text{Average Wage}$$

$$\text{Net Wages} = \text{Gross Wages} - \text{Revenue Forecast} * \left(\frac{\text{Employees}}{\text{Revenue (\$)}} \right) * \text{Reservation Wage}$$

$$\text{Net IVA Benefit} = \text{Revenue Forecast} * \left(\frac{\text{IVA}}{\text{Revenue (\$)}} \right) - \text{Gross Wages}$$

$$\text{Benefit to industrial users} = \text{Net IVA Benefit} + \text{Net Wages}$$

Where available, each measure was sourced as a time series from 2006 to 2026 from their respective IBISWorld ANZSIC Industry report. Subsequently, the CAGR was calculated from 2006 to 2020 and used to forecast each key measure over the appraisal period. The following sections will detail the approach and output of each benefit stream associated with industrial water users. Benefits have been calculated proportional to the total water availability at each stage of assessment.

Industry Value Added

The net IVA benefit stream refers to the total value of goods and services produced by an Industry over the appraisal period for this Project, net of operational and production input costs. By using the IVA approach, the intermediate inputs to other sectors are removed to ensure the final estimated benefit represents the value-added component of the industrial output supported through the development of AROWS. The IVA for each identified development was forecast, with respect to the industrial water demand that is met and supplied from the remaining water after urban use. Table 65 provides an overview of the net IVA benefit calculation for industry 1831 – *Fertiliser Manufacturing in Australia* in 2021.

Table 65: Indicative Net IVA benefit to fertiliser manufacturing water users in 2021

Measure	Calculation	Value (\$)
Estimated Project Revenue	<i>Input</i>	\$1.00
Employees/establishment	<i>Industry Benchmark</i>	9.04
Average Wage	<i>Industry Benchmark</i>	102,586.47
IVA/employee	<i>IVA per Revenue × Revenue per employee</i>	330.98
Gross Wages (\$m)	<i>Employees per establishment × Average wage</i>	0.92
Net Wages (\$m)	<i>Gross Wages – (Employees per establishment × Reservation wage)</i>	0.31
Gross IVA (\$m)	<i>Employees per establishment × IVA per employee</i>	2.99
Net IVA (\$m)	<i>Gross IVA – Total Wages + Net Wages</i>	2.37

For each identified development, the total net IVA was calculated and discounted, at 7 per cent real, constrained by the availability of water under each project option.

Wages

The wages benefit stream refers to the increased wages paid to the employees of potential industrial developments compared to a reservation wage¹⁴⁸. As previously discussed, wages were assumed to grow at 2 per cent p.a. in alignment with the lower bound of the RBA's inflation rate target. As detailed in Table 65, total wages were calculated through forecast employees per establishment and average industry wage values.

Total benefit to industrial users

Figure 68 presents the industrial water user benefits (Real \$) over the Project appraisal period. Despite Option 8 providing significant benefits to industrial users following the start of operations in 2037, the time value of money results in significantly reduced PV of benefits to industrial users.

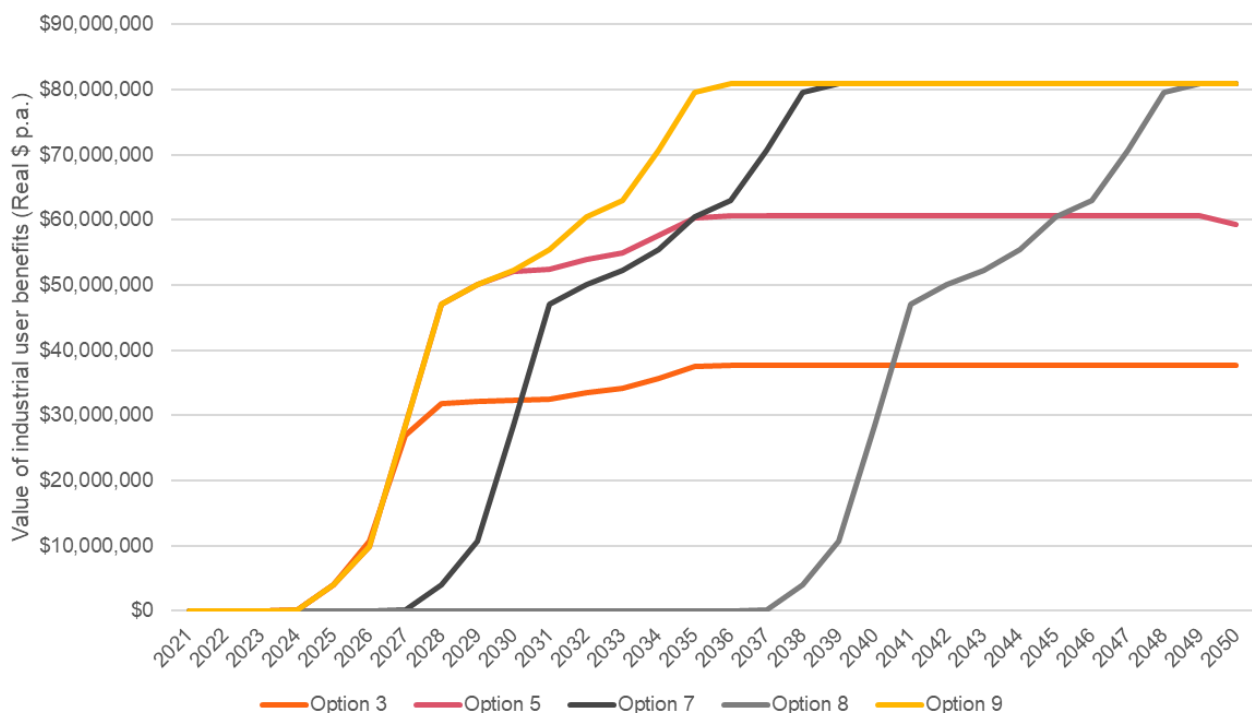


Figure 68: Real value of industrial benefits from each option over the Project appraisal period

Using the measures and subsequent forecasts for the remaining appraisal period, the total benefits to industrial users was calculated. Table 66 provides an overview on the NPV of benefits to industrial users for each Project option, highlighting Option 7 and 9 as the most beneficial to industrial users. These options, both of which including AROWS 3 as a key Project component, are forecast to benefit industrial water users by \$446m.

Table 66: Total industrial water user benefits (\$m, discounted at 7 per cent real)

Project Option	Option Components	Industrial user benefits
Option 3	Do minimum and disaggregated supply	\$284
Option 5	Manton RTS & AROWS 1c	\$444
Option 7	AROWS 3	\$440

¹⁴⁸ The reservation wage is the lowest wage rate at which a worker would be willing to accept a particular type of job

Project Option	Option Components	Industrial user benefits
Option 8	Upper Adelaide River Dam	\$224
Option 9	Manton RTS and AROWS 3	\$539

Alternative approach to valuation

An alternative approach to estimating the value of the project to industrial users is to identify the willingness to pay of the industry for the water. This approach is predicated on an assumption that the price paid for the water reflects the full value to the economy. This is an underestimate as there are additional benefits to the users of the water over the price paid.

PwC has conducted an analysis to determine the required willingness to pay for water to ensure equivalence between the two potential approaches. This has shown that the approach adopted in this analysis equates to approximately \$3,000/ML. Given the current water prices paid in the Northern Territory are in excess of \$2,000/ML, \$3,000/ML appears a reasonable estimate for the total value provided to the economy.

10.5.3 Benefit to agricultural and horticultural users

Agricultural and horticultural users will be beneficiaries of the AROWS Project as a result of the increased water supply and reliability supporting a greater crop output and the development of high-value crops and horticulture. Due to the Project's primary focus of supplying water to urban and industrial users in the greater Darwin region, the allocation of water to agricultural and horticultural users is highly dependent on the Project option and associated water yield.

Approach to monetise

The benefit to agricultural and horticultural users is estimated to be represented through increased agricultural/horticultural production, calculated through the incremental increase to the gross value of agricultural and horticultural production. By using this approach, the inputs and cost associated with agricultural and horticultural production are removed, ensuring the final estimated benefit represents the value-added component of the agricultural output. The expected benefit from the development of the Project to agricultural water users was calculated through the following equation:

$$\text{Benefit to agricultural and horticultural users} = \text{Crop Yield Revenue} - (\text{on farm costs} + \text{variable costs})$$

The key assumptions used when calculating the benefit to agricultural and horticultural users include:

- The assumed crop mix and take up rates
- The time taken to reach full production for each crop type
- On-farm costs and revenues including:
 - development cost for each crop to account for the infrastructure required to develop the farm
 - Ongoing costs associated with producing the crops
 - The gross value of the crops produced.

The following sections will detail the calculation of the Project's benefits to agricultural and horticultural users.

Crop mix and take up rates

High value crops and horticulture, when compared to broad-acre crops, require specific soil types and climates, in addition to exponentially greater levels of management and water quality and availability¹⁴⁹. Therefore, the suitability of each crop to the greater Darwin region's land, climate and soil was tested through marketing sounding with key stakeholders, and comprehensive desktop research and analysis. This included consultations with agricultural producers in conjunction with

¹⁴⁹ Agriculture Victoria (2020). *Establishing a successful small horticulture enterprise*. Accessed at <http://agriculture.vic.gov.au/agriculture/horticulture/horticulture-and-business/small-horticulture-enterprise-principles>

the analysis of comparable projects and regional data. This process is explained in detail in Chapter 4, *Potential water demand* and resulted in an ultimate crop mix outlined in Table 67.

Table 67: Assumed ultimate crop mix

Crop	Available hectares for development (ha)
Mango	1,000
Citrus Oranges	250
Citrus Lemons	250
Okra	500

This land is assumed to be taken up over a 10 year period if there is adequate water available. The land area taken up under each scenario is shown in Table 68.

Table 68: Crop mix for each option

Crop	Option 3	Option 5	Option 7	Option 8	Option 9
Mango	0	0	883	1,000	1,000
Citrus Oranges	0	0	221	250	250
Citrus Lemons	0	0	221	250	250
Okra	0	0	442	500	500
Total	0	0	1,767	2,000	2,000

Crop production profile

Three of the four crops assumed to be planted are perennial tree crops which require a number of years before reaching full production. The assumed proportion of crop production in each year from planting for these crops is shown in Table 69.

Table 69: Crop production profile (percentage of full production per hectare)

Crop	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Mango ¹⁵⁰	0	0	30	30	60	80	80	100
Citrus Oranges ¹⁵¹	0	0	30	30	60	80	80	100
Citrus Lemons ¹⁵²	0	0	30	30	60	80	80	100

The fourth crop, Okra, is an annual crop and is assumed to reach full production in year 1.

On farm costs and revenues

The key on-farm costs and revenues assumed for each crop type is shown in Table 70. These estimates are based off a range of industry benchmarks and market sounding outcomes and represent the current best estimates. The overall agricultural and horticultural benefits realised is sensitive to these inputs and it is possible that best practice operators could perform substantially better than these benchmarks.

¹⁵⁰ Substantiated through market sounding

¹⁵¹ Substantiated through market sounding

¹⁵² Substantiated through market sounding

Table 70: Key cost and revenue metrics for selected crops

Crop	Yield at full production (t/ha)	Revenue (\$/t)	On-farm development cost (\$/ha)	Variable cost (\$/ha)	Revenue per hectare (\$/ha)
Mango ¹⁵³	15	\$3,000	\$45,000	\$7,375	\$45,000
Citrus Oranges ¹⁵⁴	50	\$950	\$30,000	\$18,803	\$47,500
Citrus Lemons ¹⁵⁵	50	\$1,250	\$30,000	\$20,940	\$62,500
Okra ¹⁵⁶	25	\$5,500	\$10,000	\$70,899	\$137,500

Total benefit to agricultural and horticultural users

Figure 69 presents the agricultural and horticultural water user benefits (Real \$) over the Project appraisal period. As displayed, agricultural and horticultural users in the greater Darwin region will experience years of disbenefits due to requirement for upfront on-farm capital costs and the development time required to produce each crop at full capacity. Despite these years of negative benefits, Option 7, 8 and 9 will provide the largest real benefits to agricultural horticultural users.

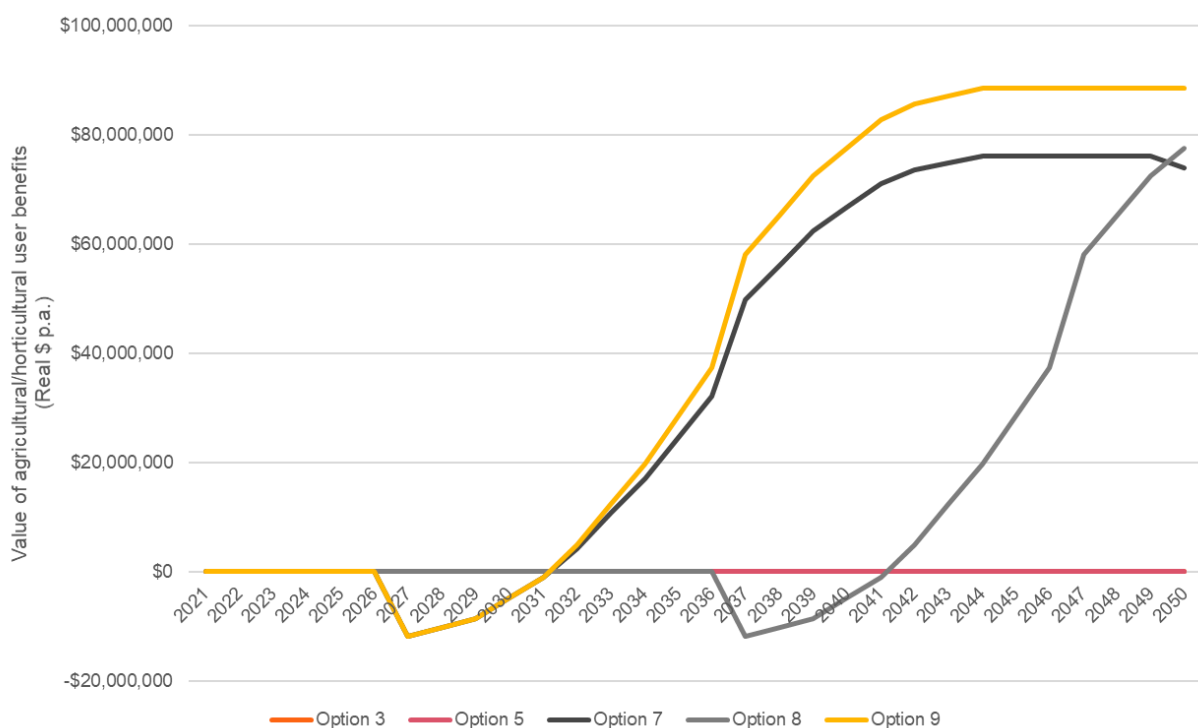


Figure 69: Real value of agricultural benefits from each option over the Project appraisal period

¹⁵³ Substantiated through market sounding

¹⁵⁴ Citrus Australia (2015). *ORC Evidence Requirements for the Citrus Industry*. Accessed at <http://www.planthealthaustralia.com.au/wp-content/uploads/2012/11/Citrus-ORC-Evidence-Framework-Perennial-trees.pdf>

¹⁵⁵ Citrus Australia (2015). *ORC Evidence Requirements for the Citrus Industry*. Accessed at <http://www.planthealthaustralia.com.au/wp-content/uploads/2012/11/Citrus-ORC-Evidence-Framework-Perennial-trees.pdf>

¹⁵⁶ Jacobs Group (2018). *Northern Territory Irrigated Agriculture Feasibility Study*; CSIRO & DPIR (2018). *Agricultural viability: Darwin catchments*. Accessed at <https://publications.csiro.au/rpr/download?pid=csiro:EP186191&dsid=DS3>

Using this process, the total NPV to agricultural and horticultural water users was calculated (see Table 71). As displayed below, both Option 7 and 9 will be the most beneficial to agricultural and horticultural users in greater Darwin. Option 7 and 9, both of which including AROWS 3 as a key Project component, are forecast to benefit agricultural and horticultural water users by \$234m and \$290m respectively.

Table 71: Total NPV benefits to agricultural water users for each Project option (\$m, discounted at 7 per cent real)

Project Option	Option Components	Agricultural user benefits
Option 3	Do minimum and disaggregated supply	\$0
Option 5	Manton RTS & AROWS 1c	\$0
Option 7	AROWS 3	\$256
Option 8	Upper Adelaide River Dam	\$157
Option 9	Manton RTS and AROWS 3	\$284

10.5.4 Total benefit to water users

Using the information presented in previous sections, the total benefit to water users in greater Darwin was calculated. Figure 70 illustrates the total benefit (Real \$) delivered from each Project option per year of the appraisal period. As illustrated, Option 7, 8 and 9 will provide the most significant benefits over the entire period. However, as previously outlined in above sections, Option 8 – Upper Adelaide River Dam will only deliver benefits from 2037 onwards. Subsequently, the PV of total benefits delivered by Option 8 will be significantly reduced, resulting in significantly greater benefits associated with Option 7 and 9.

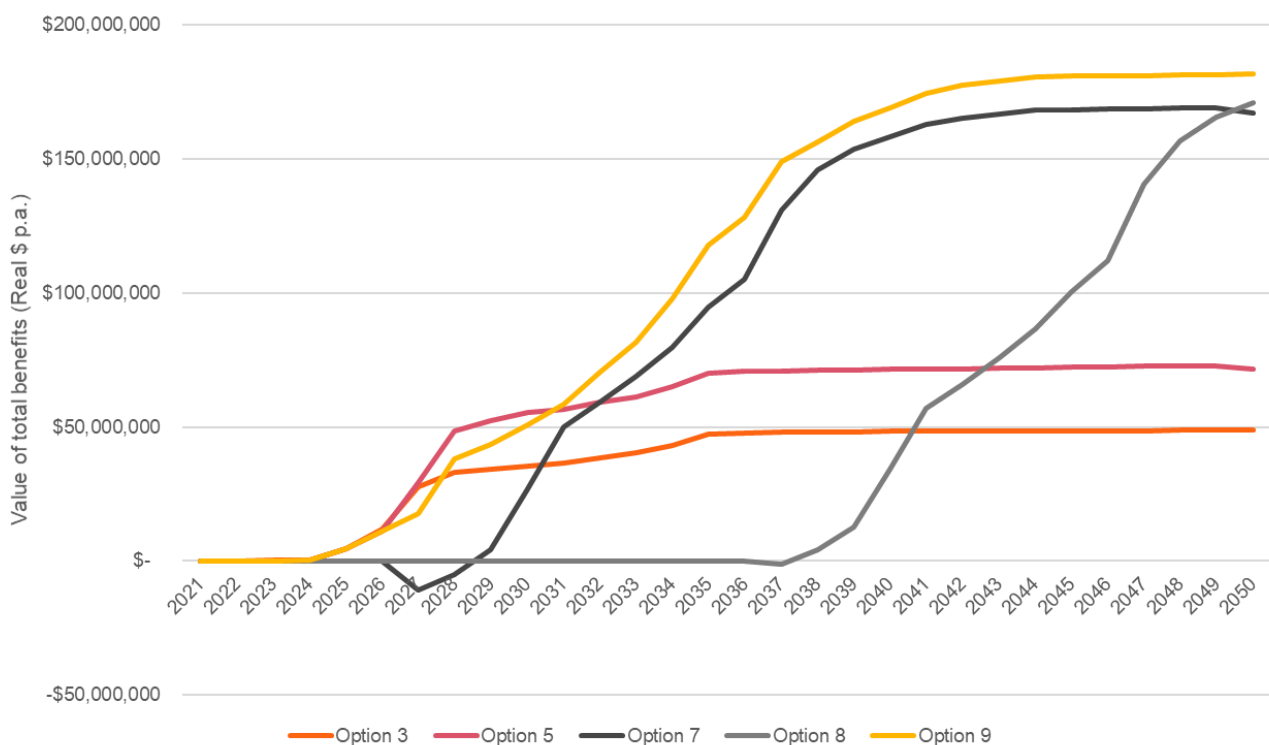


Figure 70: Total real benefits to water users from each option over the Project appraisal period

Table 72 summarises the total benefits of each Project option to urban, industrial and agricultural/horticultural water users in greater Darwin. Option 9, Manton RTS and AROWS 3, will provide the largest benefit to greater Darwin, valued at \$805m.

Table 72: Summary NPV benefits to all water users in greater Darwin (\$m)

Benefit stream	Option 3	Option 5	Option 7	Option 8	Option 9
Urban benefits	\$57	\$59	\$61	\$48	\$59
Industrial benefits	\$284	\$444	\$440	\$224	\$539
Agricultural and horticultural benefits	\$0	\$0	\$256	\$157	\$284
Total benefits	\$341	\$503	\$758	\$429	\$882

10.6 Opportunity Cost

The development of the AROWS Project will result in an opportunity cost associated with the land used or impacted. These opportunity costs are assumed to be disbenefits. However, due to the lack of correlation or association with production, the Project's opportunity costs are considered separately. The two key opportunity costs that are likely to arise from the development of the Project include:

- Manton Dam RTS
- Alternate land use.

10.6.1 Manton Dam RTS

The Manton Dam currently provides a recreational amenity to the residents in the greater Darwin region in the form of fishing, water-skiing, rowing and limited other activities. Therefore, this recreational amenity will be lost should the Dam return to service (RTS). As a result, there is an opportunity cost associated with Project options that include Manton RTS. These options are:

- Option 5 – Manton RTS and AROWS 1c
- Option 9 – Manton RTS and AROWS 3.

The estimation of this opportunity cost is limited and complex, given the amenity services provided by the Manton Dam are non-market goods and services and thus do not command a price. Therefore, the value of the Manton Dam as a recreation site has not been measured in this preliminary assessment.

10.6.2 Alternate Land Use

There is an opportunity cost associated with the land used for the development of the AROWS Project. The alternate land uses are only applicable to the expended agricultural and horticultural development supported through the AROWS Project, as industrial developments cannot be supported without the increased water supply. The alternate land use of the agricultural/horticultural land developed is a potential pine plantation.

The subsequent DBC phase should include a detailed investigation into the monetised, opportunity cost associated with the Manton RTS and development of agricultural/horticultural land.

10.7 Rapid CBA results

Table 73 presents the outcomes of the CBA for all each Project option assessed throughout this chapter.

Table 73: CBA results (\$m, discounted at 7 per cent real)

	Do minimum & disaggregated supply	Manton RTS & AROWS 1c	AROWS 3	Upper Adelaide River Dam	Manton RTS & AROWS 3
	Option 3	Option 5	Option 7	Option 8	Option 9
Costs					
Capital costs	\$431	\$659	\$872	\$769	\$957
Operating costs	\$134	\$148	\$250	\$61	\$253
Total Costs	\$566	\$807	\$1,122	\$830	\$1,212
Benefits					
Urban user benefits	\$57	\$59	\$61	\$48	\$59
Industrial benefits	\$284	\$444	\$440	\$224	\$539
Agricultural/horticultural benefits	\$0	\$0	\$256	\$157	\$284
Total Benefits	\$341	\$503	\$758	\$429	\$882
NPV	\$-224	\$-303	\$-364	\$-401	\$-330
BCR	0.60	0.62	0.68	0.52	0.73

10.8 Sensitivity testing

Sensitivity testing was undertaken on the key inputs and rivers of the CBA to ensure the robustness of the results, and sensitivity to changes in key parameters. Table 74 presents the NPV results from the sensitivity testing that was undertaken.

Table 74: NPV sensitivity testing results (\$m)

Option	4% discount rate	7% discount rate	10% discount rate
Option 3	(\$ 108)	(\$ 224)	(\$ 277)
Option 5	(\$ 141)	(\$ 303)	(\$ 368)
Option 7	\$ 39	(\$ 364)	(\$ 518)
Option 8	\$ 39	(\$ 401)	(\$ 468)
Option 9	\$ 81	(\$ 330)	(\$ 500)

Table 75 presents the BCR results from the sensitivity testing that was undertaken.

Table 75: BCR sensitivity testing results

Option	4% discount rate	7% discount rate	10% discount rate
Option 3	0.84	0.60	0.44
Option 5	0.86	0.62	0.47
Option 7	1.03	0.68	0.45
Option 8	0.97	0.52	0.28
Option 9	1.05	0.73	0.51

10.9 Summary

The rapid CBA has shown that the most economically efficient option is Option 9 – Manton RTS and AROWS 3. At a 7 per cent discount rate this option is estimated to provide total economic benefits of over \$880 million, with a BCR of 0.73. Using a 4 per cent discount rate yields total benefits of \$1,511 million and a BCR of 1.05.

This rapid economic analysis indicates that:

- There is a need for Manton RTS to be implemented in the short term to overcome the impending urban supply shortfall.
 - This has been recognised by PWC and this Project is a key component of their infrastructure strategy.
- There is an opportunity to develop AROWS 3 to provide 60GL p.a. of additional water to provide further urban water security as well as to realise growth in industrial demand and to provide opportunities for the agricultural and horticultural sector.
- In the longer term, there may be opportunities to further explore the Upper Adelaide River Dam to provide continued growth for agriculture and horticulture in the areas in close proximity to the dam.
 - The cost of the Upper Adelaide River Dam is relatively low if there is the ability to remove significant pipeline and water treatment infrastructure. By implementing AROWS3 and Manton RTS in the shorter term, there will be limited need for additional water to be delivered to the greater Darwin region, and therefore, the Upper Adelaide River Dam could be constructed as a stand-alone asset to provide a relatively low cost source of additional supply for the agricultural and horticultural industry.
- There is also an opportunity to explore small scale disaggregated water supply options including desalination and recycled water to supplement the water supply as required. This is likely to be for dedicated industrial demand where there are short term constraints limiting industrial growth where there is a high willingness and capacity to pay for the water.

11 Conclusions and recommendations

11.1 Conclusions

The Northern Territory has recognised that there is a strategic need to address the supply and demand issues associated with water in the greater Darwin region. Without a new water supply, the greater Darwin region is likely to be subject to significant water restrictions in the medium term, and new investment and growth in the agricultural/horticultural and industrial sectors will likely be constrained.

11.1.1 Project background

A significant amount of planning, investigation and analysis has been conducted on the water supply in the greater Darwin region, including a range of potential enhancement options and interventions. Previous analyses highlighted that there is significant potential for further industrial and agricultural/horticultural development in the region however, the lack of sufficient water supply is a constraint on this potential. There was general agreement that action should be taken as a priority to ensure a reliable water source for urban, industrial, agricultural and horticultural consumers. Each study concluded that further analysis and investigation be undertaken to ensure the AROWS Project addresses the strategic need for a secure water supply.

Water for the greater Darwin region is predominantly supplied by the groundwater resources and the Darwin River Dam. Based on the sustainable yield of the greater Darwin region water supply network, supply is only just sufficient to meet current demands. Given the significant fluctuations in storage levels, the Darwin River Dam is dependent on high rainfall wet seasons for recharge. Multiple successive poor recharges have been experienced recently, resulting in storage levels not being fully recharged with near-term water security risks emerging. The West and Central zones of the HGS currently supply 80 per cent of the extracted groundwater for the region. Based on the current estimates of the extraction and recharge for these zones they are 380 per cent, and 150 per cent over extracted respectively¹⁵⁷. DENR estimates that extraction would have to reduce by 24,000 ML p.a. to achieve sustainable groundwater extraction in these zones.

Figure 71 demonstrates that under the base case assumptions, water demand will exceed the sustainable yield of the reticulated water network with a shortfall of approximately 20,000 ML p.a. by 2050. This base case assumes no major economic development or growth, and only long run organic growth in population and commercial/industrial demand.

¹⁵⁷ SMEC through information provided by DENR, 2020

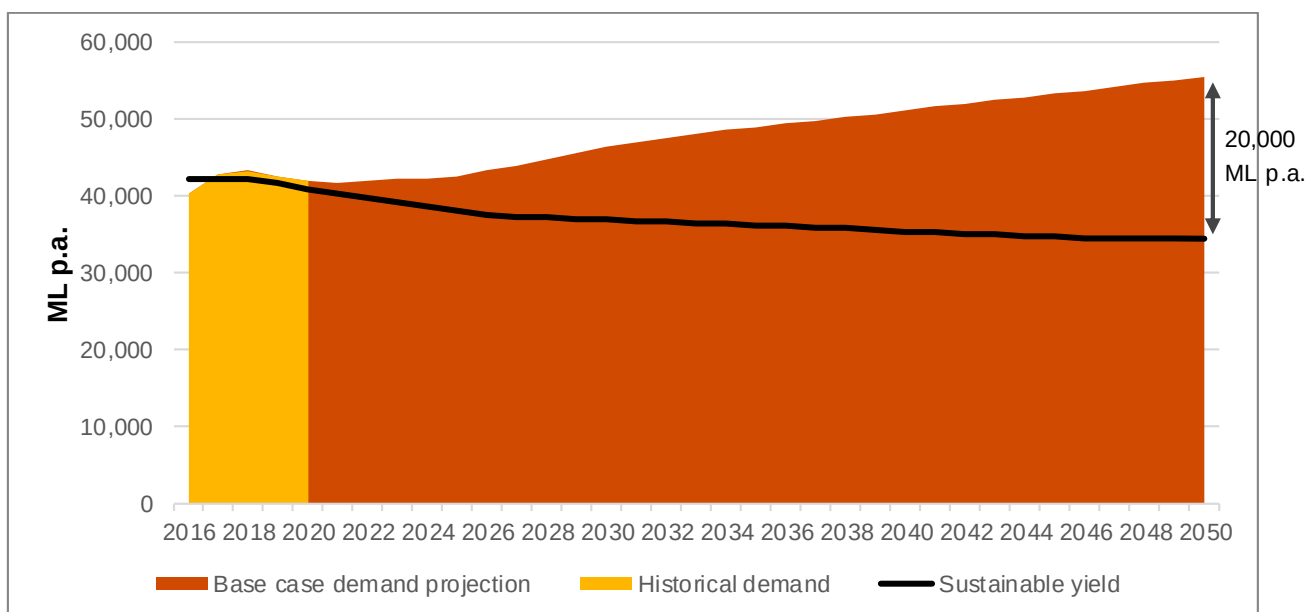


Figure 71: Supply and demand reticulated network balance

This forecast shortfall between yield and demand creates a significant near-term water security risk with no additional supply augmentations.¹⁵⁸ PWC LOS are likely to be breached under this scenario and water restrictions will need to be imposed on the greater Darwin region to ensure long term continuity of water supply.

11.1.2 Strategic need and future demand for the project

The NT consumes nearly double the water per person than any other state or territory in Australia, and the greater Darwin region has never been subject to water restrictions. Despite efforts in recent times to reduce usage through the 'Living Water Smart' demand management initiative, high water consumption is a historical issue in the Territory. High household water consumption is only expected to continue in the absence of strong demand management measures. Population growth will also result in increasing demand and competition for water for urban, industrial and agricultural/horticultural uses. As annual extraction by these users increases, water levels will continue to drop at the end of the dry season each year, threatening a fall in water levels not previously experienced.

The impacts of climate change on yields available from Darwin River Dam and the recommissioned Manton Dam are expected to be significant. Increases in evapotranspiration will affect runoff storages, which is a problem for the greater Darwin region's relatively broad and reservoirs. Whilst the NT Government has not previously imposed water restrictions on customers in the greater Darwin region, PWC modelling indicates that water supply intervention will be required by 2026 to meet future water demand and provide sufficient water security, reliability and resilience in the event of climate change impacts.

There is a significant opportunity to leverage the growing gas industry in the NT by establishing a gas-based manufacturing and industrial hub at the Middle Arm Industrial Precinct which cannot be realised without a secure and reliable water supply. Based on the current supply and demand balance, there is insufficient water available to support any meaningful industrial development without compromising urban water security. Middle Arm Industrial Precinct has the potential to create a step change economic boost for the greater Darwin region, however, the development and growth of the Precinct is currently constrained by access to a water supply that can meet the volumes required by new industrial users.

The Darwin rural region is the most productive horticultural region in the NT, producing large volumes of mangos, melons, watermelons and many other crops. There is significant potential in the greater Darwin region for new agricultural and horticultural production, particularly at Lambells Lagoon and Middle Point. While further investigations must be undertaken

¹⁵⁸ As noted previously, PWC is actively planning for supply augmentations however as the final costs for these investments have not yet been approved, they are excluded from the Base Case.

to more fully understand soil suitability, these areas are already producing a diverse range of horticulture. Development of these areas presents new opportunities to diversify or value add, and for niche sectors to emerge from new and existing agribusinesses.

High value horticulture requires high volumes of water, with estimates ranging from 7 to 12 ML/ha per annum. Extraction from key groundwater resources that service the horticultural industry in the region are at, or above, sustainable levels. This is prohibiting potential agricultural and horticultural development in the region and creating a barrier for domestic and international investment in the NT. A new agricultural and horticultural development area that is facilitated by an increased water supply will provide certainty for investment and stimulate growth and output of the region.

The Preliminary Assessment has identified seven key problems and opportunities for this Project to attempt to overcome. These are highlighted in Table 76, along with the preferred option's ability to address the requirement.

Table 76: Project's ability to address problems and opportunities

Problem / opportunity	Does Project address problem / opportunity
Darwin water supply over the medium term (5+ years) is not sufficient to provide the current Levels of Service that PWC offer or support increased population growth in the urban areas	Yes
Regional reliance on one primary water source increases the exposure of the water supply to environmental and seasonal factors and climate change which poses water security risks due to a lack of redundancy	Yes
The groundwater network in the Darwin rural region is over allocated creating water reliability, security and environmental risks and inhibiting further strategic land development	No ¹⁵⁹
The strategic positioning and development of additional cost effective and efficient water supply can enable increased high-value agricultural and horticultural production in the greater Darwin region	Yes
Potential industrial growth, specifically the Middle Arm precinct, is constrained by current water availability in the greater Darwin region	Yes
Inefficient water consumption by urban, industrial, agricultural and horticultural water users results in higher water consumption impacting water availability to potential new users, water security for existing users and natural environmental and systems	Partly
Potential efficiencies gained in water consumption may be offset by the impacts of climate change on increased water usage and a lack of resilience in the greater Darwin region water supply.	Yes

Augmenting the water supply in the greater Darwin region will result in several economic, environmental and social benefits, as well as benefits to the industrial and agricultural/horticultural sectors through significant growth opportunities.

11.1.3 Options assessment

A detailed options assessment process was undertaken to create a shortlist of five projects to be subject to rapid economic analysis. The five shortlisted projects include:

- 1 Option 9 – Manton RTS & AROWS 3
- 2 Option 5 – Manton RTS & AROWS 1c
- 3 Option 7 – AROWS 3

¹⁵⁹ As noted throughout this Preliminary Assessment, there is a range of actions which need to be taken to overcome the over-extraction from the groundwater resource, and, given the costs of enabling this Project to provide additional water to these areas, this was not considered a focus for this Project.

4 Option 3 – Do minimum & disaggregated supply

5 Option 8 - In-stream dams.

Options 5, 7, 8 and 9 all provide large volumes of water to support economic development. Option 3 still includes the delivery of new infrastructure, however, represents a packaged option combining non-infrastructure and lower capital cost infrastructure options while still providing sufficient water to support industrial development.

These five options were subject to rapid economic analysis which indicated that Option 9 (Manton RTS and AROWS 3) is the most economically efficient of the shortlisted options.

11.2 Recommendations

The Northern Territory has recognised that there is a strategic need to address the supply and demand issues associated with water in the greater Darwin region. Without a new water supply, the greater Darwin region is likely to be subject to water restrictions in the medium term, and new investment and growth in the agricultural, horticultural and industrial sectors will likely be constrained. A comprehensive range of options was identified and investigated in response to the key problems and opportunities. Whilst a number of these options appeared to have a number of strengths, they also have some limitation which meant they could not respond to the service need and therefore they will not be investigated in further detail. These include:

- Option 8 – UARD has been discounted due to its inability to meet the short and medium term water requirements, and significant development risks. However, as discussed above, its long term development could provide continued growth for the agricultural and horticultural industries.
- Option 7 – AROWS 3 has been discounted as it cannot meet the short term water requirement.
- Option 5 – Manton RTS and AROWS 1c has been discounted as it does not provide sufficient water to fully activate the industrial precinct and provides no water for agricultural or horticultural growth.

It is recommended that DTBI:

- Obtain endorsement to progress the Project to the DBC phase
 - The recommended options to progress to the DBC are:
 - Option 9 – Manton RTS and AROWS 3
 - Option 3 – Do minimum and disaggregated supply (including the delivery of a desalination plant at Middle Arm as part of the disaggregated supply component).
- Explore in greater detail the following components of the project in the DBC:
 - Environmental impacts
 - Legal and regulatory considerations
 - Delivery model
 - Financial analysis, including detailed costs and potential funding options.
- Commence works to progress Manton Dam's return to service and AROWS to minimise timeframes post completion of the DBC, including:
 - Developing an Environmental Impact Statement (EIS)
 - Undertaking community and landowner consultation to ascertain community support for the Project
 - Investigations surrounding potential native title implications
 - Developing water allocations and licencing frameworks for the additional water supplied under the Project
 - Engaging with Infrastructure Australia to confirm ongoing support for the Project from Federal Government, including developing a Stage 2 (Options Analysis) submission.

In addition to progressing the DBC and associated activities for the preferred options, it is also recommended that the NT Government pursue further regulatory and reform initiatives. These initiatives could include:

- Implementing further demand management measures, building on the success of *Living Water Smart*, to ensure maximum value is obtained from any subsequent infrastructure investment.
- Implementing a water tariff that is based on full cost pricing principles across the PWC network to assist with the high per capita water use across residential, commercial and industrial, and government sectors.
 - This recommendation is in line with competition reform which has been undertaken across Australia since the 1990s. Full cost pricing is a central tenet of the competition policy reform agenda and has been reconfirmed as a component of the *National Water Initiative Pricing Principles* by the Australian Government's 2015 *Review of Competition Policy*.

Further investigation is required to manage the overuse of groundwater resources across the greater Darwin region. This Preliminary Assessment has noted the ongoing issues related to this overuse, however, this issue has been determined by the NT Government as beyond the remit of the AROWS project. To materially reduce this overuse, a significant and potentially Territory wide reform program is required. This is a complex task which can be undertaken alongside other water supply and demand initiatives. These will likely include initiatives such as legislative reform to limit extraction from groundwater resources, introduce more stringent licensing requirements, and mandate metering at every bore, and further studies to increase the confidence of estimates of sustainable extraction and use of ground water resources

The DBC will provide analyse the two shortlisted options and provide clear direction for the Northern Territory Government to ensure that the future population and economic growth for the greater Darwin region is enabled.

12 Detailed Business Case Implementation Plan

12.1 Introduction

This chapter details how the DBC will be developed and delivered during the next phase of analysis for the AROWS Project, pending endorsement and approval from the NT Government to progress. This chapter provides a plan for the development of the DBC, including:

- Delivering the scope
- Governance structures
- Resource requirements
- Project timeframe.

12.2 Delivering the scope

The purpose of the DBC phase is to provide sufficient information to allow the NT Government to make a fully informed investment decision for the Reference Project. The DBC will undertake a more detailed analysis of the Project's economic benefits, costs, design, financial considerations and other impacts identified during the Preliminary Analysis, to determine overall viability of the Project and if there is an infrastructure solution that can achieve the service requirements and provide optimum value for money outcomes.

The DBC phase will be informed by further stakeholder consultation and market sounding processes. The DBC development process is guided by the best practice assessment frameworks from other Australian jurisdictions. The DBC recommendations, if accepted, will form the basis of the project that will progress to procurement, and guide the project's development and implementation parameters.

The key activities that will be undertaken during the DBC phase include:

- Re-confirming the service need and outcomes sought
- Confirming, and then conducting, a detailed analysis of the preferred option, including environmental assessment
- Developing risk adjusted cost estimates
- Investigating in detail the delivery models for the project and providing recommendations
- Financial and economic analyses to provide an indication of the viability and affordability of the proposed solution
- Describing indicative/potential funding arrangements
- Developing a project implementation plan, based on the recommendations
- Assurance processes aligning with the applicable assessment frameworks and approvals pathway.

The DBC requires the case for investment to be revisited, updated and expanded. During the DBC phase, the preferred option will be further developed to provide a high level of confidence in the project deliverability, cost and expected benefits.

It is expected that the reference design developed through the DBC will build on the work developed as part of the Preliminary Assessment, to further define technical and engineering requirements for the preferred option.

A greater level of analysis across financial, technical, risk, economic, regulatory, governance and delivery aspects of the project is required in the DBC to demonstrate its economic merits, its value for money outcomes and to ensure the proposed delivery team has the capability and capacity to implement all of the components of the project.

The DBC is intended to be a comprehensive document with full and complete descriptions of all project elements to support a robust investment decision. Key activities for the DBC phase have been categorised by work stream and are outlined in Section 12.3.5.

12.3 Governance framework

12.3.1 Governance overview

The intent of the project governance arrangements is to ensure that the DBC is developed in a manner which:

- Is consistent with government objectives and Preliminary Analysis recommendations
- Satisfies process and content requirements of the applicable project assessment frameworks
- Aligns with schedule, resourcing and budget parameters
- Recognises and response to stakeholder interests.

12.3.2 Governance arrangements

The DBC will continue under the governance structure that has been in place throughout the Preliminary Analysis, with the addition of a Project Working Group to provide strategic guidance and support. The role and members of the Project Working Group is outlined in Table 78. The arrangement recognises the key government sector stakeholders that have project leadership, assurance, assessment, interfacing, advisory or funding interests in the project. The project team will ensure these stakeholders remain well informed, and are able to provide feedback on DBC development, and respective interests are appropriately managed. Key stakeholders are listed in Table 77.

Table 77: Key stakeholders for the DBC

NT Government	Local Government	Other agencies
• DTBI • DIPL • Department of Chief Minister (DCM) • DENR • DTF • Department of Primary Industry and Resources (DPIR).	• City of Darwin. • Palmerston • Litchfield	• Infrastructure Australia • PWC • NT Land Corporation.

The key governance framework is described in the following sections.

12.3.3 Guidelines/assessment frameworks

The DBC will be prepared in accordance with the Infrastructure Australia Assessment Framework and relevant interstate guidance materials. These assessment guidelines and frameworks form the primary guidance material for the process and content requirements associated with DBC development.

12.3.4 Key governance groups

Table 78 describes the key governance groups expected for the DBC development phase.

Table 78: Key governance groups (DBC phase)

Governance group	Function in context of the DBC
Northern Territory Cabinet	The Cabinet considers matters with financial or budgetary implications for the government. It is anticipated that, subject to endorsement of the DBC by project governance groups and by the responsible Ministers, the DBC and associated recommendations would progress to Budget Review Subcommittee of Cabinet for consideration.

Governance group	Function in context of the DBC
CEO Steering Committee (DTBI, DIPL, DCM, DENR, DTF, DPIR, DOH, DLGCS)	The CEO Steering Committee is a body within the project governance structure which provides oversight for the project as required. Committee members, including key project stakeholders and decision makers, monitor project activity and provide direction and guidance to the project team and other stakeholders. The CEO Steering Committee for the Preliminary Analysis and DBC consist of CEOs from various agencies.
Project Working Group (DTBI, DIPL, DCM, DENR, DTF, DPIR, PWC)	The Project Working Group is proposed to consist of officer-level representatives from key government agencies who have an operation-related interface with the project. It is aimed to ensure project information is available to these stakeholders, interface/operational/related issues can be resolved in a timely manner and maintaining positive working relationships.

12.3.5 Discipline workstreams

The DBC activities and associated management and resourcing structure will be informed by the number of options carried forward to the DBC and will be built around key discipline workstreams reporting to members of the Project Working Group. These are groupings of DBC activities that align with specialisations for an infrastructure project of this nature.

It is envisaged that various sub-groups, as determined by the Project Manager and work stream leads, may be established to provide additional focus and/or further specific aspects of DBC development. The proposed work streams and key responsibilities are described in Table 79.

Table 79: DBC workstreams

DBC workstream	Description of key responsibilities
Project management	- Overarching responsibility for day-to-day management and development of DBC deliverables in accordance with relevant assessment frameworks - Oversight of external advisory engagements, probity environment (in consultation with probity advisor) - Liaising with government agency stakeholders - Coordinating DBC governance arrangements (and associated reporting), stakeholder review processes and assurance arrangements - Developing briefing documents and reports required for governance and project / reporting purposes - Providing strategic guidance in the development of DBC, associated processes and schedule priorities.
Business case management	- Developing DBC structure, and agreeing analysis methodology to ensure alignment with applicable assessment frameworks / agency stakeholder requirements - Reviewing and quality control of DBC deliverables - Coordinating the compilation, quality control and publishing of DBC chapters and appendices into a final DBC document.
Risk and project controls	- Managing expenditure against budget - Preparing an overarching schedule for the project in consultation with the project team and agency stakeholders, including reviews and updates to the schedule as required - Establishing reporting arrangements to monitor and control the performance of activities, including reporting as required by agency stakeholders and in relation to key performance indicators.
Engineering, design, constructability and cost	This work stream will undertake the technical analysis of all infrastructure required for the Project, covering investigations, calculations, modelling, analysis, drawing production

DBC workstream	Description of key responsibilities
	and review. It will cover engineering, constructability and cost estimating activities, including but not limited to: • Undertaking, evaluating and agreeing issues, constraints and actions, associated with the project, identifying critical investigations and decisions required to progress the design of the Project • Providing advice on Project design • Developing a program of studies and physical investigation works relating to the preferred option (including survey, GIS services, utilities investigations, geotechnical investigations) to support reference design development and construction planning • Developing a detailed construction program to reflect anticipated construction timing and any potential staging of the works • Preparing a cost estimates for inclusion in the DBC including capital cash flow forecasts, escalation assumptions and quantitative risk assessment and value engineering/value management activities • Identifying property and tenure requirements required to facilitate the project, updated as appropriate with design development • Engaging with key stakeholders that are likely to influence the outcome of the DBC to understand specific technical requirements and to ensure integration of the proposed solution.
Economics	• Designing and agreeing with DTBI the overall appraisal framework and identifying the required inputs • Confirming of Project options • Developing a benefit estimation process/framework • Undertaking a comprehensive evaluation of all the relevant financial, environmental and social costs and benefits associated with the Project, and calculation of the net present economic value.
Financial and commercial	• Developing a detailed financial model which will be used to assess the financial impact of the project including capital and operational cash flow implications, and funding/affordability considerations • Developing a project funding strategy • Considering delivery options and recommended project delivery strategy • Facilitating the non-technical/quantitative risk assessment process • Testing project options/sensitivity analysis.
Communications and stakeholder engagement	• Implementing the stakeholder engagement plan that includes: – detailed market sounding process that will inform delivery, economics and financial workstreams – consultation with Traditional Owners in the greater Darwin region as required – protocols to ensure a collaborative approach is taken to information sharing and engagement activities to align with key government strategic frameworks. • Informing and engaging /stakeholders on the activities of project development as required • Completing a Public Interest Assessment that identifies the potential impacts and benefits to the public of proceeding with the project.
Environmental and sustainability	• Describing the base environmental case • Identifying approvals required for the project, associated regulatory requirements and program implications • Developing of an environmental impact register to consider base environmental case and potential environmental impacts during construction and operation.

DBC workstream	Description of key responsibilities
	Undertaking a risk assessment to examine the impact register and determine significance of impacts and potential management or mitigation strategies, including costs.
Legal and regulatory	- Identifying relevant water resource regulatory frameworks, approvals and licenses required - Reviewing all aspects of relevant planning and environmental approvals.

12.4 Resource requirements

The DBC will be completed by the integrated project team, which include various specialist resources that have been procured prior to the Preliminary Analysis phase. The management of interface risks will be undertaken by PwC as the engagement lead. PwC is best placed to maintain focus, manage risks and reduce the potential for sub-standard outputs, unwarranted scope change or budgetary impacts. This approach also provides a single point of contact to enhance efficiency and optimise the functioning of the integrated project team.

The scope of deliverables will be re-confirmed at the commencement of the DBC process and will be described in the agreed DBC document outline and advisory engagement scope.

12.5 Project timeframe

A high-level program has been developed for the DBC phase which describes the key DBC activities. It is envisaged that this program will be expanded to include additional detail (in consultation with DTBI, key Territory stakeholders and advisors) prior to commencement of the DBC phase.

The strategic program for the DBC phase is shown in Figure 72.

	July - Dec 2020						Jan - Jun 2021					
	01/07	01/08	01/09	01/10	01/11	01/12	01/01	01/02	01/03	01/04	01/05	01/06
Detailed Business Case (Indicative timeframes)												
Strategic Alignment and Context												
Legal and Regulatory												
Market Sounding												
Public Interest												
Cost estimates												
Social, Environmental and Economic Assessment												
Financial and Commercial Assessment												
Delivery Model Assessment												
Conclusions and Recommendations												
DTBI review and one round of updates												
Detailed Business Case - Final Report												

Figure 72: DBC indicative timeframes

12.6 Summary

A governance structure for the DBC phase of the project has been proposed which reflects a similar structure to the one established for the Preliminary Assessment and recognises the importance of effective and clearly articulated DBC leadership, and close liaison with key government agency stakeholders through various governance forums. The governance structure can be implemented throughout the procurement and delivery phases for the Project.

Initial resource requirements and associated arrangements have been identified. Current timeframes require the DBC to be delivered over an estimated 12-month period, extending from the start of Q3 2020 with completion of the DBC at the end of Q2 2021.

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